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WAR DEPARTMENT TECHNICAL MANUAL TM 5-1168

U.S. Dept. of Army

CRANE, CRAWLER-MOUNTED,

GASOLINE, ¾-CU. YD.,

WITH ATTACHMENTS,

KOEHRING, MODEL 304

★

MAINTENANCE INSTRUCTIONS AND PARTS CATALOG

WAR DEPARTMENT • DECEMBER 1943

WAR DEPARTMENT
Washington 25, D. C. (December 8, 1943)

TM5-1168 Maintenance Manual and Parts Catalog, Crane, Crawler-Mounted, Model 304, is published for the information and guidance of all concerned.

[A. G. 300.7 (Dec. 8, 1943)]

By Order of The Secretary of War:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:
J. A. ULIO,
Major General,
The Adjutant General.

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OPERATION
AND
MAINTENANCE MANUAL
AND
PARTS CATALOG

MODEL 304
KOEHRING EXCAVATOR

P. O. NUMBER	SERIAL NUMBERS	ENGINE SERIAL NUMBERS
C-3688	2855 THRU 3054	LOWEST — 252415 HIGHEST — 265846

U. S. REGISTRATION NUMBERS — 969238 THRU 969437

MANUFACTURED FOR CORPS OF ENGINEERS

KOEHRING COMPANY
3026 WEST CONCORDIA AVE.

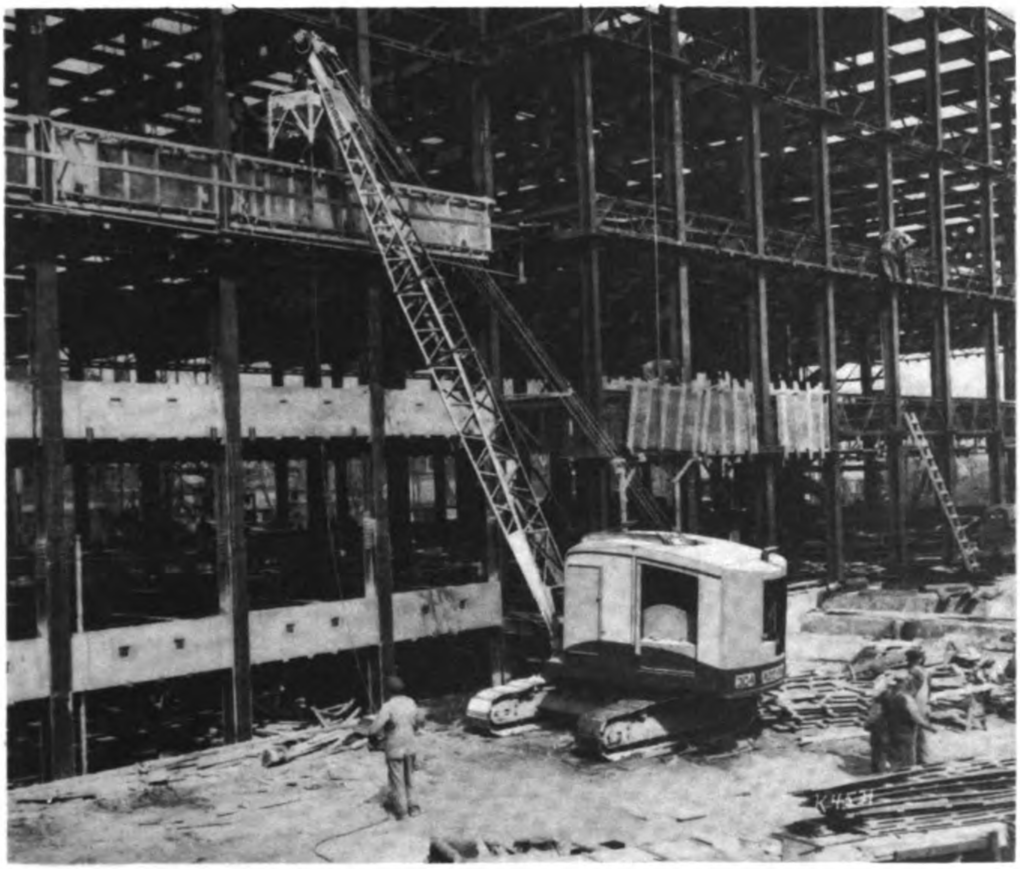
MILWAUKEE 10, — WISCONSIN

INDEX OPERATION SECTION

INDEX MAINTENANCE SECTION

INDEX PARTS SECTION

KOEHRING MODEL 304 LIFTING CRANE



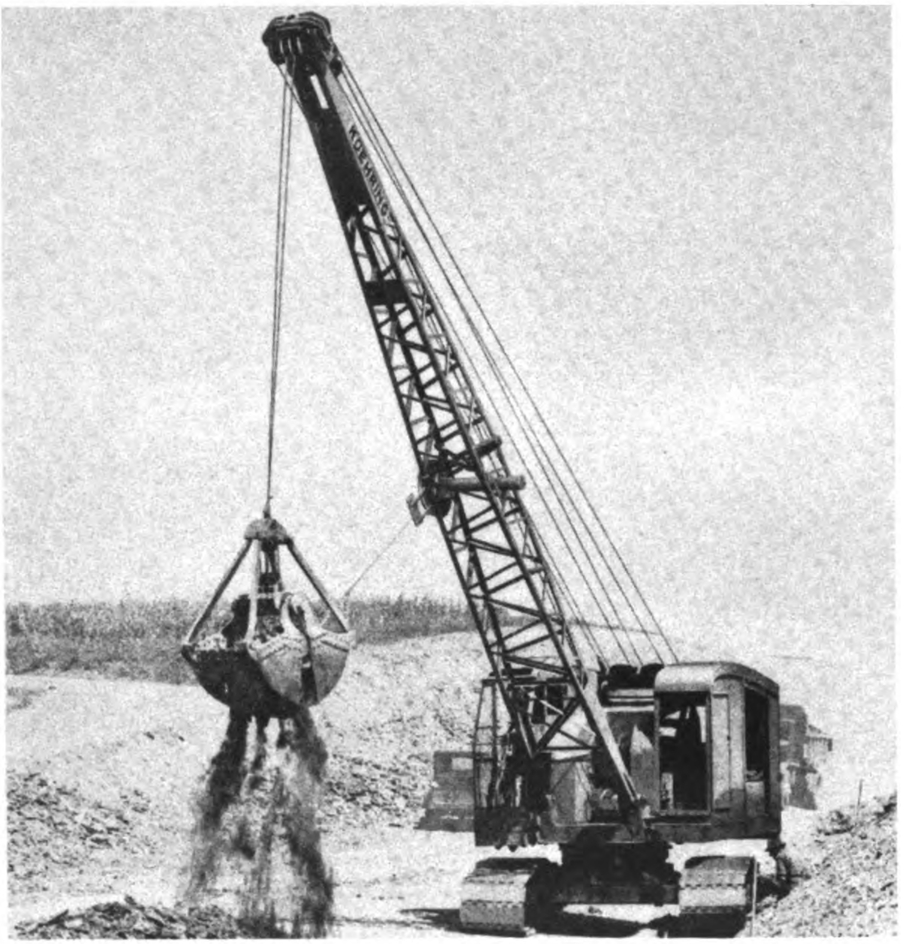
GENERAL DESCRIPTION

The Koehring Model 304 Lifting Crane may be operated with a single line, two part line or three part line of hoisting cable. (For the reeving of cable to meet these three classifications see pages 81 and 82.) Lifting Crane capacities as shown on page 28 are based on normal line speeds and line pulls for average Lifting Crane work. For loads between 18,000 lbs. and 12,000 lbs., a three part line should be used. For loads between 12,000 lbs. and 6,000 lbs., a two part line should be used. For loads of 6,000 lbs. and under, use a single part line. A three part line reduces hoist speed and line load two-thirds - a two part line, one half. Loads on hoist drum, hoist clutch and hoist brake are reduced proportionately. In computing lifting capacities, the weight of the hook block (250 lbs.) must be added to the load. Koehring Cranes are so designed that loads may be lowered against the gears to assist in careful handling of loads. This is accomplished by disengaging the engine clutch, engaging the hoist clutch and releasing the brake slightly. This rotates the gears backward and retards the movement of the load. (For Lifting Crane lever operation, see Working Operations for Hoisting and Lowering a Load, Page 58).

GENERAL USE

Lifting Cranes are used for unloading steel from carriers; placing steel in the construction of bridges, buildings, ships, etc.; lifting concrete buckets; and material handling at warehouses, supply yards, factories, shipyards, docks, etc.

KOEHRING MODEL 304 CLAMSHELL CRANE



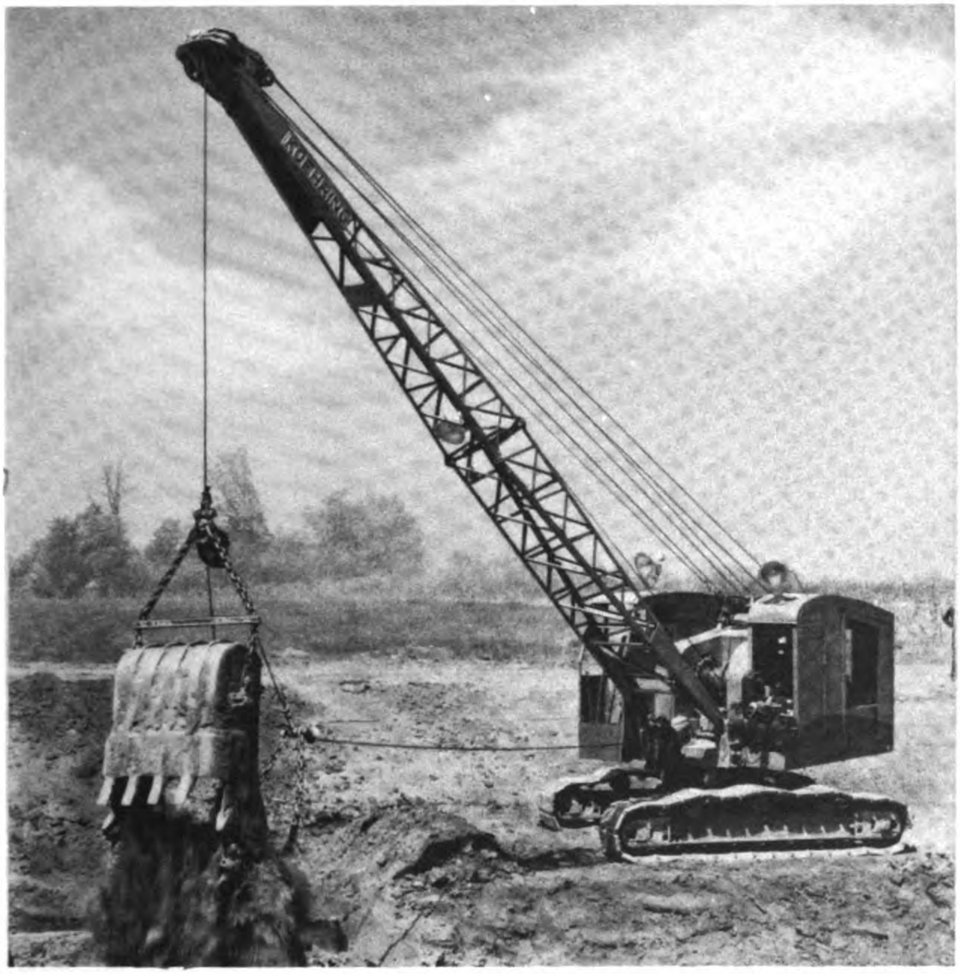
GENERAL DESCRIPTION

The Clamshell Crane is similar in every way to the Lifting crane except that it is used for excavating or material handling with a clamshell bucket and is equipped with a tagline cable to prevent the bucket from rotating or twisting the cables. (See page 83.) A clamshell bucket may be equipped with teeth for new excavation work in pits, trenches, foundations and under water. Buckets also are used without teeth for rehandling material or loading from stock piles. A clamshell bucket is operated by two cables, reeved as described on page 83. Both drum laggings are of the same diameter thus winding both cables at the same speed. The holding line lifts and holds the loaded bucket suspended. The closing line controls the closing and opening of the bucket. For smooth clamshell operation, the closing line drum clutch (right hand) should be adjusted just tight enough to close the bucket with a full load and then start slipping. The holding line drum clutch (left hand) should be adjusted tight enough to lift the bucket and load without slipping. (For working ranges see Pages 28, 29, 30 and 31.

GENERAL USE

Clamshell Cranes are used for excavation work in subways, buildings, sand and gravel pits, drainage and irrigation ditches - for stock piling and material handling.

KOEHRING MODEL 304 DRAGLINE



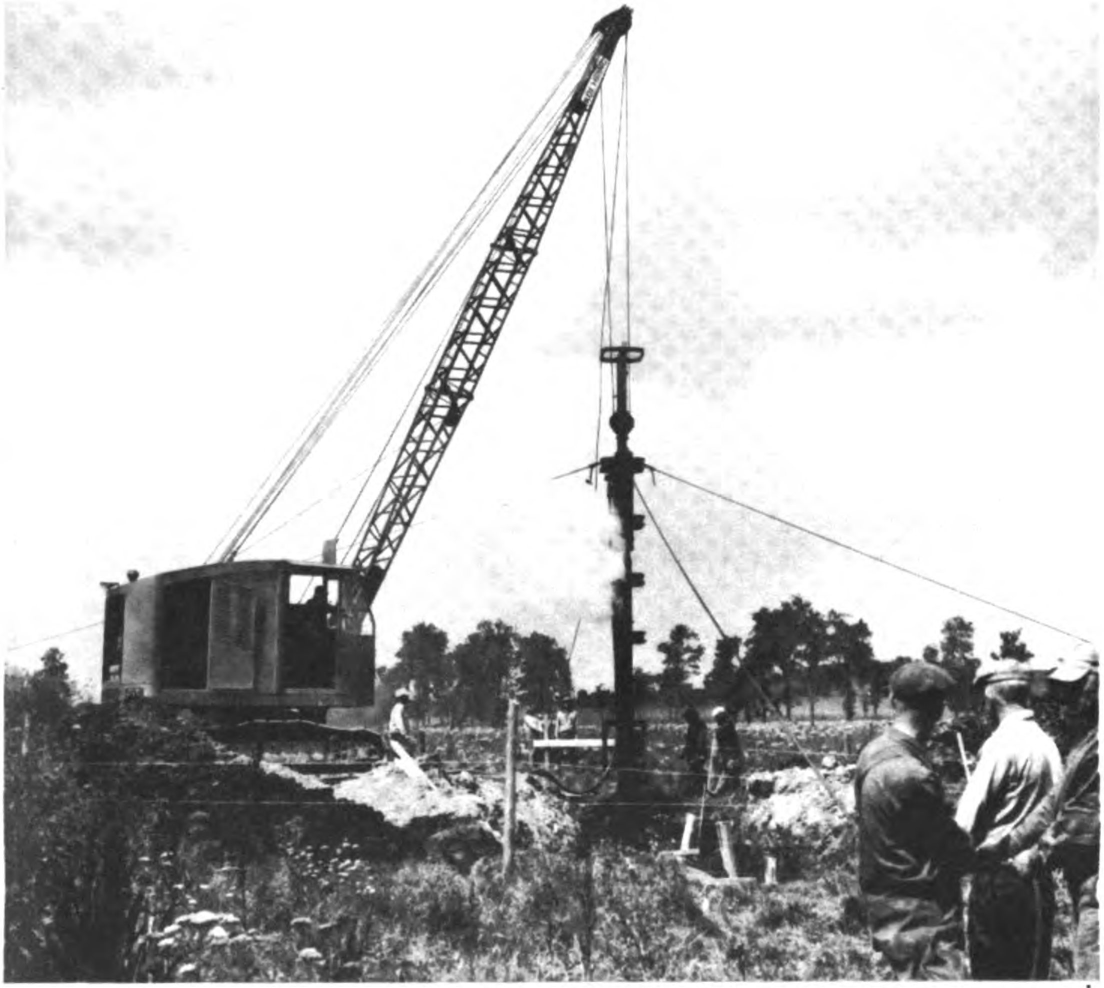
GENERAL DESCRIPTION

The dragline is similar to a Lifting Crane except that it is equipped with a fairlead (Figure 78, Page 99), used as a drag cable guide to the drag drum; with smaller lagging on the right hand or drag drum (Figure 74, Page 95), and a dragline bucket for excavating. The dragline bucket is operated by two cables, which are reeved as described on Page 82. The hoist line lifts and holds the loaded bucket suspended and controls the digging depth. The teeth of the bucket penetrate for digging as the drag cable drags the bucket towards the machine over the material being excavated. It also balances the loaded bucket while being hoisted. The dragline excavates material from a depth below the ground level of the machine. It can dig to varying depths, depending upon the length and angle of the boom, the nature of the material and the skill of the operator. It can deposit excavated material on either side or back of the machine or load into hauling conveyances. (For working ranges, see Page 33.)

GENERAL USE

Draglines are used for digging and cleaning ditches, building dikes and levees, stripping mines and gravel pits, placer mining or excavating.

KOEHRING MODEL 304 PILE DRIVER



GENERAL DESCRIPTION

The Pile Driver is similar in every way to a Lifting Crane except that it is equipped with a structural steel frame of either the stationary or swinging type known as leads which guide the hammer up and down for the pile driving operation. Stationary leads are attached to the boom point and are raised or lowered by raising or lowering the boom. Swinging leads are suspended from the boom point by a cable operated by one of the hoist drums on the machine. Two types of hammers are the drop hammer and the steam hammer. The drop hammer is lifted and dropped on the piling. The steam hammer is placed on top of the piling and operated by steam led to it through a hose from an outside source. Each type of hammer is suspended on a cable leading from one of the hoist drums over the boom point sheave to the hammer.

GENERAL USE

Pile Drivers are used for driving piling for bridges, bridge piers and building foundations. They are also used for driving sheeting or piling around excavations to keep the sides from caving.

KOEHRING MODEL 304 SHOVEL

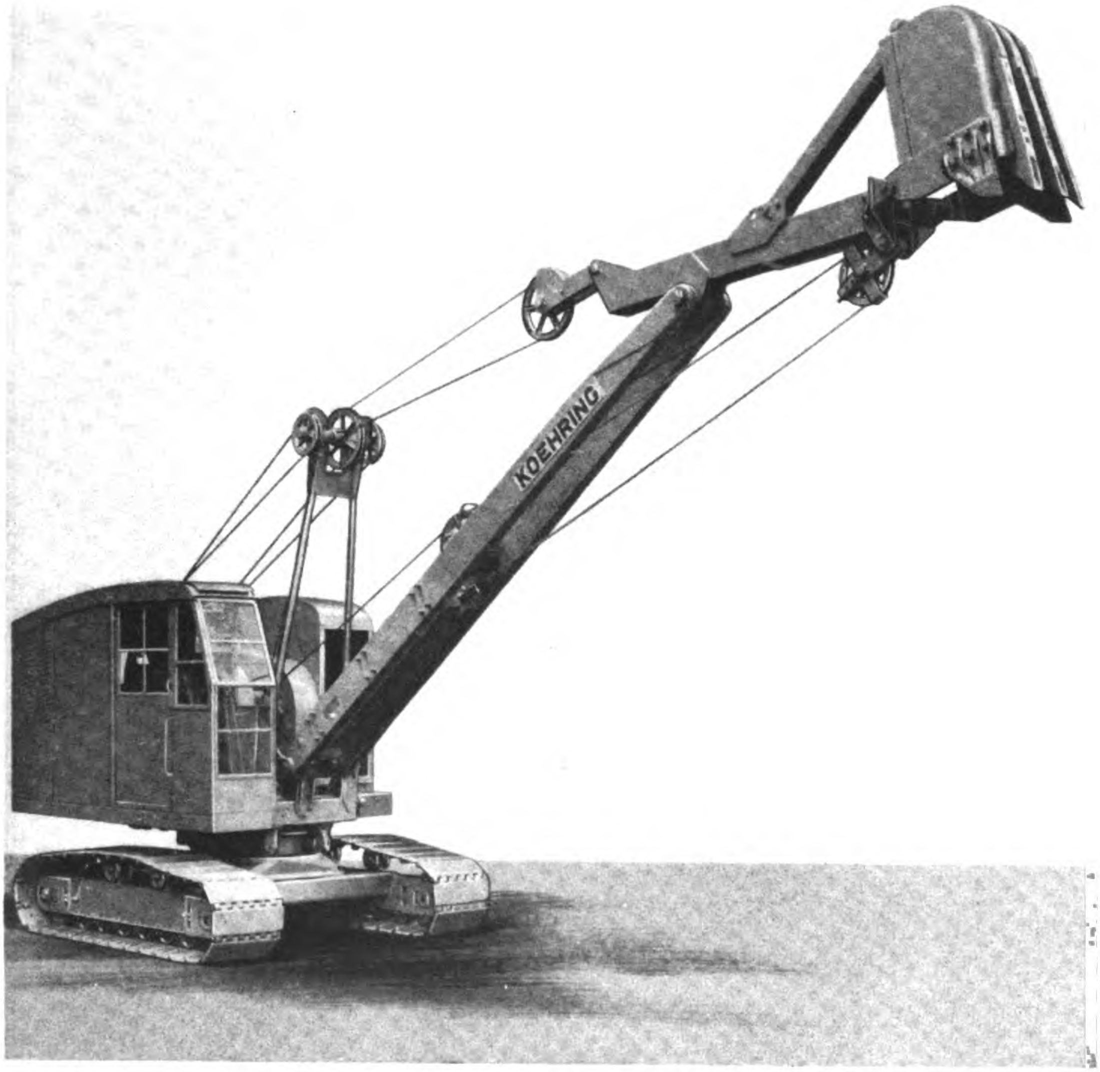
GENERAL DESCRIPTION

The Shovel is designed especially for excavating purposes and is equipped with an attachment consisting of boom, dipper sticks and dipper. A tapered drum lagging for operation of the dipper hoist cable is mounted on the left end of the hoist drum shaft as in Figure 72, Page 95. On the right end of the same shaft a split drive sprocket for the operation of the crowd chain is mounted. Although the particular function of a shovel is to dig from ground level up to the maximum digging height of the dipper, it may be used for digging shallow trenches below ground level and between the crawlers. Because of the accuracy and speed with which the dipper can be controlled, a power shovel is ideal for loading the material it digs into trucks, wagons or other conveyances. (See Page 35 for working ranges.)

GENERAL USE

Shovels are used for digging and loading rock, earth and ore on highway, general construction and mining work.

KOEHRING MODEL 304 PULL SHOVEL



GENERAL DESCRIPTION

The Pull Shovel combines some of the features of a dragline and a Shovel. The pull shovel digs as the dipper is pulled toward the machine like a dragline bucket and can be controlled with the same speed and accuracy as a shovel dipper. The main drum laggings are of the same size as those used in dragline crane service. A pin-connected gib frame at the front of the machine supports the cable sheaves employed in the boom and dipper raising and lowering operations. The boom and dipper handle are rigid members. This design of machine permits deep digging below ground level. (See Page 36 for working ranges).

GENERAL USE

Pull Shovels are used for trench digging for sewer lines and conduit, basements and foundations.

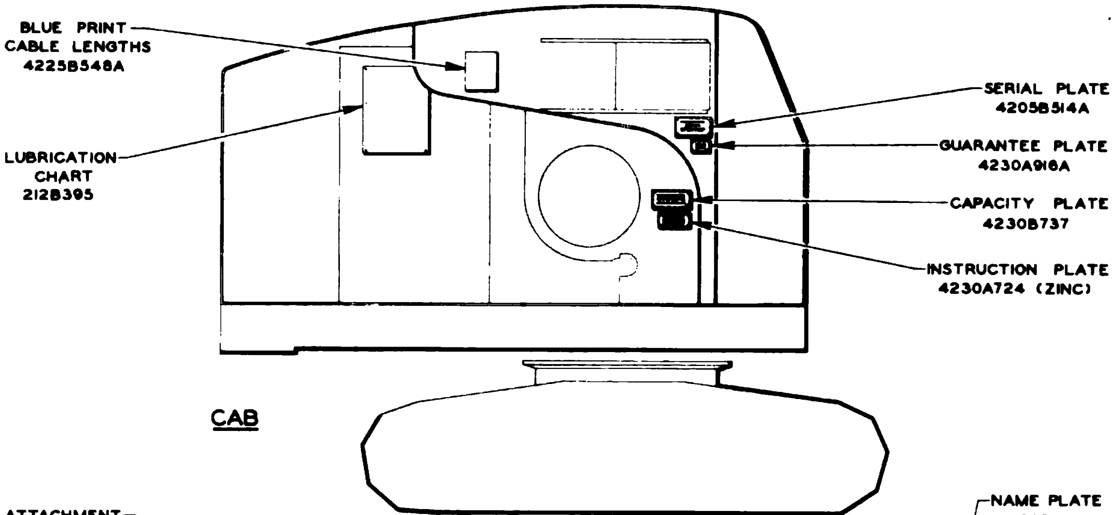
GENERAL DESCRIPTION

The Koehring Model 304 Lifting Crane is commonly known as a "combination" machine. With the exception of a few minor machinery changes in some instances, only the booms need to be changed to meet the requirements of various types of operations. All conversions are powered by the same engine. With the exception of the shovel assembly, which requires one extra lever, no changes are made in the operating levers of the various units. The operator's seat is mounted near the front on the right corner of turntable or deck where levers controlling all movements of the machine are within easy reach of the operator. Large windows at front, top and sides afford the operator a vision range of more than 180 degrees and at the same time protect him from the elements. As illustrated in the preceding pages and as described at various points throughout this manual, travel of the machine is accomplished by two endless crawlers made up of crawler shoes linked together by pins and driven over drive sprockets and idler rollers. NOTE: "Right hand side" or "left hand side" of the machine or any part of either side - as frequently referred to in this manual - means the right hand or left hand side when viewing the machine from the rear.

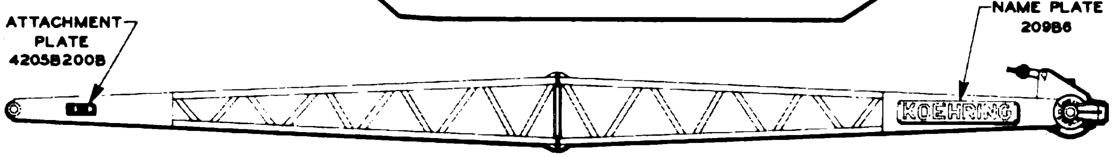
IDENTIFICATION AND ADDRESSES OF MANUFACTURERS OF ACCESSORIES AND EQUIPMENT USED ON KOEHRING MODEL 304 EXCAVATOR.

BUDA MODEL K-428 GASOLINE ENGINE	The Buda Company, Harvey, Illinois
TWIN DISC MODEL X7350A ENGINE CLUTCH	Twin Disc Clutch Co., Racine, Wisconsin
BOSCH MODEL MJC-6C, 102 MAGNETO	American Bosch Corp., Springfield, Mass.
ZENITH MODEL 456 CARBURETOR	Zenith Carburetor Div., Bendix Aviation Corp., Detroit, Michigan
AC MODEL 855758 FUEL PUMP	AC Division General Motors Corp., Flint, Michigan
DELUXE MODEL OIL FILTER	DeLuxe Products Corp., LaPorte, Indiana
DONALDSON MODEL E7764 AIR CLEANER	Donaldson Co., Inc., St. Paul, Minnesota
AUTO-LITE MODEL ML4186 STARTER	Electric Auto-Lite Co. Toledo, Ohio
AUTO-LITE MODEL GFA 4810-2 GENERATOR	Electric Auto-Lite Co. Toledo, Ohio
GLOBE MODEL V89 BATTERY	Globe Union Inc. , Milwaukee, Wisconsin
PIERCE MODEL K40504 GOVERNOR	Pierce Governor Co., Anderson, Indiana
KOHLER MODEL E1500W LIGHT PLANT	Kohler Company Kohler, Wisconsin

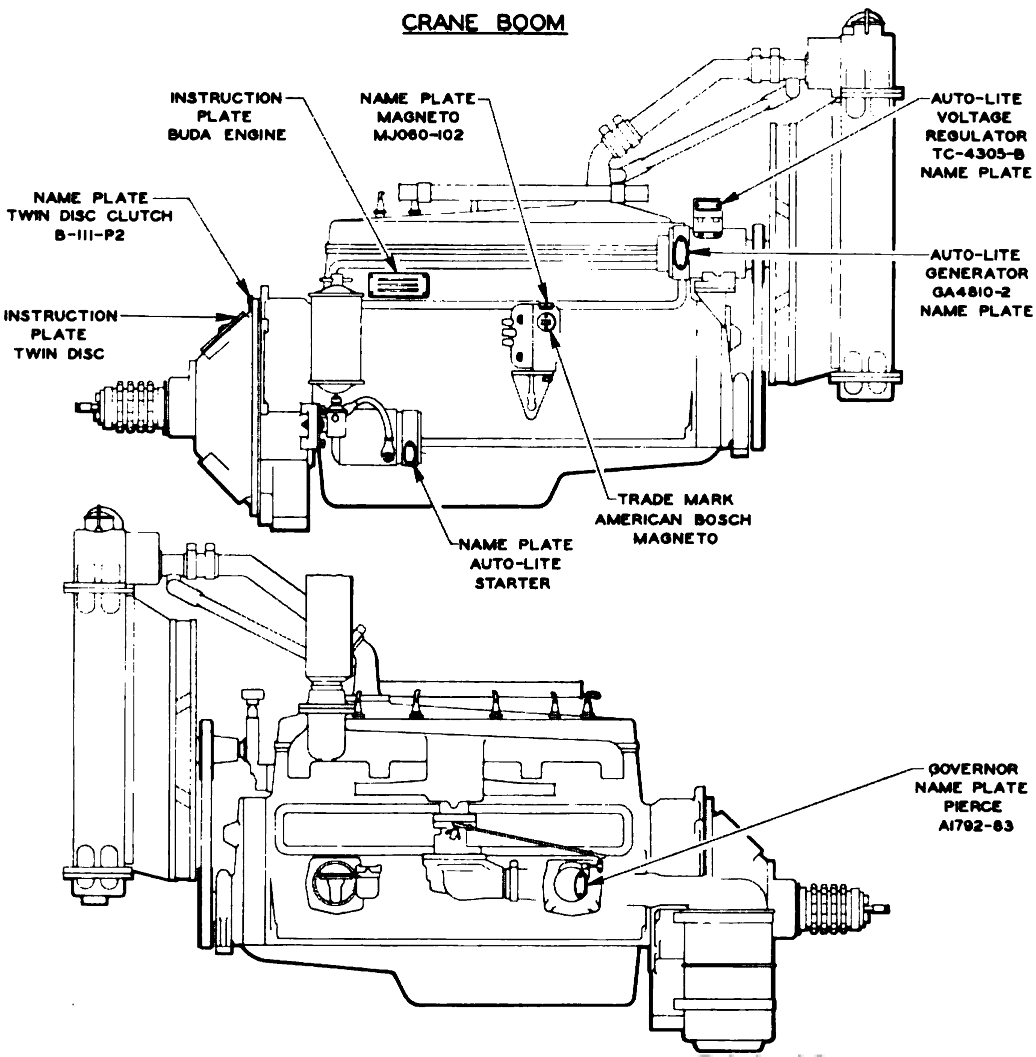
LOCATION OF NAME PLATES



CAB

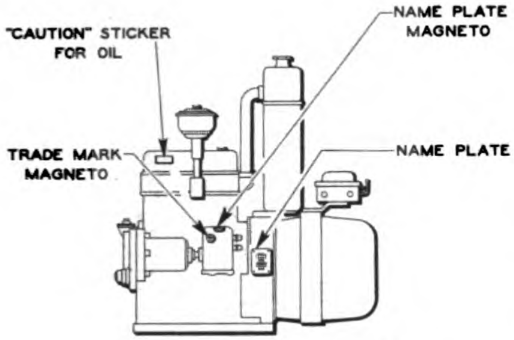


CRANE BOOM

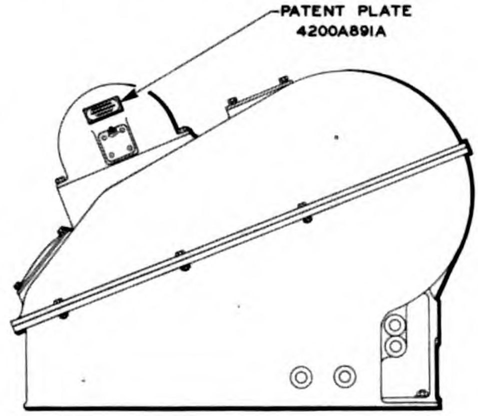


ENGINE

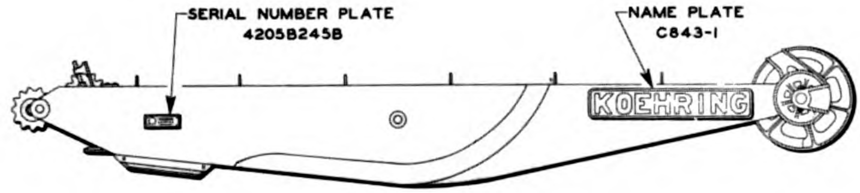
LOCATION OF NAME PLATES



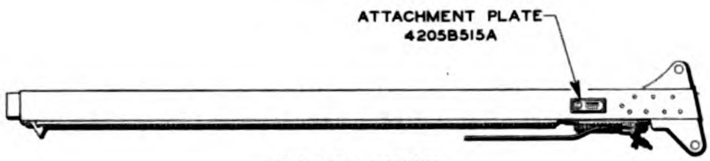
KOHLER LIGHT PLANT



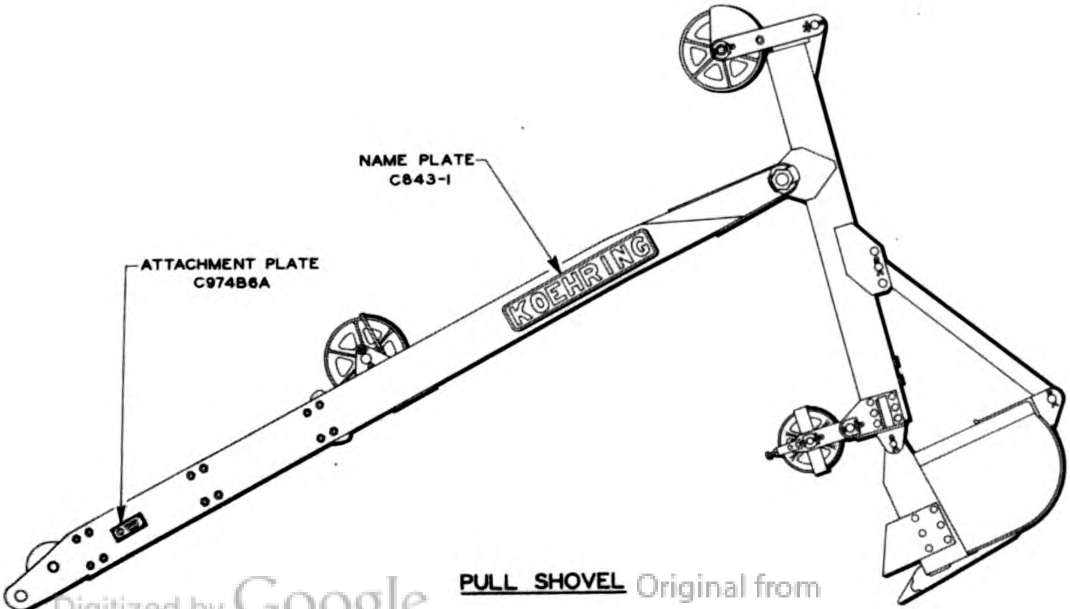
DIPPER TRIP



SHOVEL BOOM



DIPPER STICK



PULL SHOVEL

NAME PLATES


KOEHRING HEAVY DUTY
TRADE MARK
REG. U.S. PAT. OFF.
KOEHRING SHOVEL-CRANE-EXCAVATOR
KOEHRING COMPANY
MILWAUKEE, WIS., U.S.A.
SIZE
NO.
WEIGHT APPROX. TON
PATENT NUMBERS
RE18165 1676353 1770174 1861511 1947823 2233007
Des.102977 1681352 1783055 1865143 1954119 2237439
1609372 1700181 1783056 1883915 1969285 2260631
1639752 1717757 1796533 1909507 2011427 2266179
1659824 1731673 1797224 1917666 2055660 2308565
1662902 1739175 1797300 1928324 2121189
1665302 1751633 1803654 1933874 2186372
1668778 1758216
PATENTS PENDING
FOREIGN PATENTS PROCURED AND PENDING


KOEHRING HEAVY DUTY
TRADE MARK
REG. U.S. PAT. OFF.
42058515
KOEHRING SHOVEL DIPPER AND STICK
KOEHRING COMPANY
MILWAUKEE, WIS., U.S.A.
SIZE
SERIAL NO.
LENGTH FT. MAX. ALLOWABLE DIPPER YD.
PATENT NUMBERS
1917666 1609372 OTHER PATENTS PENDING
FOREIGN PATENTS PROCURED AND PENDING


KOEHRING HEAVY DUTY
TRADE MARK
REG. U.S. PAT. OFF.
42058245A
KOEHRING SHOVEL ATTACHMENT
KOEHRING COMPANY
MILWAUKEE, WIS., U.S.A.
SIZE
SERIAL NO.
KOEHRING COMPANY PATENT NUMBERS
1506906 1509295 1545545 1609372 2237439
1639752 1659824 1662902 1917666 2233007
PATENTS PENDING
FOREIGN PATENTS PROCURED AND PENDING


KOEHRING HEAVY DUTY
TRADE MARK
REG. U.S. PAT. OFF.
KOEHRING PULL SHOVEL
KOEHRING COMPANY
MILWAUKEE, WIS., U. S. A.
SIZE
SERIAL NO.
PATENT NUMBERS
1692452 1681282 1783055 1783056
PATENTS PENDING
FOREIGN PATENTS PROCURED AND PENDING

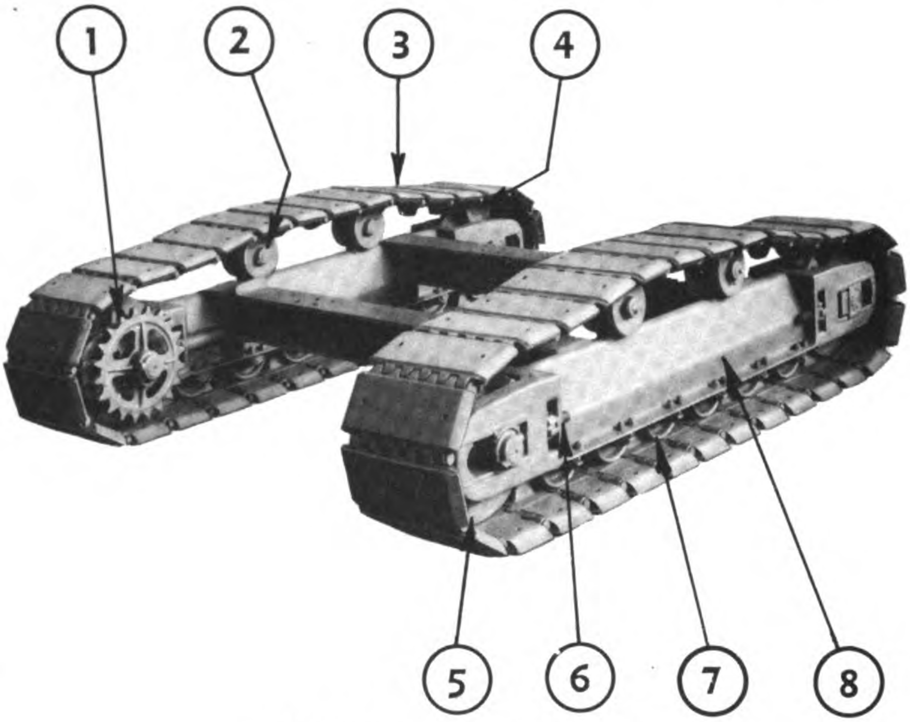

KOEHRING HEAVY DUTY
TRADE MARK
REG. U.S.
KOEHRING CRANE ATTACHMENT
KOEHRING COMPANY
MILWAUKEE, WIS., U. S. A.
SIZE
SERIAL NO.
PATENT NUMBERS
1836281-2308565
PATENTS PENDING
FOREIGN PATENTS PROCURED AND PENDING

OPERATION SECTION

INTRODUCTION

This manual, consisting of three sections (Operation, Maintenance and Parts), was prepared from the cumulative experiences of the Engineers who designed the Koehring Model 304 Excavator and the Field Service Engineers who have installed and serviced the machine in all parts of the world under every conceivable working condition. Every effort was made to present this valuable data simply and briefly without sacrificing completeness so that the inexperienced operator can easily and quickly absorb the information he needs to be efficient in his work. We urge you to study this manual carefully - it will pay you dividends later in the form of fewer troubles and better work. The experienced operator, too, will benefit by a careful study of all the material presented here because, in preparing it expressly for the inexperienced, we have uncovered and presented many important details not ordinarily found in manufacturers' bulletins and other literature on the same subject.

MACHINE COMPONENTS, ASSEMBLIES AND ACCESSORIES



KOEHRING CRAWLER

1—DRIVE SPROCKET
2—TOP CRAWLER ROLLER
3—CRAWLER BELT
4—FRONT TUMBLER
5—REAR TUMBLER
6—ADJUSTING BOLTS
7—BOTTOM CRAWLER ROLLER
8—CRAWLER FRAME

FIG. 1

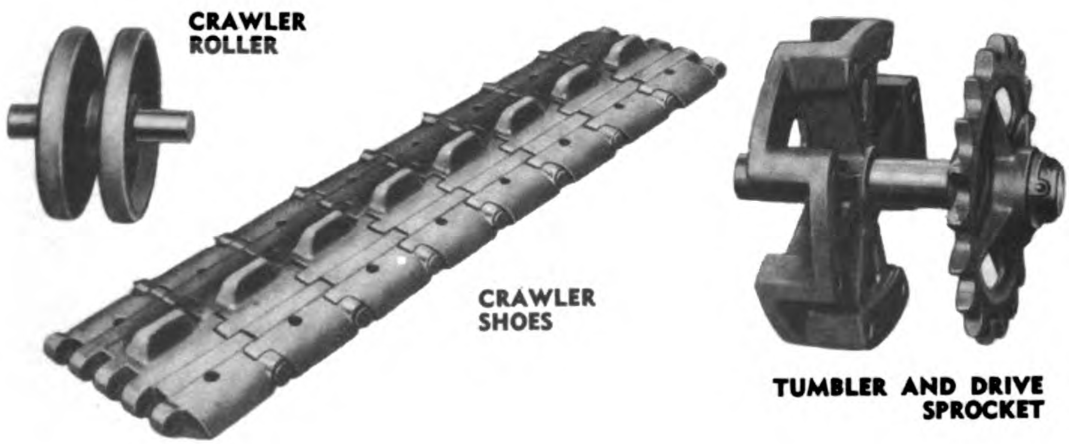
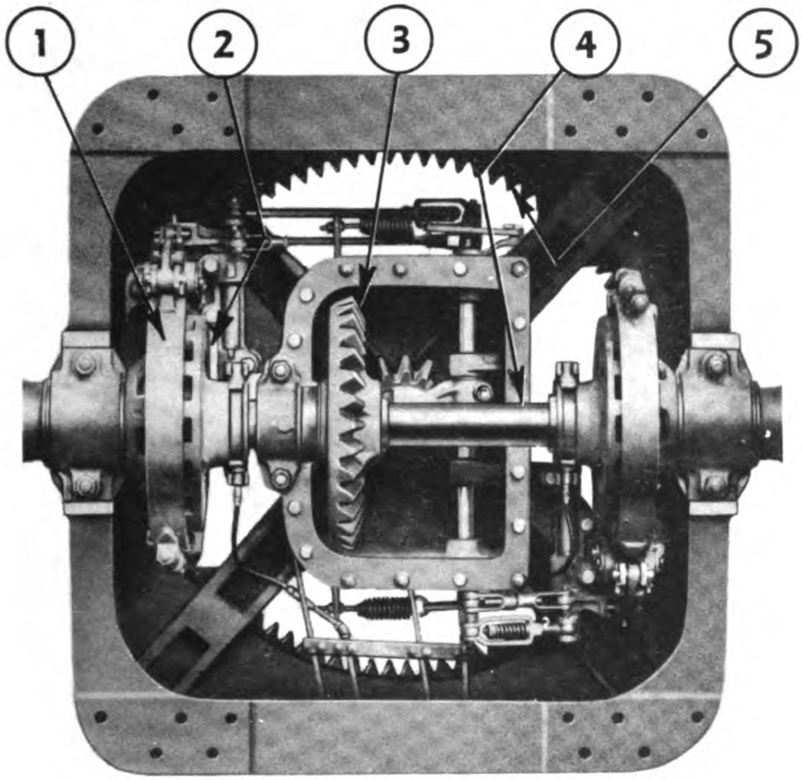


FIG. 2

MACHINE COMPONENTS, ASSEMBLIES AND ACCESSORIES



TRACTION SHAFT ASSEMBLY

1—TRACTION BRAKE
3—TRACTION BEVEL GEARS
2—TRACTION JAW CLUTCH
4—TRACTION SHAFT
5—SWING GEAR

FIG. 3

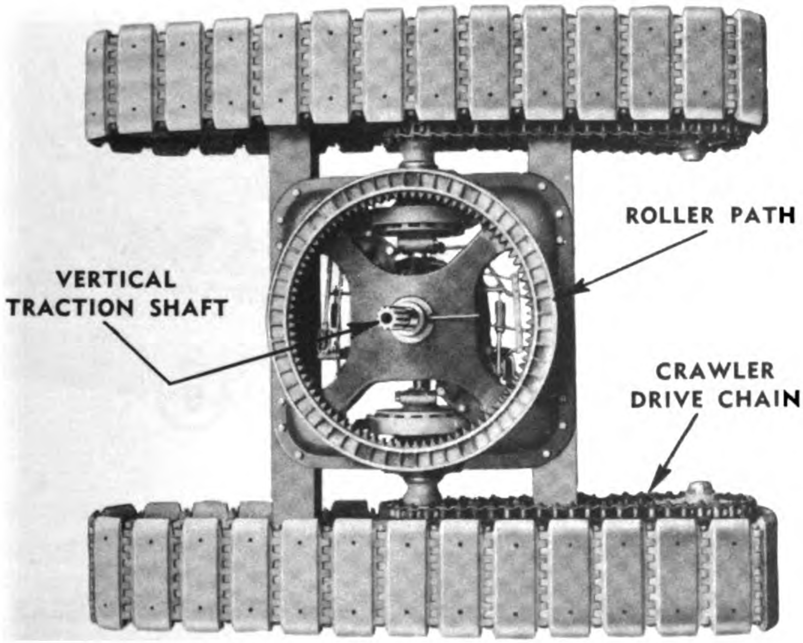


FIG. 4

MACHINE COMPONENTS, ASSEMBLIES AND ACCESSORIES

TURNTABLE ASSEMBLY

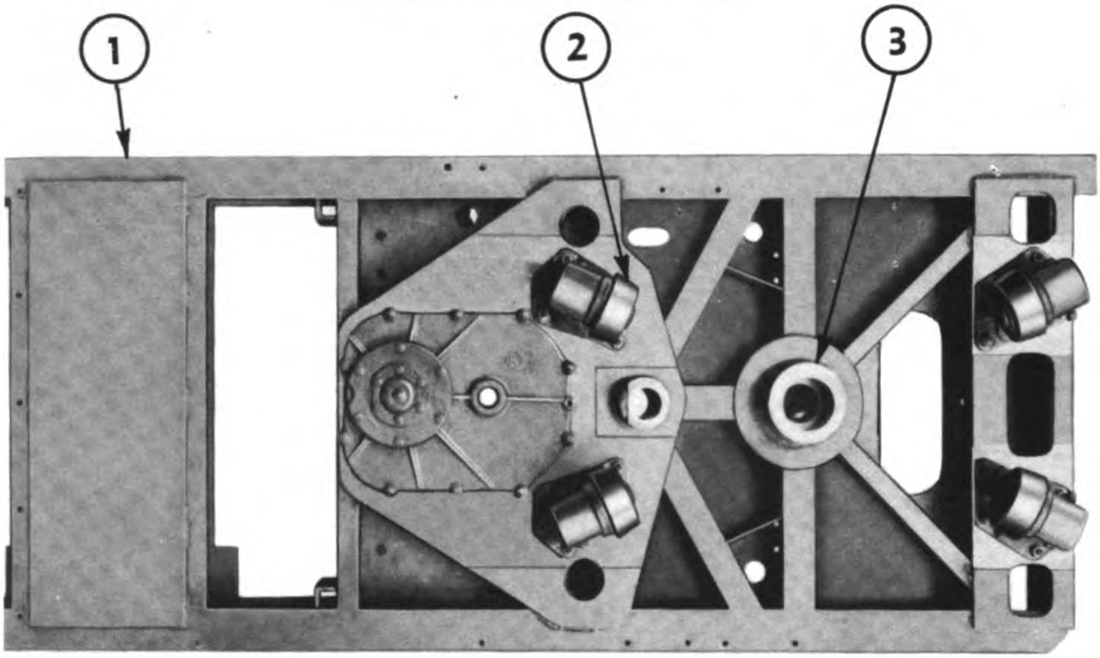


FIG. 5 BOTTOM VIEW

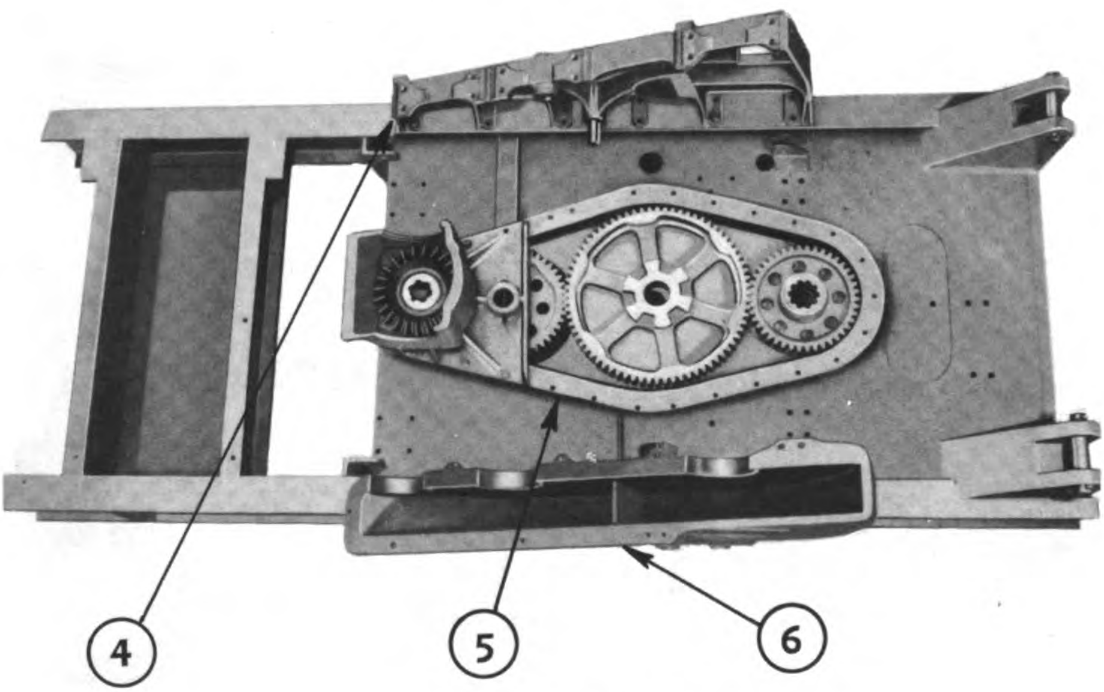


FIG. 6 TOP VIEW

1—TURNTABLE
2—TURNTABLE ROLLER
3—TURNTABLE PIVOT
4—SIDE STAND
5—UPPER TURNTABLE GEAR CASE
6—MAIN GEAR CASE

MACHINE COMPONENTS, ASSEMBLIES AND ACCESSORIES

OPERATING MACHINERY

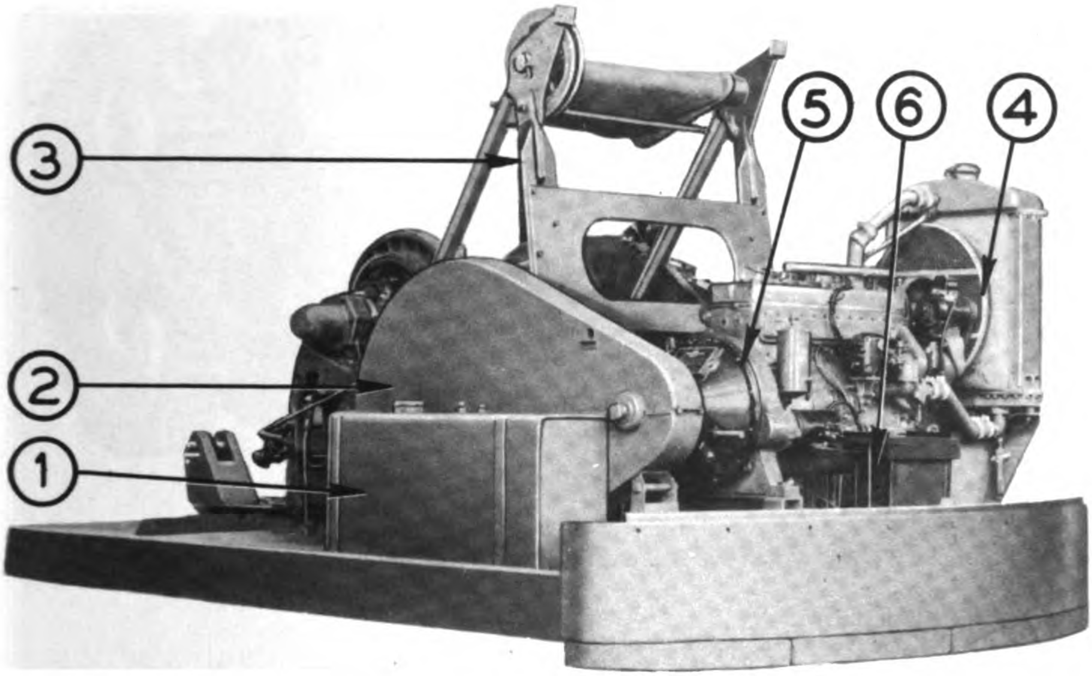


FIG. 7 REAR VIEW

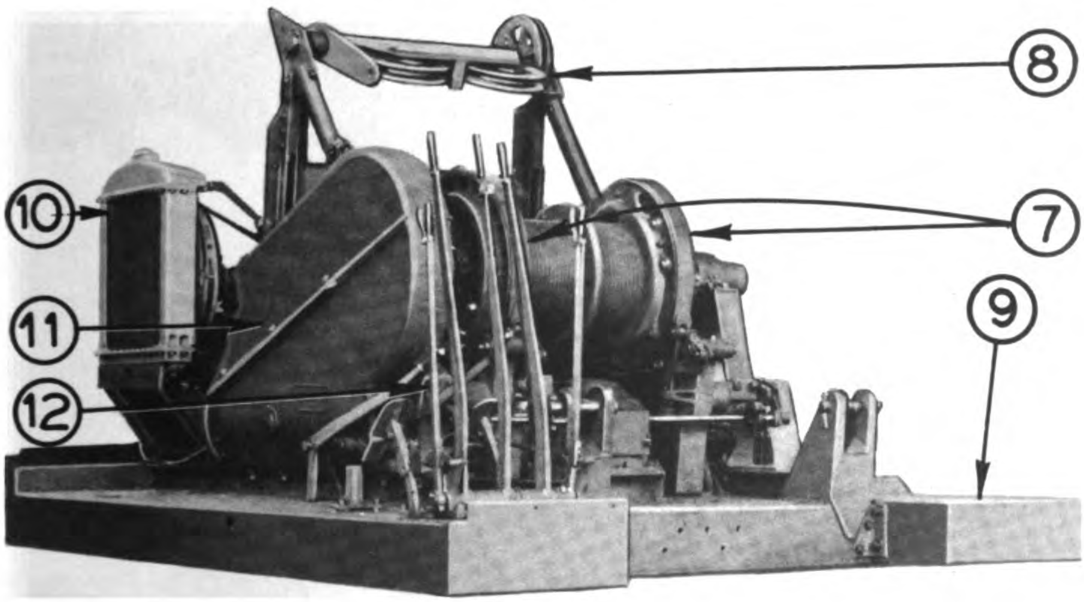


FIG. 8 FRONT VIEW

1—FUEL TANK
2—ENGINE DRIVE CHAIN CASE
3—"A" FRAME
4—ENGINE
5—ENGINE CLUTCH
6—BATTERY
7—DRUM CLUTCHES AND BRAKES
8—BOOM HOIST SHEAVES
9—TURNTABLE
10—RADIATOR
11—MAIN GEAR CASE
12—OPERATING LEVERS

MACHINE COMPONENTS, ASSEMBLIES AND ACCESSORIES
SHAFT ASSEMBLIES

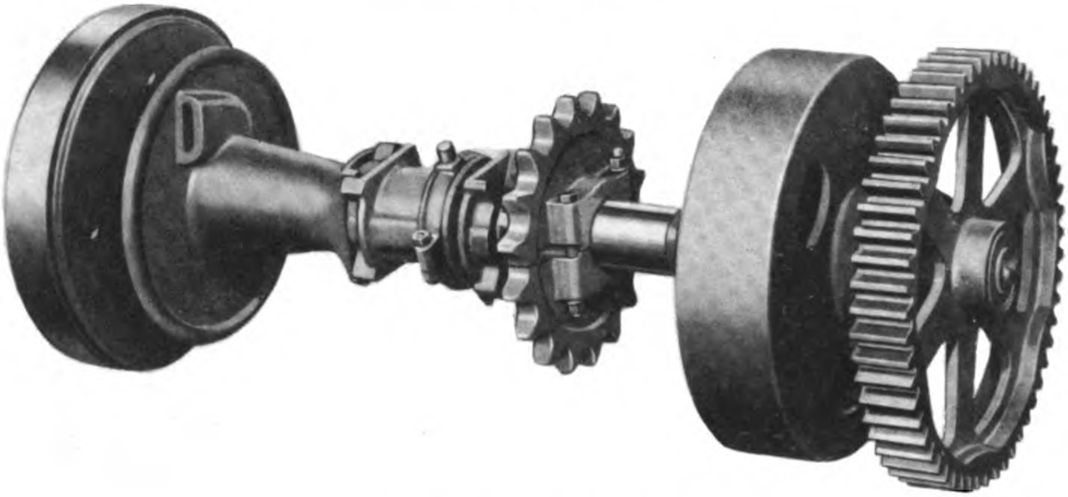


FIG. 9 BOOM HOIST

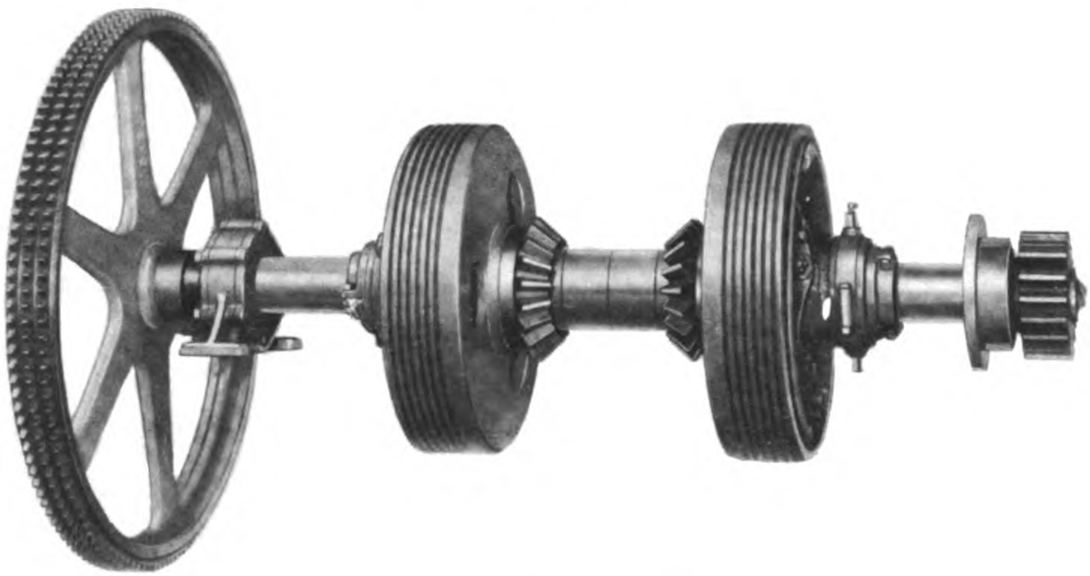


FIG. 10 SWING AND TRACTION

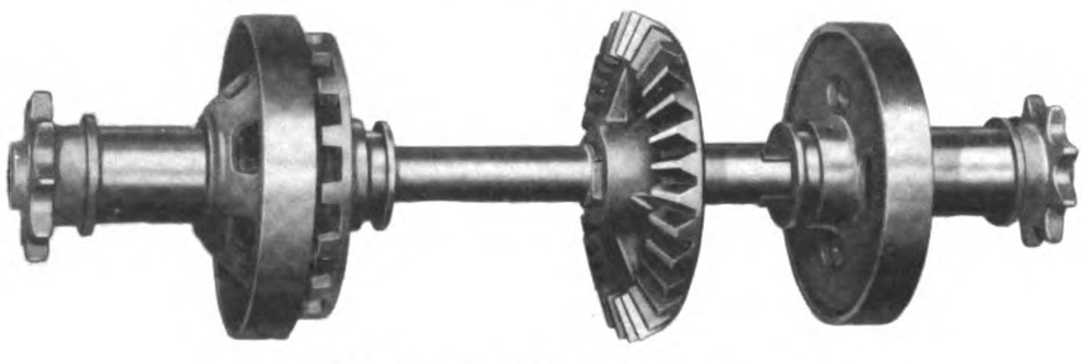


FIG. 11 LOWER TRACTION

MACHINE COMPONENTS, ASSEMBLIES AND ACCESSORIES

DRUM LAGGINGS

Various types and sizes of drum laggings are used for the various operating combinations to which the machine can be adapted. Illustrated below are the types of laggings used for the combinations indicated. Instructions for making all drum lagging changes are given under "Equipment Changes For Various Operations", (Page 96).

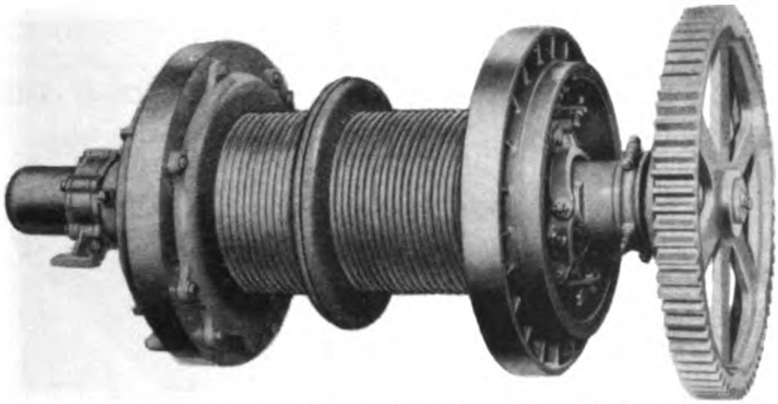


FIG. 12 CRANE, CLAMSHELL AND PILE DRIVER

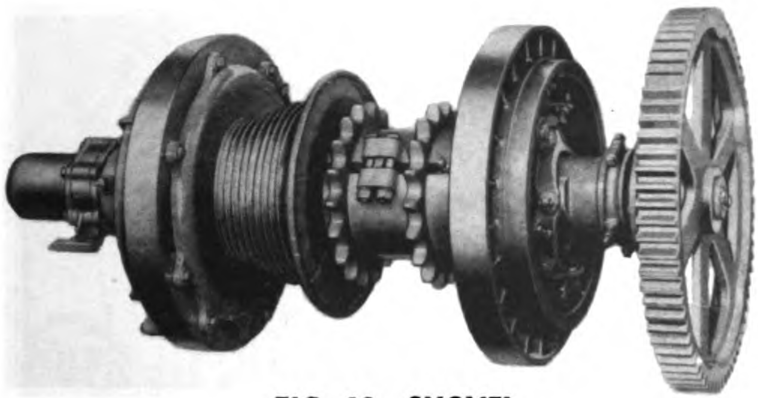


FIG. 13 SHOVEL

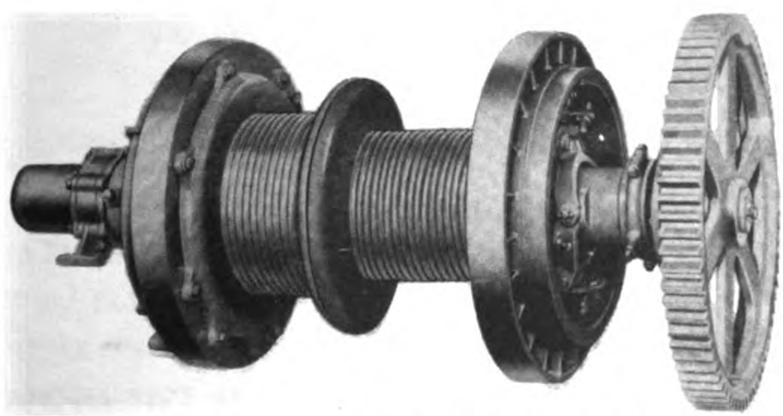
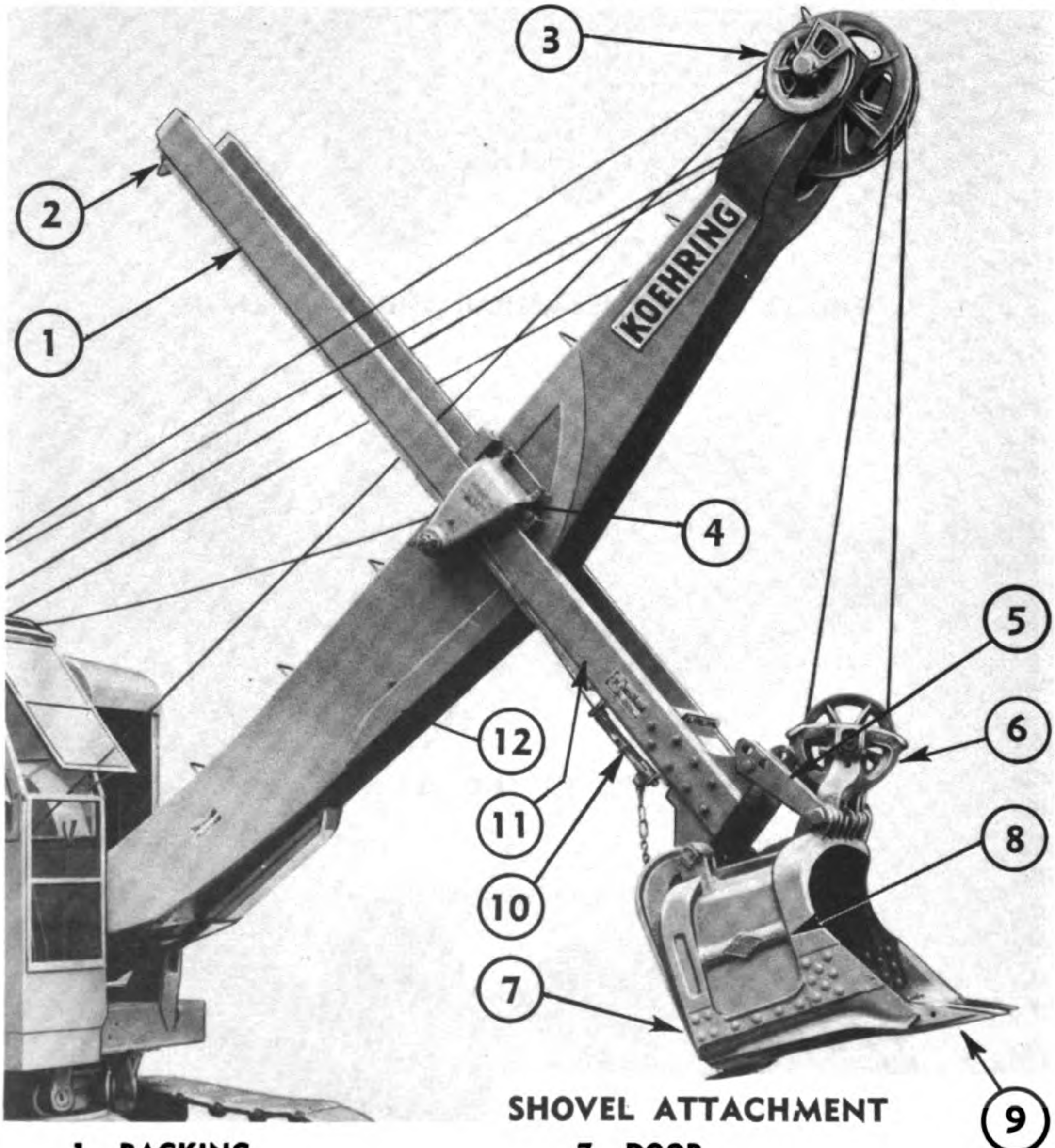


FIG. 14 DRAGLINE AND PULL SHOVEL

MACHINE COMPONENTS, ASSEMBLIES AND ACCESSORIES

FIG. 15 CRANE BOOM

1—BOOM FOOT 2—CABLE GUARD 3—POINT SHEAVES

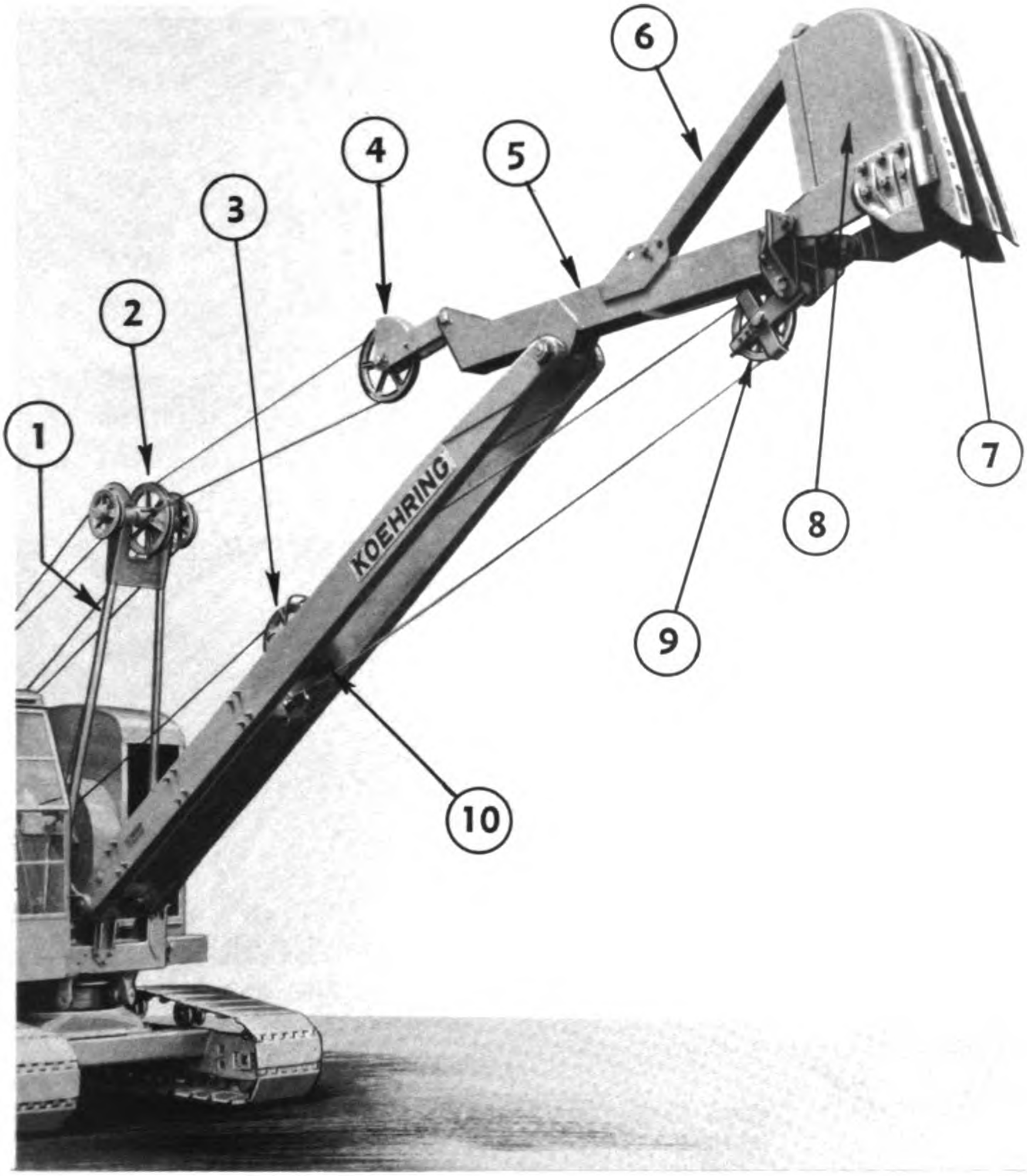


SHOVEL ATTACHMENT

1—RACKING
2—STOPS
3—POINT SHEAVES
4—SADDLE BLOCKS
5—DIPPER ANGLE BRACES
6—SHEAVE BLOCK
7—DOOR
8—DIPPER
9—TEETH
10—DIPPER TRIP MECHANISM
11—DIPPER STICKS
12—BOOM

FIG. 16

MACHINE COMPONENTS, ASSEMBLIES AND ACCESSORIES



PULL SHOVEL ATTACHMENT

1—JIB FRAME
2—JIB FRAME SHEAVES
3—BOOM FLEETING SHEAVE
4—DIPPER ARM SHEAVE
5—DIPPER ARM
6—DIPPER ANGLE BRACE
7—TEETH
8—DIPPER
9—DIPPER SHEAVE BLOCK
10—BOOM

FIG. 17

MACHINE COMPONENTS, ASSEMBLIES AND ACCESSORIES

AUXILIARY FRONT DRUM FOR PILE DRIVER

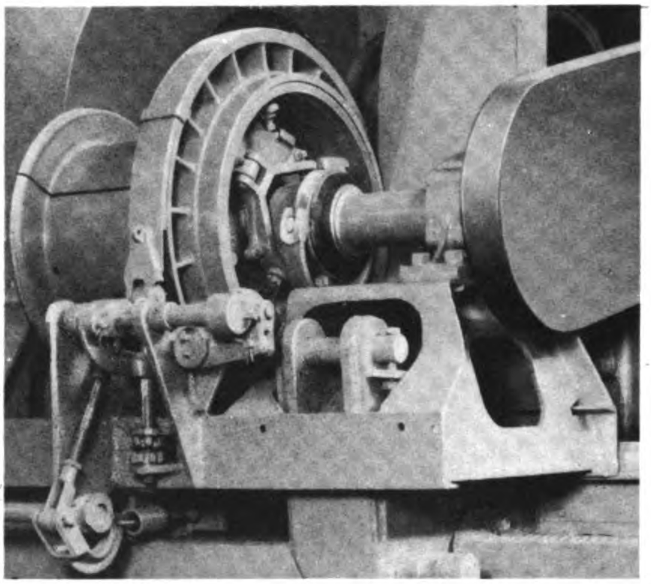


FIG. 18

DRAGLINE FAIRLEAD

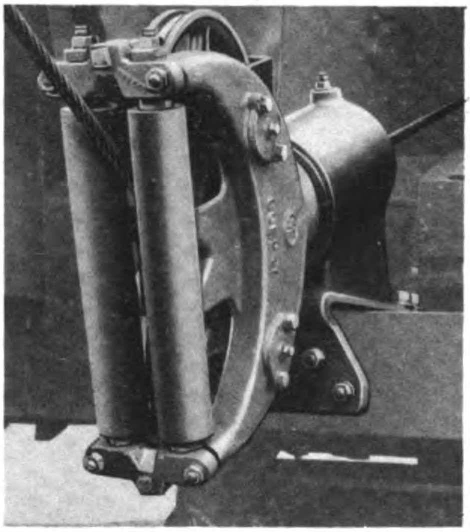


FIG. 19

TAGLINE FOR CLAMSHELL

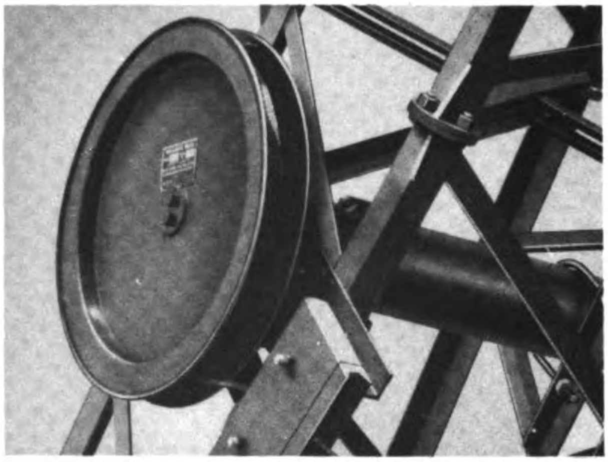


FIG. 20

BUDA GASOLINE ENGINE

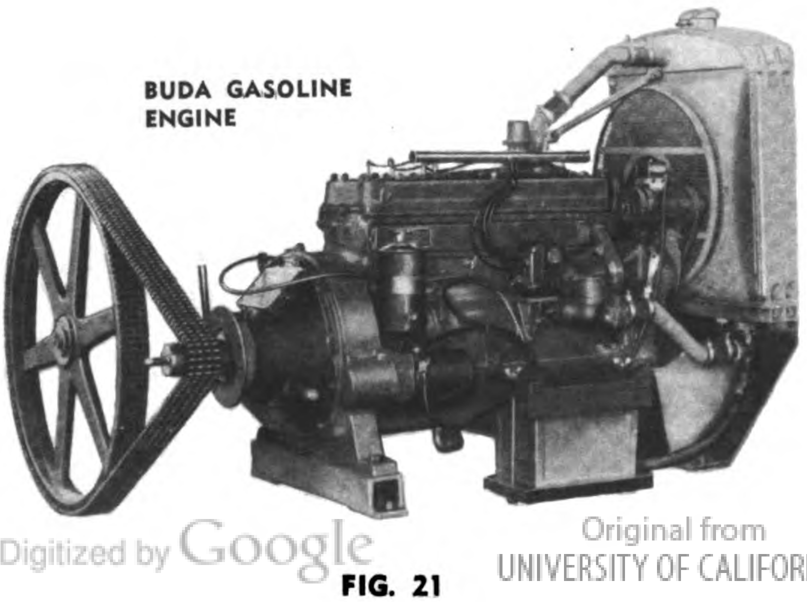


FIG. 21

MACHINE SPECIFICATIONS

Engine:

Buda, Model K-428 gasoline eng. 6 cyl., 4 3/8" bore, 4-3/4" stroke, 63 H.P. fully equipped with engine speed governed full load at 1350 R.P.M.

Engine clutch (Twin Disc) Model X7350A.

Magneto (Fixed spark) American Bosch Model MJC-6C,102.

Spark plugs - A.C. No. 87.

Spark plug gap - .025".

Firing order-1,5,3,6,2,4.

Valve Clearance (Engine hot) Intake .006", Exhaust .009".

Carburetor, Zenith updraft, Model 456.

Fuel Pump, AC-Model 855758.

Oil Filter, Deluxe #602.

Air Cleaner, Donaldson, Model E7764.

Starter, Auto Lite, 6 Volt, Model ML4221.

Generator, Auto Lite, 6 Volt, Model GFA4810-2.

Battery, 6V, 148 Amp. Globe V89.

Governor, (Full range) Pierce Model K40504.

Crankcase Capacity - 9 qts.

Radiator (Cooling System) Capacity - 8½ gals.

Fuel tank, capacity-55 gals.

Machine:

Booms -

Crane Boom-35 foot, 2 piece boom with two sheaves at boom point. Constructed with four chord angles braced by electrically welded diagonal lacing angles.

Shovel Boom - 18 feet long. All Welded box type. Shipper shaft mounted through center of boom. One Piece continuous crowd chain operating inside the boom.

Shovel Dipper Sticks-15 foot, double, outside type, all welded box construction.

Shovel Dipper-Capacity 3/4 cubic yard-all manganese front.

Pull Shovel Boom-19'-3" long, all welded box type.

Pull Shovel Dipper Arm-6'-3" long, all welded box type.

Pull Shovel Dipper-Capacity 3/4 cubic yard.

Steering or Digging Locks- Positive traction brakes controlled from operator's position. Both crawlers can be steered in any direction with the cab in any position over the carbody. As a special safety feature both traction brakes can be applied at any time.

Line speeds - Idle - Hoist (Crane, Clamshell, Dragline) 159' per minute. Drag (Dragline) 136' per minute.

Drum Shaft Idle Speed - 38.1 R.P.M.

Swing Speed - 3.5 R.P.M.

Traction Speed - 0.9 M.P.H.

Lifting Capacity - With 40' boom at 12' radius the capacity at 75% of overturning load is 18000 lbs. with machine on firm level floor.

Hook Block - 10 ton capacity, single sheave type with anti-friction swivel hook.

Weight -

Crane - approximately 40,445 lbs.

Shovel - approximately 43,400 lbs.

Over all dimensions -

Height (From ground to top of cab) 10' - 10½"

Length of Crawlers - 11' - 8"

Width of Crawlers - 9' - 7"

Rear end radius - 9' - 0"

Width of Crawler pad-21"

Length (From front of crawlers to rear of tail swing) 14' - 10"

Light Plant - Kohler (1500 Watt) Model E.

HOW TO DETERMINE LIFTING CRANE
WORKING RANGES. (SEE TEXT, PAGE 27.)

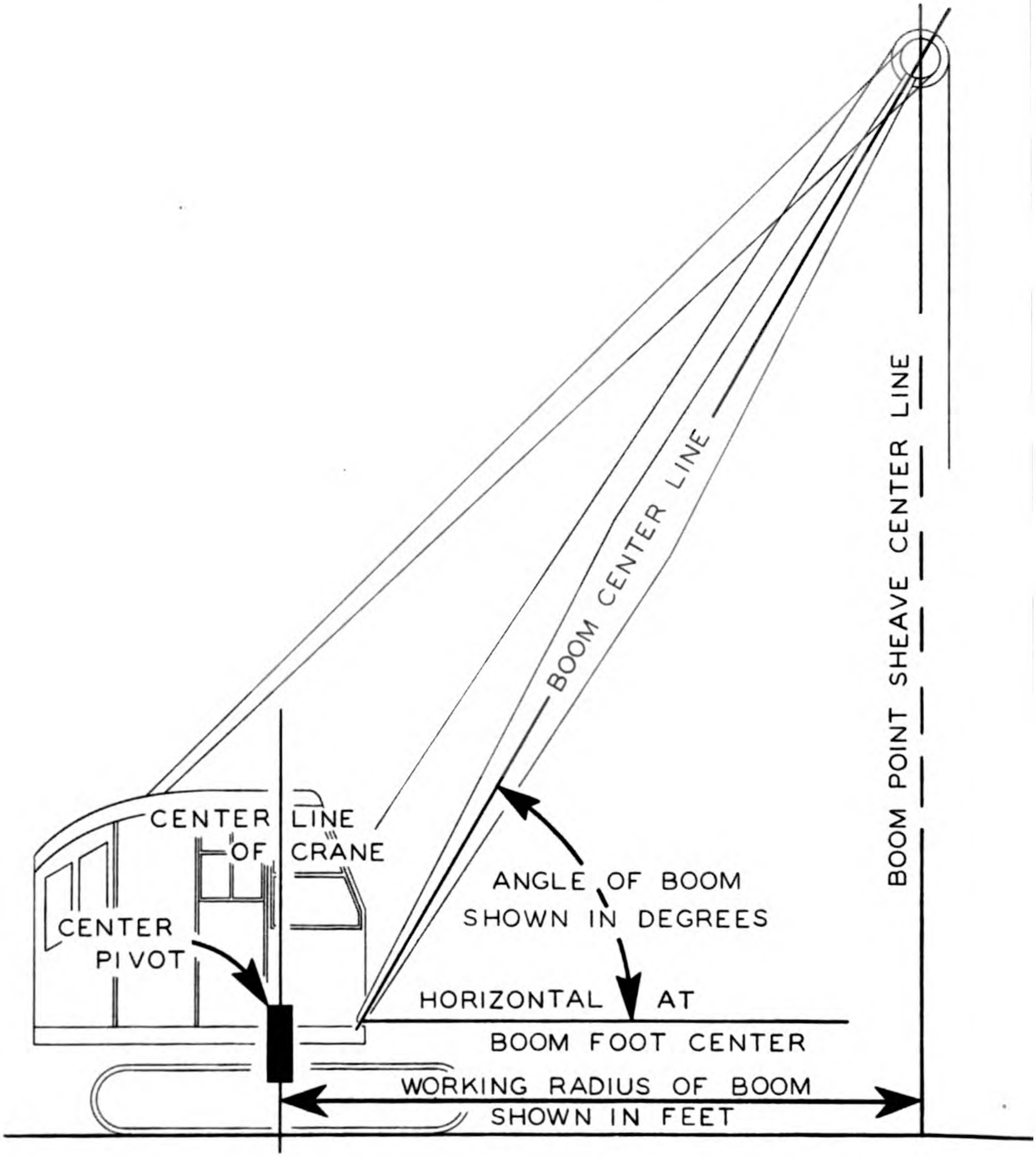


FIGURE 22

PRINCIPAL OPERATING MOTIONS OF SHOVEL

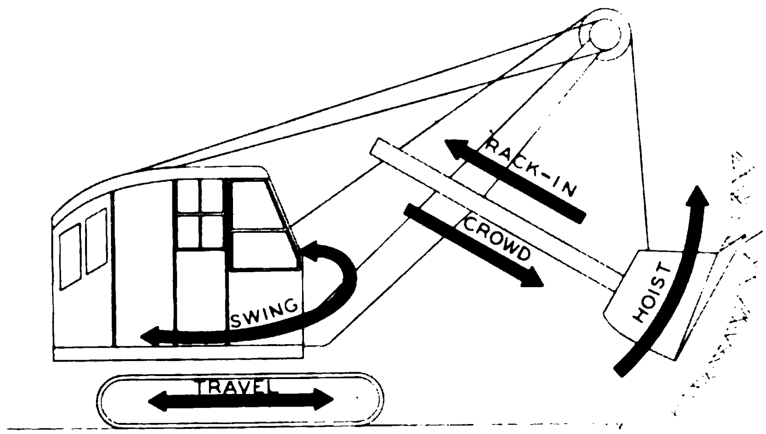


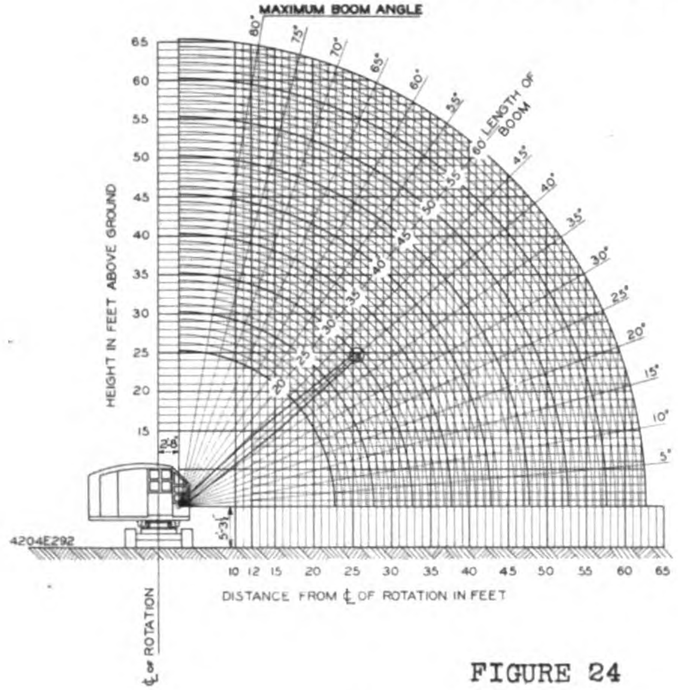
FIGURE 23

Traveling, swinging, and raising or lowering the boom are motions common to all combinations of the Koehring Model 304 Excavator (Crane, Clamshell, Dragline, Pile Driver, Shovel and Pull Shovel.) Your manipulation of the crowd, rack-in and hoist motions of the shovel determines the ease and speed at which you operate as well as the productive capacity of the shovel. With practice you will be able to crowd and hoist simultaneously while digging racking-in when necessary as your dipper travels up through the cut. As you swing to dump the loaded dipper it can be hoisted to any desired height within the range of the machine, and by racking-in or crowding (out) you can accurately spot the dipper at any point for dumping.

HOW TO DETERMINE LIFTING CRANE WORKING RANGES

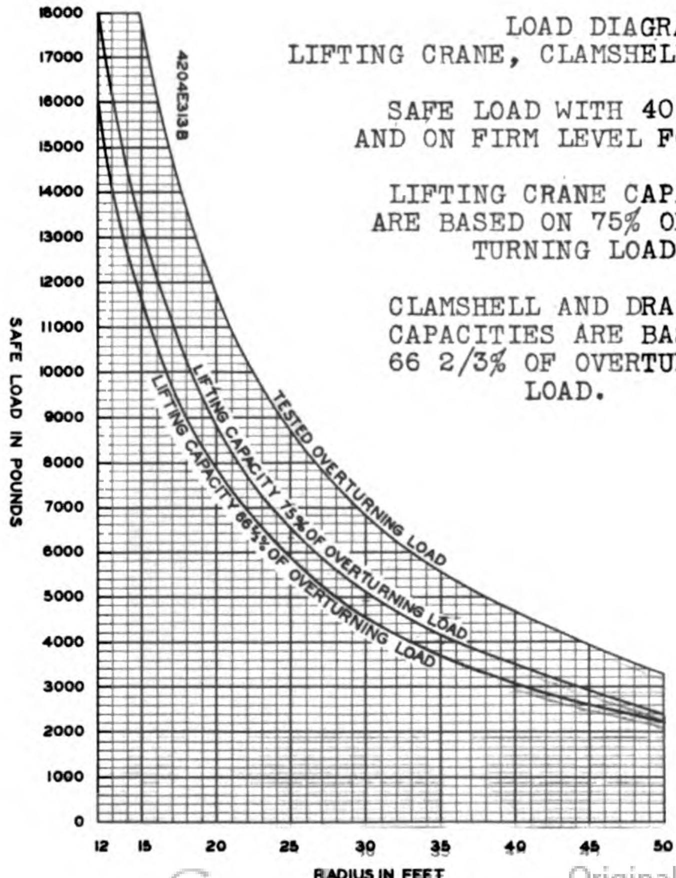
The lifting capacity of a crane, as generally specified by manufacturers, is based upon boom length, boom radius in feet and boom angle in degrees. These capacities usually are presented in tabular form and the ratings, as shown on these forms, are standard. To allow for a safety factor in continuous normal operation, lifting crane ratings are given at 75% of the tipping-over load while clamshell and dragline ratings are given at 66-2/3% of the tipping-over load. Other variations in capacity ratings are explained on page 29. Figure 24, page 28 illustrates the various working ranges by which capacities are determined. To determine the capacity of a crane, for which the standard capacity ratings have been established as shown on page 29, you must first consider the length of boom. After fixing the boom at the proper angle for the type of work, measure the distance, on the ground, from the center line of the machine to the center line of the boom point sheave. Thus with boom length and working radius established determine the crane lifting capacity under the "Lifting Crane Service" column on page 29. The use of one part, two part or three part hoist cable reeving depends upon the nature of the work and the weight of the load. For continuous operation, one part reeving should be used on loads of 1/3 and under the maximum rating. Two part reeving should be used on loads between 2/3 and 1/3 of maximum rating. Three part reeving should be used on loads between 2/3 of maximum and minimum. When handling loads with three part cable reeving, the hoist line speed and the loads on hoist drum, hoist clutch and hoist brake are reduced 2/3.

RADIUS DIAGRAM
LIFTING CRANE, CLAMSHELL AND DRAGLINE



Clamshell Bucket	
Size Cu. Yds.	Dimension "A"
1	10'-6"
¾	10'-6"
⅝	10'-0"
½	9'-6"

FIGURE 24



LOAD DIAGRAM
LIFTING CRANE, CLAMSHELL AND DRAGLINE.

SAFE LOAD WITH 40 FT. BOOM AND ON FIRM LEVEL FOUNDATION.

LIFTING CRANE CAPACITIES ARE BASED ON 75% OF OVER-TURNING LOAD.

CLAMSHELL AND DRAGLINE CAPACITIES ARE BASED ON 66 2/3% OF OVERTURNING LOAD.

FIGURE 25

304 LIFTING CAPACITIES
MACHINE ON FIRM LEVEL FLOOR

Boom	Radius in Feet	Boom Angle in Degrees	Height Sheave Pin Above Grade	Lifting Crane Service 75% Rating Type A 110" x 94" Subframe	Clamshell & Dragline Service 66⅔% Rating Type A 110" x 94" Subframe
35	12	75	39'- 2"	18000	16000
	15	69	38'- 2"	13200	11750
	20	61	35'- 9"	8850	7860
	25	50	32'- 0"	6500	5800
	30	38	27'- 0"	5100	4550
40	12	77	44'- 3"	18000	16000
	15	72	43'- 5"	13200	11750
	20	64	41'- 6"	8850	7860
	25	56	38'- 7"	6500	5800
	30	47	34'- 7"	5100	4550
	35	36	29'- 0"	4150	3700
45	12	78	49'- 4"	17850	15850
	15	74	48'- 6"	13050	11600
	20	67	47'- 0"	8700	7710
	25	60	44'- 4"	6350	5650
	30	53	41'- 0"	4950	4400
	35	44	36'- 9"	4000	3550
	40	34	30'- 6"	3350	2950
50	12	79	54'- 6"	17700	15700
	15	76	53'-10"	12900	11450
	20	70	52'- 2"	8550	7560
	25	63	50'- 0"	6200	5500
	30	57	47'- 3"	4800	4250
	35	50	43'- 9"	3850	3400
	40	42	38'- 9"	3200	2850
	45	32	32'- 0"	2600	2310
55	12	80	59'- 6"	17550	15550
	15	77	59'- 0"	12750	11300
	20	72	57'- 6"	8400	7410
	25	66	55'- 6"	6050	5350
	30	60	53'- 0"	4650	4100
	35	54	49'-10"	3700	3250
	40	48	45'- 8"	3050	2700
	45	39	40'- 4"	2450	2160
	50	31	33'- 6"	1950	1735

For average dragline and clamshell service, the 66-2/3% rating is recommended. For more favorable conditions the 75% rating is satisfactory.

For continuous dragline service we do not recommend a bucket and load exceeding 4700 and for continuous clamshell service a bucket and load exceeding 6500.

Clamshell and dragline buckets of different makes vary in weight and capacity which must be checked carefully in arriving at the proper working radii. In wet material allowance must be made for suction which at times is as much as 20% increase in weight. The weight of the hook block, slings, eveners, grapple or any device for handling the load must be considered a part of the load in determining the lifting capacity of the lifting crane.

For lifting loads for longer booms than listed, deduct 150 lbs. from above figures for each 5 ft. of boom added.

HOW TO USE THE CHART ON PAGE 31 FOR DETERMINING MAXIMUM SIZE STOCK PILE WITH DIFFERENT BOOM LENGTHS AND CLAMSHELL BUCKET CRANE

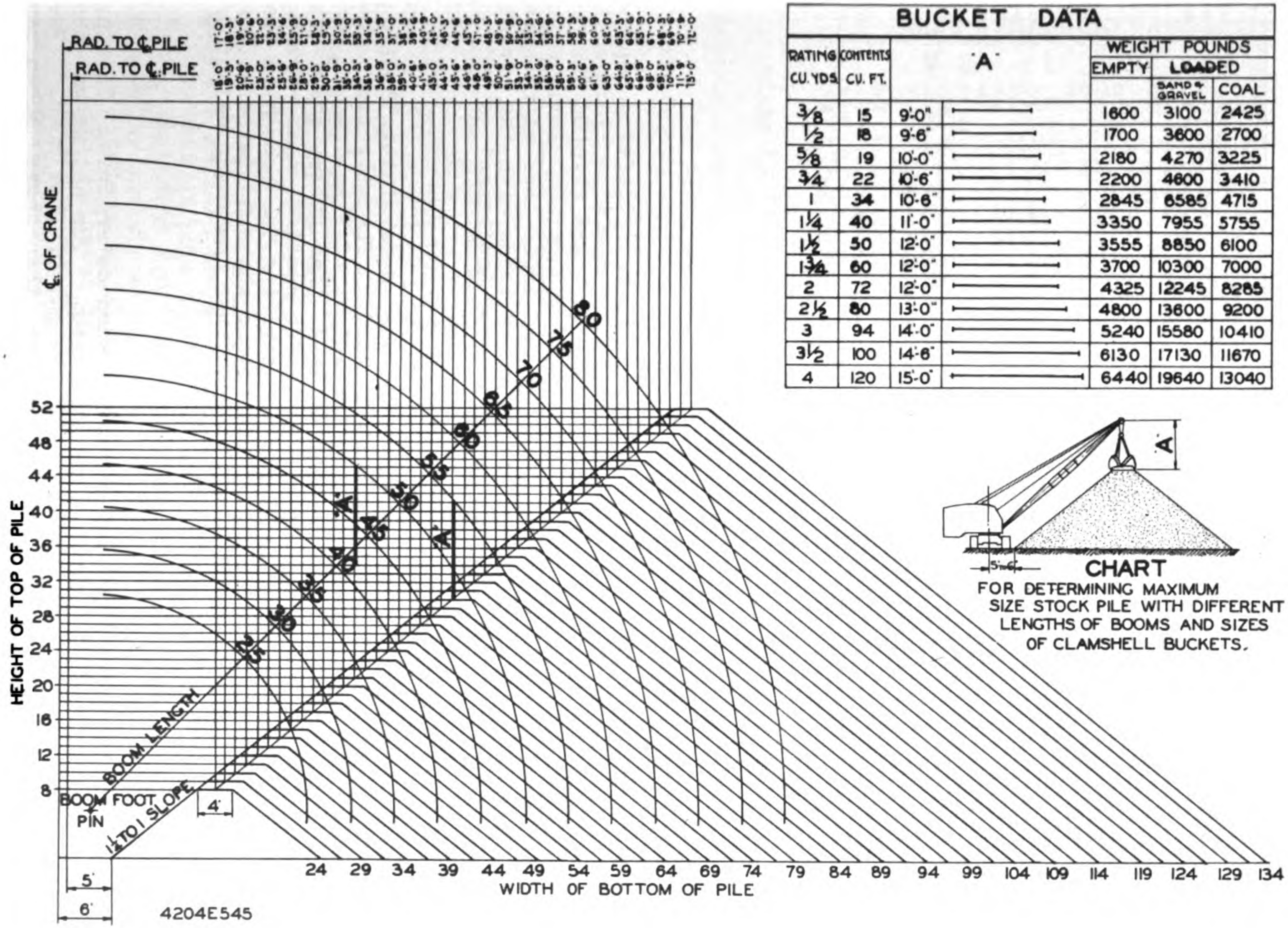
From the table "Bucket Data" take the height of bucket, dimension "A" for the size bucket to be used. Lay this dimension on the diagram with the upper end on the curve marked with the length boom used. Move this measured dimension around the curve until its lower end coincides with the diagonal line drawn through the center of the 4 foot flat top of stock pile. In other words, to a position where the vertical distance between boom point shaft and top of pile is equal to "A". If the radius as shown at the top of the diagram does not exceed the maximum allowable radius for the weight of loaded bucket, this is the maximum size stock pile that can be built. If this radius is greater than the allowable radius for the load, move the line "A" to the left until it coincides with the maximum radius as shown by the load diagram and given at the top of this diagram. The stock pile immediately below this point is the maximum that can be built.

Example 1: What is the maximum stock pile to which sand and gravel can be delivered with a 604 Crane with a 55 ft. boom and 1 yard clamshell bucket:

"A"-10' 6". The vertical distance between the curve for the boom point of a 55 ft. boom and the top of stock pile is 10' 6" at a radius of 45' 6". A 604 Crane will handle a load of 6585 pounds on a 55 ft. boom at a radius of 47' 0". Therefore the stock pile will have a radius at its center of 45' 6", a height of 30 feet and width at bottom of 79 feet.

Example 2: What is the maximum stock pile to which sand and gravel can be delivered with a 301 Crane and 3/4 yard clamshell bucket on a 50 ft. boom:

The vertical distance "A" between the curve for the boom point of a 50 foot boom and top of stock pile is 10' 6" at a radius of 42' 0". But the maximum radius at which a 301 Crane will handle a load of 4620 pounds on a 50 ft. boom is 34' 3". Therefore, the maximum radius of stock pile is 34' 3". The height is 21 feet and the width of bottom of pile is 56' 6".



BUCKET DATA

RATING CU. YDS.	CONTENTS CU. FT.	'A'		WEIGHT POUNDS EMPTY	LOADED SAND & GRAVEL	LOADED COAL
3/8	15	9'-0"		1600	3100	2425
1/2	18	9'-6"		1700	3600	2700
5/8	19	10'-0"		2180	4270	3225
3/4	22	10'-6"		2200	4600	3410
1	34	10'-6"		2845	6585	4715
1¼	40	11'-0"		3350	7955	5755
1½	50	12'-0"		3555	8850	6100
1¾	60	12'-0"		3700	10300	7000
2	72	12'-0"		4325	12245	8285
2½	80	13'-0"		4800	13600	9200
3	94	14'-0"		5240	15580	10410
3½	100	14'-6"		6130	17130	11670
4	120	15'-0"		6440	19640	13040

CHART
FOR DETERMINING MAXIMUM SIZE STOCK PILE WITH DIFFERENT LENGTHS OF BOOMS AND SIZES OF CLAMSHELL BUCKETS.

WEIGHT OF MATERIALS IN POUNDS

Material	Lbs. Per Foot	Lbs. Per Yard	Material	Lbs. Per Foot	Lbs. Per Yard
Ashes	30	810	Limestone, Block	180	....
Cement, Portland	94	2538	Limestone, Broken	100	2700
Cinders	40	1080	Magnesite, Broken	105	2835
Clay, Dry Excavated	70	1890	Marl, Wet Excavated	140	3780
Clay, Wet Excavated	110	2970	Masonry, Debris	90	2430
Coal, Broken Penn., Anthracite	57	1539	Mica, Block	180	....
Coal, Broken Bituminous	52	1404	Mica, Broken	100	2700
Coke, Blast Furnace	30	810	Mud, Fluid	110	2970
Concrete, Wet Mixed	135	3645	Peat, Moist	50	1350
Copper Ingots	550	....	Peat, Wet	70	1890
Dolomite, Fine or Lumps	100	2700	Phosphate Rock, Broken.	110	2970
Earth, Excavated Common Loam, Dry	80	2160	Plaster, Ground	60	1620
Earth, Excavated Common Loam, Moist	90	2430	Salt	76.5	2080
Earth, Excavated Common Loam, Wet	110	2970	Sand, Slightly Damp	105	2835
Granite, Block	170	....	Sand, Wet	120	3240
Granite, Broken	96	2592	Slag, Broken Furnace	110	2970
Gravel, Screen 1/4" to 2"	105	2835	Slate	96	2592
Gravel and Sand, Pit Run	120	3240	Snow	15 to 50	....
Gypsum Rock, Crushed	100	2700	Steel	490	....
Ice	57.4	....	Sugar Beets	35 to 40	....
Iron Punchings	225	....	Sulphur	125	3375
Iron, Cast	450	....	Tar	62	....
Iron, Wrought	480	....	Tin	459	....
Lead	710	....	Trap Rock, Broken	105	2835
Lignite, Broken	52	1404	Water	62.4	....
Lime	64	1728	Zinc or Spelter, Cast	430	....

PRECAUTIONS

LIFTING CRANE SERVICE:

Crane must be on firm level ground when determining lifting capacity and 75% rating must be used. The weight of the hook block must be added to the weight of the load. Handle loads of 6000 lbs. or less with single line, loads between 6000 lbs. and 12000 lbs. with two part line and loads between 12000 lbs. and 18000 lbs. with three part line. Be careful in the handling of loads with the crane boom at an angle of 65 degrees or more above horizontal.

CLAMSHELL SERVICE:

Clamshell must be on firm level ground when determining lifting capacity and 66-2/3% rating must be used. The weight of the clamshell bucket must be added to the weight of the load. For special conditions, loads greater or less than those shown may be advisable. Allowance must be made for suction when working in wet or sticky material. To prevent striking the boom with the clamshell bucket, boom angle should not be above 60 degrees. For continuous clamshell service we recommend that combined weight of bucket and load does not exceed 6500 lbs.

DRAGLINE SERVICE:

Dragline must be on firm level ground when determining lifting capacity and 66-2/3% rating must be used. The weight of the dragline bucket must be added to the weight of the load. For special conditions, loads greater or less than those shown may be advisable. Allowance must be made for suction when working in wet or sticky material. For continuous dragline service we recommend that the combined weight of drag bucket and load does not exceed 4700 lbs.

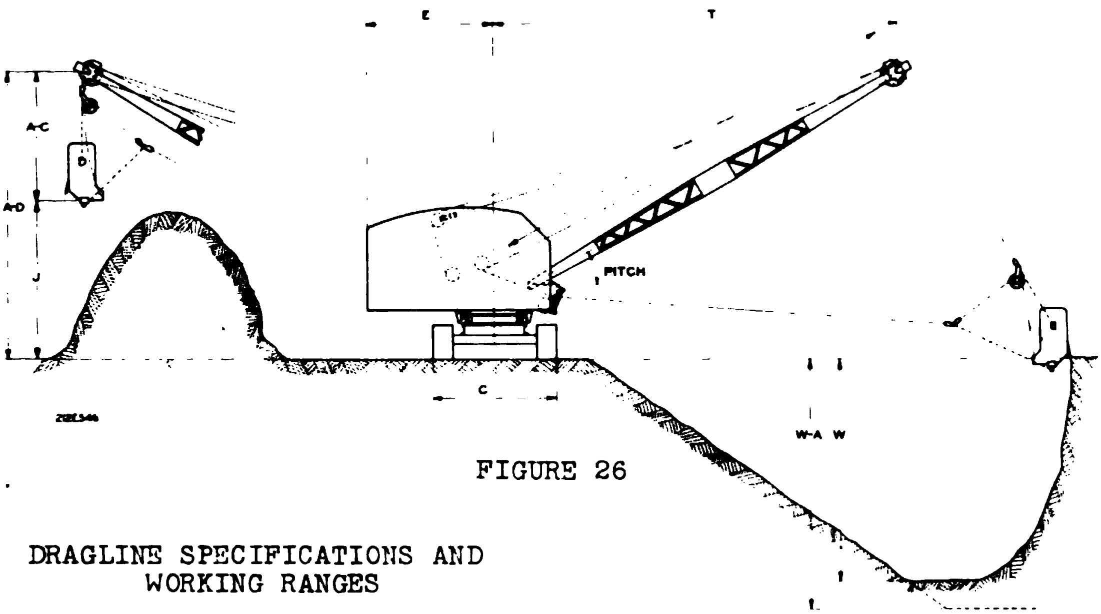


FIGURE 26

DRAGLINE SPECIFICATIONS AND
WORKING RANGES

C-Overall width crawlers.................. 9' 7"
E-Rear End Radius......................... 9' 0"
J-Dumping Height (Height of boom
minus "A-C")........................... See table Page 29
T-Maximum radius.......................... See table Page 29

Digging depth with boom at 35° and hoist line 20° from vertical, the std. ropes furnished with a dragline are of sufficient length to allow an approximate digging depth below grade equal to 1/3 boom length.

WEIGHTS OF DRAGLINE BUCKETS

Size	Empty	Loaded with wet earth	With Loaded Gravel
3/4-26 cu. ft.	2200#	4700 See Note Page 29	4700 See Note P.29
1/2-17 cu. ft.	1600	3470	3385
3/8-11 cu. ft.	900	2110	2055

Note 1-No fixed rule can be given for governing depth to which the material can be excavated as it varies greatly with the nature of the material being excavated and the skill of the operator. It increases directly as the length of the boom increases.

Note 2-A skilled operator can easily throw the bucket ten feet or more beyond the end of the boom, the distance depending upon the length and pitch of boom.

Note 3-The cut above indicates in a general way how making a cut from the side affects the digging depth. The cut indicates in a general way how making the cut from the end of the excavation affects the digging depth.

Note 4-Weights given are average and are not applicable to any certain make of bucket. Any variation in weight or cubic contents of buckdt must be taken into consideration. The working radius for any given load must not exceed the rating shown by the load diagram, Page 29.

NOTES

SHOVEL SPECIFICATIONS AND WORKING RANGES.

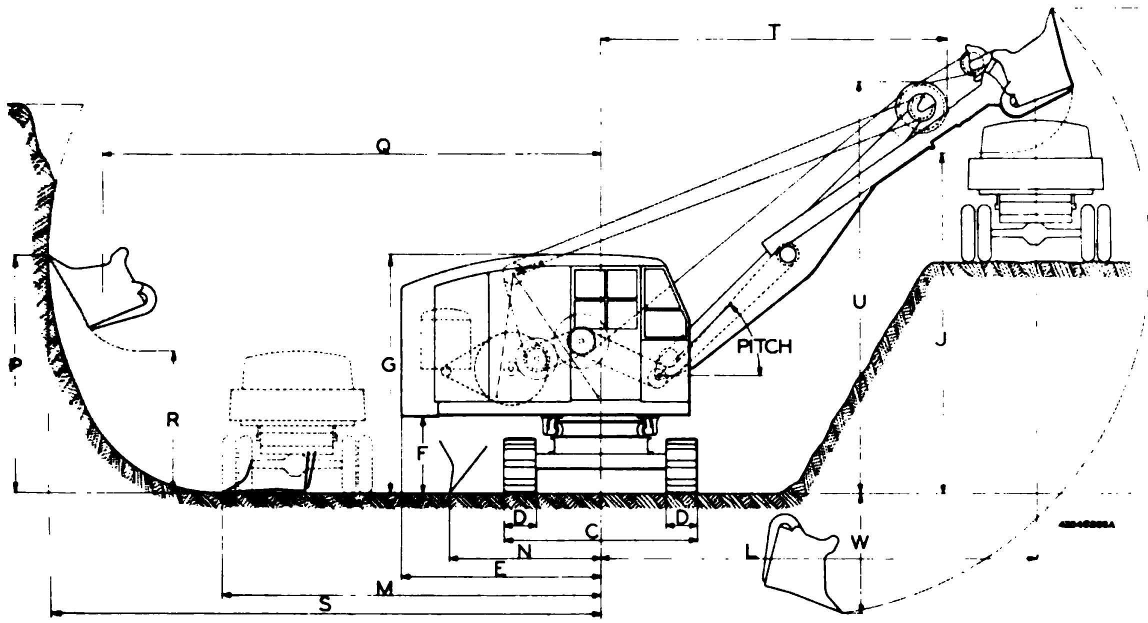


FIGURE 27

Boom Length 18′- 0″ Pitch of Boom		**35°**	**40°**	**45°**	**50°**	**55°**	**60°**	**65°**
C	Overall Width Crawlers	9′- 7″	9′- 7″	9′- 7″	9′- 7″	9′- 7″	9′- 7″	9′- 7″
D	Width of Shoe	21″	21″	21″	21″	21″	21″	21″
E	Rear End Radius	9′- 0″	9′- 0″	9′- 0″	9′- 0″	9′- 0″	9′- 0″	9′- 0″
F	Clearance under Counter-weight	3′- 7½″	3′- 7½″	3′- 7½″	3′- 7½″	3′- 7½″	3′- 7½″	3′- 7½″
G	Height, Boom Lowered	10′-10½″	10′-10½″	10′-10½″	10′-10½″	10′-10½″	10′-10½″	10′-10½″
P	Digging Height (at S)	10′- 6″	11′- 2″	11′- 9½″	12′- 4″	12′-10½″	13′- 3½″	13′- 8½″
T	Boom Clearance Radius	18′- 6″	17′- 6″	16′- 5½″	15′- 3″	14′- 0½″	12′- 8½″	11′- 3½″
U	Boom Clearance Height	17′- 0″	18′- 3½″	19′- 5″	20′- 6″	21′- 5½″	22′- 3″	23′- 0″

15 Ft. Sticks — ¾ cu. yd. Dipper

J	Dumping Height, Max.	13′- 1″	14′-10½″	16′- 7″	18′- 2″	19′- 9″	21′- 1″	22′- 4″
K	Cutting Height, Max.	18′-10″	20′-11″	22′-11″	24′- 9″	26′- 5″	27′-11″	29′- 4″
L	Dumping Radius, Maximum Height	25′- 5″	24′- 4″	23′- 1″	21′- 9″	20′- 3″	18′- 7″	16′-10″
M	Level Floor, Max. Rad.	18′- 1″	18′- 0″	17′-10″	17′- 7″	17′- 3″	16′-11″	16′- 4″
N	Level Floor, Min. Rad.	6′- 4″	6′- 7″	6′-11″	7′- 3″	7′- 9″	8′- 5″	8′- 7″
Q	Dumping Radius, Maximum Reach	25′- 6″	25′- 1″	24′- 6″	23′-11″	23′- 4″	22′- 8″	21′-11″
R	Dumping Height, Maximum Reach	6′- 7″	7′- 3″	7′-11″	8′- 6″	9′- 0″	9′- 5″	9′-10″
S	Digging Radius, Maximum Reach	28′- 3″	27′- 9″	27′- 3″	26′- 7″	26′- 0″	25′- 4″	24′- 7″
W	Cut Below Floor Level	8′- 2″	7′- 6″	6′-11″	6′- 4″	5′-10″	5′-5″	5′ 0″

PULL SHOVEL SPECIFICATIONS AND WORKING RANGES.

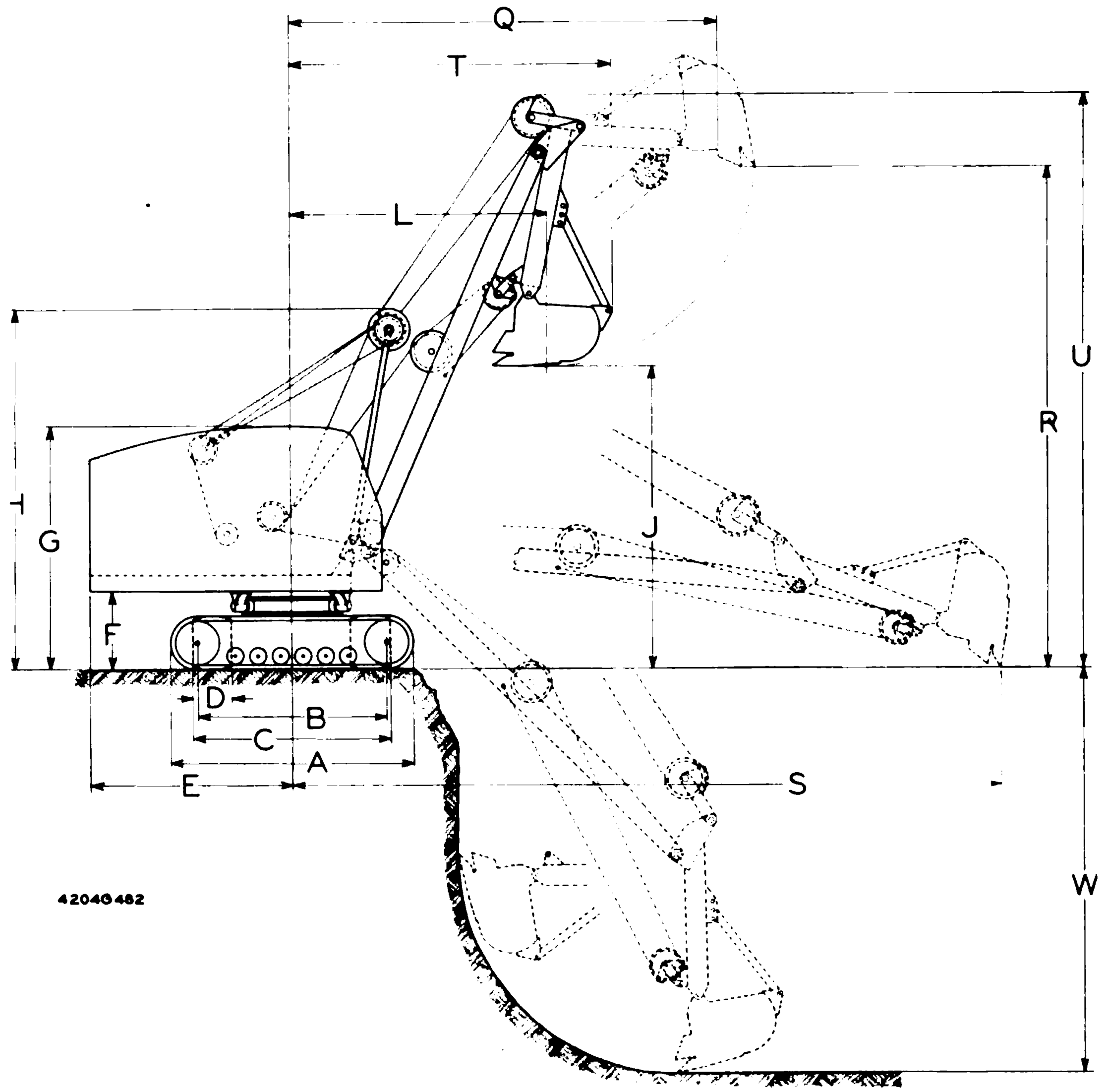


FIGURE 28

	Boom	19'-3"
	Dipper Arm	6'-3"
	Dipper	¾-yd.
A.	Overall Length of Standard Crawlers	11' 8"
	Extra long Crawlers	13' 4"
C.	Overall Width of Crawlers with	
	21" Wide Shoes	9' 7
	24" Wide Shoes	9' 10"
	30" Wide Shoes	10' 11"
	Overall Width of Cab	8' 9"
E.	Tail Swing Clearance	9' 0"
	Clearance Heights	
G.	Over Cab	10' 10½"
H.	Over Jib Frame	16' 0"
J.	Clearance Height at Beginning of Dump	12' 0"
Q.	Radius at End of Dump, Highest Position	19' 3"
R.	Clearance Height at End of Dump	22' 3"
S.	Maximum Digging Reach	32' 0"
T.	Clearance Radius of Boom and Bucket at Maximum Dumping Height	14' 5"
U	Height of Boom at Maximum Dumping Height	25' 6"
W.	Digging Depth	18' 0"

POWER FLOW DESCRIPTION
(SCHEMATIC DRAWING OF POWER FLOW, PAGES 38 AND 39)

The illustrations on pages 38 and 39 show assemblies of the upper deck or turntable machinery and the carbody or lower machinery. The flow of power from the engine clutch throughout the machinery is indicated by a solid line and arrows. When the engine clutch (A) is engaged, power is transmitted from sprocket (B) by a four strand roller chain to the larger sprocket (C) keyed to the left hand end of the swing and traction jackshaft (D) which is mounted on anti-friction bearings. The swing and traction clutch spiders (E) and (F) are keyed to the jackshaft. The swing and traction clutch drums (G) and bevel pinions (H), mounted on anti-friction bearings on the jackshaft, rotate when either one of the swing and traction clutches is engaged. An interlocking lever system prevents both swing and traction clutches being engaged at the same time. Both bevel pinions are constantly in mesh with the same bevel gear (J). As either one of the clutches is engaged, its bevel pinion drives the bevel gear which transmits power to the upper deck gears for swinging or traveling while the other bevel pinion idles in the opposite direction on its anti-friction bearings. The small spur tooth pinion (K), keyed to the right hand end of the swing and traction jackshaft, meshes with the spur gear (L) keyed to the boom hoist clutch drum assembly (M) mounted on ball bearings on the right hand end of the boom hoist shaft. The boom hoist clutch spider (N) is keyed to the boom hoist shaft. When the boom hoist clutch is engaged, power is transmitted through the shaft to the jaw sleeve (O) which is keyed to the shaft and by the sleeve jaws to the boom hoist drum on the left end of the shaft. When the boom hoist clutch is not engaged, the boom hoist shaft remains stationary and the boom hoist clutch drum and gear assembly rotates on its own anti-friction bearings. The spur gear on the boom hoist clutch drum assembly meshes with a large spur gear(P) keyed to the hoist drum shaft and keyed to the same shaft are the two clutch spiders (Q) and (R) that drive the drums. The drums are mounted on anti-friction bearings on the main drum shaft and when either or both clutches are engaged the drums will rotate with the shaft. When the main drum clutches are disengaged, the drums will remain stationary while the shaft rotates freely inside the drums on its own anti-friction bearings located at each end of the shaft. The gear train (K), (L) and (P) is enclosed and runs in transmission grease. The roller chain is enclosed and runs in oil.

Power to the lower machinery is transmitted through a series of gears, bevel pinions and vertical shafts. From bevel pinion (H) power flows to bevel gear (J) which is mounted on a spline at the upper end of the bevel gear shaft. From spur tooth pinion (S) mounted on a spline at the lower end of the bevel gear shaft power flows to the lower gear of gear assembly (T). The upper gear of this assembly meshes with the spur gear (U) on the swing shaft. Spur gear (U) meshes with the splined spur gear (V) on the vertical traction shaft when the splined spur gear (V) is down as shown in drawing.

The jaw clutch (W) slides on the splines at the upper end of the vertical swing shaft, and engages with the jaws at the top of spur gear (U) on the vertical swing shaft. Jaw clutch (W) and splined gear (V) are operated by a shifter yoke and both can not be engaged at the same time. The shifter yoke is operated by lever No. 2 Page 42. With splined gear down and jaw clutch up, the

 (Continued on Page 40)

POWER FLOW CHART
(FOR DESCRIPTION SEE PAGES 37 AND 40)

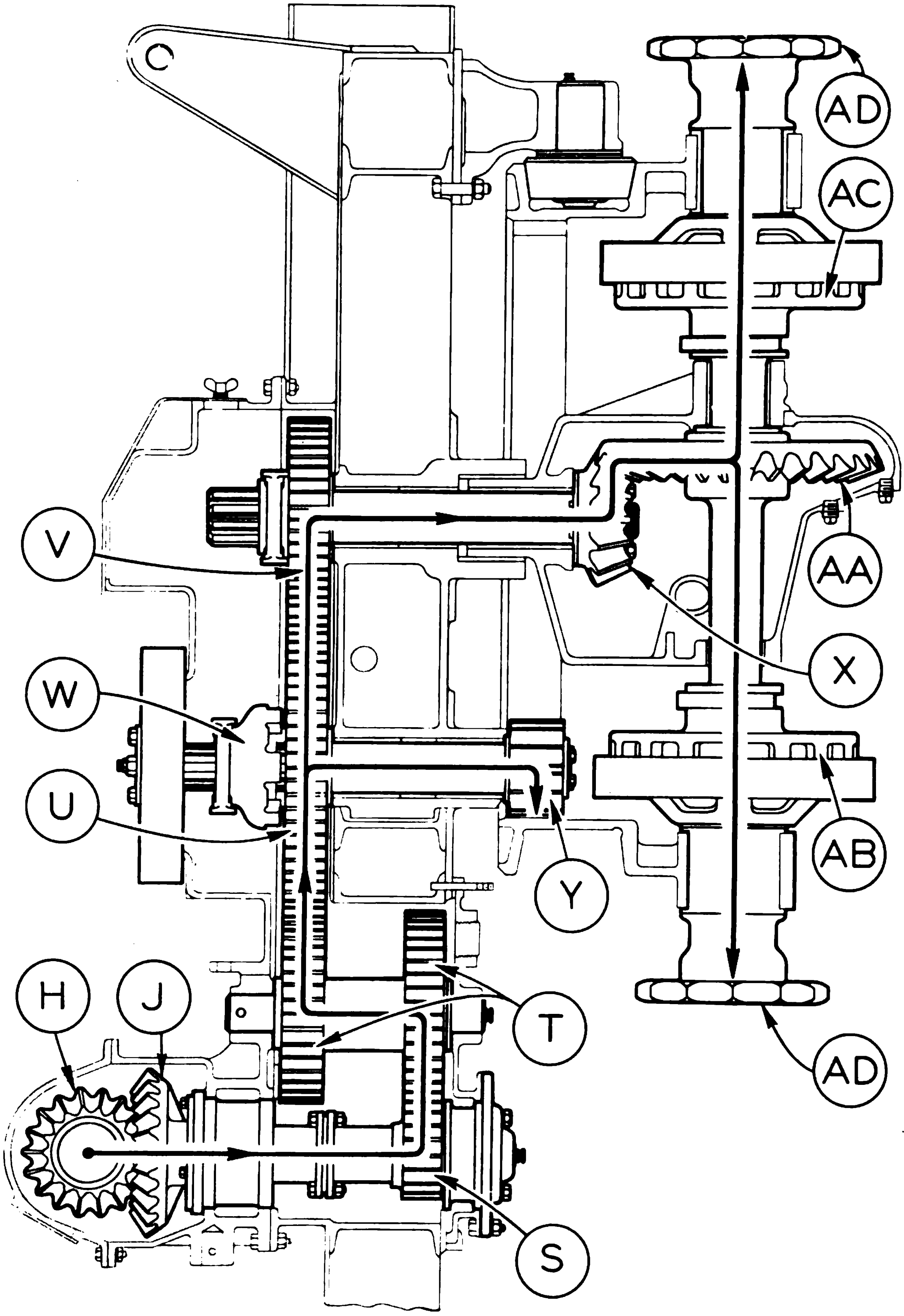


FIGURE 29

POWER FLOW CHART

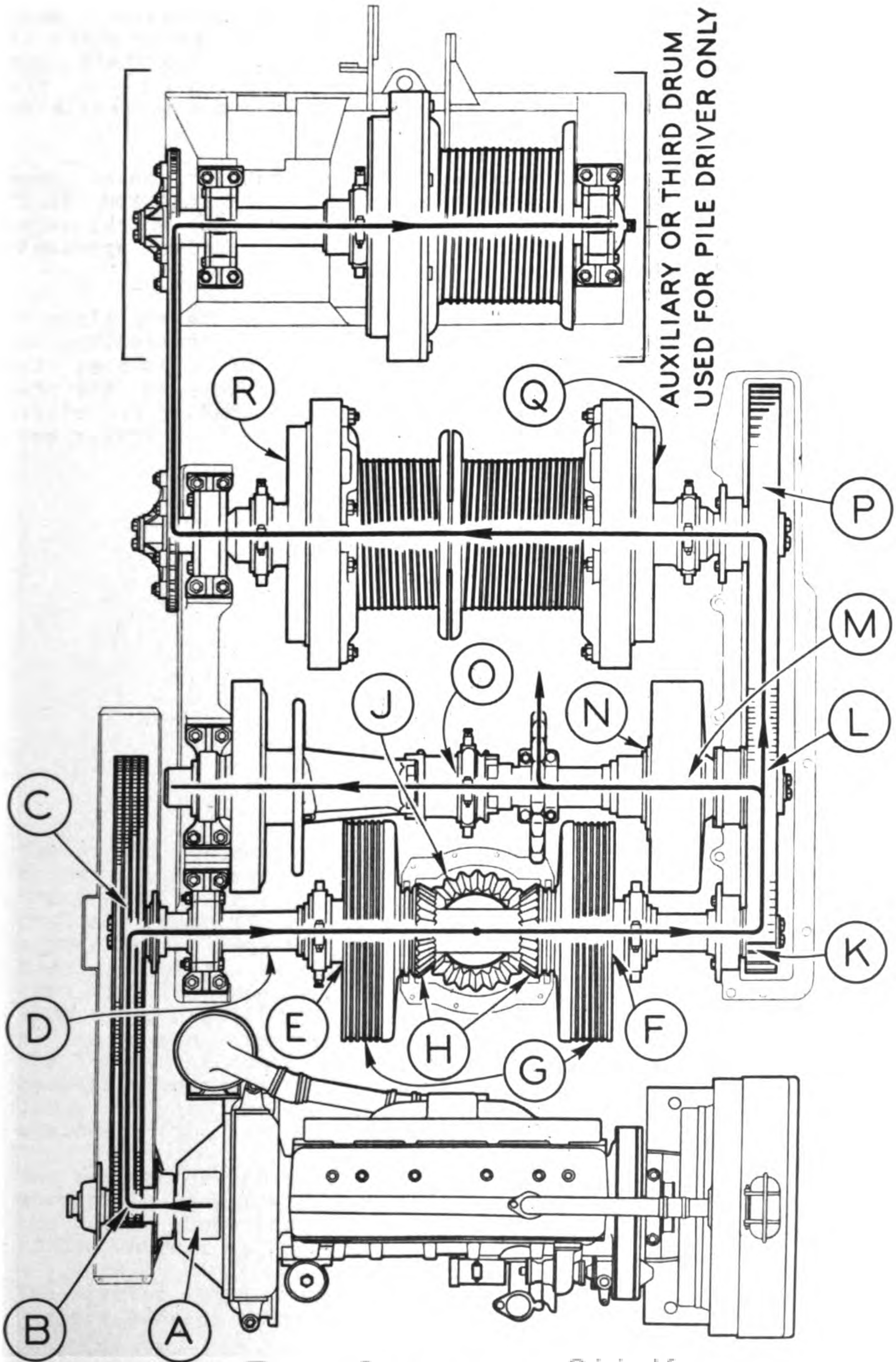


FIGURE 30

vertical swing shaft remains stationary; the swing shaft gear idles on the shaft and power flows to the vertical traction shaft, then down to the lower bevel pinion (X) to drive the machine in traction. When the splined gear (V) is raised up out of mesh with gear (U) and the jaw clutch on the vertical swing shaft is shifted down to engage the clutch jaws with the swing shaft spur gear (U), power is transmitted to the swing pinion (Y) on the lower end of the vertical swing shaft to swing the turntable as desired.

The traction bevel pinion meshes with the traction bevel gear (AA) which is keyed to the traction shaft. The traction shaft transmits power to both jaw clutches (AB) and (AC) which, when engaged, transmits the power to either or both drive sprockets and then by drive chains to the driving tumblers.

When both traction jaw clutches are disengaged, the shaft can be rotated without moving the machine. The linkage controlling the movement of both traction jaw clutches is so arranged that the disengagement of either jaw clutch will set a brake on the drum of that clutch and lock the drive sprocket and crawler for steering; or both jaw clutches may be disengaged and both brakes set, thus locking both crawlers from moving.

ENGINE CONTROLS

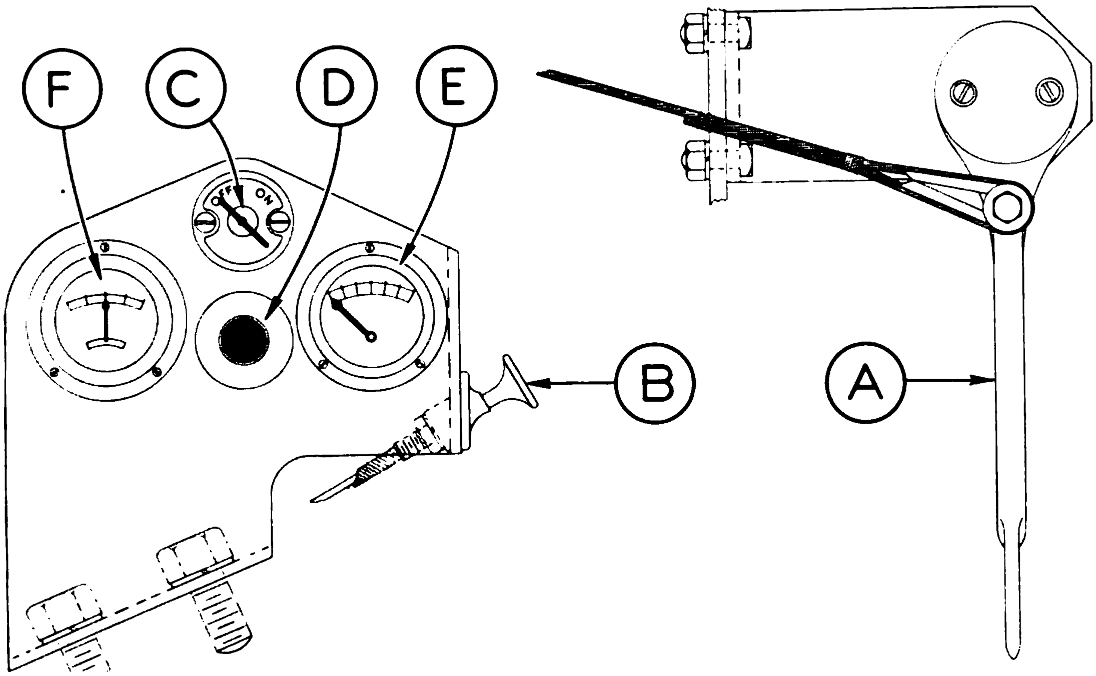


FIGURE 31
ENGINE CONTROLS

The engine controls consist of the throttle (A), choke rod (B), magneto ground switch (C) and starter button (D). In addition, the engine control panel contains an oil pressure gauge (E) which indicates the oil pressure in the oil circulating system of the engine and an ammeter (F) which indicates the rate of charge or discharge of the electric current flowing into or out of the battery with the exception of the current used by the battery. The throttle control (A) is in front of the operator at his left and is connected with the governor to control the engine speed. The instrument control panel is located at the top of the gear case back of the operator. The choke control rod (connected to the choke lever on the carburetor), the magneto ground switch and the starter button are mounted in the instrument panel.

The magneto ground switch in "off" position grounds the magneto current to stop the engine. When the switch is in "on" position, the ground connection is broken and the magneto is supplying ignition current to run the engine.

The starter button operates a magnetic switch which supplies battery current to the starting motor.

OPERATING LEVERS

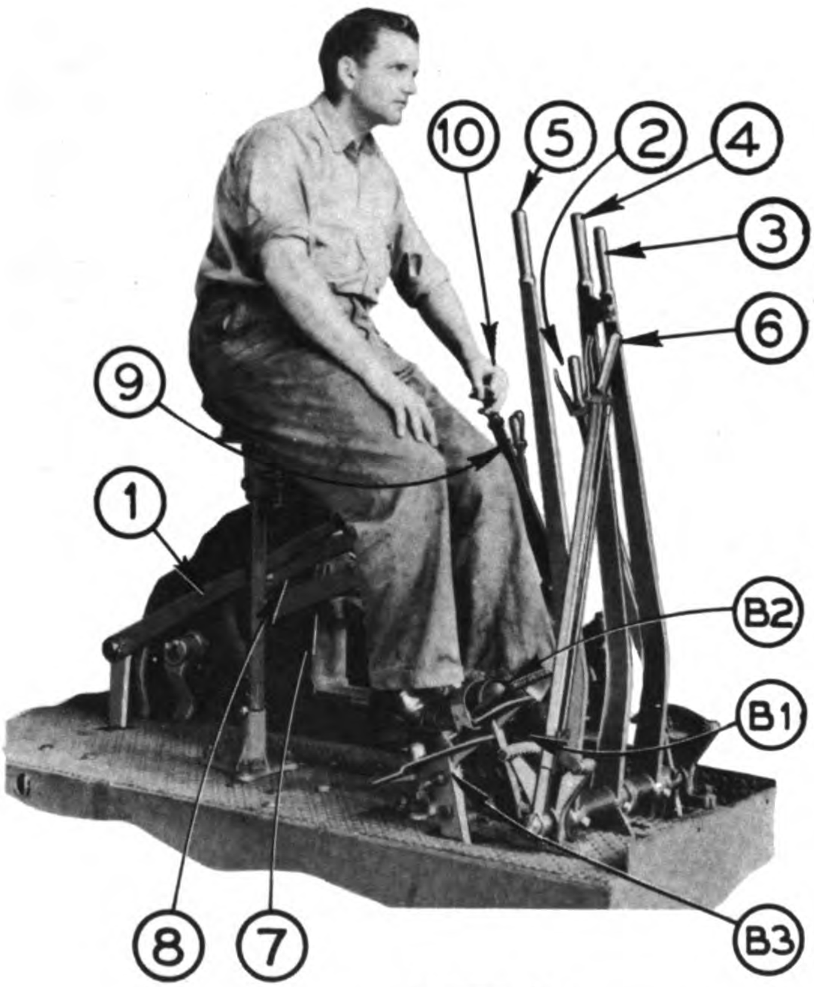


FIGURE 32

The operator's seat is mounted near the front on the right turntable platform or deck. As shown in the above illustration, all engine and machine controls are within easy reach of the operator, and all motions of the machine are controlled by the operator without leaving his position. The seat is adjustable to any desired height and may be moved forward or backward as required.

OPERATING LEVERS NAMED

#1 - Engine Clutch Lever.
#2 - Swing and Traction Jaw Clutch Lever.
#3 - Swing and Traction Clutch Lever.
#4 - Right Drum Clutch and Boom Hoist Lever-For Crane Type Operation.
#5 - Left Drum Clutch Lever.
#6 - Swing Brake Lever.
#7&#8-Steering Levers.
#9 -Used in Shovel Operation Only.
#10 -Boom Safety Ratchet Pawl Lever.
Pedal #B1 - Right Drum Brake Pedal.
Pedal #B2 - Boom Drum Brake Pedal.
Pedal #B3 - Left Drum Brake Pedal.

SUMMARY OF OPERATING LEVERS

(Levers common to all operating combinations)

OPERATION	POSITION OF LEVERS: PUSH	POSITION OF LEVERS: PULL
Swing right		#3 Lever
Swing left	#3 Lever	
Travel - Push #2 lever forward to shift from swing to travel	#3 Lever (For forward)	#3 Lever (For reverse)
Steer Right	#7 Lever	#8 Lever
Steer Left	#8 Lever	#7 Lever
Raise Boom	#4 Lever	
Lower Boom		#10 Lever #B2 Pedal
Lock for Digging		#7 Lever #8 Lever
Hoist Brake (Left Drum)	#B3 Pedal	
Swing Brake		#6 Lever
Boom Safety Pawl	#10 Lever (To engage)	#10 Lever (To disengage)
Right Drum Brake	#B1 Pedal	

LEVER APPLICATIONS WHEN USING VARIOUS ATTACHMENTS

NOTE--During the digging cycle in Shovel Operation, the left hand is used continuously for swinging. The right hand throws in the hoist lever and moves over to the crowd lever for control of crowding and racking-in. The right hand also bumps dipper trip for dumping.

	OPERATION	PUSH	PULL
CRANE	Hoist Load (Right Drum)		#4 Lever
	Lower Load (Right Drum)	#B1 Pedal	#B2 Spring released
SHOVEL	Hoist Dipper		#5 Lever
	Crowd		#4 Lever
	Rack-In	#4 Lever	
	Dipper Trip	Bump trip on handle of #4 Lever	
DRAG-LINE	Hoist Bucket		#5 Lever
	Drag Bucket		#4 Lever
CLAM-SHELL	Close Bucket		#4 Lever
	Hold Bucket		#5 Lever
	Dump Bucket		#B1 Pedal
PULL SHOVEL	Hoist Dipper		#5 Lever
	Dump		Release #B1 Pedal
	Lower Dipper		Release #B2 Pedal
	To Dig		#4 Lever

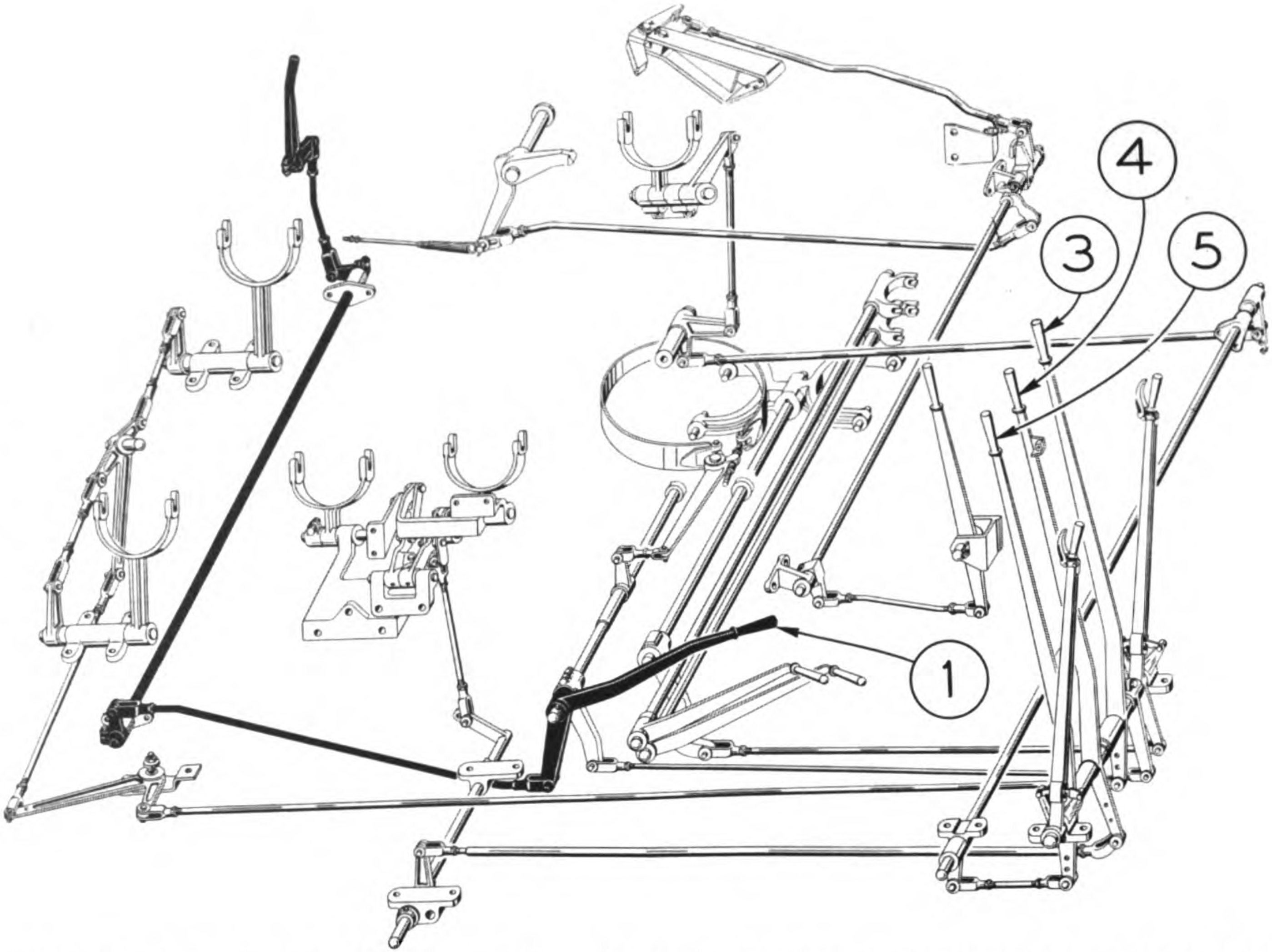


FIGURE 33

LEVER NO. 1 DESCRIBED—ENGINE CLUTCH LEVER

This lever operates the main engine clutch and should be down - engine clutch disengaged - while starting the engine. To engage engine clutch pull up on lever (1) until you feel it snap past a tight spot or, as ordinarily termed, "Snap into back-lock." It is best to engage engine clutch slowly with engine running at slow speed. BE SURE levers (3), (4) and (5) are in neutral position when engaging engine clutch. CAUTION: Engine clutch should never slip. See "Engine Clutch Adjustment", Page (87).

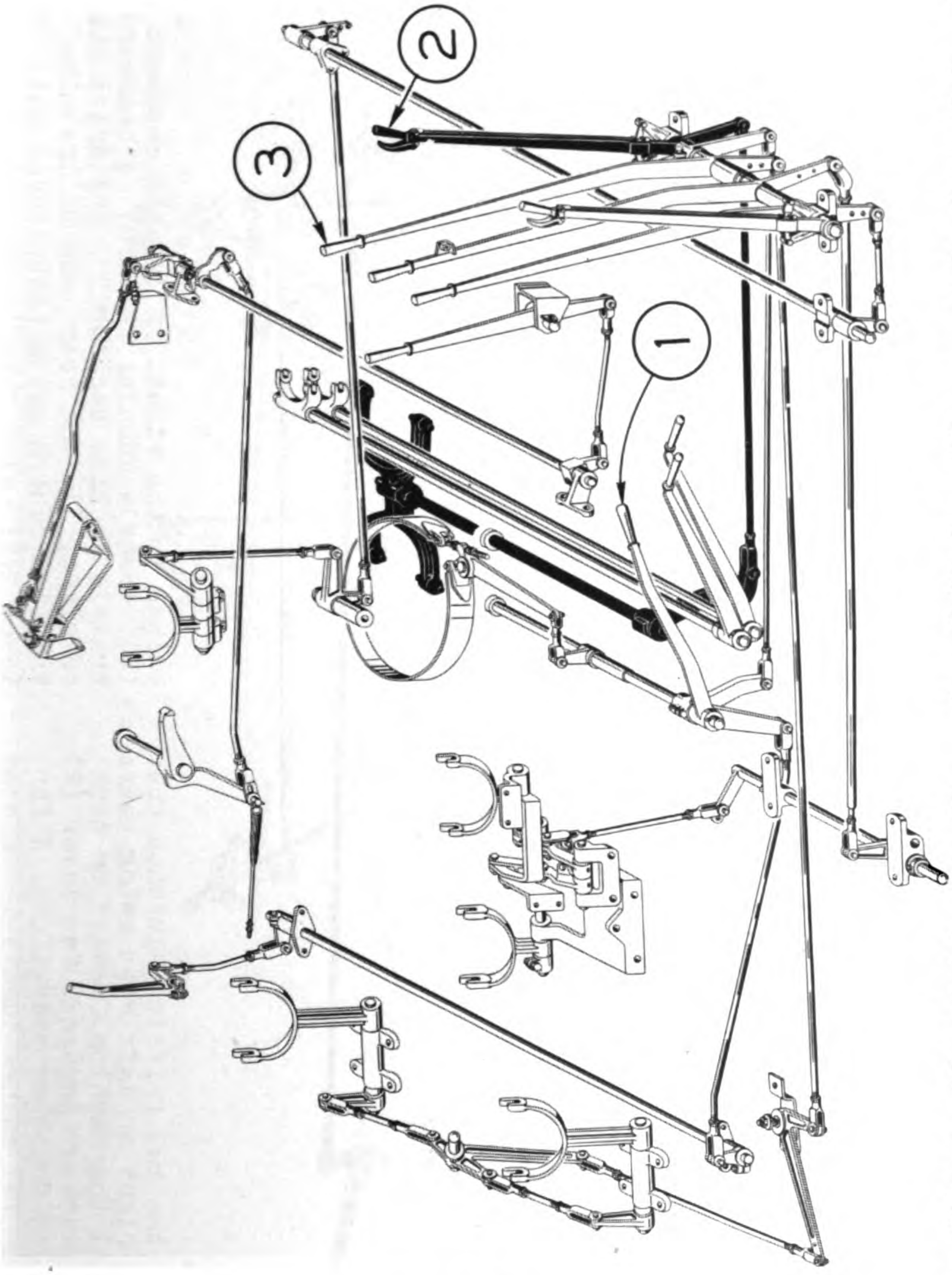


FIGURE 34

LEVER NO. 2 DESCRIBED - SWING AND TRACTION JAW CLUTCH LEVER

This lever has two positions. When latched in the forward notch, the travel gears are engaged and the machine will travel forward or backward by operating lever (3). When latched in the rear notch, the swing gears are engaged and the turntable and boom will swing right or left by operating lever (3). To shift lever (2), have lever (3) in neutral - engine clutch engaged, lever (1) up - pull back lever (2) to shift to swing or push forward to shift to traction. If lever (2) does not latch in selected position, keep pressure on it while moving lever (3) forward and backward SLOWLY, thus rotating the gears until they can be engaged and lever latched in proper notch. CAUTION: Be sure lever (2) is latched before operating machine.

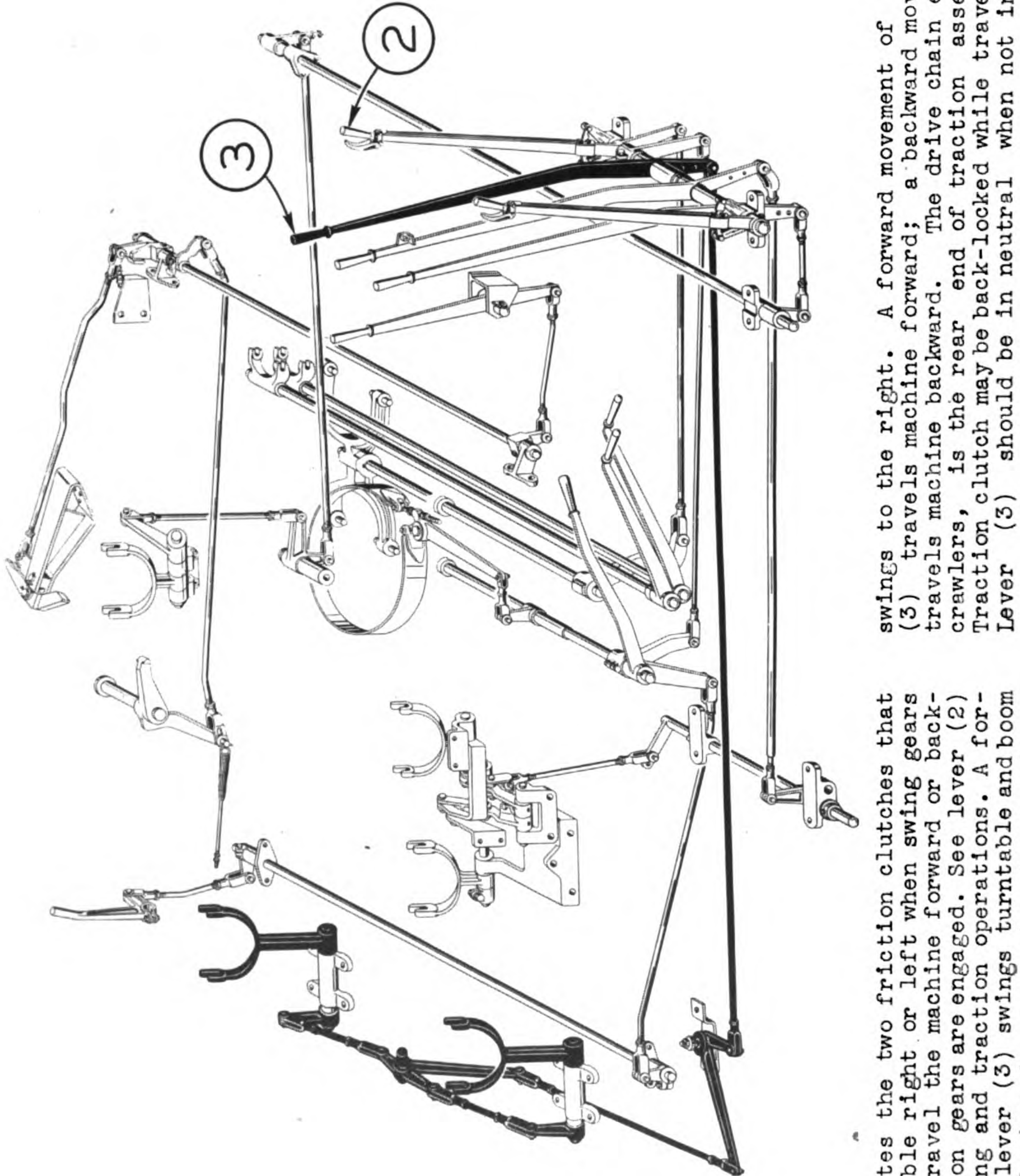


FIGURE 35

LEVER NO. 3 DESCRIBED—SWING AND TRACTION CLUTCH LEVER

This lever operates the two friction clutches that swing the turntable right or left when swing gears are engaged or travel the machine forward or backward when traction gears are engaged. See lever (2) for changing swing and traction operations. A forward movement of lever (3) swings turntable and boom to the left; a backward movement of same lever swings to the right. A forward movement of lever (3) travels machine forward; a backward movement travels machine backward. The drive chain end of crawlers, is the rear end of traction assembly. Traction clutch may be back-locked while traveling. Lever (3) should be in neutral when not in use.

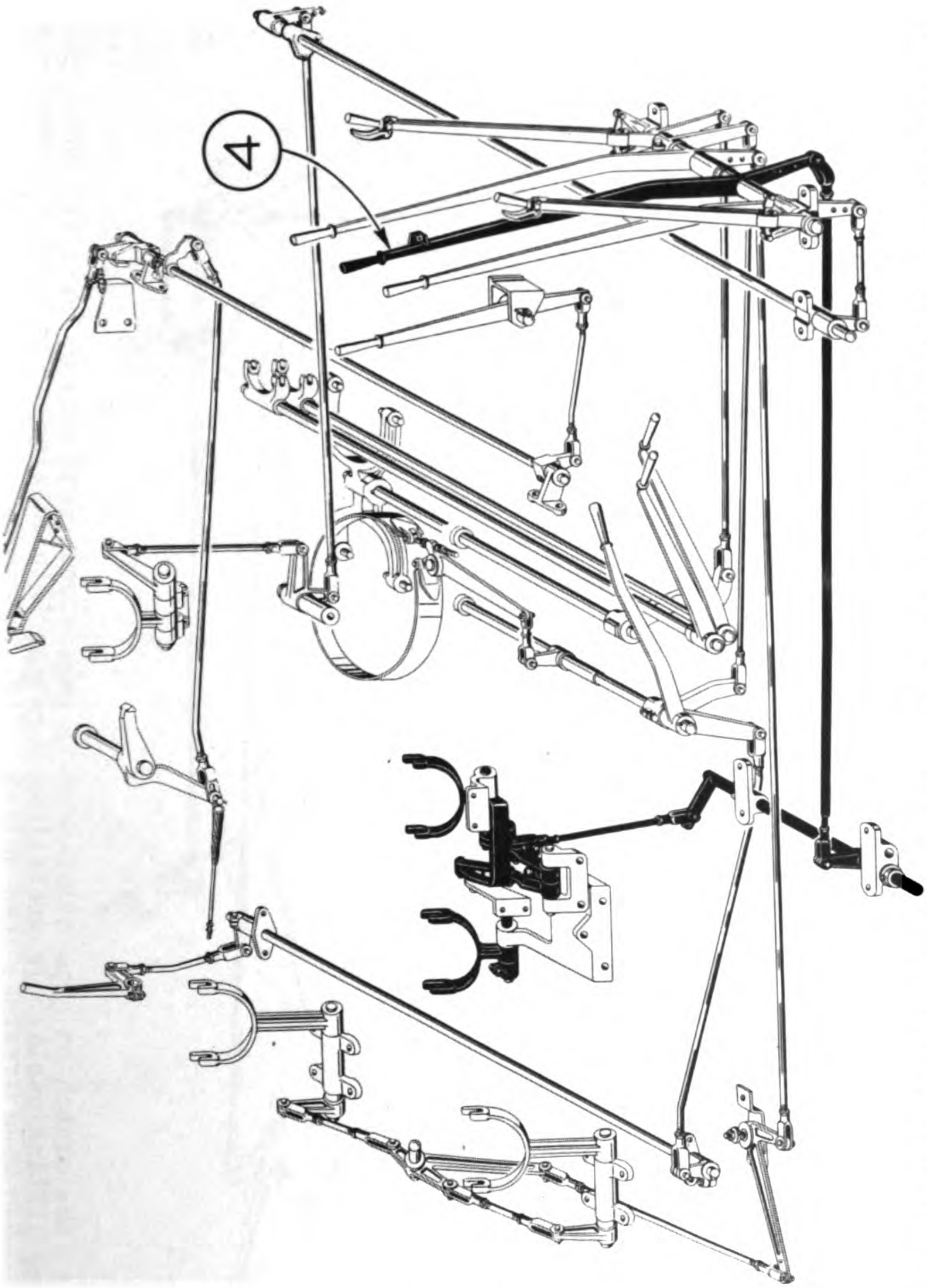


FIGURE 36

LEVER NO. 4 DESCRIBED-RIGHT DRUM CLUTCH AND BOOM HOIST LEVER
(As used in crane type operation)

This lever operates two friction clutches. When lever (4) is pulled back, the right hand drum clutch is engaged. In operation, this clutch is backlocked when the right hand drum is used as a dragline drum, closing line drum on a clamshell or as a hoist line drum on crane or clamshell. When lever (4) is pushed forward, the boom hoist clutch is engaged to raise the boom. Boom hoist clutch should not backlock. Lever (4) should be in neutral when engaging engine clutch. For the use of lever (4) in shovel operation, see "Operating A Shovel" under "Working Operations", page 60.

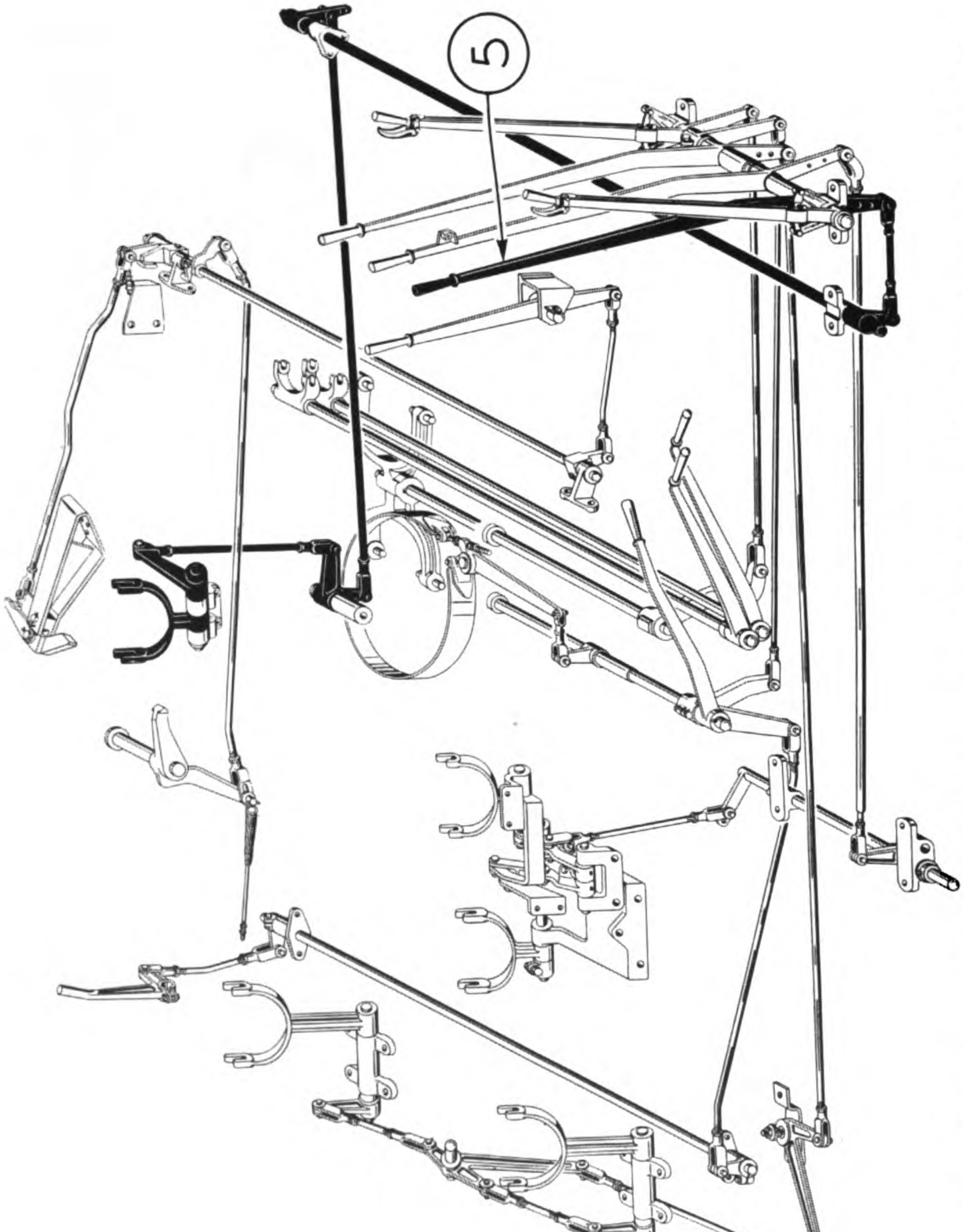


FIGURE 37

LEVER NO. 5 DESCRIBED-LEFT HAND DRUM CLUTCH LEVER

This lever operates the clutch on the hoist drum which winds the load lifting cable. In operation, this clutch is backlocked when lifting a load unless the load is to be raised only a few inches. To engage clutch pull back on lever (5) until the clutch snaps into backlock. To release clutch push lever (5) forward to end of travel. This clutch should be released when engaging engine clutch.

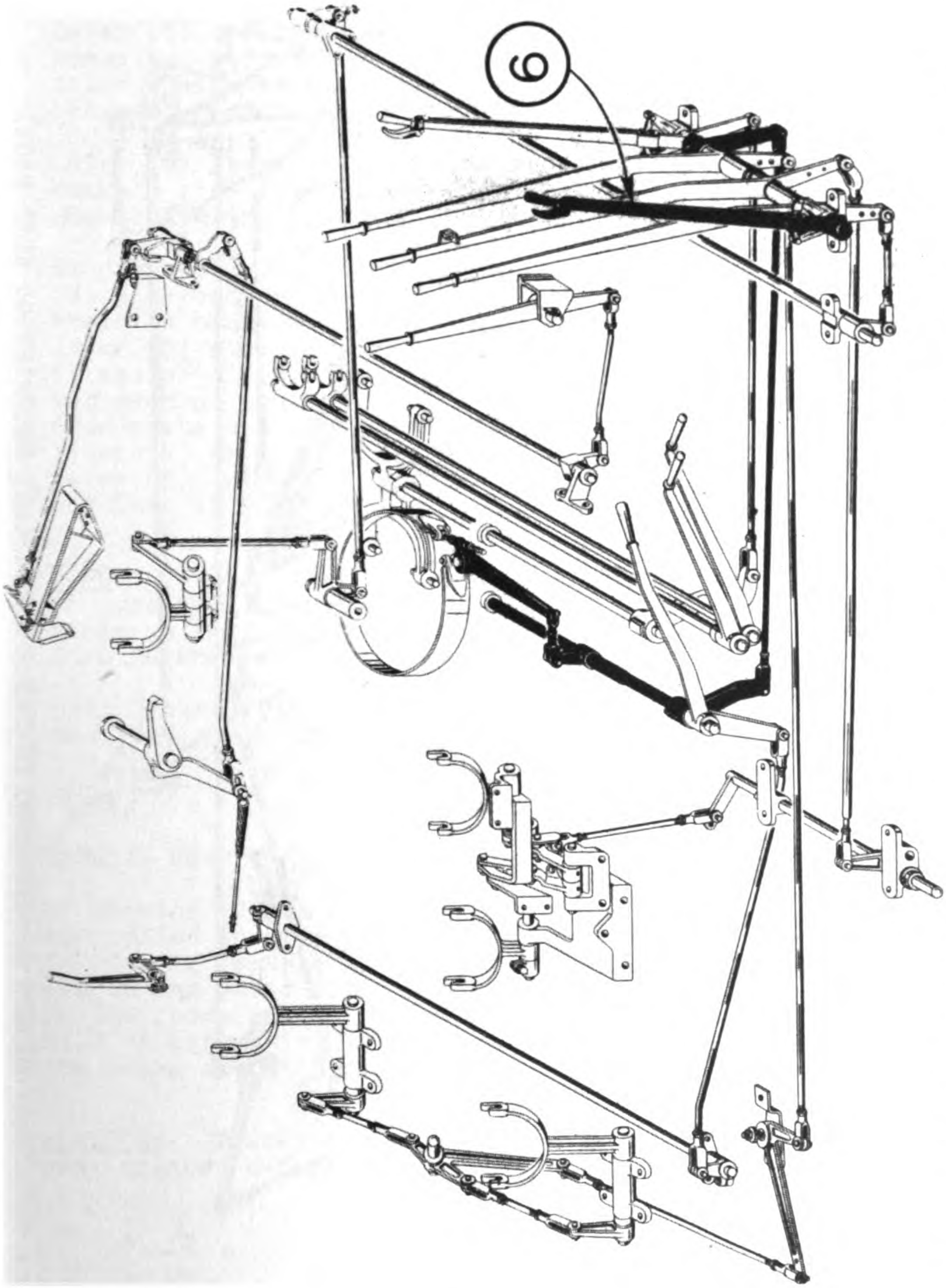


FIGURE 38

LEVER NO. 6 DESCRIBED-SWING BRAKE LEVER

This lever operates a brake which prevents the turn-table or upper deck from swinging. This lever must be in forward position - brake released - while operating in swing gear. CAUTION: Brake MUST be set when traveling. Operator should not get off machine without first setting swing and traction brakes and engaging boom pawl.

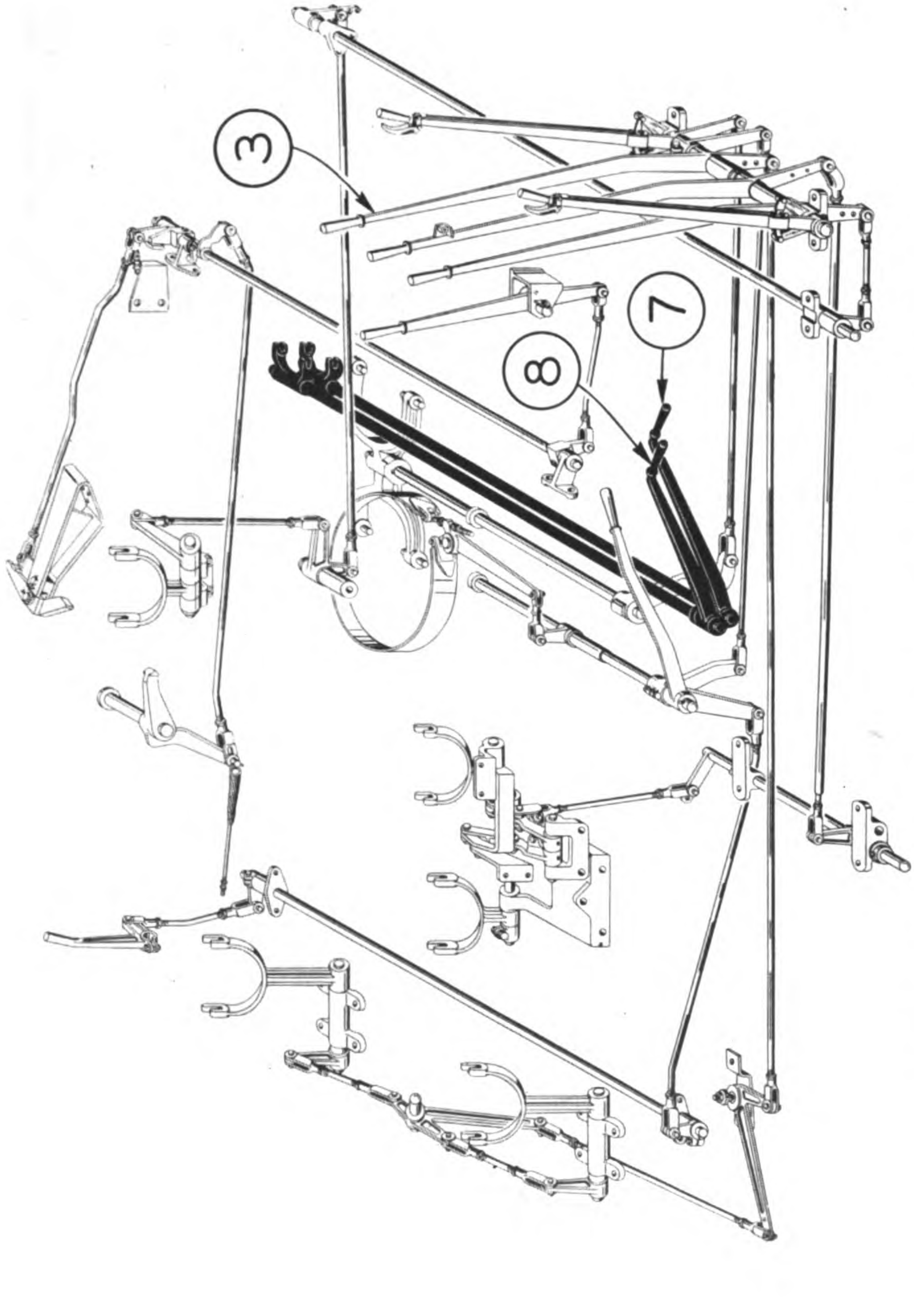


FIGURE 39-STEERING LEVERS 7 AND 8 (SEE DESCRIPTION NEXT PAGE)

LEVERS NO. 7 AND NO. 8 DESCRIBED

STEERING LEVERS:

These levers operate the steering jaw clutches and traction brakes on the lower traction shaft under the carbody.

Lever (7) operates the right hand steering jaw clutch and traction brake and steers the machine to the right when traveling forward - drive chains to the rear. It steers to the left when traveling backward - drive chains to the front.

Lever (8) operates the left hand steering jaw clutch and traction brake - steering to the left when traveling forward or to the right when traveling backward.

To operate, pull up into a backlock either lever (7) or lever (8) - depending upon the direction of steering - and the proper traction brake will be set. A momentary reverse on traction clutch lever (3) will release the load on the traction jaw clutch so that it can be disengaged. Continue travel operation with lever (3) and machine can be steered in desired direction. To release traction brake and engage steering jaw clutch, push down on steering lever (7) or (8), holding it down with left hand while reversing lever (3) until you are sure steering jaw clutch is fully engaged and that steering lever is at bottom of travel.

NOTE - Moving lever (3) forward or backward as directed above changes the direction of rotation of the lower traction shaft and lines up the traction jaws so they can be engaged or releases the load on the faces of the jaws so they can be disengaged.

Both levers (7) and (8) can be pulled up at the same time to set the traction brakes and disengage the traction jaw clutches, thus holding the machine stationary while working or when parked on an incline.

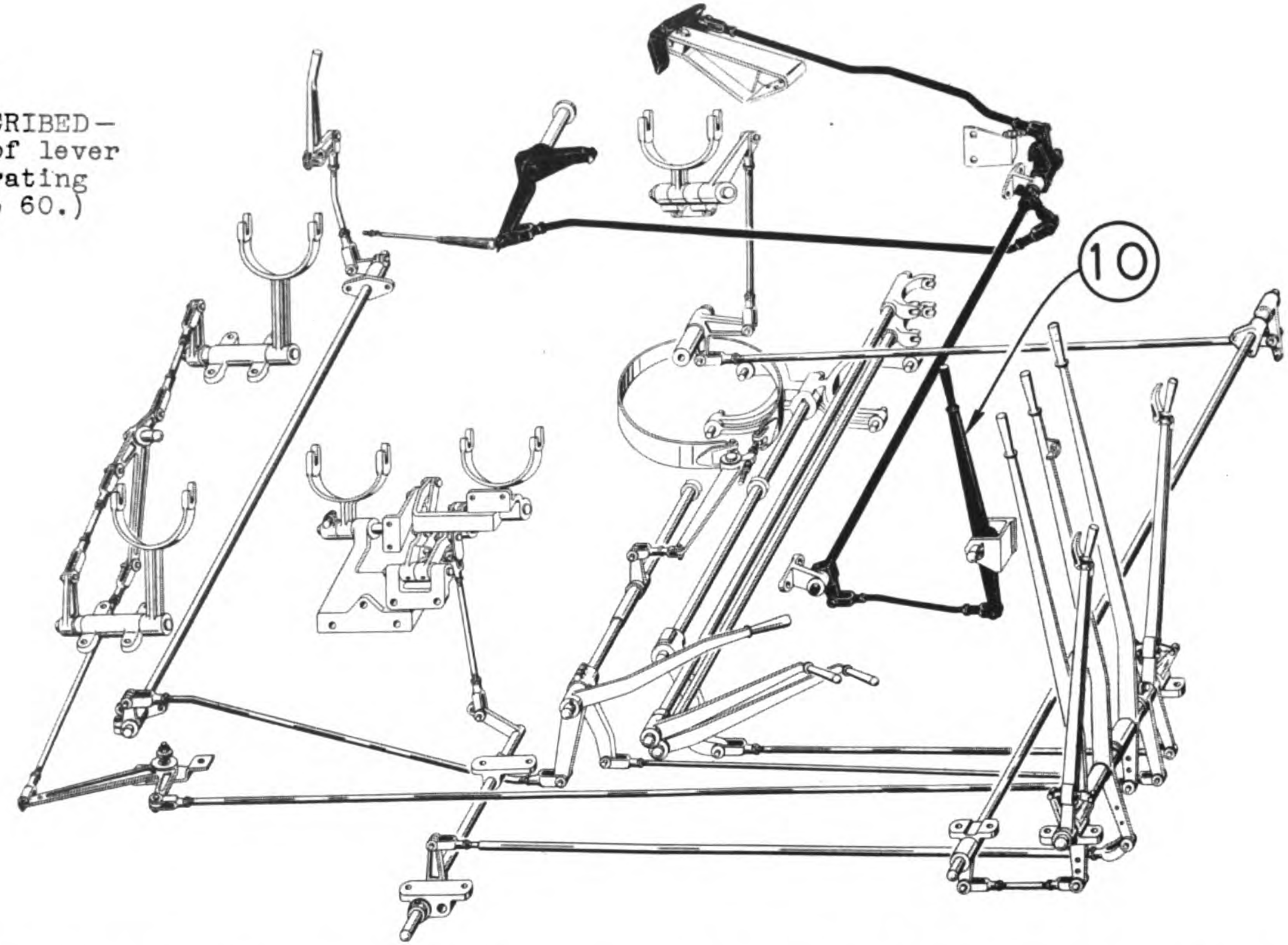
SPECIAL SAFETY FEATURE:

If machine starts coasting down grade, both traction brakes can be applied to stop machine by pulling up on levers (7) and (8). In such an emergency disregard all other levers. Setting the brakes may not disengage the traction jaw clutches until the load on the faces of the jaws has been released at which time the jaws will be automatically disengaged by a spring interconnected with the brake operating linkage.

CAUTION: Traction brakes and swing brake should be set and boom pawl engaged before operator gets off the machine.

FIGURE 40

LEVER NO. 10 DESCRIBED—
(For description of lever No. 9, see "Operating A Shovel", Page 60.)



BOOM SAFETY RATCHET PAWL LEVER: The boom safety ratchet pawl is in an engaged position when lever (10) is forward, disengaged when lever is back. Thus, to engage boom pawl, push lever (10) forward; to disengage, raise boom slightly and pull lever (10) backward. There is an interconnecting lever linkage that automatically prevents the boom pawl from becoming disengaged while boom is being raised. CAUTION: Never engage boom pawl while boom is being lowered. Always bring boom drum to complete stop before engaging ratchet pawl. Always be sure boom pawl is engaged before leaving machine.

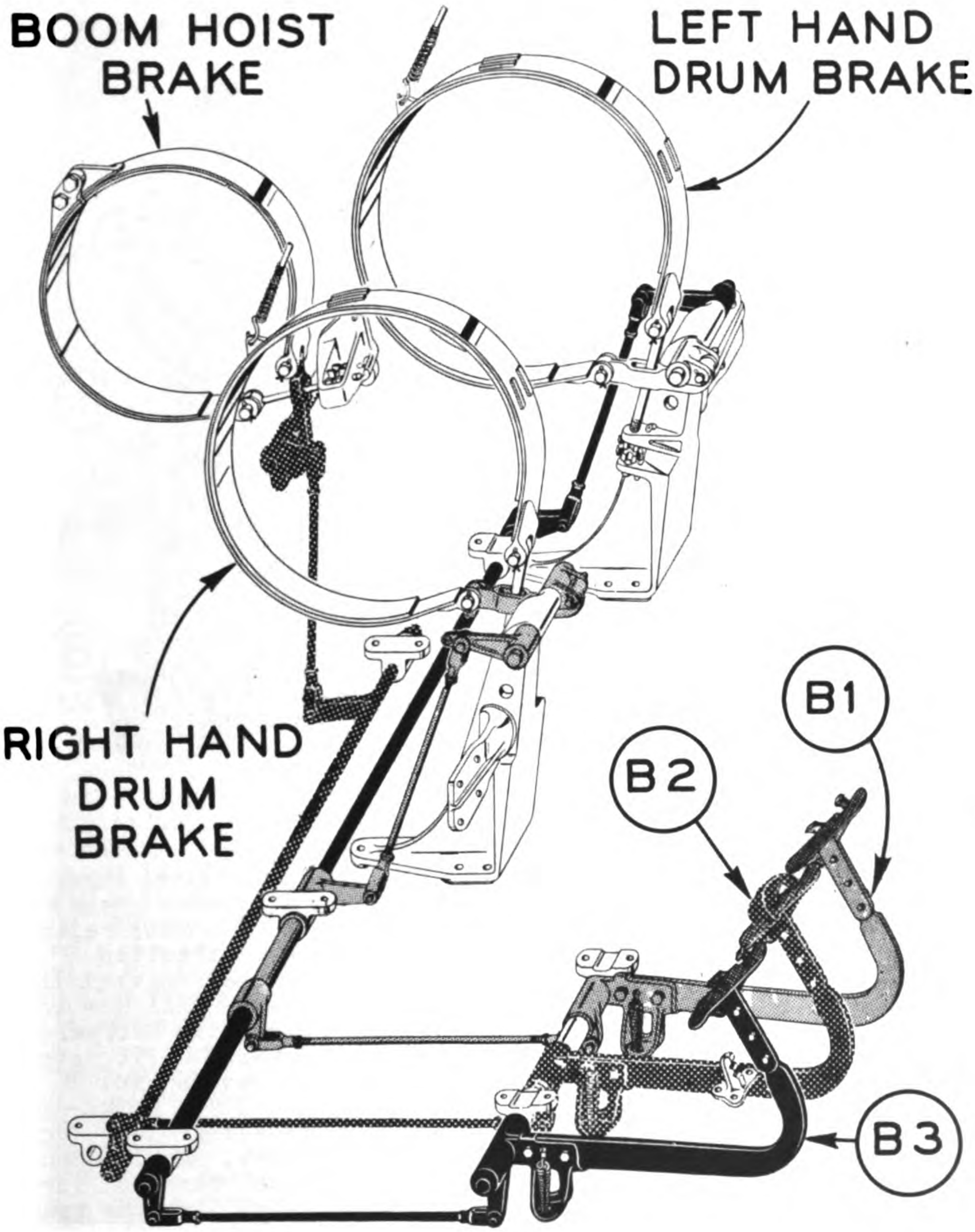


FIGURE 41

PEDALS B1, B2 AND B3 DESCRIBED—

PEDAL B1: This pedal operates the brake on the right hand drum. To set brake it is pushed down and can be latched in that position.
PEDAL B2: This pedal operates the brake on the boom hoist drum and is held under spring tension at all times.
PEDAL B3: This pedal operates the brake on the left hand drum. To set brake it is pushed down and can be latched in that position.

LEVER OPERATING PROCEDURE

(For levers named, see Page 42.)

TO START MACHINERY:

1. Be sure clutch levers No. 3, No. 4 and No. 5 are in neutral position.
2. Lift up on engine clutch lever No. 1 slowly until upper machinery is rolling freely then continue lifting the lever until you feel the engine clutch snap into a backlock.
NOTE--To avoid a jarring or jerking operation, the engine should be running only at idling speed when engaging engine clutch.

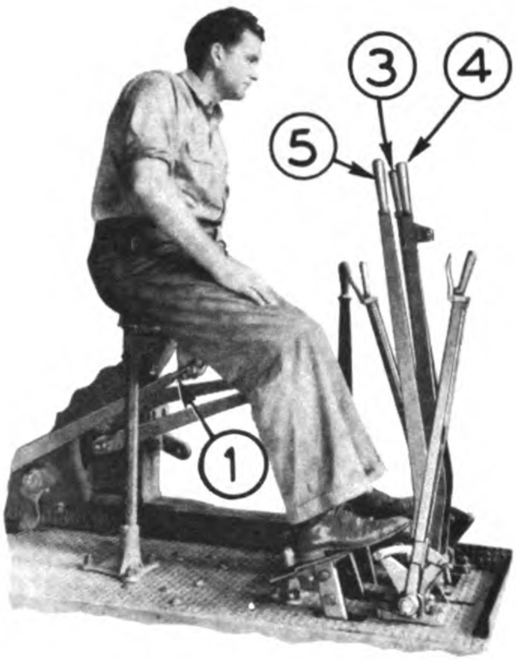


FIGURE 42

TO TRAVEL:

1. Lever No. 1 must be up (engine clutch engaged.)
2. Lever No. 2 must be in forward position (traction gears engaged.)
3. Lever No. 6 must be in backward position (swing brake set.)
4. Levers No. 7 and No. 8 must be down (traction brakes released and traction jaw clutches engaged.) Lever No. 3 will now travel machine forward or backward. (To steer, see Levers No. 7 and No. 8.) NOTE---When traveling long distances, machine should travel forward (drive chains in the rear.) Boom should be raised just high enough to balance machine so that weight is evenly distributed over all crawler rollers. If boom is too high the rear rollers will carry most of weight; if boom is too low the front rollers will carry most of weight.

FIGURE 43

LEVER OPERATING PROCEDURE (CONT'D.)

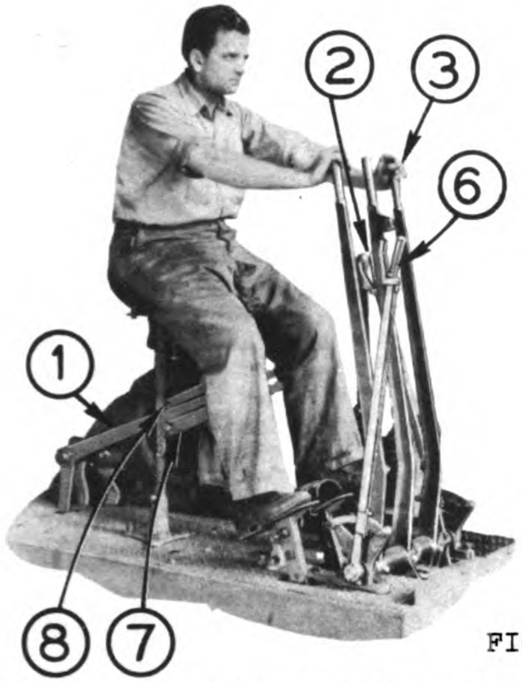


FIGURE 44

TO SWING:

1. Lever No. 1 must be up (engine clutch engaged).
2. Lever No. 2 must be in backward position (swing gears engaged.)
3. Lever No. 6 must be in forward position (swing brake released.)
4. Levers No.7 and No. 8 must be up (traction brakes set.) In some types of work on level ground, traction brakes do not need to be set. Lever No. 3 will now swing the turntable and boom right or left. To stop a swing motion, reverse on Lever No.3.

TO RAISE AND LOWER THE CRANE BOOM AND PULL SHOVEL GIB FRAME

1. Lever No. 1 must be up (engine clutch engaged.)
2. If Lever No.9 is on the machine, it must be in forward position (boom hoist engaged.) Lever No. 4 is now pushed forward to raise boom during which operation there will be a clicking noise made by the safety boom pawl dropping from one ratchet to the next. When boom is at desired working angle, return Lever No. 4 to neutral. With boom pawl Lever No.10 forward, place foot in stirrup of Pedal B2 and lift up slowly to make sure that safety boom pawl is firmly seated in the ratchet. To lower the boom, raise it slightly then disengage the safety boom pawl by pulling back on Lever No. 10; place foot in stirrup of Pedal B2 and lift up slowly. When boom is at desired angle, press down on Pedal B2; engage safety boom pawl (Lever No. 10 forward) then lift Pedal B2 slowly until you are sure safety boom pawl is firmly seated. CAUTION: Do not engage safety boom pawl while the boom is being lowered. To raise and lower shovel boom, see Page 105.

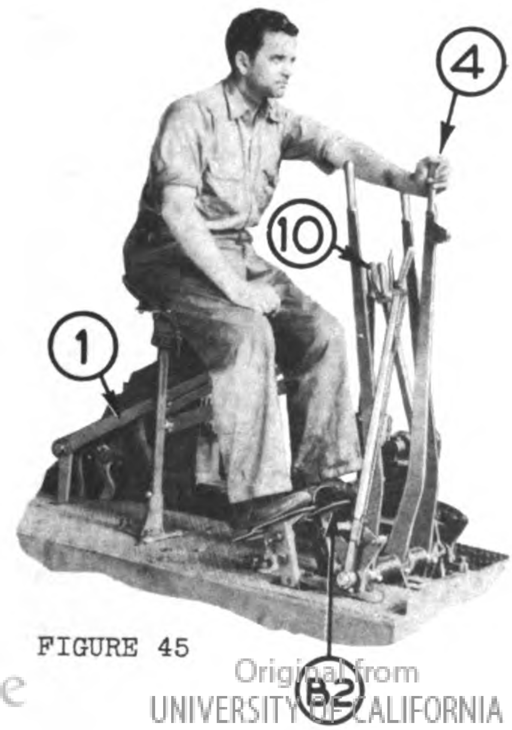


FIGURE 45

SAFETY PRECAUTIONS

For the safety of the operator and others working near the machine, and to prevent damage to the machine, the following rules should be observed:

1- Be sure all operating levers are in neutral before engaging engine clutch.
2- Always engage engine clutch slowly with the engine idling.
3- Always set swing brake when traveling.
4- Always set traction brake when parked or when operating on inclines.
5- Never lift loads greater than the rated capacity at given radii - the engine is powerful enough to tip the machine over.
6- Never swing fast when load is near or at rated capacity because fast swinging causes load to extend beyond boom point thus increasing the radius beyond the capacity of the machine. This carelessness might tip the machine over.
7- Keep the machine in good operating condition.
8- Keep the machine clean. The process of cleaning is one good way to discover trouble in the making such as loose bolts, water leaks, oil connections, etc.
9- When hand cranking the engine always use left hand and pull crank handle upward and across the engine. This reduces the hazard of the arm being struck by the crank handle should there be a reversal of direction of crankshaft rotation.
10-Read the operation section of this manual carefully.

CAREFUL OPERATION IS THE BEST INSURANCE AGAINST AN ACCIDENT.

RECEIVING A NEW MACHINE:

Before Koehring machines are shipped from the factory, they are given a final inspection. Each item is carefully checked with specifications after which each machine is put through an actual operating test. Despite these precautions, oversights sometimes occur or the machine might have been damaged in transit. To further safeguard the purchaser's interest, the machine should be carefully inspected before unloading, noting on the bill of lading any damaged or missing parts and reporting the same to the freight agent. Thus all parties concerned are properly protected until responsibility for such damages or shortages is determined.

STARTING A NEW MACHINE:

(These rules apply also to starting used machines.) Before starting machine, it should be thoroughly inspected by the operator. Remove metal shields from windows and store the shields in the rack provided for them on the left deck. Inspect all gear cases to be sure they are filled to the proper oil level. Check the greasing of machine and open gears. Inspect all cables to be sure there are no broken strands and that the cables are properly and securely fastened at both ends.

BEFORE STARTING THE ENGINE

LUBRICATION:

Check the amounts of oil in the engine and the air cleaner to be sure they are up to the proper oil levels. Refer to "Engine Lubrication", Page (67) for correct grades of oil to be used for the prevailing temperature. Remove the spark plugs and pour approximately 1/2 an ounce of engine oil into each cylinder to insure lubrication of the pistons and the cylinders at the first starting of the engine. Replace spark plugs. Note--This practice is also advisable when starting engines that have been idle for thirty days or more.

FUEL:

Fill the fuel tank. Add one pint of light engine oil to each five gallons of gasoline during the first fifty hours of operation. CAUTION: Never fill the fuel tank near an open flame or when the engine is running. Keep metal funnel in contact with metal filler when filling fuel tank to avoid the possibility of a static spark igniting the vapors.

COOLING:

Fill the cooling system with clean, soft water or anti-freeze solution, depending upon climatic conditions. The capacity is $8\frac{1}{2}$ U.S. gallons. Never pour cold water into an empty or parially empty cooling system if the engine is hot as it might cause the engine block or cylinder head to crack or warp. Never pour hot water into the cooling system when the engine is very cold as this, too, might cause the engine block or cylinder head to crack or warp.

STARTING THE ENGINE:

When you are sure all preliminary steps as outlined in the foregoing paragraphs have been completed, the engine is ready to start. Be sure engine clutch is disengaged (Lever No.1 down) and the ignition switch is off, Open the throttle about 1/4 way. Pull choke control all the way out; press on starter button and crank engine one or two revolutions. Next push choke control in half-way. Turn ignition switch on. Push starter button to start the engine. With cold motor, use choke sparingly until motor is running smoothly. Do not over choke. Let motor idle until it is thoroughly warmed before working it. Never race a cold motor. In extreme cold weather it might be necessary to remove the spark plugs and pour a small amount of gasoline into each cylinder before starting the engine. CAUTION: Be sure oil gauge registers pressure to show that oil is circulating. Do not run the engine more than a very few minutes without oil circulation. Never operate the starter more than 30 seconds at a time without pausing to allow the starter to cool. Excessive cranking periods will overheat the starter and cause its failure. A warm engine usually starts without using the choke. When the engine will not start due to "flooding" by over choking, push the choke control rod all the way in and let the engine stand several minutes to allow excess gasoline to evaporate. Also remove spark plugs, wipe them, and before replacing, crank the engine several revolutions to clear the cylinders of excess gasoline. CAUTION: Be sure ignition switch is off before removing plugs and while cranking engine with plugs out.

STOPPING THE ENGINE:

Before stopping the engine, disengage the engine clutch. Allow the engine to idle a few minutes then turn ignition switch off. CAUTION: Turning ignition switch off while engine is running fast does not give the cooling system a chance to carry off the excessive heat developed in the engine by high speed or heavy load operation.

WORKING OPERATIONS (Page 42)

HOISTING AND LOWERING A LOAD:

NOTE - Either or both right and left hand drums may be used. With the engine clutch engaged (lever No. 1 up) pull back on lever No. 5 slowly if the left hand hoist drum is used. As you feel the hoist clutch begin to engage, release the right hand brake pedal B-3 and continue pulling lever No. 5 back until the clutch is fully engaged or back-locked. When the load has been raised to the desired height, push down on the brake pedal B-3, setting the brake, and push forward on lever No. 5, releasing the hoist clutch. Setting the brake and releasing the hoist clutch must be an almost simultaneous operation - setting the brake a fraction of a second before releasing the hoist clutch. If the hoist clutch is released before the brake is set, the load will drop several feet before the brake catches it, thus putting an unnecessary strain on cables, boom, drum shaft and gears. The brake can be latched to hold a load suspended while traveling but in picking up a load and swinging it to another location, it is not necessary to latch the brake. To lower the load, ease the foot pressure on the brake pedal. If the right hand hoist drum is used for hoisting and lowering a load, operation follows the same procedure as above outlined except that lever No. 4 and brake pedal B-1 are used.

OPERATING A CLAMSHELL:

With the holding cable (left hand drum) and the closing cable (right hand drum) wound evenly on the drums with no slack in either cable, pull back on levers No. 4 and No. 5, engaging both drum clutches at the same time, and release brake pedals B-1 and B-3. When the bucket is high enough to swing over the material to be handled, push down on both brake pedals and release both clutches. If the bucket is not completely open, release left foot brake pedal B-1 slightly allowing the closing cable to unwind and the bucket to open, being careful to avoid too much slack in the cable. Swing the bucket over the material to be handled. Release both brake pedals B-1 and B-3 slightly, allowing the same amount of cable to unwind from both drums and the bucket will lower wide open to the material. With the closing cable drum clutch fully engaged or back-locked by pulling back on lever No. 4, release the left brake pedal B-1 and the bucket will begin closing. When the bucket is fully closed, fully engage the hoist clutch by pulling back on lever No. 5, release brake pedal B-3 and bucket and load will be raised. While the bucket is raising, swing the machine so the bucket will be over the desired location for depositing the material it contains. When the bucket has reached the desired height, press down on both brake pedals B-1 and B-3 and, with the right hand, release clutch levers No. 4 and No. 5. Releasing slightly on left brake pedal B-1 will open the bucket and release the load. NOTE: For clamshell operation, bend levers No. 4 and No. 5 close enough together so that they may be operated simultaneously with the right hand for disengaging both clutches. The left hand is then free for operation of the swing lever.

Precautions: Do not allow too much slack cable to unwind from

WORKING OPERATIONS (CONT'D.)

the drum when dropping the bucket on the material. Never drop a closed bucket on the material - it is destructive carelessness. Keep the cables winding evenly on the drums; crossing cables on drums will damage the cable. By keeping clutches and brakes properly adjusted and by following the operating procedure as outlined, there will be even wear on both clutch bands, both cables and both brakes. Better clamshell work can be done if machine is on level ground.

Tagline: If the tagline does not prevent the bucket from twisting around, more tension can be added by pulling several feet of cable off the drum, then hold the drum and rewrap around the drum the slack cable that has been pulled off.

OPERATING A DRAGLINE:

When dragline has been moved to its digging location, set the traction brakes (levers No. 7 and 8 up) to hold the machine stationary while dragging the bucket. For average dragline work the boom angle is usually between 30 and 40 degrees. However, certain types of work and height of spoil bank (excavated material) will determine boom angle. For example, a shallow cut will not produce a high spoil bank, therefore boom can be worked at a lower angle, whereas a deeper cut produces a higher spoil bank and consequently requires a higher boom angle for sufficient clearance to dump dragline bucket. After checking the hoist cable (left hand larger drum) and the drag cable (right hand smaller drum) to be sure the cables are wound evenly on the drums and that there is no slack, pull back on hoist clutch lever No. 5 and release brake pedal B-3 to lift the bucket to a height that is just a little more than the length of the bucket when lever No. 5 is pushed forward to disengage clutch and brake pedal B-3 is pressed down to hold bucket suspended. Swing bucket over material to be excavated. Lower the bucket to the material by releasing brake pedal B-3 gradually. Engage the drag clutch (lever No. 4) and release brake pedal B-1. As the bucket is pulled toward the machine, it will dig and load the bucket with the material being excavated. The depth of digging is controlled by tension on the hoist cable. The bucket will be filled at some point between the fairlead and the boom point when it should be raised by the hoist cable while tension on the drag cable is controlled to prevent spillage. CAUTION: The drag cable anchor on the drag chains of the bucket must never be pulled against the dragline fairlead. When the bucket is filled, push down on brake pedal B-1 and release drag clutch lever No. 4. Engage hoist clutch lever No. 5 and release hoist brake pedal B-3 Release brake pedal B-1 just enough to balance the bucket and load while it is being hoisted. CAUTION: Holding the drag brake too tight will increase the hoist load and hold the bucket too close to the under side of the boom. When the drag brake is too loose it allows the bucket to tip down and spill the load while hoisting. Never hoist the bucket against the boom point. Swing the machine to dumping position while hoisting and when the bucket has reached the desired height, set the hoist brake pedal B-3 and release the hoist clutch lever No. 5. To dump the bucket, release the drag brake pedal B-1 gradually. Always keep slack out of the cables and be sure cables wind evenly on the drums while operating.

Dragline operation requires a good sense of timing and much practice. As you become more proficient, you will be able to cast the

WORKING OPERATIONS (CONT'D.)

bucket several feet beyond the boom point either by accurately timing the drag brake release as you swing toward the digging position or by stopping the machine at the end of the swing, pulling the bucket up near the boom foot then releasing the drag brake, allowing the bucket to swing out beyond the boom point then letting the bucket down. The short cable from the arch of the bucket around a sheave on the hoist chains and down to the ends of the drag chains is called a "dump cable" and is furnished with the bucket. This cable may be lengthened or shortened to improve the balancing of the bucket. To avoid damaging the bucket, the dump sheave, the spreader bar and chains, never drop the bucket from any great height. Dropping the bucket flat on the ground will bend the bottom and thus impair the digging angle of the lip and teeth - the teeth and the front of the bucket arch should rest on the ground to be in proper digging position.

OPERATING A SHOVEL:

As illustrated on page 27, the principal operation motions of a shovel are hoisting the dipper, crowding out and racking-in the dipper, and swinging from digging position to dumping position and back. When machine is at the digging location, set the traction brakes (levers No. 7 and No. 8 up) to hold the machine stationary while working. In average work the boom should be at an angle of approximately 45 degrees. When working against a high bank which requires a high digging reach, the boom should be higher but never beyond a 65 degree angle. In a low or shallow cut the boom should be lower but never beyond a 35 degree angle. After the boom has been set at the proper working angle, with dipper on the ground, be sure the boom safety ratchet pawl is firmly seated. Shift lever No. 9 toward the operator to racking-in position. Shift lever No. 2 back to position for engagement of swing gears. Engage the racking-in clutch (lever No. 4 forward) to raise the dipper slightly for clearance then engage the hoist clutch (lever No. 5 back) with the right hand; release the hoist brake B-3; engage the crowd clutch (lever No. 4 back) with the right hand and release crowd brake pedal B-1. After the dipper has been crowded into the bank - just far enough to slice off a cut deep enough to fill the dipper as it is being hoisted - release the crowd clutch (lever No. 4 forward to neutral) and set the crowd brake (pedal B-1 down), thus holding the dipper at the desired digging depth while hoisting. When the dipper is full, release the crowd brake and rack-in the dipper away from the bank for clearance while swinging. Release the hoist clutch when the dipper has reached the desired height and set the hoist brake. Swing the dipper to dumping position then press down on the dipper trip lever to open the dipper door for discharge of the material. The dipper door will slam shut and lock as it is being lowered on the return swing to digging position. Never crowd the dipper with such force that it stalls the engine. Do not hold the dipper crowded into the bank by slipping the crowd clutch as this practice puts unnecessary wear on the crowd clutch band and takes power away from the hoist effort. The dipper can be held in any position - crowded out beyond the boom point or racked-in under the boom - with the crowd brake. The dipper can be held at any height with the hoist brake. Never swing while the dipper is resting on the ground or while digging to avoid bending the dipper sticks or twisting the boom. Never crowd out the dipper so far that the stops (sometimes called greenhorns) on the under side of the dipper sticks strike the shipper shaft pinions. Never rack in so far that dipper stick spacer block strikes boom. During operation, the

WORKING OPERATIONS (CONT'D.)

left hand is used to engage the swing clutch. The right hand is used to engage the hoist clutch then shift to engage the crowd clutch and back to the hoist lever when crowding is completed. The only exception to this procedure is when making shallow cuts where it is necessary to engage the crowd clutch slightly ahead of the hoist clutch. In this latter case the left hand is used on the crowd lever and the right hand on the hoist lever. The crowd clutch should be adjusted so that it does not back-lock during operation. Never drop the dipper too fast. Avoid striking the crawlers and thus eliminate damage to the machine and dipper.

When loading hauling equipment, never hold the dipper too high for dumping as the falling material might damage the truck or wagon. If the dipper becomes loaded at the bottom of a cut rack in enough to clear the rest of the bank while hoisting - hoisting a loaded dipper through the bank consumes extra power and time. Much practise and keen observation is required to become an efficient shovel operator.

OPERATING A PULL SHOVEL:

The operating cycle of a pull shovel consists of extending the dipper arm with dipper to its maximum reach; lowering the boom, arm and dipper to the digging point; pulling the dipper to the machine to fill it; hoisting and swinging to dumping position; dumping then swinging back to digging position. When machine is at digging location, set the traction brakes (levers No. 7 and 8 up) to hold the machine stationary while pulling on the dipper. Engage the hoist clutch (lever No. 5 back) and release hoist brake pedal B-3. Release drag drum brake pedal B-1 just enough to allow cable to pay out until the dipper arm is fully extended. Release hoist clutch (lever No. 5 forward) and set hoist brake pedal B-3. Lower the dipper to the ground by slightly releasing the hoist brake. Engage the drag clutch (lever No. 4 back) to pull the dipper toward the machine thus filling the dipper. The depth of the cut can be controlled by the tension held on the hoist cable with the hoist brake. When the dipper is filled, or pulled up close to the boom, release the drag clutch and set the drag brake. Engage the hoist clutch and release the hoist brake to raise the boom and dipper. Swing to dumping position. Releasing slightly on the drag brake will allow the dipper to swing out for dumping the excavated material. As the drag cable is paying out in the dumping operation, it is necessary to wind some hoist cable on the hoist drum to prevent the boom from lowering. Swing back to digging position. Do not swing the machine while the dipper is on the ground or being filled to avoid damaging the dipper arm and boom. Keep the cables winding evenly on the drums. Do not drop the dipper more than a few inches to force the teeth into exceptionally hard material.

WORKING OPERATIONS (CONT'D.)

MAIN DRUM SHAFT

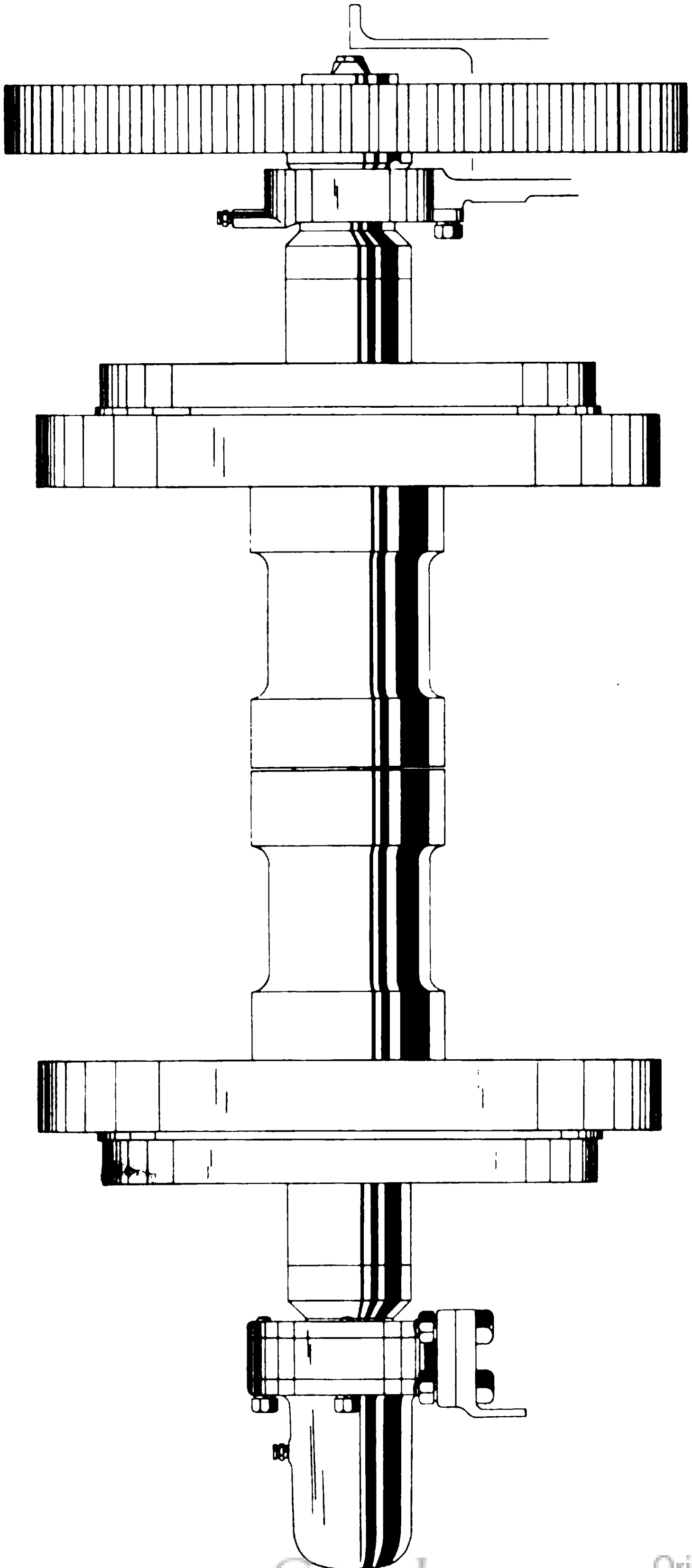


FIGURE 46

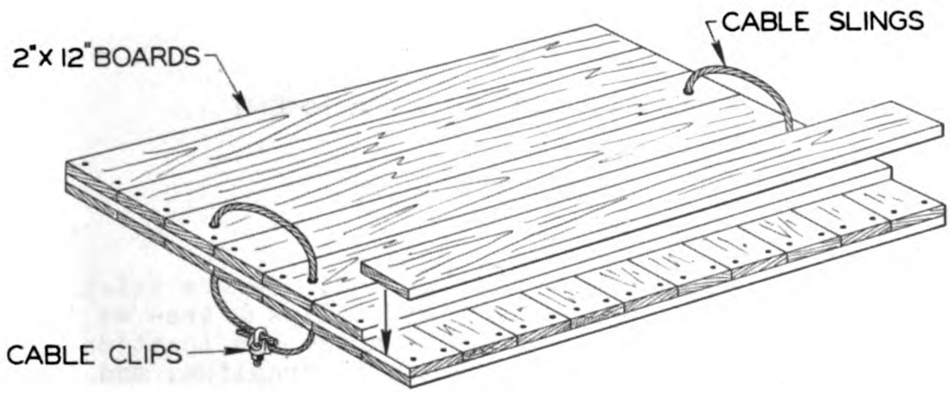
The main drum skeleton shaft is designed as illustrated in Figure 46 above. Application of the drum and sprocket laggings for use in operating the various combinations is described under "Equipment Changes For Various Operations" beginning on Page 95.

OPERATION UNDER ABNORMAL CONDITIONS

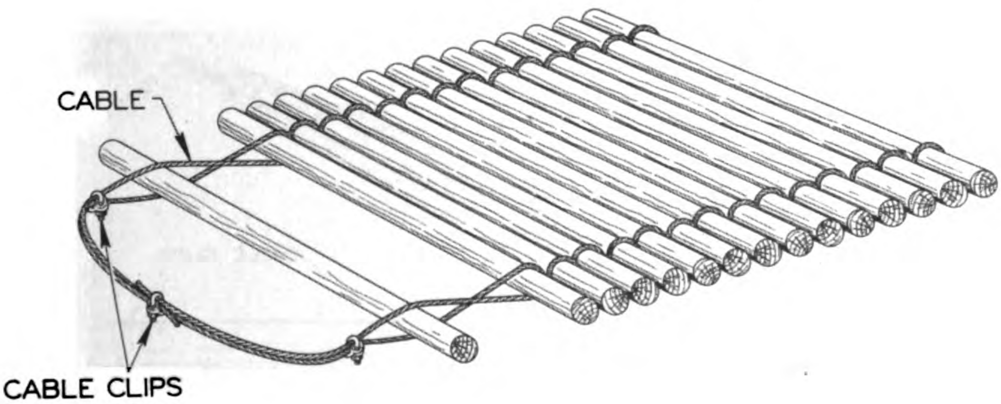
EXTREME SOFT GROUND:

A firm footing for the machine is essential. If the ground is soft enough to bog down the crawlers, mats should be used. Mats are usually made in sets of three or four so that when finished with one cut, the second and third mats can be swung into position ahead of those on which the machine is working and thus provide a continuous firm path for the machine. Mats may be built of 2" x 12" timbers or logs as illustrated in Figure 47 below.

The timber mat should be of laminated construction as shown with each board securely nailed. Holes should be bored through each end for insertion of cable slings as shown. Pieces of old cable can be used for this purpose. Mats can also be built of logs or poles laced together with old cable as shown in Figure 47, allowing enough overlap at one end for slings.



BOARD MAT



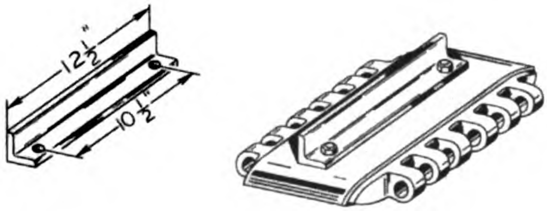
LOG MAT

FIGURE 47

OPERATION UNDER ABNORMAL CONDITIONS (CONT'D)

EXTREME SLIPPERY GROUND:

To prevent slipping in hard wet clay, ice or snow, grousers should be attached to crawler pads as shown in Figure 48 below. Holes are provided in each crawler pad for the attachment of grousers with ordinary 3/4" machine bolts. Grousers may be cut in $12\frac{1}{2}$" lengths and drilled with two 13/16" holes on one side as shown.



CLEAT-METHOD OF ATTACHMENT

FIGURE 48

WHEN MIRED IN SOFT GROUND:

If machine becomes mired in soft ground, remove hoist cable from boom and attach free end securely with clips to tree as illustrated in Figure 49 below. Apply power to hoist and traction until machine is on firm ground. If machine is dragline, use drag cable. Illustration shows front end down. If rear end is down swing cab around and fasten cable to tree in rear.

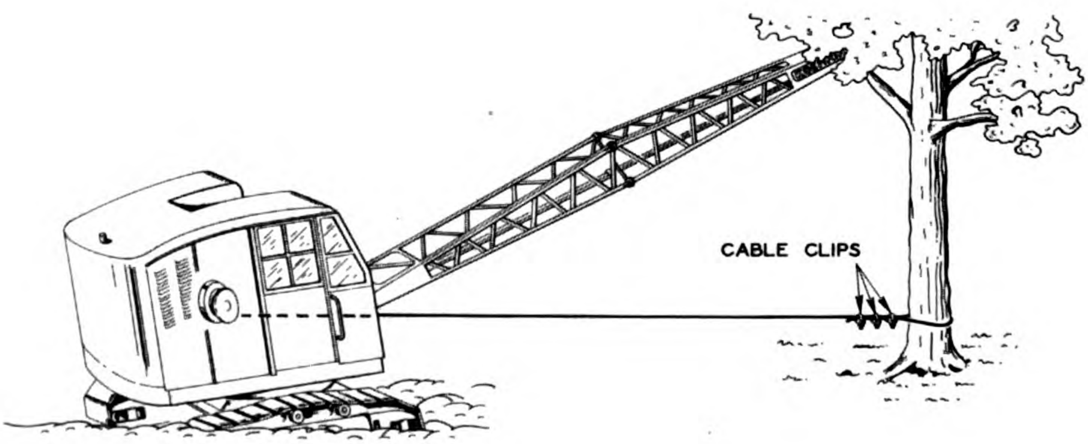


FIGURE 49

NOTE - For engine operation under abnormal conditions see Engine Section.

NOTES

WAR DEPARTMENT LUBRICATION GUIDE
CORPS OF ENGINEERS CHART NO. 1054
POINTS ABOVE TURNTABLE

CRANE, CRAWLER-MOUNTED, GASOLINE, ¾-CU YD, WITH ATTACHMENTS
(KOEHRING, MODEL 304)

MFR'S. SERIAL No. located on name plate at left of operator's position in cab.

Reference TM 5-1168.

TABLE OF CAPACITIES AND LUBRICANTS TO BE USED

UNIT	CAPACITY (Approx.)	LOWEST EXPECTED AIR TEMPERATURE		
		Above +32°F.	+32°F. to 0°F.	Below 0°F.
Power Unit Crankcase	8 qt.	OE SAE 30	OE SAE 10	Refer to TM 5-1168
Chain Drive Case	5 qt.	OE SAE 50	OE SAE 30	
Main Gear Case	10 qt.	GO SAE 90	GO SAE 90	GO Grade 75
Turntable Gear Case-Lower	18 qt.			

—KEY—

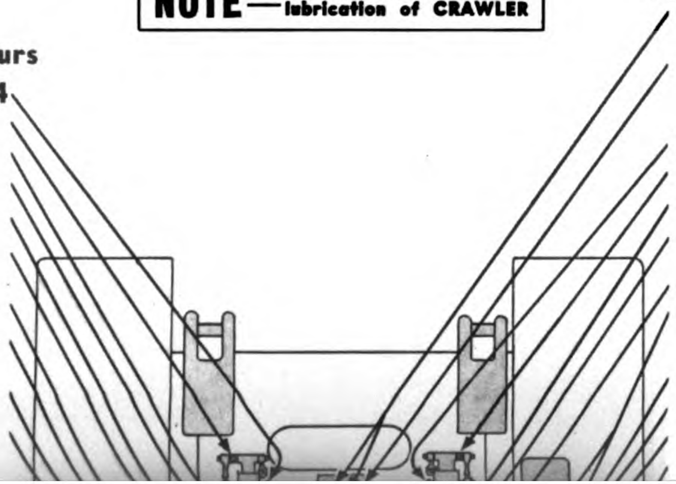
Lubricants

OE—OIL, engine
Crankcase grade
(unless otherwise specified)
GO—LUBRICANT, gear, universal
CG—GREASE, general purpose
No. 1 (above +32°F.)
No. 0 (below +32°F.)
WB—GREASE, general purpose No. 2
WP—GREASE, water pump

NOTE—See Reverse Side for lubrication of CRAWLER

Lubricant • Hours

Drum Bearing (Note 8) WB 1024
Brake Control Shaft CG 64
Clutch Crank (Sparingly) WB 64
Shifter Ring CG 8
Clutch Control Shaft CG 64
Swing Shaft Gear (Note 7) CG 4
Drum Shaft Bearing WB 256
Racking In Sprocket (Shovel only) CG 256
Brake Control Crank CG 64
Shifter Ring (Shovel only) CG 8

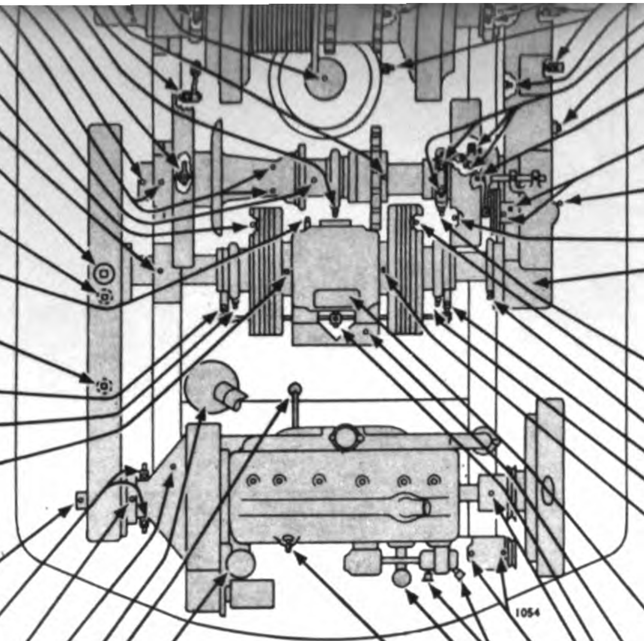


Hours • Lubricant

64 OE Shifter Fork and Collar (Remove turntable-gear case cover)
64 GO Turntable Gear Case-Lower Fill (See Table) (Fill with 18 qt. exactly)
1024 WB Drum Bearing (Note 8)
64 CG Brake Control Shaft
64 WB Clutch Crank (Sparingly)
64 CG Control Shaft Bearings (Reached through hand hole)
8 CG Shifter Ring
64 CG Lever and Control Shaft Bearings
64 CG Clutch Control Shaft
256 WB Drum Shaft Bearing
64 CG Clutch Control Shaft
64 CG Lever and Control

WAR DEPARTMENT LUBRICATION GUIDE
CORPS OF ENGINEERS CHART NO. 1054
POINTS ABOVE TURNTABLE

(Shovel work, lubricate every 4 hours)		
Shifter Sleeve (Shovel only)	CG	64
Clutch Crank (Sparingly)	WB	64
Jack Shaft Bearing	WB	256
Chain Drive Case Fill (See Table)	OE	64
Chain Drive Case Drain Plug Drain and refill (Note 6)		128
Intermediate Gear-Upper Bearing (Note 7)	CG	8
Chain Drive Case Level Plug Check level		64
Clutch Control Shaft	CG	64
Shifter Ring	CG	8
Swing and Traction Shaft Bevel Pinion Bearing (Remove bevel gear case cover) (Note 8)	WB	1024
Clutch Pilot Bearing (Remove pipe plug)	WB	256
Engine Clutch Control Shaft (oil holes)	OE	32
Take-Off Shaft Bearing (Sparingly)	WB	8
Engine Clutch Collar (Sparingly)	CG	8
Air Cleaner (Note 4)	OE	8
Crankcase Drain Plug Drain and refill (Note 5)		64
Oil Filter (Clean case and replace element)		128



64	CG	Clutch Control Shafts
1024		*Main Gear Case Drain Plug* Drain and refill (Note 6)
1024	WB	Boom Hoist Clutch Brg. (Note 8)
1024	WB	Dipper Trip Bearings (Shovel only) (Note 8)
256	WB	Dipper Trip Bearing (Shovel only)
64	WB	Clutch Crank (Sparingly)
64	GO	Main Gear Case Fill (See Table) (Note 6) (Remove inspection plate and fill to lower edge)
8	CG	Shifter Ring
64	WB	Clutch Crank (Sparingly)
256	WB	Jack Shaft Bearing
64	CG	Clutch Control Shaft
8	CG	Shifter Ring
1024	WB	Swing and Traction Shaft Bevel Pinion Bearing (Remove bevel gear case cover) (Note 8)
4	WB	Bevel Gear Case (Open inspection plate, spread grease in case on gear teeth)
8	CG	Bevel Gear Shaft-Upper Bearing (Sparingly)
32	CG	Clutch Control Lever
64	CG	Fan Hub
64	OE	Generator (3 to 4 drops)
32	WP	Water Pump
8	OE	Crankcase Fill (See Table) Drain and refill (Note 5)
8		*Crankcase Level* Check level

POINTS ABOVE TURNTABLE

(See Guides No. 1054A and No. 1054B for lubrication of points BELOW TURNTABLE and ATTACHMENTS)

SEE REVERSE SIDE

For Additional Lubrication and Service Instructions on Individual Units and Parts

Requisition replacement guide from The Engineer Field Maintenance Office, P.O. Box 1679, Columbus, Ohio.

24 Nov. 43

Above guide supersedes all previous instructions.

CHEK-CHART **No.1054** [NOT TO BE REPRODUCED in whole or in part without permission of the Office of the Chief of Engineers.]

WAR DEPARTMENT LUBRICATION GUIDE
CORPS OF ENGINEERS CHART NO. 1054
POINTS ON CRAWLER

CRANE, CRAWLER-MOUNTED, GASOLINE, ¾-CU YD, WITH ATTACHMENTS
(KOEHRING, MODEL 304)

MFR'S. SERIAL No. located on name plate at left of operator's position in cab. Reference TM 5-1168.

TABLE OF CAPACITIES AND LUBRICANTS TO BE USED

UNIT	CAPACITY (Approx.)	LOWEST EXPECTED AIR TEMPERATURE		
		Above +32°F.	+32°F. to 0°F.	Below 0°F.
Lower Traction Bevel Gear Case	2 qt.	GO SAE 90	GO SAE 90	GO Grade 75

NOTE—See Reverse Side for lubrication of points ABOVE TURNTABLE

—KEY—

Lubricants

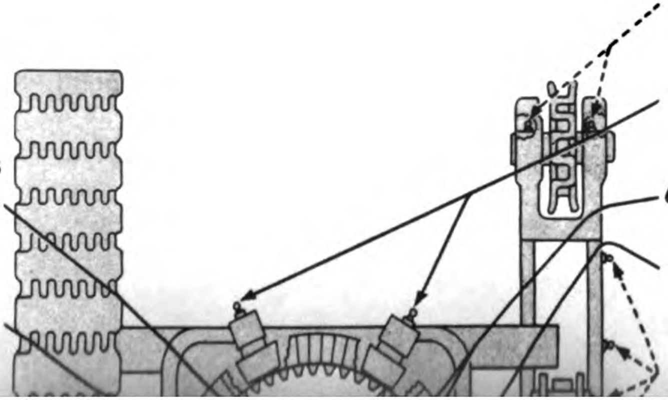
- **OE**—OIL, engine Crankcase grade (unless otherwise specified)
- **GO**—LUBRICANT, gear, universal
- **CG**—GREASE, general purpose No. 1 (above +32°F.) No. 0 (below +32°F.)
- **WB**—GREASE, general purpose No. 2
- **CW**—OIL, lub., chain and wire rope, grade 2

CAUTION Lubricate Dotted Arrow Points on BOTH SIDES

Lubricant • Hours

Lower Traction Bevel Gear Case Fill and Level (See Table) (Note 6) **GO 64**

Lower Traction Bevel Gear Case Drain Plug Drain and refill (Note 6) **1024**



Hours • Lubricant

8 CG Front Tumbler Bearings (Note 7)

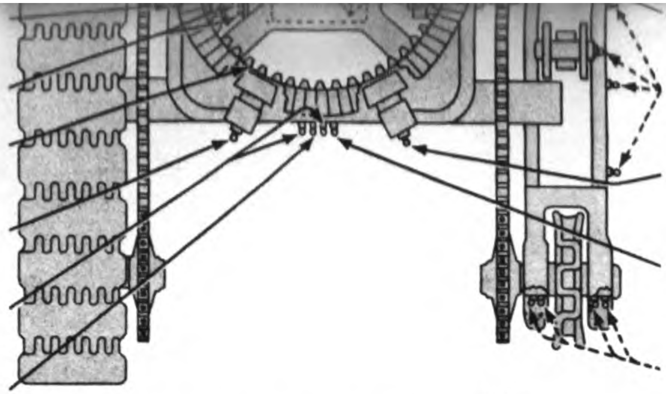
4 CG Turntable Rollers (Note 10)

64 CG Shifter Shaft

8 CG Traction Shaft Bearing (Note 7)

8 CG Guide Rollers (Note 7)

WAR DEPARTMENT LUBRICATION GUIDE
CORPS OF ENGINEERS CHART NO. 1054
POINTS ON CRAWLER



POINTS ON CRAWLER

(See Guides No. 1054A and No. 1054B for lubrication of points BELOW TURNTABLE and ATTACHMENTS)

NOTES Additional Lubrication and Service Instructions on Individual Units and Parts NOTES

1. FITTINGS—Clean before applying the lubricant gun.
2. CLEANING—SOLVENT, dry-cleaning, or OIL, fuel, Diesel, will be used to clean or wash all parts. Use of gasoline for this purpose is prohibited. All parts will be thoroughly dry before relubrication.
3. HOURS—The hours indicated are for normal service. For extreme conditions of heat, water, mud and dust, change crankcase oil and lubricate more frequently.
4. AIR CLEANER—Every 8 hours, check level, clean and refill oil cup to circular level mark with OE Remove air intake cap and clean screen. Every 64 to 256 hours, depending on dust conditions, remove filter section and wash. Clean air intake pipes and see that connections are tight after reassembling.
5. CRANKCASE *(Power Unit)*—Drain only when engine is thoroughly warm. Refill to FULL mark on gage. See Table. CAUTION: When running engine, be sure pressure gage indicates oil is circulating.
6. GEAR CASES AND CHAIN DRIVE CASE—Check level with machine on level ground and add lubricant if necessary. When draining, drain immediately after operation.
7. VERTICAL TRACTION SHAFT BEARING, SWING SHAFT GEAR, INTERMEDIATE GEAR-UPPER BEARING, DRIVE SPROCKET AND TRACTION SHAFT BEARINGS, LOWER TRACTION SHAFT BEARINGS, FRONT AND REAR TUMBLER BEARINGS, GUIDE ROLLERS—Lubricate every 2 hours, when traveling under own power.
8. DRUM BEARINGS, BOOM HOIST CLUTCH BEARING, SWING AND TRACTION SHAFT BEVEL PINION BEARINGS, DIPPER TRIP BEARINGS—To lubricate, remove plug and install fitting. Apply WB sparingly to drum bearings, boom hoist clutch bearing, dipper trip bearings and swing and traction shaft bevel pinion bearings. CAUTION: After lubricating, remove fitting and replace plug. Upon disassembly and before reassembly repack bearings with WB not more than ⅔ full.
9. TURNTABLE GEAR CASE-UPPER—While traveling apply CG on rotating gears (with gear shift in, traction and both steering clutches out).
10. TURNTABLE ROLLERS—Lubricate vertical wall of roller track with CG sparingly. CAUTION: Do not permit lubricant to run on roller path as this causes rollers to slide and will develop flat spots. Turntable rollers must rotate.
11. OIL CAN POINTS—Every 8 hours, lubricate brake and clutch pins, toggle pins, operating lever control linkage, swing shaft spline, with OE. CAUTION: Do not get oil on clutch and brake bands. Every 32 hours, lubricate throttle control linkage and swivel pulleys with OE.
12. POINTS REQUIRING NO LUBRICATION—Magneto, Starter, Traction Drive Chains, Drive Shoe Pins.

24 Nov. 43

Above guide supersedes all previous instructions.

CHEK-CHART No.1054

WAR DEPARTMENT LUBRICATION GUIDE
CORPS OF ENGINEERS CHART NO. 1054A
POINTS BELOW TURNTABLE

CRANE, CRAWLER-MOUNTED, GASOLINE, ¾-CU YD, WITH ATTACHMENTS
(KOEHRING, MODEL 304)

MFR'S. SERIAL No. located on name plate at left of operator's position in cab.

Reference TM 5-1168.

TABLE OF CAPACITIES AND LUBRICANTS TO BE USED

UNIT	CAPACITY (Approx.)	LOWEST EXPECTED AIR TEMPERATURE		
		Above +32°F.	+32°F. to 0°F.	Below 0°F.
Engine Crankcase (Lighting Plant)	7 qt.	OE SAE 30	OE SAE 10	Refer to TM 5-1168

NOTE — See Reverse Side for lubrication of CRANE and ATTACHMENTS

Lubricant • Hours

Air Cleaner (Note 4) **OE 8**

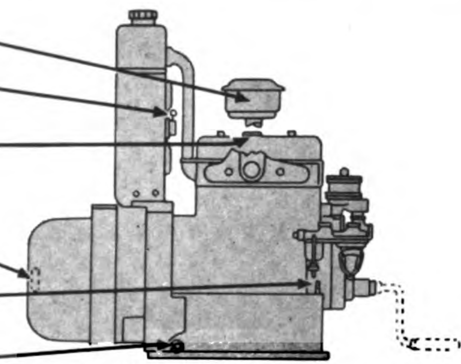
Fan Bearing **OE 64**
(Late models, packed at assembly)

Crankcase Fill (See Table) **OE 8**
(Note 5)

Electric Generator Brg. **WB 512**
(Remove cover, apply with paddle)

Crankcase Oil Level Gage **8**
Check level (Keep level between H and L)

Crankcase Drain Plug **64**
Drain and refill (Note 5)



LIGHTING PLANT

KEY

Lubricants
OE—OIL, engine Crankcase grade (unless otherwise specified)
CG—GREASE, general purpose No. 1 (above +32°F.) No. 0 (below +32°F.)
WB—GREASE, general purpose No. 2

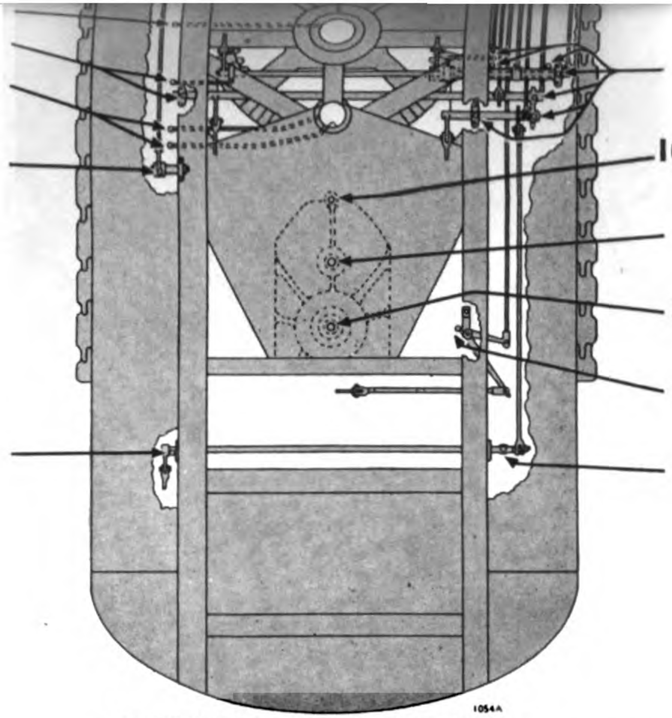
Hours • Lubricant

32 CG Lever and Control Shaft Bearings
(Located in cab above platform)

Control Shaft **CG 32**

32 CG Control Shaft

WAR DEPARTMENT LUBRICATION GUIDE
CORPS OF ENGINEERS CHART NO. 1054A
POINTS BELOW TURNTABLE



POINTS BELOW TURNTABLE

(See Guide No. 1054 and No. 1054B for lubrication of points ABOVE TURNTABLE, CRAWLER and ATTACHMENTS)

NOTES Additional Lubrication and Service Instructions on Individual Units and Parts NOTES

1. FITTINGS—Clean before applying the lubricant gun.
2. CLEANING—SOLVENT, dry-cleaning, or OIL, fuel, Diesel, will be used to clean or wash all parts. Use of gasoline for this purpose is prohibited. All parts will be thoroughly dry before relubrication.
3. HOURS—The hours indicated are for normal service. For extreme conditions of heat, water, mud, and dust, change crankcase oil and lubricate more frequently.
4. AIR CLEANER *(Lighting Plant)*—Every 8 hours, check level, clean and refill oil cup to circular level mark with OE. Remove air intake cap and clean screen. Every 64 to 256 hours, depending on dust conditions, remove filter section and wash. Clean air intake pipes and see that connections are tight after reassembling.
5. CRANKCASE *(Lighting Plant)*—Drain only when engine is thoroughly warm. Refill to FULL mark on gage. See Table. CAUTION: When running engine, be sure oil is visible at OIL SIGHT HOLE. Run engine very slowly until it indicates oil is circulating.
6. VERTICAL TRACTION SHAFT BEARING, INTERMEDIATE GEAR-LOWER BEARING—Lubricate every 2 hours, when traveling under own power.
7. PILE DRIVER—Every 8 hours, coat hammer ways and hammer grooves with CG.

(Notes continued on reverse side)

Requisition replacement guide from The Engineer Field Maintenance Office, P.O. Box 1679, Columbus, Ohio.

CHEK-CHART **No.1054A** [NOT TO BE REPRODUCED in whole or in part without permission of the Office of the Chief of Engineers.]

24 Nov. 43
Above guide supersedes all previous instructions.

WAR DEPARTMENT LUBRICATION GUIDE
CORPS OF ENGINEERS CHART NO. 1054A
POINTS ON CRANE AND ATTACHMENTS

CRANE, CRAWLER-MOUNTED, GASOLINE, ¾-CU YD, WITH ATTACHMENTS
(KOEHRING, MODEL 304)

MFR'S. SERIAL No. located on name plate at left of operator's position in cab.

Reference TM 5-1168.

CAUTION Lubricate Dotted Arrow Points on BOTH SIDES

NOTE— See Reverse Side for lubrication of points BELOW TURNTABLE and LIGHTING PLANT ENGINE

CAUTION Lubricate Dotted Arrow Points on BOTH SIDES

Lubricant • Hours

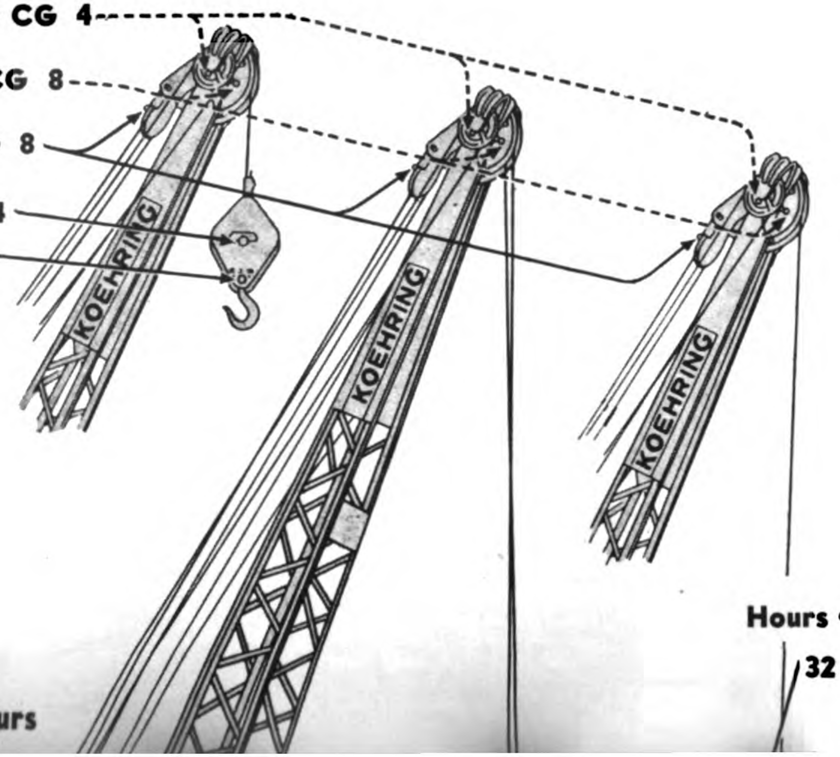
Boom Point Hoist Sheaves **CG** 4

Boom Point Suspension Sheaves **CG** 8

Boom Point Horizontal Sheave **CG** 8

Hook Block **CG** 4

Swivel Hook Bearing **OE** 8



Hours • Lubricant

32 **GO** Sheave Block (Countersunk pipe plug)

—KEY—

Lubricants

OE—OIL, engine
Crankcase grade
(unless otherwise specified)

CG—GREASE, general purpose
No. 1 (above +32°F.)
No. 0 (below +32°F.)

GO—LUBRICANT, gear, universal

Lubricant • Hours

WAR DEPARTMENT LUBRICATION GUIDE
CORPS OF ENGINEERS CHART NO. 1054A
POINTS ON CRANE AND ATTACHMENTS

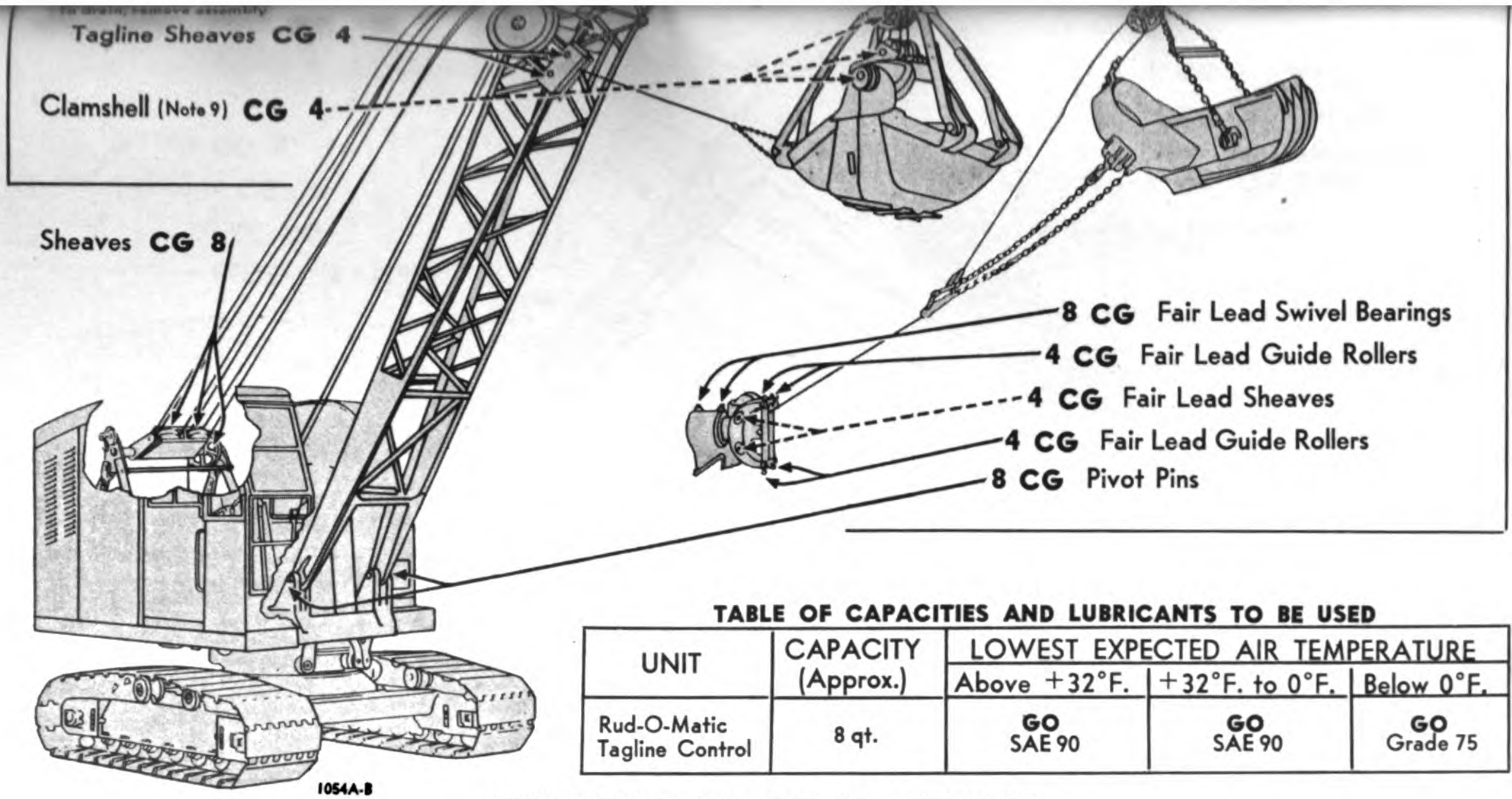


TABLE OF CAPACITIES AND LUBRICANTS TO BE USED

UNIT	CAPACITY (Approx.)	LOWEST EXPECTED AIR TEMPERATURE		
		Above +32°F.	+32°F. to 0°F.	Below 0°F.
Rud-O-Matic Tagline Control	8 qt.	GO SAE 90	GO SAE 90	GO Grade 75

POINTS ON CRANE AND ATTACHMENTS

(See Guides No. 1054 and No. 1054B for lubrication of points ABOVE TURNTABLE, CRAWLER AND ATTACHMENTS)

NOTES Additional Lubrication and Service Instructions on Individual Units and Parts NOTES

(Notes continued from Reverse Side)

8. CABLES—Keep all cables and wire rope well lubricated with OE, except those coming in constant contact with dirt.
9. CLAMSHELL (*Various makes*)—Every 4 to 8 hours, lubricate through fittings with CG.
10. OIL CAN POINTS—Every 8 hours, lubricate operating lever control linkage and shaft oil holes, clamshell guide rollers, clamshell head shaft and clamshell socket pins with OE.

CHEK-CHART **No.1054A** [NOT TO BE REPRODUCED in whole or in part without permission of the Office of the Chief of Engineers.]

24 Nov. 43
Above guide supersedes all previous instructions.

WAR DEPARTMENT LUBRICATION GUIDE
CORPS OF ENGINEERS CHART NO. 1054B
POINTS ON SHOVEL ATTACHMENT

CRANE, CRAWLER-MOUNTED, GASOLINE, ¾-CU YD, WITH ATTACHMENTS
(KOEHRING, MODEL 304)

MFR'S. SERIAL No. located on name plate at left of operator's position in cab.

Reference TM 5-1168.

NOTE—See Reverse Side for lubrication of PULL SHOVEL ATTACHMENT

CAUTION Lubricate Dotted Arrow Points on BOTH SIDES

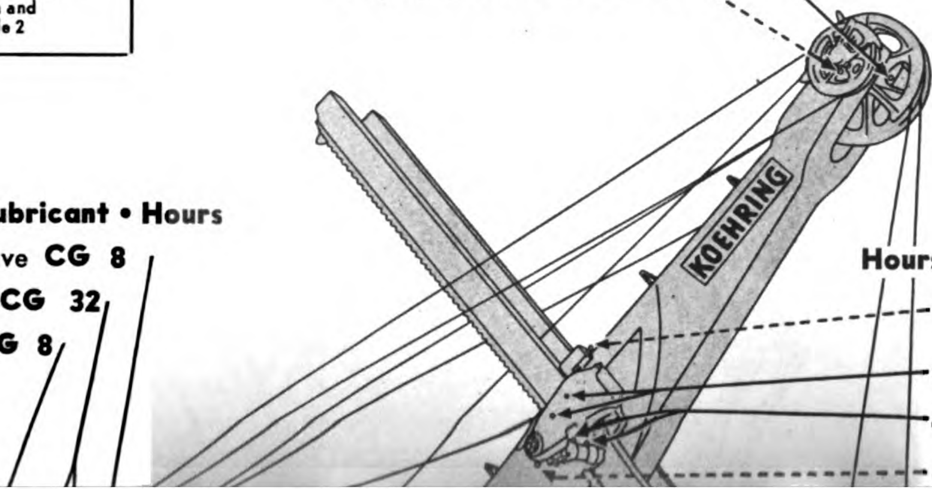
—KEY—

Lubricants
OE—OIL, engine Crankcase grade (unless otherwise specified)
CG—GREASE, general purpose No. 1 (above +32°F.) No. 0 (below +32°F.)
CW—OIL, lub., chain and wire rope, grade 2

Lubricant • Hours

Hoist Sheave **CG 4**

Suspension Sheaves **CG 32**



Lubricant • Hours

Sheave **CG 8**

Horizontal Sheaves **CG 32**

Sheave **CG 8**

Hours • Lubricant

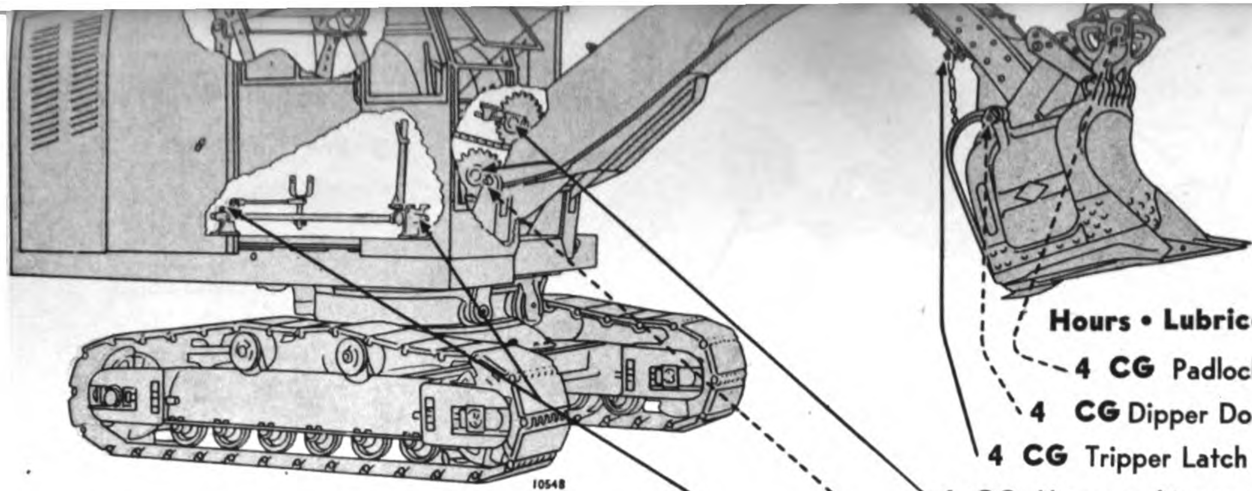
8 OE Gib Blocks (Keep filled with SAE 50)

8 CG Trip Line Sheaves

4 CG Shipper Shaft Brgs.

4 CG Saddle Block

WAR DEPARTMENT LUBRICATION GUIDE
CORPS OF ENGINEERS CHART NO. 1054B
POINTS OF SHOVEL ATTACHMENT



Hours • Lubricant

4 **CG** Padlock Sheave

4 **CG** Dipper Door Hinge

4 **CG** Tripper Latch

4 **CG** Upper and Lower Idler Sprockets

8 **CG** Pivot Pin

32 **CG** Control Shaft

POINTS ON SHOVEL ATTACHMENT

(See Guides No. 1054 and No. 1054A for lubrication of points on CRAWLER, TURNTABLE and ATTACHMENTS)

NOTES Additional Lubrication and Service Instructions on Individual Units and Parts NOTES

1. FITTINGS—Clean before applying the lubricant gun.
2. CLEANING—SOLVENT, dry-cleaning, or OIL, fuel, Diesel, will be used to clean or wash all parts. Use of gasoline for this purpose is prohibited. All parts will be thoroughly dry before relubrication.
3. HOURS—The hours indicated are for normal service. For extreme conditions of heat, water, mud and dust, lubricate more frequently.
4. CABLES—Keep all cables and wire rope well lubricated with OE, except those coming into constant contact with dirt.
5. OIL CAN POINTS—Every 8 hours, lubricate shovel bucket latch and lever, dipper trip control linkage, crowd drive chain with OE.

CHEK-CHART **No.1054B** [NOT TO BE REPRODUCED in whole or in part without permission of the Office of the Chief of Engineers.]

24 Nov. 43
Above guide supersedes all previous instructions.

WAR DEPARTMENT LUBRICATION GUIDE
CORPS OF ENGINEERS CHART NO. 1054B
POINTS ON PULL SHOVEL ATTACHMENT

CRANE, CRAWLER-MOUNTED, GASOLINE, ¾-CU YD, WITH ATTACHMENTS

(KOEHRING, MODEL 304)

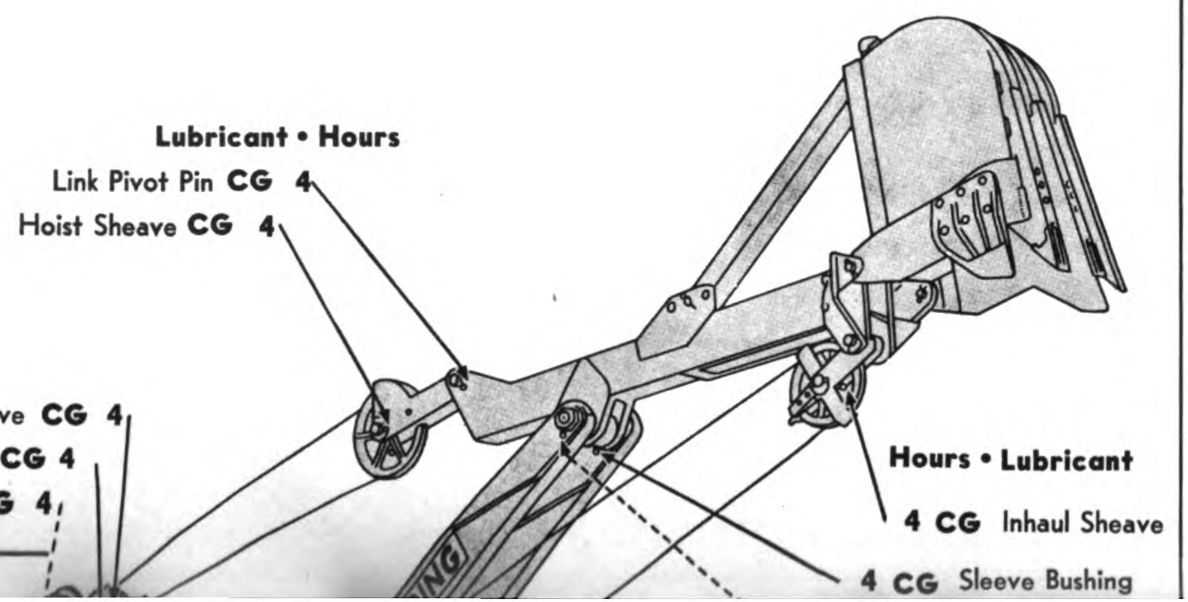
MFR'S. SERIAL No. located on name plate at left of operator's position in cab.

Reference TM 5-1168.

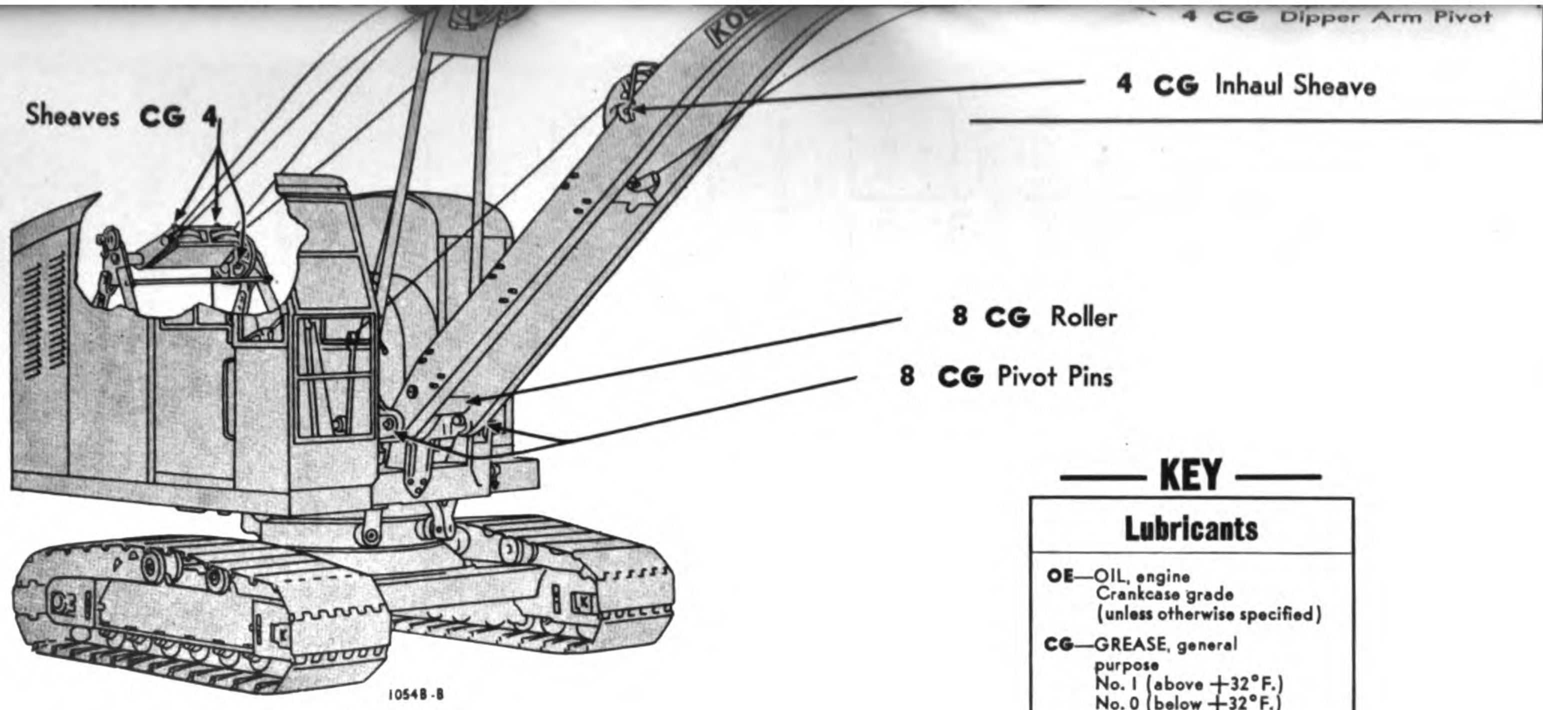
CAUTION Lubricate Dotted Arrow Points on BOTH SIDES

NOTE—See Reverse Side for lubrication of SHOVEL ATTACHMENT

CAUTION Lubricate Dotted Arrow Points on BOTH SIDES



WAR DEPARTMENT LUBRICATION GUIDE
CORPS OF ENGINEERS CHART NO. 1054B
POINTS ON PULL SHOVEL ATTACHMENT



— KEY —

Lubricants
OE—OIL, engine Crankcase grade (unless otherwise specified)
CG—GREASE, general purpose No. 1 (above +32°F.) No. 0 (below +32°F.)

POINTS ON PULL SHOVEL ATTACHMENT

(See Guides No. 1054 and No. 1054A for lubrication of points on CRAWLER, TURNTABLE and ATTACHMENTS)

NOTES Additional Lubrication and Service Instructions on Individual Units and Parts NOTES

1. FITTINGS—Clean before applying the lubricant gun.
2. CLEANING—SOLVENT, dry-cleaning, or OIL, fuel, Diesel, will be used to clean or wash all parts. Use of gasoline for this purpose is prohibited. All parts will be thoroughly dry before relubrication.
3. HOURS—The hours indicated are for normal service. For extreme conditions of heat, water, mud and dust, lubricate more frequently.
4. CABLES—Keep all cables and wire rope well lubricated with OE, except those coming in constant contact with dirt.

Requisition replacement guide from The Engineer Field Maintenance Office, P.O. Box 1679, Columbus, Ohio.

CHEK-CHART **No.1054B** [NOT TO BE REPRODUCED in whole or in part without permission of the Office of the Chief of Engineers.]

24 Nov. 43
Above guide supersedes all previous instructions.

CABLE LENGTHS FOR 304

NAME	Cable Dia.	Style	Boom Lengths							
			25'	30'	35'	40'	45'	50'	55'	60'
			Cable Lengths							
DRAGLINE										
Drag.	3/4"	X	39'	44'	49'	54'	59'	64'	69'	74'
Hoist	5/8"	O	62'	72'	82'	92'	102'	112'	122'	132'
CLAMSHELL										
Holding	5/8"	O	71'	81'	91'	101'	111'	121'	131'	141'
Closing	5/8"	O	100'	110'	120'	130'	140'	150'	160'	170'
Tagline (Rud-o-Matic)	3/8"	Ⓧ	60'	60'	60'	60'	60'	60'	60'	60'
HOOK BLOCK										
Hoist 1 Part	5/8"	O	71'	81'	91'	101'	111'	121'	131'	141'
Hoist 2 Part	5/8"	O	116'	131'	146'	161'	176'	191'	206'	221'
Hoist 3 Part	5/8"	O	153'	173'	193'	213'	235'	254'	273'	292'
BOOM HOIST 6 Part	1/2"	Ⓧ	210'	240'	270'	300'	330'	360'	390'	420'
SHOVEL			18'-0" BOOM - 15'-0" STICKS							
HOIST	5/8"	O	65'							
BOOM HOIST 4 Part	5/8"	O	120'							
TRIP	5/16"	Ⓧ	33'							
PULL SHOVEL										
BOOM HOIST	5/8"	X	75'							
DIPPER DIGGING	3/4"	X	60'							
JIB FRAME HOIST	1/2"	O	80'							

X 6 Str. - 19 Wire - Langlay - Flexible seale construction, independent wire rope center.

O 6 Str. - 19 Wire - Improved plow steel - hemp center.

Ⓧ 6 Str. - 19 Wire - Plow steel - hemp center.

CABLE HANDLING

When unreeling or uncoiling wire cable, it is important that no kinks be allowed to form. Once a kink is made, no amount of strain can remove it and the cable is unsafe for use. Many of the kinks that occur in a cable are started between the time the cable is being removed from reel or coil and the time it is reeved on the machine. Illustrated below are the proper and improper methods of handling cable.

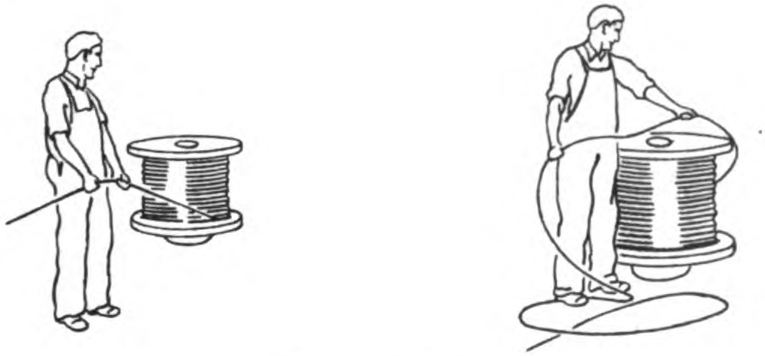


FIGURE 50

Correct way to unreel cable. Incorrect way to unreel cable.

FIGURE 51

Correct way to uncoil cable. Incorrect way to uncoil cable.

FIGURE 52

CORRECT INCORRECT

CLIPPED CABLE ATTACHMENTS

Illustrated above are the incorrect and correct ways for clipping attachments. U-bolts should bear against the short end of the rope with bases on the live side. Distance, center to center, between clips should be 6 times the rope diameter. Nuts should be tightened equally with rope under tension and retightened after the first few hours of continuous service.

REEVING OF BOOM SUSPENSION CABLE FOR
CRANE-DRAGLINE-CLAMSHELL-PILE DRIVER

With the boom for any one of the above combinations attached to the turntable by the boom foot pins and lying horizontally on blocking under the boom point, you are ready to reeve the boom suspension cable. Place the spool of cable (at the left side of the machine) on a bar or pipe properly blocked up so that the cable may be unwound as it is being reeved on the machine. Take the end of the cable to the boom point; pass the cable underneath the outer left hand boom point sheave (A); from the top of sheave (A) bring the cable back to and around "A" frame sheave (E); then out and around horizontal boom point sheave (C); back and around "A" frame sheave (D); out and over the top of the outer right hand boom point sheave (B); from the underside of sheave (B) back to "A" frame and dead end with wedge and socket attached to "A" frame at anchor (H). Pull the rest of the cable from the spool, taking this end of the cable and passing it over the left hand "A" frame sheave (G) and down to the boom hoist drum (F) where it is anchored with a wedge as shown.

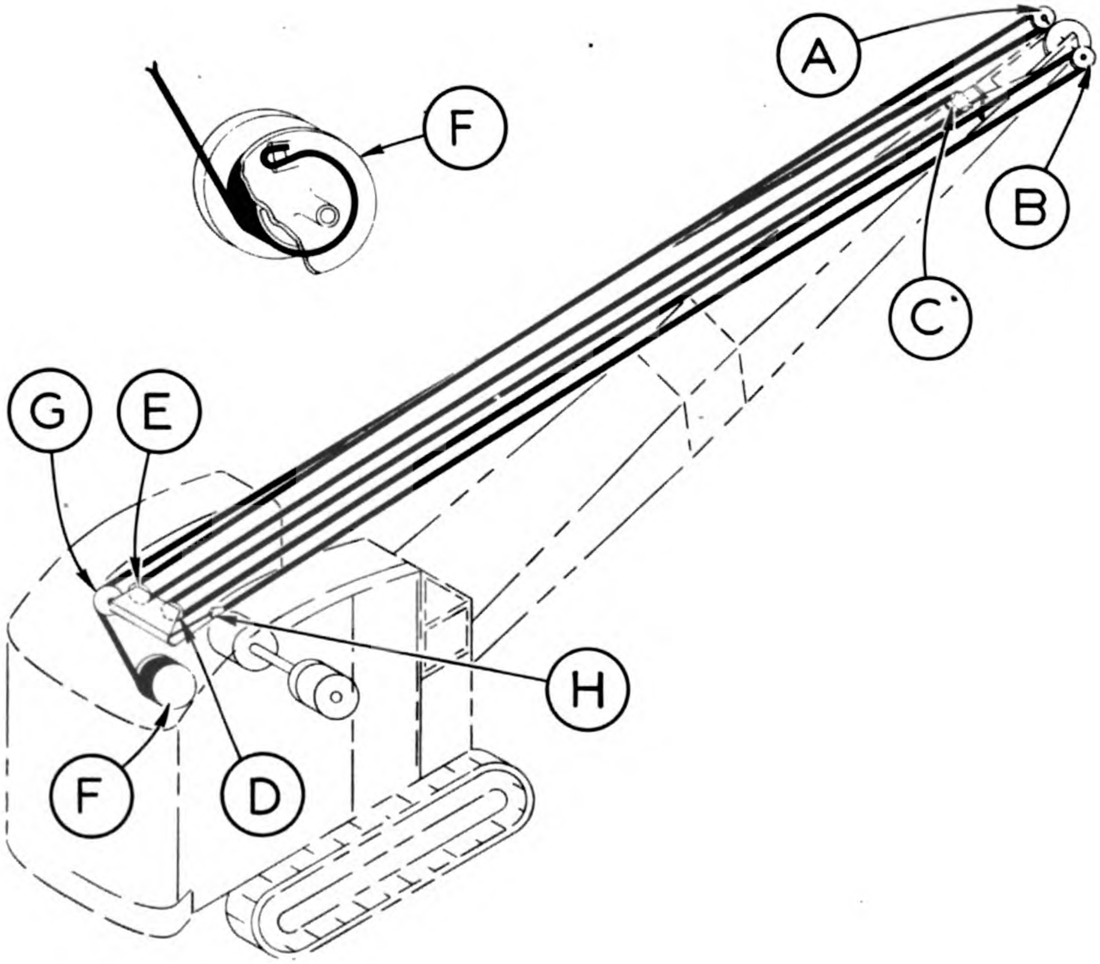


FIGURE 53

REEVING OF CABLES FOR VARIOUS OPERATIONS

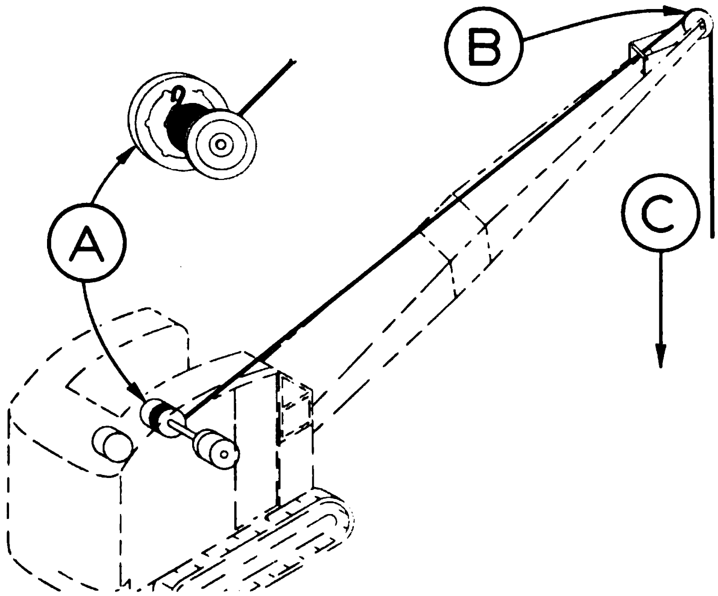


FIGURE 54

LOAD LIFTING CRANE (ONE PART LINE)

The load hoist cable is anchored to the left hand drum (A). Pass the cable underneath the drum (A) and over the large left hand boom point sheave (B) and down to the load (C).

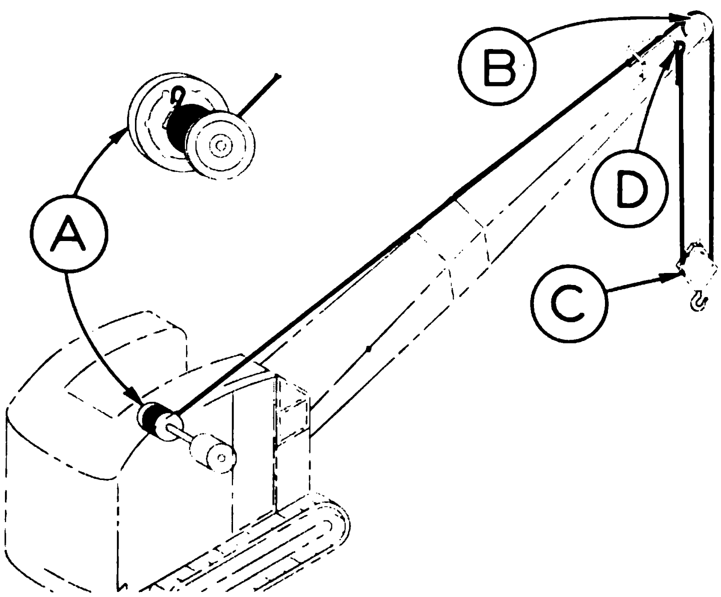


FIGURE 55

LOAD LIFTING CRANE (TWO PART LINE)

The load hoist cable is anchored to the left hand drum (A). Pass the cable underneath the drum (A) and over the large left hand boom point sheave (B), down and around hook block sheave (C) and back up to the boom point (D) where it is anchored with a wedge socket.

CABLE REEVING FOR VARIOUS OPERATIONS. (CONT'D.)

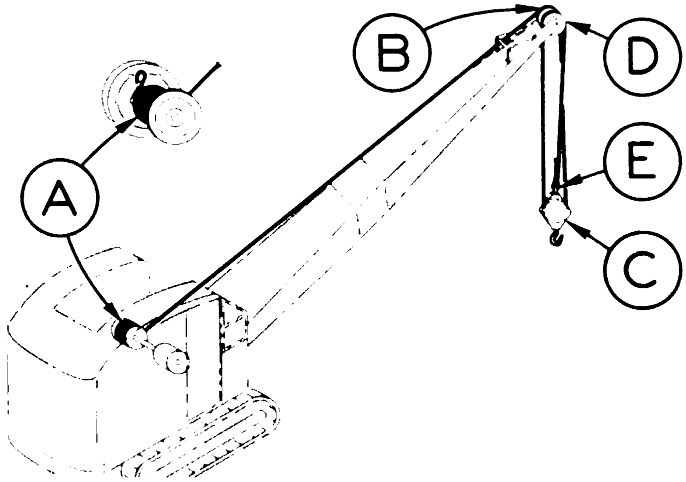


FIGURE 56

LOAD LIFTING CRANE (THREE PART LINE)

The load hoist cable is anchored to the left hand drum (A). Pass the cable underneath the drum (A) and over the large left hand boom point sheave (B); down and around hook block sheave (C); up and around the large right hand boom point sheave (D) and down to hook block where cable is anchored at (E).

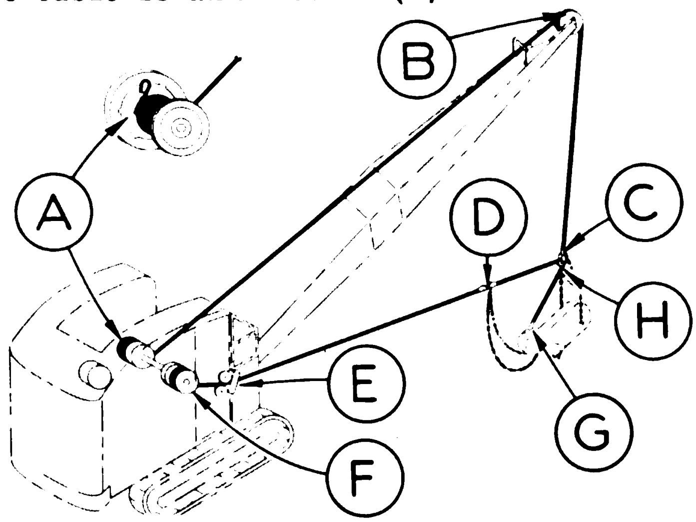


FIGURE 57

DRAGLINE

DRAG CABLE:

Fasten the live end of the drag cable to the dragline bucket chain at (D). Lead the drag cable through the dragline fairlead (E) and underneath and around the right hand drum (F) where drag cable is anchored to drum as shown. HOIST CABLE: Fasten the live end of the hoist cable to the dragline bucket bail chains at (C). Pass the hoist cable over the large boom point sheave (B) (use left hand sheave if there are two large ones at boom point). Then lead the cable down to and under the left hand drum (A) where the cable is anchored with a wedge socket as shown. DUMP CABLE: Dead end cable at bucket bail (G), pass under and over the bail sheave (H) and attach to dragline bucket chain at (D).

CABLE REEVING FOR VARIOUS OPERATIONS. (CONT'D.)

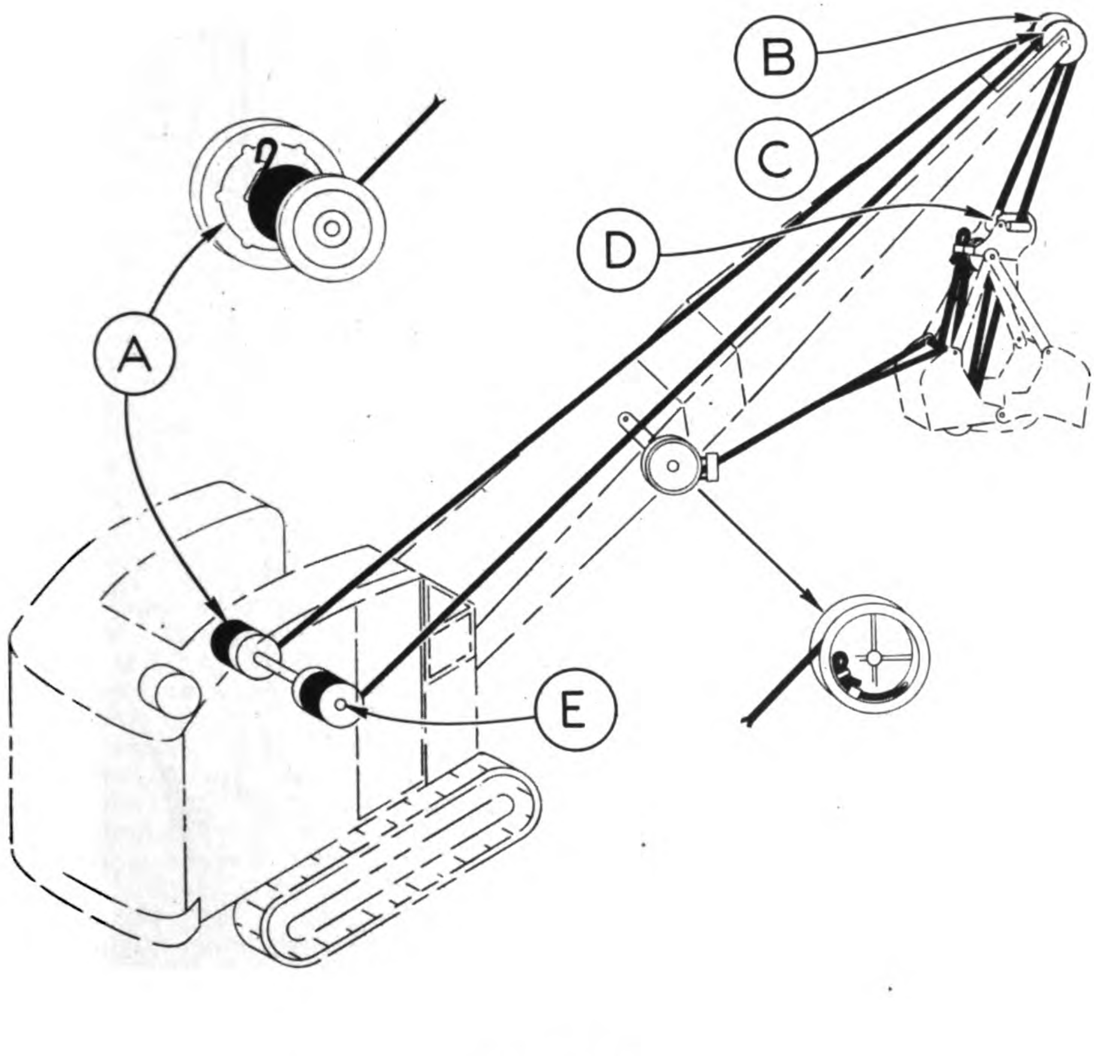


FIGURE 58
CLAMSHELL CRANE WITH TAGLINE

Fasten the clamshell hoisting or holding cable to the load pin or wedge socket on the bucket (D). Then pass the cable over the large left hand boom point sheave (B) and down to and under the left hand drum (A) where cable is anchored. Fasten one end of the clamshell closing cable to the right hand drum (E) with wedge socket. Lead the cable from under the drum (E) up to and over the large right hand boom point sheave (C) and down to the clamshell bucket. The reeving of clamshell buckets varies in accordance with the type of bucket used, therefore, reference must be made to reeving diagram supplied with bucket to be used. Tagline cable is hooked as shown.

CABLE REEVING FOR VARIOUS OPERATIONS. (CONT'D.)

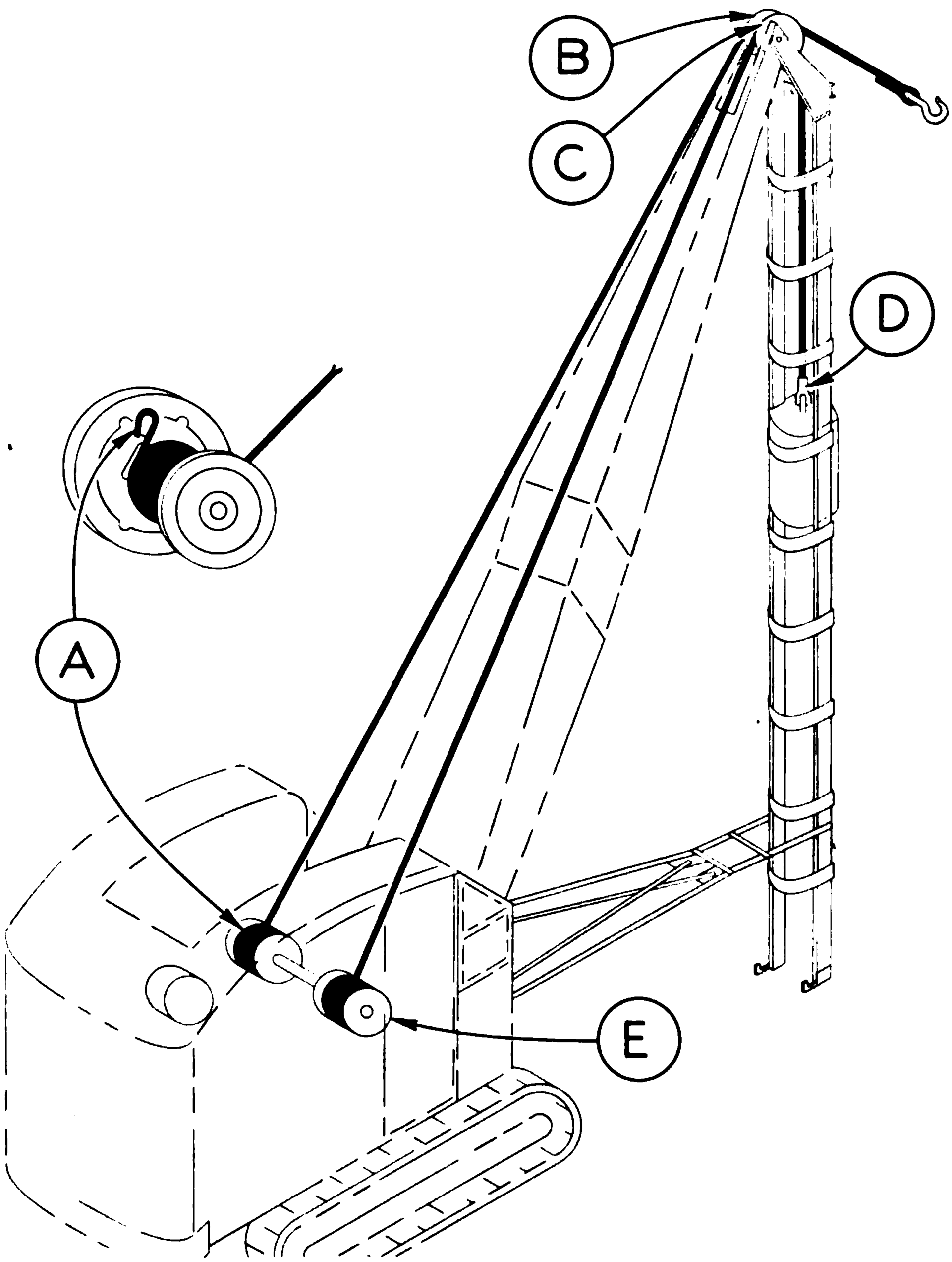


FIGURE 59
PILE DRIVER

Fasten one end of the hammer hoist cable to the hammer at (D) then lead the cable over the large left hand boom point sheave (B) and down to and under the left hand drum (A) where it is anchored with a wedge socket as shown. When stationary leads, as shown, are used, cable from the right hand drum (E) and over the large right hand boom point sheave (C) can be used to lift piling into place under the hammer (D). For swinging leads - not illustrated - fasten one end of the hoist cable to the leads, then pass the cable over the large right hand boom point sheave (C) and down to and under the right hand drum (E) where it is anchored with wedge socket.

CABLE REEVING FOR VARIOUS OPERATIONS. (CONT'D.)

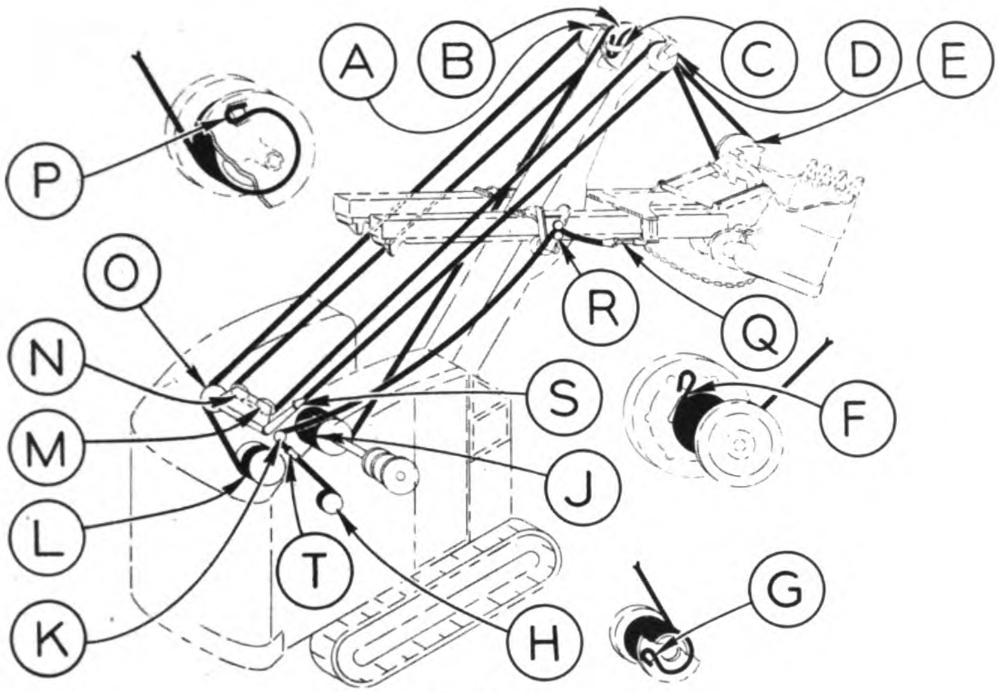


FIGURE 60

SHOVEL

To prepare a shovel for new cable reeving, crowd the dipper to extreme out position and lower it to the ground. Release the crowd and hoist brakes. With the dipper in this position, push the padlock sheave at the back of the dipper forward so that it is clear of the boom when boom is lowered. Now lower boom to a point where boom point sheaves rest on dipper stick spacer block. Remove old or worn cable. For the boom suspension cable place the spool of cable (at the left side of the machine) on a bar or pipe properly blocked up so that the cable may be unwound as it is being reeved on the machine. If the cable comes in a coil, roll it out like a hoop until the entire length is laid out straight. Take one end of the cable out to the boom point; pass the cable over and around the outer left hand boom point sheave (A). From the bottom of sheave (A) lead the cable back to and around sheave (N); across to and around sheave (M); out and over the top of the right hand boom point sheave (D); from the underside of sheave (D) back to the "A" frame where it is anchored with a wedge and socket (S). Pass the other end of the cable over the left hand "A" frame sheave (O) and down to the boom hoist drum (L) where it is anchored with a wedge as shown at (P). For the dipper hoist cable, lead the cable under the left hand drum (J) and anchor with wedge as shown at (F). Lead the other end of the hoist cable over the top of the boom point sheave (B) then down to dipper sheave block (E), through the sheave block from the front side, around the sheave then up and over the half sheave (C) where it is anchored with a wedge. For the dipper trip cable, attach a wedge socket to one end of the cable. Fasten the wedge socket to the dipper trip plunger casting (Q). Lead the other end of the cable through the saddle block guide sheaves (R); back over "A" frame guide sheave (K); through the guide tube (T), then over dipper trip drum (H) where it is anchored as shown at (G). (Follow same procedure for reeving new shovel attachment.)

CABLE REEVING FOR VARIOUS OPERATIONS. (CONT'D.)

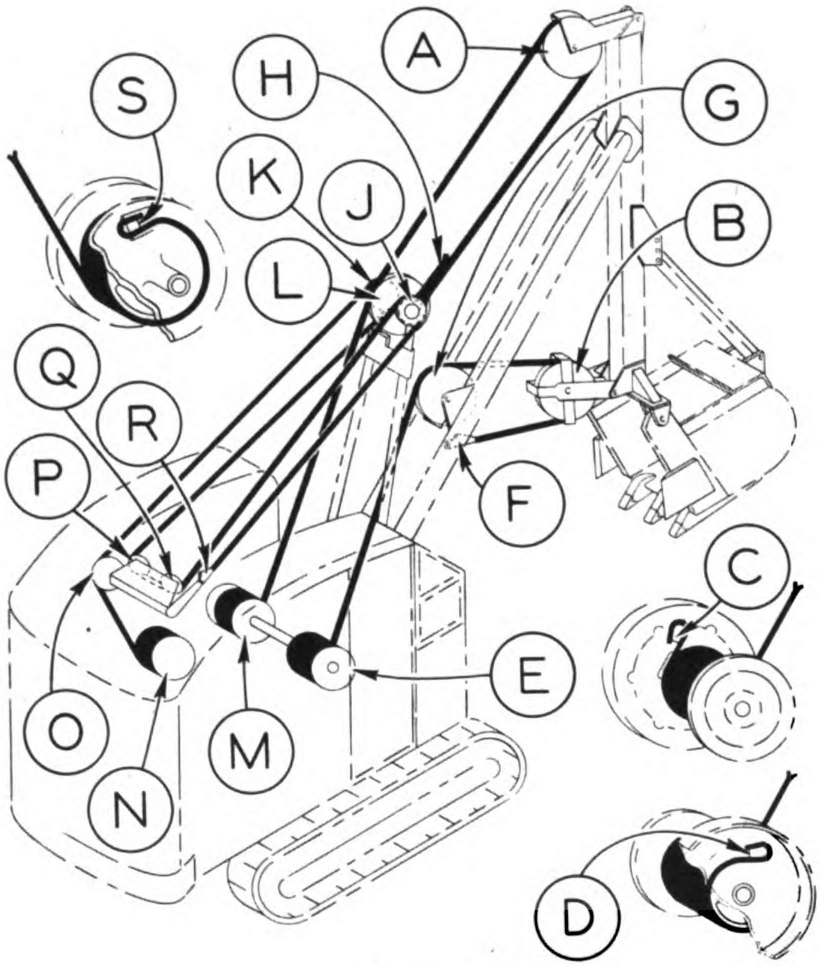


FIGURE 61

PULL SHOVEL

The jib frame cable on a pull shovel performs the same function as the boom hoist cable on a crane or shovel. To prepare a pull shovel for new cable reeving, pull in the dipper until the handle is vertical then lower the boom until the dipper is resting on the ground. For the jib frame cable, lead one end of the cable over the left hand jib frame sheave (K), from the bottom of sheave (K) back to and around sheave (P), across the sheave (Q), out and over the top of the right hand jib frame sheave (J), from the under side of sheave (J) back to the "A" frame and anchor with wedge and socket fastened to "A" frame at (R). Lead the other end of the cable over the "A" frame sheave (O) down to the boom hoist drum (N) where it is anchored with wedge as shown at (S). For the hoist cable, lead the cable under the left hand drum (M) and anchor with wedge as shown at (C). Lead the other end of the cable over sheave (L) on the jib frame, out and over sheave (A) on the dipper arm, from the under side of sheave (A) back to the jib frame and around anchor spool (H) where it is fastened with clamps. For the pull cable, lead the cable under the right hand drum (E) and anchor with wedge as shown at (D). Lead the other end of the pull cable over the top of sheave (G); out to the top of sheave (B) then from the bottom of sheave (B) back to the boom and anchor with a wedge and socket at (F). (Follow same procedure for reeving new pull shovel attachment.)

OPERATING ADJUSTMENTS

Every operator should know and understand the operating adjustments required to keep his machine in its best working condition. A properly adjusted machine is easier to operate and helps to avoid breakdowns or costly delays.

ADJUSTING THE ENGINE CLUTCH

The engine clutch is of the single plate disc type and is mounted at the flywheel end of the engine. It is important that the engine clutch backlocks when it is fully engaged for operation. This backlock or locking-in action is readily detected by the feel of a very slight kick in the hand by Lever No. 1, see page 42. If the backlock action cannot be felt, do not run the machine until proper adjustment is made to backlock the clutch. To adjust, pull out lock pin (A); turn the yoke (B) slightly to the right; release the lock pin and continue turning yoke to the right until the lock pin snaps into place in the next adjusting hole. Try clutch. If clutch slips, pull out lock pin; turn yoke slightly, then release lock pin and continue turning yoke to the right until lock pin snaps into the next adjusting hole. Try clutch again. If clutch still slips, repeat the adjustment but never turn the yoke more than one hole at a time. It is important that clutch is not adjusted so tightly that it cannot be backlocked. Ordinarily, turning the yoke one or two holes provides sufficient adjustment although a new clutch may require several similar adjustments before the friction plates wear smoothly enough for efficient operation. NEVER OPERATE WITH ENGINE CLUTCH SLIPPING. For further details see Engine Section.

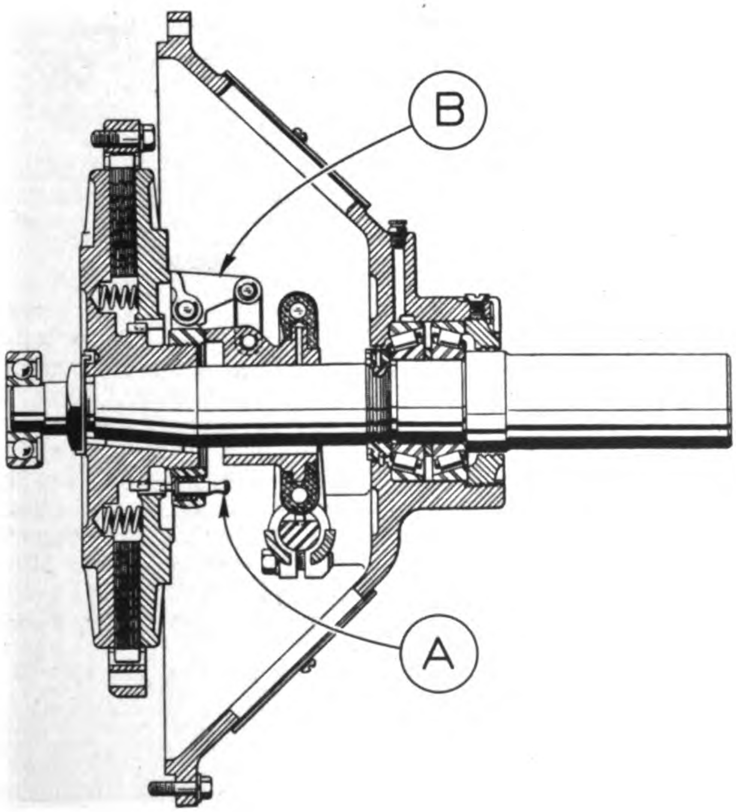


FIGURE 62

OPERATING ADJUSTMENTS. (CONT'D.)

FRICTION CLUTCH:

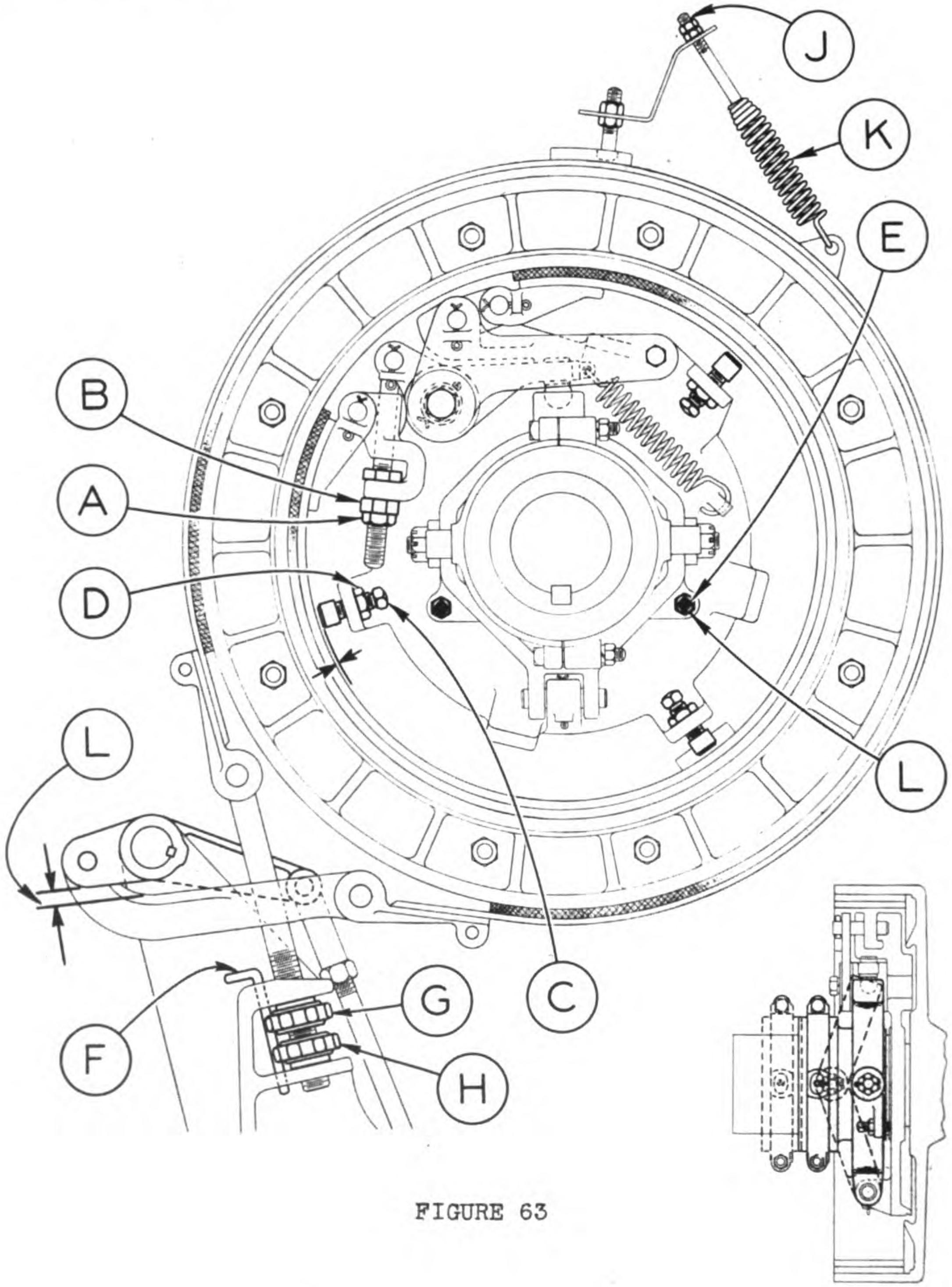


FIGURE 63

OPERATING ADJUSTMENTS (CONT'D.)

FRICTION CLUTCH ADJUSTMENTS (See Figure 63):
The swing and traction clutches, both drum clutches and the boom hoist clutch are similarly constructed and all are adjusted in the following manner:

Disengage all clutches, including the engine clutch. To tighten the clutch band, loosen the lock nut (A) and turn the adjusting nut (B) out toward the end of the eye bolt as far as is necessary for proper clutch operation. Tighten lock nut (A). NEVER set clutches so tight that they will not back-lock. A clutch that is too tight does not pull any better than one that is too loose and, furthermore, when a clutch is either too tight or too loose, the lining will burn and thus impair the efficiency of the clutch as well as shorten the life of the lining. Check the band carrier screws (C) and set them to a clearance of 1/32" between the screws and the clutch band WHEN THE CLUTCH IS ENGAGED. Be sure the lock nut on screw (D) is tightened after clearance adjustment is made.

Check the back-lock of the clutch. Set the back-lock adjusting screws (E) to provide a minimum amount of back-lock just enough to keep the clutch engaged.

To increase the amount of back-lock of the clutch, screw out on adjusting screws (E). To decrease back-lock screw in on adjusting screws (E). Both screws should be adjusted equally after which lock nuts must be securely tightened. The clutch will disengage itself when it does not have enough back-lock; hard to engage when it has too much.

When the clutch band linings are new or until they are smoothed down and properly seated, several clearance and back-lock adjustments might be required after which these adjustments should be made at regular intervals.

DRUM BRAKE ADJUSTMENTS (See Figure 63):
Both drum brakes and the boom hoist brake are of similar construction and are adjusted in the following manner:

Release all brake pedals. Be sure boom ratchet safety pawl is engaged (Lever No. 10 forward-see Page 42); lift brake pedal B-2 as high as it will go and place under it a block of wood or some other substantial support to hold the pedal up. To adjust the brake bands, pull out lock pin (F) and turn the adjusting nuts (G) and (H) up until the brake holds the required load. Turn lock nut (H) down against the casting and draw it tight. Replace lock pin (F). After boom hoist drum brake adjustment is made, be sure to remove support from under brake pedal B-2. Drum brakes should not be operated any tighter than necessary to hold the required loads. Check brake bands after adjusting to be sure they are releasing properly. If they drag, proper release is obtained by adjusting bolt (J) and spring (K).

NOTE: When brake is set clearance must be maintained at point (L).

OPERATING ADJUSTMENTS (CONT'D.)

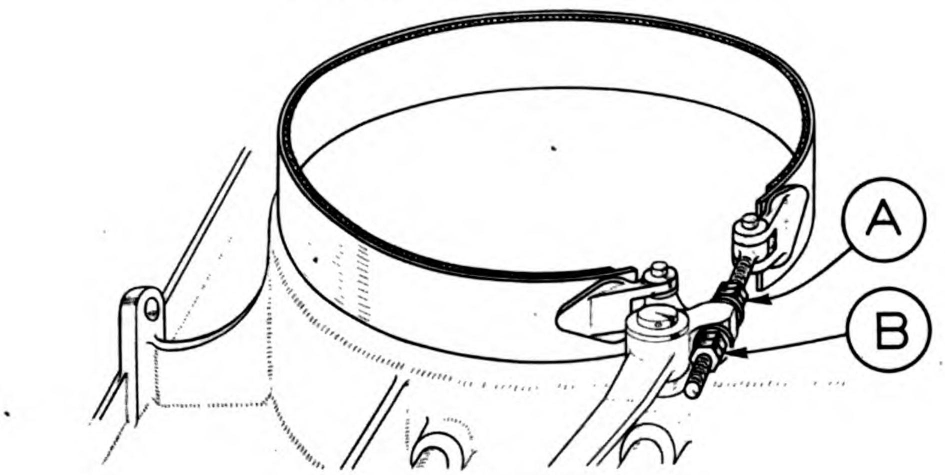


FIGURE 64

SWING BRAKE ADJUSTMENT

To tighten swing brake, push lever No. 6 (page 42) forward to release brake. Loosen lock nut (A) then tighten adjusting nut (B) just enough to make the brake hold. NOTE: The brake must not drag when released or while swinging the turntable.

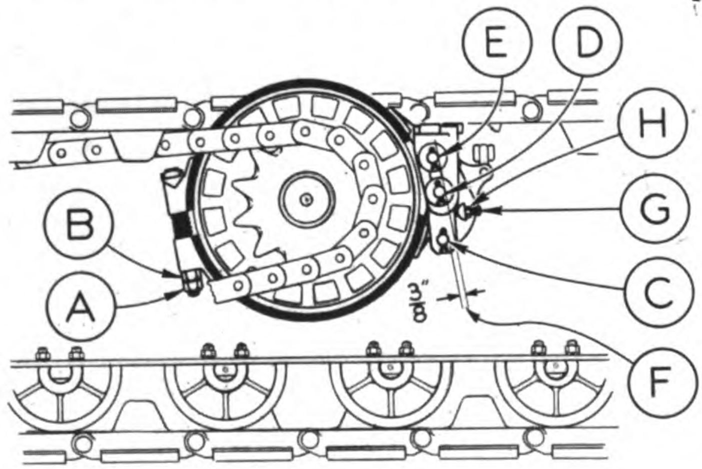


FIGURE 65

TRACTION BRAKE ADJUSTMENT

Disengage traction brakes (Levers No. 7 and No. 8 down-see page 42). Loosen lock nut (A) and turn adjusting nut (B) to tighten the band. After proper adjustment has been made, tighten nut (A). NOTE: Do not tighten brake too much without testing it. Ordinarily, turning the adjusting nut (B) from one flat side on the nut to the next flat side - or one-sixth of a turn - will be enough adjustment to make at one time before testing brake. Inspect the toggle action on the brakes at regular intervals to be sure the linkage has a sufficient amount of back-lock to keep the brakes set. Pin (C) should pass the center line of pin (D) and pin (E) about 3/8" as shown at (F) Figure 65 above, when the brake is set. To increase the amount of back-lock, turn out the adjusting set screws (G); to decrease the back-lock turn screws in. Always securely tighten the lock nuts on screws (H) after making adjustments.

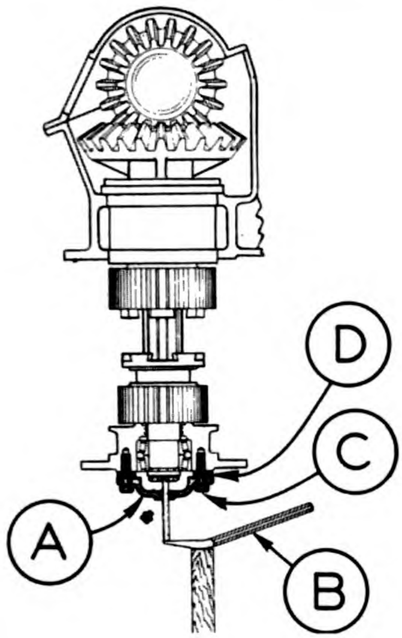


FIGURE 66

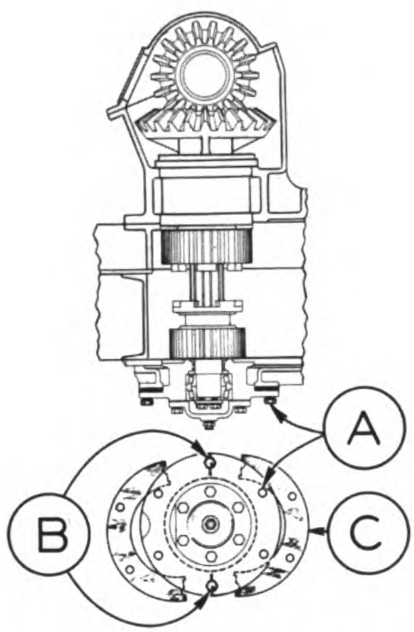


FIGURE 67

SWING AND TRACTION BEVEL GEAR SHAFT ADJUSTMENT (See Figure 66)

The swing and traction bevel gear shaft should be inspected at regular intervals to determine if any end play has developed. To check the shaft, remove the grease gun connection from the bearing retainer cap (A) and insert a 3/8" drift pin about 4" long into the grease gun connection hole, and under the pin set a pinch bar (B) supported by a timber as illustrated in Figure 66. Bear down and raise pinch bar and if shaft moves up and down from 1/16" to 1/8" or more, there is excessive end play which will require adjustment. To adjust, remove the six capscrews (C). This will allow the bearing retainer cap (A) to be removed. Be careful that the shims (D) do not drop down and become lost. Remove one shim (D). Replace the bearing retainer cap (A) and the capscrews (C). Be sure to tighten the capscrews evenly when screwing them back into place. Check shaft and if excessive end play remains, repeat the adjustment, removing only one shim at a time, until all but a very slight movement is eliminated.

SWING AND TRACTION BEVEL GEAR ADJUSTMENTS (See Figure 67)

To test the swing and traction bevel gears for excessive back lash or wear, set all operating levers at neutral, releasing all clutches and brakes. With one hand, hold the left hand drum stationary and with the other hand push the right hand drum back and forth in a rocking motion. Reverse this operation to test the left hand drum. In each case if the outer rim of the drum moves more than approximately 1/4", there is excessive wear on the swing and traction bevel gears and adjustment is required. To adjust, loosen all capscrews (A) and (B) and locate the cut in the split shims. Do not remove capscrews (B) which pass through shims at the cut. Remove capscrews (A) and pull out one shim (C). (Note that the shims are of different thicknesses to facilitate adjustment, and when removing one be sure it has identical halves.) Replace and tighten capscrews (A), then check the mesh of the bevel gears. There should be a clearance of from .012" to .040".

VERTICAL TRACTION SHAFT ADJUSTMENT

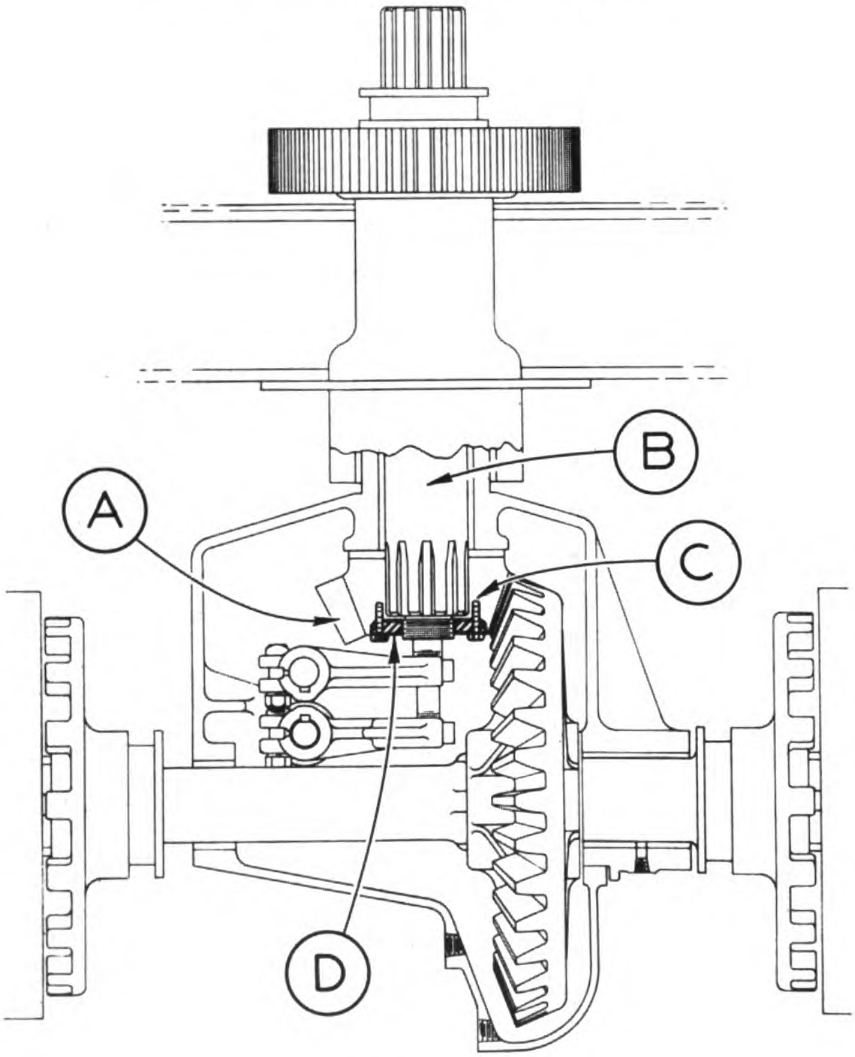


FIGURE 68

To check the vertical traction shaft for end play, place a timber or other obstruction in front of each crawler and run the machine against them - not over them - so that load is applied to the traction bevel gear which meshes with the vertical traction bevel pinion (A) at the bottom of the vertical traction shaft (B). Next remove nuts from the studs and take off dust cover so that top of vertical traction shaft can be seen. Release and apply power alternately by moving lever No. (3), page 42 back and forth, and if vertical traction shaft moves up and down 1/16" to 1/8" or more, there is excessive end play and adjustment is required.

To adjust, remove wire from the two capscrews (C); take out capscrews and turn the adjusting nut (D) clockwise until all but a very slight end play is eliminated. Replace the two capscrews (C) and wire them into place.

NOTE--It is advisable to check the vertical traction shaft for end play each time the bevel gear case cover has been removed to clean out the lower traction shaft bevel gear case.

OPERATING ADJUSTMENTS (CONT'D.)

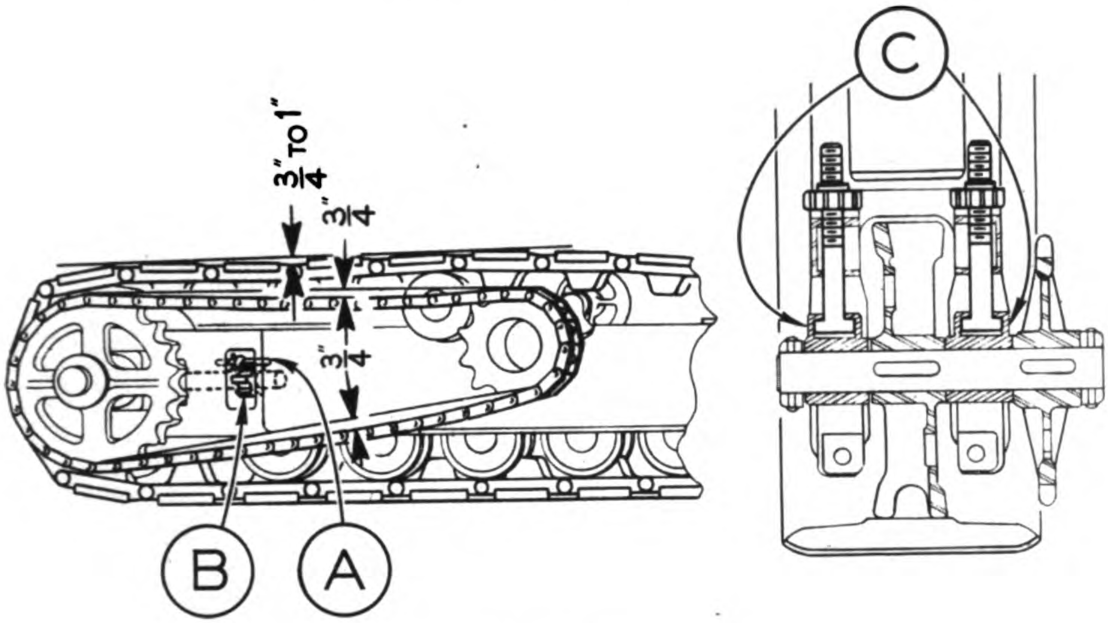


FIGURE 69

CRAWLER BELT AND DRIVE CHAIN ADJUSTMENT.

The right and left traction drive chains must have between 3/4" to 1" sag at top and bottom as shown in Figure 69. It is important that the amount of sag be equal in both chains to evenly distribute the loads they carry and to insure straight traveling. When adjusting the drive chain there must be slack in the crawler belt because tightening the chain also tightens the belt. Remove lock pins (A) and turn adjusting nut on both the inside and outside adjusting bolts as required. The inside and outside bearings (C) must be kept in perfect alignment so that the traction drive chains will run true on the drive sprockets. Replace lock pins (A). Travel the machine forward the length of the crawlers. This brings all slack in the crawler belt to the top where it can be checked for proper sag shich should be approximately 3/4" to 1" as indicated.

To adjust crawler belt, remove adjusting nut lock pin (A) and turn adjusting nut (B) on both inside and outside adjusting bolts as required. The inside and outside bearings (C) must be in perfect alignment so that the crawler belt runs true on the tumblers. Replace lock pin (A). Make adjustment opposite end of chains.

NOTE: When traveling in deep sand or other loose material it is advisable to have more slack in the chains and belt to avoid clogging.

LOCATION OF LIGHTS (For details see Parts Section)

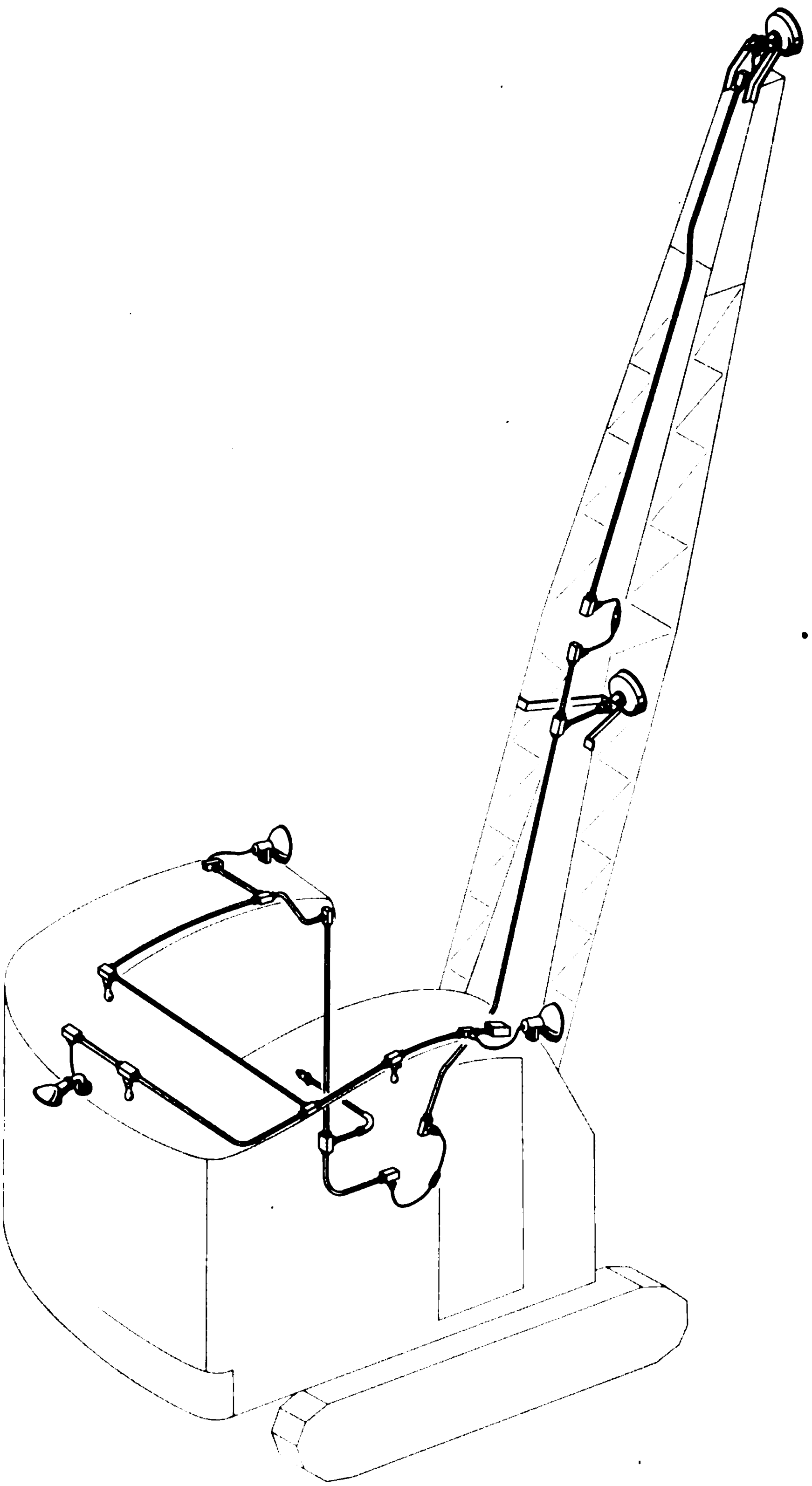
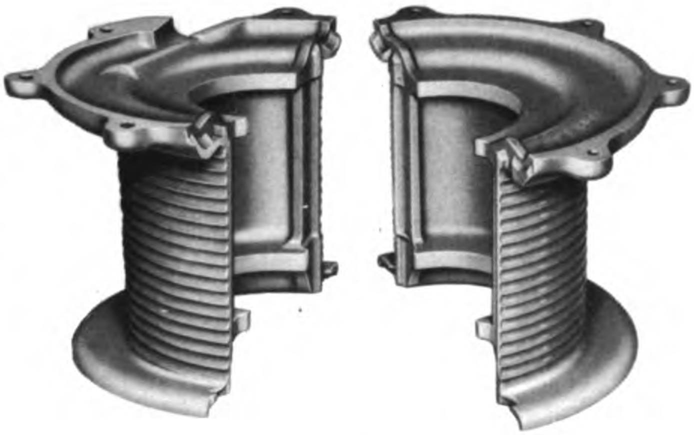


FIGURE 70

EQUIPMENT CHANGES FOR VARIOUS OPERATIONS

To convert the Koehring Crane to a clamshell, dragline, pile driver, shovel or pull shovel no changes are required in the mechanism to steer, travel or swing the machine.

"A"



"B"

FIGURE 71

FIGURE 72 SHOVEL

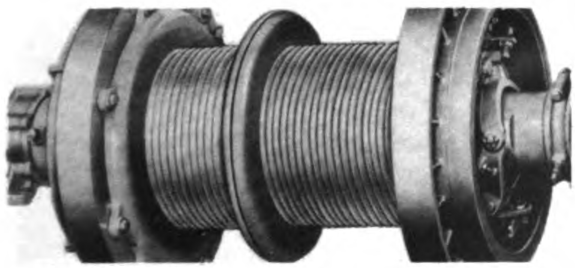


FIGURE 73 CRANE

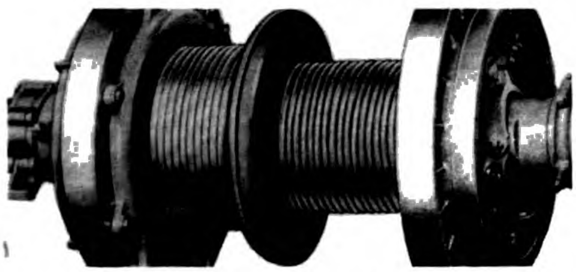


FIGURE 74 DRAGLINE

LAGGING

Drum and sprocket laggings are split to facilitate installation on the main shaft as shown in Figure 71 above. The two halves of each lagging should be used together as each pair is drilled to fit the drum before splitting. Each half is quickly and easily installed by placing it over the shaft and bolting to the drum. Figure 72 shows the drum shaft equipped to operate as a shovel. The tapered lagging for the dipper hoist cable is at the left, and the double sprocket lagging for crowding and racking-in the dipper is at the right. Figure 73 shows the drum shaft equipped to operate as a lifting crane, clamshell or pile driver. Both laggings are of the same diameter with the narrow one at the left and the wide one at the right. Figure 74 shows the drum shaft equipped to operate as a dragline or pull shovel. The larger diameter lagging for the hoist cable is at the left, and the smaller diameter lagging for the drag cable is at the right.

EQUIPMENT CHANGES FOR VARIOUS OPERATIONS (CONT'D.)

LIFTING CRANE:

Both drum laggings on the lifting crane main drum shaft are of the same large diameter. The narrow lagging is placed at the left and the wide lagging at the right. If only one drum is used, only one large diameter sheave is needed at the boom point. If both drums are used for load lifting, two large diameter sheaves are needed at the boom point. If the crane should be equipped with a fairlead for dragline work or an auxiliary front drum for pile driving work, it is not necessary to remove these two parts for lifting crane work.

CLAMSHELL CRANE:

Both drum laggings on the clamshell crane main drum shaft are of the same large diameter so that both the lifting cable and the closing cable wind on the drum at the same speed. The narrow lagging is placed at the left and the wide lagging at the right. Two large diameter sheaves are needed at the boom point, and a tagline drum attachment must be installed on the boom to operate the tagline or cable which prevents the clamshell from twisting around during hoisting and lowering operations. If the clamshell crane should be equipped with a fairlead for dragline work or an auxiliary front drum for pile driving, it is not necessary to remove these two parts for clamshell crane work.

DRAGLINE CRANE:

The left hand drum lagging on the dragline main drum shaft is used for hoisting the bucket and is of large diameter. The right hand drum lagging used for dragging the bucket is of small diameter. A dragline fairlead used to guide the drag cable to the drag drum is bolted at the place provided for it at the front-center of the turntable. Only one large diameter sheave is needed at the boom point for the hoist cable.

PILE DRIVER:

Both drum laggings on the pile driver main drum shaft are the same as used for the lifting crane. However, if the machine is already equipped as a dragline with one large diameter drum lagging and one small diameter drum lagging on the main drum shaft, no changes of lagging will be necessary as the pile driver attachment can be operated satisfactorily with the dragline drum laggings. If fairlead or tagline or both are attached to the machine, it will not be necessary to remove them. Two large diameter sheaves are required at the boom point.

CHANGING BOOMS FOR VARIOUS TYPES OF OPERATIONS

Following are the types of booms or front end attachments required for the various combinations to which the Koehring crane can be converted:

COMBINATION	FRONT END ATTACHMENT
CRANE	Crane boom with two large point sheaves
CLAMSHELL	Crane boom with two large point sheaves and tagline
DRAGLINE	Crane boom with two large point sheaves and fairlead
PILE DRIVER	Crane boom with two large point sheaves and auxiliary front drum.
PULL SHOVEL	Jib frame and boom, bucket arm and bucket.
SHOVEL	Shovel boom, dipper sticks and dipper.

To save time and heavy lifting, it is advisable to build a crib of timbers upon which the front end attachment to be installed on the machine should be placed. (See Figures 75 and 76 below and Figure 77 on Page 98.) The cribbing should be high enough to place the boom foot of the attachment at the same height as the boom foot pins on the turntable. The attachment to be placed on the cribbing should be handled by the attachment already on the machine. Another crib should be built for the storage of the attachment to be taken off the machine. The distance between cribs should not be too great as the machine is not designed to travel more than a short distance without a boom or front end attachment. Boom or attachment changes should be made on level ground.

STORING CRANE, DRAGLINE AND PILE DRIVER BOOMS ON CRIBBING

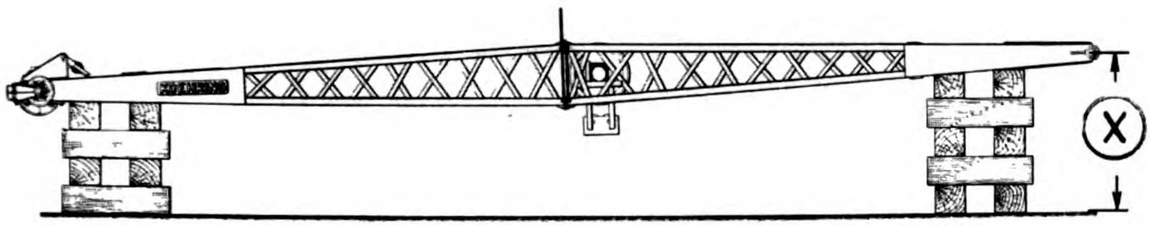


FIGURE 75

Cribbing as illustrated above is made up of 12" x 12" timbers. The distance (X) from the ground to boom foot should be approximately 5'-3".

STORING PULL SHOVEL ATTACHMENT ON CRIBBING

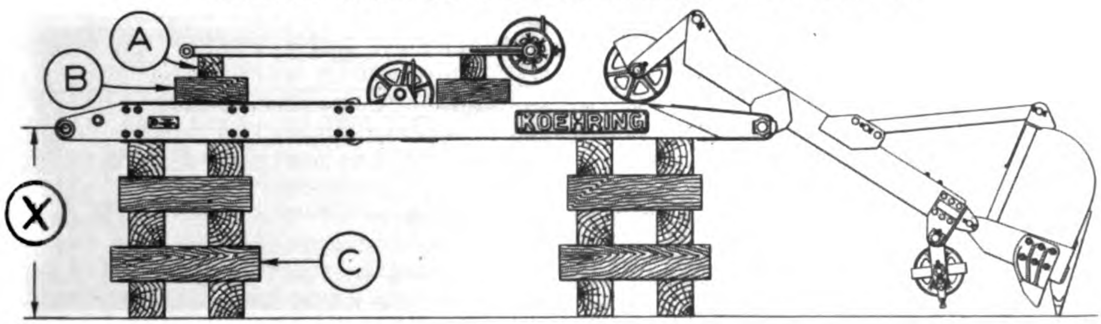


FIGURE 76

Cribbing as illustrated above is made up of 12" x 12" timbers (C), 8" x 8" timbers (B) and 6" x 6" timbers (A). The distance (X) from the ground to boom foot should be approximately 5'-3".

STORING SHOVEL ATTACHMENT ON CRIBBING

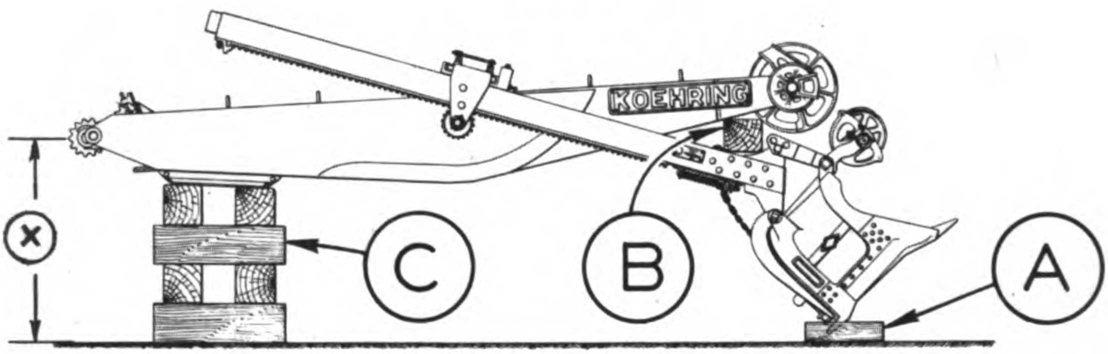


FIGURE 77

Cribbing as illustrated above is made up of 12" x 12" timbers (C), 8" x 8" timbers (B) and 6" x 6" timbers (A). The distance (X) from the ground to boom foot should be approximately 5'-3".

CHANGING BOOMS FOR VARIOUS TYPES OF OPERATIONS
REMOVING CRANE BOOM

After the machine has been moved to the proper position at the cribbing as illustrated in Figure 77 above, line up the turntable with the crawlers. Lower the boom on the cribbing which should be built high enough to permit easy removal of the boom foot pins. Remove pins, and after machine is backed away from boom, insert the pins in the boom foot casting for use with other booms. Remove the hoist cables and the boom hoist cable. Roll the cables in coils or wind them on cable spools, lubricating the cables as they are rolled or wound, and store.

MOUNTING SHOVEL ATTACHMENT

If a crane or a dragline is to be converted to a shovel, remove boom as directed under "Removing Crane Boom." In addition to the boom on a dragline, the fairlead must be removed by taking out bolts (A) shown in Figure 78, Page 99. Replace bolts in fairlead and store. Remove the right and left hand drum laggings from the main drum shaft and store. Bolt the tapered lagging (A), Figure 71, Page 95 at the left hand of the drum shaft. Bolt the double sprocket lagging at the right hand of the drum shaft. The shovel drum shaft assembly complete with tapered and sprocket lagging is shown in Figure 72, Page 95. Put the crowd chain around the left hand sprocket of the double sprocket lagging; fasten the ends of the crowd chain together with chain pin; insert cotter in chain pin and open. Do not try to adjust crowd chain until the boom is raised to an angle of approximately 40 degrees. To attach the reversing or racking-in chain which operates from the right hand sprocket of the double sprocket lagging on the main drum shaft to the single sprocket on the boom hoist shaft, remove the patch plate attached by four bolts to the curved section of the cab bulkhead. Put the chain around the sprocket on the boom hoist shaft; pass it through the hole in the cab bulkhead to and around the right hand sprocket of the double sprocket lagging on the main drum shaft; fasten the ends with a chain pin; insert cotter and open. Reeve the

CHANGING BOOMS FOR VARIOUS TYPES OF OPERATIONS (CONT'D.)

MOUNTING SHOVEL ATTACHMENT (CONT'D. FROM PAGE 98)

shovel boom hoist cable as described on page (85). Raise shovel boom to an angle of approximately 40 degrees. Wrap the end of the dipper hoist cable in a large loop around the ends of the dipper sticks - just ahead of the greenhorns on the racking to prevent slipping when hoisting - and clamp the cable securely. With the dipper resting on the ground, wind the dipper hoist cable until the rear ends of the dipper sticks are about two feet above the height of the shipper shaft on the boom. Travel the machine forward, guiding the boom between the sticks until far enough to lower sticks on the shipper shaft pinions. Check to be sure that the same number of rack teeth on each dipper stick are between the shipper shaft pinions and the end of the racking so that dipper sticks run square with the pinions. (See Figure 80, Page 100.) Release the left foot brake pedal. Lower boom and back up machine until the end of the dipper sticks are near the shipper shaft pinions. Check again on the number of teeth between pinions and end of rack to be sure there are an equal number on both sides. To place saddle blocks in proper position, remove nut (E), Figure 81, Page 101, on one end of the shipper shaft; remove thrust washer (F) behind the nut, then slide the saddle block out to a little beyond the width of the dipper stick. (Do not pull the saddle block off the shaft for this particular adjustment as it is heavy and will require added time and labor to replace.) Hold the gib (G) in place, and swing the saddle block up so the gib and saddle block will clear the top of the dipper stick, then slide the saddle block and gib in place so that gib is between saddle block and stick. Replace thrust washer and nut on the end of the shaft. Draw nut up tight, using a hammer on the special wrench furnished with the shovel attachment. Insert cotter in shaft and open. Place the other saddle block in a similar manner. Remove dipper hoist cable from dipper sticks and reeve it through dipper sheave block as described on page (85). Grease the tops of the dipper sticks and the racking. Raise the boom to an angle of approximately 40 degrees. Wing the hoist cable and lift dipper about 3 feet off the ground. Shift lever No. 9 page 42, to racking-in position. Crowd out and rack-in the dipper sticks several times using Lever No. 4. Do not strike the stops at either end of the dipper sticks. If racking teeth do not mesh properly with shipper shaft pinions, adjust saddle block gibs as described on Page 101. Adjust crowd chain as described on Page 102. Adjust right hand drum clutch as described on Page (88) to be sure it does not back-lock. Adjust dipper trip clutch as described on Page 103.

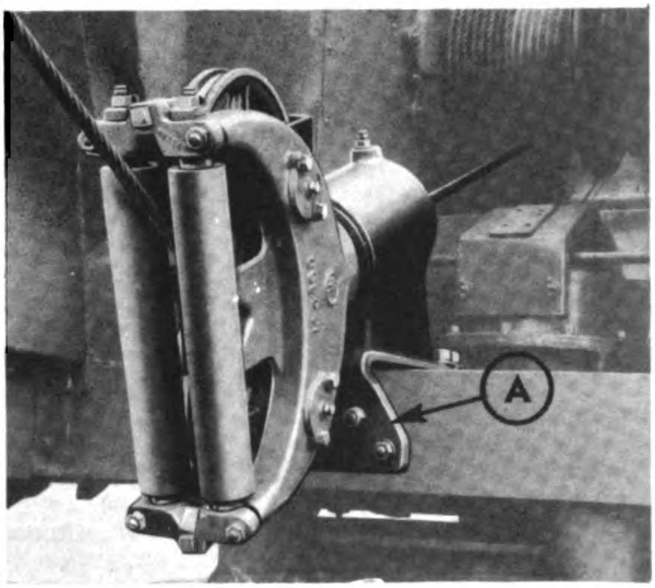


FIGURE 78

CHANGING BOOMS FOR VARIOUS TYPES OF OPERATIONS (CONT'D.)

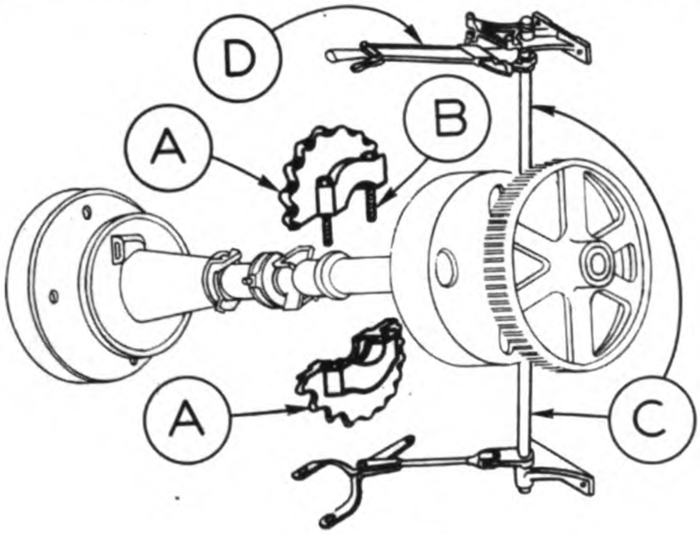


FIGURE 79

When a machine is shipped from the factory as a combination lifting crane and shovel, the racking-in sprocket and the operating mechanism to shift the sliding jaw clutch is already installed. When a machine is shipped as a crane only or dragline only, the racking-in sprocket and the sliding jaw clutch and lever linkage are omitted. To convert a crane or dragline to a shovel, move machine to cribbing prepared for storage of crane or dragline boom and remove boom as described on page (97). Remove crane or dragline laggings from the right and left hand drums of the main drum shaft and store. Bolt the tapered shovel hoist lagging to the left hand drum; place the two halves of the double sprocket lagging around the right hand drum and bolt securely (see Figure 72, Page 95.) To install the racking-in sprocket and sliding jaw clutch fork and lever linkage, as shown in Figure 79, place the two halves of sprocket (A) around the boom hoist shaft, on the shoulder provided for the sprocket, and bolt securely with bolts (B). Secure lever operating linkage (C) to turntable with bolts through holes provided on turntable and attach lever (D).

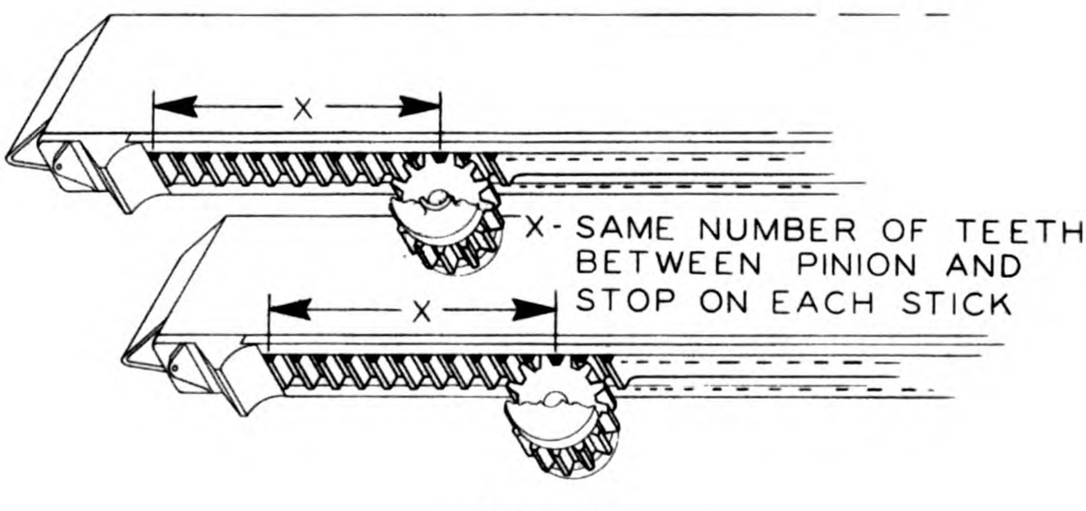


FIGURE 80

OPERATING ADJUSTMENTS (FOR SHOVEL)

For shovel operation, the right hand drum clutch - for crowding - should be adjusted so that it will not back-lock. To make this adjustment, screw in adjusting screws (E), Figure (63), Page (88), just far enough to keep the clutch from back-locking then set the lock nuts (L).

SADDLE BLOCK GIBS: (Figure 81)

Saddle block gibs must be adjusted regularly to keep the rack or shipper shaft pinions in proper mesh with the dipper stick racking. However, they must never be adjusted so tight that the sticks do not run freely. To check the saddle block gib adjustment, hoist the dipper until the dipper sticks are level. Release the crowd brake. Rock the saddle blocks backward and forward by crowding out and racking-in the dipper sticks. If the saddle blocks can be rocked more than one half inch, the gibs should be adjusted. To adjust, remove lock rod (A); loosen lock nuts (B) and (C) on both adjusting bolts (D). Turn both adjusting bolts (D) an equal distance using lock rod (A) as a wrench. Do not adjust too tight. When properly adjusted, the saddle blocks should rock forward and backward about 3/8". Be sure both adjusting bolts have been turned down the same distance. After adjustment has been made, replace the lock rod (A), then tighten lock nuts (B) and (C) on both adjusting bolts (D). Always adjust both right and left hand saddle blocks at the same time.

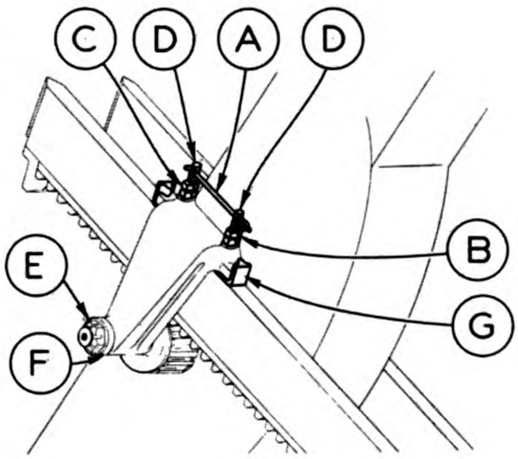


FIGURE 81

DIPPER ANGLE ADJUSTMENT AND SHEAVE BLOCK BUSHINGS: (Figure 82)

The angle of the shovel dipper, in relation to the dipper sticks, is adjusted with the adjusting links (A). To change the dipper angle, swing the turntable so that it lines up with the crawlers. Set the dipper flat on the ground as shown in Figure 82. Release the crowd drum brake (left brake pedal). Allow a little slack in the hoist cable. Remove bolt (B) from both links. To decrease dipper angle, travel machine forward; to increase dipper angle, travel machine backward - the distance traveled in either direction to be just enough to permit inserting bolt (B) into the next adjusting hole in the links. When the sheave block bushings (C) become badly worn they can be reversed for further use. To reverse the bushings, lower the dipper to the ground and release the hoist cable so that the sheave block (D) tilts forward, as shown in Figure 82. Remove bolts (E). Pull out bushings (C), turn them over and replace. Replace bolts (E) and tighten nuts.

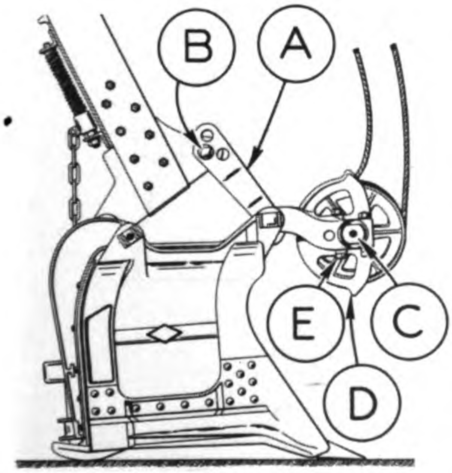


FIGURE 82

OPERATING ADJUSTMENTS (FOR SHOVEL)

DIPPER LATCH BAR:

Latch bar (A) must be set so that it goes into latch keeper not more than 1/2". To adjust, close and pull cotter (B). Loosen nut (C) and take up on nut (D) to raise latch bar out of latch keeper. Loosen nut (D) and take up on nut (C) to lower latch bar into keeper. When proper adjustment has been made tighten and cotter.

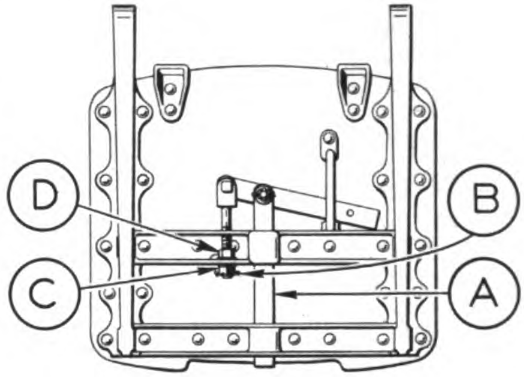


FIGURE 83

CROWD CHAIN: (Fig. 84)

To operate properly, the crowd chain must be adjusted with a sma ll amount of slack, and while making the adjustment, the boom must be set at an angle of approximately 40 degrees as indicated in Figure 84. To adjust crowd chain, crowd the dipper out almost to the end of the dipper sticks; set the crowd brake (left foot pedal), then lower the dipper to the ground. Crowding the dipper out puts all the slack in the top half of the chain and makes it easier to adjust. Loosen nuts (A) on both adjusting bolts (D). Loosen lock nuts (B) and tighten a djusting nuts (C) on both adjusting bolts to make the chain tighter. Be sure the same amount of adjustment is made on both adjusting bolts (D) so that the idler sprocket will run true in the crowd chain. After the proper adjustment is made, tighten nuts (A) and (B). Do not run the chain too tight. CAUTION: Never tighten crowd chain with the boom in horizontal position.

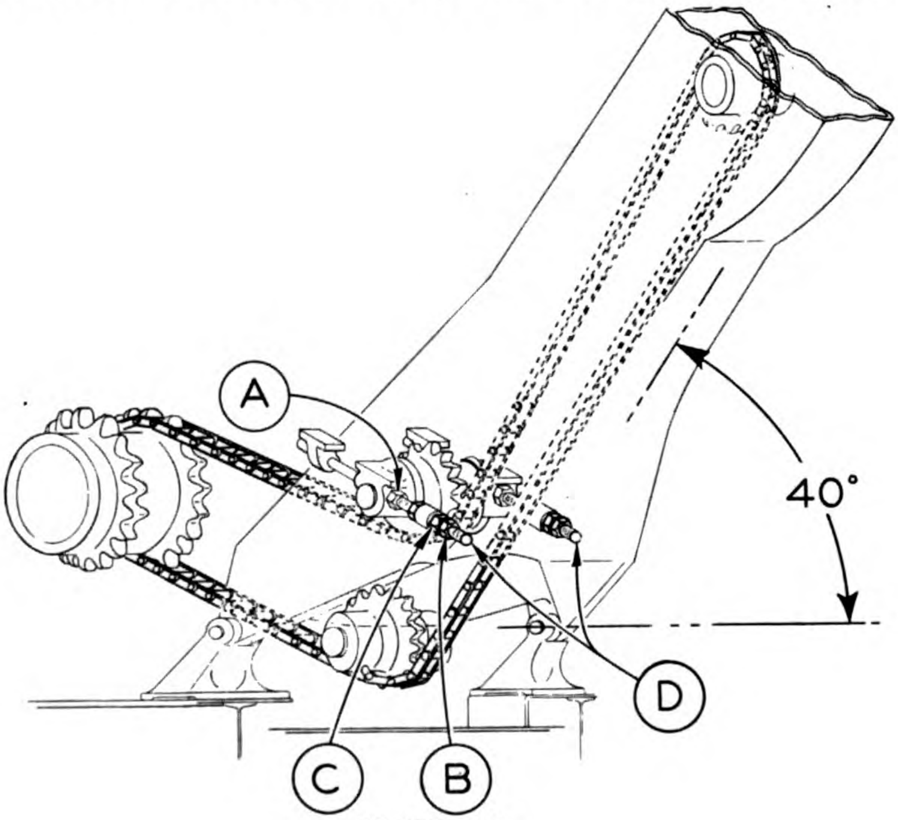


FIGURE 84

OPERATING ADJUSTMENTS (FOR SHOVEL)

DIPPER TRIP CLUTCH AND TRIP OPERATING CABLE: (Figures 85 and 86).

The dipper trip clutch (Figure 85) should be so adjusted that when the operator pushes down on the trip lever (Figure 86) which is mounted on lever No. 4 Page 42, the dipper door will open instantly. This clutch should have a slight amount of drag all the time to prevent slack in the trip cable during the cycle of operation. To adjust the clutch band (A) for dipper tripping, loosen lock nut (B) and turn the adjusting bolt (C) out of the band crank arm (D) toward the hub (E) of the clutch spider (F) to tighten the clutch just enough to open the dipper door when the trip lever is pushed down. When the adjustment on bolt (C) is used to its full extent, loosen lock nut (B), and screw bolt (C) up into band arm (D). Then loosen lock nut (G) and turn down nut (H) which moves the clutch shifter yoke (J) in toward the clutch far enough to take up the adjustment lost by screwing bolt (C) into the clutch arm. Tighten lock nut (G) and readjust clutch with bolt (C). To provide the proper amount of drag in the clutch to remove the slack in the trip cable, loosen nut (K) on bolt (L) and tighten nut (M), then test. If bolt (L) is drawn too tight, the dipper door will open during the operating cycle. Tighten lock nut (K) after proper adjustment of bolt (L) is made. The guide bolts should be so set that there is approximately 1/16" clearance between the head of the guide bolts and the clutch band when the clutch is fully engaged by holding the trip lever down. To adjust trip operating cable (N), shown in Figure 86, loosen lock nut (O) and move sheave (P) back far enough to make the cable taut. Tighten lock nut (O).

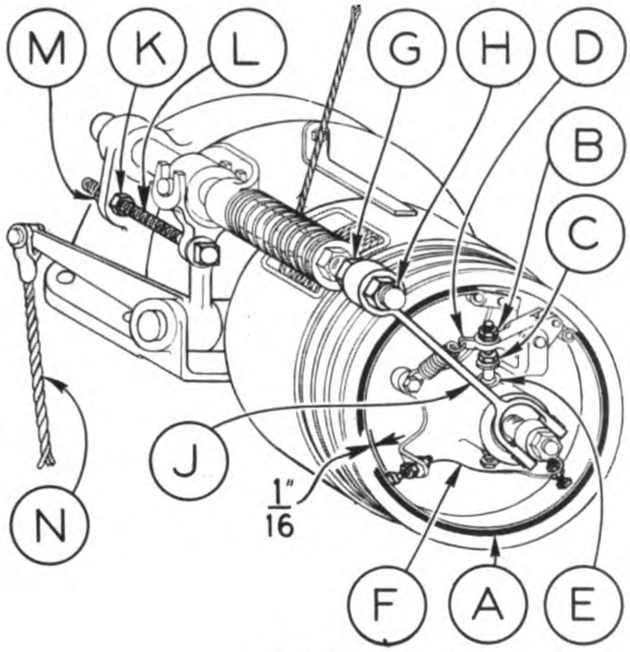


FIGURE 85

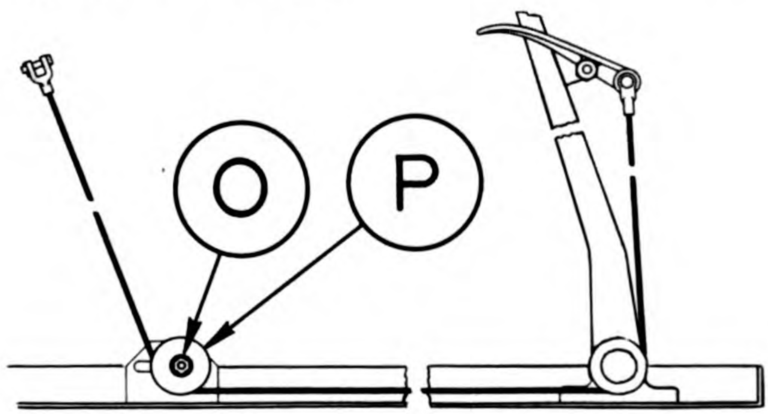


FIGURE 86

REMOVING SHOVEL ATTACHMENT

(Refer to "Storing Shovel Attachment on Cribbing," Page 98)

If the shovel attachment is to be removed but not transported to another location for storage, it can be removed without disassembling the attachment. To remove, line up the turntable with the crawlers and lower shovel boom to an angle of approximately 30 degrees. Crowd the dipper out to the end of the dipper sticks and hold the dipper about 12" from the ground. Place two short timbers (A) on the ground directly under the dipper and about 18" apart. Lower the dipper to the timbers so that latch plate of the dipper is between the two timbers (A). Place a short timber (B) across the top of the dipper sticks under the boom, then lower the boom to the timber. This timber should be so located that it prevents the boom point sheaves from resting on the dipper sheave block. Build a substantial crib, as illustrated, under the boom near the boom foot with just enough clearance between boom and cribbing to permit the insertion of wooden wedges which are then driven in far enough to take the weight of the boom off the boom foot pins. Remove the dipper hoist cable, the boom hoist cable and the dipper trip cable from the machine. Lubricate cables, wind them in rolls and store with attachment. Remove the crowd chain from the crowd drum and place it on top of the boom securing it to the boom with wire. Remove boom foot pins and back the machine away from the boom. Drive the machine to the attachment to be used and which should be stored on cribbing as illustrated on page 97. Remove the reversing or racking-in chain from the boom hoist and load hoist shafts; remove the tapered lagging and the double sprocket lagging from the hoist drums and store all of these accessories with the shovel attachment. The dipper trip unit can remain on the machine unless it is to be used on another machine not equipped with a dipper trip. If the shovel attachment is to be removed for transportation to another location, it should be disassembled as follows: Line up the turntable with the crawlers; set the boom at an angle of approximately 40 degrees; crowd the dipper out to approximately 18" from the end of the dipper sticks, then lower the dipper to the ground. Unfasten the dead end of the hoist cable at the dipper and pull the cable out of the dipper block sheave. With this free end of the cable make a loop around the dipper sticks just ahead of the rack teeth and fasten cable with clamps. Remove dipper trip cable. Remove the stops at the rear end of the dipper sticks. Wind the hoist cable until all slack is removed from the cable. Release the crowd brake. Back the machine away from the dipper, crowding out the dipper sticks until the sticks are free of the crowd pinions. Lower the sticks with the hoist brake. Replace stops on ends of dipper sticks. Remove the hoist cable from the dipper sticks and from the hoist drum on the machine. Lower the boom to cribbing which has been built high enough to permit easy removel of boom foot pins. Remove the boom hoist cable. Part the crowd chains and lay the ends of the chains on top of the boom then fasten with wire. Remove boom foot pins and back machine away from the boom.

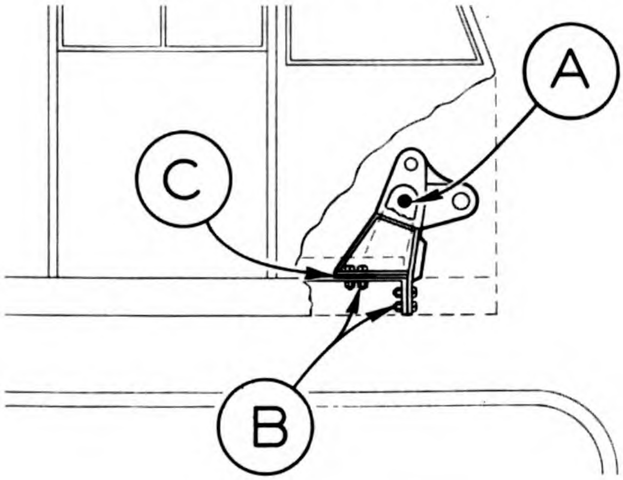
OPERATION OF BOOM HOIST AND RACKING-IN LEVER NO. 9
(For Shovel Operation Only - Page 42)

Lever No. 9 is not furnished with a machine shipped from the factory for use as a crane only. This lever shifts a jaw clutch on the boom hoist shaft. When pushed away from the operator to latched position, the jaw clutch on the boom hoist shaft engages the boom hoist drum, then by pushing forward on lever No. 4, the boom raises. When lever No. 9 is pulled toward the operator to latched position, the jaw clutch on the boom hoist shaft engages with the racking-in sprocket, they by pushing forward on lever No. 4, the dipper sticks will rack-in. To shift lever No. 9, have lever No. 4 in neutral position (engine clutch engaged by pulling lever No. 1 up); push lever No. 9 for boom hoist engagement and pull lever No. 9 for racking-in engagement. If lever No. 9 does not latch in notch for selected operation, keep pressure on it while lever No. 4 is pushed forward then back to neutral to line up the clutch jaws for engagement. The beginner will find it easier to shift lever No. 9 with the engine idling. Do not operate unless lever No. 9 is latched in selected position. Be sure boom safety ratchet pawl is engaged - lever No. 10 forward - before shifting from boom hoist to racking-in operation. When operating as a crane, lever No. 9 should be in boom hoist position all the time. The crowd and racking-in boom hoist lever No. 9 operates two friction clutches for three operations, two of which operations are selected by lever No. 9. Pulling lever No. 4 back from neutral engages the right hand drum or crowd clutch and crowds dipper sticks out. Pushing lever No. 4 forward from neutral engages the clutch on the boom hoist shaft and transmits power through the sliding jaw clutch operated by lever No. 9 to engage the boom hoist drum to raise the boom or to engage the reversing sprocket on the boom hoist shaft to rack-in the dipper sticks. The reversing sprocket is connected to the crowd drum with a roller chain which reverses the crowd drum to rack-in the dipper sticks. To select boom hoist or rack-in operation, see description of lever No. 10, Page (52). To operate lever No. 4 in crane work, see Page (47).

MOUNTING PULL SHOVEL ATTACHMENT

Pull shovel attachment should be placed on cribbing as illustrated on Page 97. If crane or shovel is to be converted to pull shovel, remove crane or shovel attachments and lagging as described on pages (98) and (104). If dragline is to be converted to a pull shovel, remove only the dragline fairlead by taking out six bolts (A) as shown in Figure 78, Page 99. Pull shovel operation requires the same drum lagging as a dragline - large diameter lagging on the left hand drum and small diameter lagging on the right hand drum. If a shovel is to be converted to a pull shovel, standard dragline laggings must replace the shovel laggings removed. If a lifting crane is to be converted to a pull shovel, keep the large diameter lagging on the left hand drum but replace the right hand lagging with the small dragline lagging.

MOUNTING PULL SHOVEL ATTACHMENT (CONT'D.)



Mount the pull shovel boom foot adapter on the turntable, using the boom foot pins (A) and bolts (B) through the bolt holes provided for the dragline fairlead, as shown in Figure 87. Use shims (C) at the bolt holes to fit adapter to the turntable.

FIGURE 87

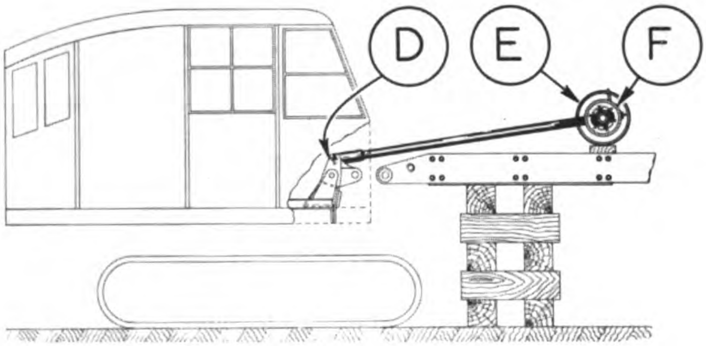


FIGURE 88

Mount the jib frame on the adapter with pins (D) as shown in Figure 88. The large sheave (E) should be at the left and the anchor spool (F) at the right.

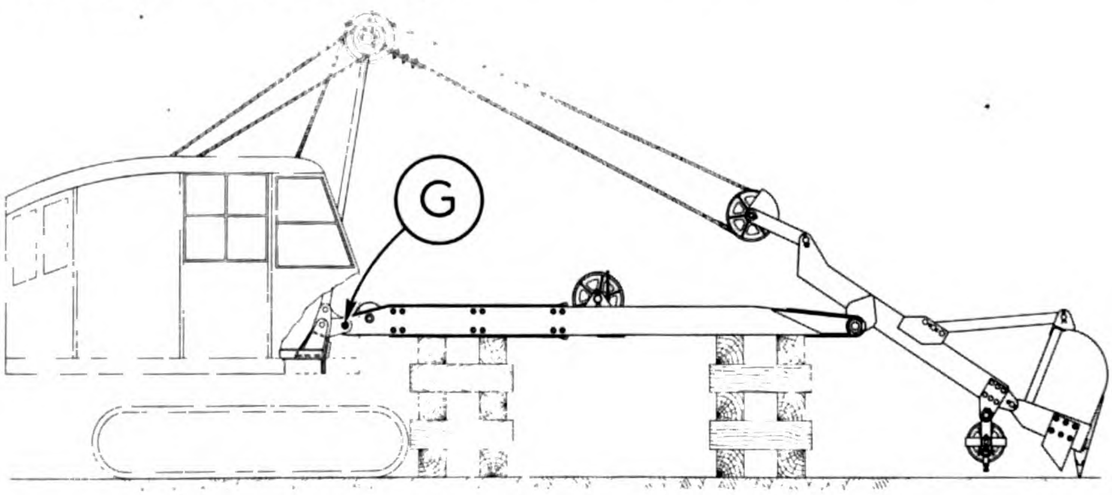


FIGURE 89

Reeve the jib frame cable as per instructions, Page (86). Raise jib frame using same levers for raising crane boom Page (47). Drive the machine to the pull shovel boom and attach boom to adapter with pins (G) as shown in figure 89. Reeve hoist and pull cables as per instructions, Page (86).

OPERATING ADJUSTMENTS FOR PULL SHOVEL

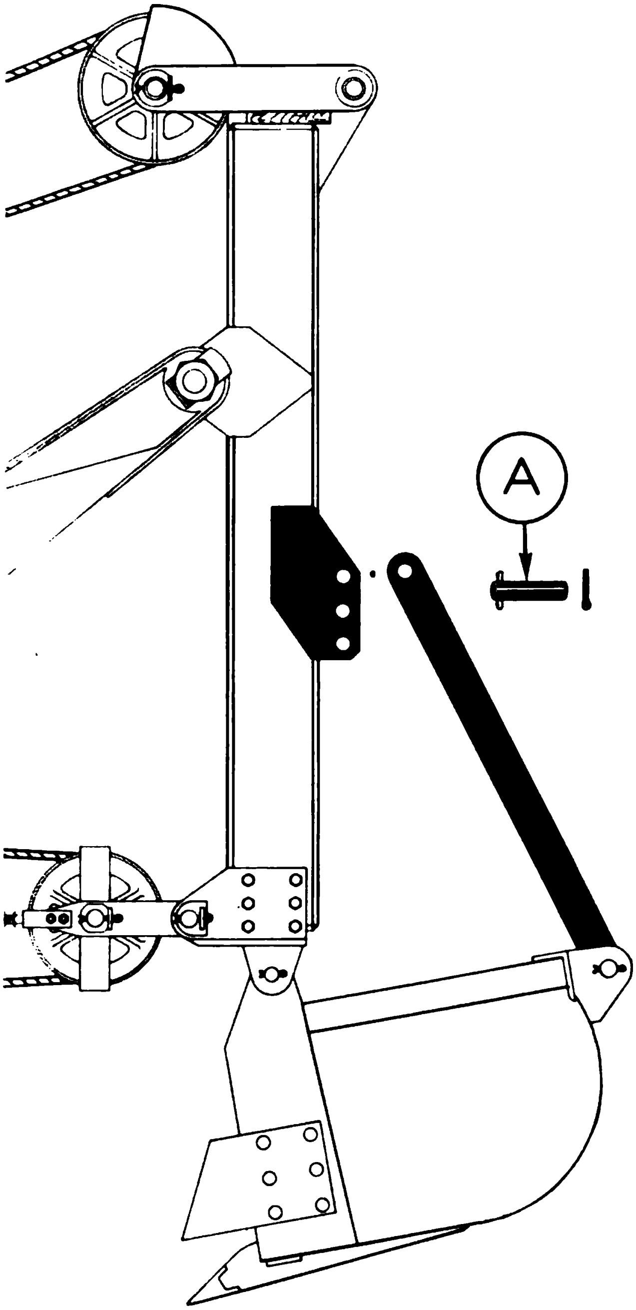


FIGURE 90

Machine operating adjustments are the same as described under "Operating Adjustments", Pages (87) to (93). If a shovel has been changed to a pull shovel, the drag clutch should be set to back-lock by screwing out on adjusting screw (E), Figure (63), Page (88). The angle of the dipper, in its relation to the dipper arm, can be adjusted by moving the dipper adjusting link Figure 90, up or down on the dipper arm. To adjust the angle, line up the turntable with the crawlers then lower the dipper to the ground. Release the hoist and drag brakes to allow a generous amount of slack in the cables. Remove link pin (A) and, with dipper on the ground, travel the machine backward or forward-depending upon the adjustment desired - until the pin (A) can be inserted into the selected hole. To remove pull shovel attachment, line up the turntable with the crawlers; extend the dipper arm out as far as it will go then lower the boom to position on two cribs as shown in Figure 76, Page 97. Remove the hoist and pull cables. Remove the boom foot pins then back the machine about one foot away from the boom. Place some blocking on top of the boom near the dipper arm and some 4" x 4" or similar timbers near the foot of the boom as shown on page 97. Lower the jib frame to this blocking and timbers, then remove jib frame mounting pins and jib frame cable. Back machine away from jib frame.

UNLOADING FROM FLAT CAR
(See Figures 92, 93 and 94, Page 109)

When unloading from a flat car, a ramp or unloading platform strong enough to support the weight of the machine is necessary. After flat car is spotted at unloading point, securely block all wheels of the flat car to prevent it from moving during the unloading operation. If machine is to be unloaded by ramp and no ramp is available, it will be necessary to build one of heavy, solid timbers as shown in Figures 92 and 94, Page 109. The ramp should be long enough to avoid a steep grade. When the machine is shipped as a crane, the regular method is to load the machine and block it at one end of the flat car, with the boom in sections, loaded on the same car behind the machine. In most cases, after the blocking which holds the machine to the car has been removed, the machine, less boom, is run down the ramp, then traveled to the other end of the car where the machine is turned to face the car and then traveled up to the car for boom attachment. The lower section of the boom is then moved toward the machine where the boom foot A is inserted into the boom foot clevises and fastened by the boom foot pins. The machine is then backed up until a short portion of the lower section is at the end of the car. Now the second section is bolted to the lower section and the machine backed up again until all sections have been mounted after which all necessary cables for the boom hoist are reeved. (For cable reeving see Pages 80 and 81.)

If conditions at the unloading point will not permit traveling machine on the ground from one end to the other, or unloading can be done from only one end of the car and the boom is loaded between that end and the machine, the following procedure will be necessary: block up solidly under both outside sills of the flat car to prevent car from tipping, then swing turntable around facing the boom sections. Assemble and mount the boom on the machine. Be sure all boom section bolts, (A) Figure 91, and cable guards are in place and tight. Reeve the boom cable as shown in Figure 53, Page 80. Raise the boom just enough to balance the machine as is traveled across the car and down the ramp.

For shovel unloading, follow the same procedure in preparing the flat car for unloading as with the crane. Shovels are shipped with shovel front end attached, and they should be unloaded with the shovel front end ahead. See Fig. 94, Page 109. After removing the blocking from the shovel and after checking all cables to see that both ends are securely fastened, raise the boom to an angle of about 40 degrees. Hoist the dipper about 3 feet from the car floor and set the hoist brake. Release the crowd brake and rack-in the dipper until it is back of the boom point, then set the crowd brake. The shovel is now ready to travel.

Draglines, Clamshells and Pile Drivers are unloaded in the same manner as Cranes. Pull Shovels are unloaded in the same manner as shovels.

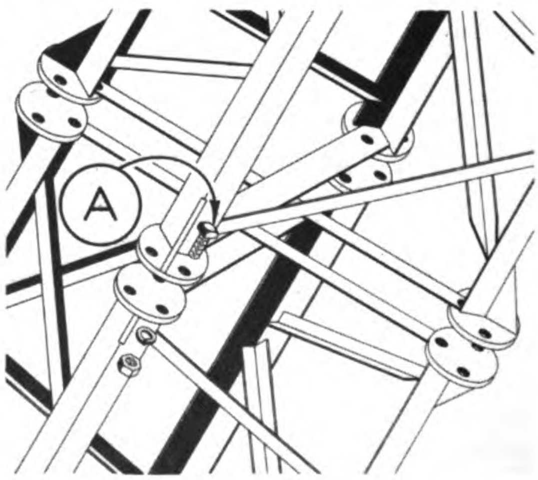
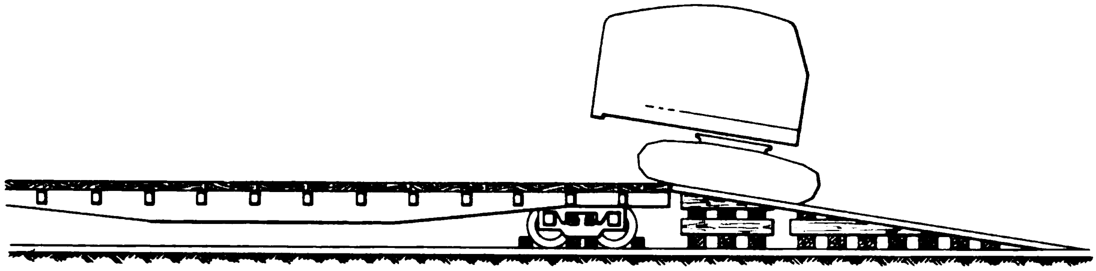
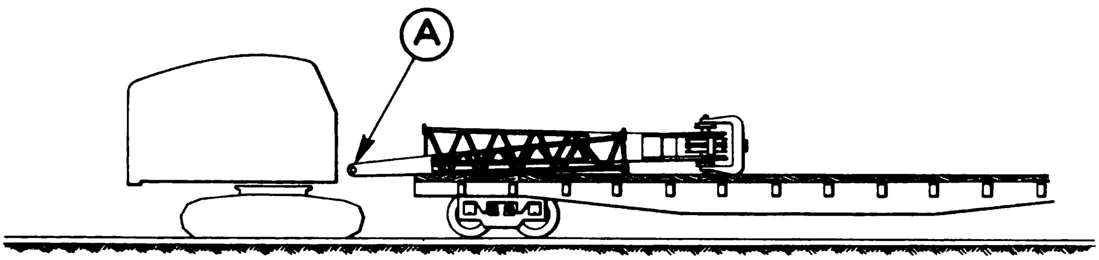


FIGURE 91



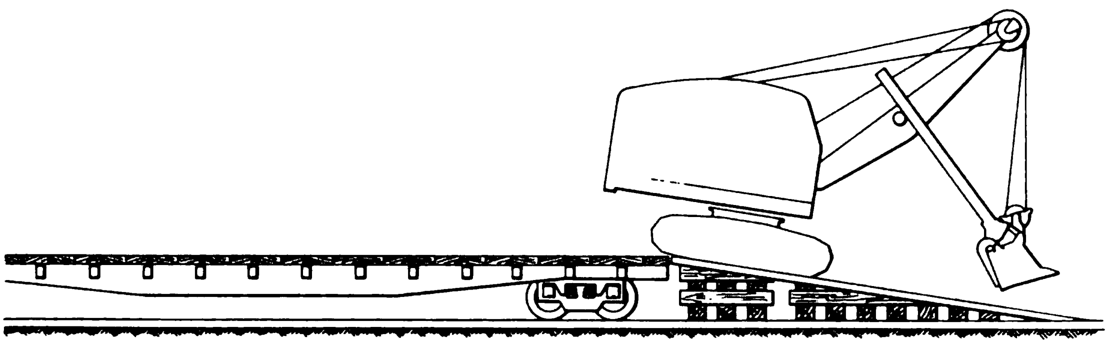
CAUTION: When unloading machine less attachment as above always face machine as shown with weight in rear to avoid tipping.

FIGURE 92



Suggested method of attaching boom after unloading machine from car.

FIGURE 93



Proper method of unloading machine with assembled attachment.

FIGURE 94

STORAGE

FOR SHORT PERIOD:
If possible, move machine under cover. Run machine up on blocking, and if shovel attachment is on machine, lower dipper to blocking. Clean crawlers and dipper thoroughly. Release tension from all cables. Grease all bearings, gears, etc. thoroughly enough to be sure all surfaces are coated to prevent rust. Grease all drum barrels being sure that surfaces under cables are coated. Grease all cables thoroughly. Install metal shields as provided with each machine, over windows. If shields are lost use boards. Set all brakes.

FOR FOUR MONTHS OR LONGER:
If storage is to be longer than four months, follow above instructions, and in addition replace paint which has worn off and exposes metal. Thoroughly clean and paint crawlers, crawler frames and dipper. Block crawlers at each end to prevent movement, and drive wooden wedges under each side of the two front turntable rollers to prevent swinging. Remove all clutch and brake bands and coat friction surfaces thoroughly with a rust preventative. CAUTION: Grease must be cleaned thoroughly from friction surfaces before replacing bands for operating use. For care of engine and engine accessories during storage, see Engine Section.

For further instructions refer to tentative technical manual TM5-9715 Preparation of Corps of Engineers Equipment for Storage issued by Engineer Field Maintenance Office, P. O. Box 1679, Columbus, Ohio.

SHIPMENT - DOMESTIC

NOTE--Working weights which should be used for field shipping weights are given in the specifications on Page 25. Overall lengths, heights, widths are shown in the specifications on Pages 28 to 36.

TO SHIP BY RAIL:
Order a flat car (42' or longer) having a capacity of 60,000 pounds or more. Machine and accessory equipment should be loaded and blocked as shown in illustrations on Page (111). Block car to prevent movement while loading. If platform loading facilities are not available, build a ramp from end of car to ground as illustrated on Page 109. The same type of ramp is necessary for side loading. Propel machine up ramp with the front end first, crawler drive chains to the rear and on to the car. Spot the machine as nearly as possible over the center of one flat car truck on center line of car at either end of the car. Block machine as illustrated. Using the boom of the machine, load other attachments or accessories over the other flat car truck to distribute or balance load, leaving space on the car to place crane boom after disassembly of boom or to lower and block shovel or pull shovel attachment. Check to be sure all machine brakes are set against swing, propelling or hoisting. Drain radiator and gasoline tank. Close cab and lock windows and doors, covering windows with metal shields provided for the purpose. CAUTION! Be sure all blocking is secure and adequate to prevent any movement of load.

TO SHIP BY TRAILER:
For short hauls or cross country hauls where railroads are not available, it will be necessary to ship by trailer. Manufacturers of trailers especially built for this purpose usually provide instructions for loading of equipment. If trailer is of ordinary flat bed, stationary axle type, it will be necessary to securely block trailer. Build a ramp of two 3" x 18" boards 16

METHOD OF BLOCKING

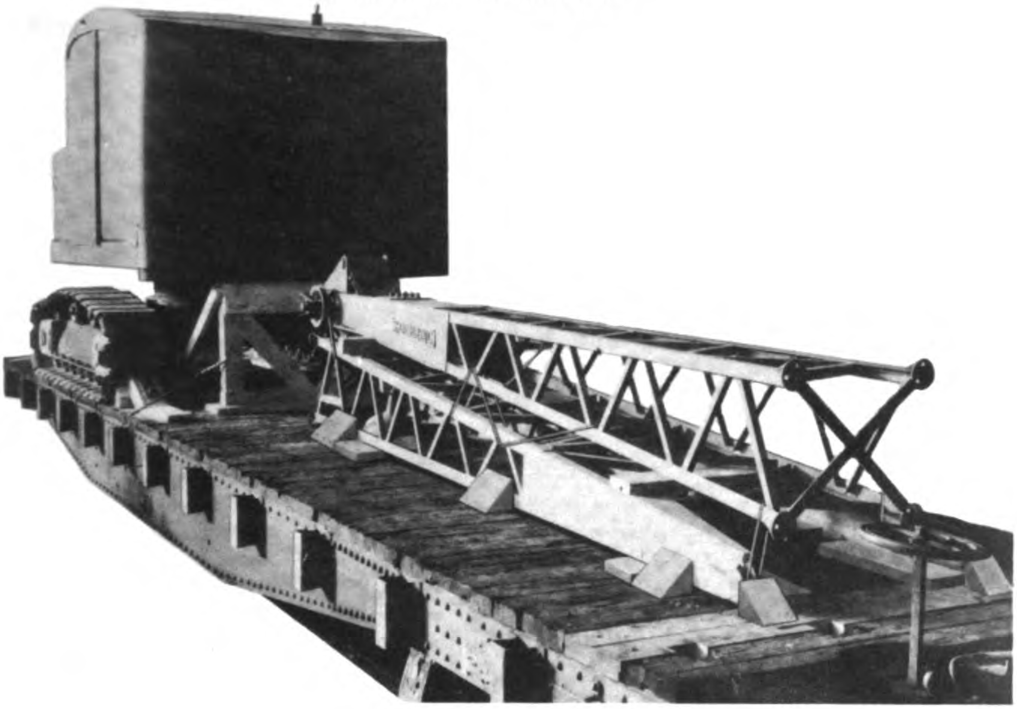


FIGURE 95

FIGURE 96

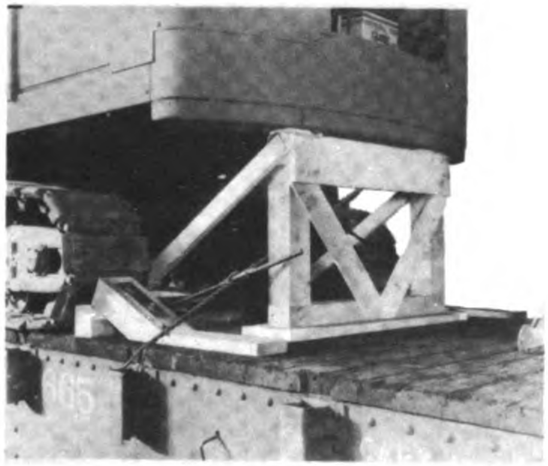


FIGURE 97

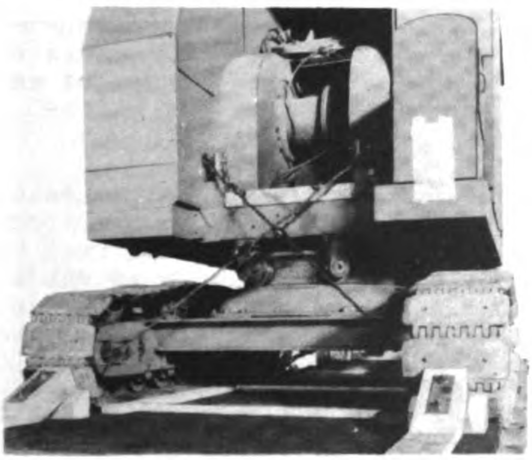


FIGURE 98

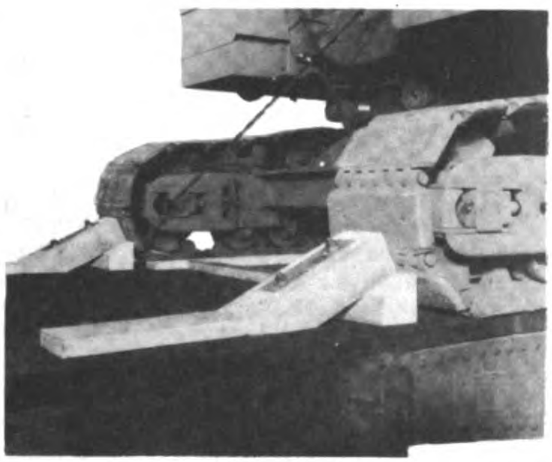


FIGURE 99

feet long supported by blocks from the ground to the trailer bed, then travel machine up ramp on to the trailer the same as for flat car loading.

NOTE: For export shipment refer to tentative technical manual TM5-9711 Instructions for Preparation of Corps of Engineers Equipment for export, issued by the Engineer Field Maintenance Office P. O. Box 1674, Columbus, Ohio.

IMPORTANT SUGGESTIONS

Keep machine clean. Dirt not only serves as a good cutting compound, when mixed with water or grease, to ruin bearings but also hides trouble in the making. A clean machine is easily and quickly inspected and is the mark of a good operator.

LUBRICATE REGULARLY ACCORDING TO INSTRUCTIONS:
Keep gasoline, lubricants and water for radiator clean. Inspect machine regularly every six shifts and tighten loose bolts. If cracks appear in heavy castings as a result of hard service, weld promptly to avoid serious breakdowns.

IN CRANE OPERATION:
Be sure footing is solid. Keep crawlers a little high on the load side. Do not exceed rated capacities. (See Page 29). Keep brakes and clutches in proper adjustment. Be careful when propelling machine with boom at high angle. Better traction is assured in soft going if the load is carried behind. When travelling with a suspended load, snub the load to the machine to prevent load from swaying. Be sure that all loads are properly secured before lifting - especially with boom close to vertical as sudden release of load might throw boom back over the cab. Always use proper cable lengths to prevent overwinding and excessive wear.

IN SHOVEL OPERATION:
Never "sweep" or swing shovel dipper sideways in cuts to level off. It is a quick way to bend sticks. Do not start swing motion of shovel until dipper is clear of bank. Avoid striking bumpers under shovel boom. If in time the armor support becomes badly bent or wood filler decays or becomes worn to about 1/2 of original thickness, support and wood filler should be replaced. Never leave machine in deep cut or pit or on stream side of a dam or levee overnight or any other time when not in operation. Flash floods or heavy rains may fill such low places. Keep dipper teeth sharp and fill the dipper at every pass. Take a relatively thin slice at a cut in hard digging so that the dipper hoists through the bank fast and easily. In soft digging it is not necessary to pull dipper through full length of bank to fill. In high banks of soft digging take top passes first. Move up and clean up cut and loosen hard material while waiting for trucks.

IN DRAGLINE OPERATION:
Keeping bucket teeth sharp and built up to proper size increases digging speed and prevents wear on bucket lip. Hoist bucket from digging as soon as it is filled. Piling dirt under boom foot by dragging full bucket too far is wasted time - wears drag cable. Inspect drag chains regularly, paying particular attention to end links which are subjected to greatest wear. Chain life can often be increased by reversal end-for-end and also top-for-bottom. DO NOT PULL DRAG CABLE SOCKET INTO FAIRLEAD. Keep fairlead sheaves and bearings well lubricated.

WAR DEPARTMENT - CORPS OF ENGINEERS
PREVENTIVE MAINTENANCE GUIDE

FOR USE WITH T. M. AND LUBRICATION GUIDES
(1054) (1054A) (1054B)
EXCAVATOR, POWERED, GASOLINE, 3/4
CUBIC YARD, KOEHRING MODEL 304.

PREVENTIVE MAINTENANCE IS THE SYSTEMATIC
APPLICATION OF COMMON SENSE MEASURES IN
"TAKING CARE OF WHAT YOU HAVE"

THE ECHELONS OF PREVENTIVE MAINTENANCE
(See Note 1)

FIRST ECHELON

Daily Preventive Maintenance.
1. Before operation services.
2. During operation services.
3. After operation services.
By operators (or crew)

SECOND ECHELON

64 hour (weekly) maintenance service.
By company or similar unit.
256 hour (monthly), maintenance services.
By regiment, battalion or similar units.
Operators will assist unit mechanics.

TECHNICAL INSPECTIONS

By commanding officer or staff
representative.
Use Form W.D. A.G.O. 461-E

THE RESPONSIBILITY FOR THE PERFORMANCE OF PREVENTIVE MAINTENANCE SERVICES RESTS NOT ONLY WITH THE OPERATORS, BUT WITH THE ENTIRE CHAIN OF COMMAND FROM THE SECTION CHIEF TO THE COMMANDING OFFICER. AR 850-15.

DAILY BEFORE OPERATION SERVICES

Purpose - To determine if condition of equipment has changed since last operated. Water, oil or fuel may have leaked out. Sabotage may have been attempted or damage due to weather, enemy fire or collision may have occurred.

1. Examine machine for exterior damage, missing accessories or signs of tampering. Look underneath for signs of water, oil or fuel leakage. Check fuel tanks - see that they are full. Check oil level in engines and coolant in radiator. Do not fill radiator (when cold) to overflow - allow room for expansion.

2. Inspect reserve supplies of oil and lubricants - see that they are complete and emergency equipment, tools and spare parts are in good condition and in place.

3. If freezing has occurred since last operation - See that track is free.

4. Check bucket. See that all pins and keeper pins are in place. Check drag bucket chains and clevis for broken or badly worn links.

5. Start Engine. Be sure main engine clutch lever is in release position (down position). Keep engine at moderate idling speed. Do not race. After engine warms up oil pressure gauge should read 25 to 35 lbs. If pressure drops below 10, stop engine. Locate and correct trouble.

6. While engine idles at moderate speed to warm up, lubricate with OE the following points: All pins on bucket and dipper, latch keepers and lever, dipper trip control linkage, dragline bucket dump sheave, clutch shifter collars, and the crowd chains.

7. With light pressure on main engine clutch lever, start clutches and gears turning. Be sure they turn easily. By doing this, any obstruction in the machinery can be detected. With everything clear, snap engine clutch in.

8. Before starting operation test all clutches and brakes.

9. Check oil pressure gauge again and frequently during operation.

10. Engineer equipment is vital to the war effort. It is your duty to take care of it. Remember - "Battles are won by machines that run".

DAILY DURING OPERATION SERVICES

This is an operator responsibility -- to detect deficiencies in operation, unusual sounds, odors or other signs of out of normal operation that would indicate trouble ahead if not corrected promptly. Report deficiencies that develop during operation. Do not continue operation until breakdown occurs.

11. When moving machine for long distances lubricate horizontal and vertical traction shafts, clutch shifter shoes, front and rear tumblers and top and lower rollers every two hours. Keep crawler drive chains at rear of machine.

Stop Period in Middle of Shift.

12. This period is very important regarding lubrication. Follow lubrication chart closely. Lubricate all four (4) and eight (8) hour points. Make certain that all fittings are open and all bearings taking grease. Replace broken or defective fittings.

13. When making spot lubrication -- check machine for loose or broken bolts, broken strands in cables, worn or broken links in chains, pins, lock pins, cracks in castings, and worn brake and clutch linings.

14. Check engine radiator. Check crankcase oil level -- fill to full mark.

DON'TS

Don't leave engine clutch engaged when engine is stopped, or when leaving operator's seat.
Don't ride foot brakes when clutches are engaged.
Don't travel with machine when carrying close-to-maximum load with crane.
Don't pull boom too close to vertical, sudden release of load may throw boom over cab.
Don't sweep the pit with bucket to level off.
Don't start swinging until bucket is clear of pit.
Don't swing bucket over truck cab while loading.
Don't pile dirt in front of machine when using drag bucket. Hoist when bucket is full.
Don't leave machine for extended period at edge of pit or bank.
Don't lubricate swing gear while machine is in operation.

DAILY AFTER OPERATION

The following daily after operation services are to be performed by the operator (or crew) immediately after the operation period and during continuous operation at 8-hour intervals.

15. Clean machine. Inspect for broken or loose bolts. Check sticks and boom for cracks.

16. Check dipper teeth. Turn over if partly worn. Renew if needed.

17. Check coolant in radiator. The level should be at or near overflow when hot. If contaminated with oil, rust or dirt, it should be changed. Check anti-freeze value when using.

18. Check crankcase oil level. Fill to full mark.

19. Remove air cleaner oil bowl - clean and refill with OE.

20. Fill fuel tank now. Use only clean fuel. Clean carburetor fuel screen and the sediment bulb on the fuel pump. Examine fuel system piping for leaks and loose connections.

21. Check fan belt for tension (3/4 inch slack). Check water pump and radiator for leaks. Examine all wiring - see that connections are tight, wires clean and not damaged.

22. Lubricate all four (4) hour points. If swing gear, top of sticks or rack pinions show bare spots, cover with CW.

23. If light plant is operated, check daily.

24. Avoid danger of heavy rain or flash floods by moving machine from deep pit. Place crawlers on firm footing, if necessary use rocks, brush or planking. (Follow this closely in freezing weather). Place bucket on ground - engage swing and traction brakes - set foot brakes and leave all clutches in neutral position. Close all doors and covers. See Notes 2 and 4.

64 HOUR OR WEEKLY MAINTENANCE
INCLUDING ALL 8 HOUR P.M. SERVICES.

25. Check saddle block gibs. Make adjustment if more than 1/16 inch play.

26. Check crowd chain. Make adjustment with boom at 40° angle.

27. Check crawler drive chain adjustment - 3/4 inch sag top and bottom.

28. Check crawler adjustment - 3/4 to 1 inch sag between top rollers and tumblers. See that all roller shaft U-bolts are tight - replace if broken.

29. Check swing rollers for flat spots and worn bushings.

30. Check boom foot pins and locking bolts for wear.

31. Check all reach rods, shifter yokes, linkage pins and cotter pins located in cab and under carbody for wear and damage lubricate with OE.

32. Check condition of all cables. Replace if badly worn or strands broken. Lubricate thoroughly with CW, except drag cable.

33. Check main engine clutch adjustment - tighten at first sign of slipping.

34. Check all operating clutches and brake bands for wear and adjustment. Renew lining when worn flush with rivets.

35. Check oil level in gear cases. Add oil if required.

36. Change oil in engine crankcase. Check oil filter, remove sludge. Change element if required. Lubricate all 4 to 64 hour points. (Refer Lubrication guide.)

37. Clean battery with brush and dampened cloth - apply thin film of CG over terminals - check solution with good hydrometer - add distilled water if required - keep air vent holes in caps open.

Kohler Light Plant.

38. Check crankcase oil level - must be up to filler plug opening. (Drain and change oil every 64 hours of operation).

39. Clean fuel pump bowl - check fuel lines and connections for leaks.

40. Start engine and check lights and wiring.

41. Clean and refill air cleaner cup with OE.

42. Check and clean commutator and brushes.

Note: On new equipment, at first 64 hour check, second echelon will tighten all bolts and capscrews including engine cylinder heads.

256 HOUR MAINTENANCE -(INCLUDING ALL 8 HOUR AND 64 HOUR P. M. MAINTENANCE SERVICES).

43. Check steering clutch adjustment - see that each clutch releases and engages brake.

44. Drain radiator. Flush and refill.

45. Remove and clean spark plugs - replace if broken or damaged. Adjust points to .025 inch.

46. Check valve tappet adjustment - clearance should be .006 inch for intake and .009 inch for exhaust valves when engine is hot.

47. Lubricate clutch pilot bearing.

48. Check magneto points. Adjust to .014 to .018 inch. Lubricate felt wick with drop of OE.

49. Check and adjust governor and carburetor shafts and link ball joints. Lubricate with few drops of OE.

50. Check starter and generator commutator and brushes for wear or surplus oil deposit on commutator. Clean commutator with #00 sand paper if required.

51. Every 512 hours remove crankcase oil pan - wash out sludge - clean oil pump screen. Have third echelon motor check.

Note 1. The daily preventive maintenance services are so important that they should be performed as a matter of regular routine, and never be entirely omitted, even in extreme tactical situations.

Note 2. Sign the P. M. card record and note repairs made today.

Note 3. Engineer equipment or attachments to be stored, or otherwise out of service for more than 30 days will be processed and protected in accordance with P. M. manual "Storage of Engineer Equipment".

Note 4. Report to section chiefs at once any worn or damaged parts requiring replacement or repair.

NOTES

MAINTENANCE SECTION

INDEX MAINTENANCE SECTION

MODEL 304 - EXCAVATOR BEARING TOLERANCES

LOCATION OF BEARING	TYPE & SIZE	TOLERANCES SHAFT		TOLERANCES HOUSING OR RETAINER BORE	
Crawler-Upper Idler Roller Shaft	Bronze Bushing XA-26	.011 .016	Loose Loose	.002 .006	Tight Tight
Crawler - Lower Roller	Bronze Bushing XA-32	.010 .016	Loose Loose	.004 .008	Tight Tight
Lower Traction Shaft	Bronze Bushing XA-60	.010 .015	Loose Loose	.000 .003	Loose Loose
	Bronze Bushing XA-78 and XA79	.013 .016	Loose Loose	.002 .006	Tight Tight
Carbody & Lower Traction Drive Sprocket	Bronze Bushing XA-53	.010 .016	Loose Loose	.000 .007	Loose Loose
Turntable Rollers	Bronze Bushing XA-149	.010 .015	Loose Loose	.003 .006	Tight Tight
"A" Frame Sheaves	Bronze Bushing XA-247	.010 .016	Loose Loose	.002 .006	Tight Tight
	Bronze Bushing XA-224	.008 .012	Loose Loose	.002 .005	Tight Tight
Clutch Bushings	Bronze Bushing XA-347	.008 .012	Loose Loose	.002 .004	Tight Tight
	Bronze Bushing XA-353	.006 .010	Loose Loose	.001 .005	Tight Tight
Dipper Trip Shaft	New Departure #7209	.0001 .0008	Loose Loose	.0002 .0014	Tight Loose
	New Departure #1209	.0001 .0008	Loose Loose	.0002 .0014	Tight Loose
	New Departure #7207	.0001 .0008	Loose Loose	.0002 .0010	Tight Loose
	Bronze Bushing XA-1318	.012 .008	Loose Loose	.001 .003	Tight Tight
Sheave for Trip Operating Cable	Bronze Bushing XA-1346	.007 .010	Loose Loose	.004 .007	Tight Tight
Rotating Dragline Fairlead	Roller Bearing XA-1481	.000 .005	Loose Loose	.000 .005	Loose Loose
	New Departure Balls XA-1482	.000 .005	Loose Loose	.000 .005	Loose Loose
Fairlead Guide Roller	Timken Roller Brg. 14137-14274 XA-1493	.0005 .0030	Loose Loose	.0005 .0030	Tight Tight
Rotating Frame	Bronze Bushing XA-1479	.005 .011	Loose Loose	.008 .013	Loose Loose
Clam & Crane Boom Point Sheaves	Bronze Bushing XA-912	.010 .015	Loose Loose	.002 .006	Tight Tight
Boom Point Suspension Sheaves	Bronze Bushing XA-889	.011 .017	Loose Loose	.002 .006	Tight Tight
Dragline Boom Point Sheave	Bronze Bushing XA-912	.010 .015	Loose Loose	.002 .006	Tight Tight
Boom Suspension Sheave Housing	Bronze Bushing XA-889	.011 .017	Loose Loose	.002 .006	Tight Tight

MODEL 304 - EXCAVATOR BEARING TOLERANCES

LOCATION OF BEARING	TYPE & SIZE	TOLERANCES SHAFT		HOUSING OR RETAINER BORE	
Swing & Traction Shaft	Fafnir #215WD	.0001 .0011+	Loose Tight	.0020 .0002	Loose Tight
	Fafnir #120WD-2N	.0001 .0014+	Loose Tight	.0020 .0002	Loose Tight
	Fafnir #120W-2	.0001 .0014+	Loose Loose	.0020 .0002	Loose Tight
	Fafnir #315-W	.0001 .0011+	Loose Tight	.0020 .0002	Loose Tight
Boom Hoist Shaft	Bronze Bushing XA-279	.013 .017	Loose Loose	.006 .002	Tight Tight
	Bronze Bushing XA-281	.012 .015	Loose Loose	.007 .003	Tight Tight
	Bronze Bushing XA-292	.012 .015	Loose Loose	.006 .002	Tight Tight
	Fafnir #7215	.0010 .0001+	Loose Tight	.0005 .0013	Loose Tight
	Fafnir #220W	.0001 .0014+	Loose Tight	.0018 .0002	Loose Loose
	Fafnir #7310	.0008 .0001+	Loose Tight	.0003 .0013+	Loose Tight
Two Speed Shaft	Hyatt #CD211	.0015 .0002	Loose Loose	.0023 .0005	Loose Loose
	Hyatt #CW211	.0015 .0002	Loose Loose	.0023 .0005	Loose Loose
Main Drum Shaft	Fafnir #215W	.0001 .0011	Loose Tight	.0020 .0002	Loose Tight
	Fafnir #120WD-2N	.0001 .0014+	Loose Tight	.0020 .0002+	Loose Tight
	Fafnir #122WD-2N	.0001 .0014+	Loose Tight	.0020 .0002+	Loose Tight
	Fafnir #218WD	.0001 .0014+	Loose Tight	.0018 .0002+	Loose Tight
Bevel Gear Shaft	Hyatt #A1216TS	.0008 .0006+	Loose Tight	.0002+ .0024+	Tight Tight
	Timken #462-453X	.0010 .0005+	Loose Tight	.001+ .003+	Tight Tight
Swing Shaft	Bronze Bushing XA-129	.009 .012	Loose Loose	.002 .006	Tight Tight
	Bronze Bushing XA-192	.012 .015	Loose Loose	.002+ .006+	Tight Tight
	Bronze Bushing XA-161	.012 .015	Loose Loose	.002+ .006+	Tight Tight
Vertical Traction Shaft	Bronze Bushing XA-66	.012 .015	Loose Loose	.002+ .006+	Tight Tight
	Bronze Bushing XA-162	.025 .020	Loose Loose	.007 .003	Tight Tight
Shovel Boom Idler Sprocket	Bronze Bushing XA-247	.010 .014	Loose Loose	.002 .006	Tight Tight
Saddle Block	Bronze Bushing XA-1215	.013 .017	Loose Loose	.002 .006	Tight Tight

MODEL 304 - EXCAVATOR BEARING TOLERANCES

LOCATION OF BEARING	TYPE & SIZE	TOLERANCES SHAFT		TOLERANCES HOUSING OR RETAINER BORE	
Shipper Shaft	Spacer	.002	Loose		
	XA-1216	.006	Loose		
	Bronze Bushing	.004	Loose	.002	Loose
	XA-1225	.008	Loose	.004	Loose
Dipper Trip	Bronze Bushing	.008	Loose	.004	Tight
Sheaves	XA-224	.012	Loose	.005	Tight
Shovel Boom	Bronze Bushing	.010	Loose	.003	Tight
Point Sheaves	XA-247 & XA1238	.014	Loose	.006	Tight
Dipper Stick	Bronze Bushing XA-1196	1/16"	Loose	1/32"	Loose
	Bronze Bushing XA-1209	1/16"	Loose	1/32"	Loose
Dipper	Bushing	.031	Loose	.001	Tight
	XA- 1183	.093	Loose	.008	Tight
	Bushing	.031	Loose	.001	Tight
	XA-1175	.093	Loose	.008	Tight
	Bushing	.031	Loose	.001	Tight
	XA-1175	.093	Loose	.008	Tight
Sheave Block	Bushing XA-1253	1/8"	Loose	1/16"	Loose
	Bushing	.003	Loose		
	XA-1241	.008	Loose		
Dipper Hinge	Bushing	.031	Loose	.001	Loose
	XA-1166	.093	Loose	.001	Tight
Pull Shovel Jib	Bushing	.010	Loose	.002	Tight
Frame Sheaves	XA-247	.014	Loose	.006	Tight
	Bushing	.011	Loose	.004	Tight
	XA-1364	.015	Loose	.007	Tight
Pull Shovel Dip-	Bushing	.011	Loose	.004	Tight
per Arm Sheaves	XA-1364	.015	Loose	.007	Tight
	Bushing	.011	Loose	.002	Tight
	XA-1411	.018	Loose	.005	Tight
	Bushing	.012	Loose	.004	Tight
	XA-1414	.016	Loose	.008	Tight
	Sleeve	.031	Loose		
	XA-1398	.036	Loose		
	Bushing	.010	Loose	.003	Tight
	XA-1446	.017	Loose	.007	Tight
	Bushing	.011	Loose	.003	Tight
	XA-1441	.017	Loose	.010	Tight
	Bushing	.014	Loose	.007	Tight
	XA-1364	.013	Loose	.004	Tight
	Bushing	.031	Loose	.016	Loose
	XA-1384	.065	Loose	.031	Loose
	Bushing	.010	Loose	.006	Tight
	XA-1388	.012	Loose	.008	Tight
Ten Ton Hook	Bushing	.010	Loose	.002	Tight
Block	XA-921	.015	Loose	.004	Tight
	Rollway CT19	.009	Loose		
		.015	Loose		

THRUST WASHERS

PART NUMBER	INSIDE DIAMETER	OUTSIDE DIAMETER	THICKNESS	MATERIAL
XA-40	3-1/2"	5-1/2"	1/8"	Mild Steel
XA-24	1-3/4"	2-3/4"	1/8"	Mild Steel
XA-107	1-1/4"	2-1/2"	3/8"	Mild Steel
XA-87	3"	3-11/16"	#16 Ga.	Mild Steel
XA-121	2-21/32"	5-1/4"	1/4"	#64 Cast Bronze
XA-124	13/16"	2-7/8"	3/16"	Mild Steel
XA-123	13/16"	2-7/8"	1/8"	Mild Steel
XA-127	3-25-/32"	6"	1/2" (7/8"at lug)	#64 Cast Bronze
XA-140	4-1/32"	6-1/2"	1/2" (3/4" at lug)	#64 cast Bronze
XA-142	4.000" 4.005"	7-1/4"	.355 .340	#64 Cast Bronze
XA-150	3-1/2"	6"	1/16"	Mild Steel
XA-151	3-1/2"	6"	1/8"	Mild Steel
XA-152	3-1/2"	6"	#21 Ga.	Sheet Steel
XA-218	3"	4-1/2"	3/16"	Mild Steel
XA-918	2-7/32"	3-3/4"	3/8"	#64 Cast Bronze

NOTE

Set Clutch Band Release Screws 1/32" Clearance. (Between Screws and Clutch band.)
Set Guide Bolts on Dipper Trip to 1/16" Clearance. (Between Bolts and Clutch Band.)
All Lever Shafts in Drilled Holes Have .002" to .010" Loose Fit.
All Lever Shafts in Babbitted Bearings Have .007" to .010" Loose Fit.
All Crawler Journal Bearings are Babbitted with a Tolerance of 1/32" Loose Fit on Diameter.

SHOVEL STICK AND BOOM CLEARANCE AND SADDLE BLOCK GIB ADJUSTMENT

1/4" Minimum Clearance between inside faces of sticks and outside overall of boom including 3/8" pads on both sides of boom.

Because of variations in the depth of stick and rack welded together the gib in the saddle block is to be adjusted so the stick clears at the deepest section. The variation in some places may be 1/8" clearance.

FOR ALL BRONZE BUSHINGS - DISREGARD SHRINKAGE.

TURNTABLE (UPPER DECK) MODEL 304 LIFTING CRANE

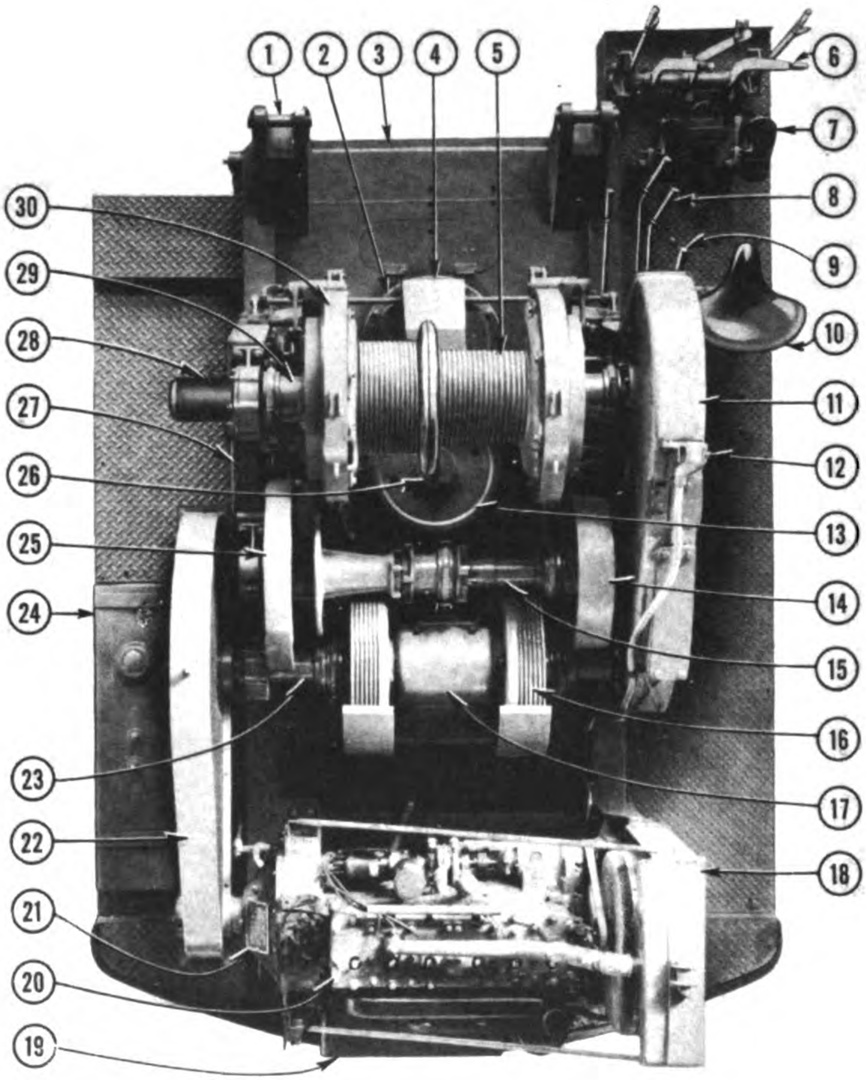


FIGURE 100

1—BOOM FOOT BIN
2—TURNTABLE GEAR CASE
3—TURNTABLE
4—INSPECTION COVER
5—DRUM LAGGING
6—OPERATING LEVERS
7—OPERATING BRAKES
8—STEERING LEVERS
9—ENGINE CLUTCH LEVER
10—SEAT
11—MAIN GEAR CASE
12—INSTRUMENT PANEL
13—SWING BRAKE DRUM
14—BOOM HOIST CLUTCH DRUM
15—BOOM HOIST SHAFT
16—SWING AND TRACTION CLUTCH DRUM
17—BEVEL GEAR HOUSING AND COVER
18—RADIATOR
19—BATTERY
20—ENGINE
21—ENGINE CLUTCH
22—CHAIN CASE
23—SWING AND TRACTION SHAFT
24—FUEL TANK
25—BOOM HOIST BRAKE DRUM
26—VERTICAL SWING SHAFT
27—SIDE STAND
28—MAIN DRUM SHAFT
29—CLUTCH SHIFTER SLEEVE
30—DRUM BRAKE

TURNTABLE (UPPER DECK)
MODEL 304 SHOVEL

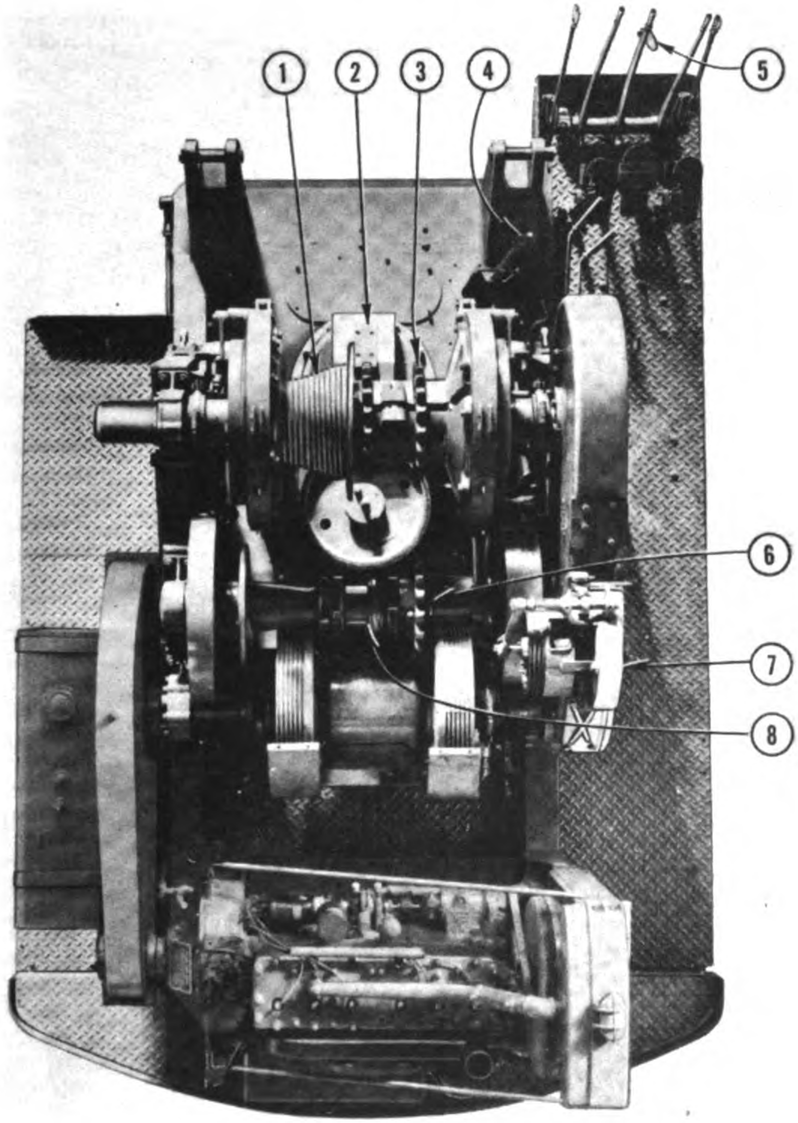


FIGURE 101

1—TAPERED HOIST LAGGING
2—CHAIN GUIDE
3—CROWD DRIVE SPROCKET
4—BOOM HOIST JAW CLUTCH LEVER
5—DIPPER TRIP CONTROL LEVER
6—RACK-IN SPROCKET
7—DIPPER TRIP MECHANISM
8—BOOM HOIST JAW CLUTCH

TOP SIDE OF TURNTABLE—LESS MACHINERY

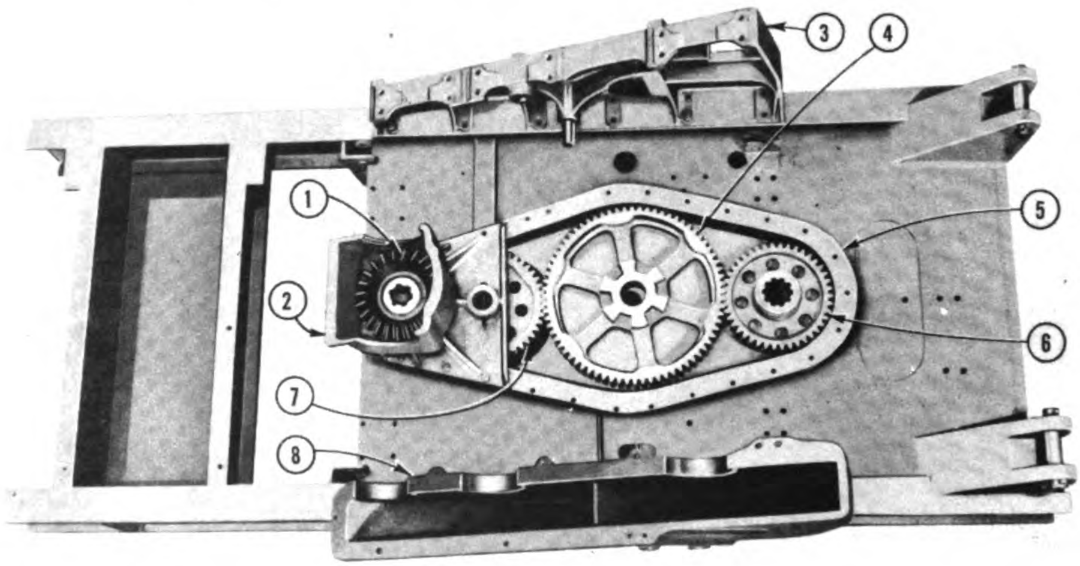


FIGURE 102

1—SWING & TRACTION BEVEL GEAR
2—BEVEL GEAR HOUSING
3—SIDE STAND
4—SWING SHAFT GEAR
5—TURNTABLE GEAR CASE
6—TRACTION GEAR
7—TWO SPEED GEAR
8—MAIN GEAR CASE

BOTTOM SIDE OF TURNTABLE

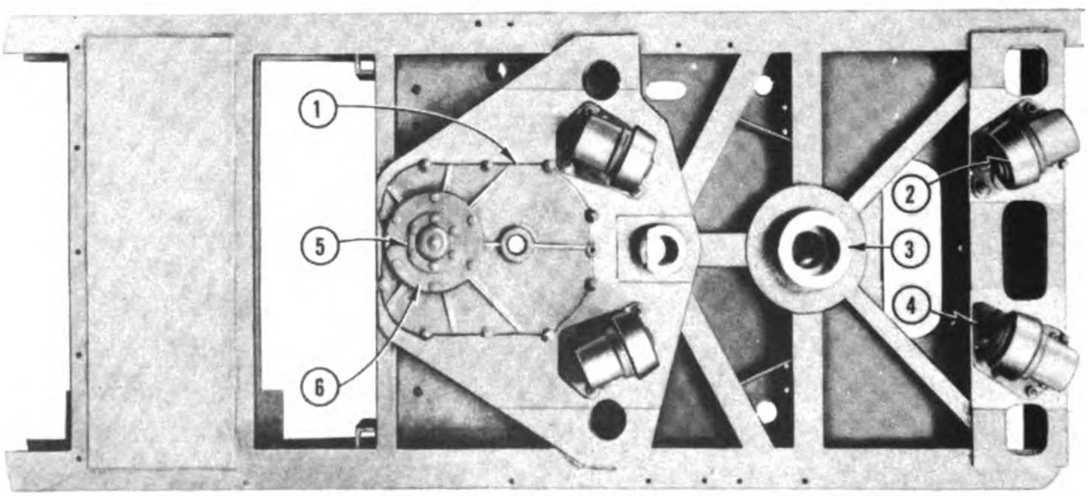


FIGURE 103

1—LOWER GEAR CASE
2—TURNTABLE ROLLER
3—TURNTABLE PIVOT
4—TURNTABLE ROLLER BRACKET
5—BEARING CAP (VERTICAL SWING SHAFT)
6—BEARING RETAINER (VERTICAL SWING SHAFT)

TOP SIDE OF CARBODY

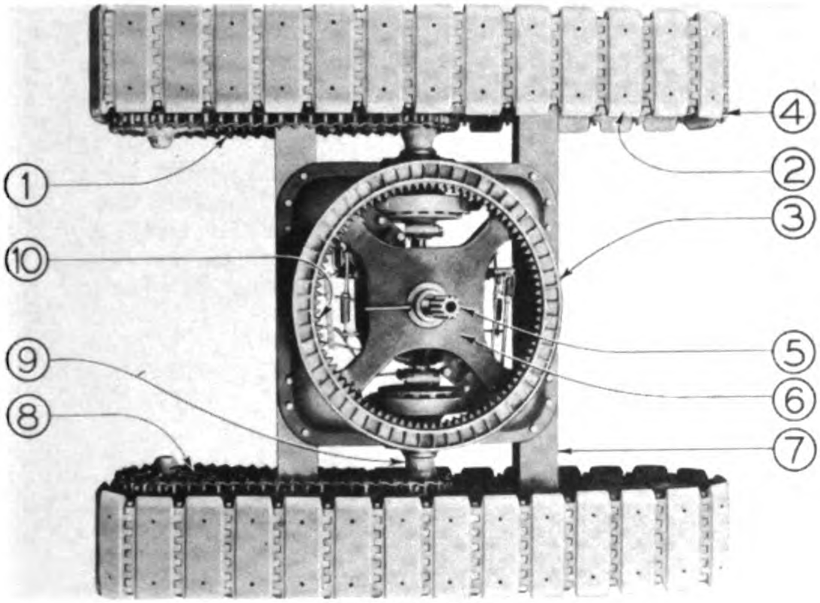


FIGURE 104

1—CRAWLER DRIVE CHAIN
2—CRAWLER SHOE
3—ROLLER TRACK
4—CRAWLERS
5—VERTICAL TRACTION SHAFT
6—CARBODY
7—CRAWLER FRAME
8—CRAWLER DRIVE SPROCKET
9—TRACTION DRIVE SPROCKET
10—SWING GEAR

BOTTOM SIDE OF CARBODY

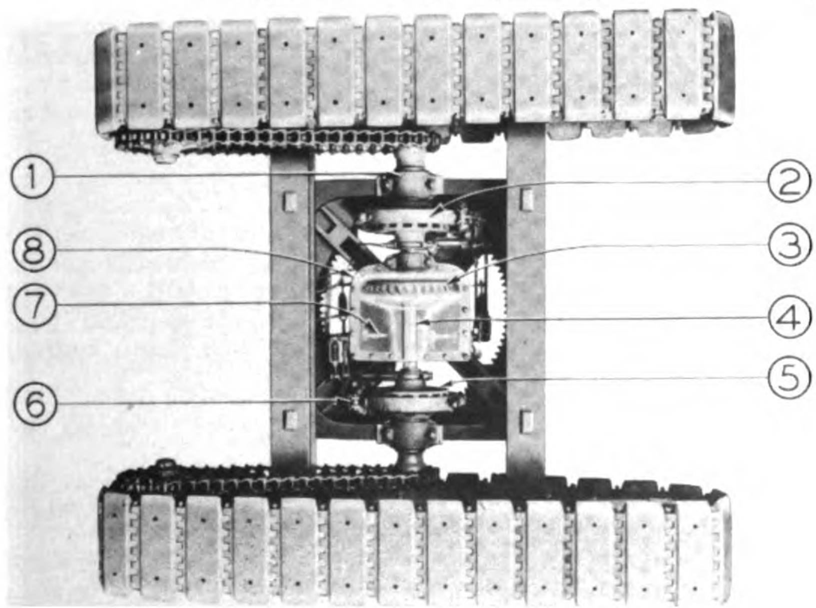


FIGURE 105

1—LOWER TRACTION SHAFT BEARING
2—TRACTION BRAKE
3—TRACTION BEVEL GEAR
4—LOWER TRACTION SHAFT
5—JAW CLUTCH (STEERING)
6—TRACTION BRAKE TOGGLE LINKAGE
7—SHIFTER SHAFT
8—LOWER TRACTION GEAR CASE

CLUTCH BANDS

Both drum clutch bands and the boom hoist clutch band are of the same size and interchangeable. Both swing and traction clutch bands are of the same size and interchangeable. Both ends of all clutch bands are alike, therefore when a relined or new band is installed either end can be started at the dead end. A further advantage of this type of construction is the ability to take out a band, turn it end for end, and replace it when the lining at the dead end of the band becomes worn. This practically doubles the life of a lining because the dead end of the band wears faster. Never allow the lining to wear down until the rivets in the lining touch the drum as the rivets might score the surface of the drum.

CLUTCH BAND ASSEMBLY

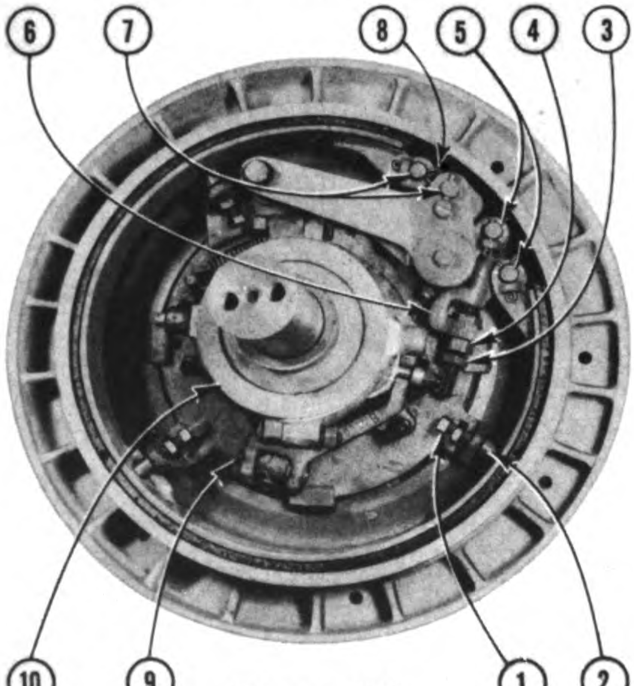


Figure 106

TO REMOVE:

Unscrew carrier screws (1) until carrier screw caps (2) can be taken out. Loosen lock nut (3) and turn adjusting nut (4) up to loosen the band adjustment. Remove cotters and take out pins (5) then adjusting link (6) can be removed. Remove pins (7) then dead end link (8) can be removed. Now slide the band out and lift it off the shaft.

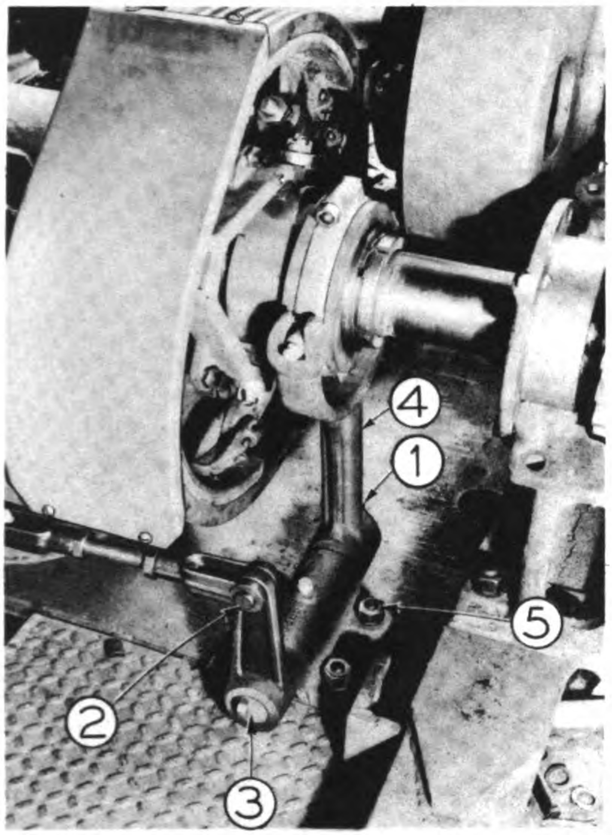
TO INSPECT:

Check carrier screws for worn or damaged threads. Check lining for wear and replace if necessary. (For relining bands, see Page 130).

TO REPLACE:

Place the band over the shaft and slide it into place in the drum. Insert dead end link (8) and secure with pins (7). Place adjusting link (6) in position; insert pins (5) and secure with cotters. Replace carrier screw caps (2) and turn carrier screws (1) in just far enough to prevent caps from falling out. (Adjust the clutch as described under "Clutch Adjustment", Page (88), Operation Section.) This procedure applies to both drum clutches, the boom hoist clutch and both swing clutches.

CLUTCH BANDS (Continued)



REMOVAL OF RIGHT HAND SWING CLUTCH BAND: (Figure 107.)

The right hand swing clutch band can be removed much easier if the right hand swing clutch fork is taken out. This can be done by pulling gib key (1) and pin (2), then pulling shaft (3) out of fork (4). Or it can be done by taking out pin (2) and the four bolts (5) holding the fork bearing to the turntable, then removing the fork and bearing as a unit. CAUTION - Do not lose shims that are under the fork bearing and be sure the shims are in the right place when assembling.

Figure 107

DRUM BRAKE BANDS

The drum brakes are similar to the design of the clutch bands in that either end can be started at the dead end or the lining turned end-for-end when partially worn at the dead end. The boom hoist brake is made in two halves bolted together. The boom hoist brake band is removed and installed the same as the drum brakes except that it is unbolted in the middle. The drum brake bands are alike and interchangeable. NOTE - Be careful not to spring the brake bands out of shape while removing, relining or installing them. Use lining as recommended and furnished by the factory. Always reline the bands before they wear down far enough for the rivets to score the drums.

TO REMOVE: (See Figure 108, Page 130)

Release the brake pedal operating the brake band to be removed. Take out lock pin (1) and screw adjusting nuts (2) and (3) toward the end of the adjusting bolt to release the band more completely. Remove cotters and take out pins (4) and (5). Unhook spring (6) and screw up guide bolt (7). Slide the band off the drum and lift it out.

TO INSPECT:

Check pins for damage and screws and nuts for worn or damaged threads. Check lining for wear and replace if necessary. (For relining bands, see Page 130).

TO REPLACE:

Place band on the drum, hook up the operating linkage with pins (4) and (5) and secure with cotters. Hook release spring (6) to the band and adjust guide bolt (7). Adjust brake as described under "Adjusting Brakes", Page (89), Operating Section.

BRAKE BAND ASSEMBLY

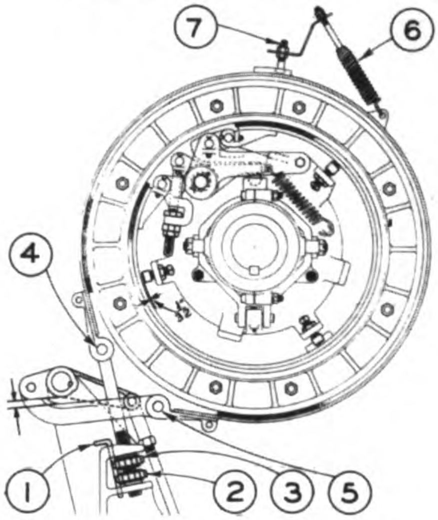


Figure 108

RELINING BANDS:

Cut the rivets holding the lining to the band with a hammer and cold chisel as shown in Figure (109) below. Drive out the rivets with a pin punch the same size as the rivets. After the lining has been removed, clean the band with a wire brush. To reline lay the band on a flat surface and fit the lining to the band, using "C" clamps to hold the lining in place as shown in Figure (110), below. NOTE - If the new lining has no rivet holes to match the holes in the band, use a drill with a bit the same size as the holes in the band and drill the lining using the band holes as guides. Counter-bore the rivet holes one-half the thickness of the lining so that rivet heads will seat properly. If not equipped with a rivet machine, place a drift punch or pin of the same diameter as the head of the rivets in a vise. Insert a rivet through the lining and band, (rivet head on lining side) turn band up and place the rivet head on the punch in the vise. Strike the band with a hammer around the rivet to draw the rivet head all the way into the counterbore to pull the lining tight to the band then peen rivet with hammer. CAUTION - Care should be taken not to bend or twist the band to avoid uneven wear on the lining. Always use lining approved or furnished by the manufacturer. Be very careful not to spring band out of shape.

FIGURE 109-REMOVING LINING

FIGURE 110-RELINING BAND

TURNTABLE (UPPER DECK) UNITS

Each shaft with all of its operating parts is considered an assembly and is so treated throughout this section of the manual. The machine is so designed that one particular assembly may be removed without disturbing the other units. With proper operation, care, lubrication and adjustment, it should not be necessary to remove any of the assemblies until after a long period of service when the machine is given a major overhauling.

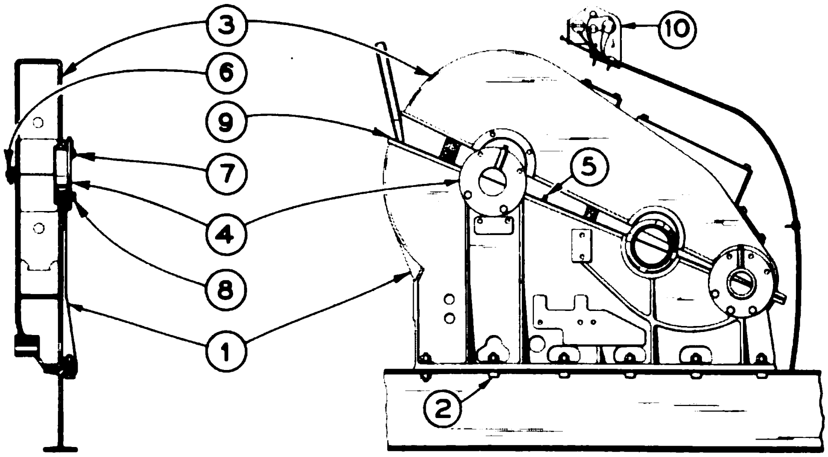


Figure 111

MAIN GEAR CASE: (Figure 111).

The main gear case on the right hand side of the turntable houses the vertical gears and acts as a side stand and bearing mounting for the horizontal shafts. The case is split in two halves - upper and lower - on a line through the center of the bearing mountings. The lower half of the case (1) is set in perfect alignment and bolted to the turntable - these bolts (2) should be kept tight. The upper half of the case (3) is aligned with the lower half by the bearing retainers (4) and two dowel pins (5) and is fastened to the lower half by eight bolts and two capscrews.

TO REMOVE UPPER HALF OF MAIN GEAR CASE:

Remove control panel assembly (10) as a complete unit and lay to one side. Remove bolts (6) and capscrews holding upper half to lower half. Remove the cap screws (7) in each bearing retainer flange in upper half and loosen the cap screws (8) in each bearing retainer flange in the lower half of case. Raise upper half with bar or chisel and insert wooden wedges to allow space for gripping with hands. Remove upper half - a two man lifting job. Be careful of gasket (9).

TO INSPECT:

Check case for cracks and weld if necessary. Check bolts and capscrews for worn or damaged threads. Check gasket for damage and if not in perfect condition, replace with new one.

TO REPLACE UPPER HALF OF GEAR CASE:

After thoroughly cleaning edges of upper and lower cases, replace gasket, lining up holes in gasket with holes in lower case. Place upper half of case in position on lower half and after lining up holes, insert all capscrews and bolts in their proper places. Tighten all bolts and capscrews evenly. NOTE - It is a good idea to go over these bolts and capscrews again after machine has been operated a few hours.

SWING AND TRACTION JACK SHAFT

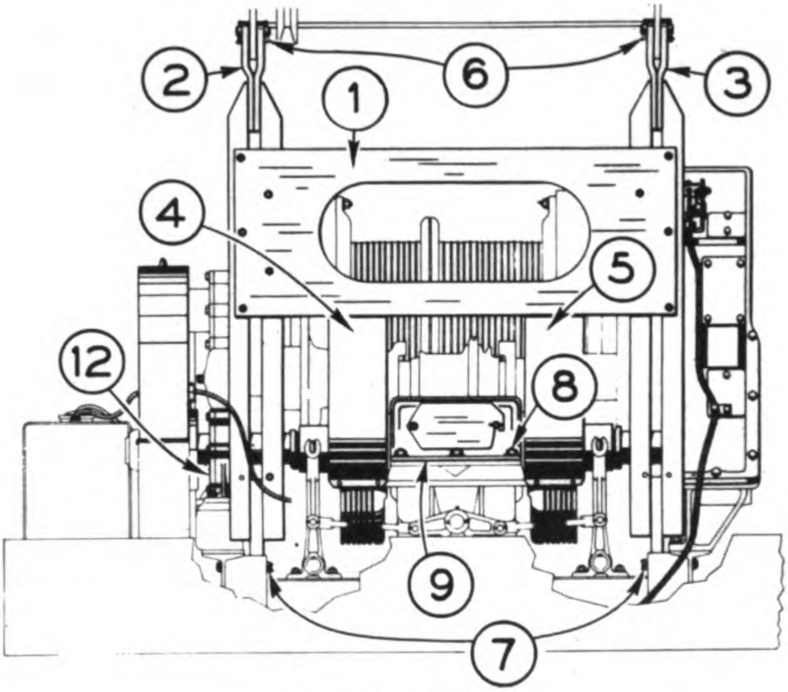


Figure 112

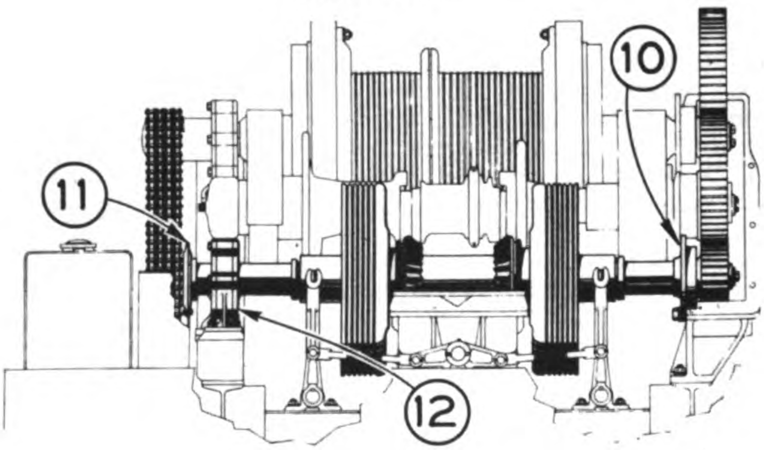


Figure 113

TO REMOVE:

Lower boom to cribbing as shown on pages 97 and 98, Operation Section. Pull enough of the boom suspension cable off boom hoist drum to relieve the "A" frame of any load. Remove plate (1) which is bolted to both "A" frame tension members (2) and (3) and to clutch guards (4) and (5). Remove "A" frame tension members (2) and (3), by taking out pins (6) and (7) at the top and bottom of each "A" frame tension member. Disconnect boom pawl spring near lower end of member (2). Take out bolts (8) at the front and rear edges of gear case cover (9). Now the swing clutch guards (4) and (5) and gear case cover (9) will come out. Remove the upper half of main gear case as described on Page 131. Take out the capscrews that hold the jack shaft bearing retainer flange (10) to the lower half of the main gear case. Remove the upper half of the jack shaft chain case and chain as described under Power Transmission Chain page (197). Remove two stove bolts holding felt retainer (11) to lower half of chain case. Lay the chain back off the sprockets.

Remove the four bolts holding the bearing retainer pillow block (12) to the left side stand. The entire shaft assembly now is ready to be lifted up. If a chain hoist is to be used, remove the curved section of the cab (32) as described on Page 166, Maintenance Section, then lay a timber across the "A" frame shaft and on blocks placed at top of cab. Fasten chain hoist to the cross timber and lift shaft. Cover the main gear case with clean rags or paper to keep out dirt while working on the shaft.

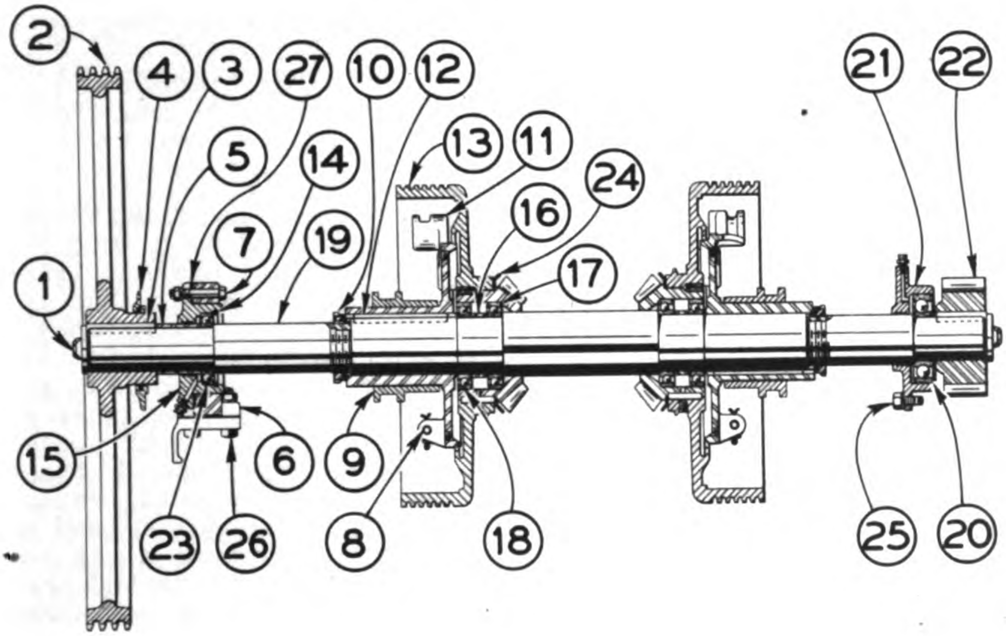


Figure 114

TO DISASSEMBLE: (See Figure 114)

The shaft assembly should be lifted high enough for the chain sprocket to clear the chain case and gasoline tank. Remove the two capscrews, capscrew lock plate and keeper plate (1) from left end of the shaft then either drive or pull off sprocket (2). Remove sprocket key (3), felt retainer (4) and spacer (5). To remove bearing retainer pillow block (6) take out two of the bolts (7) one on each side - that hold the bearing retainer and pillow block together and replace them with two long bolts through a bar placed across the end of the shaft. Then by screwing up nuts on the long bolts plate acts as a puller to remove pillow block assembly from the shaft. Remove pin (8) and slide clutch sleeve assembly (9) off the shaft. Remove lock nut and lock washer (10). Screw two long 5/8" studs into drilled and tapped holes in clutch spider (11) and with bar across the end of the shaft, pull the clutch spider. Remove clutch spider key (12). The clutch drum and pinion (13) can be pulled the same way by extending rods through the holes in the clutch drum with a flat plate or washer and nuts on the ends of the rods. The right hand end of the shaft assembly is disassembled in the same manner. CAUTION - The clutch spiders are right and left handed and must be replaced in their correct locations on the shaft. All ball bearings can be driven from their housings by using a hardwood block or brass driving rod. Snap ring (14) must be removed from the pillow block bearing retainer (15) before driving out bearing.

Do not lose the spacers (16) between the bearings in the clutch drum pinion assemblies.

TO INSPECT:

Wash all parts with cleaning fluid. Inspect ball bearings for wear or broken balls and chipped races. Oil the bearings and wrap them in clean rags or paper until they are ready to be installed again. To check for a bent shaft, place shaft on "V" blocks and rotate it, using a dial indicator. Check swing drums for scoring and if in bad condition, replace. (The drum can be pressed off the bevel pinion hub and a new drum pressed on.) Be sure all keys fit snugly. See page (121), Maintenance Section, for bearing tolerances.

TO ASSEMBLE:

Coat the inside of bearing retainer with a film of white lead and oil and place bearing (17) in position to be driven into retainer by pounding on the outer race of bearing with a brass driving rod. Install spacer (16) and fill recess with WB grease. Put in bearing (18) with grease shield to the outside, driving only on the outer races to avoid damaging grease shield. Coat shaft (19) with film of white lead and oil and place left hand clutch drum and pinion assembly on the shaft and press or drive on the inner race of the outer bearing. Be sure the inner bearing is tight against the shoulder on the shaft. After filing smooth any places in the clutch spider key (12) that may have been damaged in removal, replace it. Coat shaft and inside of clutch spider hub with white lead and oil and put clutch spider (11) on the shaft, being sure right and left hand spiders are replaced in their correct locations and that they are driven up tight against bearing (18). Put on lockwasher and lock nut (10) and clutch sleeve assembly. Secure assembly with pin (8). Install right hand clutch assembly in the same manner. Coat right hand end of shaft with white lead and oil; insert bearing (20) in bearing retainer (21); place retainer and bearing on shaft and drive them up against shoulder, using a brass driving rod on the inner race of the bearing. NOTE - Grease seal side of the bearing should be toward the end of the shaft. Insert pinion key in right hand end of shaft; coat shaft, key and inside of pinion (22) with white lead and oil, then drive pinion (22) tight against ball bearing (20). Put on keeper plate, lock plate and capscrews. Draw capscrews up tight then bend the lock plate over the capscrews.

Install bearing (23) in bearing retainer and put in snap ring (14), shielded side of the bearing toward the snap ring. Coat the shaft with white lead and oil; place bearing retainer on the shaft then place spacer (5) against the bearing. Use brass driving rod to drive the spacer and bearing on the shaft and against shoulder. Insert sprocket key (3) in left end of shaft, coat end of shaft, key and inside of the sprocket hub with white lead and oil. Put felt retainer (4) on the inside of sprocket hub. Drive the sprocket (2) on the shaft and against the spacer (5). Put on keeper plate, lock plate and capscrews (1). Draw the capscrews tight and bend lock plate over capscrews. The shaft is ready to be replaced as a unit.

TO REPLACE:

Drain and wash jack shaft chain and chain case. Clean bevel gear and case. Clean the bore in the main gear case where the right hand bearing retainer rests. Clean the left side stand where pillow block (6) rests. Lower the shaft assembly into place, being sure the countersunk grease plugs in the bevel pinion hubs are both up when the pinions mesh with the bevel gear to make the greasing operation easier. NOTE - If oil slinger (24) is bent by lowering the shaft, be sure to bend it back to its original shape. Start the two cap screws (25) into the lower half of the main gear case through bearing retainer (21) but do not tighten the colts. Be sure grease connection is up. Insert the four bolts (26) into the left side stand and pillow block. Check the backlash of the bevel pinions and bevel gear to be sure there is the same amount of backlash in both pinions. Draw pillow block bolts (26) down tight. For further adjustment of the bevel pinion backlash, add or remove shims (27) as needed. Adding shims will move both pinions to the left - removing shims will move both pinions to the right. When the shaft has been properly assembled with all bearings against their respective shaft shoulders, the distance between the bevel pinions is permanently set. When the backlash of both pinions is equal but in excess of what is required the bevel gear can be raised to decrease the backlash. Bolt felt retainer (4) to lower half of the chain case. NOTE - Use new felt if needed. Replace the chain. It will be easier to couple the chain ends together if the coupling is done on top of the large sprocket. (See instructions under "Chains", Page 197.) Replace chain case and fill case with oil as per lubrication instructions, Page (67), Operation Section. Remove the countersunk plugs in the bevel pinion hubs and screw in a grease connection. Pump WB grease into the pinion connection-the amount of grease depending upon how well the bearings were grease packed when assembled. Remove grease connections and replace countersunk plugs. Pump WB grease into pillow block and gear case ball bearing. Replace gear case cover. Replace "A" frame tension members with pins (6) and (7) and secure with cotter. (Figure 112.) Replace bevel gear case cover and swing drum guards. Replace plate (1) on the "A" frame and bolt swing drum guards to it.

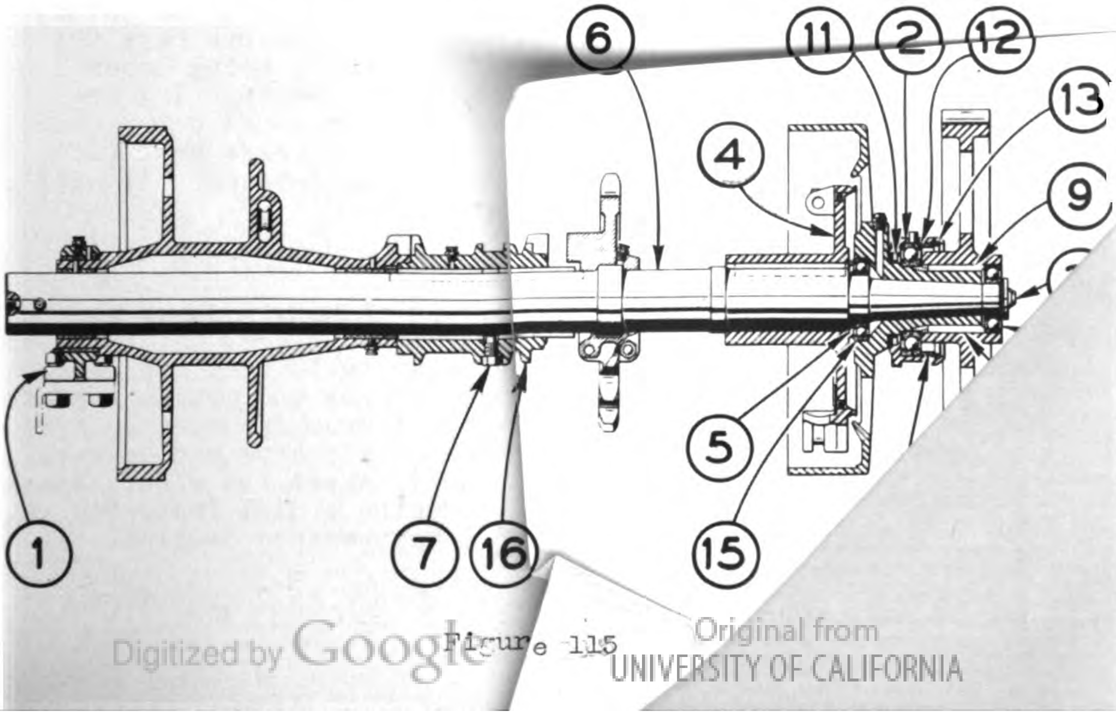


Figure 115

BOOM HOIST SHAFT (Figure 115)

TO REMOVE:

Lower the boom to cribbing as shown on Page 97, Operation Section, and pull all cable off the boom hoist drum, then knock out the cable wedge and pull cable loose from the drum. Remove plate (1) Figure 112 which is bolted to "A" frame tension members and to clutch guards (4) and (5). Remove pins (6) and (7) Figure 112 at top and bottom of "A" frame right hand tension member and remove the tension member. Remove upper half of the main gear case as described on Page (131), Maintenance Section. If a chain block is to be used for lifting, remove the curved section of the bulkhead just below the "A" frame shaft and fasten the chain block to the "A" frame shaft. Remove bolts from pillow block (1) at the left end of the shaft. Remove boom pawl spring from the left hand "A" frame tension member - near the bottom. Take out the pins in both ends of the boom hoist brake band and remove the band. Attach the chain block to the shaft and lift the shaft until the gear and clutch drum will clear the lower half of the gear case. Tilt the shaft assembly slightly as it is being raised in order to clear the boom hoist drum from the boom hoist drum ratchet pawl. Cover the main gear case to keep dirt out of it while working on the shaft assembly. CAUTION - Do not lose the dowel pin in the outside of bearing retainer (2).

TO DISASSEMBLE:

Remove the capscrews, lock plate, keeper plate and shims (3) from the right hand end of the shaft. Remove the clutch drum and gear assembly with bearings from the shaft by pulling on the gear with a gear puller or a chain and jack. The assembly now can be carried out of the cab. Remove clutch spider (4) by using studs and a bar as described on Page (133), Maintenance Section. Keep spacer ring (5) with the clutch spider. Wrap a chain around the boom hoist drum and secure the chain. Attach a chain block to the chain and raise drum high enough to permit pulling shaft (6). Loosen the lock screw (7) in jaw (16) and slide the jaw off the left end of the shaft. The clutch drum and gear assembly can be dismantled by pressing the clutch drum hub out of the gear hub after ball bearing (8) has been driven out of the gear hub with a hardwood block or brass driving rod. Drive out bearing (15). Remove keys (9) and (10) and pull bearing retainer (2) off the shaft, being careful not to damage the grease seal (11). To remove bearing (12) from the bearing retainer, take out snap ring (13) and drive out bearing and spacer (14), being careful not to damage grease seal (11). If grease seal (11) is removed from the bearing retainer it will be ruined and must be replaced with a new one.

TO INSPECT:

h all parts thoroughly with cleaning fluid. Check all ball 'ngs for wear or broken balls and chipped races. Oil the bear- nd wrap them in clean rags or paper until they are ready to lled. Inspect clutch drum for scoring and clutch band for worn lining. Check boom hoist drum for wear or cracks block bushings for wear. Check all keys and keyways in rough sides or edges. To check shaft for straightness, " blocks and rotate it, using a dial indicator. For lerances see Page 121, Maintenance Section.

TO ASSEMBLE:

If new grease seal (11) is to be installed in bearing retainer (2), be sure it is placed with the edge of the leather pointing to the ball bearing. Grease seal can be driven in with a hammer and wood block or it can be pressed in. Apply a thin coat of white lead and oil on the outside of the grease seal and the inside of the bearing retainer. Coat the inside of the bearing retainer (2) with white lead and oil then drive bearing (12) into the retainer with a brass driving rod. CAUTION - Drive only on the outer race. Put in spacer (14) and snap ring (13). Rub some light oil on the leather of the grease seal. Coat the hub of the clutch drum with white lead and oil, then put the bearing retainer assembly on the hub of the clutch drum with the grease seal next to the drum. Drive the bearing on with a brass driving rod. Drive on the inner bearing race. Put in keys (9) and (10) then press the gear on the clutch drum hub. Coat the bearing recess in the outside of the gear and the inside of the clutch drum hub with white lead and oil and drive in bearings (8) and (15). CAUTION - Drive on the outer race only, using brass driving rod. Put jaw clutch (16) on shaft with the shifter ring groove to the right end of the shaft. Grease the bushings inside the boom hoist drum and slip the shaft into the drum. Coat the inside of clutch spider hub (4) with white lead and oil and drive the spider on the shaft against shoulder. Be sure the spider fits snugly on its key. Put ring (5) on the shaft. Pack WB grease in bearing (15). Put clutch drum and gear assembly on the shaft and force it on until bearing (15) is tight against ring (5). Put shims, keeper plate, lock plate and capscrews (3) on the end of the shaft. Draw the capscrews tight and bend lock plate over them. There should be just enough shims under the keeper plate to fill the space between the keeper plate and the end of the shaft when the keeper plate is against the inner race of bearing (8). The shaft assembly is ready to be replaced.

TO REPLACE:

With shaft raised by chain block in position to be replaced, tilt the boom hoist drum down, as the shaft is being lowered, to engage the boom ratchet pawl in the boom drum ratchet. When the ratchet pawl is engaged, lower the shaft almost to the main gear case bearing. Then check to be sure the boom clutch shift collar will engage with its shifting fork and that the dowel pin in the outside of bearing retainer (2) will engage with the notch cut for it in the lower half of the gear case. Let the shaft down into place, checking dowel pin and bearing retainer again. NOTE- The dowel pin must be in its notch to align the gear case cover for proper fit. Bolt pillow block (1) on left side stand. Replace boom drum brake band, insert brake band pin and secure with cotters. Replace upper half of main gear case cover as described on Page (131). Replace "A" frame tension members (2) and (3) Figure 112 and plate (1) Figure 112. Insert pins (6) and (7) Figure 112 and secure with cotters. Hook boom ratchet pawl spring to left "A" frame tension member and replace curved section of cab under "A" frame shaft. Fasten boom cable to boom hoist drum with wedge. Adjust boom hoist brake as described under "Brake Adjustments," Page (89), Operation Section. Check boom hoist safety ratchet pawl to see that it is operating properly. Replace grease connection in pillow block (1), then pump grease into all grease connections on the shaft. Remove pipe plug in clutch drum hub, screw in grease connection, then pump in WB grease. Remove grease connection and replace pipe plug.

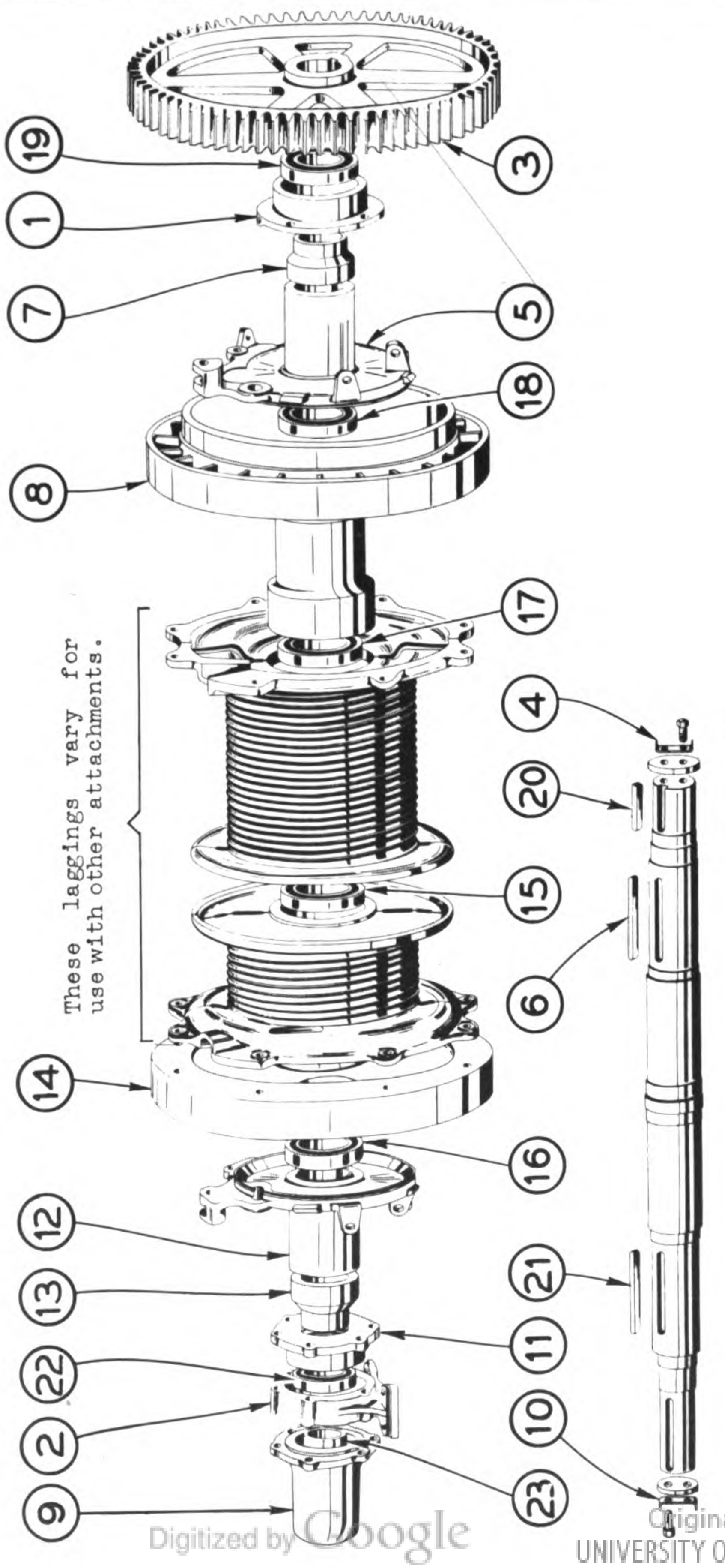


Figure 116

MAIN DRUM SHAFT ASSEMBLY
Koehring Model 304
Lifting Crane

MAIN DRUM SHAFT ASSEMBLY
Figure 116 - Page 138

TO REMOVE:

If no crane is available for lifting the drum shaft from the machine, construct an appropriate type of lifting device as described under "Handling of Heavy Parts", Page (204). Lower boom to cribbing as shown on Page 97, Operation Section. Pull off enough boom cable to permit tying the cables to the outside of the cab roof (three cables to a side) and thus provide ample clearance for lifting the shaft assembly from the machine. Remove the vertical section (28), bulkhead sections (34) and (37) and vertical section (26) at the left of the bulkhead of the cab as shown on Page 165, Maintenance Section. Remove drum guards. Remove upper half of main gear case as described on Page (131). Remove the two capscrews holding the flange of bearing retainer (1) to the lower half of main gear case. Remove both brake bands as described on Page 130. Remove bolts of pillow block (2) in left side stand. Attach chain or cable slings around the clutch sleeves and shafts at both ends of the assembly; attach chain block hook to sling and hoist the assembly high enough for drum gear (3) to clear the gear case, then swing the shaft endways to the machine and lift it out. CAUTION - Cover the main gear case to keep dirt out of it.

TO DISASSEMBLE:

Remove the capscrews, lock plate and keeper plate (4) at the gear end of the shaft. Drive or pull off gear (3) and remove gear key. Pull bearing retainer off shaft with a bar and bolts as described on Page (133). Remove pin (9) and slide clutch sleeve assembly (10) Figure 106 off shaft. Pull right hand clutch spider (5) with rods screwed in tapped holes as described on page (133). Remove clutch spider key (6). Keep spacer (7) and spider (5) together and mark them for the right hand end of the shaft. The right hand drum (8) can now be pulled off with bar and rods in the same manner as described on Page (133). Remove the shaft and bearing cover (9) on the left end of the shaft. Remove capscrews, lock plate and keeper plate (10). Pull off pillow block (2) and bearing retainer (11) as a unit. Remove pin and slide clutch sleeve assembly off the shaft. Pull left hand clutch spider (12) with rods screwed into tapped holes in the clutch spider and a bar as described on Page (133). Spacer (13) will come off with the clutch spider. Keep spider (12) and spacer (13) together, marking them for the left hand end of the shaft. The left hand drum (14) can now be pulled off the shaft in the same manner as the right hand drum was pulled or the shaft can be driven out of the drum by bumping the left end of the shaft with a heavy block. Drive the ball bearings out of the bearing retainers and drum, using a hardwood block or brass driving rod.

TO INSPECT:

Wash all parts thoroughly with cleaning fluid. Check the ball bearings for wear, broken balls and chipped races. Oil the bearings and wrap them in clean rags or paper until they are ready to be installed again. To check shaft for straightness, place it on "V" blocks and rotate it, using a dial indicator. Check all keys and keyways to be sure all keys fit snugly on the shaft. For bearing tolerances see Page 121.

TO REASSEMBLE:

Coat the bearing recesses in the drums with white lead and oil and install the drum bearings. NOTE - All drum bearings are installed with the shielded side of the bearing to the outside of the drum hub. Use brass driving rod on outer bearing race and do not damage bearing shield. Pack each drum hub with new WB grease, referring to Page (66), Operation Section, Note 8 for quantity. The grease should be packed tight around both ball bearings in each drum. To replace the left hand drum, coat the drum bearing bosses on the shaft with white lead and oil, then mount the drum on the shaft or drive the shaft into the drum by bumping the right hand end of the shaft with a wooden block. Bearing (15) should be tight against its shoulder on the shaft. Drive bearing (16) against its shoulder on the shaft, using brass driving rod on inner bearing race. To replace the right hand drum, coat the drum bearing bosses on the shaft with white lead and oil, then mount the drum on the shaft or drive the shaft into place with a wooden block against the hub of the drum and a brass driving rod against the inner race of bearing (17). Replace spider key (6); coat the key and shaft and the inside of the hub of spider (5) with white lead and oil, then drive the spider on the shaft. The spider should be tight against bearing (18) which should be tight against the bearing shoulder on the shaft. Put spacer (7) on the shaft against the spider hub. Place clutch sleeve on the spider hub and replace pin and secure with cotter. Install bearing (19) in the bearing retainer (1) with shielded side of the bearing to the gear case. Coat shaft with white lead and oil, then mount bearing and retainer on the shaft. Put in key (20); coat key, shaft and inside of the hub of gear (3) with white lead and oil, then drive the gear on the shaft against bearing (19). Put on keeper plate, lock plate and capscrews (4). Draw capscrew tight and bend the lock plate over the capscrew. NOTE - Be sure bearing (19) is against its shoulder on the shaft. Put in key (21). Coat the key, shaft and inside spider hub (12) with white lead and oil, then drive the spider on the shaft against bearing (16). Put spacer (13) on the shaft against the spider hub. Put clutch sleeve on the spider hub, insert pin and secure with cotter. Install bearing (22) in retainer (11). Drive bearing on shaft against spacer (13), using brass driving rod and driving against inner race of the bearing. Put on spacer (23), keeper plate, lock plate and capscrews (10). Draw capscrews tight and bend lock plate over capscrews, mount pillow block (2) and shaft bearing cover (9) on bearing retainer (11). Pump sufficient WB grease into end shaft bearings (22) and (19). The shaft, now completely assembled as a unit, is ready to be replaced on the machine.

TO REPLACE:

Clean the bore in the main gear case for bearing retainer (1). Clean the left side stand for pillow block (2). Lower the shaft assembly into place, being sure the clutch collars engage shifting forks and that the grease connection on bearing retainer (1) is up. Start the capscrews in lower half of main gear case through the flange of bearing retainer (1). Line up the gears in the main case and bolt pillow block (2) to the left side stand. Check the amount of grease in the main case and replace upper half of the case as directed on Page (131). Replace brake bands and adjust brakes. Replace cab and bulkhead parts.

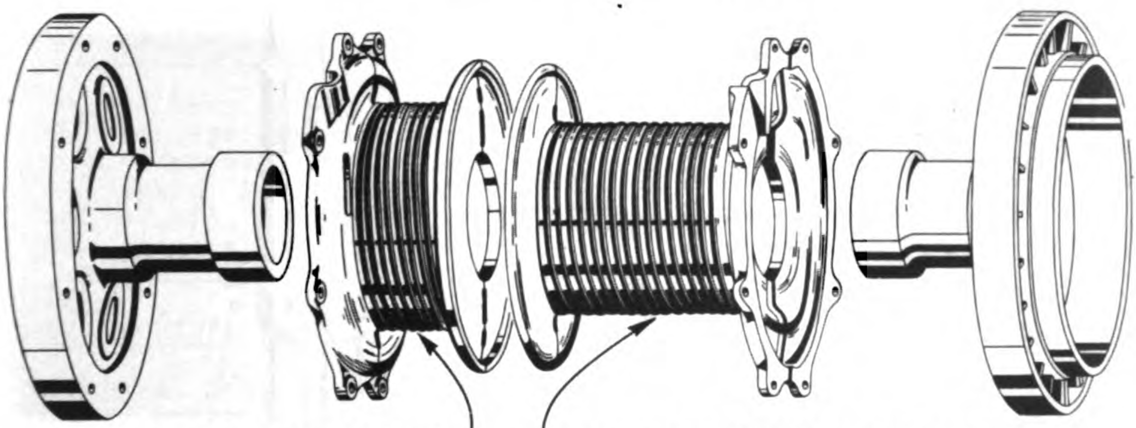
MAIN DRUM SHAFT ASSEMBLIES

(Dragline, Clamshell, Pile Driver, Pull Shovel and Shovel)

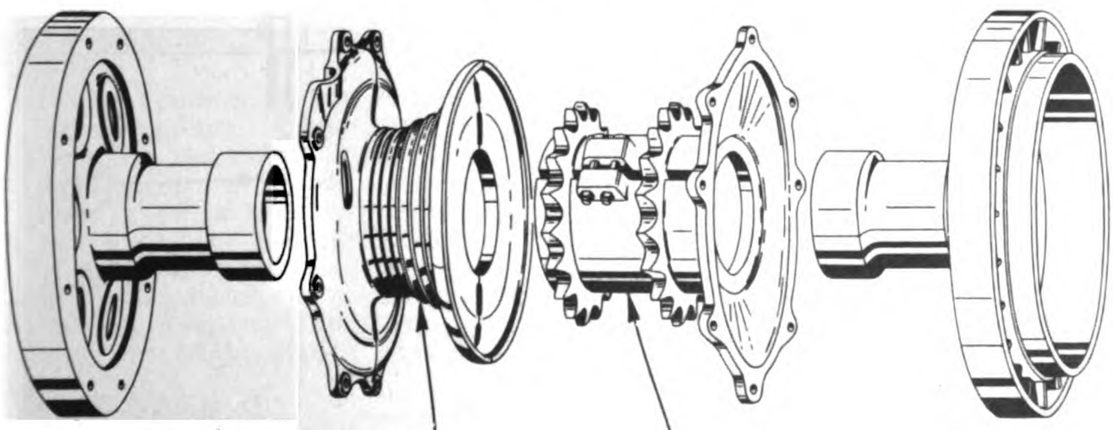
For removal, disassembly, inspection, reassembly and replacement of drum shaft assemblies for dragline, clamshell, pile driver, pull shovel and shovel, follow same procedure as outlined under "Main Drum Shaft Assembly," Page 139 Maintenance Section.

For removal and replacement of the drum laggings on these various combinations see the following pages in the Operation Section:

Crane.......... Page (96)
Clamshell...... Page (96)
Dragline....... Page (96)
Pile Driver.... Page (96)
Pull Shovel.... Page (96)
Shovel......... Page (95)



DRUM SHAFT ASSEMBLY (DRAGLINE)
Figure 117



DRUM SHAFT ASSEMBLY (SHOVEL)
Figure 118

SWING AND TRACTION BEVEL GEAR AND SHAFT

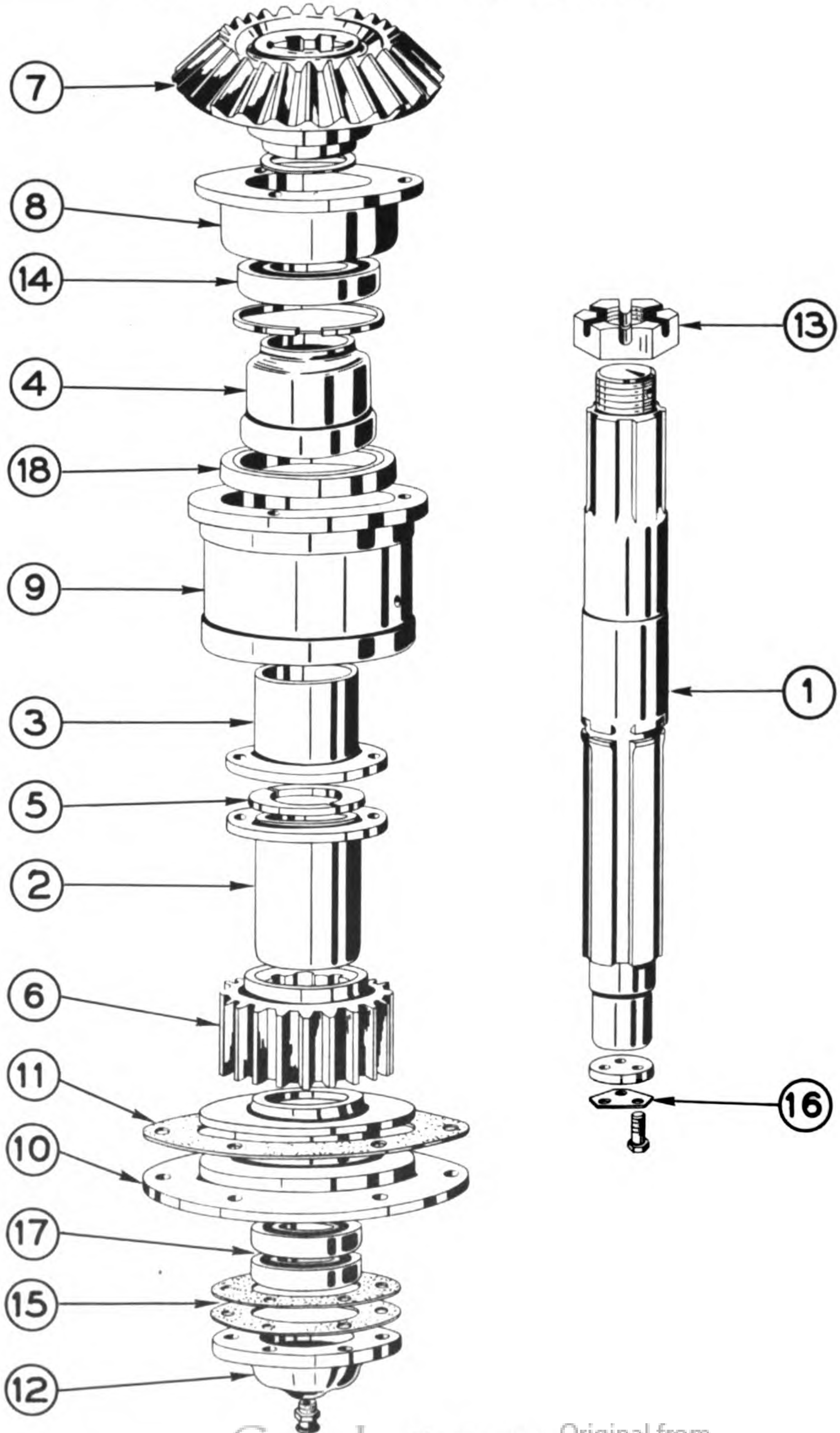


Figure 119

SWING AND TRACTION BEVEL GEAR AND SHAFT

TO REMOVE:

Shaft (1), spacers (2), (3), and (4), washer (5) and gear (6) may be taken out through the bottom, leaving bevel gear (7), bearing retainer (8) and grease seal retainer (9) in place without lifting the swing and traction jack shaft. To remove bevel gear (7), bearing retainer (8) and grease seal retainer (9), it will be necessary to raise swing and traction jackshaft assembly as described on Page (132). To remove the shaft with its parts, take out the capscrews in bearing retainer (10). Be careful not to damage shims (11). Place a jack under bearing cap (12). Remove cotter and nut (13). Lower jack about 2 inches and if the shaft does not follow the jack down, drive on top of shaft with wooden block. Be careful the entire shaft assembly does not fall out. If the swing and traction jackshaft has been raised, bevel gear (7) can be lifted off after nut (13) has been removed. Remove grease pipe leading to bearing (14) and set screw holding grease seal retainer (9), then take out bearing retainer (8) and washer.

TO DISASSEMBLE:

Remove bearing cap (12), being careful not to damage shims (15). Remove capscrew, lock plate and keeper plate (16). The shaft can now be pressed out of bearing retainer (10). Slide gear (6) off the shaft. Remove bolts from spacers (2) and (3) and take out split washer (5). Spacer (2) will slide off the lower end of the shaft and spacers (3) and (4) and bearing (14) and retainer (8) will slide off the top end of the shaft.

TO INSPECT:

Wash all parts thoroughly in cleaning fluid. Inspect bearings for wear, broken rollers and chipped races. Oil the bearings and wrap them in clean rags or paper until they are ready to be installed. To check shaft for straightness, place shaft on "V" blocks and rotate, using a dial indicator. Inspect grease seals. If grease seals have been removed from their retainers, they must be replaced with new ones. Inspect all other parts for wear. Clean old grease out of turntable.

TO REASSEMBLE:

Place spacers (2) and (3) on shaft. Insert split washer (5) and bolt spacers (2) and (3) together. Slide gear (6) on shaft, then bearing retainer with outer race of upper half of bearing (17) in retainer. Drive inner races of bearing (17) on shaft, being sure the taper is in the same direction as when taken off shaft. Attach keeper plate and lock plate with cap screws (16). Draw capscrews tight and bend the lock plate over them. Install the outer race of lower half of bearing (17) but do not draw it up too tight. Put on bearing cap (12) and shims (15). Pull cap screws up snug but not tight until final adjustment is made later.

TO REPLACE:

Replace the assembled shaft in the machine. Put in shims (11) and screw capscrews through bearing retainer (10). Replace grease seal retainer (9). Put in set screw and grease pipe. Put in bearing (14), washer and bearing retainer (8) with grease seal (18) inserted in retainer. Replace bevel gear (7) and nut (13) and secure with cotter.

TO ADJUST:

Bearing (17) is adjusted first by removing grease gun connection from bearing cap (12) and inserting a drift pin into the grease connection hole and pushing it up against the shaft. With a crow bar against the lower end of the drift pin try lifting and lowering the shaft to test for end play. Draw bearing cap cap screws tight, being sure the cap screws are tightened evenly. Check shaft again for end play. NOTE - End play should be very slight. If there is too much end play, remove bearing cap (12), take out a thin shim (15), replace bearing cap and check end play again. After bearing adjustment is completed, replace grease connection and pump bearing full of WB grease. Check the mesh of the bevel gear (7) with the bevel pinions on the swing and traction jack shaft. The entire bevel gear shaft assembly can be raised to eliminate excessive backlash or wear in the gears. To decrease the backlash, loosen the cap screws in bearing retainer (10). Locate the cuts in shims (11). The cap screws passing through the cuts in the shims should not be removed. Take out the rest of the cap screws. Pull out one shim (11), being sure both halves of the same shim are removed. Replace the cap screws and draw them up evenly and tight. Check the backlash in the bevel pinions again. Take two pieces of newspaper and, with lever (2) page (42) in neutral, run them through the teeth of both bevel pinions and the bevel gear. There should be the same amount of clearance between the teeth for the full length of each tooth face. For bevel pinion adjustment, see Page (91), Operation Section. Pump WB grease into bearing (17). Grease bevel gear and pinions. (See lubrication instructions, Page (67), Operation Section, for quantity and type of oil to be used in turntable.)

TWO SPEED GEAR AND SHAFT

TO REMOVE:

NOTE - Although it is not necessary to remove the bevel gear shaft to take out the two speed gear it can be more conveniently taken out if the shaft is removed. Take off bearing cap (12) and shims (15) Figure 119. Remove cap screws, lock plate and keeper plate (16). Put wooden wedges under bevel gear (7). Take cap screws out of bearing retainer (10) and pull the bearing retainer and bearings off the bevel gear shaft. Gear (6) will come off the shaft when bearing retainer is removed. Place a bar through inspection opening in left side of the turntable and hold the double gear up.

Remove dowel pin (1) Figure 120. (For method of removal see Figure 140). Take cap screws out and remove lower gear case cover (2). Thrust washer (3) will now come off. Remove bar and let the two speed gear (4), down - do not drop it. Remove seal ring (5). To remove the shaft (6), take bolt out of the end of the shaft. NOTE - Thrust washer (3) can be replaced by raising shaft (6) up and working through inspection opening and drain hole. To keep the gears in place while doing this, use small wedges under the lower gear. Be sure to remove the wedges after new washer has been installed and shaft pushed back into place.

TO DISASSEMBLE:

Remove bearings (7), (8) and spacer (9), Figure 120.

TO INSPECT:

Wash all parts thoroughly in cleaning fluid. Check bearing for wear, broken rollers and chipped races. Oil the bearings and wrap them in clean rags or paper until they are ready to be installed. Check thrust washers and seal.

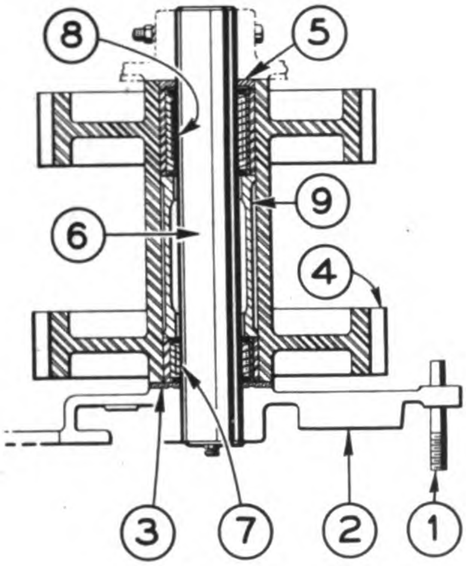


Figure 120

TO REASSEMBLE:

Install bearings (7) and (8) and spacer (9) as illustrated.

TO REPLACE:

Replace shaft (6) and put bolt through top of it. Put on seal ring (5), then slide the gear (4) up on the shaft. Replace thrust washer (3) and gear case cover (2). Put in capscrews and dowel pin (1). (See Page (163), Maintenance Section for Dowel Instructions.) Replace gear (6), shims (11) and bearing retainer (10) Figure 119. Install bearings (17), keeper plate, lock plate then screw in capscrews (16). Put on bearing cap (12) and remove wedges under bevel gear (7). Adjust bearings and shaft as described on Page 144.

SWING PINION (Figure 121)

TO REMOVE:

Place machine on firm, level ground and swing turntable so that swing pinion is directly over one of the openings in the carbody. Lower boom to a temporary support on the ground to prevent machine from turning around while the pinion is off. Remove capscrews, lock plate and keeper plate (1) then pinion (2) will slide off the shaft. NOTE - Care should be exercised to avoid injury when the pinion falls to the ground.

TO INSPECT:

Wash pinion thoroughly with cleaning fluid. Check pinion for wear on teeth.

TO REPLACE:

Slide pinion (2) up on shaft. Put on keeper plate, lock plate and capscrews. Draw capscrews tight and bend lock plate over the capscrews. When putting on new pinion, inspect splines on the shaft and file off any burrs that might be found. If the pinion teeth and carbody teeth and shaft splines and pinion splines do not line up, the shaft can be turned by having swing gears engaged and rolling one of the swing clutch drums by hand. CAUTION-Do not turn shaft by engine power when lining up assembly.

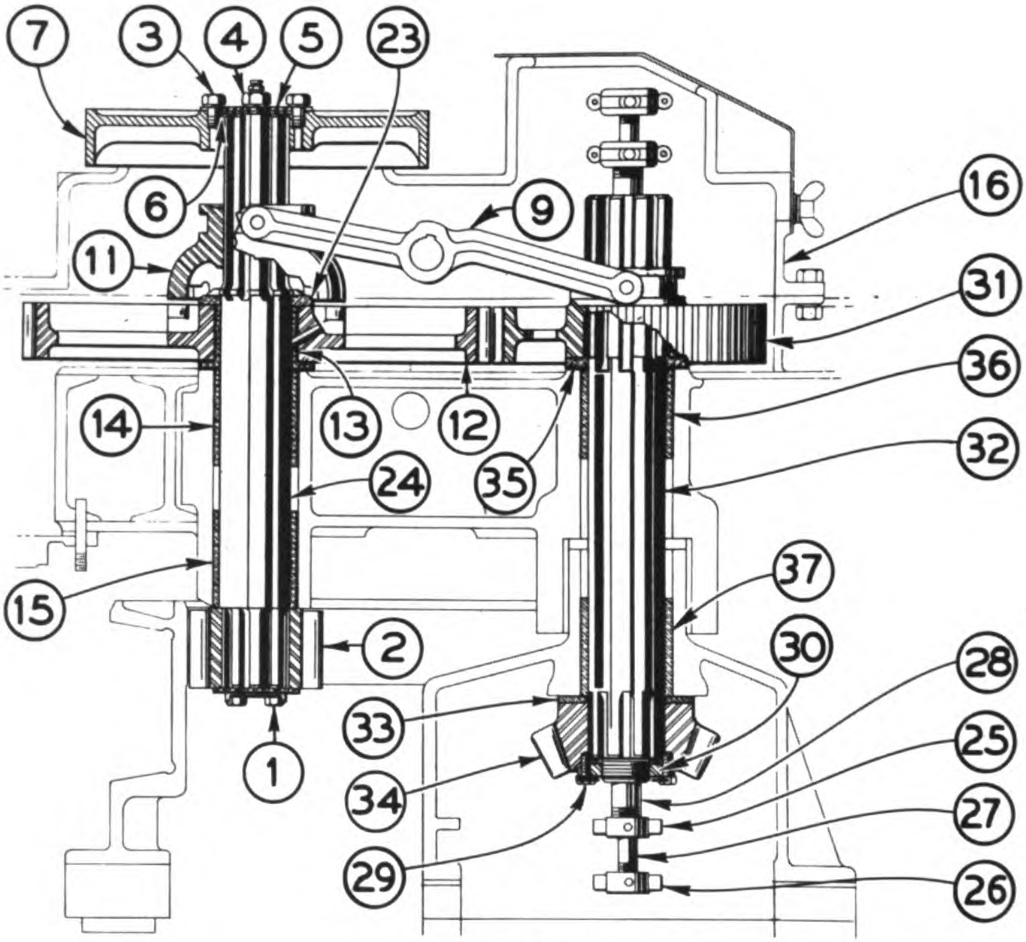


Figure 121

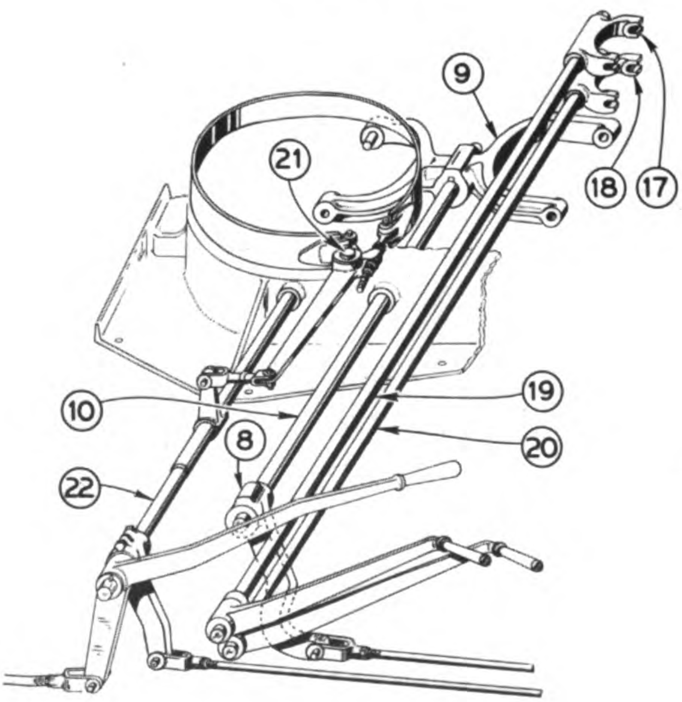


Figure 122

VERTICAL SWING SHAFT
Figure 121 and 122 Page 146

TO REMOVE:

Place machine on firm, level ground and remove swing pinion as described on Page 145, Maintenance Section. Remove curved section of the bulkhead under and behind the drums. Remove capscrews (3) and (4), plate (5) and washers (6). Lift out swing brake drum (7), exposing upper end of swing shaft and jaw clutch. Remove gib keys in crank (8) and yoke (9), then pull shaft (10) out of yoke (9). Now yoke (9) can be removed through the opening around the vertical swing shaft. Note carefully which end of the yoke is to the front as it must be replaced in the same position. Lift off jaw clutch (11). Remove half of the right hand drum lagging then turn the drum so the shaft will clear it. Screw an eye bolt or "T" bolt in the center of the shaft (24) and lift the shaft out. To remove the swing gear (12) for replacement of flanged bushing (13), or swing shaft bushings (14) and (15), the entire gear case cover (16) must be removed. To remove gear case cover, take off right and left hand curved sections of cab bulkhead and drum guards. Remove keys from yokes (17) and (18). Pull steering lever shafts (19) and (20) to the right out of gear case cover (16). Take entire swing brake assembly off at pin (21). Pull shaft (10) out of the case cover. Pull shaft (22) out of its case cover bearing. Remove all bolts holding the case cover (16) to the turntable. Take the bolts out of the right hand brake stand and shift the stand to the right or remove it entirely. Now the gear case cover can be pulled out under the hoist drums. Lift gear (12) exposing bushings (14) and (15). Do not remove the bushings unless new bushings are to be installed. All bushings are dowelled and new dowel pins should be used with new bushings. (See Page (164), Maintenance Section, for dowel instructions.)

TO INSPECT:

Wash all parts thoroughly with cleaning fluid. Inspect the jaws on the jaw clutch (11) and gear (12) to see that jaws are not cracked or the corners rounded off as there is danger of a worn or cracked jaw clutch disengaging under a heavy load. Inspect thrust washers and bushings for wear. Check grease pipes to see that they are open. Inspect swing brake lining for wear.

TO ASSEMBLE:

Pack the recess between bushings (14) and (15) full of grease. Place gear (12) in the case. Lay thrust washer (23) on the gear. Slide the shaft down through the thrust washer and gear (12) and its turntable bushings. Put on jaw clutch (11). Replace shifting yoke (9) on jaw clutch (11). Replace traction gear on vertical traction shaft. Replace swing pinion. Replace gear case cover and put in all bolts but do not tighten them. Replace yokes (17) and (18), shafts (19) and (20), shaft (10) in yoke (9) and shaft (22). Tighten case cover bolts evenly, checking often to see that none of the shafts are binding in the case cover. Replace swing brake assembly and swing brake drum. Put on washer (6), plate (5) and capscrews (3) and (4). Replace drum lagging and bulkhead. Pump grease into swing shaft bushings and into grease connection on top of swing brake drum.

VERTICAL TRACTION SHAFT
Figures 121 and 122

TO REMOVE:

Remove turntable gear case cover as described on Page 147. Remove swing and traction shifter yoke (9). Remove lower traction bevel gear case cover. Remove lock screws from shifter lugs (25) and (26). Unscrew pipe (27) and lift it out. Unscrew pipe (28) and lift it out. The shifter lugs may now be taken out of their forks. Remove lock screws (29) and unscrew adjusting nut (30) from the lower end of the vertical traction shaft. Lift gear (31) off the shaft. Pull shaft (32) out through the top. Remove thrust washer (33), bevel pinion (34), and thrust washer (35) will be loose below the carbody.

TO INSPECT:

Wash all parts thorougly with cleaning fluid. Check all parts, bushings and thrust washers for wear. Check grease pipes to be sure they are open.

TO REPLACE:

Pack the recess between bushings (36) and (37) with grease. Grease thrust washer (35) and slide it on the shaft. Grease thrust washer (33) then hold it and bevel pinion (34) in place while the vertical traction shaft is lowered down through its bushings, thrust washer (33) and pinion (34). Put on adjusting nut (30) and screw it up tight then back it off just enough to give a slight amount of up and down end play in the shaft. Replace lock screws (29) and wire them together. Put gear (31) on the shaft. Place shifter lug (25) in the top fork of the lower bevel gear case, then screw pipe (28) into the lug. Put in lock screw. Replace lug (26) and pipe (27), then put in lock screw. Replace lower traction bevel gear case cover. Refill case with lubricant as per Lubrication Instructions, Page (68), Operation Section. Replace swing and traction shifter yoke (9). Replace turntable gear case cover as described on Page 147.

TURNTABLE ROLLERS

TO REMOVE:

Place the machine on firm, level ground and be sure all four rollers are resting on the lower roller path. Place a jack under the turntable, near the roller to be removed, and jack it up enough to let the roller turn free. Remove bolt (1) from the roller bracket (5) and roller pin. Screw bolt (1) into the drilled and tapped hole in the end of roller pin (2), and using the bolt as a handle, pull out the roller pin. Move the roller (3) to one side of the roller bracket and lift it out.

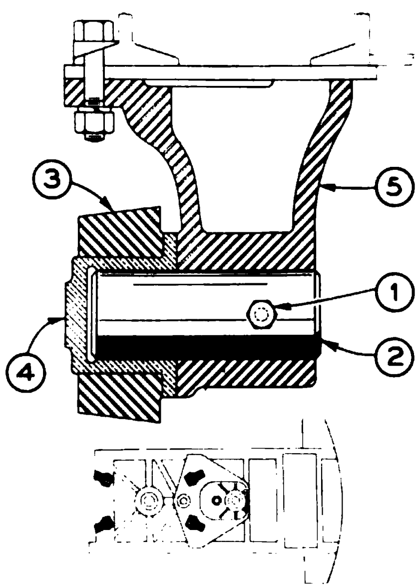


Figure 123

TO INSPECT:

Wash all parts thoroughly in cleaning fluid. Check roller bracket to be sure it is securely bolted to the turntable. Inspect shaft, bushing and thrust flange for wear. The bushing and thrust flange (4) are one piece and can be pressed out of the roller for replacement.

TO REPLACE:

Place the roller (3) in the roller path and roll it into position behind the roller bracket (5). To compensate for wear on the roller and roller paths, place a steel washer between the thrust flange of bushing (4) of the roller and the roller bracket (5) to crowd the roller deeper into the "V" shaped roller path and reduce the tipping action of the turntable. The roller should not touch both the top and bottom roller paths at the same time. When the roller is resting on the bottom roller path, there should be a clearance above the roller of about 1/32" to 1/16". After the roller is in place, put the roller pin through the roller bracket and steel washer, if one is used - and into the roller bushing. Put a punch in the bolt hole to hold the pin in line while removing the bolt from the pin. Remove the punch and put the bolt through the roller bracket and pin and draw the nut tight on the bolt. <u>NOTE - Removing the grease connection from the end of the pin will make it easier to take the pin out and put it back into place. Pump grease into roller after installing.</u>

TURNTABLE AND PILOT BUSHING

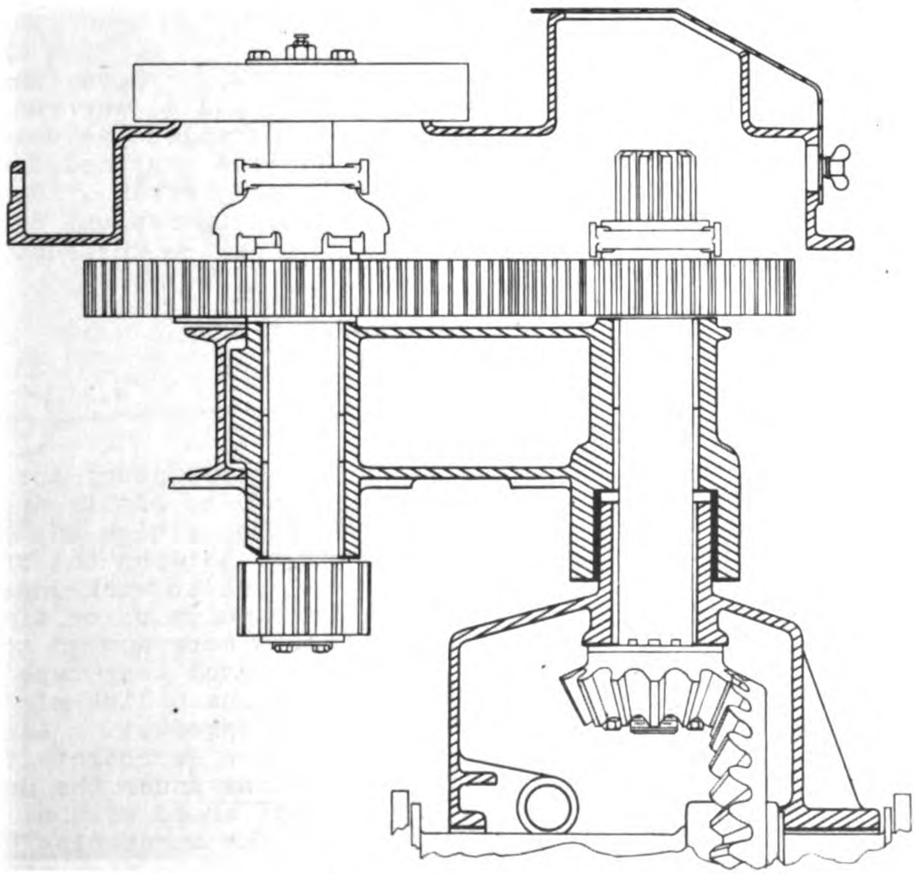


Figure 124

TURNTABLE AND PILOT BUSHING

TO REMOVE:

Place the machine on firm level ground. Line up the turntable so that the boom is over the center of either end of the crawlers. Lower the boom to cribbing or other suitable support. Pull enough boom cable off the boom hoist drum to allow considerable slack in the boom cables. Remove vertical traction shaft as described on Page (148). Build a crib under the counterweight and jack up the counterweight until the rear turntable rollers are free. Place jacks at the front of the turntable and jack it up until the front rollers are free. Remove all four turntable rollers as described on Page (148). Jack up the turntable evenly at both ends until the front end is high enough to put a strong timber under the turntable and over the carbody just back of the front turntable roller brackets. This timber or steel beam should extend out beyond the crawlers, on both sides, about four and five feet. Build a crib under each end of the timber or beam, then, using jacks at both ends of the timber or beam and under the counterweight, jack up the turntable high enough to allow the carbody and crawler assembly to move from under the machine out toward the boom. Remove old bushing. CAUTION - Keep the cribs built up close to the counterweight and under the timber ends at all times. See that the boom cable does not get tight as the turntable is lifted. The traction jaw clutches should be disengaged and traction brake adjustments loosened before moving the lower traction assembly.

TO INSPECT:

Check bushing for wear.

TO REPLACE:

Install new bushing as described on Page (162). Move the lower traction assembly back under the turntable and lower the turntable until the turntable rollers can be installed as described on Page (149), Maintenance Section. Replace vertical traction shaft as described on Page (148), Maintenance Section. Readjust traction brakes as described on Page (90), Operation Section. Grease pilot bushing as described under "Lubrication Instructions", Page (71), Operation Section.

LOWER TRACTION SHAFT ASSEMBLY
Figure 125, 126 and 127

TO REMOVE:

Before removing the lower traction shaft assembly, study the shaft and its related parts to get a clear understanding of its arrangement. Drive the machine up a ramp on to timbers high enough to clear the bevel gear and traction brake drums between the crawler axles and the ground. This also gives more room to work under the machine. If it is not possible to get the machine up on timbers, a trench can be dug under the machine to allow room enough to roll the assembly out. Remove the lower traction bevel gear case cover (1). Split both drive chains by removing a chain link pin just above the center of the chain on the driven sprocket. Also tie that part of the chains just back of the drive sprockets to the turntable. Drag the lower halves of the chains under the machine to the front end of the crawlers. Then, just ahead of the drive sprockets, tie the remainder of the chain to the turntable. NOTE - Tying the chains as described will save considerable time if it is not necessary to remove the chains.

LOWER TRACTION SHAFT

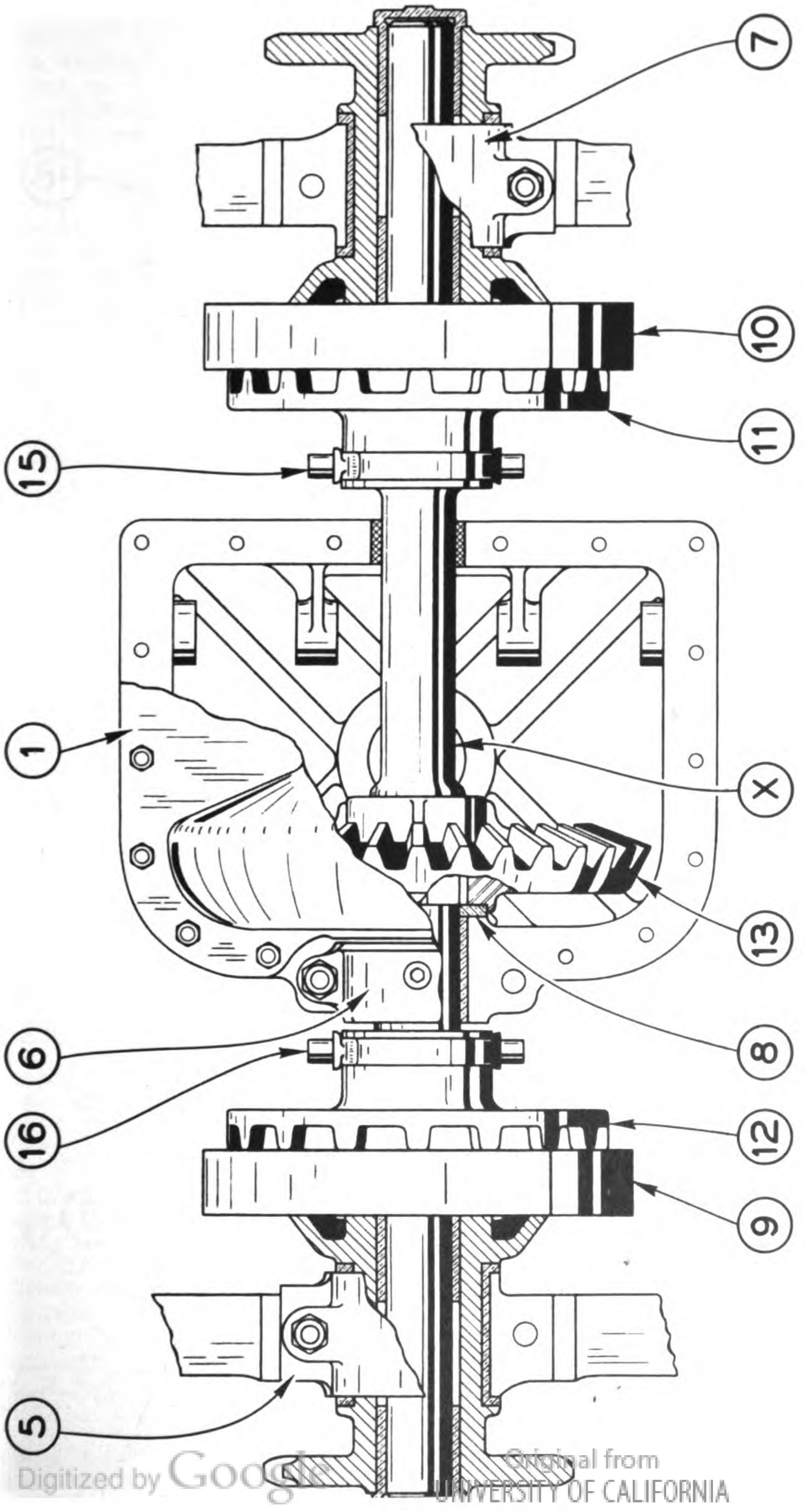


Figure 125

LEFT HAND TRACTION BRAKE BAND ASSEMBLY

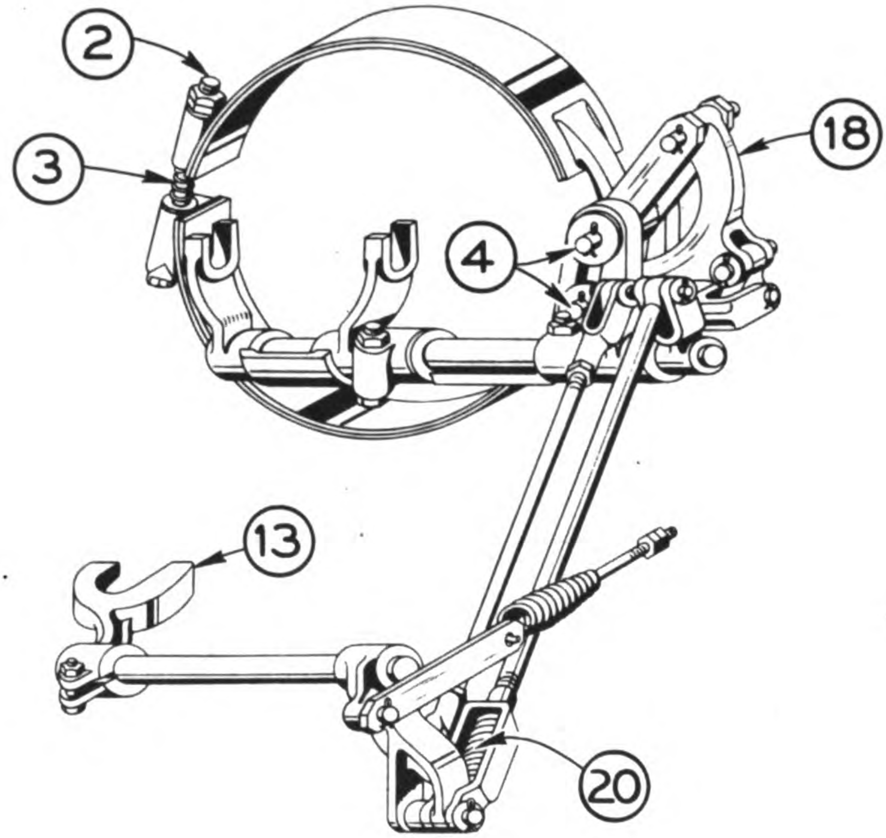


Figure 126

RIGHT HAND TRACTION BRAKE BAND ASSEMBLY

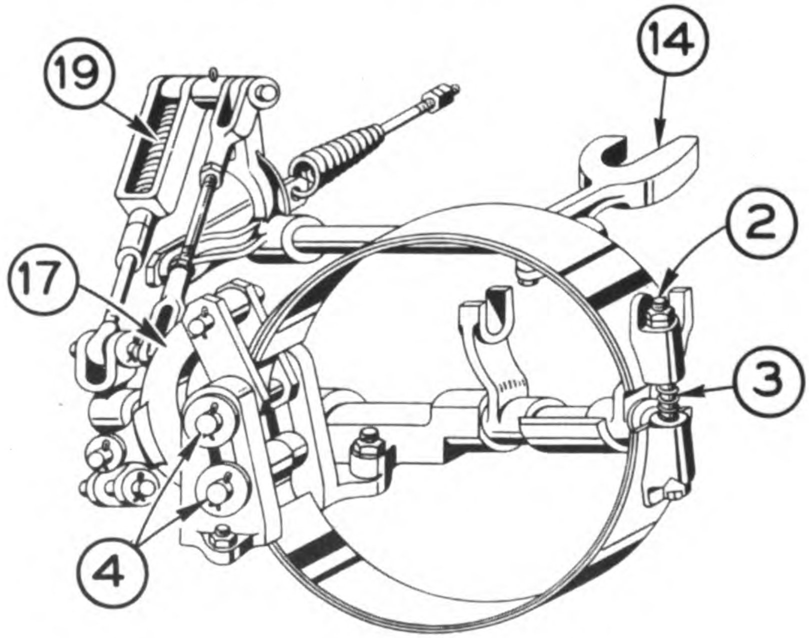


Figure 127

LOWER TRACTION SHAFT ASSEMBLY (Continued)

Remove traction brake band adjusting bolts (2) and springs (3). Take out band end pins (4) and remove brake bands. Place a good jack (hydraulic jack is best) on blocks of wood large enough to provide a good support for the jack. On top of the jack place a "V" block to contact the traction shaft at "X" next to the bevel gear. Put a slight pressure on the jack. Remove bearing caps (5), (6) and (7), keeping the bushing halves and shims with each cap as it is taken off. Thrust washer (8) is made in two pieces and can be removed after cap (6) is off. Build up a safe pile of blocking under each brake drum (9) and (10). Lower each pile of blocking about 2" as the shaft is let down 2" at a time. Keep wedges or blocks in front of and behind each brake drum on each blocking pile. When the blocking under the jack needs to be changed to set the jack lower, the brake drums and shaft will be supported by the blocks under the drums. When the shaft has been lowered to the ground it can be turned and rolled - on the brake drums and bevel gear - until it is worked out from under the machine. The brake drum and sprocket units and the steering jaw clutches (11) and (12) can be taken off the shaft while it is under the machine and brought out in units if desired. Sprockets and brake drums will slip off the shaft much easier if the grease fittings in the end of the sprocket hubs are removed. Bevel gear (13) is pressed on the shaft.

The bevel pinion (34) Figure 121 and thrust washer (33) Figure 121 may be removed while the lower traction shaft is out by removing yokes (13) and (14), then removing lock screws (29) and unscrewing adjusting nut (30) Figure 121 and sliding the pinion and thrust washer off. When the thrust washer and pinion are replaced, tighten adjusting nut (30) Figure 121 so that the vertical traction shaft has a slight amount of end play, then replace lock screws and wire them together.

TO INSPECT:

Wash all parts thoroughly with cleaning fluid. Inspect all parts for wear. Check steering jaw clutches for excessive taper on the jaws or in the jaw clutches. Excessive taper will cause these jaws to disengage under heavy loads when traveling. Square the jaws by welding. Inspect lining on traction brakes and if worn, reline brakes as described on Page (130).

TO REPLACE:

Pack the recesses between the bushings in the drive sprocket sleeves with grease. Place the shaft - assembled with its jaw clutches and drive sprockets - under the machine and jack up the shaft almost into place, being sure shifter rings (15) and (16) engage their shifting forks. When the shaft is approximately 7/8" of an inch short of being in place, wipe all dirt and dust off the bearing surfaces and bearing shells. Grease the upper bearing shells and slip them into place. Finish jacking the shaft into place. With a pinch bar, crowd bevel gear (13) as far as possible toward the bevel pinion. Grease thrust washer (8) and slip the two halves into place. Put on bearing cap (6) and shims for safety. Grease the lower bearing shells and put on caps (5) and (7) and shims. NOTE - When caps (5) and (7) are drawn up tight it should be possible to turn brake drums (9) and (10) with a short bar while jaw clutches (11) and (12) are disengaged. If the brake drums are too loose, remove one thin shim from each side of each brake drum bearing cap, then check again. After the brake drum bearings have been properly adjusted, remove the jack and draw up the bevel gear bearing and check it by placing a short bar in one of the disengaged jaw clutches then rocking the traction shaft and bevel gear. If it is too loose, remove one shim from each side of the bevel gear bearing cap. All these bearings should be snug but not so tight that the units cannot be turned with a short bar. Replace grease connections in the ends of the drive sprockets and pump some grease into all grease connections on the shaft and the operating linkage under the machine. Replace traction brake bands. Oil all operating link pins. The traction jaw clutches should fully engage or bottom in their jaw clutch drums. Traction brakes should be completely released when the jaw clutches are engaged. Engage the right hand jaw clutch (11). Check lug yoke to see that it does not strike the lower traction shaft. Check shifter yoke (13) to see that it does not strike shifter yoke (14) when the right hand jaw clutch (11) is engaged and the left hand jaw clutch (12) is disengaged. When working both jaw clutches alternately, there should be no interference at either the top or bottom end of steering pipes. Interference can be corrected by adjusting the jaw clutches operating the linkage (17) or (18). Springs (19) and (20) make it possible to apply the traction brakes even though the traction jaw clutches may not disengage. Each traction brake toggle linkage should backlock when the corresponding jaw clutch is disengaged. Adjust traction brakes as described on Page (90), Operation Section. Replace lower traction bevel gear case cover and fill case as directed on Page (70), Operation Section.

Replace drive chain as directed in "Traction Drive Chain", Page (198).

TOP AND BOTTOM CRAWLER ROLLERS
FRONT AND REAR CRAWLER TUMBLERS
CRAWLER SHOES

MAINTENANCE TEXT PAGES 156, 157, 158, and 159.

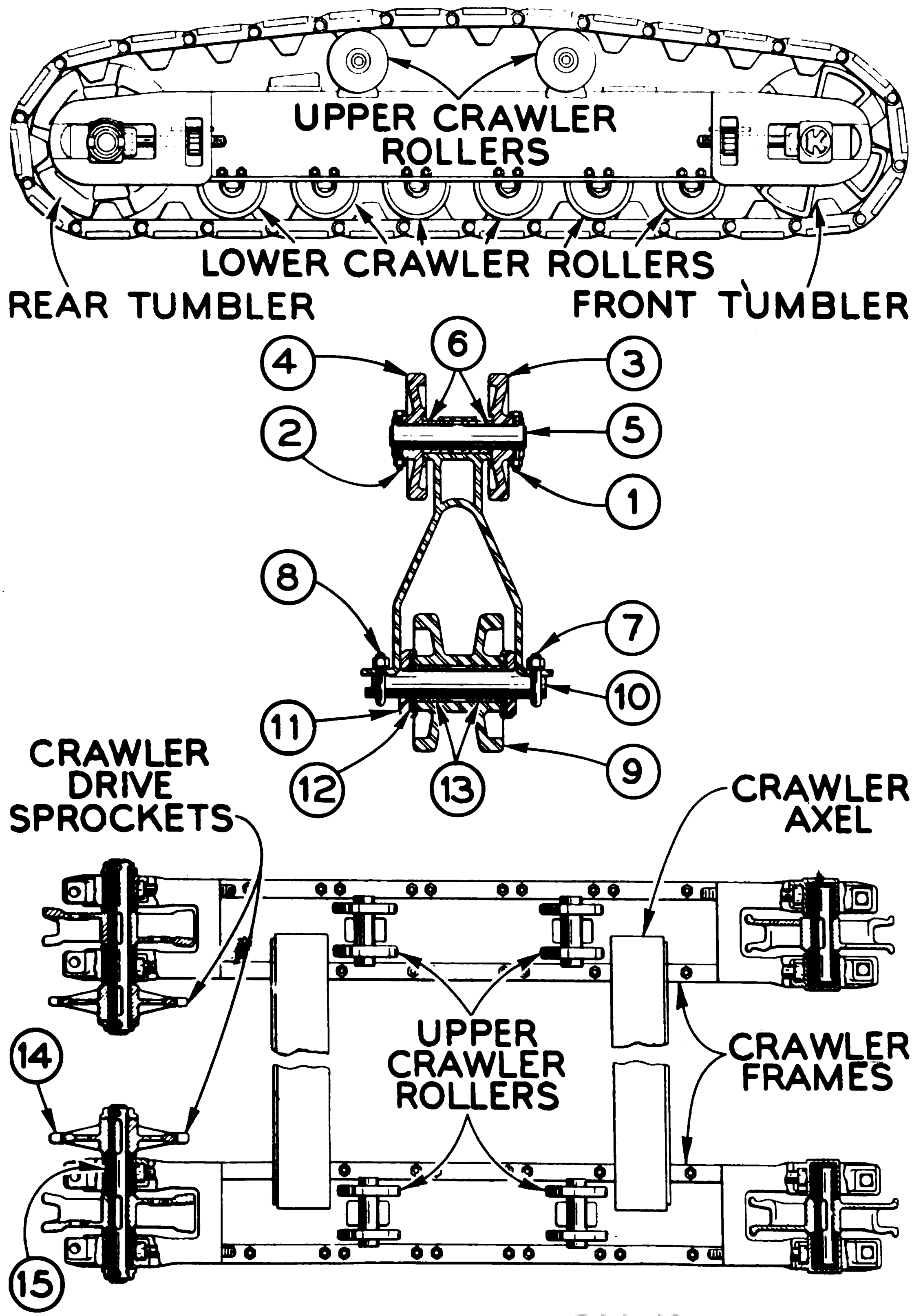


Figure 128

TOP CRAWLER ROLLERS
Figure 128

TO REMOVE:

With the machine on firm level ground, travel it forward for a distance equivalent to the length of the crawlers so that all the slack in the belt is at the top. Use a crowbar to lift the crawler belt off the top crawler roller to be removed. Block up the crawler shoes in front and in back of the roller. NOTE - If more slack is needed, release front tumbler adjustment. After the shoes are blocked up high enough, take out bolts (1) and (2), then rollers (3) and (4) and shaft (5) can be taken off. Bushings (6) can be driven out and new bushings installed. Drive in new bushings with a hardwood block or draw them in with a bushing puller using the method as described and illustrated on page (162) figure (136).

TO INSPECT:

Inspect rollers, shafts and bushings for wear.

TO REPLACE:

Fill the recess between the bushings with grease. Put the shaft (5) in bushings (6); mount the rollers (3) and (4) on the shaft and put in bolts (1) and (2). Pump grease into the grease connection.

LOWER CRAWLER ROLLERS
Figure 128

TO REMOVE:

Place machine on firm level ground. Release front tumbler adjustment entirely to provide ample slack in crawler shoes. If necessary, release the rear tumbler adjustment for additional slack. Place an 8" block of wood in front of crawler from which lower rollers are to be removed and back machine until rear tumbler is on top of block to provide clearance for removal of rollers. If jacks are used instead of blocking, place jacks under crawler axles just inside of the crawler belts. Now remove "U" bolts (7) and (8), which allow the roller and shaft assembly to drop down. Roll the assembly out from under the crawler frame. Pull the shaft (10) out of the roller (9) and thrust washers (11).

TO INSPECT:

Wash parts with cleaning fluid. Check the shaft (10), washers (12) and thrust washers (11) and bushings (13) for wear. Check roller (9) for cracked flanges.

TO REPLACE:

If new bushings are needed, drive out the old ones. Drive in new ones with a hard wood block, press them in with a press or draw the bushings in with a bolt. Fill the recess between the bushings with grease. Put in shaft (10). Place washers (12) on shaft at each side of roller. Place thrust washers (11) on the shaft. Lift shaft and roller assembly up in place and put in "U" bolts (7) and (8). Tighten "U" bolts. Pump grease into the grease connection. Lower machine to normal position and adjust crawlers as described on Page (93), Operation Section.

FRONT CRAWLER TUMBLER
Figures 129 and 130

TO REMOVE:

Place the machine on firm level ground. Travel the machine forward for a distance equivalent to the length of the crawlers to get the slack of the crawler belt on top. Place a 2" board (1) on the ground in front of the crawler from which tumbler is to be removed and travel machine over the board until the board is directly under the first roller back of the tumbler as shown in Figures 129 and 130. Place blocks (2) between crawler frame and shoe as shown to prevent belt from sagging when split for tumbler removal and thus facilitate driving out crawler shoe pin. Select a shoe pin at about (3), and remove pin. Allow the lower end of the shoes to drop to the ground and roll the top end back and tie with wire Figure 130. Remove shim and the bar (4) from both sides of the crawler frame end. Take out lock pins (5) and screw adjusting nuts (6) off adjusting bolts (7) on the inside and outside of the crawler frame. Roll tumbler forward out of the frame. Both bearings

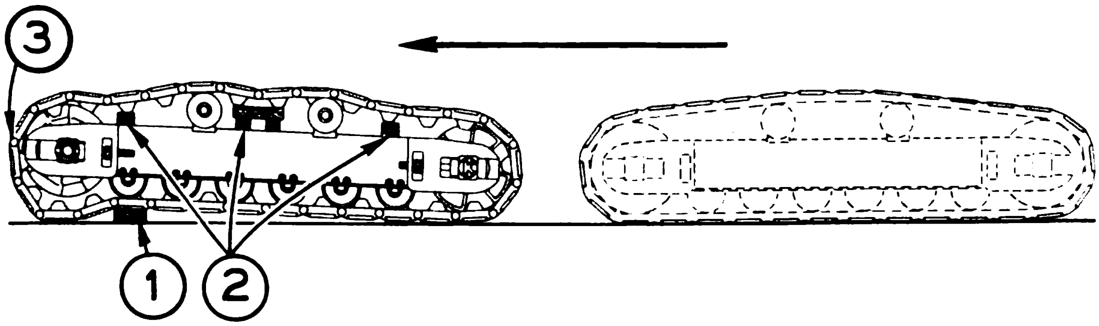


Figure 129

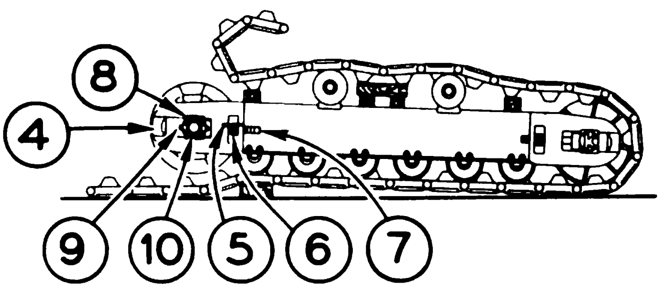


Figure 130

(8) and their adjusting bolts (7) can be pulled off for inspection. NOTE - If a new tumbler or shaft is to be installed, it will be necessary to press the shaft out of the tumbler. Tumbler and shaft are assembled at approximately 10 tons press fit.

TO INSPECT:

Inspect bearing boxes and shaft for wear. Rebabbit bearing boxes if necessary, being sure grease connection holes are open. Inspect adjusting bolts to be sure they are straight and that threads are in good condition.

TO REPLACE:

Put grease in bearing boxes, insert adjusting bolts and place the assembly on the shaft. Oil the threads on the adjusting bolts. Roll the tumbler into the crawler frame while guiding the adjusting bolts and bearing boxes into place. Start adjusting nuts (6) and screw them as far as possible, pulling the bearing boxes to the rear end of their guides. Replace shims and tie bars (4). Let the top shoes down to the tumbler. Lift up the bottom shoes and hold them with a bar or jack while lining the shoe hinges together. Put in shoe pin and key. Remove blocks from under the shoes at the top of the crawler frame. Adjust crawler belt as directed on Page (93), Operation Section.

REAR CRAWLER TUMBLER
Figures 129 and 130

TO REMOVE:

Place the machine on firm level ground and prepare crawlers by blocking and by slacking the top crawler shoes the same as for removal of front crawler tumbler described on Page 157. Remove lock pin (5) and screw adjusting nut (6) on adjusting bolt (7) - on both sides of tumbler - thus releasing the chain and shoe adjustment. Select a shoe pin at (3), and drive out pin. Let the lower end of the shoes fall to the ground and roll the upper end back off the tumbler, tying it with wire. Split traction chain as described on page (202). Remove tie bar and shim (4) on both sides of the multiplane frame. Remove adjusting nuts (6) from adjusting bolts (7) on both sides of the tumblers. Roll the tumbler assembly out. Remove pins (9) and drive collars (10) off the shaft. Slide bearing box (8) off the shaft. Press sprocket (14) Figure 128 off the shaft and remove sprocket key. Slide bearing (15) Figure 128 off the shaft. NOTE - Tumbler and shaft are assembled at approximately 10 tons press fit.

TO INSPECT:

Wash all parts thoroughly with cleaning fluid. Inspect bearings and rebabbit if necessary, being sure grease connection holes are open. Inspect sprocket teeth for wear. Inspect drive tumbler for cracks and worn driving sections. Inspect adjusting bolts to see that they are straight and that threads are in good condition.

TO REPLACE:

Slide bearing (15) Figure 128 on the shaft. Put in sprocket key and press sprocket (14) Figure 128 on the shaft. Put bearing (8) on the shaft. Oil the threads of the adjusting bolts (7) and put the bolts into bearing boxes. Roll the assembly into place in the crawler frame, put on adjusting nuts (6) and screw them up as far as possible to draw the bearing boxes and tumbler into the frame. Put on collars (10) and pins (9). Put some washers behind collars (10) to compensate for thrust wear if necessary. Replace shims and tie bars (4). Replace drive chain on sprocket and put in chain pin and key. Lower top crawler shoes to the tumbler. Lift the bottom shoes into place on the tumbler and hold them with a bar or jack while lining up shoes and inserting pin (3). Insert key in shoe pin. Pump grease into bearings. Remove blocks from under the shoes at the top of crawler frame. Adjust drive chains as directed on Page (93), Operation Section.

CRAWLER SHOES

TO REMOVE COMPLETE CRAWLER BELT: (SEE FIGURES 129 AND 130)

Remove lock pins (5) and slack off tumbler adjustments at both ends of crawler frame by turning adjusting nuts (6) to the right. Select a shoe pin (3) about half way up on either tumbler; take out lock pin and remove shoe pin. Roll top half of crawler belt back off crawler frame and then, after jacking machine up so that lower rollers clear shoes, drag crawler belt out from under crawler frame. NOTE - If jacks are not available, crawler frame may be raised by tipping the machine with hoist cable. To do this swing boom over opposite crawler, attach cable to tree or some other substantial object and hoist. CAUTION - Block machine securely under axles before attempting any further work. Crawler belt may be pulled clear of crawler frames with power by swinging boom point in line with crawler belt and attaching hoist cable. NOTE - Lower boom to horizontal before applying hoist clutch.

TO REMOVE ONE CRAWLER SHOE:

Move machine until selected shoe is just below center on either tumbler and slack off on tumbler adjustment as described above in "To Remove Complete Crawler Belt." Take out shoe pin on each side of shoe and remove shoe.

TO INSPECT:

Examine shoes for wear or other damage and inspect pins for wear or misalignment. Replace worn shoes and pins and repair cracked shoes by welding.

TO REPLACE OLD CRAWLER BELT:

Drag belt under crawler frame using procedure described in "To Remove Complete Crawler Belt" and lower machine to shoes. Move machine so that tumbler rests on third shoe from one end and then bring the other end of belt around over crawlers. Remove slack from the top side of belt by inserting blocking between crawler frame and belt, then bring the two end shoes together; insert shoe pin (3) and lock with lock pin. NOTE - For adjustment of chain see Page (93), Operation Section. Belt may be pulled over top of crawler frame with hoist cable. When doing this be sure that boom is lowered to horizontal and that boom point is properly lined up with belt.

TO REPLACE ONE CRAWLER SHOE:

Place shoe in position on lower part of crawler belt; line up holes; insert shoe pin and lock with lock pin. Move machine so that tumbler rests on third shoe from the end and then connect belt using procedure described in "To Replace Old Belt."

TO REPLACE WITH NEW CRAWLER BELT:

Split old belt over rear tumbler using procedure described in "To Remove One Crawler Shoe" and connect end shoe of new belt to top end shoe of old belt. Move machine forward as shown in Figure 131 until the new belt is in place and then connect ends as described in "To Replace One Crawler Shoe".

METHOD OF INSTALLING COMPLETE NEW CRAWLER BELT

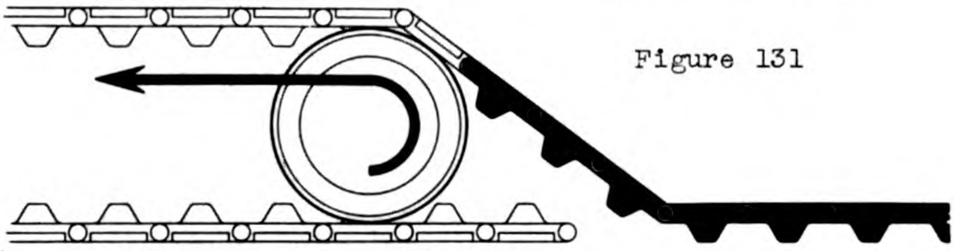


Figure 131

BRONZE BUSHINGS
LOCATIONS OF BRONZE BUSHINGS AND DOWEL TYPES

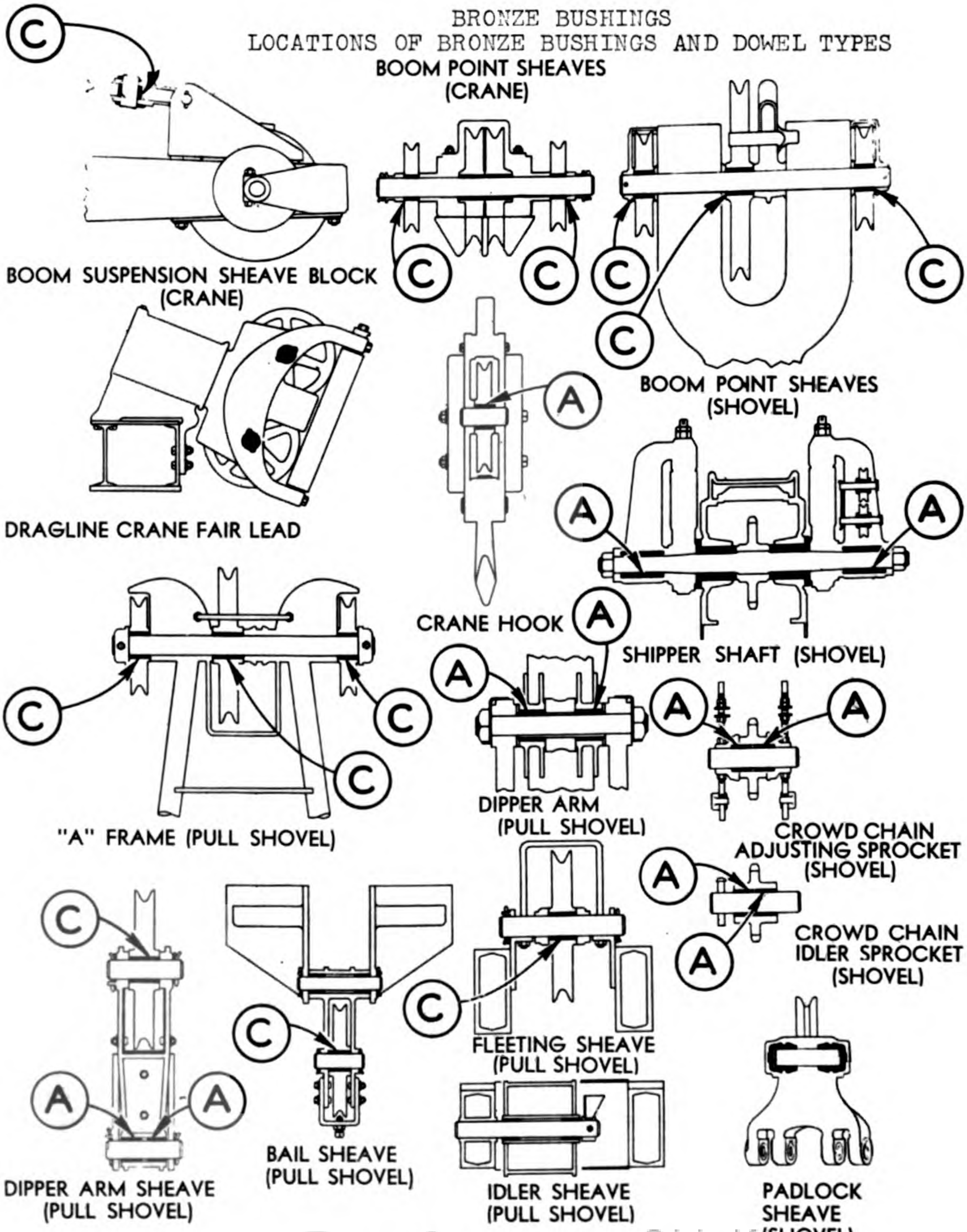


Figure 132

LOCATIONS OF BRONZE BUSHINGS AND DOWEL TYPES

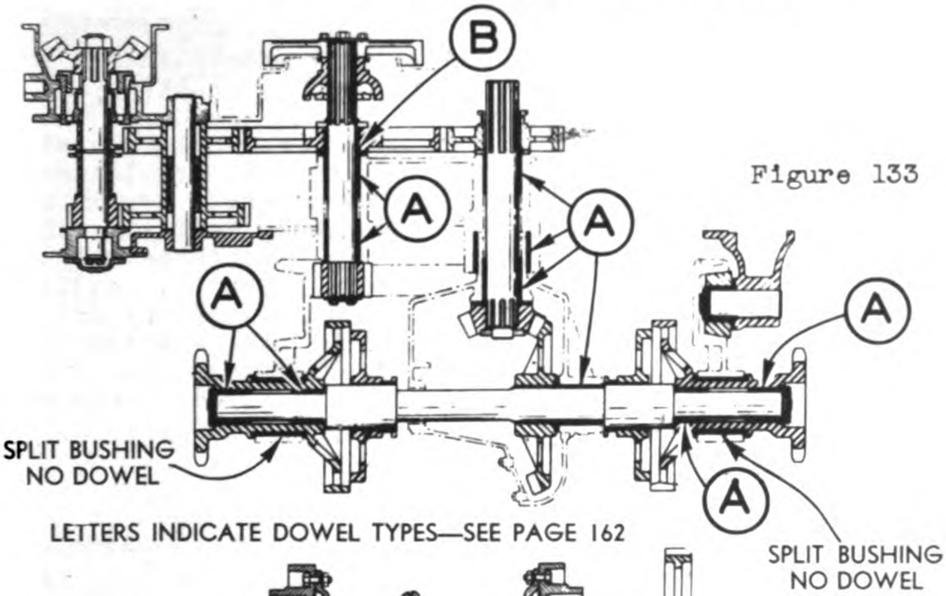


Figure 133

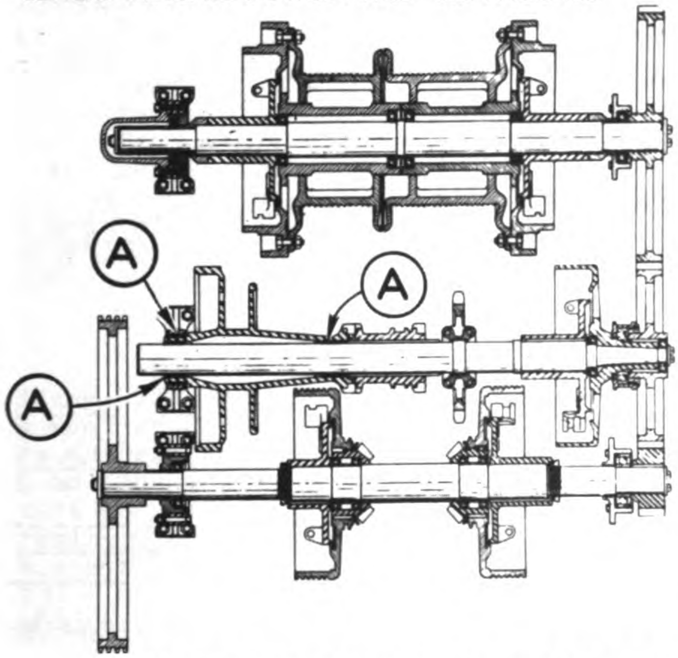


Figure 134

LETTERS INDICATE DOWEL TYPES—SEE PAGE 162

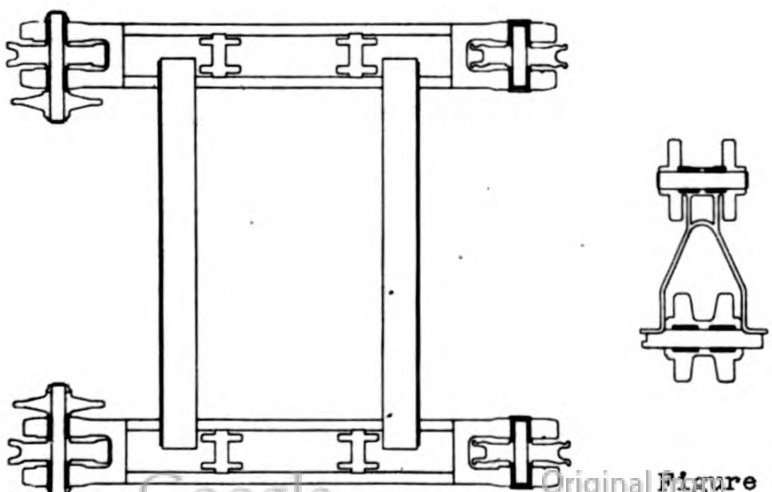


Figure 135

BRONZE BUSHINGS

Replaceable bronze bushings are used at many points in the Koehring Model 304 as shown in Figures (132), (133), (134), and (135).

In normal operation and with proper care these bushings will last indefinitely but occasionally - due to abnormal conditions or improper lubrication - replacements are necessary. Repair bushings are carefully machined so that when correctly installed they will fit the shafts without reaming or scraping. The three methods most generally used for replacing bushings are pressing, pulling and driving. All bushings can be removed and replaced by driving but it is recommended that a press or puller be used wherever possible to reduce the danger of distortion or other damage that frequently occurs when driving bushings in or out of retainers. A simple and easily constructed puller is shown in Figure (136).

TO REMOVE:

Clean part thoroughly by washing with cleaning fluid and examine bushing for dowel pins. NOTE - Figures (132), (133), (134) and (135) show which bushings are dowelled and the types of dowels used. If one or more dowels are present and are of types "A" or "B", drive them out with a hammer and a punch. (It is not necessary to remove type "C" dowel to remove bushing.) Then, using the method best suited to the job, pull, press or drive bushing out. NOTE - In some cases where the bushings are extremely tight or frozen due to abnormal operation, it may be necessary to split the bushings using a round nose or diamond point chisel. WHEN SPLITTING BUSHINGS BE CAREFUL NOT TO DAMAGE THE SURFACES OF THE RETAINING BORES.

TO REPLACE:

File ends of retaining bore and outside surface of bushing just enough to take off sharp edges, then clean all burrs from surfaces of bore and bushing and coat with white lead. Start bushing straight, tapping it lightly with a hammer and then press, pull or drive it in. NOTE - It is extremely important that bushing be started and kept straight. Forcing a bushing - when not started straight - will cause distortion and make it necessary to ream or scrape for fit.

After bushing is in place, drill dowel and grease holes as described under "Dowel Instructions," Page (164).

METHOD OF PULLING BUSHINGS

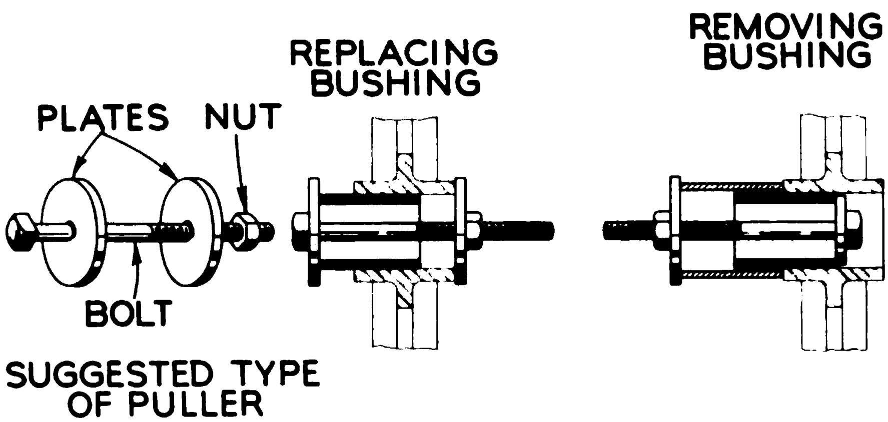
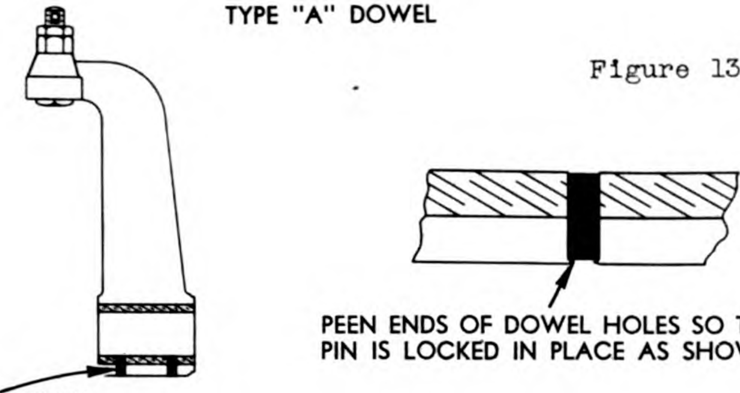


Figure 136

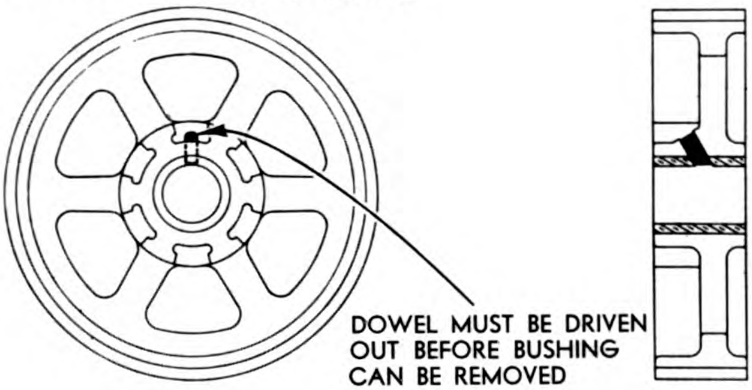
TYPE "A" DOWEL

Figure 137



TYPE "B" DOWEL

Figure 138



TYPE "C" DOWEL

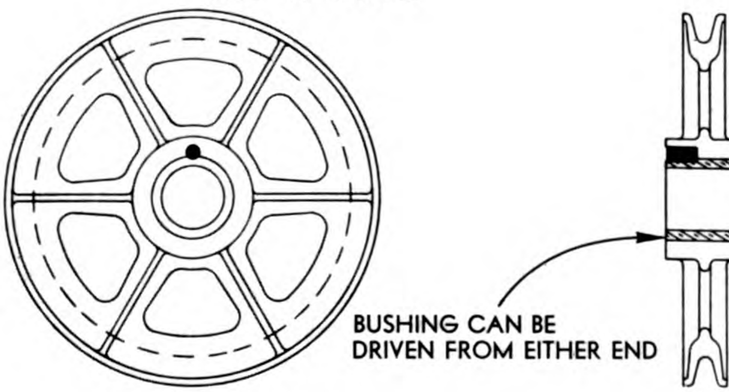
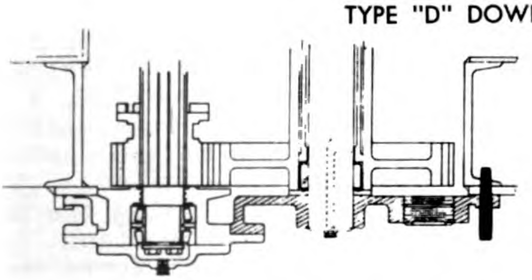
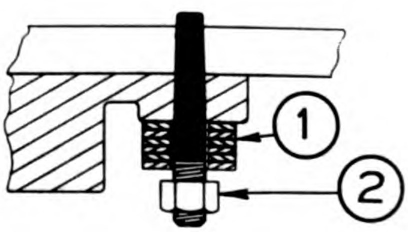


Figure 139

TYPE "D" DOWEL

Figure 140





TO REMOVE TAPERED DOWEL PIN, PLACE WASHERS OR SPACERS (1) AT POSITION SHOWN THEN TIGHTEN NUT (2) UNTIL PIN RELEASES.

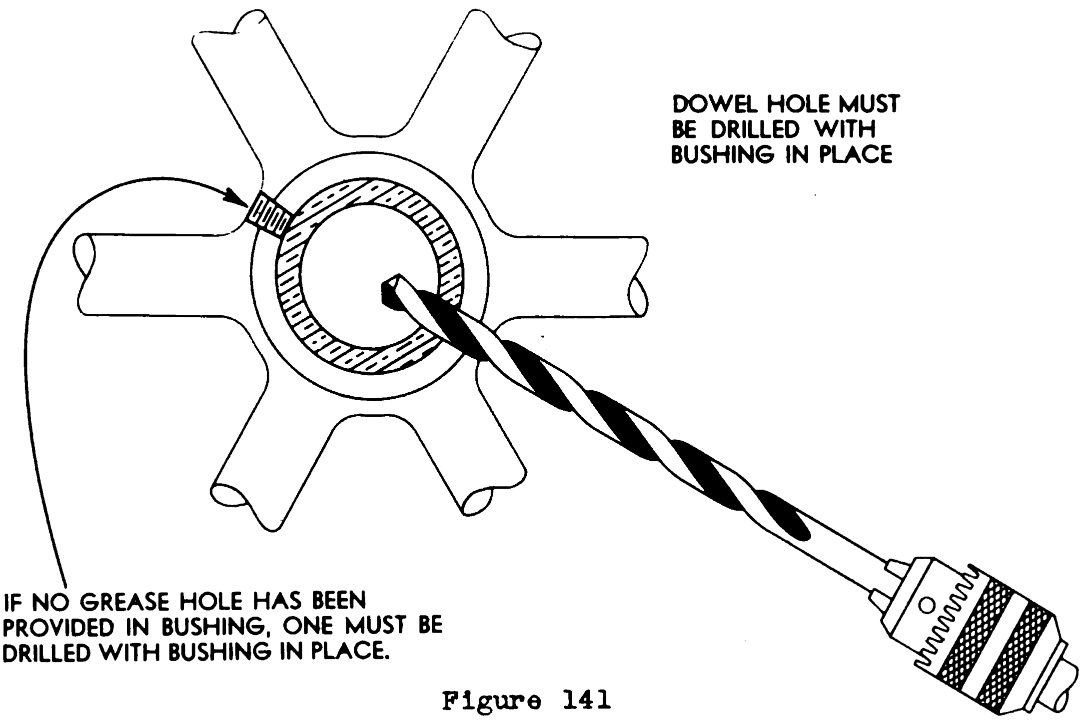


Figure 141

DOWEL INSTRUCTIONS

Dowel pins are used either to retain parts in fixed positions or to preserve alignment.

The various applications of the dowels in the Koehring 304 excavator are shown in Figures (137), (138), (139) and (140), Page (163). All repair parts requiring dowel pins must be drilled on the job as shown in Figure (141).

Where 1/2" or 3/8" brass dowel stock is used at the factory, dowel holes are drilled 1/64" undersize and then reamed to size to assure a good snug fit. This procedure is recommended for repair work in the field whenever the proper tools are available.

Where proper drills and reamers are not available dowel holes may be drilled to size but, as a precautionary measure, dowel stock should be cut slightly short so that ends of dowel hole can be peened to a smaller diameter than the pin so as to lock the pin securely in place. See inset, Figure (137).

Peening should be done with a small ball peened hammer and in such a way that surface of bearing is not distorted. In the event that bearing surface has been distorted by drilling or peening, a bearing scraper or reamer should be used to cut away irregularities. A good smooth surface must always be obtained to assure a satisfactory job. NOTE - Not all bronze bushings are doweled. Size, tolerance and application are factors in determining the use of the dowel pin. Schematic drawings showing the location of all doweled bushings and the type of dowel used can be found on Page (160) and (161).

After a part has been rebushed always check grease hole and grease fitting to be sure they are open, and always coat bushing with clean grease before mounting on shaft. NOTE - <u>If no grease hole has been provided bushing must be drilled. It is best to drill grease hole after bushing is in place.</u>

Figure 142

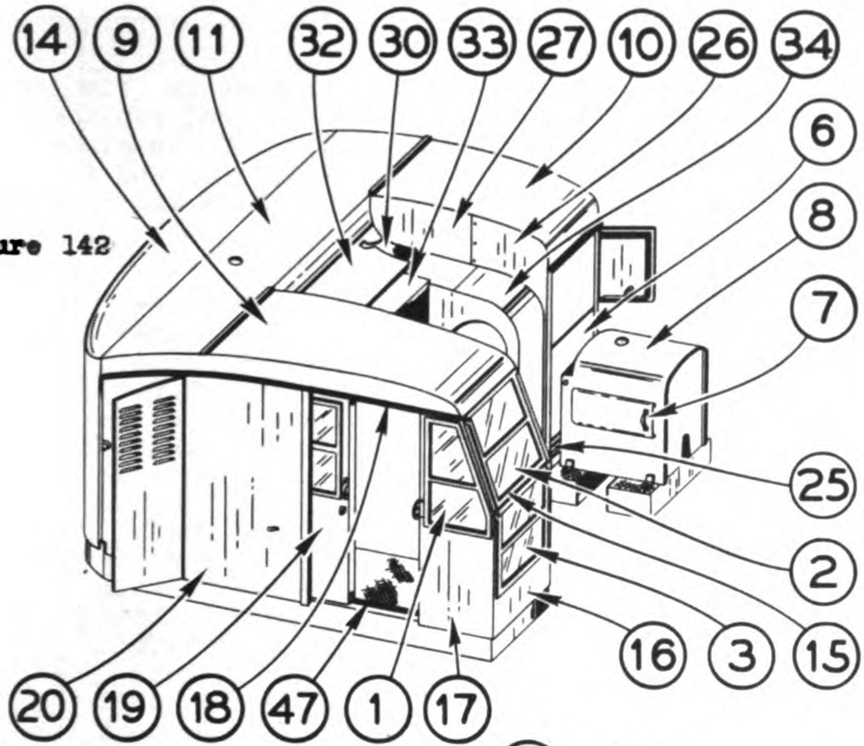


Figure 143

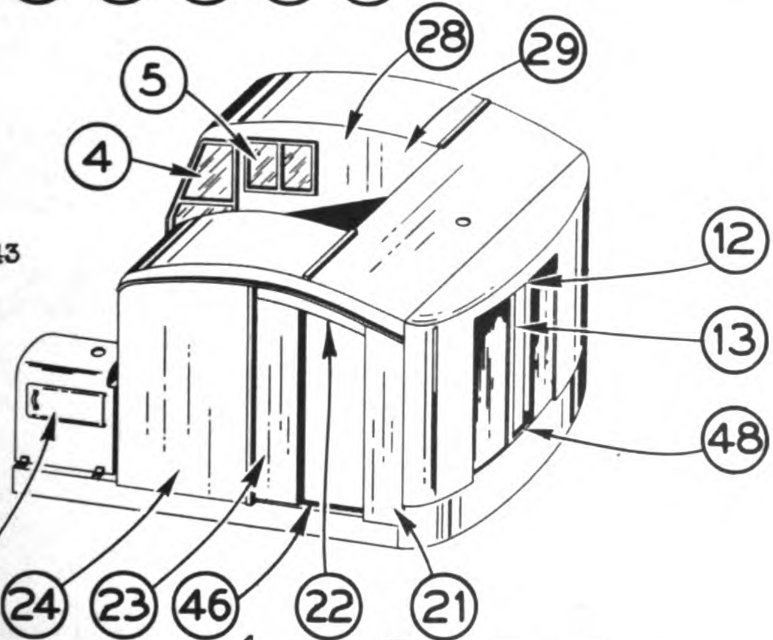
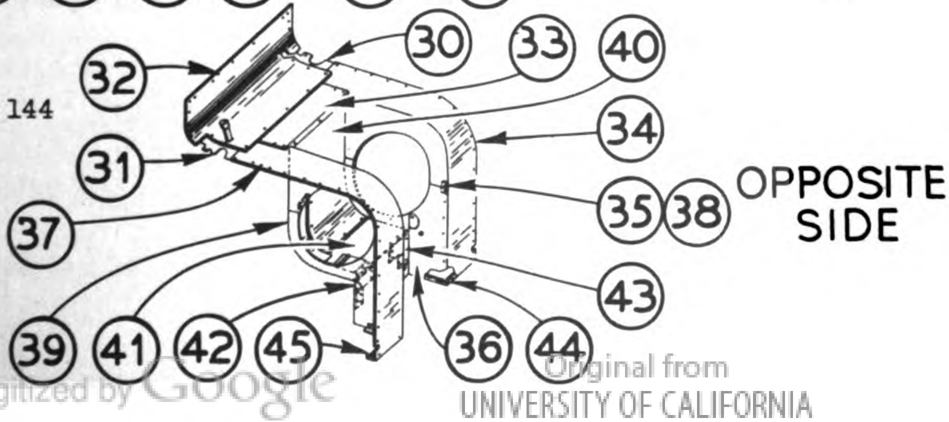


Figure 144



CAB - Figures (142), (143), (144), Page (165)

TO DISASSEMBLE:
The cab is made of steel sheets cut and shaped to fit into the design and in sizes which permit easy removal and replacement of any particular section or of the entire cab. To completely disassemble cab, take off windows (1), (2), (3), (4) and (5), then remove doors (6) and (7). Next take out bolts and remove each section of the cab in the order named below:

8 - Light Plant House
9 - Roof Section
10 - Roof Section
11 - Roof Section
12 - Door Guide
13 - Rear Doors
14 - Cab Back
15 - Tie Bolt and Spacer
16 - Plate
17 - Panel
18 - Door Guide
19 - Door
20 - Panel
21 - Panel
22 - Door Guide
23 - Door
24 - Panel
25 - Member
26. - Panel
27 - Panel
28 - Panel
29 - Panel
30 - Bulkhead Plate
31 - Bulkhead Plate
32 - Bulkhead Section
33 - Bulkhead Plate
34 - Bulkhead Section
35 - Bulkhead Plate
36 - Bulkhead Section
37 - Bulkhead Section
38 - Bulkhead Plate
39 - Bulkhead Section
40 - Bulkhead Section
41 - Bulkhead Section
42 - Bulkhead Plate
43 - Bulkhead Plate
44 - Bulkhead Support
45 - Bulkhead Support
46 - Door Track
47 - Door Track
48 - Door Track

TO INSPECT:
Check all parts for damage. Straighten all bent plates. Paint bare spots to avoid rust. Replace broken glass in windows.

TO REASSEMBLE:
Replace each cab part in the order named below. NOTE - Several small drift pins will help materially in the lining up of holes in the various parts.

48 - Door Track
47 - Door Track
46 - Door Track
45 - Bulkhead Support
44 - Bulkhead Support
43 - Bulkhead Plate
42 - Bulkhead Plate
41 - Bulkhead Section
40 - Bulkhead Section
39 - Bulkhead Section
38 - Bulkhead Plate
37 - Bulkhead Section
36 - Bulkhead Section
35 - Bulkhead Plate
34 - Bulkhead Section
33 - Bulkhead Plate
32 - Bulkhead Section
31 - Bulkhead Plate
30 - Bulkhead Plate
29 - Panel
28 - Panel
27 - Panel
26 - Panel
25 - Member
24 - Panel
23 - Door
22 - Door Guide
21 - Panel
20 - Panel
19 - Door
18 - Door Guide
17 - Panel
16 - Plate
15 - Tie Bolt and Spacer
14 - Cab Back
13 - Rear Door
12 - Door Guide
11 - Roof Section
10 - Roof Section
9 - Roof Section
8 - Light Plant House
7 - Door
6 - Door
5 - Window
4 - Window
3 - Window
2 - Window
1 - Window

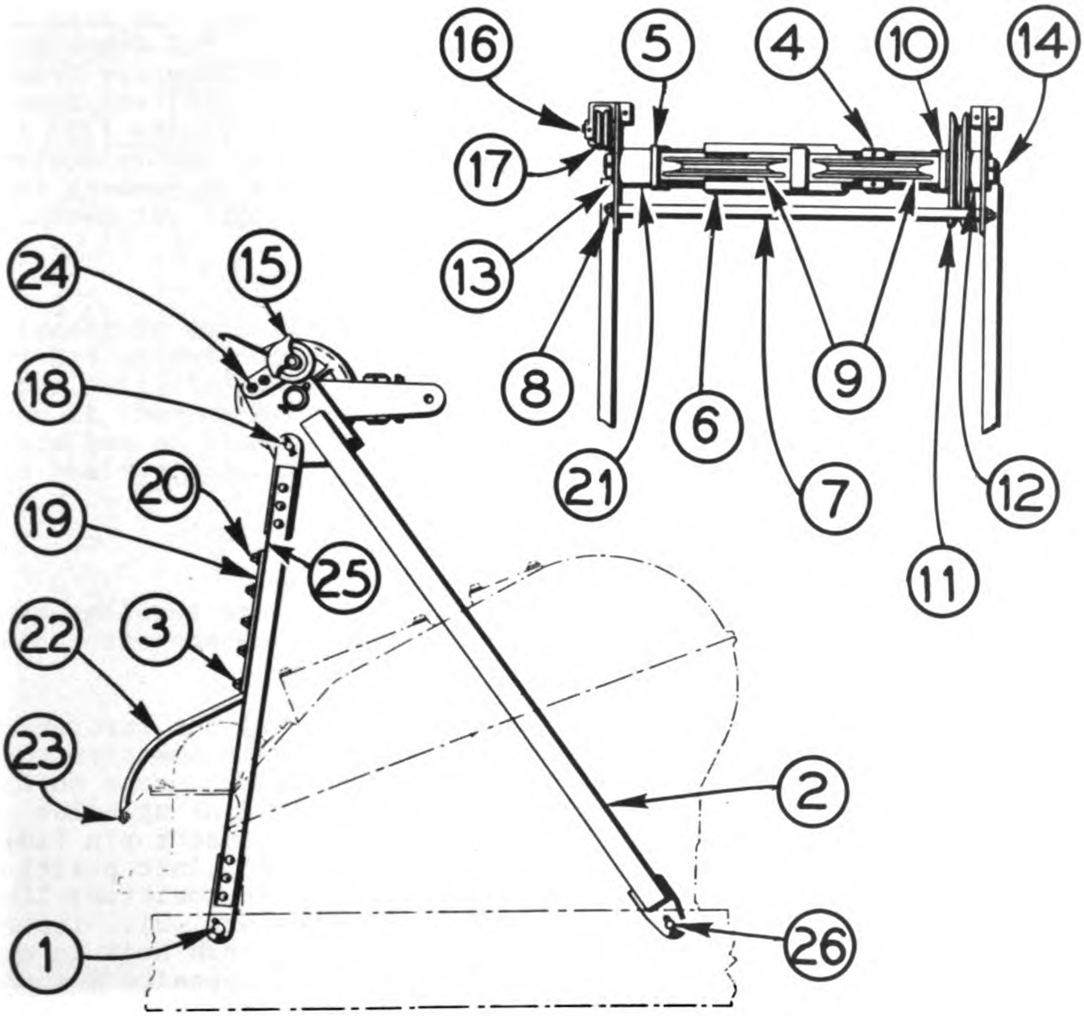


Figure 145

"A" FRAME (GANTRY)

TO REMOVE:

If crane or some other means of lifting complete assembly from machine is available, detach guards (22) by removing bolts (23) and (3). Pull cotters of pins (1) and (26) and remove pins from bases of compression members (2) and tension members (25). Raise assembly high enough to clear machinery, swing to one side and lower assembly to the ground.

If "A" frame cannot be lifted off as a complete assembly it can be disassembled on the machine.

TO DISASSEMBLE:

Close and pull cotters of pins (4) and remove pins and sheaves (9). Pull cotter of pin (16) then remove pin and sheave (17). Take out bolts (24) and remove sheave bracket (15). Next close and pull cotters of shaft (14), remove washer (13) and take out shaft, removing spacer (21), dead end hanger (5), "A" frame yoke (6), spacer (10), sheave (11) and spacer (12) as they are freed. Remove tie rod (8) and spacer (7). Take out bolts (20) and remove support plate (19). Next close and pull cotters of pins (18) and remove pins. NOTE - If disassembled on the machine, remove cotters of pins (26) and remove pins, then lift out compression members (2). Now remove pins (1) from tension members and lift out members.

TO INSPECT:

Check all sheaves, bushings and pins for wear. Examine compression members (2), tension members (25) and yoke (6) for cracks and repair, by welding, any that may be found. Check shaft (14) and if bent, straighten or replace. If spacer (7) or tie rod (8) is bent it may be straightened but if badly damaged, it should be replaced. Examine grease fittings to be sure they are open and replace any that are damaged.

TO REASSEMBLE:

If reassembly is being done on the machine, place tension members (25) into position; line up holes in the members with holes in the turntable and insert pins (1).

Next place compression members into position on the turntable; line up holes in compression members with holes in the turntable and insert pins (26). To reassemble the remaining parts on the machine or on the ground, continue as follows: Line up holes of compression member with holes in tension member; insert pin (18); insert and open cotters. Place support plate (19) into position and fasten with bolts (20). Place spacer (7) into position; line up holes in spacer with holes in compression members (2); insert tie rod (8) and tighten. Start shaft (14) through hole in one compression member (2) and push shaft through to opposite member, mounting spacer (21), dead end hanger (5), yoke (6), spacer (10), sheave (11) and spacer (12) in the order shown in Figure (145). Slip one of the washers (13) on each end of the shaft; insert and open cotters. Place sheave (17) into position in bracket (15); line up bore of sheave with holes in bracket; insert pin (16); insert cotters and open. Lift sheave assembly into place on compression member (2); line up holes, insert bolts (24) and tighten. Lift sheaves (9) into position in yoke (6); line up holes and insert pins (4), locking them into place with lock pin and cotter.

TO REPLACE:

If "A" frame is assembled on the ground, use a crane or other means to lift and swing it into position. Line up holes at bases of tension and compression members with holes in turntable; insert pins (1) and (26); insert cotters into pins and open.

Place guards (22) into position; line up holes of guards with holes of support plate (19); insert bolts (23) and (3) and tighten.

If "A" frame is assembled on the machine, replacement is made when reassembly is completed.

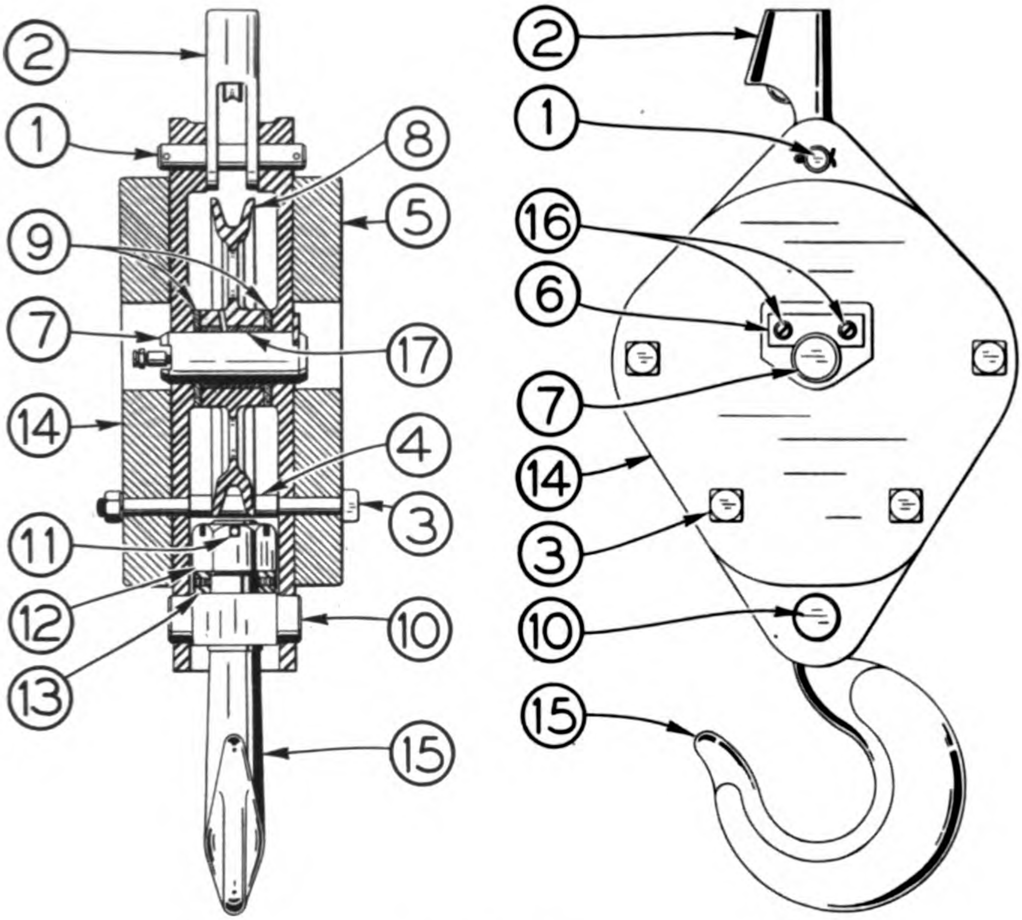


Figure 146

CRANE HOOK

TO REMOVE:

For removal of hook block (two or three part line) see Operation Section, Pages (81) and (82).

TO DISASSEMBLE:

Close and pull cotter of pin (1) and remove pin and rope socket (2). Take out four bolts (3) and remove cheek weights (5) and four pipe spacers (4). Remove capscrews (16); take off keeper plate (6) and pull pin (7). Lift off housing plate (14) being careful not to damage flat washer (9). Straighten and pull locking pin (11); unscrew nut (12) and slip bearing (13) and pin (10) from shank of hook (15).

TO INSPECT:

Examine housing plates (14) and hook (15) for cracks. Cracks in housing plate may be welded and reinforced but if any are found in hook, discard and replace with new one. Check sheave (8), bushing (17), pins (1), (7) and (10) and bearing (13) for wear and renew if necessary. If bushing (17) is renewed see "Dowel Instructions", Page (164). Check grease fitting and renew if damaged.

TO REASSEMBLE:

Slip pin (10) and bearing (13) on shank of hook (15), screw on nut (12) until snug and secure with lock pin (11). CAUTION - Pin (10) must rotate freely on shank of hook (15). Insert bolts (3) in one cheek weight (5) and lay on flat surface with bolts up. Line up holes in one housing plate (14) with bolts in cheek weight and lower into place. Next, enter pins (7) and (10) into holes provided for them in housing plate and slip sheave (8), with one flat washer (9) on each side, on pin (7). Put pipe spacers (4) on bolts and then set second housing plate (14) in place. Secure pin (7) with lock plate (6) and capscrews (16), then set second cheek weight (5) in place and screw nuts on bolts (3) and tighten. Place cable socket (2) in position in hook block, insert pin (1) and secure with cotter.

TO REPLACE:

For replacement of hook block (two or three part line), see instructions on Pages (81) and (82), Operation Section. Be sure to grease well before using.

TAGLINE

TO REMOVE:

Lower boom to a point that will bring tagline into the most convenient position for removal, then set swing, travel and hoist brakes securely. Detach cable (1) from clamshell bucket. Remove "U" bolt (2) and four machine bolts (3) from boom brackets. Pull tagline out of boom, drum end first, and lower it to the ground.

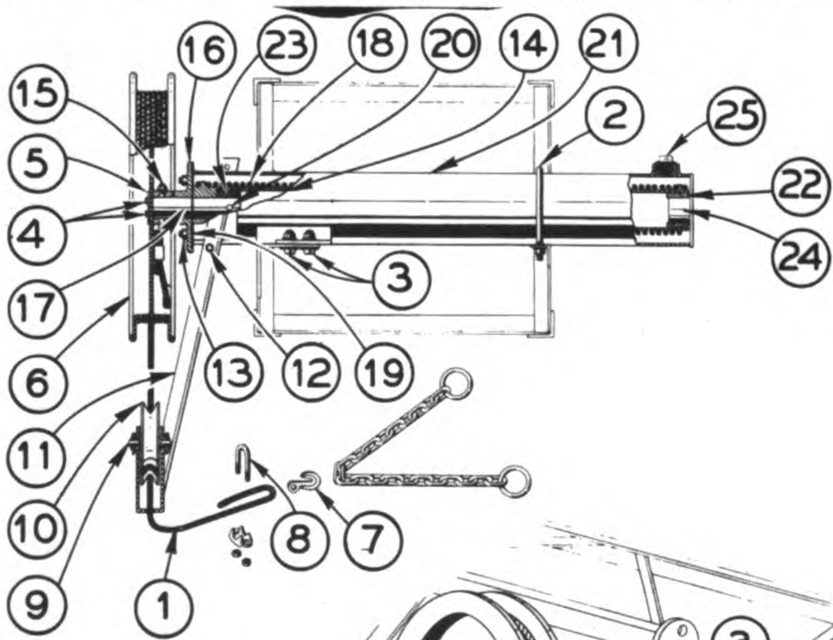


Figure 148

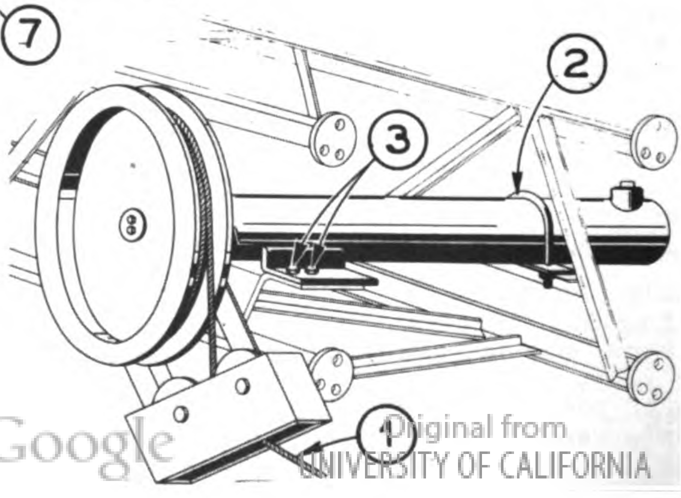


Figure 147

TO DISASSEMBLE:

Take off hook (7) by removing cable clamps (8) and remove cable (1) from drum. Close and pull cotters from pins (9) and remove pins (9) and sheaves (10) from tagline fairlead (11). Remove two capscrews (4), keeper plate (5), bolt (15), and take off drum (6). Next take out two machine bolts (12) and remove fairlead (11). Then remove four nuts (13) and pull off bearing (16), twisting it to the right or clockwise to disengage spring (18) from bearing. Be careful not to damage gasket (19). Remove tube assembly (14) and spring (18) from housing (21) by pulling on shaft (17). Spring (18) now is free to be pulled from tube assembly (14). Shaft (17) is then removed by taking out pin (20). Propeller (22) and bushing (23) may be removed from tube (14) by burning them loose with a cutting torch.

TO INSPECT:

Clean thoroughly and closely examine drum (6), fairlead (11) and housing (21) for cracks and if any are found, repair by welding. Check shaft (17) and bearing (16) for wear and renew if necessary. If hooks at either end of spring (18) are broken, new hooks may be formed by heating and bending spring ends. If spring is broken near center, replace with new one. Examine sheaves (10) and sheave pins (9) for wear and renew if necessary. Check propeller (22) and if propeller lug has broken off, repair by welding and if worn badly, replace.

TO REASSEMBLE:

If bushing (23) and propeller (22) have been removed, place new parts in position in tube (14) and weld. Next place shaft (17) in position in bushing (23); line up holes and secure with pin (20). Slip spring (18) on tube assembly (14), starting it over shaft end and slide spring and tube into housing (21). Make sure that propeller (22) is in place on pilot (24) by removing pipe plug (25) and looking through opening. Mount bearing (16) on shaft (17); line up holes with housing bolts and tighten with nuts (13) after making sure that gasket (19) is in place. Mount fairlead (11) in position on housing and secure with bolts (12). Place sheaves (10) in position in fairlead (11); insert sheave pins (9) and lock into place with cotters. Be sure grease holes and grease fittings are open. Mount drum (6) on shaft (17); line up hole in hub of drum with hole in shaft; insert bolt (15) and tighten. Place keeper plate (5) in position on end of shaft (17); line up holes; insert cap screws (4) and tighten.

TO REPLACE:

Place tagline in position on brackets in boom. Line up holes in tagline bracket with holes in boom bracket; insert four bolts (3) and "U" bolt (2) and tighten. Reeve cable as shown.

CRANE - DRAGLINE - CLAMSHELL - PILE DRIVER BOOM
FIGURES (149), (150), (151) and (152), PAGE 173

TO REMOVE:

For removal of the complete crane boom assembly - which is the same as used for dragline, clamshell and pile driver service - follow instructions on Page (97), Operation Section.

TO DISASSEMBLE:

With boom well supported on cribbing, as shown in Figure (149), Page (173), split boom into two sections by removing bolts (1) at each joint. (NOTE - Cable guard (2) can be taken off separately.)

Crane, Clamshell, Dragline and Pile Driver boom point sheave assembly shown in Figure (150), Page (173), is disassembled by taking out bolts (3), removing cable guard (4), taking out eight bolts (5) and removing guards (6) and (7). Next, take out cotters (8) and remove washer (10) and spacers (11). Slowly drive shaft (9) out of yoke (12), taking off boom suspension sheaves (13), spacers (14), hoisting sheaves (15) and thrust washer (16) as they are freed from the shaft (9). To disassemble boom suspension sheave block assembly, figure 149, close and pull cotter from pin (17); take out pin and remove block assembly from bracket (18). Next close and pull cotter in pin (19); take out pin and remove sheave (20) from housing (21). Remove bolts and take off bracket (18).

To remove boom point yoke (12) and reinforcing pad (22) cut or burn off heads of rivets (23) and punch them out.

TO INSPECT:

Examine babbitted bearings in boom foot and if worn badly, renew. NOTE - When rebabbitting use a shaft of the same diameter as the boom foot pins extending through both holes in the boom foot to locate centers so that boom will be in proper alignment when mounted on the machine.

Check boom foot pins for wear. Check boom carefully for cracks and bent chords (24) or struts (25). Repair cracked members by welding and if there is any question about strength after welding, add a reinforcing member by welding it to the weakened member as shown in Figure (151). The quickest method of straightening bent struts is to use a jack as shown in Figure (152). Blocking must be used with a jack to distribute the straightening loads over several members on the opposite side of the boom. NOTE - Always locate blocking so that load is taken at the ends of struts near the chords rather than at centers between chords. When straightening heavier members such as chords or extremely sharp and angular kinks in lighter members, always apply heat with welding torch to soften steel for straightening. To inspect boom point sheave assembly examine shaft (9), thrust washer (16) and bushings of sheaves (15) and (13) for wear. (See "Dowel Instructions", Page (164).) Note condition of sheave grooves and if sides of groove are worn thin or sharp, renew. Examine boom point yoke (12) closely for cracks and weld any that are found. If yoke is damaged beyond repair, replace. Check boom suspension sheave (20), bushing and pin for wear. If housing (21) or bracket (18) are cracked, repair by welding.

CRANE, CLAMSHELL, DRAGLINE, PILE DRIVER BOOM

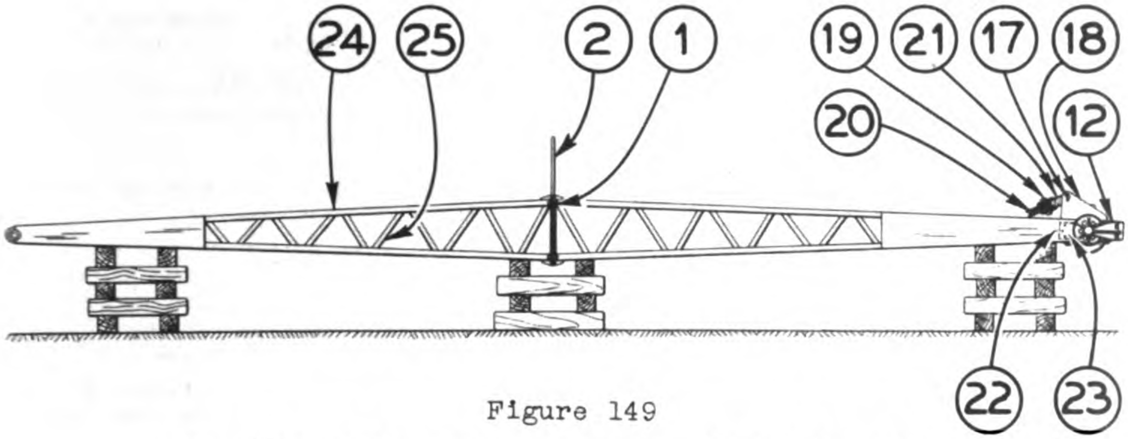


Figure 149

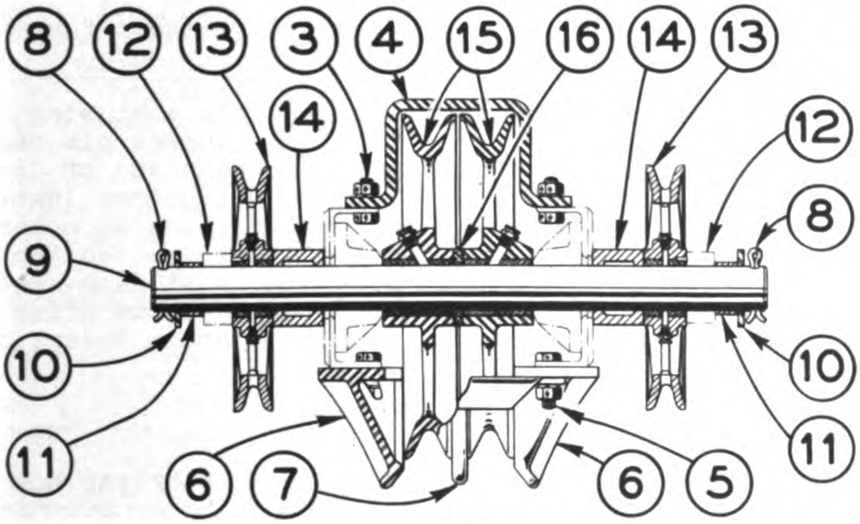


Figure 150

Figure 151

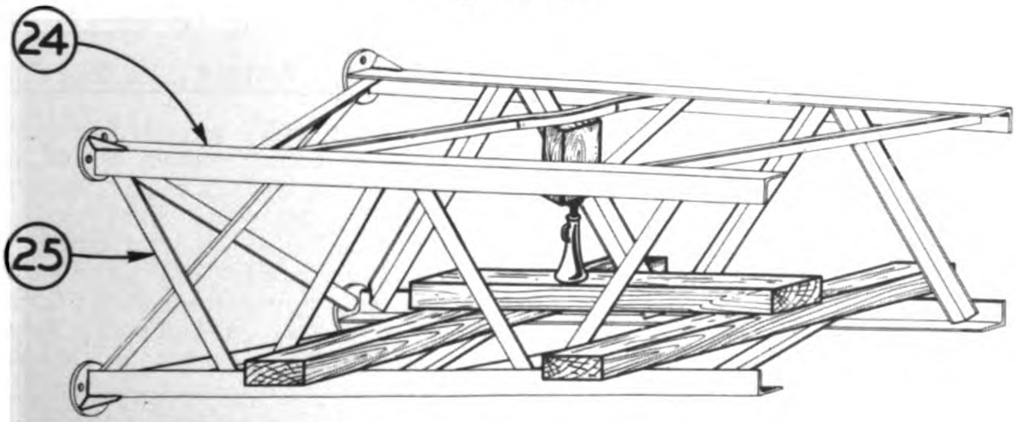


Figure 152

TO REASSEMBLE:

If boom point yoke (12) has been removed for repair place it and the reinforcing pad (22) in position on boom point; line up rivet holes; insert four machine bolts - two on each side - to hold yoke in place for riveting. NOTE - Be sure all holes will take 3/4" rivets. It might be necessary to file or ream some of the holes for fit. Heat rivets to a bright cherry red, insert into holes - one at a time - and rivet. If riveting tools are not available, use a sledge hammer for riveting and another heavy hammer or shaft for bucking up.

Start shaft (9) through boss in yoke (12) and mount sheaves, spacers and thrust washer for crane, clamshell, dragline or pile driver in the order shown in Figure (150), Page (173), replace spacer (11), washers (10) and cotters (8). Mount guard (4) and secure with bolts (3). Place guards (6) into position and line up inside holes of guard with holes in boom point. Insert two bolts in center holes of each guard and tighten. Lift guard (7) into position; line up holes with the end holes of each guard (6); insert four bolts (5) and tighten.

Mount bracket (18) and fasten with bolts. Place housing (21) into position in bracket (18), line up holes; insert pin and lock in place with lock pin and cotter. Be sure bent end of lock pin is entered into hole provided for it in bracket before inserting and opening cotter. Place sheave into housing; line up holes; insert pin and secure with lock pin and cotter. Place sections of boom into position; line up holes in butt plates of each section; insert bolts (1) and tighten. Mount cable guard on the sides of boom; line up holes with side holes in butt plate; insert bolts and tighten.

TO REPLACE:

To replace crane, clamshell, dragline or pile driver boom see instructions on Page (97), Operation Section.

DRAGLINE FAIRLEAD
Figures 153 and 154

NOTE - Because of the weight of the dragline fairlead it can be disassembled more conveniently by suspending it at a suitable height with the drag cable as shown in Figure (154), Page (176).

TO REMOVE:

Remove bolts (1) and allow fairlead to roll down on drag cable to desired height from the ground.

TO DISASSEMBLE FAIRLEAD:

Remove plug (2) from opening at top of base (3), then tip base enough to allow the removal of balls (4) through opening. After balls have been removed, pull frame (5) out of base (3) slightly and remove rollers (6). CAUTION - Do not lose balls or rollers. The correct number - 22 balls and 31 rollers - will be needed for reassembly. Fairlead may now be lowered to the ground for more convenient disassembly. Detach drag cable (7) from cable socket (8) and remove cable from fairlead. Take out capscrews (9) and remove bushings (10). Next drive out sheave pins (11) and remove sheaves (12). Take out cap screws (13) and remove caps (14) and roller assemblies (15).

TO DISASSEMBLE ROLLER ASSEMBLIES:

Remove gease fitting (16); bend down lock plate (17) then take out grease studs (18), lock plate (17), washer (19), shims (20) and spacer (21). Pull shaft (22) out of roller tube (23). To remove grease retainer (24), bearing (25) and grease seals (26), drive them out with a small shaft. NOTE - When driving out bearings, retainers and seals, shaft should be inserted into one end of the tube to drive parts from the opposite end. Tap driving shaft just hard enough to release parts for removal. BE CAREFUL NOT TO BEND RETAINERS.

TO INSPECT ROLLER ASSEMBLIES:

Check roller tubes (23) for wear and shafts (22) for alignment. If shafts are bent, replace. Check grease seals for damage or wear and replace if necessary. Bearings (25) should be checked for wear and chipped or cracked rollers. Retainers (24) might have been bent in removal and if unable to straighten, replace.

TO REASSEMBLE ROLLER ASSEMBLIES:

Insert retainers (24) in tubes (23) - one retainer in each tube - then start outer races of bearings (25), large diameters of beveled surfaces up, and tap into place on tops of retainers (24). Place bearings (25) into position in outer races and start grease seals (26) into tubes, tapping them down into place with a hammer. Insert shafts (22) into roller tubes being sure that shoulders at ends of shafts enter grease shields (26). Next place, at the other ends of the shafts, retainers (24), bearings (25) and grease shields (26) in the tubes. Next slip spacers (21) over shafts and into

DRAGLINE FAIRLEAD

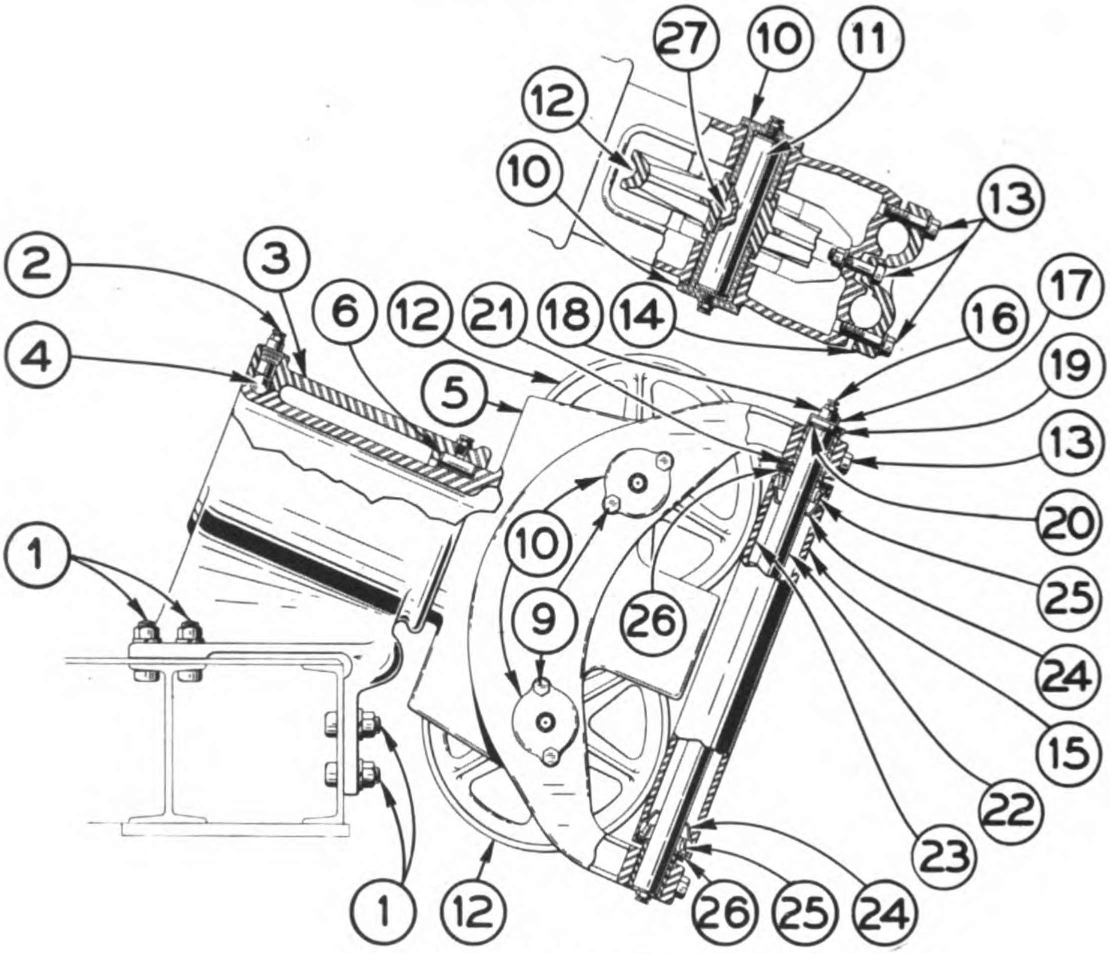


Figure 153

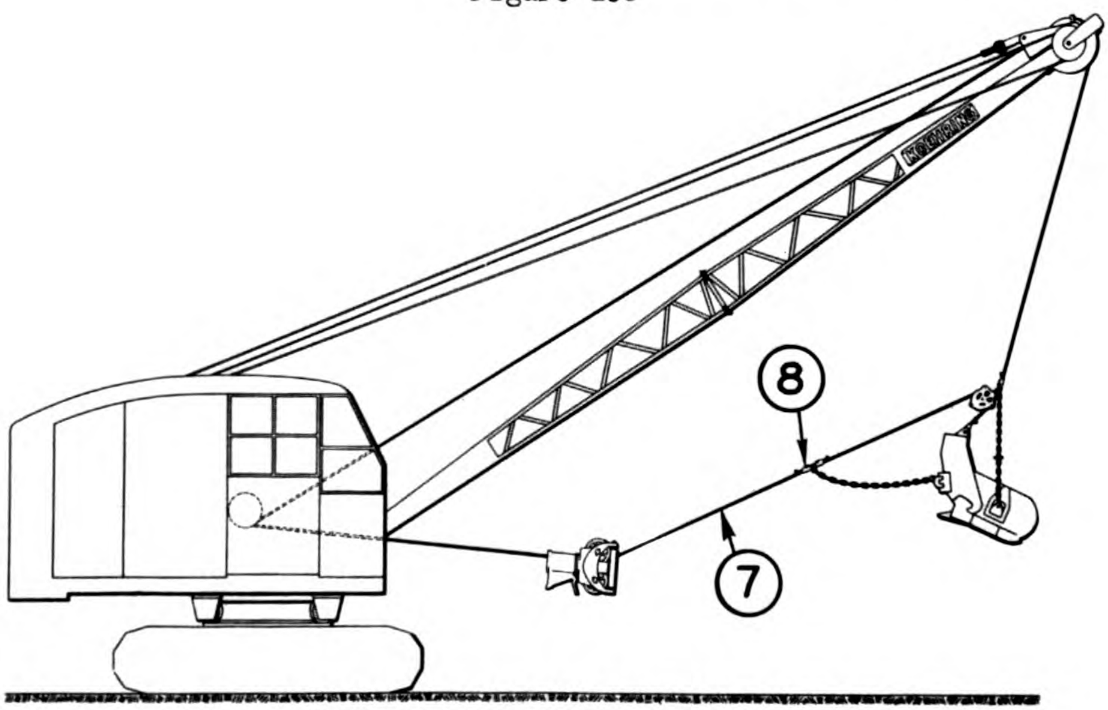


Figure 154

grease seals, then place shims (20), keeper plate (19) and lock plates (17) into position and tighten with grease studs (18). Now test roller assemblies and if they revolve freely on shafts, with no end play, they are in proper adjustment. If adjustment is necessary, add more shims (20) if rollers are tight on shafts or take out shims if rollers have end play or are too loose on shafts. Next bend up lock plates (17).

TO INSPECT FAIRLEAD:

Check bushings (10), pins (11) and sheaves (12) for wear. If fairlead base (3) or frame (5) is cracked, repair by welding or, if damaged beyond repair, discard and install new parts. If rollers (6) or balls (4) are worn or chipped, replace. Check all grease fittings to be sure they are open and replace all that are damaged.

TO ASSEMBLE FAIRLEAD:

Mount roller assemblies on fairlead frame (5), line up holes and secure with caps (14) and capscrews (13). Tap keys (27) into place in sheave pins (11) and then, after positioning sheaves (12) in fairlead frame, insert pins, making sure that keys (27) line up with keyways in sheaves before tapping them in. Place bushings (10) in position on sheave pins (11) and secure to fairlead frame with capscrews (9). Next place rollers (6) in groove of fairlead frame hub and tie with wire to temporarily hold them in position while slipping the hub of frame into fairlead base. Remove temporary tie wire when rollers start into base. Next drop balls (4) into opening in fairlead base, then close opening by screwing in plug (2).

TO REPLACE FAIRLEAD:

Thread free end of drag cable through fairlead and attach cable to dragline bucket; hoist bucket until drag cable is high enough to permit sliding fairlead into position; line up holes in base of fairlead with holes in turntable; insert bolts (1) and tighten. Be sure fairlead is well greased before using.

SHOVEL ATTACHMENT

NOTE - Before removal of dipper for repairs, it is more convenient to disassemble dipper while attached to dipper sticks. Lower dipper to the ground so that it rests on the dipper latch keeper with teeth about 2 feet from the ground, then proceed as follows:

DIPPER TEETH

TO REMOVE:

Close and pull out cotter (1). Insert wedge as shown in inset ("A") (Figure 155) and drive with sledge hammer until tooth is released from socket. Pull out tooth and remove wedge.

TO INSPECT:

Check for wear. If dull or not worn more than 2" from original length, sharpen by heating and drawing. If worn more than 2", rebuild by welding or renew.

TO REPLACE:

Insert tooth in socket and drive down with sledge hammer until cotter can be inserted in hole.

NOTE - Koehring dipper teeth are reversible and if only slightly worn, they may be taken out, turned and replaced to bring cutting edge to bottom side.

DIPPER FRONT (Figure 155)

The dipper front is of one piece and all manganese. Replacement of the front due to wear is rarely necessary. Accidents or abuse might cause cracks which will necessitate replacement.

TO REMOVE:

Remove teeth as described under "Dipper Teeth". Next burn or cut off all rivets (2) and remove front.

TO REPLACE:

Line up holes of dipper front with holes in dipper side and rivet. Install teeth as described under "Dipper Teeth".

DIPPER LATCH (Inset "B") (Figure 155)

TO REMOVE:

Detach chain (3) from lever (4). Remove bolts (5) and (6), take off lever (4) and lift out latch bar (7). Remove adjusting bolt (10) by unscrewing nuts (8) and (9).

TO INSPECT:

Check all bolts and holes for wear. If latch bar shows extreme wear at latch end, build up by welding and grind smooth to prevent bar from sticking in latch keeper at bottom of dipper front.

TO REPLACE:

Place latch bar (7) through members (24) and (11). Replace adjusting bolt (10) leaving nuts (8) and (9) loose (for adjustment after assembly). Position lever (4). Insert bolts (5) and (6), tighten them and lock with cotters. Attach chain and adjust as described under "Operating Adjustments", Page 102.

SHOVEL ATTACHMENT

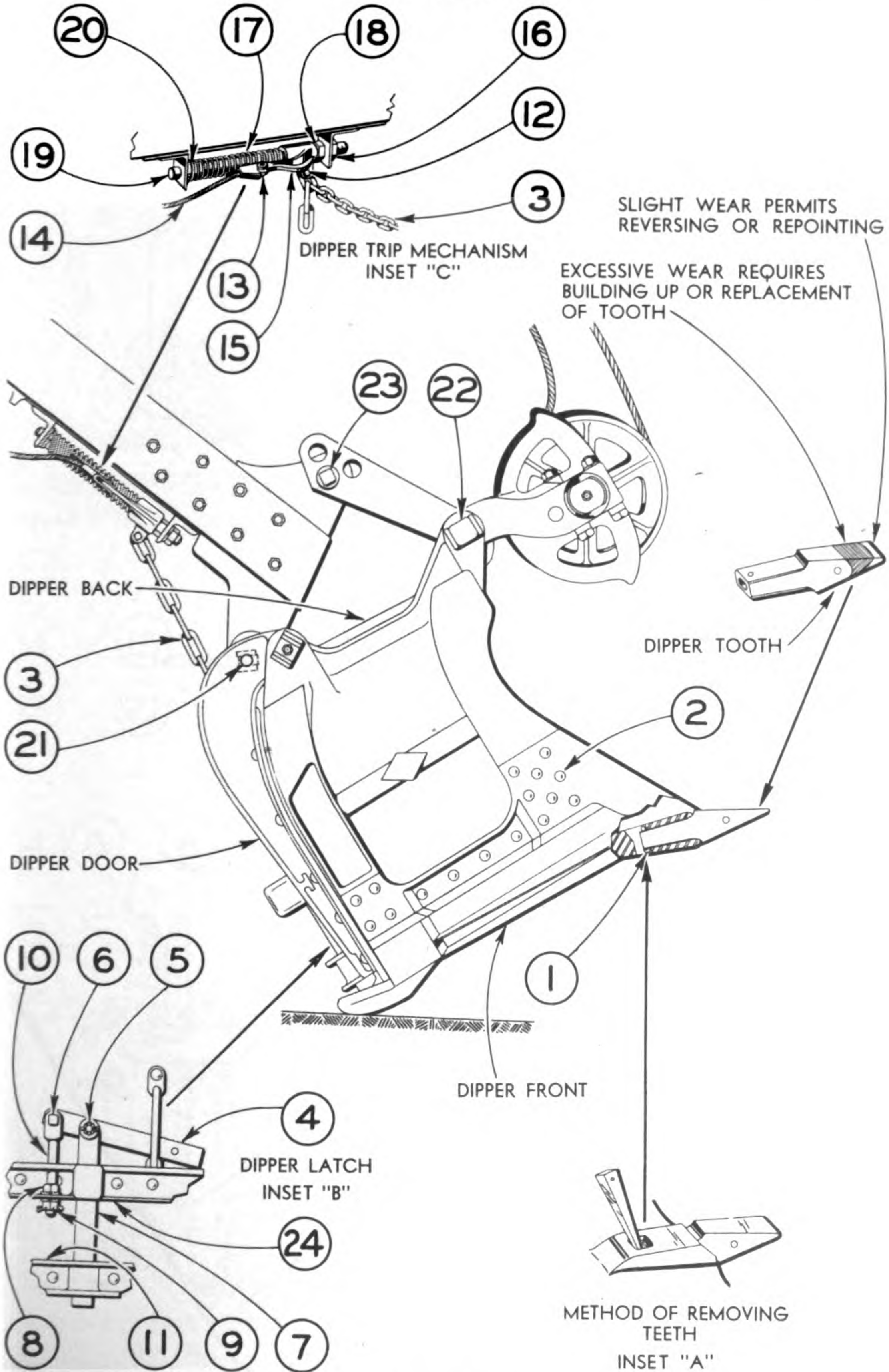


Figure 155

SHOVEL ATTACHMENT

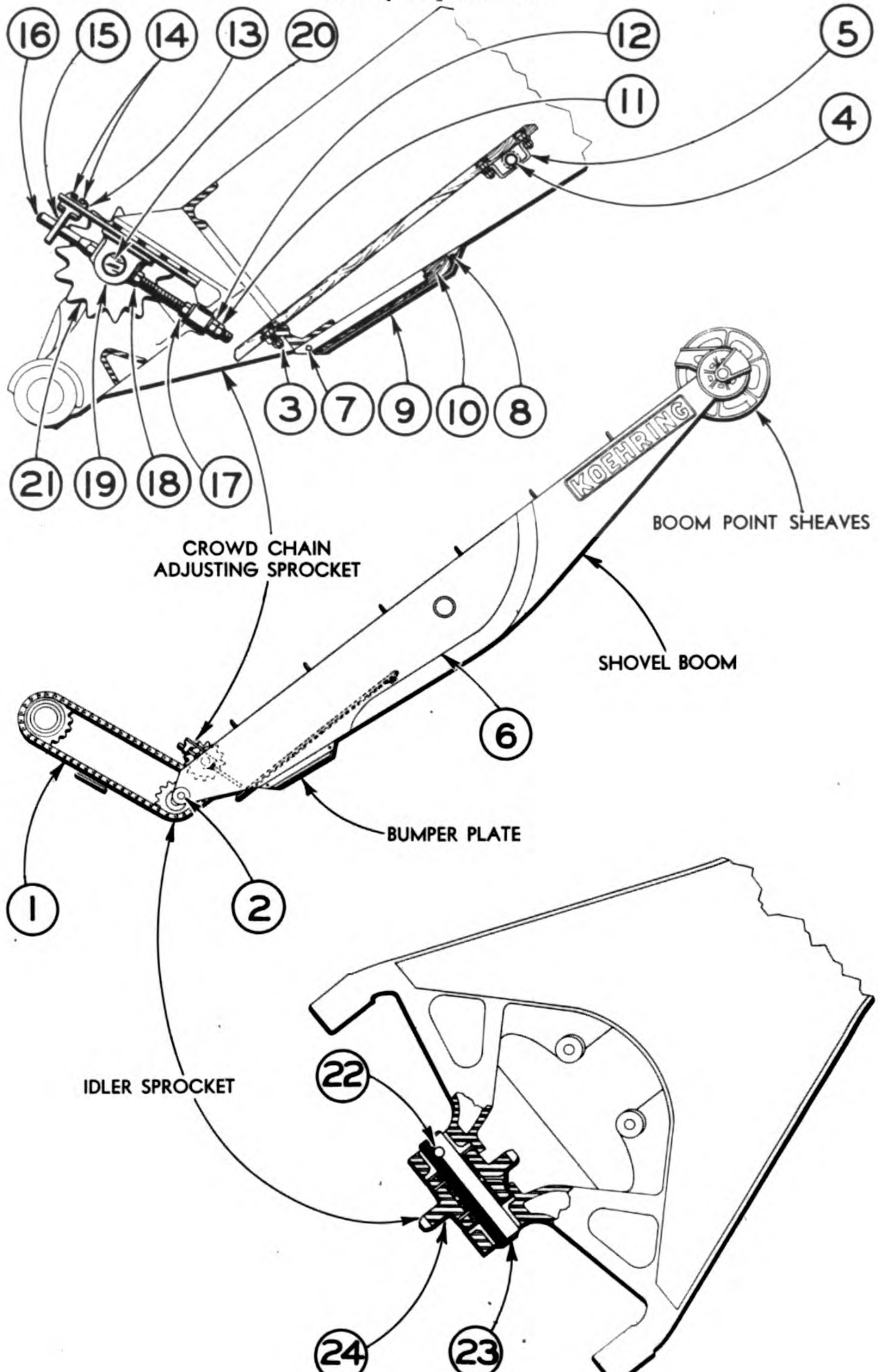


Figure 156

SHOVEL ATTACHMENT

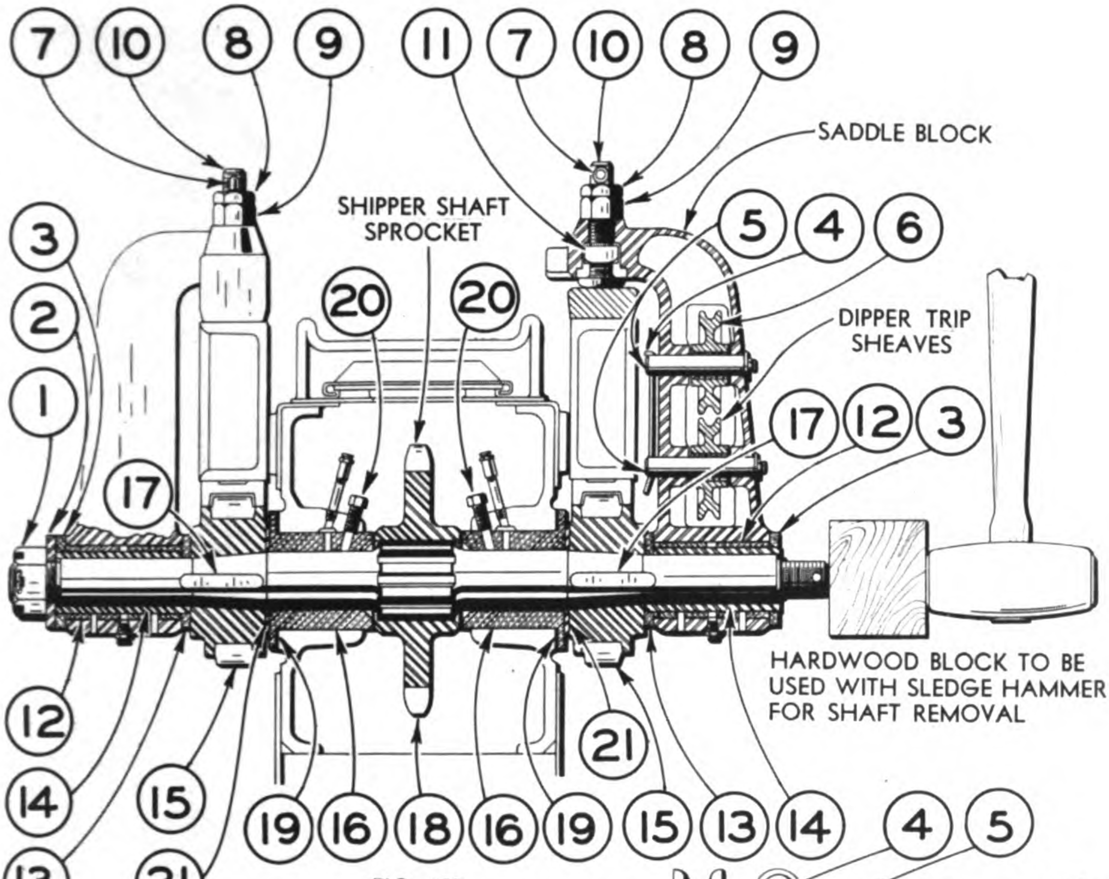
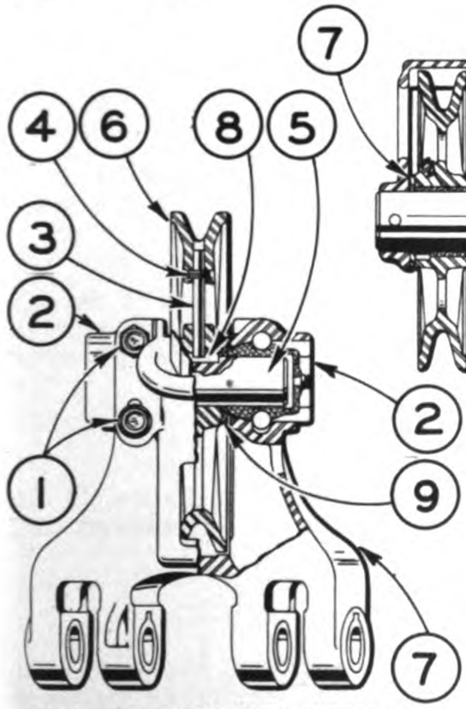
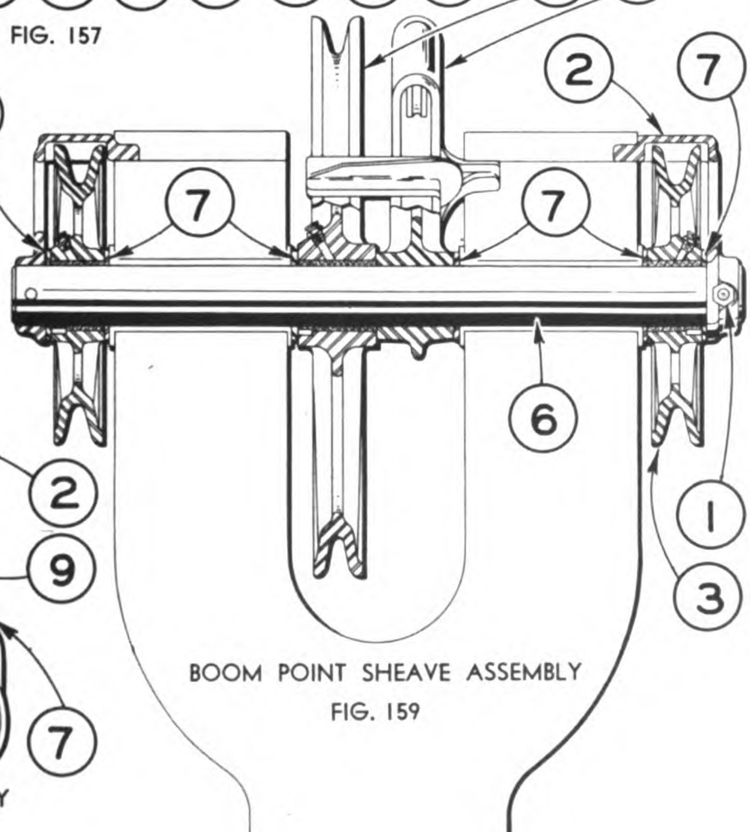


FIG. 157



PADLOCK SHEAVE ASSEMBLY
FIG. 158



BOOM POINT SHEAVE ASSEMBLY
FIG. 159

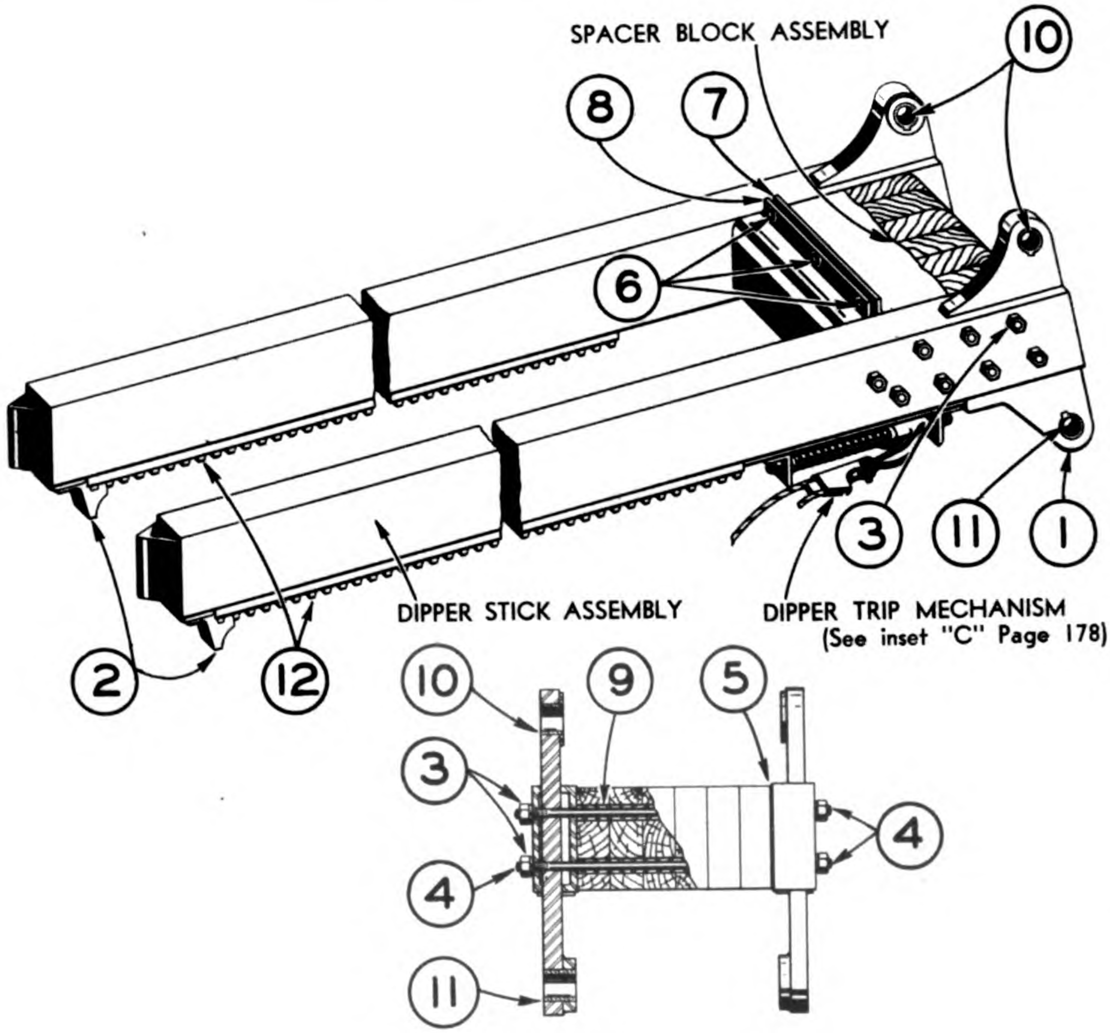


Figure 160

DIPPER TRIP MECHANISM (See Inset "C"), Page (179).

TO REMOVE:

Remove bolt (12) and detach chain (3). Remove bolt (13) and detach trip cable (14) from plunger (15). Remove nut (16) and compress spring (17) enough to allow removal of nut (18). Remove plunger rod (19), plunger (15), spring (17) and washer (20).

TO INSPECT:

Inspect plunger rod and plunger for wear or damage. Renew if in bad condition. Inspect spring for compression or breakage and replace if required.

TO REPLACE:

Insert washer (20) into one end of spring (17) and plunger (15) into other end. Place washer, plunger and spring assembly between brackets on the sticks and line up the holes. Insert plunger rod (19), then compress spring (17) enough so that nut (18) can be screwed on plunger rod (19) approximately 2". Place threaded end of plunger rod (19) through bracket and fasten with nut (16).

DIPPER DOOR (See Figure 155, Page 179).

TO REMOVE:
Place dipper on ground so that it is flat on its front. Detach chain (3) at latch lever (4). Close and pull cotters from door hinge pins and remove pins. Step to one side for safety, then with pinch bar placed between hinge and dipper back, pry door out and let it fall to ground.

TO INSPECT:
Check hinge bushings for wear and replace if necessary. Check door for distortion and cracks around hinges and reinforcing members. If bent, heat and straighten with sledge hammer. If cracked, repair by welding.

TO REPLACE:
With the assistance of a helper, place front of door on latch keeper, then raise door and insert hinges into hinge bosses, line up holes, insert hinge pins, insert cotters and open.

DIPPER BACK (See Figure 155, Page 179).

TO REMOVE:
Close and pull cotters on stick foot pins (21) and remove pins. Remove pins (22). Using pins (22) for the purpose, connect dipper sheave block to adjusting links, then hoist sticks clear of bucket.

TO INSPECT:
Check all bushings and pins for wear. Examine dipper back for cracks and weld any that appear.

TO REPLACE:
Lower sticks into position; line up holes in stick foot with holes in bottom bosses of dipper back; insert stick foot pins; insert cotters and open. Allow enough slack in hoist line to lower adjusting links to position; remove pins (22) releasing adjusting links from dipper sheave block and drop adjusting links into place; line up holes, insert pins, insert cotters and open.

DIPPER ADJUSTING LINKS (See Figure 155, Page 179).

TO REMOVE:
With dipper resting on the ground on its front, remove adjusting link bolts (23) and spacers. Remove sheave block pins (22). Lift adjusting links off.

TO INSPECT:
Check all holes, bolts, spacers and pins for wear and if badly worn, replace.

TO REPLACE:
Replace adjusting links; line up all holes and insert bolts, spacers and pins.

DIPPER SHEAVE BLOCK (See Figure 158, Page 181).

TO REMOVE:
Lower dipper to ground so that it rests on its front. Remove dipper sheave block pins (22) Figure 155. Swing block clear of bucket and lower to ground. Next remove 4 bolts (1) and take out journals (2). Remove cotter from pin (3) and pull pin, being careful not to lose washers (4). Shaft (5) can now be removed and sheave (6) and washers (9) can be lifted from block (7). Remove key (8) from shaft.

TO INSPECT:
Check journals, shaft, bushings and sheave groove for wear. If journals show wear on one side, they can be reversed. If sheave shows excessive wear in groove or groove wedges are worn sharp, replace. If shaft is worn excessively or scored, replace.

TO REPLACE:
Place sheave and washers into position (with hoist cable in groove) in sheave block, line up hole with holes in block and insert shaft (5). NOTE - Replace key (8) in keyway with hole side up so that hole in key will line up with hole in sheave for pin (3). Insert pin (3) through hole in sheave until it is seated in key (8); insert cotter in pin and open. Using hoist cable, lift sheave block into place on dipper, line up holes and insert pins (22) Figure 155.

DIPPER STICKS (See Figure 160, Page 190)

TO REMOVE:
(Complete dipper stick assembly, less dipper trip mechanism). For removal of Dipper Trip Mechanism, see Page (182). Lower dipper to ground so that it is flat on its front. Remove dipper as described under "Dipper Back", Page (183), making sure that dipper trip chain is disconnected as described under "Dipper Trip Mechanism", Page (182). Lower sticks so that bosses (1) rest on timbers or other suitable blocking. Release crowd brake and back machine until shipper shaft pinions are within approximately 2" from the stops (2) at the end of the sticks. Next release saddle blocks as described under "Saddle Blocks", Page (186) so that saddle blocks can be swung clear of sticks, being careful to remove saddle block gibs before pushing saddle blocks clear of sticks. Next remove padlock sheave from lower end of sticks. Remove dipper adjusting links as described under "Dipper Adjusting Links", Page (183). Using old cable or chain for a sling which should be placed around the sticks about two feet away from the under side of the boom, attach sheave block to sling. IMPORTANT - To avoid distortion of sticks, place a timber 15-3/8" long between the sticks at point where sling is placed. Hoist sticks far enough to pull rack teeth out of mesh with the shipper shaft pinions; back machine far enough to clear sticks from shipper shaft pinions then lower sticks to blocking on the ground. Remove sling and either swing boom to clear sticks or back machine away.

TO DISASSEMBLE:
Remove eight nuts (3) and drive out eight tie bolts (4). Dipper stick spacer block assembly is now free and can be removed. Do not bend shims (5) between spacer blocks and sticks.

TO DISASSEMBLE SPACER BLOCK ASSEMBLY:
Remove six bolts (6) and take off cover plate (7) and (8). Drive out eight pipe spacers (9).

TO INSPECT SPACER BLOCK ASSEMBLY:
Examine blocking for decay or damage. Replace if necessary. Cover plates may be damaged. If distorted straighten.

TO REASSEMBLE SPACER BLOCK ASSEMBLY:
Line up holes in spacer blocks. Insert eight pipe spacers (9) and drive them through until ends are flush with blocking. Place spacer block cover plates (7) and (8) over blocking, line up holes and insert six bolts (6) and tighten.

TO INSPECT:
(Dipper sticks less dipper trip mechanism and spacer block assembly). Thoroughly clean sticks by washing them with cleaning fluid and examine closely for cracks. Repair cracks by welding. Check stops (2) for wear or breakage. Check bushings (10) and (11) for wear. Check racking (12) for wear or damage. Worn or damaged segments of racking are renewed by burning off old segments and welding on new. CAUTION - Before replacing rack segments be sure all irregularities on the rack surface of sticks are chipped and ground to a smooth surface. Be sure new racking is properly lined up with old racking and that it is securely clamped before welding.

TO REASSEMBLE:
Line up the eight bolt holes in the dipper sticks with the holes in the spacer block assembly and insert tie bolts (4). Replace nuts on bolts and tighten. IMPORTANT-.The inside dimension between dipper sticks must be held at 15-3/8" so that bosses (1) on dipper sticks line up properly with bosses on dipper back. Special shims (5) are provided to reduce or increase the dimension between sticks as required to obtain 15-3/8".

TO REPLACE: (Complete dipper stick assembly).
Attach sling of old cable or chain around sticks approximately 5 feet from the stops (2). IMPORTANT- To prevent distortion of sticks insert a timber 15-3/8" long between the sticks at point where sling is placed. Hoist sticks high enough to clear shipper shaft pinions. With sticks placed so that boom will enter opening between sticks move machine toward sticks to a point where sticks may be lowered into position and the racking properly meshed with shipper shaft pinions as described on Page (100), Operation Section. Detach dipper sheave block and remove sling. Swing saddle blocks into place and adjust as described under "Saddle Blocks", Page (101), Operation Section.

NOTE - For replacement of dipper, see description under "Dipper Back," Page (183).

SHOVEL BOOM (Less Dipper sticks) (Figure 156)

NOTE- For removal of dipper sticks, see description on Page (184).

TO REMOVE:
Lower boom to cribbing, (example on Page 97), Operation Section. Remove cable. Split upper part of crowd chain (1) by removing chain pin midway between boom foot and crowd drum. Chain may now be removed with power by engaging the crowd clutch and crowding out and at the same time guiding the chain so that it lies flat on top of the boom. Remove boom foot pin bolts and pull out boom foot pins (2). Back machine away from boom.

CROWD CHAIN GUIDE (Figure 156)

TO REMOVE:
Remove bolt (3). Remove lock plate pin (4). Chain guide is free and can be pulled out through opening at foot of boom. Remove lock plate (5) from chain guide.

TO INSPECT:
If chain guide is deeply grooved or cracked, replace. Check lock plate for wear.

TO REPLACE:
Attach lock plate to chain guide and slide guide into position in the boom, lining up lock plate opening with holes in boom. Insert lock plate pin, attach nut to each end and tighten, being sure that ends do not extend beyond the thickness of the wearing plate (6). Insert and tighten bolt (3) at foot of boom.

BUMPER PLATE (Figure 156).

TO REMOVE:
Remove bolts (7) and (8) and take off bumper plate (9) and block (10).

TO INSPECT:
Examine bumper plate for distortion or damage. If bent, straighten with sledge hammer; if badly damaged or block is cracked, replace.

TO REPLACE:
Lift bumper plate and bumper plate block into place; line up holes with holes in boom; insert and tighten bolts.

SHIPPER SHAFT ASSEMBLY (Figure 157).

SADDLE BLOCKS

TO REMOVE:
Remove cotter and take off nuts (1) with special wrench and hammer. Take off washer (2) and thrust washer (3). Saddle block is now free but requires two men to remove because of weight. Place saddle block on ground.

TO DISASSEMBLE:
Remove lock pin (4) then pull out sheave pins (5). Sheaves (6) can now be removed. Remove lock pin (7). Next remove lock nut (8) and nut (9), then bolt (10) can be removed.

TO INSPECT:
Wash all parts thoroughly with cleaning fluid and check all parts for wear. If sheaves, sheave bushings or sheave pins are badly worn, replace. If head of adjusting bolt (10) is badly worn or threads of the bolt or of nuts (8), (9) and (11) are damaged, replace. If saddle block bushings (12) or thrust washers (3) and (13) are badly worn or scored, replace.

TO REASSEMBLE:
Screw nuts (11) down to head of bolts (10) with flat surfaces of nuts away from head of bolts. Insert adjusting bolts into place so that flat sides of nuts (11) contact flat surfaces in saddle block recesses. Then secure adjusting bolts with adjusting nuts (9) and (8) and when sticks are in place adjust as described under "Saddle Block Adjustment", Page (101), Operation Section. Place sheaves (6) in saddle block and line up sheave bores with holes in saddle blocks; insert pins (5) and lock with lock pin (4).

SHIPPER SHAFT

TO REMOVE:
Remove sleeve (14) and thrust washer (13). Drive metal wedges between pinion (15) and flange bushing (16). Place hardwood block at end of shipper shaft as shown in Figure (157), and

drive shaft with sledge hammer until pinion (15) is released. CAUTION - Do not strike shaft after pinion (15) is released as it might cause damage to flange bushing (16) by key (17). Remove pinion (15) and with hammer and chisel, remove key (17) from shaft. Use same procedure at other end of shaft to remove opposite pinion. Remove set screws (20). Place hardwood block against end of shaft and drive with sledge hammer until flange bushing (16) on opposite side of sprocket (18) has been driven from its retainer. Use same procedure at other end of shaft to drive out opposite bushing. NOTE- Be careful not to lose or damage shims (19). Remove shipper shaft. Sprocket (18) being free on shaft will come off inside the boom and can be removed through inspection opening.

TO INSPECT:
Check sleeves (14), all thrust washers and flange bushings (16) for wear or scoring and replace if necessary. Check pinions (15) for cracks, or bent or worn teeth and replace if necessary. Check sprocket (18) for tooth wear or for cracks. If teeth are worn too badly for rebuilding, replace sprocket.

TO REPLACE:
Place sprocket (18) in boom through inspection hole; line up sprocket bore with shipper shaft holes in boom and insert shaft from either end until splines on shaft are fully meshed with splines in sprocket. Replace shims (19) on flange bushing (16) and fit bushing over end of shaft, then start it toward sprocket (18) through hole in boom and drive it in by bumping until flange of bushing fits tight all the way around against machined surface on boom. Follow same procedure to replace opposite flange bushing. Place steel washers (21) on shaft against flange bushing. Insert keys in keyways, tapping them down until they are fully seated. Be sure surfaces of keys are smooth - using a file for the purpose if necessary - before replacing pinions (15). Replace pinions on shaft - lining up keyway with key - with large end of tapered bore in pinions toward boom. Place thrust washer (13) on shaft, making sure that slot in washer fits over key (17). Slide sleeves (14) on shaft. Next replace saddle blocks; thrust washer (3); flat washers (2), then replace nuts (1) and tighten, using special wrench provided for the purpose and which can be hammered to get maximum tightness.

NOTE - After mounting dipper sticks as described on Page (185), saddle blocks are adjusted as described under "Saddle Blocks", Page (101), Operation Section.

BOOM POINT SHEAVES (See Figure 159, Page 181).

TO REMOVE:
With boom lowered on cribbing and cables slack, remove bolts (1); take off guards (2) and boom suspension sheaves (3). Drive out shaft (6) which releases sheaves (4) and (5). Take out sheaves. IMPORTANT - Note positions of flat washers (7) and be sure these are replaced as shown when replacing sheaves.

TO INSPECT:
Check bushings and shaft for wear and replace if worn. Check sheave (4) particularly for wear in groove and if edges are thin or groove is worn deeply, replace. Sheaves (3) get very little use in shovel work and seldom if ever need replacement. This is also true of dummy sheave (5) which is used only as cable anchor. Check grease fittings in each sheave to be sure they are open.

TO REPLACE:
Place sheaves (4) and (5) in position, line up sheave bores with bores in boom point and insert shaft (6), placing flat washers (7) on shaft. Place boom suspension sheaves (3) on each end of shaft; place guards (2) in position and insert bolts (1).

CROWD CHAIN ADJUSTING SPROCKET (See Figure 156, Page 180).

TO REMOVE:
Remove nuts (11) and (12). Bend lock plate (13) down so that capscrews (14) can be removed. Slide guides (15) off bolt (16). Sprocket assembly can then be lifted off and placed on ground. Then remove nuts (17) and (18) from bolts (16). Bolts can now be taken out of bearing blocks (19) and then bearing blocks can be removed. Next slide shaft (20) out of sprocket (21).

TO INSPECT:
Check sprocket bushing and if badly worn or scored, replace by pressing or driving bushing out of sprocket and press or drive new one in. If sprocket teeth are worn beyond rebuilding, replace. Inspect sprocket grease fitting to be sure it is open.
NOTE - See instructions on Pages 162 and 164 if new bushing is to be installed. If threads on bolts (16) are badly worn or damaged, replace bolts and if bolts are bent, they must be straightened. Inspect bearing blocks (19) for wear.

TO REPLACE:
Insert shaft (20) through bushing which is pressed into sprocket (21) and mount bearing blocks (19) on shaft, lining up bolt holes in bearing blocks with bolt holes in shaft (20). Insert bolts (16) and fasten with nuts (18) which should be screwed tight against bearing blocks. Screw nuts (17) to within approximately 2" of nuts (18). Lift assembly to position where the threaded ends of bolts (16) can be inserted into bolt holes in boom foot. Slide guides (15) on plain ends of bolts (16); line up guide holes with holes in foot casting; place lock plates (13) over holes; insert capscrews (14); tighten and lock capscrews by bending ends of lock plates up against capscrew heads. Screw nuts (11) and (12) on ends of bolts (16). Proceed with adjustment as described under "Crowd Chain Adjustment", Page 102, Operation Section.

STATIONARY IDLER SPROCKET (See Figure 156, Page 180).

TO REMOVE:
Remove pin (22) and drive out shaft (23), being careful not to drop sprocket (24).

TO INSPECT:
Check sprocket for wear and if teeth are beyond rebuilding, replace with a new one. Check sprocket bushing and if worn, press out and replace, being sure to line grease holes. Check grease fitting to be sure it is open. Check shaft for wear.

TO REPLACE:
Lift sprocket into position, line up bore with holes in boom foot and push in shaft. Insert pin and secure with cotter.

NOTE - To replace completely assembled shovel attachment, follow instructions on page (98), Operation Section. Stripped shovel boom, mounted on cribbing, may be attached in the same manner.

PULL SHOVEL ATTACHMENT

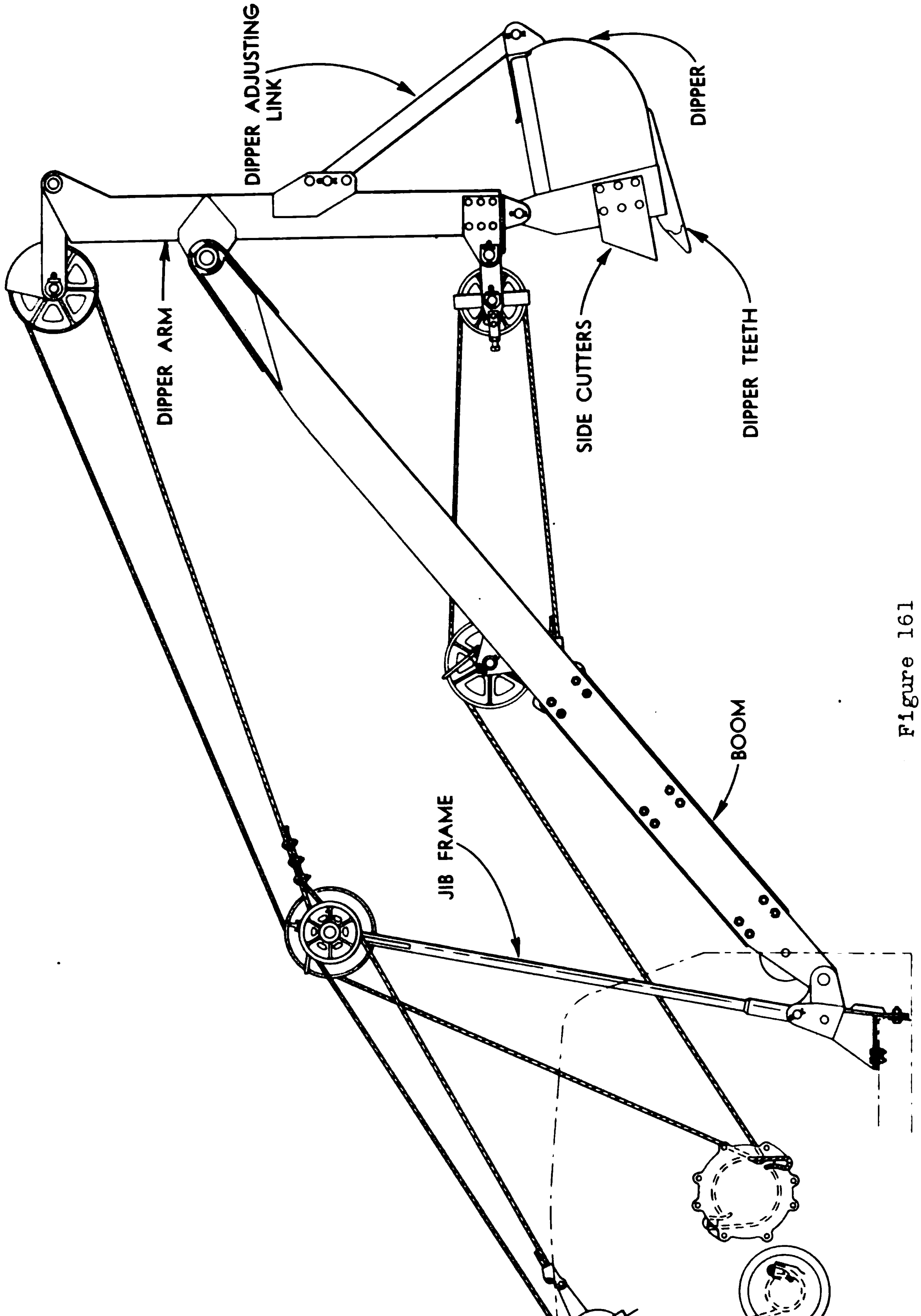


Figure 161

PULL SHOVEL ATTACHMENT

PULL SHOVEL DIPPER (See Figure 162, Page 191).

TO REMOVE:

Lower dipper until it rests flat on its bottom on the ground. Close and pull cotters in pin (7) and swing adjusting link (6) to the ground. Close and pull cotters in pin (5) and remove pin, detaching adjusting link from dipper. Close and pull cotters from pins (1) and hoist dipper arm clear of bucket.

TO DISASSEMBLE:

Remove six bolts (8) from each side cutter (2) and take off side cutters. Thread a cable through one pin hole in dipper and one pin hole in dipper arm and securely clamp ends of cable. Now raise dipper until it rests on its side. Remove cable and swing attachment clear of dipper. Close split end of wedges (9) and drive wedges out. Remove tooth points (3).

TO INSPECT:

Check adjusting link (6) for wear in pin holes. If link is bent it must be straightened. Check all pins for wear. Check side cutters (2) for wear on cutting edges. To sharpen side cutters, heat and reshape. If tooth points (3) are slightly worn, reverse; if worn beyond rebuilding, replace. If tooth bases (10) show excessive wear they should be replaced, making sure all rivets (11) are tight. If wearing plates (4) are excessively worn, they must be removed and new plates installed by welding.

TO ASSEMBLE:

Insert tooth points (3) in bases (10); drive in wedges (9) and open. Lower dipper arm until it contacts top side of dipper, then swing dipper arm against dipper and push dipper over so that it rests on its bottom or tooth base side. Place side cutters (2) into position, line up holes, insert bolts (8) and tighten. Lower dipper arm into position on dipper, line up holes, insert pins (1), insert cotters and open. Place one end of adjusting link (6) into position on dipper, line up adjusting link hole with holes in dipper boss, insert pin (5), insert cotter and open. Swing adjusting link (6) into position on dipper arm, line up hole in adjusting link with proper holes in dipper arm; insert pin (7); insert cotter and open. (See Pull Shovel Dipper Angle Adjustment, Page 107, Operation Section.)

PULL SHOVEL ARM (Less Dipper) (See Figure 163, Page 192).

NOTE - For removal, disassembly, inspection, reassembly and replacement of pull shovel dipper, see "Pull Shovel Dipper."

TO REMOVE:

Pull dipper arm in close to boom. Lower boom until arm rests on blocking as shown in Figure (163), Page (192). Drive wedge from wedge socket (1) and remove cable (2), pulling cable clear of

PULL SHOVEL ATTACHMENT

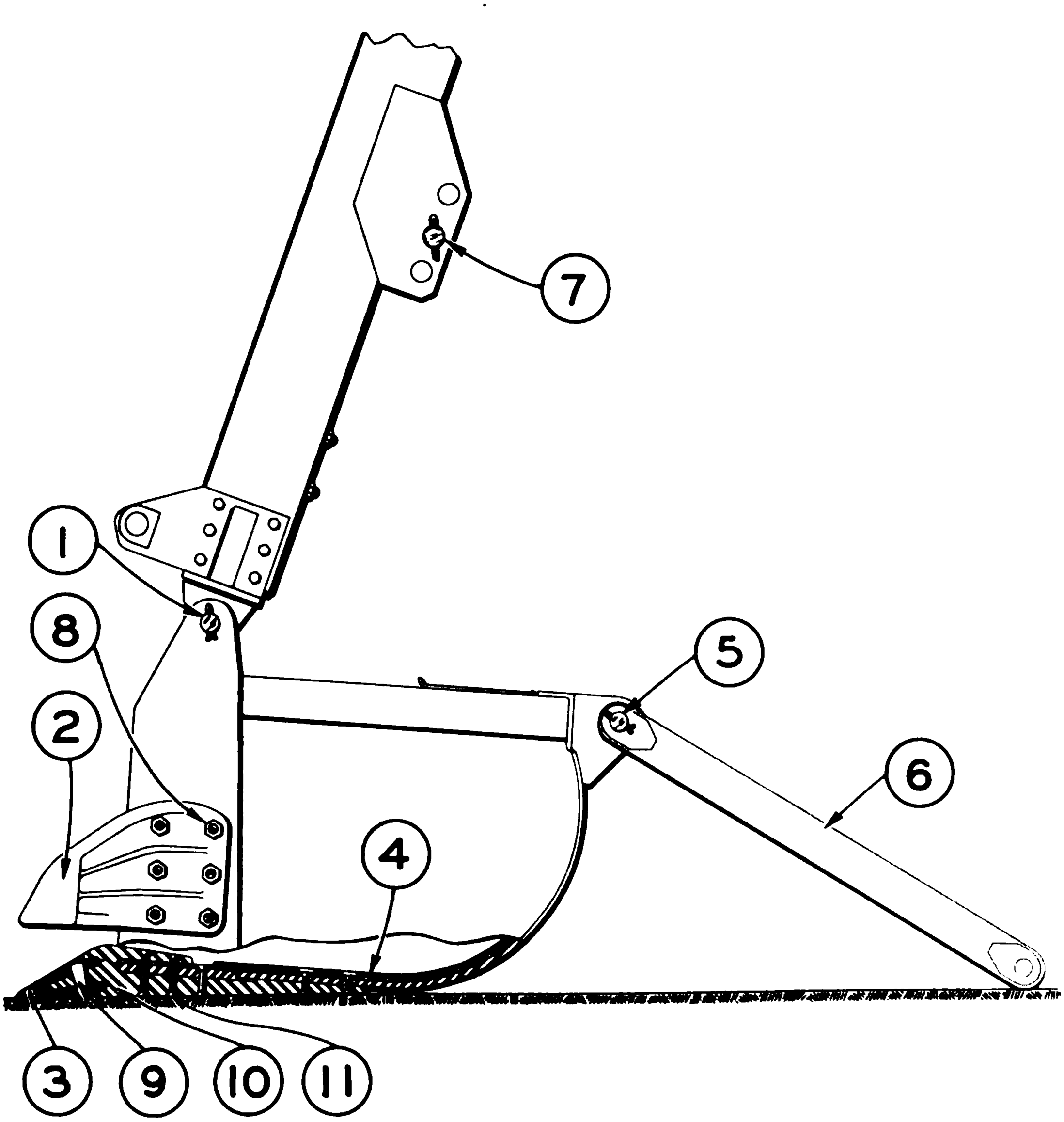


Figure 162

sheaves (3) and (4). Close and pull cotter from pin (5) and remove pin which releases sheave (6). Take out sheave. Remove guard (7) by taking off nuts. Unscrew set screws in set collars (8) until collars are loose on shaft (9). Close and pull cotters in shaft (9) and remove shaft which releases sheave (4) and set collars (8) for removal. Replace sheave (4) after having placed cable (1) as shown in Figure 164, in sheave grooves and take up slack in cable by winding it on drum with power. (After removal of dipper arm, boom can be raised and lowered with cable and can be safely used as a crane for the handling of dipper or dipper arm. Do not use as crane for any other purpose.) Bend down lock plates (10) and remove nuts (11). Using a short bar as a driver, place one end against the shaft (12) at the end opposite the shaft key and drive out shaft (12) with sledge hammer. Hoist boom and swing clear of dipper arm.

TO INSPECT:

Clean dipper arm thoroughly and examine closely for cracks, distortion of other damage. Inspect roller (13), sleeve (14), thrust washers (15) and bushing (16) for wear. To remove sleeve and roller for inspection, take off thrust washers (15); remove set screw (17) and pull out sleeve (14) being careful not to drop roller (13). If bushings (16) must be replaced see "Dowel Instructions", Page (164). To remove sheave block (18) close and pull cotter in pin (19) and remove pin which releases sheave block. Place sheave block on the ground. To disassemble sheave block (18), remove bolts (20) which release scraper bracket (21). Close and pull cotter in pin (22) and remove pin. Lift out sheave (3). To inspect, examine sheave pin, sheave bushing, block pin and block bushing for wear. Inspect sheave groove for damage or wear and scraper bolt for wear or damaged threads. If necessary to rebush sheave or sheave block see "Dowel Instructions," Page (164). To reassemble sheave block (18), place sheave in block, line up bores and insert sheave pin, locking it in place with cotters. Next, place scraper bracket into position in sheave block; line up holes in bracket with holes in sheave block and insert 4 bolts (20) and tighten. Screw bolt (23) into scraper bracket so that it just clears the bottom of sheave groove and lock in place by tightening nut. Check all grease fittings to be sure they are open. To remove sheave block assembly (24), close and pull cotter in pin (25) and remove pin.

TO DISASSEMBLE:

Close and pull cotter of pin (5) and remove pin, releasing sheave (6). Next take out bolts (26) and remove sheave housing (27). Bumper (28) may be removed by taking out two bolts.

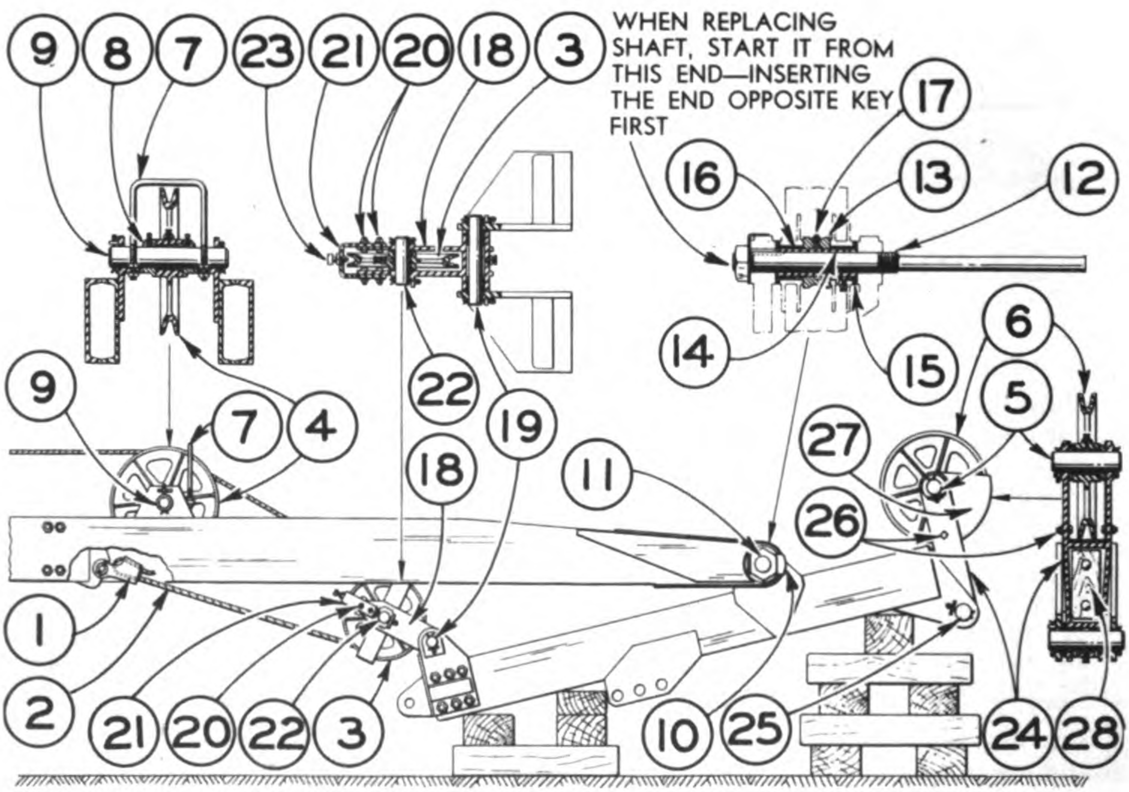


Figure 163

TO INSPECT:

Examine bushings, pins and sheave groove for wear. If bumper (28) is worn or damaged, renew. If it is necessary to rebush sheave or bracket see "Dowel Instructions", Page (164).

TO ASSEMBLE:

Place housing (27) in position on bracket (24). Place sheave (6) in housing; line up holes and insert sheave pin (5), locking it in place with cotters. Next insert bolts (26) and tighten. Place bumper (28) into position on bracket (24); line up holes and insert bolts and tighten. To replace sheave assembly line up bore of assembly with bore in dipper arm; insert pin (25) and lock with cotters.

TO REPLACE:

Place roller (13) in position in dipper arm bracket and insert sleeve (14) so that one of thrust washers (15) can be slipped on each side. Swing boom into position over dipper bracket assembly and lower it slowly into place taking care not to disturb thrust washers (15). Line up holes and insert shaft (12), (end opposite keyway first) into keyway shaft hole in boom as shown. Insert key into keyway in shaft and after lining up key with keyway in the shaft hole in boom, bump shaft in until centered. Screw on nuts and tighten so that there is approximately 1/16" clearance in assembly. Bend up lock plates (10).

PULL SHOVEL BOOM (Less Dipper Arm) See Figure (164), Page (194).

NOTE - Reeve hoist cable as described under "Pull Shovel Arm", Page (190).

TO REMOVE:

Lower boom to cribbing as shown. Detach cable (1) from dead end by removing cable clamps (2) and remove cable from sheaves. Take out locking bolts and remove boom foot pins (3). Back machine away, leaving boom resting on cribbing.

TO DISASSEMBLE:

Remove lock bolt and pull shaft (4) which releases idler sheave for removal. Next take out cotter of shaft (5) and after loosening set screws of collars remove shaft. Sheave (6) and set collars can now be taken out. Remove twelve tie bolts (7) releasing torsion box (8) from two boom members (9).

TO INSPECT:

Clean boom and torsion box thoroughly and examine closely for cracks. If any cracks are found repair by welding. Inspect twelve tie bolts (7) for wear or damage to threads and renew if necessary. Examine babbit bearings in boom foot and boom foot pins (3), also bushings and pins of idler sheave and fleeting sheave (6). If any bushings are worn badly they must be renewed; see "Dowel Instructions", Page (164).

PULL SHOVEL BOOM (LESS DIPPER ARM)

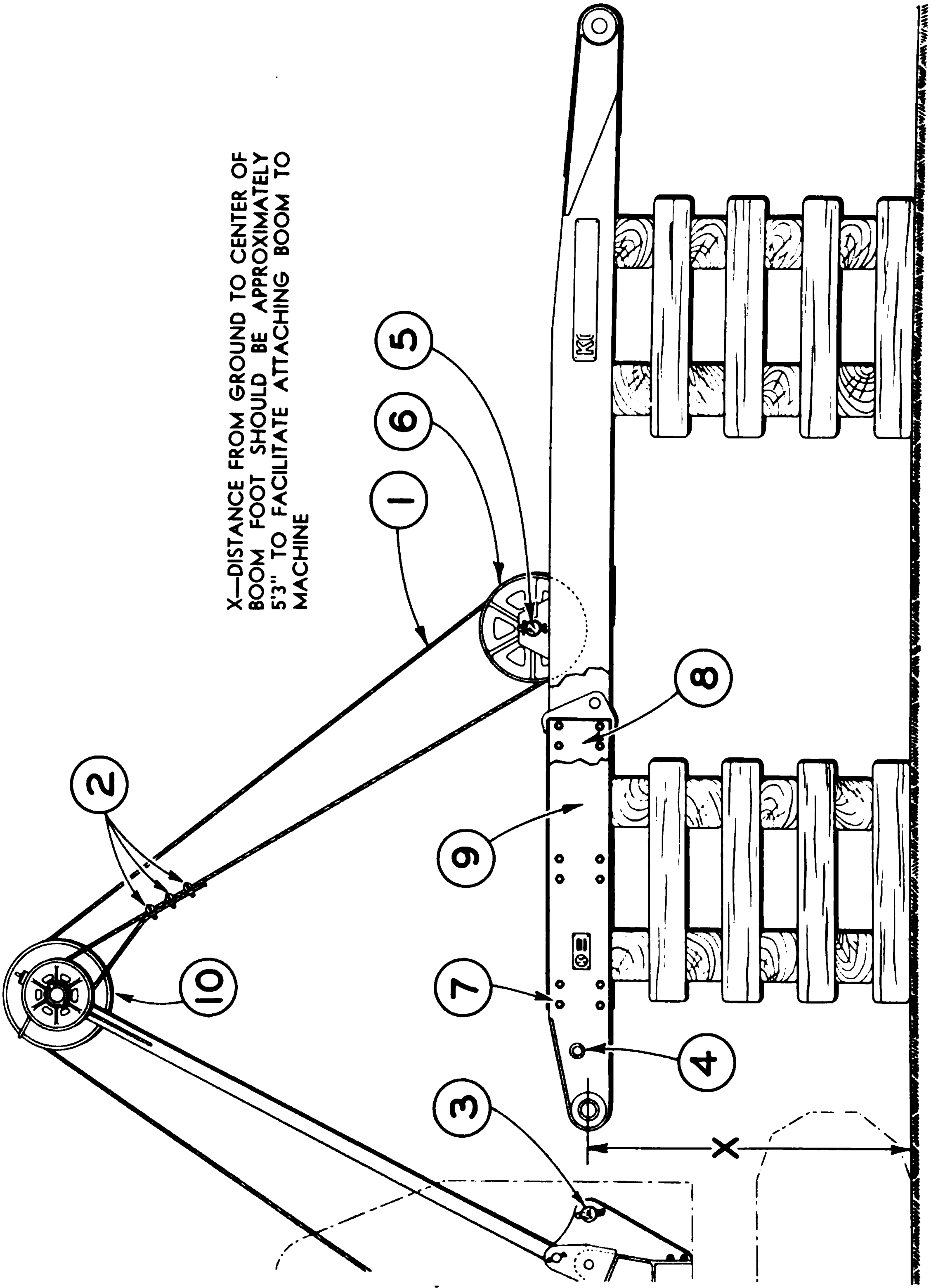


Figure 164

TO REASSEMBLE:

Place torsion box (8) in position between two boom members (9) and line up the twelve bolt holes. Insert twelve tie bolts (7) and tighten. Lift idler sheave into position in boom, insert shaft (4) and lock in place with bolt. Start shaft (5) through one bracket hole on boom and mount first one set collar then fleeting sheave (6) and second set collar on shaft, while moving the shaft through the bracket toward the other bracket. Insert cotters and open.

TO REPLACE

Move machine up to cribbing on which boom is resting and with front of machine in alignment with boom foot bring holes in pull shovel adapter into line with holes of boom foot. It might be necessary to raise or lower boom foot with the aid of bars or jacks or wooden wedges, or to swing machine slightly to bring holes into proper alignment. Insert pins (3) and secure with cotters.

If it is necessary to raise boom less dipper arm use cable (1) for hoisting. To do this draw cable (1) from jib frame sheave (10), placing it around fleeting sheave (6) and anchoring it to dead end casting securing it with cable clamps (2). When this is done raise boom by winding cable (1) on drum with power.

PULL SHOVEL JIB FRAME
(Less Boom, Dipper Arm and Dipper)

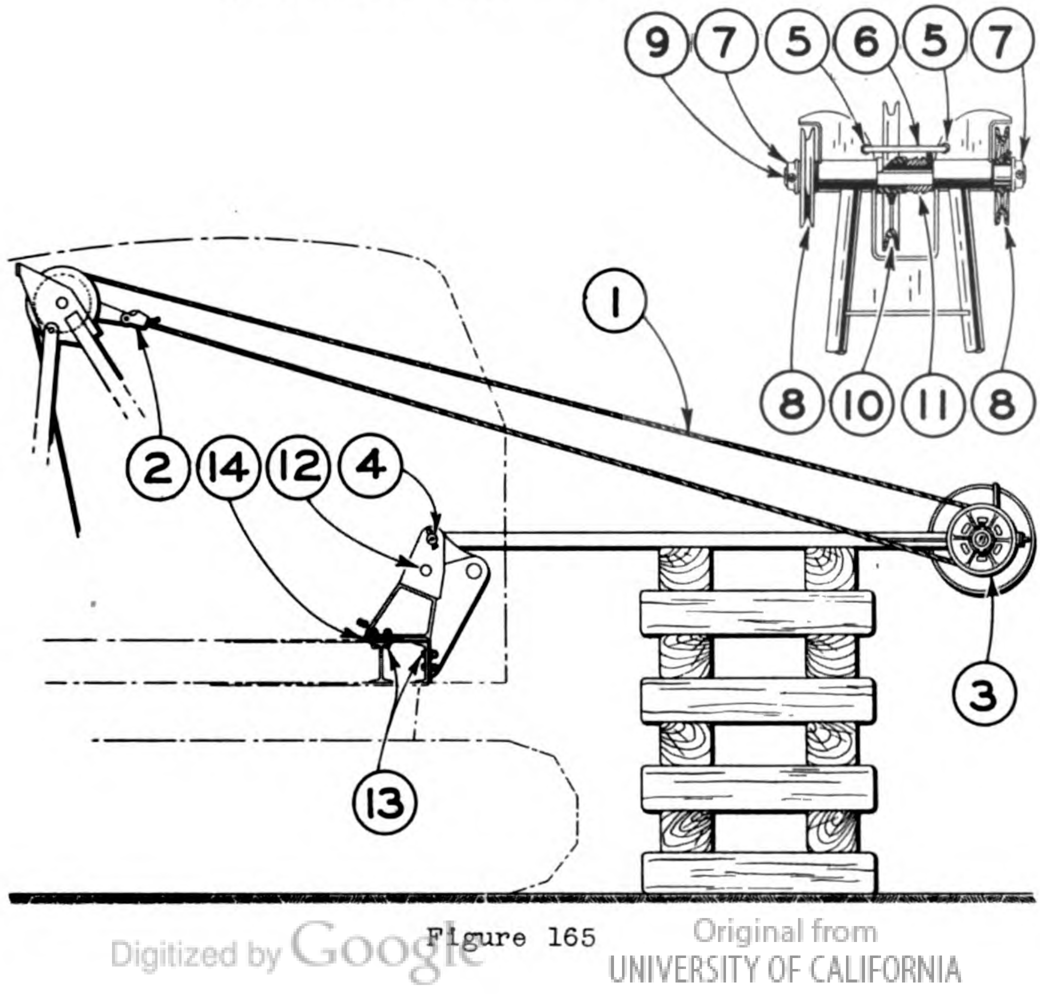


Figure 165

PULL SHOVEL JIB FRAME (Less Boom, Dipper Arm and Dipper) See Figure (165).

TO REMOVE:

Lower jib frame so that it rests on cribbing. Detach cable (1) by removing one end from cable socket (2) and remove it from jib frame suspension sheaves (3). Close and pull cotters of pins (4) and then remove pins. Back machine clear of frame.

TO DISASSEMBLE:

Take off nuts (5) and remove cable guard (6). Take out bolts and remove collars (7) and sheaves (8) from shaft (9). Next remove shaft (9) from jib frame being careful not to drop sheave (10) and dead end casting (11) as they are released.

TO INSPECT:

Examine sheave bushings and shaft (9) for wear. If it is necessary to rebush sheaves see "Dowel Instructions", Page (164).

TO REASSEMBLE:

Place sheave (10) and dead end casting (11) in position in jib frame and insert shaft (9). Then slip one of sheaves (8) on each end of shaft and replace collars (7), lining up holes in collars with holes in shaft; insert bolts and tighten.

TO REPLACE:

Move machine up to cribbing on which jib frame is resting and, with front end of machine in alignment with legs of jib frame, bring holes of pull shovel adaptor into line with holes in legs of jib frame. It may be necessary to raise or lower jib frame legs or swing machine slightly to bring holes into proper alignment. Insert pins (4) and lock with cotters. Reeve cable as described in Operation Section, Page (86), and raise jib frame.

PULL SHOVEL ADAPTOR (Less Boom, Dipper Arm, Dipper and Jib Frame) See Figure (165).

TO REMOVE:

Close and remove cotters from pins (12) and remove pins. Take out bolts (13) and let adaptor fall to the ground being careful to stand clear to avoid injury. Be sure that space to which adaptor will fall is clear of any parts that may be damaged by the adaptor. Also be sure that no shims (14) are lost.

TO INSPECT:

Clean adaptor thoroughly and examine closely for cracks. If any are found repair by welding.

TO REPLACE:

Lift adaptor into place on machine and insert pins (12) securing them with cotters. Place shims (14) into position; line up holes and insert and tighten bolts (13).

CHAINS

POWER TRANSMISSION CHAIN

The power transmission chain which transmits power from the engine to the swing and traction jack shaft is located at the left rear of the upper deck machinery and enclosed in an oil tight chain case as shown in Figure (167), Page (199). It is a 3/4" pitch, four strand, roller type chain.

With the exception of the connecting link pins, all pins are assembled with a heavy press fit and should not be distrubed unless repair links are to be installed. Connecting links are provided with slip fit center plates to facilitate shortening or removal of chain and are easily distinguished by cotters which hold the links in place.

TO REMOVE:

Drain oil from chain case by removing drain plug (9). Disconnect fuel line (1) at fuel tank, then take out bolts of support (3) and remove support blocks. Pull fuel line through chain case hole (2) and place it under the motor. Take out four bolts (4) and remove upper half of chain case (5). Locate connecting link (7) and place it in position over top center of sprocket (6). Remove cotters and using small drift or punch, drive both pins of pin link (10) through cover plate (11), then pull link pin out of chain being careful not to lose center plates (12). Remove chain.

TO INSPECT:

Clean chain thoroughly with cleaning fluid and inspect for wear and broken rollers (15), roller links (13) or pin links (10). If, due to wear, chain has lengthened 3/4" or more beyond its original length of 148½", it may be shortened by substituting a preassembled 4 pitch section for the 5 pitch section. (To remove 5 pitch section, take out connecting links on each side of section as described above in "To remove chain". To connect 4 pitch section, place section between ends of chain and insert connecting links as described below in "To replace chain".) To replace roller links, press or drive out pin links on each side of damaged roller link and replace with repair roller links and connecting links. CAUTION - Grind head of pins flush with cover plates before driving or pressing them out.

TO REPLACE:

Place chain on sprocket (6) and drop one end, to which a piece of wire has been attached, into chain case ahead of sprocket. Using the wire fastened to the end of the chain, pull chain through and under both sprockets in case, then over motor sprocket (14) to top center of sprocket (6). Engage engine clutch - Lever (8) - engine not running - and by turning sprocket (6) by hand, take all slack from top chain and mesh it with sprocket teeth at the same time. This brings the ends of chain together at top of sprocket (6). Next, start pin link (10) through roller links (13) and, placing two center plates in the spaces between each roller link bring pin link through chain. Place cover plate in position and tap it on to pin link pins and secure with cotters. Place top of chain case (5) in position; line up holes with holes in bottom of case; insert bolts (4) and tighten. Insert fuel line into hole (2) and pull it through to fuel tank and connect. Place support (3) in position on chain case bracket (top half over fuel line); line up holes; insert bolts and tighten. Replace drain plug (9). For lubrication of chain case, see Page (66), Operation Section.

CROWD, RACK-IN AND TRACTION DRIVE CHAINS

The crowd, rack-in and traction drives are equipped with steel thimble roller drive chains. Crowd and rack-in chains are identical except for length and the individual links are interchangeable. The traction drive chain links, due to a difference in size and design are not interchangeable with crowd and rack-in links. Each link of the above chains is pinned and cottered individually for quick and easy replacement of worn or damaged links.

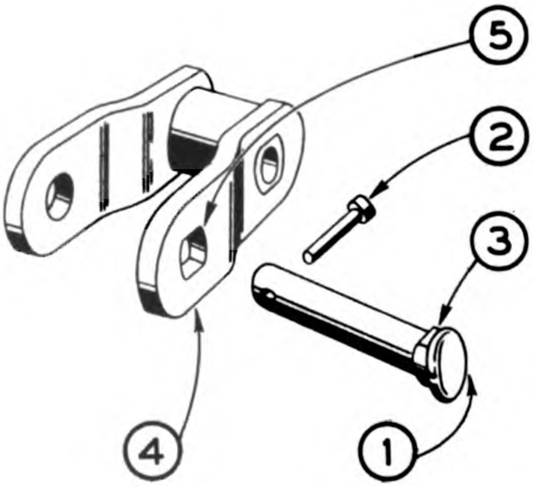


Figure 166

TO SPLIT CHAIN: (See Figure 166)

Select link pin (1) to be removed, take out lock pin (2) then drive out link pin with hammer and punch, bucking up the opposite side of the link with a heavy hammer or shaft.

TO CONNECT CHAIN:

Place ends of chain in position; line up holes and start pin (1), tapping it in until square shoulder (3) touches side bar (4). Turn pin so that shoulder (3) matches hole (5) and drive link pin in - bucking up opposite side bar of link with heavy hammer or shaft. Insert lock pin (2) and bend.

TO INSPECT CHAIN:

Clean chain thoroughly using cleaning fluid, and examine all pins, rollers and side bars for wear or damage and replace if necessary.

TO REMOVE CHAIN LINK:

Take out a link pin (1) on each side of damaged link following procedure as described under "To split chain", and remove link.

TO REPLACE CHAIN LINK:

Place link in position in chain and line up holes and follow procedure as described under "To connect chain."

CHAINS

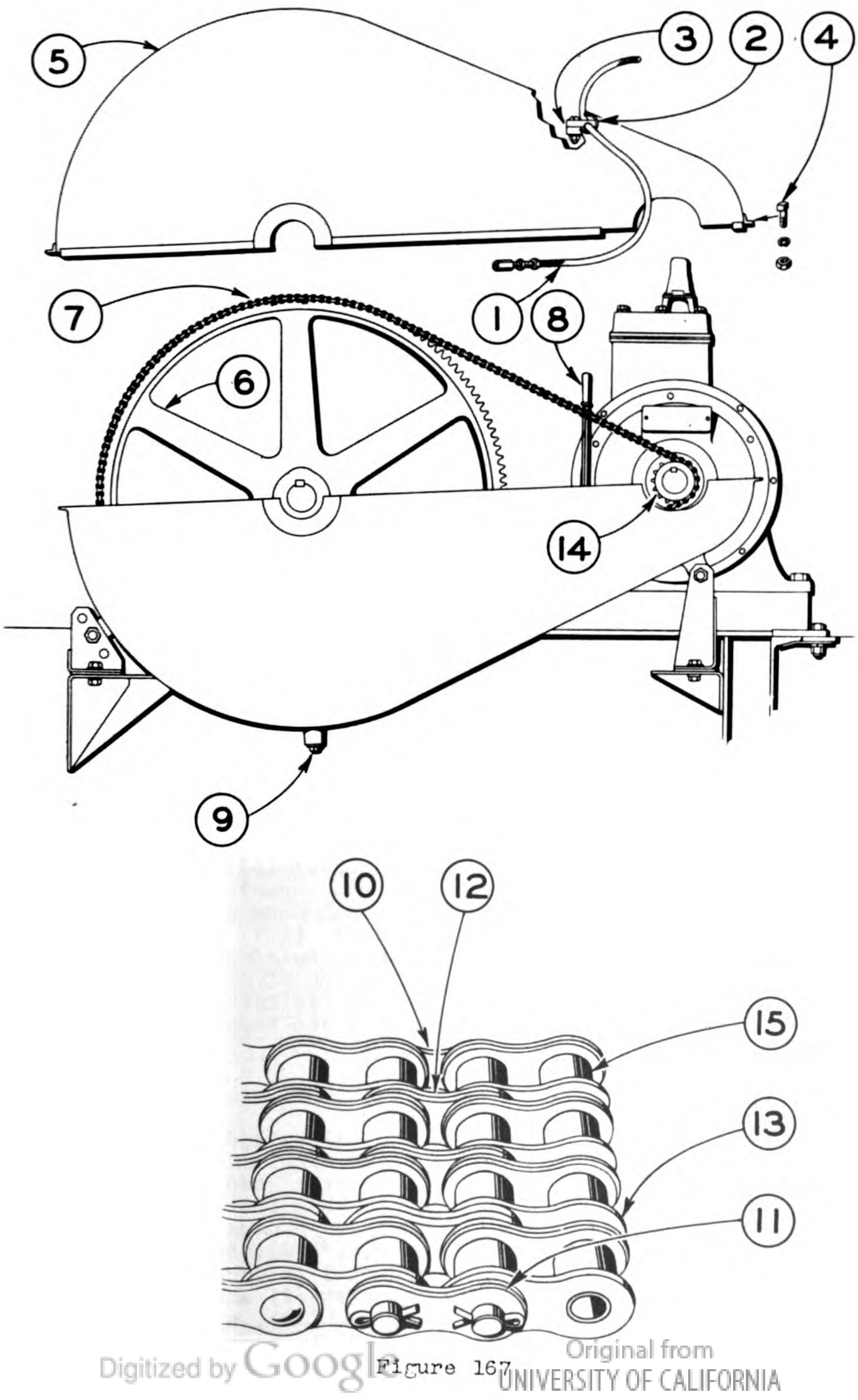


Figure 167

CROWD CHAIN (See Figure 168, Page 201).

TO REMOVE: (Without Power).

Unscrew nuts (2) to extreme out position on bolts (17) to slack off crowd chain adjustment. Split chain as described under "To split chain", Page (198), near sprocket (3) and lift section nearest the machine over sprocket (4), pulling it from sprocket (10) at the same time and let it fall to the ground.

Then remove cover (8) from opening in boom and lift chain over shipper shaft sprocket (9), allowing it to slide down guide and fall to the ground between boom foot and crawlers. NOTE - If boom is horizontal, or nearly so, it will be necessary to pull chain from boom foot opening.

TO REMOVE: (With Power).

Swing boom to a central position over front of crawlers and lower dipper to the ground so that it rests directly under shipper shaft. Slack off on crowd adjustment by unscrewing nuts (2) to extreme out position on bolts (17). Lower boom until it rests on dipper stick spacer block, split chain, as described under "To split chain", Page (198), near sprocket (3). Then, after releasing hoist brake, travel machine away from dipper, pulling chain out of boom foot opening while doing so. After chain has been removed from boom, engage racking-in clutch and slowly turn crowd sprocket (4) to pull off remainder of chain at idler sprocket.

TO INSPECT:

Follow instructions under "To inspect chain", Page (198).

TO REPLACE CHAIN: (With Power).

Fasten a rope or wire to open end of chain and pass it through boom foot opening to opening (8) at top of boom. Then, with link pin heads to the right or operator's side, pull chain through boom until it is meshed with shipper shaft sprocket (9). Next, pass rope or wire back through opening to boom foot opening and travel machine toward dipper, pulling chain through boom at the same time. Pass other end of chain around sprocket (10) and mesh it with sprocket (4) then engage crowd clutch and slowly turn crowd sprocket until all slack is taken out of the bottom of crowd chain (1). Bring ends of chain together and connect as described under "To connect chain", page (198). To adjust, see Page 102, Operation Section.

TO REPLACE CHAIN: (Without Power).

Place chain on top side of boom with roller end of chain toward boom point with heads of link pins to the right or operator's side. Fasten a rope or wire to roller end of chain and pass it through boom from opening (8) at top of boom to boom foot opening. Feed chain through opening (8) and pull it through boom with rope until it extends about two feet beyond sprocket (10). Next, fasten rope or wire to the other end of chain and pull it through boom in the same manner, passing it over crowd sprocket (4) and bringing ends of chain together between sprockets (4) and (10), approximately 18" from sprocket (10). Block sprocket (10) to keep it from turning

CHAINS

and remove all slack from chain by turning sprocket (4) and applying crowd brake. With the aid of a board (12) between sprockets (10) and (4) bring ends of chain together and connect as described under "To connect chain", Page (198). To adjust, see Page (102), Operation Section.

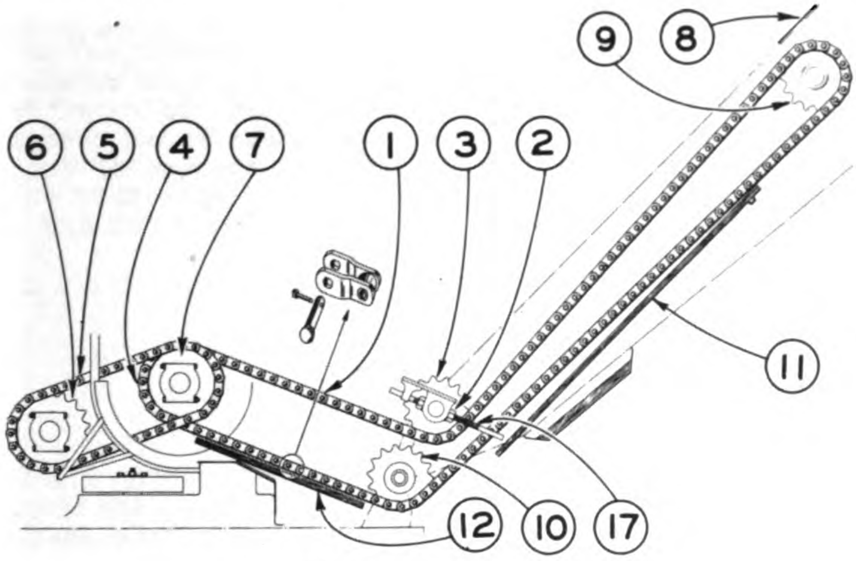


Figure 168

TO SHORTEN CHAIN:

After adjusting sprocket (3) has been taken up all the way and crowd chain runs with considerable slack, it is necessary to shorten chain by removing a link. Unscrew nuts (2) to extreme out position on bolts (17) and remove slack in upper part of chain by revolving sprocket (4) with racking-in clutch. Select a link, (see inset Figure 168,) about 18" from sprocket (10) and remove link as described under "To remove chain link", Page (198). To connect chain follow procedure described under "To replace chain", Page (198). To adjust chain, see Page (102), Operation Section.

RACK-IN CHAIN (See Figure 168).

NOTE - Due to its short length and relatively light loads, no provision has been made for the adjustment of the rack-in chain. If abnormal conditions result in excessive wear, chain may be shortened by removing link as described under "To remove Chain link", Page (197).

TO REMOVE: (See also "To split chain", Page 198).

Split rack-in chain (5) at any convenient link and remove from sprockets (6) and (7).

TO INSPECT:

(See "To inspect chain", Page 198).

TO REPLACE: (See also "To connect chain", Page 198).

Place chain on sprockets (6) and (7) with roller end of top links toward rear of machine and connect at any convenient point.

TRACTION DRIVE CHAIN (See Figure 169).

NOTE - The traction drive chains transmit power from the lower traction sprocket to the crawlers. Although they are made of special materials to withstand the abrasive qualities of the soil and designed to withstand unexpected overloads, frequent inspections should be made.

TO REMOVE:

Take out lock pins (1) and turn adjusting nuts to slack off the drive chain adjustment. Select a link pin (3) - a little above center on drive sprocket (4) - and remove it as described under "To split chain", Page (198). Lift the top end of chain forward off drive sprocket (4) then by revolving sprocket (5) (forward traction direction) with power, remove chain by pulling lower part of it from under drive sprocket (4).

TO INSPECT:

See, "To inspect chain", Page (198).

TO REPLACE:

Lay the chain flat on the ground directly behind the sprockets with open end of links toward machine and the heads of pins toward crawlers. Fasten a rope or wire to one end of the chain and pass it under and around sprocket (5) then out behind the machine. Revolve sprocket (5) - reverse traction - and pull on rope or wire to wind chain into position so that upper end of chain lays in teeth of sprocket (4) as indicated by arrow (3). Then revolve sprocket (5) (forward traction) just enough to take slack out of upper part of chain and lift bottom end of chain into place on drive sprocket (4). To connect chain follow procedure as described under "To connect chain", Page (198). To adjust chain see Page (93), Operation Section.

TO SHORTEN:

After adjusting bolts have been taken up all the way and chain runs with excessive slack, chain must be shortened by removing a link. Split chain as described under "To remove", Page (198). To remove link, follow procedure as described under "To remove chain link," Page (198). Connect chain as described under "To replace", Page (198). To adjust, see Page (93), Operation Section.

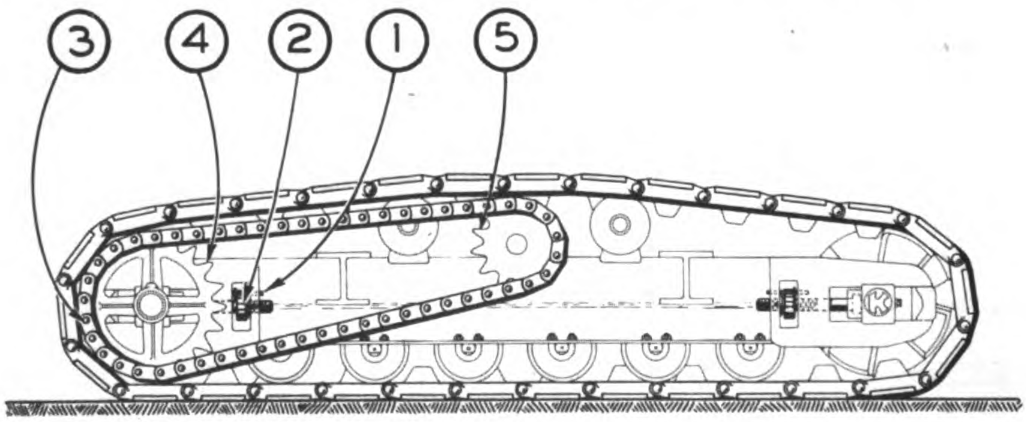


Figure 169

HANDLING OF HEAVY PARTS

When repair work is done in the field it is often necessary to handle heavy parts such as shafts, drums, castings, etc., with no crane available. In such cases various types of lifting devices, as illustrated on Pages (204), (205) and (206) must be used. Due to the varying weights of parts to be handled, the height to which such parts must be lifted or the availability of materials for construction of such devices, the type selected must depend upon the judgment of the operator or the mechanic. The successful operation of these 'home-made' lifting devices will depend largely upon the skill and ingenuity of the operator. The illustrations of the four most common types of lifting devices are given merely as a guide in constructing them and because each lends itself to many variations, or the materials used will depend upon the kind available, no definite specifications or dimensions can be given.

Materials of ample strength combined with good common sense will provide the proper type of lifting device to meet a specific requirement.

THE "GIN" POLE (Figure 170).

The "gin" pole is perhaps the most widely used device for the handling of heavy repair parts in the field maintenance of excavators. It is simple in construction, adaptable to the majority of conditions and, in most cases, the material for its construction is available.

The 'set-up' shown in Figure (170), consists of a stout timber or pole (1), studs (4) and (5), rope tackle (2), guy lines (6) and a chain hoist (3). To adapt the gin pole and the other devices illustrated to local conditions frequent substitutions may be made. For example, the pole (1) may be replaced by a steel beam or pipe, the rope tackle (2) by cables anchored to trucks or tractors and the chain hoist (3) by snatch block and cable which may be operated by a winch.

SAFETY RULES:

In the hands of a careless mechanic the "gin" pole can be a dangerous tool and for the safety of himself and others, the following rules should be observed:

Always use materials of adequate strength.
Always loop cables around pole several times before clamping.
Always use good cable clamps and a sufficient number of them.
Always anchor guy lines to objects of adequate strength and stability.
Always hitch loads securely.
Never allow slack in any guy line - when paying out on one line immediately take up slack in the others.
Never make a lift with pole at more than a 20 degree angle from vertical without pole (1) sitting in a shallow hole or without anchoring it securely in some other way.

GIN POLE

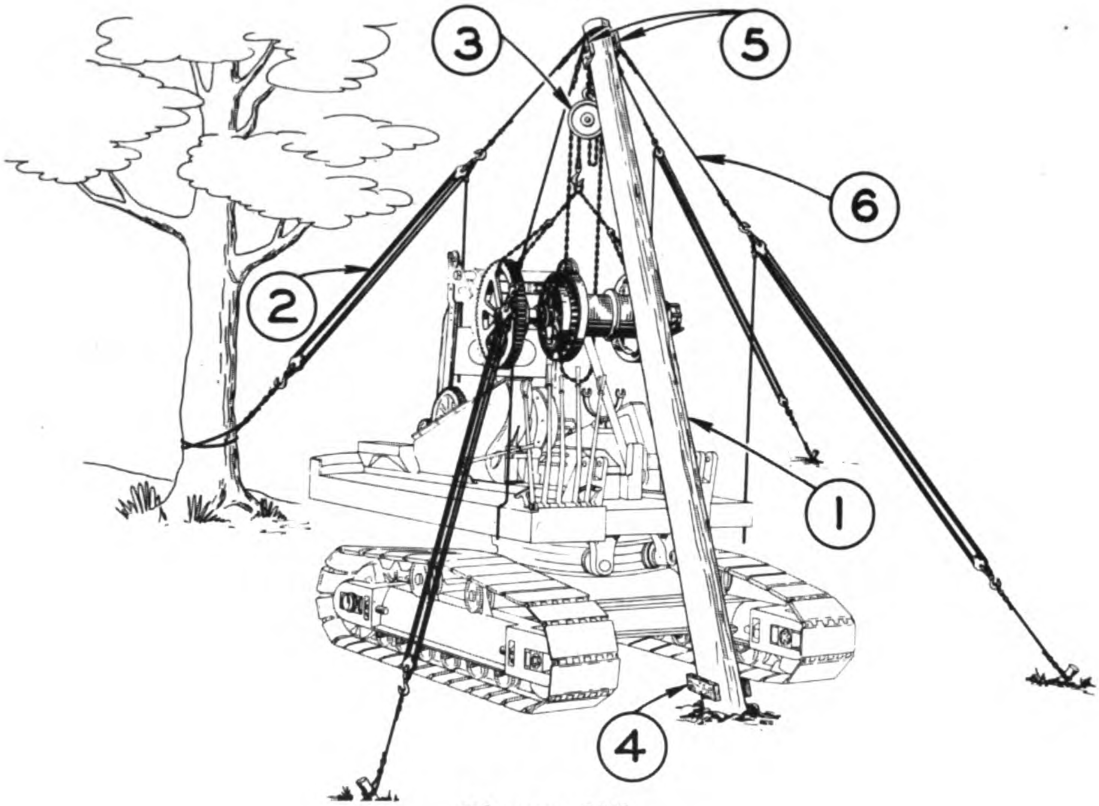


Figure 170
"A" FRAME

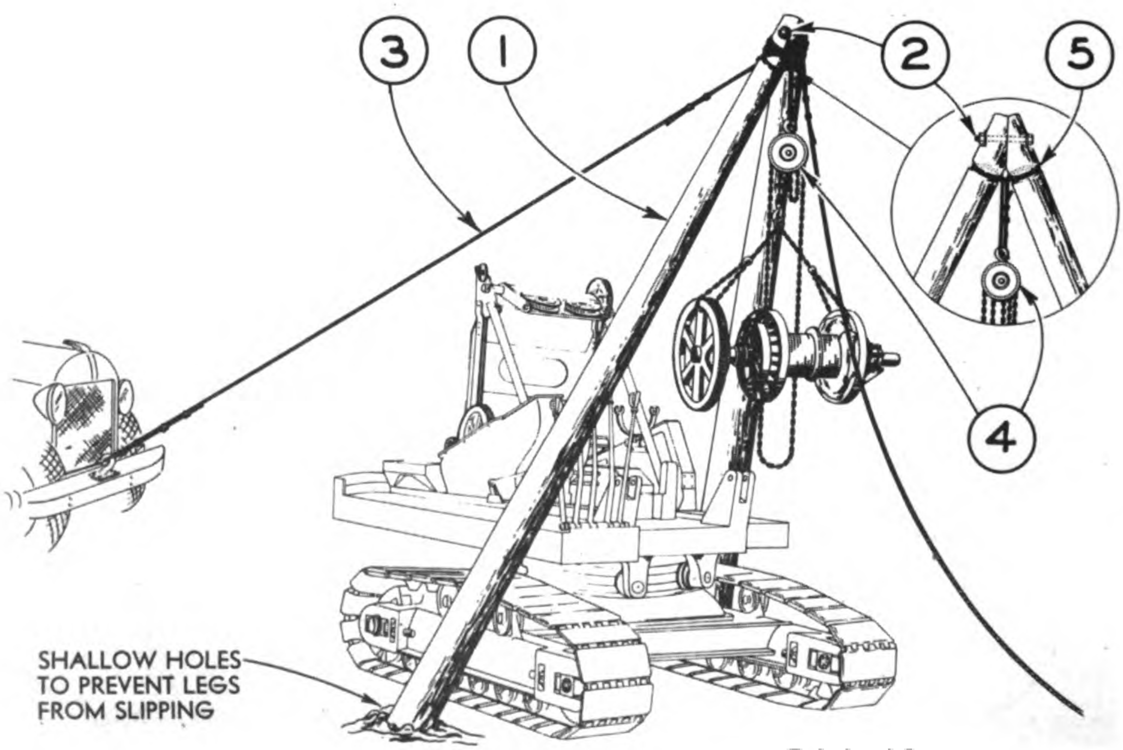


Figure 171

THE "A" FRAME (Figure 171, Page 204).

The "A" frame differs from the "gin" pole in that it is constructed of two compression members instead of one. While this design is not so flexible and therefore somewhat limited in its applications as compared with the "gin" pole, it is operated more easily and safely by the inexperienced mechanic. The "A" frame consists of two timbers (1), two suspension cables (3) and a chain hoist (4). Inset shows method of fastening timbers together with bolt (2) and method of attaching chain hoist (4) with a cable sling (5). As with the "gin" pole, substitution of materials may be made as local conditions require.

"Gin" pole safety instructions apply here - read them carefully.

THE TRIPOD (Figure 172)

The tripod is similar in construction to the "A" frame with the exception that an extra compression member or leg has been added to take the place of the suspension cables. It is usually made up of poles or steel pipe and is used as shown in the illustration. Inset shows a method of fastening the three legs (1) and clevis (2) with long bolt (3)-the clevis being used to support the chain block (4).

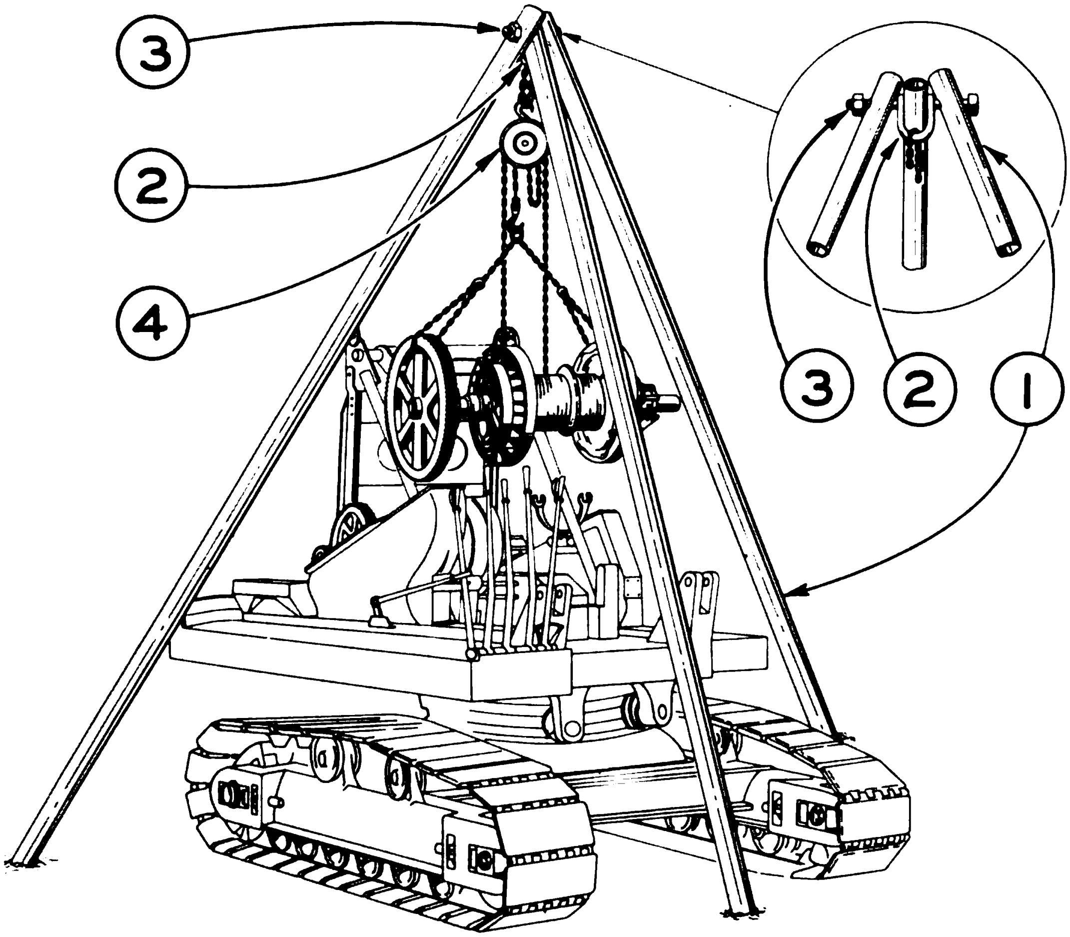


Figure 172

THE RAMP (Figure 173).

When material is not available for the construction of "gin" pole, "A" frame or tripod, it is necessary to lift assemblies or heavy units with jacks, bars and blocks, then roll or skid such assemblies and units to the ground by means of a ramp. For safety, a cable or rope (1) should be securely attached to assemblies and units and snubbed around some part of the machine to control rolling or skidding, and wooden wedges (2) should be driven under timbers as shown to stabilize ramp.

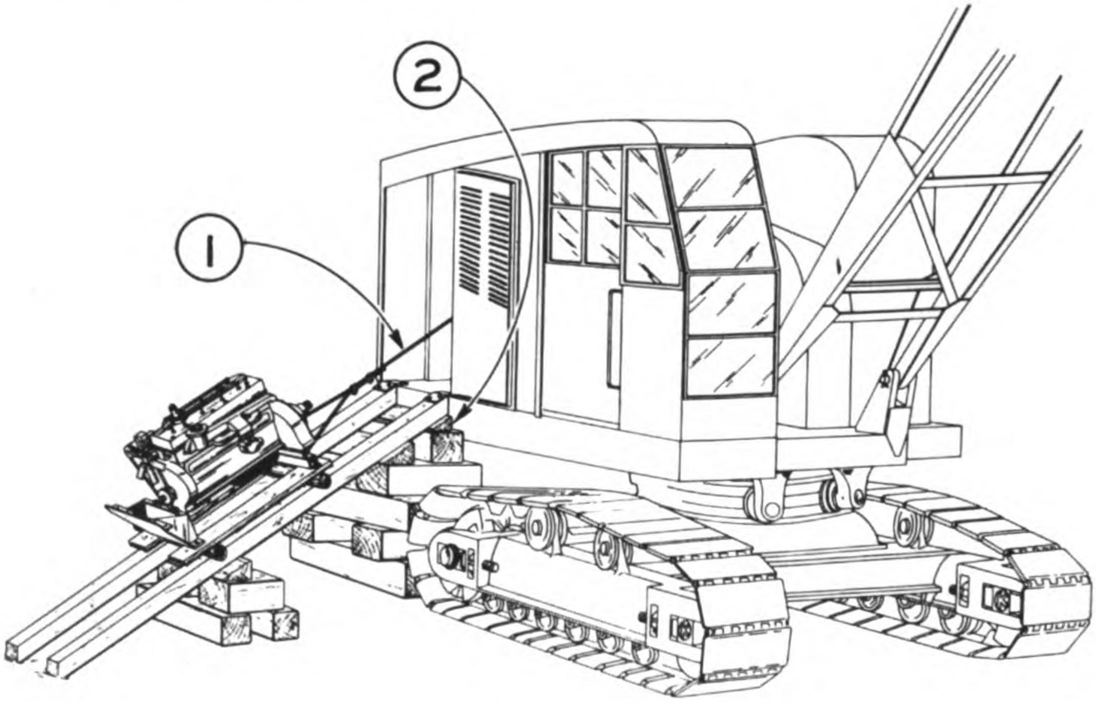


Figure 173

GREASE GUN

With proper care in the use of the grease gun, very little maintenance is required to keep it in efficient operating condition. Since most of the troubles with a grease gun are traceable to foreign particles in the lubricant, repair work consists chiefly of disassembling, cleaning and assembling of the button coupling which has a tendency to filter out the impurities and become 'stopped up'. To insure efficient and trouble-free operation these two simple rules should be followed: <u>1 - Use only clean grease free from impurities of any kind. 2 - Clean grease fittings before applying the button coupling.</u>

<u>TO DISASSEMBLE:</u> (Figures 174 and 175).

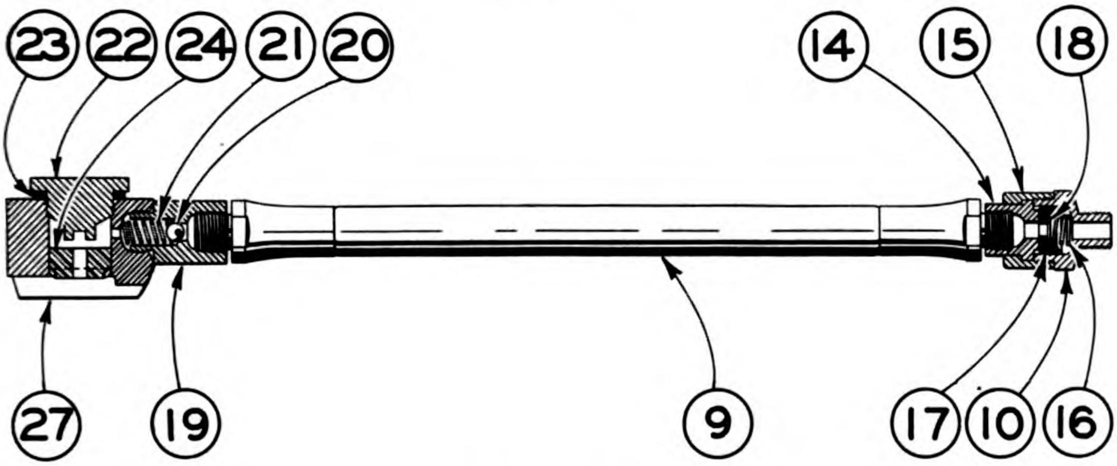
Unscrew cylinder (2) from gun head (3) and remove gasket (25). Remove nut (4) and pull follower rod (5) and latch (28) from cylinder. Remove cup leather assembly (6) and springs (7) and (8) from cylinder. Detach hose assembly (9) from gun head (3) by unscrewing at connection body (10). Punch out rivet (11) after grinding or filing off its head and remove piston (12) and handle (13) from head. Unscrew connection (14) from hose and disassemble by unscrewing hose ring (15) from connection body (10) and removing spring (16), cup leather (17) and flat washer (18). Next remove button coupling by unscrewing adapter (19) from hose and disassemble as follows: Unscrew adapter (19) from button coupling body (27) and remove steel ball (20) and spring (21). Unscrew plug (22) and remove gasket (23) and leather plunger (24).

TO INSPECT:

Clean all parts thoroughly by washing in cleaning fluid and check all metal parts for damage or wear and renew if necessary.

If leather cups of assembly (6) are stiff or worn, renew them. Examine packing (29) by removing packing nut from cup leather assembly and if worn or hard, replace. Examine all gaskets and hose (9) for damage or leaks.

GREASE GUN



.Figure 174

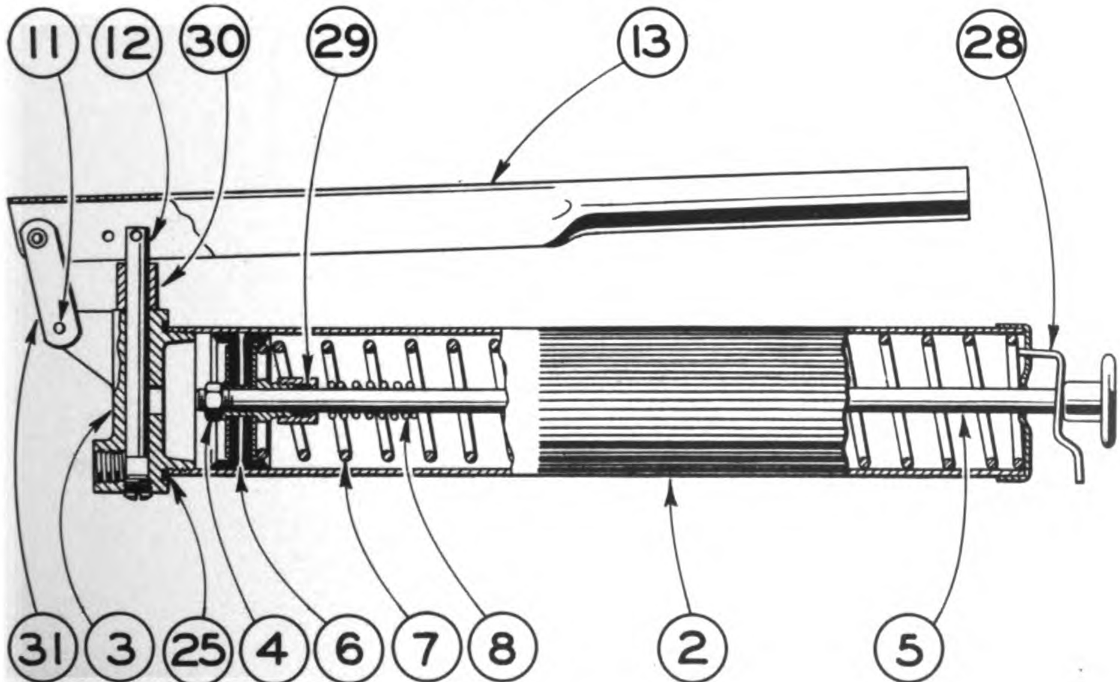


Figure 175

TO REASSEMBLE:

Place latch (28) in position in the end of cylinder (2) and insert follower rod (5), pushing the rod in all the way. Insert spring (7) into cylinder and slide spring (8) on follower rod. Next insert cup leather assembly (6) into cylinder, slipping it over follower rod (5) then attach nut (4). Slip spacer (30) on piston (12) and insert piston into head (3). Line up holes of links (31) with hole in gun head (3); insert rivet and peen. Place gasket in position on gun head (3) and screw cylinder (2) into place. Next assemble button coupling by inserting leather plunger (24) into coupling body (27) and replacing plug (22) with gasket (23) in place. Place ball (20) and spring (21) in position in adapter (19) and screw adapter into button coupling assembly. Assemble connection (14) into hose ring (15), then, after placing spring (16), cup leather (17) and flat washer (18) in position in connection body (10) as shown in Figure 174, screw connector body into hose ring and tighten. Now mount connector on one end of hose (9) and button coupling on the other end then attach hose assembly (9) to gun head (3).

PARTS SECTION

WARNING

SPARE PARTS can be supplied promptly and accurately only if positively identifed by correct part number and correct part name.

FURNISH THIS INFORMATION ON ALL REQUISITIONS. WITHOUT FAIL, on all requisitions, give name of machine, name of manufacturer, model or size, manufacturer's serial number of each machine and subassemblies attached to machine, and components and accessories for which spare parts are required.

List spare parts for only one make or kind of machine on each requisition.

Requisitions must be double spaced to provide room for office notations when necessary.

INDEX PARTS SECTION

On this page is shown a sample spare parts requisition on QMC Form No. 400 which conforms to the latest revisions. The marginal notes give instructions for preparing a requisition for spare parts for Engineer equipment.

The revised QMC Form 400 has new column headings. Until new forms are available use the present form and type or write in corrections in column headings as shown below.

Under revised heading "Nomenclature" and "Unit" list the article and the unit (ea for each; lb for pound; etc.). Under heading "Maximum or Authorized Level" list the authorized organizational allowances or depot stock levels given in ENG 7 and ENG 8 of the ASF Engineer Supply Catalog (superseding Part III, Corps of Engineers Supply Catalog). The total number on hand for each item is listed under "On Hand". In column headed "Due In" enter the total quantity previously requisitioned but not delivered. Column headed "Required" is to be changed to read "Quantity Desired" and column headed "Approved" is to read "Remarks." For "Initial" and "Replenishment" requisitions, the sum of "Quantity Desired", "Due In", and "On Hand" should equal "Maximum or Authorized Level."

(Additional details on this subject are covered in ENG 1 of the ASF Engineer Supply Catalog which incorporates information formerly contained in Section AA-1, Part III, Engineer Supply Catalog.)

State PERIOD designation by use of one of the following terms:
(1) "INITIAL"—first requisition of authorized allowances.
(2) "REPLENISHMENT"-subsequent requisitions to maintain authorized allowances.
(3) "SPECIAL"—requisitions for necessary repairs not covered by allowances.

Type "SPARE PARTS" in upper right hand corner of requisition.

Address requisitions to Engineer Field Maintenance Office, P. O. Box 1679, Columbus, Ohio (except for spare parts for searchlights and barrage balloons which are addressed to Schenectady, N. Y. or Ogden, Utah ASF depots).

Give complete shipping instructions. Special instructions for packing, marking, routing, etc., should be given at bottom of requisition.

State proper nomenclature of machine, also make, model, machine serial number and U. S. A. registration number.

Prepare a separate requisition for each different machine.

State basis or authority and date delivery is required, immediately below description of machine.

Double space between items.

Group parts required under group headings as shown in manufacturers' parts catalogs (Technical Manuals).

State OCE stock numbers, manufacturers' parts numbers and nomenclature accurately and completely. Do not use abbreviations.

SPARE PARTS

WAR DEPARTMENT
Q. M. C. Form No. 400
(Revised 10 Aug. 1943)

(SAMPLE)
REQUISITION

To: Engineer Field Maintenance Office — No. of Sheets 1 — Sheet No. 1
P.O. Box 1679, Columbus, Ohio
Requisition No. E-742-5-41 — Date May 2, 1944 — Period Replenishment

SHIP TO Engineer Property Officer, Pine Camp, New York.
MARKED FOR: Engineer Supply Officer, 802nd Eng. Battalion, Pine Camp, N.Y.

Requisitioned By (show Signature, Rank, Organization, Destination. If different from "ship to" include address):
Robert E. Roe
Robert E. Roe,
Major, C. E.,
Engineer Property Officer.

Approved
For the Commanding Officer:
John E. Doe
John E. Doe,
Col., C. E.,
Executive Officer.

MFG. NO.	NOMENCLATURE AND UNIT		AUTH. or MAX. LEVEL	ON HAND	DUE IN	REQUIRED	APPROVED
PARTS FOR CRANE, CRAWLER, KOEHRING MODEL 304							
	SERIAL NO. U.S.A. REG. NO. W-9871						
	Basis: Repair of Disabled Equipment						
	Delivery is requested by May 17, 1944						
	KOEHRING 304 CRANE GROUP CRAWLERS						
XA 15	Shoe, Crawler	ea.	0	0	0	4	
XA 11	Pin, Shoe	ea.	0	0	0	4	
	TWO SPEED SHAFT						
XA 119	Spacer, Bearing	ea.	0	0	0	1	
XA 120	Bearing	ea.	0	0	0	1	
XA 121	Washer, Thrust	ea.	0	0	0	1	
	BUDA ENGINE GROUP MODEL K428, SERIAL NO. 252415 CAMSHAFT ASSEMBLY						
XA 2045	Key, Camshaft Gear	ea.	0	0	0	1	
XA 2047	Camshaft	ea.	0	0	0	1	
	*						

*Nonexpendable items such as tools must be accounted for, when requisitioned, by a statement that they have been placed on REPORT OF SURVEY or STATEMENT OF CHARGES.

Emergency requisitions sent by telephone, teletype, cablegram, telegraph or radio must be confirmed immediately with requisition marked: "Confirming (state identifying data)."

PREPARATION OF REQUISITIONS

A Sample requisition in the correct form for submission by the Engineer Property Officer is shown on the opposite page.

THIS SHALL BE FOLLOWED IN MAKING OUT REQUISITIONS.

In order to eliminate duplication of work, Property Officers may authorize organizations to prepare requisitions in final form, leaving requisition number space blank for completion by Property Officer.

THE FOLLOWING RULES WILL BE OBSERVED CAREFULLY IN PREPARING REQUISITIONS FOR SPARE PARTS:

a. Prepare a separate requisition for each different machine.

b. Type "SPARE PARTS" in upper right hand corner of requisition form.

c. State PERIOD designation by use of one of the following terms:

(1) "INITIAL" - first requisition of authorized allowances.

(2) "REPLENISHMENT" - subsequent requisitions to maintain authorized allowances.

(3) "SPECIAL" - requisitions for necessary repairs not covered by allowances.

d. Give complete shipping instuctions.

e. State proper nomenclature of machine, and make, model, serial number and registration number.

f. State basis or authority, and date delivery is required, immediately below description of machine.

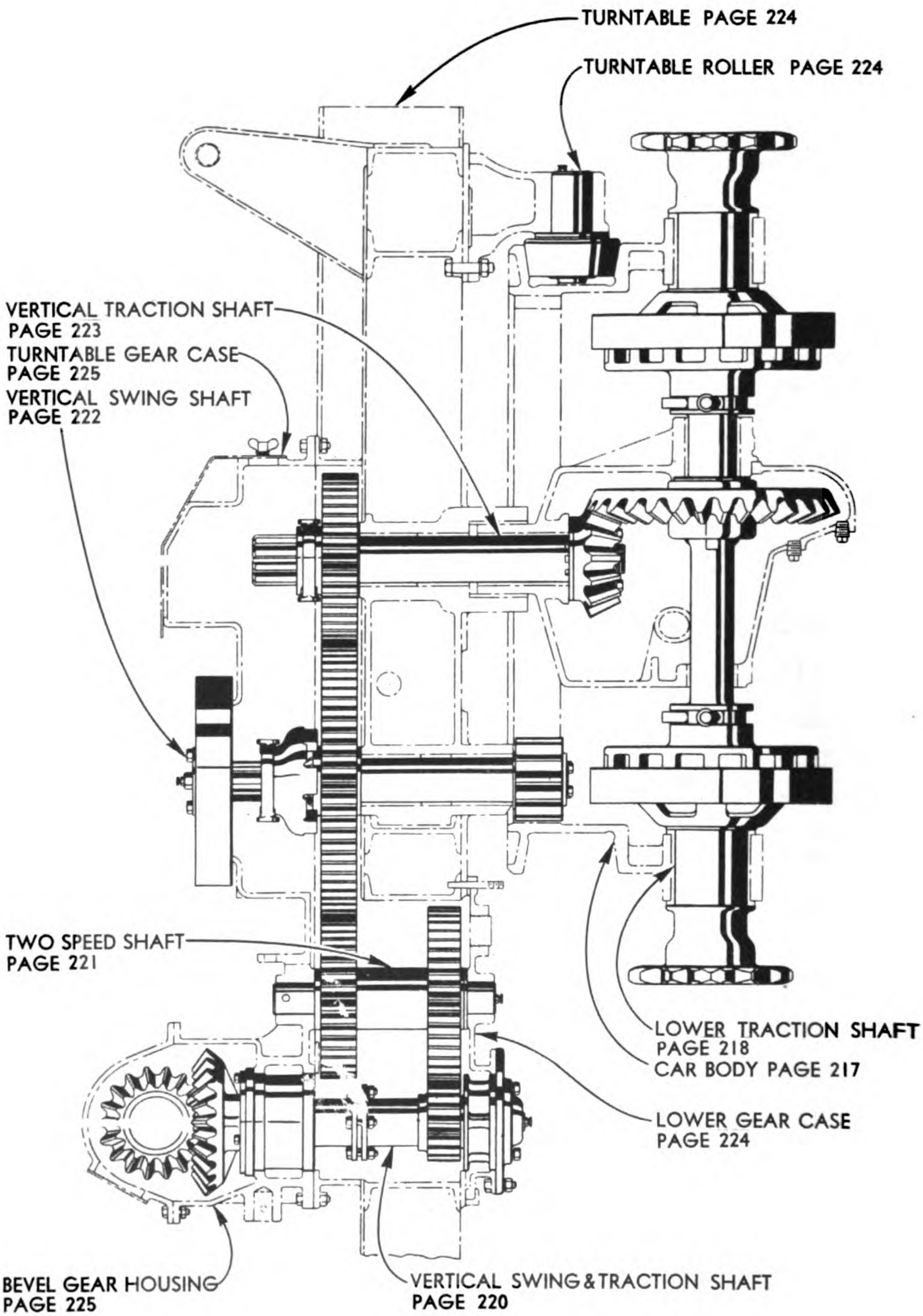
g. Group parts required under group headings as shown in manufacturers' parts catalogs.

h. State manufacturers' parts numbers and nomenclature descriptions accurately and completely. Do not use abbreviations.

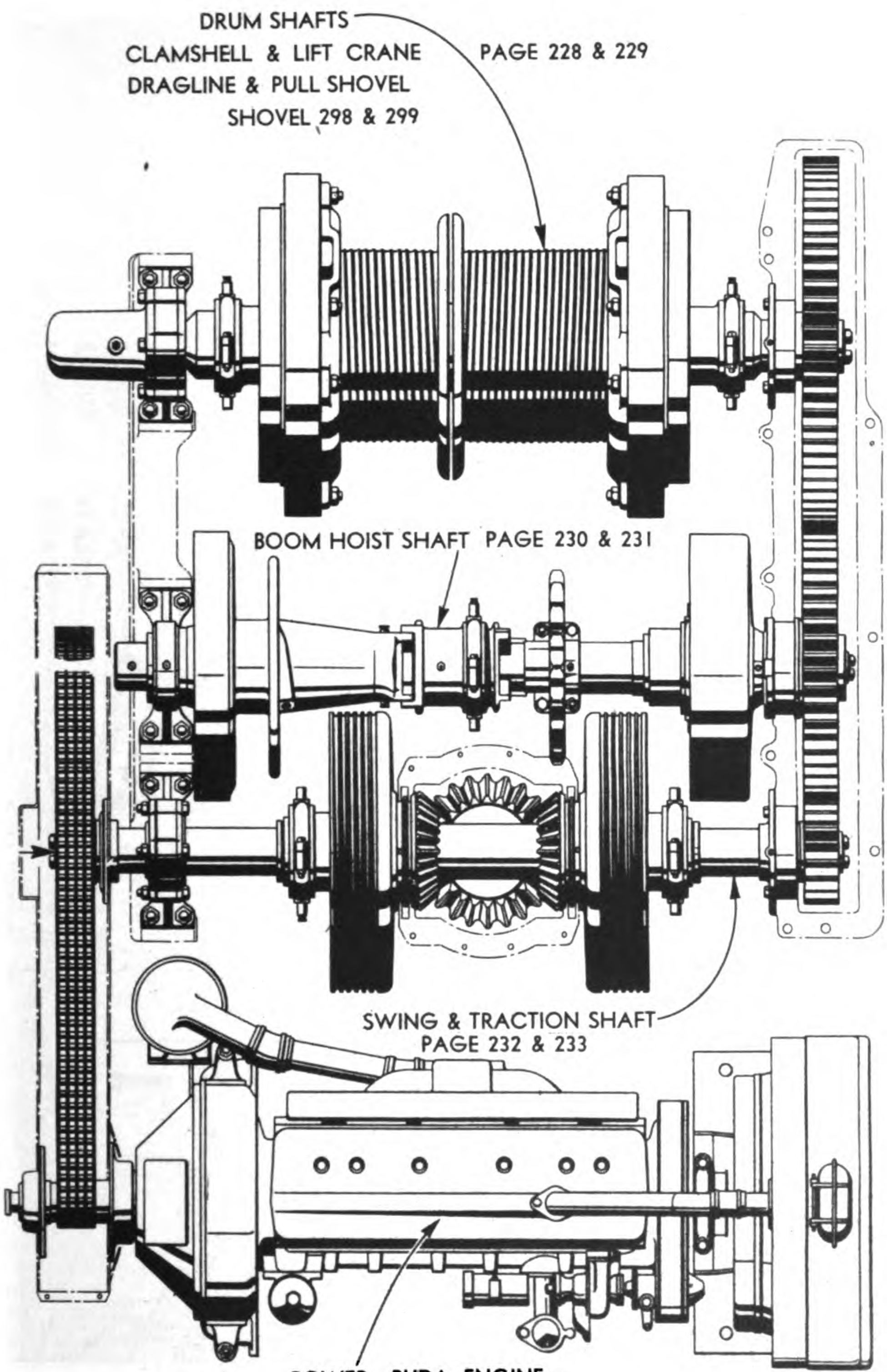
i. Double space between items.

j. Emergency requisitions sent by telephone, telegraph, or radio must always be confirmed immediately with requisition marked: "Confirming (state identifying data)".

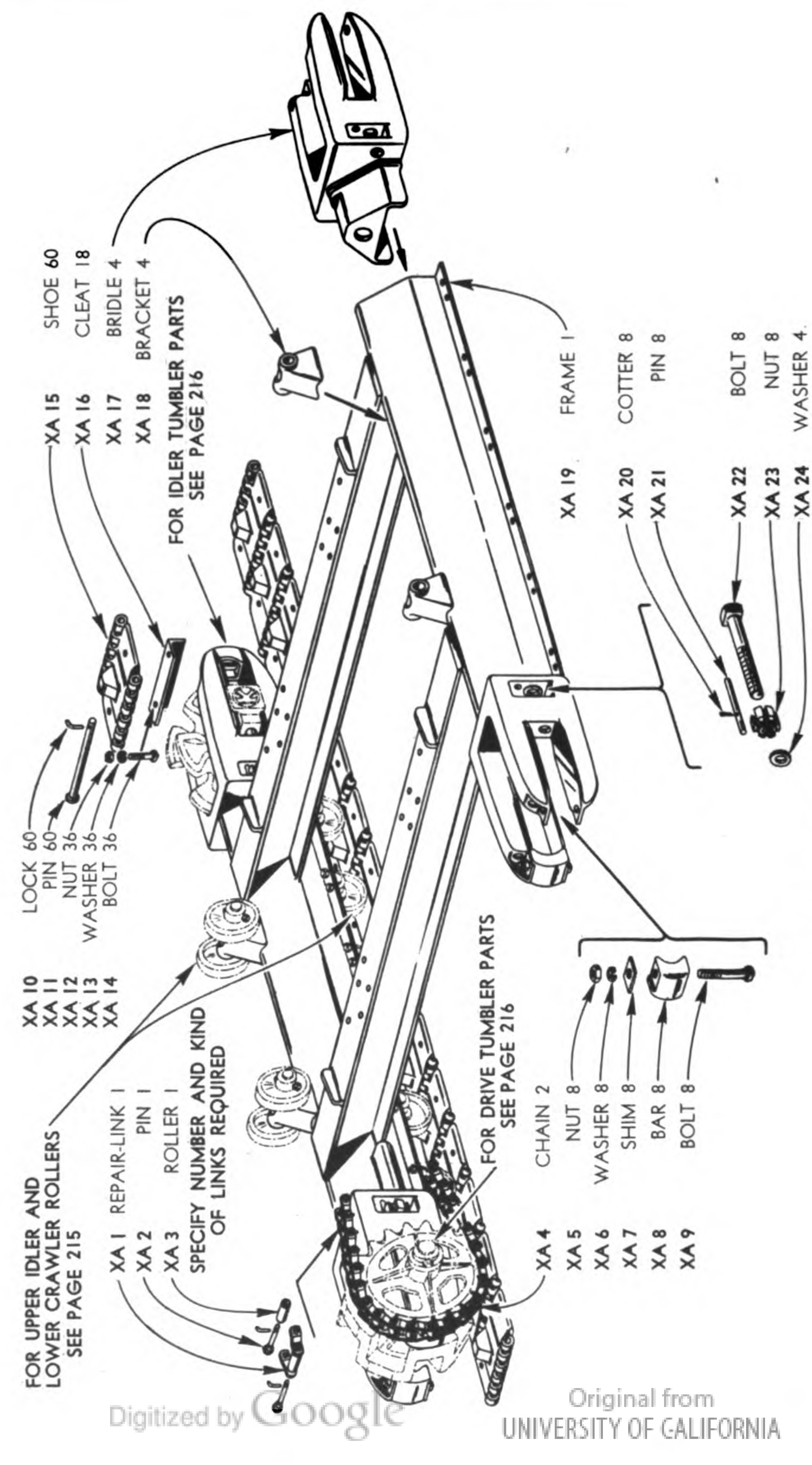
k. Nonexpendable items must be accounted for.



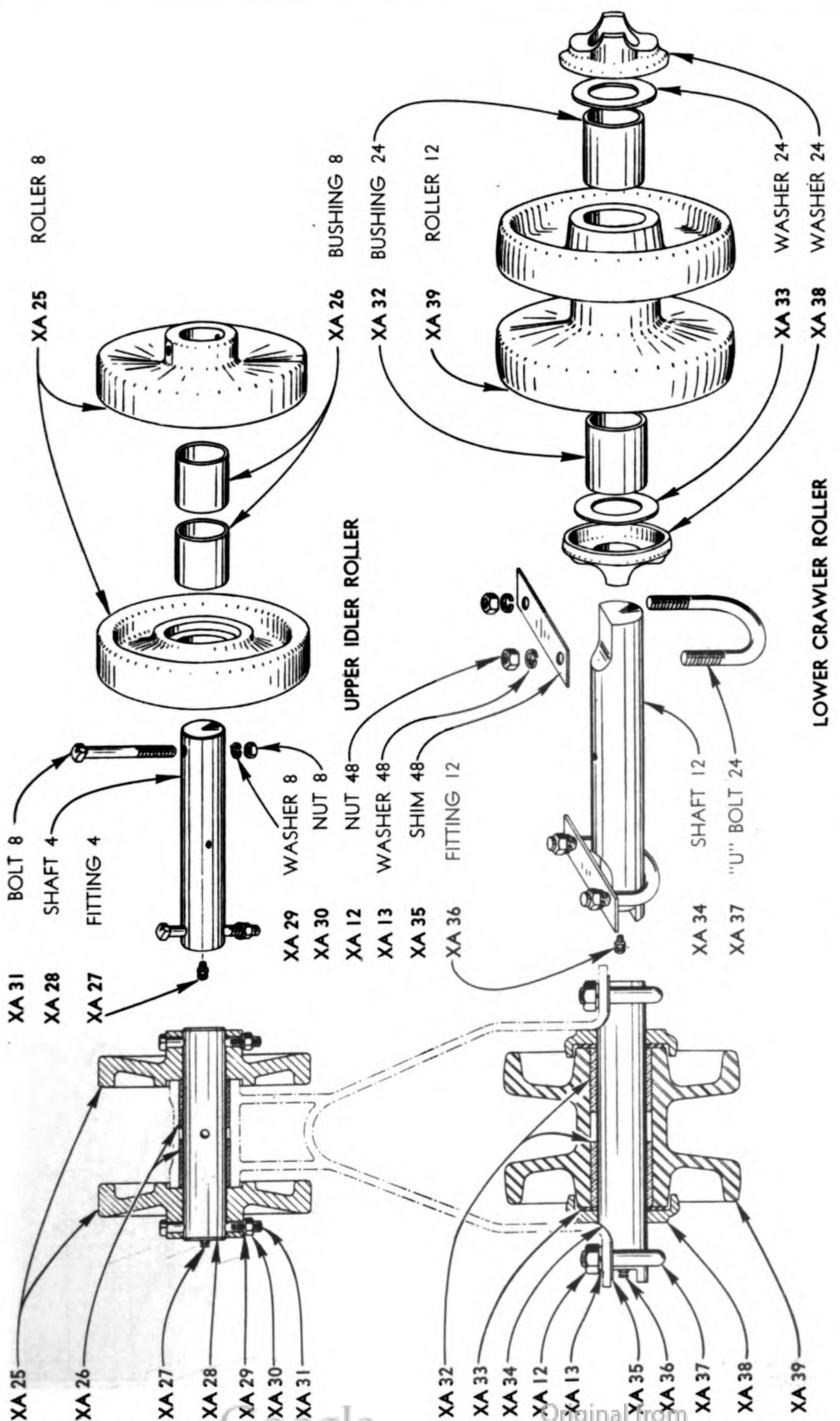
LOWER MACHINERY ASSEMBLY



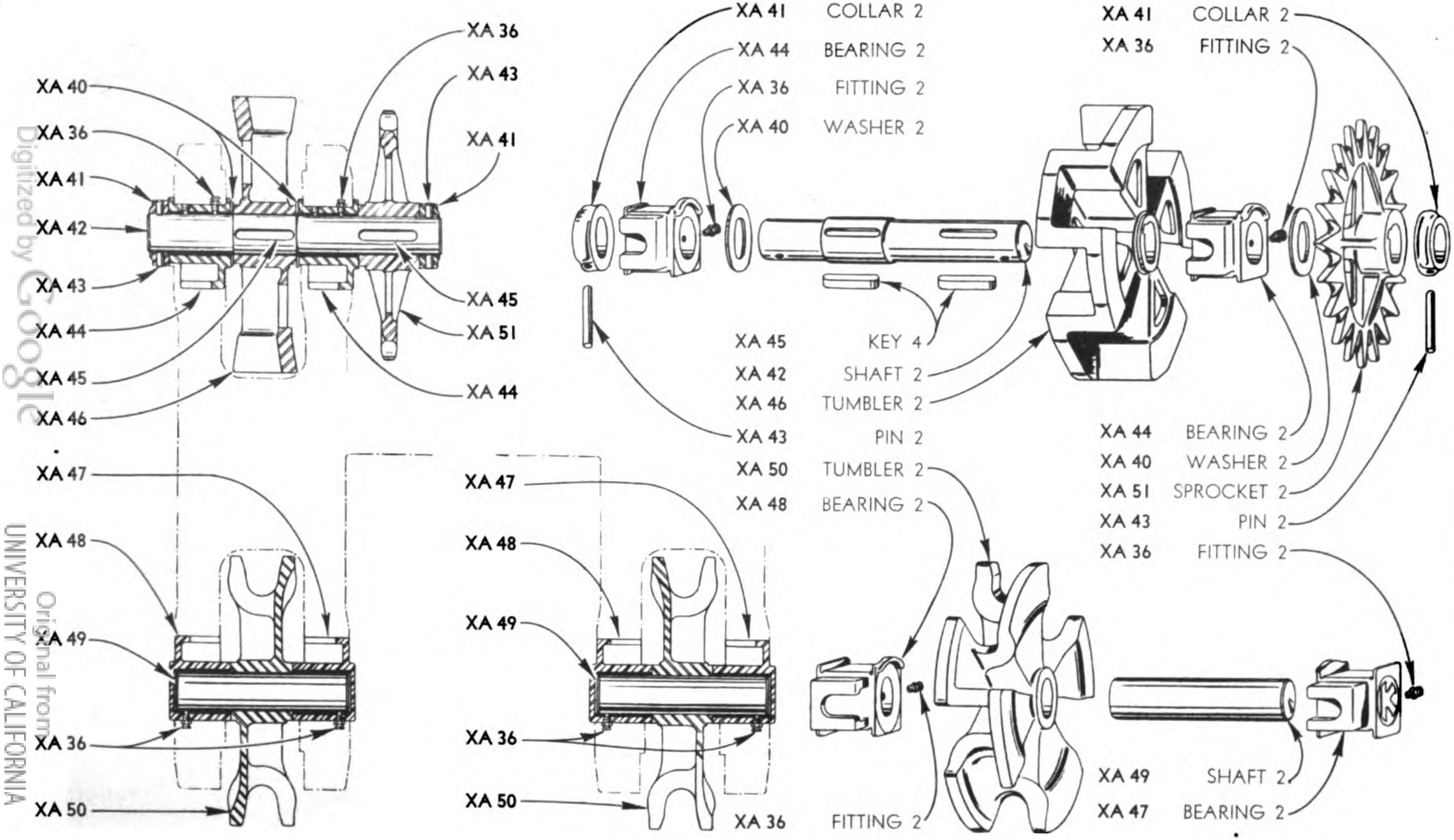
UPPER MACHINERY ASSEMBLY



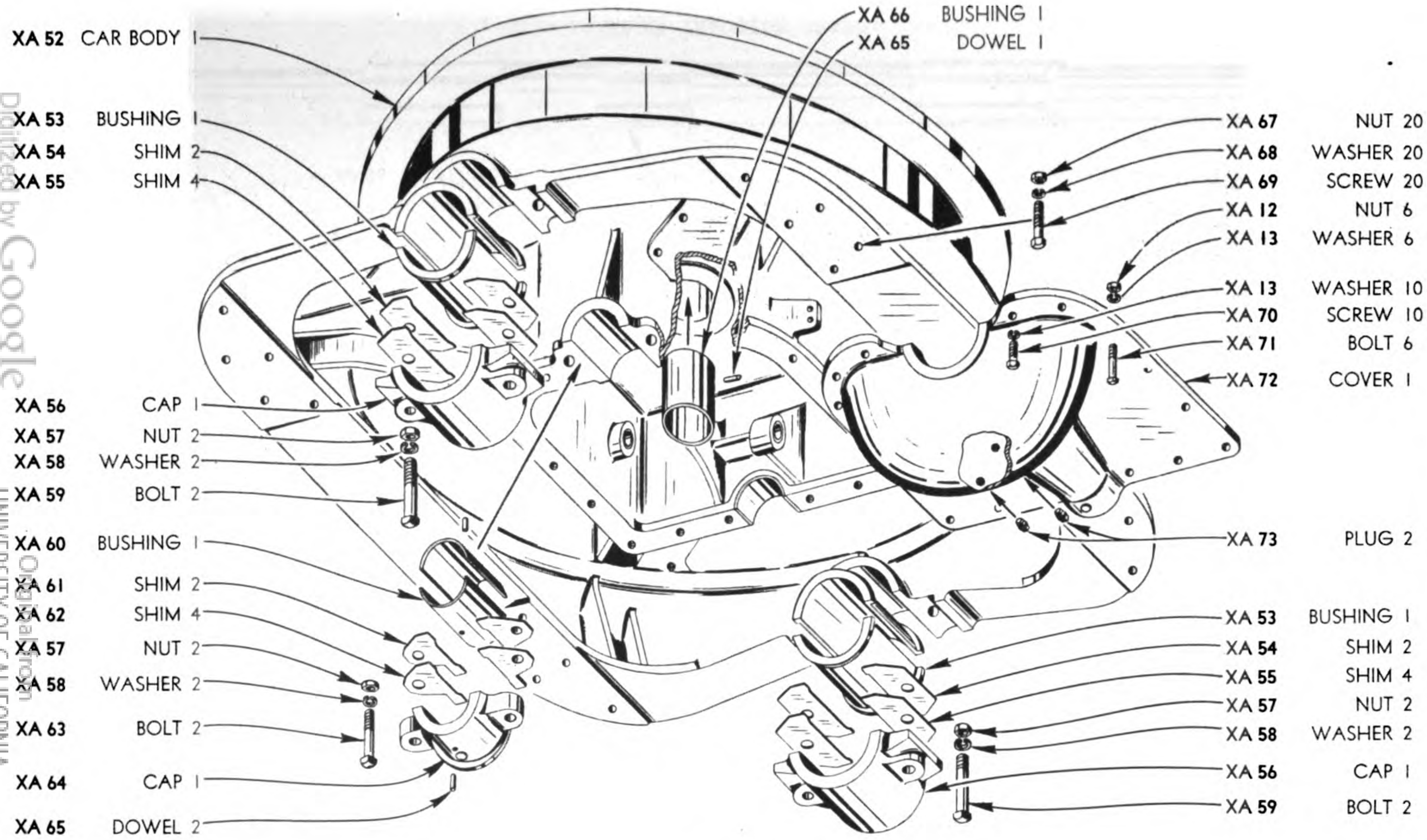
CRAWLER FRAME AND AXLE - DRIVE CHAIN



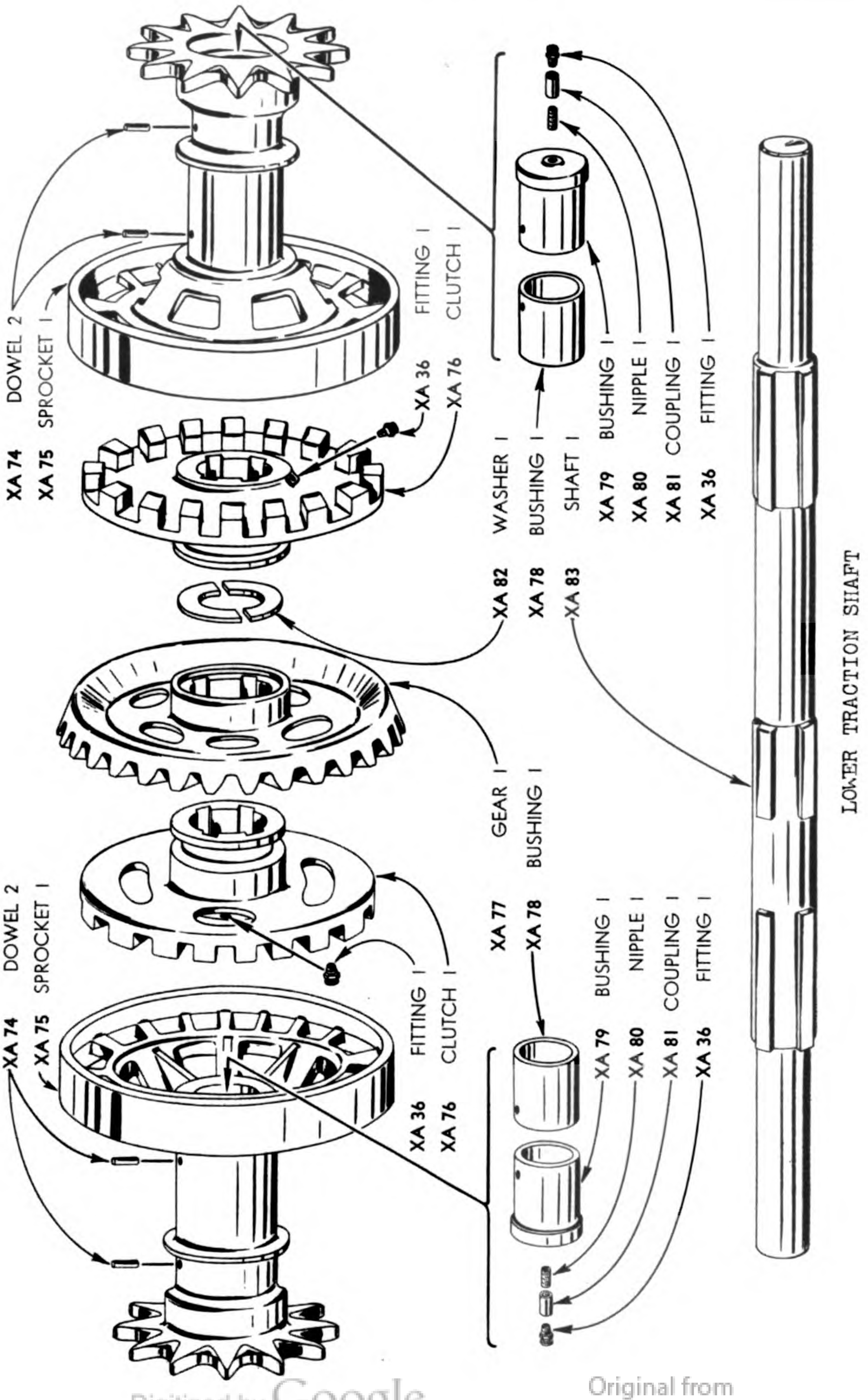
UPPER IDLER AND LOWER CRAWLER ROLLERS

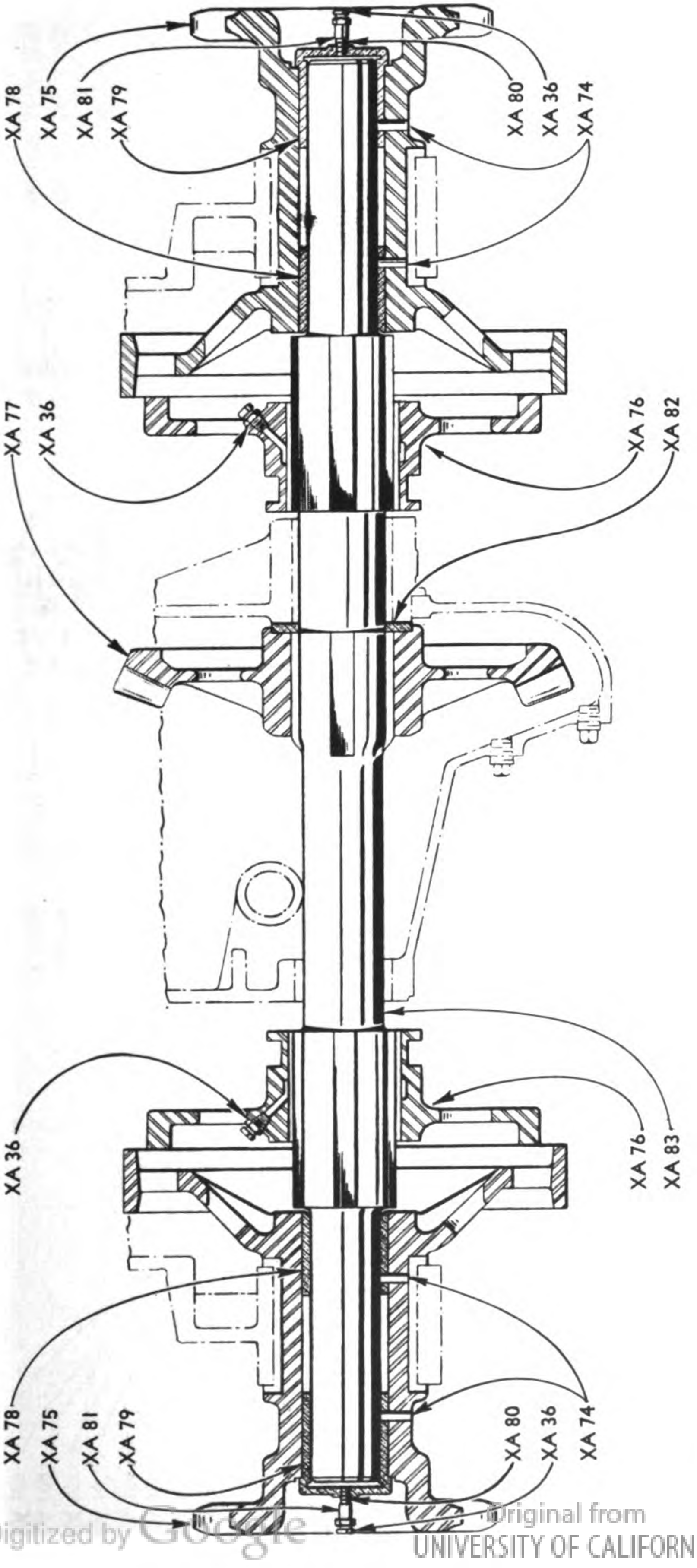


IDLER AND DRIVE TUMBLER SHAFTS

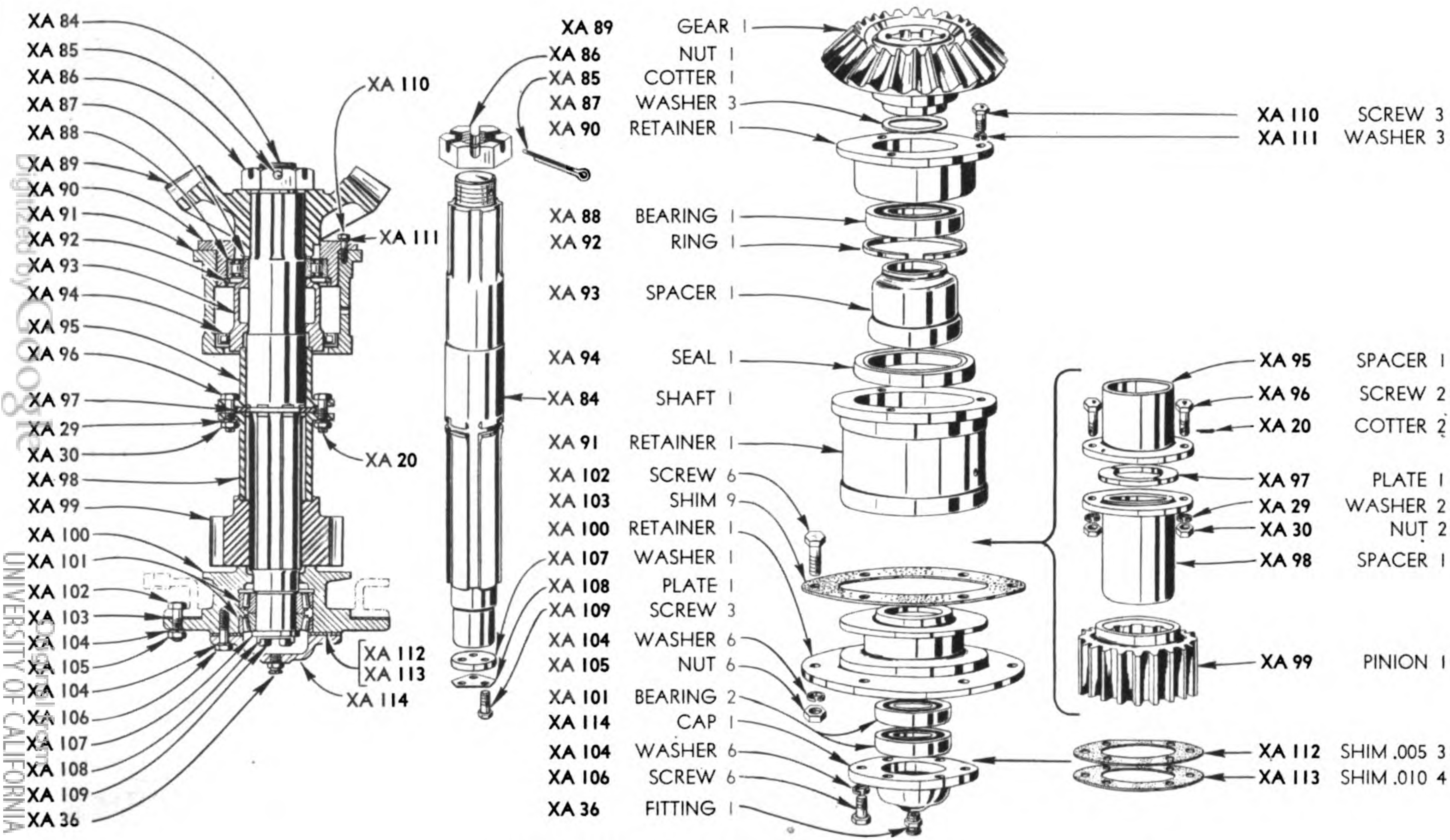

XA 52 CAR BODY 1
XA 53 BUSHING 1
XA 54 SHIM 2
XA 55 SHIM 4
XA 56 CAP 1
XA 57 NUT 2
XA 58 WASHER 2
XA 59 BOLT 2
XA 60 BUSHING 1
XA 61 SHIM 2
XA 62 SHIM 4
XA 57 NUT 2
XA 58 WASHER 2
XA 63 BOLT 2
XA 64 CAP 1
XA 65 DOWEL 2
XA 66 BUSHING 1
XA 65 DOWEL 1
XA 67 NUT 20
XA 68 WASHER 20
XA 69 SCREW 20
XA 12 NUT 6
XA 13 WASHER 6
XA 13 WASHER 10
XA 70 SCREW 10
XA 71 BOLT 6
XA 72 COVER 1
XA 73 PLUG 2
XA 53 BUSHING 1
XA 54 SHIM 2
XA 55 SHIM 4
XA 57 NUT 2
XA 58 WASHER 2
XA 56 CAP 1
XA 59 BOLT 2

CARBODY

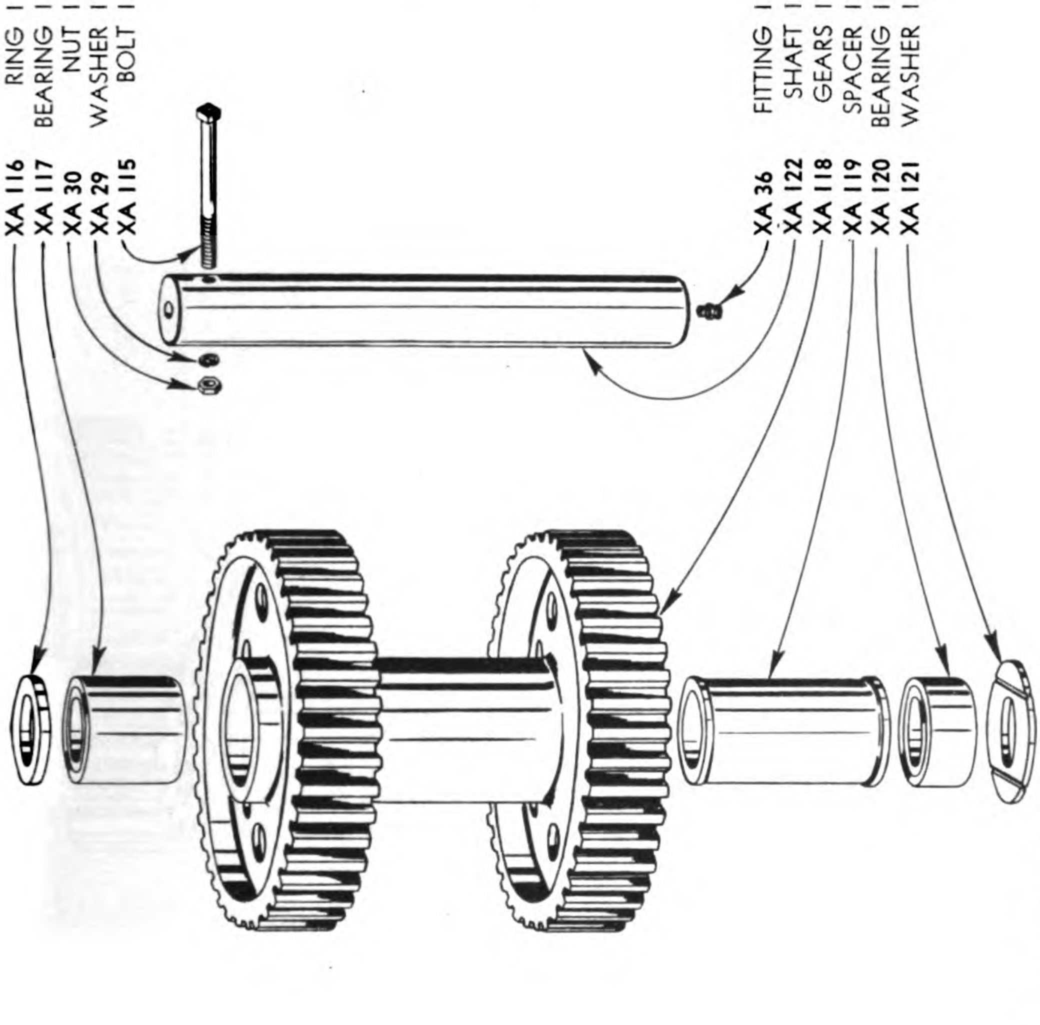

XA 74 DOWEL 2
XA 75 SPROCKET 1
XA 36 FITTING 1
XA 76 CLUTCH 1
XA 82 WASHER 1
XA 78 BUSHING 1
XA 83 SHAFT 1
XA 79 BUSHING 1
XA 80 NIPPLE 1
XA 81 COUPLING 1
XA 36 FITTING 1
XA 77 GEAR 1
XA 78 BUSHING 1
XA 74 DOWEL 2
XA 75 SPROCKET 1
XA 36 FITTING 1
XA 76 CLUTCH 1
XA 79 BUSHING 1
XA 80 NIPPLE 1
XA 81 COUPLING 1
XA 36 FITTING 1
LOWER TRACTION SHAFT



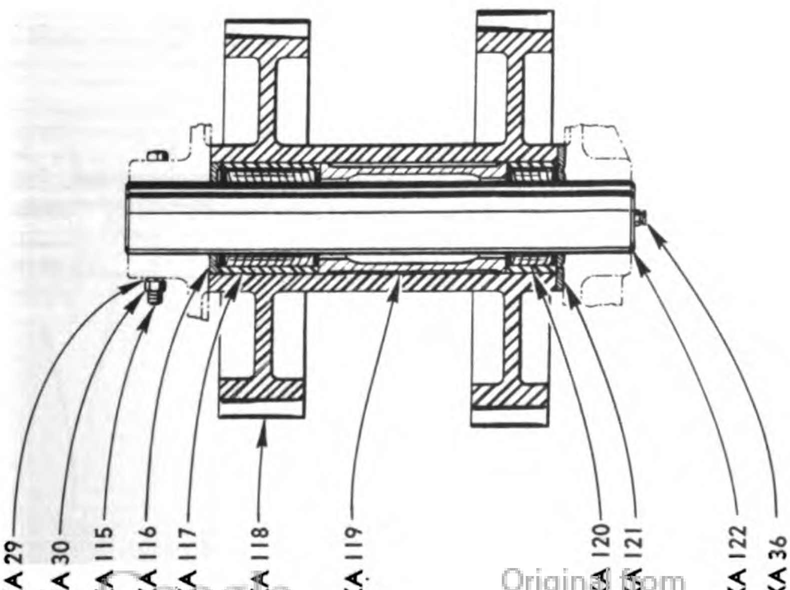
LOWER TRACTION SHAFT
(SECTIONAL VIEW)

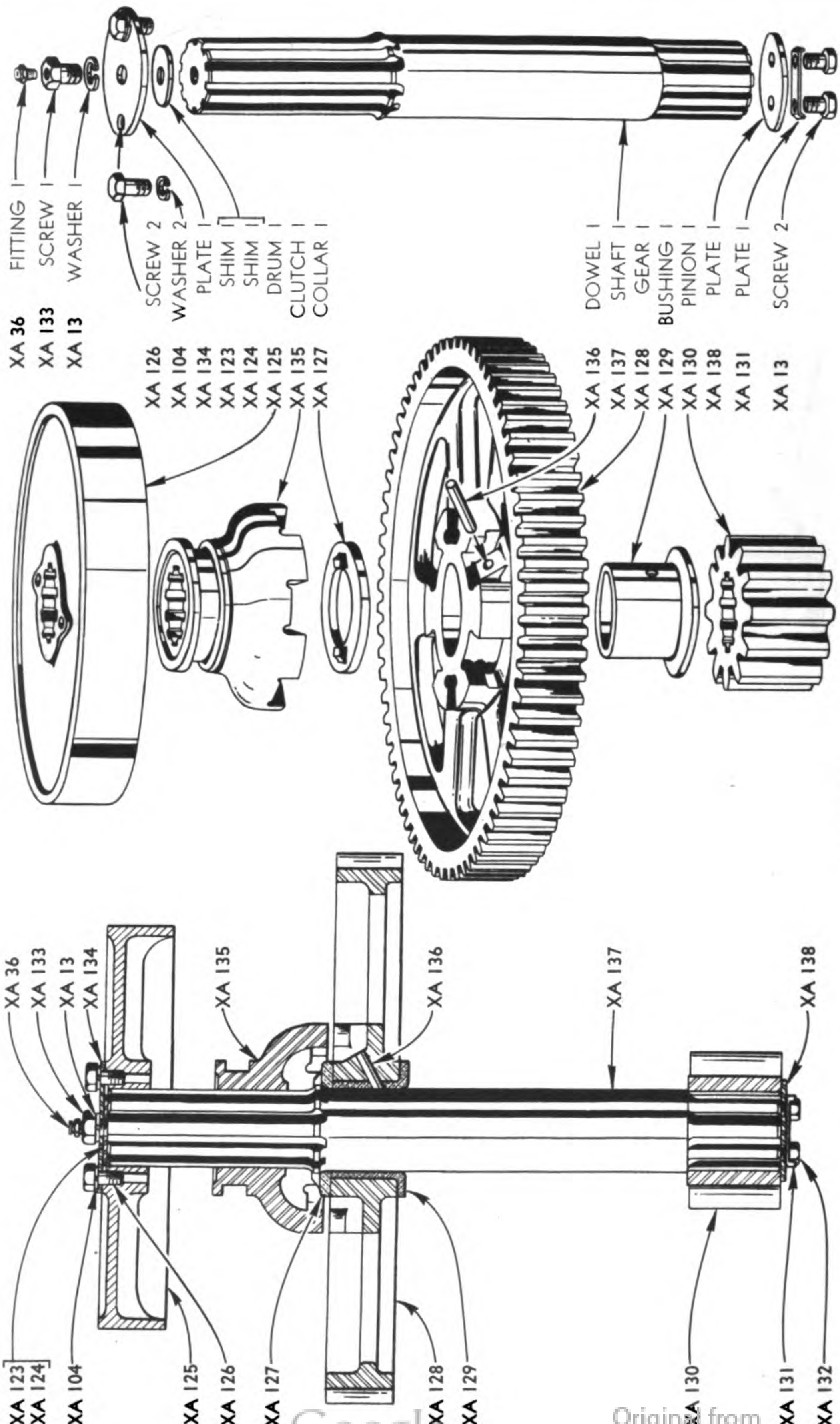


VERTICAL SWING AND TRACTION SHAFT

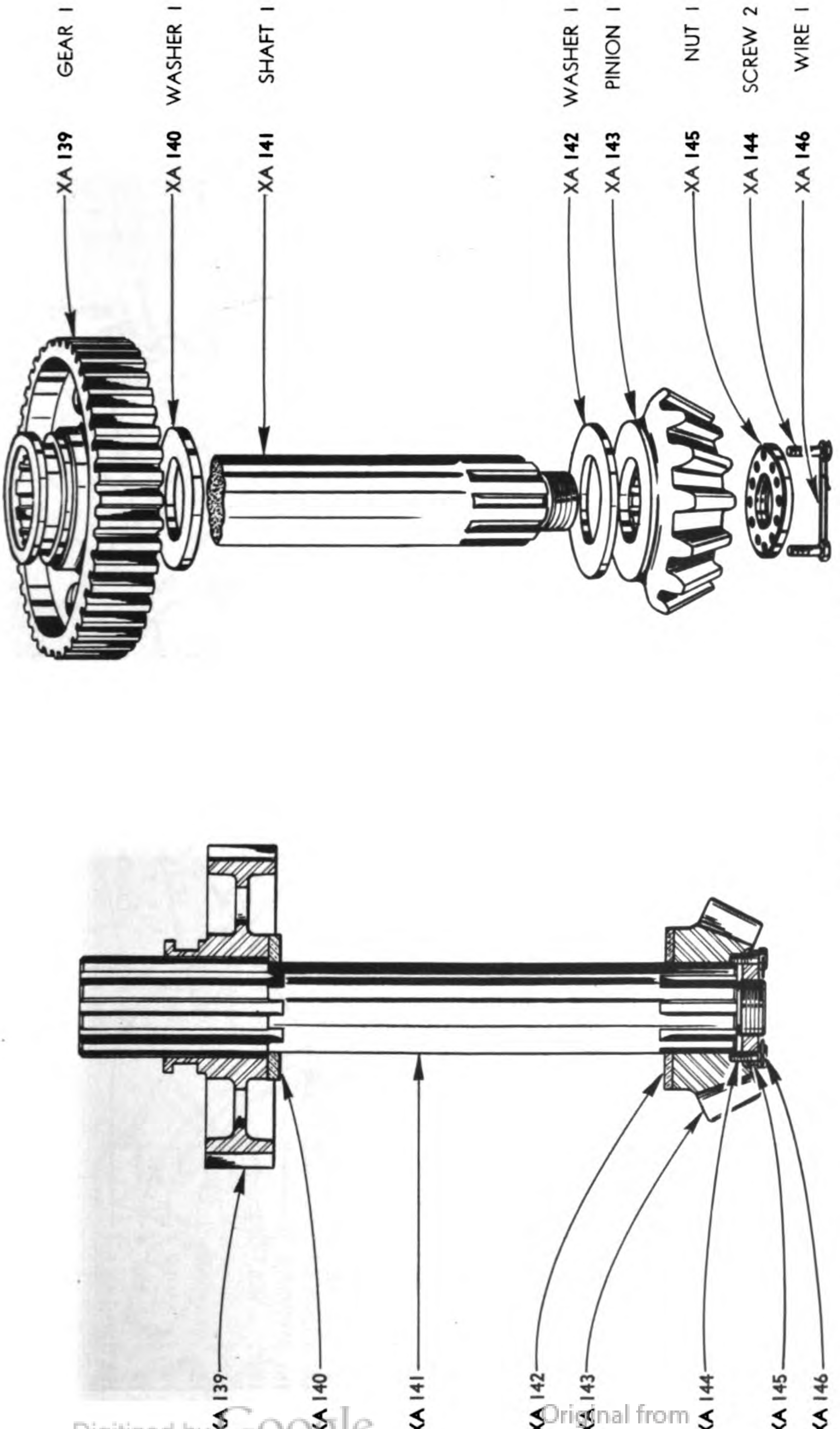


TWO SPEED SHAFT

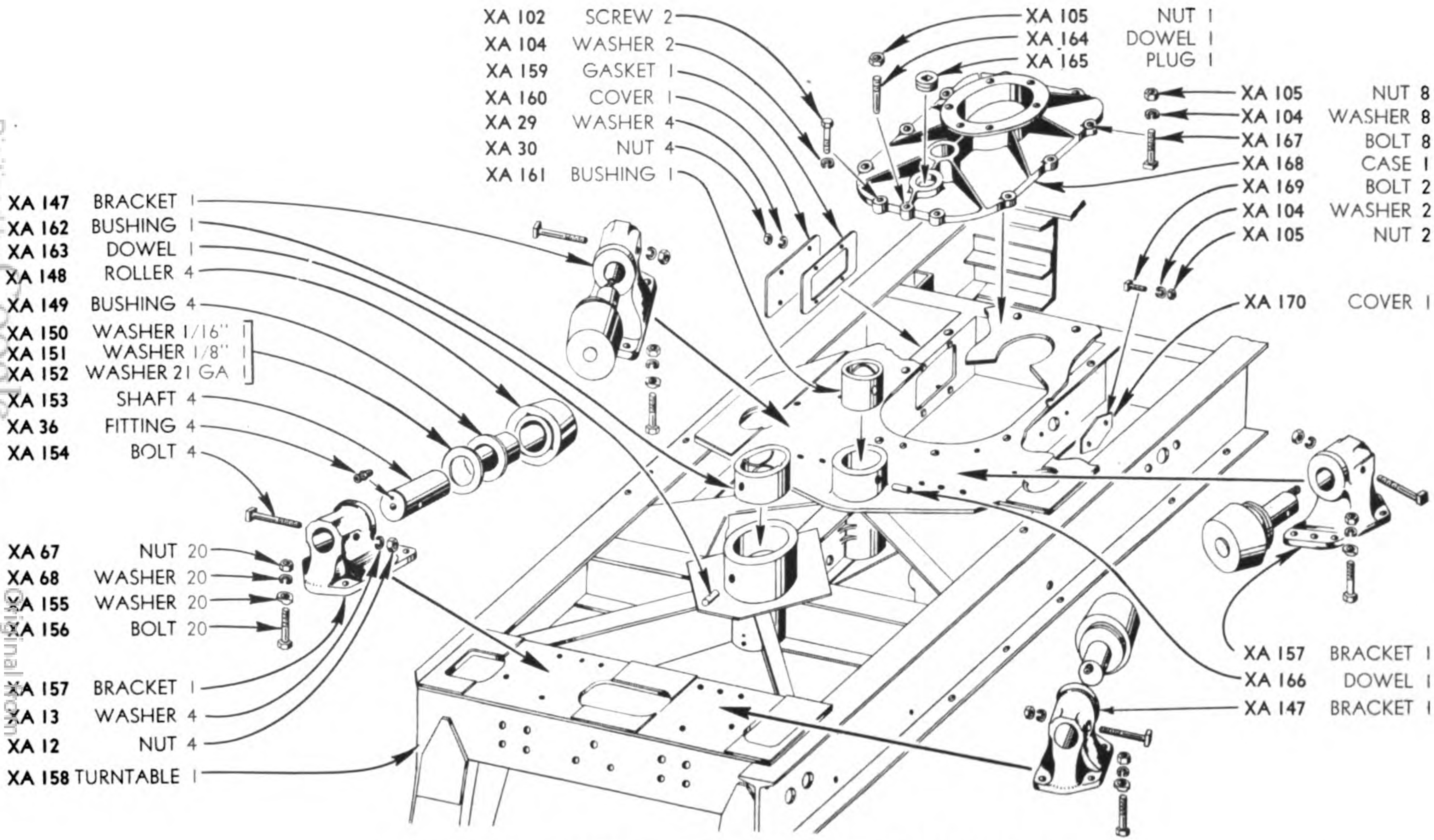




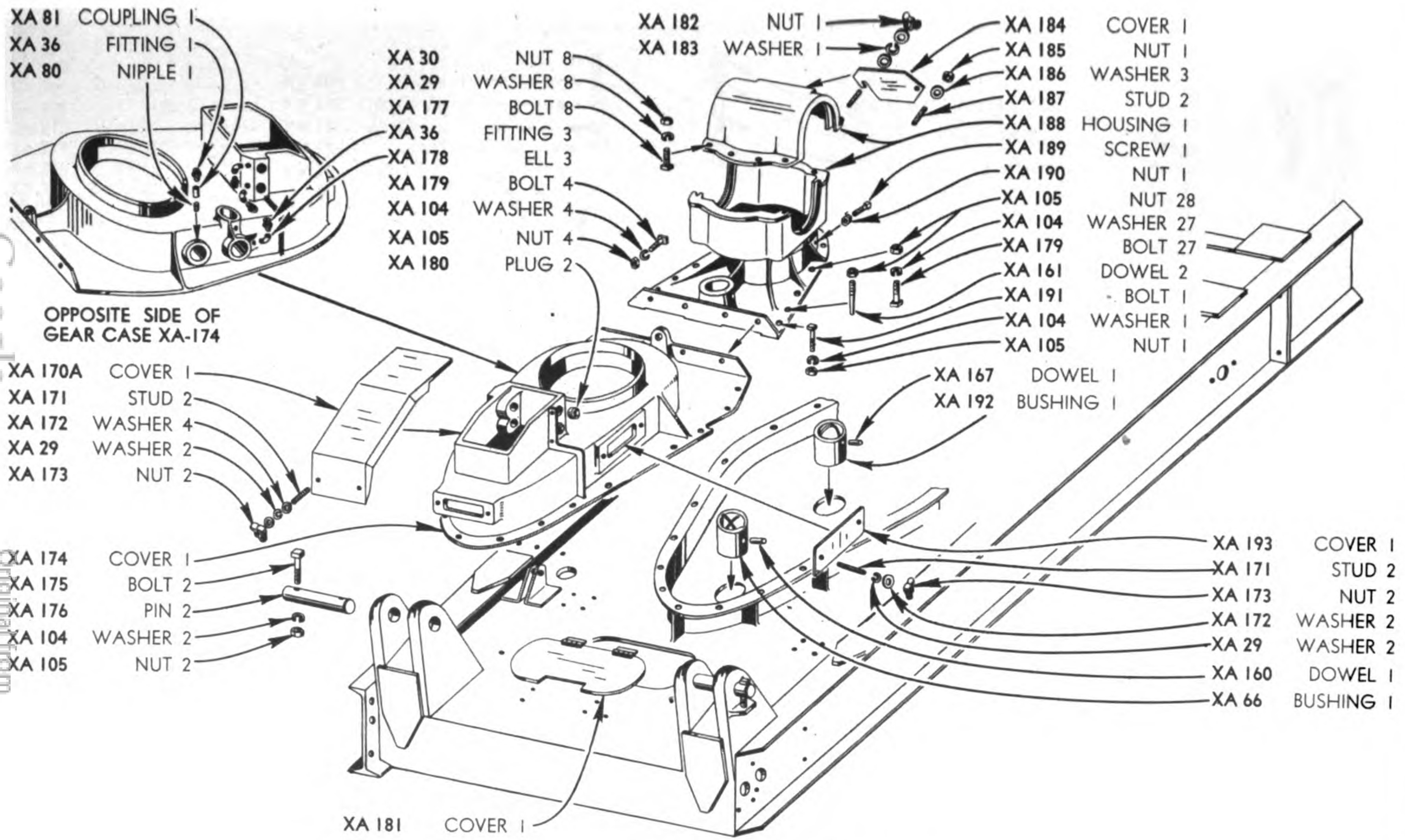
VERTICAL SWING SHAFT



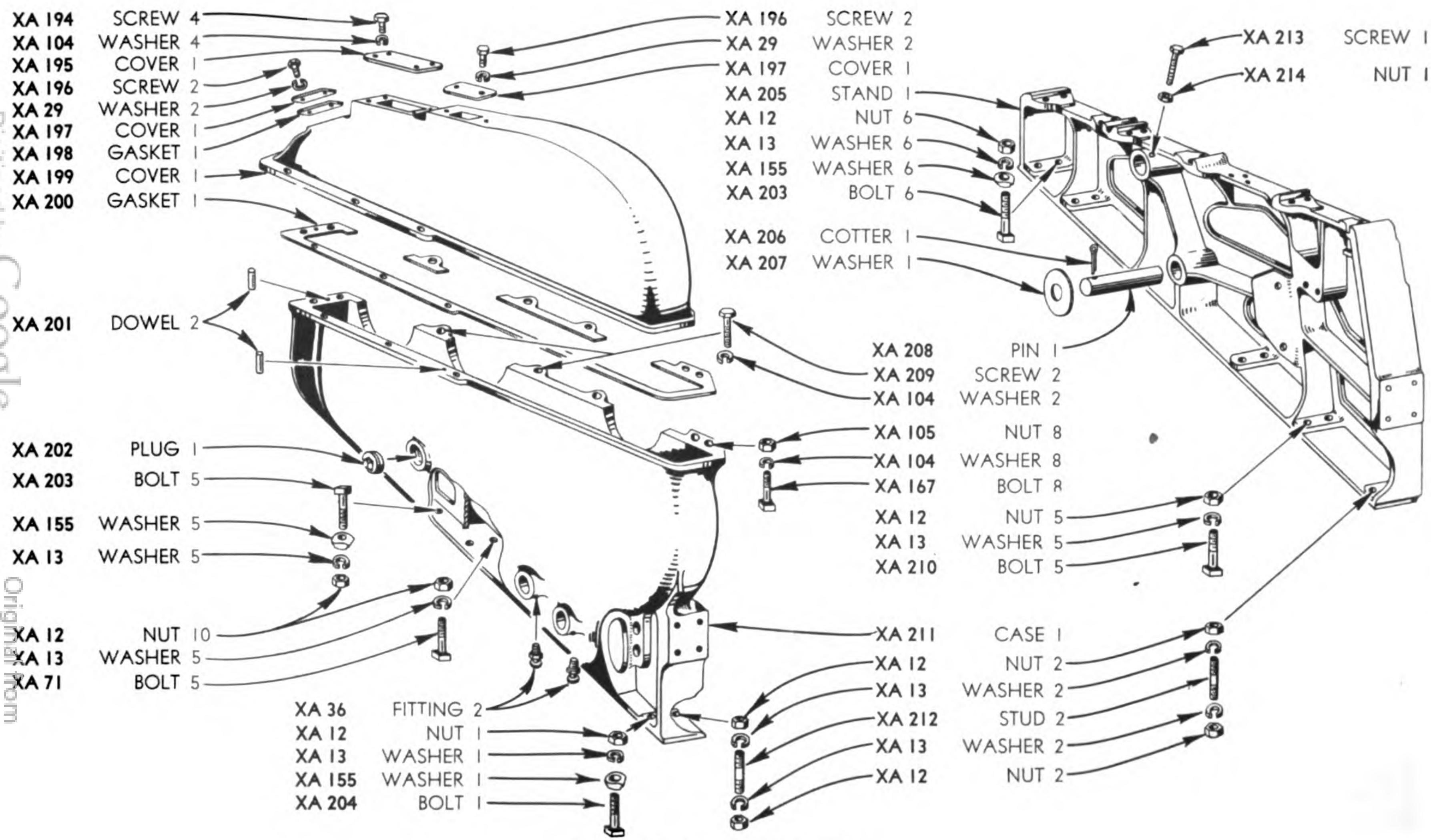
VERTICAL TRACTION SHAFT



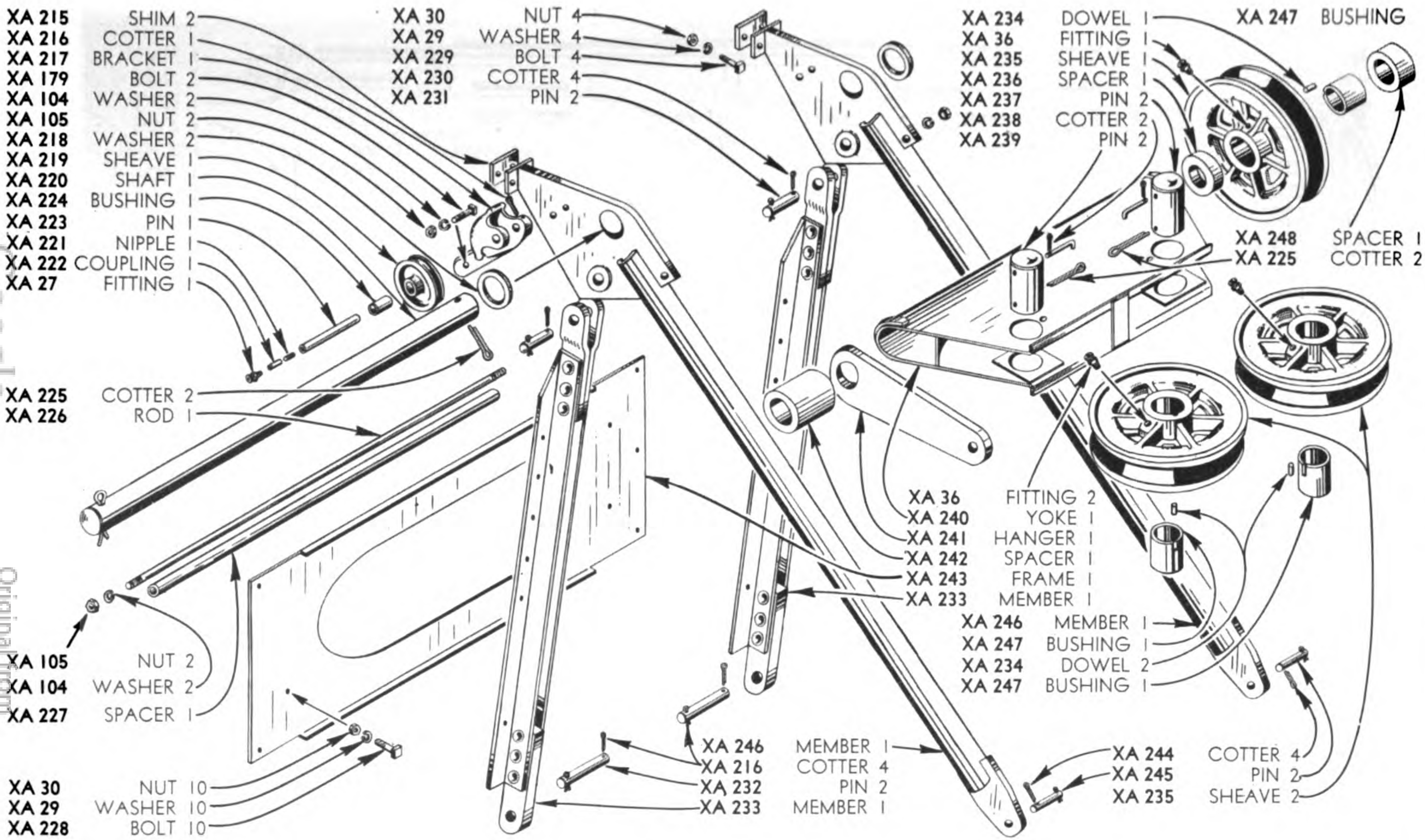
TURN TABLE - LOWER GEAR CASE - TURN TABLE ROLLERS



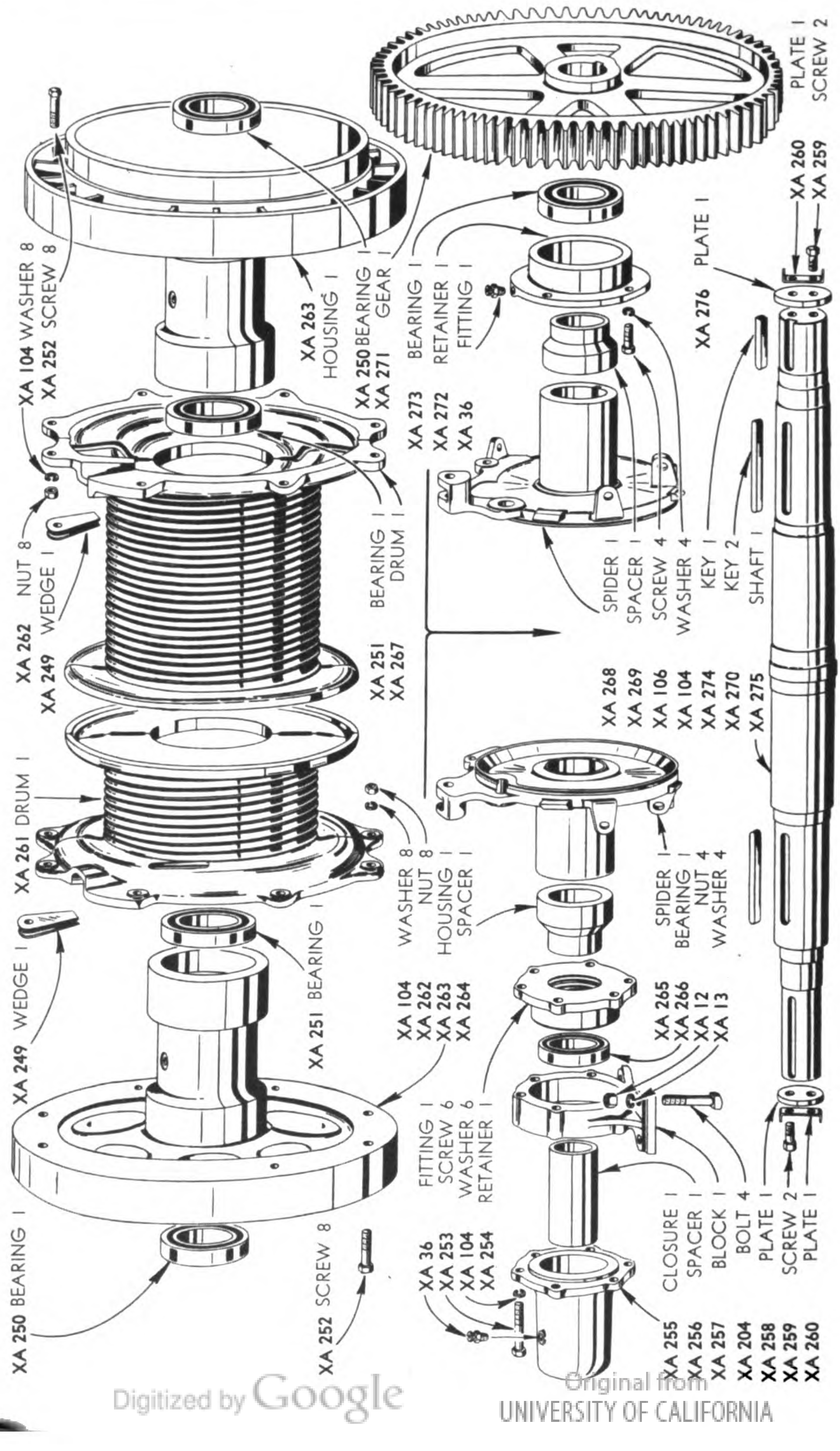
TURNTABLE GEAR CASE - BOOM PIVOT POINT



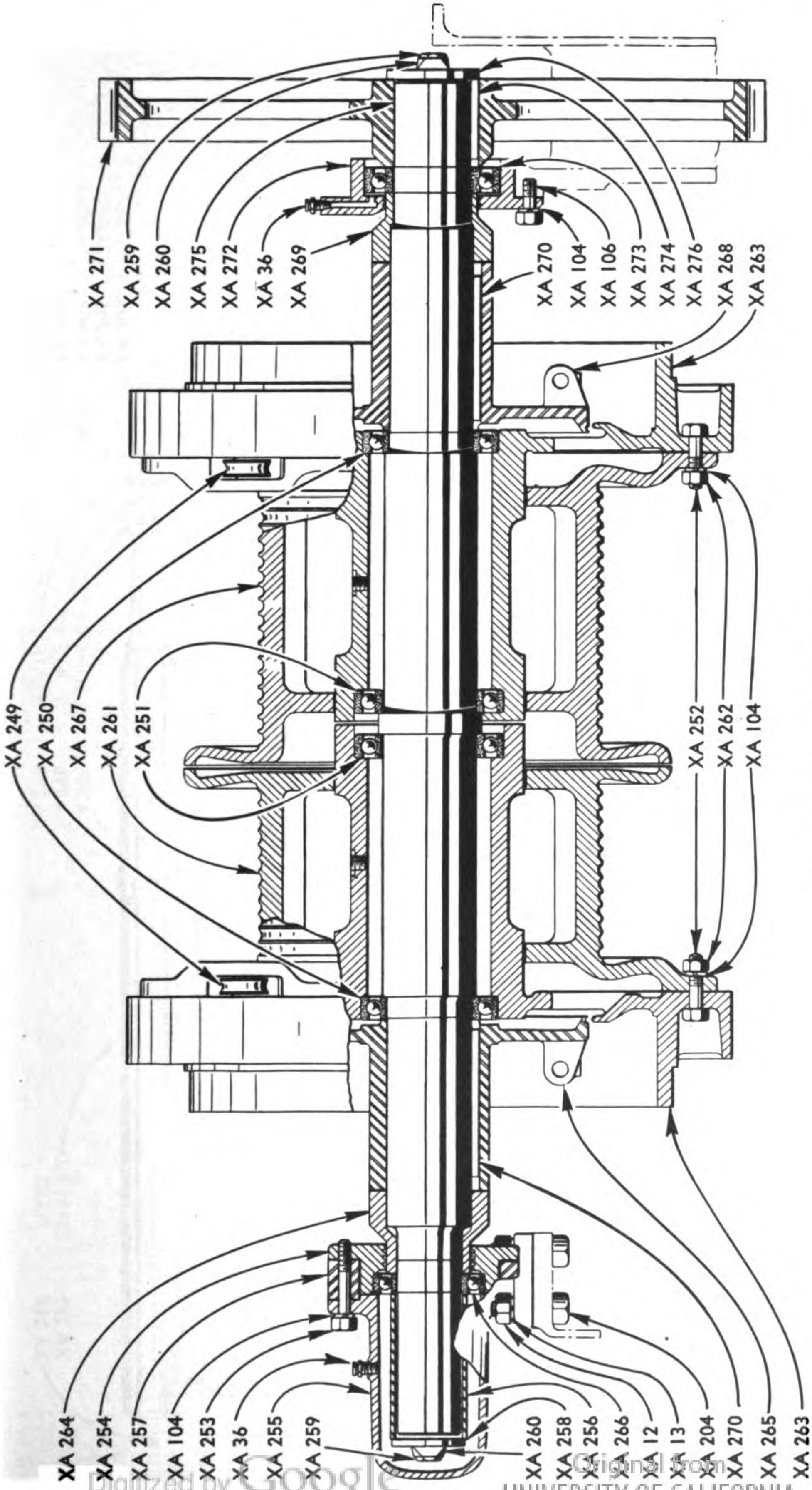
SIDE STAND - GEAR CASE


XA 215 SHIM 2
XA 216 COTTER 1
XA 217 BRACKET 1
XA 179 BOLT 2
XA 104 WASHER 2
XA 105 NUT 2
XA 218 WASHER 2
XA 219 SHEAVE 1
XA 220 SHAFT 1
XA 224 BUSHING 1
XA 223 PIN 1
XA 221 NIPPLE 1
XA 222 COUPLING 1
XA 27 FITTING 1
XA 225 COTTER 2
XA 226 ROD 1
XA 105 NUT 2
XA 104 WASHER 2
XA 227 SPACER 1
XA 30 NUT 10
XA 29 WASHER 10
XA 228 BOLT 10
XA 30 NUT 4
XA 29 WASHER 4
XA 229 BOLT 4
XA 230 COTTER 4
XA 231 PIN 2
XA 234 DOWEL 1
XA 36 FITTING 1
XA 235 SHEAVE 1
XA 236 SPACER 1
XA 237 PIN 2
XA 238 COTTER 2
XA 239 PIN 2
XA 247 BUSHING
XA 248 SPACER 1
XA 225 COTTER 2
XA 36 FITTING 2
XA 240 YOKE 1
XA 241 HANGER 1
XA 242 SPACER 1
XA 243 FRAME 1
XA 233 MEMBER 1
XA 246 MEMBER 1
XA 247 BUSHING 1
XA 234 DOWEL 2
XA 247 BUSHING 1
XA 246 MEMBER 1
XA 216 COTTER 4
XA 232 PIN 2
XA 233 MEMBER 1
XA 244 COTTER 4
XA 245 PIN 2
XA 235 SHEAVE 2

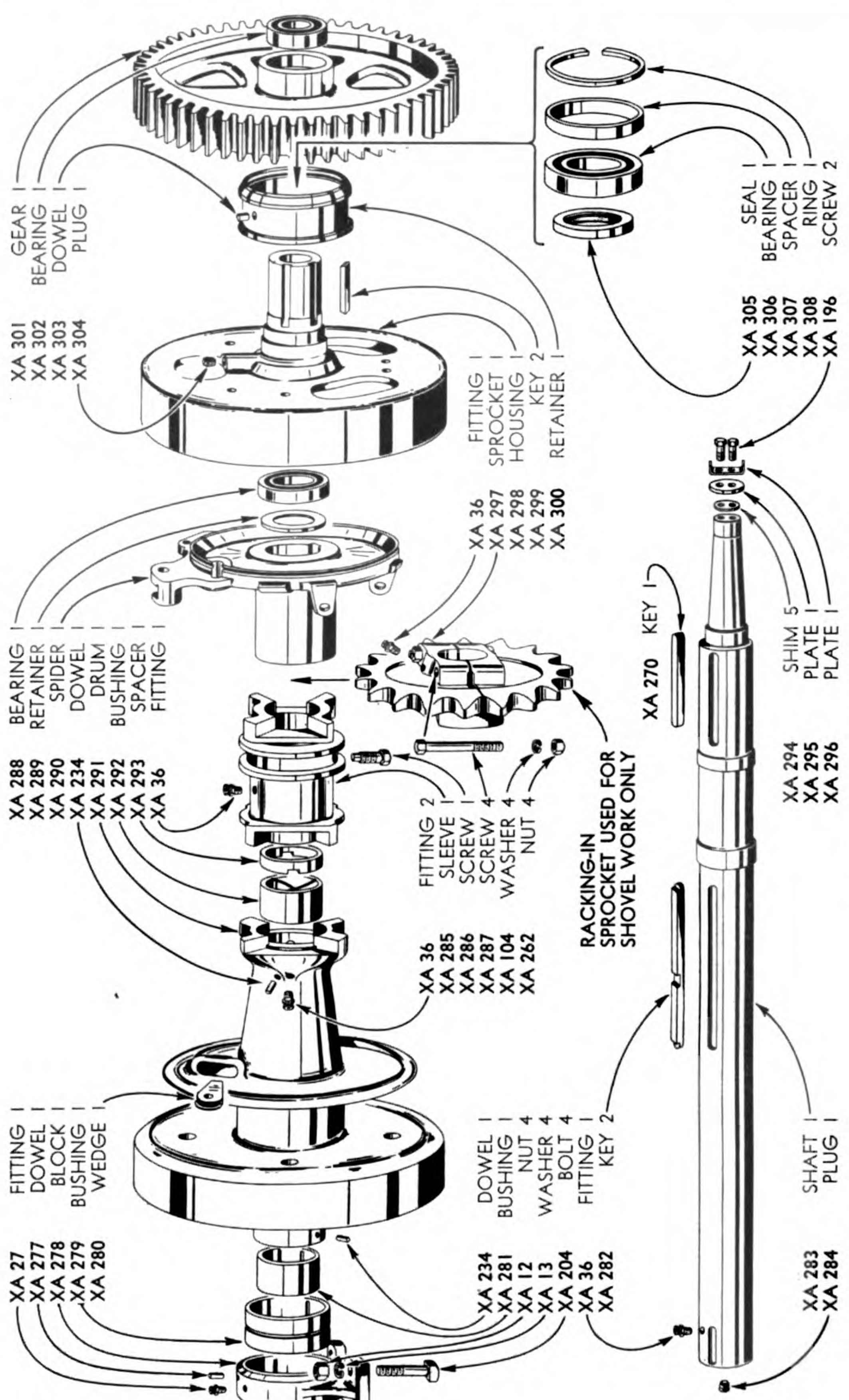
"A" FRAME



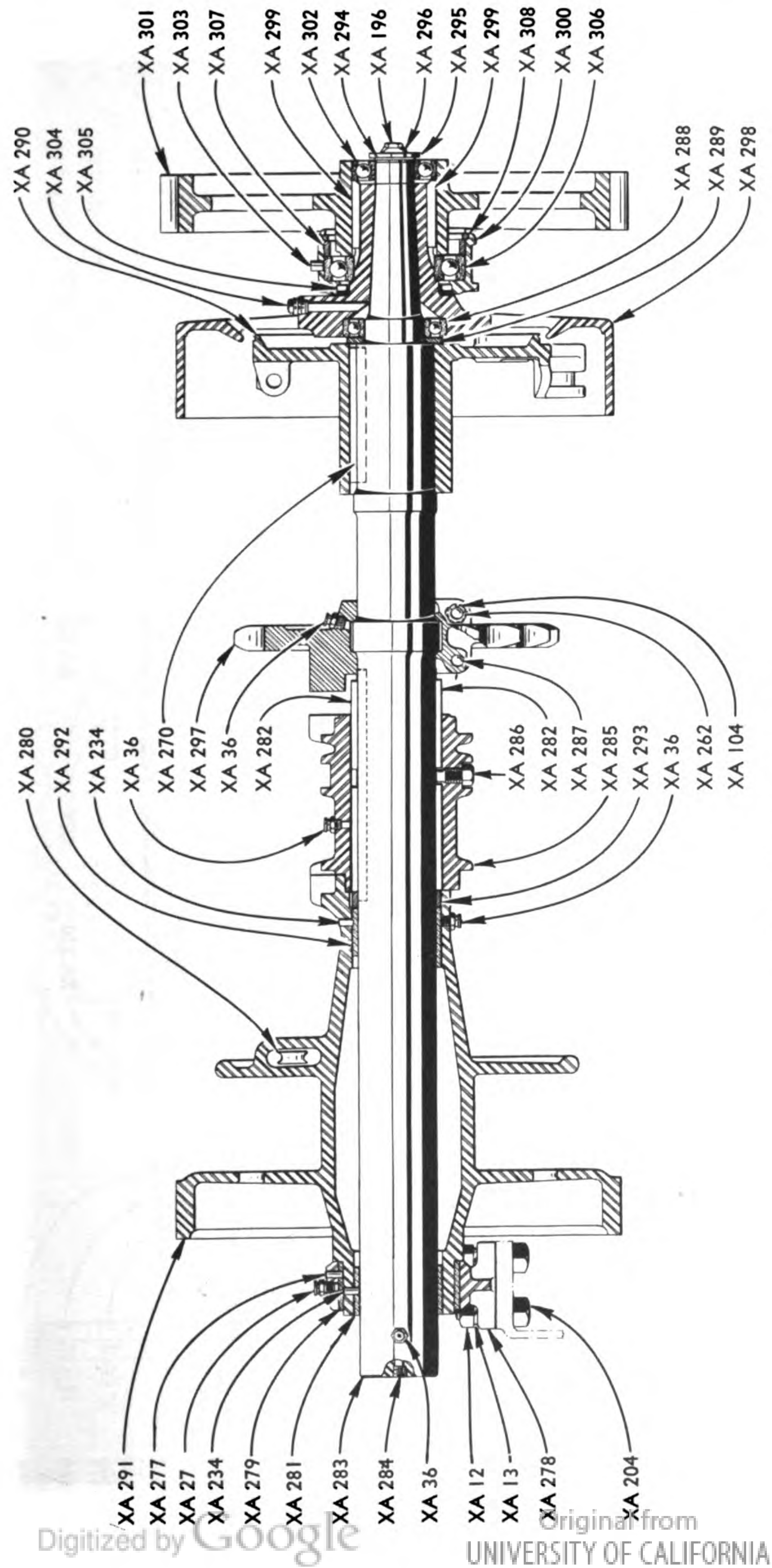
DRUM SHAFT - CLAMSHELL



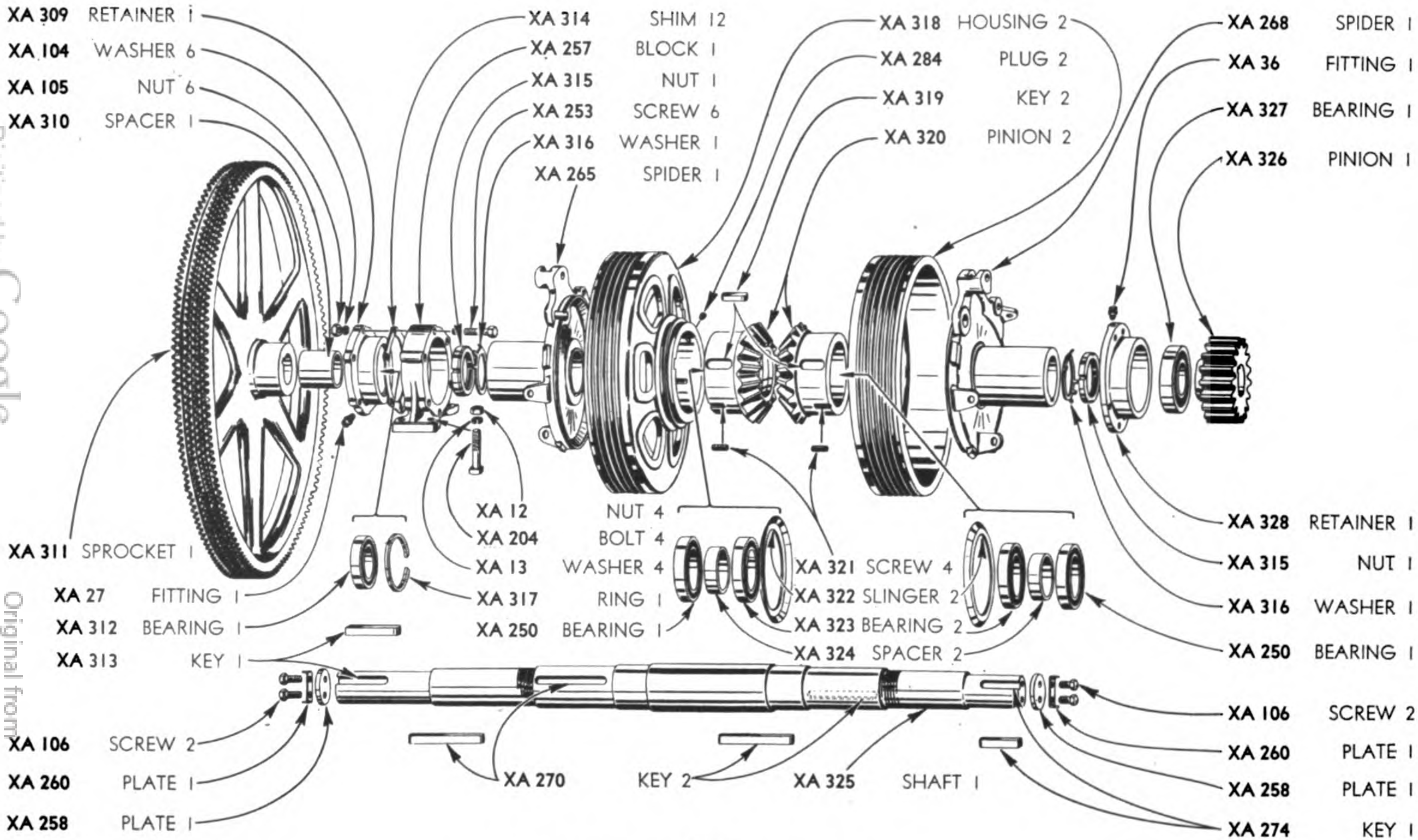
DRUM SHAFT - CLAMSHELL



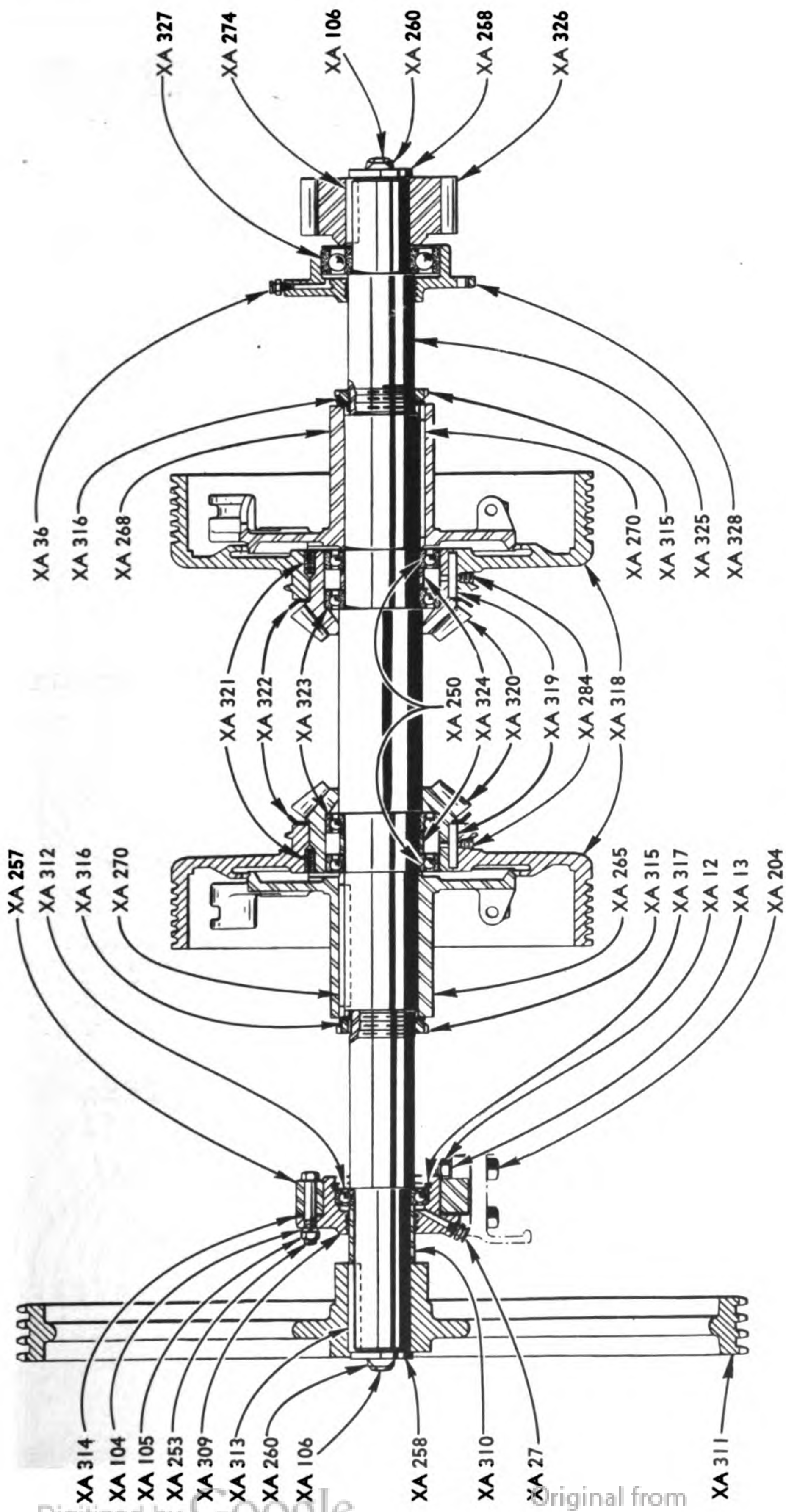
BOOM HOIST SHAFT - STANDARD



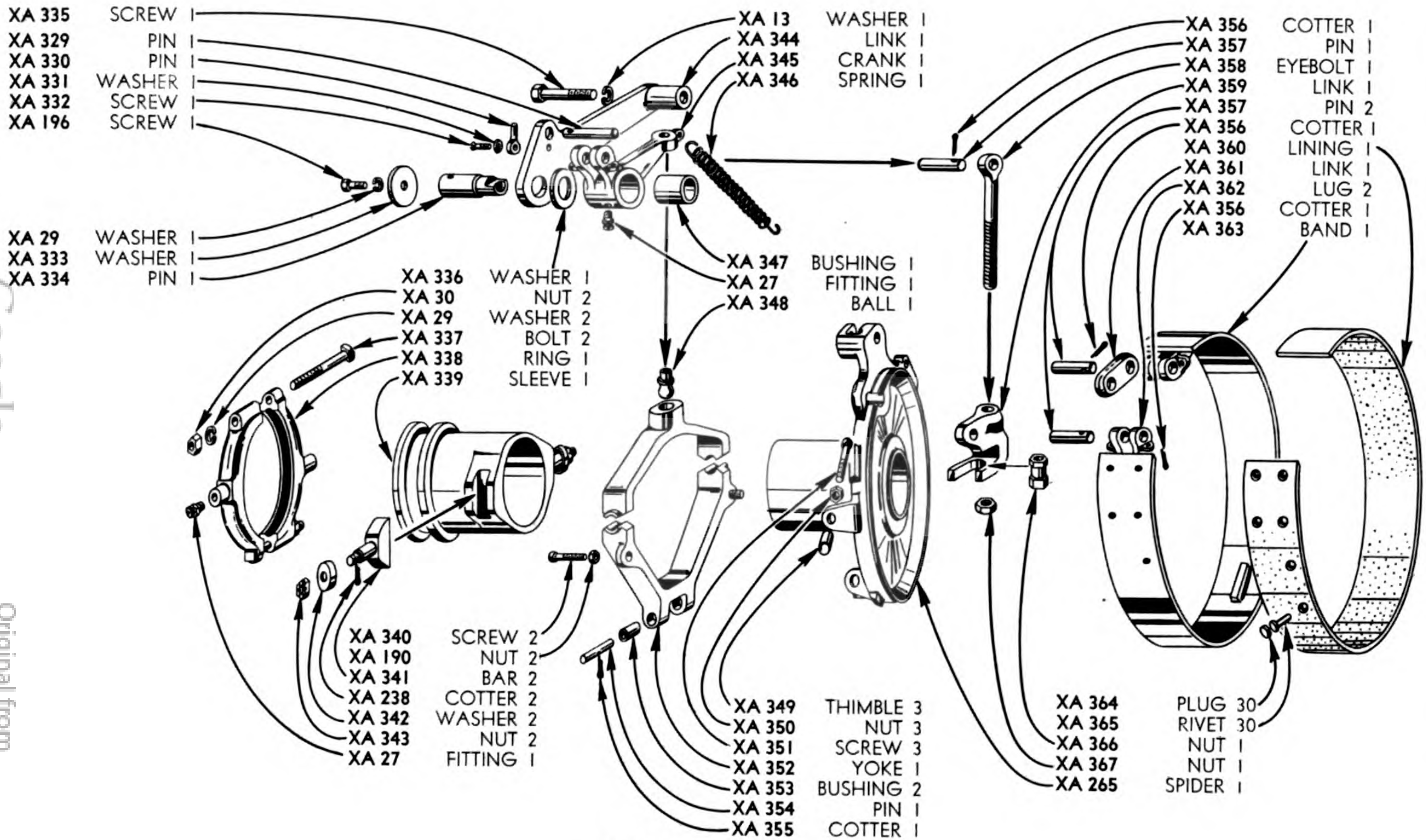
BOOM HOIST SHAFT - STANDARD



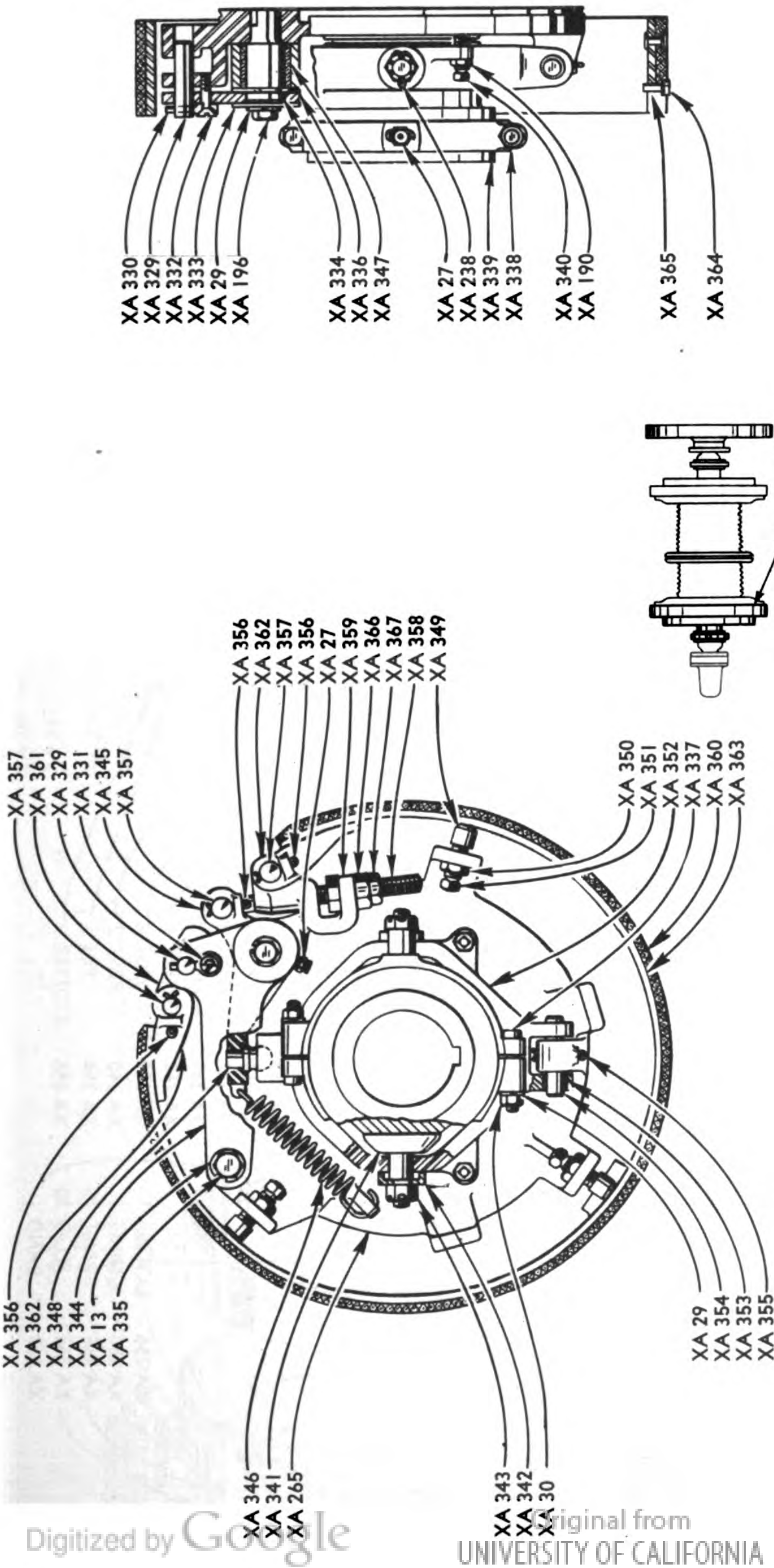
SWING AND TRACTION SHAFT (JACK SHAFT)



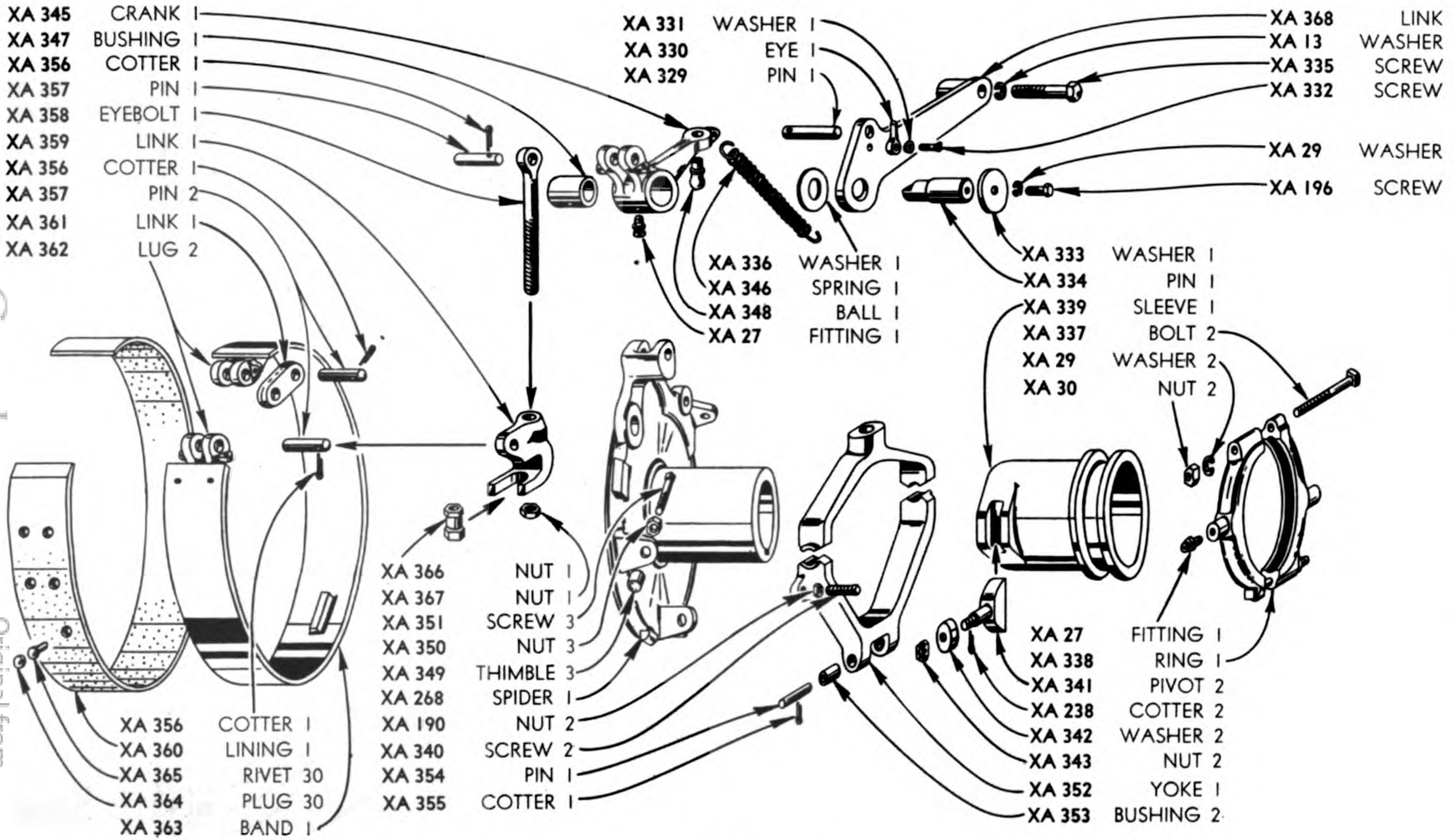
SWING AND TRACTION SHAFT (JACK SHAFT)



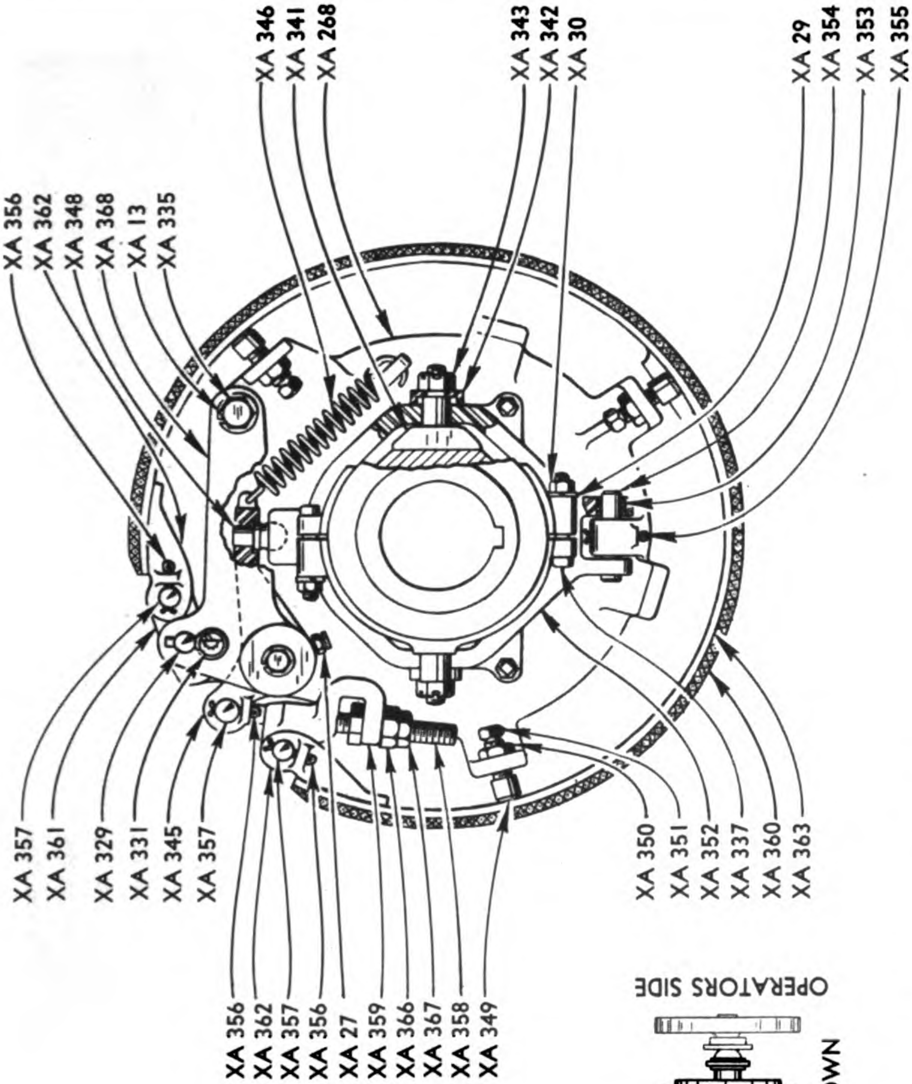
LEFT DRUM CLUTCH



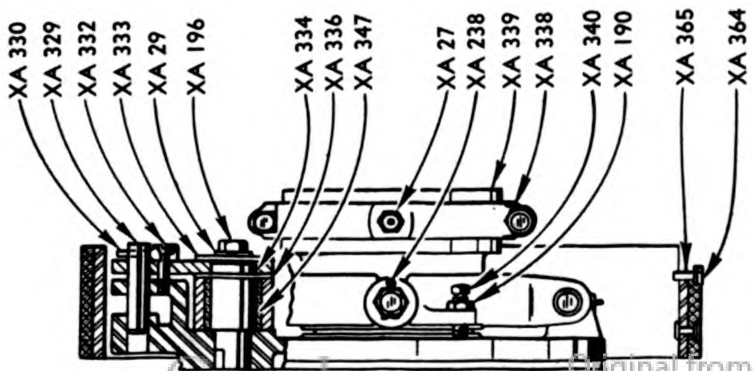
LEFT DRUM CLUTCH

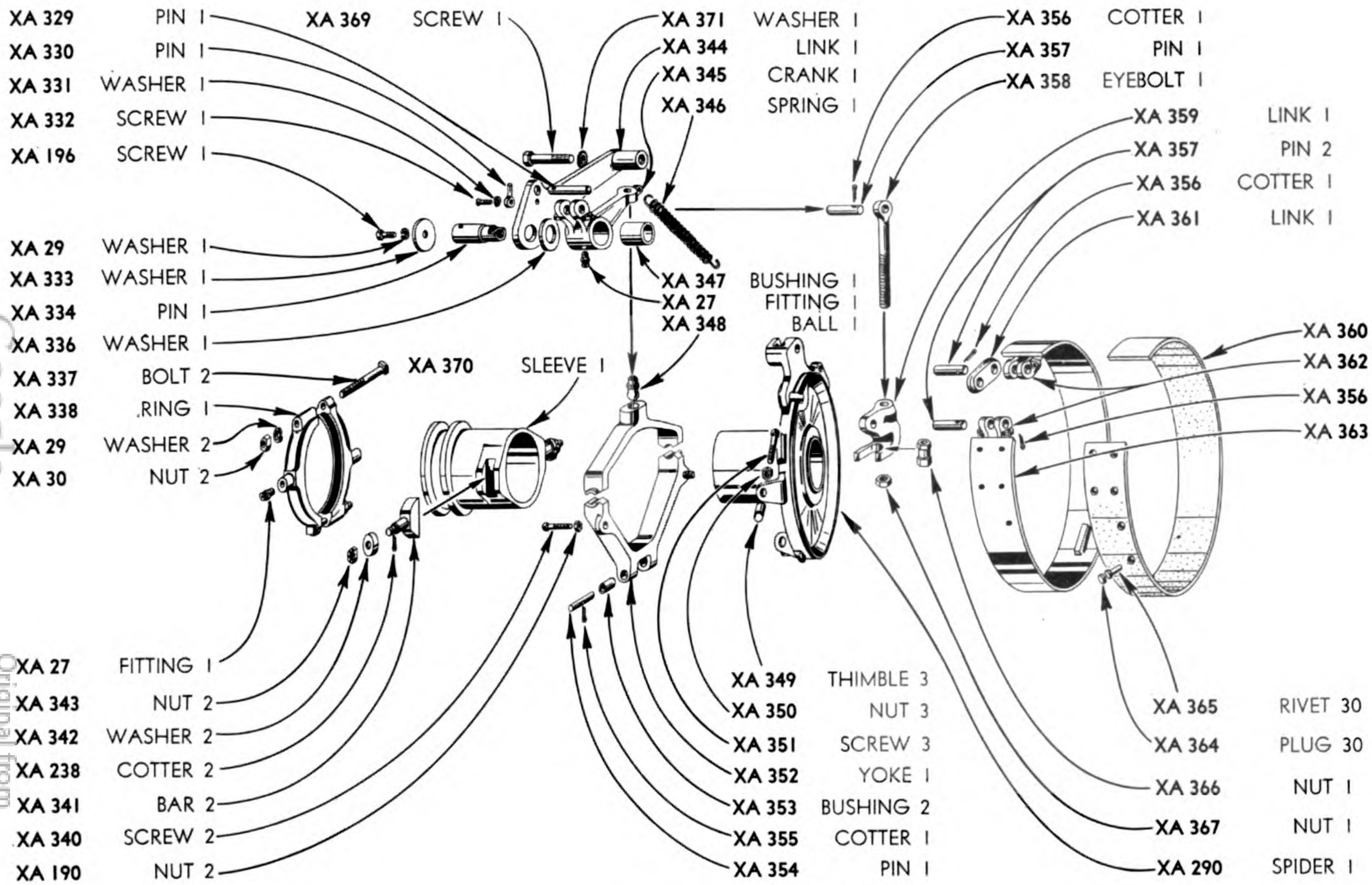


RIGHT DRUM CLUTCH

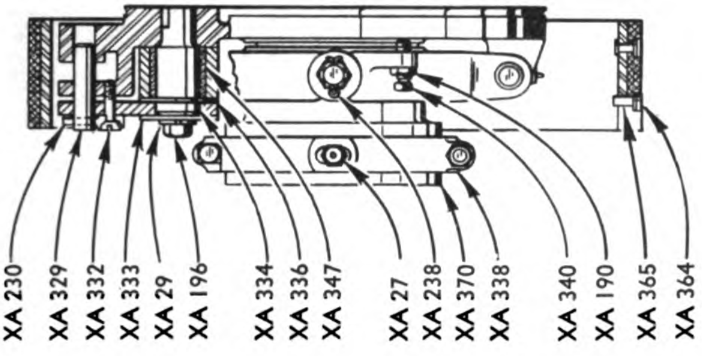


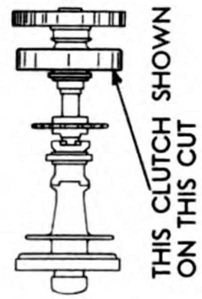
RIGHT DRUM CLUTCH

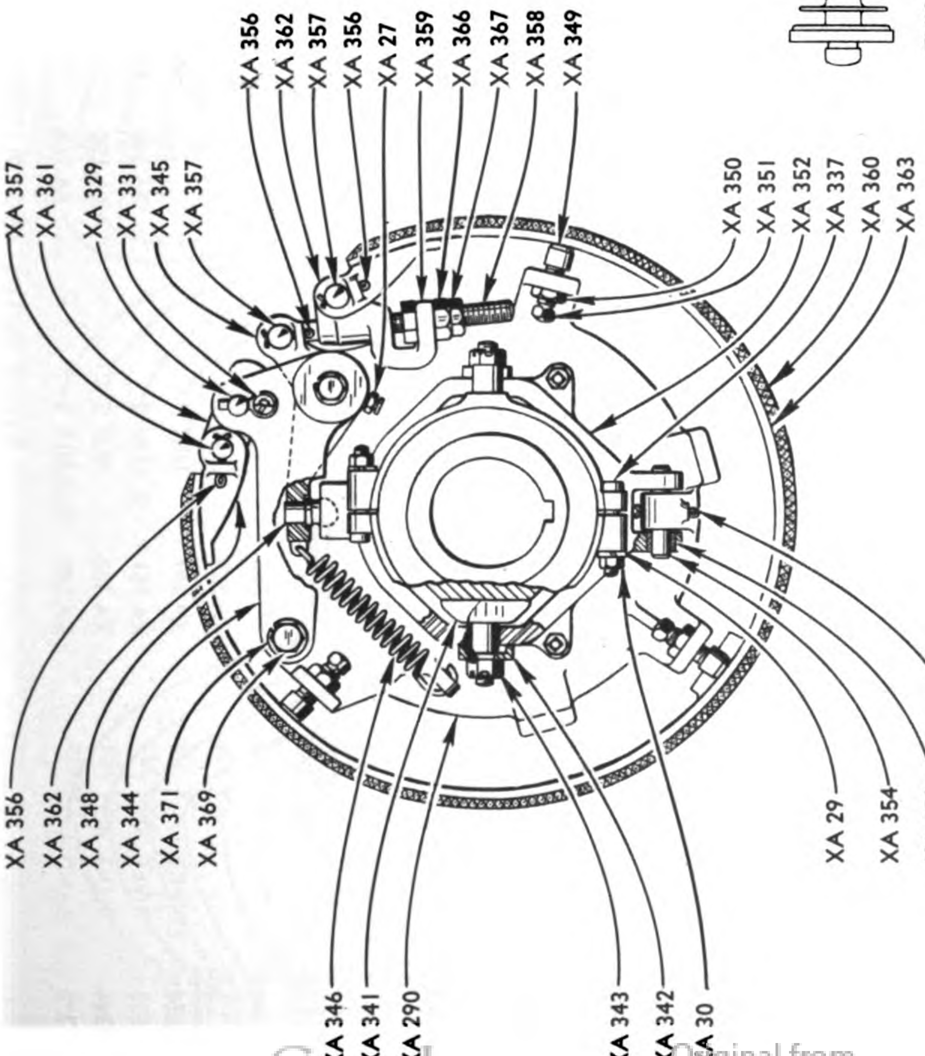




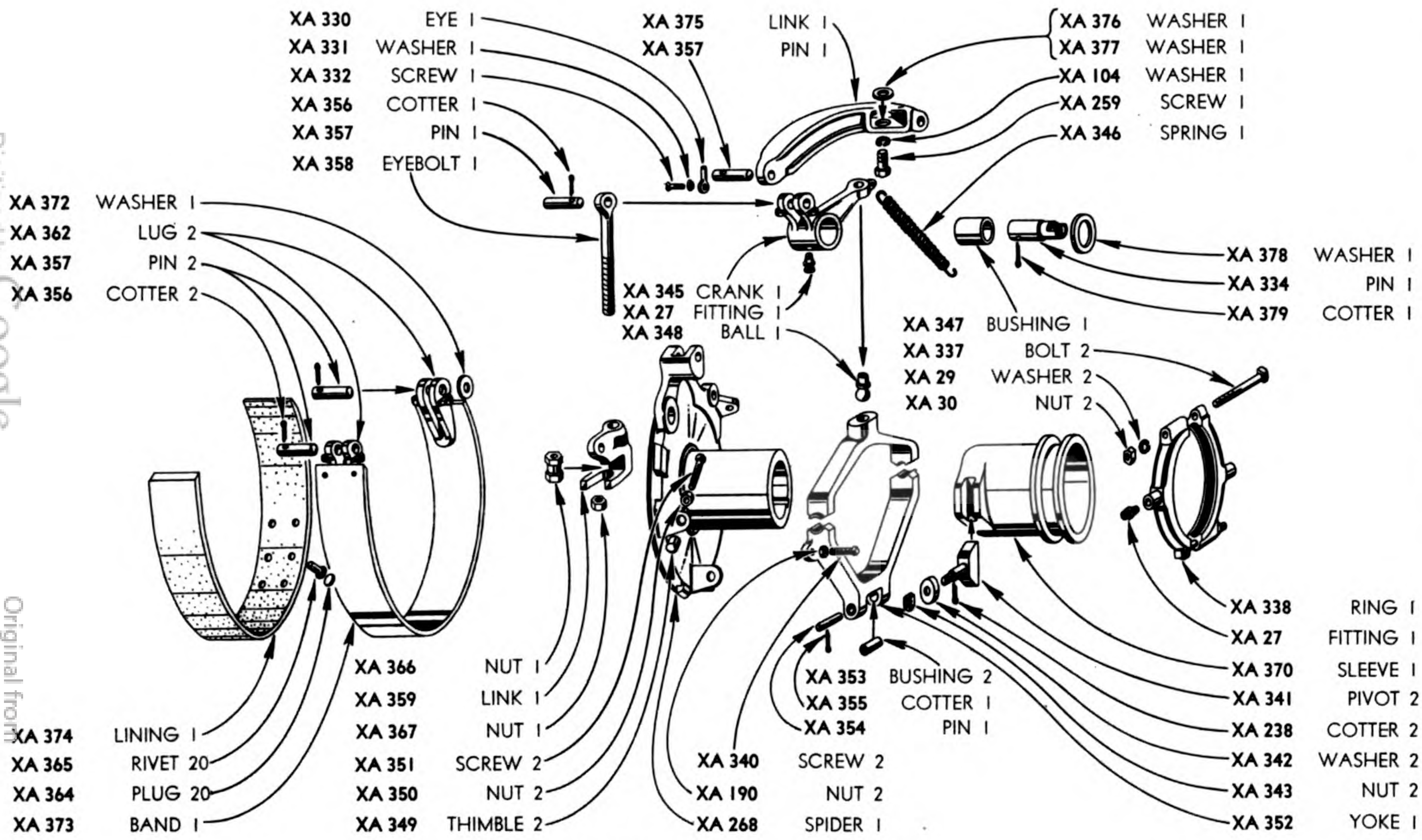
BOOM HOIST CLUTCH



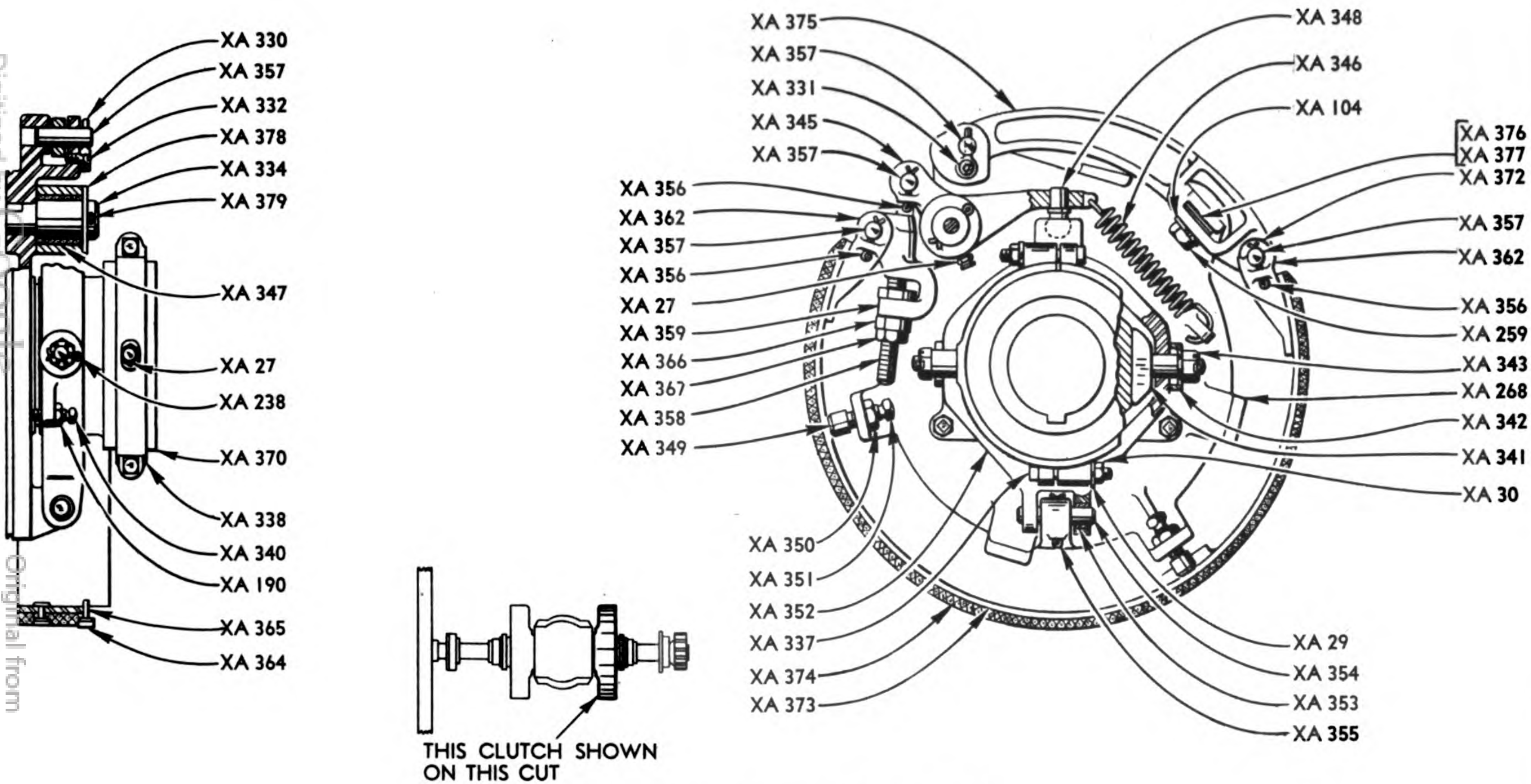




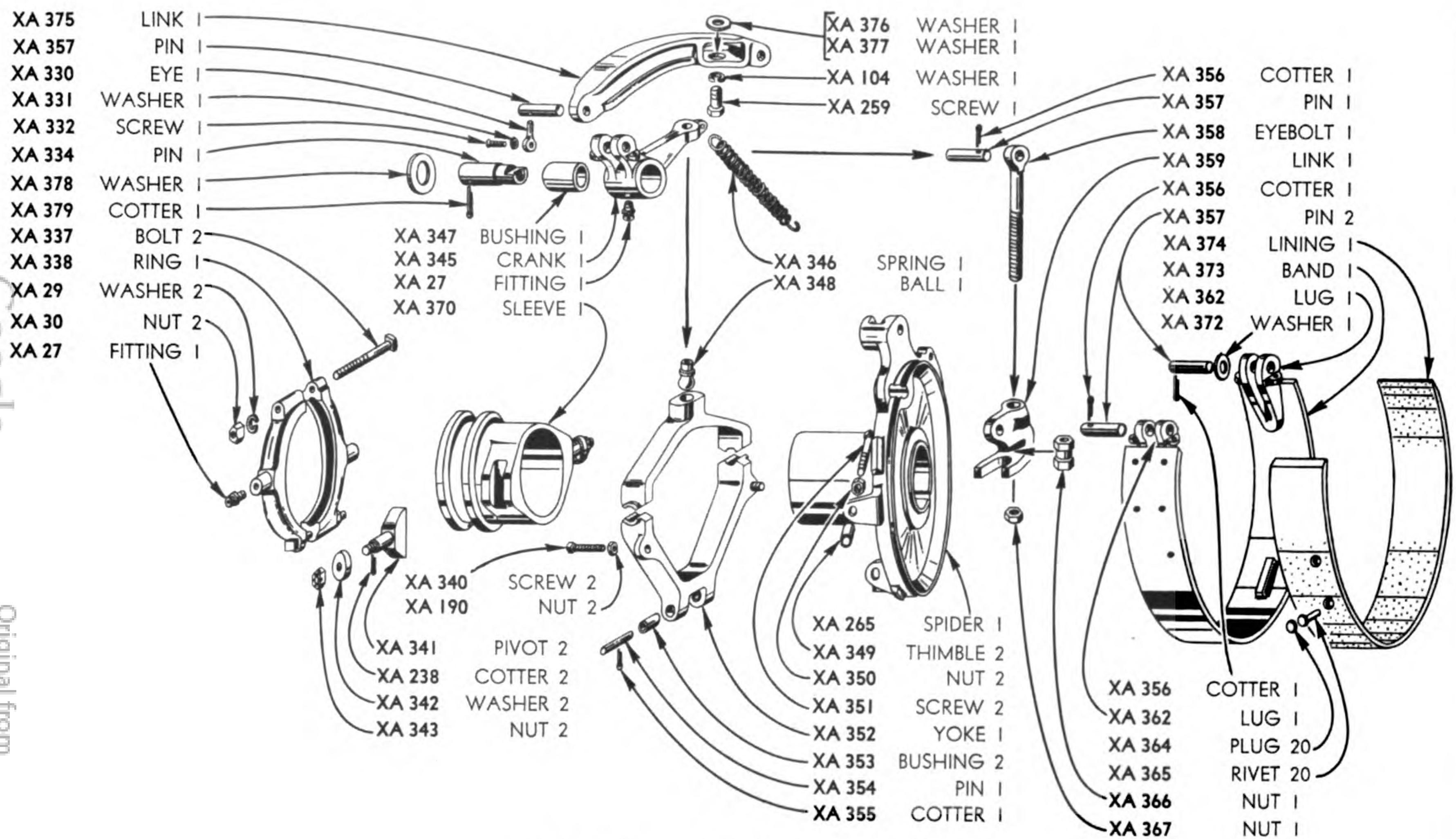
BOOM HOIST CLUTCH



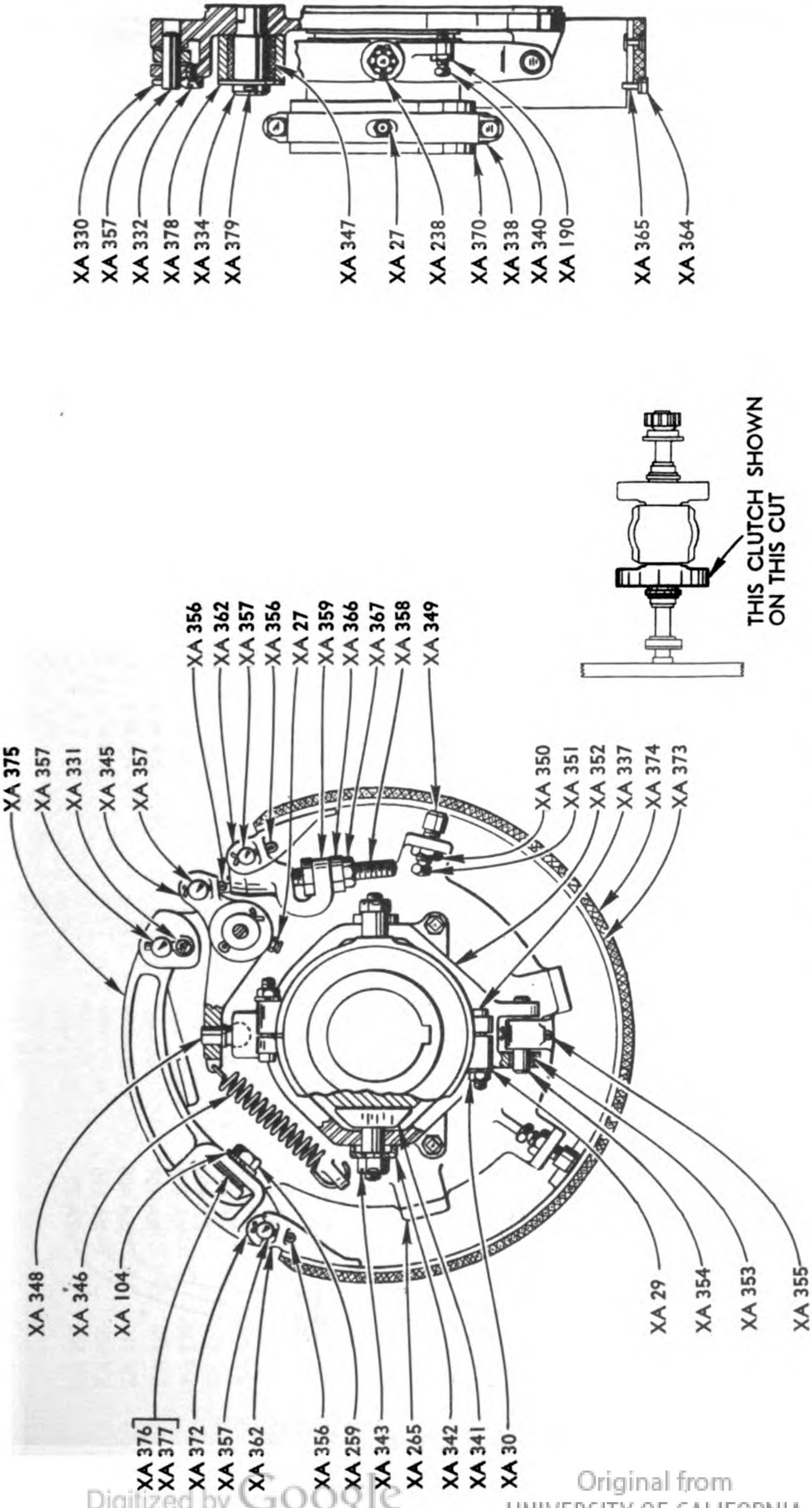
RIGHT SWING AND TRACTION CLUTCH



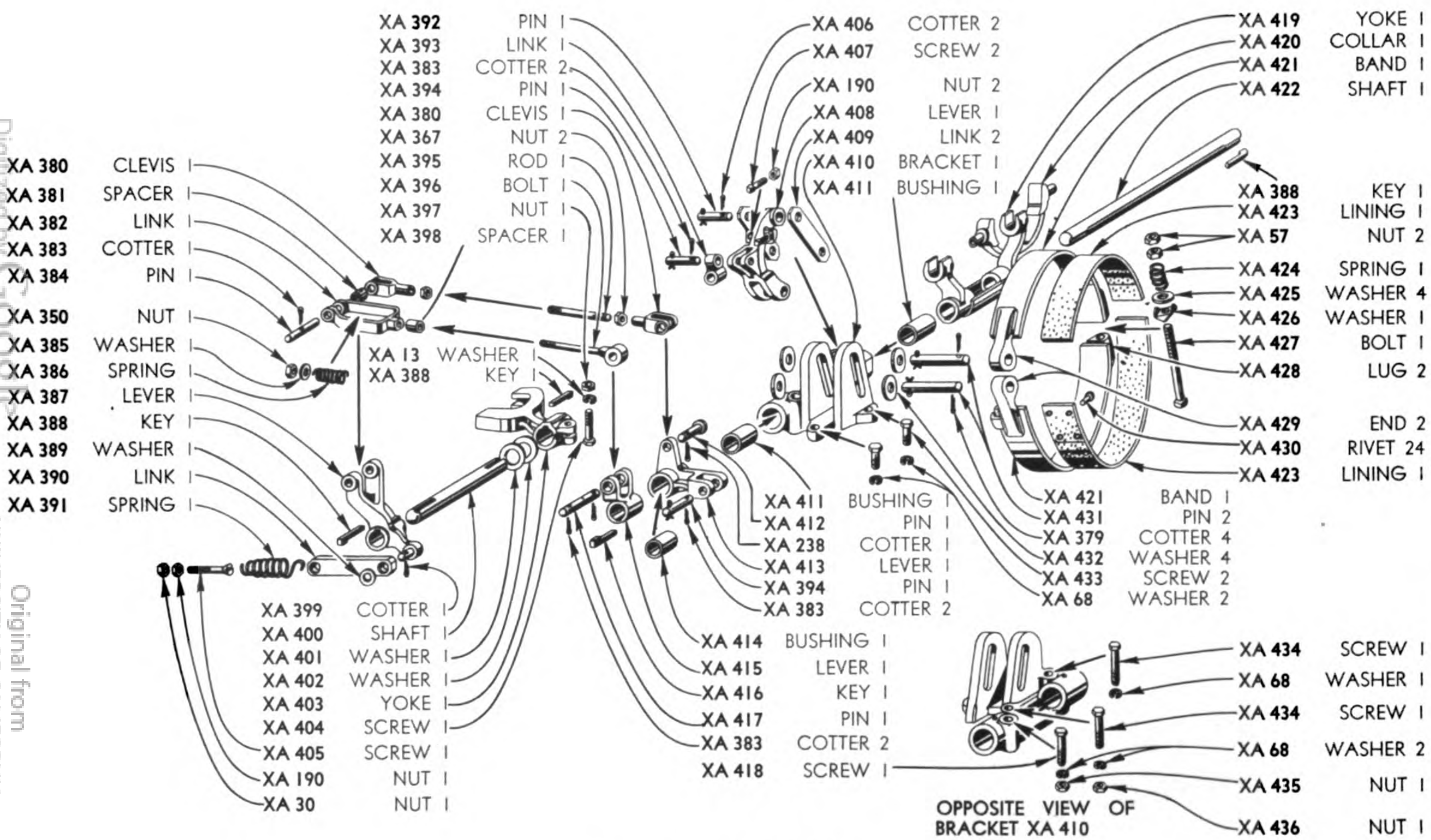
RIGHT SWING AND TRACTION CLUTCH



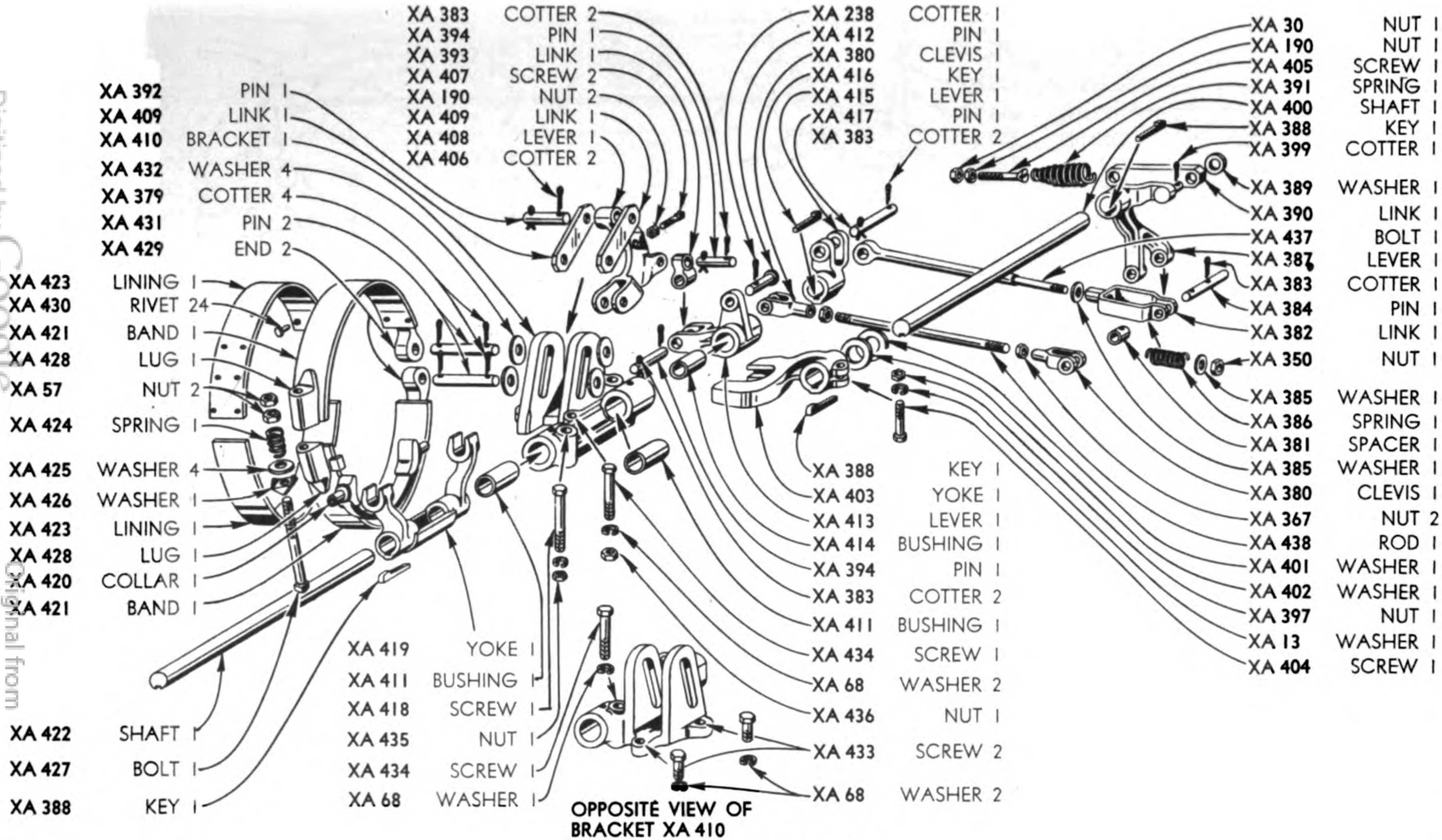
LEFT SWING AND TRACTION CLUTCH



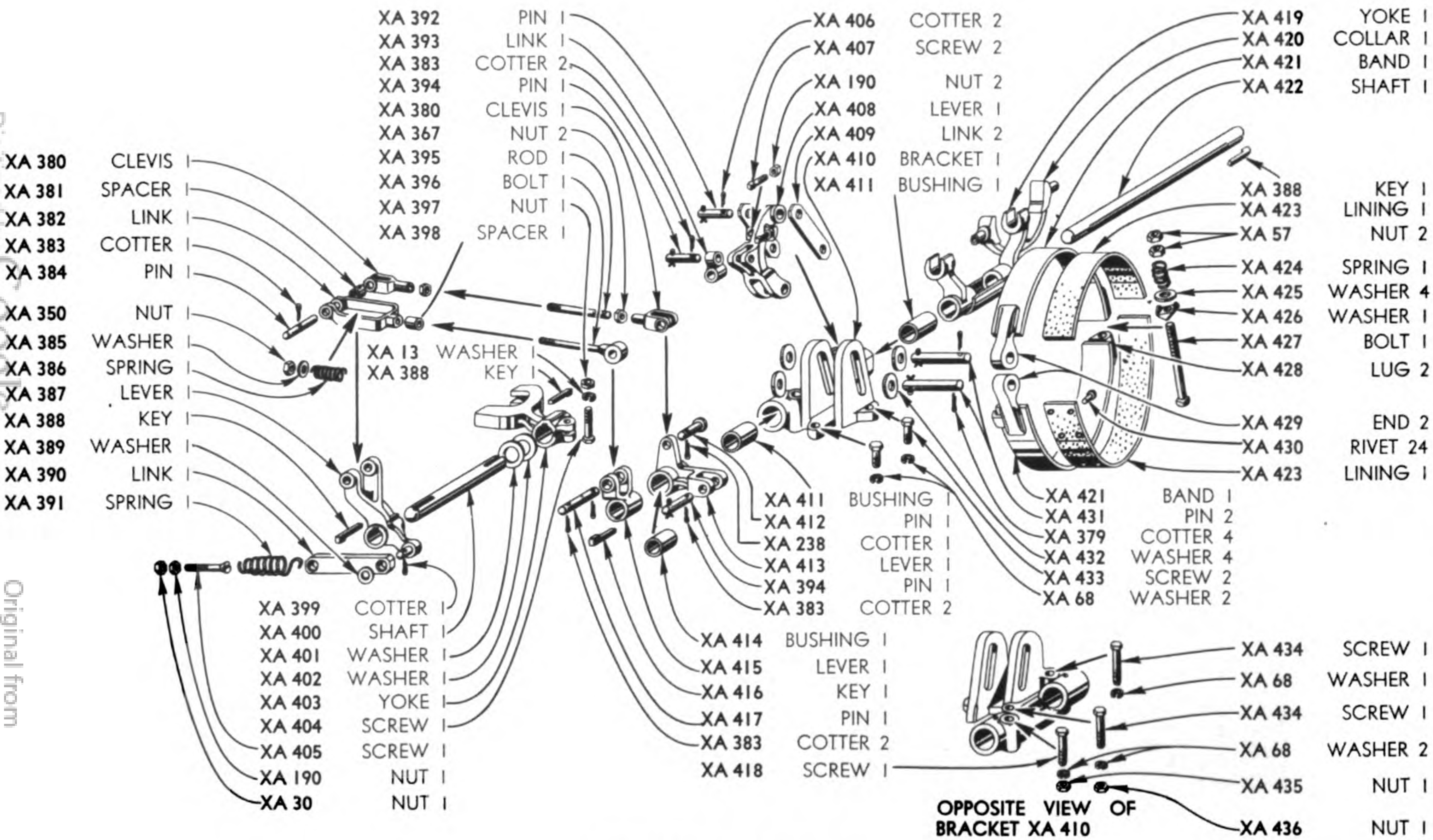
LEFT SWING AND TRACTION CLUTCH



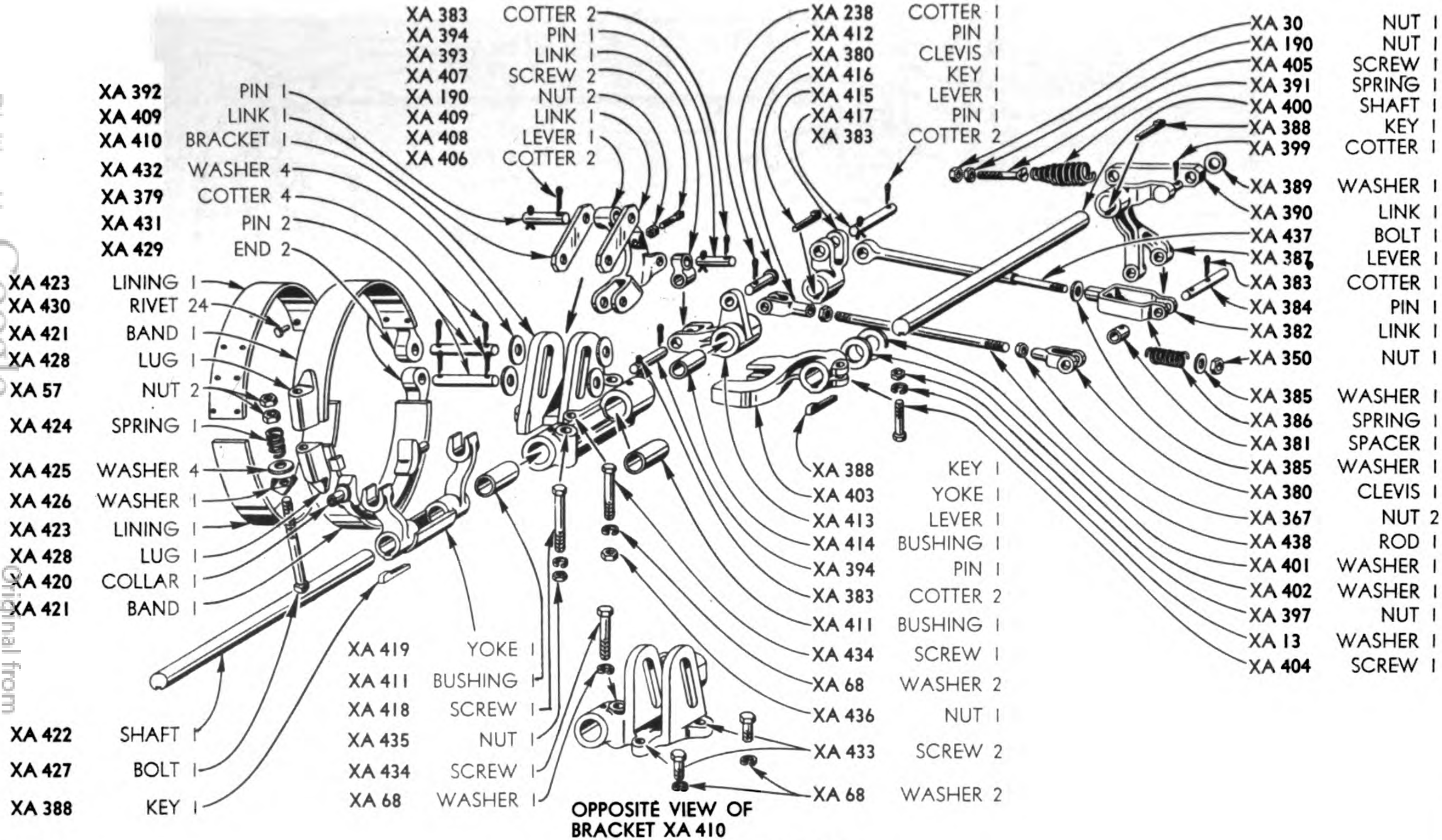
LEFT STEERING BRAKE



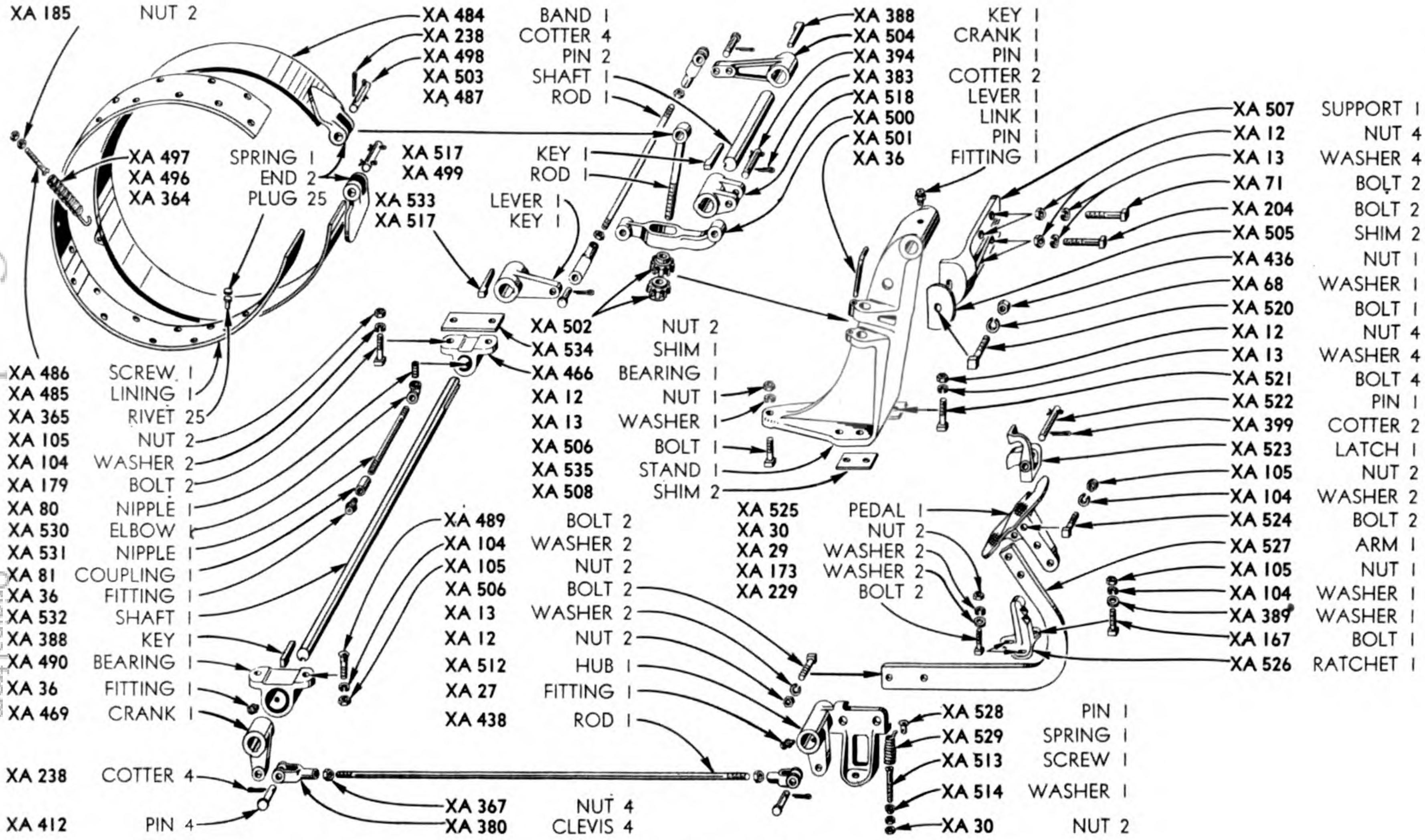
RIGHT STEERING BRAKE



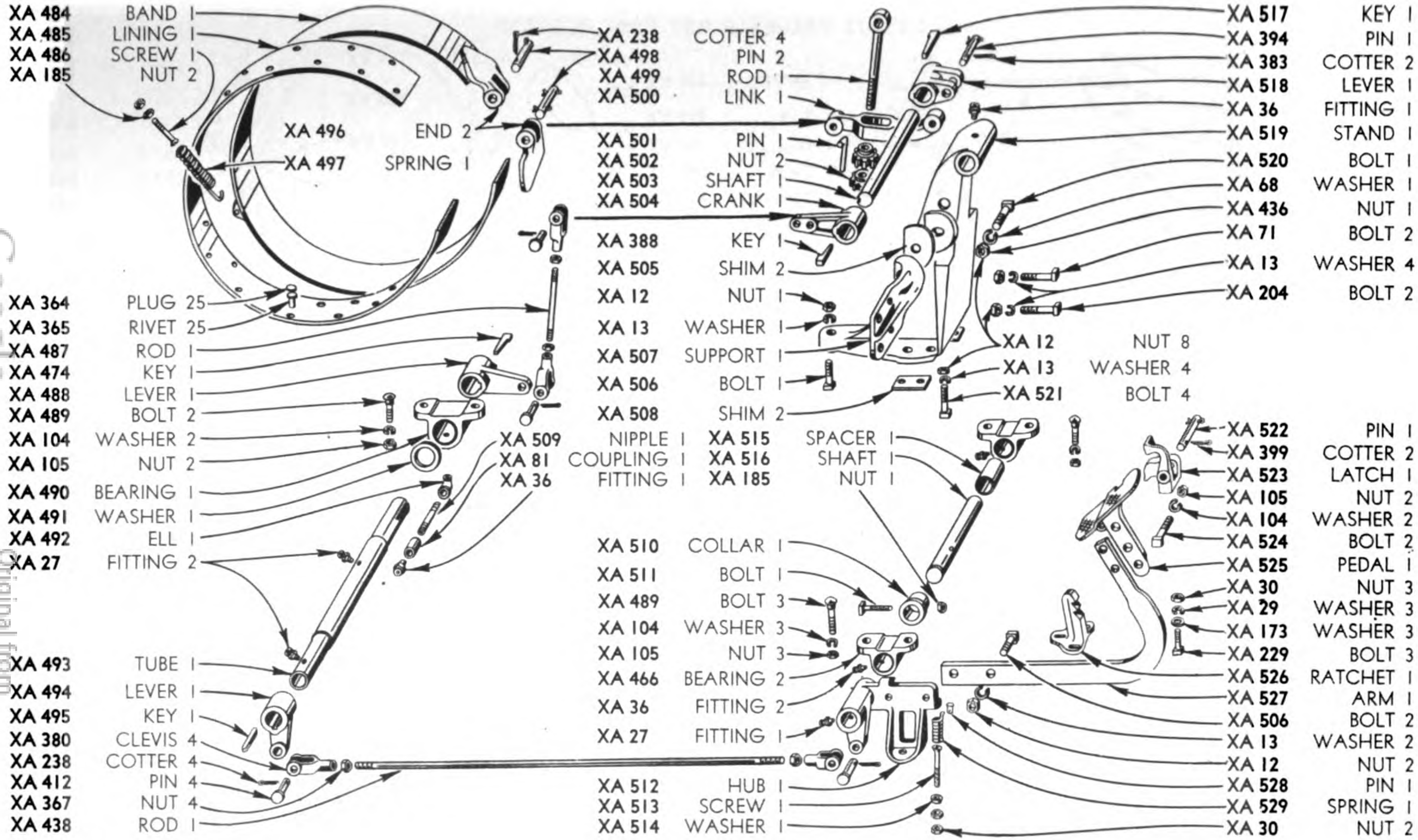
LEFT STEERING BRAKE



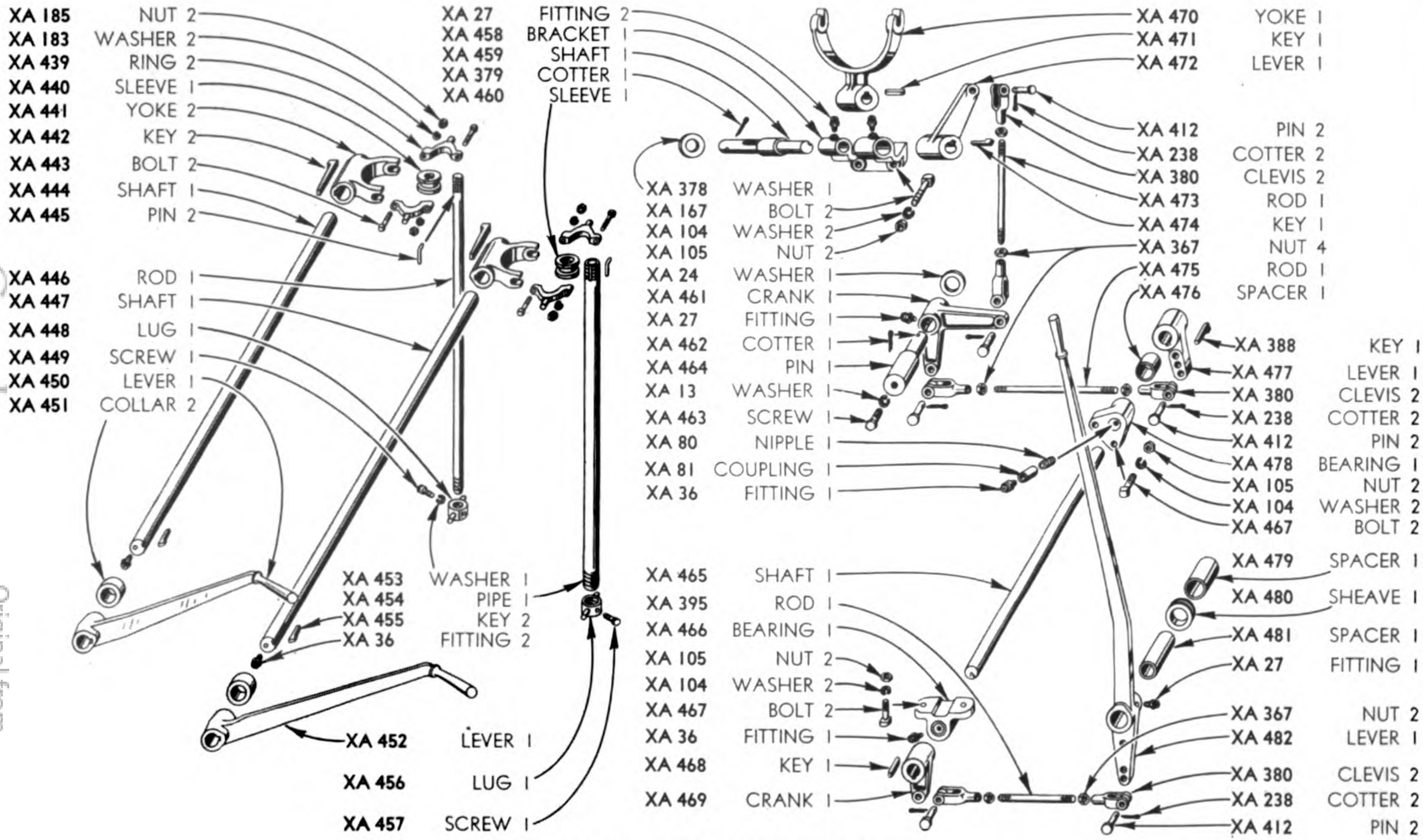
RIGHT STEERING BRAKE



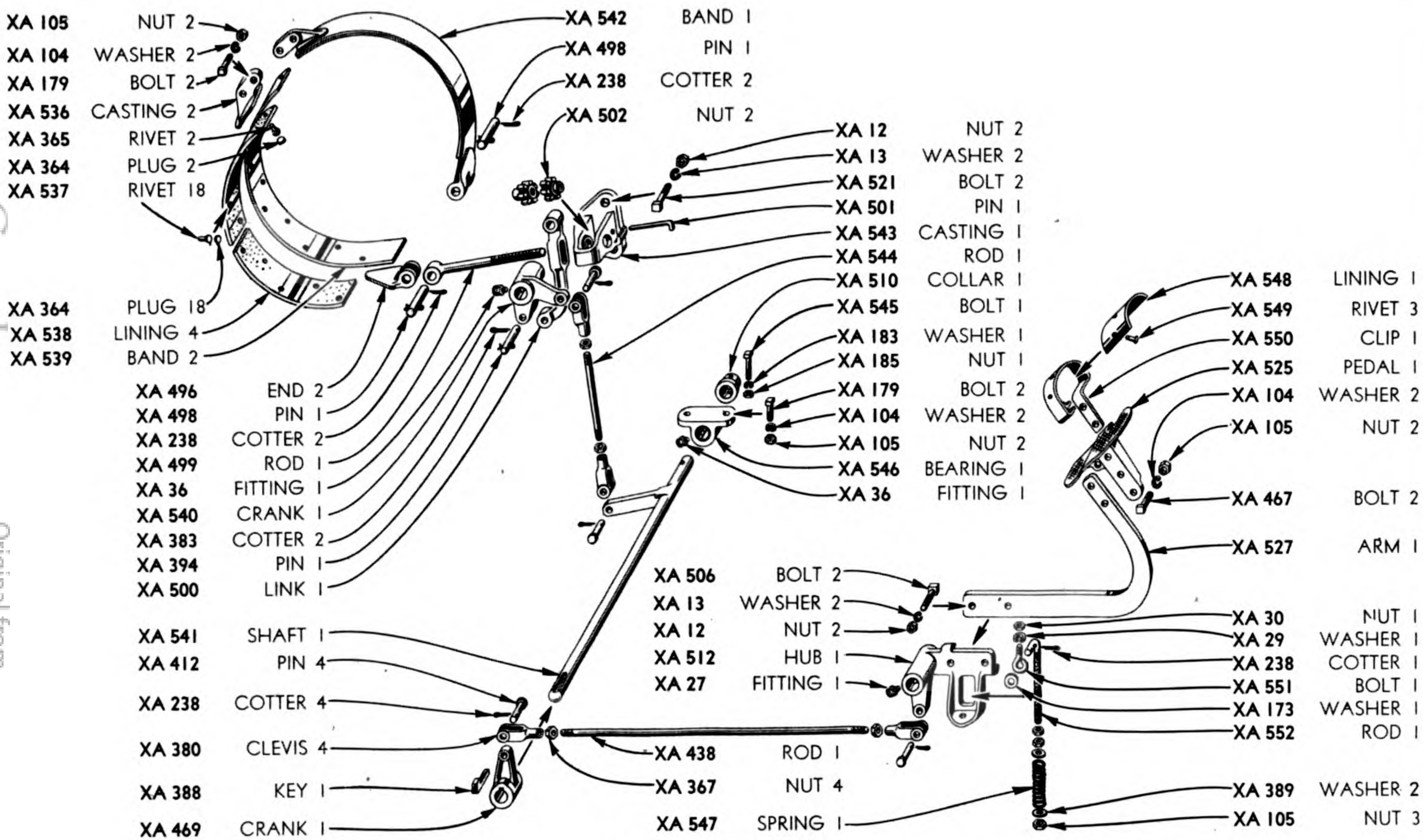
LEFT DRUM BRAKE



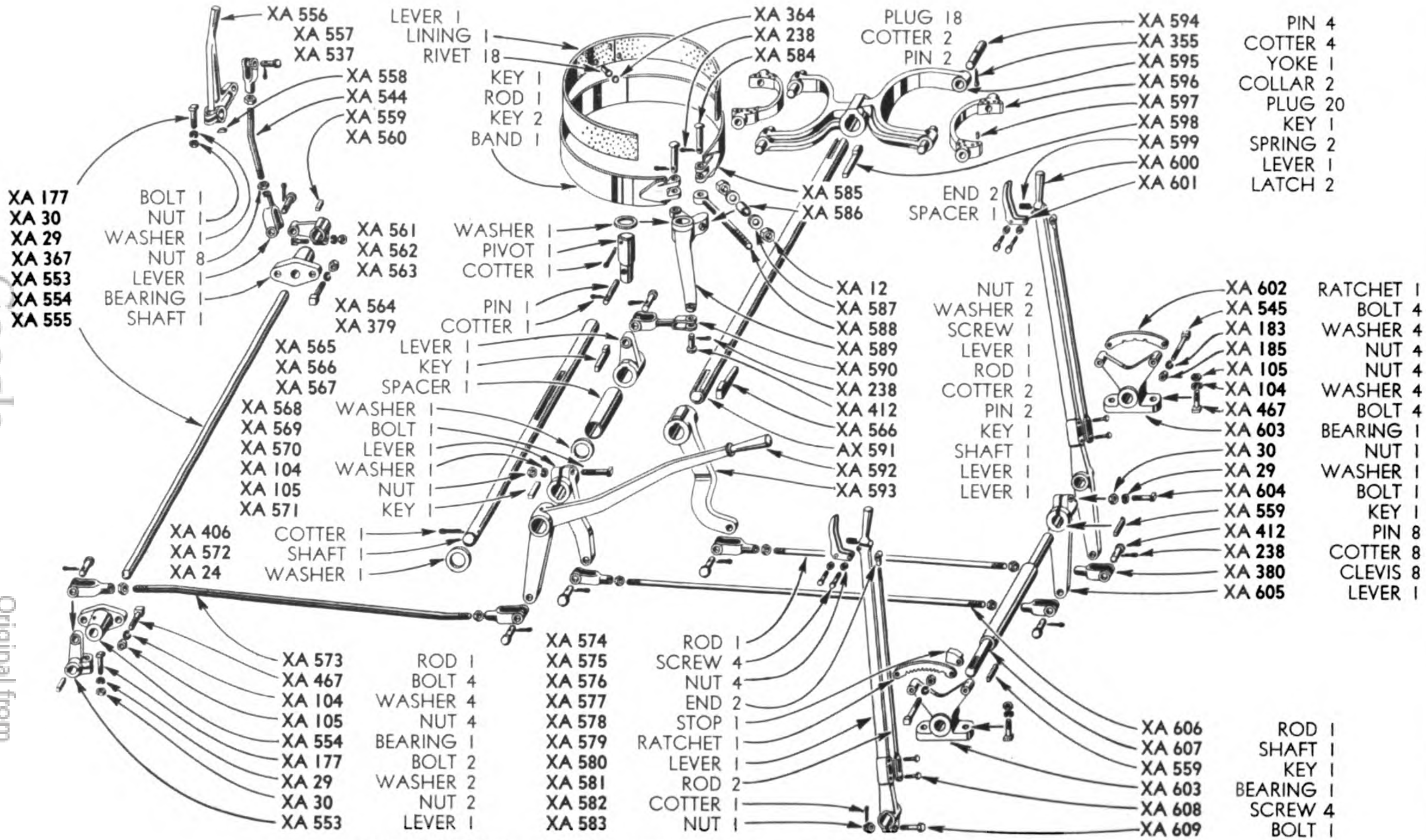
RIGHT DRUM BRAKE



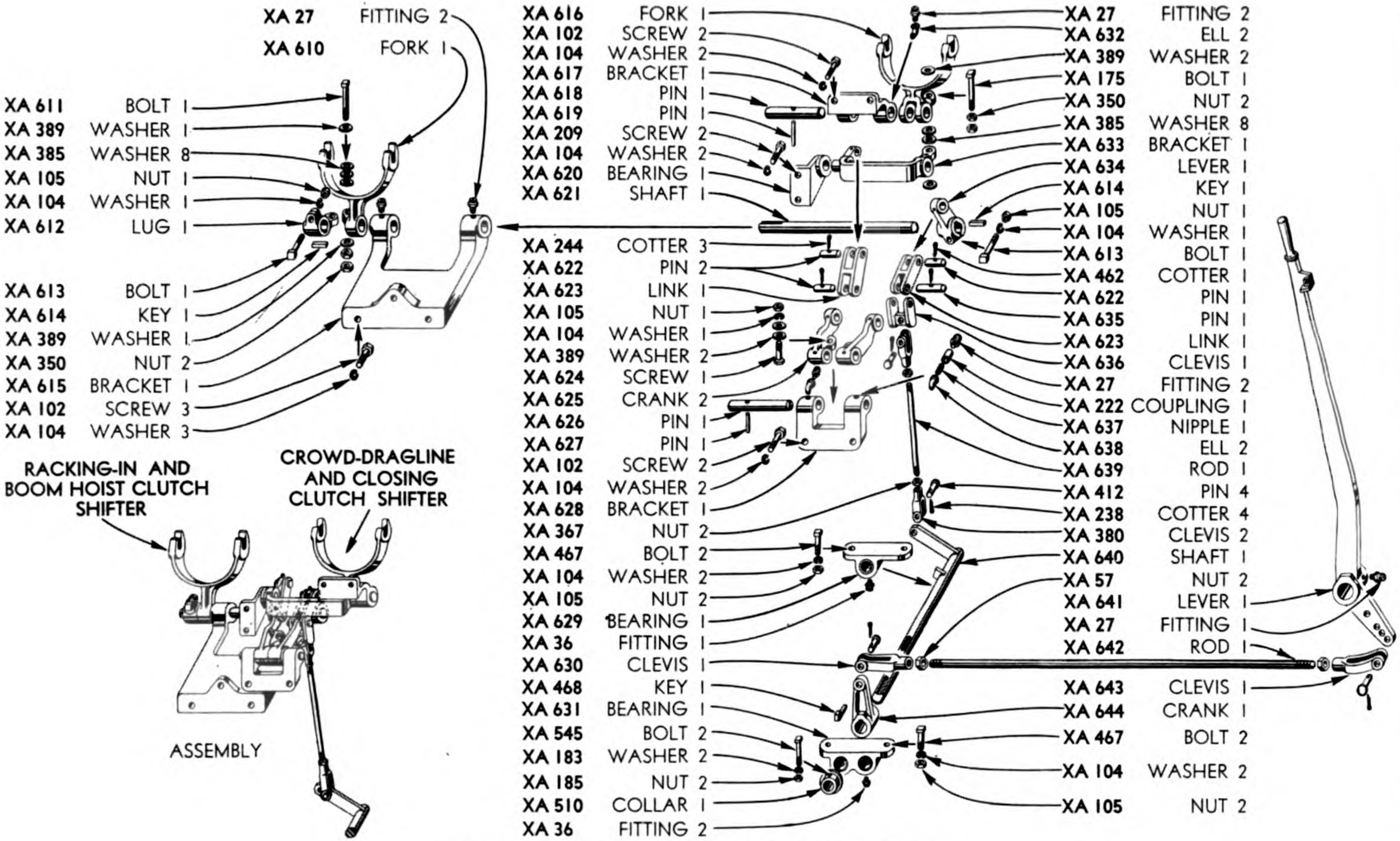
HOIST CLUTCH AND STEERING LEVERS



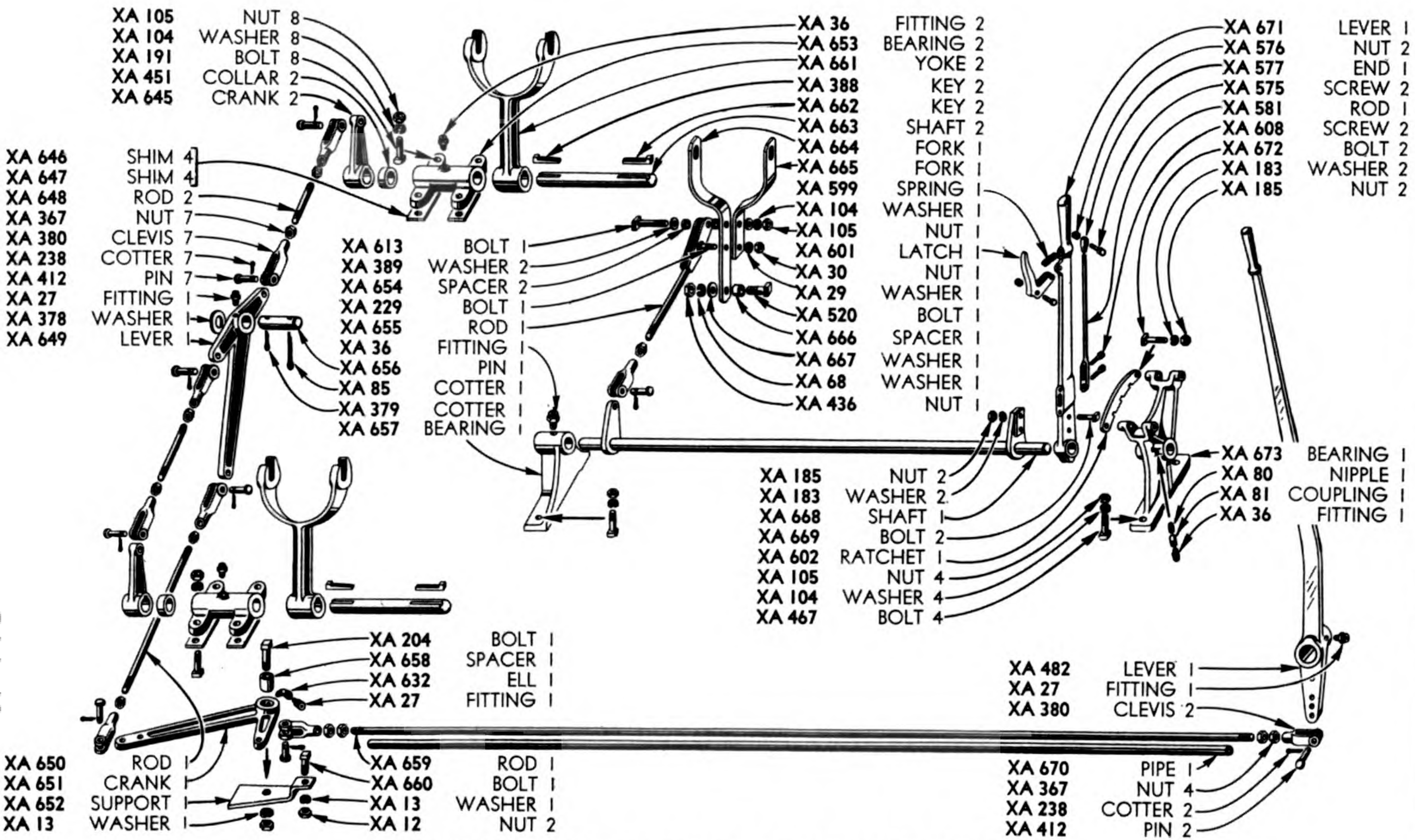
BOOM HOIST BRAKE.



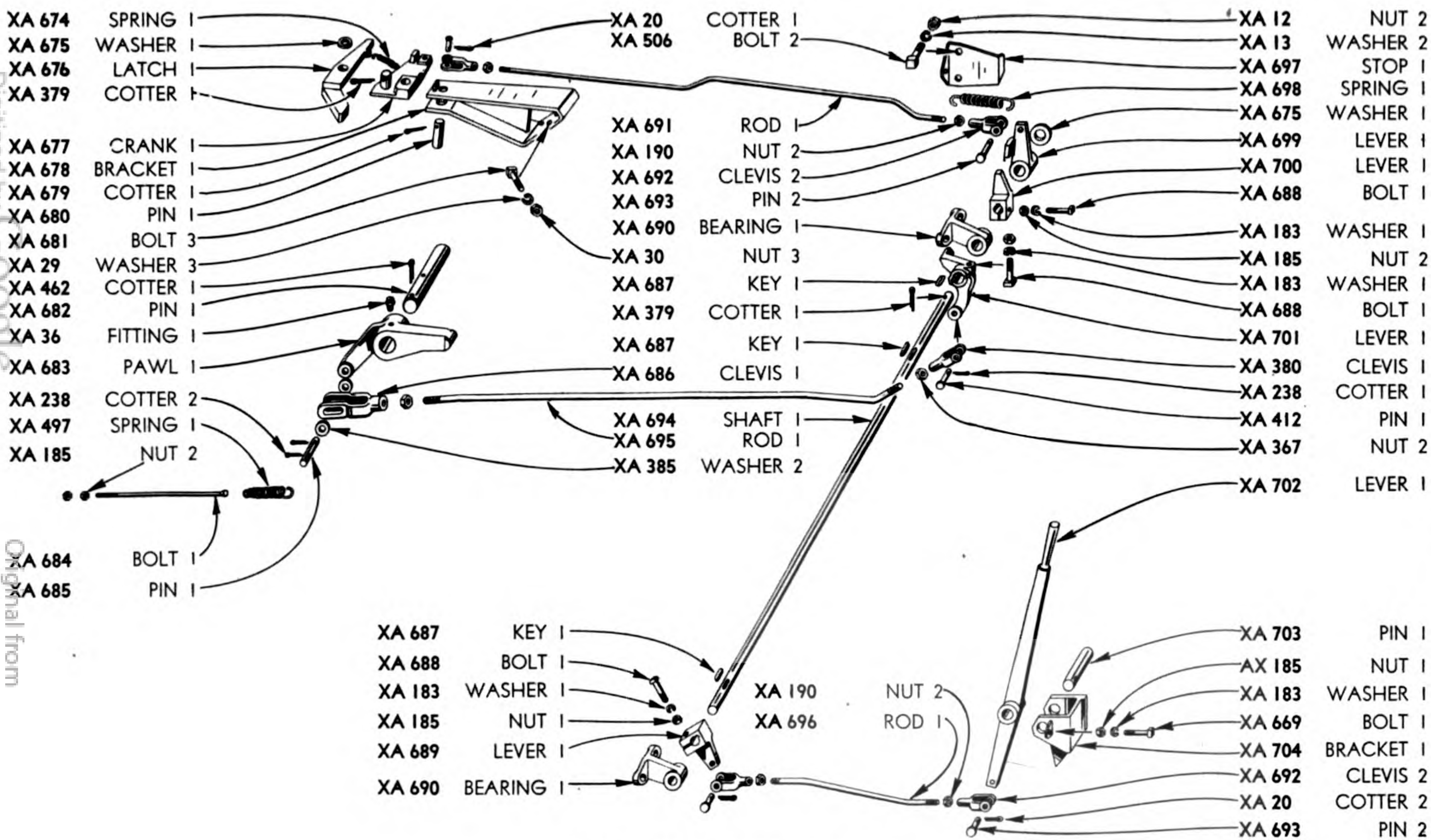
SWING BRAKE - SWING AND TRACTION GEAR SHIFT - ENGINE CLUTCH LEVER



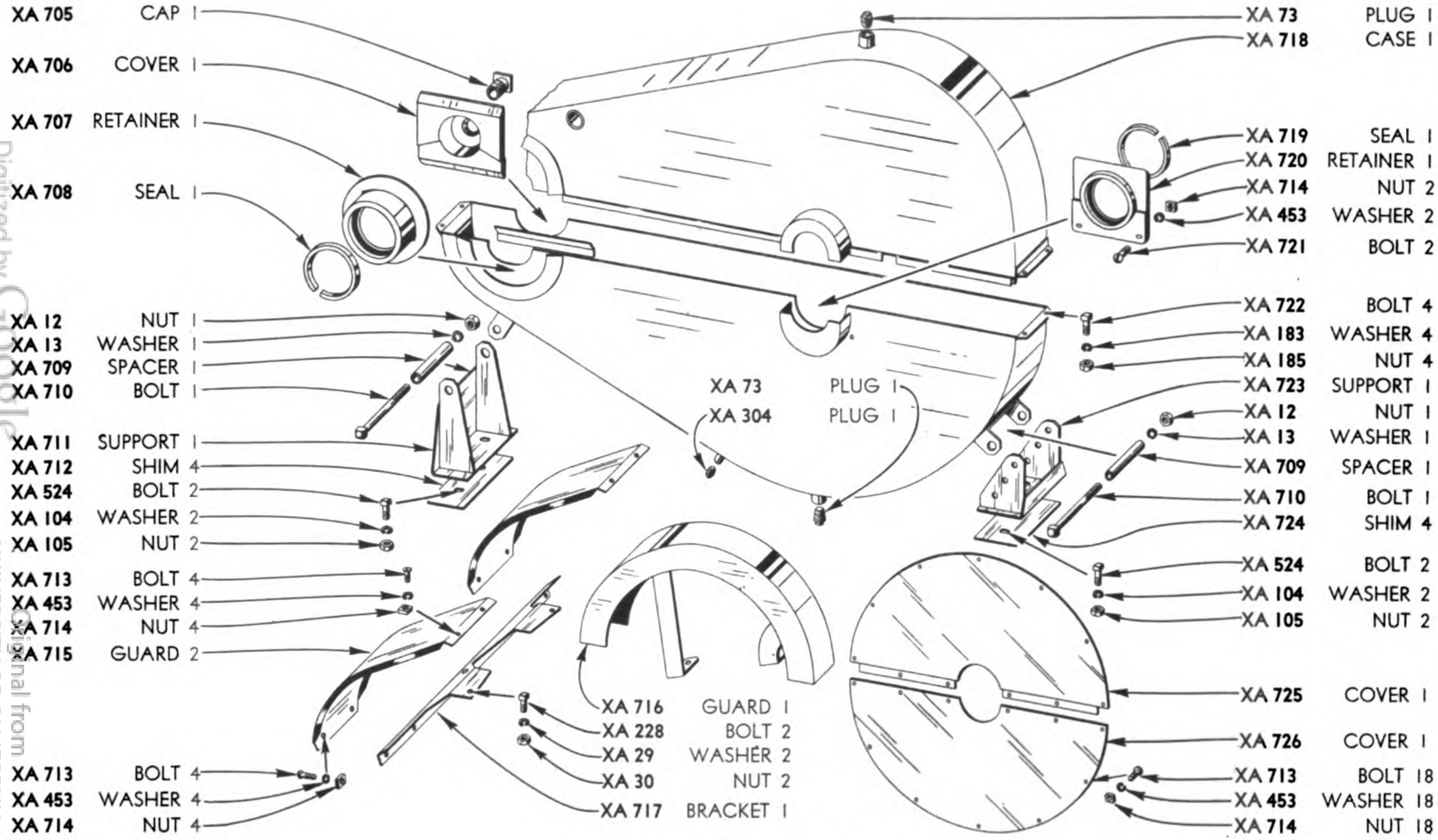
BOOM HOIST - CROWD AND RACKING IN LEVER



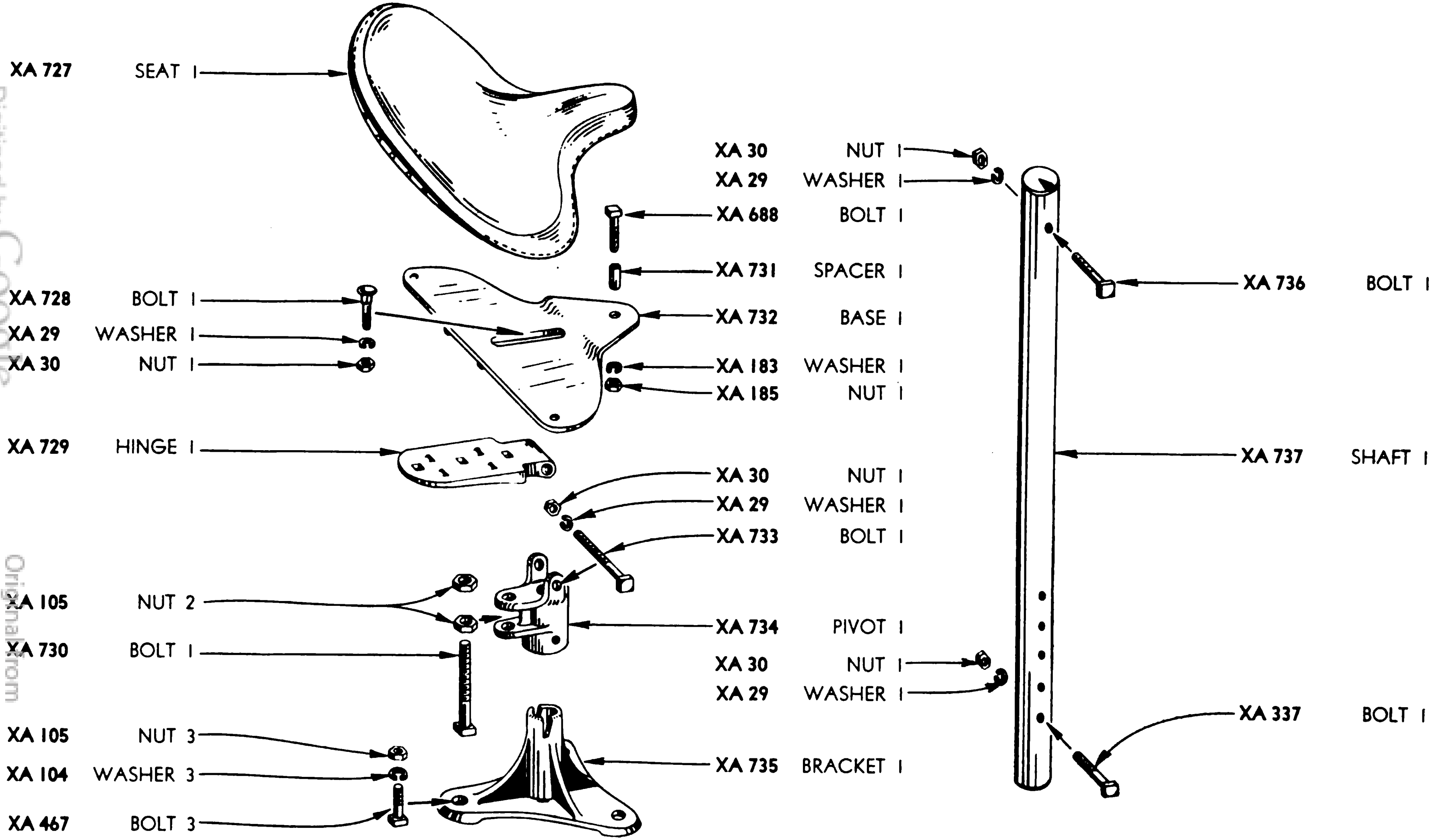
BOOM HOIST JAW CLUTCH AND SWING AND TRACTION
CLUTCH LEVER



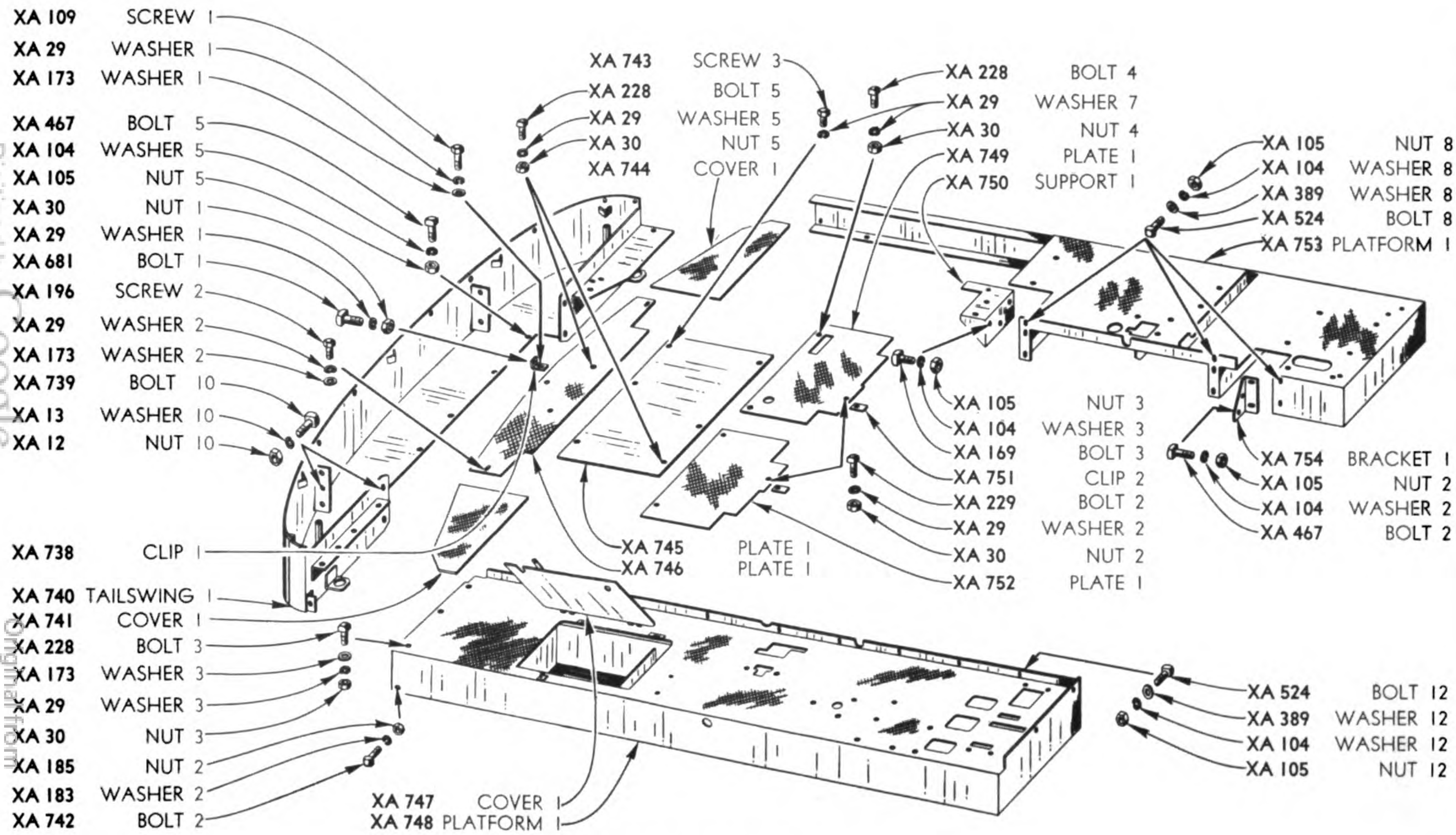
BOOM HOIST PAWL LEVER



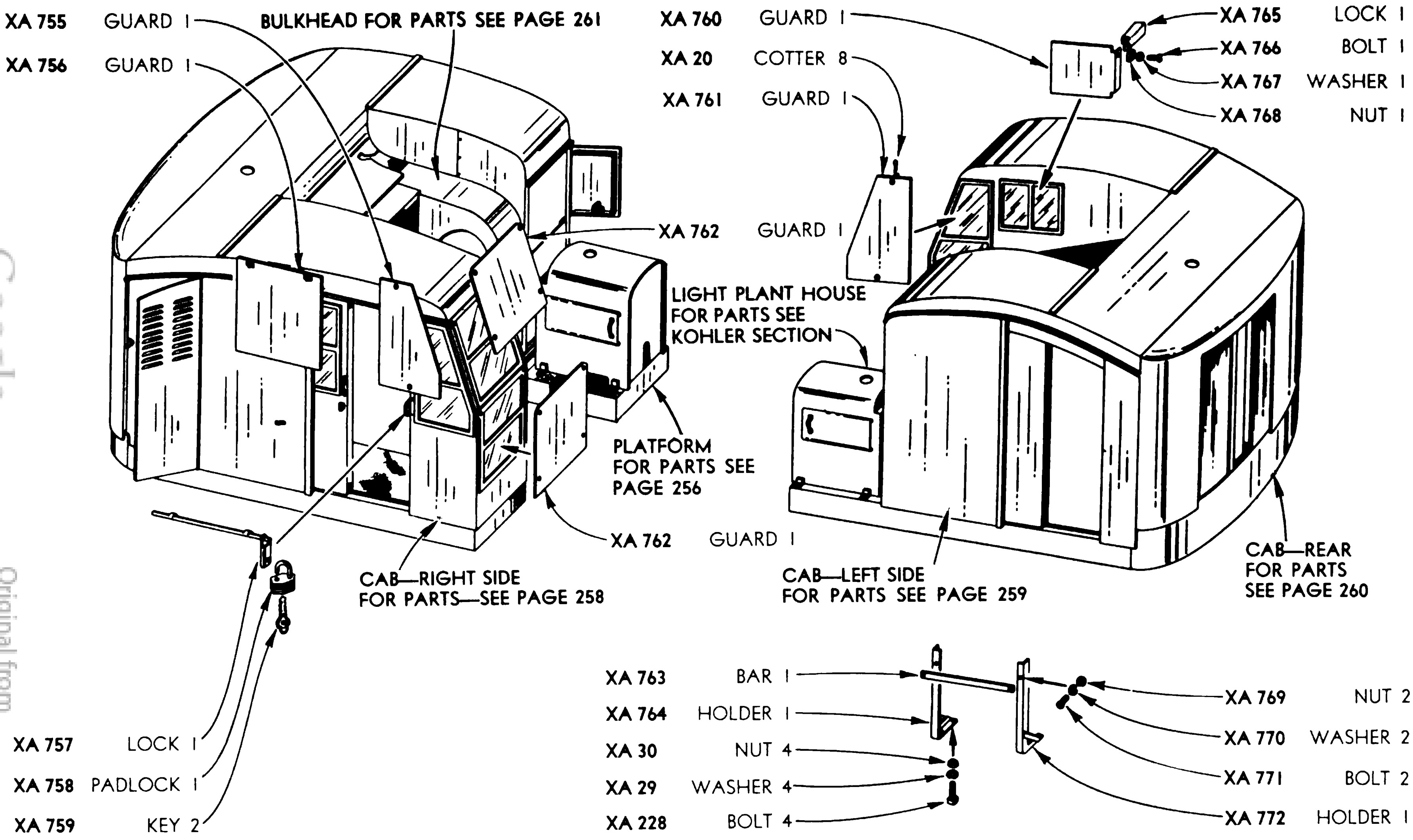
CHAIN CASE - GUARDS



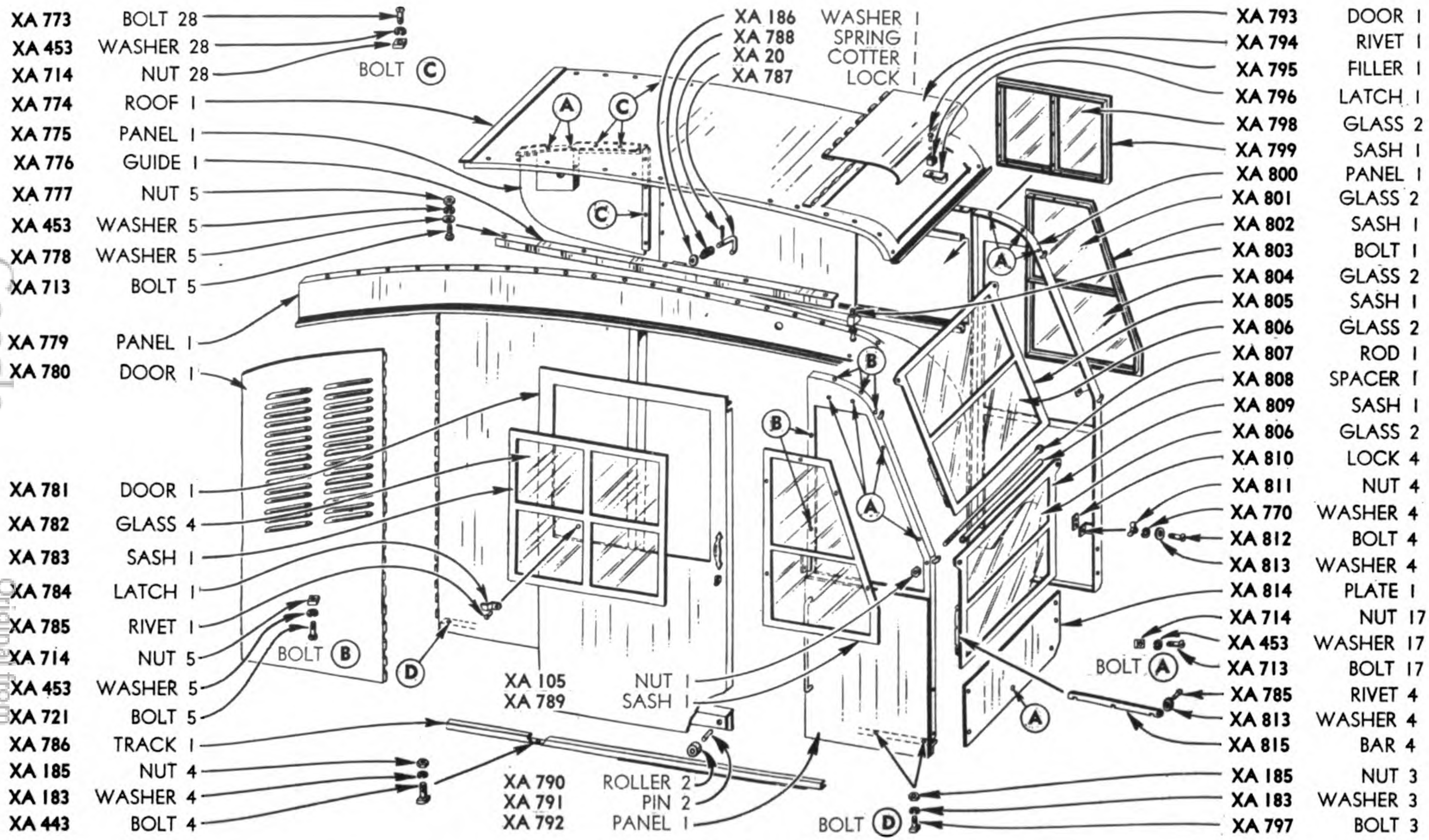
OPERATOR'S SEAT



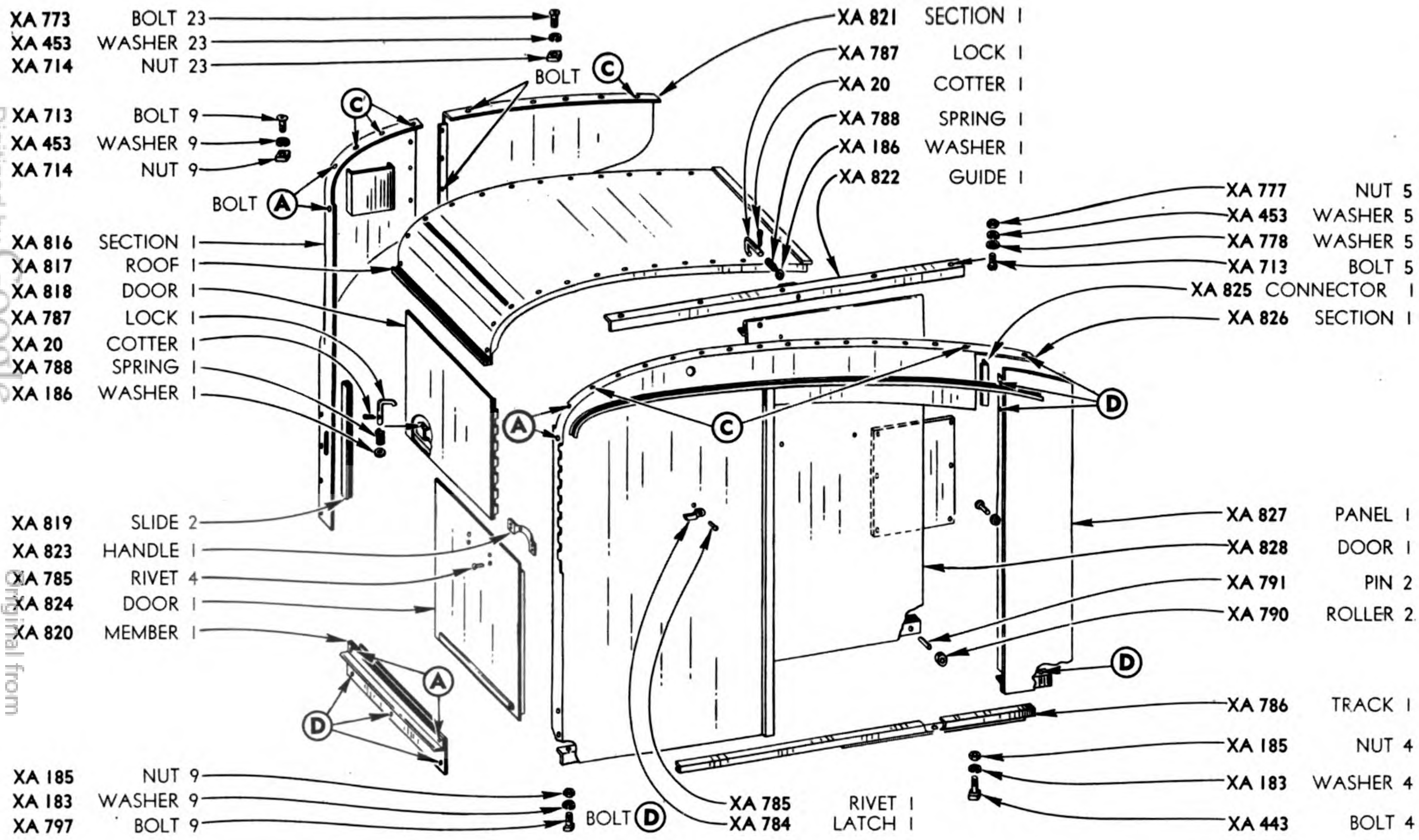
PLATFORM AND TAIL SWING



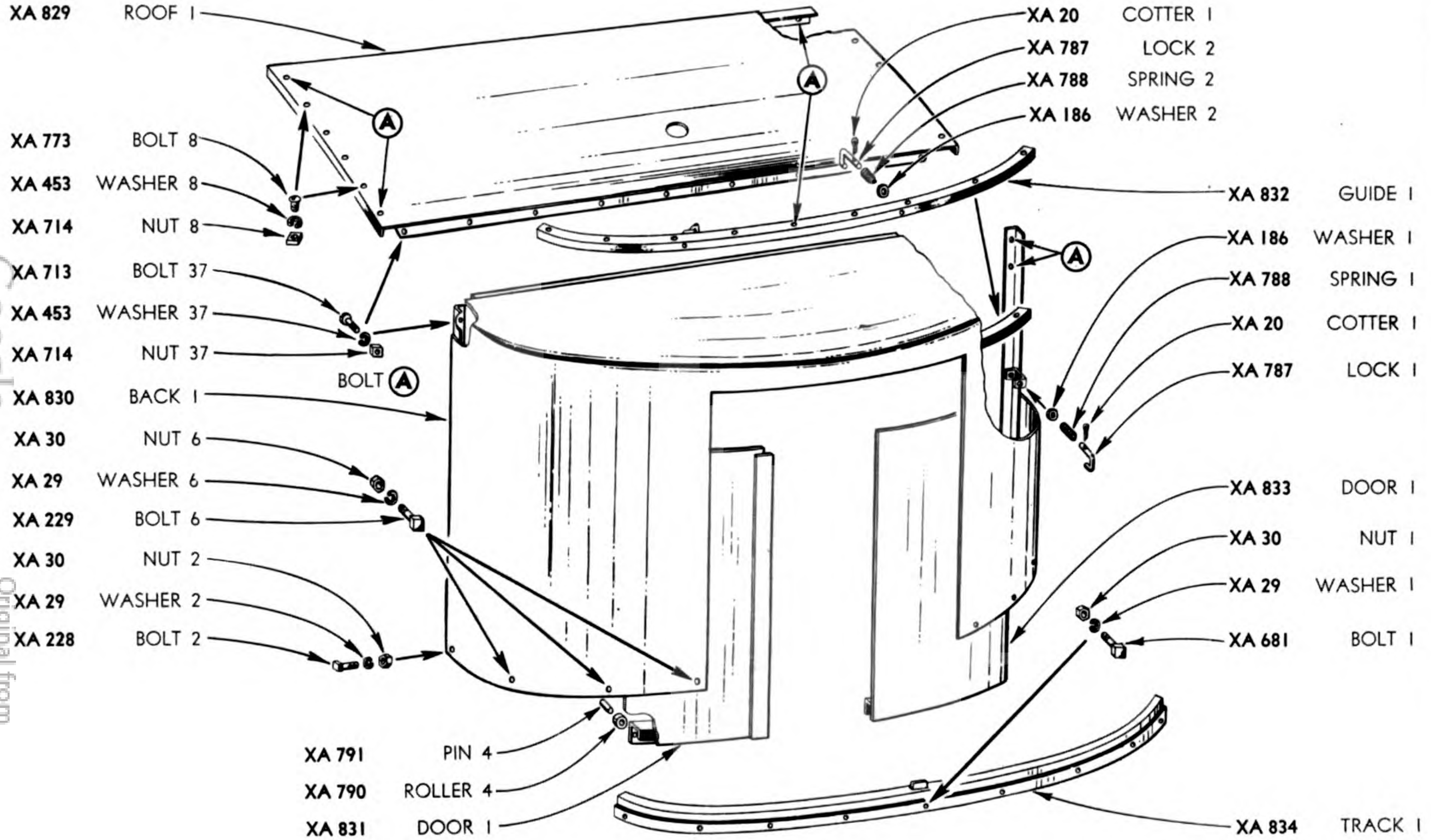
CAB - PLATFORM - BULKHEAD ASSEMBLY - WINDOW GUARD



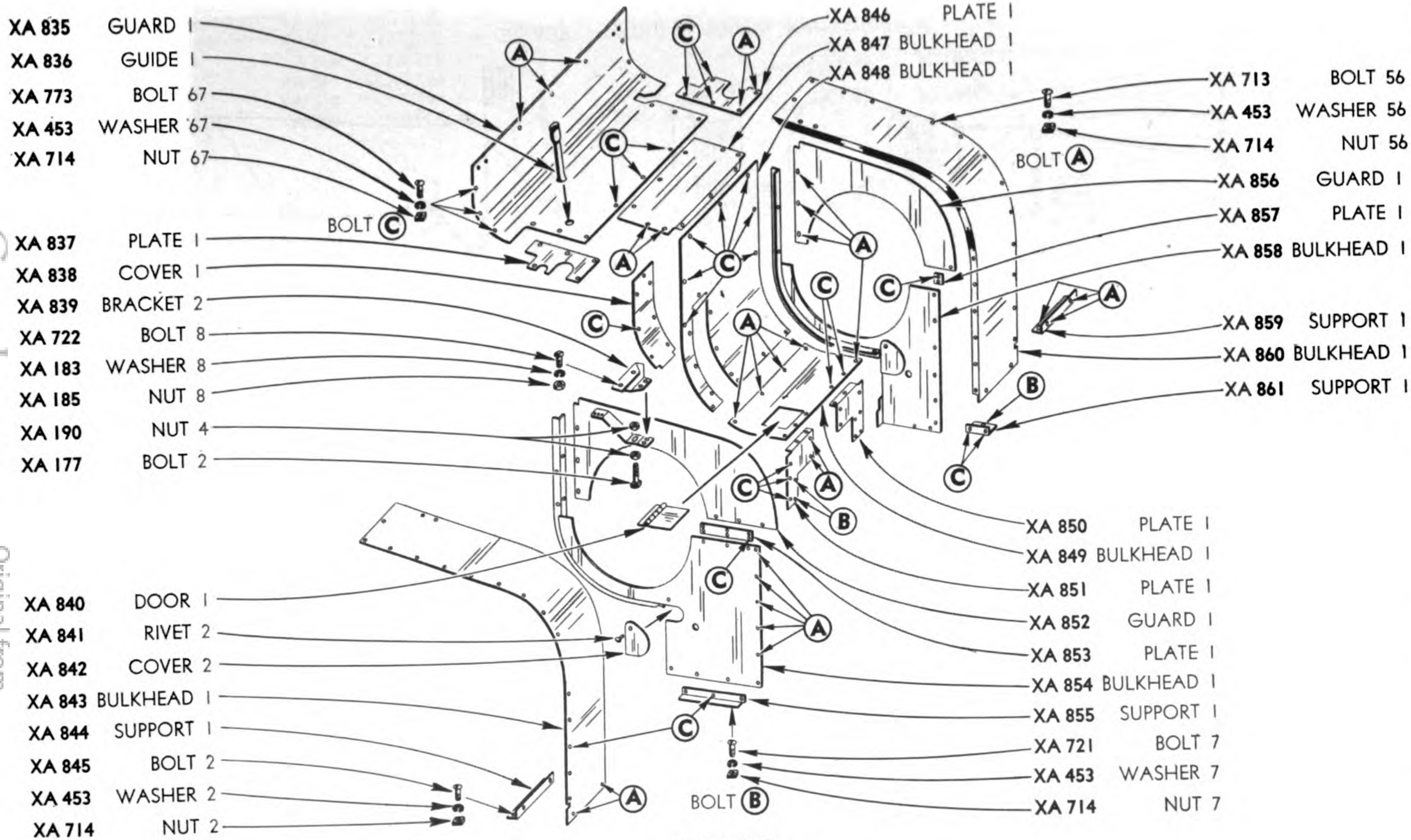
CAB - RIGHT SIDE



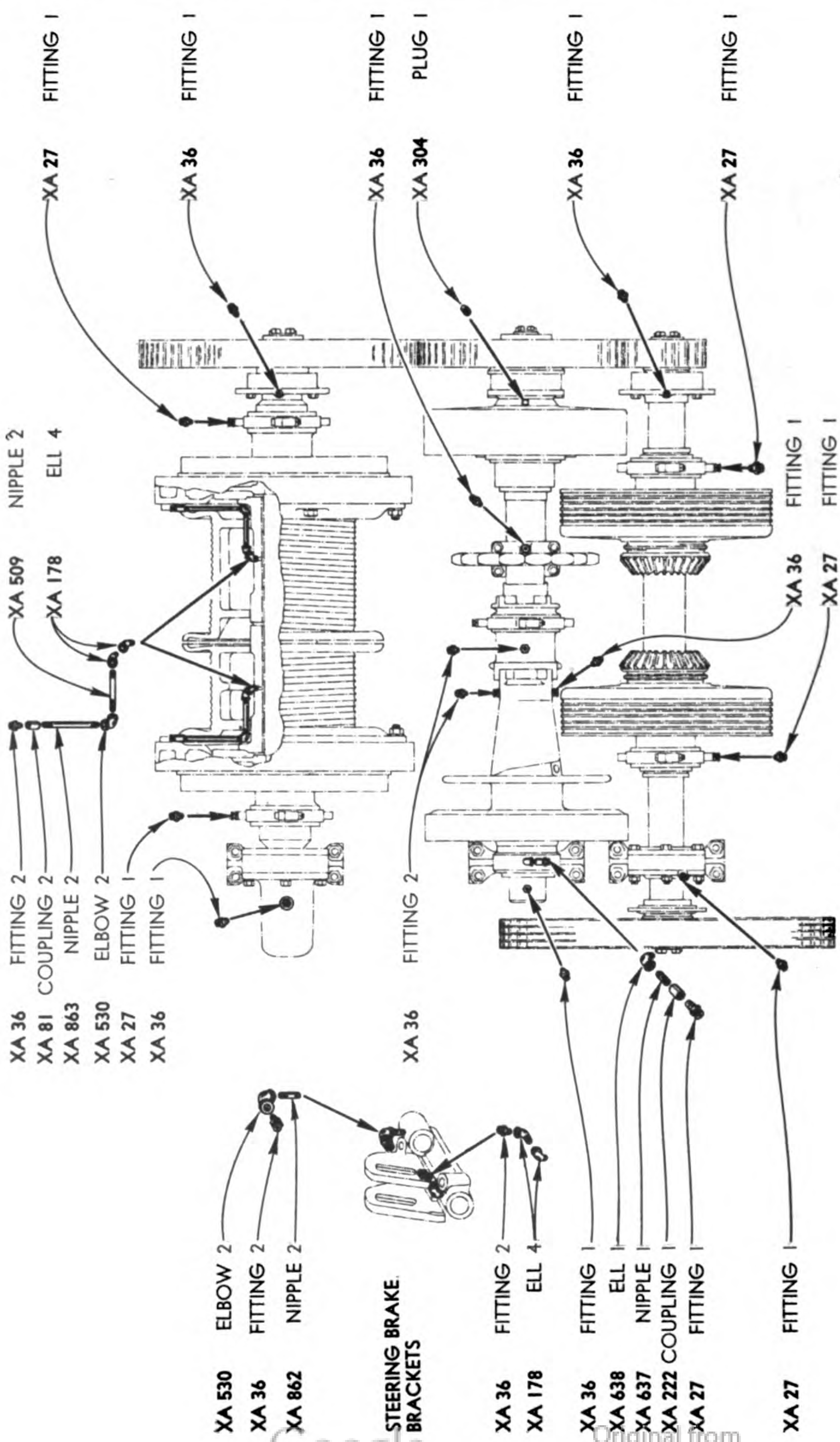
CAB - LEFT SIDE


XA 829 ROOF 1
XA 773 BOLT 8
XA 453 WASHER 8
XA 714 NUT 8
XA 713 BOLT 37
XA 453 WASHER 37
XA 714 NUT 37
BOLT A
XA 830 BACK 1
XA 30 NUT 6
XA 29 WASHER 6
XA 229 BOLT 6
XA 30 NUT 2
XA 29 WASHER 2
XA 228 BOLT 2
XA 791 PIN 4
XA 790 ROLLER 4
XA 831 DOOR 1
XA 20 COTTER 1
XA 787 LOCK 2
XA 788 SPRING 2
XA 186 WASHER 2
XA 832 GUIDE 1
XA 186 WASHER 1
XA 788 SPRING 1
XA 20 COTTER 1
XA 787 LOCK 1
XA 833 DOOR 1
XA 30 NUT 1
XA 29 WASHER 1
XA 681 BOLT 1
XA 834 TRACK 1
A

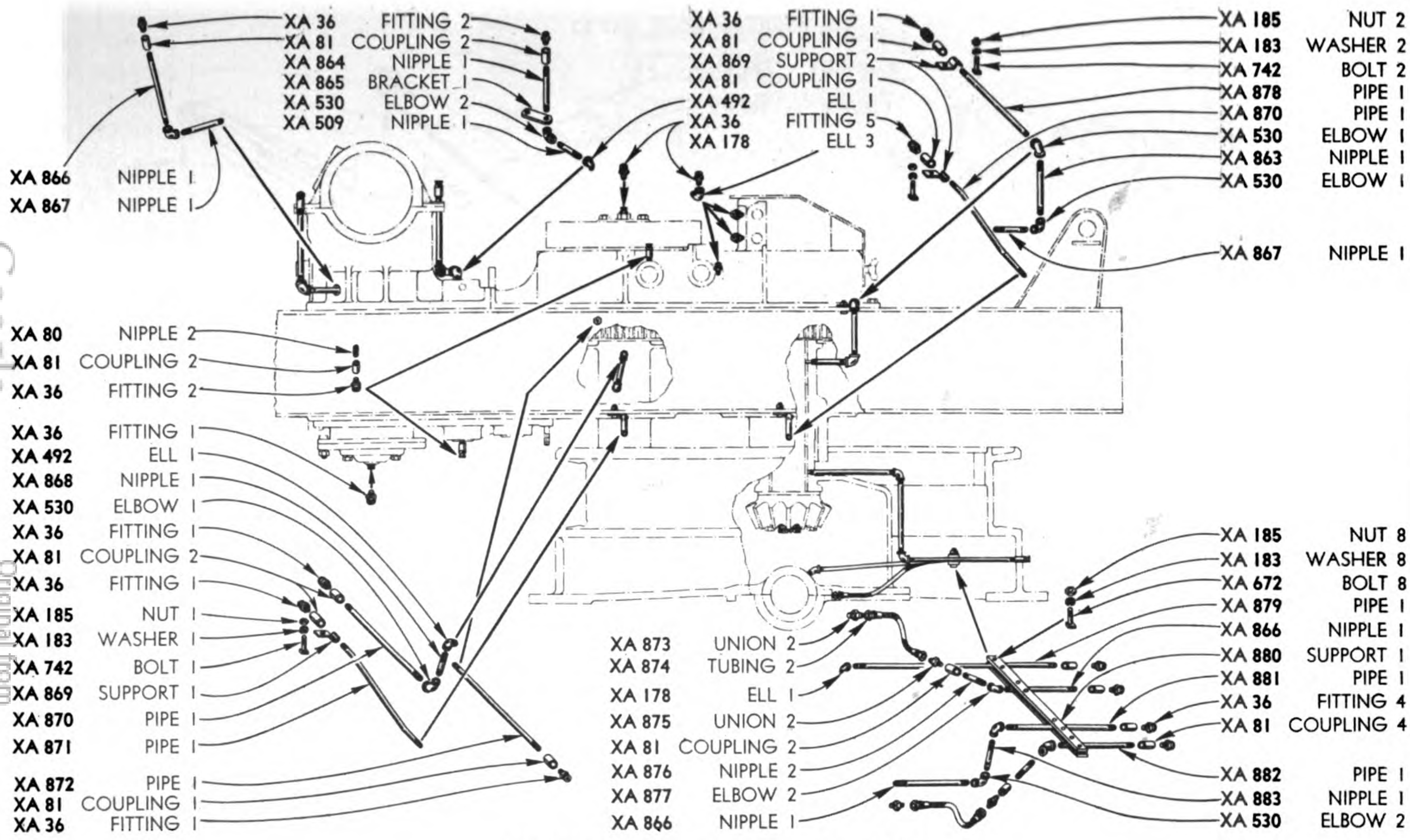
CAB - REAR


XA 835 GUARD 1
XA 836 GUIDE 1
XA 773 BOLT 67
XA 453 WASHER 67
XA 714 NUT 67
BOLT C
XA 837 PLATE 1
XA 838 COVER 1
XA 839 BRACKET 2
XA 722 BOLT 8
XA 183 WASHER 8
XA 185 NUT 8
XA 190 NUT 4
XA 177 BOLT 2
XA 840 DOOR 1
XA 841 RIVET 2
XA 842 COVER 2
XA 843 BULKHEAD 1
XA 844 SUPPORT 1
XA 845 BOLT 2
XA 453 WASHER 2
XA 714 NUT 2
XA 846 PLATE 1
XA 847 BULKHEAD 1
XA 848 BULKHEAD 1
XA 713 BOLT 56
XA 453 WASHER 56
XA 714 NUT 56
BOLT A
XA 856 GUARD 1
XA 857 PLATE 1
XA 858 BULKHEAD 1
XA 859 SUPPORT 1
XA 860 BULKHEAD 1
XA 861 SUPPORT 1
XA 850 PLATE 1
XA 849 BULKHEAD 1
XA 851 PLATE 1
XA 852 GUARD 1
XA 853 PLATE 1
XA 854 BULKHEAD 1
XA 855 SUPPORT 1
XA 721 BOLT 7
XA 453 WASHER 7
XA 714 NUT 7
BOLT B

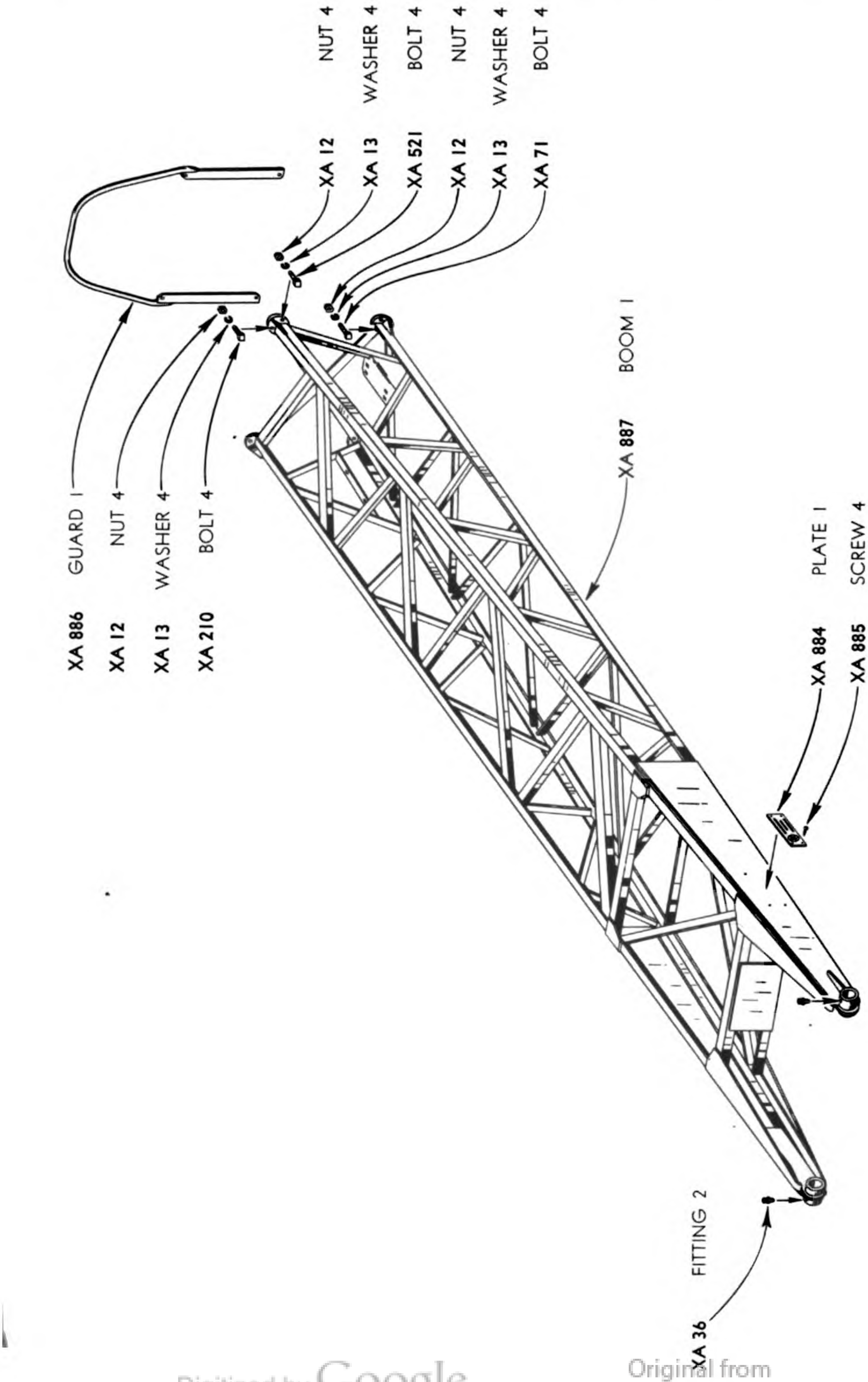
BULKHEAD



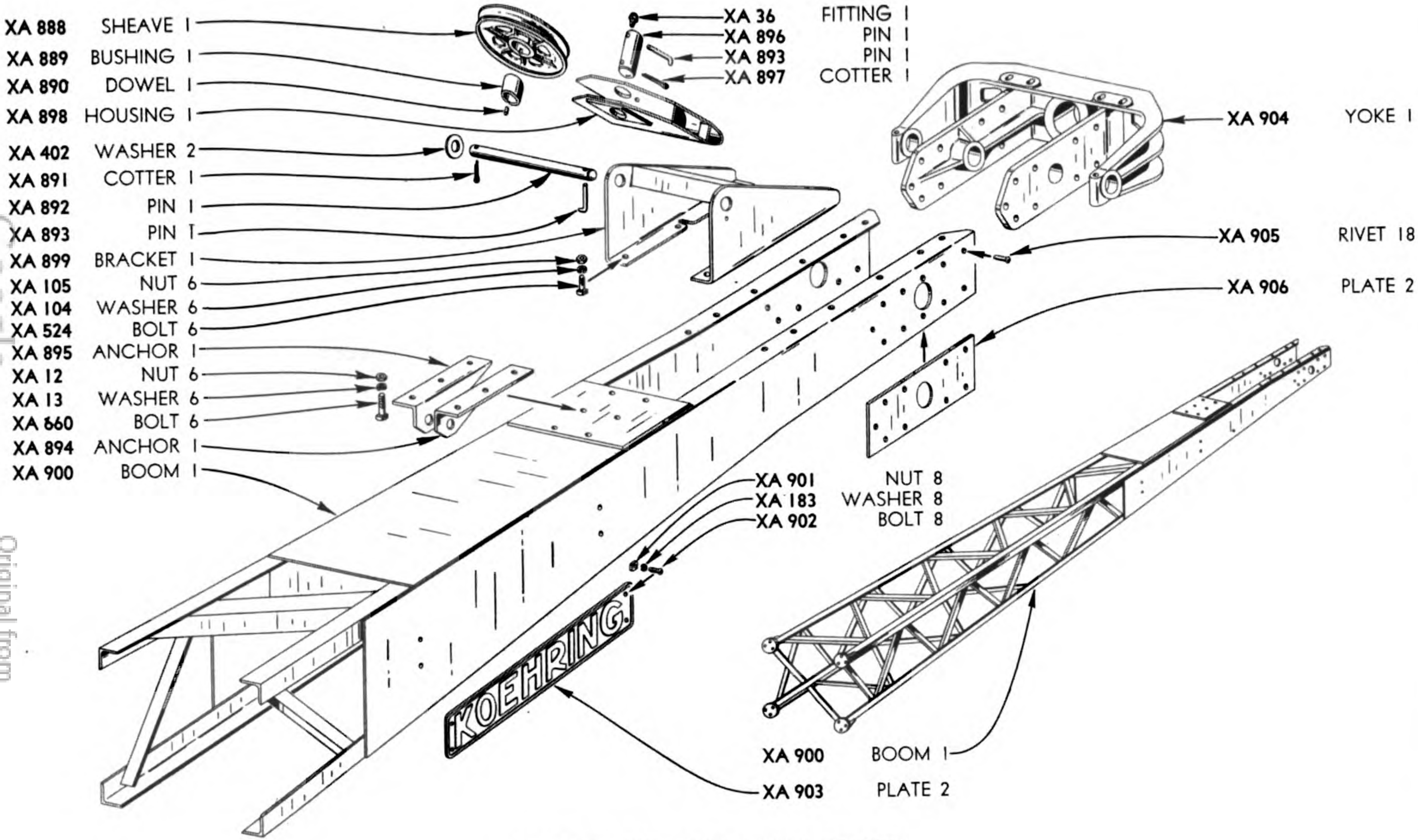
GREASE PIPING - UPPER MACHINERY



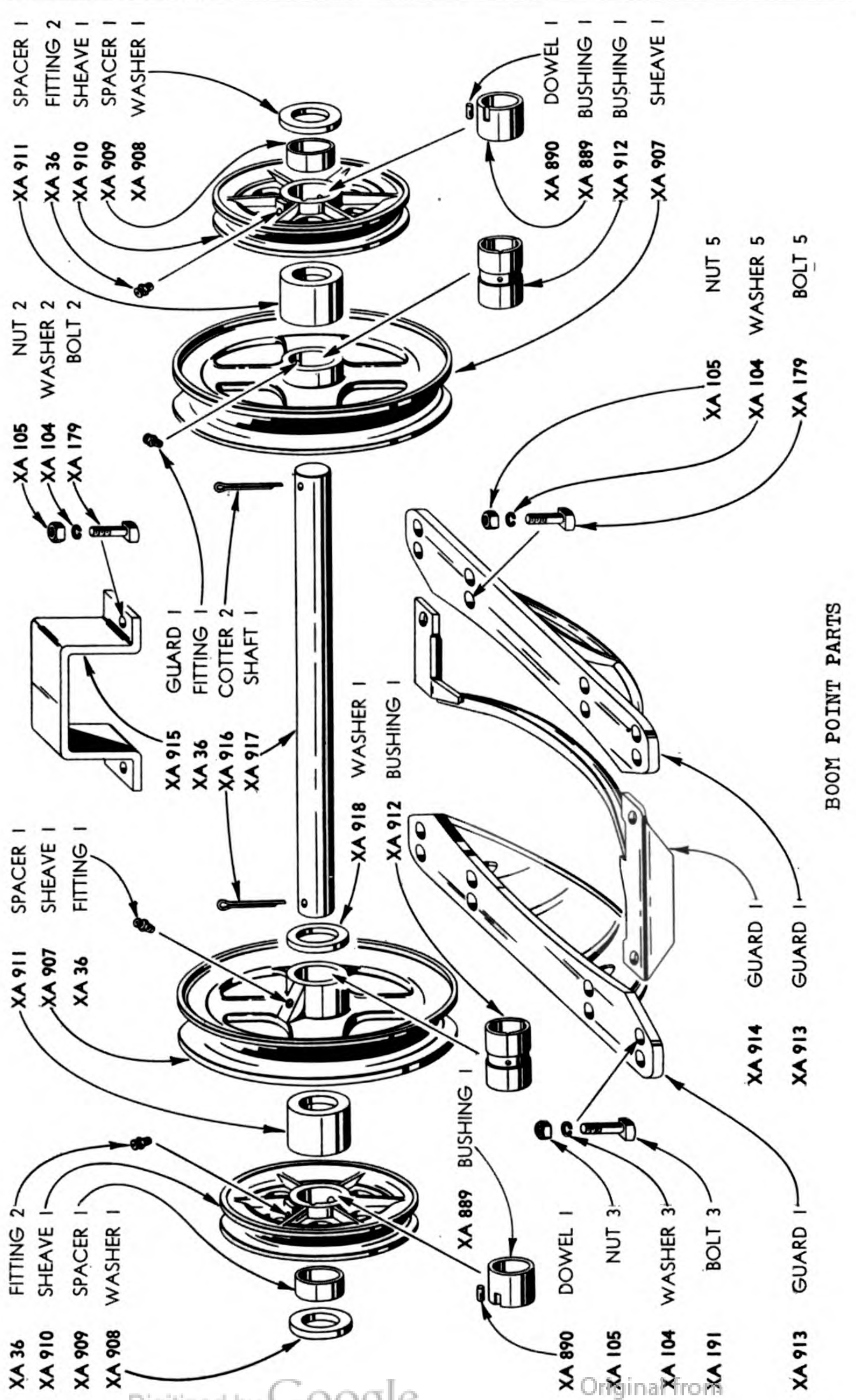
GREASE PIPING - LOWER MACHINERY



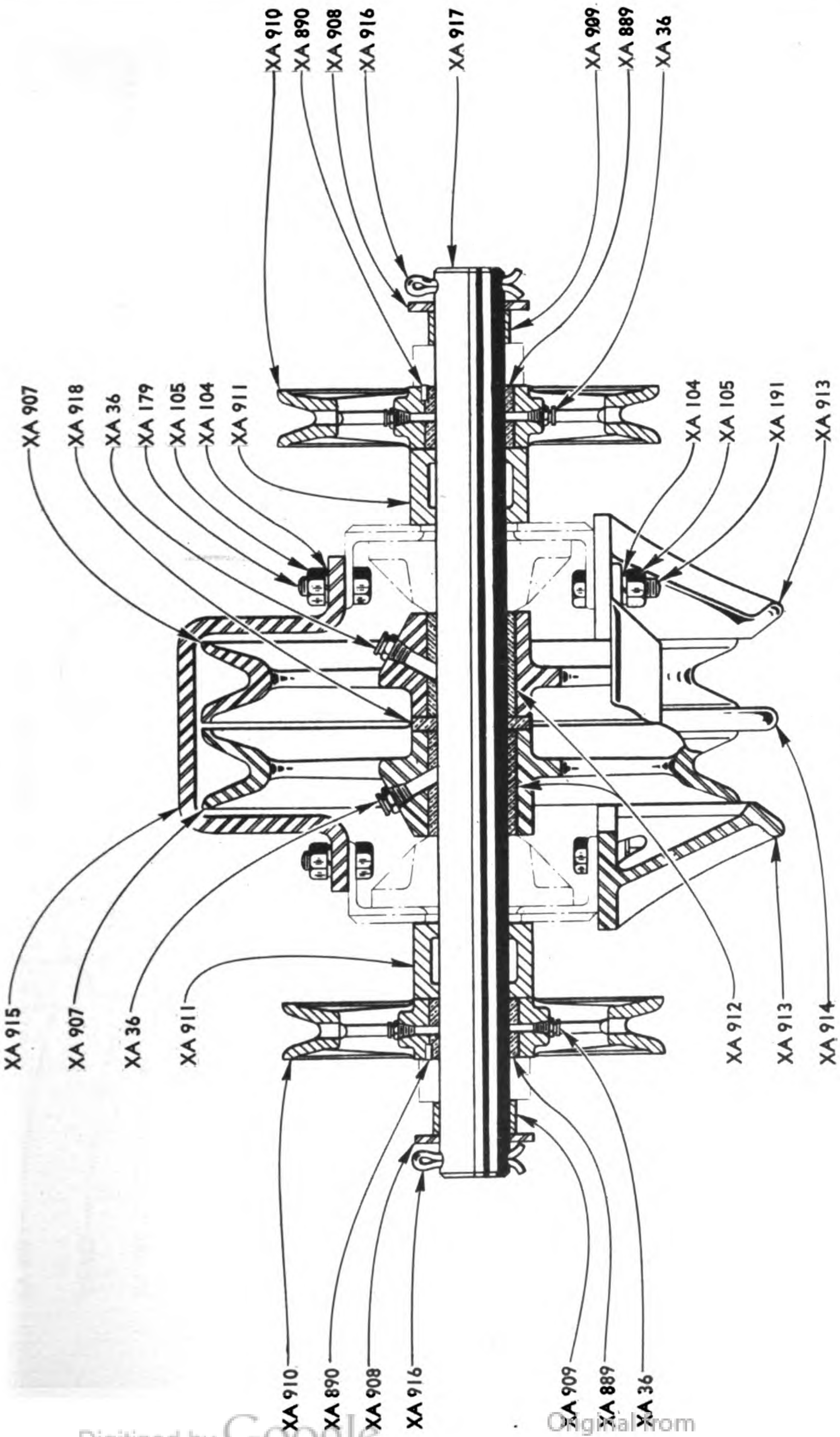
CRANE BOOM - INNER



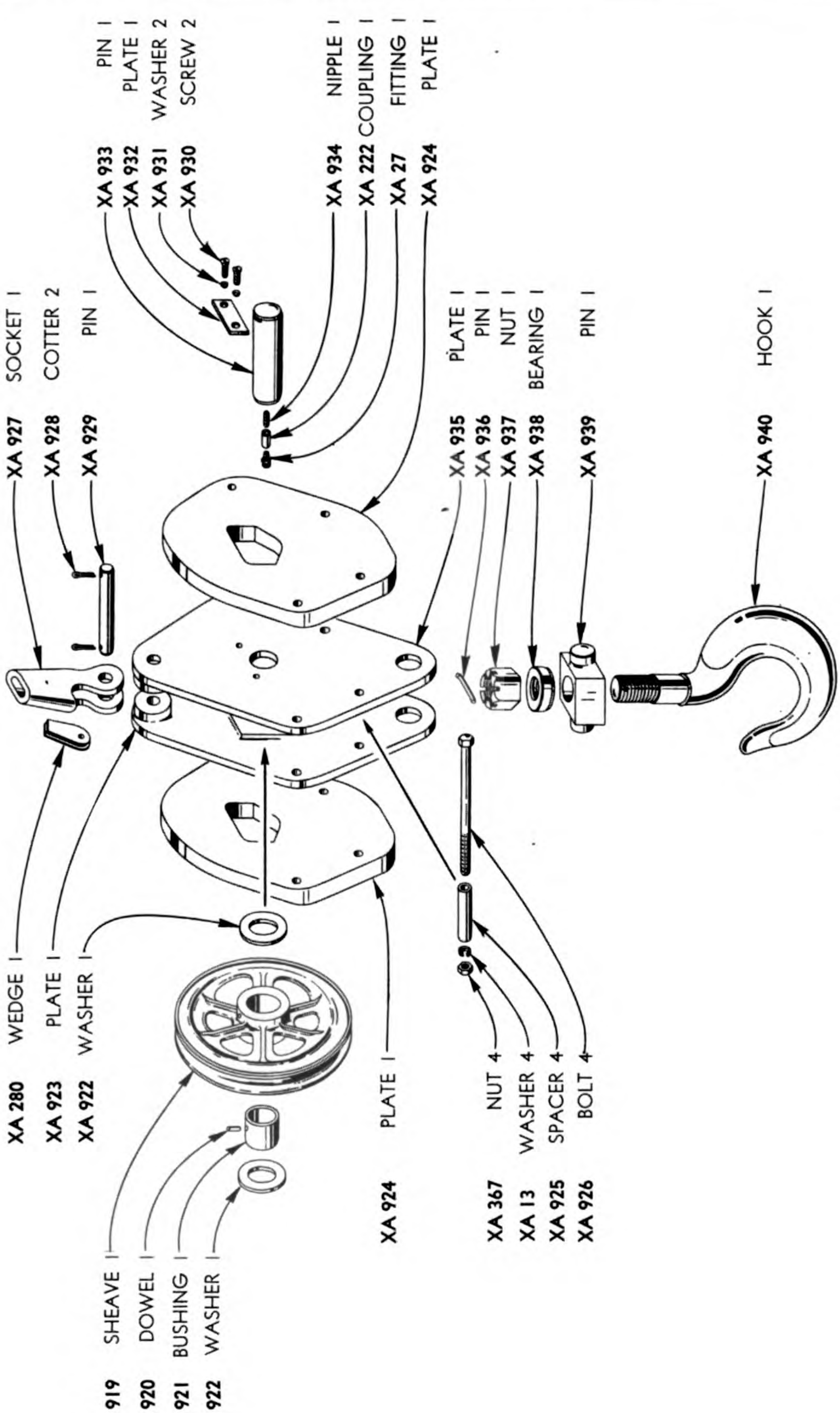
CRANE BOOM - BOOM POINT PARTS



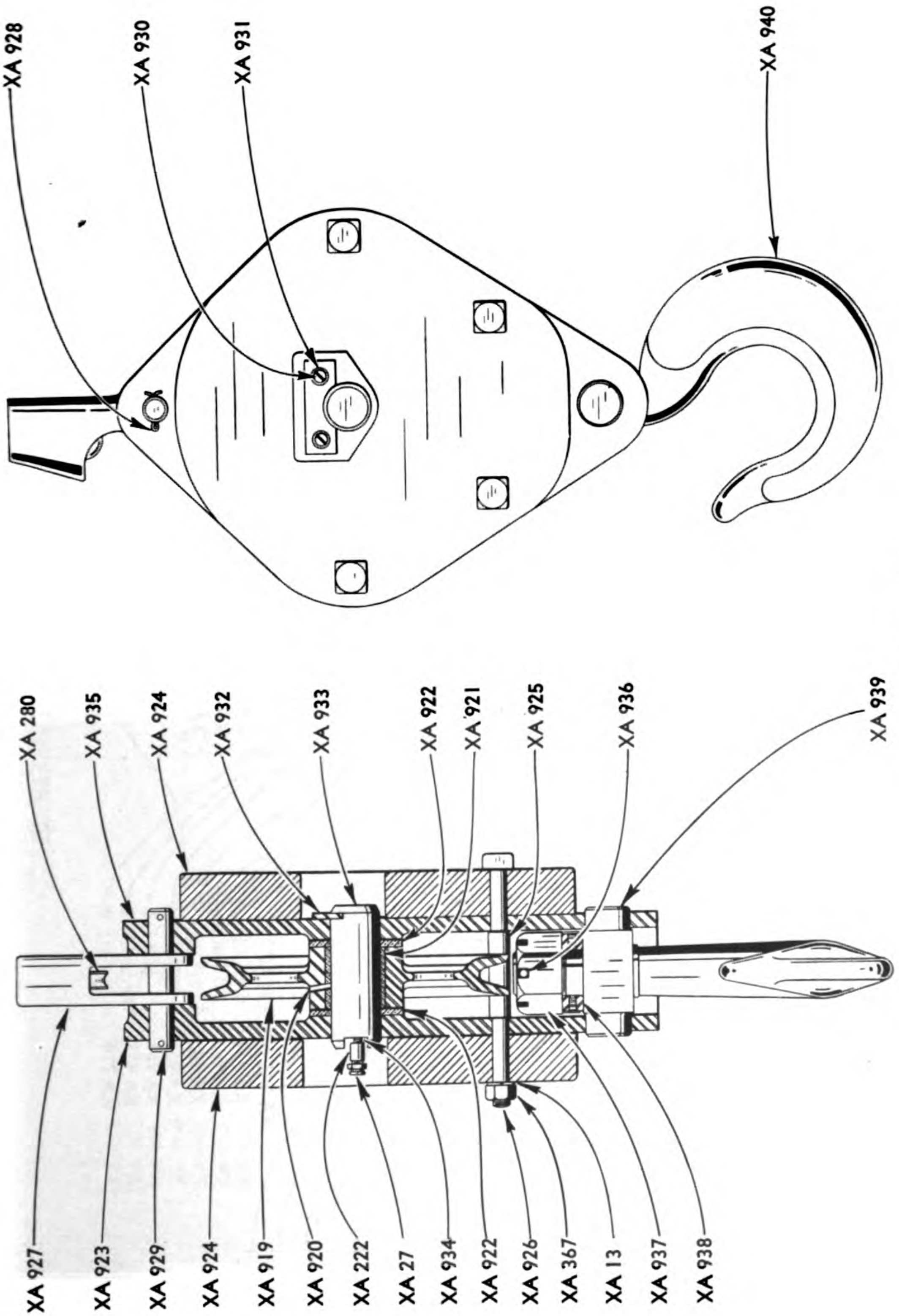
BOOM POINT PARTS



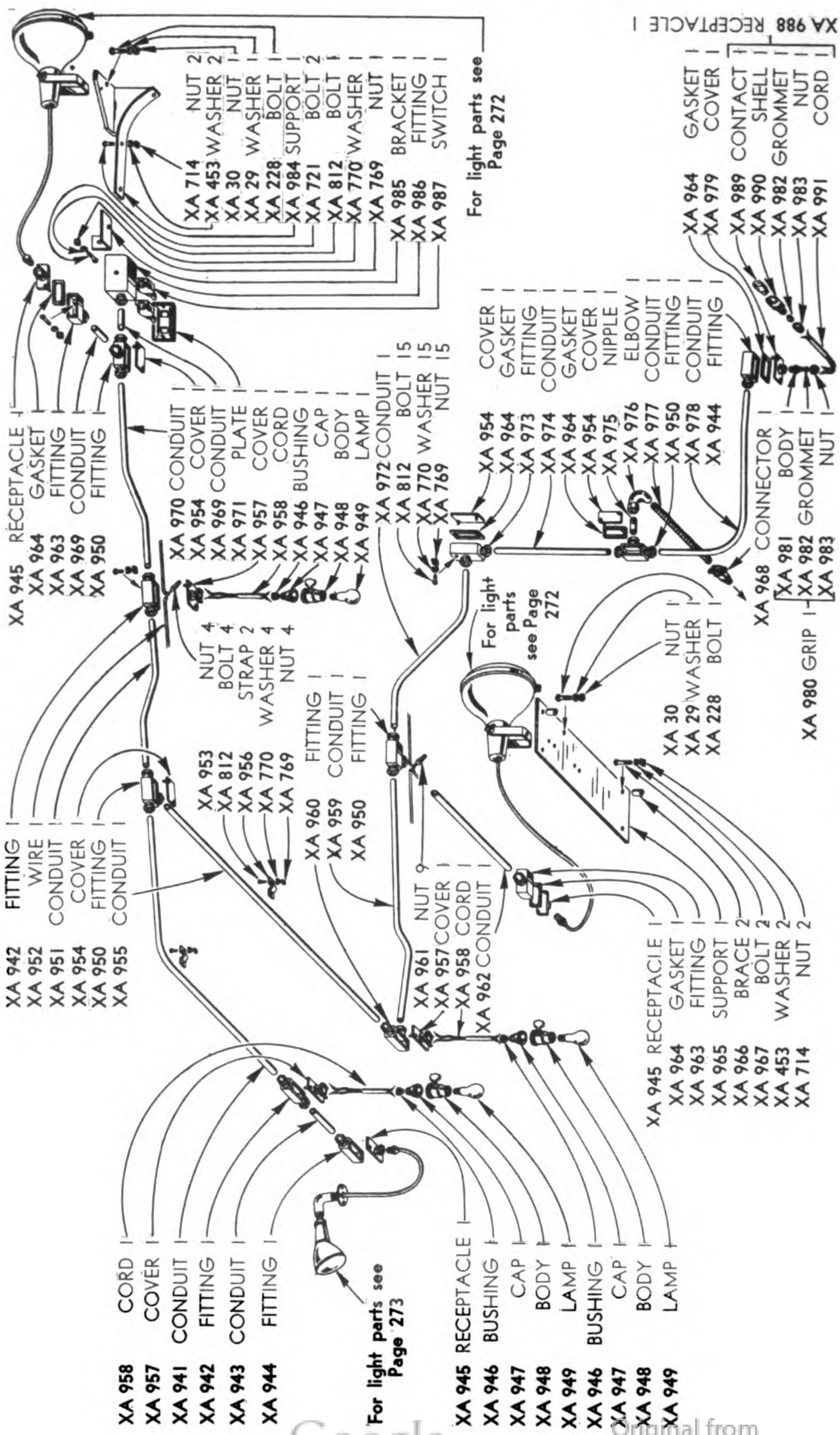
BOOM POINT PARTS



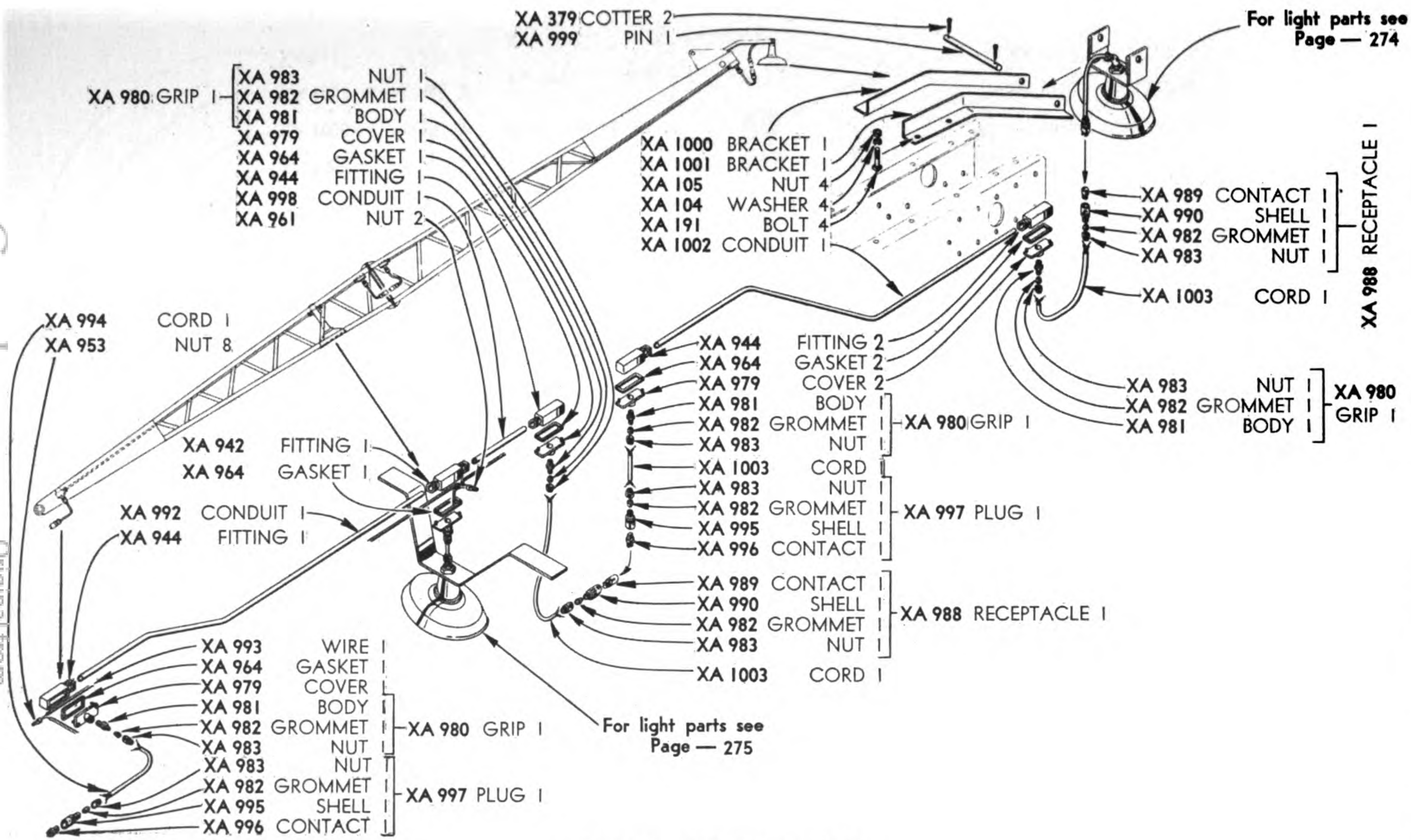
HOOK AND BLOCK



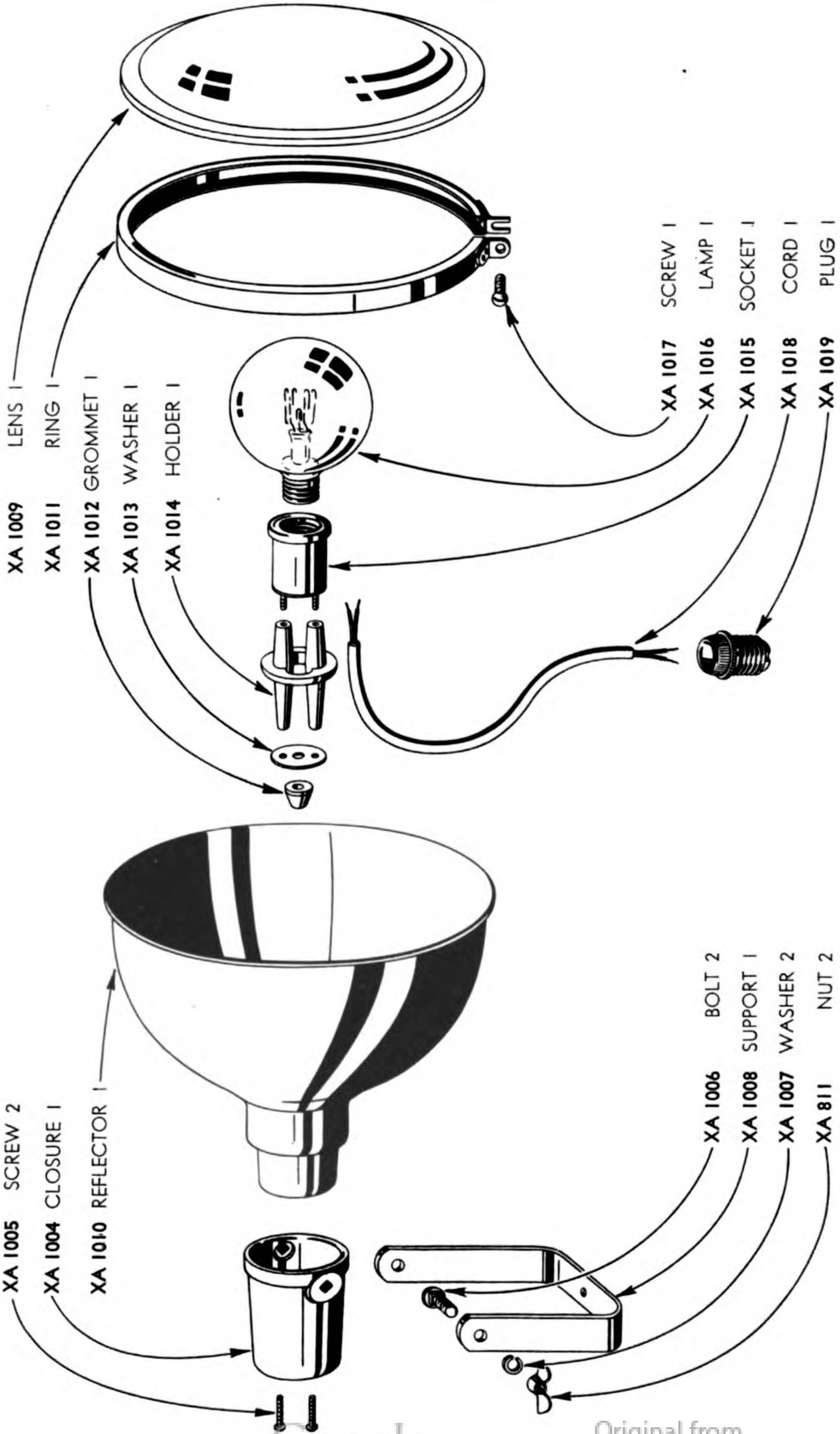
HOOK AND BLOCK



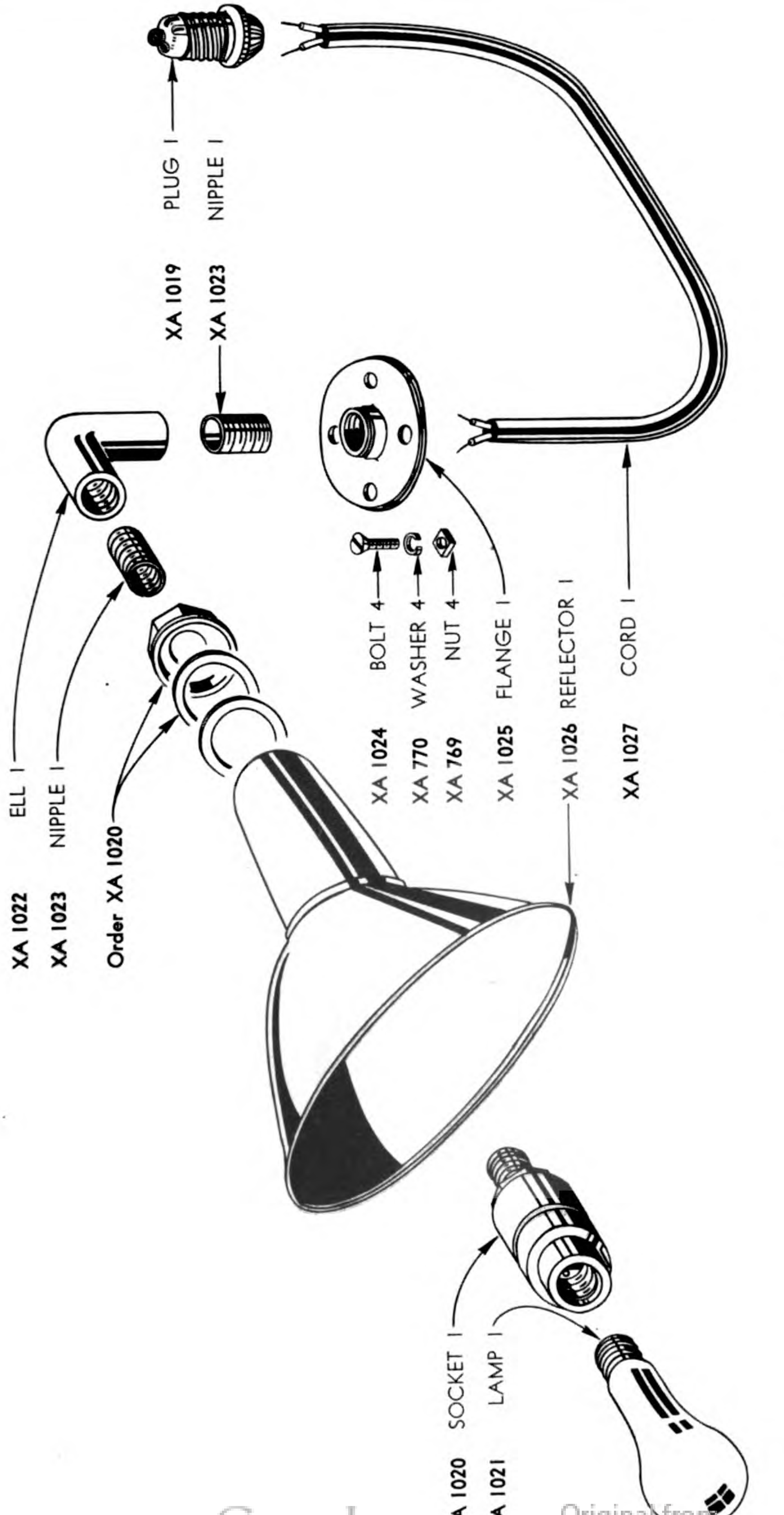
LIGHTING SYSTEM - CAB



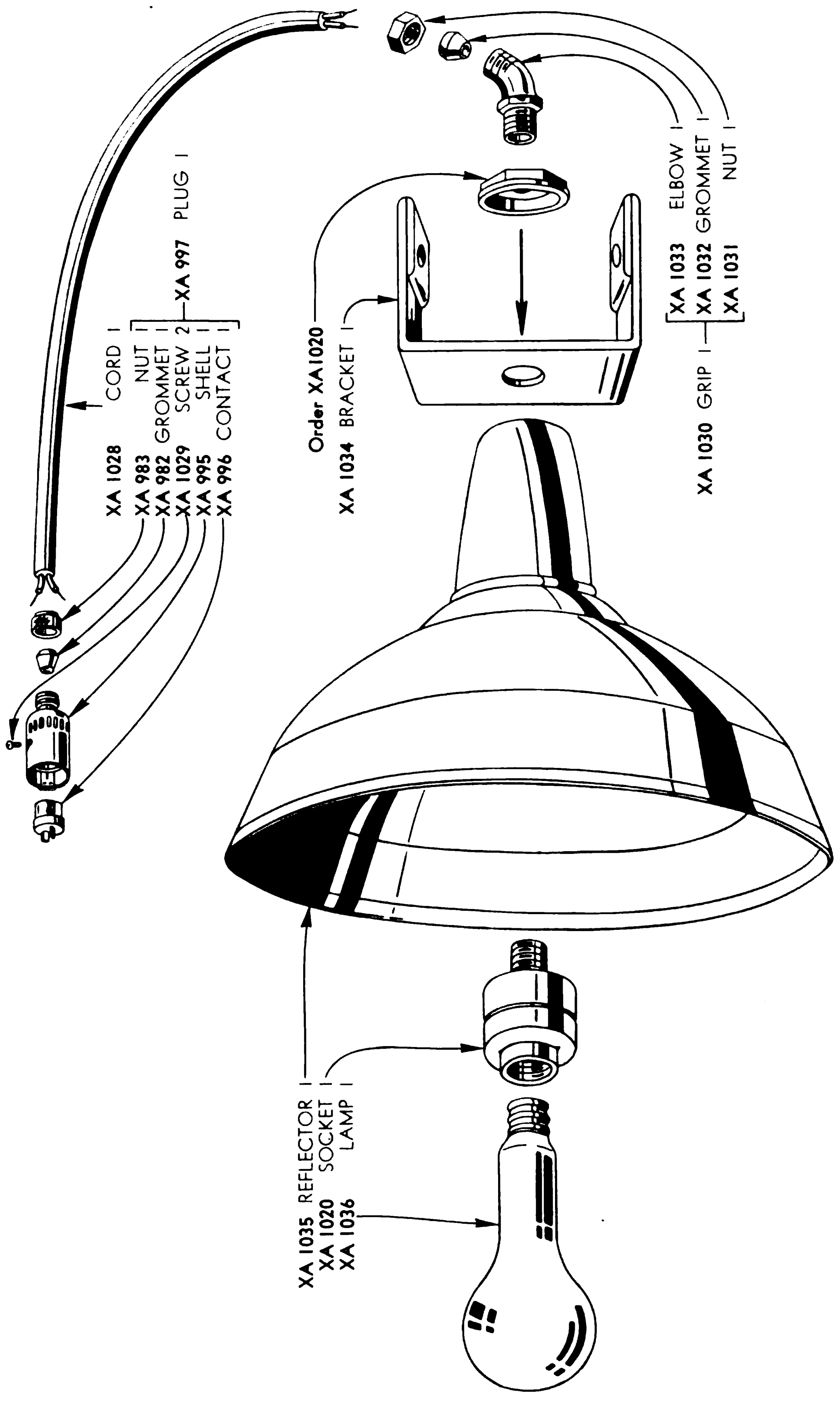
LIGHTING SYSTEM - BOOM



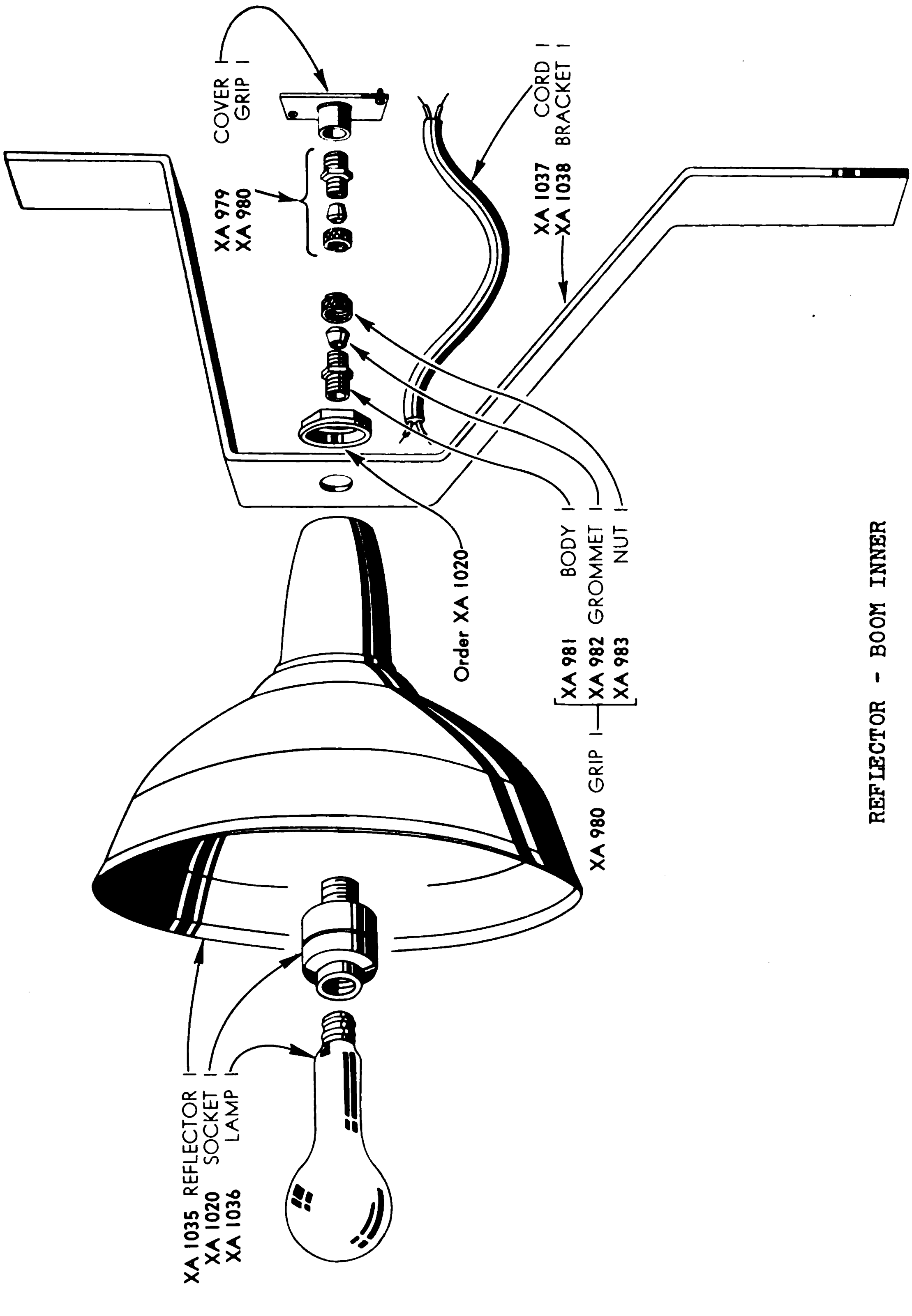
FLOODLIGHTS - CAB FRONT



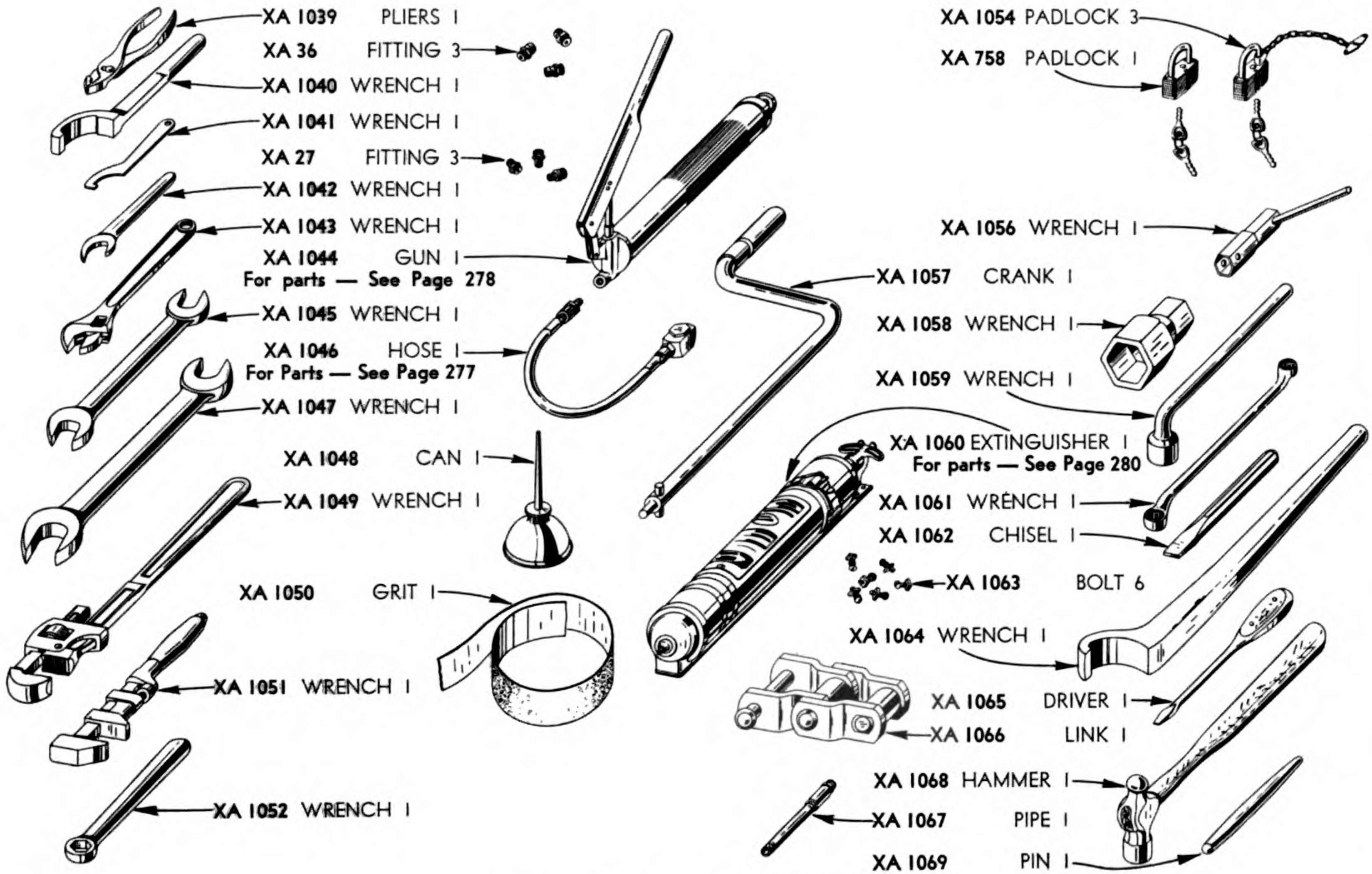
REFLECTOR - CAB REAR



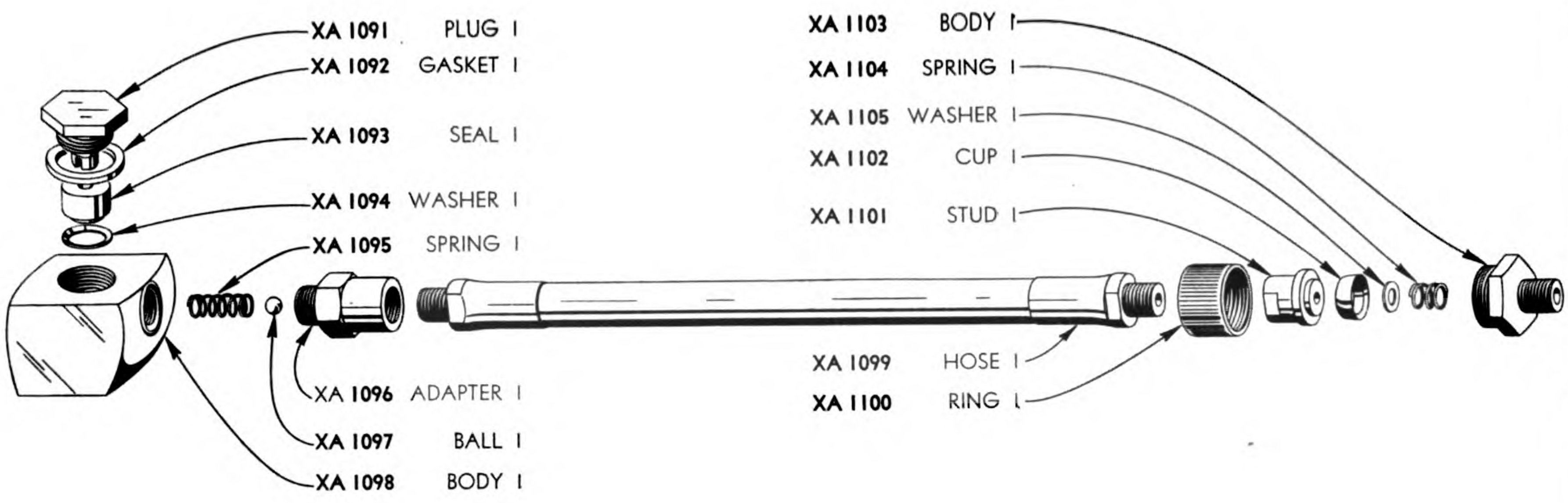
REFLECTOR - BOOM POINT

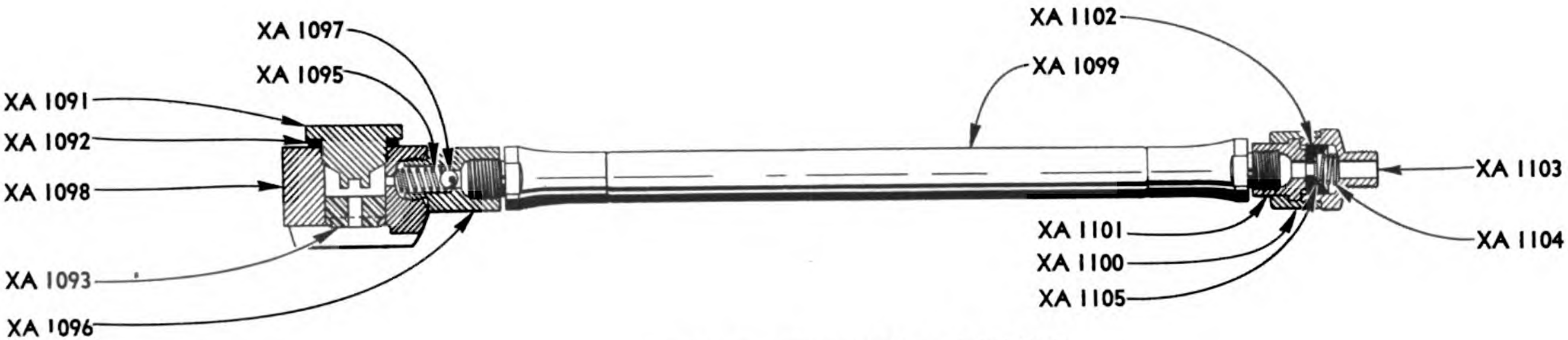


REFLECTOR - BOOM INNER

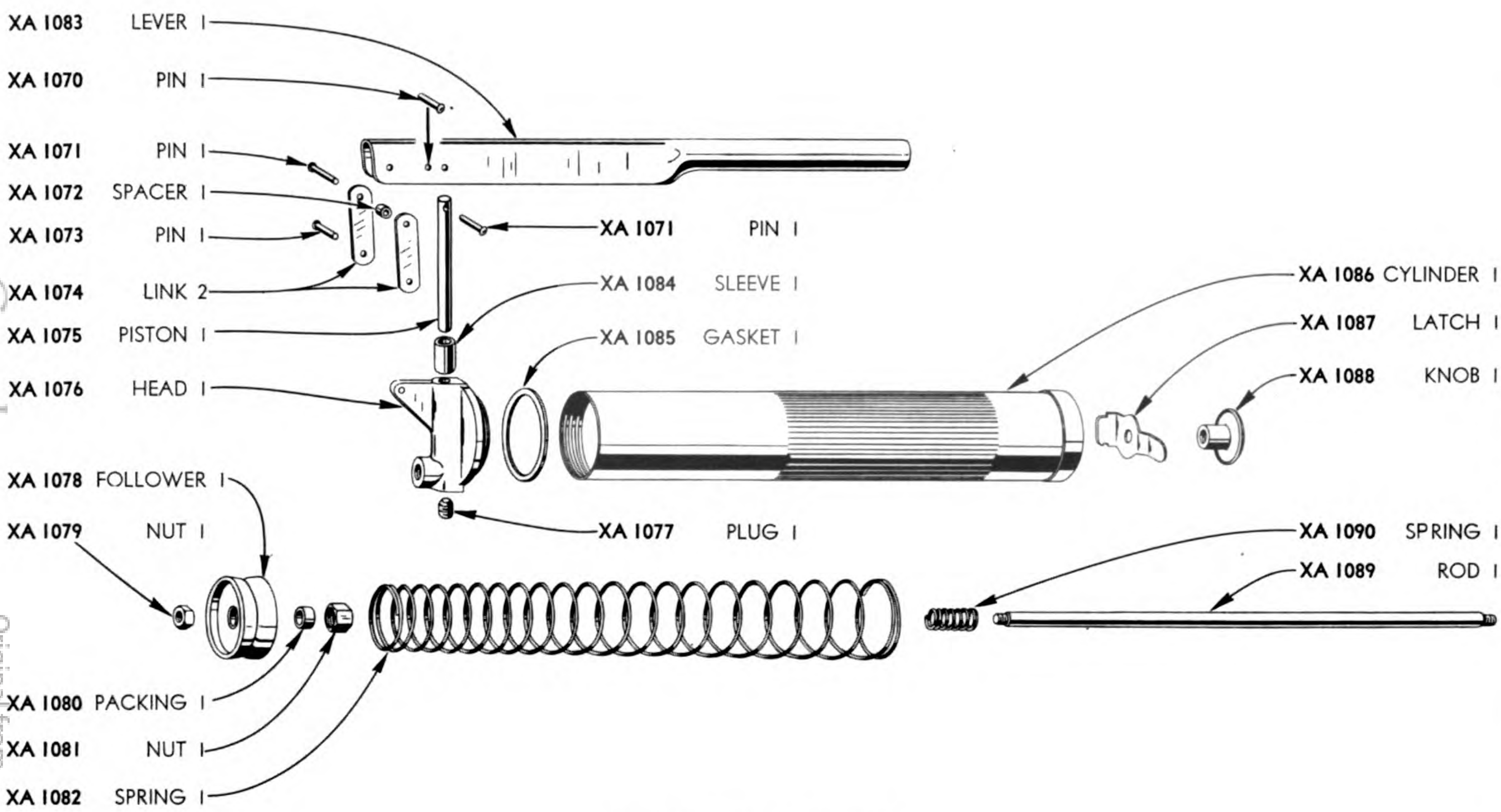


TOOL OPERATING ACCESSORIES

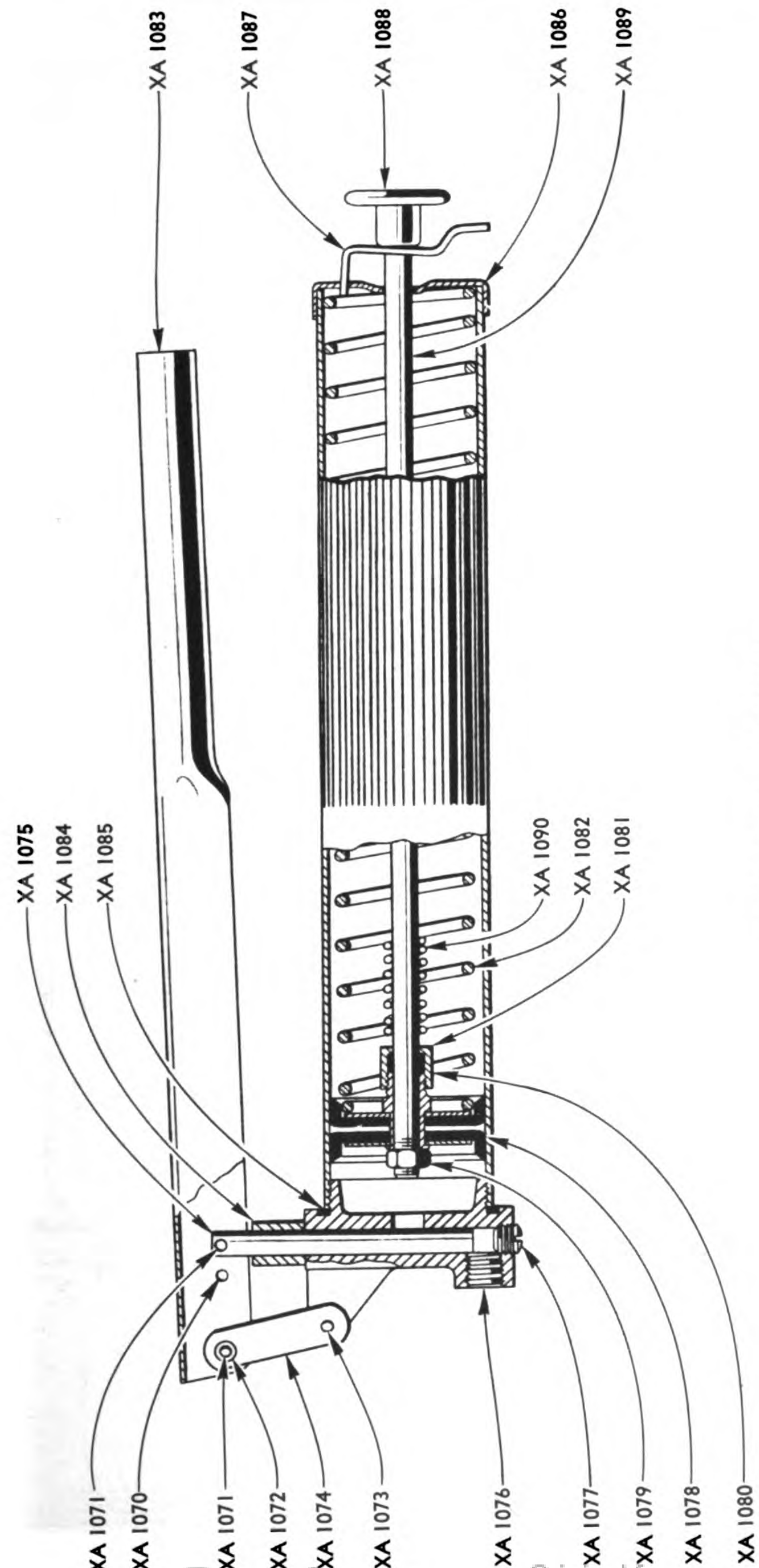




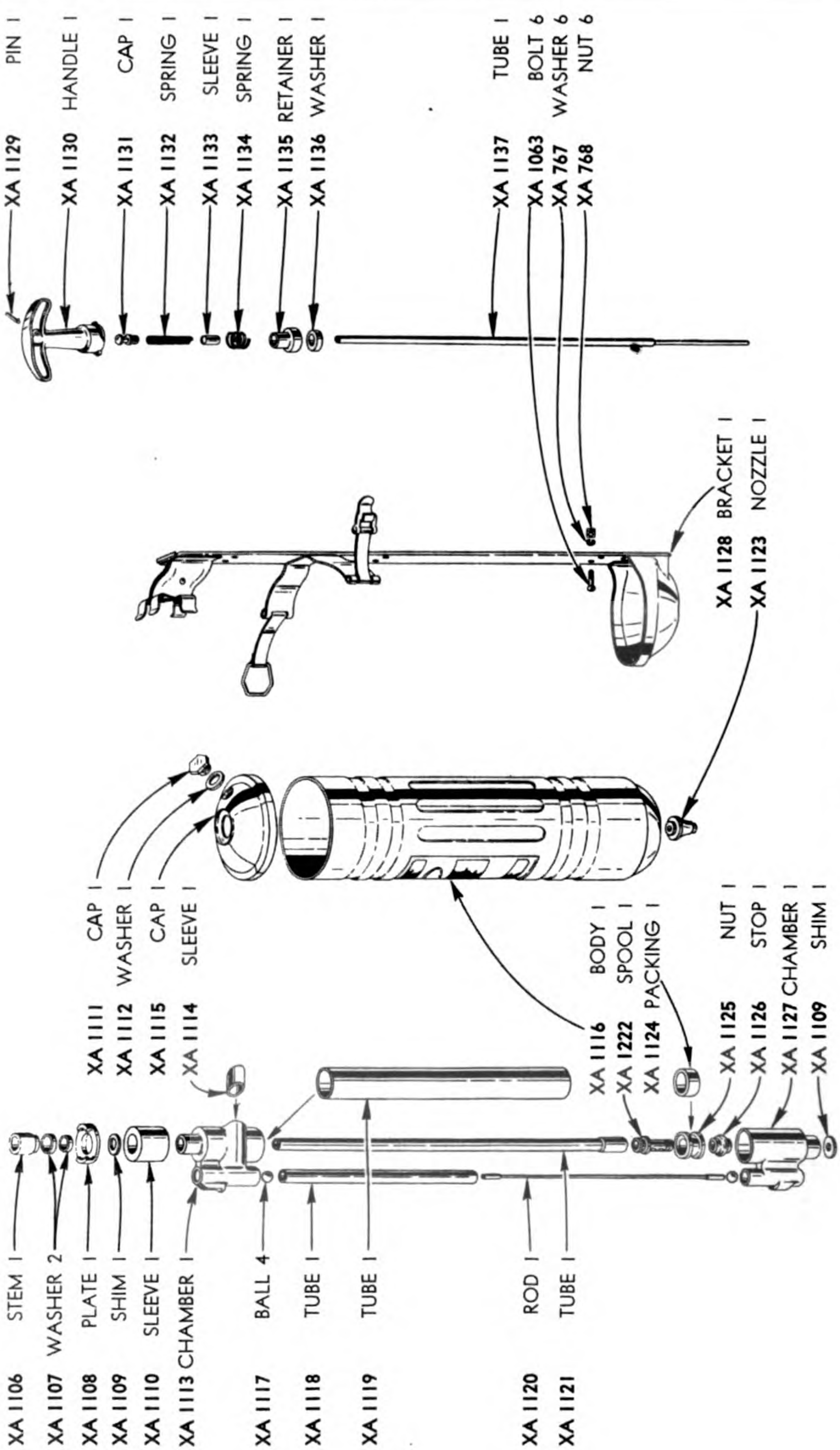
GREASE GUN HOSE - ALEMITE



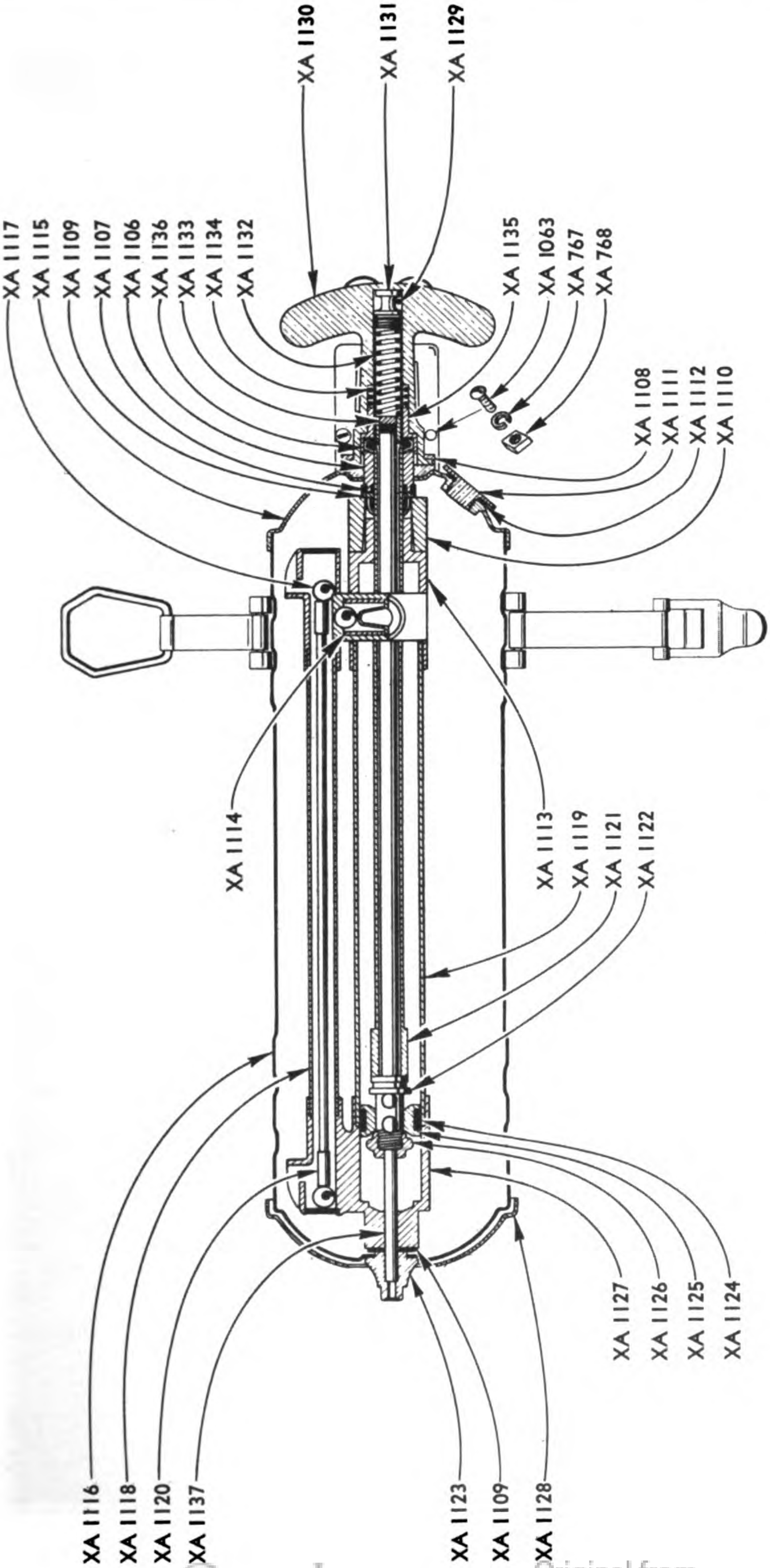
GREASE GUN - ALEMITE



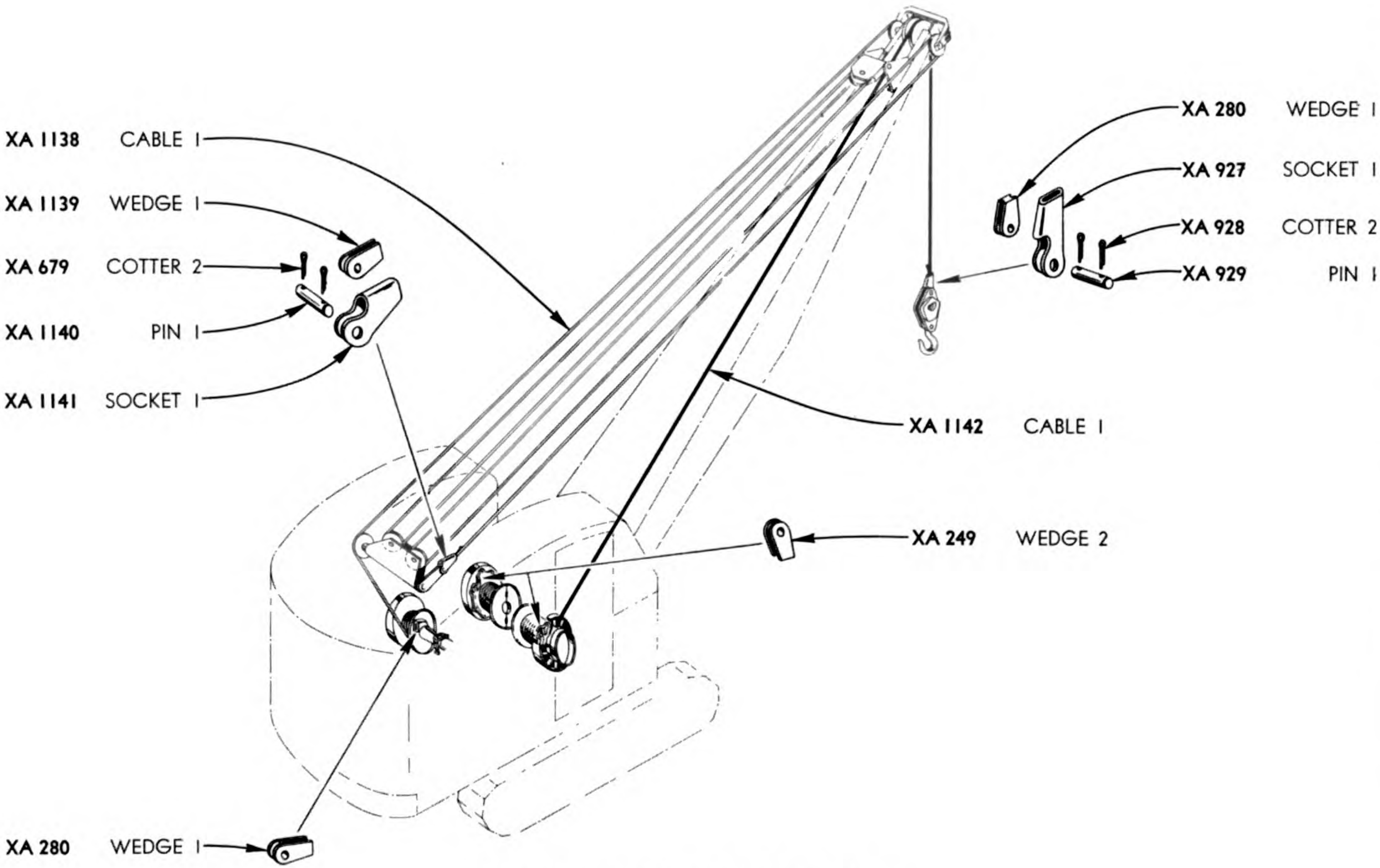
GREASE GUN - ALEMITE



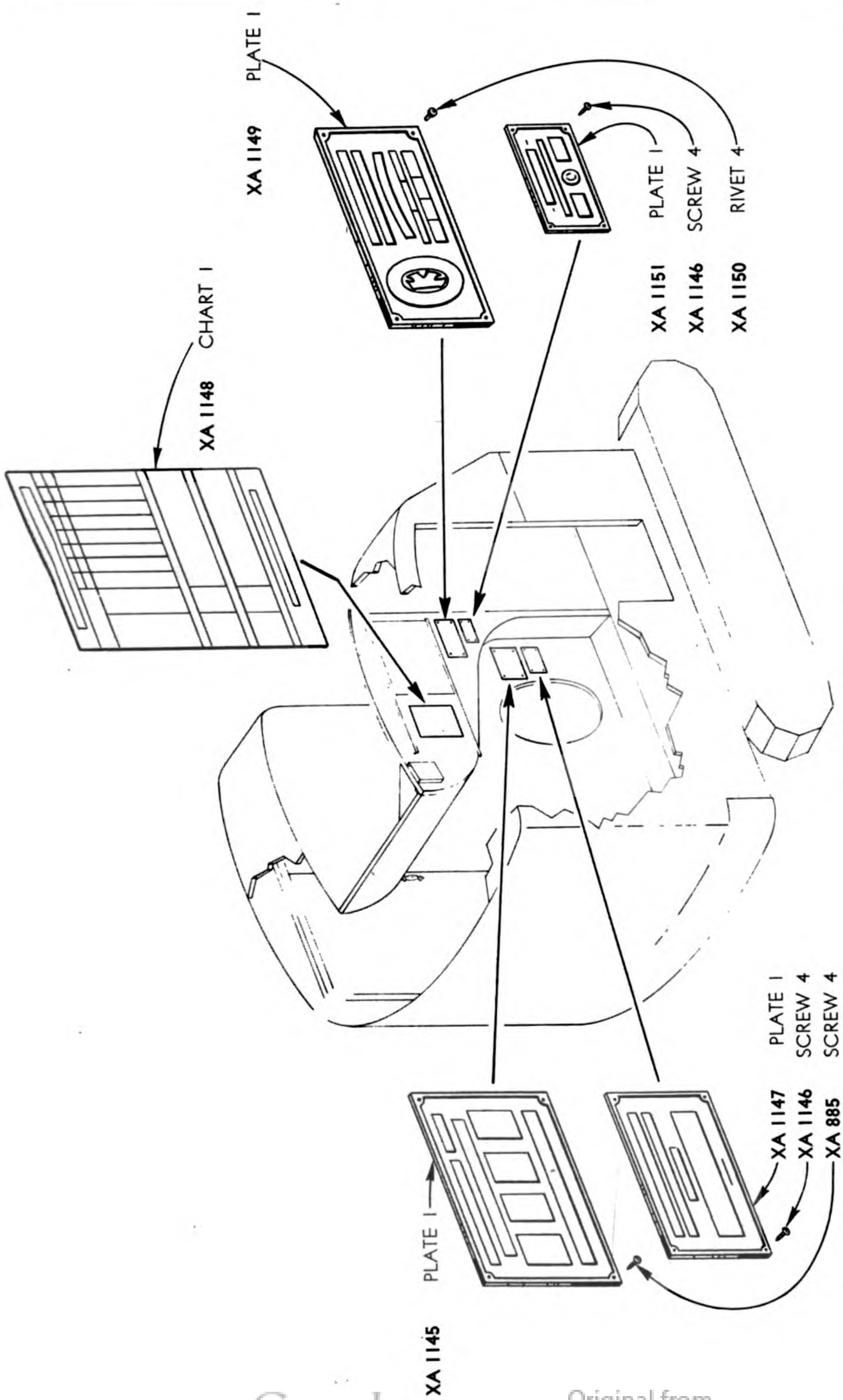
FIRE EXTINGUISHER - PYRENE



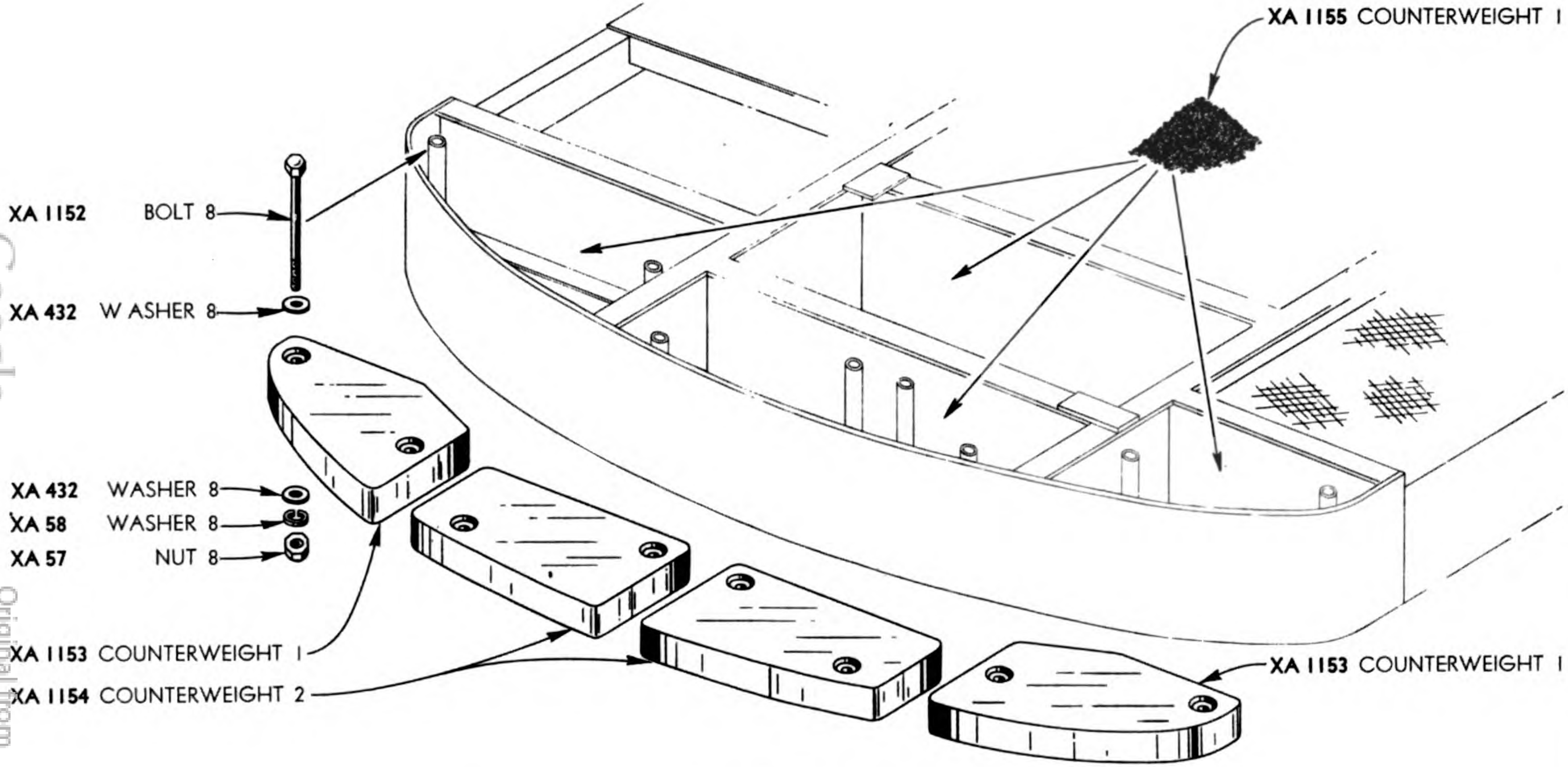
FIRE EXTINGUISHER - PYRENE



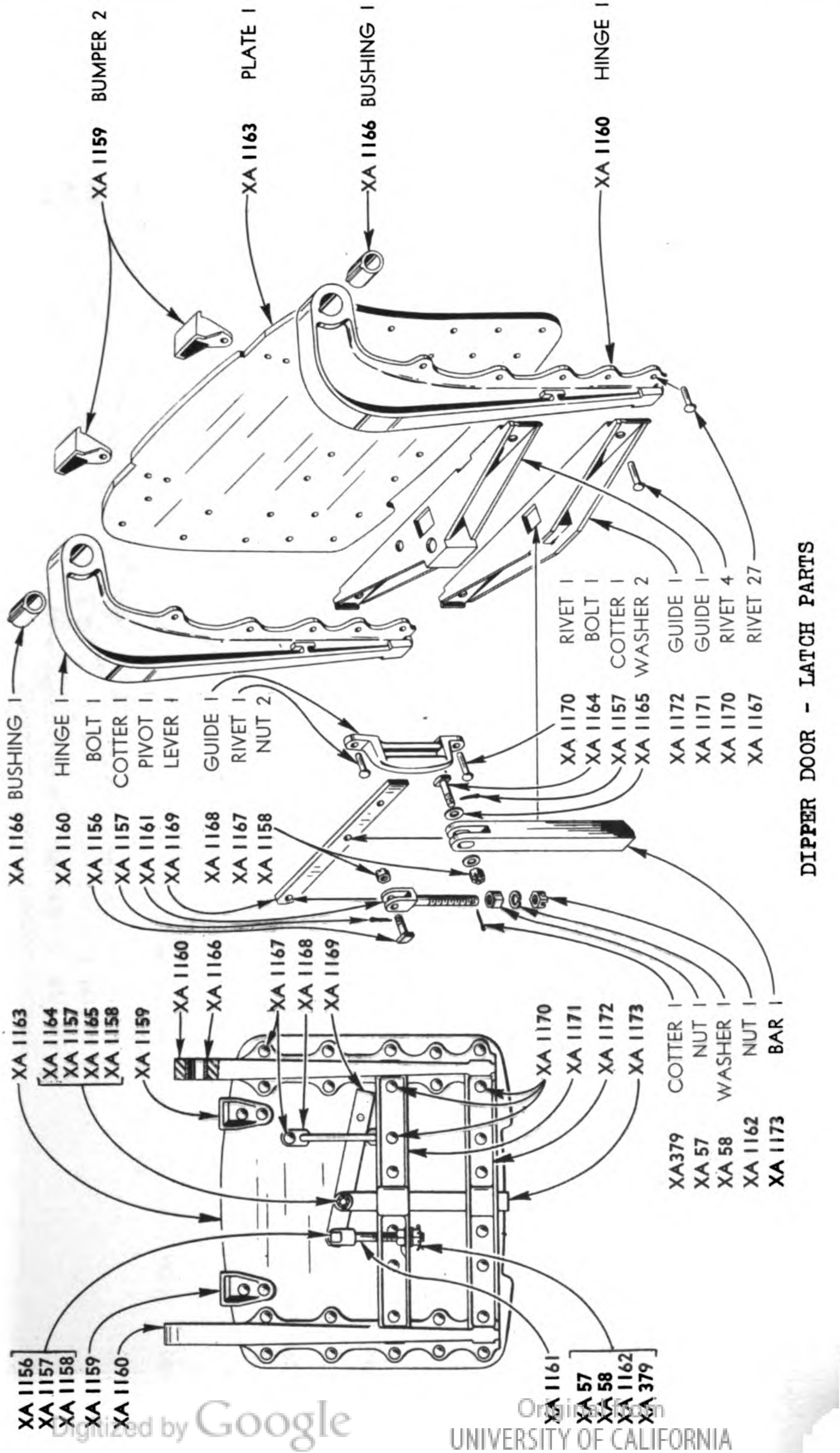
HOOK CRANE CABLES AND ANCHORS



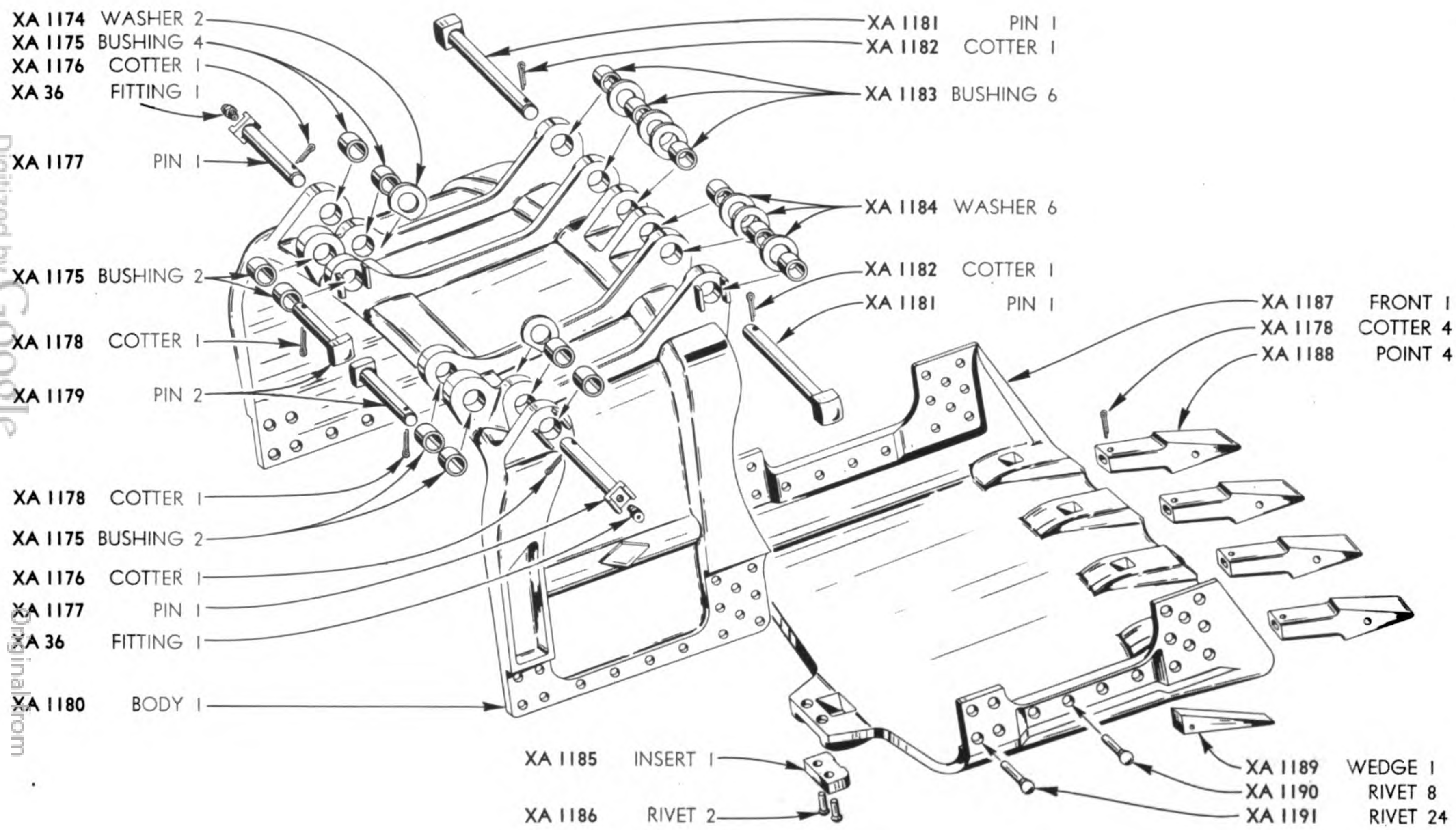
NAME PLATES ON CAB



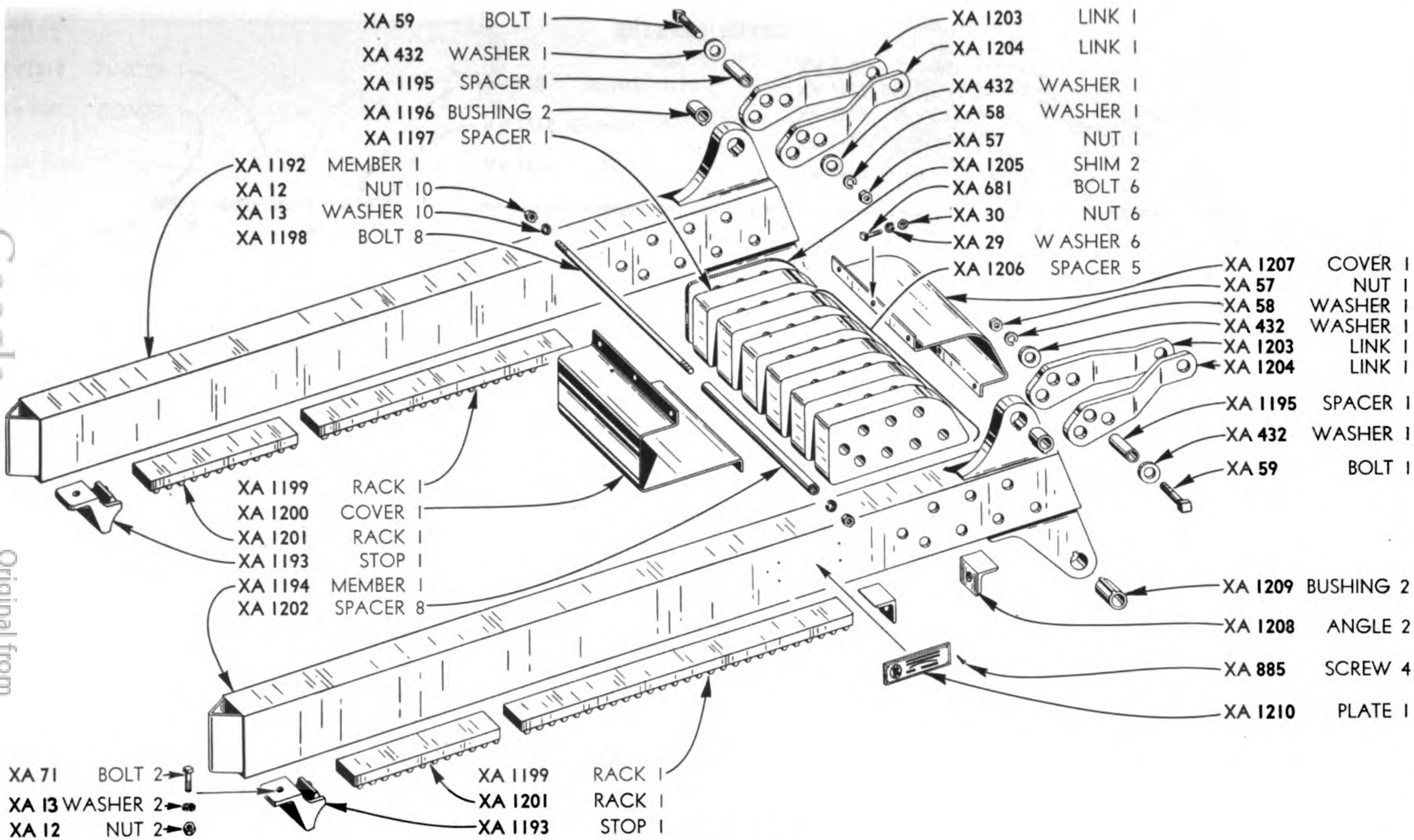
COUNTERWEIGHTS



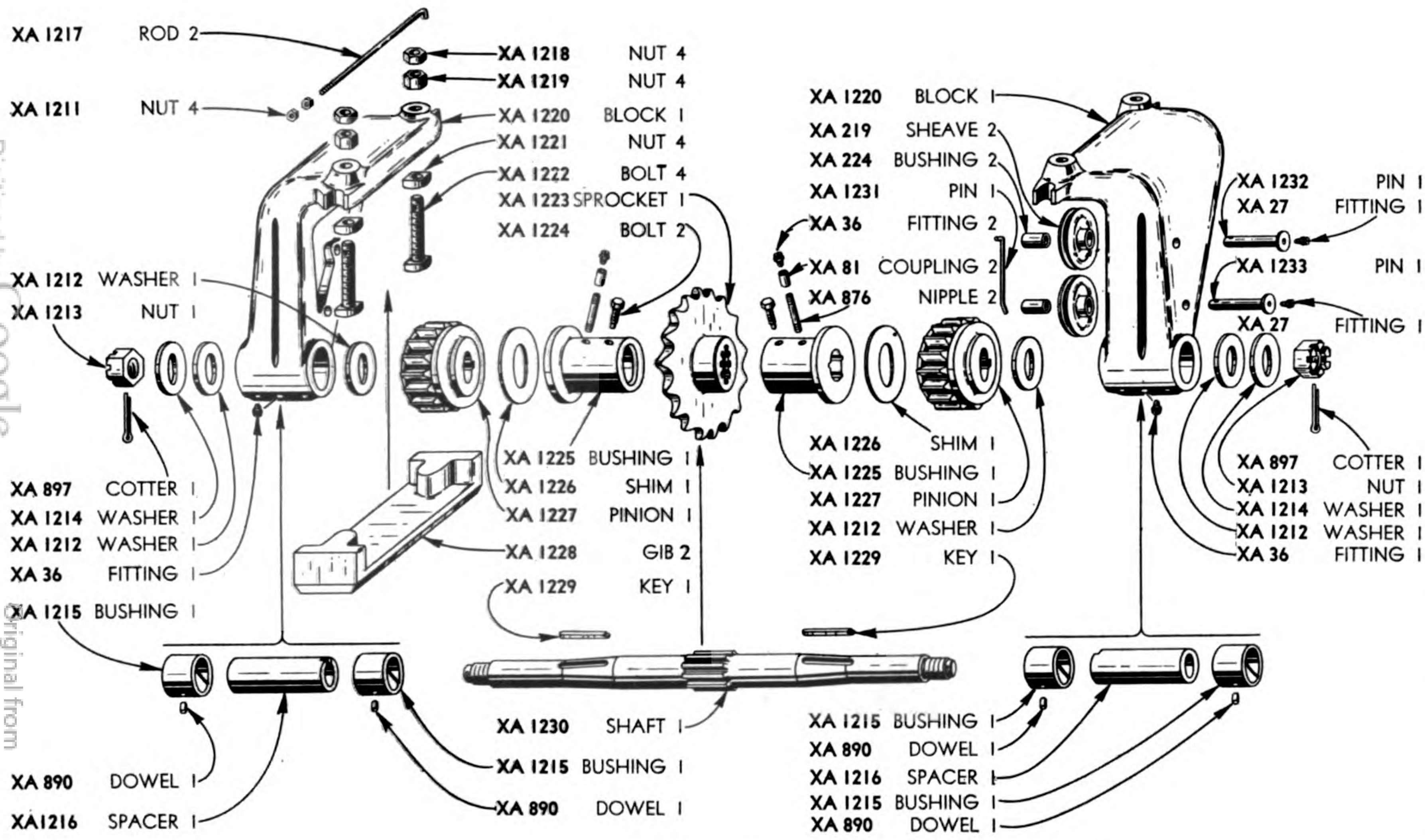
DIPPER DOOR - LATCH PARTS



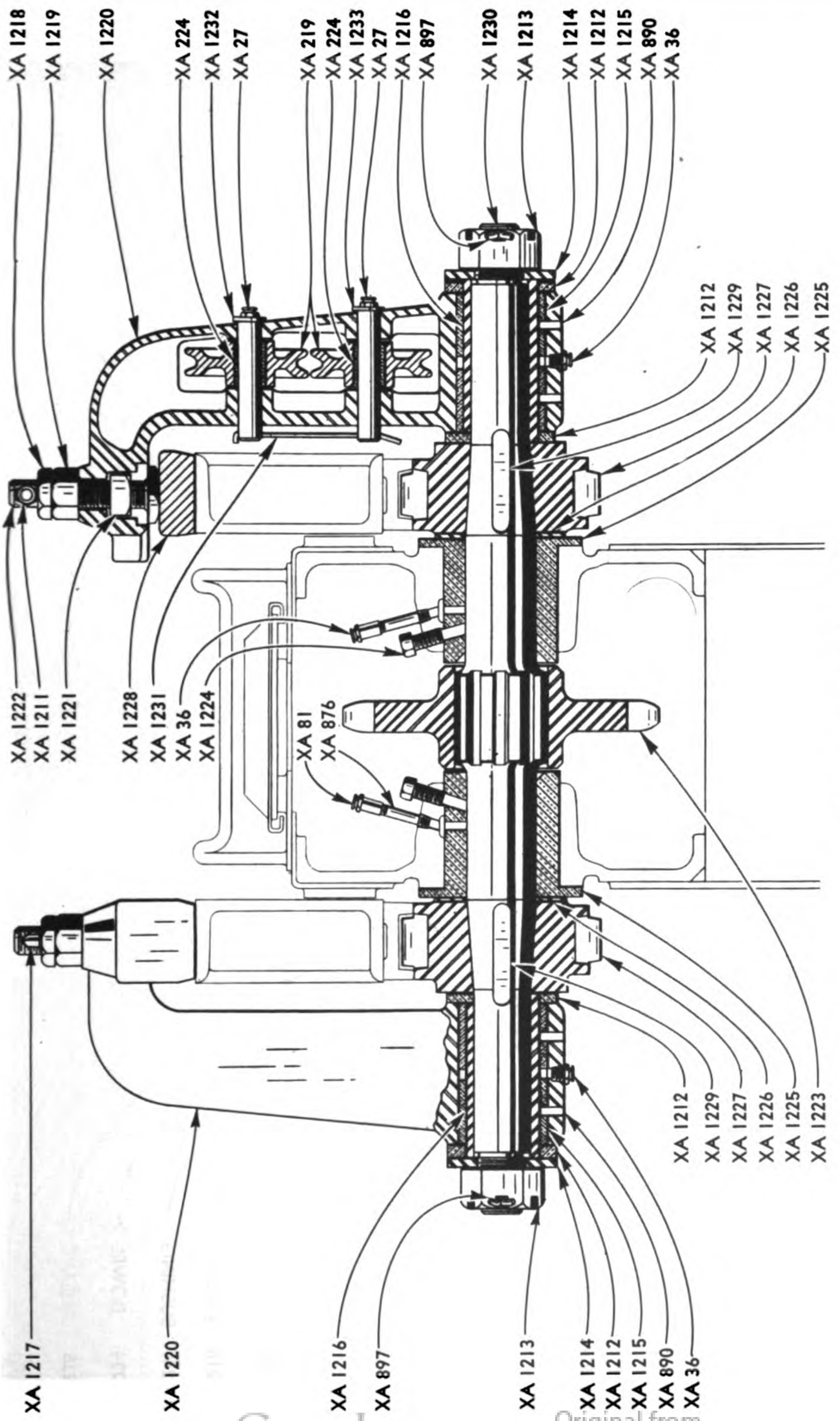
DIPPER BODY - POINTS



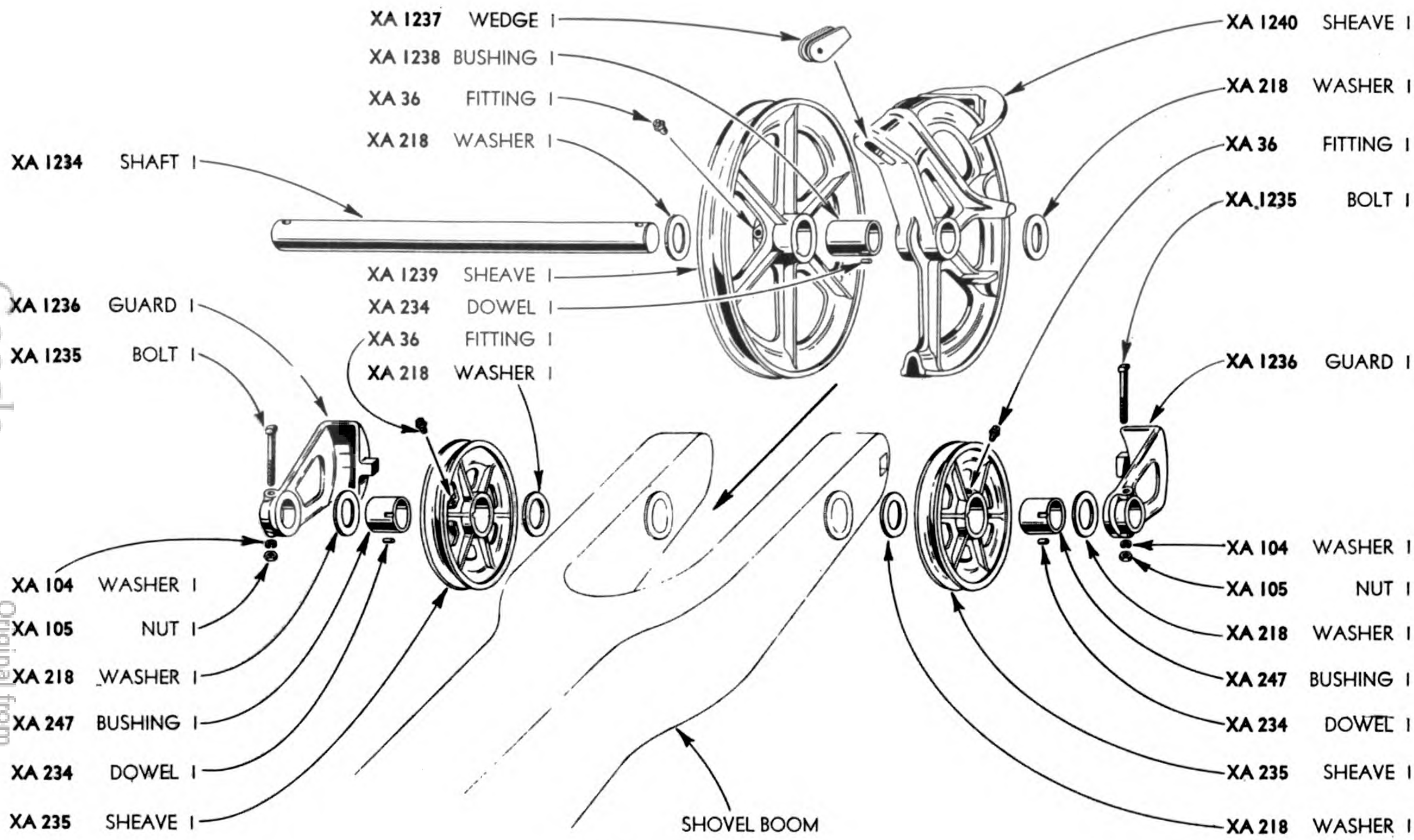
DIPPER STICKS



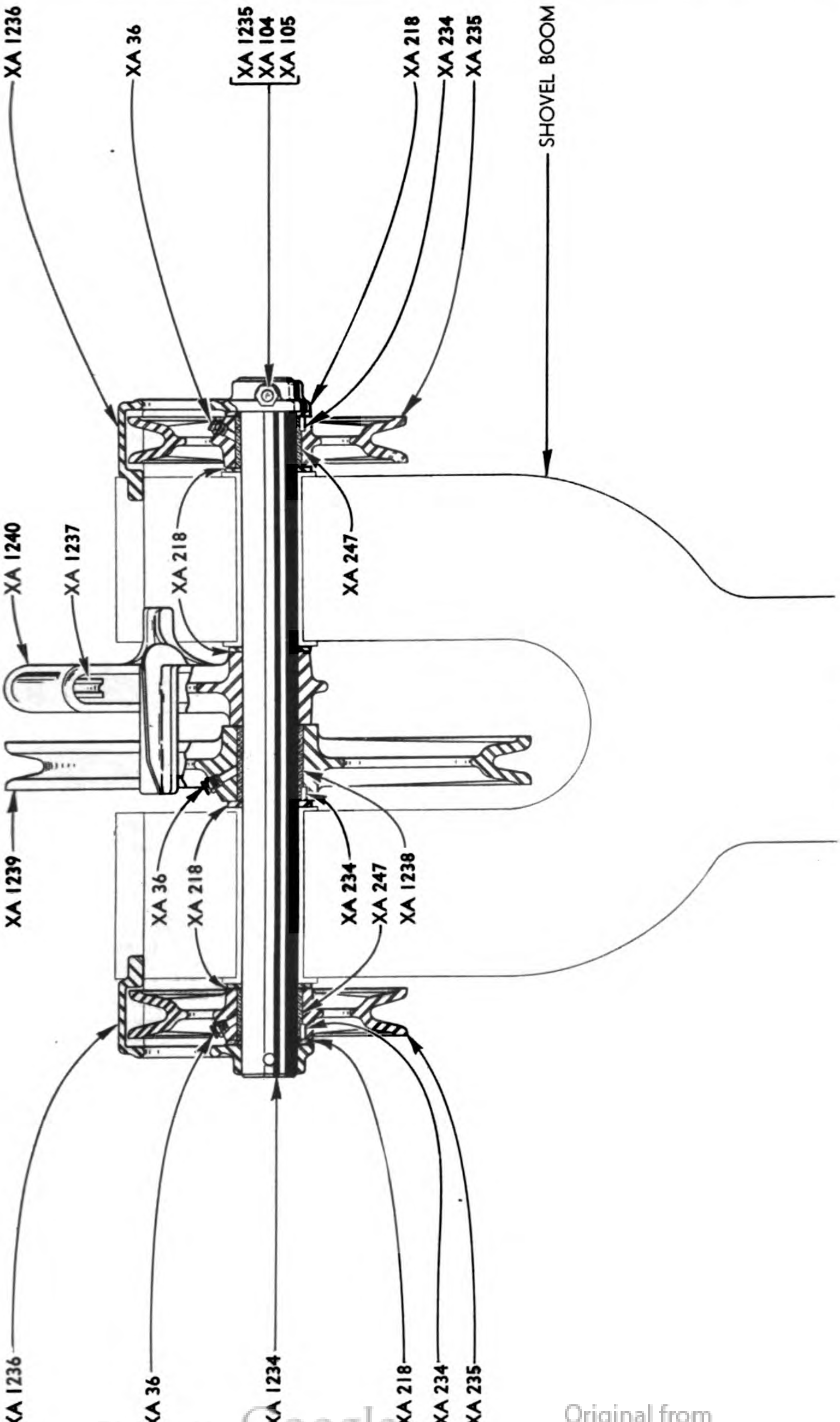
SHIPPER SHAFT



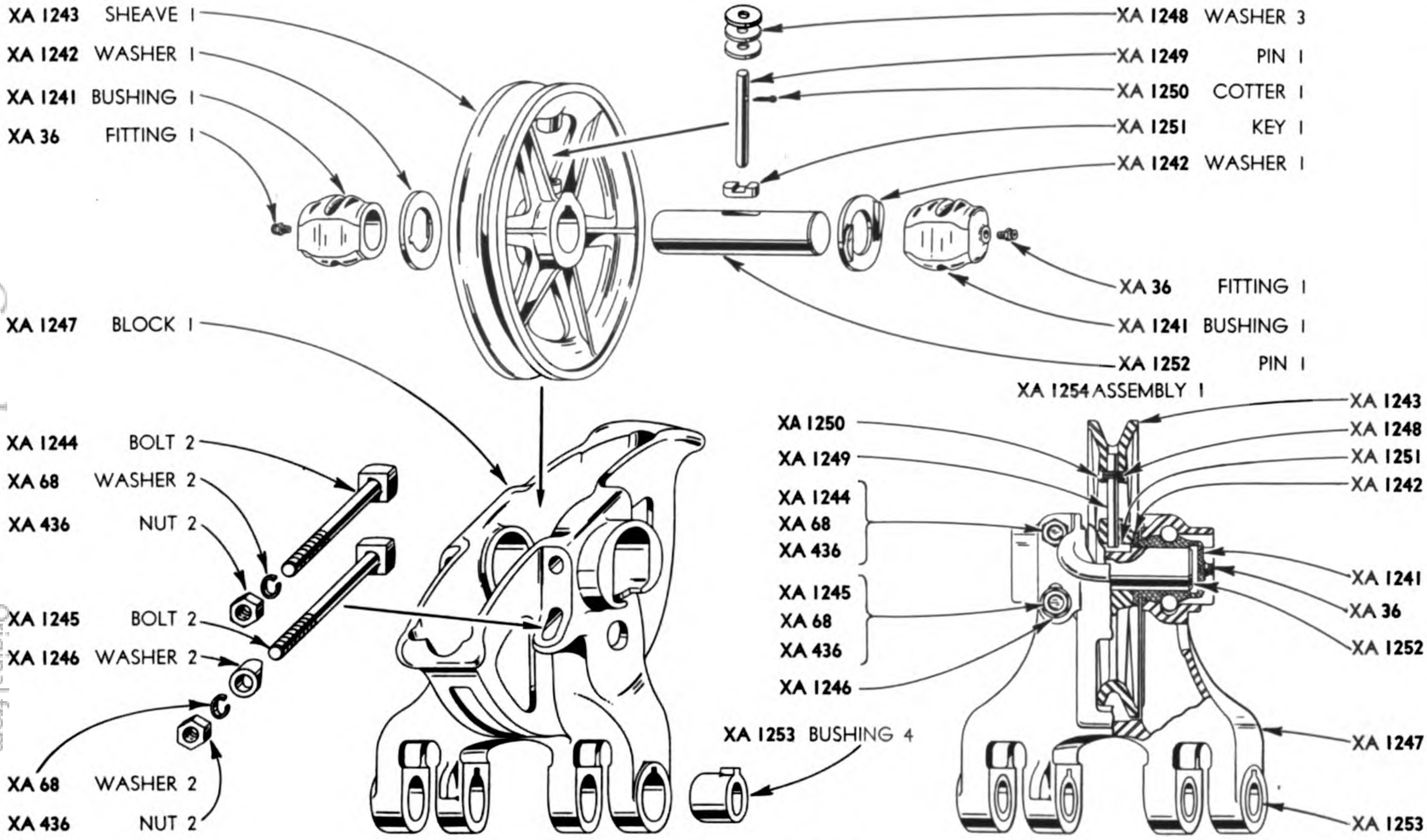
SHIPPER SHAFT



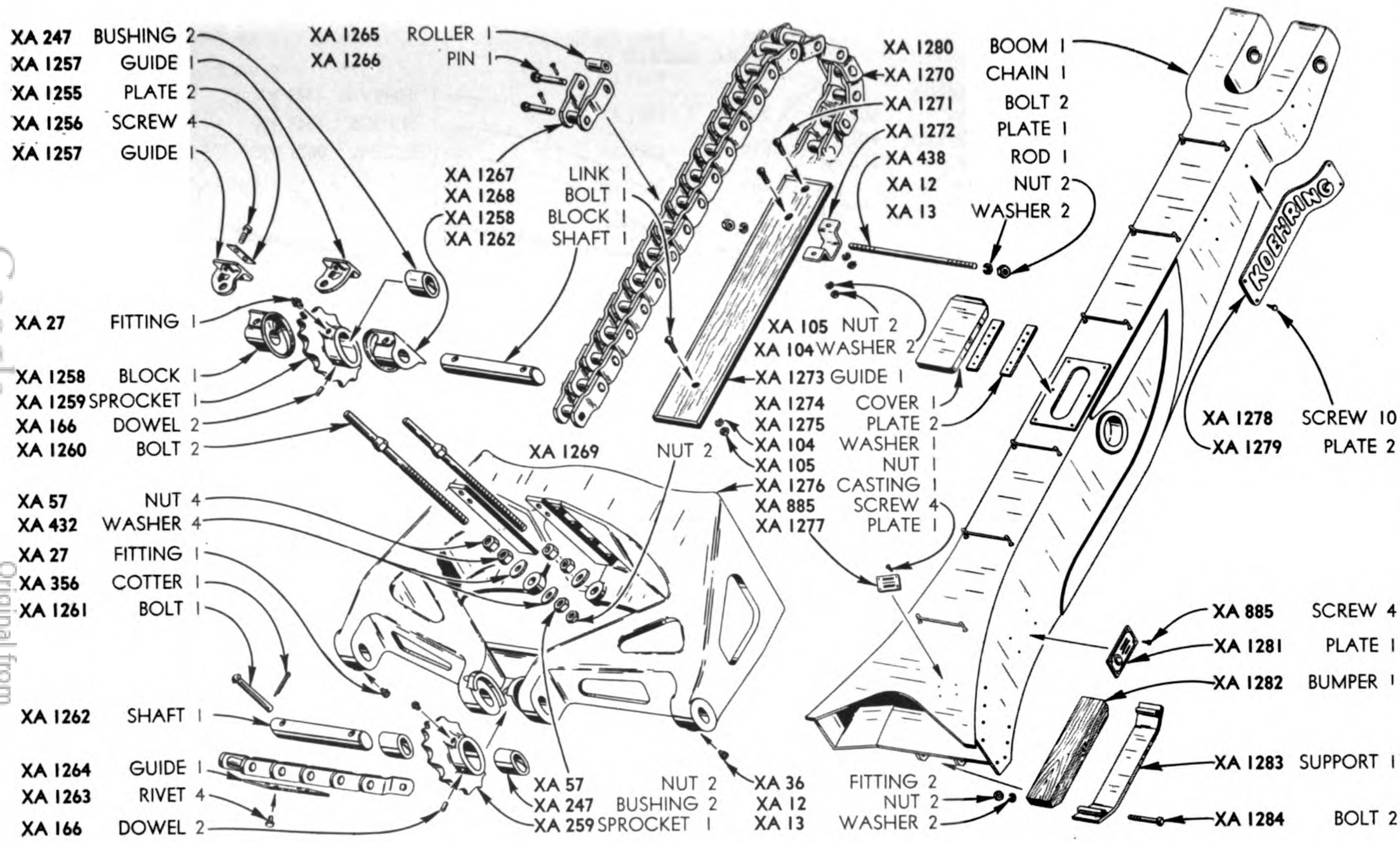
BOOM POINT - SHOVEL



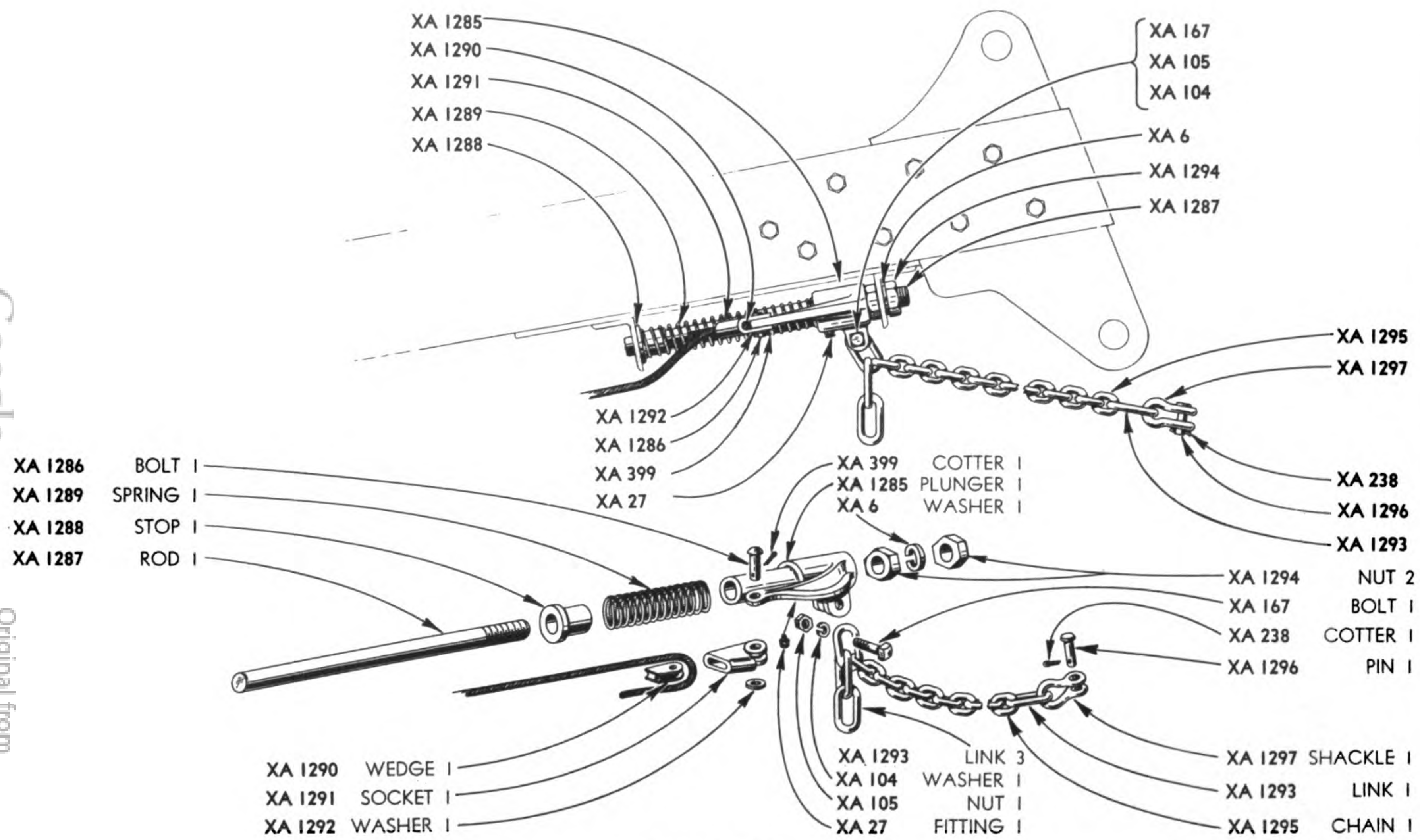
BOOM POINT - SHOVEL



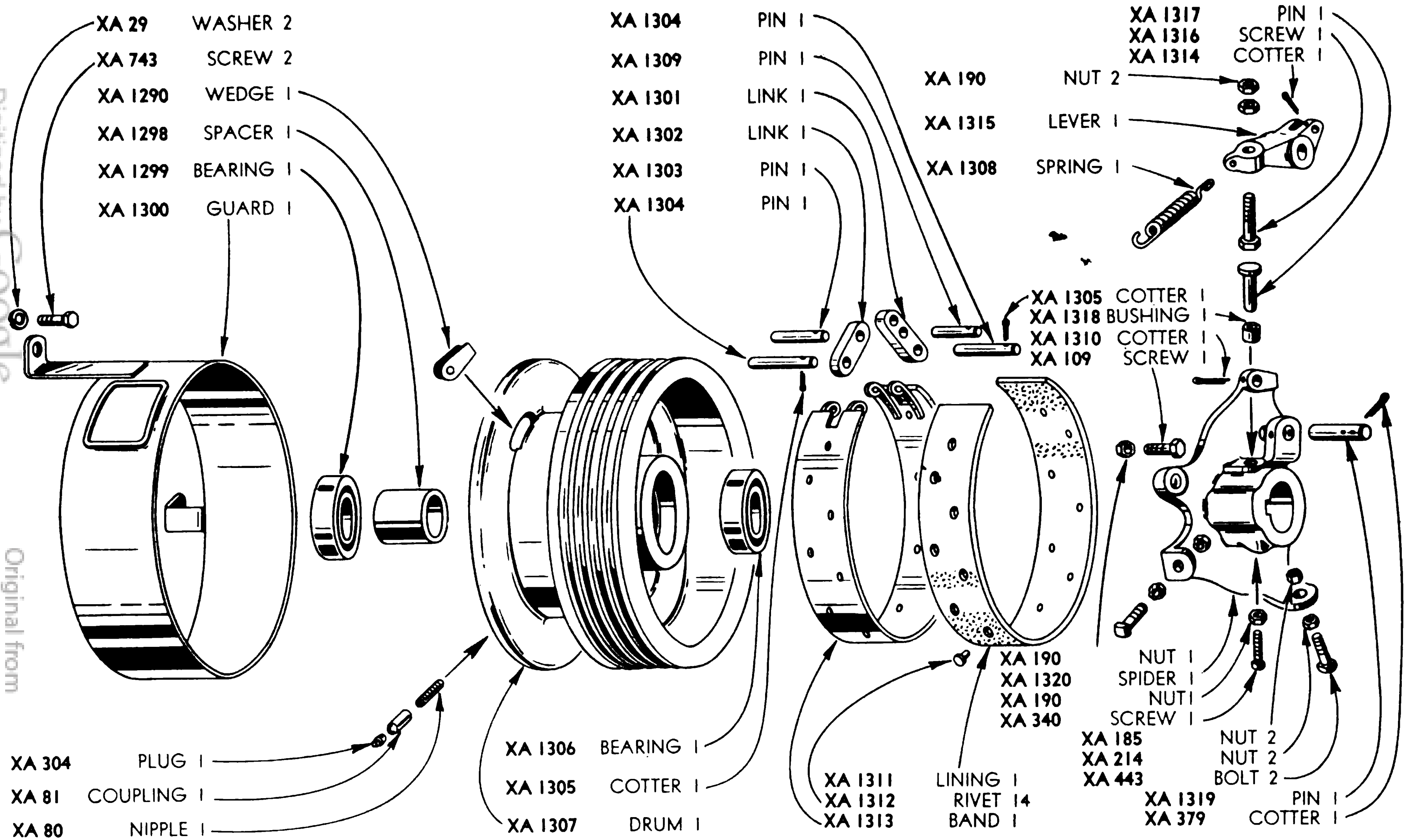
PADLOCK BLOCK - SHOVEL



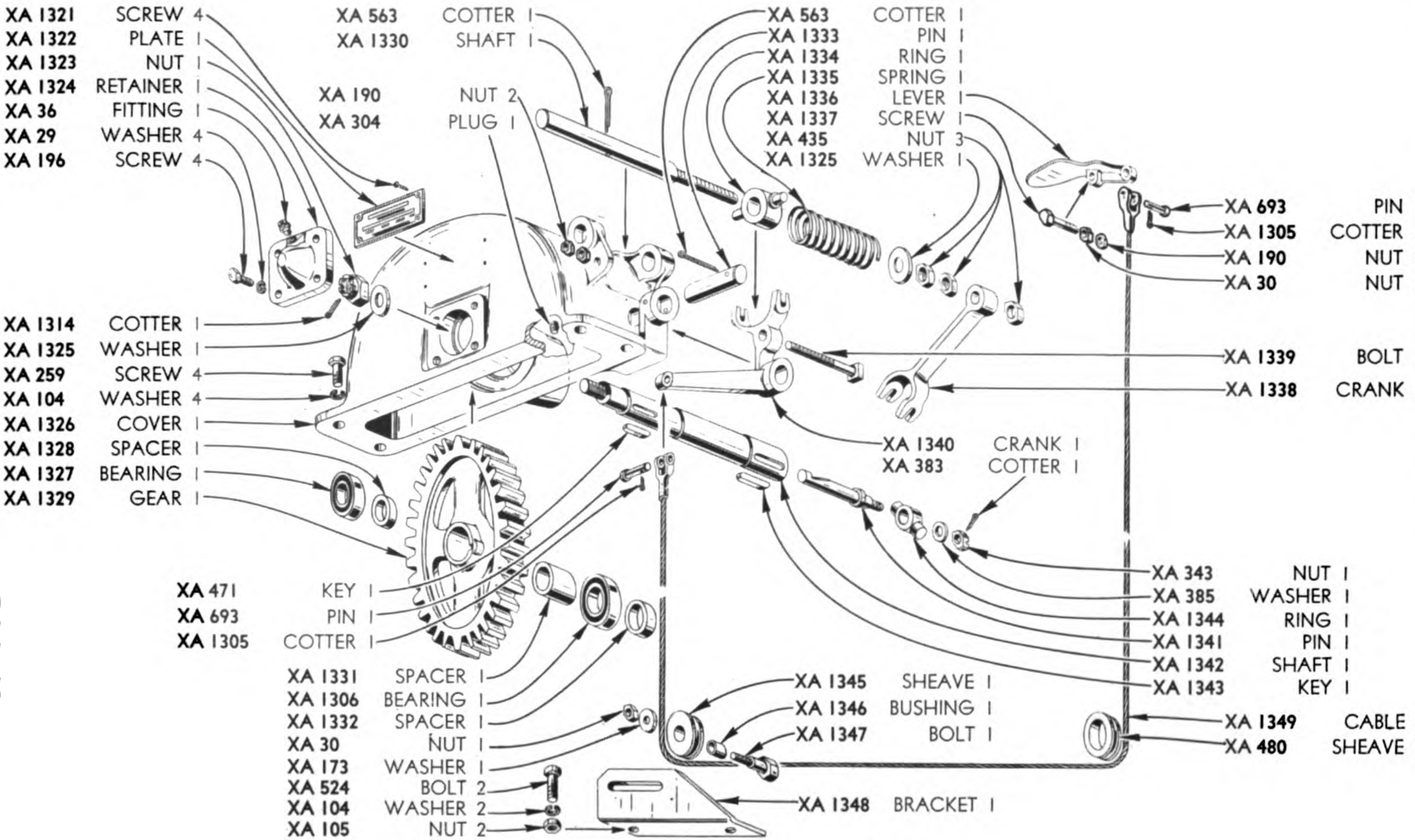
CHAIN GUIDE - SHOVEL BOOM


XA 1285
XA 1290
XA 1291
XA 1289
XA 1288
XA 167
XA 105
XA 104
XA 6
XA 1294
XA 1287
XA 1295
XA 1297
XA 1292
XA 1286
XA 399
XA 27
XA 238
XA 1296
XA 1293
XA 1286 BOLT 1
XA 1289 SPRING 1
XA 1288 STOP 1
XA 1287 ROD 1
XA 399 COTTER 1
XA 1285 PLUNGER 1
XA 6 WASHER 1
XA 1294 NUT 2
XA 167 BOLT 1
XA 238 COTTER 1
XA 1296 PIN 1
XA 1290 WEDGE 1
XA 1291 SOCKET 1
XA 1292 WASHER 1
XA 1293 LINK 3
XA 104 WASHER 1
XA 105 NUT 1
XA 27 FITTING 1
XA 1297 SHACKLE 1
XA 1293 LINK 1
XA 1295 CHAIN 1

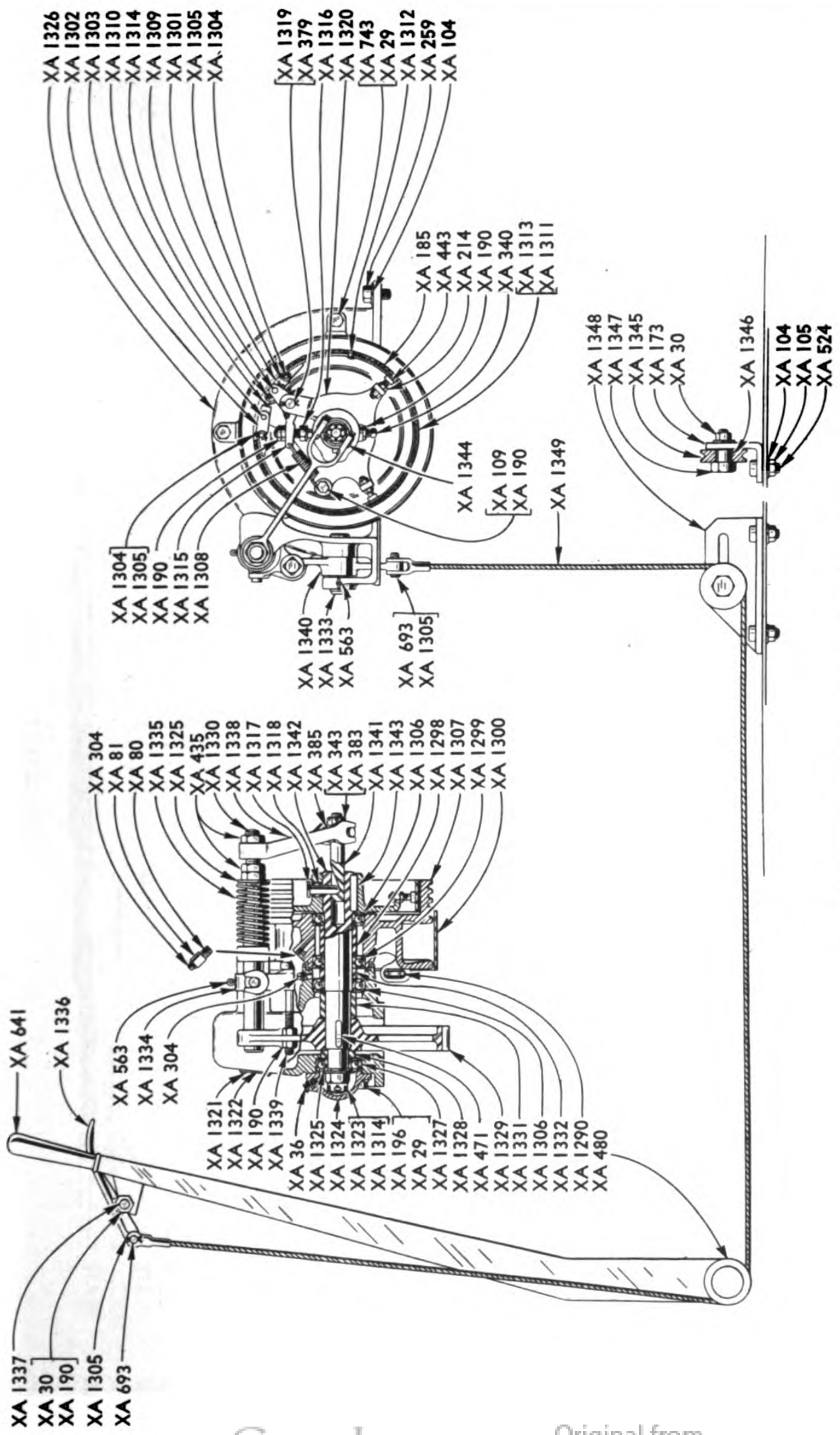
DIPPER TRIP



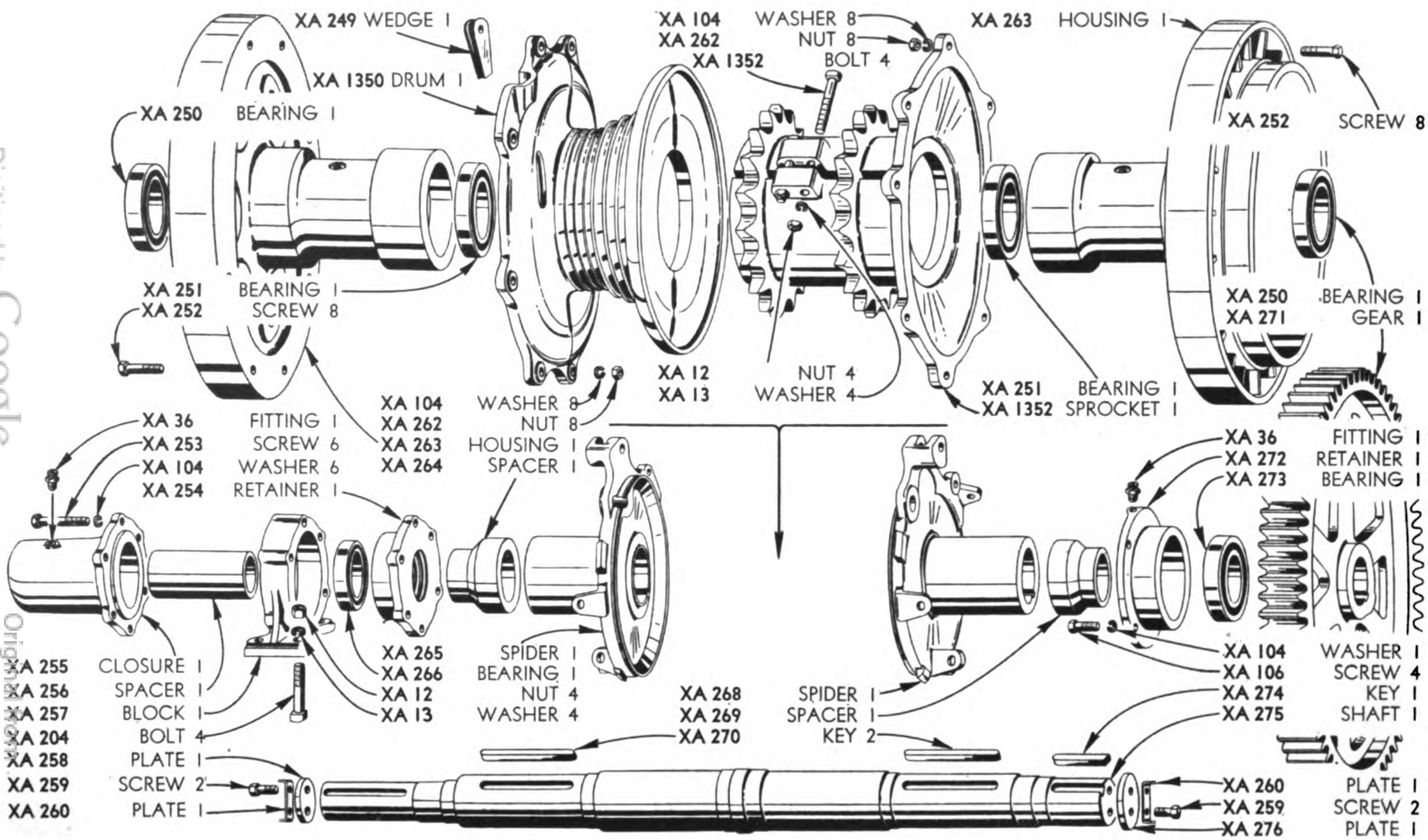
CLUTCH - DIPPER TRIP



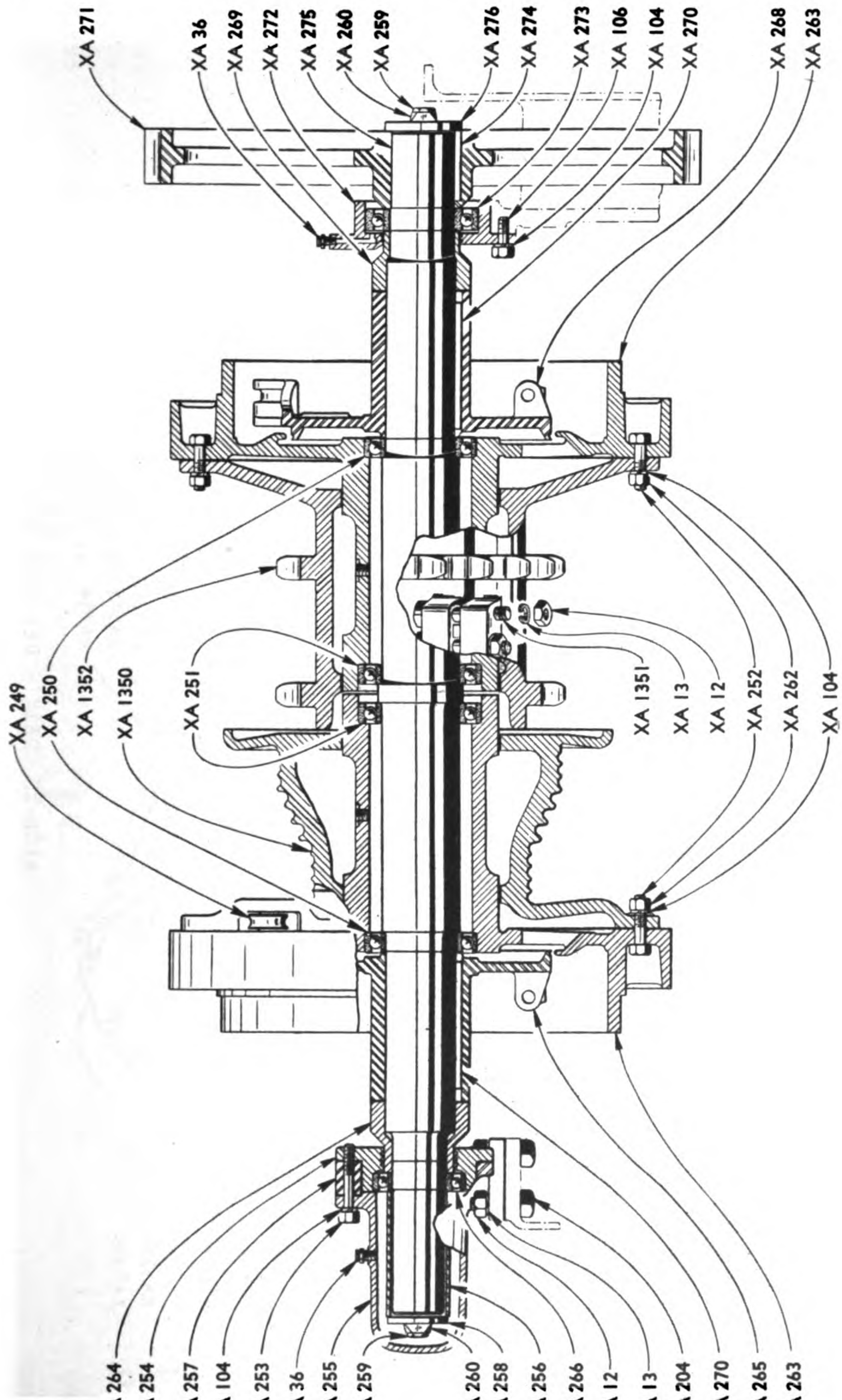
OPERATING MECHANISM - DIPPER TRIP



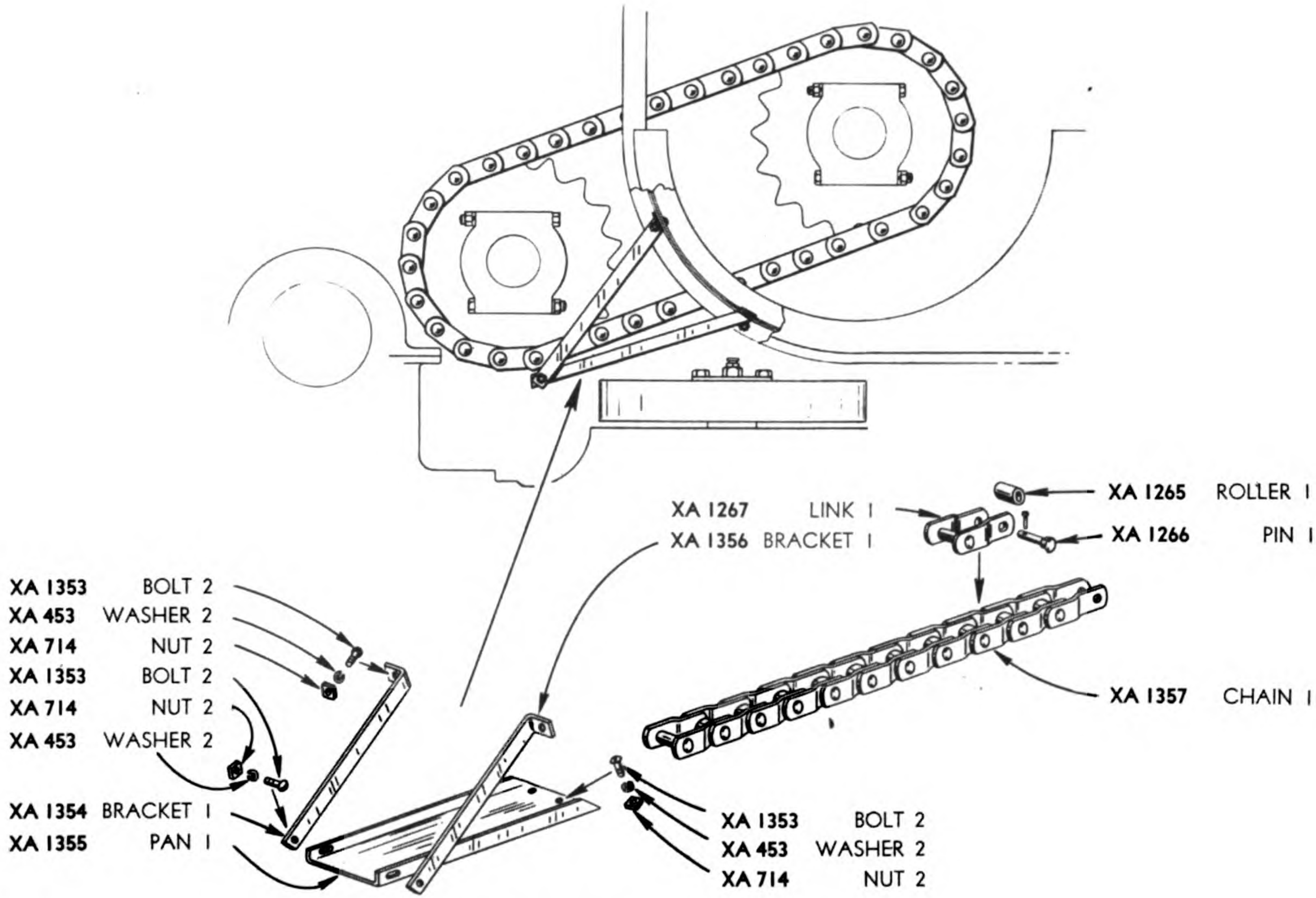
OPERATING MECHANISM - DIPPER TRIP



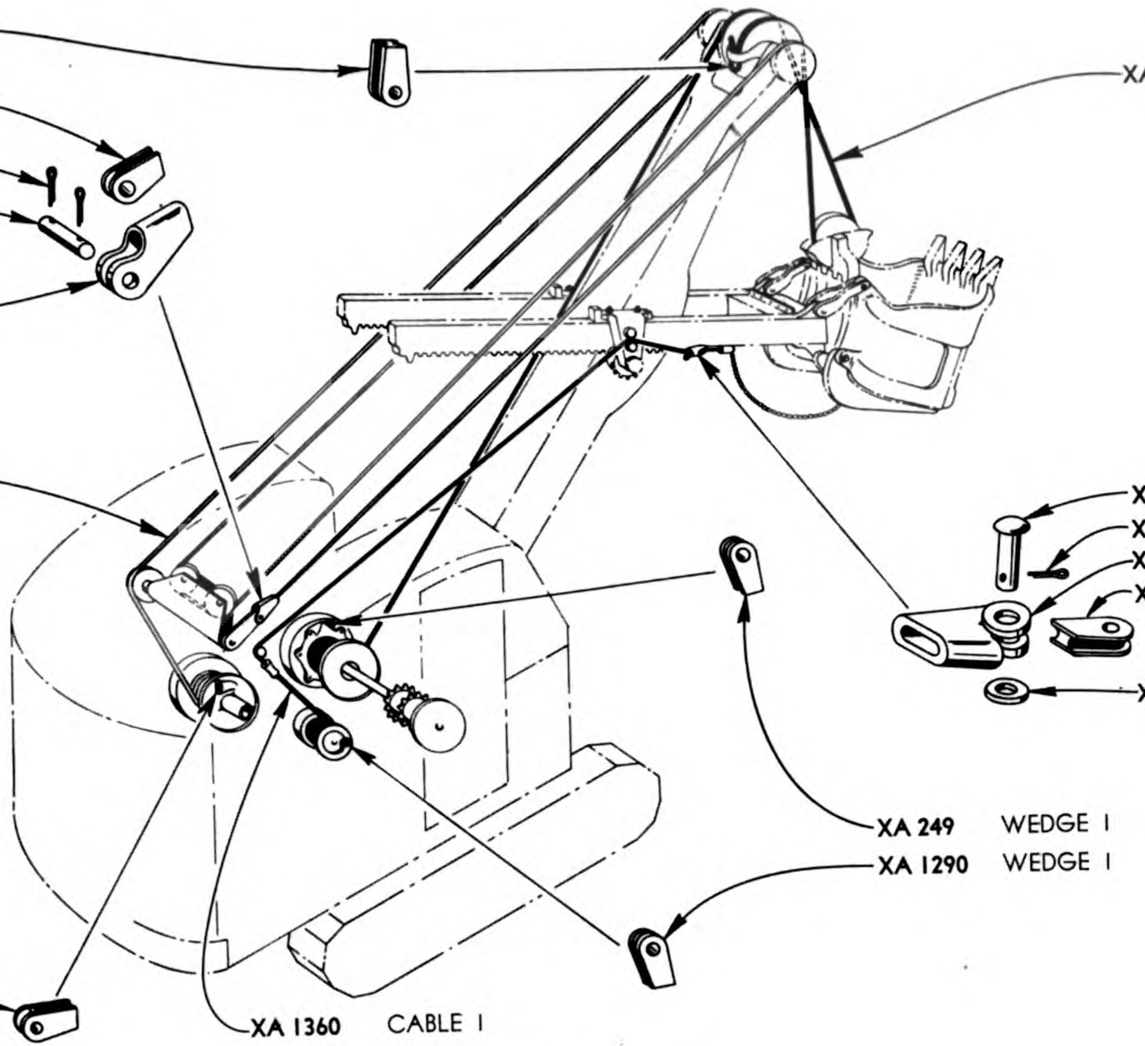
DRUM SHAFT - SHOVEL



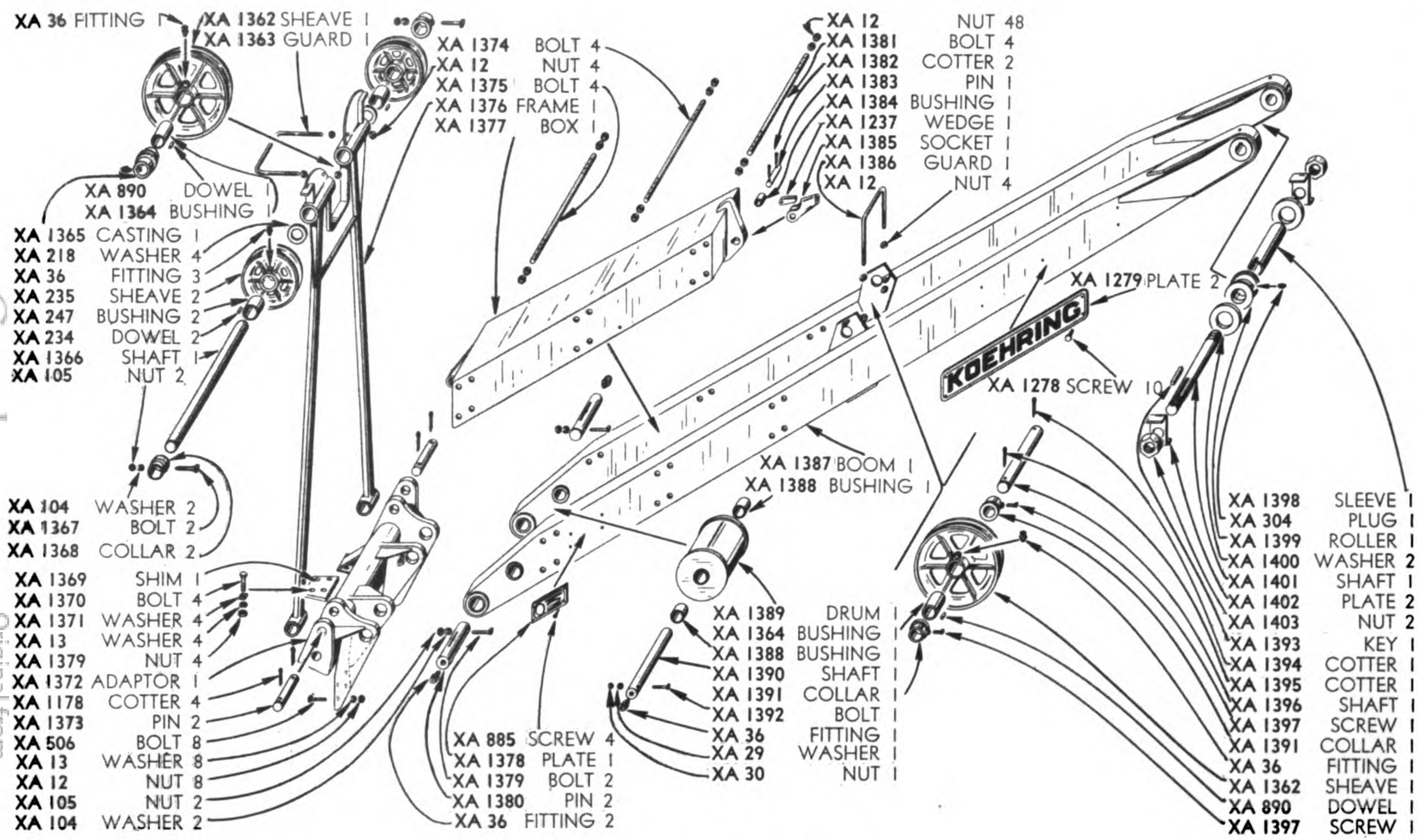
DRUM SHAFT - SHOVEL



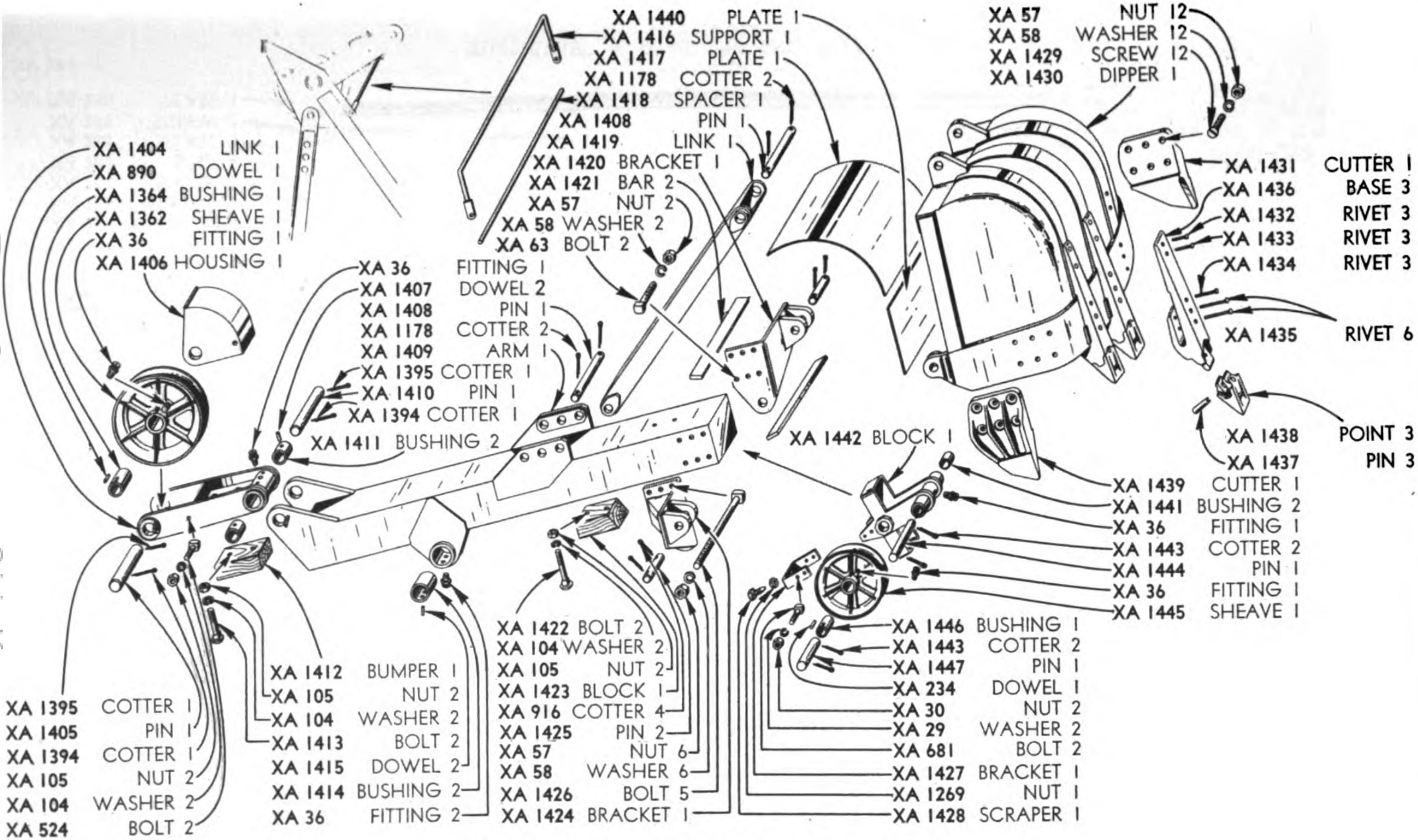
RACK-IN CHAIN - OIL DRIP PAN



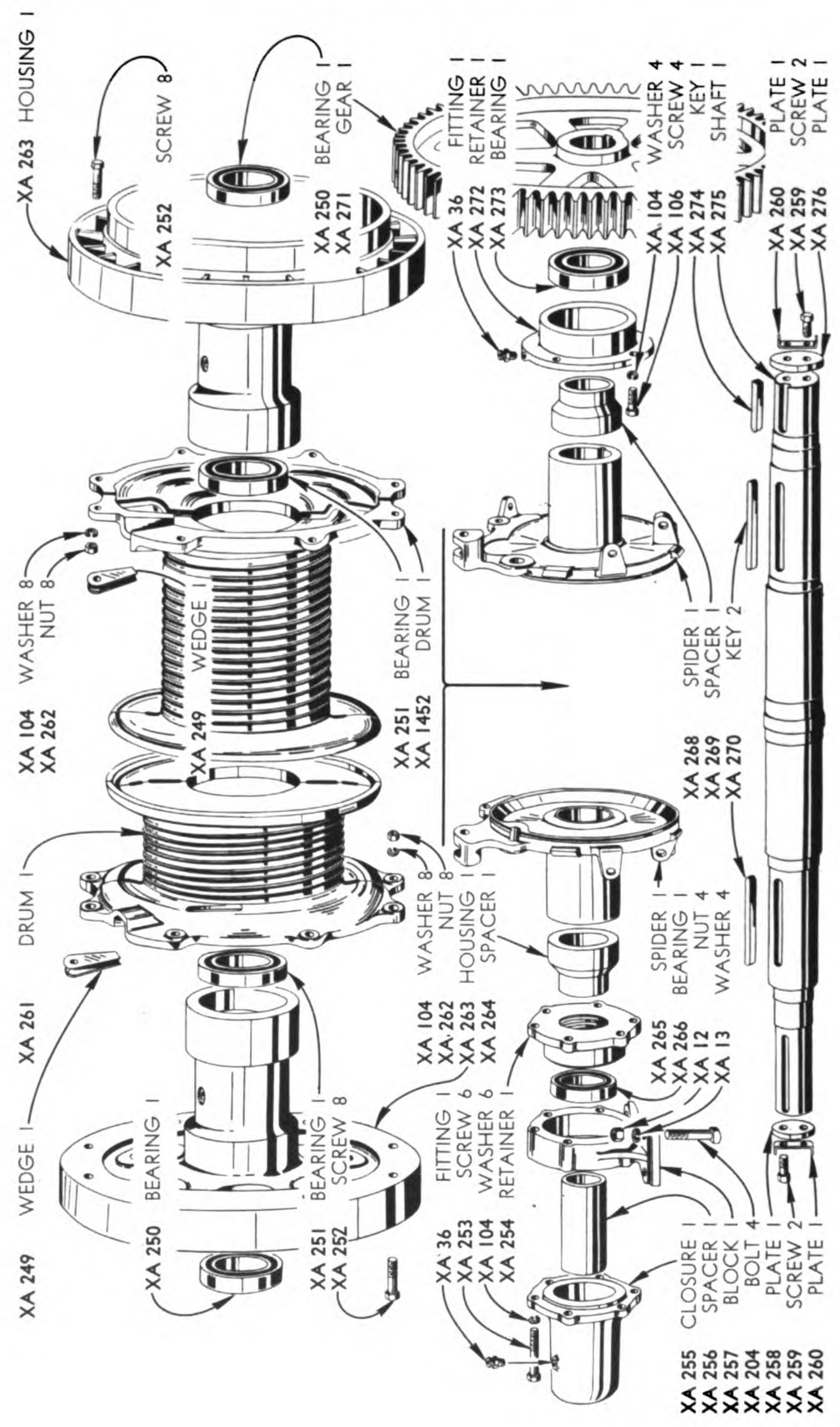
CABLES AND ANCHORS - SHOVEL



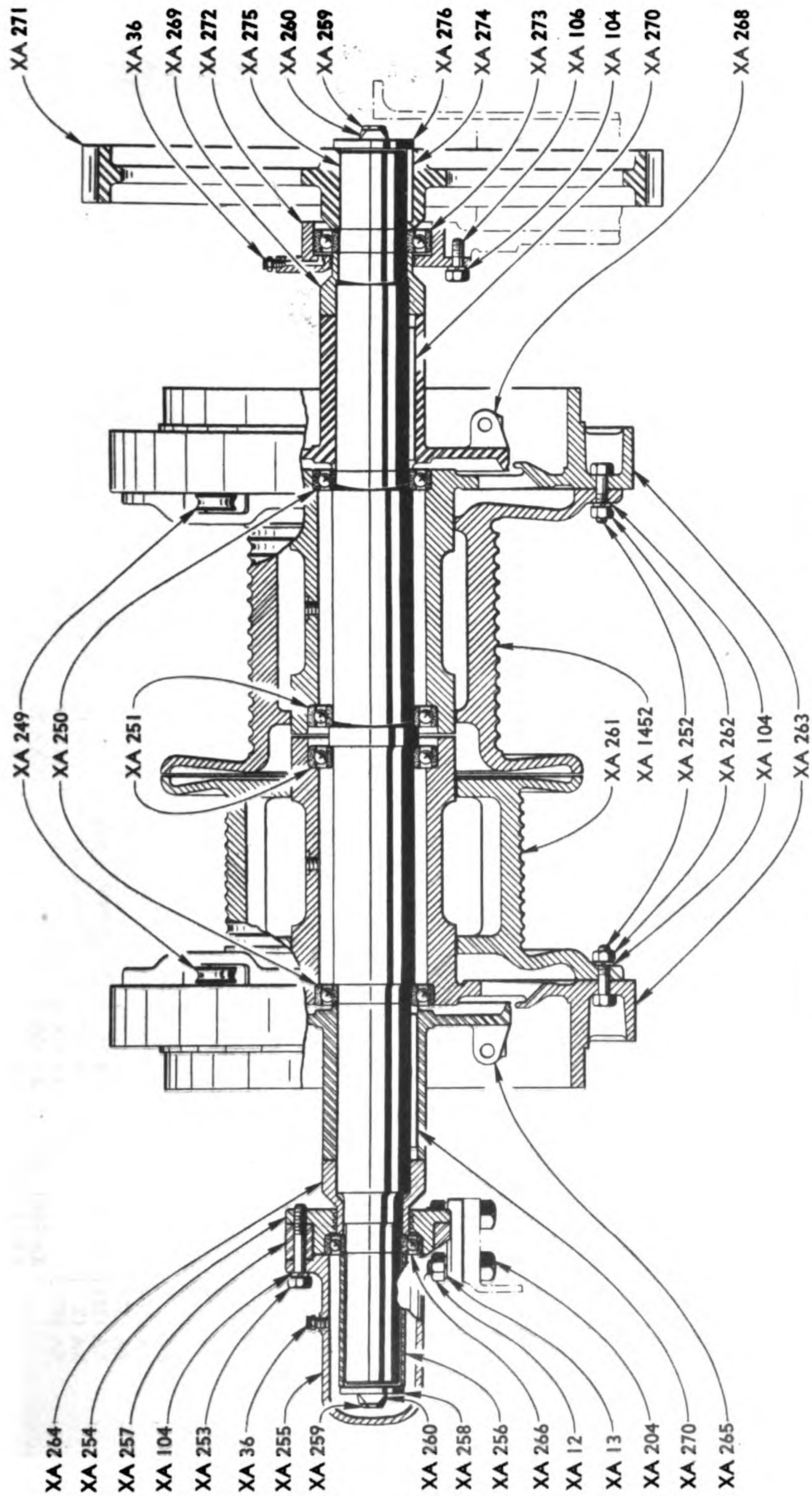
PULL SHOVEL - JIB FRAME AND BOOM



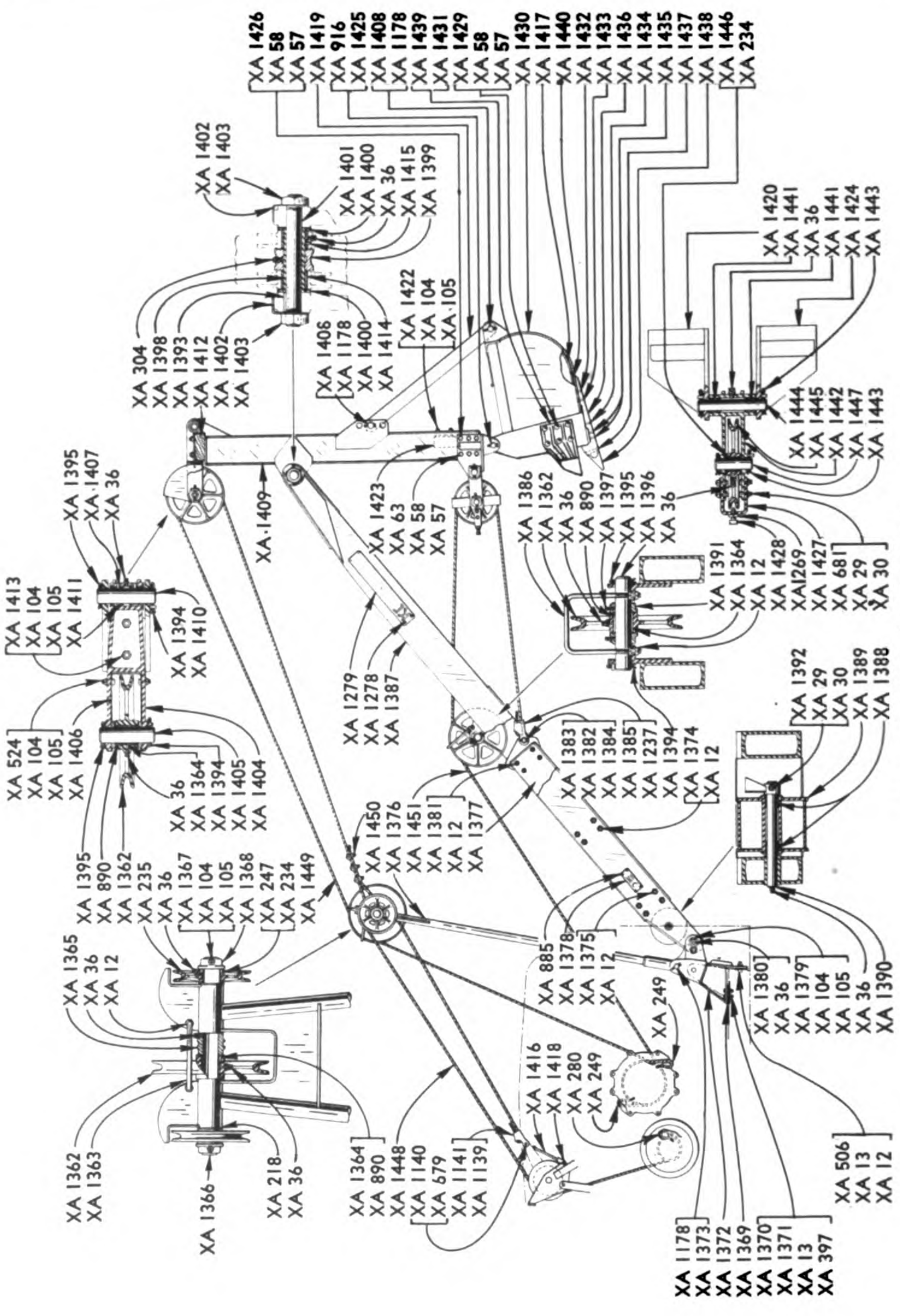
PULL SHOVEL - DIPPER ARM AND DIPPER



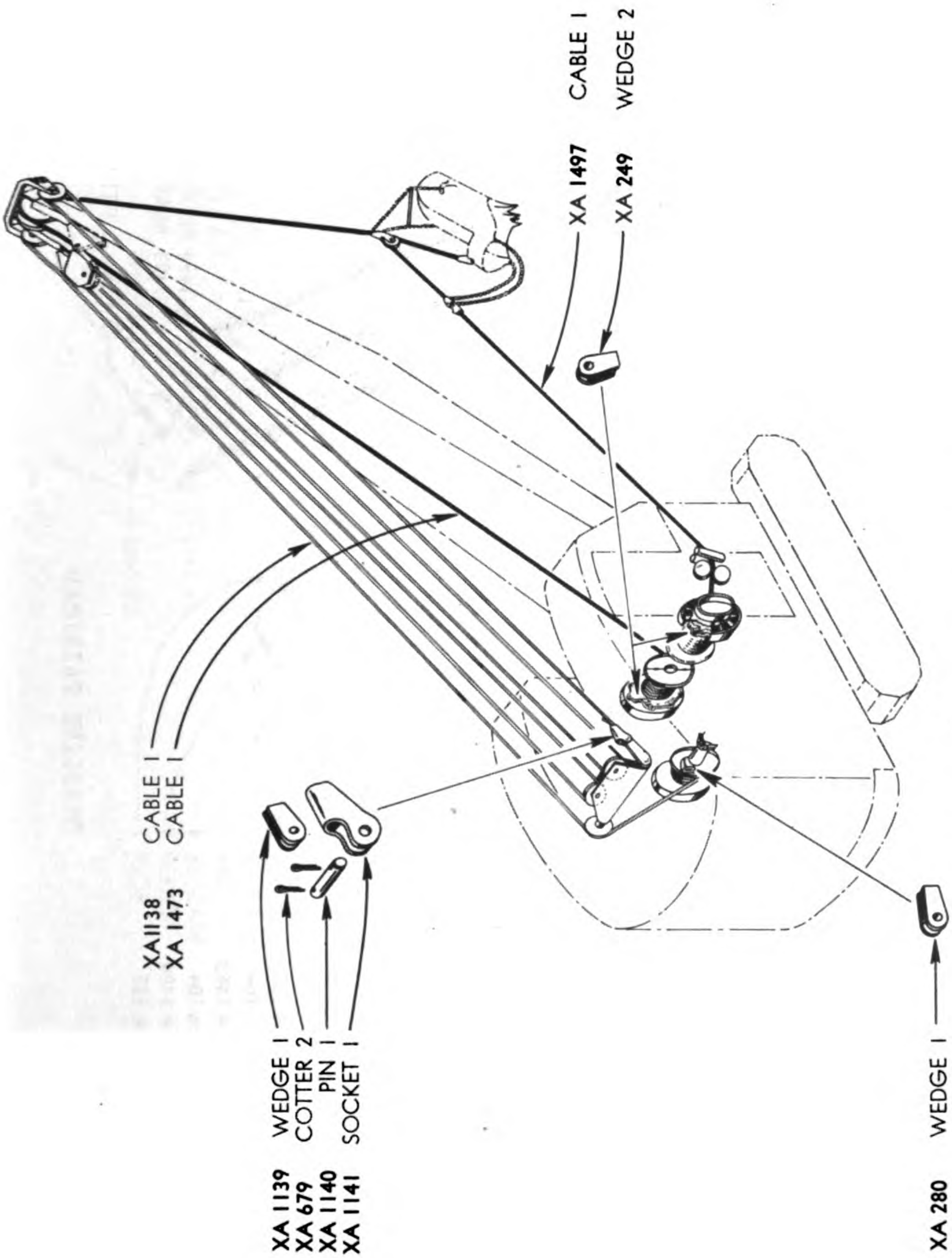
DRUM SHAFT - DRAGLINE AND PULL SHOVEL



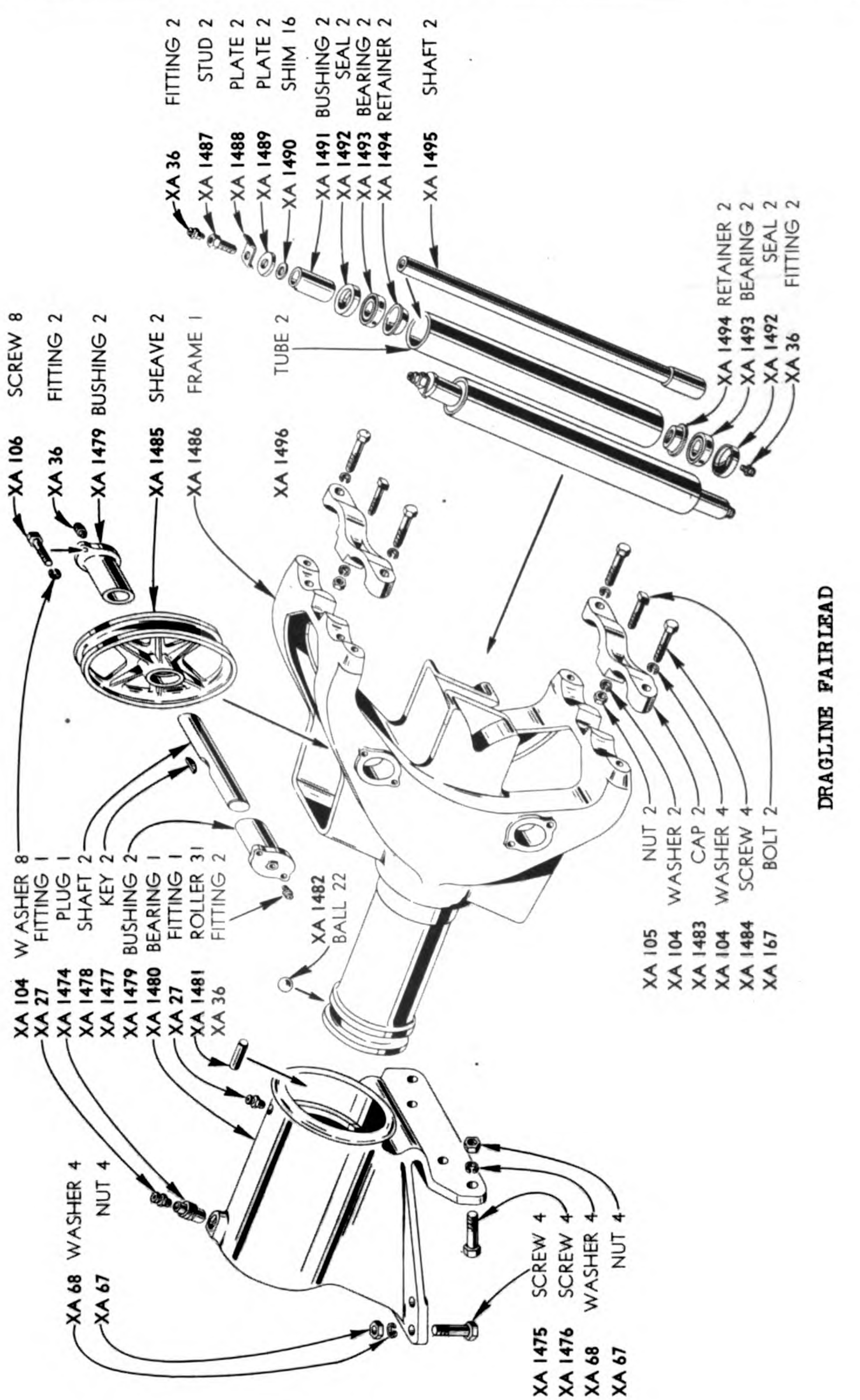
DRUM SHAFT - DRAGLINE AND PULL SHOVEL



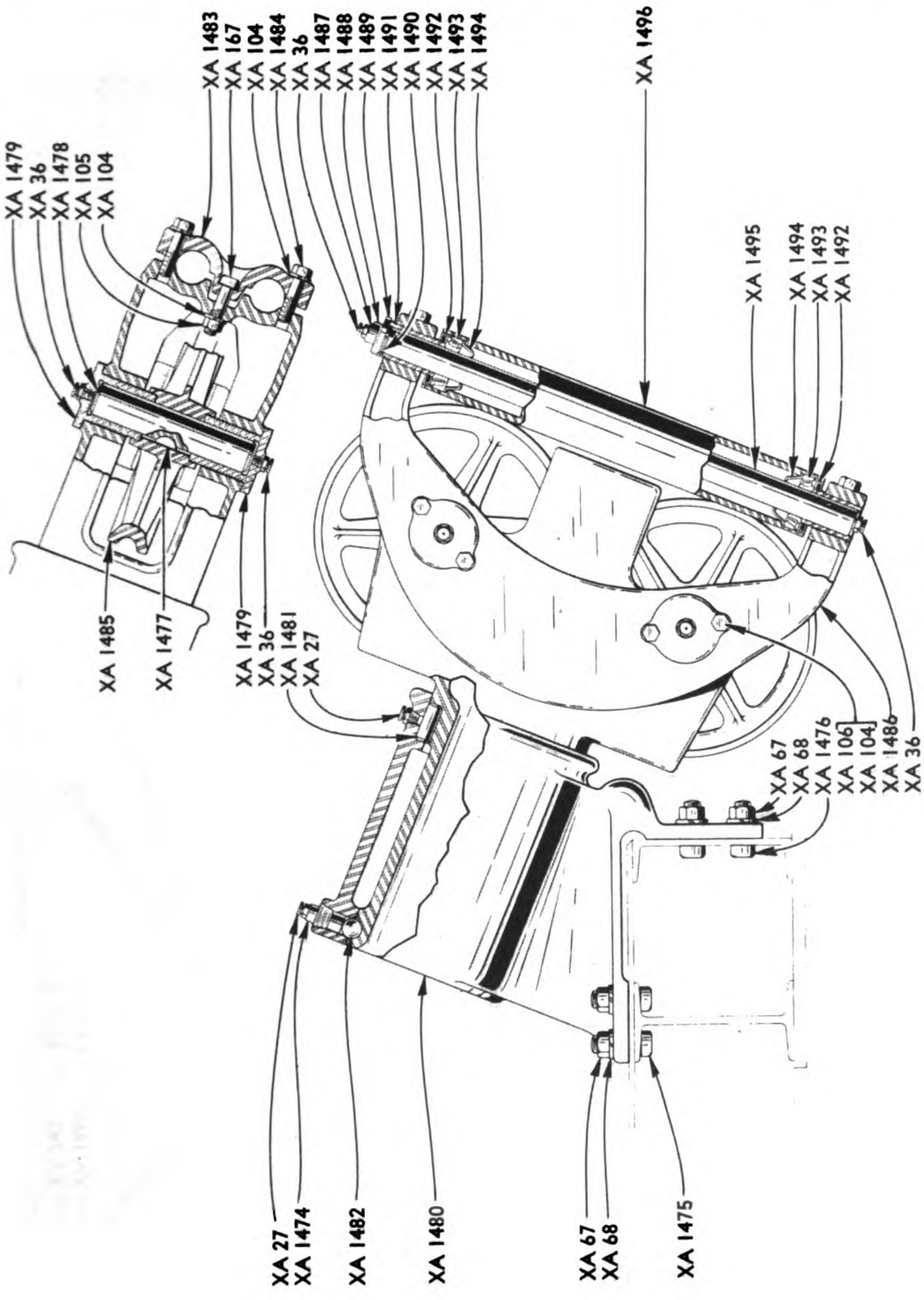
PULL SHOVEL ASSEMBLY



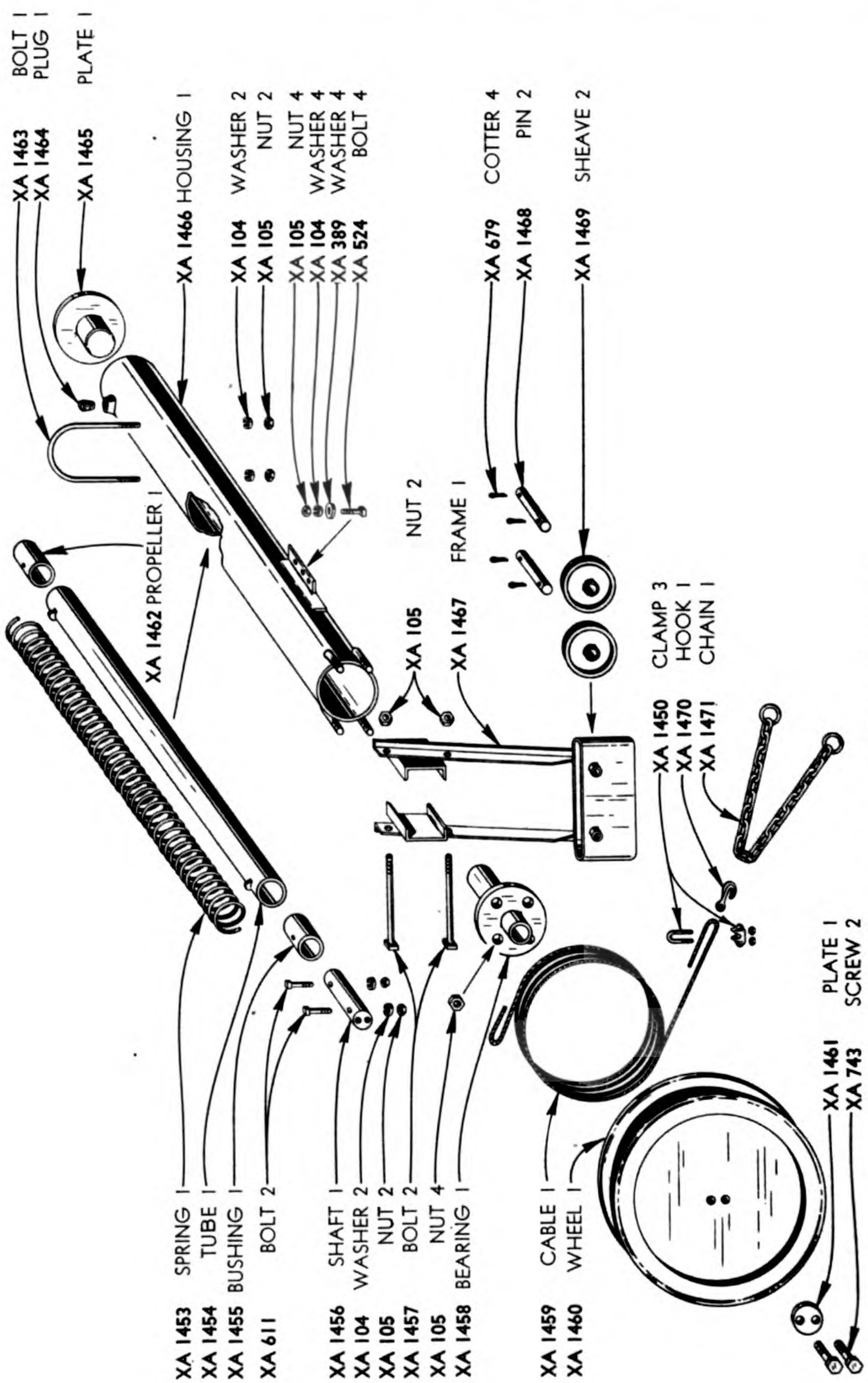
DRAGLINE - CABLE AND ANCHORS



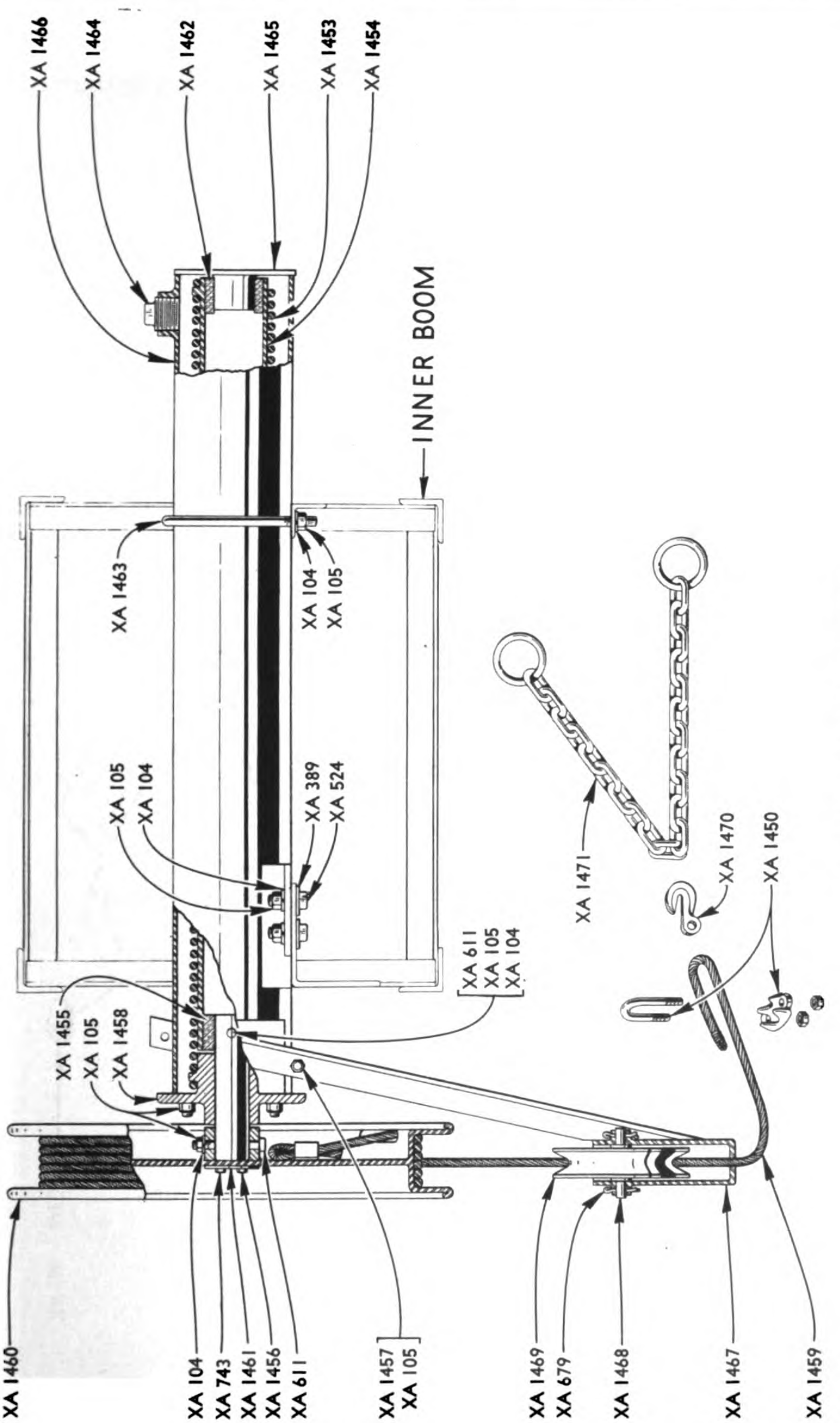
DRAGLINE FAIRLEAD



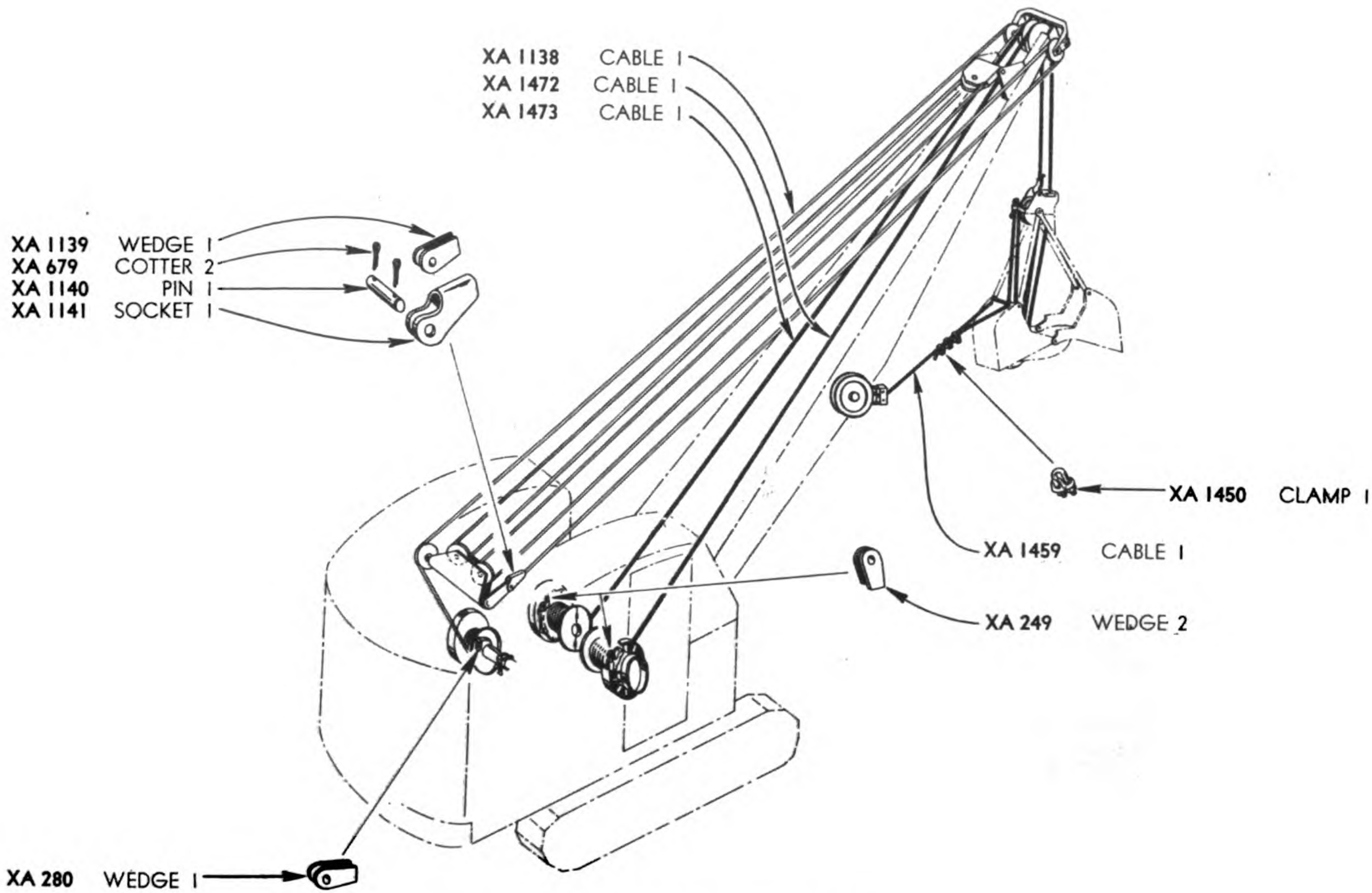
DRAGLINE FAIRLEAD



RUD-O-MATIC TAGLINE UNIT



RUD-O-MATIC TAGLINE UNIT



CLAMSHELL - CABLE AND ANCHORS

304 PARTS SECTION

SYMBOL IDENTIFICATION

A - Alemite (Grease Fittings)

BA - Batavia (Levers)

BR - Bryant (Socket)

CH - Crouse-Hinds (Electrical Fittings)

CR - Crosby (Cable Clamp)

DC - Diamond (Chain)

F - Fafnir (Bearing)

G - Gits (Oil Seal)

GO - Goodrich (Light Reflector)

H - Hyatt (Bearing)

HD - Harley-Davidson (Seat)

JE - Jeffery (Chain)

K - Kondu (Electrical Fittings)

MA - Master Lock Co. (Padlock)

ND - New Departure (Bearing)

P - Perfect (Oil Seal)

PM - Pettibone-Mulliken (Dipper Parts)

PN - Pyle-National (Electrical Fittings)

PR - Pritzlaff Hdwe. (Swivel Pulley)

PY - Pyrene (Fire Extinguisher)

R - Ross Gear & Tool (Friction Disc)

RC - Rollway (Bearing)

RU - Rud-O-Matic (Tagline Unit)

S - Shakeproof (Washers)

T - Timken (Bearing)

WE - Weatherhead (Hose & Fittings)

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 1	Link, repair JE 1803A	1	3#	$1.40	214
XA 2	Pin, link JE 1803A	1	2 pcs.1#	.50	214
XA 3	Roller, link JE 1803A	1	3 pcs.1#	.35	214
XA 4	Chain, traction drive 52 lks. ea. JE 1803A	2	161#	72.80	214
XA 5	Nut, hexagon-1-1/4" N.C.	8	3/4#	.13	214
XA 6	Washer, lock-1-1/4"	9	6 pcs.1#	.03	
XA 7	Shim, tie bar	8	6 pcs.1#	.12	214
XA 8	Bar, crawler tie	8	8-3/4#	1.80	214
XA 9	Bolt, machine-1-1/4" x 8" N. C.	8	3-1/2#	.60	214
XA 10	Lock, shoe pin	60	16 pcs.1#	.04	214
XA 11	Pin, shoe	60	5-1/4#	.60	214
XA 12	Nut, hexagon-3/4" N. C.	278	5 pcs.1#	.03	
XA 13	Washer, lock-3/4"	244	23 pcs.1#	.01	
XA 14	Bolt, machine-3/4" x 3-3/4" N. C.	36	2 pcs.1#	.12	214
XA 15	Shoe, crawler	60	68#	12.00	214
XA 16	Cleat, shoe	18	6#	1.85	214
XA 17	Casting, bridle (Front and rear)	4	289#	77.50	214
XA 18	Bracket, upper idler roller	4	12#	7.50	214
XA 19	Frame, crawler-w/axles	1	3150#	545.00	214
XA 20	Cotter, 1/8 x 1"	26	**	.10*	
XA 21	Pin, two hole	8	4 pcs.1#	.18	214
XA 22	Bolt, adjusting	8	11#	5.50	214
XA 23	Nut, adjusting	8	3-3/4#	4.80	214
XA 24	Washer, flat	6	4 pcs.1#	.06	
XA 25	Roller, upper idler	8	19-1/2#	7.20	215
XA 26	Bushing, bronze	8	3/4#	.70	215
XA 27	Fitting, "Alemite" A1184	45	23 pcs.1#	.12	
XA 28	Shaft, roller	4	8#	2.70	215
XA 29	Washer, lock-1/2"	128	80 pcs.1#	.60*	
XA 30	Nut, hexagon-1/2" N.C.	114	14 pcs.1#	.01	
XA 31	Bolt, machine-1/2" x 4-1/4" N.C.	8	4 pcs.1#	.06	215
XA 32	Bushing, bronze	24	2#	3.60	215
XA 33	Washer, flat	24	3 pcs.1#	.16	215
XA 34	Shaft, lower roller	12	13#	5.75	215
XA 35	Shim, steel	48	3 pcs.1#	.15	215
XA 36	Fitting, "Alemite" A1186	121	20 pcs.1#	.14	
XA 37	Bolt, "U"	24	1#	.70	215
XA 38	Washer, thrust	24	3#	.90	215
XA 39	Roller, lower crawler-w/bushing	12	61#	23.50	215
XA 40	Washer, flat	4	2 pcs.1#	.90	216
XA 41	Collar, set	4	5#	3.90	216
XA 42	Shaft, drive tumbler	2	61#	29.00	216
XA 43	Pin, collar	4	3/4#	.18	216
XA 44	Bearing, drive tumbler	4	30#	16.00	216
XA 45	Key, round end	4	1#	.55	216
XA 46	Tumbler, drive	2	195#	53.00	216

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 47	Bearing, idler tumbler	2	30#	$16.00	216
XA 48	Bearing, idler tumbler	2	30#	16.00	216
XA 49	Shaft, front idler tumbler	2	40-1/2#	9.00	216
XA 50	Tumbler, idler	2	192#	52.00	216
XA 51	Sprocket, tumbler shat	2	80#	36.00	216
XA 52	Carbody, complete-w/ bearing caps	1	2065#	1002.00	217
XA 53	Bushing, split	2	14-1/4#	14.50	217
XA 54	Shim, bearing	4	4 pcs.1#	.24	217
XA 55	Shim, bearing	8	8 pcs.1#	.18	217
XA 56	Cap, bearing	2	33#	20.00	217
XA 57	Nut, hexagon-1" N.C.	49	2 pcs.1#	.07	
XA 58	Washer, lock-1"	37	15 pcs.1#	.02	
XA 59	Bolt, machine-1" x 5" N. C.	6	1-1/4#	.26	
XA 60	Bushing,inner bearing	1	5-3/4#	6.60	217
XA 61	Shim, inner bearing	2	4 pcs.1#	.24	217
XA 62	Shim, inner bearing	4	8 pcs.1#	.18	217
XA 63	Bolt, machine-1" x 4" N. C.	4	1#	.25	
XA 64	Cap, bearing-inner	1	19#	15.00	217
XA 65	Dowel, 3/8" x 1"	3	29 pcs.1#	.01	217
XA 66	Bushing, center bearing	2	4-1/4#	4.20	217
XA 67	Nut, Hexagon-7/8" N.F.	48	4 pcs.1#	.07	
XA 68	Washer, lock-7/8"	65	20 pcs.1#	.02	
XA 69	Screw,cap-hex. hd. 7/8" x 3¼" N. F.	20	3/4#	.20	217
XA 70	Screw, cap-Hex. Hd. 3/4" x 1-3/4" N.C.	10	3 pcs.1#	.10	217
XA 71	Bolt, machine-3/4" x 3" N.C.	21	2 pcs.1#	.11	
XA 72	Cover, bevel gear case	1	125#	51.00	217
XA 73	Plug, male pipe-Sq. Hd. 3/4"	4	7 pcs.1#	.05	
XA 74	Dowel, Brass-3/8" x 1-1/4"	4	24 pcs.1#	.05	218
XA 75	Sprocket, Drive-with bushings	2	197#	102.00	218
XA 76	Clutch jaw	2	64#	46.00	218
XA 77	Gear, beve	1	138#	51.50	218
XA 78	Bushing, bronze	2	3-1/2#	3.60	218
XA 79	Bushing, bronze	2	5-1/4#	6.60	218
XA 80	Nipple, close-W.I. 1/4"	9	35 pcs.1#	.045	
XA 81	Coupling, Pipe-W.I. 1/4"	27	16 pcs.1#	.10	
XA 82	Washer, thrust	1	2-1/2#	2.70	218
XA 83	Shaft, lower traction	1	203#	168.00	218
XA 84	Shaft, swing and traction bevel gear	1	45#	78.00	220
XA 85	Cotter, 3/8" x 4"	2	9 pcs.1#	.02	
XA 86	Nut T-K-10339	1	2#	3.30	220
XA 87	Washer, flat	3	5 pcs.1#	.10	220
XA 88	Bearing, roller H-A1216TS	1	3 ½#	11.60	220

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 89	Gear, bevel	1	45#	$93.50	220
XA 90	Retainer, bearing	1	12½#	8.40	220
XA 91	Retainer, seal	1	25#	16.50	220
XA 92	Ring, snap	1	3 pcs.1#	1.45	220
XA 93	Spacer, cast iron	1	7¾#	7.25	220
XA 94	Seal, oil G-0S5250	1	1¼#	6.70	220
XA 95	Spacer, bearing	1	5¾#	4.50	220
XA 96	Screw, cap	2	4 pcs.1#	.14	220
XA 97	Plate, lock-split	1	3/4#	5.70	220
XA 98	Spacer, flanged	1	8½#	5.00	220
XA 99	Pinion, low speed	1	25½#	45.00	220
XA 100	Retainer, bearing	1	34#	24.00	220
XA 101	Bearing, roller T-462-453X	2	2¼#	6.50	220
XA 102	Screw, Cap. Hex. Hd. 5/8" x 2" N.C.	15	3 pcs.1#	.07	
XA 103	Shim -.010 x 12½" O.D.	4	4 pcs.1#	.55	220
XA 103A	Shim, .005 x 12½" O.D.	3	5 pcs.1#	.50	
XA 103B	Shim. #22 x 12½" O.D.	2	3/4#	.75	
XA 104	Washer, lock - 5/8"	277	44 pcs.1#	.01	
XA 105	Nut, hex.hd.-5/8" N.C.	216	9 pcs.1#	.022	
XA 106	Screw, cap-hex.hd. 5/8" x 1 1/2" N.C.	22	5 pcs.1#	.07	
XA 107	Washer, retainer	1	2 pcs.1#	2.15	220
XA 108	Plate, lock	1	8 pcs.1#	.40	220
XA 109	Screw, cap-hex.hd. ½" x 1¼" N.C.	5	9 pcs.1#	.03	
XA 110	Screw, cap-hex.hd. 3/8" x 1 1/4" N.C.	3	16 pcs.1#	.02	220
XA 111	Washer, lock-3/8"	3	200 pcs.1#	.50*	220
XA 112	Shim, steel-.005 thick	3	16 pcs.1#	.40	220
XA 113	Shim, steel-.010 thick	3	8 pcs.1#	.45	220
XA 114	Cap, bearing retainer	1	6#	3.30	220
XA 115	Bolt, machine-½" x 5½" N. C.	1	3 pcs.1#	.07	221
XA 116	Ring, seal	1	3/4#	2.10	221
XA 117	Bearing, roller H-CD211	1	5¼#	9.35	221
XA 118	Gears, double	1	154#	115.00	221
XA 119	Spacer, bearing	1	6 1/4#	4.50	221
XA 120	Bearing, roller H-CW211	1	2 3/4#	4.80	221
XA 121	Washer, Flat	1	1 1/4#	4.80	221
XA 122	Shaft, two speed	1	28#	24.00	221
XA 123	Shim, washer-1/8" thick	1	4 pcs.1#	.06	222
XA 124	Shim, washer-3/16" thick	1	3 pcs.1#	.07	222
XA 125	Drum, brake	1	59#	30.00	222
XA 126	Screw, special cap	2	5 pcs.1#	.35	222
XA 127	Collar, thrust	1	3#	2.80	222
XA 128	Gear, Swing shaft-w/ bushing	1	132#	110.00	222
XA 129	Bushing, flanged	1	4-1/4#	19.00	222
XA 130	Pinion, swing	1	22-1/2#	52.00	222
XA 131	Plate, lock	1	8 pcs.1#	.24	222
XA 132	Screw, cap	2	5 pcs.1#	.40	222
XA 133	Screw, special cap	1	3 pcs.1#	.70	222

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each
XA 134	Plate, retaining	1	1-1/4#	$ 1.20
XA 135	Clutch, swing jaw	1	31#	27.00
XA 136	Dowel, bronze-1/2" x 2-3/8"	1	7 pcs.1#	.05
XA 137	Shaft, swing	1	82#	75.00
XA 138	Plate, retaining	1	1#	.80
XA 139	Gear, traction	1	63#	65.00
XA 140	Washer, thrust	1	3-1/4#	4.50
XA 141	Shaft, vertical traction	1	85#	102.00
XA 142	Washer, thrust	1	3#	3.84
XA 143	Pinion, bevel	1	30#	40.00
XA 144	Screw, cap	2	5 pcs.1#	.25
XA 145	Nut, lock	1	2-1/2#	6.60
XA 146	Wire, soft lock-1/16" x 20'-0"	1	5 pcs.1#	.02
XA 147	Bracket, roller	2	62#	32.50
XA 148	Roller, turntable with bushing	4	36#	33.50
XA 149	Bushing, bronze	4	7-3/4#	9.60
XA 150	Washer, flat-1/16"x6" O.D.	1	3 pcs.1#	.18
XA 151	Washer, flat-1/8" x 6" O.D.	1	3/4#	.20
XA 152	Washer, flat-21 Ga. x 6" O.D.	1	5 pcs.1#	.24
XA 153	Shaft, Turntable roller	4	22#	12.00
XA 154	Bolt, machine-3/4" x 6-1/2" N.C.	4	1#	.14
XA 155	Washer, bevel	32	4 pcs.1#	.22
XA 156	Bolt, special	20	1#	.50
XA 157	Bracket, roller	2	62#	32.50
XA 158	Turntable, welded	1	3128#	1170.00
XA 159	Gasket, hand hole cover	1	4 pcs.1#	.65
XA 160	Cover, hand hole	2	4-1/4#	.55
XA 161	Bushing, bronze-"Lower"	2	4-1/2#	17.00
XA 162	Bushing, bronze-"Lower"	1	9#	7.80
XA 163	Dowel, "Bronze"-3/8" x 1-3/4"	1	14 pcs.1#	.05
XA 164	Dowel,tapered	1	2 pcs.1#	.40
XA 165	Plug, pipe-Ctsk. Head Cast Iron 2-1/2"	1	1/2#	.55
XA 166	Dowel, bronze-3/8" x 1-1/2"	5	19 pcs.1#	.05
XA 167	Bolt, Machine-5/8" x 2-1/2" N.C.	23	3 pcs.1#	.07
XA 168	Case, Lower gear	1	74#	74.50
XA 169	Bolt, Machine-5/8" x 1-1/4" N. C.	5	5 pcs.1#	.07
XA 170	Cover, plate	1	1-1/2#	.45
XA 170A	Cover, inspection	1	5-1/2#	2.10
XA 171	Stud, cover-1/2" x 1-3/4" N. C.	4	10 pcs.1#	.10
XA 172	Washer, plain-1/2"	6	26 pcs.1#	.50*
XA 173	Nut, wing-1/2" N.C.	17	10 pcs.1#	.06
XA 174	Cover,Turntable gear case	1	225#	85.00

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 175	Bolt, machine-5/8" x 3-3/4" N. C.	3	2 pcs.1#	$ .09	
XA 176	Pin, boom pivot	2	8-1/2#	2.30	225
XA 177	Bolt, machine-1/2" x 2" N. C.	13	6 pcs.1#	.04	
XA 178	Ell, street-1/4"-45°	12	12 pcs.1#	.18	
XA 179	Bolt, mach.-5/8"x2" N. C.	46	3 pcs.1#	.07	
XA 180	Plug, pipe-Male, sq. hd. 1-1/4"	2	3 pcs.1#	.09	225
XA 181	Cover, w/3" hinge-Butts	1	11#	3.50	225
XA 182	Nut, wing-3/8" N.C.	1	16 pcs.1#	.03	225
XA 183	Washer, lock-3/8"	72	200 pcs.1#	.50*	
XA 184	Cover, inspection	1	2#	1.00	225
XA 185	Nut, Hexagon-3/8" N.C.	73	32 pcs.1#	.80*	
XA 186	Washer, flat-3/8" U. S. Std.	9	66 pcs.1#	.20*	
XA 187	Stud, 3/8" x 1-1/2" N. C.	2	22 pcs.1#	.07	225
XA 188	Housing, Jack Shaft bevel gear (with cover)	1	205#	118.00	225
XA 189	Screw, Set-Dog Point Sq.Hd. 1/2" x 2-1/2" N. C.	1	4 pcs.1#	.07	225
XA 190	Nut, Hex. Half- 1/2" N. C.	32	30 pcs.1#	.016	
XA 191	Bolt, machine-5/8"x 2-1/4" N. C.	16	4 pcs.1#	.07	
XA 192	Bushing, bronze-upper	1	5#	6.00	225
XA 193	Cover, hand hole	1	1-3/4#	.30	225
XA 194	Screw, cap-hex.hd. 5/8" x 1" N. C.	4	5 pcs.1#	.06	226
XA 195	Cover, dipper trip	1	3-1/2#	.65	226
XA 196	Screw, cap-hex.hd. 1/2" x 1" N. C.	15	8 pcs.1#	.03	
XA 197	Cover, inspection hole	2	1-1/2#	.30	226
XA 198	Gasket,inspection cover	1	2 pcs.1#	.30	226
XA 199	Cover, gear case	1	347#	95.00	226
XA 200	Gasket,	1	1#	1.15	226
XA 200A	Gasket	1	4 pcs.1#	.30	226
XA 200B	Gasket	1	16 pcs.1#	.18	226
XA 201	Dowel, 3/8" x 1-1/2" C.R.S.	2	22 pcs.1#	.01	226
XA 202	Plug, pipe-Male W.I. sq. Hd. 1-1/2"	1	2 pcs.1#	.12	226
XA 203	Bolt, Machine-3/4" x 3-1/4" N.C.	11	2 pcs.1"	.11	226
XA 204	Bolt, machine-3/4" x 3-1/2" N. C.	18	2 pcs.1#	.15	
XA 205	Stand, side (with pin)	1	275#	160.00	226
XA 206	Cotter, 3/16" x 2-1/2"	1	54 pcs.1#	.40*	226
XA 207	Washer, flat 2447-13	1	5 pcs.1#	.06	226
XA 208	Pin, boom hoist brake	1	4#	1.60	226
XA 209	Screw, cap-hex.hd. 5/8" x 1-3/4" N.C.	4	4 pcs.1#	.07	

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 210	Bolt, machine-3/4" x 2-3/4" N. C.	9	2 pcs.1#	$ .11	
XA 211	Case, gear Not sold separately- Includes Part No. XA 197	1	945#	324.00	226
XA 212	Stud, 3/4" x 4 1/4" C724-5	2	2 pcs.1#	.35	226
XA 213	Screw, cap-hex. head 3/8" x 1-3/4" N.C.	1	14 pcs.1#	.03	226
XA 214	Nut, hexagon half- 3/8" N. C.	3	60 pcs.1#	.01	
XA 215	Shim, steel	2	3 pcs.1#	.15	227
XA 216	Cotter, 5/16" x 2-1/2"	5	18 pcs.1#	.01	227
XA 217	Bracket, sheave	1	5#	4.80	227
XA 218	Washer, flat	12	2 pcs.1#	.24	
XA 219	Sheave, Cable-with bushing	3	4-1/2#	3.60	
XA 220	Shaft, "A" frame	1	91#	13.50	227
XA 221	Nipple, close-1/8"	1	50 pcs.1#	.045	227
XA 222	Coupling, pipe-1/8"	4	20 pcs.1#	.10	
XA 223	Pin, sheave	1	3/4#	.90	227
XA 224	Bushing, bronze	3	3 pcs.1#	.55	
XA 225	Cotter, 1/2" x 4-1/2"	4	4 pcs.1#	.06	227
XA 226	Rod, reach	1	4#	1.00	227
XA 227	Spacer, pipe	1	4#	1.00	227
XA 228	Bolt, machine-1/" x 1-1/4" N. C.	32	9 pcs.1#	.04	
XA 229	Bolt, machine-1/2" x 1-1/2" N. C.	18	8 pcs.1#	.04	
XA 230	Cotter, 3/8" x 2"	4	15 pcs.1#	.014	227
XA 231	Pin, hinge	2	1-1/4#	.75	227
XA 232	Pin, Anchor	2	2#	1.15	227
XA 233	Member, tension	2	77#	26.00	227
XA 234	Dowel, brass-3/8" x 3/4"	11	34 pcs.1#	.05	
XA 235	Sheave, suspension	7	44#	21.50	
XA 236	Spacer, pipe	1	1-3/4#	1.75	227
XA 237	Pin, yoke	2	10-3/4#	2.90	227
XA 238	Cotter, 3/16" x 1-1/4"	69	105 pcs.1#	.10*	
XA 239	Pin, lock	2	3 pcs.1#	.55	227
XA 240	Yoke, "A" Frame-	1	85#	36.00	227
XA 241	Hanger, Dead End	1	16-3/4#	4.60	227
XA 242	Spacer, pipe	1	10#	2.40	227
XA 243	Frame, support	1	28#	5.40	227
XA 244	Cotter, 1/4" x 2-1/4"	7	36 pcs.1#	.80*	
XA 245	Pin, hinge	2	1-1/4#	.60	227
XA 246	Member, compression	2	105#	30.00	227
XA 247	Bushing, bronze	11	2-1/4#	2.40	
XA 248	Spacer, pipe	1	3-1/2#	1.95	227
XA 249	Wedge, drum	2	1#	.60	228
XA 250	Bearing, ball F-120WD-2N	4	5#	19.25	
XA 251	Bearing, ball F-122WD-2N	2	7#	26.50	228
XA 252	Screw, cap-Hex.Hd. 5/8"x2-1/2" N. F.	16	3 pcs.1#	.08	228
XA 253	Screw, Cap-Hex.Hd. 5/8" x 3-1/2" N. C.	12	3 pcs.1#	.10	

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 254	Retainer, bearing	1	13-3/4#	$19.50	228
XA 255	Closure, shaft	1	22#	9.25	228
XA 256	Spacer, pipe	1	4-1/4#	1.70	228
XA 257	Block, pillow	2	22-1/2#	23.50	
XA 258	Plate, retainer	3	1#	.35	
XA 259	Screw, Cap-Hex. Hd. 5/8" x 1-1/4" N. C.	10	5 pcs.1#	.06	
XA 260	Plate, lock	4	16 pcs.1#	.18	
XA 261	Drum, hoist	1	247#	66.00	228
XA 262	Nut, Hexagon-5/8" N.F.	20	9 pcs.1#	.03	
XA 263	Housing, clutch-21"	2	295#	138.00	228
XA 264	Spacer, cast iron	1	8-1/2#	9.50	228
XA 265	Spider, clutch	4	60#	51.50	
XA 266	Bearing, ball F-215W	1	3#	8.20	228
XA 267	Drum, closing	1	300#	78.00	228
XA 268	Spider, Clutch	4	60#	51.50	
XA 269	Spacer, cast iron	1	7-3/4#	9.30	228
XA 270	Key, straight	3	1#	.50	
XA 271	Gear, drum drive	1	175#	126.00	228
XA 272	Retainer, bearing	1	16#	14.50	228
XA 273	Bearing, ball F-218WD	1	5-3/4#	14.50	228
XA 274	Key, straight	2	2 pcs.1#	.65	
XA 275	Shaft, drum	1	218#	156.00	228
XA 276	Plate, retainer	1	2#	.90	228
XA 277	Dowel, brass-3/8"x7/8"	1	31 pcs.1#	.05	230
XA 278	Block,pillow-with bushing	1	21 1/2#	24.50	230
XA 279	Bushing, bronze	1	3 1/2#	3.75	230
XA 280	Wedge, socket	2	1 #	.65	
XA 281	Bushing, bronze-outer	1	2 1/2#	7.20	230
XA 282	Key, straight	2	1 3/4#	1.30	230
XA 283	Shaft, boom hoist	1	206#	145.00	230
XA 284	Plug, pipe-Ctsk.Hd.1/4"	3	45 pcs.1#	.07	
XA 285	Sleeve, shifter	1	47 1/2#	33.50	230
XA 286	Screw, lock	1	3 pcs.1#	.60	230
XA 287	Screw, cap-Hex.Hd, 5/8" x 6 3/4" N.F.	4	3/4#	.20	230
XA 288	Bearing, ball-N.D, 7215	1	3#	8.50	230
XA 289	Retainer, ring	1	3/4#	3.30	230
XA 290	Spider, clutch	2	59#	72.00	
XA 291	Drum, boom hoist-with bushing	1	225#	125.00	230
XA 292	Bushing, bronze-inner	1	2 1/2#	7.20	230
XA 293	Spacer, pipe	1	225#	3.60	230
XA 294	Shim, #28 Ga.	5	80 pcs.1#	.30	230
XA 295	Plate, retainer	1	4 pcs.1#	.40	230
XA 296	Plate, lock	1	21 pcs.1#	.24	230
XA 297	Sprocket, racking-in	1	66#	42.00	230
XA 298	Housing, clutch	1	104#	98.00	230
XA 299	Key, straight	2	3 pcs.1#	.30	230
XA 300	Retainer, bearing	1	8 1/2#	21.00	230
XA 301	Gear, boom hoist	1	117#	87.00	230
XA 302	Bearing, Ball-N.D. 7310	1	2 1/2#	6.70	230
XA 303	Dowel, steel - 1/2" x 5/8"	1	28 pcs.1#	.05	230
XA 304	Plug, pipe-Sq.Hd. 1/4"	5	33 pcs.1#	.04	

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description Of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 305	Seal, oil P-575412	1	3/4#	$3.55	230
XA 306	Bearing, ball F-220W	1	8 1/4#	19.50	230
XA 307	Spacer, pipe	1	1 1/4#	3.75	230
XA 308	Ring, snap	1	3 pcs.1#	1.10	230
XA 309	Retainer, bearing	1	15 1/2#	15.00	232
XA 310	Spacer, pipe	1	2 3/4#	3.25	232
XA 311	Sprocket, drive	1	239#	135.00	232
XA 312	Bearing, ball F-215WD	1	3#	8.20	232
XA 313	Key, straight	1	3/4#	.50	232
XA 314	Shims, .020 thick	3	12 pcs.1#	.35	232
XA 314A	Shims, .005 thick	9	48 pcs.1#	.20	232
XA 315	Nut, lock F-N19	2	1 1/2#	2.55	232
XA 316	Washer, lock F-W19	2	6 pcs.1#	.25	232
XA 317	Ring, snap	1	4 pcs.1#	.90	232
XA 318	Housing, clutch	2			232
Note:	Not sold separately- Includes Parts XA 318 to XA 322 Inclusive	2	167#	170.00	232
XA 319	Key, straight	2	3 pcs.1#	.55	232
XA 320	Pinion, bevel	2	29#	82.00	232
XA 321	Screw, headless socket set 1/2" x 1" N.C.	4	20 pcs.1#	.11	232
XA 322	Slinger, oil	2	2 pcs.1#	1.45	232
XA 323	Bearing, ball F-120W-2	2	5#	18.60	232
XA 324	Spacer, pipe	2	1 1/4#	1.65	232
XA 325	Shaft, jack- with #19 Fafnir nuts 40SA179B	1	207#	165.00	232
XA 326	Pinion, drive	1	37#	42.00	232
XA 327	Bearing, ball F-315 WD	1	8#	18.00	232
XA 328	Retainer, bearing	1	17 3/4#	15.00	232
XA 329	Pin, crank	3	2 pcs.1#	.35	
XA 330	Pin, eye	5	16 pcs.1#	.30	
XA 331	Washer, lock-type #15 S-1520	5	32 pcs.1#	.05	
XA 332	Screw, flat head-3/8" x 1" N. C.	5	20 pcs.1#	.05	
XA 333	Washer, retainer	3	4 pcs.1#	.06	
XA 334	Pin, shoulder	5	1#	2.00	
XA 335	Screw, cap-Hex. Head 3/4" x 3 1/2" N.C.	2	2 pcs.1#	.15	
XA 336	Washer, S.A.E.-3/4" Special	3	9 pcs.1#	.01	
XA 337	Bolt, machine-1/2" x 3" N. C.	10	5 pcs.1#	.06	
XA 338	Ring, shifter-2 halves	6	6 1/2#	5.70	
XA 339	Sleeve, shifter	2	18 1/4#	12.00	
XA 340	Screw, square head set-1/2"x1-1/2" N.C. cup point	11	8 pcs.1#	.05	
XA 341	Bar, pivot	10	1#	4.50	
XA 342	Washer, cup	10	6 pcs.1#	.40	
XA 343	Nut, hex. slotted 5/8" N. C.	11	15 pcs.1#	.03	
XA 344	Link, reinforcing	2	4 1/2#	3.60	

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 345	Crank, operating with bushing	5	4 1/2#	$10.00	
XA 346	Spring, tension	5	4 pcs.1#	.50	
XA 347	Bushing, bronze	5	3/4#	.80	
XA 348	End, ball	5	4 pcs.1#	1.20	
XA 349	Thimble, adjusting	13	10 pcs.1#	.18	
XA 350	Nut, Hex. Half-5/8" N.C.	19	18 pcs.1#	.02	
XA 351	Screw, Sq. Head Set 5/8" x 2 1/4" Cup point	13	4 pcs.1#	.09	
XA 352	Yoke, toggle-w/bushing	5	12#	18.00	
XA 353	Bushing, bronze	7	8 pcs.1#	.24	
XA 354	Pin, pivot	5	2 pcs.1#	.35	
XA 355	Cotter, 3/16" x 2 1/4"	9	60 pcs.1#	.40*	
XA 356	Cotter, 1/4" x 1 1/2"	14	50 pcs.1#	.50*	
XA 357	Pin, crank and band	17	3 pcs.1#	.30	
XA 358	Eyebolt, adjusting	5	1#	3.00	
XA 359	Link, adjusting	5	2#	4.50	
XA 360	Lining, brake- J.M.#900	3	5 1/2#	10.00	
XA 361	Link, band end	3	3/4#	.90	
XA 362	Lug, clutch band	10	1#	1.50	
XA 363	Band, clutch-with lugs	3	28#	18.00	
XA 364	Plug, rivet-9/16" x 3/16"	218	**	.02	
XA 365	Rivet, brass-1/4" x 5/8" 250	182	100 pcs.1#	.01	
XA 366	Nut, adjusting	5	3 pcs.1#	1.10	
XA 367	Nut, Hex. Half-3/4" N. C.	49	10 pcs.1#	.04	
XA 368	Link, reinforcing	1	4 1/2#	3.60	236
XA 369	Screw, cap-special	1	2 pcs.1#	.45	238
XA 370	Sleeve, shifter	3	14 1/2#	11.00	
XA 371	Washer, Type S-1132	1	160 pcs.1#	.02	238
XA 372	Washer, flat	2	20 pcs.1#	.02	
XA 373	Band, brake with lining and lugs	2	22 3/4#	30.00	
XA 374	Lining, brake-J.M. 200	2	4 1/2#	9.00	
XA 375	Link, dead end	2	3 pcs.1#	3.60	
XA 376	Washer, flat-#28 Ga.	2	176 pcs.1#	.02	
XA 377	Washer, flat-#16 Ga.	1	64 pcs.1#	.03	240
XA 378	Washer, flat	5	8 pcs.1#	.12	
XA 379	Cotter, 1/4" x 2"	19	38 pcs.1#	.60*	
XA 380	Clevis, reach rod	38	1#	1.00	
XA 381	Spacer, pipe	2	8 pcs.1#	.45	
XA 382	Link, toggle	2	1 1/4#	6.00	
XA 383	Cotter, 3/16" x 1-1/2"	21	104 pcs.1#	.20*	
XA 384	Pin, clevis and link	2	2 pcs.1#	.45	
XA 385	Washer, flat-5/8" S.A.E.	22	13 pcs.1#	.60*	
XA 386	Spring, compression	2	1#	.55	
XA 387	Lever, traction shifter	2	6 3/4#	8.00	
XA 388	Key, gib-3/8" x 3/8" x 2"	13	9 pcs.1#	.11	
XA 389	Washer, flat-5/8" St'd.	37	13 pcs.1#	.60*	
XA 390	Link, connector	3	1 1/2#	.65	
XA 391	Spring, tension	1	1 1/2#	1.10	244

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 392	Pin, lever	2	3/4#	$ .35	
XA 393	Link, connecting	2	4 pcs.1#	1.50	
XA 394	Pin, pivot	7	2 pcs.1#	.24	
XA 395	Rod, reach	2	2 pcs.1#	.55	
XA 396	Bolt, eye	1	1#	4.00	244
XA 397	Nut, Hexagon-3/4" N.F.	6	5 pcs.1#	.05	
XA 398	Spacer, pipe	1	4 pcs.1#	.30	244
XA 399	Cotter, 3/16" x 1"	7	114 pcs.1#	.10*	
XA 400	Shaft, traction shifter	2	5 3/4#	2.10	
XA 401	Washer, flat	2	8 pcs.1#	.10	
XA 402	Washer, flat	4	4 pcs.1#	.06	
XA 403	Yoke, center steering	2	7 1/4#	9.50	
XA 404	Screw, cap-hex.hd. 3/4" x 2 3/4" N.F.	2	2 pcs.1#	.12	
XA 405	Screw, cap-flat head 1/2" x 4" N.C.	2	4 pcs.1#	.24	
XA 406	Cotter, 5/16" x 2"	5	22 pcs.1#	.01	
XA 407	Screw, set-square head cup point 1/2" x 2" N.C.	4	6 pcs.1#	.06	
XA 408	Lever, brake locking	3	6 1/4#	5.25	
XA 409	Link, connection	4	1 3/4#	1.15	
XA 410	Bracket, steering brake	2	25#	27.00	
XA 411	Bushing, bronze	4	3/4#	1.15	
XA 412	Pin, clevis	40	4 pcs.1#	.14	
XA 413	Lever, brake with bushing	2	5 1/4#	8.50	
XA 414	Bushing, bronze	2	1/2#	1.75	
XA 415	Lever, shifter	2	2-3/4#	5.50	
XA 416	Key, gib-3/8"x3/8"x1½"	2	11 pcs.1#	.11	
XA 417	Pin, lever	2	4 pcs.1#	.35	
XA 418	Screw, cap-Hex. Head 7/8" x 5" N. C.	2	3/4#	.28	
XA 419	Yoke, steering clutch	2	8 1/2#	6.60	
XA 420	Collar, shifter	2	3 1/2#	5.40	
XA 421	Band, steering brake with lining and ends	4	12#	13.00	
XA 422	Shaft, shifter	2	9 3/4#	2.50	
XA 423	Lining, brake #11-7680 J.M.	4	1 3/4#	4.00	
XA 424	Spring, tension	2	4 pcs.1#	.30	
XA 425	Washer, flat	8	8 pcs.1#	.04	
XA 426	Washer, lock	2	3 pcs.1#	.55	
XA 427	Bolt, machine-special	2	2 3/4#	.75	
XA 428	Lug, brake band	4	1 3/4#	1.00	
XA 429	End, brake band	4	2 1/2#	2.15	
XA 430	Rivet, brass-1/4" x 3/4"	48	112 pcs.1#	.01	
XA 431	Pin, band end	4	1 1/2#	.75	
XA 432	Washer, flat - 1"	32	5 pcs.1#	.03	
XA 433	Screw, cap-Hex. Head 7/8" x 1 3/4" N. C.	4	3/4#	.17	
XA 434	Screw, cap-Hex. Head 7/8" x 4" N. C.	4	1#	.23	
XA 435	Nut, Hex. Half-7/8"N.C.	5	7 pcs.1#	.07	
XA 436	Nut, Hexagon-7/8" N.C.	9	4 pcs.1#	.05*	
XA 437	Bolt, eye	1	3 1/2#	4.75	245
XA 438	Rod, reach	4	2 1/4#	.50	

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 439	Ring, shifter (2 halves)	2	1 1/4#	$5.05	248
XA 440	Sleeve, upper shifter	1	1#	6.00	248
XA 441	Yoke, lower center steering	2	4 1/2#	7.20	248
XA 442	Key, gib-3/8" x 3/8" x 3-1/2"	2	6 pcs.1#	.13	248
XA 443	Bolt, machine-3/8" x 1-1/2" N. C.	12	13 pcs.1#	.03	
XA 444	Shaft, upper	1	15 1/2#	4.20	248
XA 445	Pin, lock	2	48 pcs.1#	.35	248
XA 446	Rod, steering-inner	1	10 3/4#	2.60	248
XA 447	Shaft, lower	1	15#	4.25	248
XA 448	Lug, lower shifter	1	1#	3.95	248
XA 449	Screw, cap-Hex. Head 5/16" x 1" N. C.	1	28 pcs.1#	.01	248
XA 450	Lever, upper traction	1	8#	6.55	248
XA 451	Collar, pipe	4	3 pcs.1#	1.00	
XA 452	Lever, lower traction	1	8 1/2#	7.00	248
XA 453	Washer, lock-5/16"	284	**	.30*	
XA 454	Pipe, steering-outer	1	9 1/4#	2.60	248
XA 455	Key, gib - 3/8" x 3/8" x 1 3/4"	2	10 pcs.1#	.11	248
XA 456	Lug, lower shifter	1	1#	3.95	248
XA 457	Screw, cap-Hex.Head 5/16" x 3/4" N. C.	1	30 pcs.1#	.01	248
XA 458	Bracket, bearing	1	8#	8.75	248
XA 459	Shaft, clutch yoke pivot	1	5#	6.00	248
XA 460	Sleeve, upper shifter	1	1 1/4#	5.70	248
XA 461	Crank, bell	1	5#	4.00	248
XA 462	Cotter, 1/4" x 2-1/2"	3	32 pcs.1#	.02	
XA 463	Screw, cap-hex.head 3/4" x 2" N.C.	1	2 pcs.1#	.11	248
XA 464	Pin, bell crank	1	5 3/4#	3.75	248
XA 465	Shaft, lever	1	37 1/2#	7.25	248
XA 466	Bearing, Babbitted	4	3 1/4#	1.35	248
XA 467	Bolt, machine-5/8" x 1 3/4" N. C.	30	4 pcs.1#	.07	
XA 468	Key, taper	2	16 pcs.1#	.10	
XA 469	Crank, operating	3	3 3/4#	5.00	
XA 470	Yoke, clutch	1	9 1/2#	10.00	248
XA 471	Key, straight	2	16 pcs.1#	.15	
XA 472	Lever, operating	1	5 1/2#	4.80	248
XA 473	Rod, reach	1	2 3/4#	.75	248
XA 474	Key, gib-3/8" x 3/8" x 2-1/4"	2	8 pcs.1#	.11	
XA 475	Rod, reach	1	5#	.95	248
XA 476	Spacer, pipe	1	3 pcs.1#	.30	248
XA 477	Lever, Operating	1	3 1/4#	5.75	248
XA 478	Bearing, flanged	1	3 1/2#	3.90	248
XA 479	Spacer, pipe	1	1#	.55	248
XA 480	Sheave, cable	2	2 pcs.1#	.60	
XA 481	Spacer, pipe	1	1 1/4#	.35	248
XA 482	Lever, Hand	2	15#	9.35	
XA 484	Band, Brake with lining and Ends	2	24#	29.00	
XA 485	Lining, band	2	3 pcs.1#	9.30	

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 486	Screw, cap-Flat Head 3/8" x 4" N. C.	2	8 pcs.1#	$ .20	
XA 487	Rod, reach	2	2 1/4#	.60	
XA 488	Lever, operating	1	6 1/4#	7.30	247
XA 489	Bolt, carriage-5/8"x2"	7	3 pcs.1#	.08	
XA 490	Bearing, Babbitted	2	5#	1.60	
XA 491	Washer, flat	1	3 pcs.1#	.75	247
XA 492	Ell, street-1/4"x90°	3	11 pcs.1#	.14	
XA 493	Tube, brake operating	1	24 1/2#	18.00	247
XA 494	Lever, operating	1	4 3/4#	7.75	247
XA 495	Key, feather	1	8 pcs.1#	.15	247
XA 496	End, brake band	6	1#	1.45	
XA 497	Spring, tension	3	2 pcs.1#	.70	
XA 498	Pin, band end	6	2 pcs.1#	.50	
XA 499	Rod, brake adjusting	3	3 1/4#	1.80	
XA 500	Link, brake	4	4 1/2#	3.50	
XA 501	Pin, lock	2	5 pcs.1#	.25	
XA 502	Nut, adjusting lock	6	3/4#	1.85	
XA 503	Shaft, operating	2	4#	2.15	
XA 504	Crank, operating	2	3#	4.00	
XA 505	Shim, support	4	5 pcs.1#	.10	
XA 506	Bolt, machine-3/4" x 2" N. C.	18	2 pcs.1#	.10	
XA 507	Support, brake stand	2	10#	7.75	
XA 508	Shim, brake stand	4	6 pcs.1#	.12	
XA 509	Nipple, 1/4" x 4"	4	7 pcs.1#	.07	
XA 510	Collar, set 53-396	3	1#	1.20	
XA 511	Bolt, Machine-3/8" x 3" N. C.	1	9 pcs.1#	.04	247
XA 512	Hub, brake pedal	3	10#	6.75	
XA 513	Screw, Cap-Flat Head 1/2" x 4-1/2" N.C.	2	4 pcs.1#	.32	
XA 514	Washer, cup	2	16 pcs.1#	.05	
XA 515	Spacer, pipe	1	2 pcs.1#	.24	247
XA 516	Shaft, foot lever	1	9#	1.90	247
XA 517	Key, gib-3/8" x 3/8" x 2-1/2"	3	8 pcs.1#	.11	
XA 518	Lever, operating	2	4-1/4#	3.90	
XA 519	Stand, brake	1	51#	34.50	247
XA 520	Bolt, machine-7/8" x 2-1/2" N. C.	3	3/4#	.17	
XA 521	Bolt, Machine-3/4" x 2-1/2" N. C.	14	2 pcs.1#	.11	
XA 522	Pin, latch	2	3 pcs.1#	.40	
XA 523	Latch, brake	2	2-1/4#	1.75	
XA 524	Bolt, machine-5/8" x 1-1/2" N.C.	42	5 pcs.1#	.07	
XA 525	Pedal, Brake	3	5 3/4#	3.25	
XA 526	Ratchet, latch	2	3#	1.75	
XA 527	Arm, brake pedal	3	9-1/2#	3.55	
XA 528	Pin, button head	2	5 pcs.1#	.12	
XA 529	Spring, brake pedal	2	1 1/4#	.85	
XA 530	Elbow, 1/4"-90°	12	9 pcs.1#	.12	
XA 531	Nipple, 1/4" x 8"	1	4 pcs.1#	.20	246
XA 532	Shaft, brake operating	1	34 1/4#	5.75	246
XA 533	Lever, operating	1	5 1/4#	5.45	246

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 534	Shim, bearing	1	1#	$ .30	246
XA 535	Stand, brake	1	52#	37.50	246
XA 536	Casting, splice	2	1 3/4#	2.60	249
XA 537	Rivet, flat head-1/4" x 1/2" brass 250	36	80 pcs.1#	.01	
XA 538	Lining, block	5	1 1/4#	3.60	
XA 539	Band, brake Order XA 542	2			249
XA 540	Crank, bell	1	5 1/4#	8.65	249
XA 541	Shaft, lever	1	35#	13.00	249
XA 542	Band, brake with lining, ends and splice casting. (two halves)	1	23#	50.50	249
XA 543	Casting, anchor	1	11 1/2#	10.50	249
XA 544	Rod, reach	2	1 3/4#	.70	
XA 545	Bolt, machine 3/8" x 2 3/4" N. C.	7	10 pcs.1#	.03	
XA 546	Bearing, solid	1	3 1/4#	1.30	249
XA 547	Spring, foot brake	1	3/4#	.60	249
XA 548	Lining, clip	1	3 pcs.1#	.25	249
XA 549	Rivet, countersunk head 1/4" x 5/8" copper	3	100 pcs.1#	.01	
XA 550	Clip, brake pedal	1	1 3/4#	6.85	249
XA 551	Bolt, eye	1	3 pcs.1#	.55	249
XA 552	Rod, foot brake spring	1	1#	1.10	249
XA 553	Lever, operating	2	1 3/4#	3.70	250
XA 554	Bearing, lever shaft	2	3#	1.60	250
XA 555	Shaft, clutch lever	1	13 1/2#	3.15	250
XA 556	Lever, engine clutch	1	3 1/2#	8.40	250
XA 557	Lining, brake band	1	3#	5.10	250
XA 558	Key, Woodruff 808	1	40 pcs.1#	.03	250
XA 559	Key, straight	4	32 pcs.1#	.05	250
XA 560	Band, brake with lining and ends	1	15#	23.00	250
XA 561	Washer, flat	1	4 pcs.1#	.50	250
XA 562	Pivot, lever	1	4#	3.25	250
XA 563	Cotter, 1/4" x 3"	3	27 pcs.1#	.02	
XA 564	Pin, lock	1	6 pcs.1#	.30	250
XA 565	Lever, operating	1	3#	4.45	250
XA 566	Key, gib 7/16" x 7/16" x 2"	2	6 pcs.1#	.15	250
XA 567	Spacer, pipe	1	1 1/4#	.50	250
XA 568	Washer, flat 1-5/8"	1	2 pcs.1#	.05	
XA 569	Bolt, machine 5/8" x 3-1/4" N. C.	1	3 pcs.1#	.08	250
XA 570	Lever, operating	1	7 1/4#	5.75	250
XA 571	Key, straight	1	16 pcs.1#	.15	250
XA 572	Shaft, swing brake	1	18 1/2#	5.00	250
XA 573	Rod, reach	1	5#	1.90	250
XA 574	Rod, reach	1	6#	1.45	250
XA 575	Screw, latch	6	80 pcs.1#	.09	
XA 576	Nut, latch screw BA-X-05	6	**	.02	
XA 577	End, rod BA-X-06-4	3	16 pcs.1#	.50	
XA 578	Stop, lever	1	16 pcs.1#	1.00	250

* Price Per 100 Pcs.

** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 579	Ratchet, notched	1	2 pcs.1#	$1.50	250
XA 580	Lever, hand	1	7 3/4#	9.35	250
XA 581	Rod, pawl BA-X-07C-36B	3	2 pcs.1#	1.15	
XA 582	Cotter BA-X-09	1	**	.01	250
XA 583	Nut, castle BA-X-20	1	40 pcs.1#	.02	250
XA 584	Pin, band	2	3 pcs.1#	.20	250
XA 585	End, band	2	1#	1.00	250
XA 586	Spacer, pipe	1	5 pcs.1#	.25	250
XA 587	Washer, flat	2	5 pcs.1#	.02	250
XA 588	Screw, take-up	1	1 1/4#	3.30	250
XA 589	Lever, brake band	1	6#	7.25	250
XA 590	Rod, reach	1	3/4#	2.15	250
XA 591	Shaft, lever	1	24#	4.85	250
XA 592	Lever, hand	1	11#	8.75	250
XA 593	Lever, operating	1	10 3/4#	7.35	250
XA 594	Pin, shift collar	4	3 pcs.1#	.25	250
XA 595	Yoke, gear shift	1	20 1/2#	14.50	250
XA 596	Collar, gear shift with graphite plugs	2	2#	7.50	250
XA 597	Plug, Dixon's graphite	20	**	.05	250
XA 598	Key, gib-7/16" x 7/16" x 2 1/2"	1	5 pcs.1#	.16	250
XA 599	Spring, latch BA-X-03	3	80 pcs.1#	.12	
XA 600	Lever, hand	1	9#	11.00	250
XA 601	Latch, grip BA-X-02	3	5 pcs.1#	.35	
XA 602	Ratchet, blank BA-X14-4B	2	3 pcs.1#	.60	
XA 603	Bearing, lever shaft	2	6 3/4#	3.60	250
XA 604	Bolt, machine 1/2" x 2-1/4" N. C.	1	6 pcs.1#	.05	
XA 605	Lever, swing brake	1	4#	7.00	250
XA 606	Rod, reach	1	6 3/4#	.85	250
XA 607	Shaft, lever	1	14 3/4#	7.00	250
XA 608	Screw, pawl BA-X-08	6	48 pcs.1#	.15	
XA 609	Bolt, clamp BA-X-55	1	16 pcs.1#	.07	250
XA 610	Fork, shifter	1	8 1/2#	10.00	251
XA 611	Bolt, machine 5/8" x 4" N. C.	3	2 pcs.1#	.09	
XA 612	Lug, adjusting	1	3 1/4#	5.50	251
XA 613	Bolt, machine 5/8" x 3" N. C.	3	3 pcs.1#	.08	
XA 614	Key, straight	2	5 pcs.1#	.15	251
XA 615	Bracket, lever bearing	1	35#	17.00	251
XA 616	Fork, shifter	1	9 1/4#	9.90	251
XA 617	Bracket, shifter fork	1	6 3/4#	7.80	251
XA 618	Pin, one hole	1	3#	2.10	251
XA 619	Pin, lock 5/16" x 3 1/2"	1	12 pcs.1#	.01	251
XA 620	Bearing, bracket	1	3 1/2#	2.40	251
XA 621	Shaft, clutch operating	1	8 1/2#	2.90	251
XA 622	Pin, one hole	3	2 pcs.1#	.30	251
XA 623	Link, clutch operating	2	3/4#	3.30	251
XA 624	Screw, cap-Hex. Head 5/8" x 3 1/4" N.C.	1	3 pcs.1#	.10	251
XA 625	Crank, adjusting-Half	2	4#	5.70	251
XA 626	Pin, one hole	1	2 3/4#	2.30	251
XA 627	Pin, lock	1	8 pcs.1#	.02	251

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 628	Bracket, bearing	1	8 1/2#	$10.00	251
XA 629	Bearing, solid	1	3 3/4#	.90	251
XA 630	Clevis, reach rod	1	1 3/4#	2.30	251
XA 631	Bearing, double	1	5 1/2#	1.75	251
XA 632	Ell, street 1/8" x 45°	3	22 pcs.1#	.18	
XA 633	Bracket, adjusting	1	12 3/4#	12.50	251
XA 634	Lever, operating	1	2 3/4#	3.00	251
XA 635	Pin, one hole	1	3/4#	1.10	251
XA 636	Clevis, special	1	2#	3.00	251
XA 637	Nipple, 1/8" x 1 1/2"	2	35 pcs.1#	.05	
XA 638	Ell, street-1/8" x 90°	3	22 pcs.1#	.14	
XA 639	Rod, reach	1	1 3/4#	.55	251
XA 640	Shaft, lever	1	14 1/2#	10.50	251
XA 641	Lever, hand	1	15 1/2#	15.00	251
XA 642	Rod, reach	1	12#	1.85	251
XA 643	Clevis, offset	1	1 1/2#	2.80	251
XA 644	Crank, operating	1	2 3/4#	4.25	251
XA 645	Crank, operating	2	3#	4.20	252
XA 646	Shim, 1/8" thick	4	2 pcs.1#	.17	252
XA 647	Shim, #16 gauge	4	4 pcs.1#	.15	252
XA 648	Rod, reach	2	3/4#	.65	252
XA 649	Lever, equalizer	1	7#	5.35	252
XA 650	Rod, reach	1	3#	.85	252
XA 651	Crank, bell	1	5 3/4#	6.75	252
XA 652	Support, bell crank	1	3 1/4#	1.45	252
XA 653	Bearing, shifter yoke	2	9 3/4#	3.25	252
XA 654	Spacer, pipe	2	3 pcs.1#	.04	252
XA 655	Rod, connecting	1	4 1/2#	3.90	252
XA 656	Pin, pivot	1	1 3/4#	1.20	252
XA 657	Bearing, lever shaft	1	9 1/2#	4.85	252
XA 658	Spacer, pipe	1	2 pcs.1#	.45	252
XA 659	Rod, reach	1	10#	1.90	252
XA 660	Bolt, machine 3/4" x 2-1/4" N. C.	7	2 pcs.1#	.10	
XA 661	Yoke, clutch	2	14#	8.70	252
XA 662	Key, gib 3/8" x 3/8" x 3"	2	7 pcs.1#	.12	252
XA 663	Shaft, lever	2	5 3/4#	2.40	252
XA 664	Fork, shifter-half	1	3 3/4#	3.00	252
XA 665	Fork, shifter-half	1	3#	3.00	252
XA 666	Spacer, pipe	1	1 1/4#	.35	252
XA 667	Washer, flat 7/8" S.A.E.	1	6 pcs.1#	.02	252
XA 668	Shaft, lever	1	2 1/2#	10.00	252
XA 669	Bolt, machine 3/8" x 2" N. C.	3	12 pcs.1#	.03	
XA 670	Pipe, reinforcing 3/4" x 72"	1	6 3/4#	1.85	252
XA 671	Lever, hand	1	5 1/2#	9.60	252
XA 672	Bolt, machine 3/8" x 1 3/4" N. C.	10	14 pcs.1#	.03	
XA 673	Bearing, lever shaft	1	15 1/2#	5.75	252
XA 674	Spring, tension	1	48 pcs.1#	.10	253
XA 675	Washer, flat	2	16 pcs.1#	.03	253
XA 676	Latch, engagement	1	3 1/2#	3.60	253
XA 677	Crank, bell-with pin	1	2#	3.60	253
XA 678	Bracket, bell crank	1	9#	5.00	253

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 679	Cotter, 3/16" x 2"	7	66 pcs.1#	$ .30*	
XA 680	Pin, pivot	1	2 pcs.1#	.40	253
XA 681	Bolt, machine 1/2" x 1-3/4" N. C.	13	7 pcs.1#	.04	
XA 682	Pin, pawl pivot	1	4 1/2#	1.30	253
XA 683	Pawl, boom hoist	1	8#	8.35	253
XA 684	Bolt, spring	1	2 pcs.1#	.80	253
XA 685	Pin, clevis	1	4 pcs.1#	.45	253
XA 686	Clevis, reach rod	1	2#	2.10	253
XA 687	Key, straight	3	32 pcs.1#	.12	253
XA 688	Bolt, machine 3/8" x 2-1/4" N. C.	4	11 pcs.1#	.03	
XA 689	Lever, operating	1	1 3/4#	3.60	253
XA 690	Bearing, lever shaft	2	2 1/2#	2.40	253
XA 691	Rod, reach	1	2 1/4#	1.00	253
XA 692	Clevis, reach rod	4	3 pcs.1#	.55	253
XA 693	Pin, clevis	6	8 pcs.1#	.08	
XA 694	Shaft, pawl operating	1	13 1/4#	3.75	253
XA 695	Rod, reach	1	6#	2.15	253
XA 696	Rod, reach	1	1#	.75	253
XA 697	Stop, lever	1	5 pcs.1#	.75	253
XA 698	Spring, tension	1	3 pcs.1#	.90	253
XA 699	Lever, engagement	1	2#	2.45	253
XA 700	Lever, engagement	1	1 1/2#	2.45	253
XA 701	Lever, operating	1	2 1/4#	6.75	253
XA 702	Lever, hand	1	6 1/2#	4.75	253
XA 703	Pin, pivot	1	1 1/4#	.60	253
XA 704	Bracket, hand lever	1	4#	2.90	253
XA 705	Cap, grease pipe	1	3/4#	1.00	254
XA 706	Cover, clutch shaft	1	6 1/2#	2.45	254
XA 707	Retainer, felt seal	1	8 1/2#	1.90	254
XA 708	Seal, felt-medium hard 1/2" x 1/2" x 17-3/4"	1	53 pcs.1#	.30	254
XA 709	Spacer, pipe	2	2 pcs.1#	.17	254
XA 710	Bolt, machine-3/4" x 7" N. C.	2	1#	.15	254
XA 711	Support, chain case (rear)	1	10#	5.75	254
XA 712	Shim, support	4	2 pcs.1#	.25	254
XA 713	Bolt, stove-round head 5/16" x 3/4" N. C.	155	28 pcs.1#	.02	
XA 714	Nut, square 5/16" N.C.	297	45 pcs.1#	.90*	
XA 715	Guard, swing and traction clutch	2	4#	.90	254
XA 716	Guard, boom hoist brake	1	12#	9.60	254
XA 717	Bracket, clutch guard	1	4#	2.15	254
XA 718	Case, chain-upper and lower	1	125#	55.00	254
XA 719	Seal, felt-5" I.D. x 3/8" thick x 5-3/4" O. D.	1	80 pcs.1#	.60	254
XA 720	Retainer, felt seal	1	5 1/2#	3.00	254
XA 721	Bolt, stove-round head 5/16" x 1" N. C.	16	25 pcs.1#	.02	
XA 722	Bolt, machine-3/8" x 3/4" N. C.	12	22 pcs.1#	.03	

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 723	Support, chain case (front)	1	6 1/2#	$3.25	254
XA 724	Shim, support	4	2 pcs.1#	.15	254
XA 725	Cover, plate	1	6#	3.50	254
XA 726	Cover, plate	1	7#	1.75	254
XA 727	Seat, operator's HD-3181-25	1	5 3/4#	7.20	255
XA 728	Bolt, carriage-1/2" x 1-1/4"	1	6 pcs.1#	.04	255
XA 729	Hinge, seat	1	2 1/2#	1.40	255
XA 730	Bolt, adjusting	1	2 pcs.1#	.50	255
XA 731	Spacer, pipe	1	16 pcs.1#	.12	255
XA 732	Base, operator's seat	1	3#	2.10	255
XA 733	Bolt, machine-1/2" x 4" N. C.	1	4 pcs.1#	.06	255
XA 734	Pivot, seat	1	3#	1.50	255
XA 735	Bracket, seat shaft	1	6#	4.20	255
XA 736	Bolt, machine-1/2" x 2-1/2" N.C.	1	6 pcs.1#	.05	255
XA 737	Shaft, supporting	1	13 1/4#	3.25	255
XA 738	Clip, tailswing cover	1	5 pcs.1#	.30	256
XA 739	Bolt, machine-3/4" x 1-3/4" N. C.	10	3 pcs.1#	.10	256
XA 740	Tail swing, counter-weight	1	405#	110.00	256
XA 741	Cover, tailswing corner	1	15#	3.75	256
XA 742	Bolt, machine 3/8" x 1-1/4" N. C.	5	17 pcs.1#	.03	
XA 743	Screw, cap- Hex. Hd. 1/2" x 3/4" N. C.	7	10 pcs.1#	.03	
XA 744	Cover, tailswing corner	1	15#	3.75	256
XA 745	Plate, engine	1	30#	3.75	256
XA 746	Plate, tailswing cover	1	31#	8.10	256
XA 747	Cover, tool box	1	18 1/2#	5.00	256
XA 748	Platform, operator's side	1	395#	100.00	256
XA 749	Plate, floor	1	28#	4.80	256
XA 750	Support, platform	1	10#	4.60	256
XA 751	Clip, floor plate	2	3 pcs.1#	.24	256
XA 752	Plate, floor	1	28#	4.80	256
XA 753	Platform, opposite operator's	1	260#	57.50	256
XA 754	Bracket, platform	1	2 1/4#	1.00	256
XA 755	Guard, window	1	11#	2.70	257
XA 756	Guard, window	1	18#	3.00	257
XA 757	Lock, door	1	3#	3.00	257
XA 758	Padlock, door-with keys MA-500	2	2 pcs.1#	.65	
XA 759	Key, padlock	2	16 pcs.1#	.25	257
XA 760	Guard, window	1	7#	1.35	257
XA 761	Guard, window	1	11#	3.50	257
XA 762	Guard, window	2	13 1/2#	3.00	257
XA 763	Bar, guard holder	1	3#	.75	257
XA 764	Holder, window guard	1	9 1/2#	3.35	257
XA 765	Lock, window guard	1	3 pcs.1#	.65	257
XA 766	Bolt, stove-round head 3/16" x 3/4" N. C.	1	90 pcs.1#	.50*	257

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 767	Washer, lock-3/16"	7	**	$ .20*	
XA 768	Nut, square-3/16" N.C.	7	105 pcs.1#	.10*	
XA 769	Nut, square-1/4" N.C.	26	75 pcs.1#	.40*	
XA 770	Washer, lock-1/4"	30	**	.20*	
XA 771	Bolt, stove-flat head 1/4" x 3/4" N. C.	2	50 pcs.1#	.20*	257
XA 772	Holder, window guard	1	9 1/2#	3.35	257
XA 773	Bolt, stove-round head 5/16" x 1/2" N. C.	126	32 pcs.1#	.02	
XA 774	Roof, cab	1	75#	26.50	258
XA 775	Panel, cab-inner section	1	15 1/2#	12.50	258
XA 776	Guide, door	1	8#	2.10	258
XA 777	Nut, hexagon-5/16" N.C.	10	50 pcs.1#	.70*	
XA 778	Washer, flat-5/16" Std.	10	90 pcs.1#	.20*	
XA 779	Panel, cab-outer section	1	145#	34.00	258
XA 780	Door, hinged	1	57#	15.00	258
XA 781	Door, operator's	1	102#	53.10	258
XA 782	Glass, sash	4	3#	.60	258
XA 783	Sash, window-with glazing angles and cork assembled	1	13 1/4#	20.00	258
XA 784	Latch, door	2	16 pcs.1#	.80	
XA 785	Rivet, iron-1/4" x 5/8"	10	77 pcs.1#	.10*	
XA 786	Track, door roller	2	11#	2.75	
XA 787	Lock, door	6	5 pcs.1#	.50	
XA 788	Spring, door lock	6	16 pcs.1#	.35	
XA 789	Sash, window with glazing angles and cork assembled	1	10 1/2#	20.00	258
XA 790	Roller, door	8	1#	.55	
XA 791	Pin, roller	8	5 pcs.1#	.15	
XA 792	Panel, front with window sash	1	56#	17.50	258
XA 793	Door, roof	1	6 3/4#	4.00	258
XA 794	Rivet, iron-1/4" x 1-1/4"	1	43 pcs.1#	.20*	258
XA 795	Filler, latch	1	10 pcs.1#	.15	258
XA 796	Latch, door	1	5 pcs.1#	1.00	258
XA 797	Bolt, machine-3/8" x 1" N. C.	12	19 pcs.1#	.03	
XA 798	Glass, sash	2	2 1/2#	.50	258
XA 799	Sash, window with glaxing angles and cork assembled	1	6 1/2#	12.00	258
XA 800	Panel, cab-inner section	1	90#	42.00	258
XA 801	Glass, sash	2	3 1/2#	.60	258
XA 802	Sash, window with glazing angles and cork assembled	1	10 1/2#	20.00	258
XA 803	Bolt, spring PR-1000	1	16 pcs.1#	.05	258
XA 804	Glass, sash	2	3 3/4#	.70	258
XA 805	Sash, window with glazing angles and cork assembled	1	11#	19.00	258
XA 806	Glass, sash	4	7 1/2#	4.80	258

* Price Per 100 Pcs.

** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 807	Rod, tie	1	3/4#	$ .90	258
XA 808	Spacer, pipe	1	1 1/4#	.35	258
XA 809	Sash, window with glazing angles and cork assembled	1	10 1/2#	17.50	258
XA 810	Lock, window	4	16 pcs.1#	.30	258
XA 811	Nut, wing-1/4" N.C.	8	64 pcs.1#	.02	
XA 812	Bolt, stove-round head 1/4" x 3/4" N.C.	24	48 pcs.1#	.02	
XA 813	Washer, flat-1/4" Std.	8	142 pcs.1#	.10*	258
XA 814	Plate, front	1	9#	2.00	258
XA 815	Bar, latch	4	3 pcs.1#	2.00	258
XA 816	Section, inner-front	1	38#	19.00	259
XA 817	Roof, cab	1	55#	18.00	259
XA 818	Door, upper front	1	25#	7.90	259
XA 819	Slide, door	2	2 1/2#	1.00	259
XA 820	Member, cross-lower front	1	10 1/2#	2.70	259
XA 821	Section, inner-rear	1	22#	10.50	259
XA 822	Guide, door	1	8#	2.40	259
XA 823	Handle, door	1	4 pcs.1#	.24	259
XA 824	Door, sliding	1	20#	7.25	259
XA 825	Connector, panel	1	3/4#	.45	259
XA 826	Section, outer-front	1	155#	43.00	259
XA 827	Panel, rear side	1	35#	8.40	259
XA 828	Door, sliding	1	92#	20.00	259
XA 829	Roof, rear	1	121#	22.00	260
XA 830	Back, cab	1	285#	52.00	260
XA 831	Door, rear-half	1	66#	11.50	260
XA 832	Guide, door	1	11 1/2#	7.00	260
XA 833	Door, rear-half	1	60#	12.00	260
XA 834	Track, door roller	1	30#	10.00	260
XA 835	Guard, bulkhead-top	1	28#	8.10	261
XA 836	Guide, flared	1	2 1/4#	1.45	261
XA 837	Plate, guard	1	3/4#	1.10	261
XA 838	Cover, plate	1	3 1/2#	.85	261
XA 839	Bracket, brake	2	2#	.75	261
XA 840	Door, hinge	1	1 3/4#	2.25	261
XA 841	Rivet, round head 5/16" x 1/2" long (iron)	2	48 pcs.1#	.30*	261
XA 842	Cover, plate	2	3/4#	1.75	261
XA 843	Bulkhead, upper	1	35#	15.00	261
XA 844	Support, angle	1	1#	.65	261
XA 845	Bolt, stove-round head 5/16" x 1-1/4" N.C.	2	23 pcs.1#	.03	261
XA 846	Plate, guard	1	3/4#	.90	261
XA 847	Bulkhead, top-upper	1	7 1/2#	1.50	261
XA 848	Bulkhead, front	1	19 1/2#	4.20	261
XA 849	Bulkhead, top-lower, with hinged door	1	9 1/2#	5.10	261
XA 850	Plate, side	1	1 1/2#	.85	261
XA 851	Plate, side	1	1 1/2#	.60	261
XA 852	Guard, bulkhead side	1	14 1/2#	3.90	261
XA 853	Plate, connection	1	1#	.30	261
XA 854	Bulkhead, lower-side	1	22 1/2#	12.00	261
XA 855	Support, angle	1	1 1/2#	.60	261

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 856	Guard, bulkhead side	1	11 1/2#	$4.80	261
XA 857	Plate, connection	1	8 pcs.1#	.24	261
XA 858	Bulkhead, lower-side	1	17#	9.90	261
XA 859	Support, angle	1	1#	.70	261
XA 860	Bulkhead, upper	1	32#	15.00	261
XA 861	Support, angle	1	1#	.24	261
XA 862	Nipple, W.I.-1/4" x 1 1/2"	2	22 pcs.1#	.05	
XA 863	Nipple, W.I.-1/4" x 6"	3	5 pcs.1#	.10	
XA 864	Nipple, W.I.-1/4" x 8-1/2"	1	3 pcs.1#	.22	263
XA 865	Bracket, grease pipe	1	10 pcs.1#	.18	263
XA 866	Nipple, W.I.-1/4" x 9"	3	3 pcs.1#	.26	263
XA 867	Nipple, W.I.-1/4" x 5"	2	6 pcs.1#	.08	263
XA 868	Nipple, W.I.-1/4" x 3-1/2"	1	8 pcs.1#	.07	263
XA 869	Support, grease pipe	3	8 pcs.1#	.24	263
XA 870	Pipe, W.I.-1/4" x 25"	2	1#	.55	263
XA 871	Pipe, W.I.-1/4" x 27-1/2"	1	1#	.57	263
XA 872	Pipe, W.I.-1/4" x 15-1/2"	1	2 pcs.1#	.35	263
XA 873	Union, half WE-W48x5	2	20 pcs.1#	.17	263
XA 874	Tubing, flexible grease	2	8 pcs.1#	1.15	263
XA 875	Union, half WE-W48x5A	2	13 pcs.1#	.24	263
XA 876	Nipple, W.I.-1/4" x 3"	4	10 pcs.1#	.06	
XA 877	Elbow, W.I.-1/4" x 45°	2	12 pcs.1#	.14	263
XA 878	Pipe, W.I.-1/4" x 29"	1	1#	.57	263
XA 879	Pipe, W.I.-1/4" x 24"	1	3/4#	.55	263
XA 880	Support, grease pipe	1	1 1/4#	.70	263
XA 881	Pipe, W.I.-1/4" x 13-1/2"	1	2 pcs.1#	.30	263
XA 882	Pipe, W.I.-1/4" x 8"	1	7 pcs.1#	.20	263
XA 883	Nipple, W.I.-1/4" x 10"	1	3 pcs.1#	.28	263
XA 884	Plate, attachment	1	3 pcs.1#	.70	264
XA 885	Screw, drive-#7x1/2" Parker-Kalon	24	16 pcs.1#	.50*	
XA 886	Guard, cable	1	32#	7.50	264
XA 887	Boom, crane inner section	1	780#	270.00	264
XA 888	Sheave, boom suspension with bushing	1	19 1/2#	16.00	265
XA 889	Bushing, bronze	3	1 1/2#	3.50	
XA 890	Dowel, bronze	10	16 pcs.1#	.05	
XA 891	Cotter, 3/8" x 2-1/8"	1	13 pcs.1#	.02	265
XA 892	Pin, housing	1	6 1/2#	1.50	265
XA 893	Pin, lock	2	5 pcs.1#	.30	265
XA 894	Anchor, dead end	1	6#	2.50	265
XA 895	Anchor, dead end	1	6#	2.50	265
XA 896	Pin, sheave	1	4 1/2#	3.00	265
XA 897	Cotter, 3/8" x 3-1/2"	3	10 pcs.1#	.02	
XA 898	Housing, sheave	1	16#	17.50	265
XA 899	Bracket, housing	1	36 1/2#	12.50	265
XA 900	Boom, crane-outer section	1	835#	276.00	265

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 901	Nut, square-3/8" N.C.	8	28 pcs.1#	$ .01	265
XA 902	Bolt, stove-round head 3/8" x 3/4"	8	20 pcs.1#	.03	265
XA 903	Plate, name	2	1#	.90	265
XA 904	Yoke, boom point	1	145#	73.00	265
XA 905	Rivet, button head 5/8" x 1-3/4" (Steel)	18	4 pcs.1#	.02	265
XA 906	Plate, filler	2	3#	.60	265
XA 907	Sheave,point with bushing	2	45#	32.00	266
XA 908	Washer, thrust	2	2 pcs.1#	.17	266
XA 909	Spacer, pipe	2	3/4#	.35	266
XA 910	Sheave, suspension with bushing	2	18 1/2#	12.00	266
XA 911	Spacer, cast iron	2	4 1/4#	1.10	266
XA 912	Bushing, bronze	2	2#	3.00	266
XA 913	Guard, cable-bottom	2	23 1/2#	6.00	266
XA 914	Guard, cable-center	1	7 1/2#	17.00	266
XA 915	Guard, cable-top	1	5#	2.10	266
XA 916	Cotter, 1/2" x 3-1/2"	6	5 pcs.1#	.05	
XA 917	Shaft, boom point sheave	1	31#	7.00	266
XA 918	Washer, thrust	1	1#	2.70	266
XA 919	Sheave, hook block with bushing	1	40#	35.00	268
XA 920	Dowel, bronze-1/4" x 7/8"	1	70 pcs.1#	.02	268
XA 921	Bushing, bronze	1	1 3/4#	3.60	268
XA 922	Washer, thrust	2	1#	.90	268
XA 923	Plate, block	1	65#	35.00	268
XA 924	Plate, cheek	2	145#	27.00	268
XA 925	Spacer, pipe	4	2 pcs.1#	.25	268
XA 926	Bolt, machine-3/4" x 11" N. C.	4	1 1/2#	.20	268
XA 927	Socket, cable wedge	1	8#	4.20	268
XA 928	Cotter, 3/8" x 2-1/4"	2	15 pcs.1#	.02	268
XA 929	Pin, wedge socket	1	2 1/4#	.65	268
XA 930	Screw, cap-flat head 1/2" x 1" N. C.	2	8 pcs.1#	.09	268
XA 931	Washer, 1524-1	2	**	.05	268
XA 932	Plate, lock	1	2 pcs.1#	2.40	268
XA 933	Pin, sheave	1	9#	3.00	268
XA 934	Nipple, W.I.-1/8" x 2"	1	25 pcs.1#	.05	268
XA 935	Plate, block	1	65#	35.00	268
XA 936	Pin, Lock	1	8 pcs.1#	.05	268
XA 937	Nut, slotted	1	4#	2.50	268
XA 938	Bearing, roller RC-CT-19	1	2 1/4#	27.00	268
XA 939	Pin, hook	1	9#	9.50	268
XA 940	Hook, 10 ton - 15 Williams-Vulcan 223B1	1	46#	40.00	268
XA 941	Conduit, 1/2" x 67" long	1	4 1/2#	.50	270
XA 942	Fitting, Kondu-1/2" K-C2	3	1#	.60	
XA 943	Conduit, 1/2" x 7" long	1	2 pcs.1#	.10	270
XA 944	Fitting, Kondu-1/2" K-E2	6	3/4#	.40	

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 945	Receptacle, Kondu-1/2" K-PRS2	3	3 pcs.1#	$ .55	270
XA 946	Bushing, socket-3/8"	3	**	.01	270
XA 947	Cap, socket BR-3981	3	8 pcs.1#	.10	270
XA 948	Body, socket BR-3984	3	5 pcs.1#	.30	270
XA 949	Lamp, 60 watt-110 volt Westinghouse	3	10 pcs.1#	.10	270
XA 950	Fitting, Kondu-1/2" K-T2	4	1#	.75	270
XA 951	Conduit, 1/2" x 38" long 212E367-31	1	2 1/2#	.30	270
XA 952	Wire, R.C #14-90' 0" long	1	1 1/4#	1.80	270
XA 953	Nut, wire	12	112 pcs.1#	.05	
XA 954	Cover, Kondu K-200	4	9 pcs.1#	.07	270
XA 955	Conduit, 1/2" x 73" long	1	4 3/4#	.55	270
XA 956	Strap, pipe-1/2"	2	25 pcs.1#	.01	270
XA 957	Cover, Kondu-1/2" K-210G23	3	8 pcs.1#	.35	270
XA 958	Cord, 16-2 Super Service 7" long	3	10 pcs.1#	.10	270
XA 959	Conduit, 1/2" x 61" long	1	4#	.45	270
XA 960	Fitting, Kondu-1/2" K-LR2	1	1#	.60	270
XA 961	Nut, wire 106	11	48 pcs.1#	.05	
XA 962	Conduit, 1/2" x 26" long	1	1 3/4#	.20	270
XA 963	Fitting, Kondu-1/2" K-A2	2	3/4#	.40	270
XA 964	Gasket, Kondu K-GR2	10	80 pcs.1#	.12	
XA 965	Support, light	1	11 3/4#	1.20	270
XA 966	Brace, support	2	8 pcs.1#	.25	270
XA 967	Bolt, stove-round head 5/16" x 3"	2	13 pcs.1#	.04	270
XA 968	Connector, Greenfield KC12	1	5 pcs.1#	.10	270
XA 969	Conduit,1/2" x 2-1/2"long	2	7 pcs.1#	.05	270
XA 970	Conduit, 1/2" x 50" long	1	3 1/4#	.40	270
XA 971	Plate, switch K-1781B	1	6 pcs.1#	.10	270
XA 972	Conduit, 1/2" x 29" long	1	2#	.20	270
XA 973	Fitting, Kondu-1/2" K-LB2	1	1#	.60	270
XA 974	Conduit, 1/2" x 42" long	1	2 3/4#	.25	270
XA 975	Nipple, special 1/2" x 1-1/4" thread one end	1	5 pcs.1#	.05	270
XA 976	Elbow, Pyle-National PN-FCCF-11-L	1	3/4#	.50	270
XA 977	Conduit, Greenfield-1/2" x 10"	1	2 pcs.1#	.10	270
XA 978	Conduit, 1/2" x 28" long	1	2#	.20	270
XA 979	Cover, Kondu K-21F4	6	6 pcs.1#	.35	
XA 980	Grip, cord-complete PN-DB3	7	6 pcs.1#	.30	
XA 981	Body, cable grip PN-DB-3-A	7	9 pcs.1#	.15	
XA 982	Grommet, rubber PN-DB-4-C	13	**	.08	

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 983	Nut, cable grip PN-DB-4-B	13	32 pcs.1#	$ .15	
XA 984	Support, light	1	4 1/2#	1.85	270
XA 985	Bracket, switch	1	3 pcs.1#	.30	270
XA 986	Fitting, Kondu-1/2" K-FSE12	1	2#	1.00	270
XA 987	Switch, toggle K-1L1311	2	11 pcs.1#	.40	270
XA 988	Receptacle-2 Pole Midget Triploc "Female" PN-RAD-3115221	3	5 pcs.1#	1.50	
XA 989	Contact, female PN-RA215	3	16 pcs.1#	.95	
XA 990	Shell, plug-female PN-RAD15031	3	8 pcs.1#	.85	
XA 991	Cord, 16-2 Super Service 10-1/2" long	1	8 pcs.1#	.10	270
XA 992	Conduit,1/2" x 16'-0"long	1	12 1/2#	1.44	271
XA 993	Wire, #14R.C.-85'-0" long	1	5#	1.70	271
XA 994	Cord, 16-2 Super Service 16" long	1	4 pcs.1#	.10	271
XA 995	Shell,plug-male PN-PA15031	3	5 pcs.1#	.85	
XA 996	Contact, male PN-PA215	3	21 pcs.1#	.95	
XA 997	Plug, male-2 pole PN-Midget Triploc PAD3115221	3	3 pcs.1#	1.50	
XA 998	Conduit,1/2" x 28-1/2"long	1	2#	.20	271
XA 999	Pin, swivel	1	1 1/2#	1.00	271
XA 1000	Bracket, angle	1	5 1/2#	1.70	271
XA 1001	Bracket, angle	1	5 1/2#	1.70	271
XA 1002	Conduit,1/2" x 18'-0" long	1	16#	1.60	271
XA 1003	Cord, 16-2 Super Service 12" long	3	5 pcs.1#	.10	271
XA 1004	Closure, reflector CH-KL5694	2	1 1/4#	2.30	272
XA 1005	Screw, machine-round head #6-32x3/4"	4	**	.01	272
XA 1006	Bolt, carriage-1/4"-20 x 3/4" long	4	35 pcs.1#	.02	272
XA 1007	Washer, lock CH-KL5296	4	48 pcs.1#	.04	272
XA 1008	Support, reflector CH-KL1193	2	2 pcs.1#	.75	272
XA 1009	Lens, reflector CH-HL6814	2	1 1/2#	3.50	272
XA 1010	Reflector, flood light CH-KL5366	2	1 3/4#	8.50	272
XA 1011	Ring, lens clamping with screws CH-KL5675	2	3 pcs.1#	1.50	272
XA 1012	Grommet, rubber CH-HL6537	2	48 pcs.1#	.13	272
XA 1013	Washer, retainer CH-KL5695	2	16 pcs.1#	.35	272
XA 1014	Holder, socket CH-KL5691	2	3 pcs.1#	.75	272
XA 1015	Socket, lamp CH-KL1198	2	4 pcs.1#	.50	272
XA 1016	Lamp, 250 Watt.-110 volts Westinghouse	2	4 pcs.1#	1.15	272
XA 1017	Screw, machine-round head #8-32x1/2"	2	**	.01	272

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 1018	Cord, service CH-KL5700	2	4 pcs.1#	$ 1.00	272
XA 1019	Plug, Benjamin 903	3	12 pcs.1#	.20	
XA 1020	Socket, light	3	1 1/2#	1.05	
XA 1021	Lamp, 100 Watt-110 volts Westinghouse	1	10 pcs.1#	.15	273
XA 1022	Ell, Condulet VEL1190	1	3/4#	.35	273
XA 1023	Nipple, close-1/2" W.I.	2	14 pcs.1#	.05	273
XA 1024	Bolt, stove-flat head 1/4-20x3/4"	4	50 pcs.1#	.02	273
XA 1025	Flange, floor-1/2"	1	2 pcs.1#	.25	273
XA 1026	Reflector, light GO-90228	1	1 3/4#	1.90	273
XA 1027	Cord, Super Service 16-2 x 23" long	1	10 pcs.1#	.10	273
XA 1028	Cord, 16-2 Super Service 24" long	1	3 pcs.1#	.15	274
XA 1029	Screw, machine #4-36x 5/32" Hd. Stl.Rolled thread (Cad.Pct.)	2	**	.02	274
XA 1030	Grip, cord PN-BD945	1	2 pcs.1#	.65	274
XA 1031	Nut, compression PN-DB-9-B	1	4 pcs.1#	.18	274
XA 1032	Grommet, rubber PN-DB-9-D	1	**	.12	274
XA 1033	Elbow, cord grip PN-DB945-A	1	3 pcs.1#	.48	274
XA 1034	Bracket, swivel	1	3 3/4#	1.30	274
XA 1035	Reflector, light- less socket GO-50216	2	4 1/2#	3.05	274
XA 1036	Lamp, 200 Watt-110 volts Westinghouse	2	4 pcs.1#	.27	
XA 1037	Cord, 16-2 Super Service 17" long	1	4 pcs.1#	.10	275
XA 1038	Bracket, reflector	1	8 3/4#	1.25	275
XA 1039	Pliers, 6"	1	2 pcs.1#	.50	276
XA 1040	Wrench, spanner for brakes	1	1 1/2#	.70	276
XA 1041	Wrench, water pump	1	10 pcs.1#	.20	276
XA 1042	Wrench, open end-Bonney 1-1/4" for adjusting clutches ~~1240~~	1	3 pcs.1#	1.65	276
XA 1043	Wrench, adjusting cres-ent 10"	1	1#	1.55	276
XA 1044	Gun, Alemite Grease-13 oz. A-6637	1	3 1/2#	5.75	276
XA 1045	Wrench, double head for 5/8" and 3/4" nuts 37	1	2#	1.75	276
XA 1046	Hose, grease gun-Alemite 15" with coup-ling A-5823	1	3/4#	6.30	276
XA 1047	Wrench, double head for 7/8" and 1" nuts 41	1	4#	4.20	276
XA 1048	Can, oil-1/2 pint	1	3 pcs.1#	.40	276
XA 1049	Wrench, 18" pipe	1	4 1/4#	2.65	276
XA 1050	Grit, Aloxite cloth 2" x 18" #50	1	16 pcs.1#	.10	276
XA 1051	Wrench, monkey-12"	1	2 1/2#	2.55	276
XA 1052	Wrench, box for 5/8" nuts	1	1#	1.20	276

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 1054	Padlock, laminated with chain and keys	3	2 pcs.1#	$ .65	276
XA 1056	Wrench, spark plug with handle	1	2 pcs.1#	.25	276
XA 1057	Crank, starting	1	6#	7.00	276
XA 1058	Wrench, socket for crawler tie bracket bolts	1	3#	1.50	276
XA 1059	Wrench, offset socket for 3/4" nuts	1	2 3/4#	2.10	276
XA 1060	Extinguisher, fire-Pyrene PY-C31-T	1	9 3/4#	11.50	276
XA 1061	Wrench, drum barrel for 3/4" x 7/8" nuts	1	3/4#	1.65	276
XA 1062	Chisel, Doso-3/4" x 9"	1	1#	.75	276
XA 1063	Bolt, stove-round head 3/16" x 1/2"	12	106 pcs.1#	.50*	
XA 1064	Wrench, crawler	1	8 1/2#	4.30	276
XA 1065	Driver, screw	1	2 pcs.1#	.70	276
XA 1066	Link, repair for traction chain	1	3#	1.40	276
XA 1067	Pipe, grease for pilot bearing	1	6 pcs.1#	.31	276
XA 1068	Hammer, ball Peen-2 lbs.	1	2 1/4#	1.20	276
XA 1069	Pin, drift	1	1#	.40	276
XA 1070	Pin, rivet-43/64" long A-51538	1	165 pcs.1#	.02	278
XA 1071	Pin, rivet-21/32" long A-50897	2	192 pcs.1#	.05	278
XA 1072	Spacer, link A-50899	1	**	.03	278
XA 1073	Pin, rivet-17/32" long A-50896	1	**	.05	278
XA 1074	Link, pivot A-50898	2	48 pcs.1#	.10	278
XA 1075	Piston,head- Not sold separately Order XA 1076				
XA 1076	Head, piston and A-G50911	1	3/4#	2.15	278
XA 1077	Plug, adjusting-1/8" A-A-155	1	55 pcs.1#	.02	278
XA 1078	Follower, grease A-G52036	1	20 pcs.1#	.60	278
XA 1079	Nut, hexagon-1/4" x 20 A-40355	1	125 pcs.1#	.05	278
XA 1080	Packing, cord A-52038	1	**	.05	278
XA 1081	Nut, Hexagon A-53735	1	22 pcs.1#	.25	278
XA 1082	Spring, main A-52032	1	4 pcs.1#	.50	278
XA 1083	Lever, hand A-5092	1	3/4#	1.00	278
XA 1084	Sleeve, piston A-51914	1	18 pcs.1#	.10	278
XA 1085	Gasket, cylinder A-50903	1	**	.05	278
XA 1086	Cylinder, grease A-G50888	1	1#	2.00	278
XA 1087	Latch, release A-52031	1	10 pcs.1#	.15	278
XA 1088	Knob, follower A-42221	1	3 pcs.1#	.35	278
XA 1089	Rod, follower A-52037	1	4 pcs.1#	.50	278

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 1090	Spring, follower A-53751	1	45 pcs.1#	$ .10	278
XA 1091	Plug, body A-42023	1	28 pcs.1#	.30	277
XA 1092	Gasket, plug A-G-985	1	**	.05	277
XA 1093	Seal, rubber A-301080	1	**	.25	277
XA 1094	Washer, steel A-301081	1	**	.03	277
XA 1095	Spring, check A-Z715	1	**	.03	277
XA 1096	Adaptor, hose A-301976	1	8 pcs.1#	.30	277
XA 1097	Ball, steel A-C-122	1	**	.05	277
XA 1098	Body, coupling A-42035	1	2 pcs.1#	2.25	277
XA 1099	Hose, grease-18" A-G51410	1	3 pcs.1#	1.60	277
XA 1100	Ring, hose A-43809	1	10 pcs.1#	.10	277
XA 1101	Stud, female A-H-15-100	1	17 pcs.1#	.15	277
XA 1102	Cup, leather A-46118	1	**	.04	277
XA 1103	Body, connection A-H-15-99	1	7 pcs.1#	.25	277
XA 1104	Spring, swivel A-A-618	1	**	.03	277
XA 1105	Washer, steel A-43851	1	**	.02	277
XA 1106	Stem, lock plate PY-6B	1	20 pcs.1#	.09	280
XA 1107	Washer, packing PY-24	2	**	.04	280
XA 1108	Plate, lock PY-6	1	30 pcs.1#	.27	280
XA 1109	Shim, pump PY-20	2	**	.02	280
XA 1110	Sleeve, chamber PY-30A	1	12 pcs.1#	.22	280
XA 1111	Cap, filler PY-4	1	30 pcs.1#	.27	280
XA 1112	Washer, filler cap PY-25	1	**	.05	280
XA 1113	Chamber, upper valve PY-31A	1	6 pcs.1#	.90	280
XA 1114	Sleeve, brass PY-16A	1	20 pcs.1#	.11	280
XA 1115	Cap, top PY-29	1	6 pcs.1#	.36	280
XA 1116	Body, brass PY-35	1	1 1/2#	3.60	280
XA 1117	Ball, valve PY-18 Not sold separately, Order XA 1127 and XA 1113	4			280
XA 1118	Tube, suction PY-33	1	24 pcs.1#	.18	280
XA 1119	Tube, pump PY-41	1	6 pcs.1#	1.10	280
XA 1120	Rod, valve ball PY-17	1	66 pcs.1#	.18	280
XA 1121	Tube, piston valve PY-38A	1	6 pcs.1#	.72	280
XA 1122	Spool, slide valve PY-3A	1	32 pcs.1#	.18	280
XA 1123	Nozzle, tube PY-1	1	34 pcs.1#	.13	280
XA 1124	Packing, slide valve PY-10	1	**	.02	280
XA 1125	Nut, packing PY-9C	1	90 pcs.1#	.09	280
XA 1126	Stop, spool PY-2A Not sold separately, Order XA 1121	1			280
XA 1127	Chamber, lower valve PY-31A	1	6 pcs.1#	.90	280
XA 1128	Bracket, extinguisher PY-B4T	1	1#	1.50	280
XA 1129	Pin, handle PY-46	1	**	.04	280
XA 1130	Handle, operating PY-7F	1	1#	1.35	280
XA 1131	Cap, piston valve tube PY-5	1	83 pcs.1#	.09	280
XA 1132	Spring, washer retainer PY-12	1	**	.04	280

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 1133	Sleeve, sealing plug PY-43C	1	50 pcs.1#	$ .18	280
XA 1134	Spring, handle PY-21	1	140 pcs.1#	.05	280
XA 1135	Retainer, sealing washer PY-13	1	41 pcs.1#	.09	280
XA 1136	Washer, handle sealing PY-28	1	**	.05	280
XA 1137	Tube, nozzle PY-39A	1	17 pcs.1#	.18	280
XA 1138	Cable, boom hoist-6 strand 19 wire improved plow steel-hemp center 1/2" x 300'-0"	1	124#	36.00	282
XA 1139	Wedge, socket	1	2 pcs.1#	.50	282
XA 1140	Pin, wedge	1	3/4#	.35	282
XA 1141	Socket, wedge	1	5#	.60	282
XA 1142	Cable, hoist-6 strand-19 wire, improved plow steel Hemp center 5/8" x 213'-0"	1	135#	44.73	282
XA 1145	Plate, capacity	1	3/4#	2.40	283
XA 1146	Screw, drive -#2x1/4"	8	**	.30*	283
XA 1147	Plate, instruction for lower traction brakes	1	4 pcs.1#	.60	283
XA 1148	Chart, cable length	1			283
XA 1149	Plate, serial	1	2 pcs.1#	.85	283
XA 1150	Rivet, round head 3/16" x 1/4"	4	**	.18*	283
XA 1151	Plate, guarantee	1	5 pcs.1#	.30	283
XA 1152	Bolt, machine-1" x 14" N. C.	8	4#	.41	284
XA 1153	Counterweight, corner	2	250#	25.00	284
XA 1154	Counterweight, center	2	250#	25.00	284
XA 1155	Counterweight, iron ore	1	3000#		284
XA 1156	Bolt, lever PM-F3905	1	2 pcs.1#	.20	285
XA 1157	Cotter, 3/16" x 1-3/4"	2	25 pcs.1#	.30*	285
XA 1158	Nut, slotted-Hex.3/4"-10 N. C.	2	6 pcs.1#	.06	285
XA 1159	Bumper, door PM-F3811	2	3 1/2#	2.55	285
XA 1160	Hinge, dipper PM-B3000-A	2	50#	15.60	285
XA 1161	Pivot, latch lever PM-F3977	1	2 1/2#	6.10	285
XA 1162	Nut, slotted Hex.-1"-8 N. C.	1	3 pcs.1#	.11	285
XA 1163	Plate, door PM-B3068	1	160#	39.50	285
XA 1164	Bolt, lever PM-F3906	1	2 pcs.1#	.20	285
XA 1165	Washer, 3/4" wrought	2	8 pcs.1#	.01	285
XA 1166	Bushing, hinge PM-PC974	2	1 1/2#	1.35	285
XA 1167	Rivet, button head 5/8" x 2-1/4"	28	4 pcs.1#	.02	285
XA 1168	Guide, latch lever PM-F3989	1	5 3/4#	2.55	285
XA 1169	Lever, latch PM-F3990	1	6#	1.20	285
XA 1170	Rivet, button head 5/8" x 2-3/4"	5	3 pcs.1#	.02	285
XA 1171	Guide, rear latch bar PM-F3809A	1	31 1/2#	11.35	285

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 1172	Guide, front latch bar PM-F3808A	1	27 1/2#	$10.35	285
XA 1173	Bar, latch PM-F3889	1	19#	8.00	285
XA 1174	Washer, wrought-1-3/4" PM-F3991	2	2 pcs.1#	.40	286
XA 1175	Bushing, hinge PM-PC973-1	8	1#	1.75	286
XA 1176	Cotter, 1/2" x 2 1/2"	2	6 pcs.1#	.03	286
XA 1177	Pin, hinge PM-PC946-4	2	5#	3.25	286
XA 1178	Cotter, 1/2" x 3"	14	5 pcs.1#	.04	
XA 1179	Pin, stick foot PM-PC918-7	2	8#	2.70	286
XA 1180	Body, dipper PM-AA808	1	600#	353.00	286
XA 1181	Pin, dipper block	2	10 1/2#	2.35	286
XA 1182	Cotter, 5/8" x 3"	2	3 pcs.1#	.06	286
XA 1183	Bushing, dipper block PM-PC973	6	3/4#	1.75	286
XA 1184	Washer, flat-1-3/4" W.I.	6	2 pcs.1#	.30	286
XA 1185	Insert, latchkeeper PM-F3985	1	2 3/4#	1.40	286
XA 1186	Rivet, liverpool-3/4" x 3"	2	2 pcs.1#	.10	286
XA 1187	Front, dipper PM-A793-A	1	496#	145.00	286
XA 1188	Point, dipper PM-730-8M	4	15#	6.50	286
XA 1189	Wedge, point-for driving out socket points PM-F3279	1	4 1/2#	2.20	286
XA 1190	Rivet, liverpool-3/4" x 2-3/4"	8	2 pcs.1#	.10	286
XA 1191	Rivet, liverpool 3/4" x 3-1/4"	24	2 pcs.1#	.10	286
XA 1192	Member, dipper stick side with crowding racks	1	770#	240.00	287
XA 1193	Stop, crowding	2	5#	5.50	287
XA 1194	Member, dipper stick side with crowding racks	1	770#	240.00	287
XA 1195	Spacer, link	2	1 1/2#	1.05	287
XA 1196	Bushing,adjusting link PM	2	1#	1.15	287
XA 1197	Spacer, oak block	1	10#	3.85	287
XA 1198	Bolt, special	8	3 1/4#	.90	287
XA 1199	Rack, crowding-68 teeth	2	98#	57.50	287
XA 1200	Cover, wood filler	1	30 1/2#	4.50	287
XA 1201	Rack, crowding-22 teeth	2	33#	18.00	287
XA 1202	Spacer, pipe	8	1 1/2#	.40	287
XA 1203	Link, adjusting	2	18#	6.00	287
XA 1204	Link, adjusting	2	18#	6.00	287
XA 1205	Shim, filler block	2	5#	.65	287
XA 1206	Spacer, oak block	5	11#	2.50	287
XA 1207	Cover, wood filler	1	31#	4.50	287
XA 1208	Angle, support	2	2#	1.25	287
XA 1209	Bushing, stick foot PM-2093	2	1/2#	1.15	287
XA 1210	Plate, attachment	1	3 pcs.1#	.75	287
XA 1211	Nut, hexagon-7/16" N.C.	4	20 pcs.1#	.01	288
XA 1212	Washer, thrust	4	1 1/4#	2.10	288
XA 1213	Nut, slotted	2	3/4#	1.80	288
XA 1214	Washer, flat	2	1 1/2#	4.80	288

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 1215	Bushing, saddle block	4	2 3/4#	$2.75	288
XA 1216	Spacer, saddle block	2	7#	12.50	288
XA 1217	Rod, lock	2	2 pcs.1#	.60	288
XA 1218	Nut, Hex. Half-1-1/8" N. C.	4	3 pcs.1#	.15	288
XA 1219	Nut, Hex.-1-1/8" N.C.	4	3/4#	.12	288
XA 1220	Block, saddle with bushing	2	98#	60.00	288
XA 1221	Nut, square	4	2 pcs.1#	.25	288
XA 1222	Bolt, gib adjusting	4	1 3/4#	1.30	288
XA 1223	Sprocket, chain	1	43#	27.00	288
XA 1224	Bolt, lock	2	5 pcs.1#	.45	288
XA 1225	Bushing, flanged	2	22#	18.50	288
XA 1226	Shim, bushing	2	3 pcs.1#	.50	288
XA 1227	Pinion, crowd	2	55#	42.00	288
XA 1228	Gib, saddle block	2	41#	8.50	288
XA 1229	Key, straight	2	3/4#	.60	288
XA 1230	Shaft, shipper with nuts	1	78#	110.00	288
XA 1231	Pin, lock	1	16 pcs.1#	.24	288
XA 1232	Pin, sheave	1	1#	1.15	288
XA 1233	Pin, sheave	1	1#	1.80	288
XA 1234	Shaft, boom point	1	70 1/2#	11.00	290
XA 1235	Bolt, machine 5/8" x 5-1/2" N. C.	2	2 pcs.1#	.10	290
XA 1236	Guard, sheave	2	10#	8.50	290
XA 1237	Wedge, socket	2	1#	.70	
XA 1238	Bushing, bronze	1	3 1/4#	2.70	290
XA 1239	Sheave, boom point with bushing	1	93#	46.00	290
XA 1240	Sheave, dummy	1	94#	36.00	290
XA 1241	Bushing, sheave pin	2	5 1/2#	7.50	292
XA 1242	Washer, thrust	2	1#	1.20	292
XA 1243	Sheave, padlock block	1	44#	26.50	292
XA 1244	Bolt, machine 7/8" x 6 1/2" N. C.	2	1 1/2#	.22	292
XA 1245	Bolt, machine 7/8" x 7 1/2" N. C.	2	1 3/4#	.24	292
XA 1246	Washer, bevel	2	3 pcs.1#	.50	292
XA 1247	Block, padlock	1	114#	30.00	292
XA 1248	Washer, flat	3	15 pcs.1#	.04	292
XA 1249	Pin, anchor	1	2 pcs.1#	.65	292
XA 1250	Cotter, 1/4" x 1-1/4"	1	55 pcs.1#	.60*	292
XA 1251	Key, lock	1	8 pcs.1#	.30	292
XA 1252	Pin, sheave	1	11 3/4#	3.90	292
XA 1253	Bushing, Mang. steel	4	1 3/4#	1.80	292
XA 1254	Assembly, padlock block	1	200#	96.00	292
XA 1255	Plate, lock	2	5 pcs.1#	.20	293
XA 1256	Screw, cap-3/4" x 1-1/2" N. C.	4	2 pcs.1#	.10	293
XA 1257	Guide, tension bolt	2	2 3/4#	4.00	293
XA 1258	Block, bearing	2	17#	13.50	293
XA 1259	Sprocket, idler with bushing	2	48 1/2#	21.50	293
XA 1260	Bolt, tension	2	5 1/2#	1.80	293
XA 1261	Bolt, anchor	1	2#	.60	293
XA 1262	Shaft, idler sprocket	2	22#	4.50	293

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 1263	Rivet, flat head #250 x 1/2" brass	4	120 pcs.1#	$ .01	293
XA 1264	Guide, chain	1	3/4#	.70	293
XA 1265	Roller, chain link JE-1641AA	2	4 pcs.1#	.25	293
XA 1266	Pin, link with lock pin JE-1641AA	2	3 pcs.1#	.35	
XA 1267	Link, repair with side bars, rollers, link and lock pins JE-1641AA	1	1 3/4#	1.20	293
XA 1268	Bolt, carriage 5/8" x 2-1/2"	1	3 pcs.1#	.08	293
XA 1269	Nut, Hexagon half-1" N. C.	3	4 pcs.1#	.09	
XA 1270	Chain, crowd-144 links Jeffery steel thimble JE-1641AA	1	255#	172.80	293
XA 1271	Bolt, carriage-5/8" x 1-3/4"	2	3 pcs.1#	.08	293
XA 1272	Plate, lock	1	3/4#	.95	293
XA 1273	Guide, chain	1	10#	3.20	293
XA 1274	Cover, inspection	1	9 1/2#	2.20	293
XA 1275	Plate, guide	2	4 3/4#	1.75	293
XA 1276	Casting, foot	2	580#	250.00	
XA 1277	Plate, instruction	1	5 pcs.1#	.50	293
XA 1278	Screw, cap-Hex. Head Parker-Kalon self threaded 3/8" dia. x 3/4"	20	20 pcs.1#	.02	
XA 1279	Plate, name	4	2#	1.50	
XA 1280	Boom, shovel	1	2565#	780.00	293
XA 1281	Plate, serial number	1	3 pcs.1#	.80	293
XA 1282	Bumper, oak	1	15#	2.70	293
XA 1283	Support, bumper	1	35#	6.60	293
XA 1284	Bolt, machine 3/4" x 7-1/2" N. C.	2	1 1/4#	.16	293
XA 1285	Plunger, dipper trip	1	6 1/4#	5.40	294
XA 1286	Bolt, blank	1	6 pcs.1#	.14	294
XA 1287	Rod, plunger	1	6 1/2#	1.35	294
XA 1288	Stop, spring	1	3/4#	.18	294
XA 1289	Spring, plunger	1	1 1/4#	.90	294
XA 1290	Wedge, socket	2	6 pcs.1#	.35	
XA 1291	Socket, wedge	1	1#	.85	294
XA 1292	Washer, flat	1	60 pcs.1#	.04	294
XA 1293	Link, special	4	18 pcs.1#	.75	294
XA 1294	Nut, Hex. Half-1-1/4" N. C.	2	2 pcs.1#	.21	294
XA 1295	Chain, trip	1	4 1/2#	4.00	294
XA 1296	Pin, shackle	1	3 pcs.1#	.35	294
XA 1297	Shackle, chain	1	1#	.95	294
XA 1298	Spacer, bearing	1	3/4#	1.70	295
XA 1299	Bearing, ball-N.D. ND-1209	1	1#	4.70	295
XA 1300	Guard, cable	1	4#	3.90	295
XA 1301	Link, clutch band-live end	1	2 1/4#	.70	295

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 1302	Link,clutch band-dead end	1	8 pcs.1#	$ .40	295
XA 1303	Pin, one hole	1	16 pcs.1#	.24	295
XA 1304	Pin, one hole	2	16 pcs.1#	.25	295
XA 1305	Cotter, 1/8" x 3/4"	4	**	.10*	
XA 1306	Bearing, ball-N.D. N.D.-7209	2	1#	4.75	
XA 1307	Drum, clutch and winding	1	46#	24.00	295
XA 1308	Spring, tension	1	1 1/4#	.60	295
XA 1309	Pin, one hole	1	16 pcs.1#	.24	295
XA 1310	Cotter, 1/8" x 1-3/4"	1	**	.15*	295
XA 1311	Lining, clutch-J.M.200	1	3/4#	1.30	295
XA 1312	Rivet, brass-3/16" x 3/8"	14	**	.01	295
XA 1313	Band, friction with lining	1	3#	9.90	295
XA 1314	Cotter, 1/8" x 1-1/2"	2	**	.10*	
XA 1315	Lever, operating	1	3/4#	3.30	295
XA 1316	Screw, cap-Hex. head 1/2" x 1-1/2" N. C.	1	8 pcs.1#	.04	295
XA 1317	Pin, lift	1	40 pcs.1#	.80	295
XA 1318	Bushing, bronze	1	40 pcs.1#	.65	295
XA 1319	Pin, one hole	1	8 pcs.1#	.70	295
XA 1320	Spider, clutch with bushing	1	6 1/2#	16.00	295
XA 1321	Screw, drive-#7x1/4"	4	**	.50*	296
XA 1322	Plate, patent	1	16 pcs.1#	.75	296
XA 1323	Nut, castle-7/8" N.F.	1	2 pcs.1#	.08	296
XA 1324	Retainer, bearing	1	2 1/4#	5.00	296
XA 1325	Washer, flat-7/8"	2	8 pcs.1#	.02	296
XA 1326	Cover, gear case	1	62#	48.00	296
XA 1327	Bearing, ball-N.D. ND-7207	1	3/4#	2.60	296
XA 1328	Spacer, bearing	1	3 pcs.1#	1.10	296
XA 1329	Gear, drive	1	25#	22.00	296
XA 1330	Shaft, shifter	1	4#	2.25	296
XA 1331	Spacer, bearing	1	1#	1.70	296
XA 1332	Spacer, bearing	1	4 pcs.1#	1.70	296
XA 1333	Pin, one hole	1	1#	.60	296
XA 1334	Ring, shifter	1	1#	3.00	296
XA 1335	Spring, tagline	1	3/4#	1.10	296
XA 1336	Lever, hand	1	1 1/4#	2.70	296
XA 1337	Screw, cap-Hex. head 1/2" x 2" N. C.	1	6 pcs.1#	.05	296
XA 1338	Crank, shifting	1	1 3/4#	4.20	296
XA 1339	Bolt, special	1	4 pcs.1#	.24	296
XA 1340	Crank, adjusting yoke	1	3#	6.00	296
XA 1341	Pin, plunger	1	1#	4.80	296
XA 1342	Shaft, dipper trip	1	8 1/4#	18.75	296
XA 1343	Key, straight	1	4 pcs.1#	.24	296
XA 1344	Ring, shifter	1	2 pcs.1#	.95	296
XA 1345	Sheave, cable with bushing	1	1#	4.80	296
XA 1346	Bushing, bronze	1	12 pcs.1#	2.20	296
XA 1347	Bolt, shoulder	1	2 pcs.1#	.90	296
XA 1348	Bracket, sheave	1	4 1/2#	1.50	296
XA 1349	Cable, operating	1	1 3/4#	6.30	296
XA 1350	Drum, hoist	1	230#	78.00	298

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 1351	Bolt, machine-3/4" x 5-1/2" N. C.	4	3/4#	$ .14	298
XA 1352	Sprocket, drive	1	224#	67.00	298
XA 1353	Bolt, stove-round head 5/16" x 5/8" long	6	30 pcs.1#	.02	300
XA 1354	Bracket, pan	1	1/2#	.50	300
XA 1355	Pan, drip	1	3 1/2#	1.00	300
XA 1356	Bracket, pan	1	1/2#	.50	300
XA 1357	Chain, reverse-39 links Jeffery Steel Thimble JE-1641AA	1	65#	46.80	300
XA 1358	Socket, wedge	1	8 1/2#	4.20	301
XA 1359	Cable, boom hoist - 6 strand, 19 wire, improved Plow Steel-Hemp Center Brown Strand 5/8" x 120'-0"	1	77#	25.20	301
XA 1360	Cable, dipper trip - 6 strand, 19 wire-Hemp Center-Plow Steel 5/16" x 33'-0"	1	6#	2.64	301
XA 1361	Cable, hoist- 6 Strand, 19 wire, improved Plow Steel-Hemp Center-Brown Strand 5/8" x 65'-0"	1	42#	13.65	301
XA 1362	Sheave, cable with bushing	3	89#	52.00	
XA 1363	Guard, sheave	1	4#	2.45	302
XA 1364	Bushing, bronze	3	4#	6.80	
XA 1365	Casting, dead end	1	11 1/4#	7.25	302
XA 1366	Shaft, suspension	1	70#	11.00	302
XA 1367	Bolt, machine-5/8" x 5-3/4" N. C.	2	2 pcs.1#	.10	302
XA 1368	Collar, set	2	3 1/2#	2.75	302
XA 1369	Shim $6\frac{1}{2}$" x $\frac{1}{4}$" x 7"	1	2 1/2#	.55	302
XA 1369A	Shim $6\frac{1}{2}$" x #10 x 7"	1	1 3/4#	.50	302
XA 1369B	Shim $6\frac{1}{2}$" x #14 x 7"	2	1#	.45	302
XA 1370	Bolt, S.A.E.	4	2 pcs.1#	1.55	302
XA 1371	Washer, bevel - 3/4"	4	6 pcs.1#	.06	
XA 1372	Adaptor, boom foot	1	575#	190.00	302
XA 1373	Pin, foot	2	7#	1.80	302
XA 1374	Bolt, thru	4	3 1/2#	.60	302
XA 1375	Bolt, thru	4	3 3/4#	.60	302
XA 1376	Frame, jib	1	510#	246.00	302
XA 1377	Box, Torsion	1	440#	150.00	302
XA 1378	Plate, attachment	1	3 pcs.1#	.85	302
XA 1379	Bolt, machine-5/8" x 4-3/4" N. C.	2	2 pcs.1#	.09	302
XA 1380	Pin, boom pivot	2	20#	6.00	302
XA 1381	Bolt, thru	4	3 1/2#	.60	302
XA 1382	Cotter, 5/16" x 2-3/4"	2	18 pcs.1#	.01	302
XA 1383	Pin, wedge socket	1	2#	1.10	302
XA 1384	Bushing, Manganese	1	2 pcs.1#	1.20	302
XA 1385	Socket, wedge	1	11#	6.00	302
XA 1386	Guard, sheave	1	4#	5.10	302

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 1387	Boom, pull shovel with Torsion box	1	2700#	680.00	302
XA 1388	Bushing, bronze	2	1#	3.10	302
XA 1389	Drum, idler with bushings	1	90#	45.00	302
XA 1390	Shaft, idler drum	1	15 3/4#	4.60	302
XA 1391	Collar, set	2	1 1/2#	3.25	302
XA 1392	Bolt, machine-1/2" x 3-3/4" N. C.	1	4 pcs.1#	.06	302
XA 1393	Key, straight	1	3/4#	.30	302
XA 1394	Cotter, 5/8" x 5"	3	2 pcs.1#	.14	
XA 1395	Cotter, 5/8" x 4"	3	2 pcs.1#	.10	
XA 1396	Shaft, idler	1	33#	6.25	302
XA 1397	Screw, set - square head cup point 5/8" x $1\frac{1}{4}$" N. C.	2	4 pcs.1#	.06	302
XA 1398	Sleeve, tube	1	17 1/2#	21.00	302
XA 1399	Roller, cable deflector	1	21 1/4#	5.70	302
XA 1400	Washer, thrust	2	1 3/4#	3.95	302
XA 1401	Shaft, boom point	1	47#	26.50	302
XA 1402	Plate, lock	2	1 1/4#	.65	302
XA 1403	Nut, half-Hex. 3" x 8 N. F.	2	5 3/4#	3.00	302
XA 1404	Link, dipper	1	102#	70.00	303
XA 1405	Pin, link	1	14 1/4#	4.50	303
XA 1406	Housing, sheave	1	19#	15.00	303
XA 1407	Dowel, brass-3/8" x 1-1/8"	2	25 pcs.1#	.05	303
XA 1408	Pin, adjusting link	2	10 1/4#	3.00	303
XA 1409	Arm, dipper	1	720#	275.00	303
XA 1410	Pin, dipper arm	1	21#	4.50	303
XA 1411	Bushing, bronze	2	2 3/4#	3.60	303
XA 1412	Bumper, wood	1	4#	2.25	303
XA 1413	Bolt, carriage-5/8" x 3-1/2"	2	2 pcs.1#	.09	303
XA 1414	Bushing, bronze	2	5 3/4#	11.00	303
XA 1415	Dowel, brass	2	18 pcs.1#	.04	303
XA 1416	Support, "A" Frame yoke	1	8 1/2#	4.30	303
XA 1417	Plate, wearing	1	48#	15.00	303
XA 1418	Spacer, pipe	1	4 3/4#	1.00	303
XA 1419	Link, adjusting dipper	1	112#	33.00	303
XA 1420	Bracket, dipper arm	1	84#	43.00	303
XA 1421	Bar, reinforcement	2	14 1/4#	1.15	303
XA 1422	Bolt, carriage-5/8" x 4-1/2"	2	2 pcs.1#	.09	303
XA 1423	Block, bumper	1	4 1/2#	2.30	303
XA 1424	Bracket, dipper arm	1	84 1/2#	43.00	303
XA 1425	Pin, dipper hinge	2	4 3/4#	1.50	303
XA 1426	Bolt, machine-1" x 12"	5	3 1/2#	.40	303
XA 1427	Bracket, scraper	1	5 1/2#	3.45	303
XA 1428	Scraper, sheave	1	3/4#	4.35	303
XA 1429	Screw, cap-flat head 1" x 3-1/2" N.C.	12	1#	.90	303
XA 1430	Dipper, 31" wide	1	1385#	550.00	303
XA 1431	Cutter, side	1	78#	41.00	303
XA 1432	Rivet, countersunk head 5/8" x 3-1/2"	3	3 pcs.1#	.03	303

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 1433	Rivet, countersunk head 5/8" x 4"	3	3 pcs.1#	.03	303
XA 1434	Rivet, countersunk head 5/8" x 5-1/4"	3	2 pcs.1#	.05	303
XA 1435	Rivet, countersunk head 5/8" x 6-3/4"	6	3/4#	.08	303
XA 1436	Base, tooth	3	108#	36.50	303
XA 1437	Pin, tooth point	3	1#	.65	303
XA 1438	Point, tooth	3	17 1/2#	4.15	303
XA 1439	Cutter, side	1	78#	41.00	303
XA 1440	Plate, wearing	1	23#	11.00	303
XA 1441	Bushing, bronze	2	1 1/2#	3.50	303
XA 1442	Block, sheave	1	56 1/2#	70.00	303
XA 1443	Cotter, 1/2" x 4"	4	4 pcs.1#	.02	303
XA 1444	Pin, anchor	1	14 1/4#	3.25	303
XA 1445	Sheave, equalizer with bushing	1	48 1/2#	35.00	303
XA 1446	Bushing, bronze	1	2#	8.50	.303
XA 1447	Pin, sheave	1	7#	2.25	303
XA 1448	Cable, Jib Frame Hoist 6 strand, 19 wire Plow Steel, Hemp Center 1/2" x 80'-0"	1	33#	9.60	306
XA 1449	Cable, boom hoist- 6 strand, 19 Wire, Flexible Seal Construction Langlay with Independent Wire Rope Center 5/8"x75'-0"	1	47#	17.25	306
XA 1450	Clamp, cable CR- 5/8"	6	1 1/4#	.58	
XA 1451	Cable, Shovel Digging 6 strand, 19 wire, Flexible Seal Construction Langlay with Independent Wire Rope Center 3/4" x 60'-0"	1	64#	22.80	306
XA 1452	Drum, cable dragline and digging cable for pull shovel	1	238#	96.00	304
XA 1453	Spring, operating RU-Y38	1	54#	25.00	310
XA 1454	Tube, operating RU-Y36	1	17#	4.50	310
XA 1455	Bushing, tube RU-Y28	1	3#	3.50	310
XA 1456	Shaft, coupling RU-Y35	1	9#	5.00	310
XA 1457	Bolt, machine 5/8" x 9-1/2" N. C.	2	1#	.13	310
XA 1458	Bearing, wheel RU-Y27	1	18#	15.00	310
XA 1459	Cable, tagline- 6 strand, 19 wire, Improved Plow Cable-Hemp Center- 3/8" x 60'-0"	1	13#	6.00	310
XA 1460	Wheel, cable RU-Y26	1	31#	25.00	310
XA 1461	Plate, safety RU-Y34	1	12 pcs.1#	1.00	310
XA 1462	Propellor, tagline RU-Y29	1	3 1/2#	3.50	310
XA 1463	Bolt, "U" 5/8" x 30" long	1	2 1/2#	4.50	310
XA 1464	Plug, pipe 2"	1	1#	.18	310

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 1465	Plate, end RU-Y24	1	3#	$6.00	310
XA 1466	Housing , tagline RU-Y39	1	54#	15.00	310
XA 1467	Frame, Fairlead RU-Y30	1	13#	3.00	310
XA 1468	Pin, sheave RU-Y33	2	4 pcs.1#	1.00	310
XA 1469	Sheave, Fairlead RU-Y31	2	5#	4.00	310
XA 1470	Hook, Grab - 3/8"	1	3/4#	.25	310
XA 1471	Chain, tagline	1	10 3/4#	4.75	310
XA 1472	Cable, closing- 6 strand 19 wire, Improved Plow Steel Hemp Center 5/8" x 130'-0"	1	82#	27.30	312
XA 1473	Cable, holding- 6 strand 19 wire, Improved Plow Steel Hemp Center 5/8"x101'-0"	1	64#	21.21	312
XA 1474	Plug, pipe	1	2 pcs.1#	3.25	308
XA 1475	Screw, cap-Hex. Head 7/8" x 2-3/4" N.F.	4	1#	.18	308
XA 1476	Screw, cap-Hex. Head 7/8" x 2-1/4" N.F.	4	1#	.16	308
XA 1477	Key, Woodruff 21	2	20 pcs.1#	.04	308
XA 1478	Shaft, sheave	2	6#	2.00	308
XA 1479	Bushing, flanged	4	3 1/2#	6.60	308
XA 1480	Bearing, Fairlead	1	115#	90.00	308
XA 1481	Roller, bearing	31	4 pcs.1#	.12	308
XA 1482	Ball, New Departure-1"	22	6 pcs.1#	.25	308
XA 1483	Cap, Fairlead Frame	2	3 3/4#	2.30	308
XA 1484	Screw, cap-Hex.Head 5/8" x 2-3/4" N.C.	4	3 pcs.1#	.09	308
XA 1485	Sheave, Fairlead	2	25#	24.00	308
XA 1486	Frame, Fairlead	1	225#	118.00	308
XA 1487	Stud, grease	2	5 pcs.1#	.70	308
XA 1488	Plate, lock	2	18 pcs.1#	.24	308
XA 1489	Plate, lock	2	1#	.30	308
XA 1490	Shim .015x1-11/32" O.D.	14	192 pcs.1#	.02	308
XA 1490A	Shim .025x1-11/32" O.D.	2	118 pcs.1#	.02	308
XA 1491	Bushing, roller	2	1#	1.10	308
XA 1492	Seal, T-50000	4	8 pcs.1#	.18	308
XA 1493	Bearing,roller T-14137-14274	4	3/4#	2.15	308
XA 1494	Retainer, bearing T-49574	4	4 pcs.1#	.12	308
XA 1495	Shaft, roller	2	11#	8.60	308
XA 1496	Tube, roller	2	21#	12.50	308
XA 1497	Cable, drag - 6 strand, 19 wire, Flexible Seal Construction Langlay with Independent Wire Rope Center 3/4" x 54'-0"	1	57#	14.04	307

* Price Per 100 Pcs.
** Over 200 Pcs. Per Lb.

ENGINE SECTION

OPERATORS' MANUAL

BUDA

Model K428

Engine

for use in

KOEHRING COMPANY

Model 304 Crane

Engine built by

The BUDA Co.

Harvey, Illinois

INDEX

OPERATOR'S MANUAL

Buda Model K-428 Engine

CONTENTS

CONTENTS-continued

SPECIFICATIONS OF BUDA MODEL K-428 ENGINE FOR KOEHRING COMPANY MODEL #304 CRANE

Engine Model - Buda K-428

Type - Vertical en-bloc "L" head, four cycle, six cylinder, Water cooled.

Power - 70 HP at 1350 RPM, laboratory test

Bore and Stroke - Bore, 4 3/8 inches; Stroke, 4 3/4 inches

Piston Displacement - 428 cubic inches

Rotation - Clockwise, viewing it from front or fan end of engine

CAPACITIES

Crankcase Oil Capacity...........9 quarts

Cooling System Capacity..........8 1/2 gallons

Air Cleaner Oil Capacity.........1 quart

ACCESSORIES

Description	Buda Part No.	Manufacturer	Manufacturer's Model No.
1. Air Cleaner		Donaldson, Inc; St. Paul, Minn.	E 7764
2. Battery		Globe Battery Co. Milwaukee Wis.	Z 89
3. Carburetor	K40487	Zenith Carburetor Div. Detroit, Mich.	#456
4. Clutch		Twin Disc Clutch Co. Racine, Wis.	X7350A-Mod. B111P2 Spec. 17732

ACCESSORIES (Cont.)

Description	Buda Part No.	Manufacturer	Manufacturer's Model No.
5. Fuel Pump	2903	A.C.Spark Plug Div. General Motors. Detroit, Mich.	A.C.855758
6. Generator	K40506	Elec. Auto-Lite Co. Toledo, Ohio	GFA-4810
7. Governor	K40504	Pierce Governor Co. Anderson, Indiana	A 1729 F-13
8. Magneto	H11848	American Bosch Corp. Springfield, Mass.	MJC-6C
9. Magneto Switch	AP5893	American Bosch Corp. Springfield, Mass.	81663-14
10. Starter Motor	K40505	Elec.Auto-Lite Co. Toledo, Ohio	ML-4186
11. Push Button Starter switch	2715	Delco-Remy Co. Anderson, Ind.	406 A
12. Spark Plugs	H11629	A.C.Spark Plug Div. Flint, Mich.	87-S
13. Oil Filter	H11677	The DeLuxe Products Corp. La Porte, Ind.	CSB-41-602M
14. Ammeter	AP 6592	United States Gauge Co. New York City	
15. Oil Pressure Gauge	AP3883	United States Gauge Co. New York City	444050
16. Magnetic Starting Switch		Delco-Remy Co. Anderson, Ind.	SS-4007
17. Radiator		Perfex Corporation Milwaukee, Wis.	R-2018-G

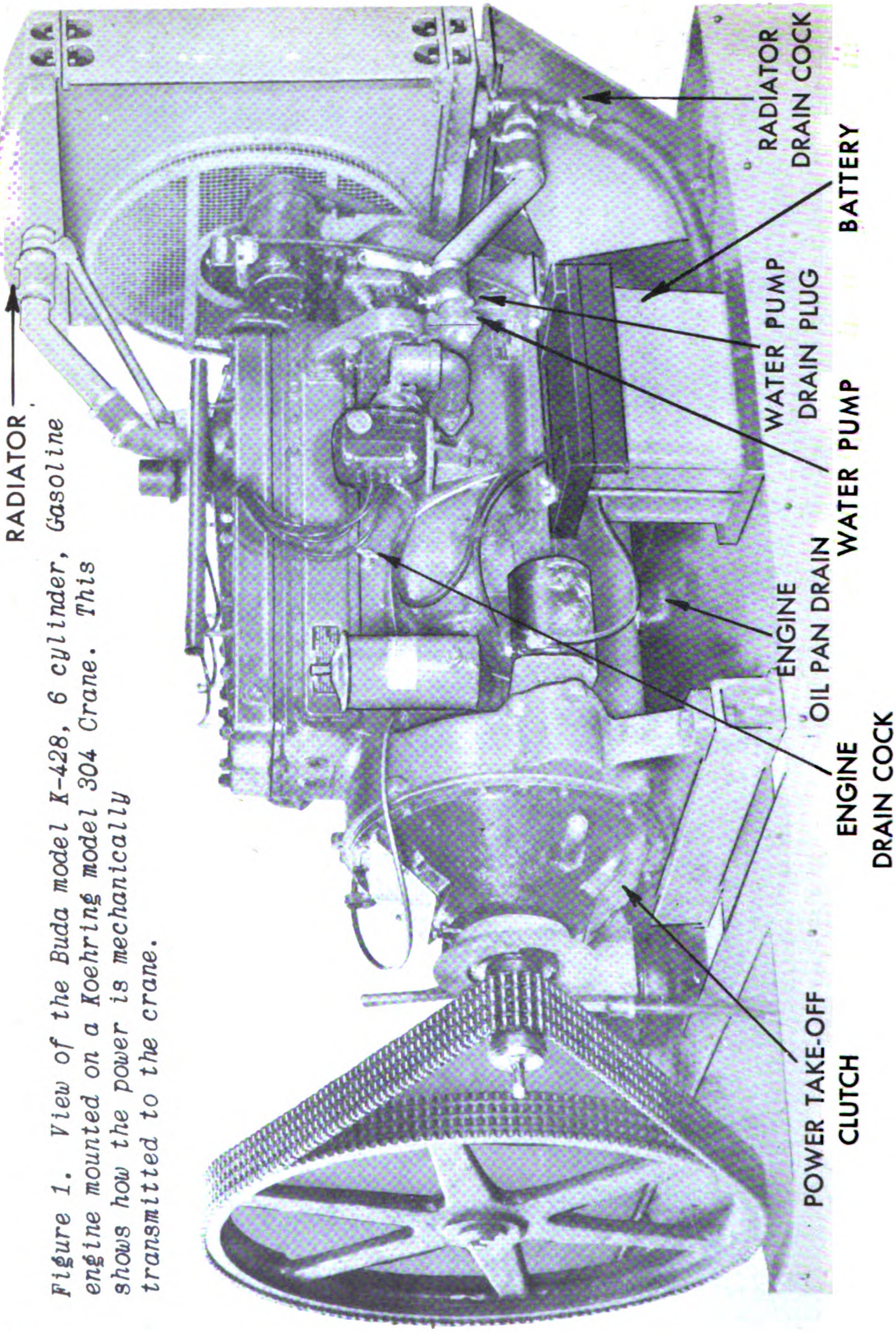


Figure 1. View of the Buda model K-428, 6 cylinder, Gasoline engine mounted on a Koehring model 304 Crane. This shows how the power is mechanically transmitted to the crane.

Chapter I

GENERAL DATA

1. GENERAL DESCRIPTION

This Buda, Model K-428, Gasoline engine is of the well-known Buda-Hivelo series - high velocity lubrication and cooling systems, and is a heavy duty engine, designed especially for heavy duty jobs. With reasonable care, no matter how tough the going, this Buda engine not only can "take it," but it can deliver the power as well.

The engine is of four stroke cycle design, right hand rotation (viewing the fan end) (see Figure 2) and the firing order, as given on the valve instruction plate fastened to the side of the cylinder head, is 1-5-3-6-2-4.

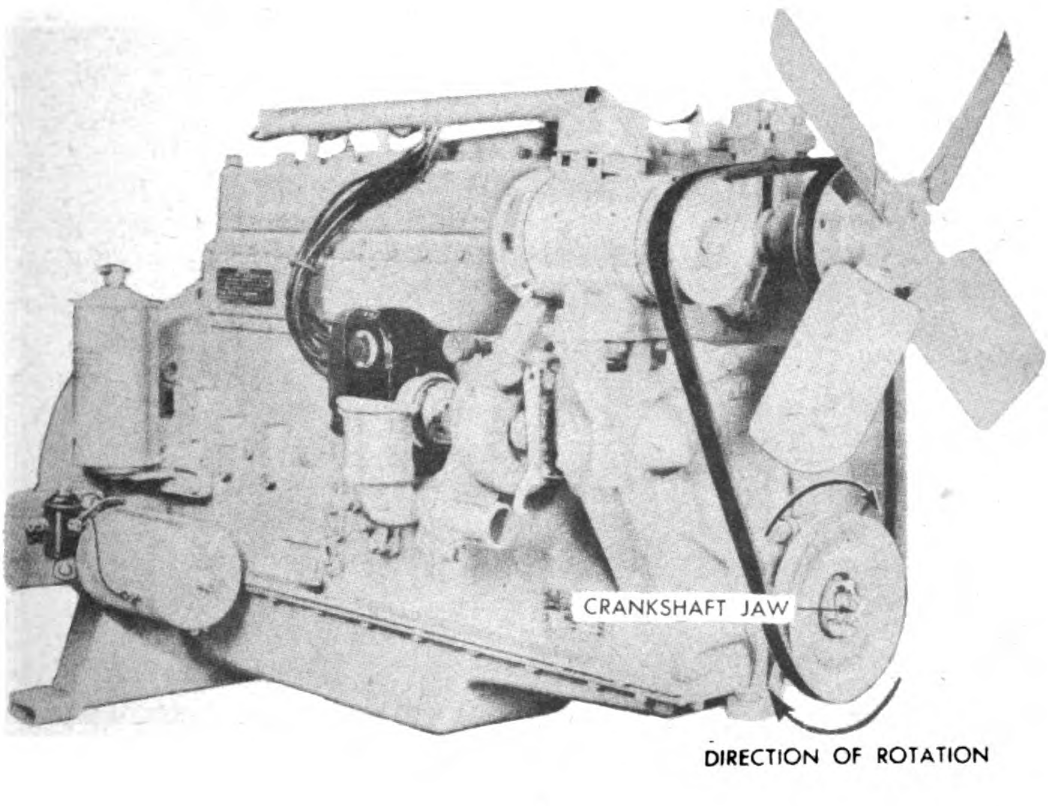


Figure 2. Right side of engine showing direction of rotation.

2. PRINCIPLE OF OPERATION

Within each cylinder of the engine is a piston which has an upward and downward movement. This movement is controlled by a crankshaft to which each of the six pistons is attached by means of a connecting rod and piston pin.

The full movement of a piston in either direction is called a stroke. There are two strokes of the piston to each full revolution of the crankshaft.

By "one cycle of the engine" is meant the complete cycle or circle of operations which takes place in the engine from the time the charge of gas is first drawn into the cyclinder until it is again time for a new charge to be drawn in.

In the four-stroke cycle engine four strokes, or two complete revolutions of the crankshaft, are required for one complete cycle of operation, i.e., one down stroke, one up stroke; one down stroke, one up stroke. It will be seen that in any engine two strokes of the piston (one down stroke and one up stroke) are required for one revolution of the shaft. These four strokes are named in the order in which they always appear, namely; (a) Suction Stroke, down, (b) Compression Stroke, up, (c) Firing or Power Stroke, down, and (d) Exhaust Stroke, up.

There are two valves to each cylinder, the intake valve and the exhaust valve, for the purpose of opening and closing passages between the intake and exhaust manifolds and cylinders. The valves are made to open by the action of cams upon a camshaft located within the crankcase, and driven at half crankshaft speed, through gears, by the crankshaft. They are closed by springs.

If the crankshaft of the engine is revolved until the first explosion occurs, the following action takes place within the cylinder: (The following is illustrated in Figure 3.)

Upon the Suction Stroke (3a) of the piston, the intake valve is mechanically opened, and as the piston moves downward gas is drawn from the carburetor (by the partial vacuum created) into the increasing space between the top of the piston and the head of the cylinder. (The exhaust valve is closed at this time.)

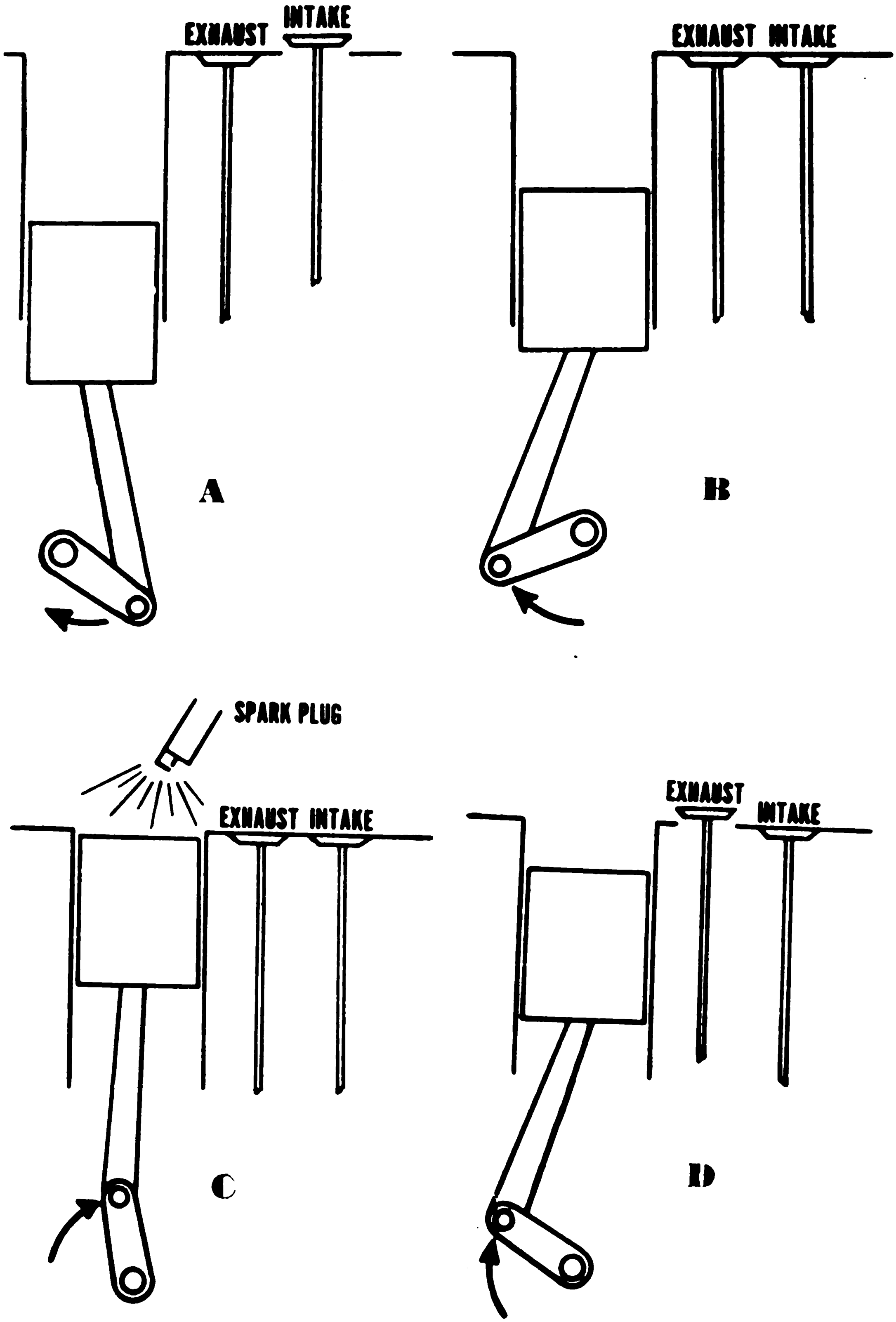


Figure 3. (3a) Suction stroke. (3b) Compression stroke. (3c) Firing or power stroke. (3d) Exhaust stroke.

At the end of this stroke, the piston starts upward (3b Compression Stroke), both valves are made to close and the gas is compressed into a small space, making it highly explosive.

When the end of the stroke is reached, and just before the piston starts downward again, the compressed charge is ignited by means of an electric spark which takes place between the points of a spark plug screwed into the top of the cylinder head.

The ignition of the gas causes an expansion or explosion which drives the piston rapidly downward (3c Firing or Power Stroke), at the same time imparting movement to the other five pistons which are attached to the main crankshaft. Both valves remain closed during this stroke.

In the next stroke, which is upward (3d Exhaust Stroke), the exhaust valve is opened to allow the burnt gas to be forced out by the piston through exhaust manifold and muffler into the open air. The intake valve remains closed during this stroke.

These strokes follow each other in the manner described as long as the engine is in operation and exactly the same series of actions occur in all six cylinders, although no like strokes are taking place at the same time in any of the cylinders.

In this way, the explosions are so divided that there are three power impulses to each revolution of the crankshaft. The explosions always occur within the cylinders in this order: No. 1, No. 5, No. 3, No. 6, No. 2, No. 4. This is termed the firing order of the engine. No. 1 cylinder is the one nearest the fan.

3. MAJOR COMPONENTS OF THE ENGINE

In an internal combustion engine there are certain component functions that are necessary to keep the engine running properly.

The engine must not be allowed to overheat, hence, there must be a cooling system. There must be a continuous flow of fuel, (fuel system), electrical energy (electrical system), and lubrication (lubricating system). Also, a method of timing must be provided so that all necessary action will take place at the right instant, (timing system).

4. TIMING SYSTEM

Timing is obtained by so setting the camshaft gear with the crankshaft to whieh the pistons are attached, that the camshaft opens and closes the valves for each cylinder in their firing order, so that each step necessary in a four-stroke cycle engine can be performed at the right time.

5. ELECTRICAL SYSTEM

The same is true of the timing of the ignition that it, too, will perform its function at the proper instant. Whether the electrical energy for the spark comes from a magneto or from a storage battery, a distributor must so time the spark that it will occur at the right position of the piston to produce the power stroke.

The distributor, or the magneto which also acts as the distributor, is geared in time with the crankshaft. The distributor shaft, whether of the battery type or magneto, turns at 1/2 crankshaft speed, as it takes two complete revolutions of the crankshaft to fire all six cylinders. The armature or rotating magnet, turns at 1-1/2 crankshaft speed because the armature has a two lobe cam for opening the interrupter points. Therefore, to get six interruptions, or sparks, for two revolutions of the crankshaft, the 1-1/2 to 1 ratio is necessary (two revolutions of the crankshaft turn the armature three revolutions).

The electrical system includes a starter motor for cranking the engine, a generator for charging the battery, a voltage regulator for regulating the charging, and switches and cables for connecting the various units of the system. See the Wiring Diagram, Figure 4.

6. FUEL SYSTEM

The fuel system cleans, prepares, and regulates the mixture of air and gas to the engine.

The fuel is pump fed from the fuel tank to the carburetor; there the gasoline is vaporized by the rush of air through the carburetor as it is drawn into the cylinder of

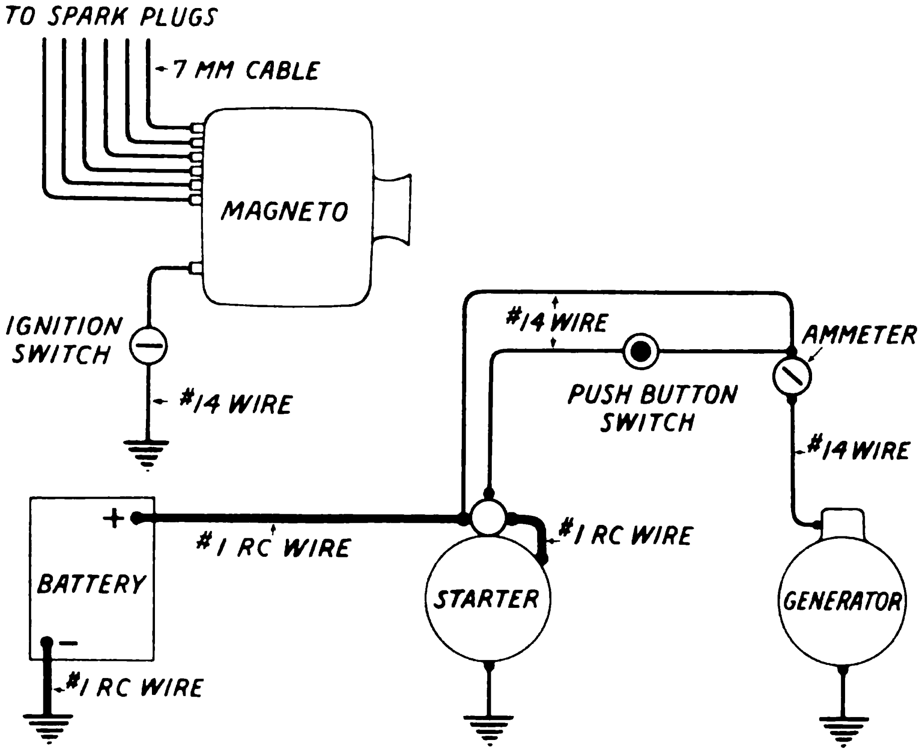


Figure 4. Wiring diagram.

the engine. The air must, however, first pass through an air cleaner to remove all impurities since most of these are abrasive and will wear the engine.

In the carburetor, the proper amount of fuel is mixed with the air to produce a powerful explosive mixture. The rate of flow of the fuel and air mixture controls the engine speed.

A variable speed governor automatically regulates the speed of the engine. When the load on the engine increases, the governor opens the throttle, and will not allow the engine to operate beyond its maximum safe speed. Thereby, the governor maintains the rate of operation at an even pace, increasing engine power when necessary or decreasing it to the minimum requirements. Figure 5 illustrates and shows the location of the units of the fuel system.

7. LUBRICATING SYSTEM

Without a lubricating system, the engine would not run for long. The heat produced by friction would destroy the engine. Oil cushions the moving parts from each other and carries away fine particles of wear which are cleaned out of the oil by an oil filter. A high velocity oil pump

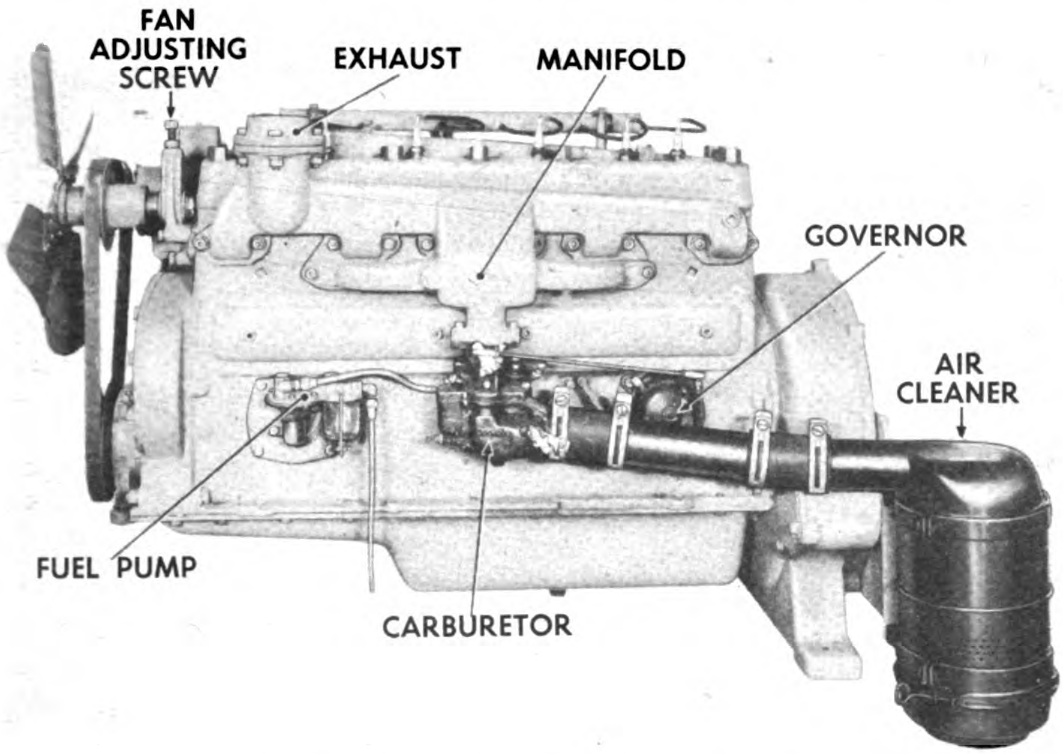


Figure 5. Left side of Buda Model K-428 showing location of the units of fuel system.

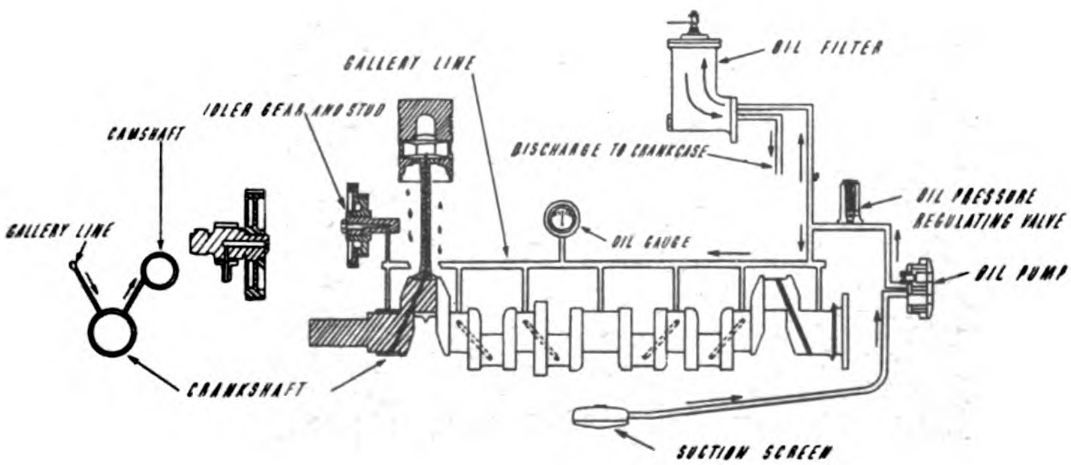


Figure 6. Lubricating oil diagram.

provides full force lubrication to the internal workings of the engine. Figure 6 illustrates the lubricating system.

The oil pump assembly fits in a recess in the flywheel end of the crankcase, and is driven directly from the rear end of the camshaft. Connection to the pressure and suction passages in the crankcase is made by hollow dowels and sealed against oil leaks by copper asbestos gaskets.

The oil is drawn from the pan through a floating suction screen to the oil pump. From the pressure side of the pump, it enters a drilled passage in the crankcase casting to the oil pressure relief valve. Here excess oil is by-passed to the oil pan. The balance of the oil passes on to the main gallery line in the crankcase. From the main gallery line, side passages are drilled to the main bearings, oil pressure gauge connections, and idler gear stud. From the main bearings, the oil is delivered to the connecting rod bearings by means of the drilled crankshaft. The piston pin receives its oil through the rifle drilled connecting rods. The cylinders are lubricated by oil thrown from the connecting rod bearings.

From the main bearings, side passages lead to the camshaft bearings. A supply of oil is delivered to the idler gear hub through the drilled idler gear shaft. Oil from the hub of this gear is thrown out through drilled holes and is picked up by a groove in the rim of the gear where it passes through small drilled holes to the gear teeth, spraying the entire gear train.

8. COOLING SYSTEM

The water cooling system carries off the excess heat from the engine and holds it to a temperature that makes for efficient operation. The water is circulated through the water jacket and radiator by a centrifugal pump, where the cooling takes place. A fan creates a draft through the radiator. See Figure 1.

CONSTRUCTION FEATURES

The Buda Company has been manufacturing gasoline engines since 1910 - Diesels since 1923. Because of this organization's long experience in engine manufacture together with continuous research both in the plant laboratory and in actual field operations, the Buda engine embodies the latest in engine developments.

Throughout the complete manufacturing of Buda engines, parts and assemblies are carefully checked and inspected before and after installation on the engine-assembly line. All engines are carefully "run in" and completely tested before leaving the factory.

9. CRANKCASE AND CYLINDER ASSEMBLY

The crankcase and cylinder assembly is a one-piece, Ni-Chrome semi steel casting. The cylinder head, flywheel housing, timing gear housing, and oil pan are removable.

10. CONNECTING RODS AND PISTONS

The connecting rods are made of special open-hearth steel - heat treated. The I-beam sections are drilled throughout their entire length for piston pin lubrication. Pistons pins are a special case hardened alloy steel. The pistons are cast iron with four piston rings placed in deep and narrow ring grooves which allow a minimum wear of the rings in the grooves.

11. CRANKSHAFT AND TIMING GEAR

The generously large crankshaft is a special open-hearth No. 1045 S.A.E. steel forging - heat treated. The seven main bearings are located between every crankpin throw, and at each end of the crankshaft. All main bearings are of the "precision" type. No reaming, scraping, or fitting is necessary in field replacement. The crankshaft is balanced both statically (at rest) and dynamically (in motion).

The timing gears are made from cast iron and steel. This selected combination of metal assures long wear and quiet running.

12. VALVES

The inlet valves are made of a chrome nickel alloy steel and the exhaust valves are made of Silchrome alloy steel. The exhaust valves seat on casehardened rings inserted in the block. The valve push rods or lifters are the mushroom type and are a gray iron casting with chilled heads.

13. CAMSHAFT

The camshaft is made from open-hearth steel, case hardened, and runs in four bronze bushings which are pressed into the crankcase. Holes are drilled in the camshaft bearings to allow force feed lubrication from the oil pump.

14. WARRANTY

All the assemblies and parts made by The Buda Company are guaranteed against defective material or workmanship. The accessories are similarly guaranteed by the accessory manufacturers.

15. NAME PLATE

The name plate is on the right side of the engine. It carries the engine identifying model serial and B/M numbers, all of which should be included when ordering spare or replacement parts.

Chapter II

16. OPERATORS' TEN COMMANDMENTS

The following "Ten Commandments" of engine operation are the road to a long and useful life, free from days of engine trouble:

I Know your engine. Read this manual of instruction and do the things advised herein.

II Keep the engine and its accessories clean. Dirt often hides trouble in the making. Look for loose connections or bolts as you clean.

III Keep the radiator filled with clean water. Never add water to an overheated engine. Allow it to cool first.

IV Use only the oil of recommended specifications.

V In starting, use the choke no more than necessary, as too much use of the choke allows gasoline to dilute the oil.

VI Warm up the engine slowly when the weather is cold. Never race a cold engine.

VII Do not force the engine - avoid over-load. When not using the engine - idle it; stop it if the period is prolonged, unless the weather is sub-zero, then allow the engine to idle.

VIII If trouble develops, correct it before it becomes serious. Don't run an engine that is not operating properly.

IX Always keep the air and oil filtering systems clean.

X Visually inspect the engine and its accessories daily.

Chapter III

17. LUBRICANTS RECOMMENDED

Because lubrication is so vital to efficient engine performance, one of the first concerns should be lubrication.

The Army lubricants recommended for the Buda K-428 Engine and their symbols are as follows: OE-10, OE-30, OE-50-engine oil. This is a fluid lubricant provided in three S.A.E. grades - 10, 30, 50.

These lubricants are based on U.S. Army Specifications 2-104A and are for use in crankcase, air cleaner, water pump, starting motor and generator, and such other lubrication points requiring a fluid lubricant. See Lubrication Chart for periods of lubrication and other lubricants required.

With temperatures below 32° F., use OE-10.

With temperature from 32° F., to 90° F., use OE-30.

*With temperature over 90° F., use OE-50.

*The use of OE-50 is not recommended except for extremely high operating temperature under heavy load conditions. Care must be exercised in using this heavy body oil, as power loss due to using an oil of this weight will result in an increase in oil pan temperatures which will more than offset any possible gain in lubricating values.

18. EXTREME COLD WEATHER

In temperatures -20° or below; the crankcase should be drained at the end of the day's operation; the oil should be heated to 200° before pouring it back into the crankcase at the start of the next operation.

19. GREASES

WB-3 grease, wheel bearing heavy duty No. 3. This grease is designed to withstand heavy load and temperature above 90° F.

WP-3 grease, is specially prepared for water pumps.

Figure 7 shows the points of engine and accessory lubrication.

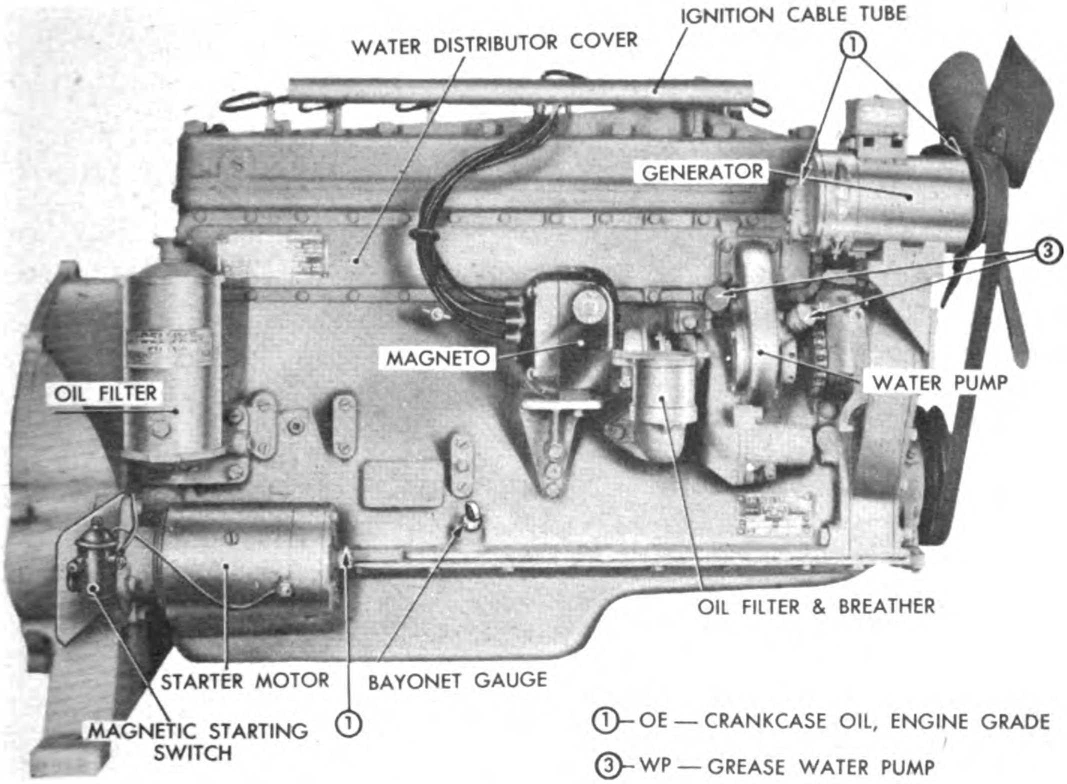


Figure 7. Points of lubrication for engine and accessories.

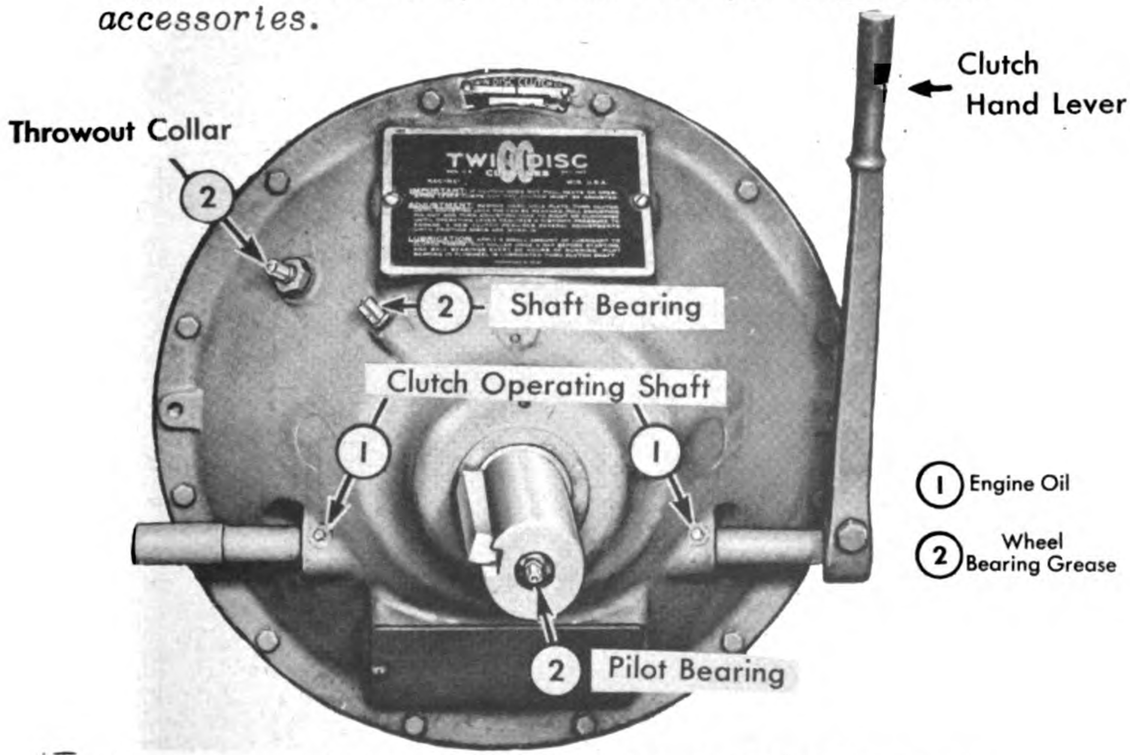


Figure 8. Points of lubrication on clutch power take off.

LUBRICATION CHART

PERIODS OF OPERATION	POINTS OF LUBRICATION	LUBRICANT REQUIRED
8 hrs.	1. Air Cleaner---clean, change oil	OE
	2. Clutch Throw-out collar	WB-3
	3. Check crankcase---add if necessary	OE
	4. Lubricate Clutch Throw-out Collar	WB-3
64 hrs.	1. Drain and refill crankcase	OE-9 qts.
	2. Water pump---grease cups	WP
	3. Generator---oil cup and oil hole	OE
	4. Starting Motor---oil hole	OE
128 hrs.	1. Change oil filter cartridge and refill crankcase	OE-10 qts.
	2. Carburetor throttle shaft, choke, and control cables---flex cables to apply	OE
	3. Governor throttle shaft and ball joints	OE
	4. Clutch Housing Bearing	WB-3
	5. Clutch Pilot Bearing	WB-3
	6. Clutch Operating Shaft	OE
	7. Magneto-Felt Wick	OE 2 to 3 drops
512 hrs.	1. Fan---grease plug	WB-3

Chapter IV

20. PREPARING NEW ENGINE FOR OPERATION

To prepare a new engine or one which has been standing for a long period of time and has had the fuel and lubricating oil drained, follow these steps:

A. Give the engine a detailed inspection. See that all drain plugs are tightly replaced. Figure I shows location of all drain plugs and cocks.

B. Check wiring and electrical connections, as well as the hose connections, both for the cooling and air induction systems.

C. Remove the spark plugs and pour about 1/2 an ounce of engine oil into each cylinder. This pre-oils the rings and cylinder walls so as to immediately assure good compression.

D. See that the engine turns freely by hand - two or more complete revolutions. This will distribute the oil on cylinder walls.

E. Fill the crankcase with the recommended oil for the prevailing temperature. See chapter 3. Lubricate the governor link ball joints, governor throttle shaft and the carburetor throttle shaft. Apply #3 wheel bearing grease to the clutch housing bearing and the clutch pilot bearing. Oil the generator and grease the water pump. See Figures 7 and 8.

F. Fill cooling system with clean water or proper anti-freeze mixture if weather below freezing is to be expected.

G. Connect storage battery. See wiring diagram, Figure 4.

H. Fill fuel tank with gasoline. Open valve.

I. Open the drain plug on the bottom of the carburetor and crank the engine until the gasoline flows. See Figure 9.

THE ENGINE IS NOW READY FOR STARTING

21. CONTROLS

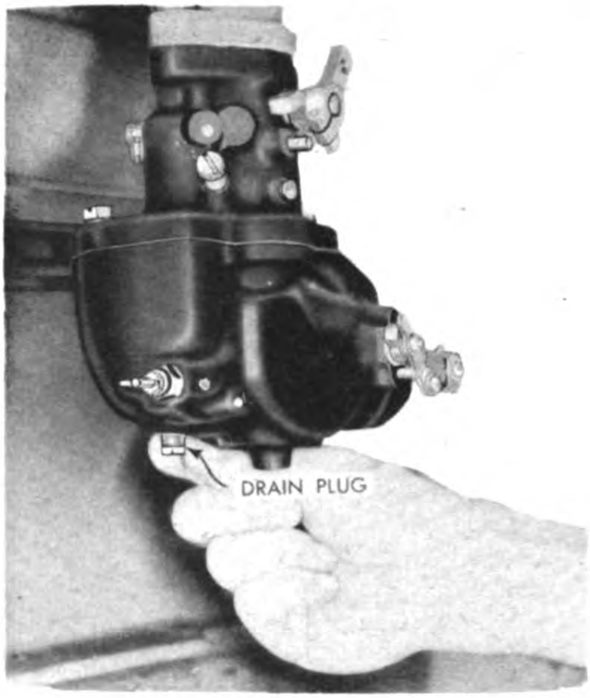


Figure 9. Close up view of carburetor showing location of drain plug.

The hand controls necessary to start and operate the engine are: The choke, throttle, starter push button switch and governor control. These are conveniently located near the operator's seat on the control assembly of the machinery for which the engine supplies the power. See Figures 10 and 11.

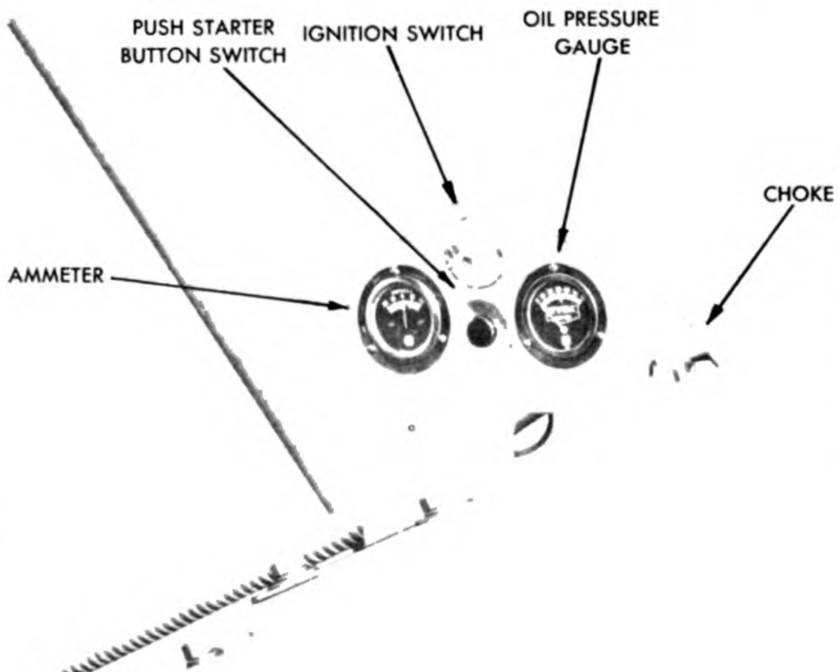


Figure 10. Close up view of the engine control panel located near the operator's seat.

22. INSTRUMENTS

The instruments used on this engine to indicate efficiency of its component functions are an ammeter and an oil pressure gauge. See Figure 10.

23. AMMETER

The ammeter indicates the rate of charge or discharge. The readings are from 0 to 30 (charge) and 0 to -30 (discharge). Because the voltage regulator controls the rate of charge, it is common for the reading to be at 0 or close thereto. This indicates that the battery is fully charged or in a high state of charge. If the reading continues at a high figure (over-10), this indicates trouble with the voltage regulator. However, a rundown battery will take a

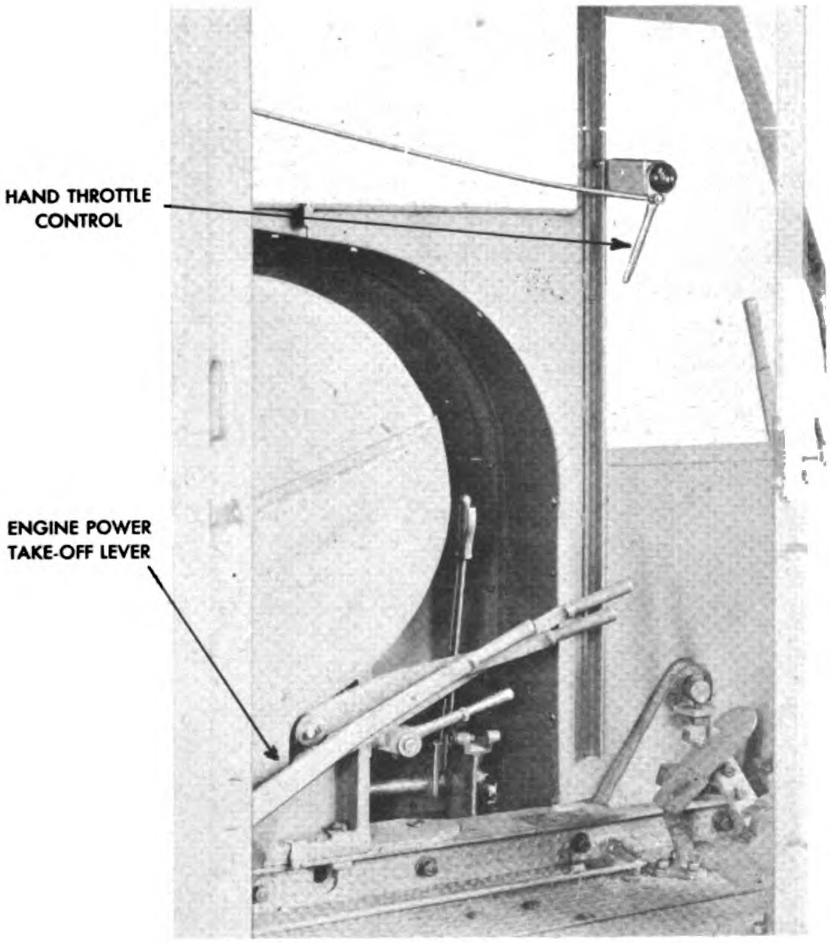


Figure 11. View looking into shovel control cab showing location of the hand throttle control and engine power take-off lever. The engine power take off clutch lever is mechanically connected to the clutch lever on the engine.

higher rate of charge for a few hours. If the reading shows high on the discharge, there is a short somewhere between the ammeter and the generator. See Voltage Regulator and Generator, Chapter VI, paragraph 54.

24. OIL PRESSURE GAUGE

This gauge is located at the operator's controls and should be observed a number of times during the operation period- and especially just after the engine is started. See Figure 10. This gauge indicates whether or not the proper amount of pressure is being delivered to lubricate satisfactorily the internal workings of the engine. The pressure for normal operating speeds is approximately 30 pounds when engine is warm. The connection to the pressure system is on the right side of the crankcase just ahead of the flywheel.

If the reading indicates low oil pressure, checks for the following conditions should be made: oil in crankcase low, or oil to thin; leaks in oil pressure line; leaks in the line to the oil filter and in the line to the governor. If those items are all right, the pressure loss is in the engine and a maintenance mechanic should check as indicated in the Maintenance Manual, Section II. If the reading is high, either the oil being used is too heavy or the check valve spring tension is too high. In the case of the latter, this condition should be corrected by the maintenance repair man.

25. BAYONET GAUGE

The bayonet gauge, or dip stick, or oil level stick is located at the right side of the engine, and it indicates the level of the oil in the crankcase. The level of the oil should show "F" or full. See Figure 7.

26. TO START ENGINE

A. Move the throttle about one-quarter the way open.
B. Pull the choke out all the way.
C. Turn on the ignition.
D. Push the starter button. Allow the engine to turn approximately two revolutions, then move the choke back to mid-position; this allows the engine enough air to run on after it commences firing. Release the starting button as soon as engine fires. As the engine warms up, gradually

push the choke control all the way in. At the same time move throttle to idling position to prevent the engine from racing. Always allow engine to warm up to normal operating temperature range before beginning actual operations.

27. TO STOP ENGINE

Always slow down the engine to idling position of throttle (control pushed down), and allow the engine to idle a few minutes before stopping. This allows the engine to cool off gradually so the temperature of the contracting parts will remain approximately the same. Too rapid cooling may warp valves or crack the manifold. Shut off the ignition switch to stop the engine.

28. COLD WEATHER OPERATION

With proper care the usual satisfactory operations can be maintained in cold weather. Make certain the lubricating oil is correct for the prevailing temperature. See Chapter III.

If the weather is 32°F. or less, drain the crankcase unless the crankcase is filled with anti-freeze mixture as given on page 27.

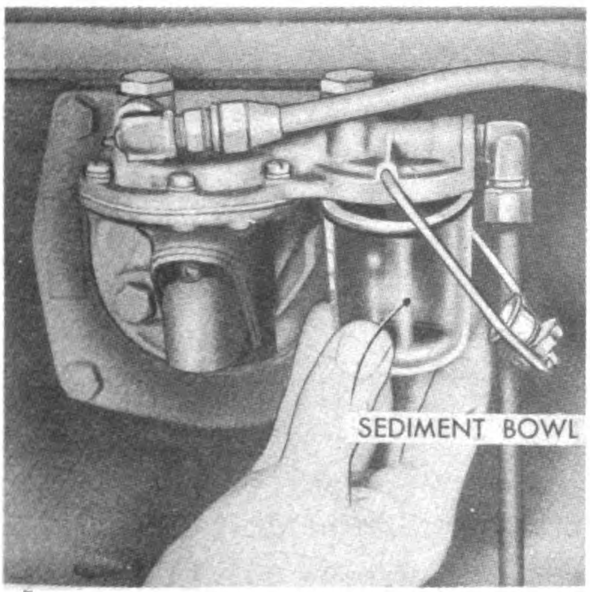


Figure 12. Removing fuel sediment bowl.

To assure a hot spark and fully charged battery, check the ignition and test the battery as outlined in Chapter VI.

In freezing weather it is also well before starting the day's operations to remove fuel sediment bowl see Figure 12, empty contents, and clean and replace the bowl. Push the starter button, or crank the engine by hand until gasoline flows. This assures that no water from condensation has frozen, thereby restricting the flow of gasoline. Also remove drain plug from carburetor (see Figure 9); if no gasoline runs out, insert a short wire to see if the opening is plugged with ice; if ice has formed, thaw the carburetor by either pouring hot water over it, or heat a brick or stone and hold it against the carburetor bowl. (DANGER: Do not use a blow torch on the carburetor.) When the gasoline flows through, insert drain plug and continue to turn the engine over as advised above until full of fuel.

Except for turning the engine over by hand two revolutions before starter is used, follow the regular instructions for starting engine. The hand-turning before using starter assures that the engine is free to turn. If water pump is frozen and the starter is then used, serious damage may result, such as broken water pump shaft or broken impeller.

If engine does not start, see trouble chart, Chapter VII. CAUTION: The starting motor is not designed for continuous running. Stop it after ten seconds to allow it to cool and the battery to rest for about ten seconds.

29. ANTI-FREEZE MIXTURES

The anti-freeze mixtures recommended are as follows:

Denatured Alcohol and Water

Freezing temperature degrees Fahrenheit	Amount of alcohol to add to each gallon of water
20	2 pts.
0	4 pts.
-20	6 pts.
-40	10 pts.
-60	19 pts.

For example, for each gallon of water placed in the radiator when the temperature draws near 20^{o} below zero, add six pints of denatured alcohol.

Ethylene Glycol (Prestone) and Water

Freezing temperature degrees Fahrenheit	Amount of ethylene glycol to add to each gallon of water
16	2 pts.
0	4 pts.
-19	6 pts.
-24	8 pts.
-49	10 pts.
-62	12 pts.

30. HOT WEATHER OPERATION

In extremely hot weather conditions, check the cooling systems every four hours and keep the system filled with clean water. Use the oil specified for the prevailing temperature as outlined in Chapter III.

31. PREPARING ENGINE FOR STORAGE

A. Drain the oil out of the crankcase.

B. Fill the crankcase with one gallon of fresh heavy engine oil (S.A.E. #50), OE-50.

C. Take off the cover from the oil filter to remove the element. Then drain the oil filter housing. Replace the cover and the drain plug. See Figure 13.

D. Start the engine. Stop it after it has run two minutes.

E. Remove the drain plugs from the radiator, water pump and cylinder block. Do not replace the drain plugs after the water is out, but fasten the drain plugs to the engine with a small wire to prevent their loss.

Figure 13. Removing the oil filter element.

F. Remove the spark plugs and pour 2 ounces of heavy engine oil (S.A.E. #50) into each cylinder. Slowly crank the engine over by hand. This allows the oil to cover the cylinder walls, piston rings and the valve heads. Insert and tighten the spark plugs and brush the outside of the plugs with the same heavy oil.

G. Remove valve cover and squirt oil with an oil pump gun on the valve stems and springs. Use special oil pump gun. See Figure 14. Replace and tighten the cover.

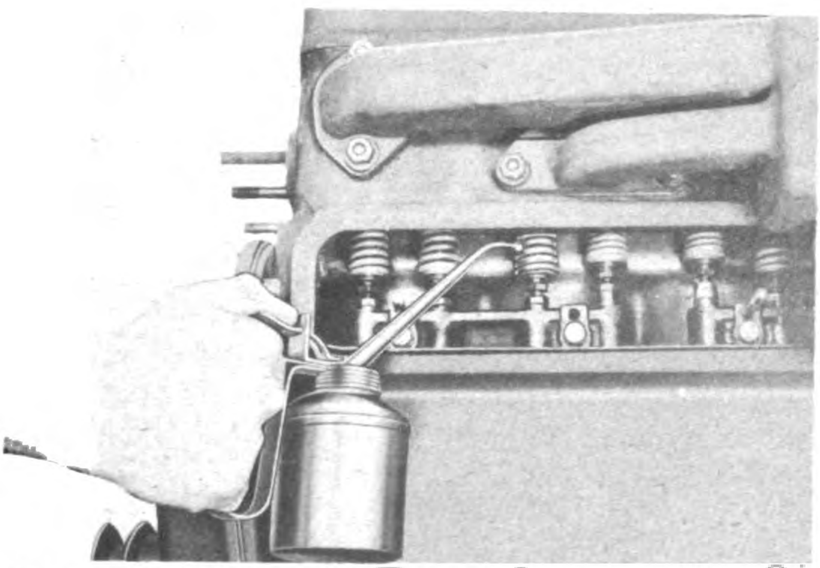


Figure 14. Oiling valve stems and springs with special oil pump gun.

H. "Paint" the outside of the fuel pump, the carburetor and the governor housing, including the throttle shafts and ball joints with heavy oil. Also include the generator and the starter with same heavy oil.

I. Remove the air cleaner oil cup (see Figure 15) and wash it with gasoline; then "paint" the inside surface with the heavy engine oil. If the paint on the outside surfaces is in bad condition, repaint to prevent rust.

J. Now drain the excess oil from the crankcase.

K. Remove and store the battery. An unused or stored battery must be slightly charged once a month.

Figure 15. Removing air cleaner cup.

L. Cover engine with canvas or waterproof material to protect from sun, rain, wind; or store engine in garage or similar suitable place.

NOTE: If the engine thus prepared for storage is prepared for service when the weather is zero or colder, mix the lubricating oil used in crankcase with one-half kerosene. Remove the spark plugs and pour a teaspoonful of gasoline into each cylinder; this is to assure easy starting. Replace and tighten the plugs. Follow the regular procedure as outlined in preparing a new or stored engine for service except for removing spark plugs and pouring small amount of oil on pistons. Where a commercial preservative is used, follow the manufacturer's directions.

After the engine is warm, drain the oil which has been diluted with kerosene and refill with fresh oil of the grade specified for the prevailing temperature. See paragraph 17.

Chapter V

CARE OF ENGINE - PREVENTIVE MAINTENANCE
(Periods of Lubrication Inspection and Maintenance)

32. To maintain the efficiency of this Buda engine, it is necessary that the operator lubricate, inspect and care for the engine at regular intervals. Regularity in lubrication and other normal maintenance operations eliminates the development of serious trouble and unnecessary delays and is called preventive maintenance.

Here let it be noted that distinction is made between the maintenance, adjustments and minor repairs which the operator can and should normally perform, and the disassembly, major repairs and reassembly by the service maintenance man who has the required tools, equipment and special data. Information on the latter is contained in the Maintenance Manual (Section II), and is referred to as Maintenance Repairs, or *MR*.

Because operating conditions may vary, it is somewhat difficult to lay down rigid rules as to the time intervals when lubrication and other maintenance should be made. However, the periods given in the accompanying Inspection and Maintenance Chart can be followed under most all operating conditions. This chart includes all paragraph references which give detailed instruction for the various servicings.

The items the operator will have to check, adjust or repair as the result of the regular periods of inspection and maintenance are listed alphabetically immediately after the Inspection and Maintenance Chart. Any other information needed to make such adjustments not given in the Inspection and Maintenance Chart, such as timing magneto, can be found under the item concerned---example, for timing magneto---See Magneto.

33. NEW ENGINE.

After the first 8 hours of operation, and also after the first 128 hours, the cylinder head studs should be tightened. Figure 16 shows the correct sequence of tightening the cylinder head studs. See maintenance chart for servicing to be done.

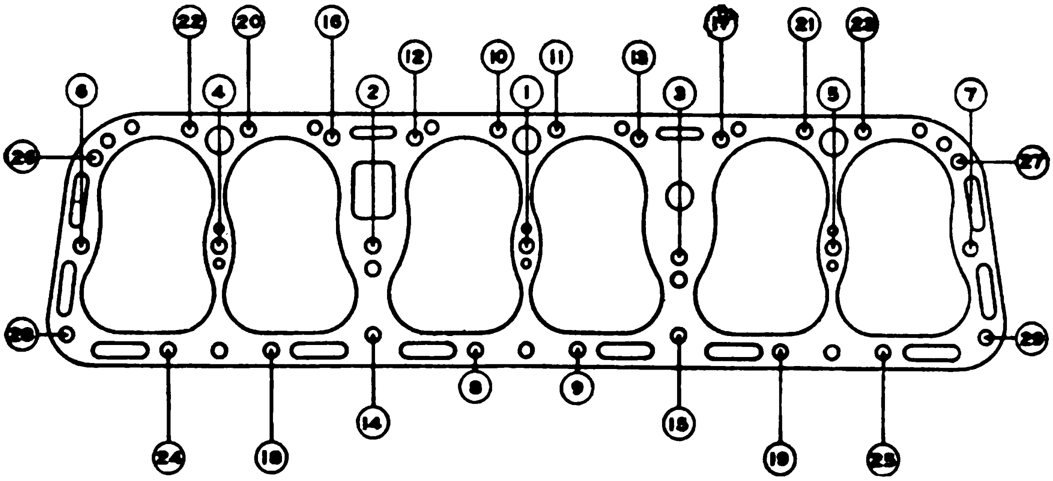


Figure 16. The diagram of the correct sequence for tightening cylinder head stud nuts.

34. TOOLS & EQUIPMENT NEEDED

To make the necessary adjustments and servicings as required of the operator he should have a screw driver, pliers, hammer, cold chisel, punch, open end wrenches and socket sets 7/16" to 1", tappet wrenches, #00 Sandpaper feeler gauge, machinists rule, and water pump packing nut wrench. Some of these items are included in the tool kit furnished with the engine.

INSPECTION AND MAINTENANCE CHART

HOURS OF OPERATION	SERVICING TO BE DONE	REFERENCE
8	1. Check bolts, nuts, capscrews and connections.	
	2. Check radiator; fill if necessary; check radiator fins and passages between tubes; remove any restriction to air flow.	Par. 66
	3. Check crankcase oil level, keep full.	Par. 25
	4. Clean air filter cup; refill with OE.	Par. 37
	5. Lubricate clutch throwout collar.	OE
64	1. Change crankcase oil;drain while engine is warm.	Par. 25
	2. Check battery water level.	Par. 38
	3. Grease water pump.	Fig. 8
	4. Oil generator and starter.	Lubrication Chart
128	1. Renew oil filter cartridge.	Par. 37
	2. Oil governor link ball joints and shaft.	Par. 56
	3. Oil throttle and choke cables; flex cable when applying.	Lubrication Chart
	4. Check valve tappet clearance.	Par. 74
	5. Check spark plugs for carbon and gap clearance.	Par. 68
	6. Check generator brush and commutator.	Par. 47
	7. Check starting motor brushes and commutator.	Par. 71
	8. Check fan belt tension.	Par. 44
	9. Clean crankcase oil breather in gasoline. Dip in oil.	Fig. 8

INSPECTION AND MAINTENANCE CHART - (Cont'd.)

HOURS OF OPERATION	SERVICING TO BE DONE	REFERENCE
128	10. Check battery specific gravity. 11. Grease Housing bearing. 12. Grease Pilot bearing. 13. Oil operating shaft.	Par. 38 WB-3 WB-3 OE
256	1. Tune up generator and voltage regulator. 2. Tune up starting motor and switch.	* MR * MR
512	1. Lubricate fan. 2. Overhaul generator. 3. Overhaul starting motor. 4. Tune up and lubricate magneto 5. Install new Spark Plugs; check gaps.	Lubrication Chart * MR * MR * MR Par. 68
1,024	1. Wash engine with kerosene or fuel oil. 2. Remove oil pan; wash out sludge; clean suction screen float. 3. Check oil float bracket. 4. Check connecting rod, cotter pins and bearing lock wires.	* MR * MR * MR * MR
2,048	1. Overhaul engine.	* MR

*MR - Job for Maintenance Repair as outlined in Maintenance Manual.

OPERATING ADJUSTMENTS AND REPAIRS

Chapter VI

OPERATOR'S SERVICINGS, ADJUSTMENTS AND REPAIRS

35. GENERAL PRECAUTIONS

As indicated in the Maintenance and Lubrication Chart, there are certain adjustments, servicings and repairs which the operator must perform in the line of regular maintenance. Detailed instructions for these servicings are given in this chapter, including the references given in the Maintenance Chart. These instructions, however, give only those repairs and servicings which come within the scope of the operator. Complete engine maintenance and repair instructions are given in the Maintenance Manual, Section II.

For convenience, the items that the operator may have to check, adjust or repair are listed alphabetically.

A. AIR CLEANER

It is the function of the air cleaner to prevent the abrasive dust, which is the chief cause of engine wear, from entering the engine. In order to remove the dirt efficiently, the air cleaner must be properly serviced.

36. CHECKING HOSE CONNECTIONS

The CONNECTIONS between the air cleaner and engine MUST BE KEPT AIR-TIGHT AT ALL TIMES. Tighten the clamps on the hose connections.

37. CLEANING CLEANER

Remove the oil cup at the lower end of the cleaner, empty the oil and scrape out the dirt. See Figure 15. Any coating of dirt on the walls of the center tube should be removed by raming a cloth through the tube with a stick so that the flow of air to the engine will not be restricted. Refill the oil cup to the oil level with new engine oil. Replace the oil cup securely. Never remove the oil cup while the engine is running, and do not run the engine unless the oil cup is filled with oil to the proper level.

B. BATTERY

The battery is the storehouse for the electrical energy used to operate the starter motor. The battery is kept charged by the generator.

38. CHECKING AND SERVICING BATTERY

Do not allow the surface of the electrolyte (battery water) to get below the top of the separators. Use only clean, distilled water to keep the battery filled. Do not fill higher than just below the bottom of the filling tube, for "gassing" will cause the electrolyte to spill over. Never add acid to the battery, as this will give a false reading as to the condition of the battery.

Keep the terminals tight and clean. If they show a tendency to corrode, clean and apply a thin coat of vaseline to protect them from the acid. Keep the outside of the battery clean. Neutralize any electrolyte that may be on the metal surfaces with a cloth saturated with ammonia or bicarbonate of soda solution (one pound of baking soda to one gallon of water), then wash off the water and dry.

Test the specific gravity of each cell with a hydrometer. A reading of 1.270 to 1.285 indicates fully charged; 1.230, half charged; and 1.150, dead. Never take a reading just after adding water, as the reading will not be true. CAUTION: Do not allow battery to stand in the discharged state. It will become ruined by sulphation.

If the battery requires frequent addition of water and is gassing excessively, test it. If in good condition, it is undoubtedly due to overcharging. The voltage regulator should be checked by maintenance repair for faulty adjustment, as outlined in the Maintenance Manual. If one or more cells continually require more water than others, it is an indication of a damaged cell which should be checked by maintenance repair.

39. COLD WEATHER CARE

It is especially important in cold weather to test the specific gravity. A battery freezes between the temperatures 20 degrees above zero and 50 degrees below zero, depending on the state of its charge. Do not add water after shutting down for the night, or it will freeze quickly; see that it gets a charge after adding water.

C. CARBURETOR

The carburetor mixes the proper amounts of air and gasoline in order to produce a highly combustible mixture.

40. ADJUSTING THE MAIN JET

The main jet determines the maximum amount of fuel which may be obtained for high speed operations. The main jet adjustment reduces this amount as it is turned towards its seat. Ordinarily the main jet adjustment has no effect after it is two turns open. To set this adjustment, open the throttle to approximately one-quarter open with the engine running. Turn the adjustment clockwise shutting off the fuel until the engine speed decreases due to a very lean mixture. Now open the adjusting screw until the engine speed decreases due to too much fuel. The adjustment should be set at a position half-way between these two extremes. See Figure 17.

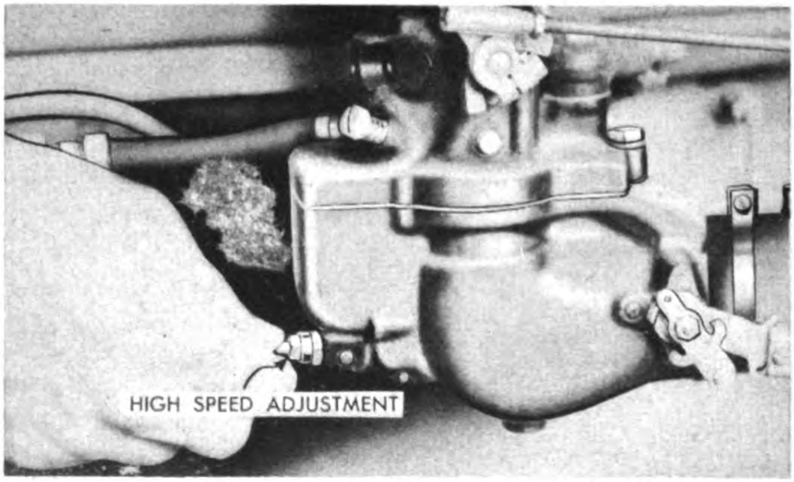


Figure 17. Close up view of carburetor showing main jet adjustment.

41. ADJUSTING FUEL-AIR MIXTURE

Before making an adjustment of the idling system, the engine should be run until it reaches normal operating temperature. To make the mixture richer, turn the idling needle valve IN; to make the mixture leaner, turn the idling needle valve OUT. See Figure 18. After the engine is warm, set the throttle stop screw for normal engine idling speed. Turn the idling needle valve adjustment to the right or left until the engine runs steady and as fast as this throttle position will permit. After the engine runs smooth and steady, it may be necessary to change the position of the throttle stop screw. See Figure 18.

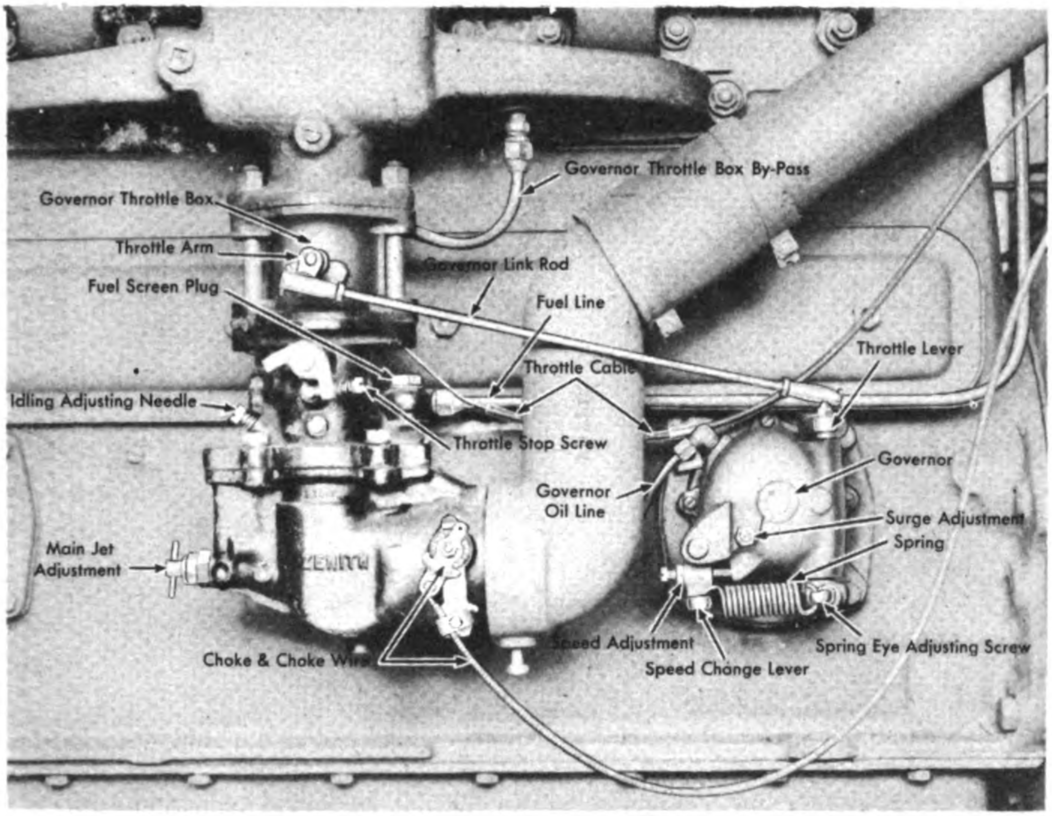


Figure 18. Close up view of carburetor and governor.

42. CLEANING FILTER SCREEN

Remove the fuel line inlet connection at the carburetor as shown in Figure 19. Clean the screen; reinstall screen and nut, tightening the latter.

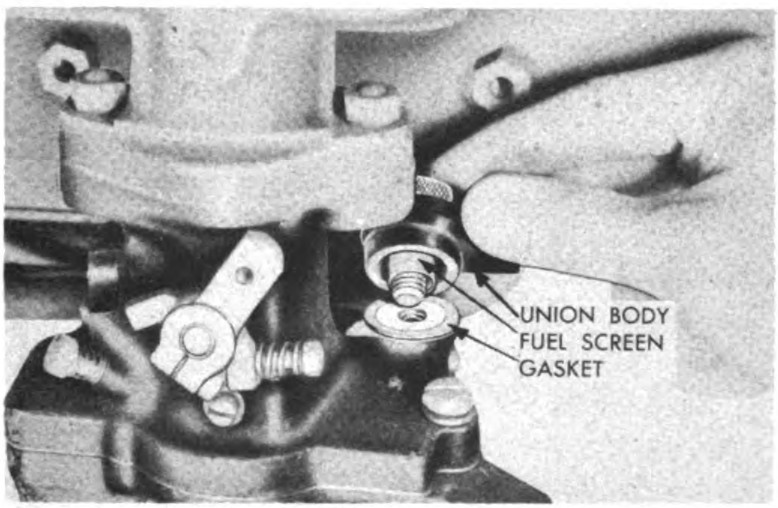


Figure 19. Removing the filter screen of the carburetor.

D. CLUTCH

The power take off is a device called a clutch,by means of which the power of the engine is engaged or disengaged with the rest of the equipment.

43. ADJUSTING A SLIPPING CLUTCH

The engine clutch should be adjusted whenever it slips, does not pull, heats, or the operating lever jumps out. A new clutch will require adjustment more frequently than one with the friction surfaces worn in. For correct clutch adjustment, it is necessary to first remove the hand hole cover plates, reach in and take hold of adjusting lock pin pulling it back as far as it will go. Then turn adjusting yoke clockwise (to tighten clutch) or counterclockwise (to loosen) notch by notch until the proper adjustment has been acquired. See Figure 20.

It is suggested that the clutch be engaged at intervals during this procedure in order to feel when the proper overlock or adjustment has been reached. The operating lever will require distinct pressure to engage. Release pin making sure it seats correctly in an adjusting hole - holes are located in the floating plate. Replace hand hole plates and resume operation.

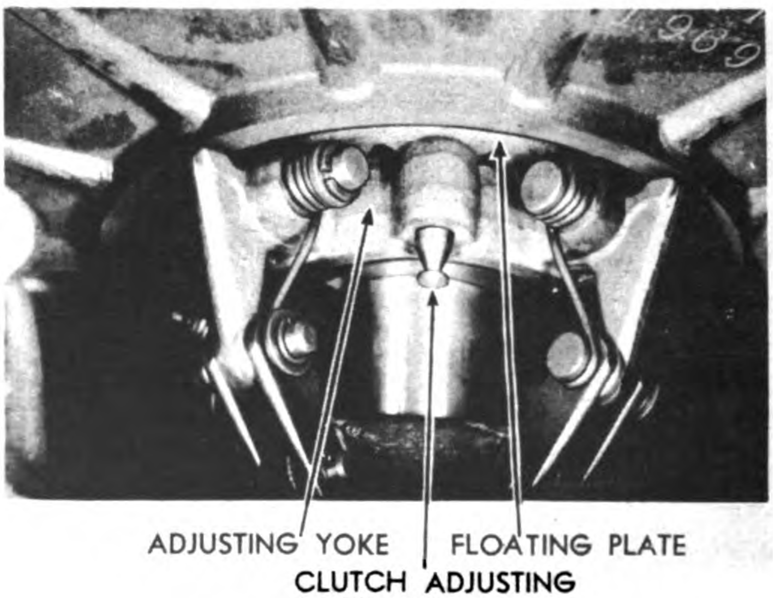


Fig. 20. Close up view looking into hand-hole cover.

E. FAN BELT

The fan belt drives the fan and the generator from the pulley on the crankshaft.

44. CHECKING BELT AND ADJUSTING FAN BELT TENSION

There should be approximately 3/4 of an inch slack as all V-belts must run just loose enough to prevent slipping. See Figure 21.

Loosen the lock nut of the fan belt tension adjusting screw shown in Figure 21, and turn the adjusting screw to the left to tighten, right to loosen. When proper tension is obtained, tighten the lock nut.

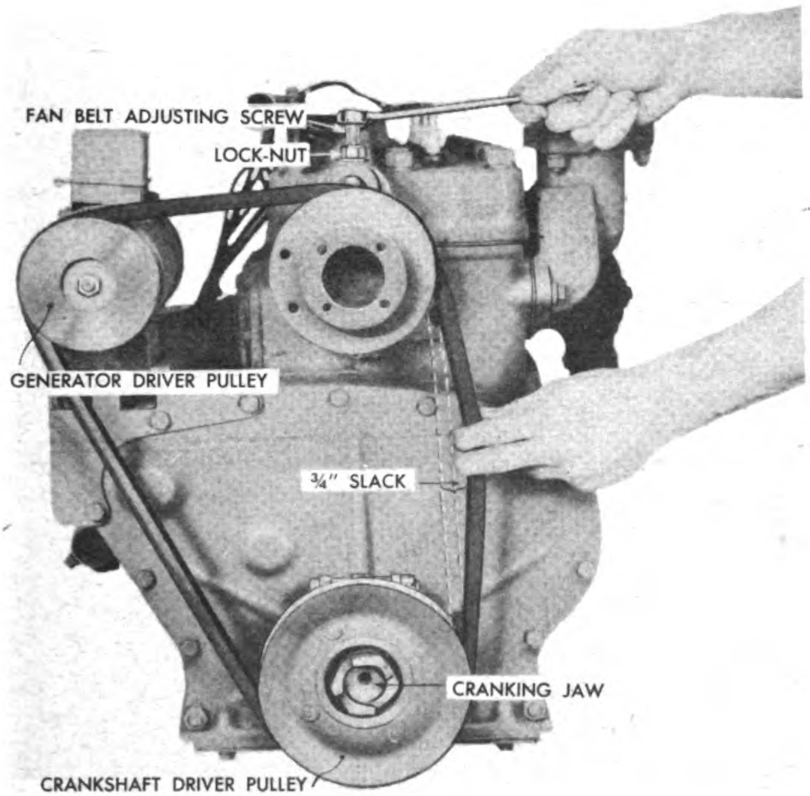


Figure 21. Adjusting fan belt tension.

45. INSTALLING BELT

Whenever installing a r. v belt, always loosen the fan belt adjustment so as to allow the belt to be slipped in place without forcing. This will avoid any internal damage to the belt.

F. FUEL PUMP

The AC mechanical fuel pump supplies fuel from the supply tank to the carburetor to meet engine requirements at all speeds. The power is applied to the rocker arm by an eccentric on the camshaft. The rocker arm movement through the link and rod pulls the diaphragm away from the fuel chamber against a spring pressure of 2-1/2 to 6 pounds. The vacuum created by the diaphragm movement pulls the gasoline from the supply tank through the inlet valve and into the fuel chamber. The return stroke (low point of cam) releases the compressed diaphragm spring expelling the fuel through the outlet valve into the carburetor bowl.

46. INSPECTING, CLEANING, AND ADJUSTING FUEL PUMP

Inspect the pump for: (1) dirt in the sediment bowl; (2) dirty screen; (make certain that the cork gasket is properly seated when replacing bowl); (3) loose valve plugs or worn gaskets; (4) leaky tubing or connections; (5) bent or kinked tubing; (6) loose cover screws - any of these conditions will contribute to the lack of fuel at the carburetor.

If the valves are damaged or warped, they must be replaced. It is not necessary to remove the fuel pump from the engine. Just unscrew the valve plugs and remove the springs carefully so as not to scratch the plugs.

Before inserting the new valves, assemble the valve seats to make certain that there are no irregularities which prevent proper seating. (if there are any, pump cover should be replaced.) Place the valves in the valve chamber. Reassemble the valve plugs and springs. Make certain that the springs are inside the lower stems of the valve plugs. Use new gaskets under the valve plugs. See Figure 22.

Fuel leakage at the edge of the diaphragm is usually caused by loose cover screw. Tighten the cover screws alternately and securely. Also check inlet and outlet-pipe connections.

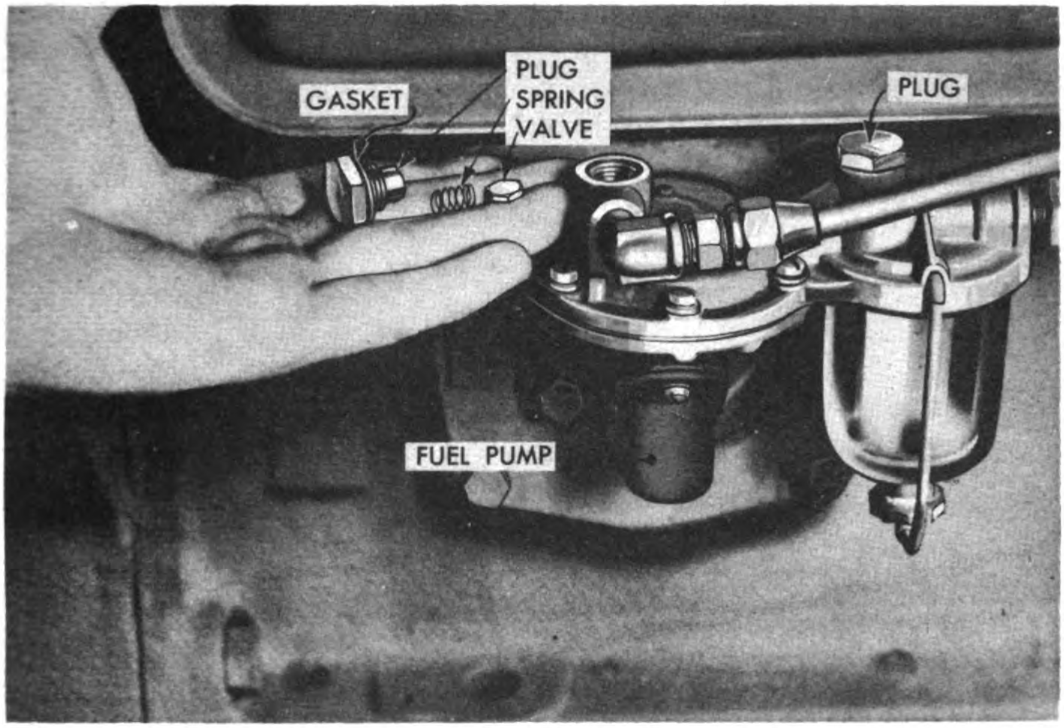


Figure 22. Fuel pump with one valve plug exploded.

G. GENERATOR

The generator changes mechanical energy into electrical energy, which is stored in the storage battery to be used as needed.

47. CHECKING COMMUTATOR AND BRUSHES

Remove the cover band to inspect the commutator and the brushes for dirt and wear, and also check for high mica (the insulation material between the copper bars) or for the commutator being out of round. This latter can be determined by watching the brushes as the commutator revolves. If the commutator is out of round or has high mica, this becomes a job for maintenance repair as outlined in the Maintenance Manual (Section II).

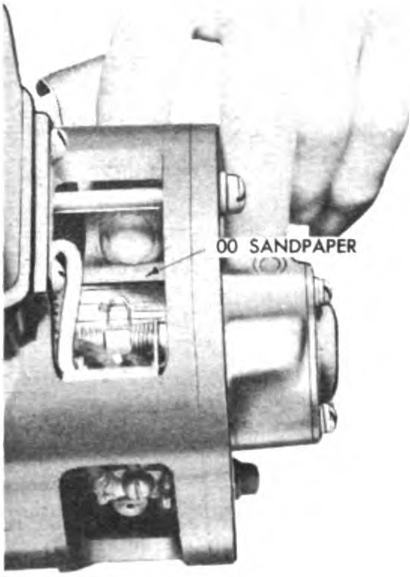


Figure 23. Cleaning Commutator

48. CLEANING COMMUTATOR

Clean the commutator with No. 00 sandpaper. Cut a strip of sandpaper as wide as the commutator and hold the sandpaper against the revolving commutator as illustrated in Figure 23. Never use emery cloth. All dust must be blown from the generator with dry compressed air or a hand bellows.

49. CHECKING BRUSH WEAR

New generator brushes are 13/16" long. Brushes worn down to 1/2" long must be replaced.

50. REPLACING GENERATOR FUSE

The generator fuse is located in the base of the voltage regulator, as shown in Figure 24. It is a five ampere fuse and is held in place by a thumb screw.

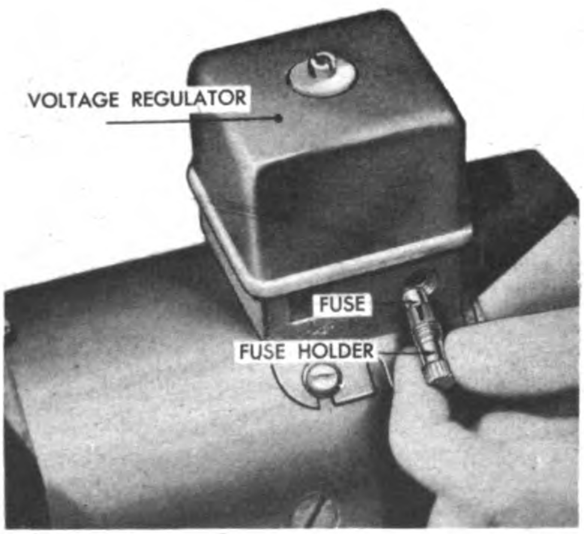


Figure 24. Replacing Generator Fuse

51. CHECKING AND ADJUSTING BRUSH MOVEMENT

Brushes must move freely in their holders. Do not fold or twist the brush "pigtails" so that they prevent free brush movement. If the brushes are gummed, clean them with clean unleaded oil-free gasoline. Do not

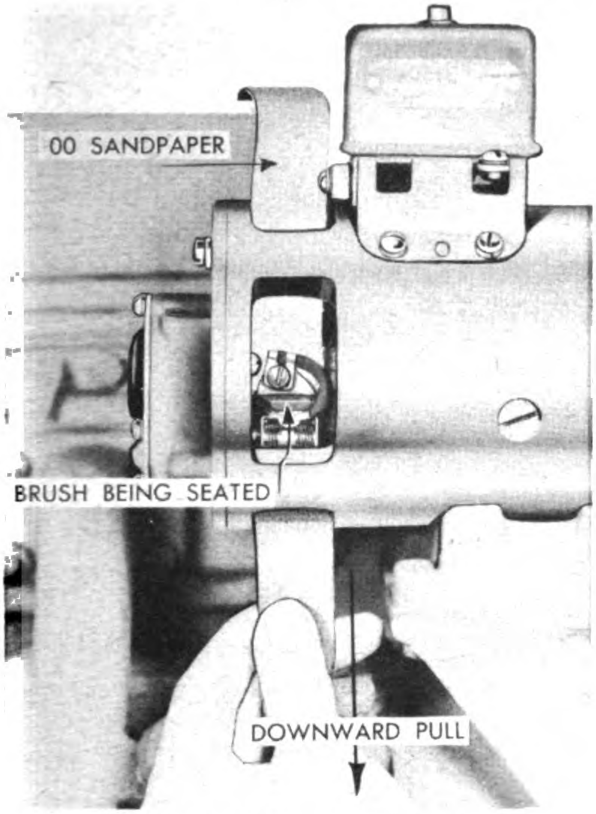


Figure 25. Replacing Generator Brushes

soak them, allow them to dry thoroughly before using. If brushes are caked with any substance, do not sand excessively or round the contact edges of the brush. Clean the brush holders. Brushes worn down to 1/2" must be replaced.

52. REMOVING BRUSH DUST AND DIRT

Blow the brush dust or dirt out of the motor and the generator, especially at the commutator end and brush rigging, with dry compressed air or hand bellows, to prevent short circuits, grounding, etc.

53. REPLACING BRUSHES

Place the new brushes in their holders and connect brush pigtails. To seat brushes properly, cut a strip of No. 00 sandpaper slightly wider than the brush. See Figure 25. Slip under one brush at a time. With the abrasive side against the brush and the brush at its proper spring tension, draw the paper upward or downward, making certain that the entire face of brush is being ground. DO NOT GRIND EXCESSIVELY. The other brush barely showing in the picture is released from its spring tension to permit clearance for the sandpaper as the sandpaper is drawn upward. Blow out the dust and examine both edges of the brush to see that they are touching the commutator properly. Oil generator regularly every 64 hours. Figure 26.

Before replacing cover band, fold brush "pigtail" wires down so that they will not touch the band. They must not touch any metal except that of the brush holder to which they are attached. This precaution prevents a short or ground at the generator. The connection screws attaching the brush pigtails to the holders must be tight.

H. VOLTAGE REGULATOR

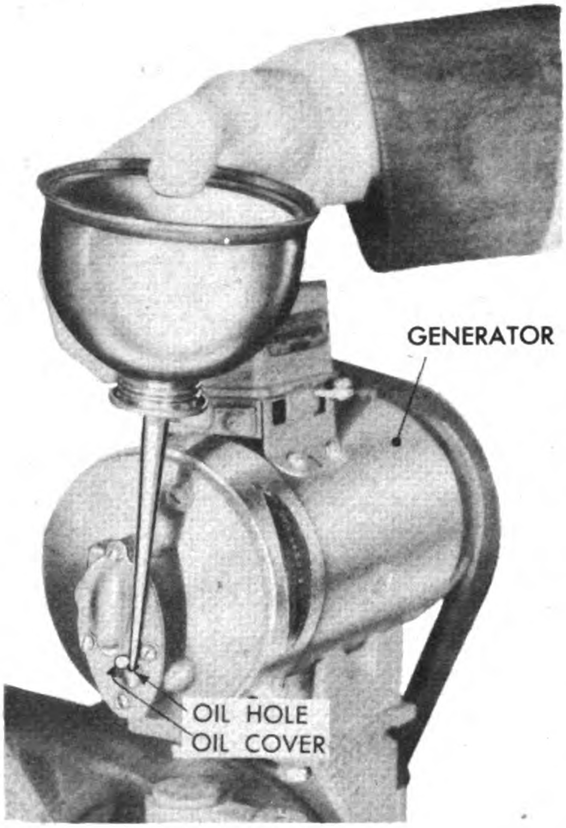


Figure 26. Oiling Generator

The voltage regulator, which is mounted on the generator, automatically controls and limits the generator voltage in order to properly charge the battery. The voltage regulator permits a comparatively high charging current when the battery is in a discharged condition, and will cause this current to gradually decrease as the battery becomes charged, thereby protecting the battery from damage by continued high charging currents. The regulator also cuts out the generator from the battery when the generator is not running, to prevent the battery from discharging back through the generator.

WARNING: Because the regulator is precision adjusted and special electrical meters are needed for this setting, the operator should turn the job of adjusting the regulator over to maintenance repair, as outlined in the Maintenance Manual (Section II). However, the operator can clean the contacts if he has the necessary material and is careful in so doing.

54. CLEANING CONTACTS

First make certain to disconnect the battery from the control unit or regulator while cleaning the contacts. Take off the cover. Clean the contacts by drawing crocus cloth between them while holding the contacts together under slight pressure. See Figure 27. Crocus cloth is a very fine abrasive. Do not use coarse abrasives. Blow away the cleaning dust. Be careful not to leave lint or

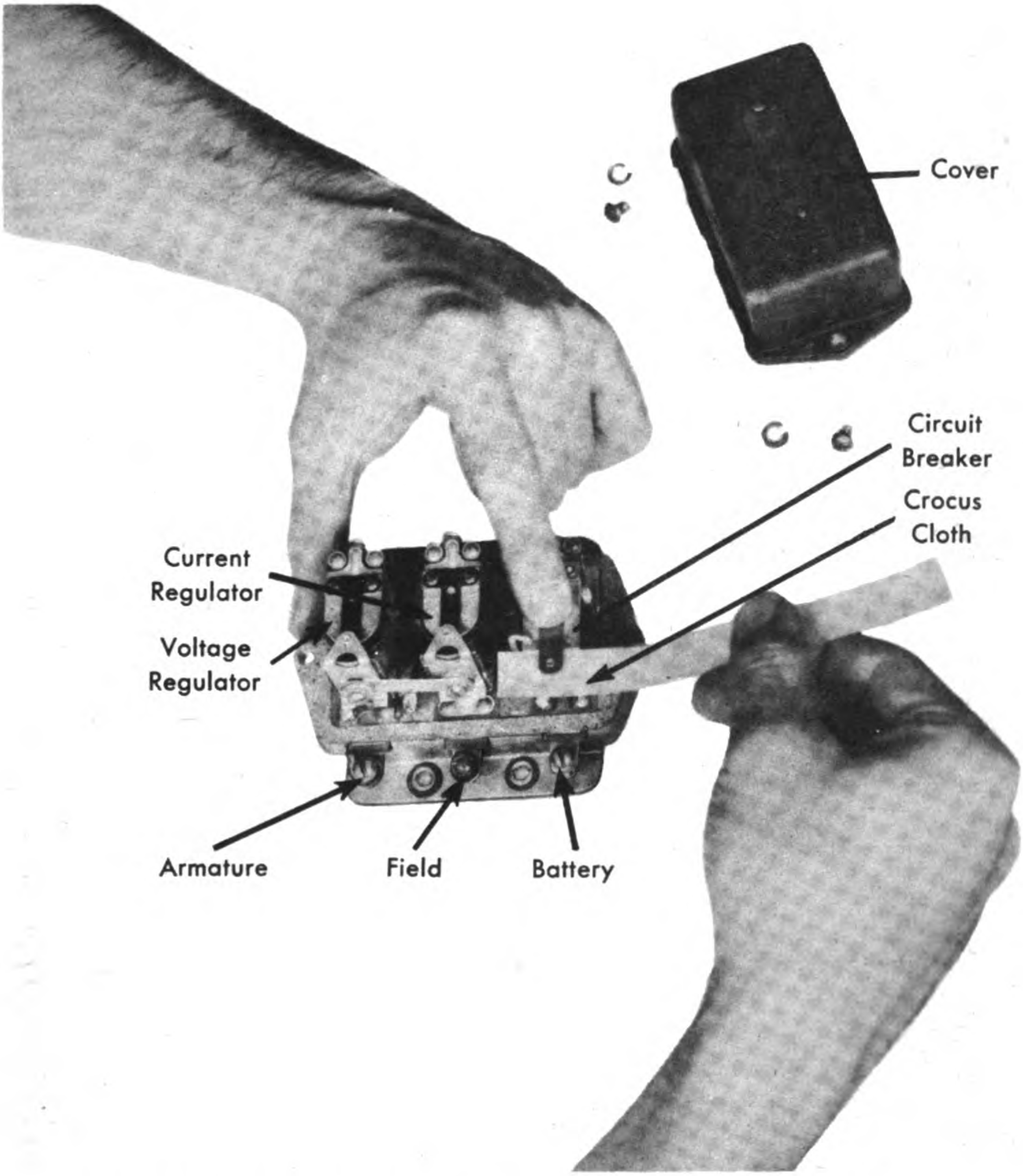


Figure 27. Cleaning Voltage Regulator Contacts

dust between the contacts, because that will prevent operation. Gently snapping the contacts open and closed may dislodge the lint or dust, or drawing a piece of smooth hard paper between the contacts will also dislodge the particles. Do not use a file except to remove projections or extreme roughness, and be sure to use only a fine mill cut file. Continuous filing will remove all contact material from the thin metal disc to which it is welded. DO NOT FILE TOO MUCH.

NOTE: If the regulator must be sent to maintenance repair for adjustment, the regulator and the generator must always accompany each other. One should not be adjusted or repaired without the other being adjusted and checked.

1. GOVERNOR

The governor maintains within close regulation any desired engine speed with the normal idling and nominal maximum speed range, irrespective of engine load. In addition, the governor controls the engine idling speed to prevent stalling and the maximum speed to prevent racing. The governor is connected to the governor throttle box butterfly valve located between the carburetor and the intake manifold by a link rod. See Figure 18. The governor is pressure lubricated internally.

CAUTION: The main speed adjustment is correctly set at the factory and should not be changed. If, because of some mishap or damage, it becomes necessary to reset the adjustment, the operator must turn this job over to the maintenance repair, as outlined in the Maintenance Manual (Section II), because the distances must be accurately calibrated.

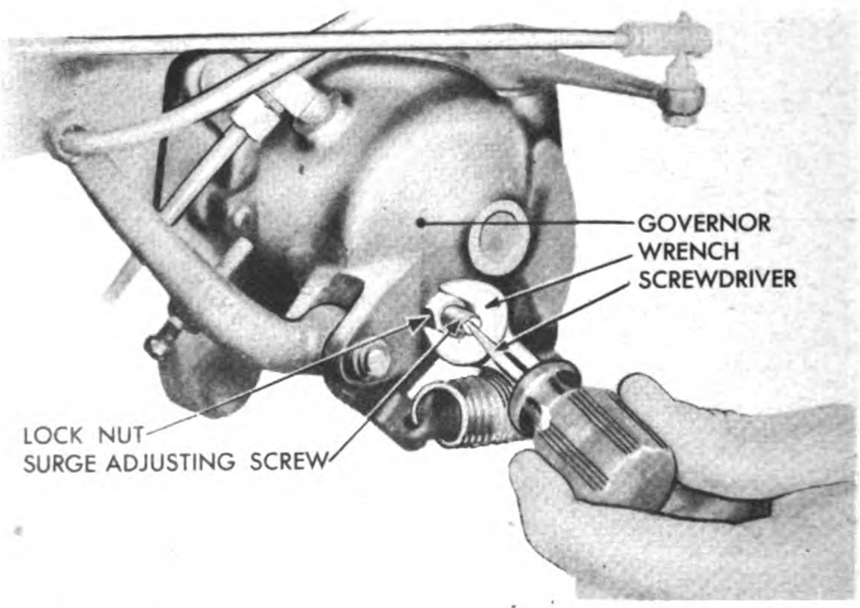


Figure 28. Governor Surge Adjustment

55. ADJUSTING ENGINE SURGE

If the engine is unstable at top engine speed, running without load or part load, turn the adjusting screw, as in Figure 28, inward a half turn at a time until the surging stops, being sure that you do not raise the speed of the engine by so doing.

56. ADJUSTING GOVERNOR LINK ROD BALL JOINTS

The governor link rod ball joints at both ends of the link rod should be snug, but move without friction. See, in Figure 29, the screwdriver is turning the ball joint adjusting plug and the fingers are testing for friction at the carburetor end. A small cotter pin through the screw must be removed to make the adjustment. Replace the cotter pin after the adjustment is made. Never bend the rod. Keep ball joints lubricated.

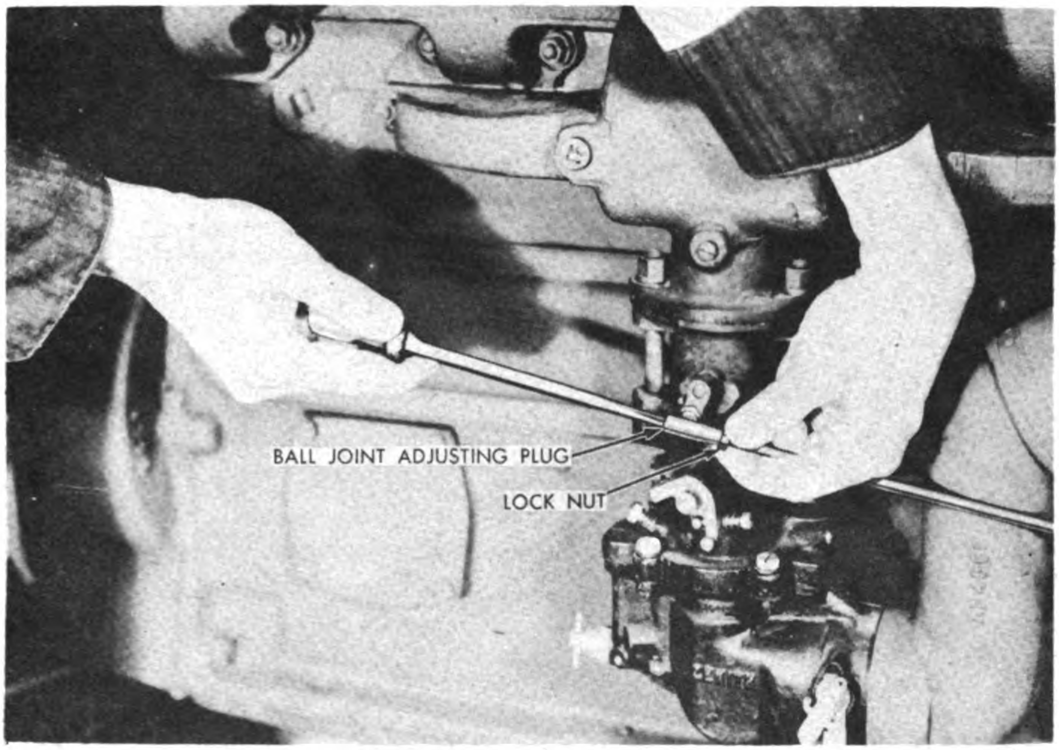


Figure 29. Adjusting Governor Ball Joints

57. ADJUSTING GOVERNOR LINK ROD

With engine stopped, loosen both the ball joint locknuts, remove the ball joints from the governor arm, and, with the governor throttle in wide open position, adjust the rod by turning the ball joint either to the right or left, depending upon the adjustment required. The rod must be so adjusted that when the engine is stopped the rod holds the governor throttle lever with a very slight amount of slack from the wide open position. See Figure 30.

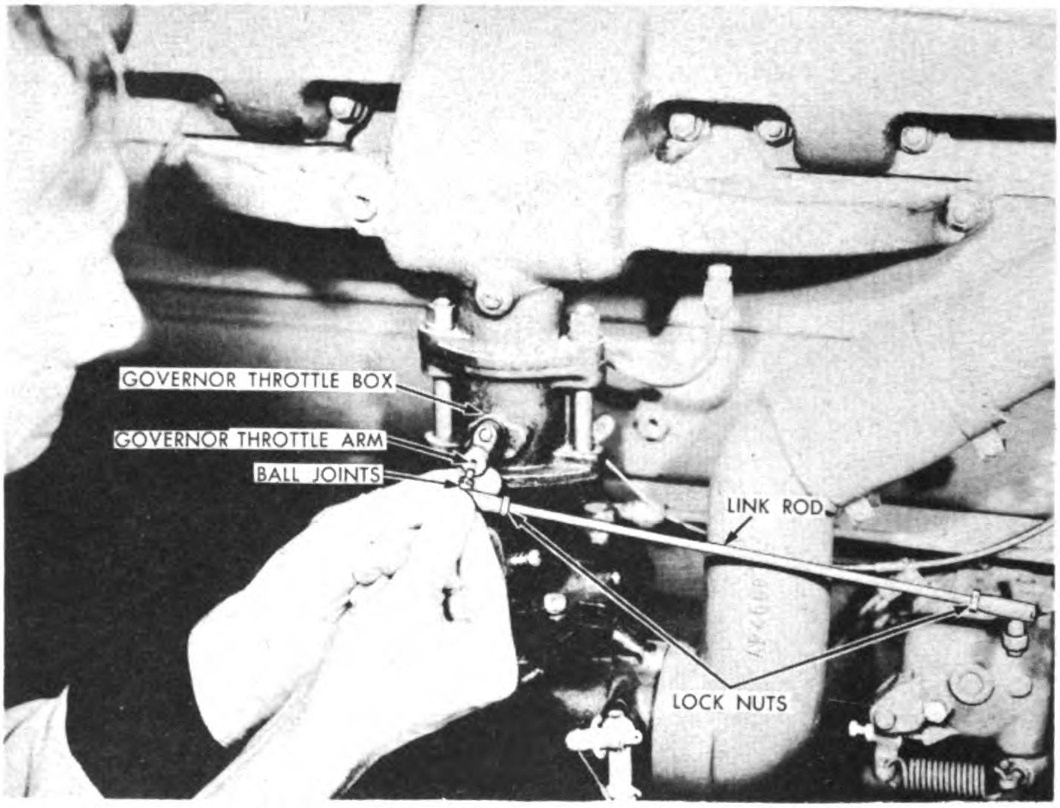


Figure 30. Adjusting Link Rod

J. MAGNETO

The magneto provides the electrical charge to the spark plugs at the instant it is required. See Figure 31. To lubricate the felt wick or adjust the interrupter points, it is necessary to remove the distributor plate which should be done as follows because the distributor gear is fastened to the distributor plate.

58. REMOVING AND REPLACING DISTRIBUTOR PLATE

See Figure 32. Turn the engine over until line on distributor gear is visible in the observation window.

Remove the four fastening screws and withdraw the entire distributor plate assembly. Adjustments or inspection can now be made. When replacing the distributor plate assembly, line on the distributor gear must be visible in the observation window. Engage magnet rotor shaft with rotor gear and tighten distributor plate fastening screws.

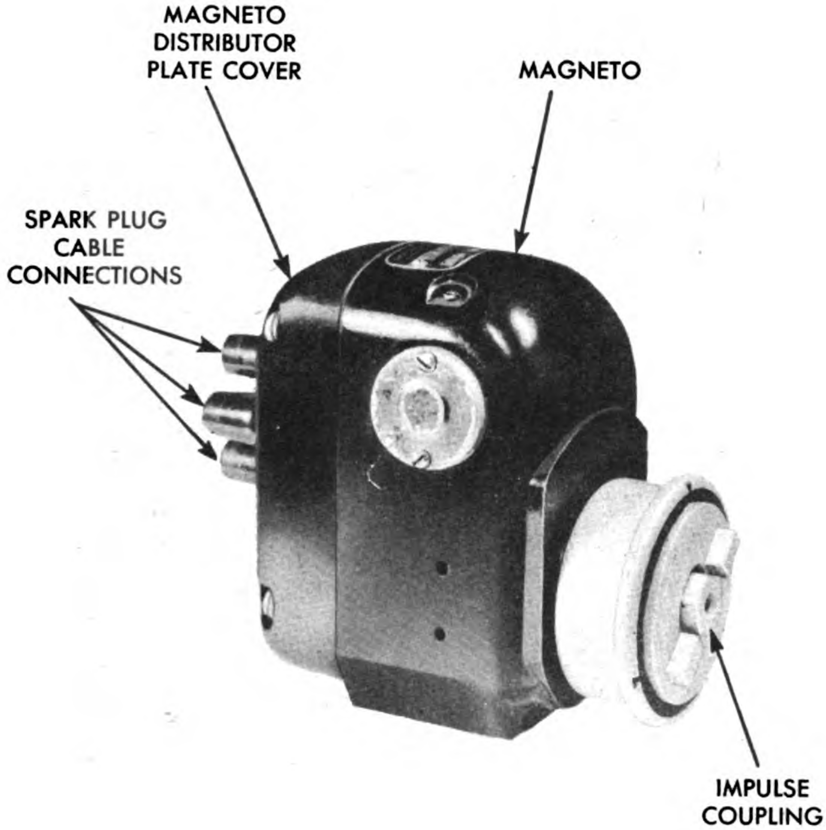


Figure 31. Magneto

NOTE: If the distributor plate assembly was removed before the instructions given above were noted, it will be necessary to rotate the engine until piston No. 1 cylinder (this is the cylinder nearest the fan) is in approximate firing position of the compression stroke. Rotate the distributor gear, until line is visible in observation window. Engage the magnet rotor shaft with rotor gear and slightly move the rotor gear in either direction as required to permit engagement. Tighten distributor plate fastening screws.

59. LUBRICATING THE FELT WICK

Remove the distributor plate and lubricate the felt wick, in Figure 32, with a small quantity of S.A.E. 50 or 60 oil. Extreme care must be used so that the contact points remain free from oil and grease. The contacts, in Figure 32, should be adjusted to an opening of .014 of an inch to .018 of an inch when the interrupter lever, in

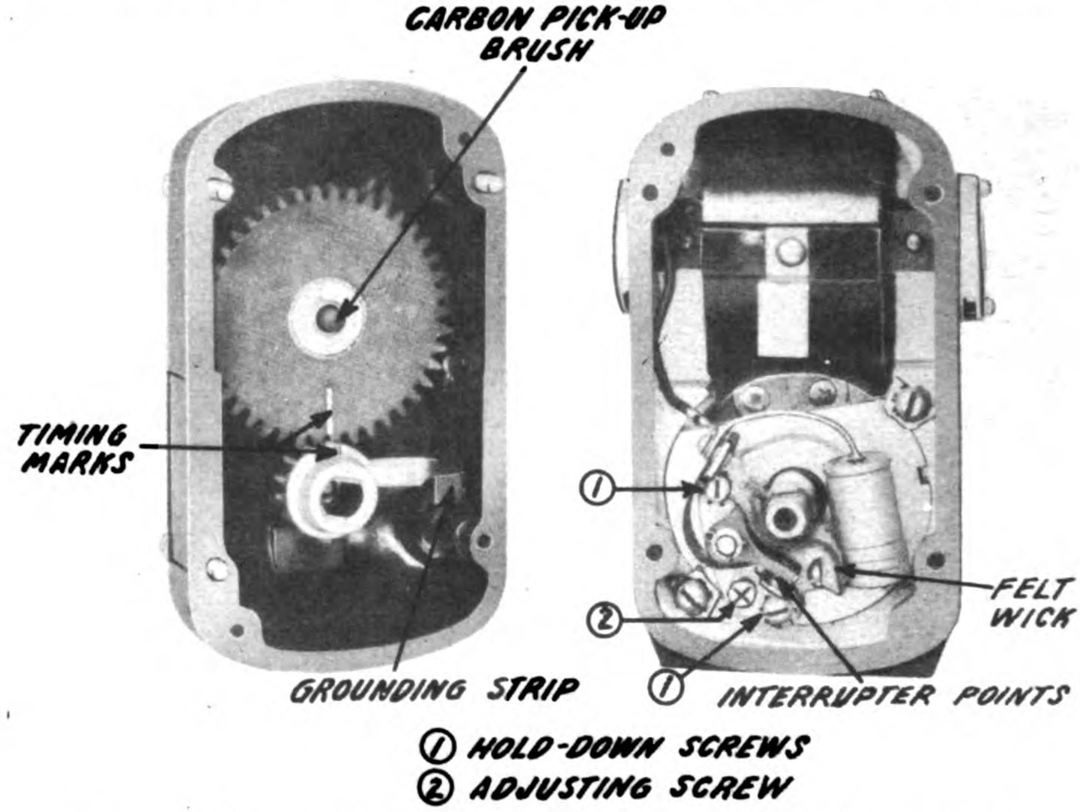


Figure 32. Magneto with distributor plate removed.

Figure 32, fibre bumper rests on top of the cam lobe This is done by shifting the adjustable contact bracket until the correct opening has been reached. After the adjustment, the bracket must be secured by means of its fastening screws. The contact points must be free from oil or grease and be in proper alignment so that the full surfaces of both contacts meet flush. Pitted contacts should be cleaned on a suitable stone. A file is not recommended.

60. TIMING THE MAGNETO

Turn the engine with the hand crank until the piston in cylinder No. 1 moves upward on the compression stroke. (The compression stroke can be obtained by turning the engine until the intake valve, second valve from fan end opens and closes - this necessitates removing the valve cover plate.) Carefully continue turning so that the top-dead-center line on the flywheel centers in the timing hole of the flywheel. See Figure 33. With a wrench on the crankshaft jaw, now back up the flywheel 2-9/16" as measured on the surface of the flywheel through the timing hole. Since the full 2-9/16" cannot be measured off as a

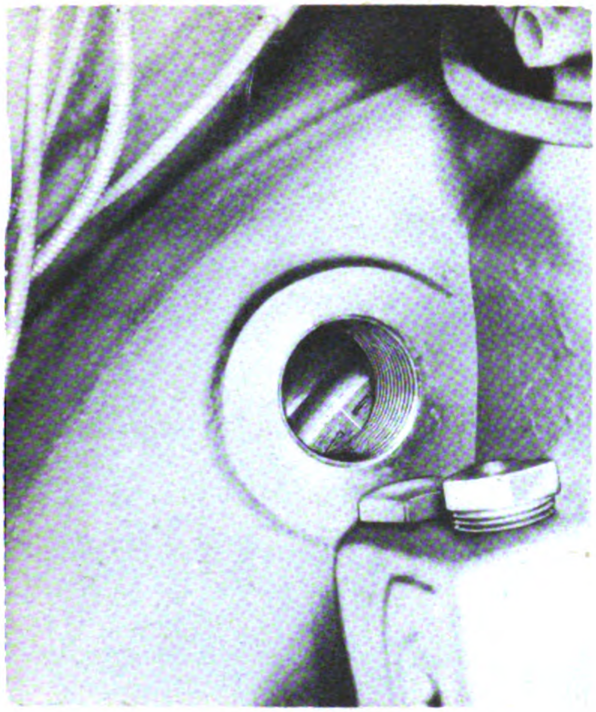


Figure 33. Timing Hole

whole, with a pair of dividers measure off 3/4" at a time. After three such measurements, and additional 5/16" will give the point at which the ignition should occur.

Then straighten the tabs on the lockwasher (see Figure 34) of the water pump half of the timing coupling, and loosen the nut. Tap lightly the adjusting coupling flange to loosen it from the tapered hub. Rotate the intermediate drive disc until the line on the distributor gear is visible in observation window. This operation is best performed by turning the armature in the opposite direction of rotation to that in which it will be given by the engine, thus eliminating the engagement of the impulse weights. Approximate timing is now obtained.

Remove the distributor plate by loosening the four screws. This will expose the interrupter assembly. To obtain the exact timing, the interrupter points must begin to open. It may be necessary, in order to get that position, to turn the impulse coupling in a clockwise or counter-clock direction. Install, and tighten the two coupling capscrews.

Reinstate the distributor plate and insert the cable between outlet No. 1 (mark on distributor plate) and cylinder No. 1, which is then timed to fire correctly.

Complete the installation by connecting the remaining cables of the magneto, to the spark plugs in their proper firing order, 1-5-3-6-2-4. The firing sequence on the distributor or high tension end of the magneto follows the opposite direction of rotation from the indicated by the arrow on the magneto name plate and this must be taken in-

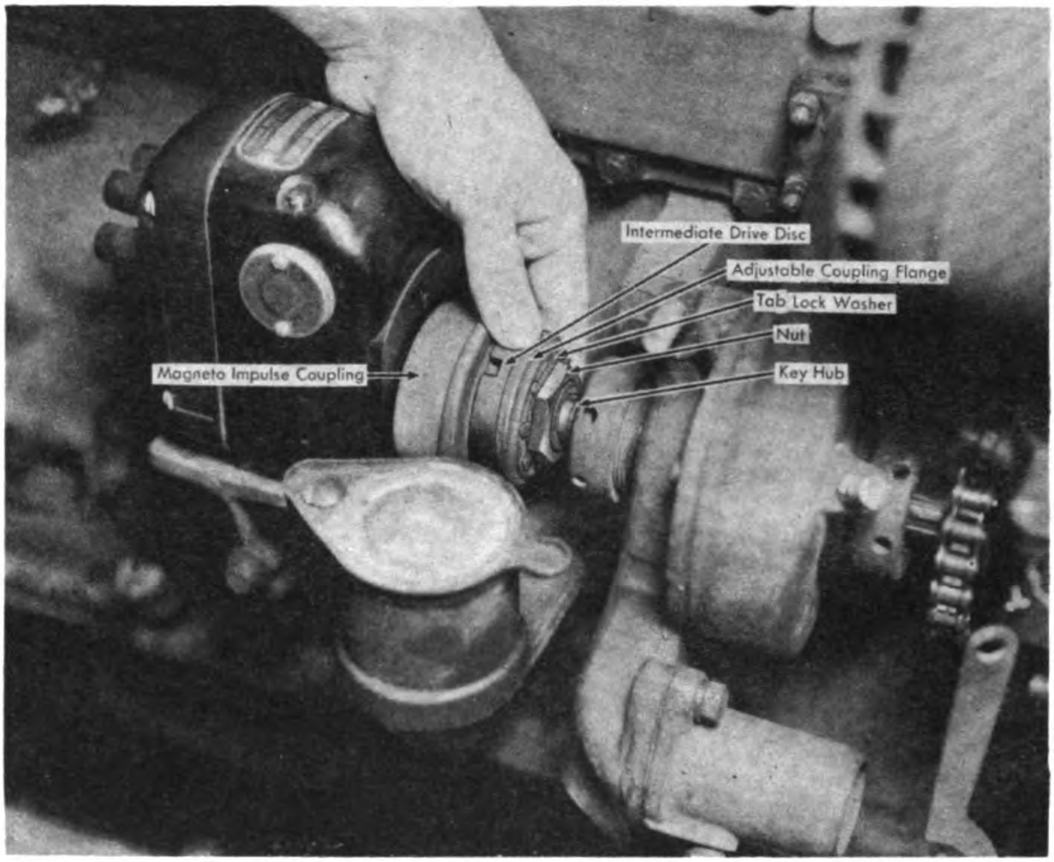


Figure 34. Timing Impulse Coupling

to consideration when the cables are connected to the spark plugs.

K. MANIFOLD

The manifold provides a means of entrance of the combustible gases into the combustion chamber and also a means of exit of the burned gases from the combustion chamber.

61. CHECKING A WARPED MANIFOLD

With a straight edge, check across the gasket faces lengthwise. If warped, the ends usually bow in and the center bows out. The manifold must be either replaced or machined by maintenance repair as outlined in the Maintenance Manual, Section II. Frequent blowing of the gasket is an indication of a warped manifold.

L. MAGNETIC SWITCH

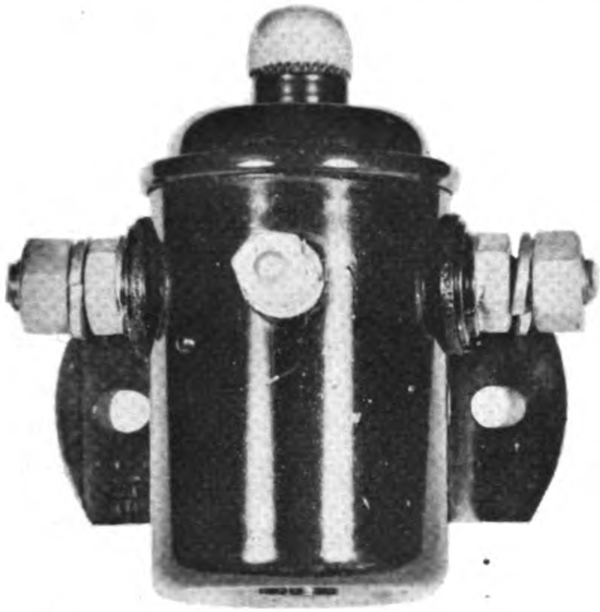


Figure 35. Magnetic Starting Switch

The magnetic starting switch comes as a complete unit or assembly and if worn or damaged must be completely replaced. Figure 35. The magnetic switch, when the push button switch is operated, completes the starting circuit between the battery and the starting motor. The push button switch is a simple button type with a retracting spring that opens the contact when the finger is removed from the button.

In time, the con- contacts of the magnetic starting switch will require resurfacing or possible renewal. Resurface perfectly flat with a fine mill file, then polish the surface on sandpaper laid on a perfectly flat surface. A rounded surface will not permit sufficient contact for heavy current.

M. OIL FLOAT

The oil float is a floating oil pump suction screen arranged to rise and fall with the oil level in the crankcase so that only the best oil is taken for the bearings - thus avoiding the sludge and the foam, either of which would cause bearing damage. See Figure 36.

62. CHECKING THE FLOAT

When the oil pan is removed, check the joints about which the body of the float swings. It must be free of any binding. A damaged tube on the float or a damaged casting in which the float tube pivots can cause binding at these points. The damaged part should be replaced. Since the tube cannot be removed from the float body as-

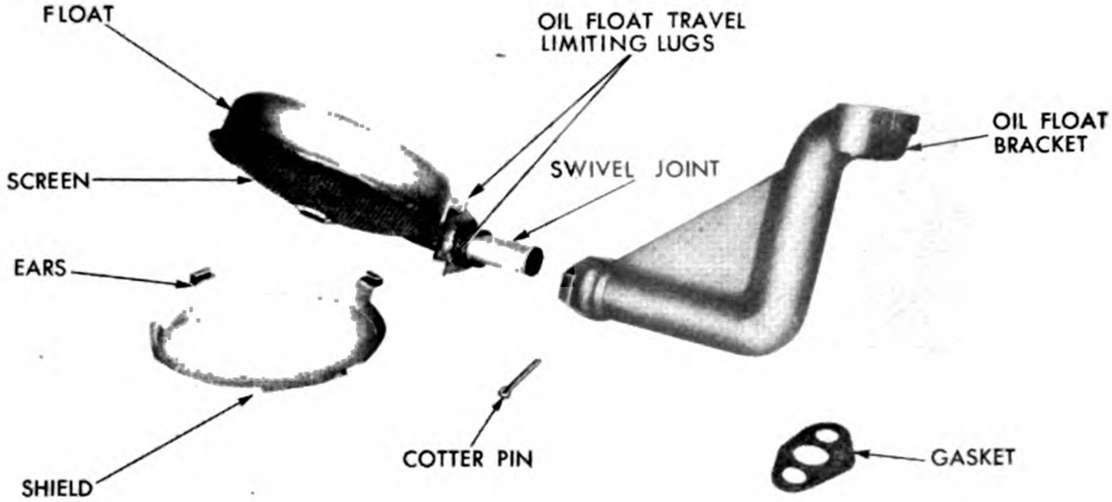


Figure 36. Exploded view of Oil Float

sembly, the entire unit must be replaced if the tube is damaged.

63. CLEANING THE FLOAT SCREEN

When the oil pan is removed, examine the screen and if necessary, clean it by removing the float and washing it in gasoline, naptha, or a good cleaner. Blow the screen with compressed air. If the fouling is particularly bad, bend out the ears, and remove the shield. The screen can then be thoroughly cleaned with a wire brush. The shield should be carefully positioned, and the ears turned back over the body flange. Clinch the ears with pliers, never use a hammer.

N. OIL PAN

64. CLEANING OUT THE SLUDGE

Remove the oil pan and wash out the sludge with kerosene. If the sludge is thick, the engine is being incorrectly operated, and an investigation of operating conditions should be made. Sludge is the result of moisture being present in the oil pan. The moisture is caused either by the natural sweat of the engine, leaky piston rings, or water in the oil.

O. OIL FILTER

The oil filter removes dirty particles that are the result of engine operation. Not only does the filter help to cut down engine wear, but also to prolong the usefulness of the oil.

65. RENEWING FILTER ELEMENT

Unscrew the cover assembly by turning the handle at the top of the filter counter-clockwise until the threads disengage. Remove the drain plug to drain the accumulation in the sump and to break the vacuum created while removing the element. Pull out the dirty element by the wire handles. Flush out the filter housing with kerosene. Insert the new element and replace the drain plug. Inspect the top gasket; if recessed, replace it with a new non-laminated DeLuxe gasket. With filter completely assembled, check for leakage by running the engine till filter is warm. See Figure 13.

P. RADIATOR

With the air pulled through the radiator tubes by the fan, the radiator cools the water in the cooling system. It is important that only clean, soft water be used in the cooling system. The use of hard water will cause scale to form in the engine jackets and in the radiator, thereby tending to clog up the circulation. Where the use of hard water cannot be avoided, use a commercial water softener.

66. FLUSHING RADIATOR

Drain the radiator, refill and flush it. Examine the hose connections for disintegration. Anti-freeze solutions have a tendency to cause the rubber hoses to deteriorate. Particles of rubber thus pass into the system and fill up the water passages. If the system is clogged, attach a hose to the bottom of the radiator at the drain hole, and turn on 20 or 30 pounds of water pressure. This reverses the flow and will tend to carry the dirt, which has been lodged down in the tube, back upward and out through the top of the radiator. While doing this allow the radiator to overflow through the top. If the radiator is so badly clogged that this does not serve to free the circulation, then the following steps must be taken:

67. CLEANING THE RADIATOR

Use a solution of one part of muriatic acid to three parts of water in sufficient quantity to fill the radiator, or a solution made up with three or four cans of commercial lye added to a sufficient quantity of water to fill the cooling system. Allow either of these solutions to stand in the system for three or four hours. Drain the radiator and thoroughly flush the cooling system with clean water. After flushing, fill with clean water.

CAUTION: Do not use liquid solder or radiator compounds to stop leaks, as these tend to clog the radiator tubes. A leaky radiator should be repaired in the regular manner by maintenance repair as outlined in the Maintenance Manual (Section II).

Q. SPARK PLUGS

The spark plug has two electrodes so arranged that, when the high-tension electric current passes through the plug, a spark is produced which ignites the compressed gas mixture. The center electrode is insulated and the outer electrode is grounded.

68. CHECKING AND ADJUSTING SPARK PLUGS

Figure 37. Checking Spark Plug gap

The gap between the electrodes should always be set at .025 inch. Use a wire feeler gauge as shown in Figure 37 to check the gap. Inspect the porcelain for cracking and chipping; if porcelain is damaged, discard the plug. Where possible, use a spark plug sand blaster to clean, or scrape off the carbon with a knife. The outside of the porcelain should be kept free from oil and dirt on which moisture can collect and "short" the plugs. Spark plugs should be renewed every 1,000 hours of operation.

69. CHECKING MISFIRING SPARK PLUGS

To find the plug, or plugs, not firing, ground a screwdriver to the block (as shown in Figure 38) and tilt the screwdriver to contact the metal terminal on the cable connecting the spark plug to the magneto. The plugs, or plug, not firing will have no effect on the running of the engine when shorted by the screwdriver, and indicates misfiring.

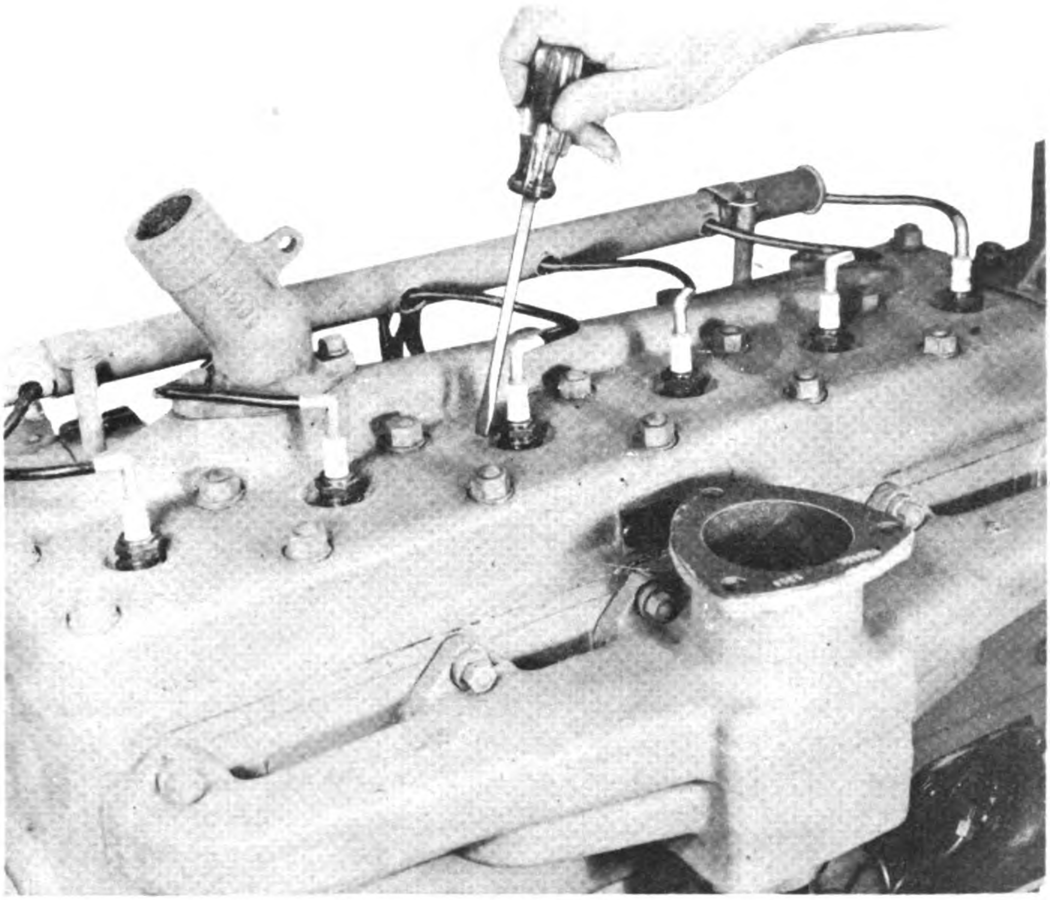


Figure 38. Checking for misfiring spark plug

R. STARTING MOTOR

The starting motor cranks the engine; however, it does not start the engine, because the actual starting is a function of the engine itself. A Bendix drive keyed to the armature shaft automatically engages the cranking pinion with the flywheel gear as the armature begins to revolve when the magnetic switch is closed. When the engine fires, the overrunning effect of the flywheel on the pinion disengages it from the flywheel. See Figure 39.

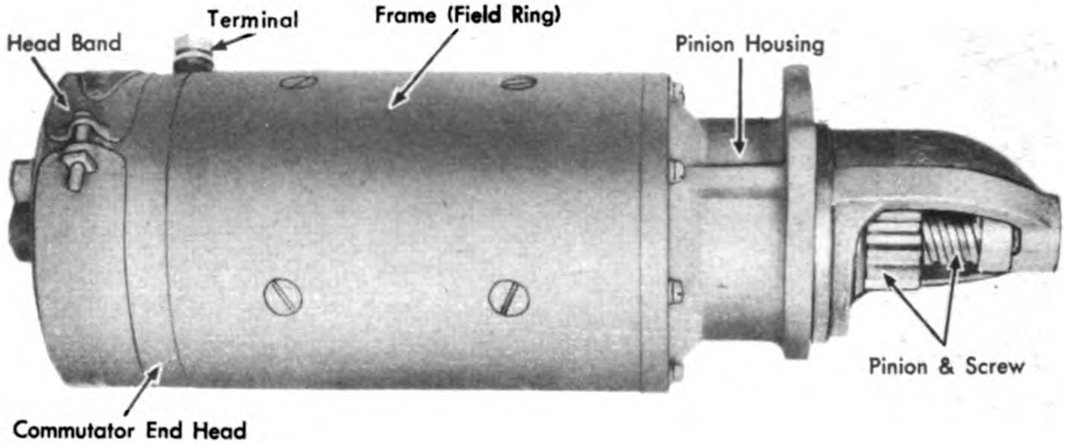


Figure 39. Starter Motor

CAUTION: Avoid prolonged cranking, as this may cause overheating of the cranking motor and the battery. If the engine does not start in a few seconds, investigate and correct the cause. The cranking motor must be used only when the engine is free of other loads. Be sure the clutch is disengaged.

70. CHECKING AND CLEANING COMMUTATOR

If the commutator becomes slightly rough or coated, it will be necessary to remove the starting motor from the engine, take off the end plate and brush assembly and with a strip of No. 00 sandpaper, holding the ends of the paper in each hand, polish the surface smooth. Do not use metal for holding sandpaper and do not use emery cloth for cleaning. If the commutator has high mica or is out of round, it must be machined and the mica undercut. This will necessitate removing starter from engine. This procedure is outlined in the Maintenance Manual (Section II).

71. CHECKING AND SERVICING BRUSHES

The brushes should be checked for wear, sticking or insufficient spring pressure. New motor brushes are 13/16 inches long, and the brushes must be replaced when they are worn down to 1/2 inch in length. Grind in the new brushes with No. 00 sandpaper held on the contour of the

commutator with the sanded side against the brush. Then pull the sandpaper in the direction of the rotation of the armature, as shown in Figure 25, the same method that is used in seating generator brushes.

The brushes must move freely in the holders. If they are oily or dirty, clean the brushes in unleaded (not-ethyl) gasoline, but do not soak them. If brushes are caked with any substance, remove with fine sandpaper laid on a true, flat surface. Do not sand them excessively or round the contact edges of the brush.

For new full length brushes there is usually enough spring pressure when the brush spring ends are in the first notch of the lever. When the brushes are worn down to 21/32 inch long, or if "arcing" is occurring between the brush spring ends in the second notch, counting from the brush end of the lever. If the spring temper has been taken out by overheating, replace the brush holder. Attempting to use worn-out brushes may cause overheating of the brush springs.

72. CHECKING, CLEANING, AND REPAIRING THE BENDIX DRIVE

Remove the starter from the flywheel housing. To remove the Bendix, first loosen the shaft spring screw, which is accessible through the hole in the pinion housing. Take out the housing screws and slide the pinion housing and the Bendix off the shaft. See Figure 39. If Bendix is worn or the spring distorted, they should be replaced. When re-assembling the Bendix on the shaft, give the shaft a thin coating of light oil.

S. TAPPETS

73. The tappets bear directly on the ends of the valve stems and provide a means of adjusting the valve so they will seat and open correctly.

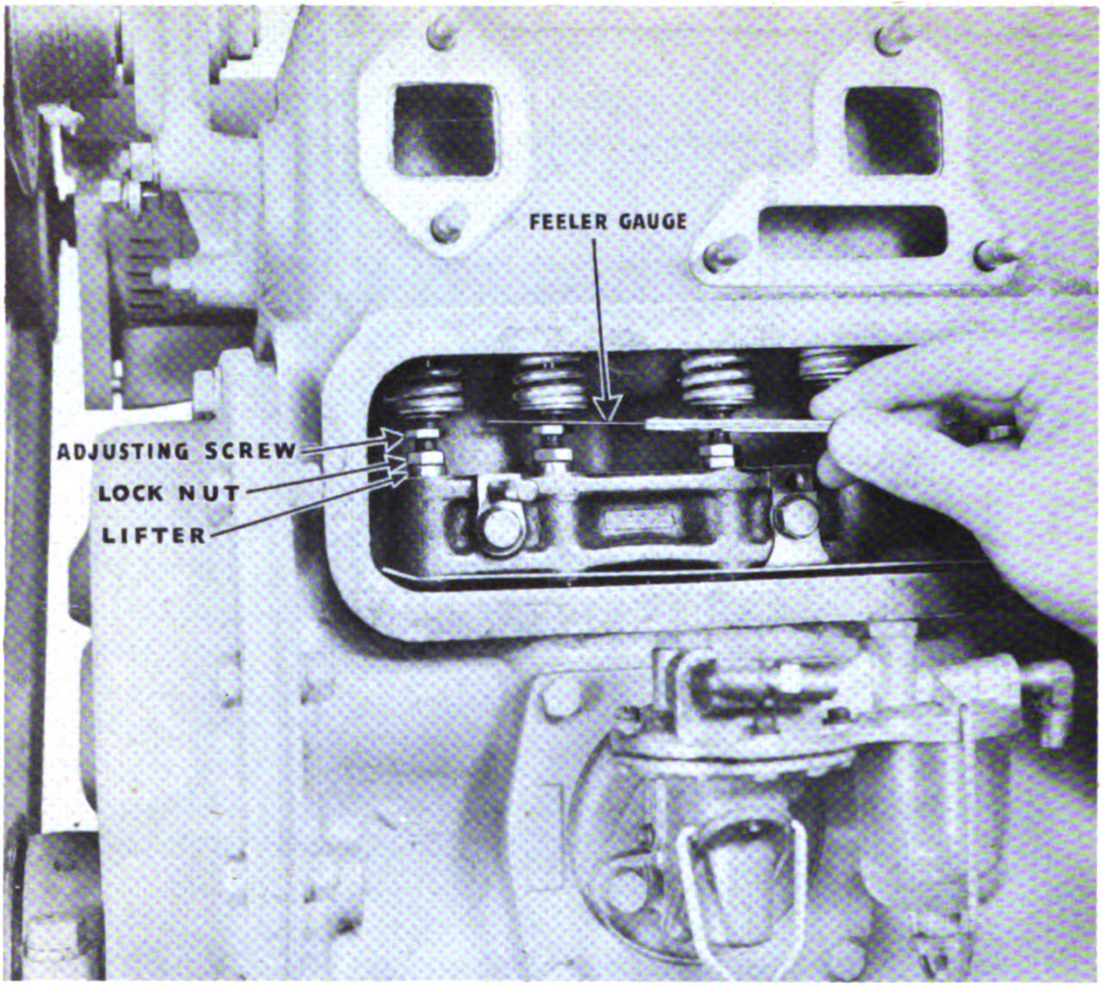


Figure 40. Adjusting Tappets

74. CHECKING TAPPET CLEARANCE

It is of utmost importance that at all times there is the correct amount of clearance between the tappets and the valve stems.

To check this clearance (see Figure 40): First remove the valve cover plate. Turn the engine over by hand until the intake valve closes on the particular cylinder you are working on. Continue to turn the engine 1/2 revolution to be certain that the cam is out from under the lifter. The piston is now approximately at top dead center, and both the intake valve and exhaust valves are in position for checking or adjusting. Figure 41 shows the positions of the exhaust and intake valves.

With feeler gauge, check the clearances: For the intake valve on a hot engine, .006"; for the exhaust valve, .009".

To adjust: The lifter must be held rigid while loosening the middle locknut. Turn the top adjusting screw in either direction, depending upon the adjustment that is needed, until the correct clearance is checked. Tighten locknut and check to be sure that the adjusting screw has not moved. Repeat this procedure for all the valves and bear in mind that both the intake and exhaust valves can be checked together for that particular cylinder. CAUTION: The position for adjusting and checking is determined by the closing of the intake valve; therefore check the ports in the manifold to be certain that it is the intake valve you are closing to obtain the proper position as shown in Figure 41.

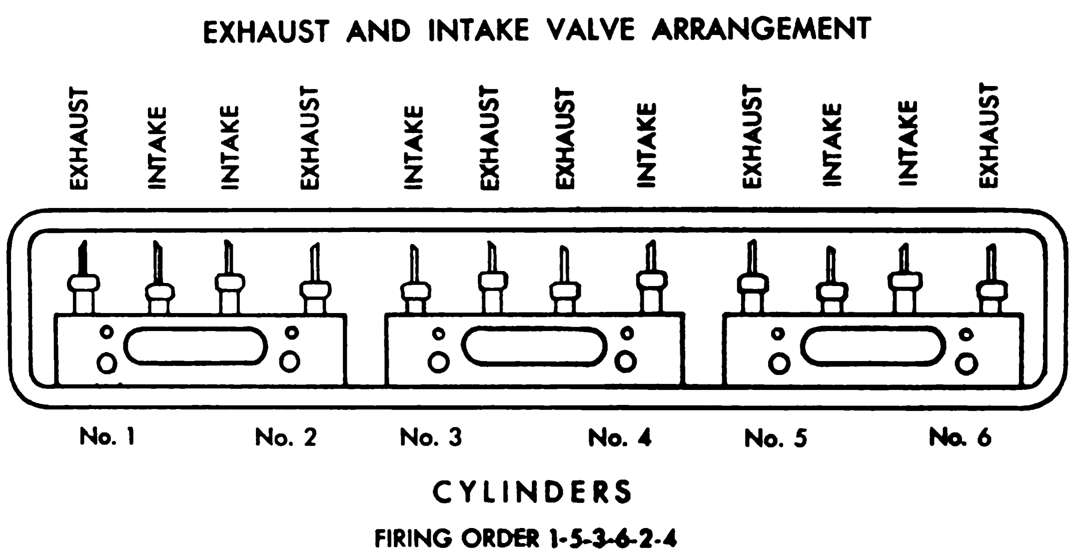


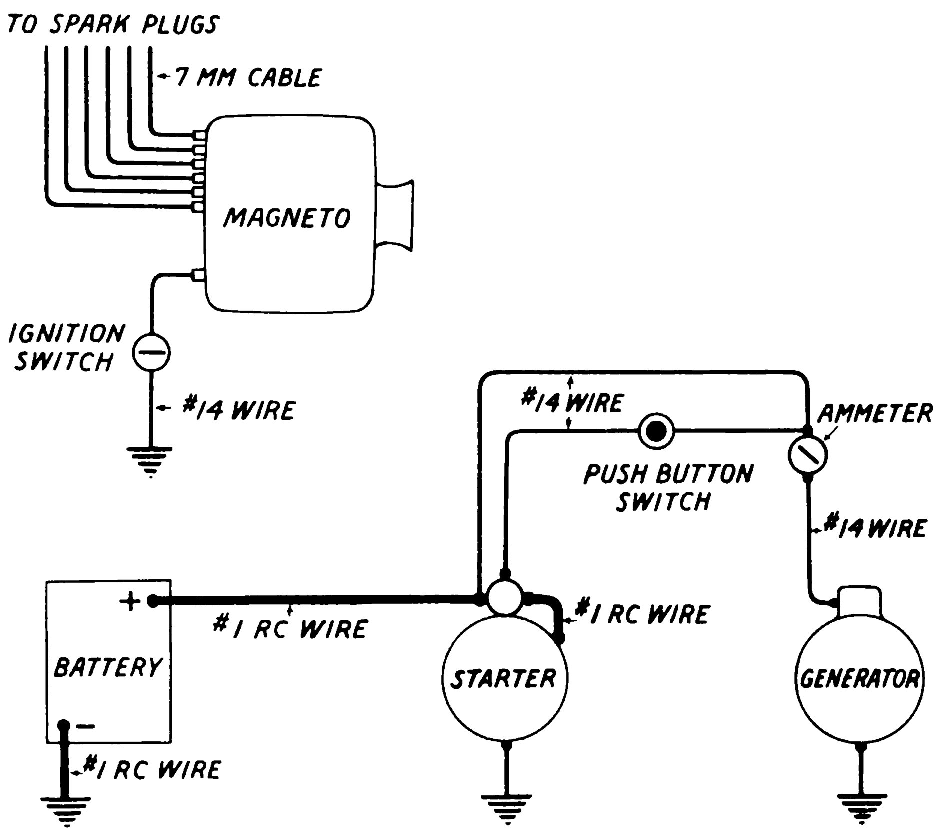
Figure 41. Valve arrangement

T. WIRING

The cables or wires carry the electrical current from the source of supply to where it is used or stored. See Figure 4.

75. CHECKING AND REMOVING WIRING

The wiring should be kept free from grease and oil which causes the insulation to crack and break down. When the cables show signs of cracking or the wiring becomes frayed, replacement is necessary, for they are no longer waterproof. CAUTION: The wires or cables needing replacement must not be replaced with other than the specified size cables as indicated in the Wiring Diagram. If smaller cables or wires are used, the flow of current is restricted, which will result in inefficient operation of the electrical system. Keep the ground cable free from corrosion at the battery terminal connection.



OPERATING ADJUSTMENTS AND REPAIRS

Chapter VII

TROUBLE SHOOTING AND EMERGENCY TREATMENT

76. Over 90% of engine trouble can be prevented by good preventive maintenance as outlined in Chapter V. The time and energy consumed in preventive maintenance is only a fraction of what must be incurred when trouble ties up operations.

To remedy as quickly as possible, troubles that may develop,the following list of symptoms, cause and remedies is given. Where the remedy is not within the scope of the operating personnel, it is so indicated in the "Remedy" column. This means that the engine needs the attention of the maintenance shop, which has the necessary tools, skill and data, as cutlined in the maintenance manual (Sec. II).

77. EMERGENCY TREATMENT

With an engine which has been submerged in fresh water or salt water, a complete tear-down is necessary. Although this is a job for the maintenance repair personnel, there are certain steps the operating personnel can take to aid in salvaging the engine.

Because it is so important that air be kept from contacting the wet steel and iron parts, it is oftentimes much better to allow the engine to remain under water if the maintenance repair personnel cannot immediately service the submerged engine. Of course, the engine should not remain under water for an unreasonable length of time. NOTE: Too much stress cannot be given to the importance of working quickly if it is expected that the engine is to be salvaged. Therefore, arrangements must be promptly made to dismantle the engine as quickly as possible and to thoroughly clean and slush each part.

All parts of the engine should be thoroughly dried and coated with oil to prevent the air reaching them. If the submersion occurred in salt water it is recommended that as soon as the engine is dismantled all parts other than electrical equipment be washed in hot fresh water, dried, and slushed with lubricating oil that has been heated to 180°F. Electrical equipment such as starters and generators, should be thoroughly flushed with fresh water, dried and overhauled before using.

If circumstances are such that the operating personnel can dismantle the engine, they should do so, thoroughly drying and carefully handling the machine surfaces so as not to mar or injure them, leaving the job of reassembly of the engine to the maintenance repair personnel.

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY or "WHAT TO DO"
A. Engine Hard to Start	1. Water in the fuel.	1. Let stand. When the water has settled to the bottom, drain the water from the carburetor, sediment bowl and gasoline tank.
	2. Gasoline flow obstructed.	2. Check fuel lines, carburetor screen, the fuel valves in the carburetor, and the sediment bowl. Locate and remove obstruction.
	3. Improper valve clearance	3. Adjust. (See Tappet Adjustment.) Chapter VI.
	4. Spark plug gap too wide or plug is shorted	4. Adjust gap. (See Spark Plugs Chapter VI) If short is caused by cracked porcelain, replace with a new plug.
	5. Defective wires.	5. Replace with new wires.
	6. Improper gas mixture.	6. Adjust. (See Carburetor Adjustment Chapter VI).
	7. Incorrect Timing.	7. See Ignition Timing. (Chapter VI).
	8. Leaks at the intake manifold	8. Tighten manifold to cylinder block and the carburetor to the manifold. If gaskets are defective, replace, and check the manifold for warping; if warped, it must be machined as outlined in the Maintenance Manual (Section II).

TROUBLE	PROBABLE CAUSE	REMEDY or "WHAT TO DO"
A. Engine Hard to Start (Cont.)	9. No compression.	9. Valves not seating properly. This is a job for maintenance repair. Piston rings may also be worn out and should be replaced as described in Maintenance Manual (Chapter II).
	10. Carburetor choke not set properly.	10. Adjust. See Carburetor Adjustment. (Chapter VI).
	11. No spark at the plugs.	11. Distributor breaker points not opening. Adjust. Ground wire may be shorted, or faulty switch connections. Check and connect. This may also be due to internal trouble in magneto - a job for maintenance repair. See Maintenance Manual. (Chapter II).
B. Engine Stops Suddenly	1. No fuel	1. Refill tank.
	2. Carburetor fuel valve closed.	2. Check carburetor fuel valve. (See Chapter VI Carburetor Adjustments).
	3. Dirt in fuel.	3. Drain out. Refill with fresh fuel only after sediment bulb, carburetor and gasoline tank have been cleaned. (See Fuel System Chapter VI)
	4. Dirt in filter.	4. Clean the carburetor and air filters..

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY or "WHAT TO DO"
	5. Water in fuel.	5. Follow instructions of Trouble A, Remedy 1.
B. Engine Stops Suddenly (Cont.)	6. Plugged fuel lines.	6. Disconnect fuel lines, blow and remove obstructions.
	7. Ignition failure.	7. See Magneto (Chapter VI)
	8. Internal Breakdown.	8. This is a job for maintenance repair.
	1. Spark Plug fouled.	1. Remove carbon with a pocket knife
	2. Spark plug gap not properly adjusted	2. Adjust as outlined under Spark Plugs (Chapter VI).
	3. Chafed wiring, broken cable or loose connections.	3. Replace or tighten the connections.
C. Engine Misses	4. Leaks at cylinder head Gasket	4. Tighten head or replace gasket. (Chapter VI Cylinder Head Gasket).
	5. Leaks at the intake manifold gasket.	5. Replace gasket and check the manifold for warping.
	6. Warped valves.	6. This is a maintenance repair job, as outlined in Maintenance Manual 1-A.

TROUBLE	PROBABLE CAUSE	REMEDY or "WHAT TO DO"
C. Engine Misses (Cont.)	7. Stuck valve.	7. Remove valve cover and with screwdriver free the sticking valve. Valve stem and guide will have to be cleaned to restore proper clearance. If condition continues, valves need regrinding. This then becomes a maintenance repair job as outlined in the Maintenance Manual.
	8. Valve tappets out of adjustments.	8. Adjust. (See Tappet Adjustment. Chapter VI).
	9. Engine overheats, causing valves to stick.	9. Check cooling system. Do not add cold water immediately. Allow engine to cool to avoid cracking the cylinder head. Free the valves by cleaning the valve stems.
D. Engine Knocks	1. Carbon in combustion chamber, "pinging"; knocking in the cylinder.	1. Remove cylinder head, scraps and clean out carbon. (See Maintenance Manual 1-A Chapter II).
	2. Loose connecting rod bearings. (Sharp knock-low oil pressure).	2. This is a job for maintenance repair as outlined in the Maintenance Manual
	3. Loose main bearings (heavy thump) low oil pressure.	3. This is a job for maintenance repair as outlined in the Maintenance Manual

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY or "WHAT TO DO"
D. Engine Knocks (Cont.)	4. Loose piston pins (sharp double knock)	4. This is a job for maintenance repair as outlined in the Maintenance Manual.
	5. Piston and cylinder wear	5. This is a job for maintenance repair as outlined in the Maintenance Manual.
	6. Magneto timing fast ("pinging" knock in the cylinder if not caused by carbon).	6. See Magneto Timing, Chapt. VI
	7. Improper Tappet clearance.	7. Adjust. (See Tappet Adjustment Chapter VI).
E. Engine Overheats.	1. Iack of water.	1. Add water.
	2. Scales on water jacket.	2. Use solvent solution and thoroughly flush the cooling system.
	3. Particles of rubber hose. Sticks or other foreign substances inside the cooling system.	3. Remove by thoroughly flushing out radiator and cooling system. (See Radiator Chapter VI).
	4. Intake hose at pump collapses.	4. Replace with wire-reinforced hose.
	5. Damaged water pump caused by ice or other substances.	5. This is a maintenance repair job as outlined in the Maintenance Manual.

TROUBLE	PROBABLE CAUSE	REMEDY or "WHAT TO DO"
	6. Lubricating oil thin or dirty.	6. Drain oil and add new oil of correct viscosity for the prevailing temperature. See Lubrication, Chapt. III
	7. Broken fan belt, or belt is slipping.	7. Replace if broken, or adjust tension as outlined under Fan Belt Tension, Chapt. VI. If slipping is caused by grease, it may be necessary to replace the belt.
	8. Carburetor choke not set properly.	8. Adjust. See Carburetor Adjustment. Chapter VI.
E. Engine Overheats. (Cont.)	9. The core of the radiator clogged with bugs and leaves.	9. Remove by use of air hose or whisk broom.
	10. Leaky radiator.	10. Repair. Do not use quick stop-leak solders as these tend to clog the circulation. Lead solder must be used.
	11. Engine running in close quarters, not getting enough ventilation.	11. Open up the ventilation.
	12. Loose timing coupling bolts- incorrect setting.	12. Tighten; If incorrect setting. See Timing Coupling. Chapt. VI

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY or "WHAT TO DO"
F. Loss of power.	1. Low oil pressure, due to (a) external oil leaks, (b) thin oil, or (c) sticking of oil relief valve.	1. (a) Repair leaks by tightening the line. (b) Drain and fill with fresh oil. (See Lubrication Chapt. III). (c) Remove oil relief valve and clean it. Do not stretch spring. See Chapt. VI.
	2. Faulty ignition or timing.	2. See Magneto, Spark Plugs and Cables in Chapt. VI.
	3. Leaky valve.	3. This is a job for the maintenance repair as outlined in the Maintenance Manual. However, if the leaky valve is caused by its improper adjustment, the operator can correct as outlined in Tappet Adjustment. Chapt. VI.
	4. Worn piston rings.	4. This is a job for maintenance repair as outlined in the Maintenance Manual.
	5. Blown cylinder head gasket.	5. Replace.
	6. Air cleaner obstruction.	6. Clean air cleaner and tighten connections. (Chapter VI).
	7. Obstruction in exhaust line.	7. Remove obstructions

TROUBLE	PROBABLE CAUSE	REMEDY or "WHAT TO DO"
F. loss of Power (Cont.)	8. Choke valve out of adjustment.	8. Adjust. (See Carburetor Adjustment Chapter VI)
	9. Improper governor butterfly valve adjustment.	9. See Governor Adjustment Chapt. VI
	10. Improper fuel	10. Be sure to use only a good gasoline.
	In high altitude operation there is approximately 3% loss of horse power per 1,000 feet of altitude.	
G. Smoky Exhaust	1. Carburetor float sticking. (Black smoke).	1. Tap carburetor lightly with hammer handle. If this does not correct the condition carburetor must be cleaned. (Chapter VI).
	2. Carburetor needle valve open; too much black smoke.	2. Adjust. (See Carburetor Adjustment. Chapter VI)
	3. Worn piston rings and out of round and tapered cylinders. (Blue smoke).	3. This a job for maintenance repair as outlined in the Maintenance Manual.
	4. Thin lubrication oil. (Blue smoke).	4. Use oil of correct viscosity.
	5. Oil level too high.	5. Drain surplus oil from crankcase.

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY or "WHAT TO DO"
H. Explosion in Exhaust	1. Late ignition.	1. Retime ignition. See Magneto timing. Chapt. VI
	2. Weak spark.	2. Check Coil, Spark Plugs and Cables. Chapt. VI
	3. Partially Open exhaust.	3. (a) Remove grime from valve stem, (b) Adjust tappet clearance, (c) Replace broken spring.
	4. Warped exhaust valve.	4. This is a job for maintenance repair as outlined in the Maintenance Manual.
I. Engine Runs irregularly (sputters)	1. Out of adjustment.	1. See Carburetor Adjustment, Chapt. VI
	2. Leaky valves.	2. This is a job for maintenance repair as outlined in the Maintenance Manual.
	3. Leaky intake manifold.	3. Tighten or replace gaskets: if manifold is warped it must be machined (maintenance repair job).
	4. Air leaks in gaskets	4. Tighten or replace gaskets.
	5. Partially closed tank shut-off valve.	5. Open valve

TROUBLE	PROBABLE CAUSE	REMEDY or "WHAT TO DO"
I. Engine Runs irregularly, (sputters) (Cont.)	6. Water and sediment in carburetor	6. (a) Let water settle to bottom, and drain, (b) Drain out sediment and clean screens (Chapter VI).
	7. Fuel lines partially blocked.	7. Check line and remove obstruction and any kinks in tubing.
	8. Clogged air cleaner.	8. Clean. (Chapter VI)
	9. Loose jets in the carburetor	9. This is a job for maintenance repair.
J. Generator does not charge	1. Commutator dirty.	1. Clean commutator. Chapt. VI
	2. Worn brushes	2. Replace. See brush replacement generator. Chapt. VI
	3. Blown field fuses.	3. Renew field fuse.
	4. Loose fan belt.	4. Adjust, as outlined under Fan Belt Adjustment. Chapt. VI
	5. Broken external connection.	5. Reconnect.
	6. Shorted armature.	6. This is a job for maintenance repair as outlined in the Maintenance Manual.

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY or "WHAT TO DO"
J. Generator does not charge (Cont.)	7. Shorted field	7. This is a job for maintenance repair as outlined in the Maintenance Manual.
	NOTE: Inspect for short circuits in the generator, requiring special test meters. This is a job for maintenance repair. The generator should be overhauled at the 2,048 - hour general inspection and overhaul period of the engine.	
K. Starter motor failure.	1. Broken connection.	1. Reconnect or replace cable.
	2. Faulty switches.	2. See Switches (Chapter VI). If magnetic switch needs repairs, have maintenance install new one.
	3. Battery dead, or low charge.	3. Recharge or renew.
	4. Commutator dirty.	4. Clean with No. 00 sandpaper; do not use emery cloth (Cnapter VI).
	5. Worn brushes.	5. Replace. See Brush Replacement under Generator, Chapt. VI
	6. Broken bendix.	6. Replace. See repairing Bendix Drive. Chapter VI.

TROUBLE	PROBABLE CAUSE	REMEDY or "WHAT TO DO"
K. Starter motor failure. (Cont.)	7. Bad teeth on flywheel gear.	7. Renew. This is a job for maintenance repair as outlined in the Maintenance Manual.
	NOTE: Any short circuit in the starter motor requires special test meters. This is a job for maintenance repairs, which has all the tools and data necessary, as outlined in the Maintenance Manual.	
L. No gasoline at the carburetor	1. Clogged fuel line.	1. Check the fuel lines between the tank and the carburetor.
	2. Float stuck (dirty needle valve.) Valve closed.	2. Tap the carburetor bowl gently - or remove the carburetor and clean the needle valve and float chamber. (See carburetor Chapter VI).
	3. Fuel tank empty.	3. Refill.
M. Engine Surges	1. Surge spring out of adjustment.	1. Adjust Governor as outlined in Chapter VI.
	2. May be caused by rich gasoline mixture.	2. Adjust Carburetor (Chapter VI).
N. Clutch overheats.	1. Slippage of clutch.	1. Adjust Clutch (Chapter VI).
O. Carburetor leaks gasoline when idling	1. Float stuck (dirty needle valve.)	1. Tap carburetor gently to dislodge the dirt in the fuel valve. If this does not correct the condition, remove the carburetor and clean the valve.

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY or "WHAT TO DO"
O. Carburetor leaks gasoline when idling (Cont.)	2. Float level incorrect.	2. Adjust. (See Carburetor Chapter VI).
	3. Drain plug not tight.	3. Tighten
P. Radiator Boils	1. Lack of water.	1. Add water.
	2. Frozen radiator.	2. Run engine for three minutes with blanket covering radiator. Stop for five minutes. Again run engine for three minutes and stop for five minutes. Continue this operation until radiator is thawed. Check for leaks. Do not run continuously to thaw, as water will boil away and overheat, thus seriously damaging the engine.
	3. Leaky Radiator.	3. Repair radiator. Do not use liquid solder, as it tends to clog the system.
	4. Faulty hose connections.	4. Tighten or replace hose.
	5. Internal collapse of suction hose at the pump.	5. Renew with wire-reinforced hose.
	6. Leaky pump.	6. This is a job for maintenance repair as outlined in the Maintenance Manual.

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY or "WHAT TO DO"
P. Radiator Boils (Cont.)	7. Dirt, rust, scales and sediment in the water jacket.	7. Use a solvent to remove; flush and drain entire system.
	8. Pieces of broken hose in system.	8. Remove by draining and flushing the system.

NOTES

NOTES

NOTES

MAINTENANCE MANUAL

BUDA

Model K428

Engine

for use in

KOEHRING COMPANY

Model 304 Crane

Engine built by

The BUDA Co.

Harvey, Illinois

INDEX

MAINTENANCE MANUAL

Buda Model K-428 Engine

CONTENTS

Buda Model K-428 Engine

CONTENTS - Continued

Chapter I

SPECIFICATIONS, TOLERANCES, TOOLS AND EQUIPMENT AND HINTS FOR THE MECHANIC

BUDA ENGINE, MODEL K428

TYPE

Vertical -en-bloc "L" head, four cycle, six cylinder

SIZE

Bore 4-3/8" (111.1 mm.)
Stroke 4-3/4" (120.6 mm.)

PISTON DISPLACEMENT

428 cu. in.

ROTATION

Clockwise, viewing the front or the fan end of the engine.

POWER

N.A.C.C. rating.	45.9
B.H.P. at 1000 R.P.M..	53
B.H.P. at peak	107
R.P.M. at peak of B.H.P.	2600
Torque in foot lbs. at peak.	280
R.P.M. at peak of torque	1200
B.H.P. at peak of torque	64

(Note: In all internal combustion engines there is approximately 3-1/2% loss of horsepower per thousand feet of altitude.)

SUSPENSION

3 point.

IGNITION

Magneto.

SPARK PLUGS

AC 87

CARBURETOR FLANGE

S.A.E. 1-3/4 in.

LUBRICATION

Force feed pressure to all crankshaft, camshaft, and connecting rod bearings, timing gears, - also, to piston pin bearings. Distributing effected through holes rifle drilled in crankcase. Oil pump drives directly from rear end of camshaft.

CAPACITIES

Crankcase Oil Capacity, 9 quarts.
Cooling System Capacity, 8-1/2 gallons.
Air Cleaner Capacity, 1 quart.

COOLING

Centrifugal pump driven from accessory drive shaft.
Pump shaft of stainless steel.

CRANKSHAFT

3" diameter statically and dynamically balanced.
Special open hearth No. 1045 S.A.E. steel forging, heat treated.
Number of bearings, 7.

CRANKCASE-CYLINDERS

One piece Ni-Chrome semi-steel casting.
Crankcase divided horizontally three inches below crankshaft center.
Removable cylinder head.

CONNECTING RODS

Special open hearth steel, drop forging. Heat treated.
I-beam sections are drilled out through entire length for piston pin lubrication.
Length, center to center - 9-1/2 in.
Diameter of connecting rod bolts - 1/2".
Number per rod - 2.
Babbitt is "spun in" large end of rod.
Phosphor bronze bushing at wrist pin end.

CAMSHAFT

Open hearth steel, case hardened, drop forged.
Gear driven.
Number of bearings - 4.

SPECIFICATIONS

PISTONS

Grey iron, carefully matched in weight.
Length 4-3/8".
Four rings - lower ring is an oil control ring.

PISTON PINS

Special case hardened alloy steel - diameter 1-1/4".

VALVES

Inlet valves - clear diameter 1-3/4" - chrome nickel steel.
Exhaust valves - clear diameter 1-5/8" - Silchrome No. 1 Steel.

VALVE LIFTERS

Mushroom type - grey iron casting with chilled head.

TIMING GEARS

Helical cut, 1-1/2" wide. Constant oil bath from pressure pump at point of gear contact.

CRANKSHAFT BEARINGS

Steel Shell - babbitt lined "precision bearings."
Diameter -
- Front, 3 in. (76.2 mm.)
- Intermediate, 3 in. (76.2 mm.)
- Center, 3 in. (76.2 mm.)
- Rear, 3 in. (76.2 mm.)

Length -
- Front, 1-3/4 in. (44.4 mm.)
- Intermediate, 1-1/4 in. (31.7 mm.)
- Center, 2-1/4 in. (57.1 mm.)
- Rear, 2-1/2 in. (63.5 mm.)

CAMSHAFT BEARINGS

Diameter
- Front, 2-1/4 in. (57.1 mm.)
- Second, 2-1/4 in. (57.1 mm.)
- Third, 2-1/4 in. (57.1 mm.)
- Rear, 1-1/2 in. (38.1 mm.)

Length -
- Front, 1-3/4 in. (44.4 mm.)
- Second and third, 1-1/4 in. (31.7 mm.)
- Rear, 1-1/2 in. (38.1 mm.)

CONNECTING ROD BEARINGS
Diameter, 2-3/8 in. (60.3 mm.)
Length, 1-3/4 in. (44.4 mm.)

PISTON PIN BEARINGS
Diameter, 1-1/4 in. (31.75 mm.)
Length, 1-1/2 in. (38.1 mm.)

BASE
Cast iron front and rear supports.

ACCESSORIES

Description	Buda Part No.	Manufacturer	Manufacturer's Model No.
Air Cleaner		Donaldson, Inc. St. Paul, Minn.	E 7764
Battery		Globe Battery Co. Milwaukee, Wis.	Z 89
Carburetor	K40487	Zenith Carburetor Div., Detroit, Michigan	X456
Clutch		Twin Disc. Clutch Co. Racine, Wis.	X7350A-Mod. B111P2 Spec. 17732
Fuel Pump	2903	A.C. Spark Plug Div., General Motors, Detroit, Michigan	A.C. 855758
Generator	K40506	Elec.Auto-Lite Co. Toledo, Ohio	GFA-4810
Governor	K40504	Pierce Governor Co. Anderson, Indiana	A 1729 F-13
Magneto	H11848	American Bosch Corp., Springfield Mass.	MJC-6C

ACCESSORIES - Cont'd.

Description	Buda Part No.	Manufacturer	Manufacturer's Model No.
Magneto Switch	AP5893	American Bosch Corp., Springfield Mass.	81663-14
Starter Motor	K40505	Elec.Auto-Lite Co. Toledo, Ohio	ML-4186
Push Button Starter Switch	2715	Delco-Remy Co. Anderson, Indiana	406 A
Spark Plugs	H11629	A.C.Spark Plug Div. Flint, Mich.	87-S
Oil Filter	H11677	The DeLuxe Products Corp., La Porte, Ind.	CSB-41-602-M
Ammeter	AP6592	United States Gauge Co., New York, N.Y.	
Oil Pressure Gauge	AP3883	United States Gauge Co., New York, N.Y.	444050
Magnetic Starting Switch		Delco-Remy Co., Anderson, Ind.	SS-4007
Radiator		Perfex Corp. Milwaukee, Wis.	R-2018-G

NOMINAL CLEARANCES FOR THE K-428 ENGINE

Fits should never be made tighter than the low limit values given in the table. Where engines are being reassembled with old gears the high limits specified for the gear fits may be larger than the values in the tables.

Piston to cylinder clearance:
.004 diam. clear, measured at extreme bottom of skirt at 90^{0} from center of piston pin hole with 10-14 lbs. pull on .003 thick x 1/2 wide ribbon gauge.

Compression ring gap:
.013 to .018 gap.
Oil ring gap:
.013 to .018 gap.
Fire ring to groove clearance:
.002 to .004.
Composition and oil control side clearance:
Above pin: .0005 to .002.
Below pin: .0005 to .0025.
Piston pin in piston:
.00025 to .00045.
Piston pin to rod bushing:
.00025 to .00045.
Care should be exercised in making these fits.
Crankshaft end play:
.003 to .009.
Main bearing clearances;
.003 to .0052.
Connecting rod side clearance:
.004 to .009.
Connecting rod bearing clearance:
.0015 to .003.
Camshaft bearing clearance:
.0014 to .004
Camshaft end play:
.005 to .008.
Idler gear end play:
.004 to .007.
Accessory gear end play:
.003 to .006.
All gear back lash:
Idler gear .002 to .004.
Accessory gear .002 to .004.

CLEARANCES

Valve stem to guide, intake and exhaust:
.002 to .004.
Tappet adjustment (set hot).
Intake .006, Exhaust .009.
Valve lifter or tappet fit to guide:
.0001 to .0009.
Water pump shaft to bushing:
.002 to .004.
Oil pump gears back lash:
Not over .002.
Oil pump gears to case:
Not over .002 to .003 on a side.
Oil pump gears to case flange:
To be flush.
Idler gear to stud clearance:
.0015 to .0025

TOOLS AND EQUIPMENT NEEDED

TOOLS

Socket Wrenches

1/2 inch, 7/16 inch, 9/16 inch, 5/8 inch, 3/4 inch, and 13/16 inch.
An 18 inch breakover handle.
A 12 inch extension

Open End Wrenches

5/16 inch, 3/8 inch, 7/16 inch, 1/2 inch, 9/16 inch, 5/8 inch, 11/16 inch, 3/4 inch.

Pipe Wrench

One 18 inches long.

Screw Drivers

One 1/4 inch blade, one 3/8 inch blade, one 3/4 inch blade. (Note: The 3/4 inch blade is for the front support plate screws; a drag link socket can be used instead.)

Pliers

One diagonal, one flat nose.

Hammer

Medium size, ballpein.
Lead hammer.

Pin Punches

One set 3/16 inch to 1/2 inch.

Chisels

One set, medium size.

Miscellaneous Tools

Valve lifter, putty knife, feeler gauge, piston ring compressor, gear puller, and machinists square, stub valve lifter, and valve grinder.

EQUIPMENT

Chain hoist, (1 ton), work bench and vise, valve refacer, and valve reseater, (if the latter two are not a part of the regular equipment, new valves can be ordered and the seats ground at a machine shop), cylinder grinder, piston pin hone, or reamer, small lathe, cylinder hone, connecting rod aligner.

Ammeters

One, range 0 - 600 amperes.
One, range 0 - 30 amperes.

Voltmeter

Range 0 to 10 volts

Electrical Test Equipment

Test light, storage battery with cables, and a spring balance 0 to 100 pounds.

Micrometer

Outside - 2 inches to 3 inches.
Outside - 3 inches to 4 inches.
Inside - 1/2 inch to 6 inches.

Tachometer

Range 50 to 10,000 R.P.M.

Carburetor Tools

The following tools are obtained from the Zenith dealer or from the Zenith factory, Detroit, Michigan, and are needed for overhauling the carburetor.

T-30016, fuel valve seat assembly, bolt and lower plug wrench, C-161-2, valve tool, C-161-5 extractor, C-161-9 (782932) idle jet wrench, C-161-25 (15517) cap jet wrench, C-161-81 (15522) main jet wrench, (30137) driver. C-181-168 gasket kit - C-182-347 Repair Part Kit.

Magneto Tools

American Bosch Tools
TSE 5265
TSE 76108
TSE 76101
TSE-5269
TSE 528
TSE 5238

American Bosch Magnetizer - 5210

HINTS FOR THE MECHANIC

1. Keep tools in efficient working order.

2. Good "housekeeping" in the shop saves time.

3. Never guess - always investigate the source of trouble.

4. Use the proper measuring gauges and electrical test meters - guessing is not accurate enough.

5. Every part, no matter how small, has a job to perform - don't overlook the smallest detail.

6. Carefully handle and store bearings and parts with machined surfaces, so as to prevent damage either by scratching or by falling objects.

7. Always use new gaskets. Whenever a piston, or pistons, are removed, replace the rings if they are more than 100 operating hours old, for it would be impossible to place the rings back in exactly the same position they "wore in".

8. Provide clean boxes for small parts, capscrews, and bolts, - never strew them on the bench or floor.

9. Don't send an engine "back to work" until you are certain that the engine and its accessories are in good working order.

Chapter II

GENERAL OVERHAUL

In this chapter, the necessary steps for a general overhaul will be considered in their recommended sequence. It is obvious that where it becomes necessary to repair the engine due to an accident to one or more of the parts all these steps may not apply.

And it is also pointed out that before the general overhaul, there are four servicings that the maintenance repair man will have to give the engine after every 1,024 hours of operation. They are grinding valves, checking the voltage regulator, the magnetic starting switch, and visually checking the engine and its accessories. The procedures for these servicings are given under the items involved, Valves, Chapter III, Voltage Regulator and Magnetic Switch, Chapter IV.

The general overhaul should take place after every 2,048 hours of operation when the engine and its accessories should be disassembled completely and any worn parts replaced. If this disassembly and inspection results in only a thorough cleaning of the engine and its accessories, much will have been gained in lengthening the engine life and enable it to give trouble-free performances.

STEPS OF DISASSEMBLY

The following steps are the recommended sequence of disassembly:

1. DRAINING ENGINE

Drain oil and water from the engine, water pump and radiator. See Figure 100.

2. REMOVING PIPE AND TUBING

Remove the exhaust pipe, gasoline and all copper tubing and the oil drain pipe at the bottom of the engine.

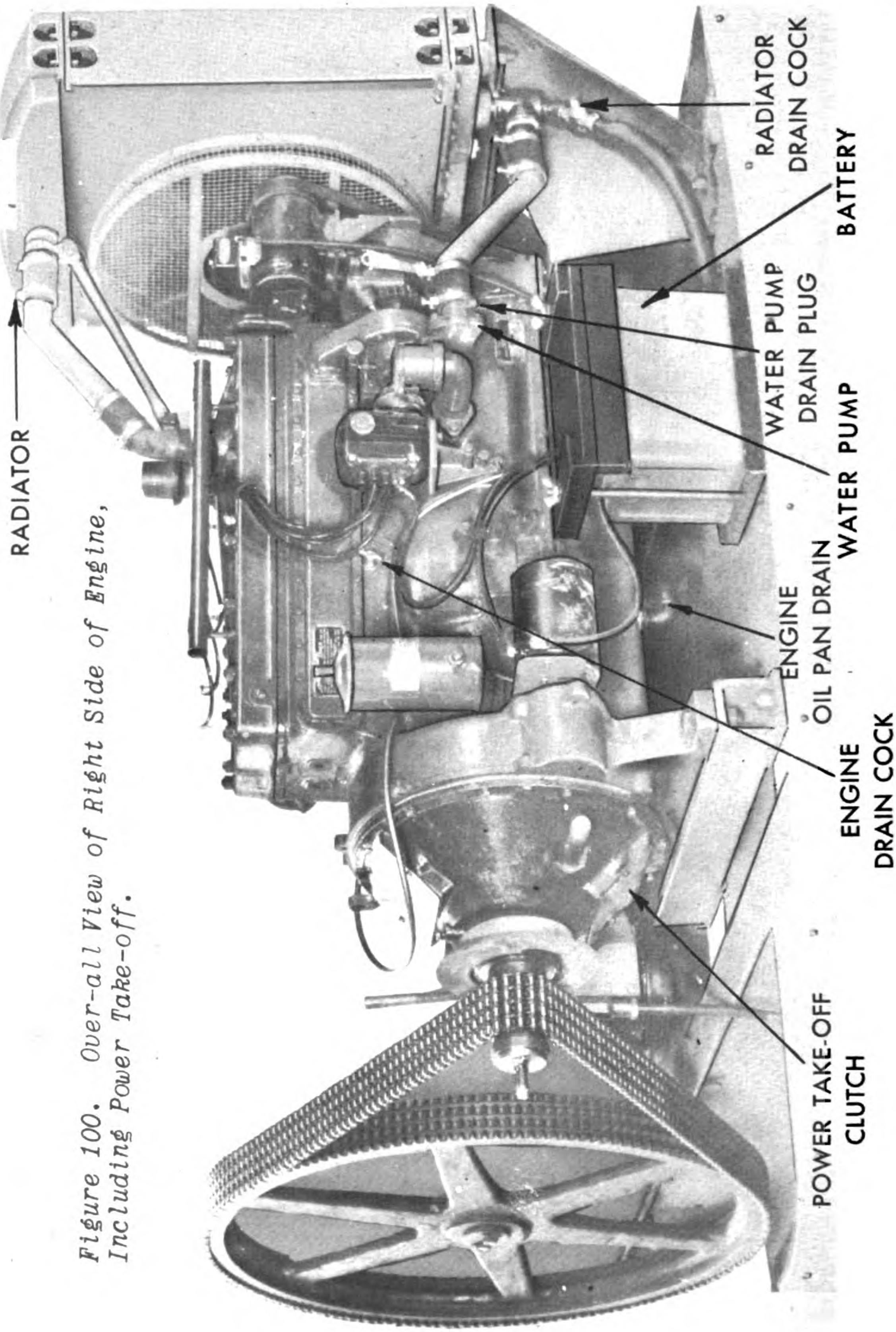


Figure 100. Over-all View of Right Side of Engine, Including Power Take-off.

3. DISCONNECTING THE BATTERY AND AIR CLEANER.

Disconnect the battery and remove the air cleaner and tubing that connects to the carburetor.

4. DISCONNECTING ELECTRIC WIRES, CABLES, ETC.

Disconnect the electric wires and the flexible conduit that houses the wires leading from the operators' panel. (Tie small tags to the wires at both ends and indicate where the wires lead to. This will aid in reassembly.)

5. DISCONNECTING THE CHAIN DRIVE AND CLUTCH HANDLE.

See instruction as given in Koehring instructions.

6. REMOVING CLUTCH HANDLE.

After making sure that the clutch is in an engaged position, remove the handle. This is a precaution to prevent the clutch plates from falling out when removing the clutch power take-off.

7. REMOVING THE RADIATOR.

Disconnect all hose connections and remove the brace that holds the back of the radiator to the engine. Next, remove the nuts that hold the radiator to the front engine support and pull off the radiator. Also remove the engine hold down bolts, 2 at front, and 2 at rear.

8. REMOVING ENGINE FROM TURNTABLE.

The engine and its component parts can now be skidded from the turntable onto the rear of a truck for removal to the overhauling section. To facilitate further disassembly, we suggest the use of an assembly stand. If none is available, lift the engine on to a flat platform or lay it on the floor, using a chain hoist as shown in Figure 101. (Note the engine head is provided with two tapped 3/4" holes, National Course threads for inserting eye screws for lifting with hoist.

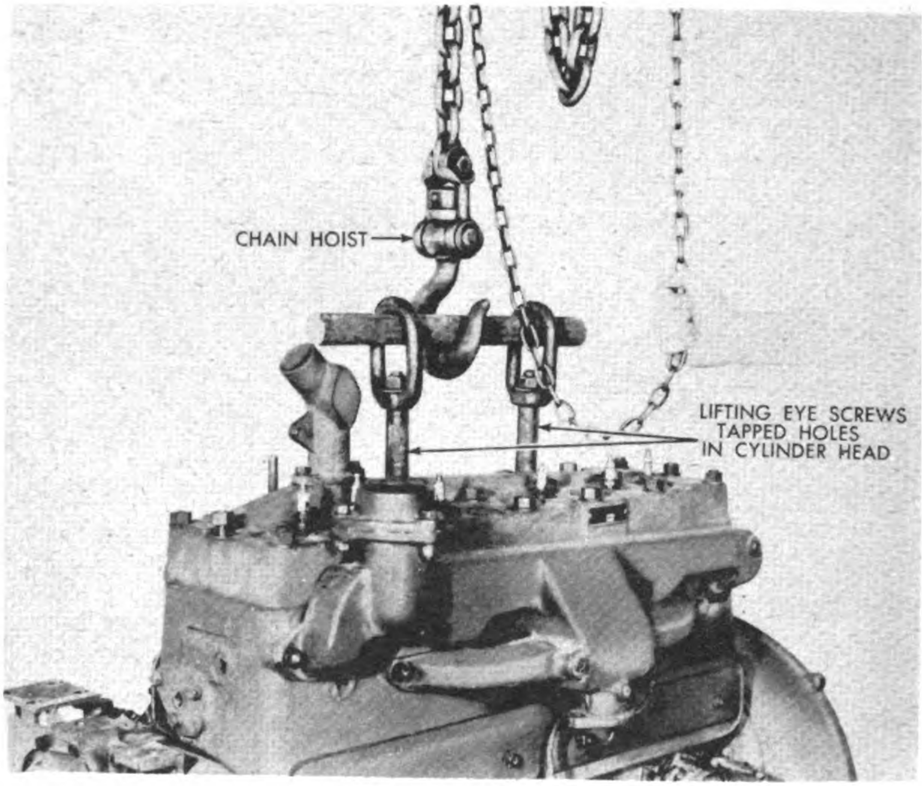


Figure 101. Lifting Engine With Chain Hoist

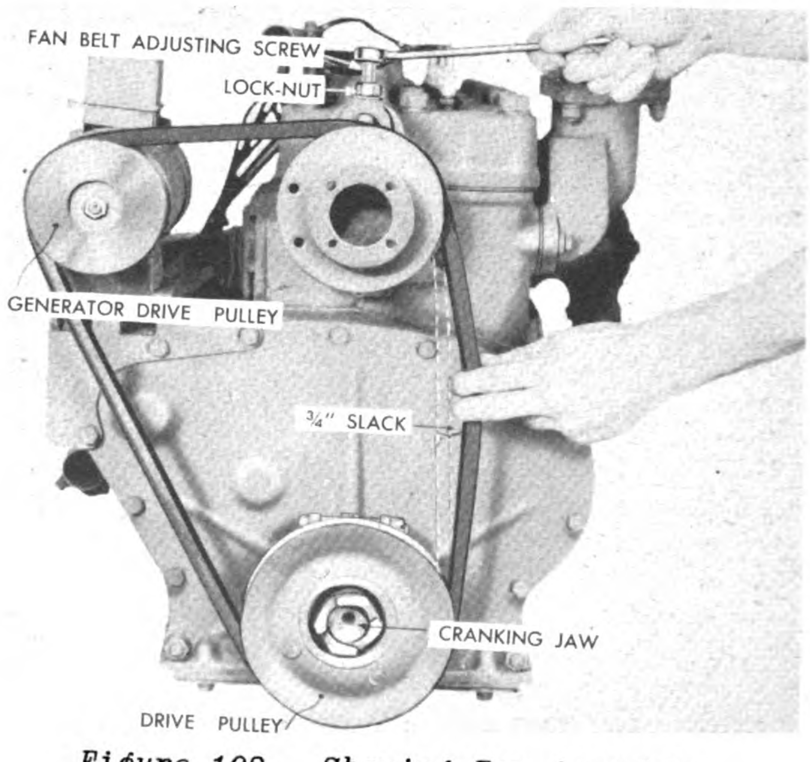


Figure 102. Showing Fan Assembly

9. REMOVING FRONT SILL.

If a stand is used make sure that both ends of the engine clear the stand so that the ends can be removed. If a flat platform is used timbers should be set so as to permit removal of the front end which can be taken off by removing the bolts that fasten it to the sill.

10. REMOVING FAN ASSEMBLY

Remove the fan belt tension adjusting screw. Remove the fan shaft nut and pull off the fan assembly. Figure 102.

11. REMOVING ACCESSORIES

a. Fuel Pump. Disconnect the copper gasoline line and the capscrews holding the fuel pump to the adaptor plate. Now remove the adaptor plate by removing the four capscrews that fasten it to the engine. Figure 103.

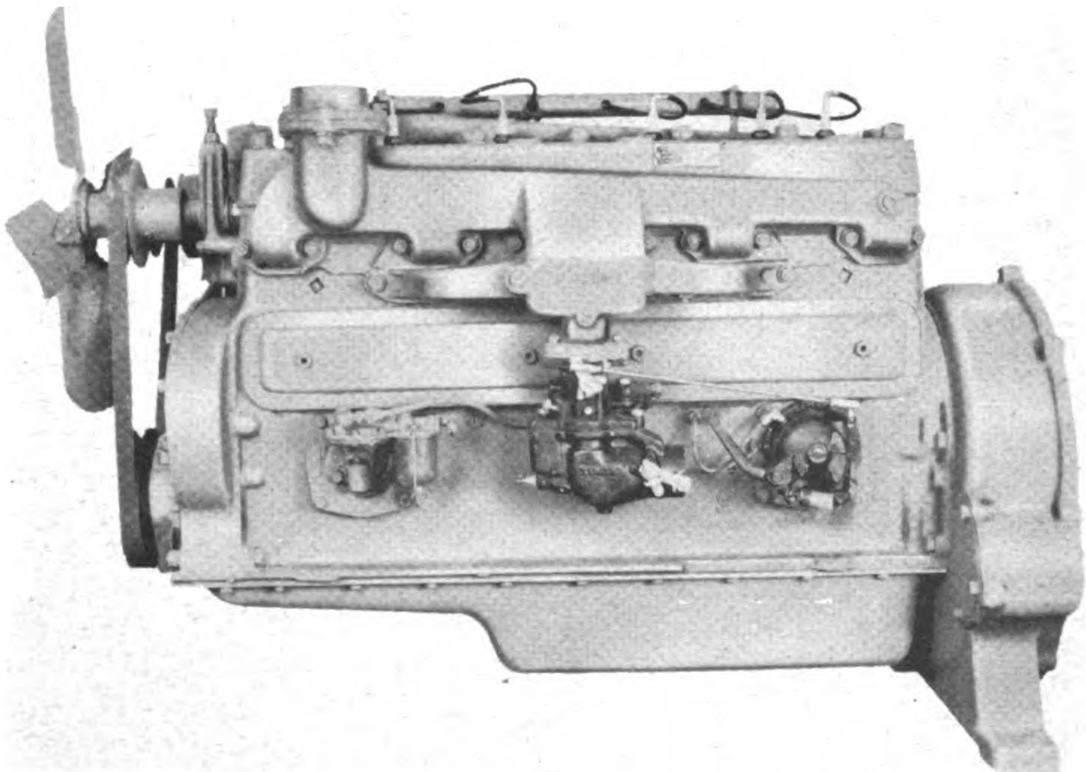


Figure 103. Left Side of Engine Showing Fuel Accessories

STEPS OF DISASSEMBLY

b. Carburetor, Governor, Oil Filter, Oil Breather, Magnetic Switch, Starter, Generator and Generator Bracket. These eight accessories can be removed by removing the capscrews that fasten them in place as shown in Figs. 103 and 104.

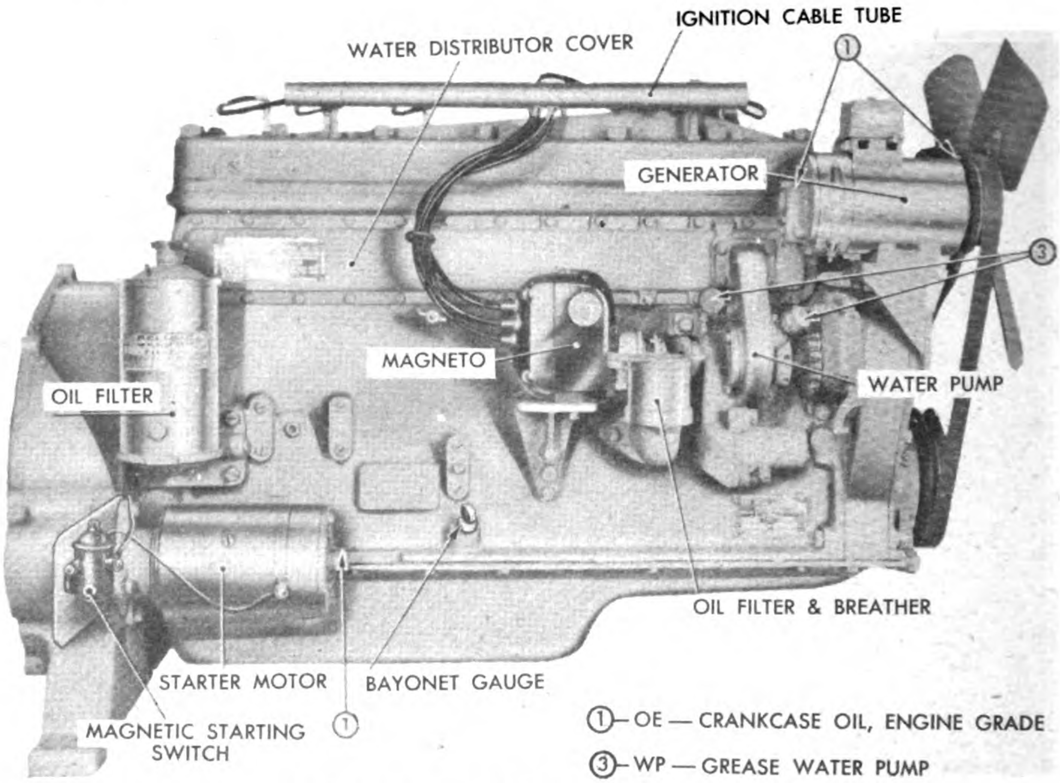


Figure 104. Right Side of Figure Showing Accessories and Points of Lubrication

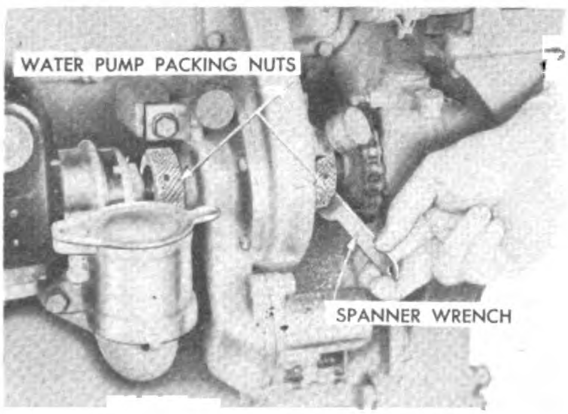


Figure 105. Showing Water Pump and Magneto Impulse Coupling Assembly

c. Magneto and Cable Tube. Fig. 105. The magneto can be removed by disconnecting the two capscrews that hold it in position on the magneto bracket. Also disconnect the

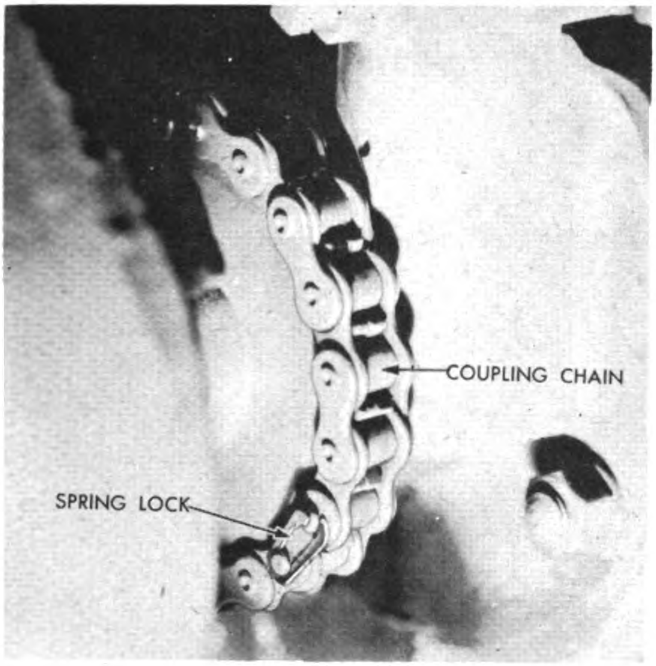


Figure 106. Showing Water Pump Coupling Chain

cable tube and spark wires. The magneto bracket should also be removed. It may be necessary to pry slightly after removing the capscrews.

d. Water Pump. Disconnect the spring lock on the pump coupling chain, see figure 106, and remove the water pump to cylinder connection by unfastening the four capscrews that hold it to the wa-

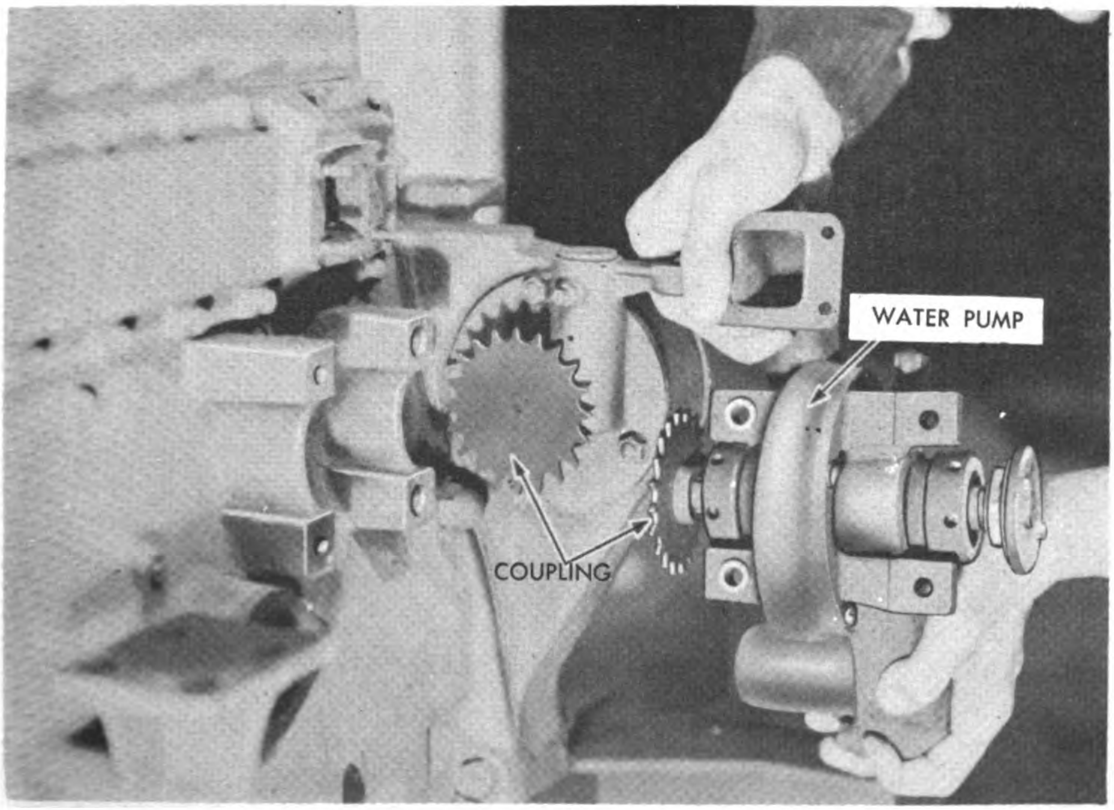


Figure 107. Removing Water Pump

ter distributor cover, and the three capscrews holding the water pump to the crankcase. See Figure 107.

12. WASHING THE ENGINE.

Wash the engine with cleaning fluid. If the deposit of dirt is thick, allow the kerosene to soak ten minutes or more, then wash off the dirt with hose and water.

13. REMOVING CLUTCH (Power Take-Off)

Remove the capscrews holding the clutch power take-off to the flywheel housing and insert two 1/2" N.C. bolts with 2-1/2" of thread into the tapped holes in the clutch housing and screw in to push off the power take-off, as shown in Figure 108.

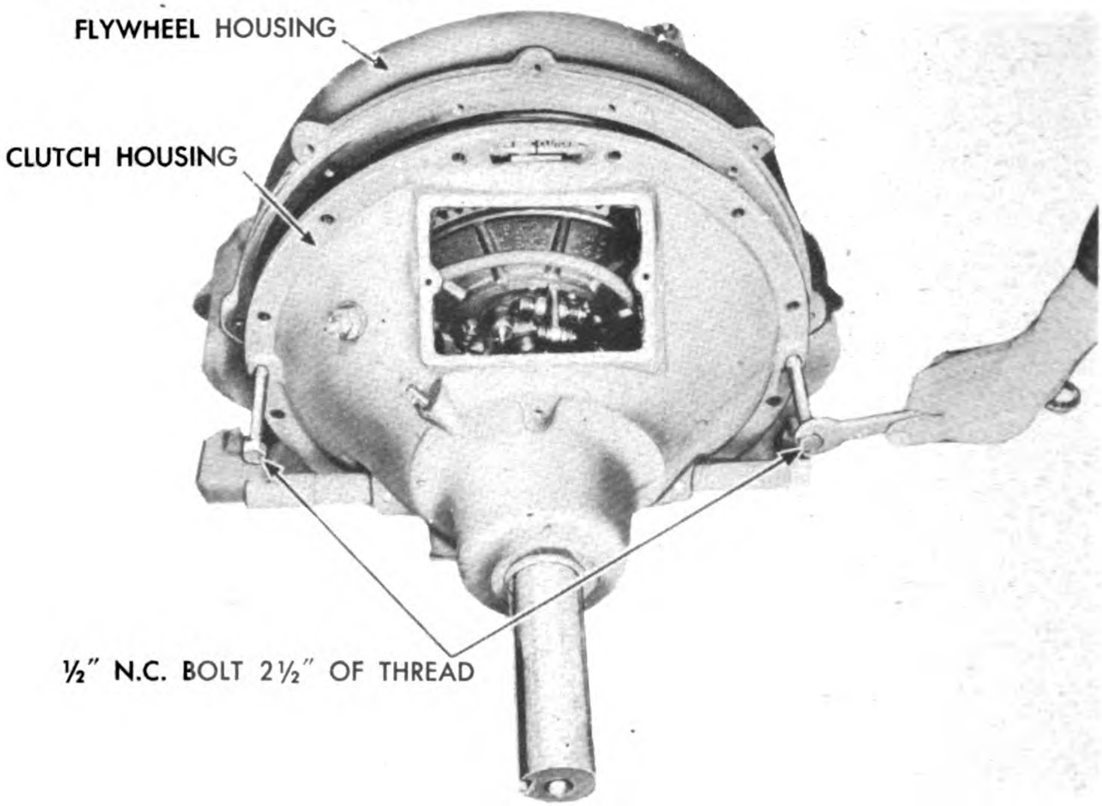


Figure 108. Removing Clutch (Power Take-off)

14. REMOVING CYLINDER HEAD MANIFOLD, WATER JACKET COVER AND WATER DISTRIBUTOR.

Take off the capscrews and lock washers that fasten these units to the engine. Discard the head gasket. See Figure 109.

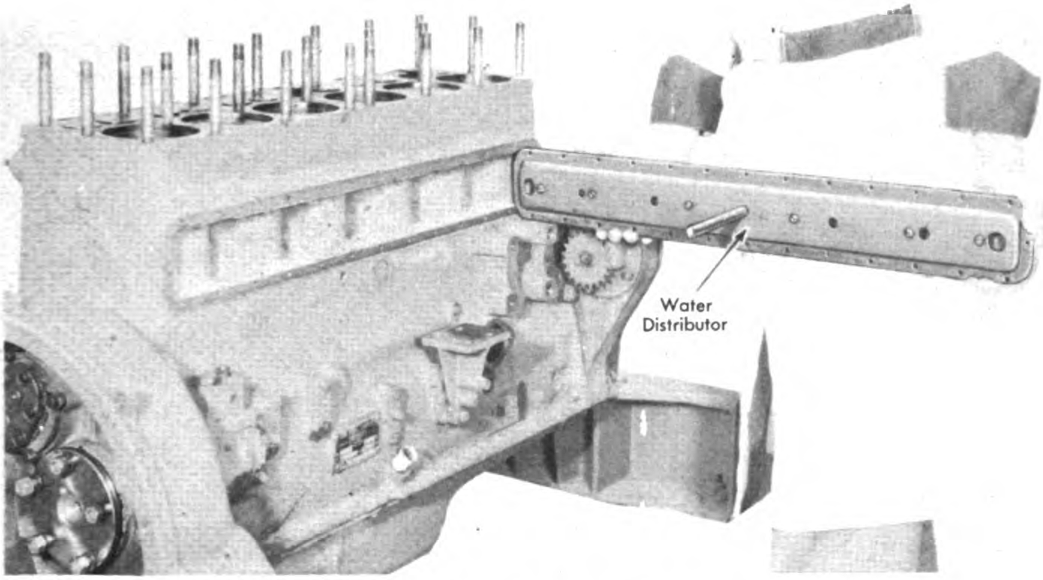


Figure 109. Removing Water Jacket Cover and Distributor

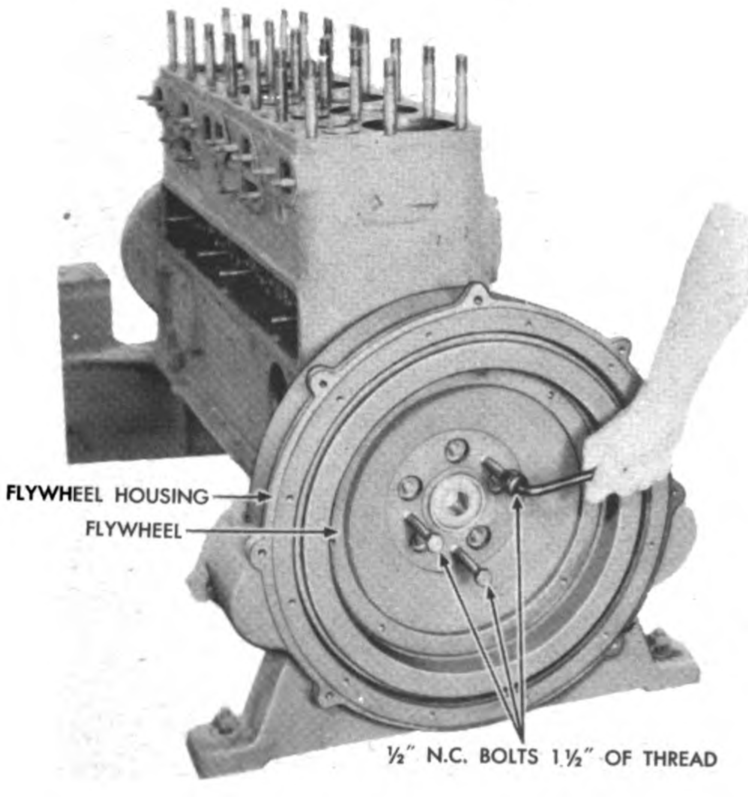


Figure 110. Removing Flywheel

15. REMOVING FLYWHEEL

Remove the five flywheel bolt nuts and washers. (These washers are very thin so don't attempt to use them in any other place.) Now use three 1/2" capscrews with 1/2" thread about four inches long and screw these into the three tapped holes in the hub of the flywheel to push the flywheel off. See Figure 110. These capscrews can be used as a handle to lift the flywheel out of the housing, or will hold a small chain if you prefer to use a hoist in removing the flywheel which is heavy and unwieldy. In order to protect the flywheel threads put the nuts back on the flywheel housing bolts. As an aid in reassembly, chalk mark each flywheel bolt and hole with a corresponding mark (1-2-3-4-5).

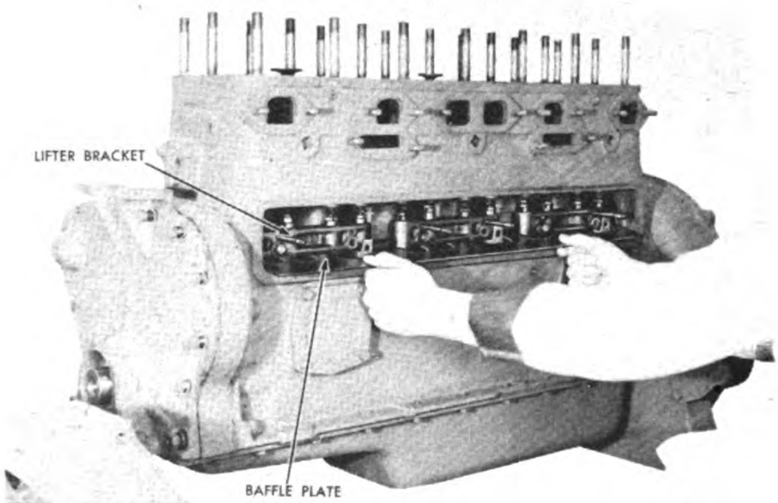


Figure 111. Removing Valve Chamber Oil Baffle Plate

16. REMOVING VALVE COVER AND BAFFLE PLATE.

Take off the nuts and remove the valve cover. The baffle plate can be removed by taking off the three capscrews. See Figure 111. NOTE: the holes for the three capscrews holding the valve lifter brackets and baffle plate open directly into the cylinder bore. If any of these capscrews must be replaced, ones of identical length must be used.

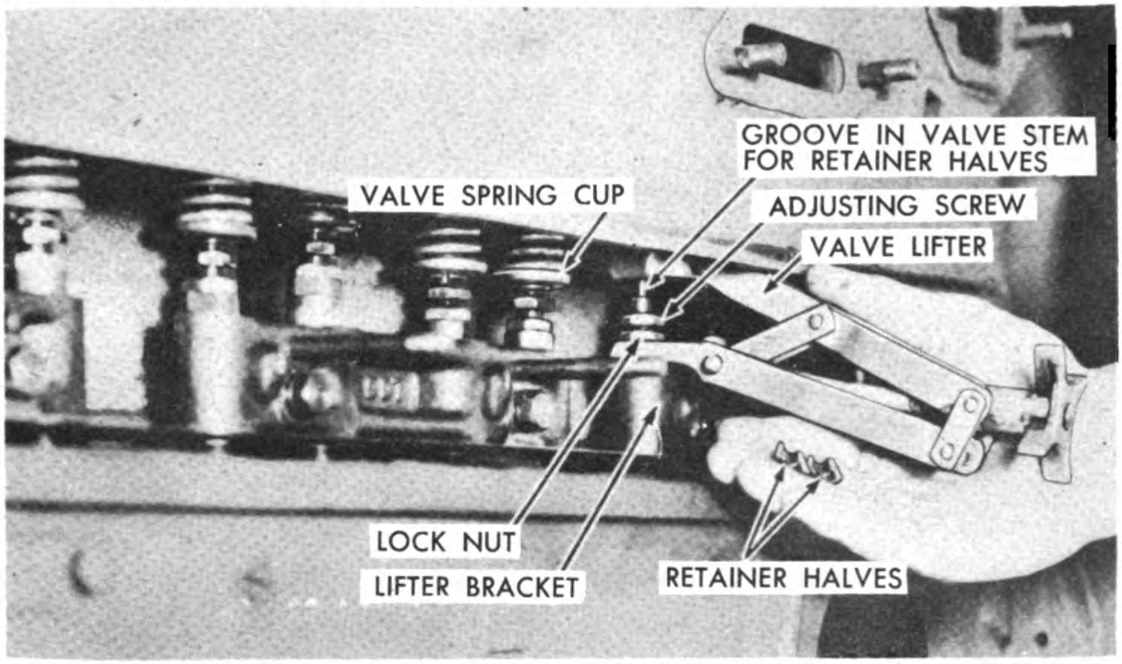


Figure 112. Removing Valve Retainer Halves and Valve Assembly

17. REMOVING VALVE ASSEMBLY.

Using a valve lifter inserted between the valve spring cup and lifter bracket, make sure that the valve to be lifted is in a closed position. (If it isn't crank the engine by hand). Now lift the valve spring cup so that it clears the retainer halves and remove the halves. Figure 112. NOTE: Insert a cloth into the chamber to prevent the halves from falling into the oil pan.

The valve spring and both upper and lower seats can now be removed.

Remove the capscrews holding the valve lifter bracket and grasping the bracket as shown in Figure 113, to prevent the lifter from falling into the crankcase, remove the lifter bracket assembly.

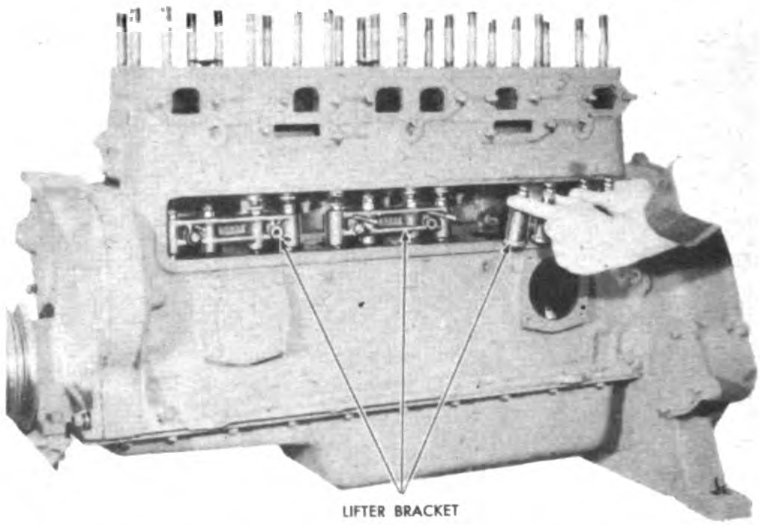


Figure 113. Removing Valve Lifter Bracket Assembly

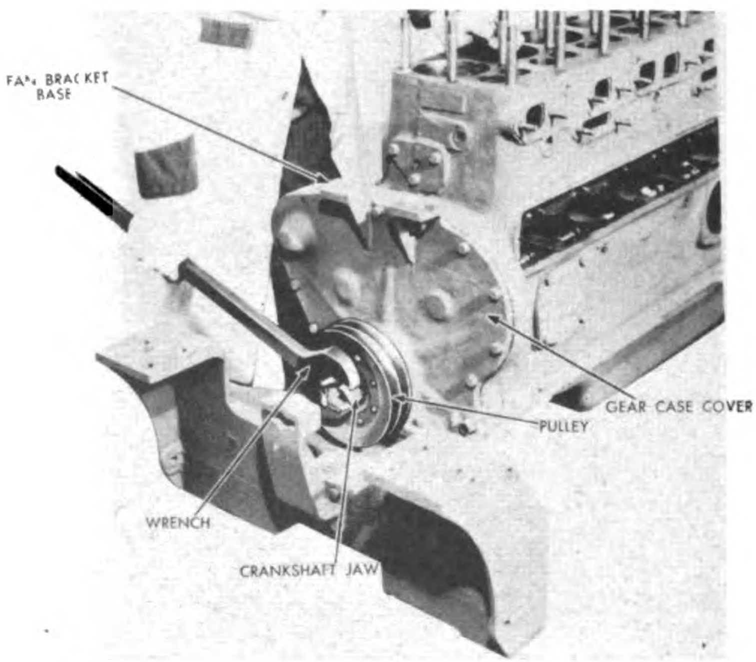


Figure 114. Removing Crankshaft Jaw

18. REMOVING CRANKSHAFT JAW.

Turn anti-clockwise as shown in Figure 114.

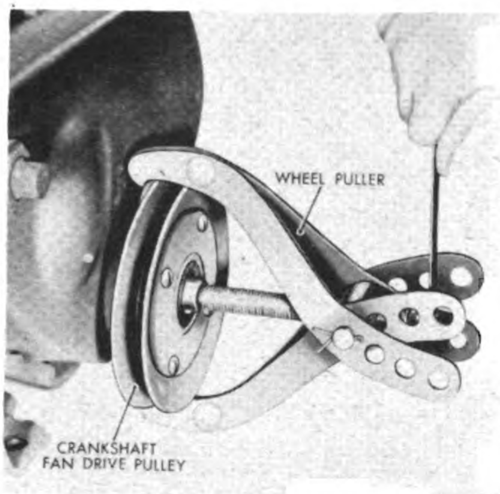


Figure 115. Removing Fan Drive Pulley with Wheel Puller

19. REMOVING FAN DRIVE PULLEY.

Using a wheel puller, as in Figure 115, pull the pulley off the crankshaft. Caution: Back up the ears of the wheel puller with solid pieces of steel or wood so as to equalize the pressure against the pressed steel pulley which bends easily.

20. REMOVING FRONT SUPPORT.

Loosen the clamp bolt at the top of the front support and pry off.

21. REMOVING GEAR CASE COVER.

Remove the capscrews and bolts holding the gear case cover to the gear housing. Lift off the cover and gasket, noting the condition of the oil seal. If the seal has worn a groove in the spacer, the spacer must be replaced, driving in a new oil seal similar to Figure 116. Now with a chain hoist lay the engine on its right side. Caution: Timbers should be so laid that both ends of the crankcase will be free.

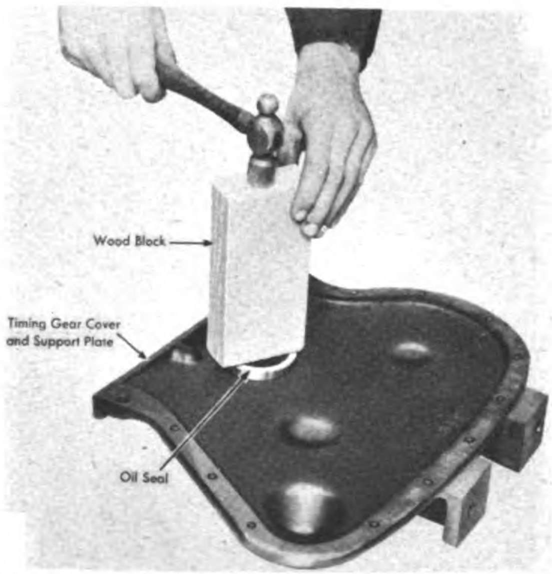


Figure 116. Installing Gear Case Cover Oil Seal

STEPS OF DISASSEMBLY

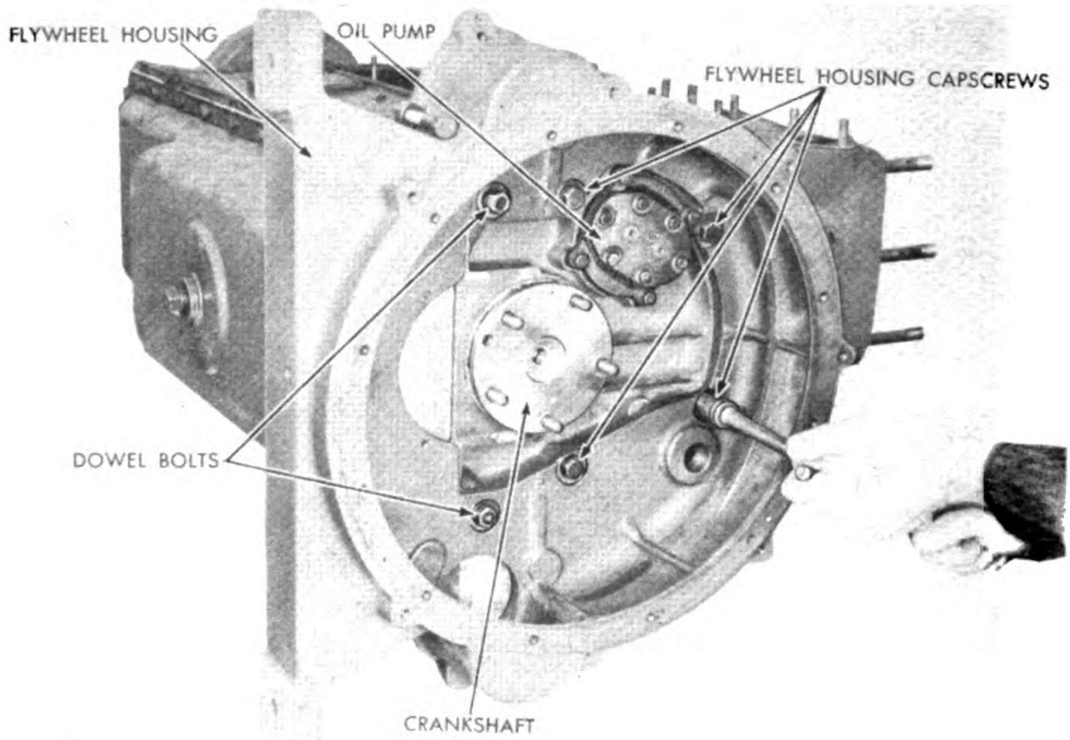


Figure 117. Removing Flywheel Housing

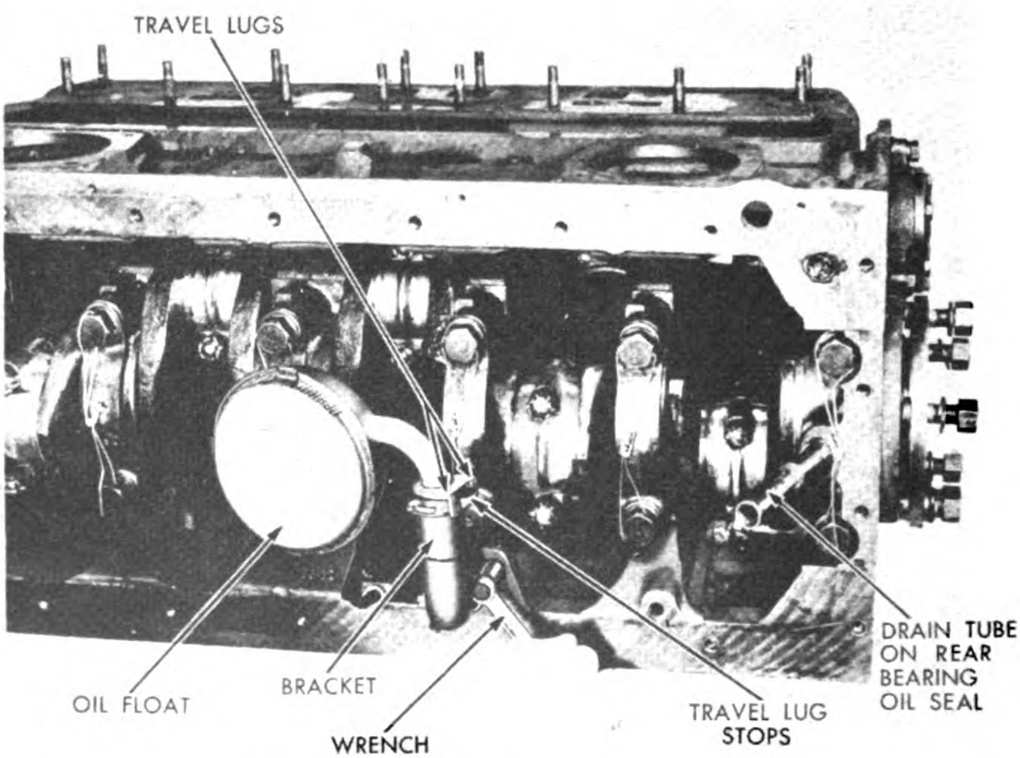


Figure 118. Removing Oil Float and Drain Tube

22. REMOVING FLYWHEEL HOUSING.

Remove the four capscrews and the two dowel bolts that hold the housing to the crankcase. See Figure 117. Remove the housing.

23. REMOVING OIL PAN, OIL FLOAT, DRAIN TUBE AND BRACKET ASSEMBLY.

Take off the capscrews and washers that hold the oil pan and the capscrews and washers that hold the oil float and bracket assembly. Use a pipe wrench to remove the rear bearing drain tube. See Figure 118.

24. REMOVING OIL PUMP.

Remove the four capscrews holding the oil pump to the crankcase and remove the oil pump. Figure 119.

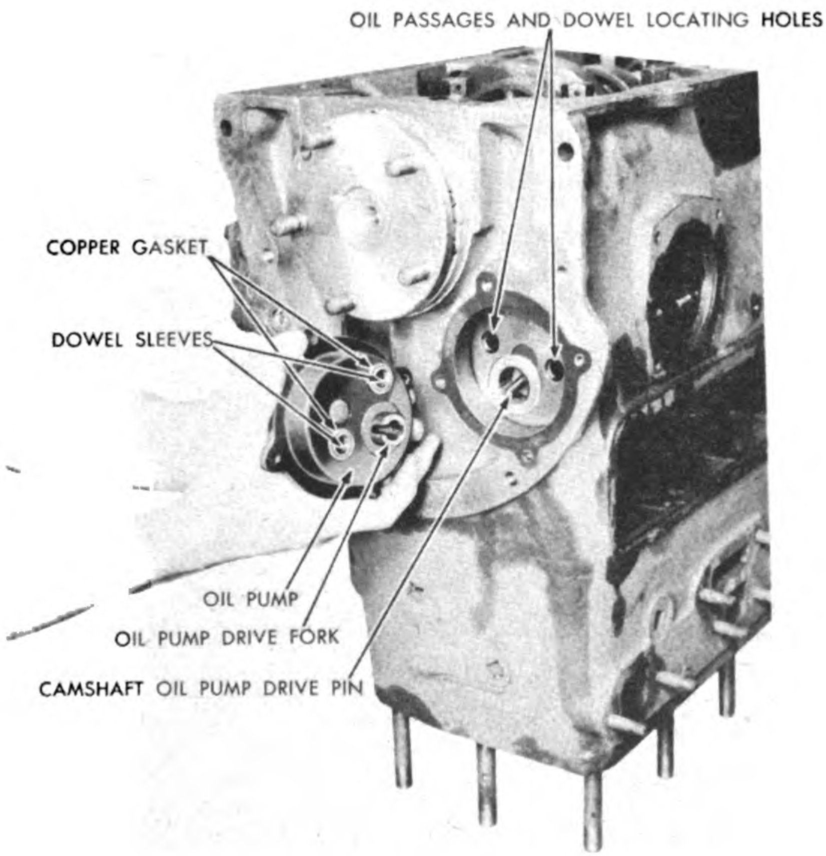


Figure 119. Removing Oil Pump

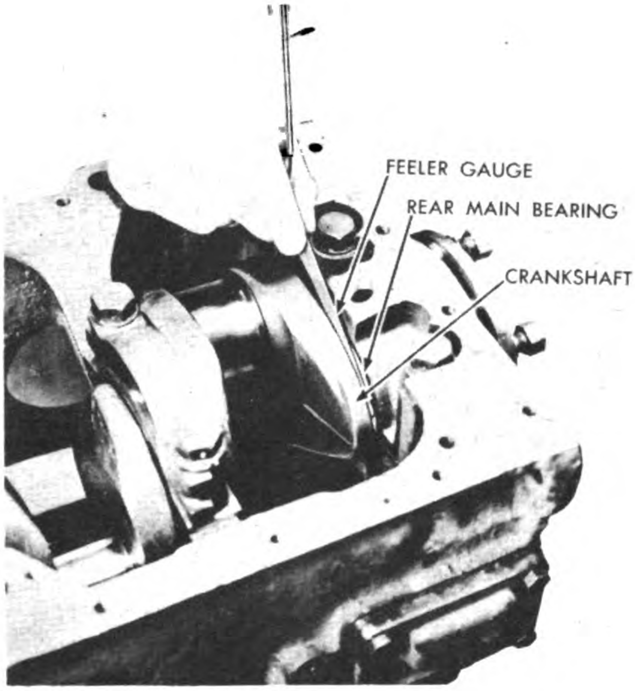


Figure 120. Checking Crankshaft End Play.

25. CHECKING FOR REPLACEMENTS.

At this point it is recommended that the mechanic stop and determine what further disassemblies or replacements will be needed.

A. Slip a feeler gauge between the end of the rear main bearing and the crankshaft. See Figure 120. Run the feeler gauge clear around the shaft. The proper clearance is .003" to .009". If more than .012" a new rear main bearing is needed. See Chapter III, paragraph 61.

B. Check the idler gear end play by inserting a feeler gauge between the idler gear hub and the retaining washer, as shown in Figure 121. Desired clearance should be .004", maximum .007".

C. Check for backlash between the idler gear at all three points where it meshes with the other two gears. If more than .005" of an inch, replace the idler gear with larger one. See Figure 122.

Now back to disassembly.

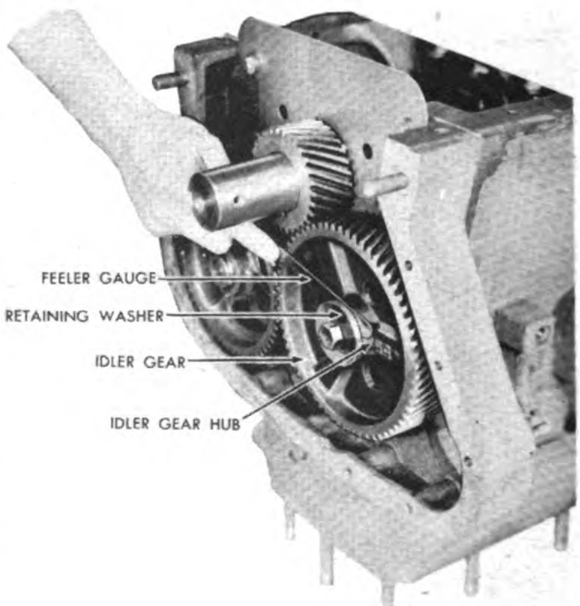


Figure 121. Checking Idler Gear End Play.

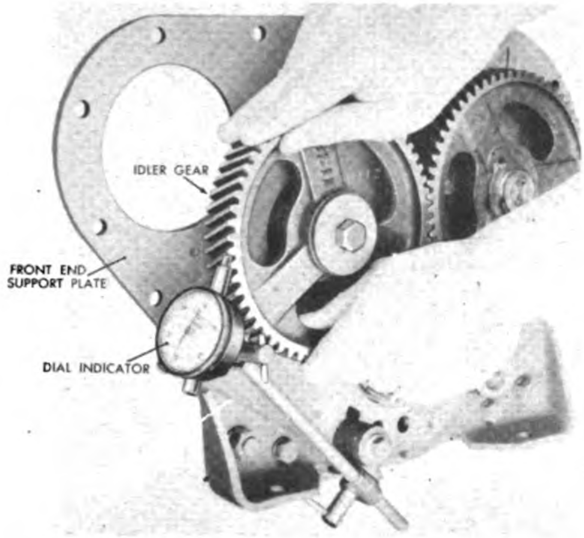


Figure 122. Checking Idler Gear Back Lash.

26. REMOVING OIL BAFFLE PLATE.

Remove the four capscrews and pull off the oil baffle plate. See Figure 123.

27. CAMSHAFT.

Flatten out the three camshaft thrust plate locks around the capscrews that hold the camshaft in position. See Figure 124. Remove the capscrew thrust plate and lock plate. See figure 125.

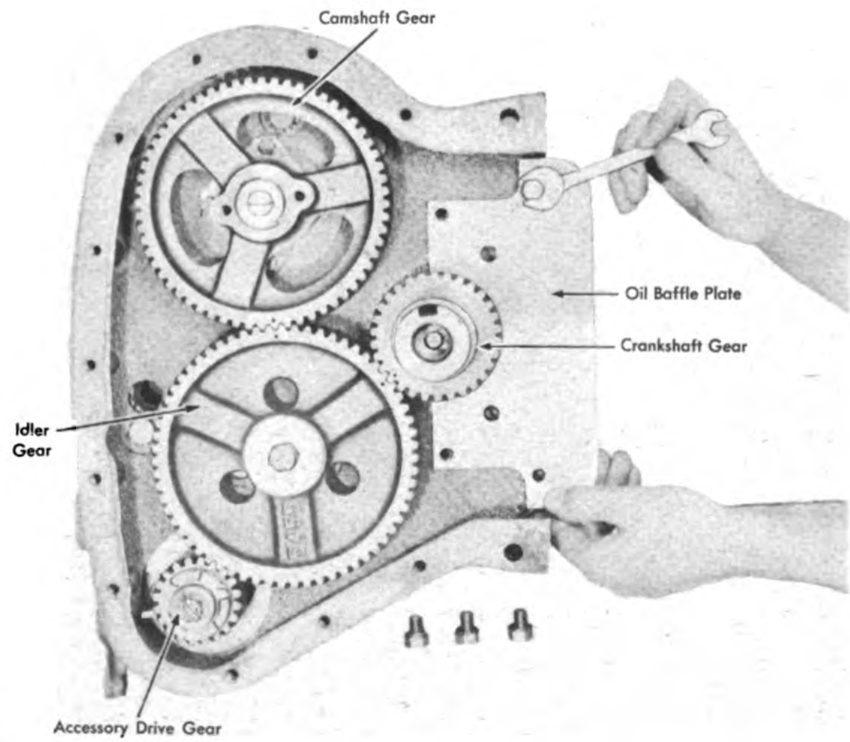


Figure 123. Removing Oil Baffle Plate

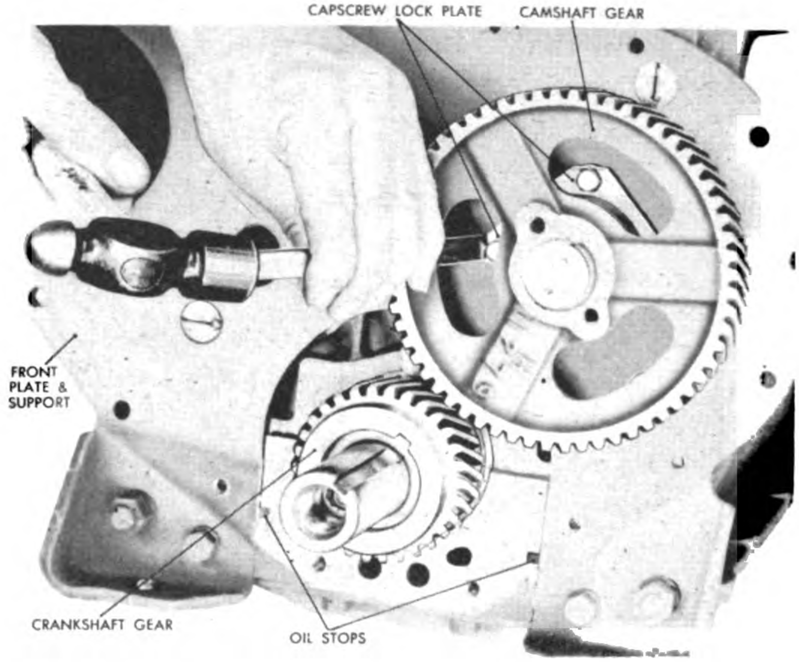


Figure 124. Removing Camshaft Capscrew Lock.

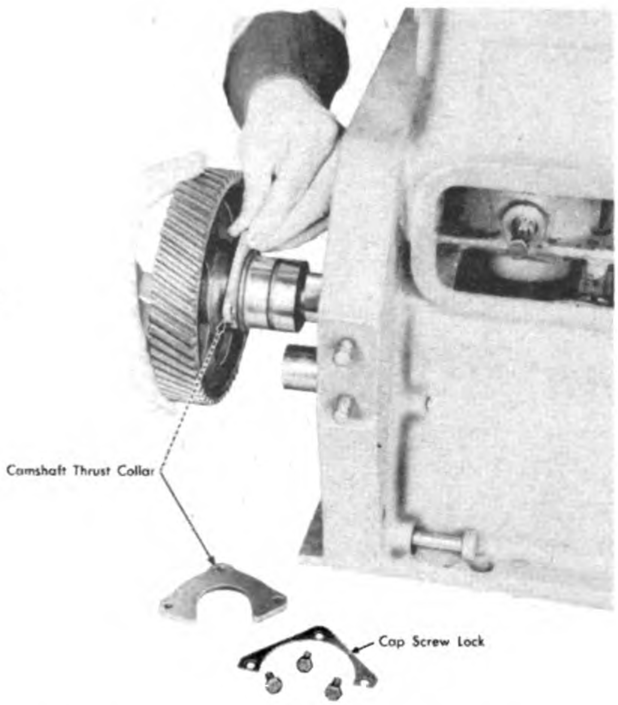


Figure 125. Removing Camshaft Thrust Collar.

28. CHECKING CAMSHAFT BUSHINGS.

Place a feeler gauge between each of the four bushings. The clearance should be between .0014" to .004". If more than .005" replace the bushings according to instructions given in paragraph 45. See Figure 143.

29. REMOVING CAMSHAFT.

Remove the camshaft by carefully guiding its removal, a little at a time, so as to avoid damaging the bearings. Figure 126.

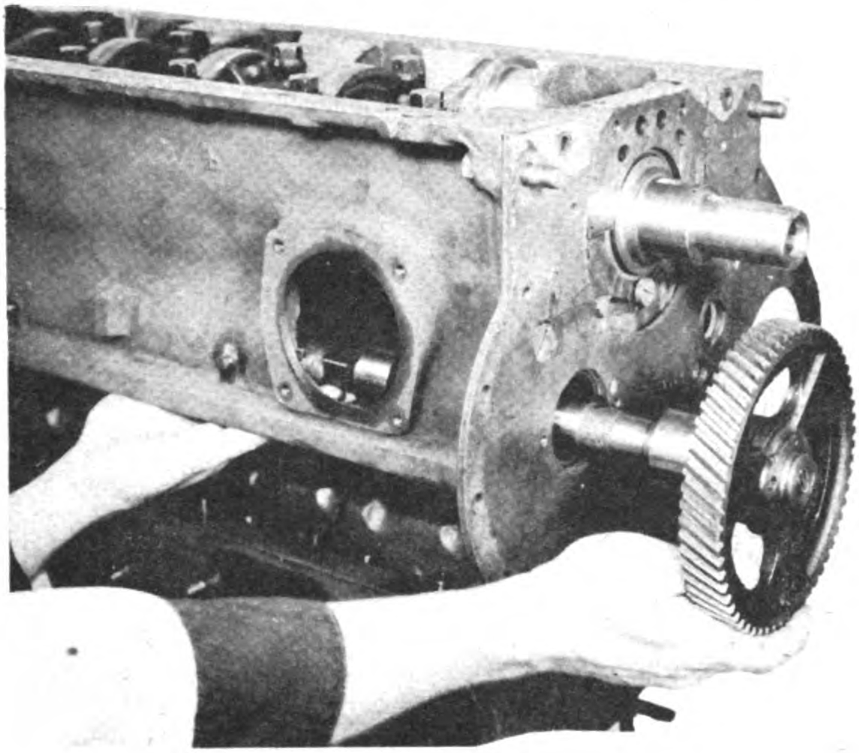


Figure 126. Removing Camshaft.

30. CHECKING CAMSHAFT END PLAY.

Check the camshaft end play by measuring the space between the hub and the thrust collar, as shown in Figure 127. This measurement shall be .005" to .008". If excessive, this can be corrected by replacing the thrust collar. Only on rare occasions will it be necessary to replace the gear.

31. REMOVING IDLER GEAR.

Since the idler gear has a thrust screw with a left hand thread, turn the screw to the right, or clockwise, to remove the gear. See Figure 128. Next remove the idler gear acorn lock nut located on the outside of the crankcase, then the lockscrew can be removed, see Figure 129. With a puller like the one used to install the crankshaft gear, Chapter III, paragraph 60-B, pull out the idler gear shaft. CAUTION: Be sure you do not break off the dowel pin that holds the spacer on the front of the shaft.

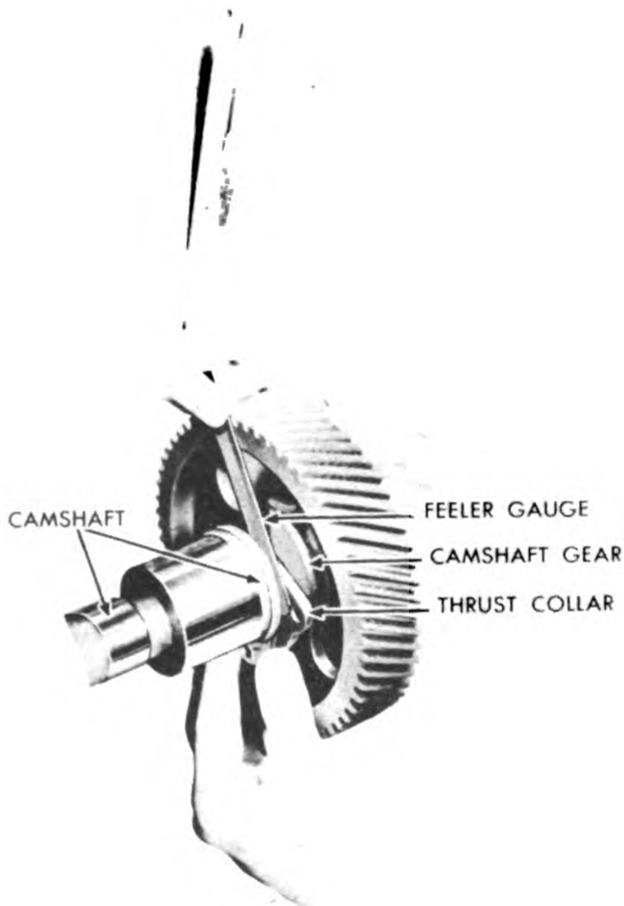


Figure 127. Checking Camshaft End Play

32. REMOVING THE CONNECTING RODS AND CAPS.

Remove and discard the cotter pins locking the castellated nuts and remove the nuts and caps. In pushing the rods through the cylinder bore employ a short wooden handle fitted at one end with a piece of copper tubing. The tube fits over the bolt and the handle acts as a guide to avoid damaging the cylinder walls and bearing surfaces. See Figure 130. Replace the caps and the nuts on their respective rods. Caution: The caps and rods are all numbered for this purpose. DO NOT REVERSE THE POSITION OF THE CAPS FOR THEY MUST BE PUT BACK IN THEIR ORIGINAL POSITION.

AGAIN WITH A CHAIN HOIST STAND THE ENGINE ON ITS CYLINDER HEAD STUDS SO THAT WHEN THE MAIN BEARING CAPS ARE REMOVED THE CRANKSHAFT WILL NOT FALL OUT.

33. REMOVING ACCESSORY DRIVE.

Remove the nuts that hold the accessory drive to the gear case and lift off. See Figure 131.

34. REMOVING MAIN BEARING CAPS

Remove and discard the lock wires of the main bearing caps and remove the caps. The rear bearing cap with lower half of the oil seal attached can be removed with a

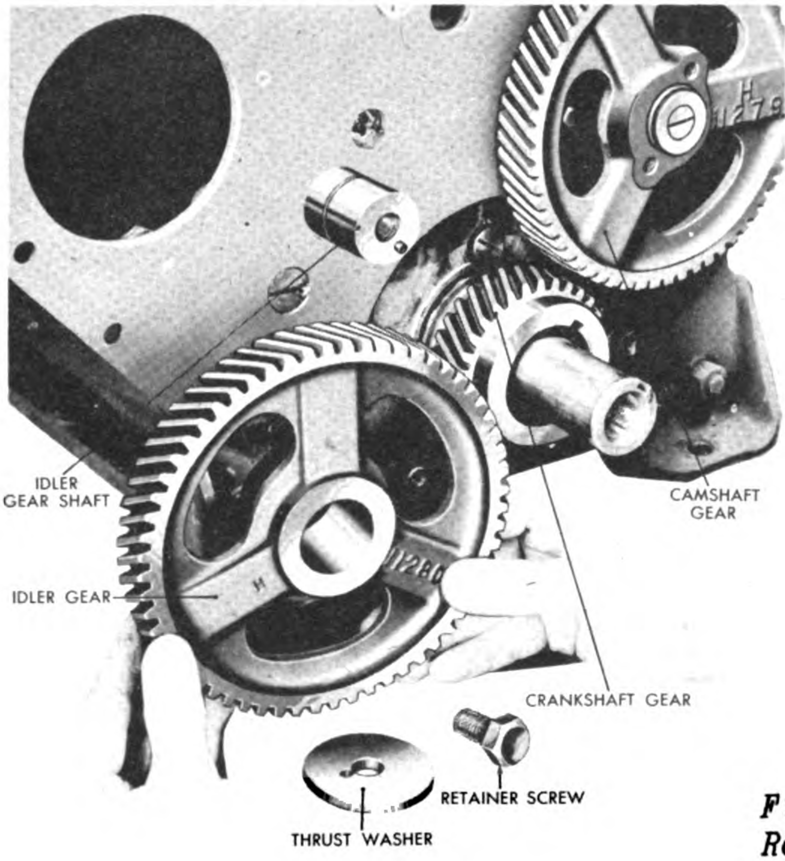


Figure 128. Removing Idler Gear.

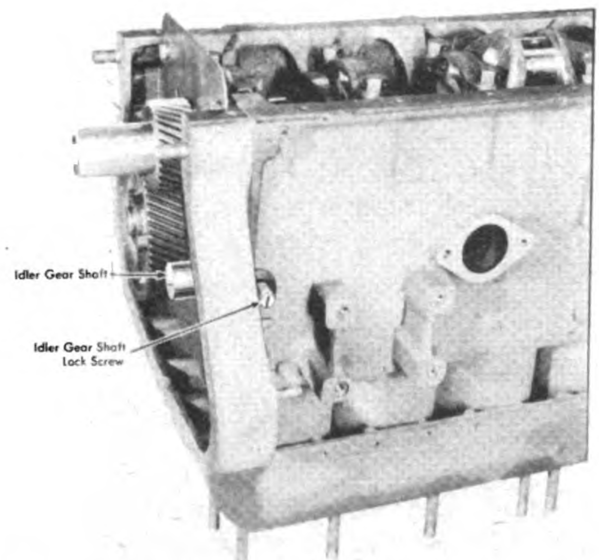


Figure 129. Removing Idler Gear Shaft Lock Screw.

pry bar, two blocks of wood and bolts as shown in Figure 132. Caution: The main bearing caps are numbered consecutively starting at the front or fan end, one to seven inclusive.

35. LIFTING OUT THE CRANKSHAFT.

When removing the crankshaft care should be taken to prevent damaging the bearing surfaces.

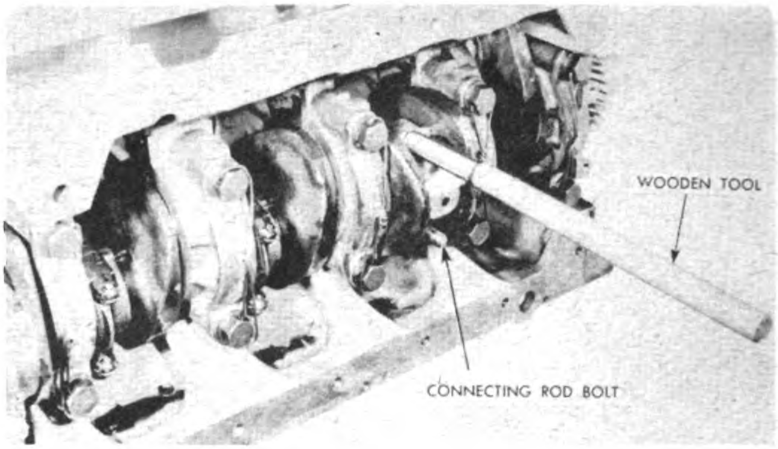


Figure 130. Removing Connecting Rod with Wooden Tool.

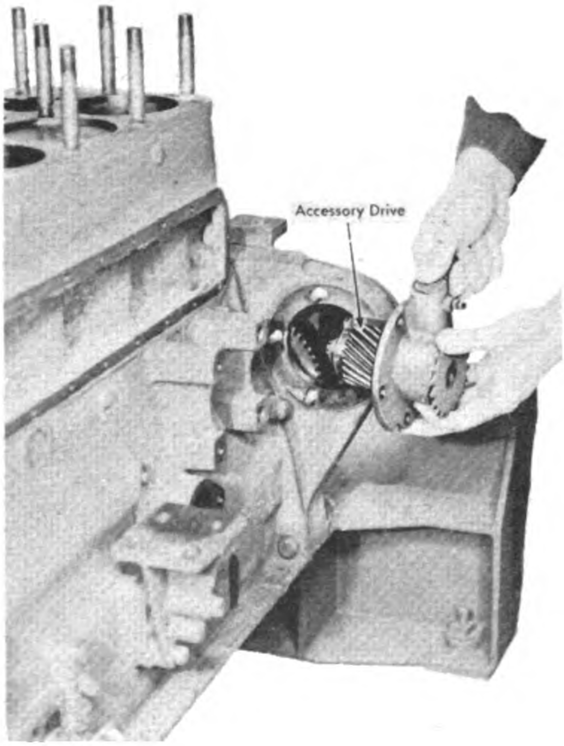


Figure 131. Removing Accessory Drive.

36. REMOVING UPPER HALF REAR BEARING OIL SEAL.

Remove the three capscrews holding the upper half of the rear bearing oil seal and discard the felts and gaskets. See Figure 133.

37. REMOVING UPPER AND LOWER BEARING SHELLS.

Remove the bearing shells from both the crankcase and the caps. See Figure 134. THESE SHELLS ARE NOT NUMBERED, THEREFORE, THEY MUST BE LAID AWAY SO THAT THEY CAN BE PLACED BACK IN THEIR RESPECTIVE PLACES EXACTLY AS THEY CAME OUT. EVEN THEIR INDIVIDUAL POSITIONS IN THE CRANKCASE AND THE CAPS MUST NOT BE REVERSED. If any of the bearing shells are pitted or burned all should be replaced, not just one.

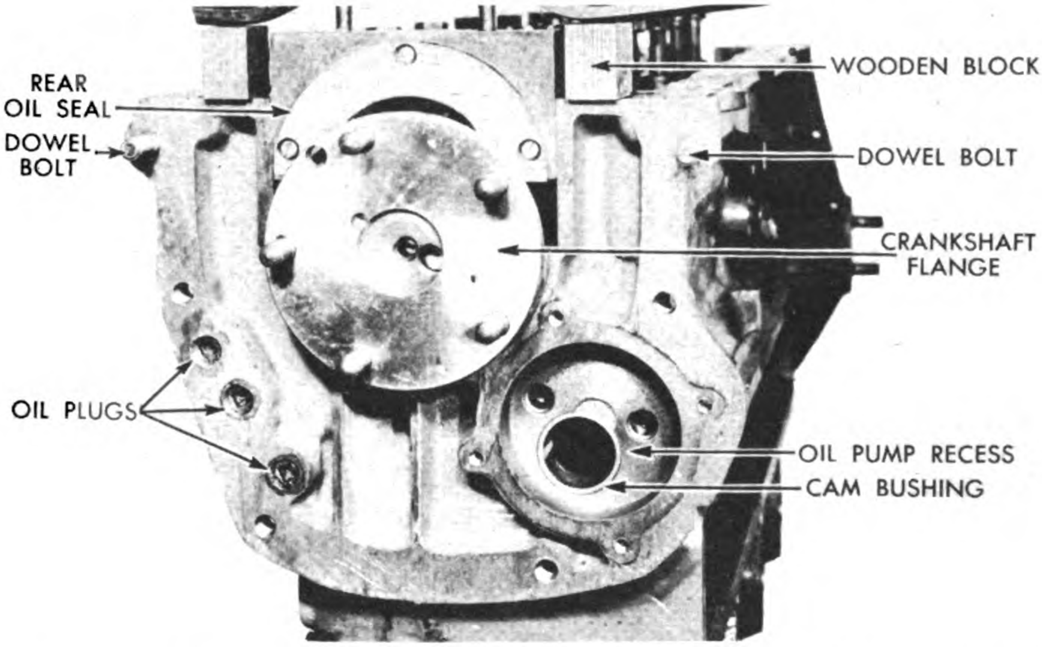


Figure 132. Removing Lower Half Rear Bearing Oil Seal.

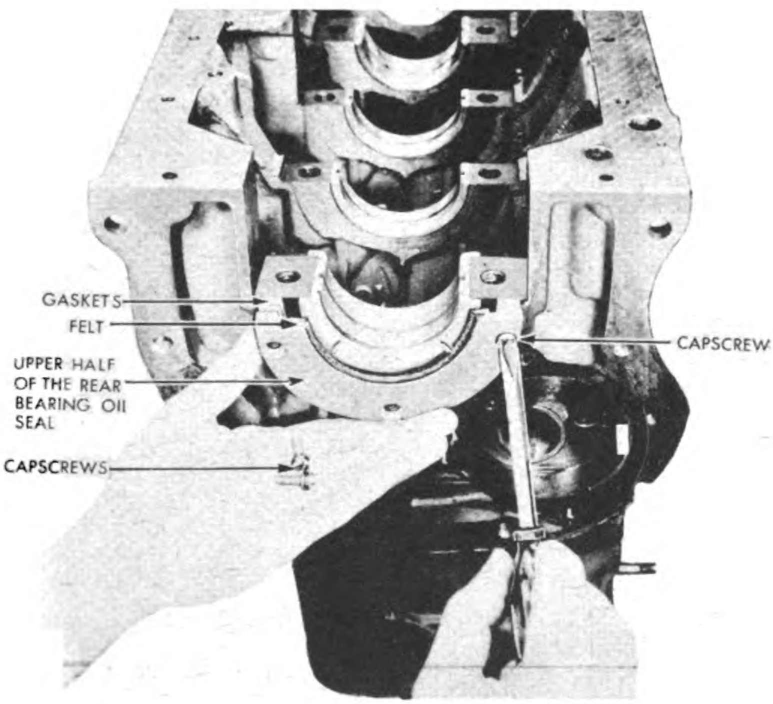


Figure 133. Removing Upper Half Rear Bearing Oil Seal.

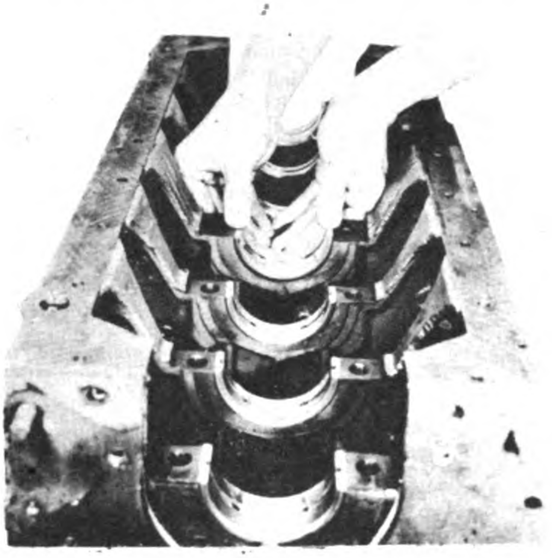


Figure 134. Removing Upper Half of Bearing Shells.

38. REMOVING TIMING GEAR SUPPORT PLATE.

Remove the six capscrews that fasten the timing gear support plate or housing to the crankcase and remove the housing and gasket. See Figure 135.

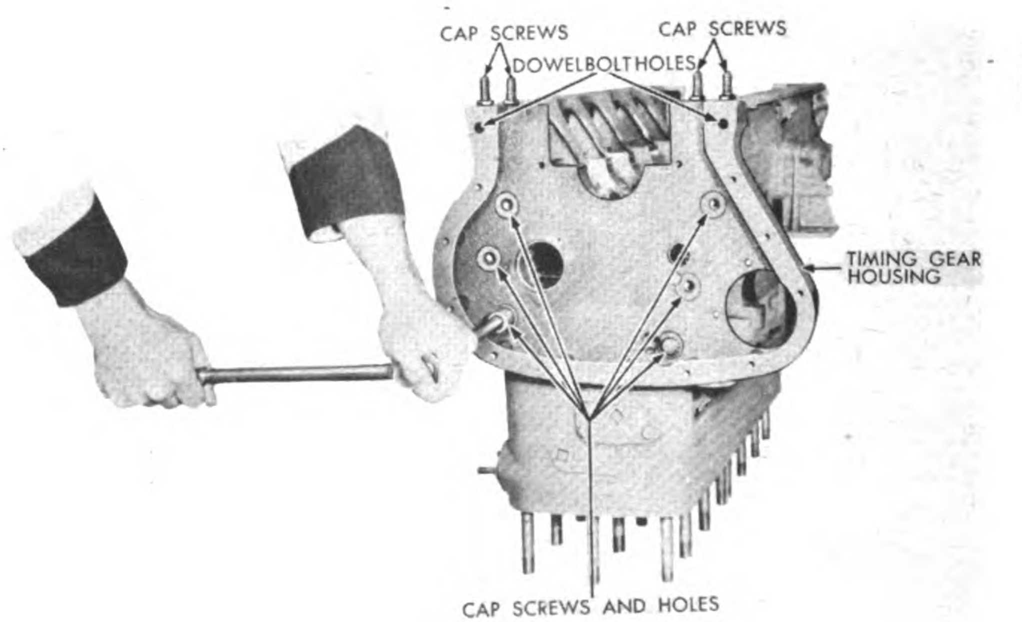


Figure 135. Removing Timing Gear Support Plate.

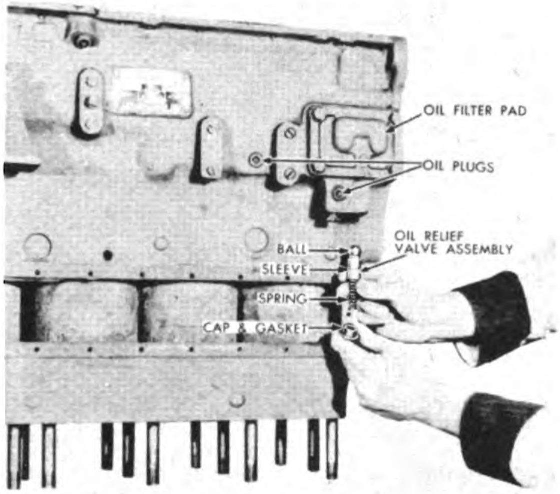


Figure 136. Removing Oil Pressure Relief Valve.

39. REMOVING OIL PRESSURE RELIEF VALVE.

Remove the oil pressure relief valve, and two oil pipe plugs as shown in Figure 136.

40. REMOVING OIL PLUGS.

Remove oil plug in front end of oil line, See Figure 137. Three at the rear end of the crankcase, see Figure 138. One at the bottom side and two in the outside of the crankcase.

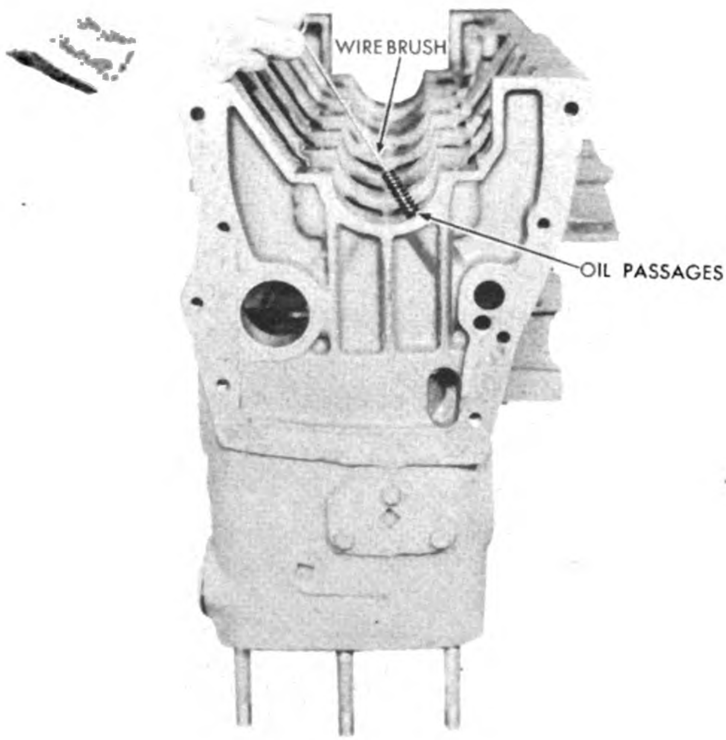


Figure 137. Brushing Out Oil Passages

STEPS OF DISASSEMBLY

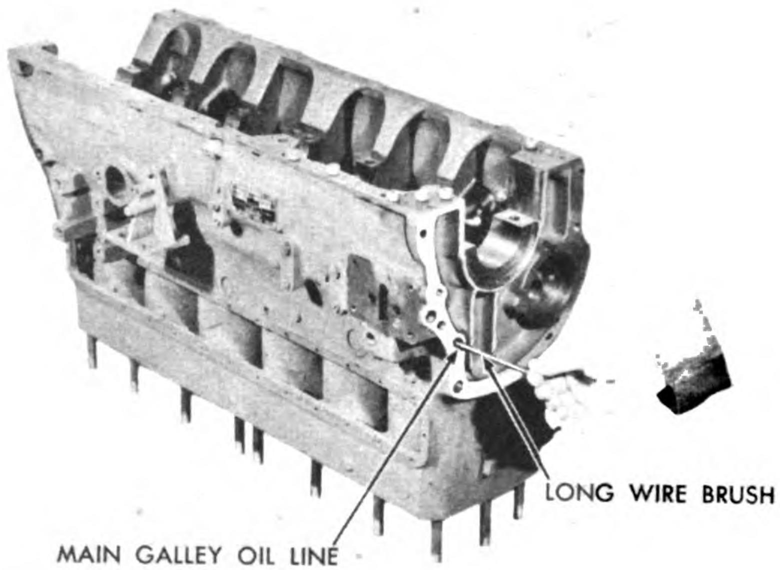


Figure 138. Brushing out Main Gallery Oil Line.

THE ENGINE IS NOW COMPLETELY DISASSEMBLED EXCEPT FOR THE ACCESSORY UNITS. THE INSPECTION AND CONDITIONS FOR REPLACEMENT OF ANY PARTS ARE GIVEN IN THE FOLLOWING PARAGRAPHS.

Chapter III

INSPECTION AND REPAIR OF ENGINE PARTS

This chapter deals with the inspection and repair of the engine proper. The instructions here given take into consideration almost all repairs or replacements that can be made. Therefore, it should not be assumed that all of these repairs or parts replacements are normal. For the most part, they will be rare, but all these extreme conditions are given in order to aid the mechanic to do a skillful job no matter what the condition might be.

An accurate inspection can be made only if the parts are thoroughly cleaned, both inside and out. If no cleaning tank is available, washing the parts in kerosene is recommended. No further mention will be made of cleaning as the first rule of a good mechanic is to keep tools and parts clean.

The assemblies, or parts, of the engine proper to be serviced are listed alphabetically.

ACCESSORY DRIVE

The accessory drive is driven by the idler gear to turn the water pump and the magneto. Provision is made for a distributor gear should one be desired. The accessory drive is internally oiled from the timing gears.

41. DISASSEMBLY OF ACCESSORY DRIVE.

Remove the coupling sprocket with a wheel puller. Remove the cotter key and nut from the gear end of the shaft. NOTE: The nut is a left handed thread. Remove the spider from the shaft and pull off the gear. See Figure 139. With a long-nose pair of pliers, remove the lock or snap spring from the water pump side of the shaft. See Figure 140. Tap the threaded end of the shaft with a wooden mallet to remove the oil seal and the washer. See Figure 141.

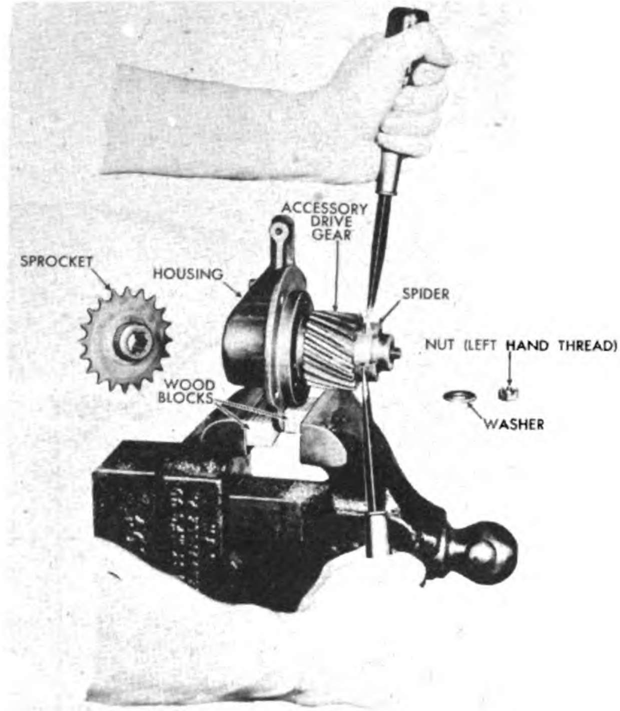


Figure 139. Removing Spider from Accessory Drive.

42. INSPECTION AND REPLACEMENT OF PARTS.

After thoroughly cleaning the gear, examine the gear for wear in the following places: the teeth, the bushing and the spider slot. Also examine the spider for excessive wear on the jaws and wear on the internal spline. Any wear on the internal spline will also show on the external spline of the shaft. Check the accessory drive housing for cracks and mutilation, paying particular attention to the bearing surfaces on which the shaft and the gear ride. Examine the thrust washer for signs of wear and roughness. Replace if necessary. Examine the shaft for wear in the following places: thrust washer surface, bearing surface, and splines. Always renew the felt retaining washer. To reassemble the accessory drive, reverse the procedure under disassembly. Paragraph 41.

CAMSHAFT

43. CAMSHAFT.

The camshaft is of open-hearth steel, case-hardened, and runs in four bronze bushings which are pressed in the crankcase. The clearance should be .0014" to .004". The camshaft, being case-hardened, will never

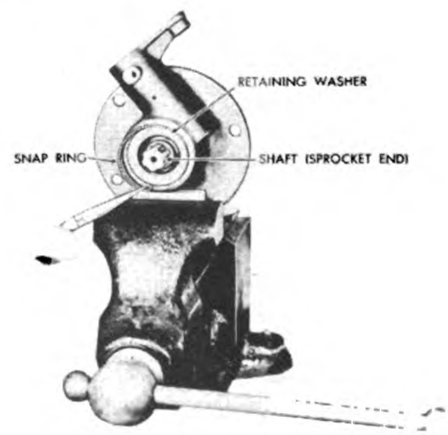


Figure 140. Removing Snap Ring

have to be replaced because of too much clearance. The bushings will need replacement to maintain the proper clearance. The instructions for the replacement are given undercamshaft instruction in paragraph 44. Under normal conditions the camshaft will need replacement if the gear that drives the governor is worn or damaged. See Figure 142.

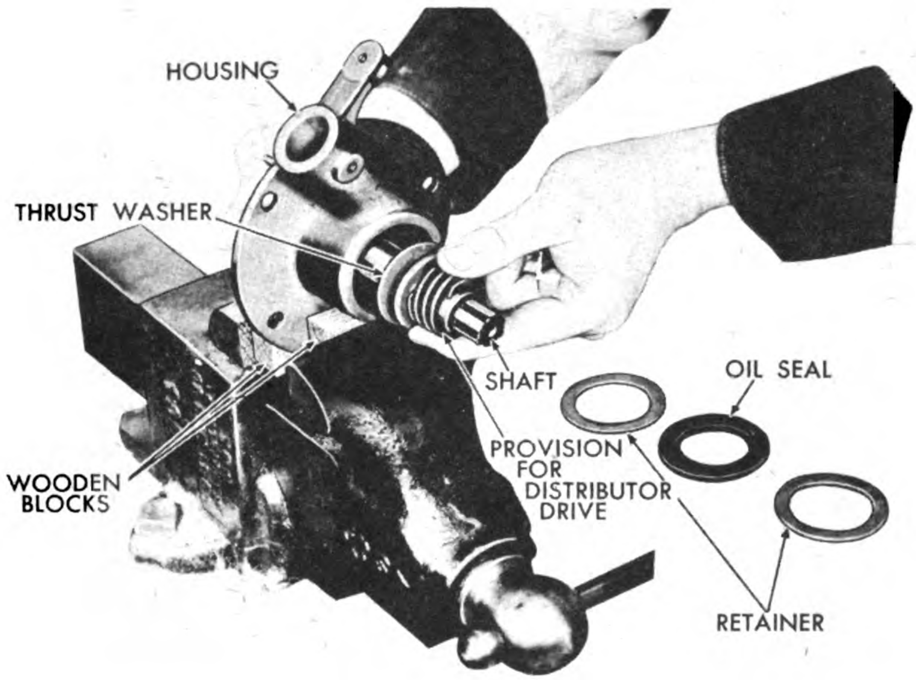


Figure 141. Removing Shaft and Oil Seal.

The camshaft is held in place by a thrust collar which is fastened to the crankcase by three capscrews Figure 124 which are prevented from coming loose by a camshaft thrust collar lock plate. This lock plate is bent over the sides of the heads of the capscrews. The desired camshaft end play should be between .005" to .008", maximum permissible, .015". Figure 127. If it is excessive, this excessive end play can usually be overcome by replacing the camshaft thrust collar.

Examine the oil pump drive pin at the rear end of the camshaft. If worn or cut, replace with a new one.

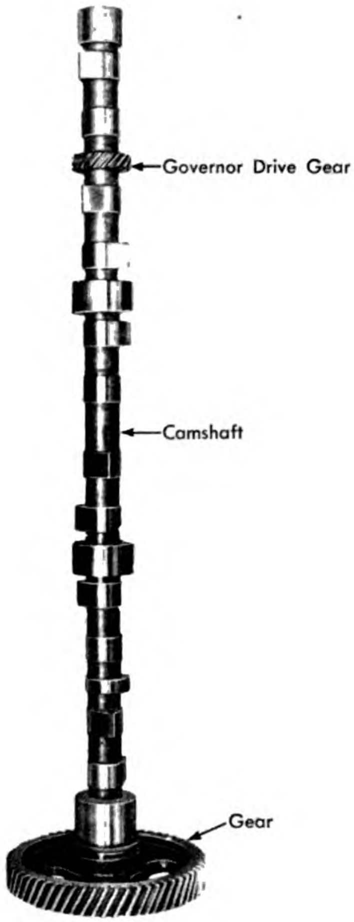


Figure 142. Camshaft

Be sure the ends of the new pin are below the surfaces of the rear bearing surfaces.

The camshaft governor drive gear is placed towards the rear end, see Figure 142.

44. CHECKING AND REPLACING THE CAMSHAFT BUSHINGS.

The camshaft runs in four bronze bushings which are pressed into the crankcase. The camshaft bearing clearance should be between .0014" to .004". If clearance is more than .005" replace the bushing, Figure 143.

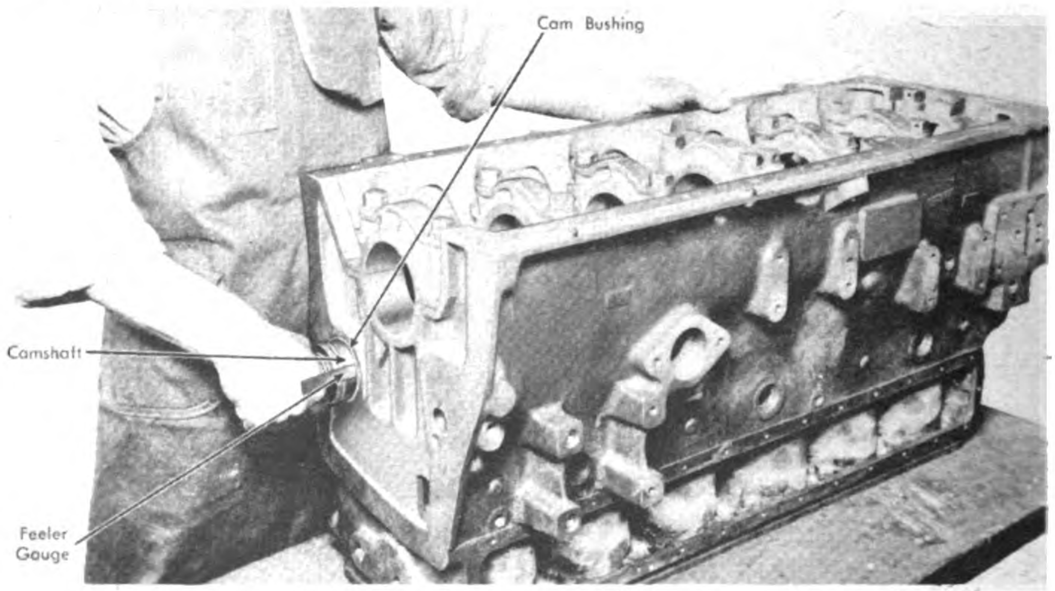


Figure 143. Checking Camshaft to Bushing Clearance with Feeler Stock.

The bushings are of precision type and do not require reaming after being pressed into the case. However, all burrs and high spots must be removed so the camshaft will turn easily.

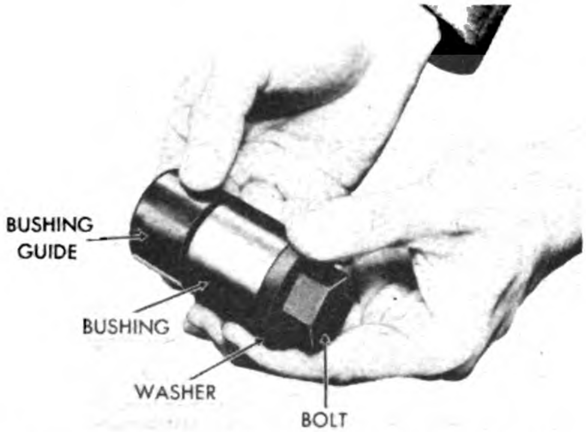


Figure 144. Camshaft Bushing Installing Tool.

45. REMOVING CAMSHAFT BUSHING.

With a hacksaw blade, carefully cut through the bushing, being careful not to cut into the crankcase. With a cold chisel and hammer, break the bushing loose and knock it out.

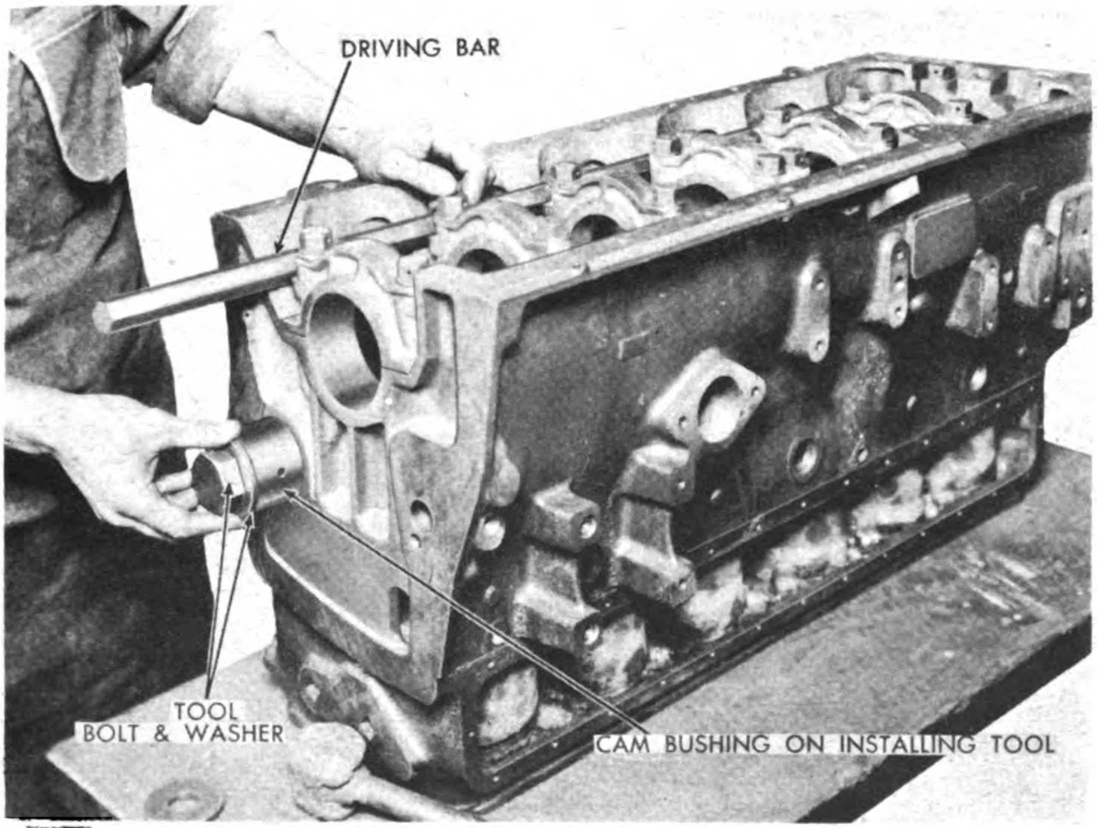


Figure 145. Installing Camshaft Bushing.

46. INSTALLING CAMSHAFT BUSHING.

With a tool similar to the one shown in Figures 144-145, put the bushing in place and drive it in, being careful to line up the oil hole.

If such a tool, as shown in Figures 144-145, is not available, use two washers slightly larger than the bushing and with holes in the center just large enough through which a bolt 1/2" in diameter and at least 2" to 3" long can pass. Put one washer on one side of the web of the hole in which the bushing fits and the other on the opposite side. Insert the bolt and screw on the nut and carefully turn the nut to pull the bushing into position.

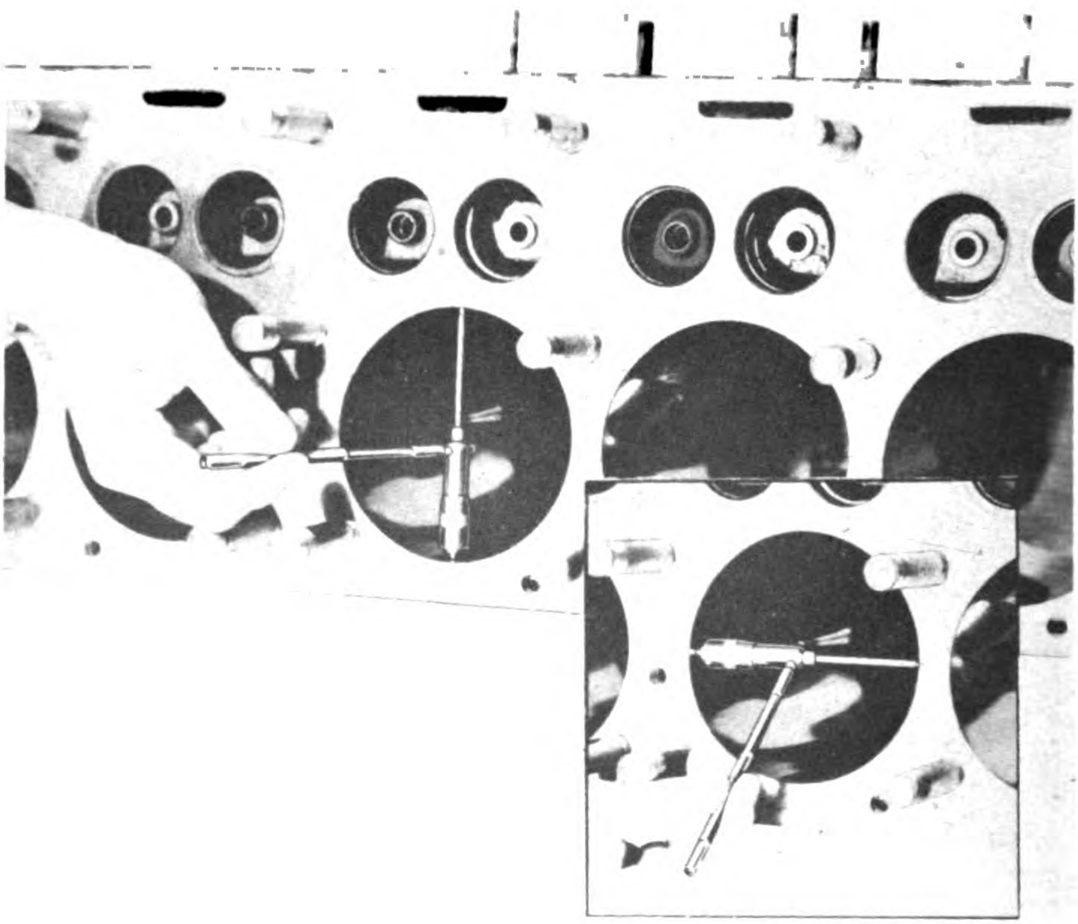


Figure 146. Checking Cylinders with Micrometer

CRANKCASE

In order to thoroughly clean the crankcase for inspection, all the plugs must be removed as indicated in the Steps of Disassembly, Chapter II, par. 39 and 40.

47. BRUSHING OUT OIL LINES

With a wire brush, as shown in Figures 137 and 138, brush out all the oil lines to remove any sediment.

48. CHECKING FOR OUT OF ROUND AND TAPER.

Check each cylinder with an inside micrometer at the upper end of the ring travel, as shown in Figure 146.

First, check in a position parallel to the crankshaft and then in a position at right angles to the crankshaft, as shown in Figure 146. The difference between these two readings shows the amount of cylinder out of round.

To obtain the amount of each cylinder taper, measure the bottom of each cylinder and again take two readings, one position parallel to the crankshaft and the other at right angles to the crankshaft. Compare the top "parallel" reading with the bottom "parallel" reading, and the top "right angle" reading with the bottom "right angle" reading to obtain the taper.

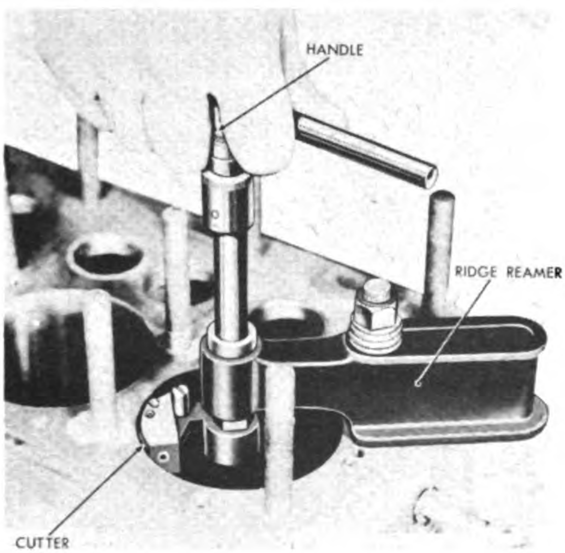


Figure 147. Removing Ring Travel Ridge with Reaming Tool.

If the out of round or taper is more than .005", the cylinders should be machined to a standard size by a grinder, a hone, or a portable boring bar: The best finish is obtained by using a hone after the cylinders are ground or bored.

49. RECONDITIONING THE CYLINDERS.

If the cylinders are within the limits specified in the preceding paragraph and are free from scores and scratches, remove the ring travel ridge at the top of the cylinders with a ridge reamer as shown in Figure 147. The removal of this ridge will forestall top ring breakage and unnecessary ring "clicking".

50. CHECKING VALVE SEATS AND VALVE GUIDES.

Inspect the exhaust and intake valve seats for pits and burns. The exhaust valve seats can be replaced if they are in a very bad condition. The intake valve seats can be refinished with a valve seat reamer.

Check the valve guides for wear by inserting a valve and noticing the amount of side play. If worn, remove the guide by driving it from the block with a driver, as shown in Figure 148. Install new guides with a press. Ream the guide so that the clearance between the new valve and new guide will be between .002" and .004". Also replace the valve.

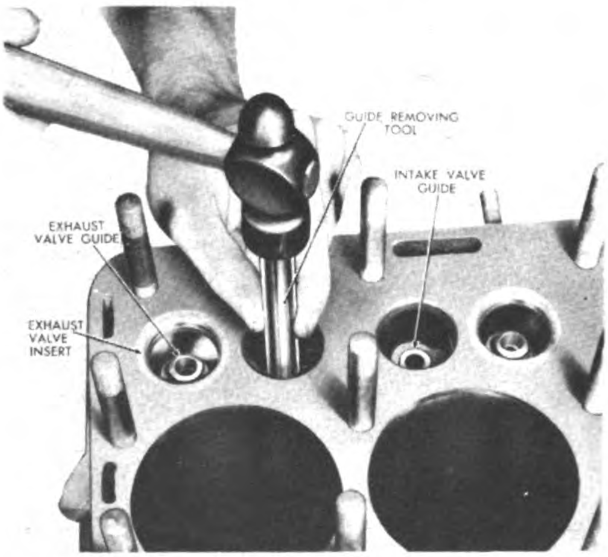


Figure 148. Driving Out Valve Guides.

51. REPLACING EXHAUST VALVE INSERTS.

The insert is held in place by a shrink fit, and by rolling metal around the hole over the edge of the seat. See Figure 149. This is sometimes referred to as peening.

To remove the insert, first roll the peened edge of the metal away from the insert, with a crimping or peening valve seat tool. (Figure 150). With a small punch, center punch the insert (See Figure 151), and drill; be careful not to drill through into the valve seat insert recess. With a small cold chisel, carefully break through the drilled holes and remove the insert.

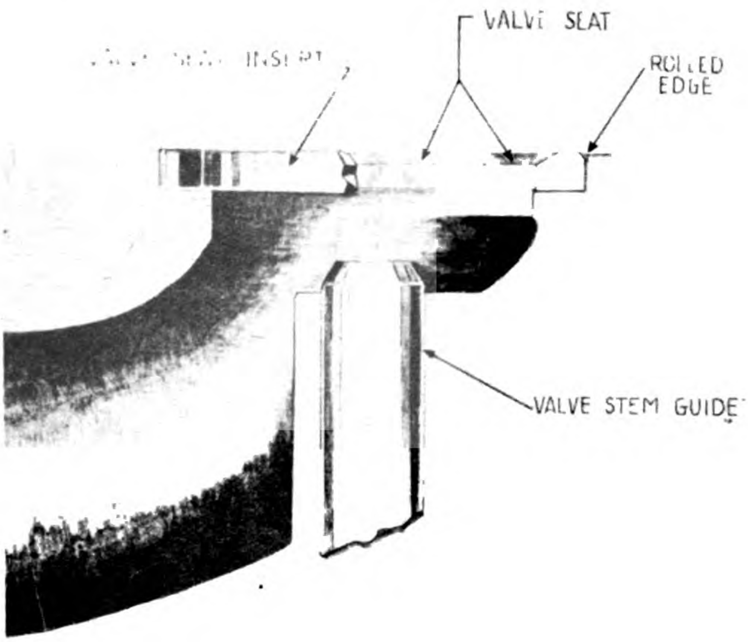


Figure 149. Exhaust Valve Insert.

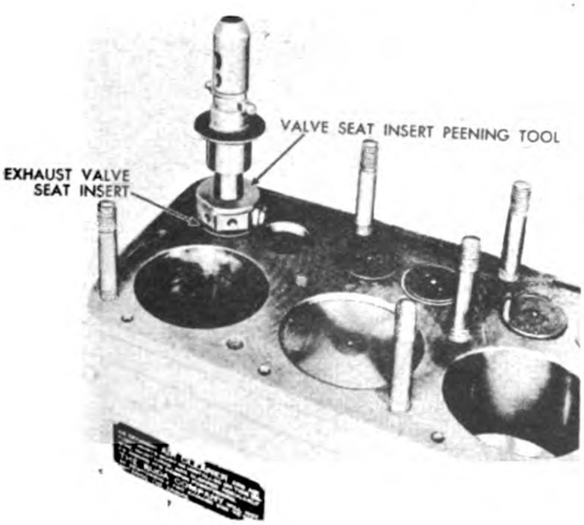


Figure 150. Valve Insert Peening Tool.

Remove all burred edges around the hole and be sure the insert recess is clean.

To install the new insert, chill it by placing insert in can of solvent, chilling with dry ice, or wrap the insert in cellophane and chill with dry ice. Drive insert in place with a driving tool, as shown in Figure 152. Roll the edges of the hole with a valve seat

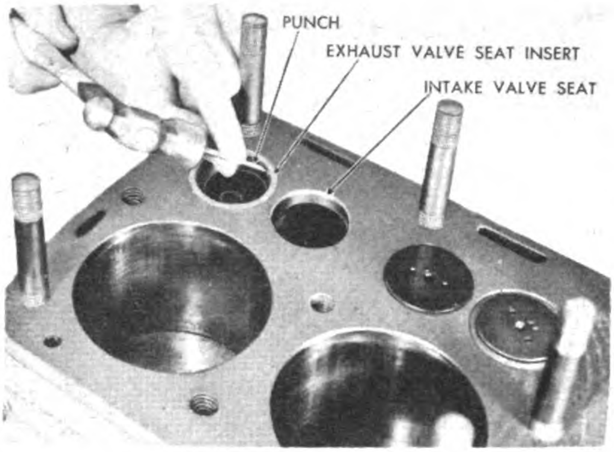


Figure 151. Removing Exhaust Valve Insert.

tool over the edge of the insert. See Figure 150. It will be necessary to refinish the valve seat with a grinder. The same grinder can be used on the intake valve seat.

NOTE: If no dry ice is available or climatic conditions are such that the foregoing procedures are not feasible, the following is recommended.

In Hot Climate: Allow the crankcase to stand in the sun until it gets as hot as the sun can heat it. Cool the valve seat insert as much as possible. Then drive the insert into the block and peen the edges with a valve seat tool.

In Cold Climate: Lay the valve insert on ice or let it remain outdoors until it is thoroughly chilled. Remove the chill from the crankcase and fill water jacket with boiling water. It may be necessary to change the water three or four times to warm the crankcase efficiently. With the water still in the block, to retain as much heat as possible, drive the valve insert and roll the edges of the block with a valve seat tool.

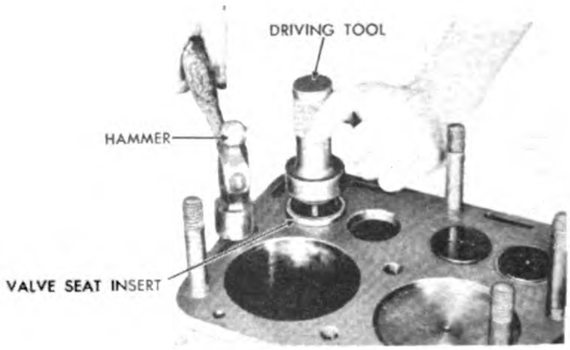


Figure 152. Installing Exhaust Valve Insert.

CRANKSHAFT

The crankshaft has seven main bearing surfaces, one between each crankpin throw and at each end of the crankshaft. The crankshaft is balanced both statically and dynamically.

52. CHECKING CRANKSHAFT WEAR.

NOTE: Because of the number of micrometer readings necessary to find the taper and out-of-round of all the bearing surfaces of the crankshaft, as outlined in the following instructions, it is advisable that these readings be recorded in some such diagram as given in Figure 153.

	MAIN BEARING #1			MAIN BEARING #2			MAIN BEARING #3			MAIN BEARING #4			MAIN BEARING #5			MAIN BEARING #6			MAIN BEARING #7		
HORIZONTAL																					
VERTICAL																					
	CONNECTING ROD BEARING #1			CONNECTING ROD BEARING #2			CONNECTING ROD BEARING #3			CONNECTING ROD BEARING #4			CONNECTING ROD BEARING #5			CONNECTING ROD BEARING #6					
HORIZONTAL																					
VERTICAL																					

Figure 153. Diagram for Recording Micrometer Readings.

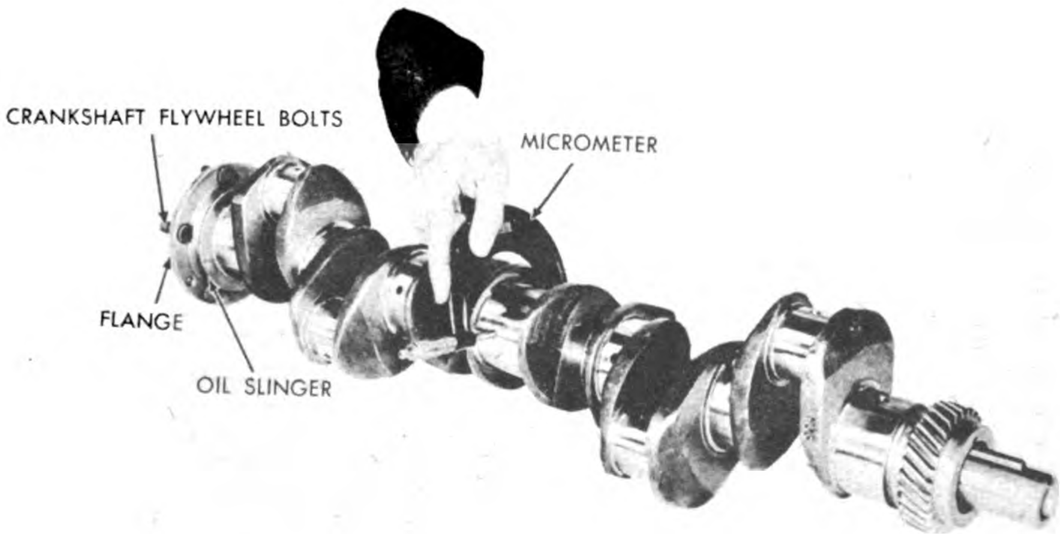


Figure 154. Checking Crankshaft with Outside Micrometer.

Check the wear of each bearing surface, or journal, with a 2" to 3" outside micrometer. See Figure 154. Before recording, take readings all around one journal to find the lowest reading on the micrometer, or the smallest diameter of the bearing, which usually will be at one end. Using that small end as a starting point, take three readings in line, one at the small end, the second at the middle of the bearing surface and the third at the other end. Record these readings. These three readings will give the amount of taper in this line of this journal

At a point 90° or one-quarter of the way around this bearing surface, again take three readings in line, the first at one end, the second at the middle, the third at the other end. If the first three readings were horizontal, the second three readings must be vertical or vice versa. The second three readings give the amount of taper in that plane, or the vertical position.

For the amount of out-of-round, compare the first horizontal reading with the first vertical reading, the second horizontal reading with the second vertical reading, the third horizontal reading with the third vertical reading. Repeat this procedure on all the other bearing surfaces, both main and connecting rods of the crankshaft.

The main bearing size is 3" and the bearing clearance is .003" to .0052" which is taken off the shaft. Therefore, the original size of the shaft is 2.997". If the wear of the shaft is more than .0015" or measures less than 2.995", replace with standard size shaft.

The connecting rod bearings are 2.375" and the bearing clearance is .0015 to .003" which is size taken off the shaft. Therefore, the original size of the crankpin is 2.3720" to 2.3735". If the wear of the crankpin is more than .0015 or measures less than 2.3705" it should be replaced. The connecting rods can be exchanged for the standard undersize to which the main bearings have been ground. The bearings in the rods are of the poured type, which necessitates the exchange of the entire rod.

Check the crankshaft flange for nicks and smooth them if necessary. The flywheel bolts should be tight in the flange. Also check the oil slinger for burrs that might cut the rear main bearing oil seal. See Figure 154. If the oil slinger is bent, straighten it.

53. CHECKING CRANKSHAFT GEAR.

Check the crankshaft gear for wear. If worn excessively, replace the gear with the same size as marked on the gear. See Gears, paragraphs 58 and 60.

CYLINDER HEAD AND MANIFOLD

54. CHECKING FOR CRACKS AND WARPING.

With a straight edge, as shown in Figure 155, check for a warped condition of both the cylinder head and the manifold. For the cylinder head, place the straight edge diagonally from one corner to the other. If the head is warped, it can be machined. CAUTION: Do not remove more than 1/16" of metal from the cylinder head surfaces, because if more than that amount is removed, the compression ratio will be increased and this will require the use of a premium gasoline with high anti-knock value.

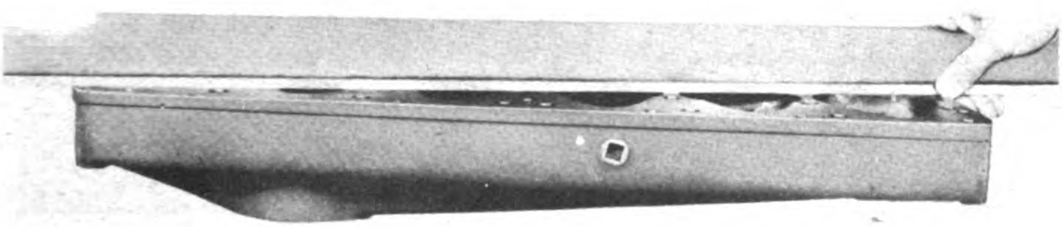


Figure 155. Checking Cylinder Head for Warping.

55. CHECKING MANIFOLD.

For the manifold, place a straight edge ruler across the gasket faces lengthwise. If warped, the ends usually bow in and the center bows out. Remachine just enough so that all points touch.

FLYWHEEL AND FLYWHEEL HOUSING

56. INSPECTION.

Inspect the flywheel ring gear for damaged teeth. If teeth are mutilated, replace with a new ring gear. See Figure 156. Examine the clutch pilot bearing hole. If the fit of the bearing in the hole is loose, either repair the flywheel by pressing in a bushing or replace the flywheel. Examine the bolt holes; if they are loose or worn, replace the flywheel. Inspect the bell housing for cracks. If not too badly cracked, the housing can be welded; otherwise replace the housing.

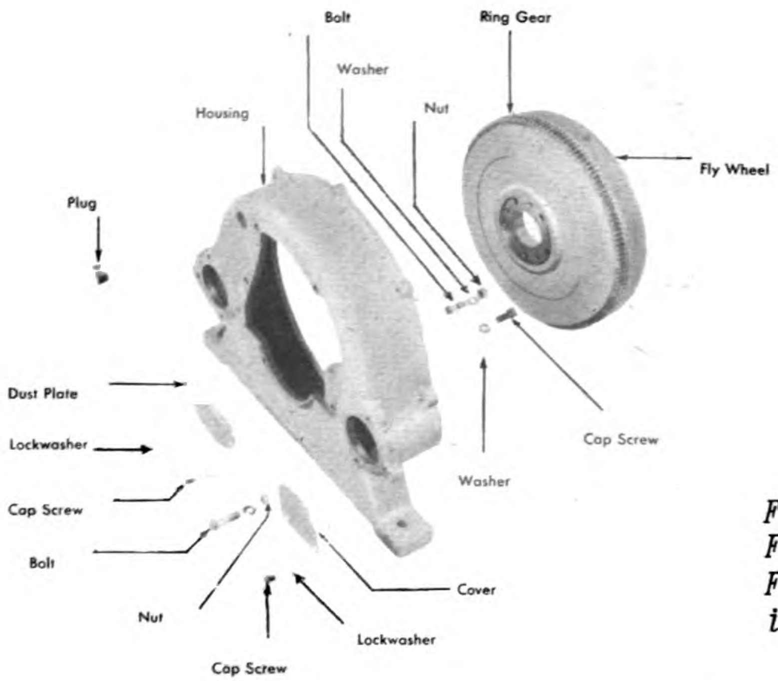


Figure 156. Flywheel and Flywheel Housing.

The flywheel housing bore should be checked for out of round and out of alignment when reassembling the engine. With a dial indicator attached to the flywheel as shown in Figures 157 and 158, slowly crank the engine and check the dial reading. The maximum tolerance or out-of-round allowed is .005". If the out of round or the alignment is more than .005", remove the housing and thoroughly clean both the machined surfaces of the crankcase. If this does not correct the excessive out of round, or excessive out of alignment, replace the flywheel housing. To check the run-out of the flywheel see Chapter V, Reassembly of Engine.

57. INSTALLING RING GEAR.

To remove the old ring gear, lay the flywheel flat on the floor with the front side of the flywheel up.

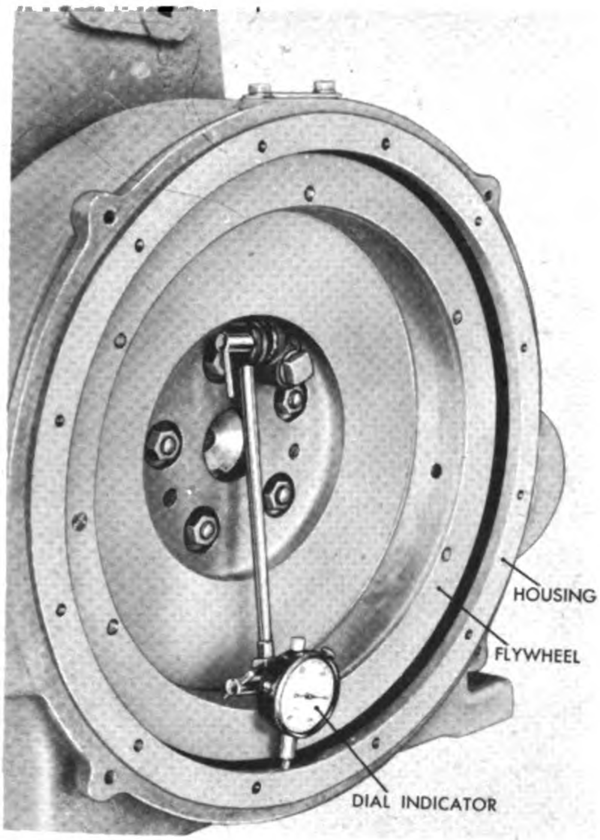


Figure 157. Checking Flywheel Bore.

With a 3/16" drill, drill two or more holes through the gear parallel with the teeth. Do not drill into the flywheel. With a cold chisel, cut the remaining metal between the holes to split the gear completely in two. Drive off the ring gear with a punch and hammer. See Figure 159. Boil the new ring gear in oil for fifteen minutes, or heat evenly with a torch to expand the gear. With the flywheel flat on the floor front side, or crankshaft side up, lay the heated ring gear in place with the bevel end of the teeth up. Be sure the ring gear is seated properly against the shoulder and allowed to cool.

GEARS

The crankshaft gear drives the camshaft and the accessory drive gear through an idler gear. See Figure 160. The camshaft and accessory drive shaft turn in the same direction as the crankshaft. The gears are on fixed centers, and adjustments are made by selecting oversize or undersize gears.

The idler gear rotates on a stub shaft which is pressed into the crankcase. The shaft is secured by a lockscrew which screws into the right hand side of the case. See Figure 129. The timing gears are made of cast iron or steel, a selected combination of metal that assures long wear and quiet running.

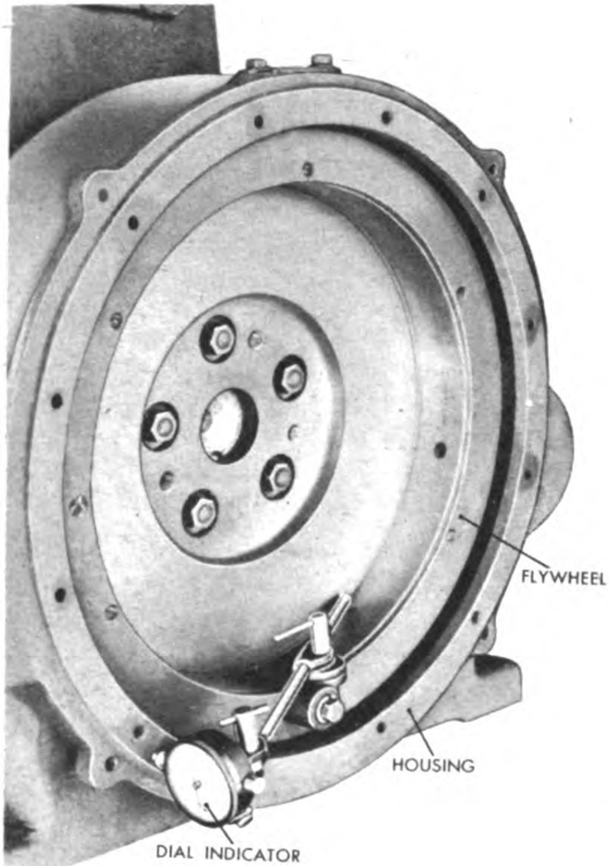


Figure 158. Checking Flywheel Housing Alignment.

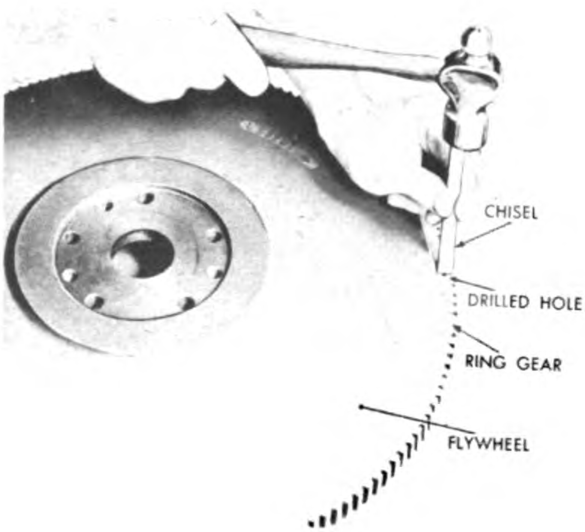


Figure 159. Removing Old Ring Gear.

58. CHECKING FOR WEAR AND REPLACEMENT.

The crankshaft, idler, and camshaft gears should be fitted with .002" to .004" backlash, while the accessory drive gear may have .004" backlash. See Figure 160. When ordering one gear for replacement, use the size marking of the old gear with allowance for wear on the others.

Each gear is marked with a number within either an 0 or a letter U, thus 2 or 3. The surrounding symbol denotes oversize (0) or undersize (U) respectively, and the number gives the deviation from the standard in thousandths of an inch. The letter S denotes standard size. NOTE; The new gear, or gears, for replacement must correspond in size to the gear or gears replaced. Due allowances should be made for wear on the other gears.

59. REPLACING THE IDLER GEAR BUSHINGS.

If the idler gear wobbles, the bushing

needs to be replaced. NOTE: If the bushing is replaced, it must be bored in a lathe to a running fit on the stud. Hand reaming will not be straight and will cause the gear to run out. The clearance between the idler gear bushing and stud should be .0015" to .0025". See Figure 122. The maximum limit is .005". NOTE: It is recommended that the gear be replaced rather than installing a new bushing into the old gear.

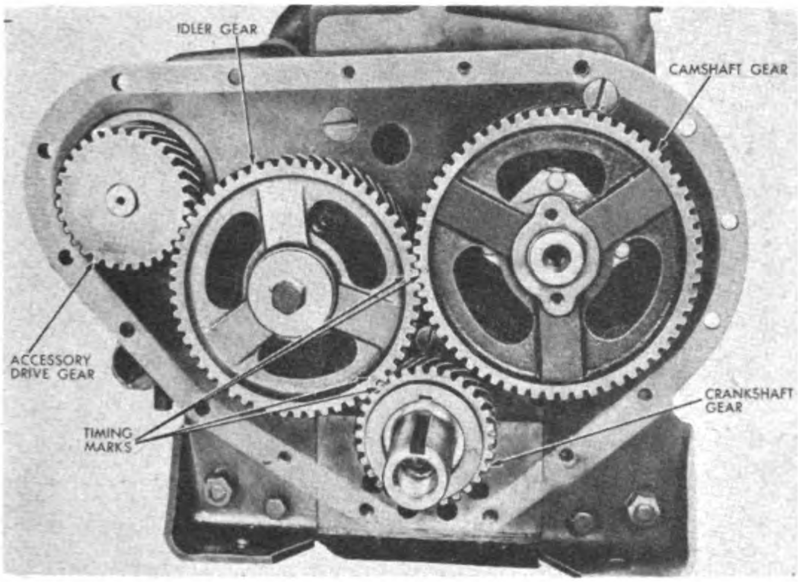


Figure 160. Gears.

60. REPLACING CRANKSHAFT GEAR.

Method A. The best method for installing the crankshaft gear is to boil it in oil for approximately fifteen minutes in order to expand the gear as much as possible. At the end of this time pick up the gear with tongs or pliers and slip it on to the crankshaft. Be sure to align the key way and the key. This method of heating the gear assures maximum expansion with no injury to the gear.

Method B. If step A is not feasible, method B can be used after the crankshaft has been installed in the engine. For this procedure a long 7/8" S.A.E. stud, a pipe with the same outside diameter as the gear hub, and washers to set over the end of the stud against the end of the pipe, and a nut to go on the end of the stud are needed.

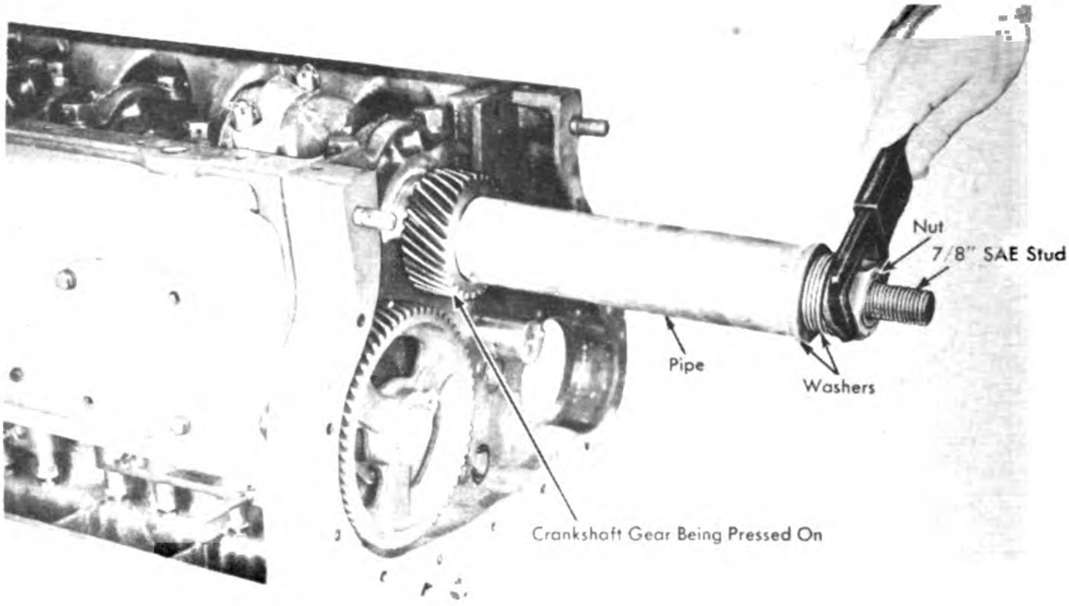


Figure 161. Pressing on Crankshaft Gear.

First, coat the crankshaft with white lead. Place the gear in position on the shaft with the keyway and the key in alignment. Screw the stud into the shaft. Place the pipe over the shaft with the washer in place and tighten the nut to press on the gear. See Figure 161. Watch the key to be sure that it stays in position. NOTE: Method B should be done during the steps of engine reassembly.

MAIN BEARINGS

61. REPLACEMENT.

The main bearings are of precision type and can be replaced individually. No scraping and fitting is required. Replacement can easily be made in the field by simply pushing out the old shell, as shown in Figure 162. This is best done by inserting into the oil hole in the crankshaft journal, a small bolt of practically the same diameter as the oil hole in the shaft, but with the head filed down to less than 3/16". Slowly turn the crankshaft by hand and push the old shell out.

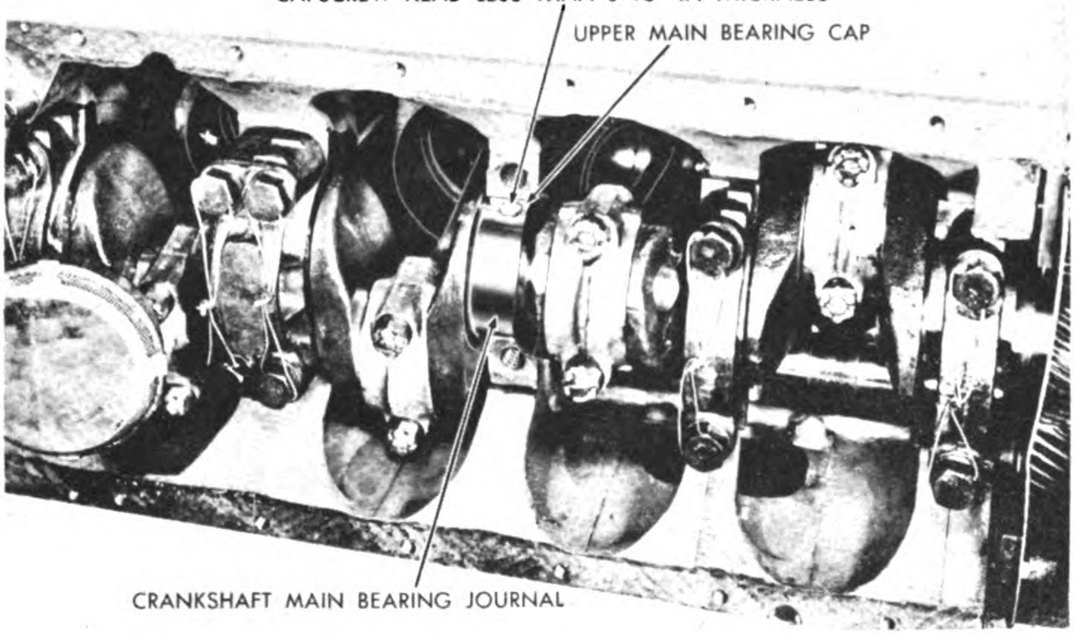


Figure 162. Removing Main Bearing Shell.

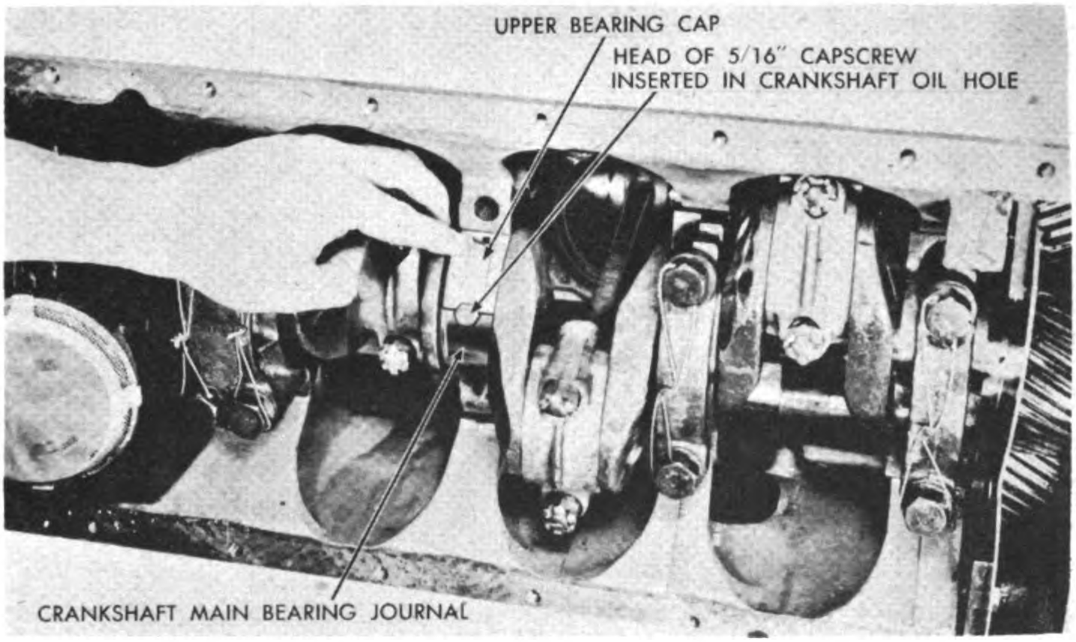


Figure 163. Installing Main Bearing Shell.

To install the shell, as shown in Figure 163, start the shell into position by hand, being careful not to mar the bearing. After it is well started in, insert the same bolt that was used to remove it, only this time allow the head to project over the bearing shell and to keep it from raising up as you slowly turn the crankshaft by hand. When almost in place, stop and back up the crankshaft to release the bolt from over the shell and insert a bolt of the same diameter, but with a higher head, and slowly push the shell into position by turning the crank.

NOTE: It is recommended that if one main bearing needs replacing, they all should be replaced. The upper shells are not dowelled, the lower shells being dowelled in the caps to hold them in place. No shims are required.

62. INSPECTING BEARINGS.

Look for holes or cracks in the bearing surfaces and check the assembled bearings with an inside micrometer. It is necessary that the main bearings be in the crankcase and the caps clamped in place to obtain accurate measurements. If there are holes and cracks in the bearings and the crankshaft wear is less than .0015", replace with new bearings of standard size. New main bearings standard size is 3". If the main bearing wear is more than .0015" and the crankshaft wear is less than .0015", replace them with new bearings of standard size.

63. REPLACING BEARING CAP OIL STOPS.

Replace the rear main bearing cap oil stops. See Figure 164. If standard oil stops are not available the grooves can be packed with candle wick, which should be firmly calked into place by means of a small tapered tool

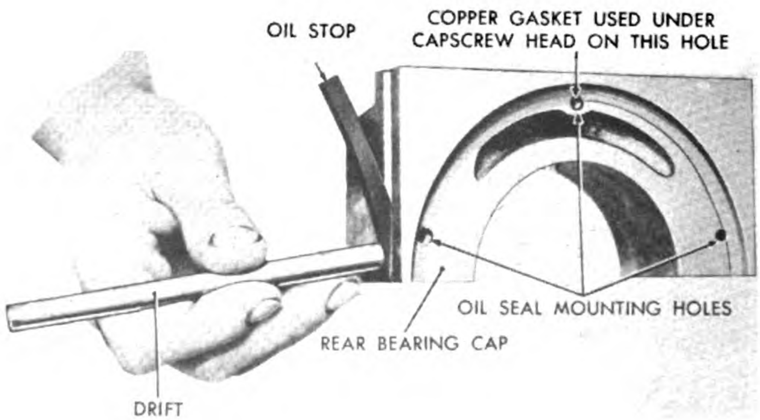


Figure 164. Installing Oil Stops.

or punch and hammer, pounding the wick gradually up to the grooves until they are packed full.

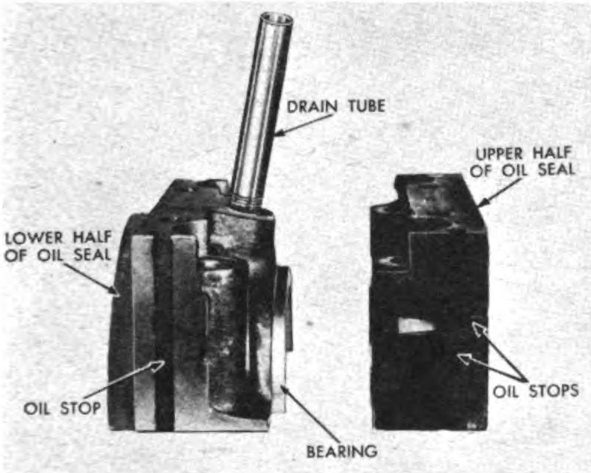


Figure 165. Rear Bearing Cap and Oil Tube.

The rear bearing cap has an oil drain tube attached to it which leads down below the oil level in the oil pan in order to assist in preventing oil leaks through the rear main bearing. Figure 165 shows a cap with a tube in place. Replace the rear bearing oil seal felt as follows:

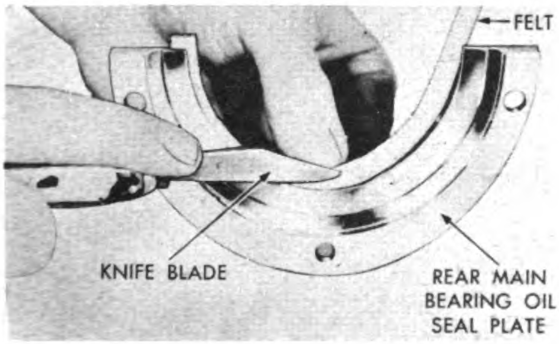


Figure 166. Installing Rear Bearing Oil Seal Felt.

First remove the old felt from the groove with a knife. Do not cut away any of the metal. Coat one side of the felt with shellac and calk the felt into the groove with the shellac side down as shown in Figure 166. The shellac must not be allowed to penetrate through to the crankshaft side of the felt. Oil the outside surface of the felt with graphite grease to keep it from burning up when the engine is first started.

64. MAIN BEARING CAPS.

The main bearing caps are numbered from 1 to 7 starting from the timing gear housing at the front end. Dowels in the cap hold the lower main bearing shells in place. The caps should be installed in their respective places so that the single case lobe is pointed to the camshaft side of the engine. See Figure 167. The caps should be checked for cracks or any indications of movement of the main bearing in the cap which will necessitate either the replacement of the bearing shell, the dowel, or the cap.

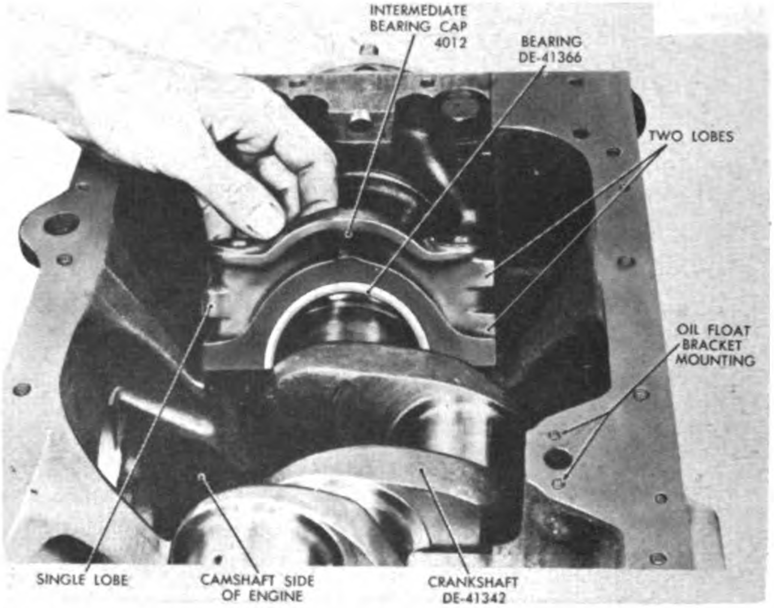


Figure 167. Installing Rear Bearing Caps.

PISTON AND CONNECTING ROD ASSEMBLY

The pistons are cast iron and have four rings all above the pin. The top, or fire ring, is a plain ring and is followed by two combination compression and scraper rings, and the lower is an oil control ring of the slotted type. See Figure 168. If cylinders need regrinding, this necessitates replacing the pistons.

65. CHECKING AND FITTING THE PISTONS.

After the pistons and connecting rods have been disassembled and the piston rings removed, visually inspect the grooves and the ring lands for cracks. Also check the head of the piston and the skirt, both inside and out for cracks. If there are any, the pistons must be replaced.

The pistons should be fitted as follows: First thoroughly clean the cylinders and pistons with compressed air and wipe them dry with a clean cloth. With a

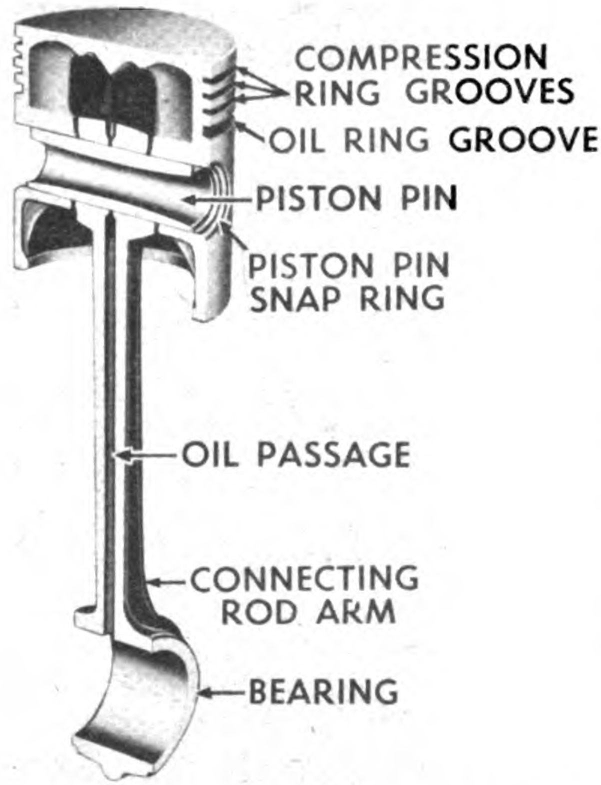


Figure 168. Sectional View of Piston and Connecting Rod.

.003" feeler ribbon attached to a spring scale and the feeler ribbon inserted between the piston and the cylinder at a position 90° from the piston pin hole and in line with the thrust surface of the piston, the feeler ribbon should pull out with approximately six to eight pounds tension, as shown in Figure 169.

66. CHECKING THE PIN WEAR AND REPLACING PIN.

The piston pins are full floating type and are made to rotate in the connecting rod bushings. The pins are held in place by means of two snap rings and lock in grooves in the outer end of the piston pin bosses which prevent the piston pin from coming in contact with the cylinder walls. If these grooves are worn so that the locks will not fit tightly in these grooves, the piston will have to be replaced.

The pins have the ends ground flat and polished to prevent their cutting through the lock ring. The pin to piston is a light tap fit with a rawhide mallet. Figure 170. The piston pin to connecting rod bushing is a light push fit with the palm of the hand. Figure 171.

If replacement is necessary, replace the pin with the next first oversize and ream out the piston and connecting rod bushings. The piston pin bushings should be reamed or honed to allow thumb push fit as shown in Figure 171.

If the piston pin to bushing clearance exceeds .002", replace the pin. Replace the lock rings if any signs of wear are visible.

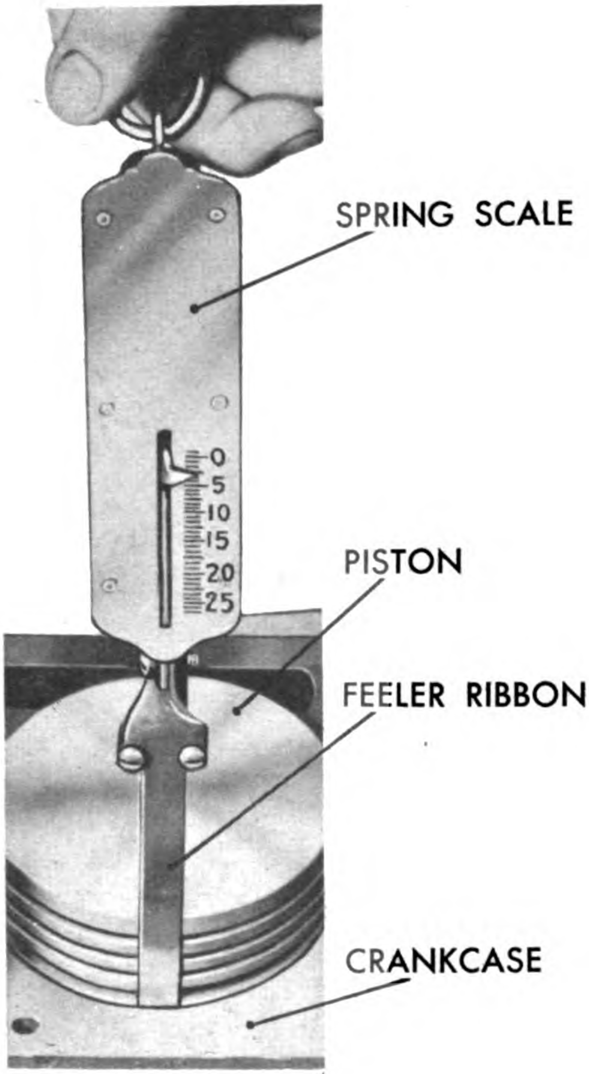


Figure 169. Fitting Piston to Cylinder.

67. INSTALLING PISTON PIN SNAP RINGS.

Particular care should be used when installing the snap rings or retainer rings. Use a pair of long-nose pliers as shown in Figure 174, and make sure that the rings fit snugly into the grooves. Do not force the retainer rings into or out of the grooves with a screw driver. When these retainer rings are installed correctly, they cannot be turned with the fingers. If the pin has to be replaced, it will be necessary to realign the connecting rod as given in paragraph 70.

68. REPLACING PISTON RINGS.

Always replace the piston rings during the 2,000 hour overhaul whether or not the cylinders have to be machined.

NOTE: If, at any time, after 100 hours of operation, a piston, or the pistons, must be removed from the engine, always replace rings with new ones. This is advisable because it will be impossible to get the piston rings back into the same positions into which they had worn. Therefore, if they are not replaced, there is the possibility of the pistons pumping oil, and it is recommended not to slip the new rings on until ready to put the pistons back in the engine.

REPAIR OF PISTON AND CONNECTING ROD

First check the depth of the ring groove in the piston, as shown in Figure 173 and check the clearance between the ring lands and the ring with a feeler gauge, as shown in Figure 172. The clearance should be .0005" to .0015". Check the gaps of all the rings with a feeler gauge, as shown in Figure 175. Compression ring gap should be .013" to .018", the oil ring gap .013" to .018".

CONNECTING RODS AND CONNECTING ROD BEARINGS

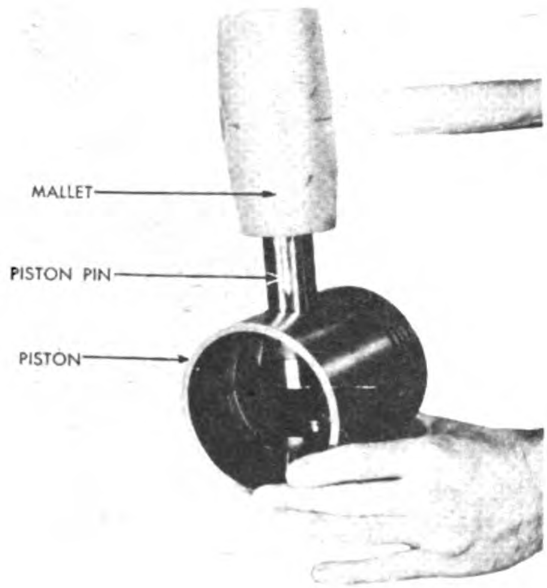


Figure 170. Installing Piston Pin in Connecting Rod.

The connecting rods are rifle-drilled for pressure lubrication to the piston pin. Side clearance of the connecting rod between the sides of the bearing and the crankshaft check should be maintained at .004" to .009" and a uniform clearance allowed between the upper end of the rod and the piston pin bosses.

The babbit type bearings are spun directly into the connecting rods. When bearing replacement becomes

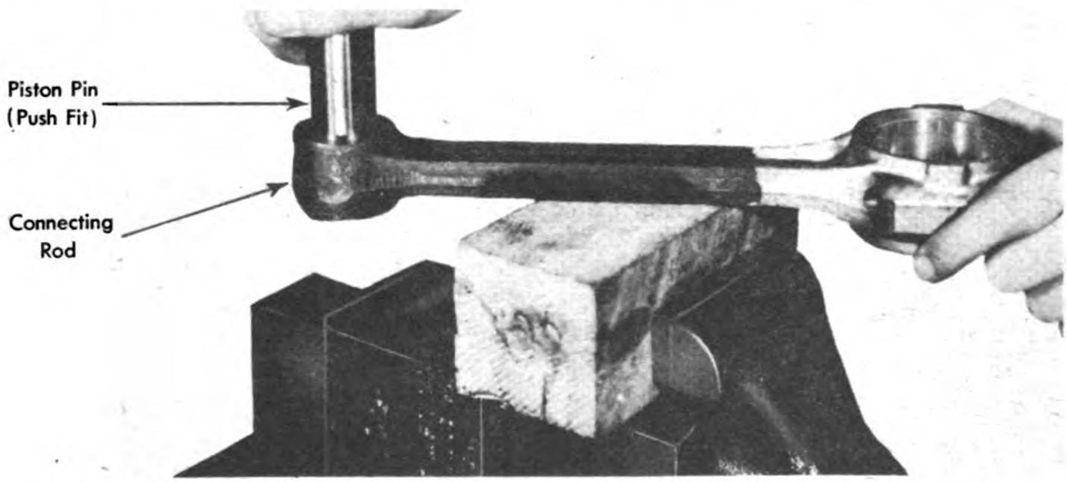


Figure 171. Pushing Piston Pin in Connecting Rod

REPAIR OF CONNECTING ROD AND CONNECTING ROD BEARINGS

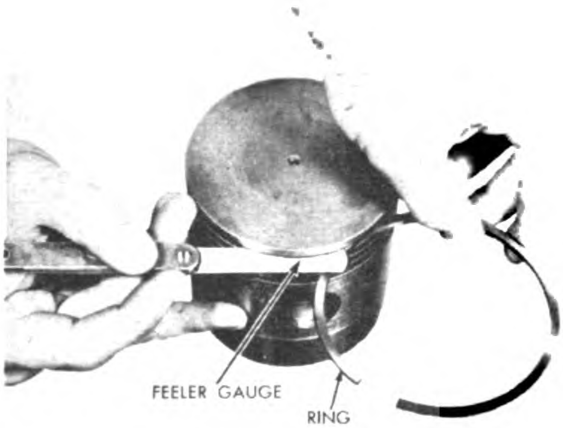


Figure 172. Checking Clearance of Ring Land and Ring.

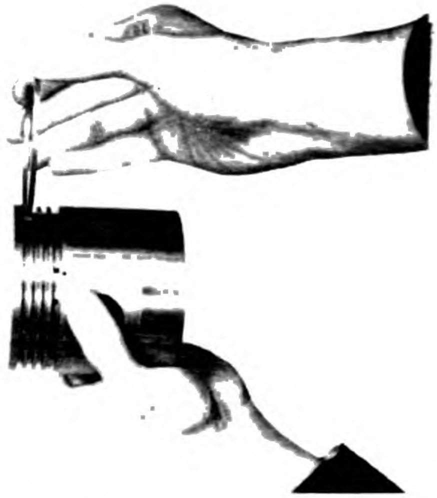


Figure 173. Checking Depth of Ring Groove.

a necessity the entire rod and cap must be replaced. If the crankpin is reground to a standard undersize, the connecting rod must be replaced with the same standard undersize to fit, such as .010", .020", .030", .040".

69. INSPECTING AND REPLACING THE CONNECTING ROD.

If the bushing is loose in the connecting rod, the entire rod must be replaced, as even a new bushing would fit loosely in the old rod. Check the wear of the connecting rod bearing (cap in place) with an inside micrometer. If worn more than .0015", or the reading is more than 2.3765", replace the entire rod with a new rod of standard size, provided the crank pin bearing wear is negligible and no regrinding of the crankpin is necessary.

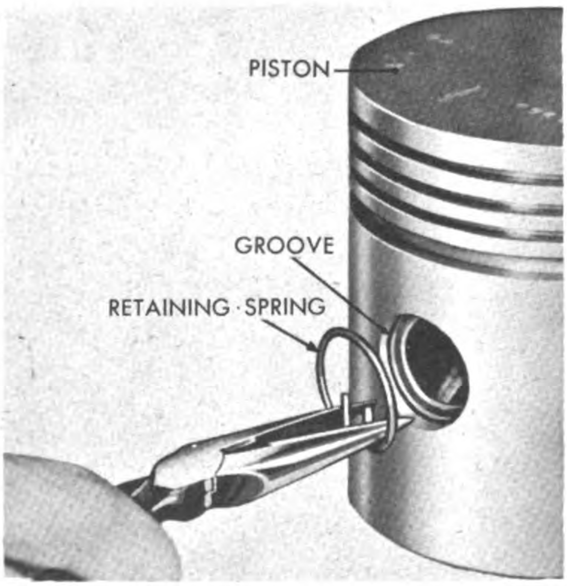


Figure 174. Installing Piston Pin Retainer or Snap Ring.

REPAIR OF CONNECTING ROD AND CONNECTING ROD BEARINGS

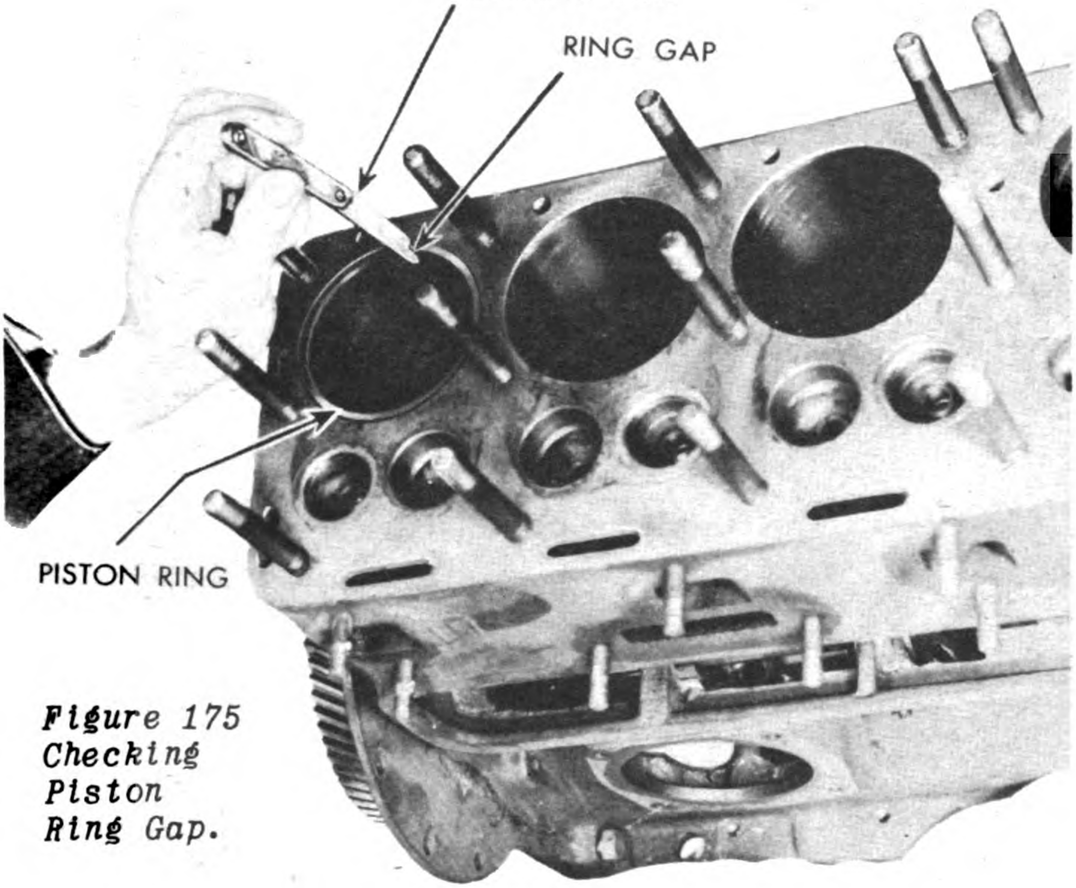


Figure 175 Checking Piston Ring Gap.

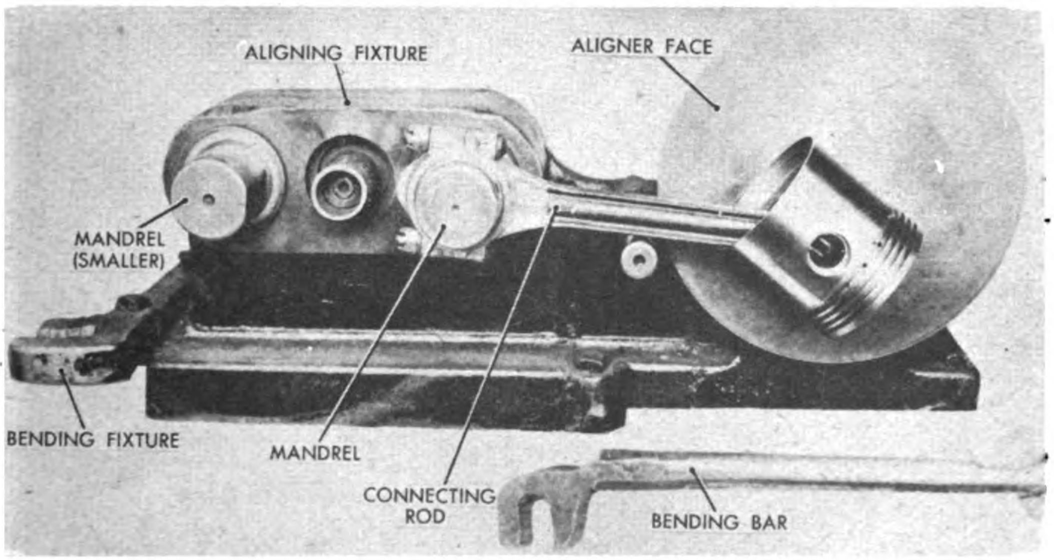


Figure 176. Checking the Alignment of Connecting Rod and Piston.

REPAIR OF CONNECTING ROD AND CONNECTING ROD BEARINGS

70. CHECKING THE ALIGNMENT OF CONNECTING ROD AND PISTON.

With the piston and connecting rod assembly clamped into the mandrel of the aligning fixture, swing the rod into a horizontal position (parallel to the floor.) See Figure 176. With the piston held diagonally to the rod (piston head pointing to the floor), observe the space between the face of the fixture and the skirt of the piston as shown in Figure 177, if this space is not even,

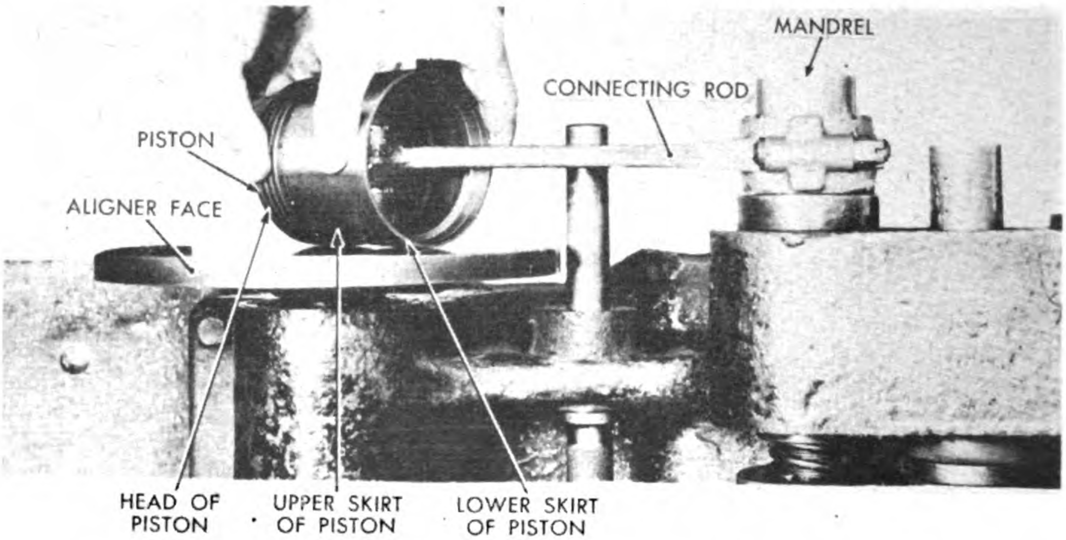


Figure 177. Checking Connecting Rod (Piston Head Down)

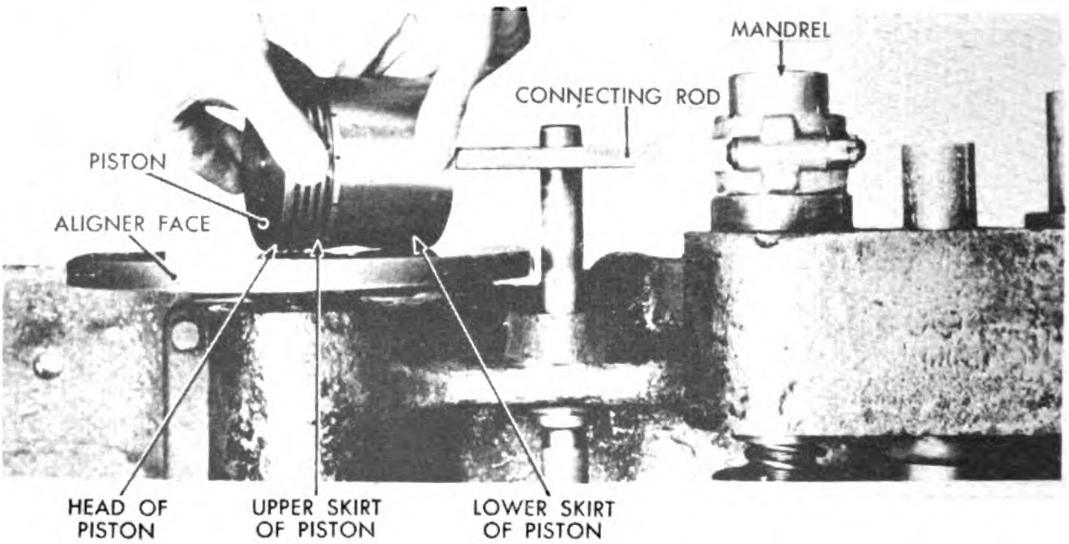


Figure 178. Checking Connecting Rod (Piston Head Up-Skirt Down)

the rod is twisted out of line. NOTE: the ring lands at the top of the piston are smaller than the skirt; therefore, check the alignment of the rod along the full length of the skirt only. Twist the rod with a large wrench until space between the aligner and the piston is even. Now check for a twist in the opposite direction by moving the piston into the opposite diagonal line to the rod (piston head pointing up.) See Figure 178. Observe the space between the aligner face and piston skirt; if the space is uneven, twist the rod with a large wrench until true alignment is obtained. Check for a bent rod by moving the piston into a parallel position with the connecting rod and observe the space between the aligner face and the piston skirt; if the space is not even, the rod is bent. See Figure 179. Straighten by careful bending the rod with a large wrench.

71. SHEET METAL HOUSING AND FRONT ENGINE MOUNTING BASE.

During the 2,048 hour overhaul, the sheet metal radiator, and front engine mounting base, together with the flywheel housing, should be thoroughly cleaned and painted. Check all the mounting and fastening bolts and nuts and replace worn or stripped bolts. Check the mounting pads on which the radiator assembly rests. If they are worn or cracked, replace with new ones.

72. TIMING GEAR HOUSING AND FRONT SUPPORT.

Examine the front end gear case cover for cracks; if cracked either weld or replace the cover. Always replace the oil seal in the front gear case cover. Clean out the recess in which the oil seal sets. See Figure 180. Also inspect the water pump shaft thrust button and spring for sufficient spring tension and freedom of movement. If the button sticks, clean the hole or button, and if the spring is weak, replace this with a new one.

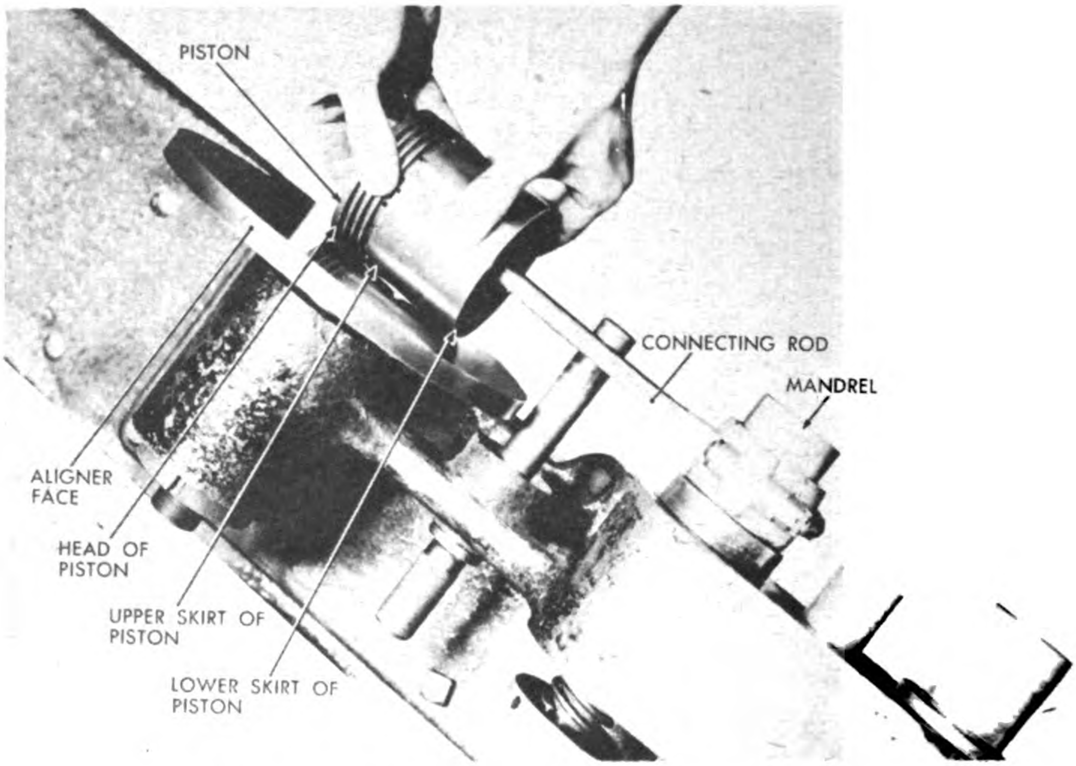


Figure 179. Checking for Bent Rod.

VALVES

Inspection of the valves includes the valve springs, valve spring seats, retainers, lifters, adjusting screws, and brackets. See Figure 181.

73. INSPECTING THE VALVES FOR GRINDING AND REPLACEMENT.

If the valves are warped or burned, they must be replaced. If they are pitted, they should be refaced in a refacing machine at an angle of 45°.

74. CHECKING THE VALVE SPRINGS FOR REPLACEMENT.

Check the spring tension of each spring with a spring scale designed for this purpose. The tension of all springs should be equal. If weak, cracked or broken, replace the spring. Tension is as follows: free length, 2-9/16"; 51 to 57 lb. pressure at 2-7/32".

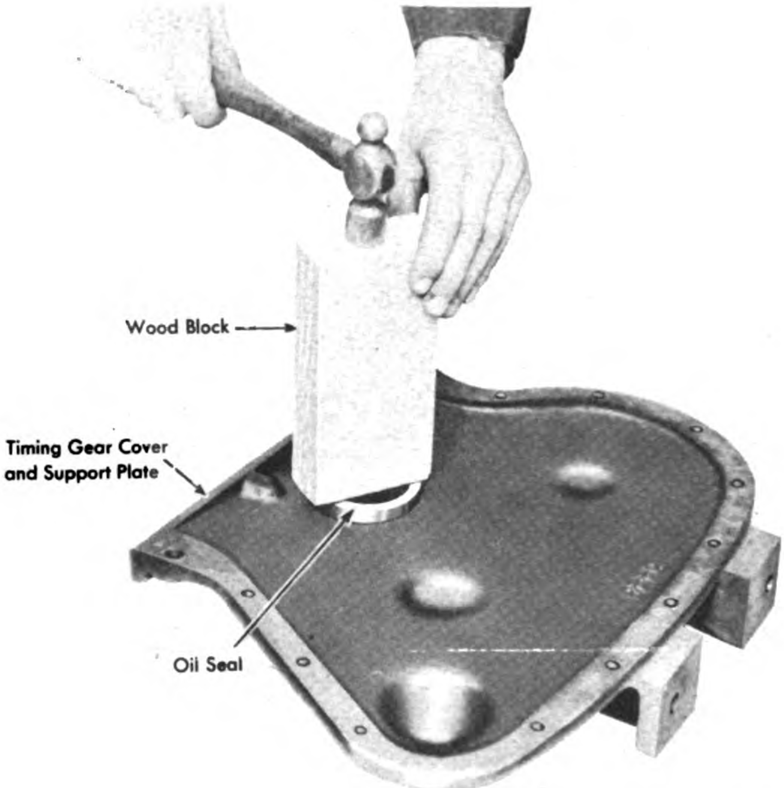


Figure 180. Inserting Oil Seal in Front Cover.

NOTE: When the spring is compressed to a length of 1-19/32" which is equal to valve-open position, the scale should read 96 lbs. to 104 lbs.

75. CHECKING THE LIFTER, ADJUSTING SCREWS AND BRACKETS FOR REPLACEMENT.

The lifter is of mushroom type and is made of grey iron with a chilled head. Check the head for cracks; replace if cracked.

The adjusting screw tends to become worn where the valve stem strikes it. If the adjusting screw is at all worn, it must be replaced.

Check the lifter holes in the bracket by inserting a lifter in the hole. If the fit, is loose more than .001", replace the bracket.

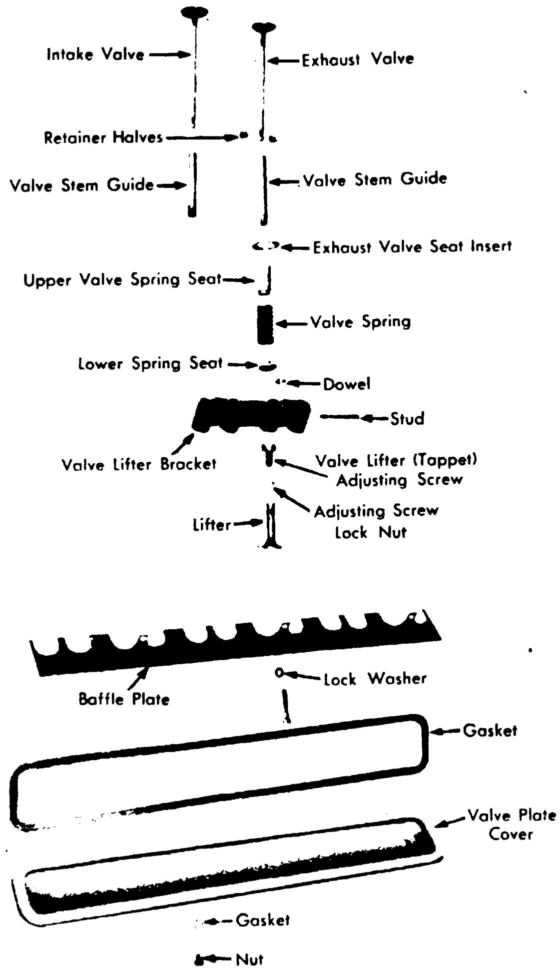


Figure 181. Valve Assembly.

76. REPLACING THE RETAINERS AND SEATS.

Only because of loss or accident should it become necessary to replace the valve spring seats and retainers.

77. VALVE GRINDING.

When grinding the valves, a good quality water soluble valve grinding compound should be used. This type of compound loses its cutting properties on contact with oil. A valve grinding tool like the one shown in Figure 182 or one similar is recommended.

78. VALVE GRINDING PROCEDURE.

Thoroughly examine the valve stems and the valve guide clearance before grinding the valves. Do not mix the valves during the inspection because the same valve must always go back into its original port. The intake and exhaust valves are made of different materials and if exchanged, they will not give proper service.

The valve stems can be cleaned with cleaning fluid and a cloth buffer. Under no circumstances, use emery cloth or a wire brush on the stems, for the smooth glaze which is a normal result of engine operation will be destroyed. It is desirable to retain this glazed finish, since it prevents metal to metal contact. A wire brush may be used to free the valve heads of carbon.

With inside calipers or micrometers, check the valve guide clearance. The desirable clearance is from .002"

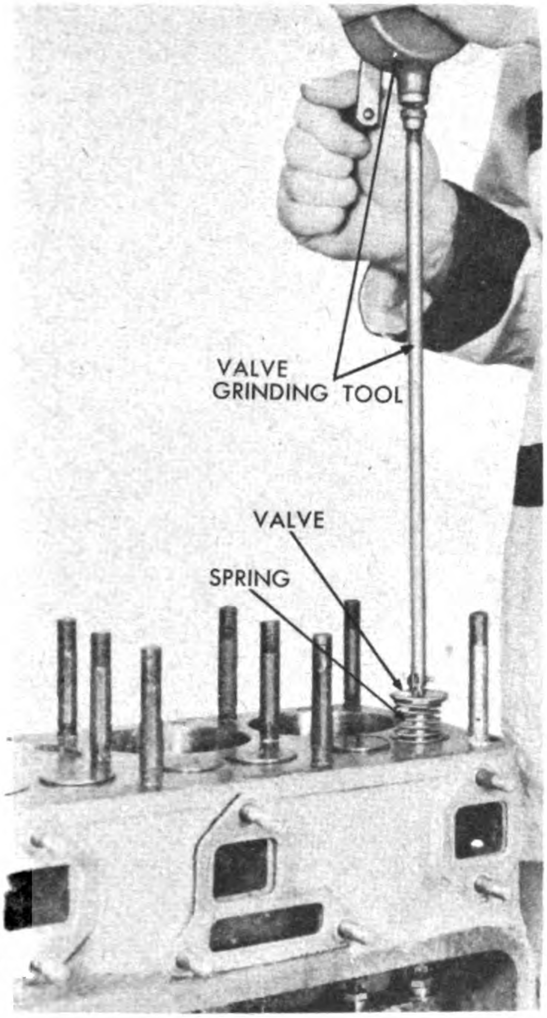


Figure 182. Grinding Valves.

to .004". If more than .0055", replace the valve guide, or guides.

Before beginning the actual grinding of the valves, all traces of carbon should be removed from the cylinder head and valve chambers, or ports. Care must be used so as not to scratch the valve seats or damage the metal in any way when removing the carbon.

It is not always necessary to reface the valves or reface the valve seats. Only if there are evidences of warping or serious pitting will the valves need refacing. A good method of detecting warping is to put each valve stem in the chuck of a valve face grinder and slowly rotate the valve while the grinding wheel is brought near the rotating valve face. The grinding wheel must be set to the proper valve seat angle. Move the grinding wheel toward the valve until it almost touches the valve. Any slight eccentricity will be noticed immediately.

If there are deep pits or grooves on the valve seats, it will be necessary to reface the seats.

If the valve faces and seats are believed to be in sufficiently good condition to grind in properly without reconditioning a final test with valve compound should be made. First place a circular piece of fine emery cloth which is slightly larger than the valve port over an old valve head or a valve seat reamer so that the cloth will be between the valve and seat with the cutting side against the seat when the valve is placed in the cylinder. Press firmly on the valve stem, with a grinding tool attached, and turn back and forth through several revolutions, to remove the hard glaze from the valve seat. Unless this is done, a great amount of unnecessary grinding will be spent in cutting through this glaze.

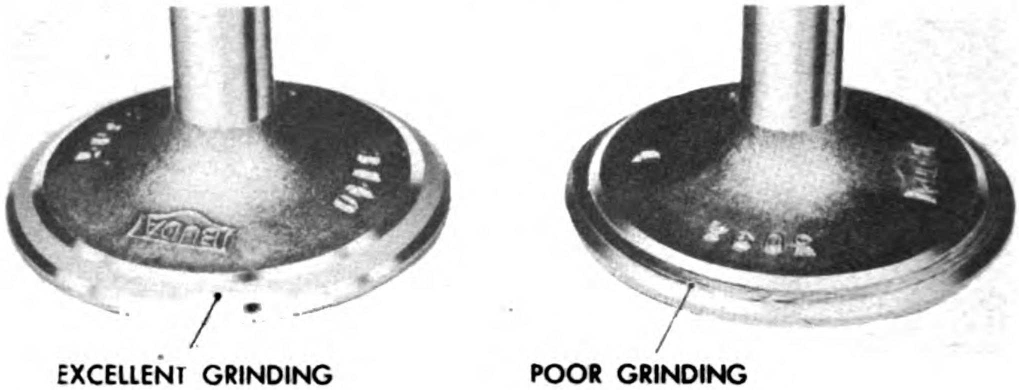


Figure 183. Example of Good and Poor Valves.

To test the seat and valve condition with grinding compound, place a very little bit of compound on the valve face, and grind against the seat in the usual manner. After a short time, remove the valve and clean both seat and valve of grinding compound. If both valve and seat show an even grey mark around their entire circumference, it proves that they are contacting fairly well, and that grinding may be accomplished without refacing and recutting. If either valve or seat shows a mark around but part of its circumference, then reconditioning is necessary before a satisfactory grinding job can be accomplished.

When refacing valves, be careful to avoid removing unnecessary metal. Just enough to clean up the valve face, and no more, should be removed.

When recutting valve seats, remove just enough to clean up the seat, and remove all evidence of pitting and grooving. Then place that particular valve in place, with a little grinding compound, and grind lightly. Remove, and observe where valve and seat contact. Then with a proper refacing angle stone (usually 30^{o} and 60^{o}) narrow the seat down until it is slightly narrower than the valve face. The width of the finished seat should be between 1/16" and 3/32". Unless this is done, it will be impossible to get a good valve seat, no matter how long you grind.

To grind the valves, put a small quantity of valve grinding compound on the valves, just sufficient to cover the seating area. Grind the valves with a light but firm pressure, letting the spring lift the valve from the seat every two revolutions of the valve grinding tool crank. As soon as the "grinding feel" diminishes, wash the valve and seat in kerosene and examine the seat and valve. If the valve face or seat has lines or rings ground in it, this indicates that either the valve grinding compound was ground out, or too much pressure was applied, or the valve was not lifted off the seats often enough during the grinding operation. Therefore, the grinding must be done over.

If the valve and seat have the appearance of grey emery paper, apply a small amount of Prussion Blue on the valve face. Wipe off the excess so just a faint trace of blue appears. Insert the valve and turn the valve on the seat one complete revolution under slight pressure. If the valve seat has a light blue ring completely around the seat, this indicates that the valve is seating properly. If the line is not complete, the valve and seat are not making complete contact and must be ground until they do. Figure 183.

When grinding the valves, use care to avoid scratching or marring the seats or stems. Be very careful to avoid grinding compound entering the valve guides, and all traces of compound must be cleaned away at intervals during grinding, to avoid excess amounts spilling onto valve stem.

After valve grinding is completed, the parts should be thoroughly cleaned before reassembly, and the valve stem oiled.

Be sure to wash off the compound when the job is finished, and again check to see that all loose pieces

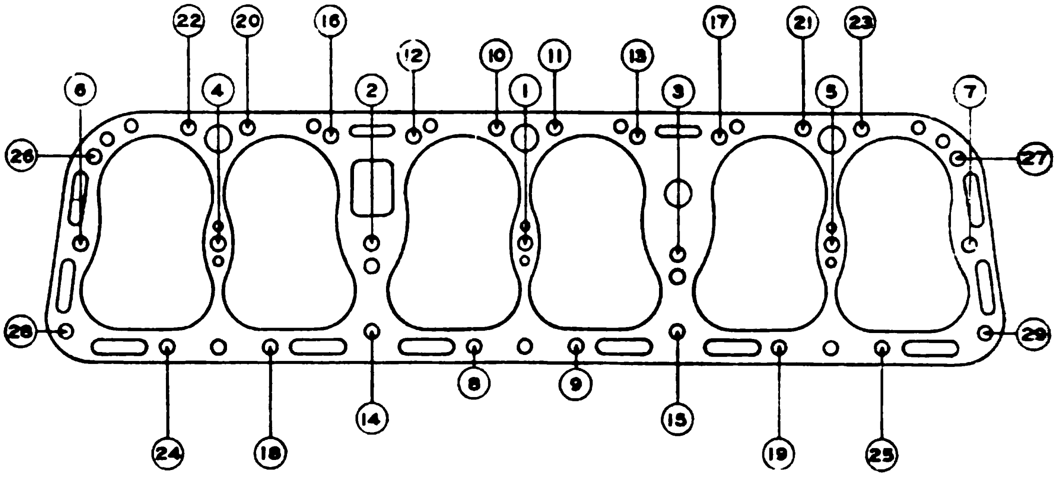


Figure 184. Tightening Cylinder Head Bolts.

of carbon around the valves and particularly between the piston head and cylinder walls are removed, for many well done jobs of valve grinding are ruined by failing to remove small particles of carbon. Replace the head gasket with a new one. Tighten the cylinder head in the numerical sequence shown in Figure 184.

Readjust the tappets, as shown in Chapter V, Reassembly of Engine. The clearance on a hot engine should be .006" for the intake, .009" for the exhaust. After the engine has been run and is thoroughly warm, tighten the cylinder head again. See Figure 184.

Chapter IV

Inspection and Repair of the Component System and Their Accessories, viz: COOLING--ELECTRICAL--FUEL--LUBRICATING.

This chapter gives detailed instructions for the inspection, disassembly, repair and adjustment of the component systems of the engine and their accessories.

FOREWARD

The same care and cleanliness used in overhauling the engine proper must be exercised in overhauling the component systems of the engine. For convenience, the instructions for the overhaul of the component systems are given alphabetically. There are: The Cooling system; the electrical group which includes the starting system, generating system, and ignition system; the fuel system; and the lubricating system.

COOLING SYSTEM

Positive water circulation is assured by an impeller type water pump mounted on the side of engine and driven from the accessory drive assembly. The water is drawn from the radiator by the water pump and forced to the water distributor on the side of the cylinder crankcase. This distributor distributes the water evenly between each cylinder barrel. The stream then passes upward to the cylinder head and into the water outlet manifold.

The cooling system includes Water Pump with adjustable packing glands, Radiator, Thermostat, Fan and Fan Belt, Water Distributor, hose connections, and drain cocks.

WATER PUMP

79. TIGHTENING PACKING NUTS.

The water pump impeller shaft is provided with packing glands and are kept leakproof by means of two packing nuts (front and rear). When leaks occur tighten these nuts with the special packing nut wrench furnished with engine only sufficiently to stop leakage, then back off slightly to relieve the pressure Figure 185.

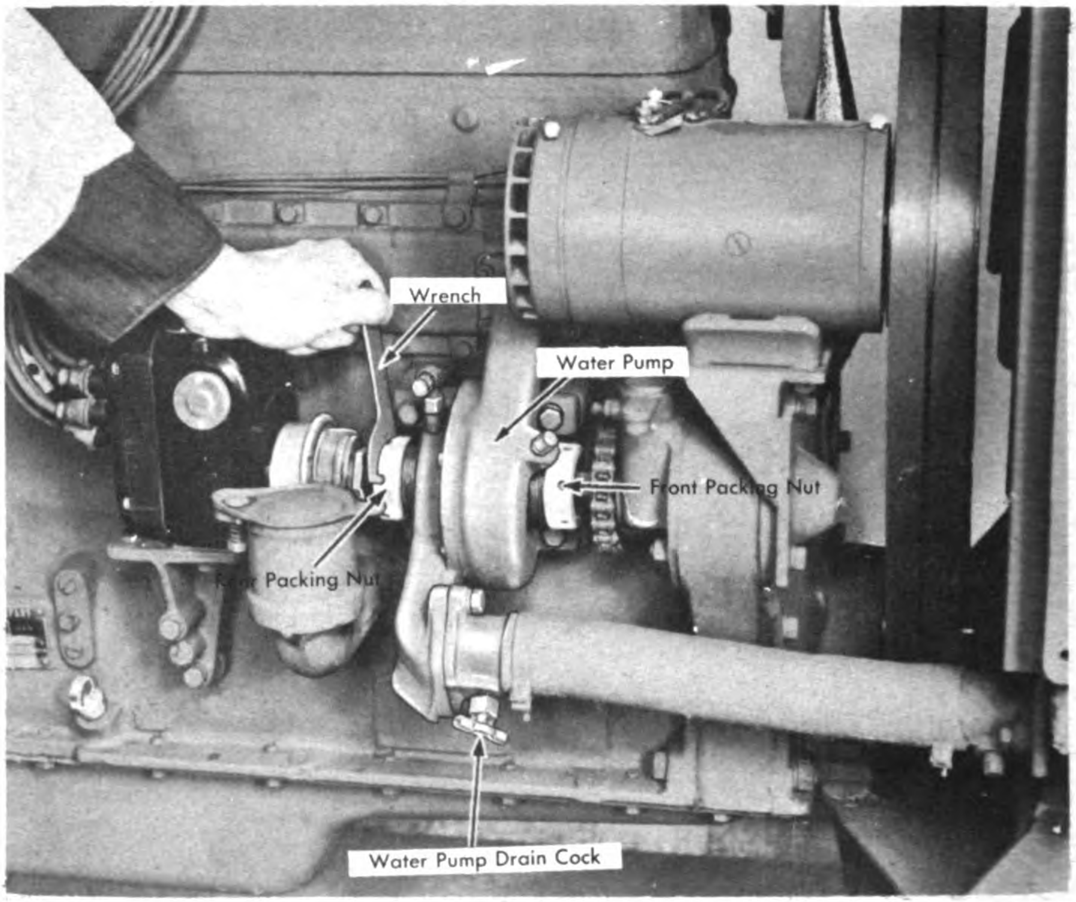


Figure 185. Tightening Water Pump Packing Nut.

If these packing nuts are kept too tight, the shaft will gall and cause leakage. If frequent adjustment is necessary, it is an indication of worn bushings, worn shaft or misalignment of the water pump and its drive or driving units.

80. WATER PUMP SHAFT ALIGNMENT.

The water pump also drives the Magneto from its rear end by means of a coupling. Alignment should be carefully made, since misalignment causes excessive wear on the water pump bushings and frequent adjustment of the packing nuts are necessary due to the run out of the water pump shaft.

81. DISASSEMBLING THE WATER PUMP.

See Figure 190.

A. Pull the Coupling sprocket off the shaft with a wheel puller.

B. Straighten the tab lockwasher on the magneto driven coupling locknut, See Figure 185.

C. Unscrew the locknut and lightly tap the flange to release the adjustable coupling and flange from the inner core. Then slip off the shaft.

D. Remove the woodruff key and the two packing nuts. Note: One is a right hand and the other is a left hand thread.

E. Separate the water pump by removing the five capscrews.

F. Remove the shaft and impeller from the water pump housing. Note: It is not necessary to remove the impeller from the shaft unless the item needs to be replaced.

82. INSPECTION AND REPLACEMENT OF WATER PUMP PARTS.

A. If the shaft is worn so that a new bearing will not hold it steady the shaft must be replaced. Also if the shaft is worn or gouges from the packing, it should be replaced.

B. Check the impeller for cracks or corrosion. If either condition exists, replace.

C. Check the pump body bushing for wear with the shaft in position. If the fit is loose, replace the bushing. In like manner, check the cover bushing for wear and replace if necessary.

D. Examine the water pump body and cover for cracks. Replace if necessary.

E. Always replace the water pump packing.

83. REASSEMBLING THE WATER PUMP.

A. Attach the woodruff key that holds the impeller to the shaft and insert shaft and impeller into the water pump body.

B. Fasten the pump cover and cover gasket by tightening the five capscrews.

C. Insert the bearings (one on each end of shaft) press the packing in place around each end of shaft with each gland in place and tighten the packing nuts around each packing using the special Water Pump wrench that is supplied by Buda for that purpose.

D. Press on the coupling sprocket. The water pump is now ready to be installed on the engine.

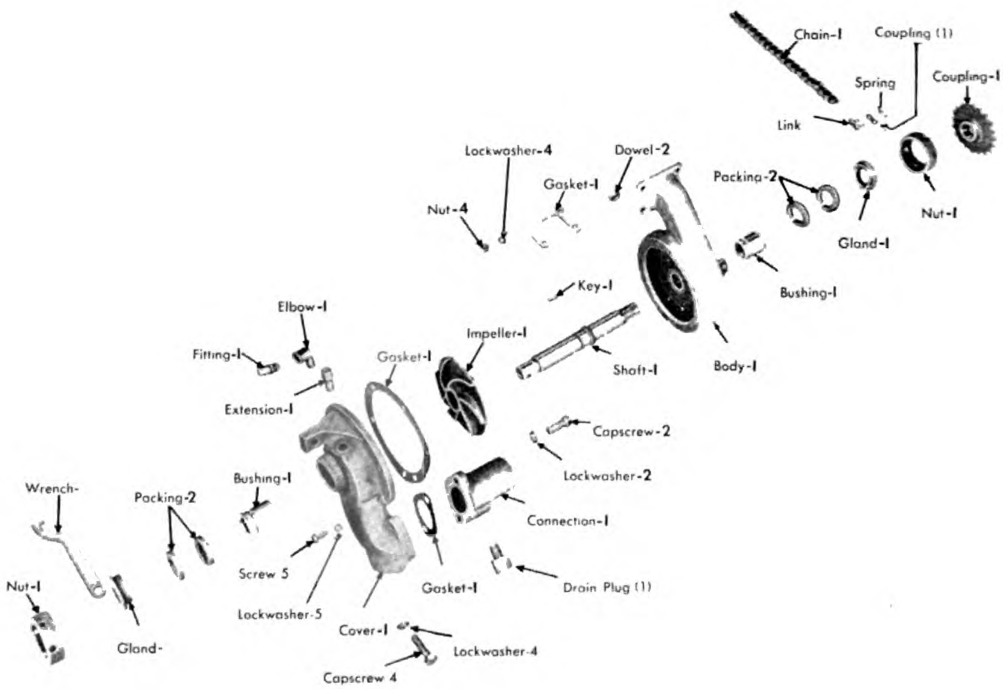


Figure 190. Exploded View of Water Pump.

WATER DISTRIBUTOR

84. CLEANING WATER DISTRIBUTOR.

Barring accidents only a thorough cleaning of the rust and sediment deposits is necessary with the water distributor. Remove the copper distributor plate from the water jacket cover and thoroughly clean and free both of any dirt or sediment see Figure 109.

FAN AND FAN BELT

The fan is of the pusher type blowing the air through the radiator away from the engine. The fan is lubricated with wheel bearing grease WB-3 every 512 hours of operation as indicated in the lubricating chart. At the 2,048 hour overhaul, the fan should be disassembled, thoroughly cleaned, and the parts checked for any excessive wear and such replacements made as are found necessary. The instructions for the overhaul are given in paragraphs 86 and 87.

85. ADJUSTING FAN BELT.

The fan belt is of the vee type. The vee type belt must run with some slack-just enough to prevent slippage in order to avoid excessive wear, must be approximately 3/4" slack. To adjust fan belt tension loosen the nut at the back of the fan shaft, also the hex nut that locks the vertical adjusting screw and turn either way until the desired fan belt tension is obtained. After which tighten the nuts. See Figure 102.

When reinstalling a new fan belt, always loosen the fan belt adjustment so as to allow the belt to be slipped in place without forcing. This will avoid any internal damage to the belt.

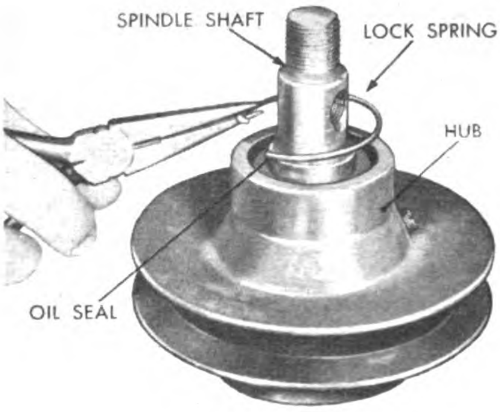


Figure 191. Removing Fan Hub Lock Spring.

86. DISASSEMBLING FAN.

A. Remove the four capscrews holding the fan blade assembly to the fan pulley. Place the fan pulley on a bench so that the fan mounting face is down.

B. Then remove the lock spring holding the oil seal in place as shown in Figure 191.

C. Turn the pulley over and remove as much of the old grease as possible.

D. Remove the cotter key from the fan spindle shaft and remove the castellated nut. When the nut is removed the spring will force the cup shaped washer off the shaft revealing the ball bearing.

E. Tap the end of the shaft inside the pulley with a small block of wood to force the shaft and the oil seal from the pulley. The ball bearing and oil seal can now be removed from the shaft. The bearing on the opposite side left in the pulley will fall out when the pulley is turned over.

87. INSPECTION AND REPLACEMENTS.

A. Always replace the felt seal and gasket.

B. Thoroughly clean the parts of the fan pulley assembly with cleaning fluid. NOTE: Both bearings are alike, but they should not be interchanged since they must operate on the original race from which they were removed. Therefore, when cleaning them, be sure to keep them identified.

C. Examine the pulley bearings for pitting or irregularity in the balls and for wear, pits, and unevenness in the recess. If the races of the bearings are

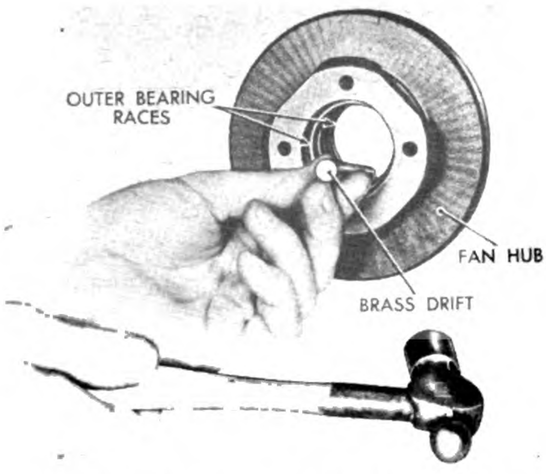


Figure 192. Removing Outer Race.

pitted or worn, remove the outer race, as shown in Figure 192 with a punch and hammer.

D. Examine the fan spindle shaft for mutilated threads and any evidence of the ball bearing inner race turning on the shaft. If either of the foregoing conditions exist, replace the shaft.

E. Check the fan pulley for cracked flanges, mutilated threads, looseness of the outer bearing races. If the foregoing conditions exist, replace the pulley.

88. REASSEMBLING FAN.

A. If either of the bearing races were removed, drive the new outer race or races into the pulley with a block of wood, making certain to get the races in straight.

B. Push the ball bearing which is nearest to the seal onto the shaft and coat liberally with grease.

C. Push the shaft into the pulley through the seal end. Pack WB-3 grease around the shaft in the hub and push the outer bearing in place on the shaft. See Figure 193.

D. Install the large flat washer, spring, cup shaped washer, small washer and the nut on the fan side of the shaft. Secure the nut and insert the cotter key. Fill the hub with WB-3 grease so that the grease is even with the fan mounting face. See Figure 193.

E. Turn the pulley over and install the large paper gasket against the outer bearing race.

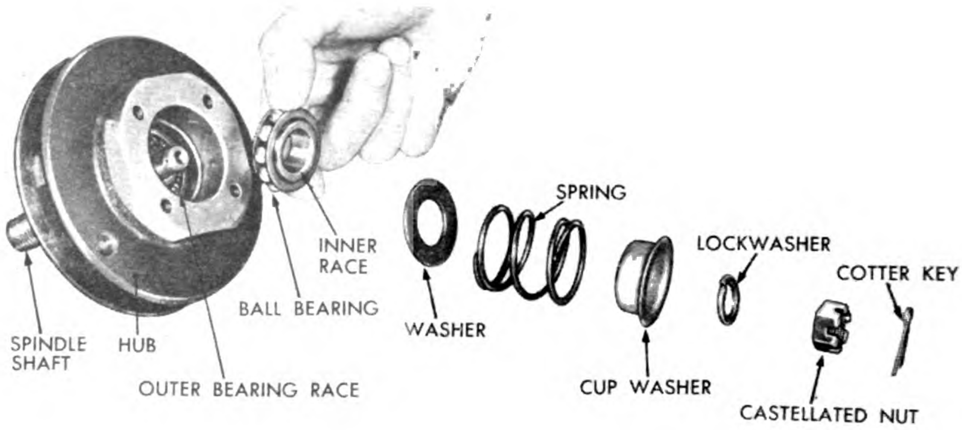


Figure 193. Removing Bearing.

F. Install the slightly concave washer against the bearing so that the concave side is out. Push the cork seal into the retainer and install on the shaft and into the pulley. Install the lock or snap ring. See Figure 191.

G. Install the fan blade to the hub.

RADIATOR

The radiator is designed to cool water under all operating conditions. However, the radiator core must be kept free from corrosion and scale at all times. The cleaning of the radiator, inspection of the connections and mounting bolts, are part of the periodic service procedures that are recommended. During the engine overhaul, the radiator core should be examined for leaks, bent tubes, and repairs that are necessary to be made.

It is important that only clean soft water be used in the cooling system. The use of hard water will cause scale to form in the engine jackets and in the radiator, thereby tending to clog up circulation. Where the use of hard water cannot be avoided, use a commercial water softener. Blow out bugs or any leaves or lint, or any other obstructions that may have lodged between the fins on the core and the tubes with air pressure. Bent fins should be straightened.

89. REPAIRING A LEAKY RADIATOR.

Do not use liquid solder or radiator compounds to stop leaks as these tend to clog the radiator tubes. A leaky radiator should be tested under water with about four to five pounds of air pressure. Note the source of the air bubbles and solder the leaks. Be sure to wash off the acid after soldering, for many well done jobs have been ruined by not washing off the acid which will eat into the tubes.

90. SERVICING A CLOGGED RADIATOR.

If a hose is available through which there will be twenty to thirty pounds of water pressure, attach the hose to the bottom of the radiator at the drain hole. This reverses the flow and will tend to carry the dirt which has been lodged down in the tube back upward and out through the top of the radiator. If the radiator is so badly clogged that this does not serve to free the circulation, then use a solution of one part of muriatic acid to three parts of water in sufficient quantity to fill up the radiator. If muriatic acid is not available, a solution can be used made up of approximately three pounds of commercial lye added to a sufficient quantity of water to fill the cooling system. In either case, the solution should be allowed to stand in the system three or four hours. After draining the radiator and engine, the cooling system should be thoroughly flushed with clean water before filling with clean water.

91. HOSE AND HOSE CONNECTIONS.

Occasionally pieces of broken hose will clog the radiator and cause overheating. This condition can be overcome by draining and flushing the radiator. Be sure that all hose connections are tight.

92. ADDING WATER TO OVERHEATED ENGINE.

When engine overheats due to lack of water, keep the engine running at slow speed and add water slowly, to avoid cracking the block or radiator.

ELECTRICAL GROUP

The electrical group includes the starting system, generating system, and ignition system. The magneto provides the electrical energy for ignition.

The Buda K-428 engine is equipped with a single wire electrical system. This single wire system contains various size wires and connections by means of which all electrical units are interconnected with a storage battery, except, of course, the magneto. The engine and metal parts act as a ground for completing the other circuits necessary for conducting the electrical energy to the various electrical units. See wiring diagram, Figure 194.

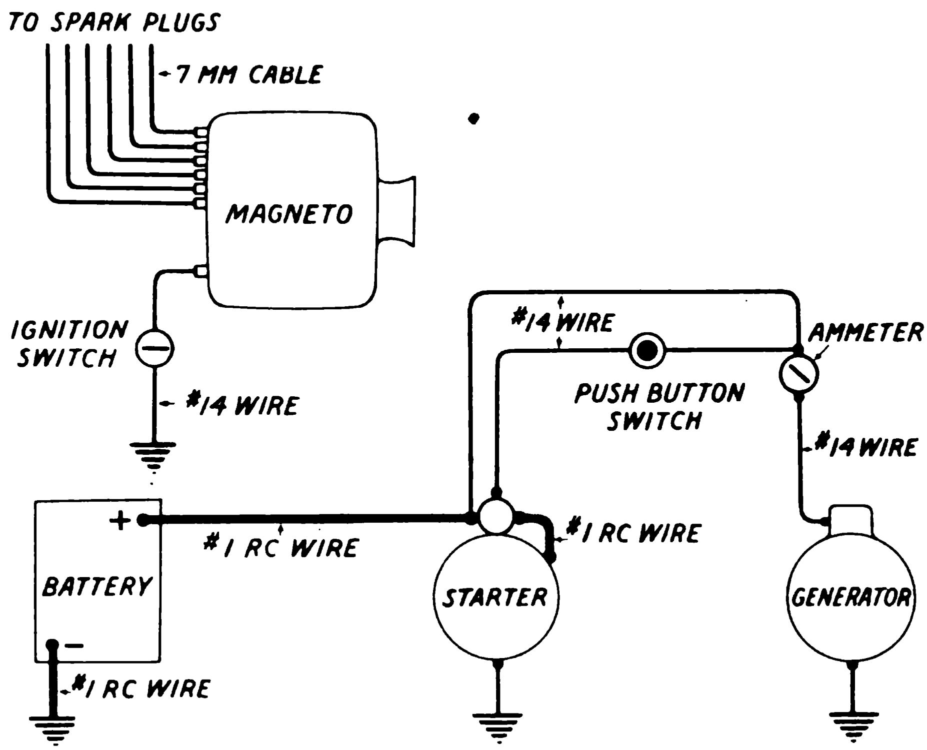


Figure 194. Wiring Diagram.

For accurate tests of the electrical units and satisfactory repairs, it is necessary that adequate tools, equipment, and precision gauges and meters are available. Although such units as starters, generators, regulators, and magnetos are sturdily constructed, they have delicate mechanisms which require extremely accurate adjustments for precision operation.

No adjustments of the voltage regulator should be attempted without the necessary information, test meters, and such tools as are necessary for satisfactory repair jobs.

STARTING SYSTEM

Starting Motor and Magnetic Switch. The starting or cranking motor is a four brush, four pole unit with the armature supported by a grey iron bearing at the commutator end and a bushing at the drive end. When current is passed through the field coils, a powerful magnetic field is created. Current then flowing through the armature windings causes a strong force to be exerted on the armature windings so that the armature is forced to rotate or spin. This rotating movement is transmitted by the starting motor drive pinion to the engine flywheel so that the engine is cranked. The Bendix Drive provides meshing of the drive pinion with the engine flywheel when the cranking motor operates, and demeshes the drive pinion as soon as the engine starts running. See Figure 195.

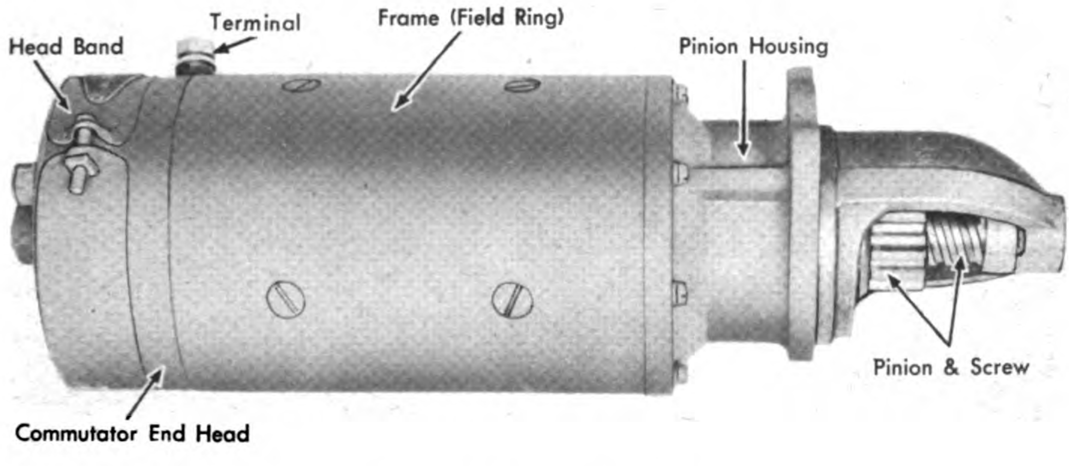


Figure 195. Starter.

The magnetic switch consists of a winding, plunger, contact terminal, and contact disc. Figure 196. When the winding is energized (connected with the battery) by the closing of the cranking motor switch, the resulting

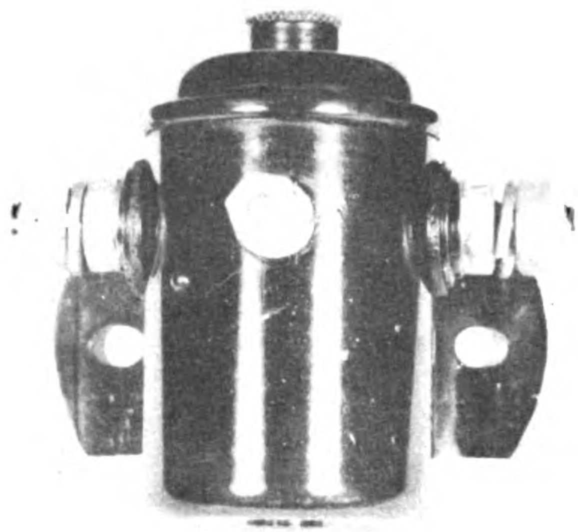


Figure 196. Magnetic Switch

magnetic field pulls in the solenoid plunger, forcing the contact disc against the contact terminals and connecting the cranking motor to the battery. Opening of the cranking motor switch disconnects and magnetic switch winding from the battery so that the magnetic switch spring can separate the contact disc from the terminals opening the circuit between the cranking motor and battery.

93. TABULATED DATA

Clockwise rotation, viewing drive end.
Brush spring tension - 32 to 36 ounces.
No load -50 max. amperes at 5.5 volts at 2980 min. r.p.m.
Lock torque test - 18 pounds feet at 555 amperes at 3.0 volts.

THREE SERVICINGS ON STARTER

There are three servicings which the maintenance personnel must give the starting motor. These servicings are the 128 hours of operation check, the 256 hours of operation tune-up, and the 512 hours of operation overhaul.

94. CHECKING STARTING MOTOR EVERY 128 HOURS OF OPERATION

A. Remove the head band and inspect the commutator. If the commutator is dirty or discolored, it can be cleaned by holding a piece of #00 or 000 sandpaper against it while turning the armature slowly. Blow the sand out of the motor after cleaning the commutator. If the commutator is rough or worn, the motor should be removed from the engine for an overhaul.

B. Inspect the brushes. The brushes should slide freely in their holders and make full contact on the commutator. Make sure that the brushes are perfectly in line with the commutator segments. If brush holders need repair or if the brushes are worn to less than one-half their original length, the motor should be removed for an overhaul as given in Paragraph 104.

C. Inspect the wiring from the battery to the ground and from the battery to the starting switch, and from the switch to the motor for loose or corroded connections and for frayed insulation.

D. Add three to five drops of engine oil to the oiler in the commutator end head.

E. Inspect the push button and starting switch to see that they are firmly mounted and that the leads are properly connected to the terminals. Check the operation of the units and remove them for a tune-up inspection if the operation is not satisfactory.

95. TUNING UP STARTING MOTOR EVERY 256 HOURS OF OPERATION

A. Remove the starting motor from the engine end and take off the head band.

B. Inspect the commutator brushes, and wiring, and add three to five drops of engine oil to the oiler in the commutator end head.

C. Lift the brushes out of the holders as shown in Figure 197.

D. Remove the screws holding the pinion housing to the frame and pull the housing and armature off the frame.

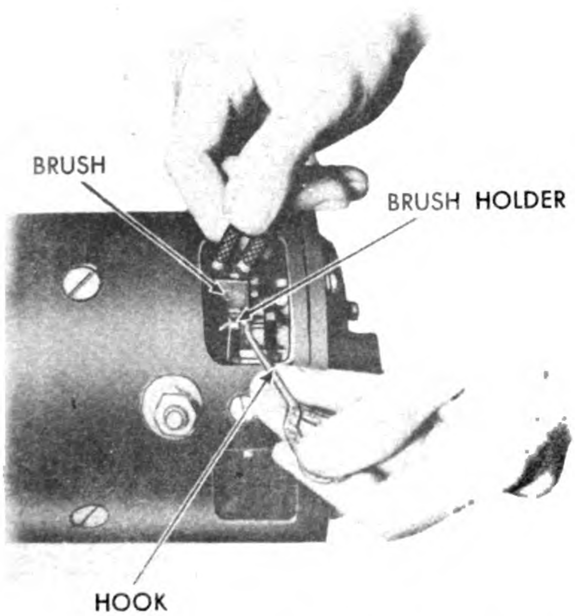


Figure 197. Lifting Brushes out of the Holder.

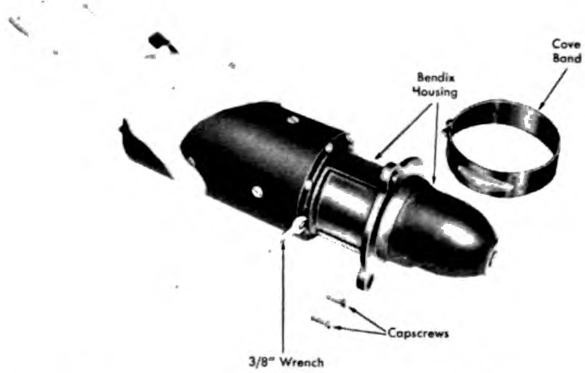


Figure 198. Removing Pinion Housing Screw.

See Figure 198. Press the armature out of the pinion housing with an arbor press as shown in Figure 199. Loosen the Bendix shaft spring screw as shown in Figure 200 and slide the Bendix off the shaft. See Figure 201.

Clean the Bendix and armature shaft in kerosene and lubricate sparingly with light oil. Inspect the Bendix for worn parts or distorted spring and replace any faulty parts.

E. Assemble the Bendix on the armature shaft making sure that the woodruff keys are in place. Tighten the shaft spring screws so that it enters the hole in the armature shaft.

F. Clean the pinion housing and soak the bearings in medium oil. Assemble the housing on the motor and fasten to the holding screws. See Figure 198.

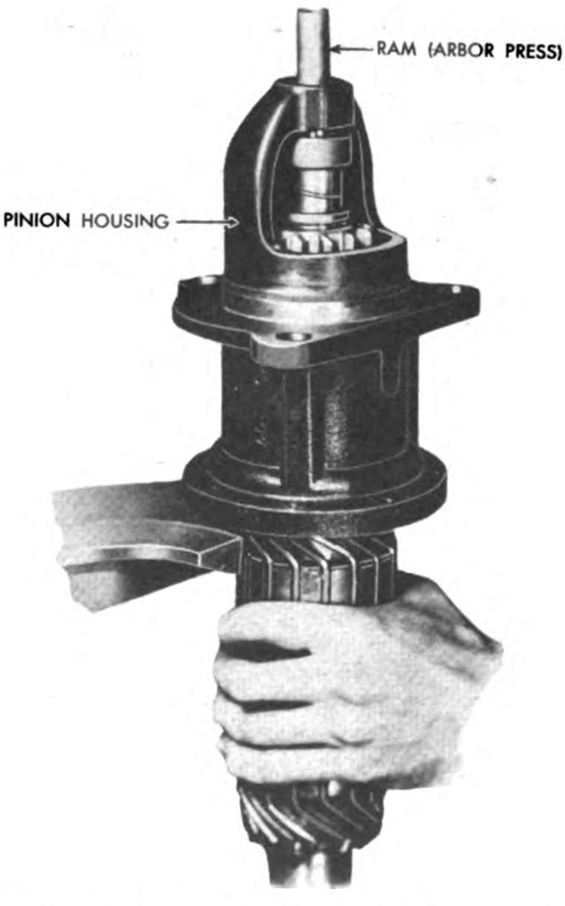


Figure 199. Pressing Armature Shaft out of Pinion Housing.

96. STARTING MOTOR NO LOAD TEST

Connect an ammeter, carbon pile rheostat, and battery in series with the motor terminal and the frame. (Starting motor should be removed from the engine for this test). Connect

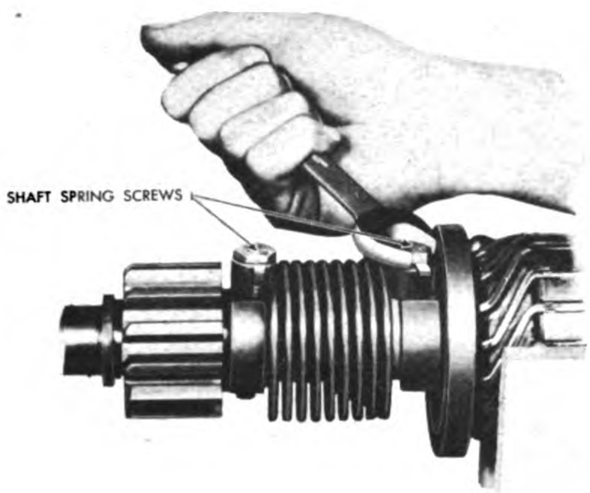


Figure 200. Removing Bendix Shaft Screw.

a voltmeter from the motor terminal to the motor frame. See Figure 202. Adjust the voltage to 11.0 volts and read the ammeter which should not show more than 100 amperes. Hold a tachometer against the drive end of the armature shaft and read the speed while operating at 11.0 volts. The speed should be at least 4000 R.P.M.

If the current is high and the speed low inspect the bearings for correct alignment and make sure the armature turns freely without interference. If the current is low, inspect the brushes for correct bearing on the commutator and inspect the internal connections of the motor for high resistance.

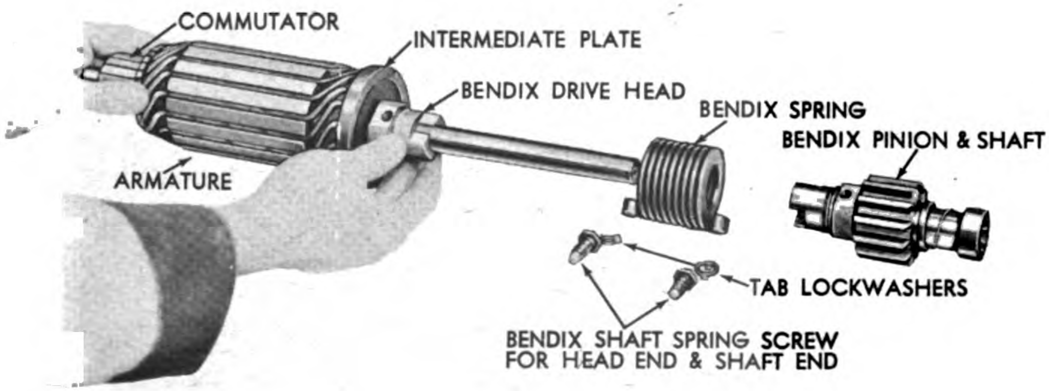


Figure 201. Sliding Bendix Off of Shaft.

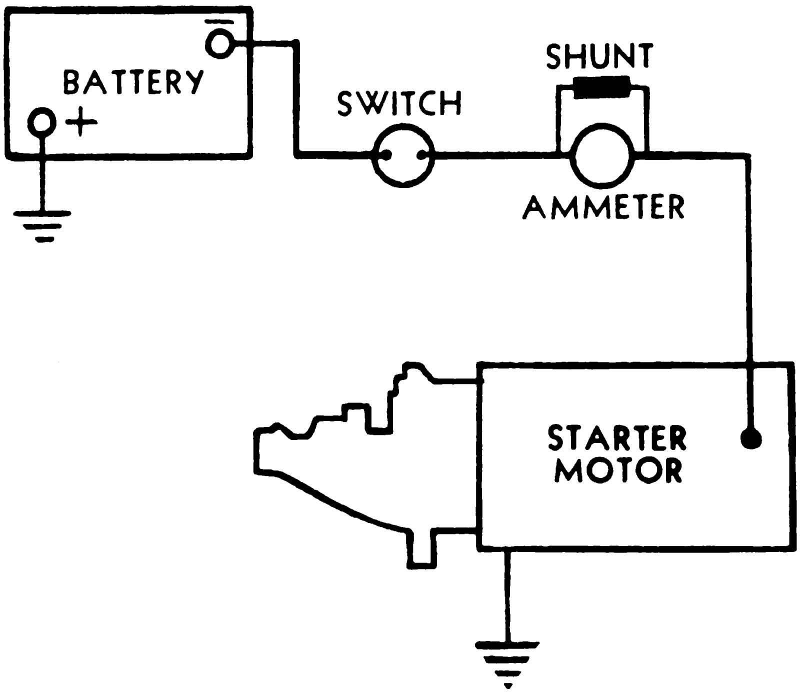


Figure 202. Hook-up for No Load Test.

97. STARTING MOTOR TORQUE TEST

With the motor connected as given in the foregoing Paragraph 96, and using a spring scale and torque arm, measure the stalled torque. Figure 202A.

Fasten the torque arm securely to the starter motor shaft. The motor should be clamped rigid to a work bench. Hook the spring scale to the torque arm exactly 12" from the center of the motor shaft. With the current flowing through the motor adjust the voltage to 3.0 volts and read the ammeter and spring scale. The current should be 840 amperes maximum and the torque should be more than 29 foot pounds. If the current is high or the torque too low, inspect the motor for high resistance connections, incorrect bearing alignment, and incorrect brush seating.

98. STARTING SWITCH 256 HOUR CHECK

The push button is mounted on the control panel and the magnetic or solenoid switches are contained in the

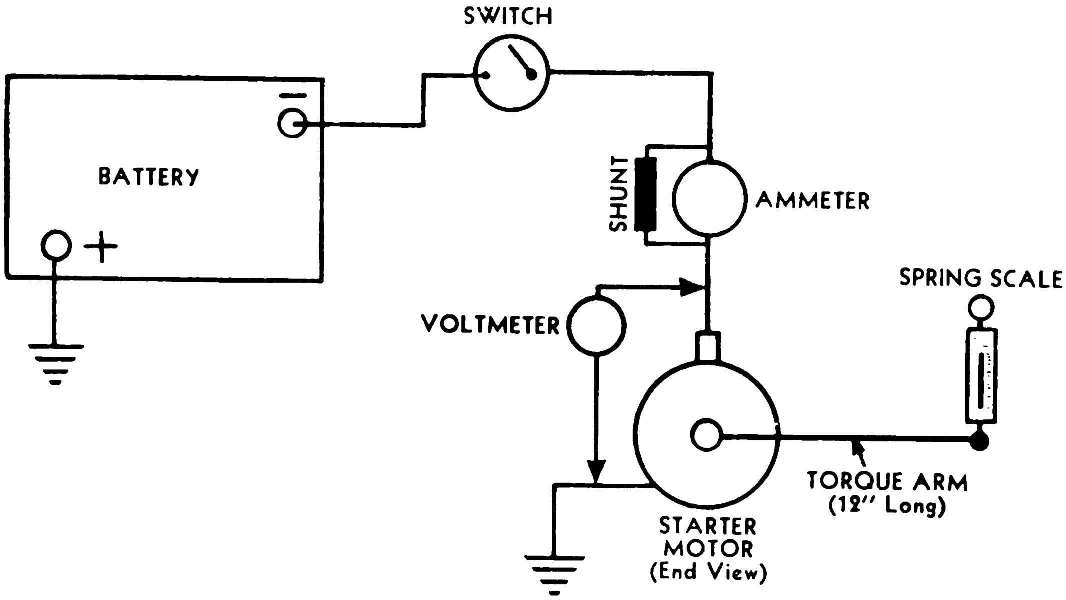


Figure 202A. Hook-up for Lock Torque Test.

control box. When the push button is depressed, one of the solenoid switches closes immediately and connects the starting motor to the battery through a .0356 ohm resistance. This resistance reduces the large current that would flow through the motor. When the motor begins to revolve, the time relay operates and excites the second solenoid switch. When this switch closes the resistance is shorted out and the full battery voltage is applied to the starting motor.

99. INSPECTING STARTING SWITCH

A. Remove the starting switch from the control panel.

B. Take out the terminal studs and remove the cover nuts. The cover will then lift off.

C. Clean the switch and inspect the leads, insulation, and connections for fraying, breaks, or improper and loose connections.

D. Inspect the push button for loose or corroded connections and terminals.

E. Replace the control box cover and assemble the terminal studs.

F. Remount the switch on the panel and connect the leads.

100. CHECKING STARTING SWITCH.

With the switch in place on the control panel, connect a voltmeter between the two 3/8" - 16 terminals of the control box. Operate the starter in the normal manner and read the voltmeter. If the voltage reading is larger than .05 volts per 100 amperes, approximately .25 volts during normal starting, the starting switch should be completely overhauled. See Paragraphs 98 and 99.

101. 512 HOURS OF OPERATION OVERHAUL

Disconnect the lead from the motor and take out the flange bolts. The motor can then be taken to the bench for an overhaul.

102. DISSASSEMBLING STARTER MOTOR

A. Remove the head band.

B. Lift the brushes out of the holder. See Figure 197.

C. Remove the commutator and head holding screws. Take the head off the motor. See Figure 203.

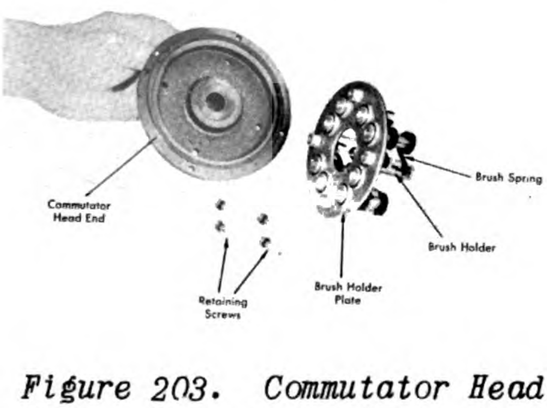


Figure 203. Commutator Head End.

D. Remove the pinion housing and the armature off the frame and field.

E. Press the armature out of the pinion housing with an arbor press as shown in Figure 199.

F. Take off the

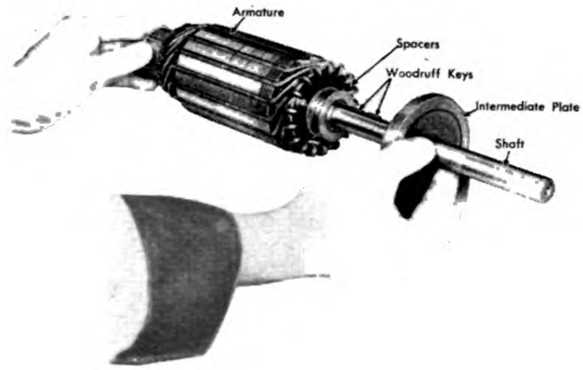


Figure 204. Removing Intermediate Plate & Trust Washer.

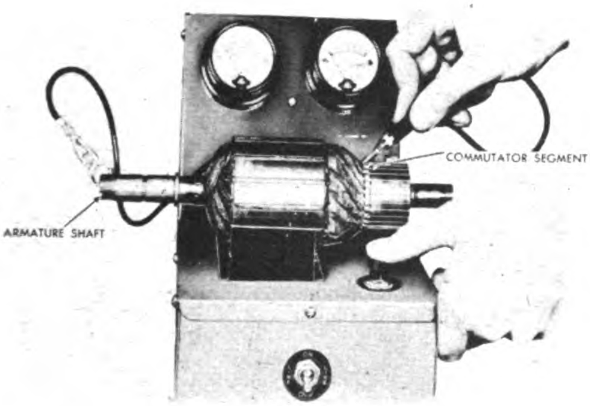


Figure 205. Testing Armature for Grounds.

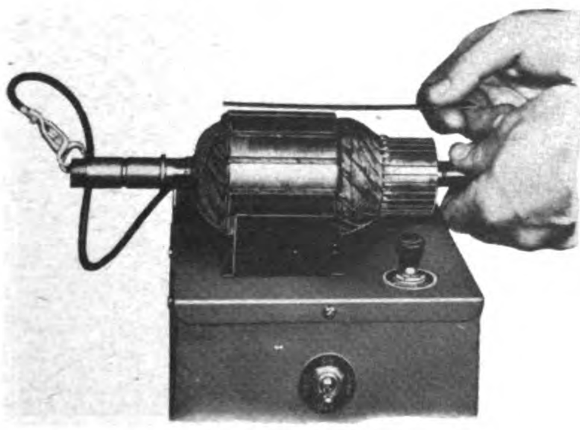


Figure 206. Testing for Shorts on Growler.

Bendix shaft spring screw and slide the Bendix assembly off the shaft. See Figure 200.

G. Remove the intermediate plate and thrust washer from the armature shaft. See Figure 204.

103. INSPECTING THE ARMATURE.

A. Inspect the armature and commutator for evidences of wear. Inspect the insulation and soldering to make sure that all coils are in proper working order. Make sure the coils are properly staked to the commutator and core slots. If the shaft or the core is worn, the armature should be replaced. If it is necessary to turn down the commutator in a lathe, take only a light cut with the armature mounted on the bearing seats and not on the shaft centers. Remove all burrs from the commutator and undercut the mica segments and clean and square to a depth of 1/32".

B. With test probes, check the armature for grounds. Touch one probe to the shaft and touch each commutator segment in turn with the other probe as illustrated in Figure 205. NOTE: Do not touch the probes to the bearing or brush surfaces, as an arc would burn the smooth finish. If a ground is present, the lamp will light. Check the armature for shorts on a growler, as shown in Figure 206. Place the armature on a growler and hold a steel strip on the core. Rotate the armature slowly and if a ground is present, the steel strip will vibrate. Replace the armature if grounded or shorted.

104. INSPECTING AND SERVICING THE FRAME AND FIELD

A. Inspect the brushes. If they are oil soaked or worn to less than 3/8" long, they should be replaced. Make sure the grounded brush terminals are securely fastened and are free from corrosion. To replace the insulated brush, unsolder the lead from the brush connector and pry open the lead in the connector. Insert the new brush lead to its full depth in the lip and clinch tightly before resoldering. A good soldering job must be done to prevent loss of starting efficiency due to a poor contact. Seat a new brush as shown in Figure 207 according to the instructions in Paragraph 104, Step A.

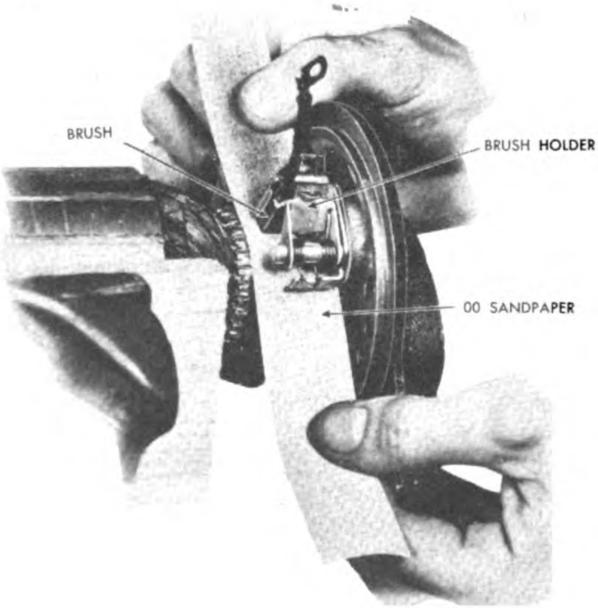
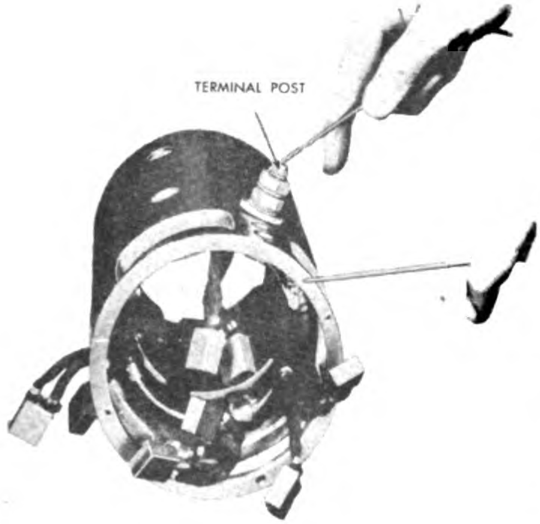


Figure 207. Seating Brushes

B. Check the field coils and terminal posts for grounds and open circuits with test lamp. Make sure the brushes are not touching the frames or connections, and touch one probe to the terminal post and the other probe to the frame as illustrated in Figure 208. If ground is present, the lamp will glow. Touch one probe to the terminal post and the other probe to one of the insulated brushes, as illustrated in Figure 209. If an open circuit is present, the lamp will not light.



'gure 208. Testing Field 'ls for Grounds.

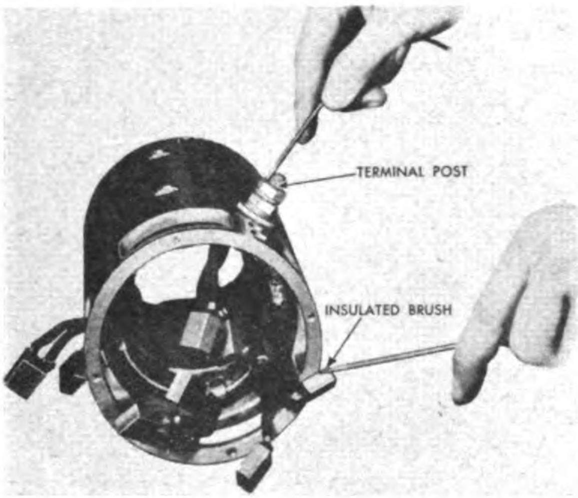


Figure 209. Testing Field Coils For Open Circuits.

C. If ground or open circuit is present, disassemble the frame and field and inspect each part.

1. First, remove the terminal post by taking off the nut and washer and pressing the post out of the frame. Inspect the washer and insulated bushing and replace those that are not in good condition.

2. Take out the pole piece screws and remove the pole pieces and field coils. See Figure 210. Inspect the field coils for faulty insulation and check for opens with the test lamp and probes. NOTE: If it is necessary to replace any field coil, make sure the connectors are clinched tightly and soldered properly.

3. Reassemble the field coils in the frame, using pole piece screws that have been dipped in boiled linseed oil. After the screws are tightened, hit the frame a few short blows with a raw hide mallet to align the pole pieces properly.

4. Assemble the terminal post and washer and again check the assembly for grounds and opens with the lamp and test probes, as given in Step 104B.

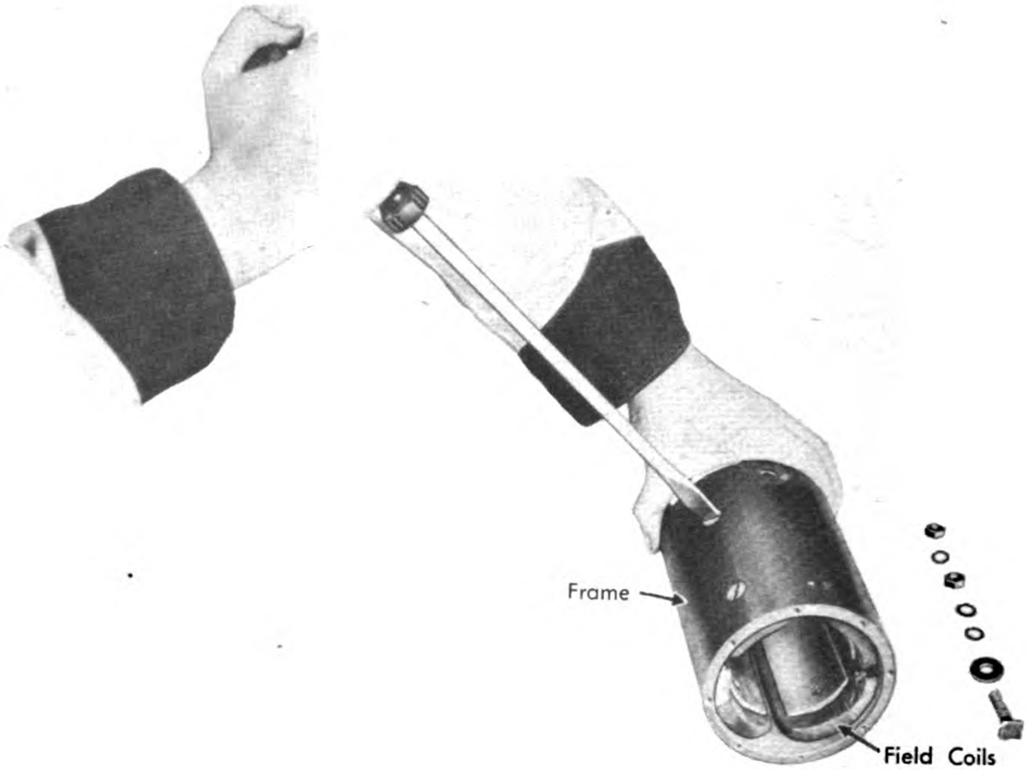


Figure 210. Removing Pole Piece Screws.

105. INSPECTING AND SERVICING THE COMMUTATOR END HEAD.

A. Disassemble the brush holder plate from the head, See Figure 203.

B. Remove the oiler and felt wick from the head and take out the shaft, cover and felt pad. Clean both plates thoroughly and inspect them for cracks. If cracked, replace the plates. Inspect the brush holders for distortion. Check the bearing. If it is worn excessively, replace it. Use the proper arbor to install the new bearing in order to secure the proper bearing fit. Replace the head if it is damaged, and replace the brush holder plate if the brush holders or springs are corroded, distorted, or bent.

C. Soak the bearing and felts in medium engine oil and reassemble the end head. Make certain that the drain hole in the end cap is at the bottom of the head.

D. With lamp and test probes, check the brush holders for grounds. Replace the brush holder plate, if a ground is present.

106. INSPECTING AND SERVICING PINION HOUSING.

Clean the housing and inspect it for cracks. Check the bearing for wear and replace it if worn excessively. Use the correct arbor to install a new bearing to secure the right bearing fit. Soak the bearing in medium engine oil.

107. INSPECTING AND SERVICING BENDIX DRIVE.

Disassemble and clean the Bendix drive. Inspect each part for wear and distortion. Replace any faulty part and lubricate the threads sparingly with engine oil. NOTE: Use new lockwashers every time the Bendix is assembled.

108. INSPECTING AND SERVICING THE INTERMEDIATE BEARING.

Clean the intermediate bearing end plate and inspect for cracks and wear. Replace the plate or bearing if necessary, using the correct arbor to install the bearing. Soak the bearing in medium engine oil.

109. REASSEMBLY OF STARTING MOTOR.

A. Assemble the two 1" steel thrust washers on the drive end of the armature shaft and assemble the intermediate bearing on the shaft. See Figure 204.

B. Apply a thin coat of light oil to the armature shaft and assemble the Bendix drive on the shaft. See Figure 201. Make sure the two woodruff keys are in their proper place and tighten the Bendix spring screws. Bend the ears of the lockwashers to prevent the screws from loosening.

C. Assemble the armature in the pinion housing and turn the intermediate plate so that the dowel pin fits into the slot. Press the intermediate plate down against the shoulder in the housing.

D. Assemble the armature and pinion housing on the frame and field and fasten with the holding screws. Tighten the screws securely with lockwashers on all screws. See Figure 198.

E. Assemble the fibre thrust washer for controlling end play on the commutator end of the shaft, and then assemble the 5/7" steel washer.

F. Assemble the commutator end head on the motor and fastening with the holding screws. Assemble the brushes in their holders. NOTE: If brushes have been replaced, they should be sanded according to the instructions in Paragraph 119, Step E, as shown in Figure 207.

110. FINAL INSPECTION OF OVERHAULED STARTING MOTOR.

A. Inspect the alignment of the brushes on the commutator. If the brushes are not perfectly in line with the commutator segments, remove the head and replace the brush holder plates.

B. With a spring scale, measure the spring tension. Hook the scale under the brush spring at the end and pull on a line parallel to the face of the brush. Take the reading just as the spring leaves the brush. If the reading is not between 40 and 50 ounces, remove the head and twist the spring holder with pliers. NOTE: Always remove the brushes from the holders before removing the end head.

C. Check the armature end play. With a feeler gauge, check the clearance between the Bendix stop and the inner side of the pinion housing and bearing with the armature in its two extreme positions. Do not compress the Bendix drive spring. See Figure 211. If the end play is not within .005" to .030", remove the commutator end head and change the fibre washer to one of the following: 1/32" thick, 1/64" thick, or 3/64" thick.

D. Add 5 to 10 drops of medium engine oil to the oiler in the commutator end head.

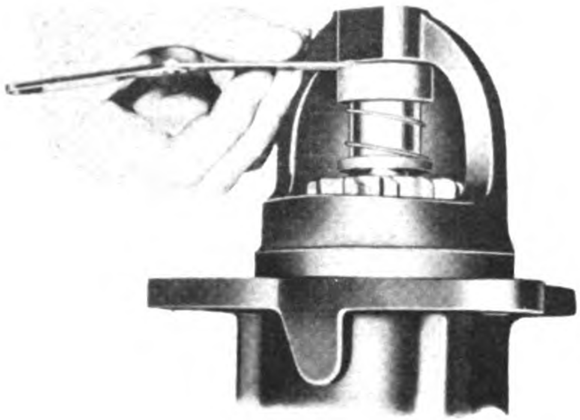


Figure 211. Checking Armature End Play.

E. Subject the starting motor to the no-load and lock torque tests as outlined in Paragraphs 96 and 97.

111. DISASSEMBLY OF MAGNETIC SWITCH.

Disassemble by removing only the outside nuts and lockwashers. The inner nuts should not be removed since this would allow the studs to turn so leads inside the switch would break off.

112. REPAIRS AND REPLACEMENTS.

Any defective insulators, screws, washers, leads, studs, plates, etc., should be replaced. Studs or screws which are bent, battered, broken, or which have crossed or damaged threads, are defective; leads which have broken strands, frayed insulation, are defective, and must be replaced.

113. BATTERY

Keep the terminals tight and clean. A loose battery connection will cause the voltage regulator to chatter- and this may result in early failure of the regulator. If they show tendency to corrode, clean and apply a thin coat of vaseline to protect them from the acid. Keep the outside of the battery clean. Neutralize any electrolyte that may be on the metal surfaces with a cloth saturated with ammonia or bicarbonate of soda solution (one pound of soda to one gallon of water) then wash off with water and dry.

114. TESTING BATTERY.

Test the specific gravity of each cell with a hydrometer. A reading of 1.270 to 1.285 indicates fully charged; 1.230, half charged; and 1.150, dead. Never take a reading shortly after adding water. CAUTION: Use only distilled water. Do not allow battery to stand in a discharged state. It may become ruined by sulphation. A stored or unused battery should be given a slight charge once a month. A battery can sometimes be brought out of sulphation by a long and steady low charge.

If the battery requires frequent addition of water and is gassing excessively, test it. If in good condition, it is undoubtedly due to overcharging. The voltage regulator should be checked for faulty adjustment. If one or more cells continually require more water than others, it is an indication of a damaged cell.

115. COLD WEATHER CARE.

It is especailly important in cold weather to test the specific gravity. A battery freezes between the temperatures 20° above zero and 50° below zero depending on the state of its charge. Do not add water after shutting down for the night. It will freeze quickly. See that it gets a charge after adding water.

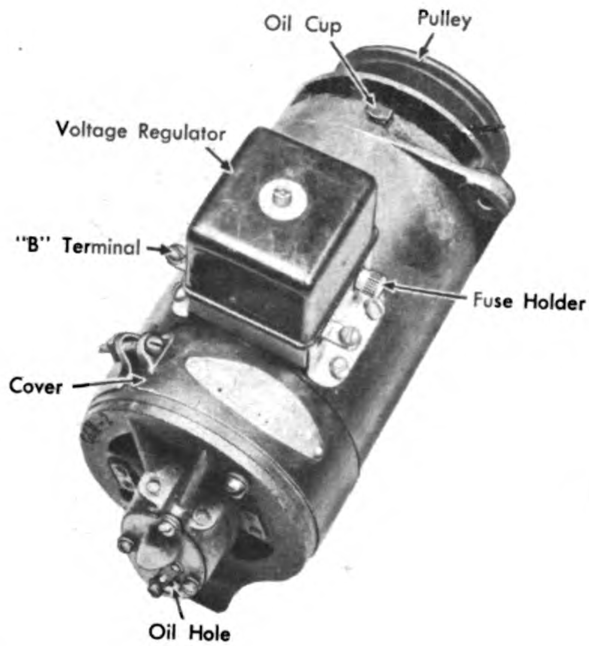


Figure 212. Generator and Voltage Regulator.

GENERATOR

The battery charging generator is a device for changing mechanical energy into electrical energy which is stored in the battery for starting the engine and operating such other engine accessories as are electrically operated. See Figure 212.

Mounted on the generator frame is a combination circuit breaker and voltage regulator. The circuit breaker is an automatic switch that closes and opens the circuit between the generator and the storage battery. It consists of an electromagnet and a set of contacts. When the generator is not running, the contacts are open. When the generator is started, the contacts are automatically closed to connect the generator to the battery. When the engine is stopped or the generator loses speed, the voltage falls; and as soon as the generator voltage drops below the battery terminal voltage, the contacts automatically open, thus preventing the battery from discharging back through the generator.

The voltage regulator reduces the generator output when the maximum is not needed, thus preventing high voltage and overcharged batteries. When the battery is in a low charged state, the regulator automatically increases the generator output to its maximum, and when the battery reaches a high state of charge, the regulator automatically decreases the rate of charge.

116. CHARACTERISTICS.

Rotation:	Clockwise at drive end
Controlled Output:	16.0 amperes
Volts:	6 volts
Poles:	2
Brushes:	3
Ground Polarity:	Positive

Output Test

Volts	Amperes	R.P.M.
7.4	8.0	1030 Max.
7.6	14.4 to 16.4	Max.
8.0	15.0 to 17.0	Max.

Field Coil Draw: 1.65 to 1.82 amperes at 6 volts.
Motorizing Draw: 3.08 to 3.40 amperes at 6 volts.

117. SERVICING THE GENERATOR.

There are three regular servicings which the maintenance repair personnel should give the generator. They are the 128 hour general inspection, 256 hour tune-up and 512 hour overhaul.

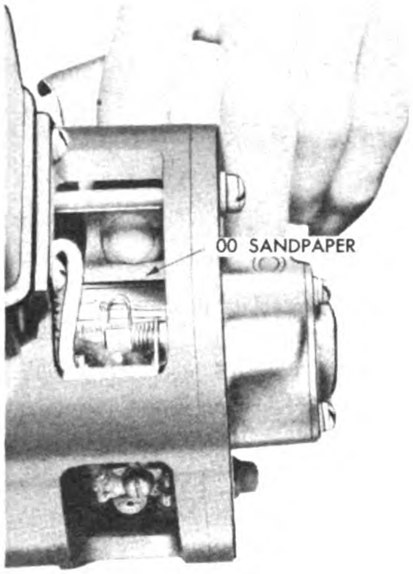


Figure 213. Cleaning Commutator.

118. 128 HOUR GENERAL INSPECTION.

A. Remove the head band and inspect the commutator. If the commutator is dirty or discolored, it can be cleaned by holding a piece of 00 or 000 sandpaper against it while turning the armature slowly. Blow the sand out of the generator after cleaning the commutator. See Figure 213. If the commutator is rough or worn, the generator should be removed and completely overhauled. See paragraph 124.

B. Inspect the brushes and brush holders. The brushes should slide freely in their holders and should be perfectly in line with the commutator segments. If the brushes do not slide freely, are out of alignment, oil soaked, or worn to less than one-half of their original length, the generator should be removed for a tune-up inspection given in paragraph 119.

C. Inspect all the wiring from the generator to the regulator, and from the regulator to the battery, and from the battery to the ground for worn or frayed insulation, broken wires, and for loose or corroded connections. Repair or replace the defective wiring.

D. Run the generator at maximum output (approximately 1030 r.p.m.) and note the commutator action. If there is excessive arcing between the brushes and commutator, remove the generator for the tune-up inspection according to paragraph 119. Inspect the regulator. Check the wiring as indicated in "C". Paragraph 118.

E. Start the engine and note the ammeter action.

Slowly increase the engine speed. The ammeter should show a gradually increasing charge, and if the battery is fully charged the charging rate will drop back when the output approaches its maximum. If the battery is not fully charged, the generator will continue to charge at its maximum rate. If the regulator does not operate in this manner, it should be given a tune-up inspection as given in Paragraph 121.

F. The drive end ball bearings of the generator should be given three to five drops of medium engine oil in the hinged top oiler at the top of the end head. Fill the commutator end oil pocket with medium engine oil in the combination oiler in the commutator end cap cover.

119. 256 HOUR TUNE-UP.

A. Remove the generator from the engine and take off the head band.

B. Inspect the commutator and if it is dirty or discolored, clean it by holding a piece of 00 or 000 sandpaper against the commutator while turning the armature by hand. Blow the sand out of the generator after cleaning the commutator. If the commutator is rough or worn, the generator should be disassembled and completely overhauled according to paragraph 125, Step C.

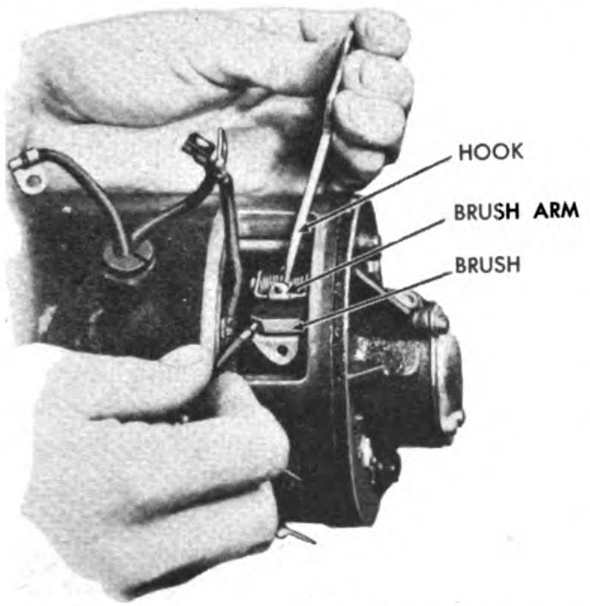


Figure 214. Removing Brushes from Holder.

C. Inspect the brushes. Each should slide freely and should be free from oil and dirt. Brushes that are oil soaked or are worn to less than one-half their original length should be replaced.

D. To remove the brushes, lift the brush arm as shown in Figure 214, and disconnect the brush leads as illustrated in Figure 215.

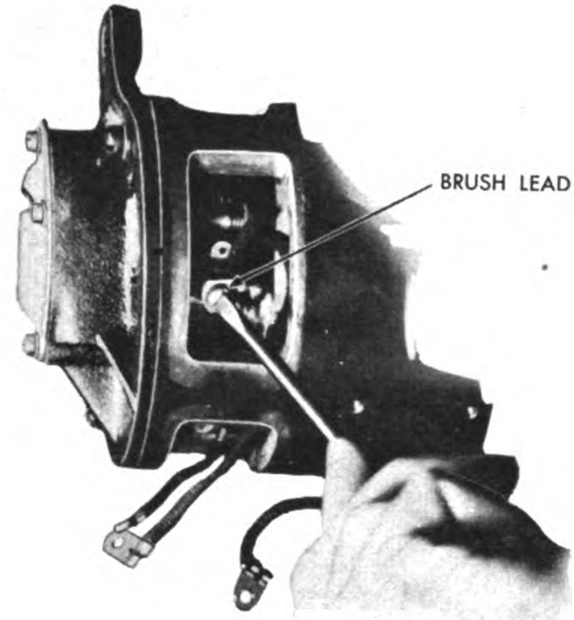


Figure 215. Disconnecting Brush Leads.

When installing brushes make sure that the brushes are assembled so that the beveled face of the brush fits the commutator. Check the alignment, to make sure that the brush edge is parallel with the commutator segments. If the alignment is off, or if the brushes do not slide freely, the commutator end plate should be disassembled and inspected as described in paragraph 127.

E. After new brushes are installed, they should be sanded to make sure of the proper fit on the commutator. To sand the brushes, cut a strip of 00 or 000 sandpaper to the exact width of the commutator. Slip this strip under a brush. With the abrasive side against the brush and the brush at its proper spring tension, draw the sandpaper following the contour of the commutator and make certain that the entire face of the brush is being ground. Do not grind excessively and be careful not to break the edge of the brushes. See Figure 216.

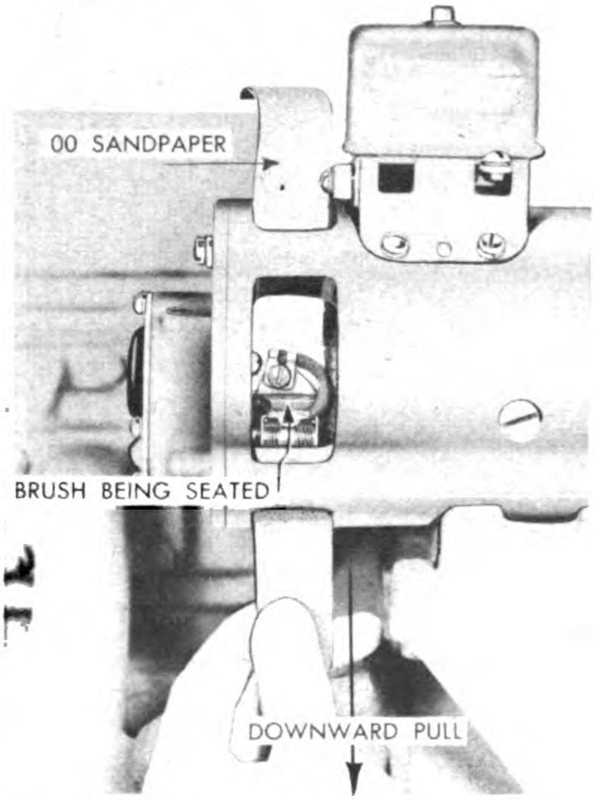


Figure 216. Seating Brushes

F. Check the brush spring tension. Hook a spring scale under the third brush arm near the end or in the hole in the lip of the main brush arms and pull on a line parallel to the face of the brush. Take the reading just as the arm leaves the brush. The main brush spring tension should be 53 ounces, maximum. The third brush spring tension should be 50 to 60 ounces. If the tension is too great, the brushes and the commutator will wear excessively.

120. BATTERY CHARGING GENERATOR BENCH TEST.

A. Before subjecting the generator to the bench test, remove the voltage regulator by taking out the regulator mounting screws and disconnecting the regulator leads as shown in Figure 217.

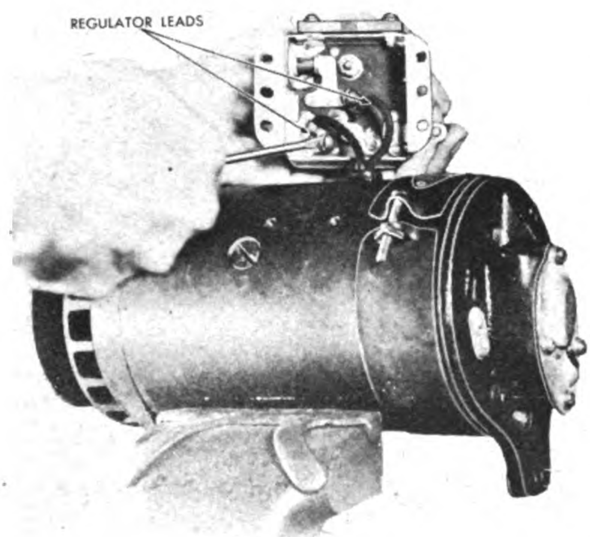


Figure 217. Removing Voltage Regulator Leads.

B. Connect an ammeter, battery, and variable resistance in series with a field coil lead and the third brush terminal. Connect a voltmeter from the third brush terminal to the field coil lead. Adjust the voltage to 6.0 volts and read the ammeter which should show 1.65 to 1.82 amperes. If the current is not within these limits, it indicates faulty field coils or connections.

C. Next, connect an ammeter, battery and variable resistance in series with the armature lead and the generator frame. Ground the field lead to the generator frame and connect a voltmeter from the armature lead to the generator frame. Adjust the voltage at 6.0. The armature should turn slowly, and the ammeter should show 3.08 to 3.4 amperes. If the current is not within these limits, it indicates high resistance connections, worn bearings, or poor brush contact.

(If the following test cannot be done on the test bench, the generator can be mounted on the engine.)

D. Connect the field lead to the ground and connect an ammeter between the armature lead and the battery. Connect a voltmeter from the armature lead to a ground on the generator frame. Operate the generator and increase the speed slowly, noting the maximum charging rate obtained. This charging rate should not be set above the figures given as follows:

7.6 volts, 14.4 to 16.4 amperes, maximum output.
8.0 volts, 15.0 to 17.0 amperes, maximum output.

To adjust the maximum output, advance or retard the third brush by applying pressure to the base of the brush holder.

121. INSPECTING AND ADJUSTING VOLTAGE REGULATOR.

NOTE: The regulator should be removed from the generator and the leads disconnected for the following inspection and adjustment.

CAUTION: Tape the battery leads to prevent short circuiting.

A. Remove the regulator cover and inspect the regulator visually for: (1) evidence of burning or abnormal high temperatures at the coils, contacts, insulation, external terminals, or any other points; (2) loose connections resulting from poor soldering; (3) loose nuts on the bottom of the magnet cores; (4) loose nuts and screws. (NOTE: All nuts and screws must have lockwashers); (5) broken or altered carbon resistor. Repair or replace any of the items mentioned above that may be faulty.

B. Inspect the contacts. If they are dirty or burned, they can be cleaned with a piece of crocus cloth. See Figure 218. Do not use sandpaper or a file. After cleaning, the contacts should be cleaned, if possible, with refined carbon tetrachloride, to remove any dirt or grease; after which a piece of clean linen tape or hard paper, such as kraft wrapping paper, should be pulled between the contacts to remove any fine dirt or lint.

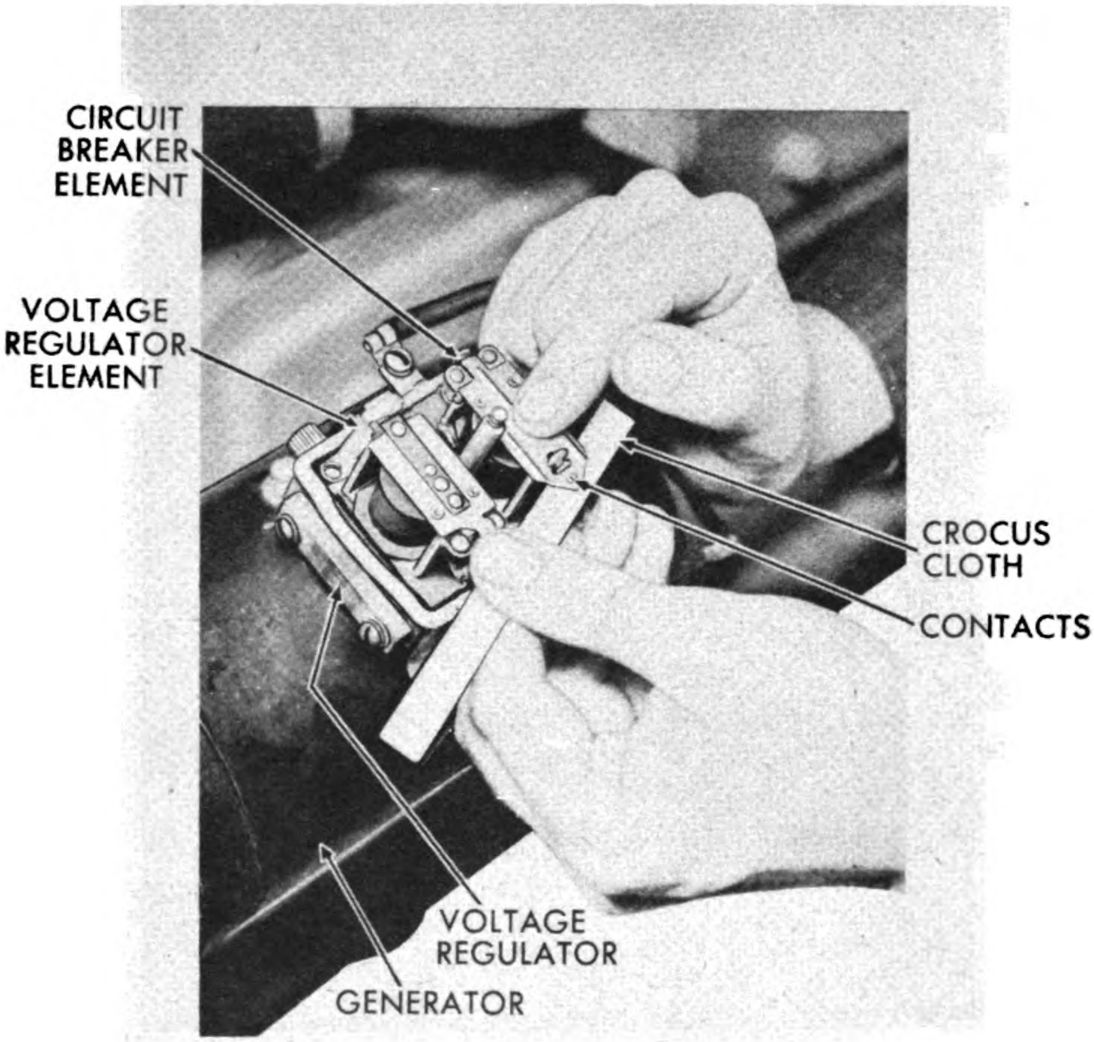


Figure 218. Cleaning Regulator Contacts.

122. TESTING AND ADJUSTING VOLTAGE REGULATOR.

A. Connect the voltmeter and a battery so that an accurate control is obtained of the voltage applied between the armature terminal and the base of the regulator. Connect a lamp bulb in series between the battery terminal of the regulator and the regulator base. Connect the voltmeter from the armature terminal to the base. Increase the voltage from "0" and note the voltage at which the circuit breaker contacts close, which will be indicated by the lighting of the lamp. This voltage reading should be between 6.5 and 7.25 volts.

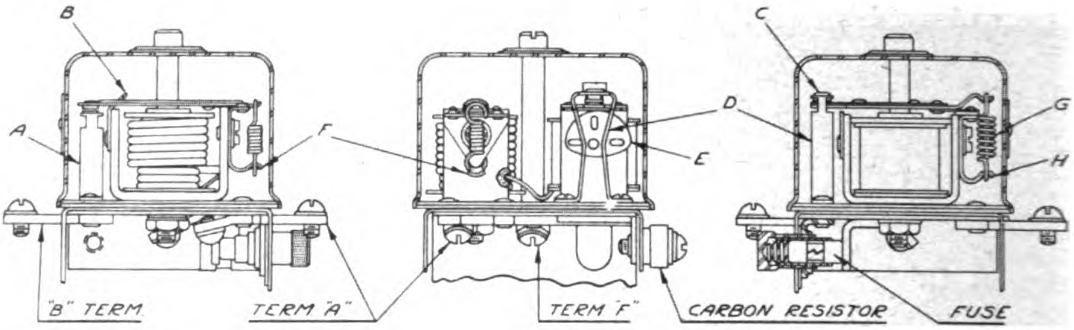


Figure 219. Voltage Regulator Line Drawing.

B. Adjust the closing voltage by bending the lower spring hanger (F in Figure 219) on the circuit breaker unit. Bending it down increases the spring tension, and bending it up decreases the spring tension.

C. The contact open specifications under various temperature conditions are as follows:

Temp. F.	50°	60°	70°	80°	90°	100°	110°
Volts	8.15	8.07	8.00	7.93	7.85	7.78	7.71

Reduce the voltage and check the contact closing voltage as indicated by the lighting of the lamp. This voltage should be 1.8 to 2.0 volts below the reading obtained for the contact opening. Adjust by turning the brass cam (E in Figure 219) on the contact side of the voltage regulator yoke. This changes the contact gap (C in Figure 219) which must not be less than .005" after the adjustments are completed. When the regulator is correctly adjusted, apply a drop of air drying varnish to the cam to prevent slipping. Replace the regulator covers and reassemble the regulator on the generator.

123. 512 HOUR OVERHAUL.

It will be necessary, for the overhaul, to remove the generator from the engine by disconnecting the battery lead from the regulator and removing the mounting bolts. NOTE: Tape the battery leads to prevent short circuiting.

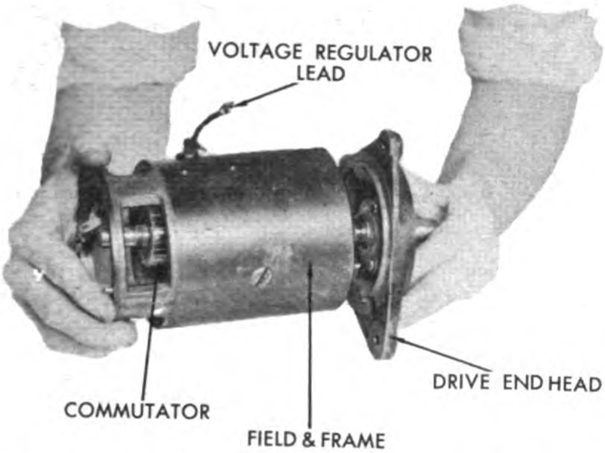


Figure 220. Removing Armature from Generator.

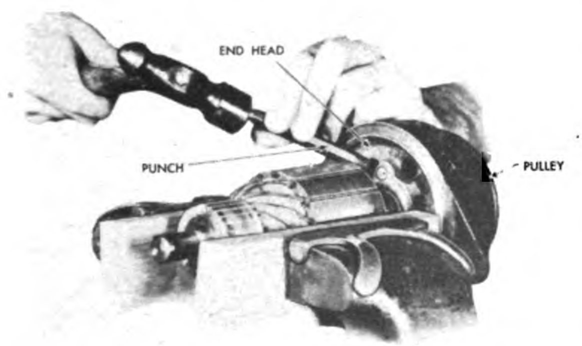


Figure 221. Removing Pulley from Armature Shaft

124. STEPS OF DISASSEMBLY.

A. Remove the regulator mounting screws and disconnect the regulator leads as shown in Figure 217.

B. Remove the nut and lockwasher from the armature shaft.

C. Remove the generator head band.

D. Disconnect the lead at the third brush and the insulated main brush as shown in Figure 215. Lift the brushes off the commutator as illustrated in Figure 214.

E. Remove the two frame screws at the commutator end. Slide the commutator end head off the generator.

F. Pull the armature, the drive end head, and the pulley from the generator. See Figure 220.

G. Remove the pulley from the armature shaft with a puller or by tapping, as shown in Figure 221. Press the armature shaft out of the end head with an arbor press as illustrated in Figure 222.

125. INSPECTING THE ARMATURE.

A. Inspect the armature and commutator for evidences of wear. Inspect the insulation and the soldering to make sure that all coils are in proper working order. Check the armature for grounds with a set of test

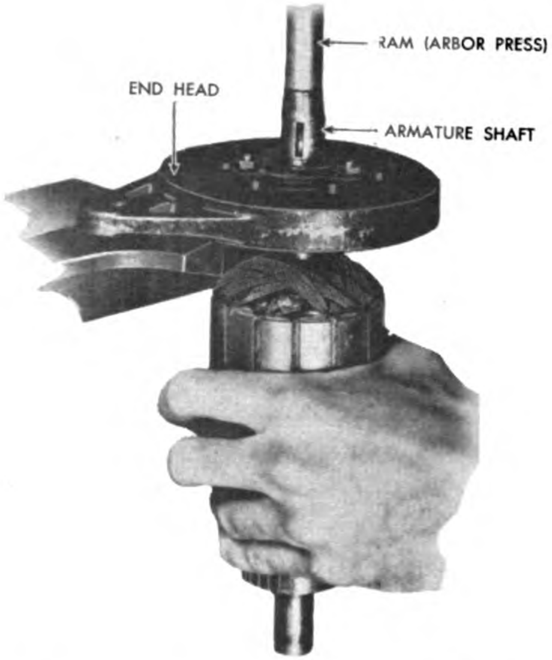


Figure 222. Pressing Armature Shaft from Drive End.

probes consisting of a lamp in series with two points and connected to a source of electricity. Touch one probe to the armature shaft (not on the bearing surface) and touch the other probe to each commutator segment, as shown in Figure 223. Do not touch the brush surfaces of the commutator as an arc would mar the smooth finish. If an armature coil or commutator segment is grounded, the lamp will light. If the ground is accessible, it should be repaired, otherwise replace a grounded armature.

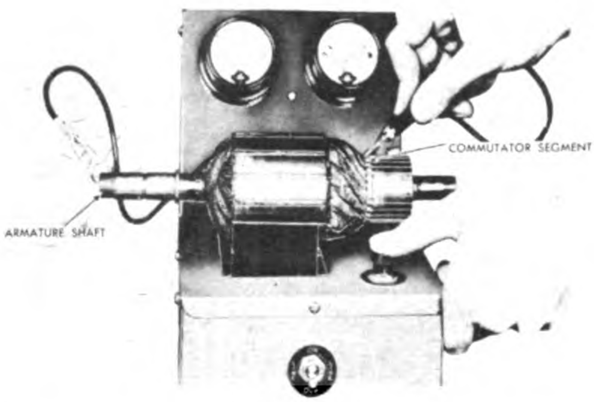


Figure 223. Testing Armature for Grounds.

B. Check the armature for shorts on a growler as illustrated in Figure 224. Replace the armature if it is found to be shorted. Check for open by touching the test probes to the core of the shaft and each segment. If the lamp fails to light, the coil is open and the armature should be replaced.

C. If the commutator is rough or worn, it should be turned down in a lathe. Mount the armature on the bearing seats and not on the shaft centers. Take only a light cut and remove all burrs. Undercut the mica to a depth of 1/32" after turning the commutator. The undercut should be square

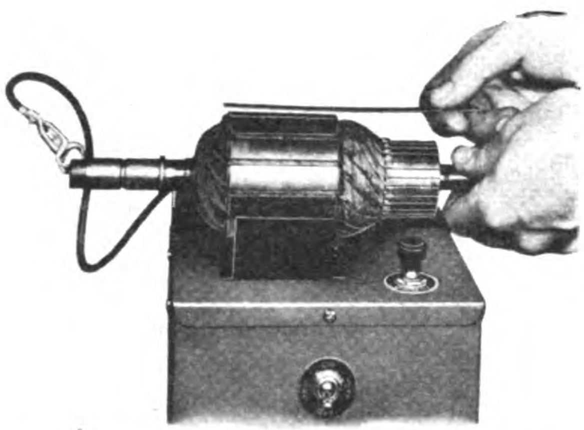


Figure 224. Testing Armature on Growler for Grounds.

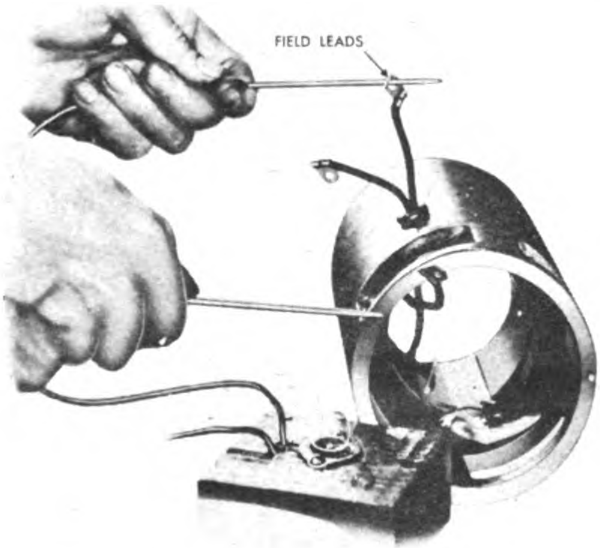


Figure 225. Testing Field Coils for Grounds.

and free from burrs. The maximum eccentricity of the commutator is not to exceed .003".

126. INSPECTING THE FRAME AND THE FIELD.

A. Inspect the insulation on the field coils and leads and replace any faulty parts. Inspect the leads and terminal posts for broken wires, frayed insulation or poorly soldered terminals.

B. With test probes check the field coils for grounds and opens. Touch one probe to the field lead and touch the other to an unpainted ground on the frame as shown in Figure 225. If the field coils or the lead is grounded, the lamp will light. Touch one probe to the field lead and touch the other to the third brush lead as illustrated in Figure 226. If the coils or leads are open, the lamp will not light.

C. If it is necessary to replace a field coil, remove the pole piece screws. Assemble the new coils on the pole pieces and tighten securely with pole piece screws that have been dipped in boiled linseed oil. As the screws are tightened the frame should be struck with a raw hide mallet a few times to settle properly and to align the pole pieces.

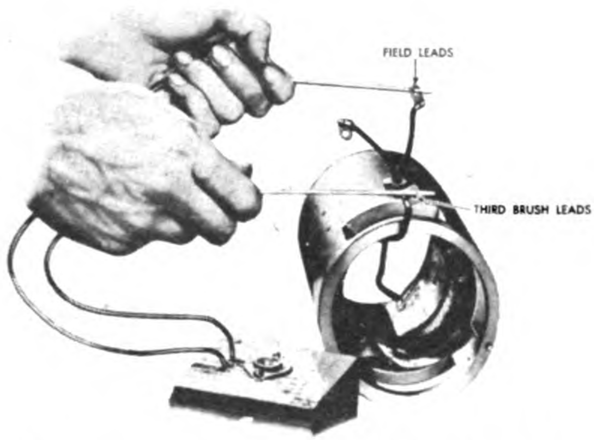


Figure 226. Testing Coils for Opens.

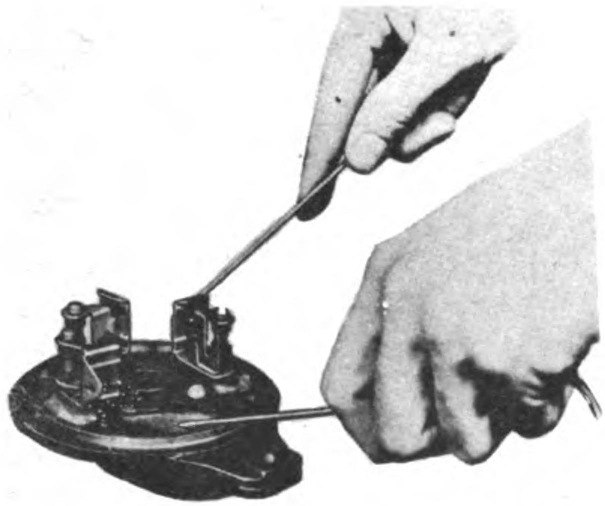


Figure 227. Testing Holders for Grounds.

127. INSPECTING COMMUTATOR END HEAD.

Disassemble the cap cover and oil retainers and take out the felt wick. Remove the third brush plate and brushes and clean both plates thoroughly. With the test probes, check the insulated brush holders for grounds. See Figure 227. Inspect the brush arm and holder to see that they are not bent or corroded. Clean the bearings thoroughly and inspect for wear. Soak the bearing and oil wick in engine oil and assemble the oil retainer and gasket. NOTE: Do not assemble the oil wick until after the head and armature have been assembled on the generator.

128. INSPECTING DRIVE END HEAD.

Dissasemble and clean the bearings and retainers. Inspect each part for wear or failures, and replace any faulty part. Pack the bearing one-half full with a high melting point grease, and reassemble the drive end head. The felt washer should be soaked in oil before reassembling the head.

129. STEPS OF REASSEMBLY OF THE BATTERY CHARGING GENERATOR.

A. Assemble the armature in the drive end head with an arbor press as shown in Figure 228. Make sure the snap ring on the shaft fits down tightly against the bearing.

Figure 228. Pressing Armature into Drive End.

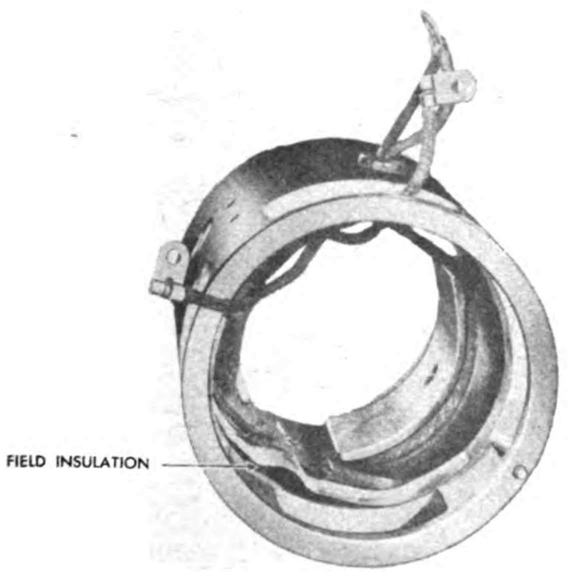


Figure 229. Frame Screw under Field Insulation

B. Assemble the drive end head and armature on the frame and field, making sure that the dowel pin is in place.

C. Assemble the commutator end head on the frame and field, making sure the dowel pin is in place.

D. Assemble and tighten the frame screws. Be sure that the frame screw is under the field connection insulation. See Figure 229.

E. Assemble the brushes in their holders and connect the brush leads. Make sure that the brushes are assembled so that the beveled face fits the commutator. If the brushes needed replacing, they should have been sanded according to the instructions given in paragraph 119, step E.

F. Assemble the felt wick in the commutator end head. See Figure 230 for proper position after assembly.

G. Add five to ten drops of oil to the drive end oiler and

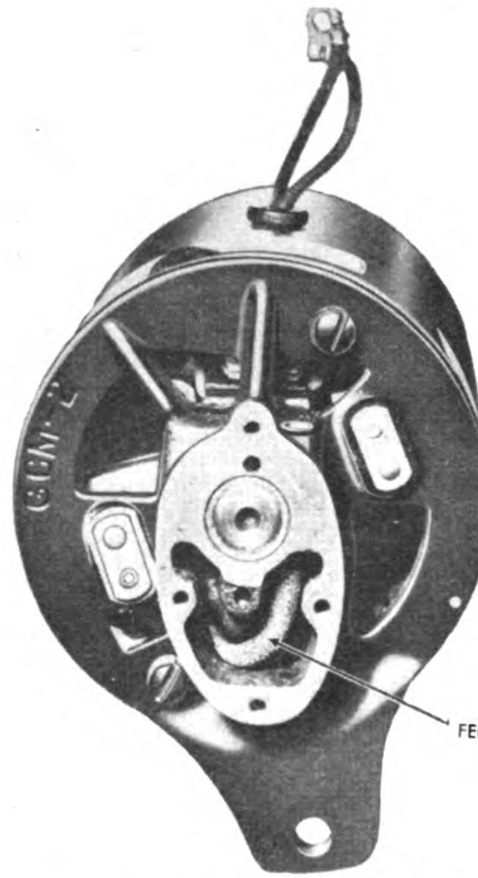


Figure 230. Felt wick in Commutator End Head.

fill the commutator and oil pocket to the combination oiler and overflow hole.

H. Test and adjust the generator according to paragraph 120. The voltage regulator should be subjected to the tests given in paragraph 121 and 122.

130. VOLTAGE REGULATOR RESISTANCE TESTS.

Besides the tests already given for the voltage regulator in paragraph 122, the following regulator tests should be included during the generator overhaul period.

131. RESISTANCE TESTS.

Remove the carbon resistor and check its resistance on an ohmmeter. If it is not between 1.85 and 2.10 ohms, replace the resistor.

Measure the resistance from the "A" terminal to the regulator base. Replace the regulator if this resistance is not between 15.9 and 18.0 ohms.

132. ARMATURE AIR GAP TESTS.

A. Circuit breaker unit - .010" to .030".

This gap is measured with the regulator contacts closed. It can be adjusted by raising or lowering the stationary contact "A" in Figure 219. Keep the contacts closed.

B. Voltage Regulator unit - .045" to .001" (contacts closed).

This gap is measured with the contacts closed. It can be adjusted by raising or lowering the upper contact "C" in Fig. 219, by expanding or contacting the bridge "D" holding the upper contact.

133. ADJUSTING CONTACT POINT GAP.

A. Circuit breaker unit - .015" to .045".

Adjust by bending the armature stop in Figure 219.

B. Voltage regulator unit - .005" minimum.

Adjust by turning the brass cam "E" in Figure 219.

IGNITION SYSTEM

The ignition system consists of magneto and spark plugs with the necessary high tension cables between. The ignition is set to occur at 20° before top dead center, at 1200 r.p.m. full load.

134. DEFECTIVE IGNITION OR MISFIRING.

Misfiring may be due to a chafed or broken cable, or loose connections. The metal terminals must not come in contact with any metal parts of the engine, other than those for which they were designed. Keep the cables and terminals clean and free from dirt, dust or oil.

When a cylinder misfires the fault is usually in the spark plug. See paragraph 152.

If cables and plugs are in good condition and the ignition is irregular, the trouble will be found in the magneto, particularly the interrupter points (see paragraph 136) or the engine may be out of time. See paragraph 137.

MAGNETO

The magneto provides the electric spark through the spark plugs at the instant it is required. The magneto not only acts as a distributor but a dynamo as well. The current, however, is not continuous but intermittent, an impulse coupling is connected thereto. See Figure 231.

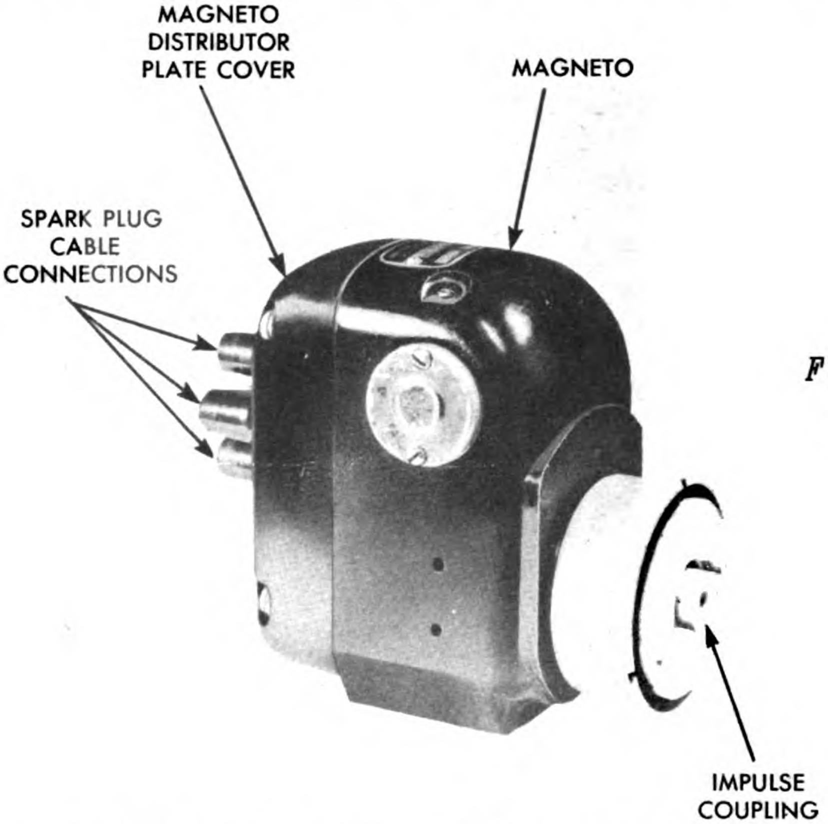


Figure 231. Magneto

It has a two-pole, brush type, employing the induction principle of current generation producing two sparks for every 360° of magnet rotor travel. Its rotation is anti-clockwise.

The condenser, breaker and coil assembly are stationary and the magnet rotor rotates between laminated pole shoes. A single casting, the open end of which is covered by a distributor plate, encloses the entire magneto. An observation window is placed in the center of the plate so that the timing arrow on the distributor rotor can be observed when timing the magneto to the engine.

Labyrinth type ventilators at either side of the magneto housing, plus the fan action of the revolving magneto rotor insures cooling of the interior.

135. SERVICE ADJUSTMENTS.

The proper method of removing and replacing the distributor plate assembly to permit contact inspection or adjustment is: (See Figure 232).

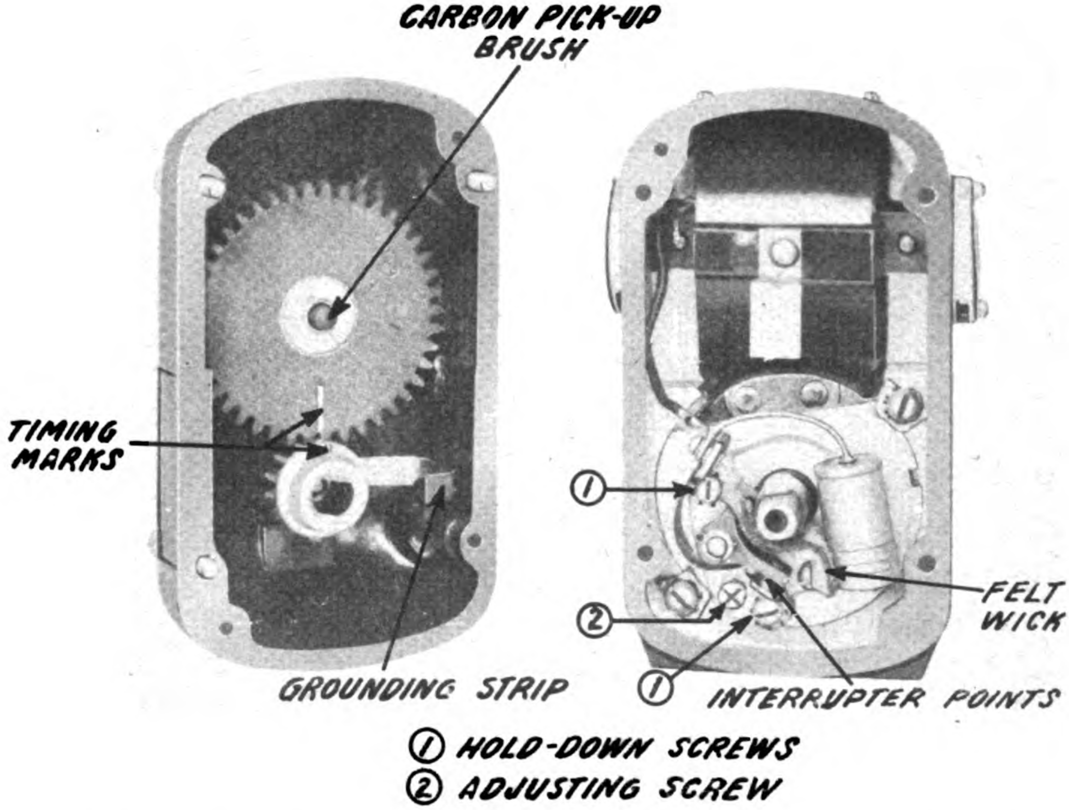


Figure 232. Magneto with distributor Plate Removed.

(A) Rotate engine until line on distributor gear is visible in the observation window. (B) Then remove the four fastening screws, (two top, two bottom, and remove the entire distributor plate assembly. (C) Adjustments or inspections can now be made.

When replacing the assembly, the line on distributor gear must be visible in observation window. Engage magnet rotor shaft with rotor gear and tighten distributor plate fastening screws.

NOTE: If the distributor plate assembly was removed before the instructions given above were noted, it will be necessary to (A) rotate the engine until piston of No. 1 cylinder is in approximate firing position of compression stroke: (B) rotate the distributor gear until line is visible in the observation window; (C) engage magnet rotor shaft with rotor gear, slightly moving rotor gear in either direction, as required, to permit engagement. Tighten the plate fastening screws.

136. INTERRUPTER ADJUSTMENT.

The contacts Figure 232, should be adjusted to an opening of .014" - .018" when the interrupter lever fibre bumper rests on the top of the cam lobe. Do this by shifting the adjustable contact bracket until the correct opening has been reached, then tighten the bracket by means of its fastening screws.

Contact points must be free from oil or grease, so that the fuel surfaces of both contacts meet flush. Pitted contacts should be cleaned with a suitable stone. A FILE IS NOT RECOMMENDED.

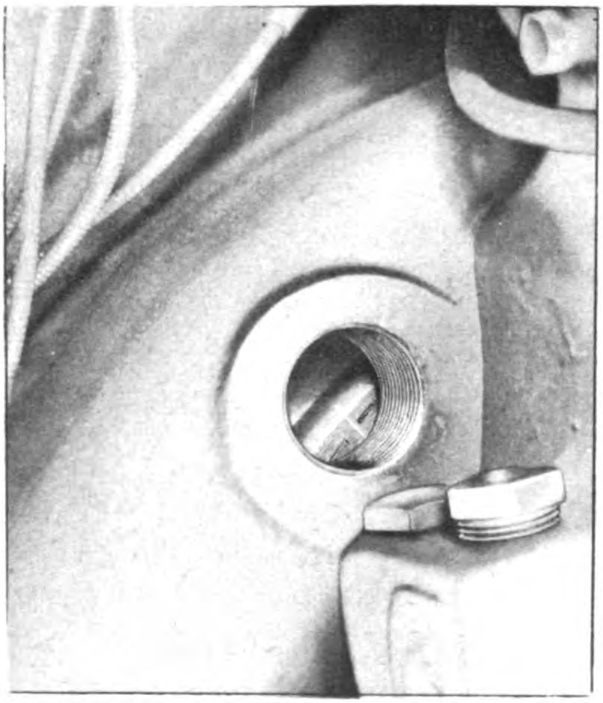


Figure 233. Timing Hole.

137. MAGNETO TIMING.

A. With the magneto in place remove the valve cover plate, turn the engine with the hand crank until the piston in cylinder No. 1 moves upward on the compression stroke. (The compression stroke can be obtained by turning the engine until the intake valve opens and closes. The intake valve is the second valve from fan end. Carefully continue turning so that the top dead center line on the flywheel centers in the timing hole in the flywheel. See Figure 233. With a wrench on the crankshaft jaw, now back up the flywheel 3" as measured on the surface of the flywheel through the timing hole. Because the full 3" cannot be measured off as a whole, measure off 1" at a time. After three such measurements, will give the point at which ignition should occur.

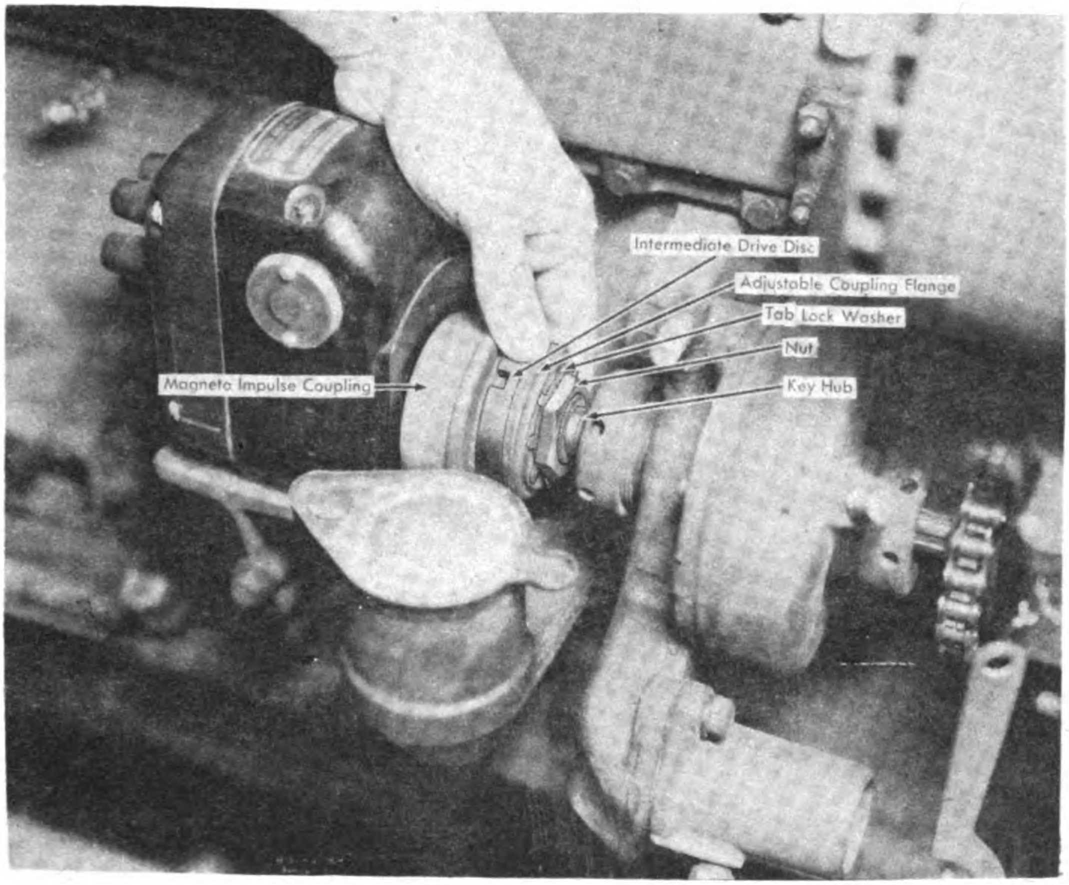


Figure 234. Timing Coupling.

B. Then straighten the two tabs on the lockwasher connecting the two halves of the timing coupling, See Figure 234, and rotate the rear half of the timing coupling until the line on the distributor gear is visible in observation window. Figure 232. This operation is best performed by turning the armature in the opposite direction of rotation to that in which it will be driven by the engine, thus eliminating the engagement of the impulse weights. Approximate timing is now obtained.

C. Remove the distributor plate by loosening the four screws. This will expose the interrupter assembly.

D. To obtain the exact timing, the interrupter points must just begin to open. Turn the impulse coupling in a clockwise direction until the points just start to open on the front side of the cam or when magneto is turned in a clockwise direction. Screw in the two capscrews in the two holes that line up without turning the coupling.

E. Reinstate the distributor plate and insert the cable between outlet No. 1 (Mark on Distributor Plate) and cylinder No. 1 which is then timed to fire correctly.

Complete the installation by connecting the remaining cables of the magneto to the spark plugs in their proper firing order, 1-5-3-6-2-4. The firing sequence on the distributor or high tension end of magneto follows the opposite direction of rotation from that indicated by the arrow on the magneto name plate and must be taken into consideration when the cables are connected to the spark plugs.

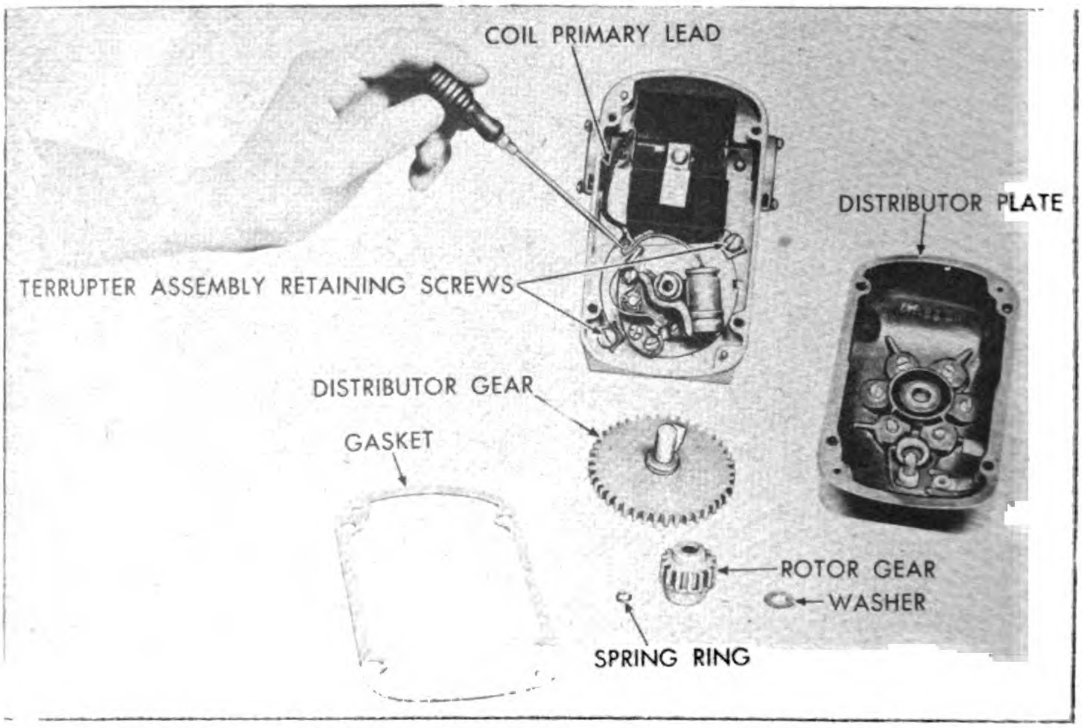


Figure 235. Disassembly of Magneto.

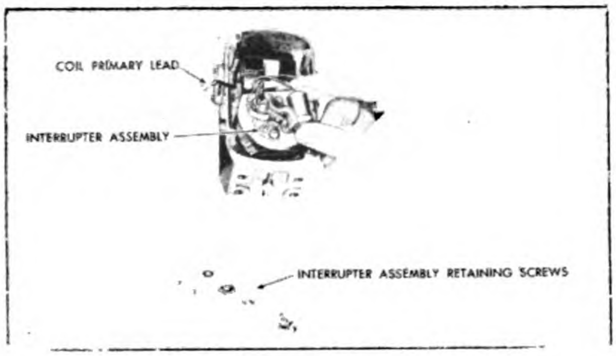


Figure 236. Interrupter Assembly.

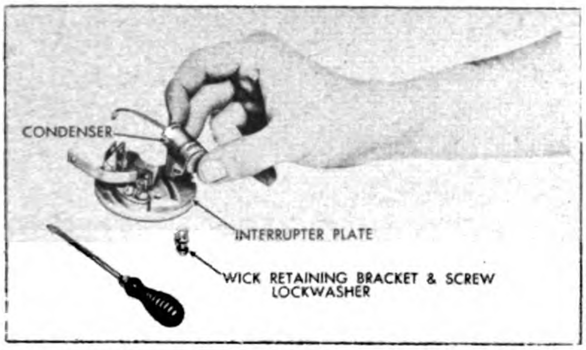


Figure 237. Interrupter Plate Condenser and Wick Assembly.

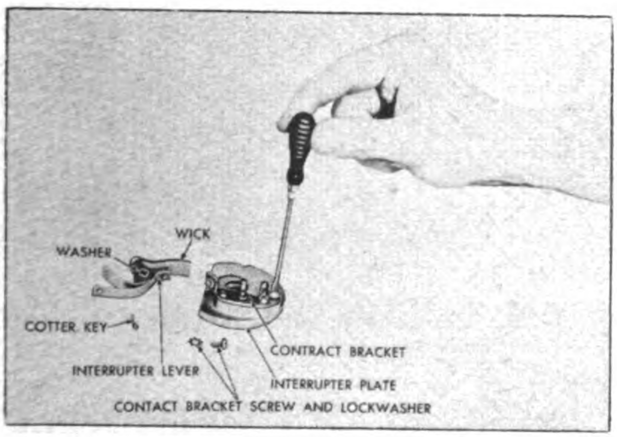


Figure 238. Disassembling Interrupter Assembly.

138. DISASSEMBLY OF MAGNETO.

To facilitate the reassembly of the magneto, it is suggested that the parts be laid on a clean bench or placed in a clean pan in the order in which they are disassembled. Remove impulse coupling before proceeding with the disassembly of the magneto. See chapter I for tools needed.

A. Refer to Figure 235. Remove distributor plate assembly by loosening fastening screws. The spring ring holding the rotor gear to the rotor gear shaft can easily be removed by taking the distributor plate assembly up in one hand and bringing it down rapidly on a bench so that the four corners of the open end of the distributor plate strike simultaneously. Rotor gear and distributor gear can then be removed, see Figure 235. Remove coil primary lead screw and lockwasher Figure 235.

B. Remove the interrupter assembly by withdrawing the two screws and locking plates. See Figure 236.

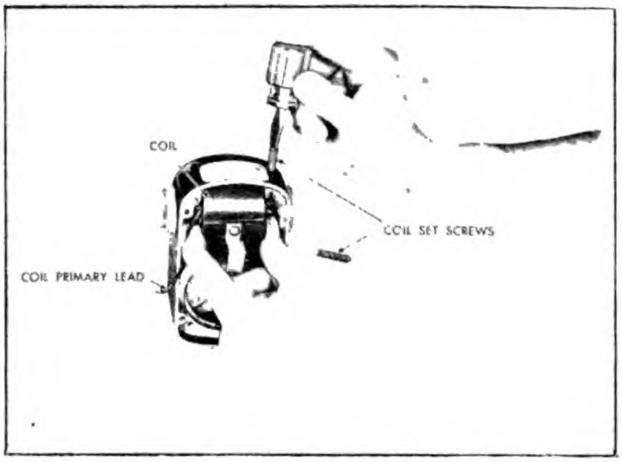


Figure 239. Removing High Tension Coil.

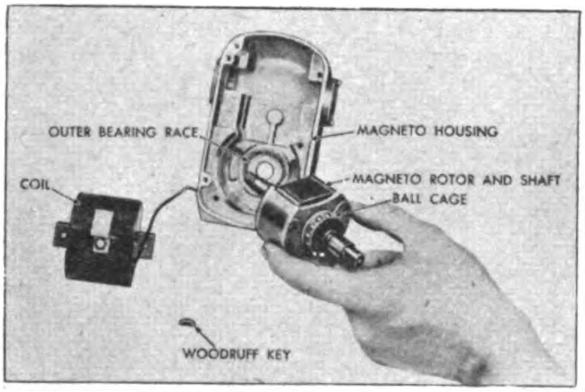


Figure 240. Removing Magnet Rotor and Shaft Cage Assy.

C. Remove the condenser and wick retaining bracket, withdrawing fastening screw and lockwasher Figure 237.

D. Disassemble the interrupter assembly by removing the interrupter lever cotter pin and washer, and pull out the interrupter lever. Figure 238.

E. To remove contact bracket, withdraw fastening screws and lockwashers Figure 238. Loosen coil setscrews on the outside top of the Magneto Housing and pull out high tension coil Figure 239.

F. Remove woodruff key from drive end of magnet rotor and pull out magnet rotor and shaft. Figure 240.

G. Now remove the ball cages from both ends of magnet rotor and remove the ball bearing, inner race rings by using tool No. TSE-5265 with split jaws and tool No. TSE-76108. Figure 241.

H. Remove ball bearing outer race rings from drive end of magneto frame and reverse side of the interrupter bracket by using tool No. TSE-76101. See Figure 242.

139. INSPECTION AFTER DISASSEMBLY.

A. Visually inspect the rotor gear distributor gear and carbon brush for possible wear. Figure 235. Check the distributor plate for current leakage or damage. If cracked replace. However, if inspection reveals no

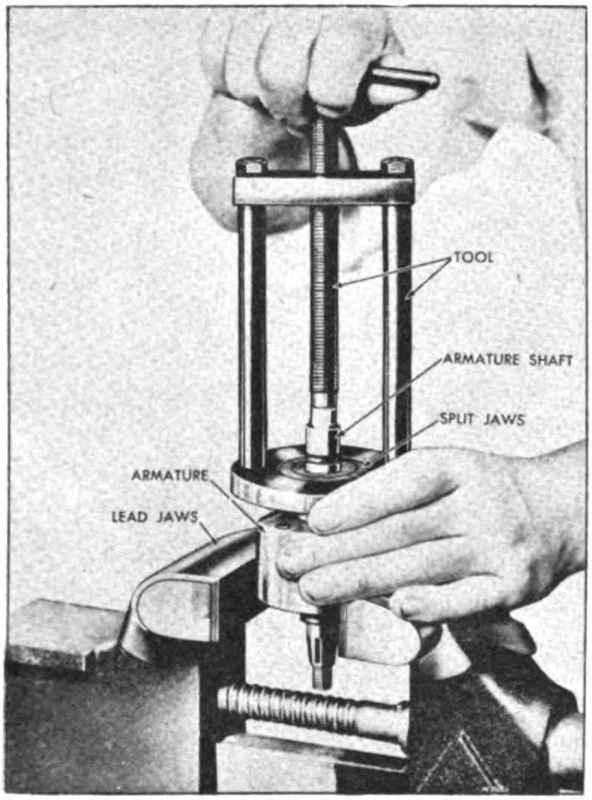


Figure 241. Removing Inner Race Rings.

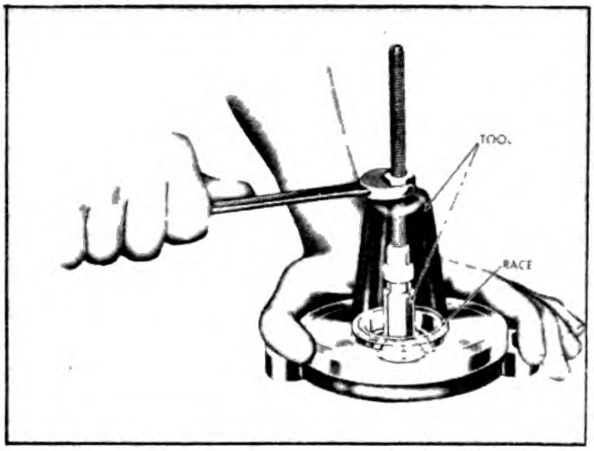


Figure 242. Removing Outer Race Rings.

burned or cracked places, wipe out the inside of the plate with a suitable cleaner such as acetone, alcohol, or carbon tetrachloride.

B. The interrupter contact should be checked. Pitted points can be dressed on a fine stone; the use of a file is NOT recommended. If point renewal is necessary, always replace both the interrupter lever and contact bracket at the same time.

C. Check tne condenser for leakage, or damage, or for short circuit, with test lamp. Place one lead on condenser case, the other on the lead; if light glows, there is a short. Replace the condenser.

D. Examine the high tension coil for cracked housing, loose core, loose primary cable connection. Inspect all soldered connections. Check continuity of secondary winding on a condensoscope, or test as follows with a 110 volt test light; place one lead on the high tension spring and the other on the primary terminal; make and break the connection. By so doing spark should be obtained; if there is no spark, the wires are broken.

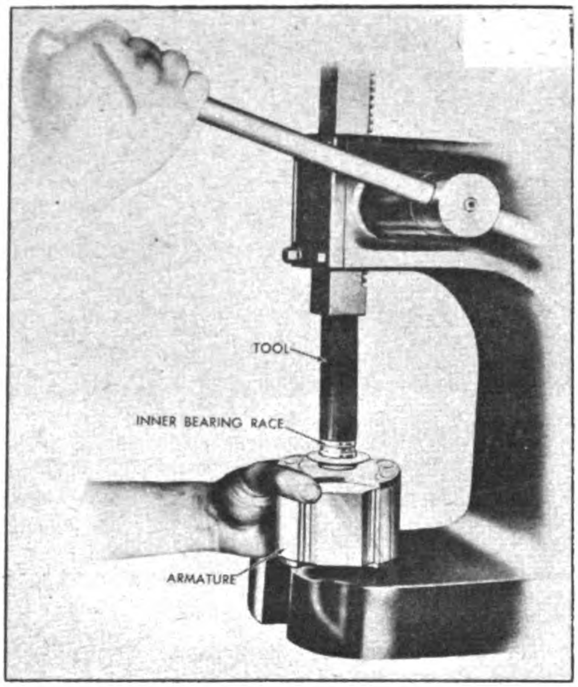


Figure 243. Pressing Inner Race Rings.

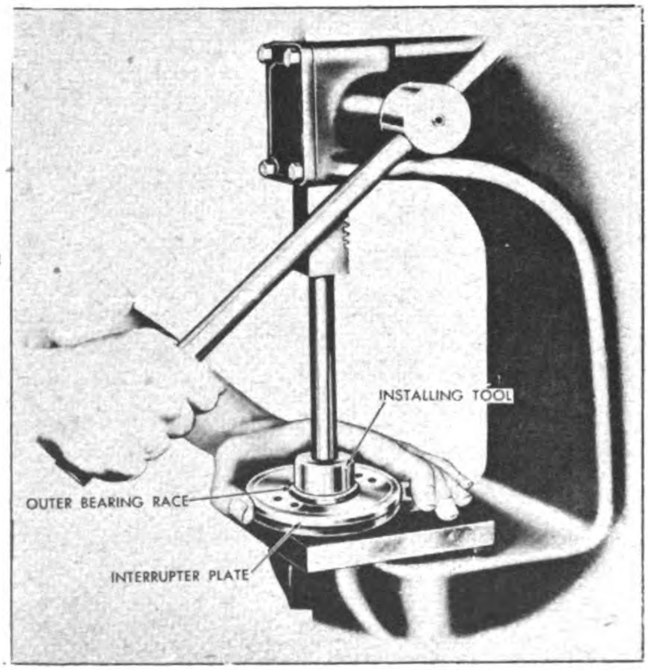


Figure 244. Pressing Outer Race Rings on Shaft.

E. Inspect ball bearing inner and outer race rings for scores and excessive wear. Inner and outer race tracks and balls should not be discolored and should have a mirror finish.

140. REASSEMBLY OF MAGNETO.

A. Before installing ball bearings, make sure all surfaces of bearing seats are clean. The bearing inner race rings can be installed on the magnet rotor shaft by using pressing tool No. TSE-76112 and an arbor press. See Figure 243.

B. Place felt washer with steel retaining washer next to it, then place paper washer at the bottom, and packing strip around the side of the bearing recess in the magneto housing and interrupter plate. Both ends of the packing strip are to meet at the milled out slot in the recess of the magneto housing and interruptor bracket. Center bearing outer race ring over recess and press into place using pressing tool No. TSE-5269 and an arbor press. See Figure 244.

C. After bearing outer race rings have been installed trim off excess portion of packing strip with a sharp pen knife or razor blade. Place ball cage on bearing inner race rings and install magnet rotor into magneto housing.

D. Install High Tension Coil by sliding coil into the upper portion of the magneto housing. See Figure 239. Each end of the coil core is to rest on top of the magneto pole shoes in the magneto housing. The counter-sunk holes at either end of the coil core should be upright so as to allow the tapered end of the coil securing screws to engage the counter-sunk holes. Drive screws into holes provided on the outside top of the magneto housing. Securely tighten screws to assure a good electrical connection between the coil core and pole shoes. Apply a coat of shellac to the protruding end of each screw to prevent the entrance of moisture.

E. Assemble interrupter assembly by setting contact bracket on the boss of interrupter plate provided for this purpose. See Figure 238.

F. Replace fastening screws and lockwashers and tighten securely. Place interrupter lever with felt wick on pivot pin of interrupter plate. Place interrupter lever washer on pivot pin after interrupter lever has been installed. Replace cotter pin in hole provided on pivot pin. Set condenser on interrupter plate. See Figure 237. Put felt wick retaining bracket and lockwasher on fastening screw and engage hole of condenser bracket. Drive screw into place.

G. Loosely replace primary lead fastening screw and lockwasher (engaging interrupter lever springs and condenser lead) into insulated post of contact bracket. Place interrupter assembly on magnet rotor shaft and slide it into the recess of the magneto housing provided for this purpose. See Figure 236. The slot in the outer edge of the interrupter plate is to line up with the stake mark in the recess of the magneto housing. Drive interrupter plate fastening screws with washers and locking plates into place. Make certain that the two points on the narrow end of the locking plates grip the interrupter plate firmly.

H. Connect coil primary lead clip to insulated post of contact bracket and tighten screw. See Figure 235.

I. Assemble distributor plate by inserting shaft of distributor gear into bronze bearing of distributor plate. Make sure that the spacing washer is on the shaft. Rotate distributor gear until the white line points directly to the rotor gear shaft. Place the spacing washer and the rotor gear on the rotor gear shaft engaging the tooth painted red on the rotor gear with the distributor gear slot marked with a white line. Put spring ring on rotor gear shaft using tool No. TSE 528. Place distributor plate assembly into place. See Figure 235. The oblong shaped hole of the rotor gear is to engage the magnet rotor shaft. Drive distributor plate fastening screws into place.

141. REMAGNETIZING MAGNETO.

The permanent magnets used in these instruments do not generally require remagnetizing. However, if it is deemed absolutely necessary to remagnetize one of these units, use American Bosch magnetizer No. TSE 5210 for this purpose. The cast "Alnico" magnets used in these magnetos are a special magnet with a great amount of magnetic strength and a magnetizer with sufficient strength to fully saturate the magnets must be used. Therefore, make certain your magnetizer has strength equal to the above mentioned unit before remagnetizing an American Bosch magneto.

The following procedure is to be followed when remagnetizing the MJC magneto on an American Bosch magnetizer No. TSE 5210.

Remove magnet rotor from magneto and place rotor and jaws No. TSE 5238 on magnetizing stand. The magnet rotor shaft must be placed in such a position so that the key way of the shaft is located at the left in a horizontal position when looking at the shaft from the drive end. After the rotor has been magnetized, reassemble the magneto and place the complete unit on the magnetizer making certain that the magnet rotor shaft is in the same position as outlined above. Using the flat ends of jaws TSE 5238, magnetize complete magneto after it has been assembled. NOTE: When remagnetizing a complete magneto, the impulse coupling should always be removed.

142. CHECKING GAP BETWEEN ARMATURE AND FIELD.

It is important, from the standpoint of efficiency, to interrupt the primary circuit in the high tension coil at the time when the magnet rotor is in its most favorable position for maximum magnetic disturbances or change of flux. This position of the magnet rotor in relation to the pole shoe is expressed in terms of a mechanical measurement called the "edge distance".

The edge distance is always determined as the magnet rotor leaves the pole shoe; never when the magnet rotor approaches it. The proper edge distance for this magneto is 2 millimeters minimum and 3 millimeters maximum, an average of 2.5 millimeters.

To measure the edge distance, remove the distributor plate assembly. Turn the magnet rotor in the direction the magneto is to be driven until the rotor has gone slightly beyond the edge of the pole shoe. Insert a 2.5 millimeter edge distance gauge between the magnet rotor and pole shoe. Turn the magnet rotor back against the edge distance gauge. While holding the rotor in this position, adjust the interrupter contacts so that they just begin to open. This is done by loosening the contact bracket fastening screws and by turning the eccentric screw until proper adjustment has been obtained. Do not forget to tighten screws after the proper contact adjustment has been obtained. Since the contact points and fibre block on the interrupter lever wear, it is recommended that the edge distance be checked periodically in order to assure maximum efficiency at all times.

143. LUBRICATION DURING OVERHAUL OF MAGNETO.

A. Ball Bearings:

Repack ball bearings with high temperature grease. (U.S. 508).

B. Interrupter:

Cover can surface with a light film of lubricating oil No. US 511. The interrupter felt wick should be saturated with oil or grease No. 2. A small lump of US 510 grease should be placed on the leading side of the interrupter lever fibre block.

C. Distributor Gear:

Repack hole in the distributor gear shaft with high temperature grease No. US 5.0. Also put a thin film of grease on the distributor gear teeth.

144. IMPULSE COUPLING.

The impulse coupling aids the starting of the engine. The action is automatic. The coupling is so designed that when attached to the magneto, it gives the rotor a short quick turn regardless of how slowly the engine is cranked. The impulse coupling does this by momentarily stopping the rotating magnet then releasing it at the proper instant; thus the rotation speed past the coils is increased, thereby producing a hotter spark, slightly retarded to avoid "kicking". See Figure 231.

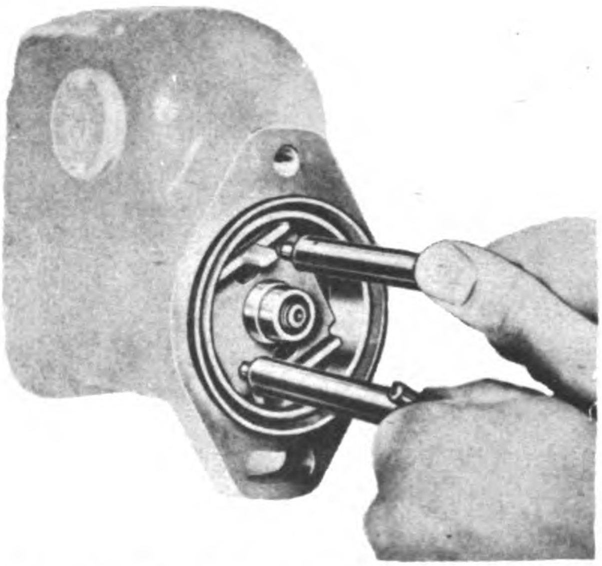


Figure 245. Removing the Coupling with Puller.

The impulse coupling automatically disengages when the magneto attains a speed of approximately 180 r.p.m. and then acts as a positive drive only.

GENERAL MAGNETO OVERHAUL DISASSEMBLY

When disassembling the coupling to check parts for wear or damage, use a puller to remove the coupling hub from the magneto shaft. See Figure 245. Damaged or worn parts must be replaced. See Figure 246.

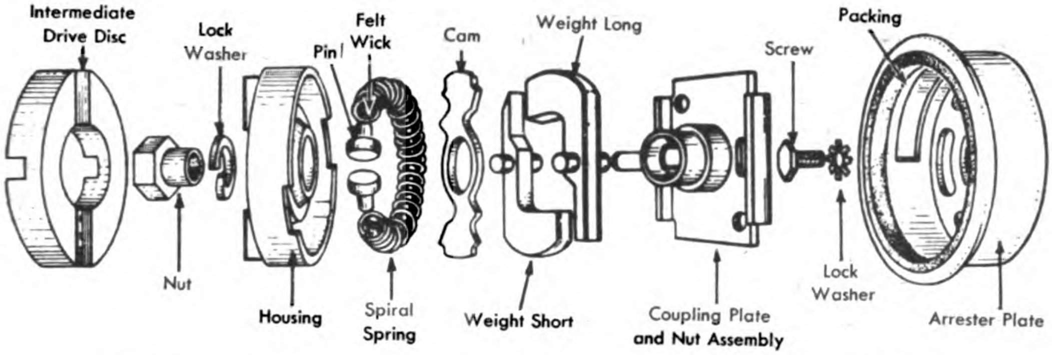


Figure 246. Disassembly of Impulse Coupling.

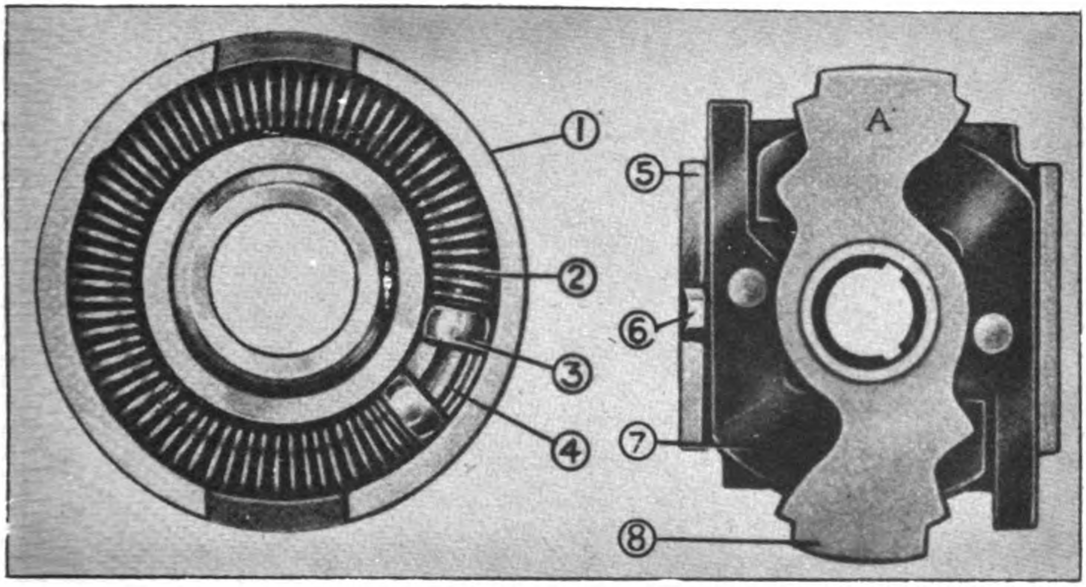


Figure 247. Reassembling Coupling.

1. Coupling housing.
2. Spiral spring with felt felt wick.
3. Pins.
4. Groove in housing panel.
5. Coupling hub.
6. Ear of coupling hub.
7. Weights.
8. Cam.

145. REASSEMBLING THE COUPLING.

A. Refer to Figure 247. Reassemble pins and spiral spring with felt wick to coupling housing. Pins must rest against groove in housing channel.

B. With ear of coupling facing you, locate weights in elongated hub slots.

IMPORTANT: If the coupling is being assembled for clockwise rotation, letter "C" stamped on weights must be face up.

C. Place cam on coupling hub with letter "A" or "C" facing upward as required. Engage ear of coupling hub between pins in housing and mesh the two assemblies.

Figure 248. Arrester Plate.

146. INSTALLING THE COUPLING ON MAGNETO.

NOTE: To provide accurate setting of the coupling retard, marks spaced 50° apart have been placed adjacent to the upper lefthand slot of arrester plate used with the coupling. See Figure 248.

When heavy center mark lines up with fastening hole in magneto housing automatic retard or lag angle of coupling is approximately 30° for either clockwise or anti-clockwise rotation.

Turning the arrester plate in a clockwise direction increases the automatic retard or lag angle and turning it in an anti-clockwise direction decreases the automatic retard or lag angle for clockwise magnetos. The opposite is true if the magneto operates in an anti-clockwise rotation.

Retards of from 10° to 50° are obtained by moving the arrester plate as outlined above.

A. Fasten the arrester plate to the magneto frame. Adjust plate to required retard and securely fasten in place.

B. Locate impulse member assembly on magneto drive shaft and fasten in place with rotor shaft nut and lockwasher. NOTE: Hub (5) of the impulse member assembly is provided with two keyways - one for clockwise rotation marked "C", the other for anti-clockwise rotation marked "A". Be sure to select the proper keyway.

CABLES AND WIRES

147. REPLACING CABLES AND WIRES.

When cables show signs of cracking or wires are frayed, replacement is necessary. They must not be replaced with other than the specified sizes indicated in the wiring diagram. See Figure 194. If smaller cables are used, the flow of current is restricted. Keep the ground cables free from corrosion at the battery terminal connections.

148. CHECKING GENERATOR WIRING CIRCUIT.

To check the generator wiring circuit electrically, connect an ammeter between the battery terminal of the regulator and the lead removed from this terminal. Run the engine at a medium speed and turn on the lights or accessories to obtain a generator output of 10 amperes. If there are no lights or accessories, connect two automobile headlight lamps. At this time, 10 ampere charging rate, a voltage reading should be taken with a 10 volt voltmeter between the following points: (a) generator frame to battery ground post - 0 volts; (b) the battery ground post to regulator base 0 volts; (c) the generator frame to the regulator base 0 volts; and (d) generator "A" terminal to the regulator "A" terminal - .1 volt maximum. If readings higher than these are obtained, the cause should be located and corrected. These causes usually are due to improper grounding caused by loose wiring connections or wires of improper capacity.

149. CHECKING THE STARTING CIRCUIT.

The starting circuit should be given a voltage loss test to make sure that there is no loss of starting motor efficiency due to high resistance connections. In making this test, the voltage loss from the battery terminal to the starting motor terminal should not exceed .12 volt maximum for each 100 amperes. The loss in voltage between the battery ground post and the starting motor frame should not exceed .12 volt maximum for each 100 amperes. If the voltage loss is greater than the above limits, the voltage should be measured over each part of the circuit to locate the resistance causing the voltage loss.

Figure 249. Checking Spark Plug.

150. SPARK PLUGS.

The spark plug has two electrodes so arranged that when the high tension electric current passes through the plug a spark is produced which ignites the compressed gas mixture. The center electrode is insulated and the outer electrode is grounded.

151. CHECKING AND ADJUSTING THE SPARK PLUGS.

The gap between the electrodes should always be set at .025". Use a wire feeler gauge as shown in Figure 249 to check the gap. Inspect the porcelain for cracking and chipping and if porcelain is damaged, discard the plug. Where possible, use a spark plug sand blaster to clean, or scrape off the carbon with a knife. The outside of the porcelain should be kept free from oil and dirt on which moisture can collect and "short" the plug. Spark plugs should be renewed every 512 hours of operation.

152. CHECKING MISFIRING SPARK PLUGS.

To find the plug, or plugs, not firing, ground a screw driver to the block (as shown in Figure 250) and tilt the screw driver to contact the metal terminal on the cable connecting the spark plug to the distributor. The plugs, or plug, not firing will have no effect on the running of the engine when shorted by the screw driver.

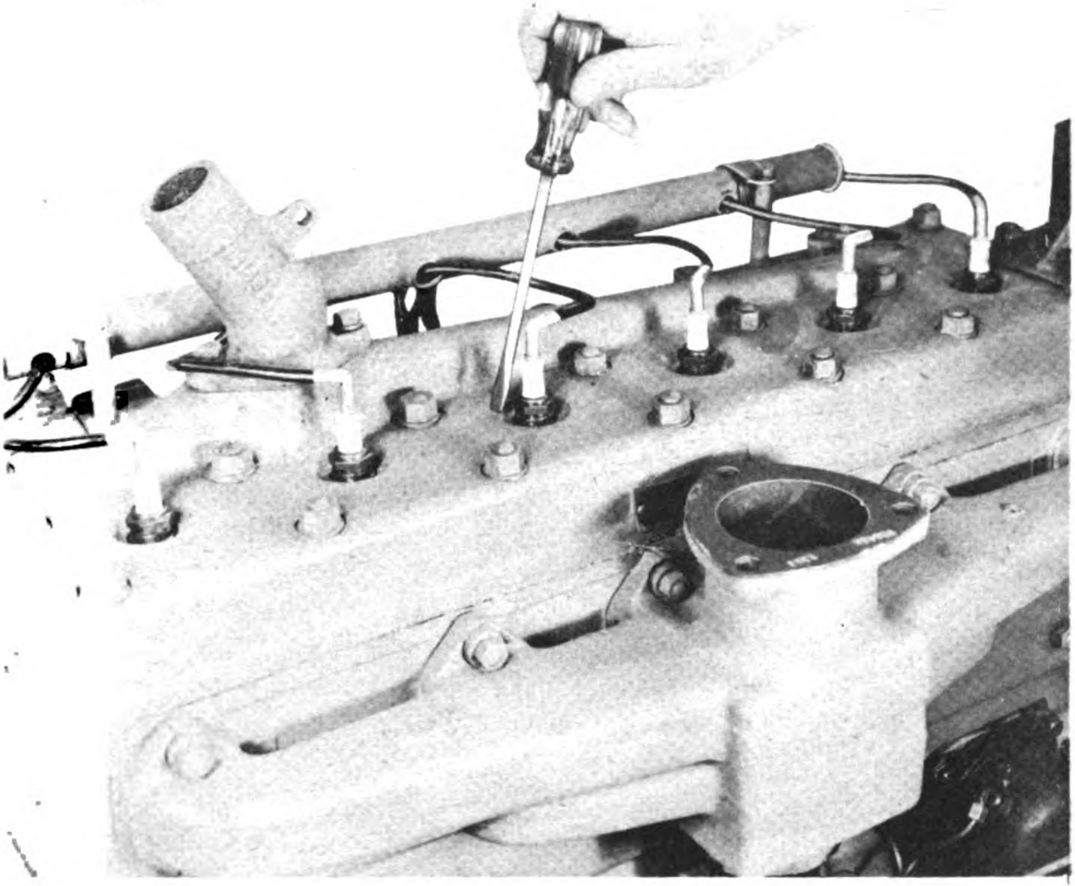


Figure 250. Checking Misfiring Spark Plug.

FUEL SYSTEM

The fuel system accessories are: air cleaner, carburetor, fuel pump, governor and the necessary fuel lines and fuel tank.

The gasoline is fed from the fuel tank to the carburetor by a fuel pump. A constant speed governor automatically controls the speed of the engine. The air cleaner purifies the air that is drawn into the carburetor.

Detailed instructions for servicing the accessories are given alphabetically in the following pages.

153. AIR CLEANER.

The air cleaner is of the oil bath type. As the air that is drawn in strikes the oil, a fine mist is produced. The mist removes part of the dust and dirt, the balance being removed by the filter element in the main body of the cleaner which the oil mist keeps moist. As the oil mist collects in the cleaning element, drops form and as they drain into the oil cup where the sediment is deposited, these drops of oil wash the filter element. Because abrasive dust is the chief cause of engine wear, it is important that the air cleaner be serviced every eight hours, as recommended in the Maintenance Chart. If the dust and dirt conditions are severe, the cleaner should be serviced every four hours.

Figure 251. Air Cleaner.

154. SERVICING AIR CLEANER.

Remove the oil cup at the lower end of the cleaner, empty the oil, and scrape out the dirt. See Figure 251. Any coating of dirt on the walls of the center tube should be removed by ramming a cloth through the tube with a stick so that the flow of air to the engine will not be restricted. Refill the oil cup to the oil level, the same grade of oil used in the crankcase. See Figure 251. Replace the oil cup securely.

NEVER REMOVE THE OIL CUP WHILE THE ENGINE IS RUNNING AND DO NOT RUN THE ENGINE UNLESS THE OIL CUP IS FILLED WITH OIL.

All connections between the air cleaner and engine MUST BE KEPT AIR TIGHT AT ALL TIMES. Also, the clamps on the hose connections should be kept tight.

155. DISASSEMBLY AND INSPECTION OF PARTS.

Loosen the two clamps and remove the top (pre-cleaner) and bottom (oil cup). Remove the spring wire baffle the inner and outer tube and clean with cleaning fluid. Clean the oil cup and soak the filter element in cleaning fluid. Blow clean with high pressure air.

The whole body can be immersed into the cleaning solution. All air hose connections should be replaced during the general overhaul periods.

To reassemble, reverse the procedure.

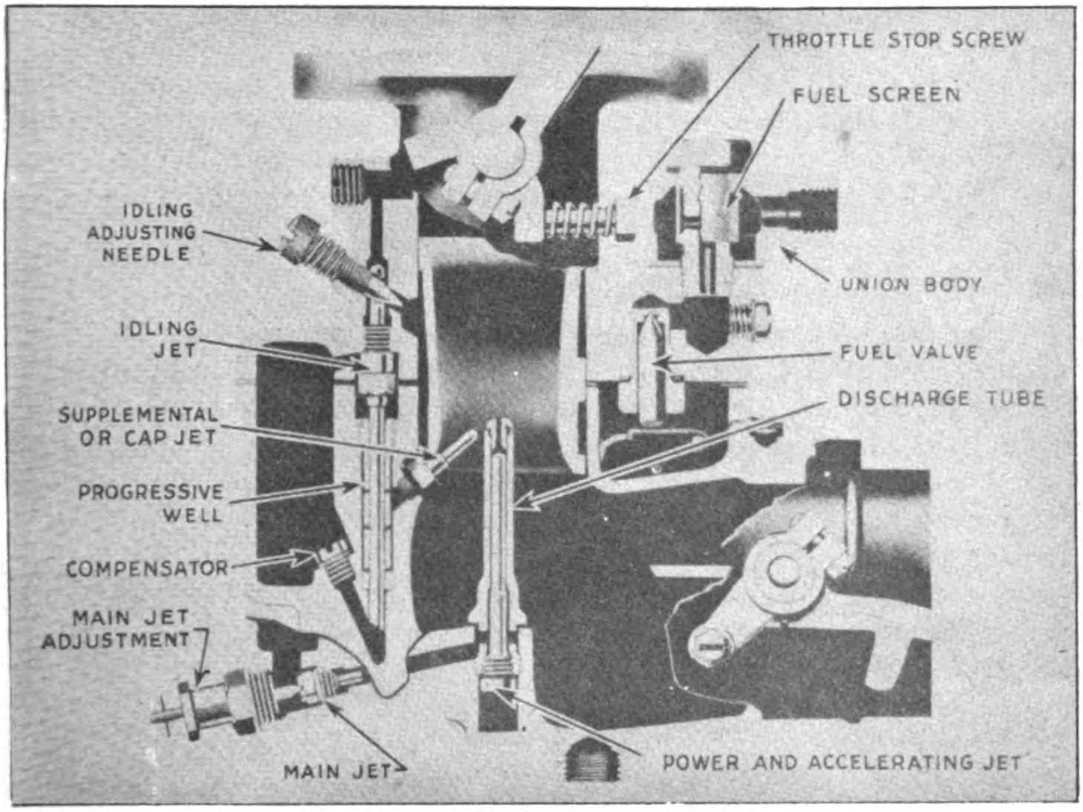


Figure 252. Sectional View of Carburetor.

156. CARBURETOR.

The Zenith 456 series is of the double venturi design. Figure 252. It is a balanced carburetor which maintains proper depression ratio between the air intake and the fuel bowl. It has two jets - the main jet, often referred to as "High Speed", directly connecting fuel in the bowl with the air stream in the carburetor barrel through the main jet discharge tube; and the compensating jet flowing into an open well and connected with the air stream through the supplemental jet.

The main jet flow varies with suction, delivering more fuel as the engine speed increases, thus its tendency is to richness at top engine speed. On the other hand, the compensating jet is not effected by suction, thus flows the same at all speeds, and has a tendency to leanness at top engine speed. In combination, the rich and lean jets give an average mixture of correct proportions.

The carburetor also has an idling jet and tube to supply the fuel, an idling needle valve to correct the idling mixture and a channel to carry the mixture into the carburetor barrel at the edge of the throttle. The idling system functions only on starting and idling and the desired speed is set by the stop screw on the throttle lever.

It also is equipped with a power jet (accelerating jet) which operates only when extra fuel is needed for developing maximum power. At part throttle operation the manifold vacuum is sufficient to overcome tension of the power jet piston spring and the psiton is held up in its cylinder. Under certain conditions such as sustained high speeds, lugging with wide open throttle, or when the throttle is opened suddenly, the manifold vacuum drops. This permits the vacuum piston to descent in its cylinder and causes the power jet valve to open and permit fuel to flow through the power jet. This fuel, added to the main jet supply, furnishes proper mixture for full power development.

157. ADJUSTING IDLING SYSTEM.

Before making an adjustment, warm the engine so that the intake manifold is at least warm to the hand (120° F. or higher). To make the mixture richer, turn the needle IN - to make the mixture leaner, turn OUT. See Figure 252. Keep turning in or out until the engine runs steady and as fast as this throttle position will permit. When satisfied that the engine runs smooth and steady set the throttle stop screw.

158. ADJUSTING THE MAIN JET

The main jet, see Figure 252, determines the maximum amount of fuel which may be obtained for high speed operation. The main jet adjustment reduces this amount as it is turned towards its set. Ordinarily the main jet adjustment has no effect after it is two turns open. To set this adjustment, open the throttle to approximately one-quarter open with the engine running. Turn the adjustment clockwise shutting off fuel until the engine speed decreases due to too lean a mixture. Now open the adjustment until the engine speed decreases due to too much fuel. The adjustment should be set to a position halfway between two extremes.

159. TOOLS RECOMMENDED FOR OVERHAULING CARBURETOR.

The tools recommended for overhauling can be obtained from the Zenith Carburetor Division, Detroit, Michigan. They are as follows:

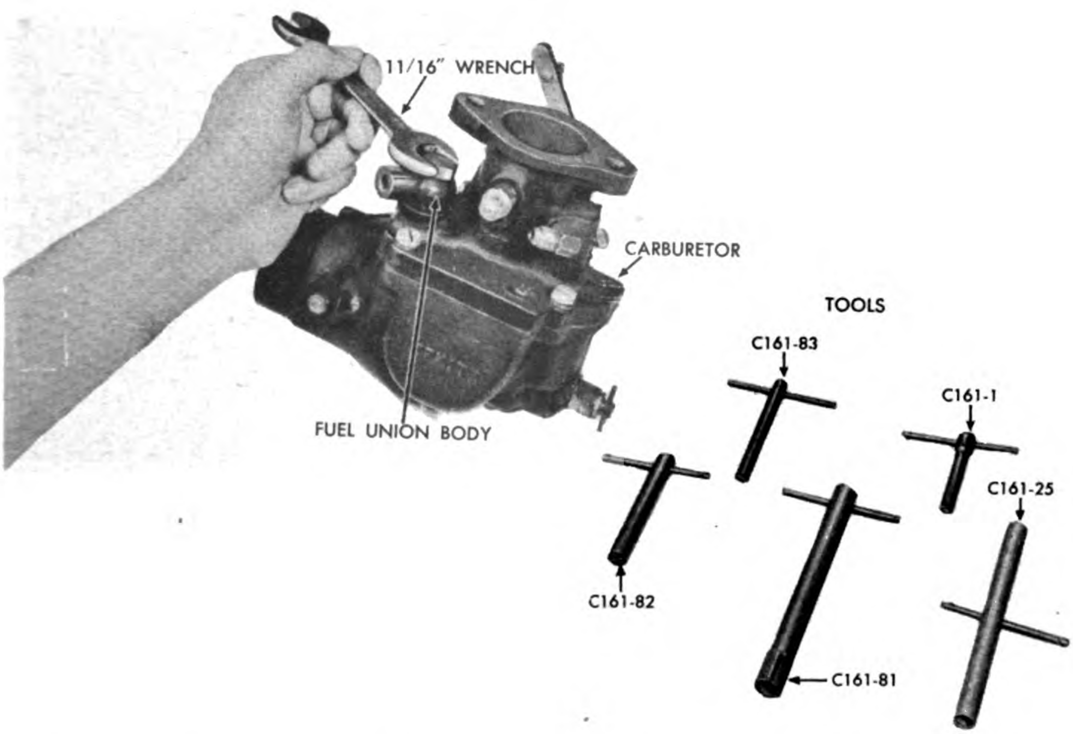


Figure 253. Removing Fuel Body and Showing Tool Kit.

C-161-1 Progressive Well wrench.
C-161-25, discharge tube, cap jet and idling jet wrench.
C-161-81, Power jet valve wrench.
C-161-82, 7/16" screw driver for check valve assembly.
C-161-83, 5/16" screw driver for main jet wrench.
Also an ordinary 1/2" socket wrench, see Figure 253 for illustration of tools.

160. OVERHAULING THE CARBURETOR.

Check numbers on metal identification disc riveted to top of float bowl cover against specifications shown in maintenance manual. The inside number next to the rivet is the Zenith Assembly Number and the one next to outer edge of the disc is the manufacturer's.

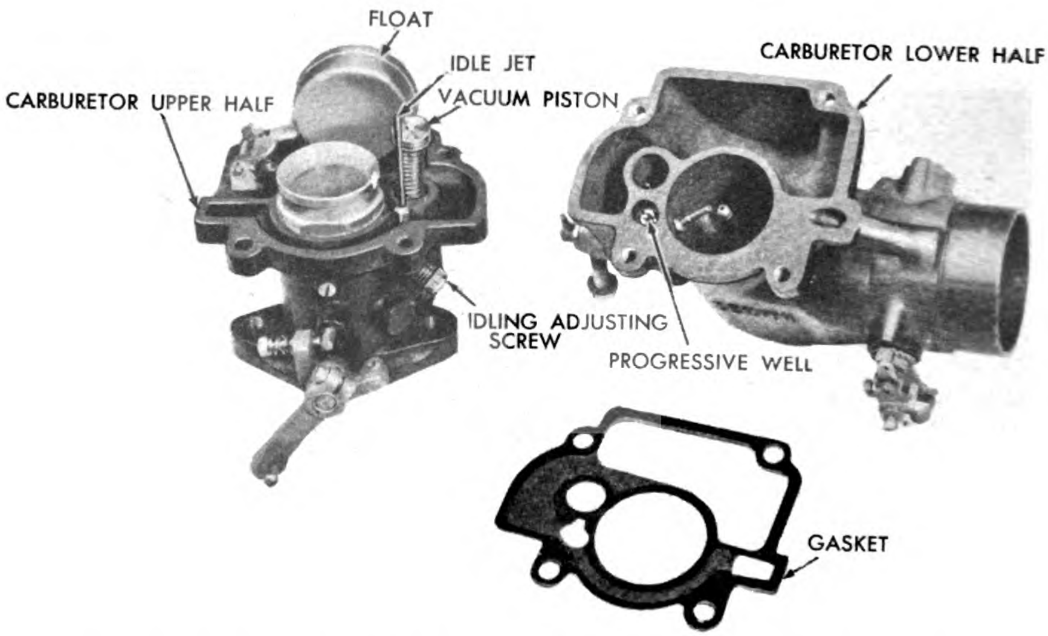


Figure 254. Upper and Lower Carburetor Bodies.

A. Remove the large (hex) fuel filter plug, two fibre washers, filter screen and filter body from top of float bowl using an 11/16" wrench. Figure 253.

B. Remove the two assembly screws (hex) and lock-washers which attach the throttle body to the fuel bowl body. Figure 253.

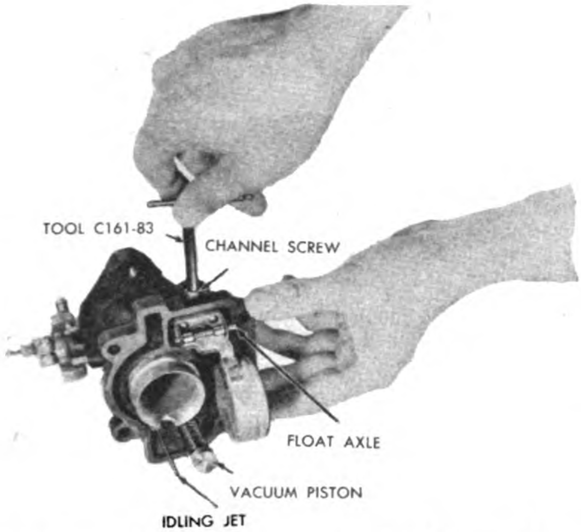


Figure 255. Removing Channel Screw and Vacuum Piston.

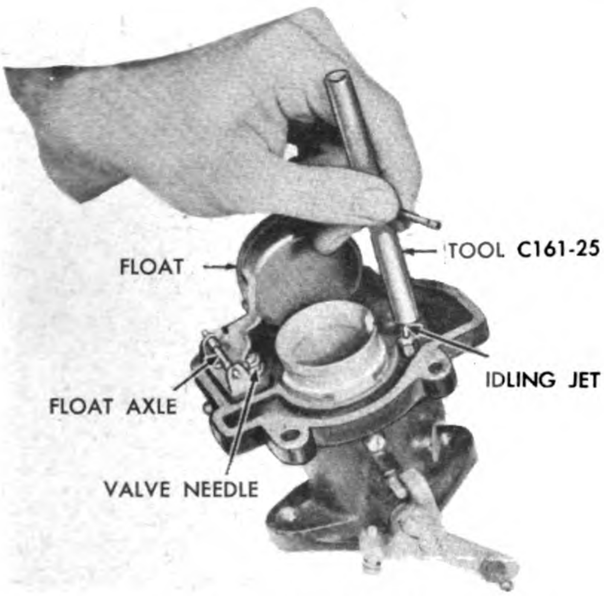


Figure 256. Removing or Installing Idling Jet.

C. Separate the throttle body from the fuel bowl being careful to avoid damaging the float and idling jet which are assembled in the throttle body. Figure 254.

D. Remove the throttle body to fuel bowl assembly gasket from the machined surface of the throttle body. Figure 254.

E. Remove priming hole channel screw and the vacuum piston assembly. Figure 255.

NOTE: To loosen, press pump piston down against spring and pull back sharply several times striking vacuum piston against pump assembly retainer in air intake body.

F. Remove the idling jet from the throttle body near the vacuum cylinder. Figure 254.

G. Remove float axle as follows:

1. Press screwdriver against float axle at slotted side of float hinge bracket and force through hinge bracket.

2. Using fingers remove float axle completely from opposite side and remove float. Figure 255.

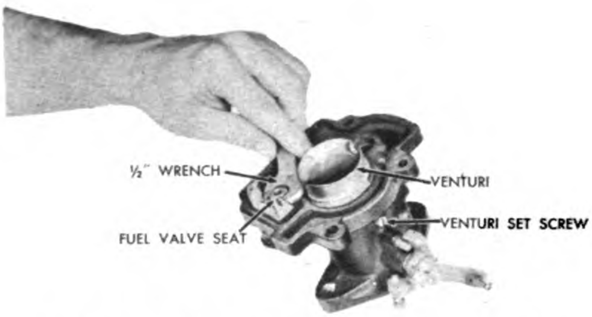


Figure 257. Removing or installing Fuel Valve Seat.

H. Remove the fuel valve needle from the fuel valve seat under float lever, using the fingers. Figure 256.

I. Remove fuel valve seat and fibre washer using a 1/2" socket wrench. Figure 257.

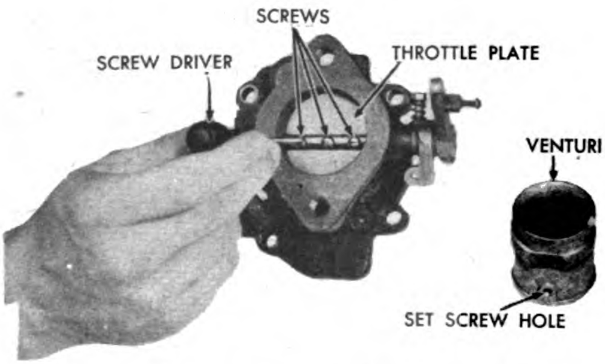


Figure 258. Removing or Installing Throttle Plate Screws.

J. Remove idling adjusting needle valve and friction spring from side of air intake body.

K. Remove the throttle plate screws and pull out the throttle plate. Figure 258.

L. Remove throttle clamp lever, stop lever, throttle lever bushing and packing retainer as follows:

1. Back out the throttle stop screw until the threaded end is flush with lever.

2. Place match marks on the throttle lever, stop lever and throttle body with center punch or file to indicate when closed and also the side of body on which the throttle lever is located.

3. Loosen the clamp lever set screw and remove lever from shaft.

4. Remove the two taper pins in the throttle stop lever and bushing on opposite end of shaft using a small punch and hammer. Figure 259.

5. Remove throttle shaft and stop lever by driving shaft through the bushing using a punch close to the same size as the shaft.

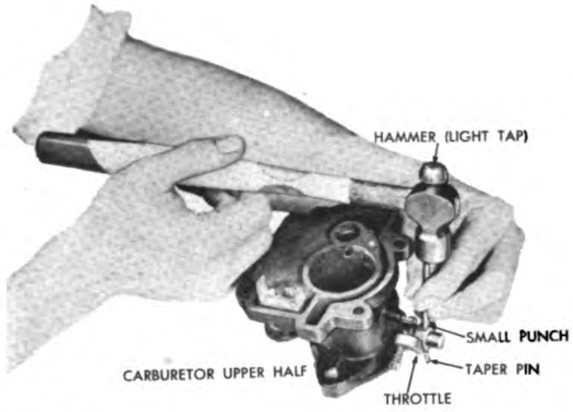


Figure 259. Removing Throttle Stop Tapered Pin.

6. Remove the stop lever from shaft by supporting the lever and driving shaft through the lever.

M. Remove the venturi from the throttle body bore as follows:

1. Remove the venturi set screw and lockwasher from the side of the throttle body using a screwdriver.

2. Pull out the venturi.

N. Remove the passage plug (hex) from the outside of the throttle body next to vacuum cylinder.

O. Remove the throttle shaft bushings from the throttle shaft openings in the throttle body as follows:

CAUTION: Do not attempt to remove the throttle shaft bushings unless new bushings are available for replacement. New bushings are under shaft size and require reaming with a 3/8" line reamer to fit shaft. Both bushings and reamer must be available to successfully complete this operation.

1. Screw a fine thread taper tap 1/16" larger than shaft into bushing until it is firmly seated.

2. Insert long punch or rod in opposite shaft hole and drive punch against tap until bushing is free of body.

3. Repeat above operation to remove second bushing from opposite shaft hole.

P. Remove the main jet adjustment and fibre washer from the outside of fuel bowl near bottom, using an end wrench. Figure 262.

Q. Remove the main jet and fibre washer from threaded passage underneath main jet adjustment.

NOTE: Use service tool C161-1 on this Model 456 Zenith Carburetor.

R. Remove the discharge tube and fibre washer from the center of the round openings on the machined surface of the fuel bowl.

S. Remove the accelerating and power jet and fibre washer from the bottom of the main discharge tube, using a screwdriver. Figure 260-261.

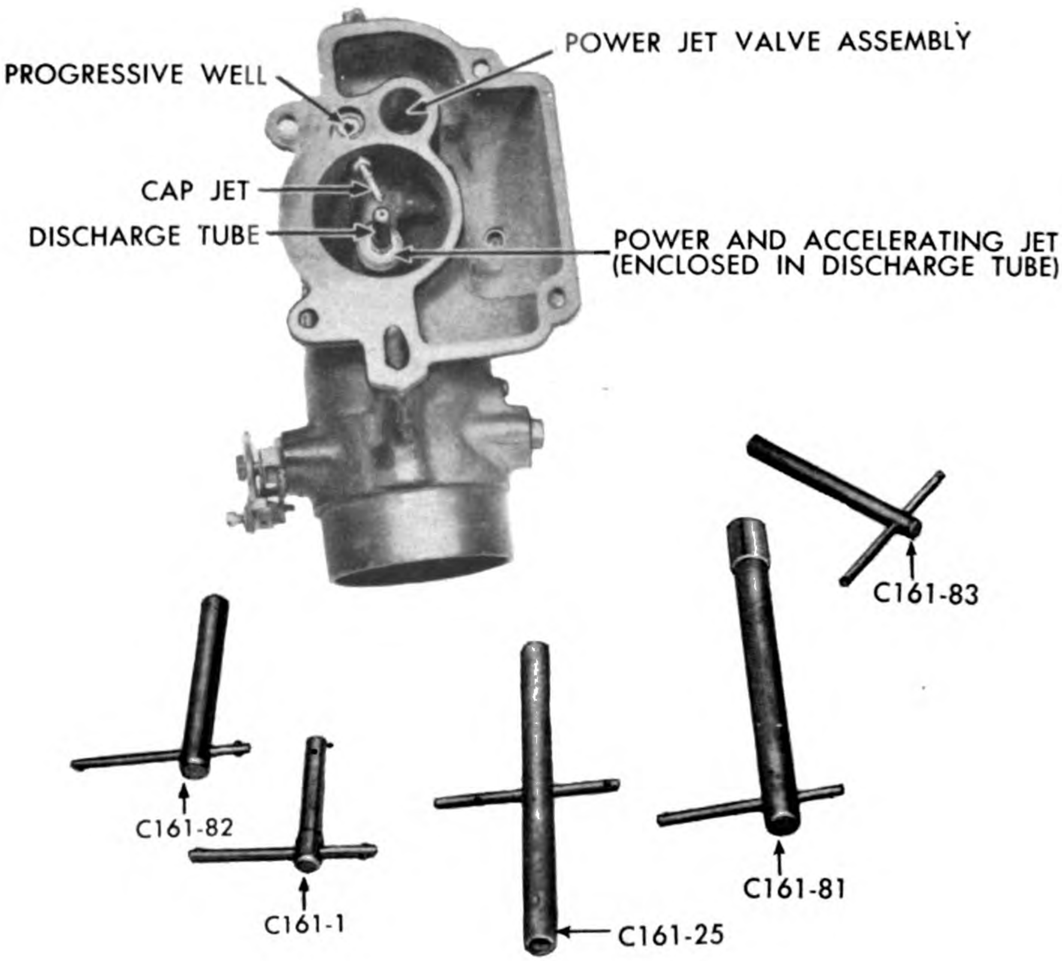


Figure 260. Lower Carburetor Body Assembly & Tools.

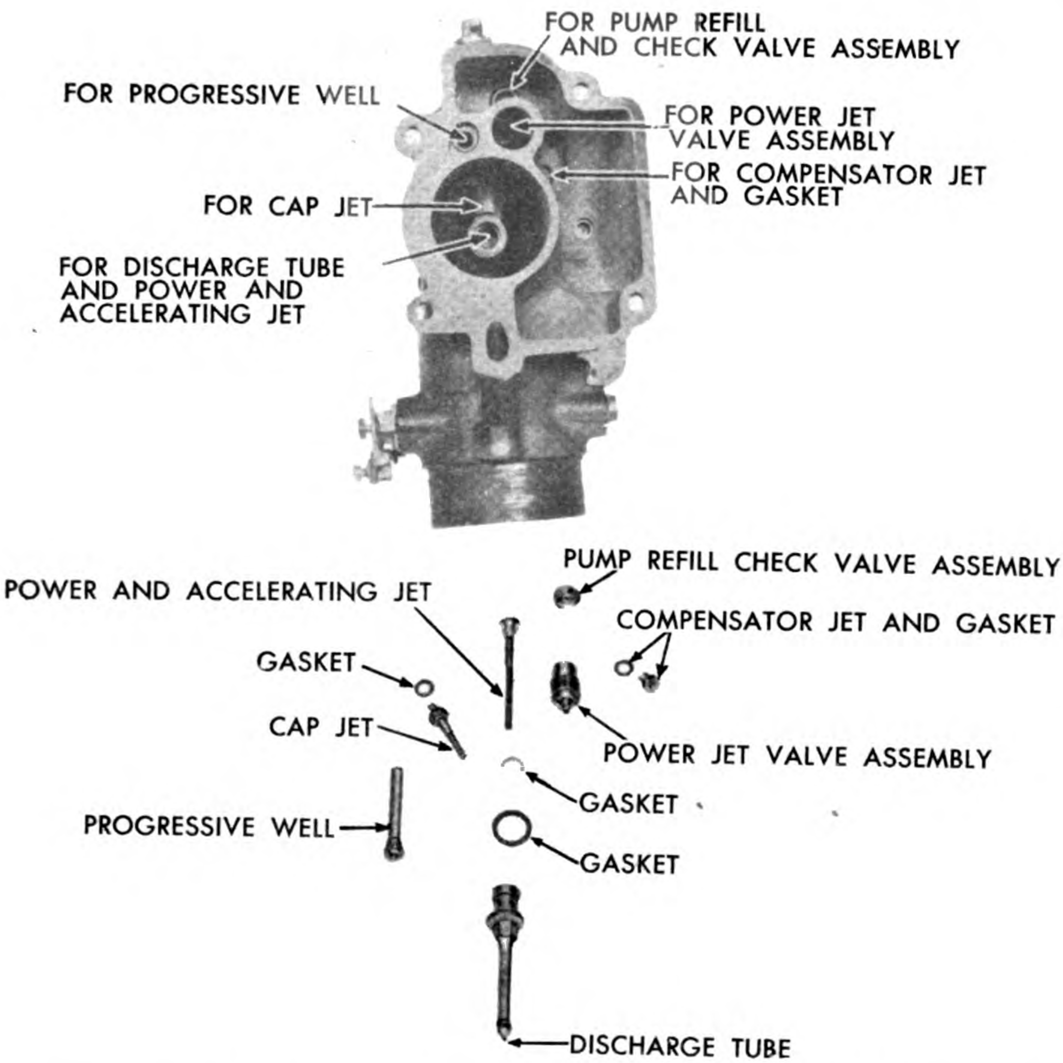


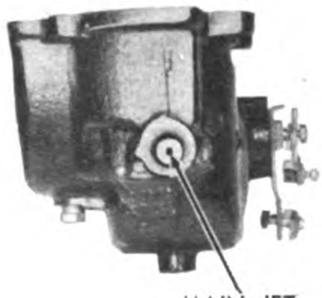
Figure 261. Lower Carburetor Body with Parts Removed.

T. Remove the cap jet and fibre washer from the side of the round opening on the machined surface of the fuel bowl. Figure 260.

U. Remove the progressive well from the counter-bored passage in the machined surface of the fuel bowl next to pump cylinder. Figure 260-261.

V. Remove the compensating jet and fibre washer from the inside of fuel bowl near bottom of pump cylinder, using a screwdriver.

W. Remove the pump check valve from the bottom of the fuel bowl next to pump cylinder, using a 7/16" screw-driver. Figures 260-261.



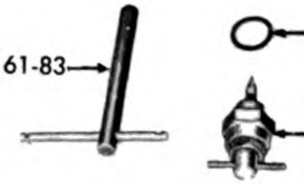


Figure 262. Carburetor with Main Jet Removed.

X. Remove the power jet valve from the bottom of the pump cylinder using a C-161-81 tool.

Y. Remove the air shutter (choke) plate screws and lockwashers and pull out the air shutter plate from air entrance. Figure 263.

Z. Remove the air shutter (choke) lever retainer nut and lock-washer and remove lever and thrust washer from end of air shutter shaft. Figure 263.

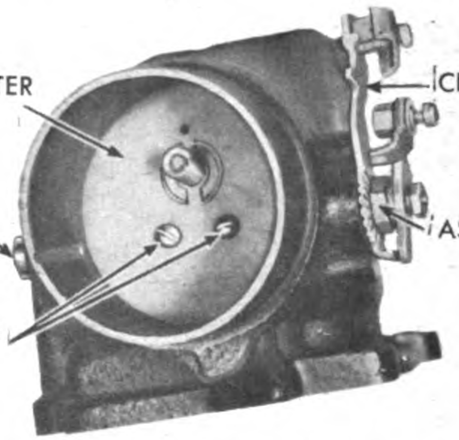


Figure 263. Carburetor Air Shutter Shaft & Lower Assy.

AA. Remove the air shutter shaft from side of air entrance opposite choke bracket.

BB. Remove the air shutter (choke) bracket retainer screw from side of air entrance and remove bracket, using a 1/2" socket wrench.

CAUTION: Place match marks on bracket and side of air entrance with center punch or file to indicate position bracket should be in to avoid confusion during re-assembly.

161. CLEAN PARTS, GROUP PARTS BY CIRCUITS.

Clean all metal parts thoroughly with cleaning solution and rinse in solvent and blow out all passages in the air intake assembly, fuel bowl assembly and throttle body.

NOTE: Be sure all carbon deposits have been removed from throttle bore and idle port. It is advisable to reverse flow of compressed air in all passages to insure all dirt has been removed.

CAUTION: Never use a wire or drill to clean out jets or any passages other than those recommended in this procedure.

162. CHECK PARTS OF CARBURETOR AS FOLLOWS.

NOTE: All gaskets and parts in the standard repair parts kits should be installed when a carburetor has been disassembled for an overhaul. These parts are subject to wear which is difficult to detect by visual inspection or there are other sound technical reasons for not taking a chance of spoiling an otherwise good job by reassembling an old part of questionable condition. Part No. C-182-347 covers standard repair parts kit and part number C-181-168 covers standard gasket kit. Open the kits and replace old with the new parts in each kit. (See parts list below)

QUANTITY	REPAIR PART NO.	PART - KIT C-182-347
2	C-136-3	Screw - Throttle Plate
2	T-8-S-31-16	Screw - Body to Bowl
2	T-43-103	Washer - Body to Bowl Screw
1	CT-63-9	Pin - Thrust Washer Taper
2	T-15-B-6-4	Screw - Air Shutter
2	T-43-6	Washer - Air Shutter Screw
1	T-22-S-8	Nut - Air Shutter Shaft
1	T-45-8	Washer - Air Shutter Shaft
1	T-1-S-10-6	Screw - Venturi
1	T-41-10	Washer - Venturi
1	C-150-1	Screen - Filter
1	C-120-6	Axle - Float

QUANTITY	REPAIR PART NO.	PART - KIT C-182-347
1	C-41-9	Valve - Pump Check
1	C-54-1-114	Jet - Idling
1	C-57-1-34	Jet - Cap
1	C-36-18	Pump, Vacuum
1	C-81-3-55	Valve and Seat, Fuel (Pack 1-T56-23)
		REPAIR PART GASKET KIT C-181-168
1	C-142-38	Gasket - Body to Bowl
1	T-56-5	Washer - Channel Screw Fibre
1	T-56-36	Washer - Union Body Fibre
1	T-56-15	Washer - Filter Plug Fibre
1	T-56-2	Washer - Discharge Tube Fibre
1	T-56-23	Washer - Main Jet Adjustment
1	T-56-24	Washer - Main Jet Fibre
1	T-56-24	Washer - Compensation Jet Fibre
1	T-56-48	Washer - Power
1	T-56-24	Washer - Cap Jet Fibre
1	T-56-23	Washer - Fuel Valve Seat Fibre
1	C-141-4-2	Gasket - Flange

163. FLOAT ASSEMBLY.

A. Inspect top side of float level for wear where it contacts fuel valve needle. Replace the float if it is loaded with gasoline, damaged, or if the float axle bearing is worn excessively.

B. If the slightest wear is detected, replace the following - float axle - throttle shaft.

C. Because wear cannot be detected visually, also replace the following: vacuum accelerating pump and piston assembly, power jet valve, pump check valve, fuel valve seat and needle assembly.

D. Inspect point of idling adjusting needle. This must be smooth and free of ridges.

E. Throttle plate should be inspected for burrs or damaged edges. CAUTION: Never clean with a buffing wheel or a sharp instrument.

F. Inspect air shutter choke for bends, burrs or damaged edges. See that poppet valve is in good condition.

G. See that air shutter shaft (choke) is straight.

H. Inspect throttle shaft bushings. Replace if new shaft has more than .005" side play. Any excess will allow dust or grit to pass into the engine.

I. Examine pump cylinder at lower end for evidence of excessive wear, deep scratches or ridges. Desirable clearance between pump piston and pump cylinder at lower operating end is .001", maximum clearance, .003". Any clearance in excess will reduce accelerating pump discharge and result in poor acceleration. REPLACE WITH NEW CARBURETOR IF ABOVE CONDITION IS FOUND.

J. Examine vacuum piston cylinder in throttle body assembly for evidence of excessive wear, deep scratches, ridges, or any mutilation of cylinder head. Desirable clearance between vacuum piston and cylinder or upper operating end is .001", maximum .003". If any excess is found REPLACE THE CARBURETOR.

164. REASSEMBLING THE CARBURETOR.

A. Fit power jet valve on formed end of service tool C-161-121 and install valve in bottom of pump cylinder. Figure 260-261.

B. Install pump check valve in large threaded passage in bottom of fuel bowl near pump cylinder using a 7/16" screwdriver. Figure 260-261.

C. Install compensating jet and fibre washer in small threaded passage inside of the fuel bowl near bottom using C-161-25 tool.

D. Install progressive well in counter bored threaded passage in machined surface of fuel bowl next to pump cylinder, using service tool C-161-1 or screwdriver. Figure 260-261.

E. Install main jet and fibre washer in threaded passage in bottom side of fuel bowl, using service tool C-161-82. Figure 261.

F. Install main jet adjustment and fibre washer in threaded passage over main jet, using a 5/8" wrench. Figure 262.

NOTE: Back out adjusting needle before installing adjustment assembly to avoid forcing needle into main jet.

G. Screw main jet adjusting needle in (clockwise) with the fingers until it seats, then back out two full turns. Hold needle in this position and tighten packing nut enough to hold needle from turning freely.

H. Install cap jet and fibre washer in threaded angle passage on side of air opening in machined surface of fuel bowl, using service tool C-161-25.

CAUTION: The cap jet can easily be twisted and broken. Seat firmly with moderate pressure of the fingers on the wrench.

I. Install accelerating and power jets and fibre washer in bottom of main discharge tube, using a screwdriver. Figure 260-261.

J. Install main discharge tube assembly and fibre washer in threaded passage in bottom of air entrance, using service tool C-161-25 and tighten firmly.

K. Install air shutter shaft, plate, screws, lockwashers, bracket and lever as follows: Figure 259.

1. Refer to match marks placed on air intake and bracket during disassembly step Paragraph 160-BB and inset air shutter shaft in air intake to allow levers to be assembled on correct side.

2. Hold fuel bowl with machined surface up and face air entrance.

3. Rotate shaft to face float section down.

4. Insert air shutter plate in slot in air entrance poppet valve first and with spring of poppet valve facing down.

5. Rotate shaft and plate (clockwise) and close.

6. Align holes in air shutter plate with threaded screw holes in shaft and start the screws and lockwashers into shaft loosely.

7. Tap air shutter plate lightly to center it and tighten screws firmly.

L. Install air shutter bracket and retainer screw. Refer to match marks on bracket and air intake, place bracket in correct position and tighten retainer screw securely using a 1/2" socket wrench.

M. Install thrust washer on air shutter shaft over retainer screw.

N. Install air shutter lever on shaft as follows:

1. Hold choke in wide open position.

2. Place air shutter lever on shaft with swivel in lever facing air intake and with lug on lever contacting lug bracket at bottom end.

3. Install air shutter shaft nut and lockwasher and tighten securely.

O. Install new throttle shaft bushings (if removed) as follows:

1. Place new bushing on bushing driver tool C-161-72-4 with taper end of bushing away from shoulder of tool.

2. Start the bushing into shaft hole and drive it in until it bottoms, using a light hammer.

3. Repeat this operation to install second bushing in opposite shaft hole.

P. Line ream the two throttle shaft bushings, using special reamer tool C-161-71-4.

Q. Install throttle shaft, throttle plate and screws as follows: Figure 259.

1. Place throttle body on bench with two hole mounting flange up and facing the idling port plug on the inside of the throttle body bore.

2. Insert shaft in the throttle body in the correct position to allow levers to be assembled in the same position as removed.

NOTE: Refer to match marks placed on throttle levers and throttle body during disassembly step Paragraph 160-L2.

3. Rotate shaft to face threaded side of throttle shaft screw holes with slot in shaft in a vertical position.

4. Insert the throttle plate, center it and then rotate shaft (anti-clockwise) to close it.

NOTE: The screw holes in the throttle plate are off center. Start the side of the throttle plate with the shortest distance between the screw holes and beveled edge into the shaft first.

The throttle plates are made with two opposite edges beveled to fit the throttle body bore when the plate is closed. The throttle plate will not close tightly if installed upside down.

To properly center the plate in the throttle body bore, the screws should be started in the shaft and then with the plate closed, it should be tapped on the mounting flange side. Pressure on the plate must be maintained with the finger until the screws are tightened.

When properly installed, the side of the throttle plate farthest away from the mounting flange will be aligned with the idle port when the plate is closed.

5. Start the throttle plate screws into shaft loosely, tap the plate lightly to center it and tighten screws securely.

R. Install throttle stop lever and throttle shaft packing washer (felt) on throttle shaft as follows:

NOTE: The following steps are based on a new shaft being installed. If the original shaft is reused, no drilling of the shaft will be necessary.

1. Hole the throttle in exact vertical wide open position.

2. Place throttle shaft packing washer in recessed counter bore in stop lever and press lever on shaft with end opposite idling stop screw contacting stop pin on side of throttle body.

CAUTION: The stop lever must be positioned on the shaft to stop throttle in exact wide open position. Make sure idling stop screw contacts the stop pin squarely and lever fits close to side of throttle body allowing about .002" end play of shaft. Refer to match marks and install lever on same side as removed.

3. Hold stop lever in above position and drill shaft for taper pin. Figure 259.

4. Install taper pin securely.

S. Install throttle shaft lever bushing, throttle shaft packing (felt) and throttle shaft packing ring on end of throttle shaft opposite stop lever as follows:

1. Place packing washer on shaft followed by packing ring and throttle shaft lever bushing allowing about .002" end play in shaft.

2. Drill throttle lever bushing and shaft for taper pin and install taper pin securely.

T. Install idling adjusting needle and friction spring in threaded angle passage in side of throttle body. Seat lightly with fingers and back out 1-1/2 full turns. Figure 254.

U. Install venturi in throttle body bore, large opening first; rotate it to align threaded screw hole in venturi with screw hole in throttle body and install venturi set screw and lockwasher. Tighten set screw firmly with screwdriver. Figure 257.

V. Install fuel valve seat and fibre washer and tighten securely using a 1/2" socket wrench. Figure 257.

W. Install fuel valve needle in seat, followed by float and float axle.

NOTE: Insert tapered end of float axle into float bracket on side opposite slot and push through the other side. Press float axle into slotted side until the axle is centered in bracket. Figure 255-256.

X. Set float level to specifications using a standard 6" depth gauge.

CAUTION: Do not bend, twist or apply pressure on the float body.

NOTE: With throttle body in inverted position viewed from float side, float should be centered at right angles to machined surface of throttle body. The float setting is measured from the machined surface of the throttle body to top side of float at highest point. Depth gauge should read 2-1/8". Figure 264.

To increase or decrease distance between float and the machined surface of throttle body, use long nosed pliers and bend float lever close to the float body.

Y. Install idling jet in threaded passage in machined surface of throttle body next to vacuum cylinder, using service tool C-161-25. Figure 256.

Z. Install channel screw and vacuum piston assembly in vacuum cylinder in throttle body. Figure 255. Check for free travel of the vacuum piston.

AA. Install throttle body to fuel bowl assembly gasket on machined surface of throttle body. Figure 254.

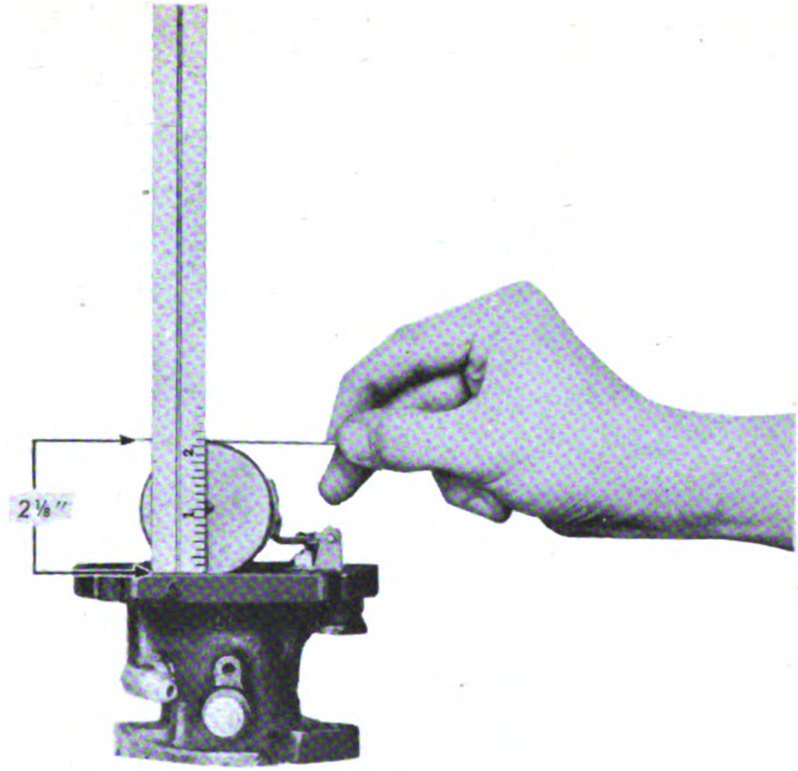


Figure 264. Measuring Correct Float Setting.

BB. Assemble completed throttle body to the fuel bowl assembly; install and tighten assembly screws evenly and firmly.

CC. Install throttle clamp lever on throttle stop lever in the same position as when removed.

NOTE: Refer to match marks placed on lever and throttle body during disassembly.

DD. Install floating lever on throttle shaft in same position as when removed. Figure 259.

EE. Install fuel filter body, filter plug, screen, and two fibre washers to throttle body and tighten firmly.

FF. Hold throttle lever in a closed position and turn throttle adjusting stop screw in (clockwise) until it just contacts stop on body, then turn screw in 1-1/2 additional turns.

FUEL PUMP

The AC mechanical fuel pump is installed on the engine next to the carburetor. See Figure 265. The suction side is connected to the fuel tank and the discharge side is connected to the carburetor by tubing designed to carry the fuel. The purpose of the pump is to suck the fuel from the supply tank and push it into the carburetor float bowl as it is required by the engine.

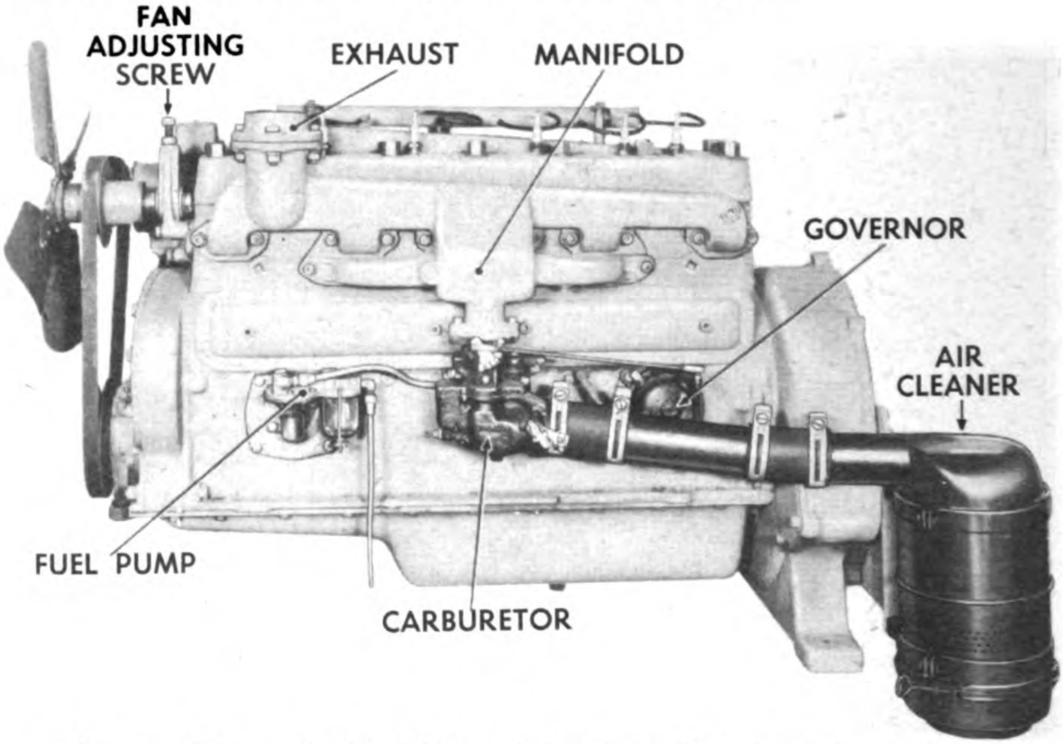


Figure 265. Left Side of Engine Showing Fuel Pump.

Operation is accomplished through a rocker arm on the pump contacting an eccentric on the engine camshaft. Downward movement of the pump diaphragm, or the suction stroke, is caused by the rotation of the eccentric actuating the pump rocker arm, pulling the diaphragm downward against the pressure of the diaphragm spring, producing a vacuum in the fuel chamber.

This vacuum holds the outlet valve closed and pulls the inlet valve open, making fuel flow from the supply tank through the inlet and filter screen and down through the inlet valve into the fuel chamber. On the return stroke of the rocker arm, the diaphragm is forced up by the diaphragm spring, the inlet closes and the outlet valve is forced open, allowing the fuel to flow through the outlet to the carburetor.

The link is hinged to the rocker arm so that it can be moved down, but cannot be raised, by the rocker arm. The only function of the rocker arm spring is to make the rocker arm follow the cam. The link and diaphragm are moved upward only by the diaphragm spring. The pump, therefore, delivers fuel to the carburetor only when the fuel pressure in the outlet line is less than the pressure maintained by the diaphragm spring. This condition arises when the float needle valve is not seated and the fuel passage from the pump into the carburetor float chamber is open. When the needle valve in the carburetor float chamber is closed, and held in place by the pressure of the fuel on the float, the pump builds up pressure until it overcomes the diaphragm spring. This pressure results in almost a complete stoppage of diaphragm movement until more fuel is needed.

165. FUEL PUMP TROUBLE SHOOTING.

Fuel pump repairs are divided into two classifications:

a. Repairs made without disturbing pump installation on engine.

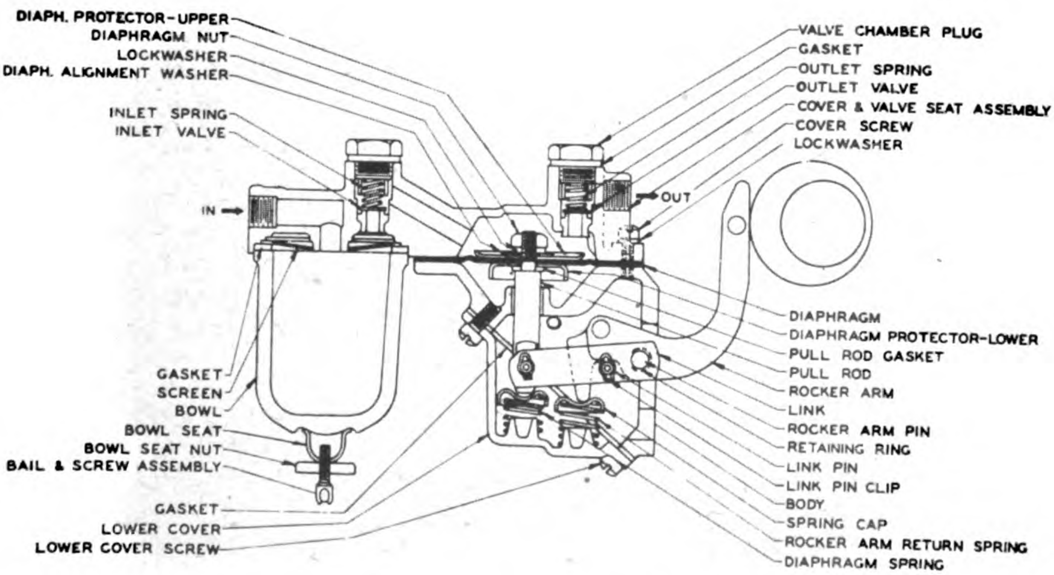


Figure 266. Cross Section Diagram of Fuel Pump.

b. Repairs which necessitate removal of pump from engine and disassembly. Figure 266 shows cross section diagram of fuel pump.

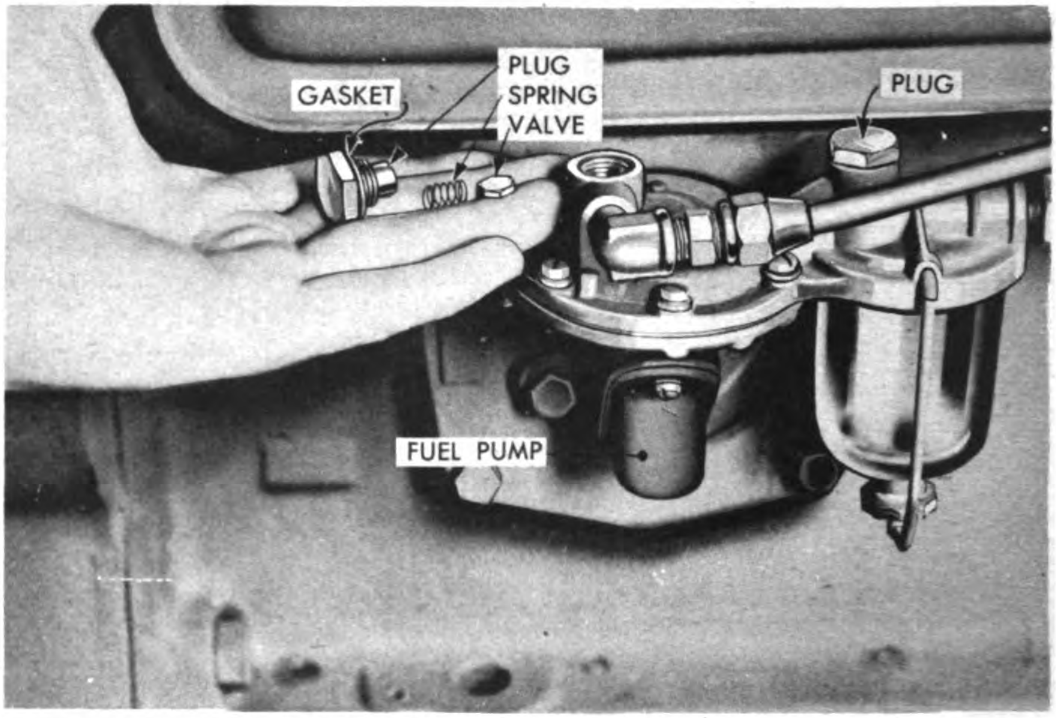


Figure 267. Fuel Pump with One Valve Exploded.

Leaks at Edge of Diaphragm

Cause	Remedy
Loose Cover Screws	Tighten cover screws alternately and securely. Also check inlet and outlet pipe connections.

Lack of Fuel at Carburetor

Cause	Remedy
Gasoline Tank Empty	Refill
Leaky tubing or connections	Replace tubing and tighten all pipe connections at the fuel pump and gas tank.
Loose valve plug	Tighten valve plugs securely, replacing valve plug gasket if necessary. Figure 267.
Bent or kinked tubing	Replace tubing.
Dirty screen	Clean the screen. Make certain that cork gasket is properly seated when reassembling.

Dirty or warped valves	Remove valve plugs and valves. If they are damaged or warped, replace them. Figure 267. Examine seats to make certain there are no irregularities which prevent proper seating of valves. Place valves in valve chambers. Reassemble valve plugs and springs, making certain that springs are around the lower stems of the valve plugs properly. Use new gaskets if necessary.

Repairs that Require Removal of Pump from Engine and Disassembly:

FUEL PUMP TROUBLE CHART

Trouble	Evidenced by:	Remedy
Broken Rocker Arm	Visible	Replace
Broken Rocker Arm Spring	Visible	Replace
Defective or worn links	Pump does not supply sufficient fuel	Replace links. Also check for air leaks.
Broken diaphragm return spring	No fuel at carburetor	Replace spring.
Punctured or worn out diaphragm.	Fuel leaking through vent hole	Replace complete diaphragm. Do not attempt to replace just one or two layers.
Leakage around pull rod	Fuel leaking through vent hole in body	Replace pull rod gasket, tightening pull rod nut securely.

166. OVERHAULING THE FUEL PUMP.

IMPORTANT: MARK THE TOP COVER AND BODY BEFORE DISASSEMBLING SO THAT IN REASSEMBLING THEY ARE PLACED BACK IN THE SAME RELATIVE POSITION. Figure 268.

FUEL PUMP

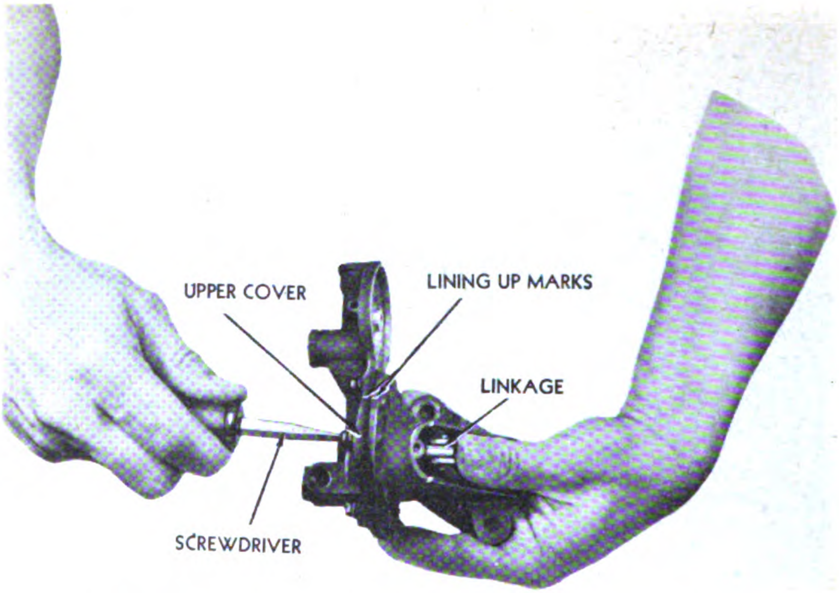


Figure 268. Aligning Diaphragm.

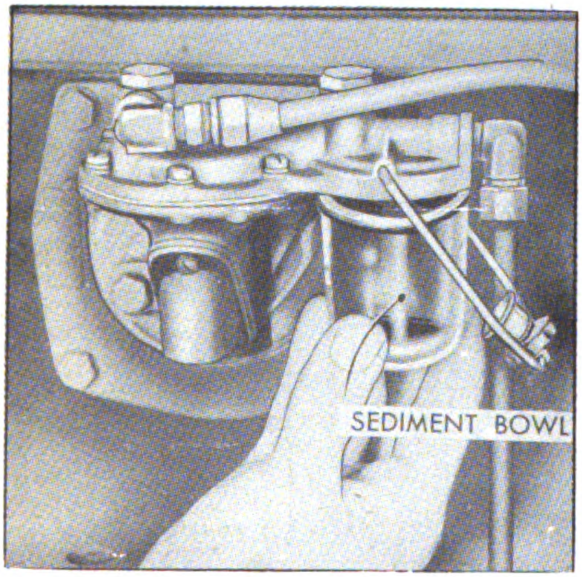


Figure 269. Removing Fuel Pump Sediment Bowl.

A. Wash the outside of the pump with cleaning solvent and blow off with compressed air to remove loose grit and grease.

B. Loosen bail-nut screw and remove bowl, bowl gasket, and bowl seat. Figure 269.

C. Remove strainer screen from top cover.

D. Remove valve plug and gasket from top cover over strainer.

E. Remove the inlet and outlet valve springs and their valves.

F. Remove top cover screws and lockwashers.

G. Separate top cover from pump body by jarring loose with screwdriver handle. CAUTION: DO NOT ATTEMPT TO PRY OFF.

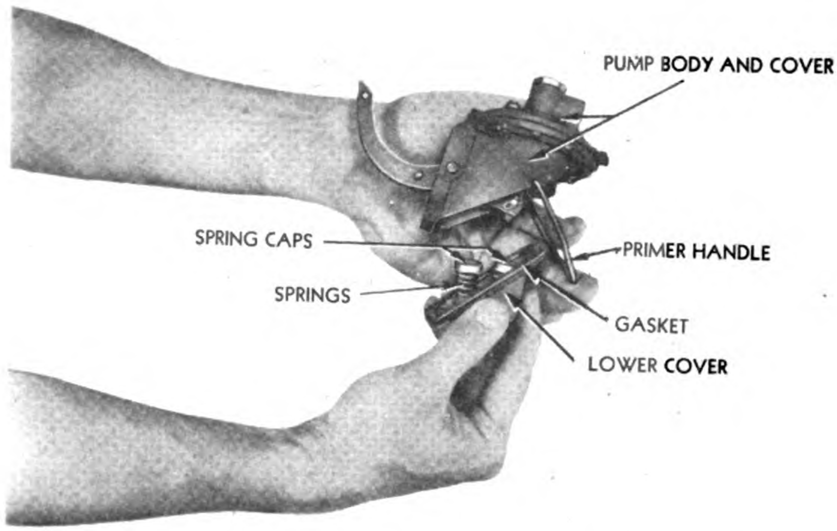


Figure 270. Bottom Cover Assembly.

H. Remove the three body bottom screws and remove the bottom cover, cover gasket, rocker arm spring and cap and diaphragm pull rod spring and cap. See Figure 270.

I. Remove pull rod nut and remove the lockwasher, hexagon washer, upper protector, diaphragm, lower protector and pull rod washer.

J. Clamp mounting flange of pump body in vise with riveted end of rocker arm pin upward and with flange gasket surface against one jaw in vise. Then file small end of rocker arm pin until it is flush with face of washer.

K. Drive out the rocker arm pin from the pump body, driving on the filed end using a pin punch and remove the rocker arm washer, rocker arm and the links, pins and pull rod assembly. Also remove the hair pin clips from link pins and disassemble links and pull rod.

L. Clean all metal ports, except valve plug in cleaner, and rinse in solvent. Blow out all passages with compressed air.

167. INSPECTION AND REPLACEMENT OF PARTS.

A. Check top cover and pump body for cracks and breakage. Inspect for warpage by testing on a smooth flat surface. Examine all threaded holes for stripped or crossed threads. Broken, damaged, or severely warped castings must be replaced. If body is worn at rocker arm pin holes or warped at the mounting or diaphragm flange replace.

B. Check inlet and outlet valve seats in top cover for scores, scratches or damage. If seats are rough, irregular, or loose, or the wall in the valve well is worn, or if the strainer gasket seat is rough or warped, replace the top cover.

C. Inspect rocker arm for wear or scores at camshaft pad, at point of contact with link, or at pin hole. If worn or scored, replace.

D. Replace the strainer screen. Inspect new screen for damage and obstruction. Screen must fit snugly around inner and outer edges.

E. Because wear on most of the parts mentioned below is not visible or through natural wear, the following parts should always be replaced: 1. Rocker arm pin* and washer; 2. Links*; 3. Link pins*; 4. Pull rod*; 5. rocker arm spring*; 6. pull rod spring*; 7. diaphragm*; 8. diaphragm protector washer; 9. valves and valve spring*; 10. all gasket*.

* Parts marked with asterisk (*) are supplied in the standard repair parts kit. WHEN ORDERING USE PART NUMBER WHICH IS STAMPED INTO BOSS ON FUEL PUMP BODY ABOVE ROCKER ARM.

168. PROCEDURE IN ASSEMBLING OF FUEL PUMP.

A. Body, Rocker Arm and Link Assembly.

The links used with the rocker arm are held together by a link pin (assembled in the hole nearest the larger rocker arm pin hole). The movement of the linkage and pull rod is procured by the rocker arm striking this link pin.

1. Assemble the two side pieces making up the linkage using the link pin and clips. See Figure 271.

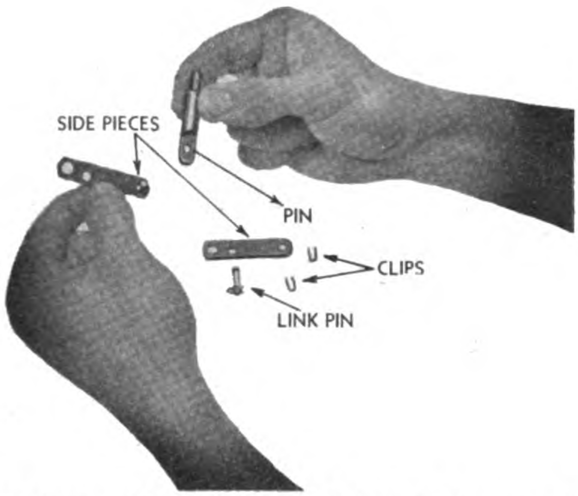


Figure 271. Assembling Pin and Side Pieces of Link Assembly.

2. Attach the linkage to the pull rod using link pin and clips. Make certain that the sheared corners of the two side pieces are assembled upward.

3. Insert the rocker arm pin through the holes of the pump body, linkage and rocker arm. See Figure 272. Install lock ring; seat it properly in the groove.

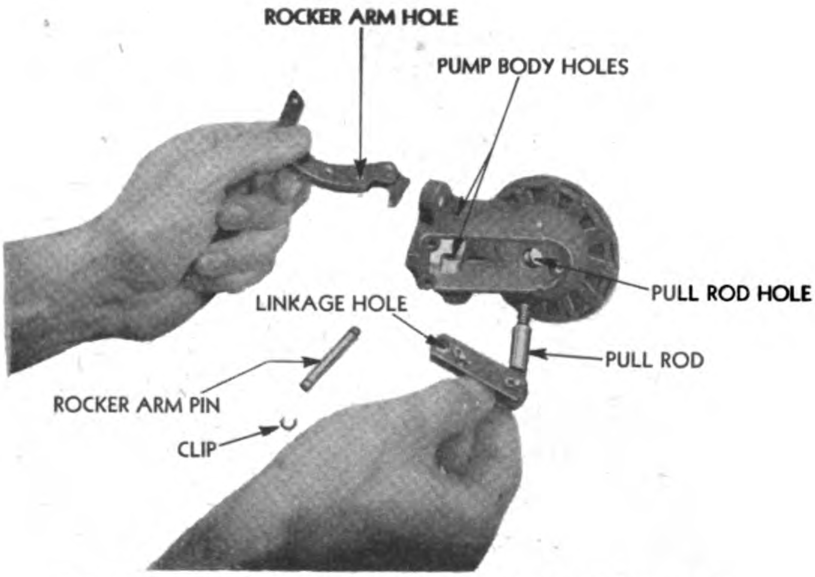


Figure 272. Diaphragm Assembly (a).

4. Check assembly to see that rocker arm and linkage move freely on rocker arm pin.

B. Diaphragm Assembly.

1. With fuel pump body held in bench vise, place the pull rod gasket over threaded end of pull rod, seating the gasket against the shoulder of the pull rod.

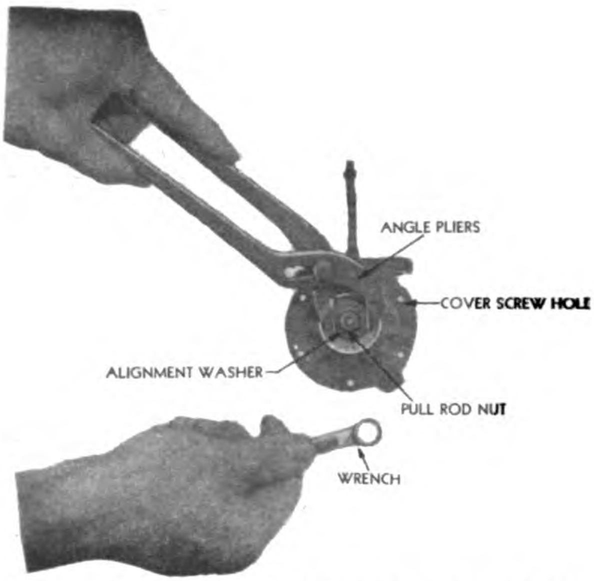


Figure 273. Diaphragm Assembly (b).

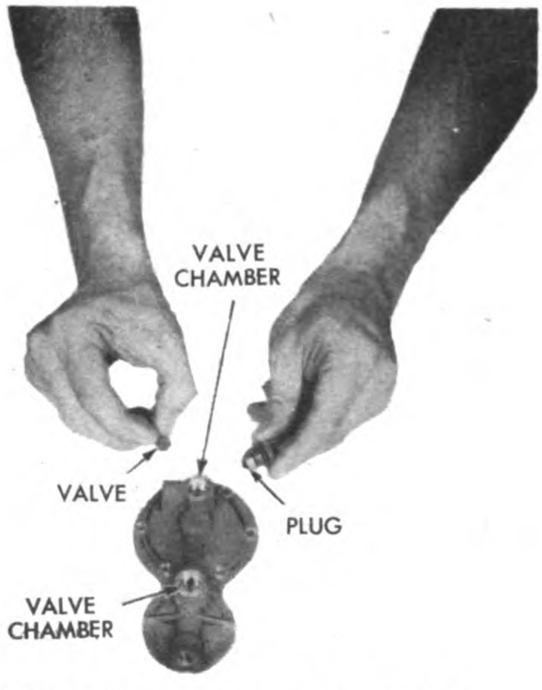


Figure 274. Fuel Pump Valve Assembly.

2. Place lower diaphragm washer (small cup) over threaded end of pull rod, cup side down.

3. Place diaphragm over threaded end of pull rod.

4. Line up holes in diaphragm with a screw hole in body diaphragm flange.

5. Place upper diaphragm protector washer over threaded end of pull rod cupside up.

6. Place hexagon shaped diaphragm alignment washer over end of pull rod. Assemble lockwasher and pull rod nut. Tighten the nut securely. See Figure 273.

NOTE: It is extremely important that the diaphragm be held exactly in alignment while the pull rod nut is being tightened. If it is allowed to twist or become distorted, unsatisfactory operation of pump will result.

C. Valve Assembly

1. Blow out each valve chamber and make certain that no foreign particles are present which might prevent valves from seating properly. Also observe that no burrs or irregularities exist in the valve seats and that valve seats are securely held in place in the upper cover. Figure 274.

2. Place valves in proper position in valve chambers. Make certain that valves lie flat against the

valve seats and are not standing on edge or tipped.

3. Insert valve spring on top of valves.

4. Place fibre gasket on valve plugs and then place stems of valve plugs around the valve spring and tighten plugs securely. Be certain that the stems of the valve plugs do not distort the valve spring but fit properly around them.

D. Cover assembly.

THE POSITION OF THE DIAPHRAGM WHEN THE FUEL PUMP COVER IS ASSEMBLED IS THE MOST IMPORTANT SINGLE ITEM TO BE OBSERVED IN REPAIRING AND ASSEMBLING AC FUEL PUMPS. IF THE DIAPHRAGM IS NOT IN THE PROPER POSITION WHEN THE TOP COVER SCREWS ARE TIGHTENED THE PUMP WILL NOT FUNCTION CORRECTLY WHEN REPLACED ON THE ENGINE. FOLLOW INSTRUCTIONS CAREFULLY.

1. Lay cover on pump in proper position determined by marks made before pump was disassembled. See Figure 268.

2. Insert screws from top through lockwashers, upper cover and diaphragm.

3. Tighten screws until they barely engage lockwashers.

4. Exert pressure upward on the linkage with thumb. This forces the diaphragm to its extreme high position and while it is held in this position, the cover screws should be tightened alternately and securely.

E. Bottom Cover Assembly.

Hold pump right side up, with middle finger on tip of priming handle. With springs, spring caps, and gasket in place in the bottom cover, carefully assemble lower cover to the pump body, making certain the spring caps and springs remain in their proper positions. Tighten screws securely. See Figure 270.

F. Sediment Bowl Assembly.

1. Assemble screen in pump cover. Make certain that it fits snugly around the gasoline inlet and edges of the casting.

2. Place bowl gasket next to screen, then complete the assembly of the bowl and bail and screw assembly. See Figure 269.

GOVERNOR

The automatic control of the engine speed is regulated by a Pierce centrifugal governor, horizontal type. See Figure 275. The governor is enclosed in a housing. The shaft is gear driven from the camshaft. On the shaft is a weight holder or spider which supports the two governor weights.

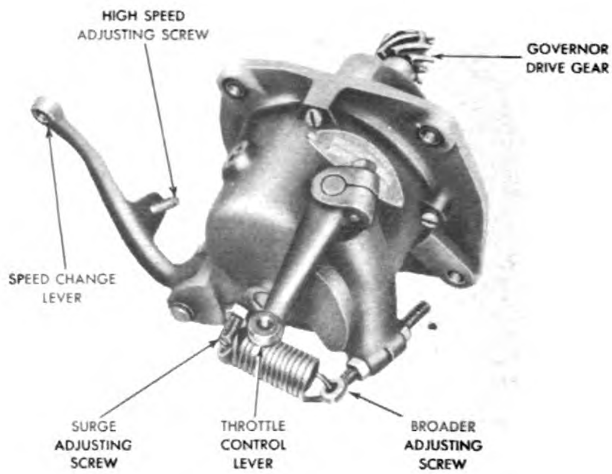


Figure 275. Governor

As the governor shaft rotates, the centrifugal energy developed in the two weights causes these two weights to swing outward on their pivots. The energy of the weights is counter-balanced by a spring, the tension of which can be regulated. When the centrifugal energy of the weights overcomes the spring tension, a thrust bearing is forced against the rocker yoke to which the governor control lever is attached. The movement of the rocker yoke lever causes the control lever to move, which in turn opens or closes the governor throttle valve in the governor throttle box. The sensitivity or regulation of the governor can be adjusted by the adjusting screw. This setting of this screw should not be altered after the top working speed has been set.

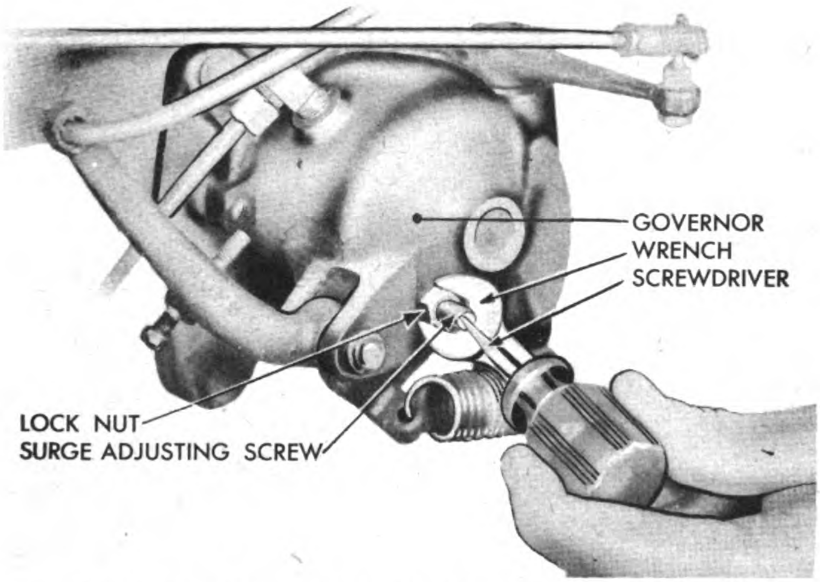


Figure 276. Adjusting Engine Surge.

169. ADJUSTING ENGINE SURGE.

If the engine surge is unstable at top engine speed, running without load of part load, turn the adjusting screw, as shown in Figure 276, inward half a turn at a time until the surging stops being sure that you do not raise the speed of the engine by so doing.

170. ADJUSTING GOVERNOR LINK BALL JOINTS.

The governor link ball joints at both ends of the link rod should be snug but move without friction. In Figure 277 the screwdriver is being used to adjust the ball joint adjusting plug and the fingers are testing for friction. A small cotter pin through the screw in the adjusting plug must be removed first to make the adjustment and replaced after the adjustment is made. Never bend the link rod. The ball joints must be kept lubricated with engine oil.

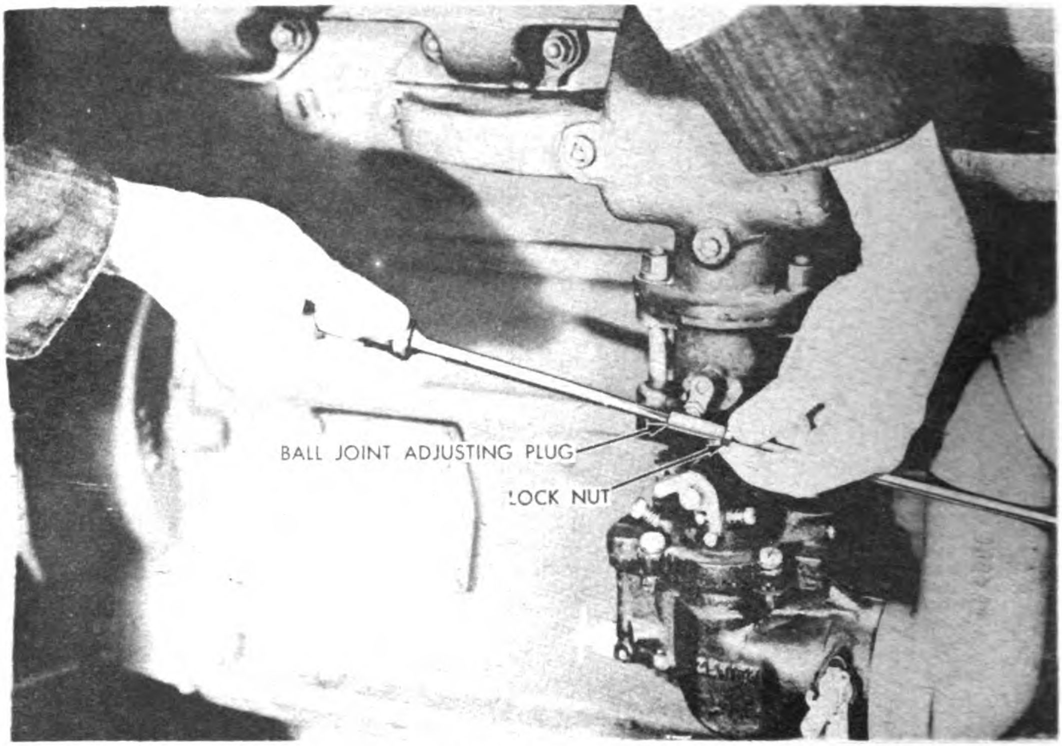


Figure 277. Adjusting Governor Ball Joints.

171. ADJUSTING GOVERNOR LINK ROD.

The link of the link rod must be so adjusted that when the engine is stopped, the rod holds the governor throttle box lever slightly short of wide open position. See Figure 278. To make this adjustment the engine should not be running. Loosen both of the ball joint locknuts. Remove the ball joints from the governor arm and with the governor throttle in wide open position, adjust the link rod by turning the ball joints either to the right or to the left, depending upon the adjustment required.

172. ADJUSTING GOVERNOR SPEED.

The main speed adjustment is correctly set at the factory and normally should not be changed. However, if an overhaul of the governor is necessary, the main speed adjustment will have to be set. Turn the surge adjusting screw out until only three or four threads are engaged. Tighten the locknut and leave in this position for the present. See Figure 276. Adjust the governor for engine speed of 1350 r.p.m. by turning the high speed adjusting

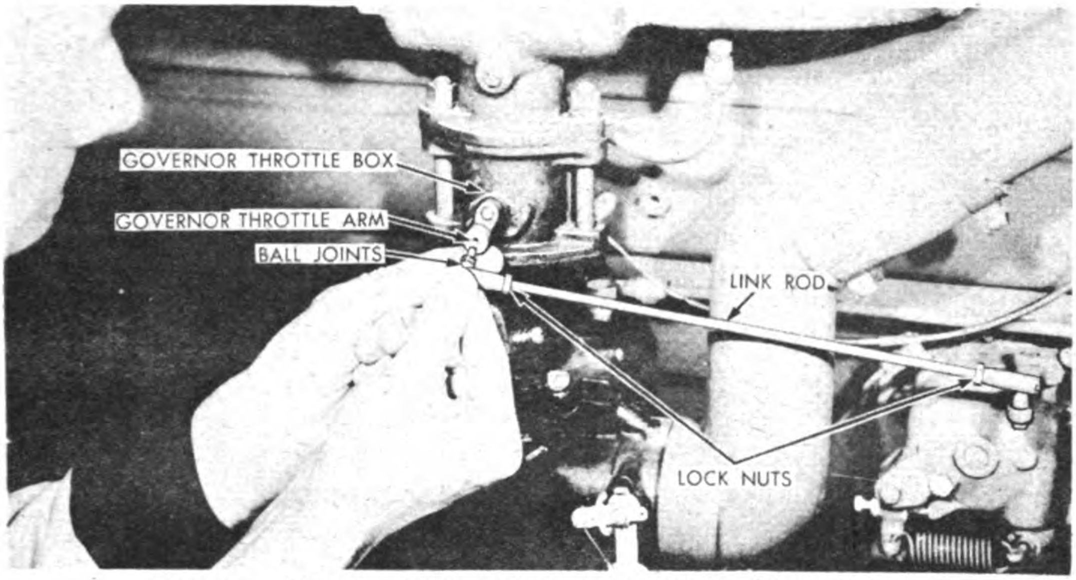


Figure 278. Adjusting Governor Link Rod.

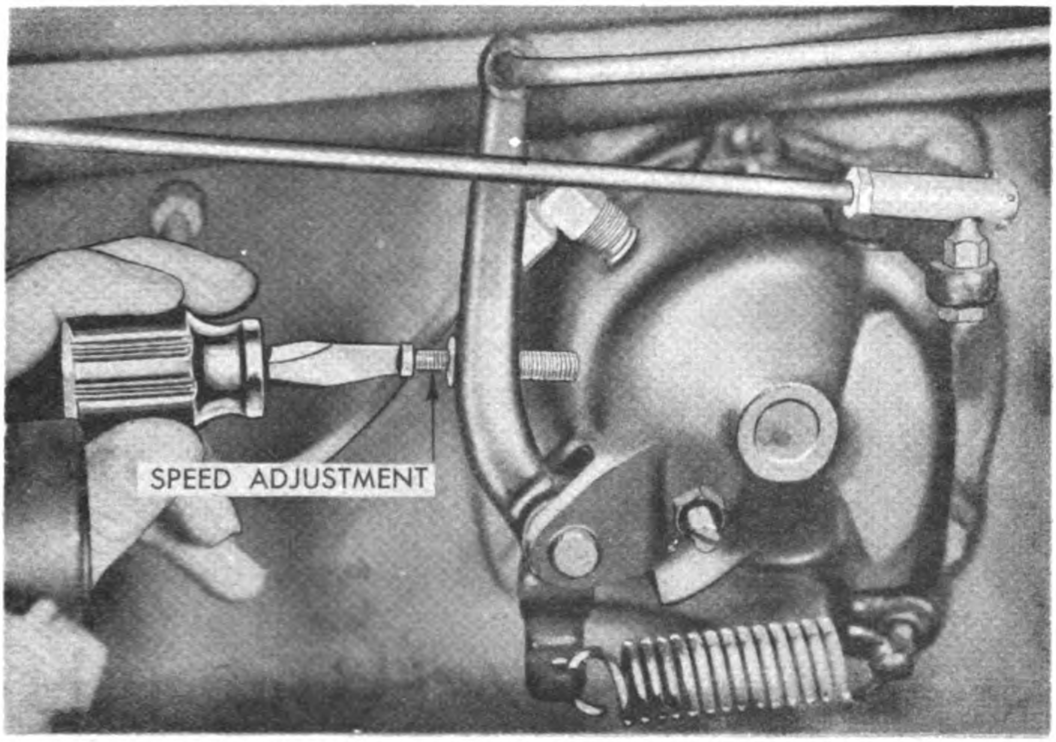


Figure 279. Adjusting Governor High Speed.

GOVERNOR

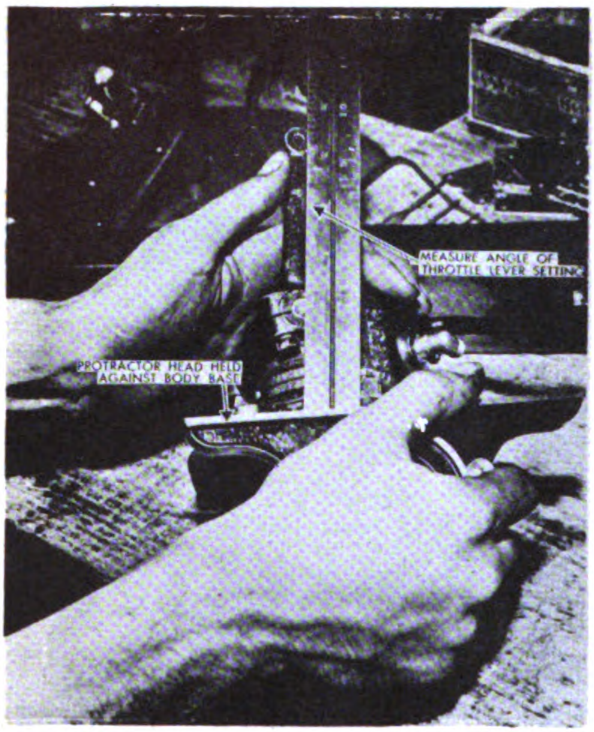


Figure 280. Taking Protractor Reading of Throttle Lever Angle

Figure 281. Taking Protractor Reading of Spring Eye Adjusting Screw Angle.

screw. See Figure 279. Turning in will increase speed. Turning out will decrease speed. Set the governor so that the engine will operate under no load at 1350 r.p.m. with the throttle in wide open position.

The r.p.m. can be checked by using a hand tachometer inserted in center of flywheel or, if the clutch is on the engine, hold the tachometer at the outer end of the clutch shaft with the clutch engaged.

Should the governor surge at no load speed, turn the surge adjusting screw in slowly until the surge is overcome. Do not turn this screw in so far as to increase speed.

NOTE: Should the engine surge under load or part load, turn the spring eye adjusting screw out a few turns at a time until surging stops, and recheck engine speed adjustment. For sensitive regulation, keep this screw in as far as possible without creating load surge.

Figure 282. Removing Governor Bearing Retainer Ring.

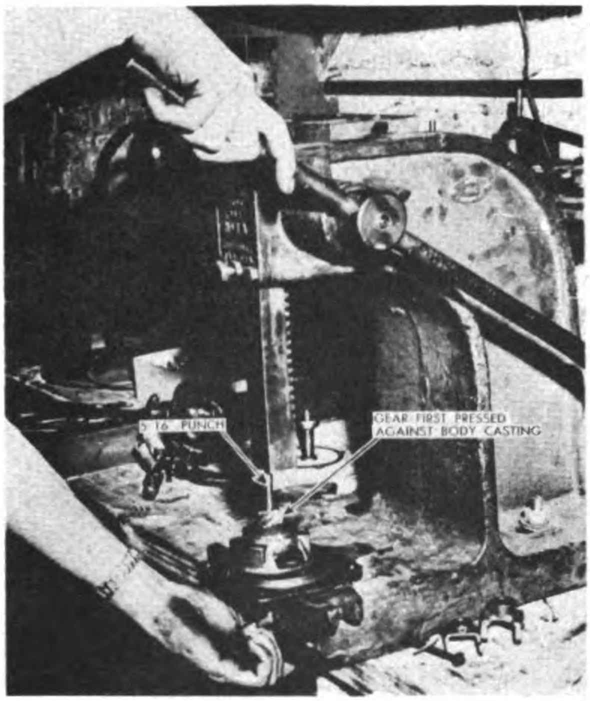


Figure 283. Pressing off Governor Gear.

173. OVERHAUL OF THE GOVERNOR.

NOTE: Before disassembling the governor, get a protractor reading of the throttle lever and of the spring eye adjusting angle. The protractor reading should be taken with the base of the protractor laid against the base of the governor body and with some tension on the governor spring. See Figures 280 and 281.

Release tension from the governor spring before removing the body bolts. Then disassemble by unscrewing the four body bolts.

174. GOVERNOR BODY CAP DISASSEMBLY.

1. 1T To disassemble governor cap, remove thrust sleeve and thrust bearing from drive shaft.

2. Pull out cotter pin and unscrew castle nut holding gear. Remove bearing retainer ring with long screwdriver or hook. See Figure 282.

3. Press off gear with arbor press.

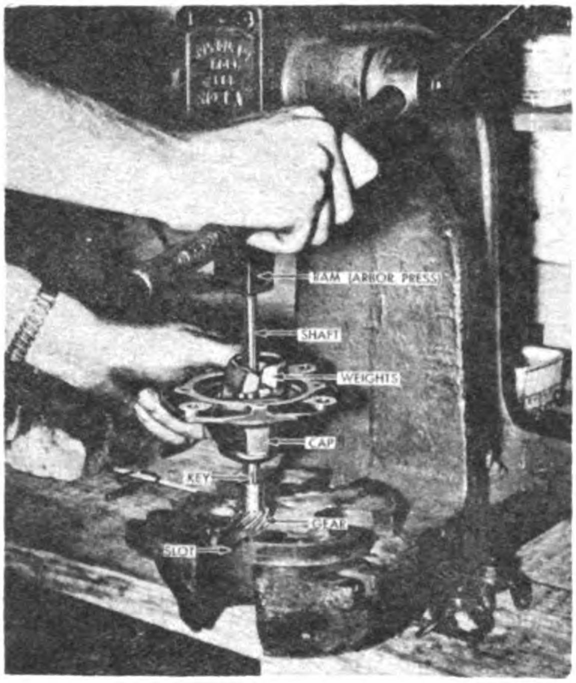


Figure 284. Pressing off Governor Shaft.

This is done in two steps. First, press gear so that shoulder rests against body casting. Then use 5/16" punches to force shaft on through gear. Hold weights, spider and shaft assembly with free hand so that they do not fall after gear is pressed loose and mutilate drive shaft. See Figure 283. Press bearing from shaft with arbor press and two pieces of flat stock. See Figure 284.

4. If necessary to remove weights, grind riveted end of weight pins and then drive out with punch (3/16").

175. GOVERNOR BODY DISASSEMBLY.

1. To disassemble body, loosen throttle lever screw (drive 1/8 groove pin from throttle lever, if pinned, using 3/32" punch) and remove throttle lever from rocker shaft.

2. Remove governor spring and spring eye screw and drive out taper pin holding spring eye bracket to rocker shaft. Use 3/32" punch.

3. Remove yoke screws. Drive out rocker shaft with raw hide mallet. See Figure 285, Spring eye bracket, bearing retainer, oil seal, felt and one rocker shaft bearing will come with the shaft.

4. Be sure pin has been removed from spring eye bracket and press bracket, bearing retainer, oil seal and bearing from shaft with arbor press. Use 3/8" punch. See Figure 286. In replacing this part, a new oil seal, and bearing retainer must be used. The other rocker shaft bearing, oil seal and retainer can then be knocked out of the body cap with a raw hide mallet and 1/2" dia. punch.

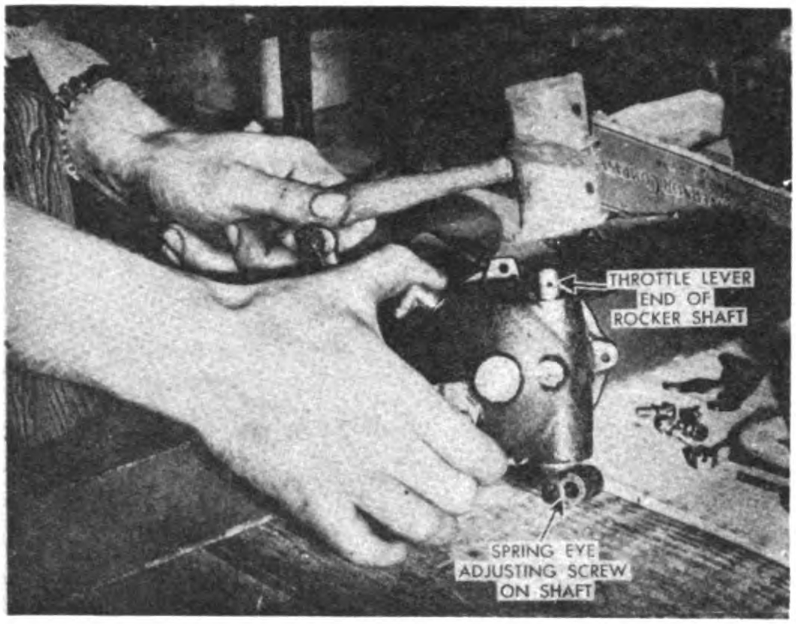


Figure 285. Driving out Rocker Shaft with Raw Hide Mallet.

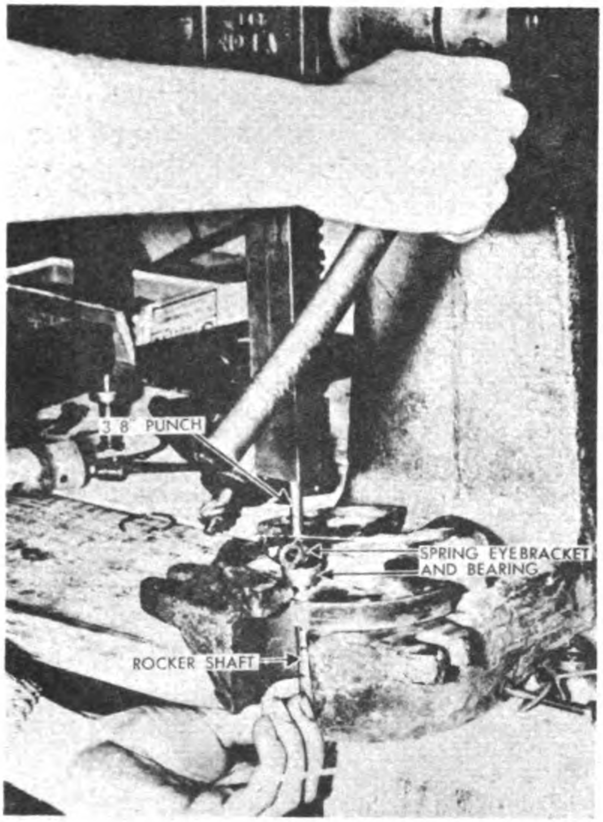


Figure 286. Pressing Bracket Bearing Retainer, Oil Seal and Bearing from Shaft.

5. To remove welch plug and oilite drive shaft bushing from body cap, drive from inside with 7/16" punch. This will ruin both the welch plug and the oilite bushing, and each will have to be replaced with new material.

176. INSPECTION AND REPLACEMENT OF GOVERNOR PARTS.

1. On disassembling governor body, thoroughly clean all parts, and look for wear in the bearings on the weight noses thrust lead, and the end of the drive shaft which operates in oilite bushing in the body.

2. The weight noses which bear on the thrust leads have a ground radius at the point of contact, and if there are any flat spots in this radius, repair the worn weights with new material. The thrust sleeve at the point of contact with the weights has been ground to extremely close limits, and any pitting or rough spots in the thrust sleeve calls for the replacement of this part. The bearing on the shaft is a radial bearing and should be replaced if, in rotating with a thumb and finger, there seems to be any rough spots or points of friction indicating wear or foreign material in the bearing; or if the bearing races are loose enough to indicate wear. The thrust bearing on the thrust sleeve shows wear by looseness between the top thrust surface and the opposite race. Any sign of wear in bearing parts requires a replacement of these items with new material.

3. The oilite bearing in the end of the body should be checked for wear and also the end of the drive shaft where it seats in the oilite bearing.

4. On reassembling the drive shaft weights and thrust sleeve on the governor body, check to see that there is at least 1/4" left on the thrust sleeve when the weights are exploded. Movement from closed to wide open position must have a resultant movement of the thrust sleeve on the shaft of at least 1/4". If the sleeve does not have 1/4" to travel, grind the weight stop tip that contacts the spider until the weight will open far enough to give necessary sleeve travel.

177. REASSEMBLY OF THE GOVERNOR.

A. Body Cap Reassembly.

1. To reassemble the governor body cap, press the bearing into the housing and fasten with the snap ring. Then press the shaft into the bearing and press on the gear with an arbor press. See Figure 287. Be sure that there is an adequate hole or slot in the arbor press table so that the shaft can extend through the gear and will not be bent in this operation. The gear is not only held by a press fit and castle nut but is also keyed on with a Woodruff key. Be sure that the keyway and slot line up before pressing the gear.

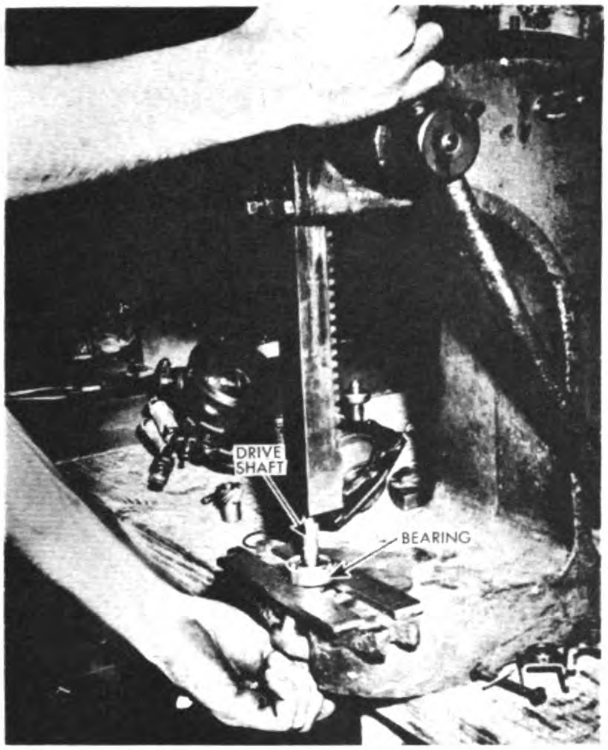


Figure 287. Pressing Shaft into Bearing and Gear.

NOTE: This shaft is held to plus or minus .001" in manufacture. Careless handling can easily spring it many thousandths of an inch out of line. In pressing the shaft with the arbor press, do not force on with continuous pressure, but use short interrupted strokes to give the shaft a chance to center.

B. Governor Body Reassembly.

1. To reassemble the body, install new oilite bushing for the drive shaft. This bushing requires a special tool for installation. Turn one end of a 6" piece of 1/2" round stock to 3/8" diameter by 11/32" long, with a square shoulder. Place the bushing on the 3/8" turned tip and insert into the body hole from the inside. Tap into position with a mallet so that the shoulder of the bearing tool comes flush with the body casting. This bearing must line up so that it does not bind the drive shaft.

2. Seat the welch plug with a 1/2" dia. punch.

3. Place the snap rings on the rocker shaft and place shaft in the body without the bearings. Assemble the yoke to the shaft. Press the rocker shaft bearings on each end of the shaft by hand with the lettering on the bearing outside. These bearings must be seated against the shoulder in the casting, and this operation requires a simple tool or short piece of tubing. The rocker shaft is approximately 7/16" in diameter, and the seating tool is made from a piece of 7/8" OD round stock with 15/32" hole drilled through the center. The

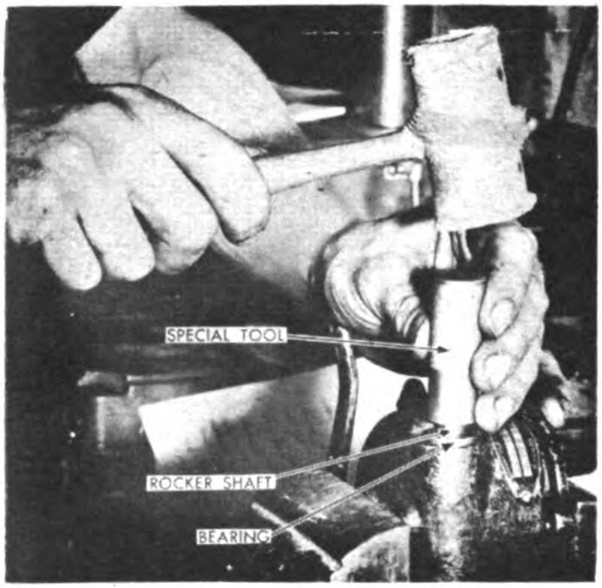


Figure 288. Seating Bearing into Body.

body is placed in a vise, and bearings seated by placing the tool over the shaft and driving with a rawhide mallet. The bearing must not be cocked in the hole and when seated in position, the shoulder in the casting with the bearing retainer will be just above the top of the bearing. See Figure 288. Oil seal felt should be placed in the bearing retainer, and the retainer and washer spacer slipped over the rocker shaft and tapped into position with a hammer. The retainer is then seated against the shoulder in the casting with the same tool used for the installation of the bearing. After installation of the rocker shaft, check for excessive friction or misaligned bearing by oscillating the shaft with thumb and finger. If the shaft cannot be turned with the thumb and finger, there is too much friction in the mechanism and this will have to be eliminated.

C. Body and Cap Reassembly.

1. Reassemble the body and cap with a new gasket. The drain hole in the body should be down. The oil inlet will appear on the top side of the body. When the body and cap are bolted securely together, rotate gear by hand to check for friction or binding in the shaft. If the shaft does not rotate freely, tap the body cap casting around the oilite bushing with a rawhide mallet. This will tend to line up drive shaft bushing. All friction must be eliminated before proceeding. Install spring eye screw and eye screw bracket and place it on the rocker shaft. To set it at the correct angle measured by the protractor before disassembling the governor, rotate the spring eye back away from the governor body and then push towards the speed change lever until

you can feel the yoke resting on the thrust bearing. Then advance the spring eye screw to the desired setting. See Figure 288. The protractor giving the correct angle will be held against the base of the body as originally measured. With the spring eye bracket in this position, drill the bracket and shaft with a #27 drill (.1440) and ream with a #1 taper reamer. Install the taper pin. After installation of the spring eye bracket, set the throttle lever on the shaft in the same manner as the mounting bracket. Pull the lever away from the governor and push towards the speed change lever so that the yoke is against the thrust bearing and then on forward to the correct setting measured with the protractor. Lock the lever with the screw, and if originally pinned, install a 1/8" groove pin (use 1/8" drill).

178. INSTALLING THE GOVERNOR.

The governor is lubricated by oil pressure from the engine, and once properly installed and adjusted, no attention is required other than a periodical inspection to see that the bolts and nuts are tight and to lubricate link rod ball joints with a few drops of oil.

When installing the governor on the engine, see that the governor gear is properly meshed with the gear on the camshaft before tightening the bolts on the governor flange, and be sure to connect the oil line to the governor. Install the governor control rod to the throttle lever and the governor arm. The rod should be just long enough that with the engine running and with some tension on the governor spring, the throttle valve will be just short of wide open position. See Figure 278. The throttle valve and shaft must move freely and there must be no binding where the rod enters the holes in the two levers. For speed adjustment, see paragraph 56 under Chapter V on Reassembly of Engine.

LUBRICATING SYSTEM

The lubricating system comprises the following: Oil pump, oil pressure relief valve, oil float, oil pressure gauge and oil filter. Figure 289 shows how the oil circulates through the system.

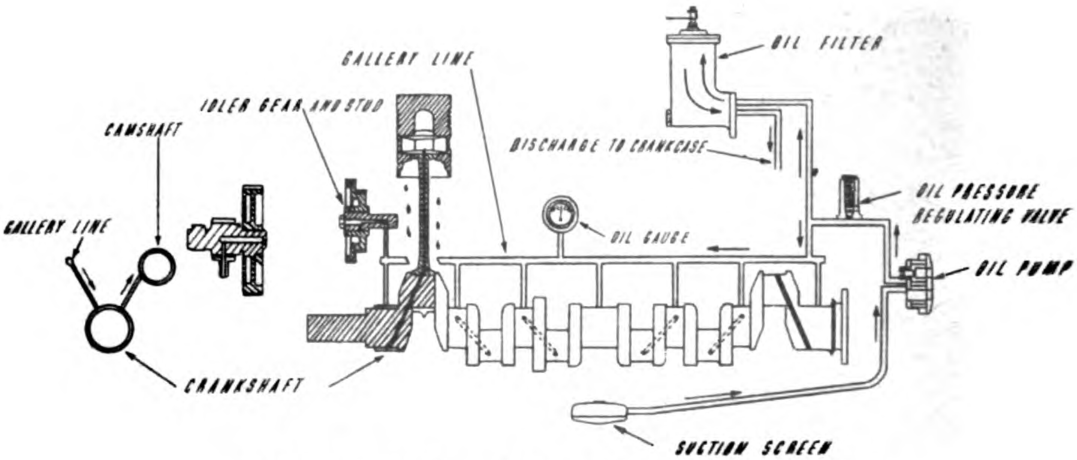


Figure 289. Lubricating Diagram.

OIL PUMP

The oil pump has a hydraulic relief in the casting. The oil which would otherwise be trapped between the teeth is allowed to return through the hydraulic relief to the pressure side of the pump. There are no movable parts in this type of relief. The idler gear and the drive gear have bushings which were machined in the gear blank before the teeth were cut. The gears and bushing should be replaced as a unit. The expansion plug in the oil pump casting is used as an oil seal at the end of the idle shaft. This plug should not be removed from the oil pump body. The oil inlet and oil outlet passages go through the two locating sleeve dowels.

The oil pump assembly fits in a recess in the flywheel end of the crankcase and is driven directly from the rear end of the camshaft. Connection to the pressure and suction passages in the crankcase is made by hollow dowels and sealed against oil leaks by copper asbestos gaskets.

The oil is drawn from the pan through a suction screen to the oil pump. From the pressure side of the pump, it enters a drilled passage in the crankcase casting to the main gallery line and the oil pressure relief valve. Excess oil is by-passed to the oil pan from the oil pressure relief valve. On the way to the oil pressure relief valve a side passage diverts part of the oil to the oil filter. The clean oil from the oil filter is returned to the oil pan. From the main gallery line, side passages are drilled to the main bearings, oil pressure gauge connectings and idler gear stub. From the main bearings, the oil is delivered to the connecting rod bearings by means of the drilled crankshaft. The piston pin receives its oil through the rifle drilled connecting rods. The cylinders are lubricated by oil thrown from the connecting rod splash.

From the main bearings, side passages lead to the camshaft bearings. A supply of oil is delivered to the idler gear hub through the drilled idler gear shaft. Oil from the hub of this gear is thrown out through drilled holes and is picked up by a groove in the rim of the gears, where it passes through small drilled holes to the gear teeth, spraying the entire gear train.

179. DISASSEMBLING, INSPECTING AND REPLACING OIL PUMP PARTS

To disassemble the pump, remove the six capscrews and oil pump cover. Check the teeth and the bushings in the gear for wear. If either is worn, both the bushing and the gear must be replaced as a unit. Check the clearance between the teeth and the case. See Figure 290. If more than .008", replace with new gears and bushings. NOTE: If the shaft is in place, the clearance should not be more than .004". Check the backlash as shown in Figure 291. If more than .005", replace the gears. Also if the

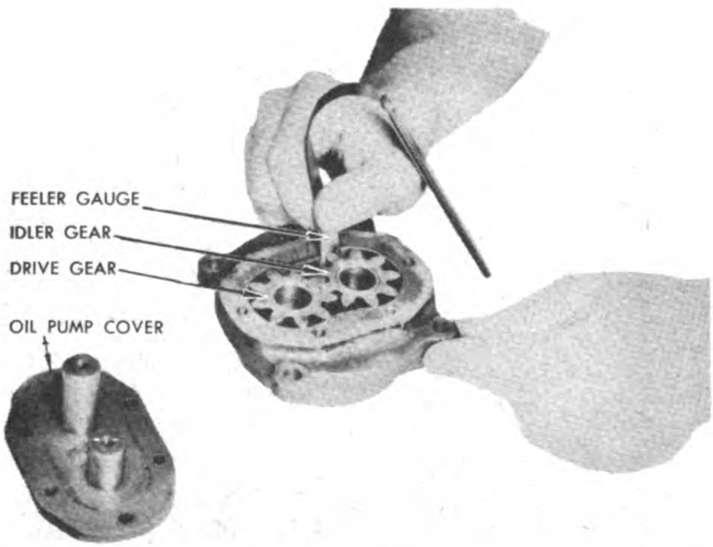


Figure 290. Checking Oil Pump Gear Clearance to Pump Case.

ends of the gears are not within .001" flush with the case, replace the gears and bushings.

Examine the shafts on which the bushings run. If the shafts are worn, replace the shafts with new ones. Examine the case for cracks and replace if necessary.

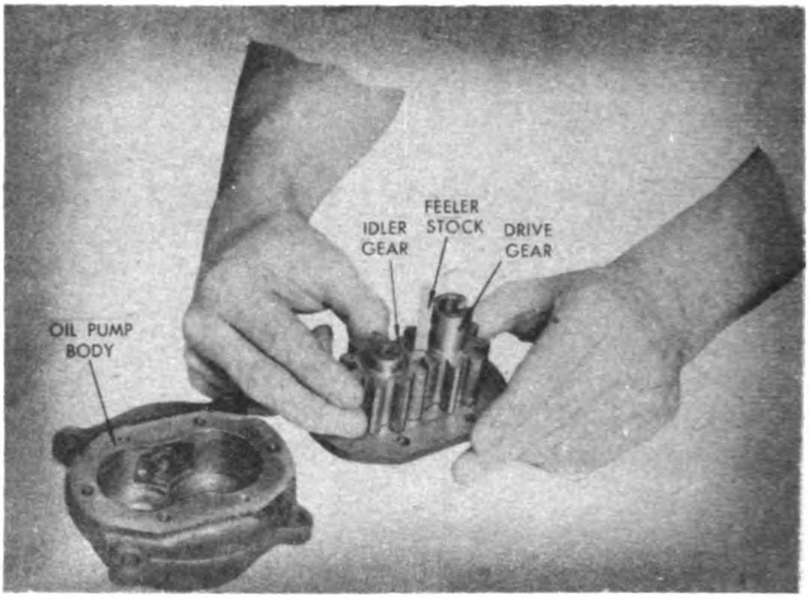


Figure 291. Checking Backlash of Oil Pump Gears.

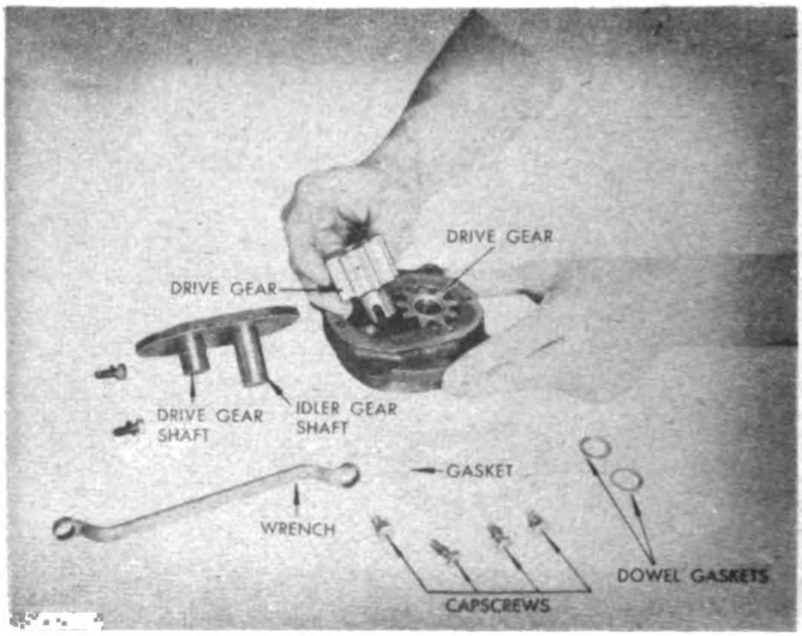


Figure 292. Installing Oil Pump Gears.

180. ASSEMBLING OIL PUMP

Put the drive gear and the idler gear in the housing. Slip the gasket on the housing. See Figure 292. Set the cover in place by starting the idler shaft in the idler gear and then the drive gear shaft in the drive gear. See Figure 293. Make sure the holes of the gasket are in alignment with the cover and body capscrew holes before installing and tightening the six capscrews. Check pump to be sure gears turn freely. To avoid having to prime the pump after it is installed on the engine, fill the pump with oil before installation. When installing pump be sure to install the dowel gaskets as shown in Figure 294.

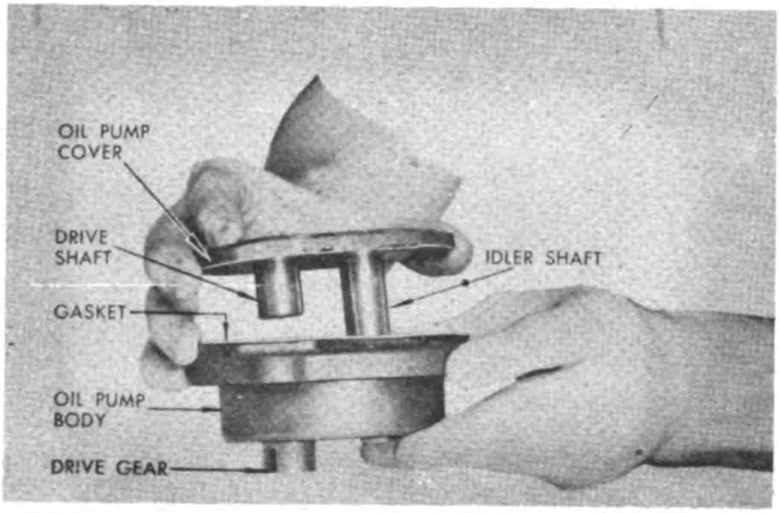


Figure 293. Installing Oil Pump Gear Shafts.

181. PRIMING OIL PUMP.

If it becomes necessary to prime the pump after installation, remove the plug in the side of the crankcase just above the oil pressure gauge connection. See Figure 104. This priming must be done while the engine is running and can be most easily done by means of hand oil pump or gun. However, the same results can be obtained by connecting a piece of tubing to the oil priming connecting and raising the oil lever above the level of the pump, forcing a quantity of oil into the suction passage while the engine is running. DO NOT RUN THE ENGINE MORE THAN ONE MINUTE WITHOUT OIL CIRCULATION. The priming hole should be covered as quickly as possible after pressure is obtained. Afterwards the engine can be shut down, the plug replaced.

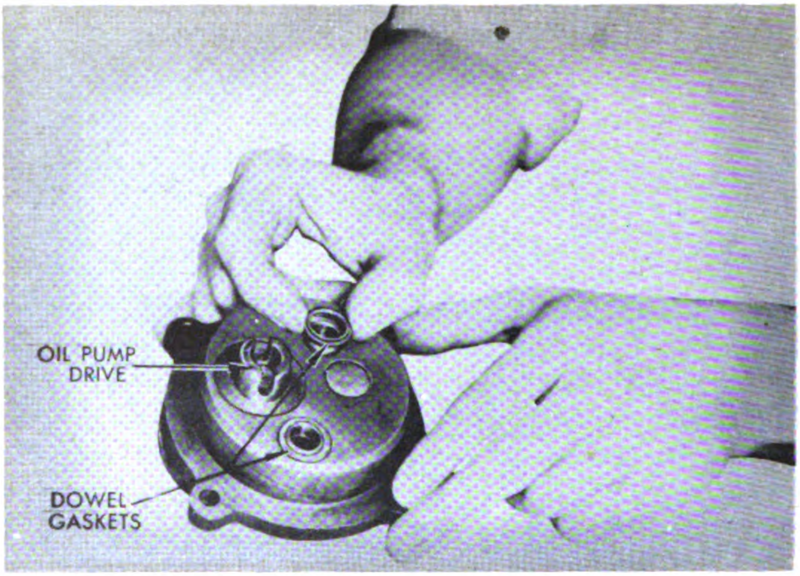


Figure 294. Installing Oil Pump Dowel Gaskets.

If pressure is not obtained after this, examine oil pressure gauge and relief valve. If these are in good condition, remove oil pump and re-examine the drive pin in the end of the camshaft, also the copper gaskets on the sleeve dowels.

182. OIL PRESSURE RELIEF VALVE.

The oil pressure relief valve is designed to maintain an operating pressure of approximately 30 lbs. at normal speed and temperature. No adjustment is provided. The spring furnished is of the proper weight and length. A temporary adjustment can be made by stretching or compressing the spring. However, a new spring should be obtained as a stretched spring soon loses its tension. See Figure 295.

OIL FLOAT

The oil float is a floating screen arranged to rise and fall with the oil level in the crankcase so that only the best oil is taken for the bearings. See Figure 296.

Free spring tension length 2¾".
Lb. pressure when spring compressed to 2-13/32" - 7 lb.

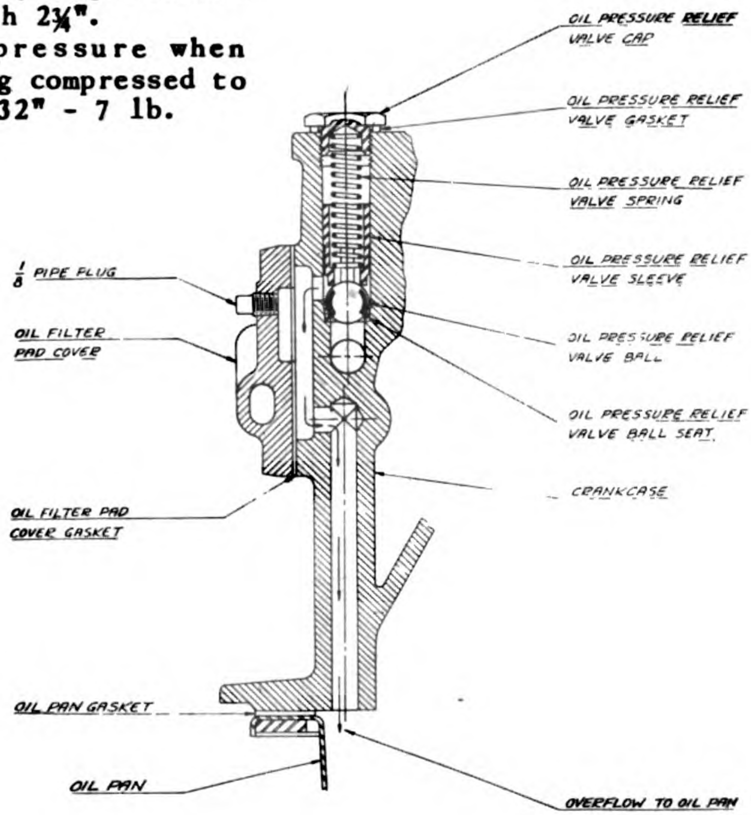


Figure 295. Oil Pressure Relief Valve.

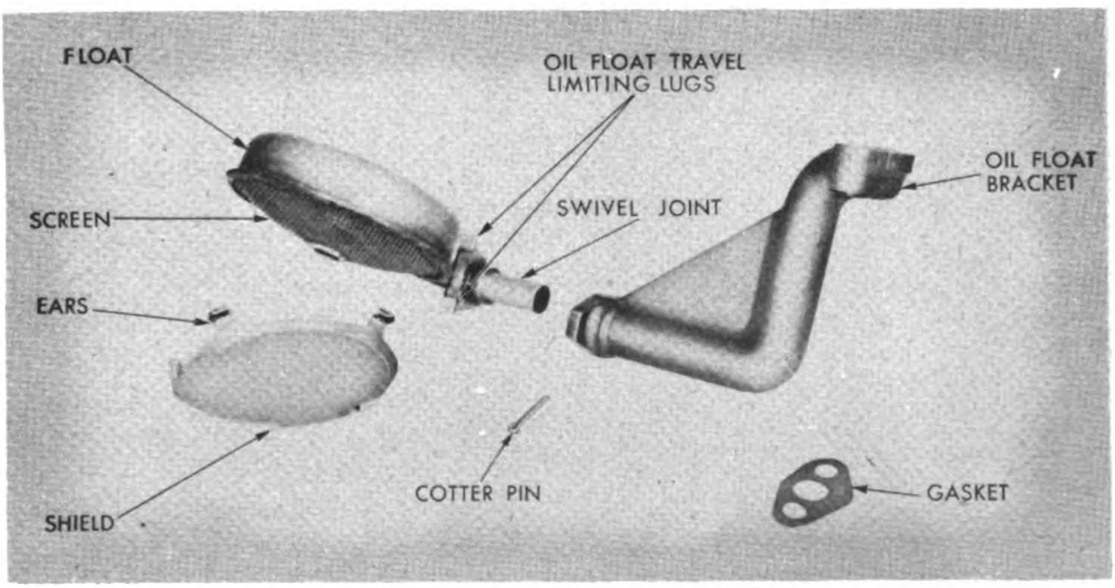


Figure 296. Oil Float Assembly.

183. CHECKING, REPAIRING, AND REPLACING PARTS OF THE OIL FLOAT.

First thoroughly clean the float in cleaning fluid. Blow the screen with compressed air. If the fouling is bad, straighten the ears of the shield, remove the shield and clean the screen with a wire brush. If the mesh is broken or loose frcm the float and beyond repair, replace the entire float assembly. If the tube is damaged, the entire assembly must be replaced since the tube cannot be removed and replaced. When putting back the shield, it should be carefully positioned and the ears turned over the body flange. Clinch the ears with pliers, not a hammer.

Figure 297. Removing the Oil Filter Element.

Make certain the float swivel joint is free to move so that the float can "float" on the surface of the oil.

The float is equipped with travel limiting lugs. Make sure they are not bent out of line. The lugs should be at right angles to the plate soldered on the tube.

Check the bracket for cracks. If cracked, it should be replaced.

OIL FILTER

The function of the oil filter is to remove particles of dirt that are the result of normal engine operation. See Figure 104. The filter not only helps to cut down engine wear, but also prolongs usefulness of the oil. The filter element should be replaced after every 128 hours of operation or every other crankcase oil change.

184. OIL FILTER ELEMENT.

Unscrew the cover assembly by turning the handles at the top of the filter counter-clockwise until the threads are disengaged. Remove the drain plug to remove the accumulation in the sump and to break the vacuum created while removing the element. See Figure 297. Remove the dirty element by the wire handles. Flush out the filter housing with kerosene. Inspect the top gasket. If it is "recessed", replace it with a new non-laminated gasket. With the filter completely assembled, check the leakage by running the engine until the filter is warm. Note: Be sure oil pan drain plug is removed while flushing filter sump.

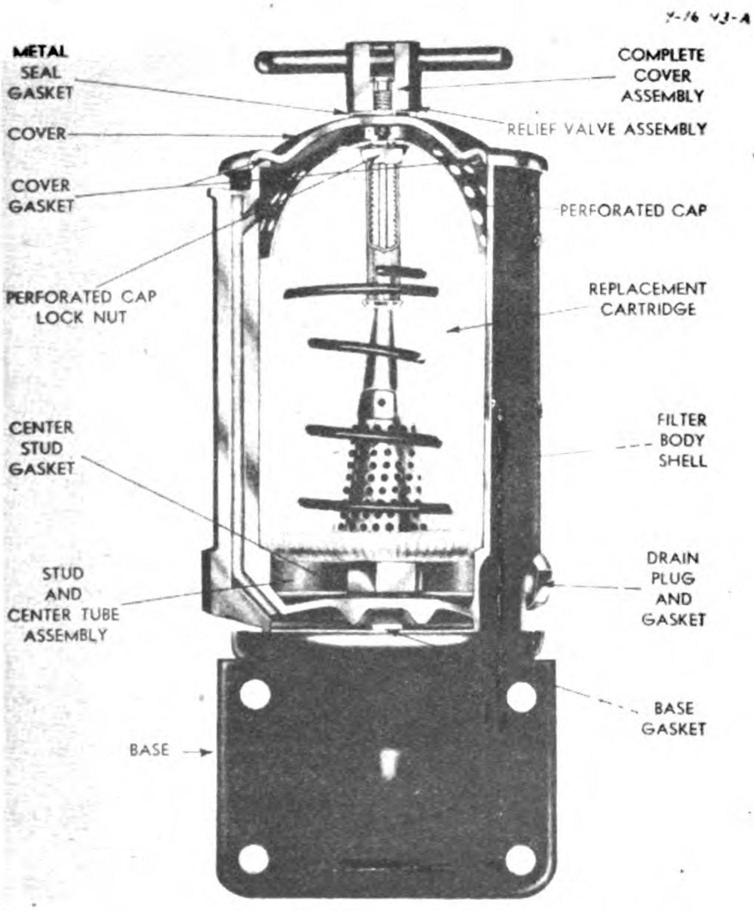


Figure 298. Cross Section of Oil Filter.

185. DISASSEMBLING AND INSPECTING OIL FILTER.

Remove the cover assembly and filter element as described in the foregoing paragraph. The filter body can be taken off the base by unscrewing the center stop. See Figure 298. Examine the base for cracks. If cracked, replace the base. Make certain that the upper edge of the filter body shell has no nicks or burrs that interfere with the seating of the gasket. Examine the center stud and cover nut for stripped or damaged threads. Always remove cartridge filter and gasket during the overhaul.

LUBRICATION CHART

Periods of Operation	Points of Lubrication	Lubricant Required
8 Hours	1. Air Cleaner - clean, change oil.	OE
	2. Clutch Throw-out collar	WB-2
	3. Check crankcase - add if necessary.	OE
64 Hours	1. Drain and refill crankcase.	OE-9 qts.
	2. Water pump - grease cups.	WP
	3. Generator - oil cup and oil hole. (Sparingly)	OE
	4. Starting Motor - oil hole. (Few drops)	OE
128 Hours	1. Change oil filter cartridge and refill crankcase	OE-10 qts.
	2. Carburetor throttle shaft, choke, and control cables - flex cables to apply.	OE
	3. Governor throttle shaft and ball joints.	OE
	4. Clutch Housing Bearing.	WB-3
	5. Clutch Pilot Bearing.	WB-3
	6. Clutch Operating Shaft.	OE
	7. Magneto-Felt Wick	OE 2 to 3 drops
512 Hours	1. Fan - grease plug	WB-3

CLUTCH
(Power Take-Off)

The power take-off or clutch is a Twin Disc Model, No. X7350A Model B 111-P2 specifications No. 17732. The clutch is a device by means of which the power of the engine is engaged or disengaged with the equipment for which the engine is supplying the power See Figure 299.

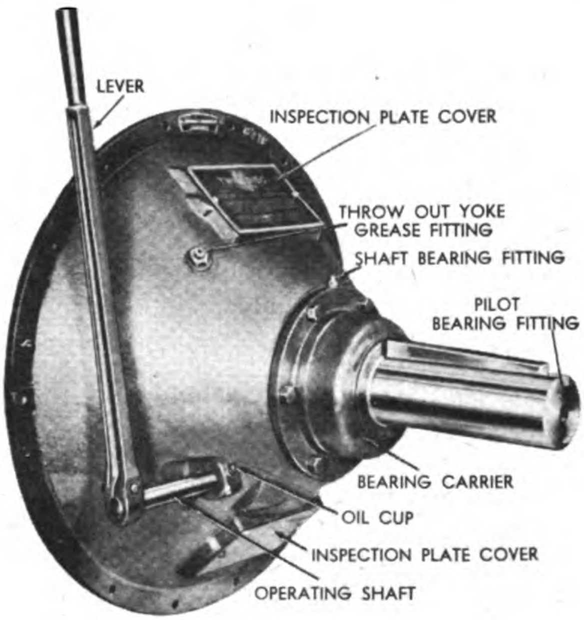


Figure 299. Clutch.

The Twin Disc power take-off is of the single plate clutch type, with the shafts supported in the housing by means of Timken bearings. A driving ring is attached to the flywheel of the engine with the pilot bearing inserted into the center of the flywheel recess. The Timken bearings are adjusted at the factory to provide for satisfactory operating temperatures to not exceed 160°F. Any adjustments that may become necessary to the bearing must be made by the maintenance repair personnel.

186. CHARACTERISTICS.

Number of notches backed off from tight adjustment-3
Recommended end play of shaft - .002" to .005"
Distance of the center line of the load from the face of flywheel housing - 10 7/8"

187. LUBRICATING THE CLUTCH.

a. Lubricating Throw-Out Collar.

Apply a small amount of lubricant every 8 hours through the throw-out fitting in the housing, as shown in Figure 299. Use wheel bearing grease #2. After every

128 hours of operation lubricate the clutch shaft at either end of the housing through the spring cover oil holes, as shown in Figure 299.

b. Lubricating Clutch Pilot Bearing.

Lubricate the clutch pilot bearing every 24 hours of operation by pumping grease in the Alemite fitting, which is located on the end of the clutch shaft extension.

c. Lubricating Clutch Shaft Bearing.

After every 128 hours of operation, lubricate the shaft bearing with WB-3 grease by pumping the grease into the Alemite fittings located in the housing. See Figure 299.

d. Lubrication of Operating Shaft.

After every 128 hours of operation lubricate the operating shaft through the oil buttons in the housing shown in Figure 299 with OE.

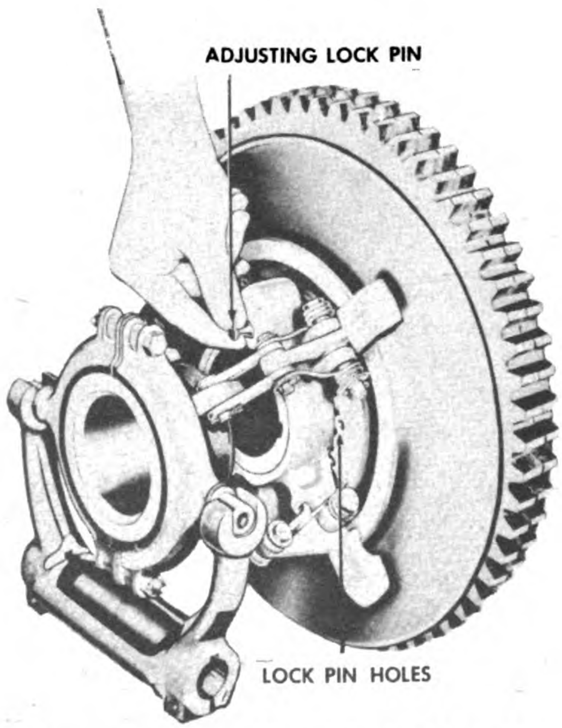


Figure 300. Adjusting Clutch.

188. ADJUSTING THE CLUTCH

If the clutch does not pull, or if it heats or the operating lever jumps out, the clutch must be adjusted. NOTE: A new clutch will require adjustments more frequently than one with the friction surfaces worn in. To adjust the clutch first stop the engine and remove the hand hole cover plates shown in Figure 299.

Pull back the adjusting pin shown in Figure 300 and turn the adjusting pin to the right, or clockwise, one notch at a time until the operating lever requires a distinct pressure to engage. However, the clutch should be adjusted just tightly enough to pull the load. If the clutch is adjusted too tightly the engaging mechanism will not snap over center. If the clutch is too loose, it will not pull the load and eventually the friction discs will burn out.

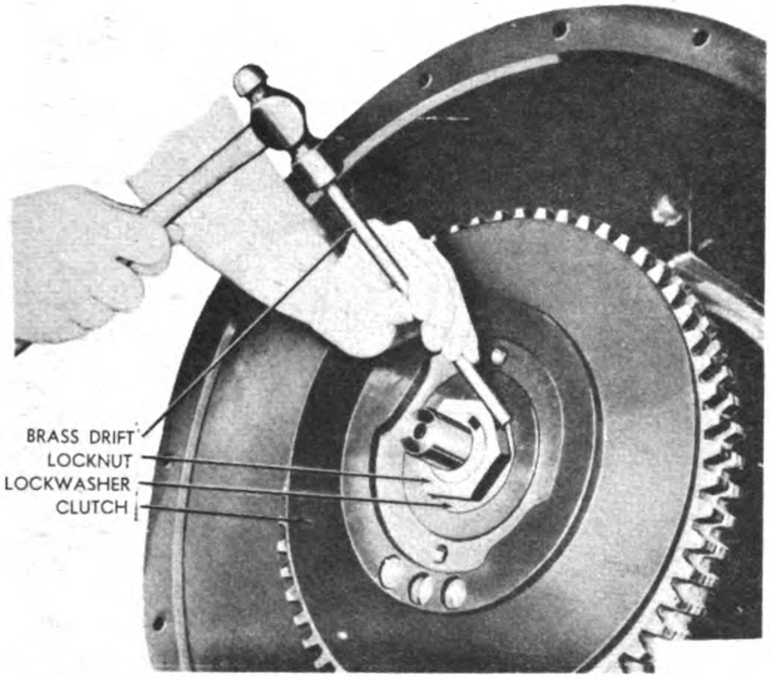


Figure 301. Straightening Lock Plates.

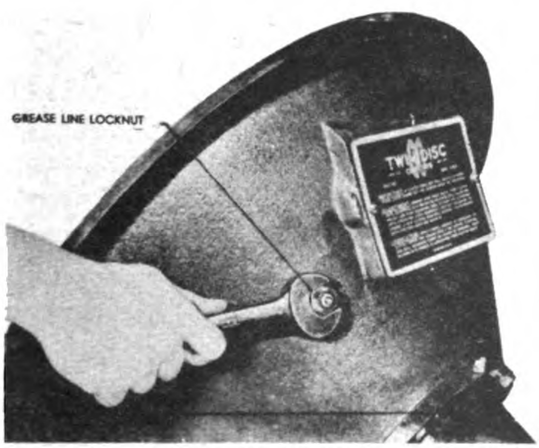


Figure 302. Removing Grease Line Lockwasher.

The clutch should be engaged at intervals during the adjusting procedure in order to feel when the proper overlock or adjustment has been reached. Make sure that the clutch adjusting lockpin seats correctly in an adjusting hole located in the floating plate. Replace the hand hole plate.

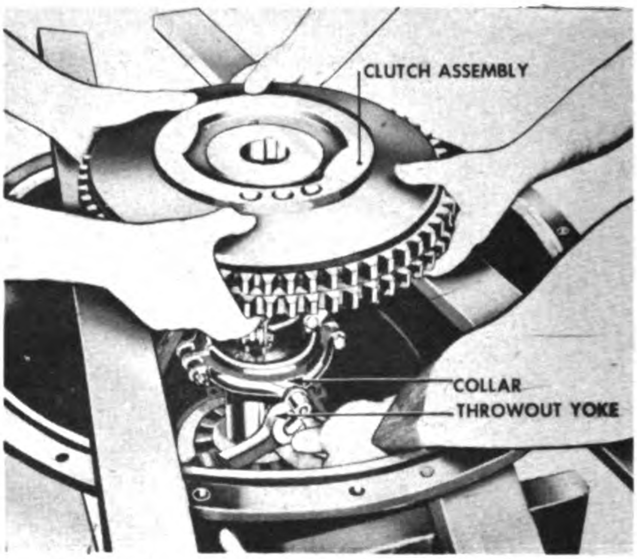


Figure 304. Removing or Installing Clutch Assembly.

189. CLUTCH DISASSEMBLY.

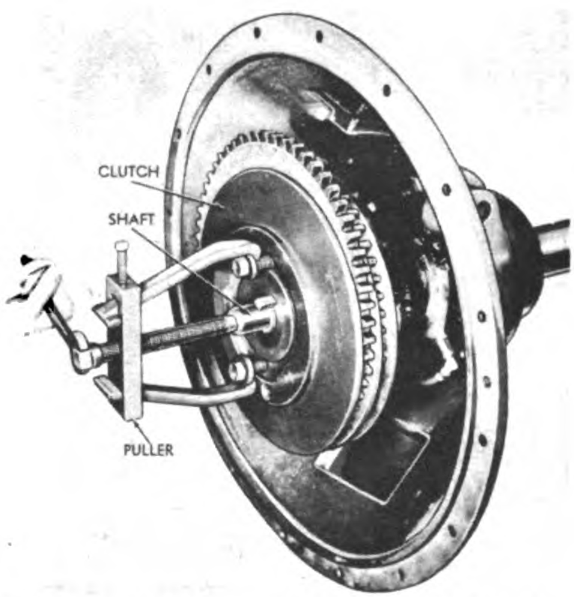


Figure 303. Loosening Clutch Assembly from Shaft.

A. Straighten the lock plate and remove the locknut as shown in Figure 301.

B. Remove the nut and lockwasher holding the grease line to the clutch housing as shown in Figure 302.

C. Set the clutch housing onto an assembly stand or horse as shown in Figure 304 and loosen the clutch assembly from the shaft with a wheel puller as shown in Figure 303. Be sure that the operating shaft throw out yoke is in its full release position.

D. Lift the clutch assembly off the shaft as shown in Figure 304.

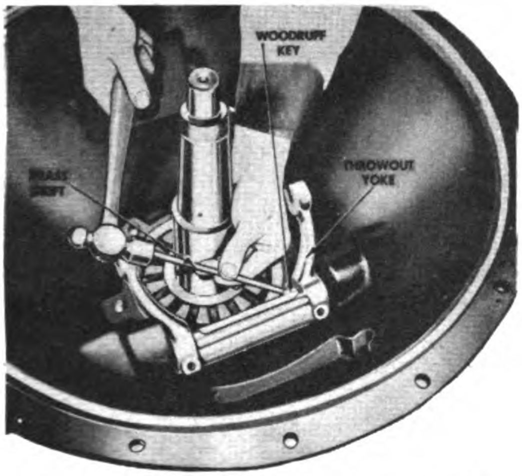


Figure 305. Removing Woodruff key.

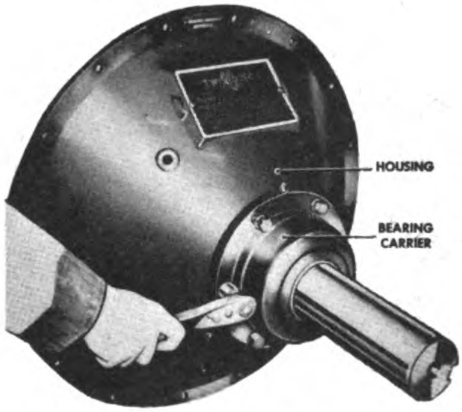


Figure 306. Removing Bearing Retainer Bolts.

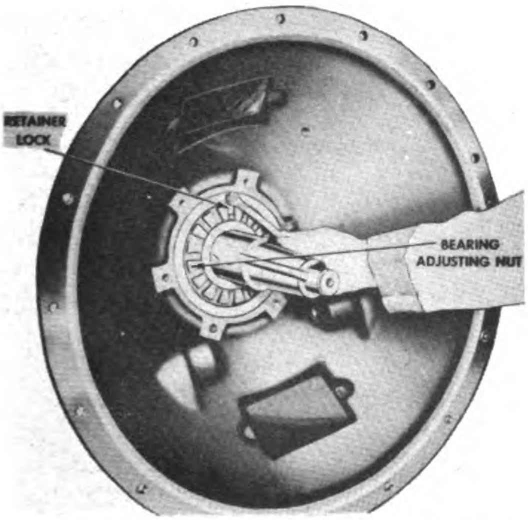


Figure 307. Removing Bearing Retainer Lock Capscrew.

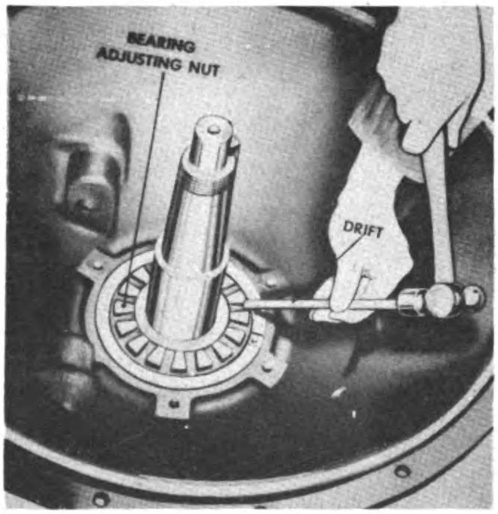


Figure 308. Removing Bearing Retainer.

190. DISASSEMBLING HOUSING AND SHAFT ASSEMBLIES.

A. To remove the operating shaft, drive out the Woodruff keys from the keyway of the operating shaft and the throw out yoke with a brass drift as shown in Figure 305 or by driving out the operating shaft with a lead hammer or a block of wood and hammer.

B. Remove the bolts securing the bearing retainer to the clutch housing. See Figure 306.

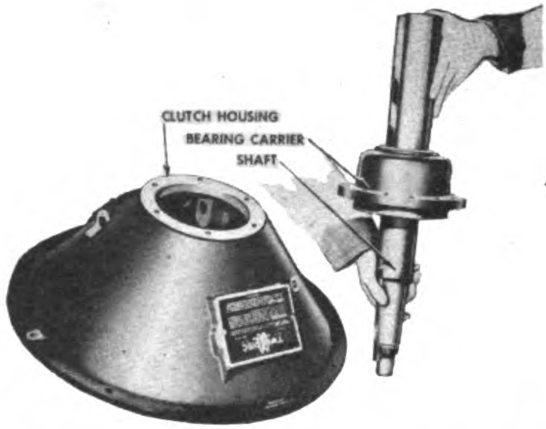


Figure 309. Removing Shaft and Bearing Carrier.

C. Remove the bearing retainer lock capscrews from the bearing retainer. See Figure 307.

D. Remove the bearing retainer from the housing using a drift and a hammer to loosen it and unscrewing it by hand the rest of the way. See Figure 308.

E. Remove the bearing housing and shaft from the clutch housing as shown in Figure 309.

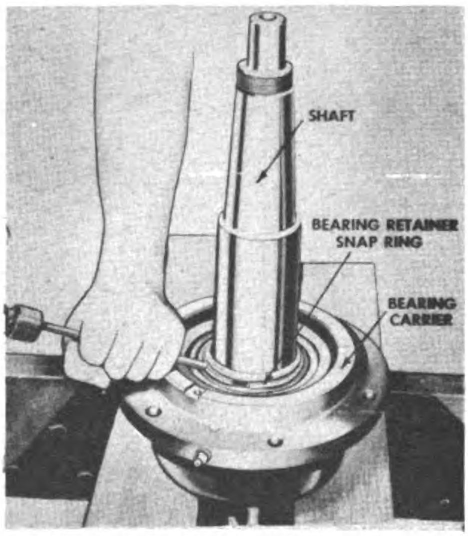


Figure 310. Removing Bearing Snap Ring

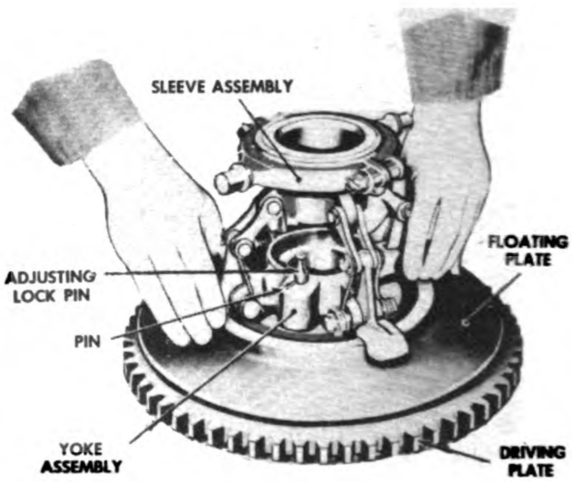


Figure 311. Removing Sleeve and Yoke Assembly.

F. Remove the bearing retainer housing snap ring as shown in Figure 310. If necessary, remove the race from the bearing retainer housing. If the bearings must be removed from the shaft, the inner races will have to be pressed with a hydraulic press, having a capacity of 15 tons.

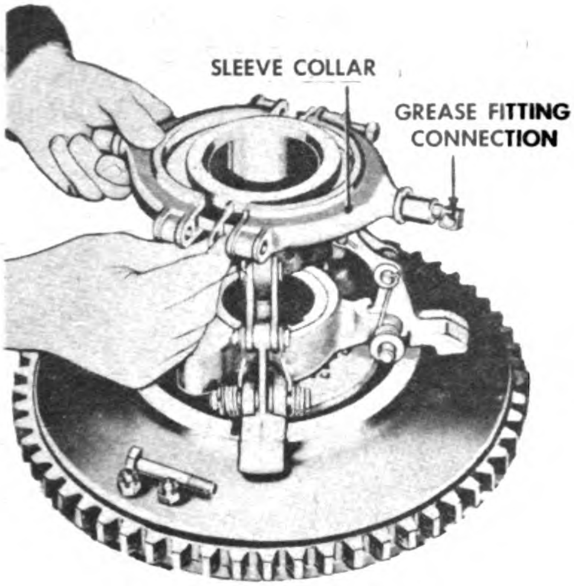


Figure 312. Removing Sleeve Assembly.

191. DISASSEMBLING THE YOKE AND SLEEVE ASSEMBLY

A. If it is not necessary to disassemble the yoke and sleeve assembly, lift the adjusting lock pin out of the notch and insert a cotter or small nail through the lock pin hole and screw the yoke to the left to remove it to get at the hub in the back plate. See Figure 311. If it is necessary to disassemble the yoke and sleeve assembly, remove the sleeve collar by unscrewing the two bolts as shown in Figure 312.

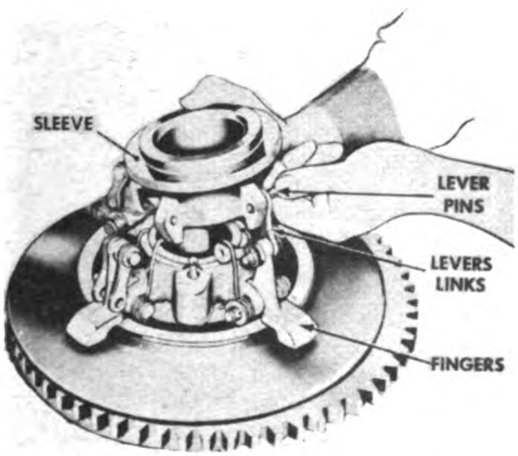


Figure 313. Removing Sleeve Assembly.

B. Slip the snap ring off the link lever pins. Remove the cotter key and washer as shown in Figure 313. Remove the sleeve.

C. Lift the lock adjusting pin and insert a cotter key into the hole in the pin as shown in Figure 314 and remove the yoke from the hub by screwing it to the right.

D. Remove the pins holding the fingers to the yoke and remove the link levers from the yoke. See Figure 314.

192. HUB AND BACK PLATE DISASSEMBLY.

Remove the floating plate from the driving ring as shown in Figure 315, and the back plate and hub.

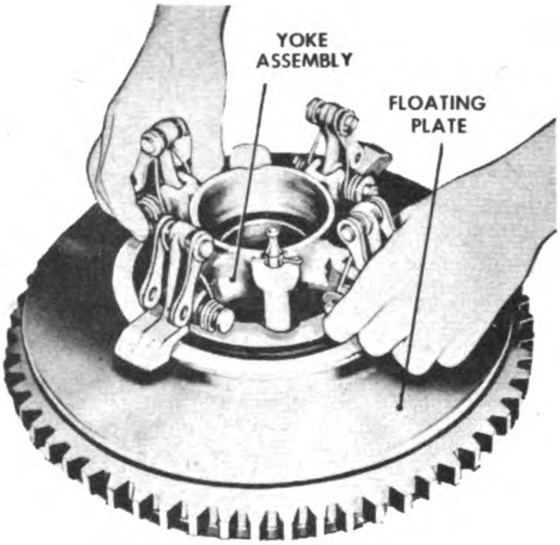


Figure 314. Removing Yoke Assembly.

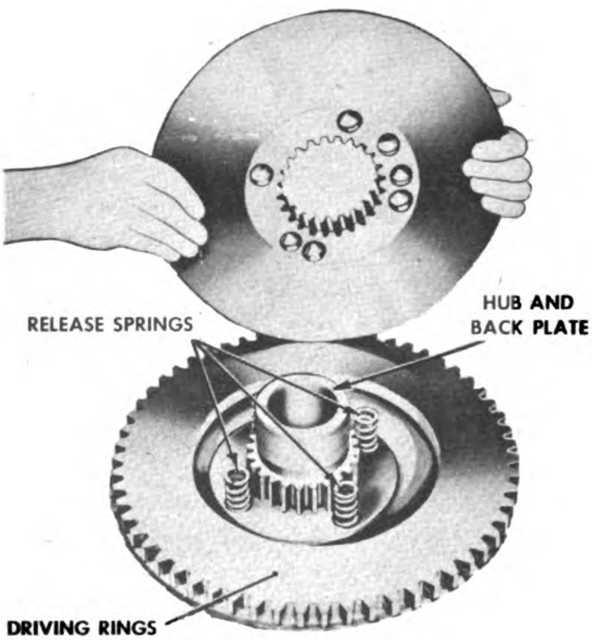


Figure 315. Removing Floating Plate.

The clutch assembly is now completely disassembled.

193. INSPECTION OF CLUTCH.

A. For proper inspection, the parts should be thoroughly washed in cleaning solution.

B. Inspect the facings of the floating plate, back plate, and driving plate for excessive wear. Usually it is the driving plate that will need replacement. Excessive glazed conditions on the drive plate indicate clutch slippage during the engine operations.

C. Examine the internal teeth on the floating plate for excessive wear, and also check the back plate external teeth.

D. Check also the internal teeth of the driving ring that goes onto the flywheel and the external teeth of the driving plates. If the driving plates are worn excessively they should be replaced. Remove any burrs or ridges on the teeth.

E. Examine the four springs of the back plate for equal tension. Also check the back plate hub taper for signs of looseness on the shaft.

F. Check the pilot bearing for rough spots and indications of bearing binding.

G. Check the throw-out collar for tightness. If the bolts are loose, check for undue wear on the collar. Replace the collar if necessary.

H. Also examine the throw-out yoke for looseness on the shaft. If loose when the bolts are tight, examine the shaft and shaft holes to determine which is worn. If both are worn, replace both the shaft and the throw-out yoke.

I. Examine the torsion springs for any breaks and see that the locks on the pins are in good condition.

J. Check the roller bearings for undue wear or any pits. Ordinarily, wear can be taken up by the adjusting nut.

K. Inspect the spring on the lock pin to be sure that the lock pin is held inward towards the locking holes.

194. REASSEMBLY OF CLUTCH HOUSING AND SHAFT.

A. If it was necessary to remove the bearing races from the shaft, press the inner races on the shaft with an hydraulic press. NOTE: If an hydraulic press is not available, immerse the inner races in oil at a temperature of 400° F. for about twenty minutes using a tong to slip the inner races onto the shaft.

B. Assemble the Timken bearings with fresh grease applied to the bearing holder and the inner race.

C. Install the outer race into the bearing carrier housing and slip the shaft with the other bearing into the housing and install the outer race.

D. Install the snap ring see Figure 310 and install the threaded bearing retainer screwing it down so that thread is slightly below flush.

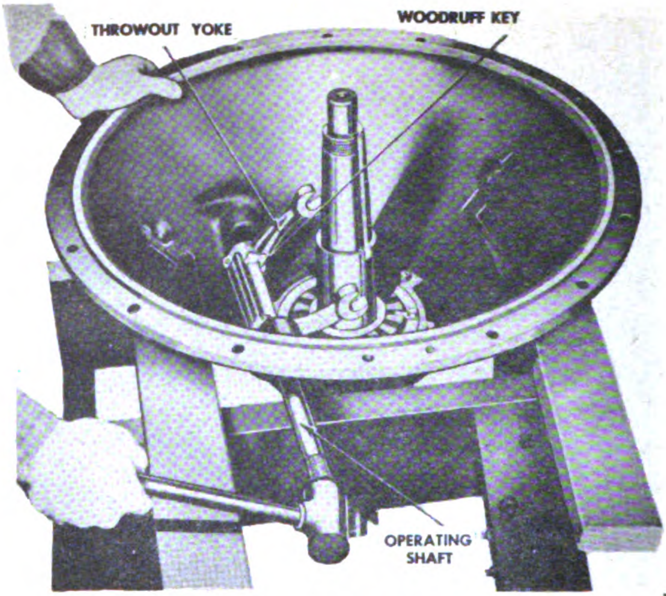


Figure 316. Installing Operating Shaft and Throw Out Yoke.

E. Install the bearing retainer lockwasher and capscrew.

F. Install the shaft and bearing carrier to the clutch housing. See Figure 309.

G. Drive in the operating shaft with the throw-out yoke in place in the housing. See Figure 316.

H. Insert the Woodruff keys into the throw-out yoke and operating shaft keyways. See Figure 317.

I. Assemble the sleeve and yoke assembly reversing the procedure given in Paragraph 191.

J. Assemble the hub and back plate assembly reversing the procedure given in Paragraph 192.

K. Install the yoke and sleeve assembly onto the hub and back plate lifting the adjusting lock pin and keep it from engaging the adjusting notches by inserting a cotter key into the lock pin hole as shown in Figure 311.

L. Screw the yoke and sleeve assembly onto the hub.

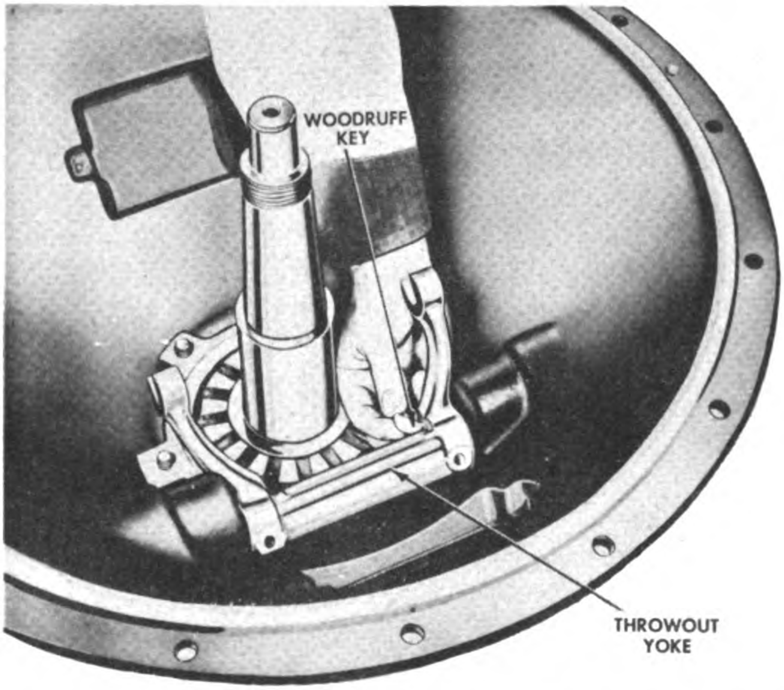


Figure 317. Installing Woodruff Keys in Yoke and Operating Shaft.

195. REASSEMBLING CLUTCH TO HOUSING.

With the clutch housing and shaft setting on an assembly stand, lay two boards across the housing as shown in Figure 304. Lift the clutch assembly onto the shaft. Line up the throw-out yoke with the collar, remove the boards and slip the clutch assembly into place on the shaft. Install the lock plate and lock nut and bend the lock plate over the hub. See Figure 301.

196. REINSTALLATION CAUTION.

Care should be taken to avoid excessive wear or the scrubbing of any parts due to improper alignment between the engine and power takeoff. If such wear is experienced, the following three points should be carefully checked.

A. To determine the concentricity of the flywheel housing bore and the alignment of the flywheel housing face, a dial indicator may be mounted on the engine flywheel and the readings made by cranking the engine. See Figure 157. Satisfactory standard limits recommended by the S.A.E. are "The tolerance of the flywheel housing bore shall be maximum eccentricity .010", total indicator reading. The maximum deviation of the face of the flywheel housing and flange shall be .006", total indicator reading."

B. To avoid overloading of shafts and bearings due to overhanging loads, all pulleys or sprockets should be mounted as close as possible to the housing. At no time should the center line of the drive load be located further away from the housing than one-half of the standard shaft extension.

C. Excessive loads will tend to deflect the adjoining parts to which the power take-off is mounted. To determine the extent to which the deflection occurs under actual operating conditions, mount a dial indicator on a rigid part of the engine, such as the crankcase or independently on the foundation. Readings taken before the drive is installed with the engine standing still and readings taken under actual operating conditions will indicate the deflection. In no case should the indicated deflection exceed .010" at the bearing in the power take-off.

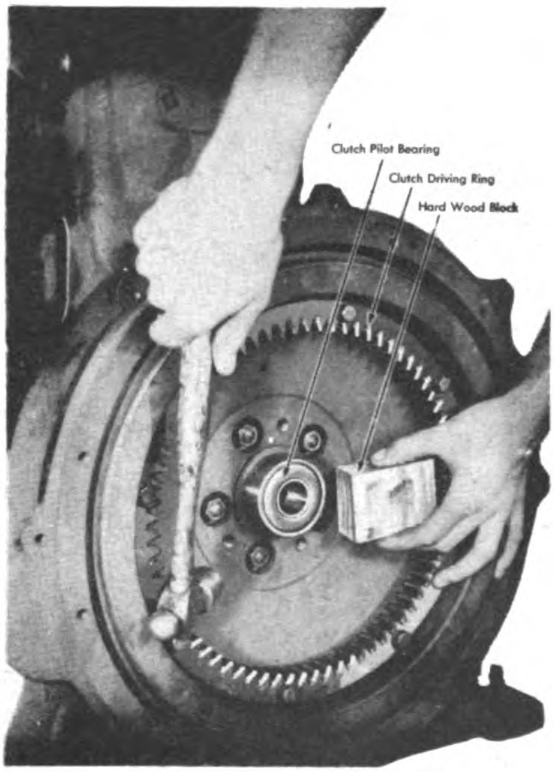


Figure 318. Driving Pilot Bearing into Flywheel Recess.

NOTE: After the power take-off has been assembled to the engine or the bearings have been adjusted, raise the shaft with a block of wood and hammer to break loose any tightness that may result due to the resistance of the pilot bearing when being pressed into the flywheel. To drive the pilot bearing into the flywheel housing, use a block of wood and a hammer as shown in Figure 318. Be sure the pilot bearing recess in the flywheel housing is clean when installing the bearing.

Chapter V

STEPS OF REASSEMBLY

At all times during the steps of reassembly of the engine, the mechanic should bear in mind that dirt is the engine's worst enemy. Therefore the parts should be wiped clean and note particularly to remove lint. Do not use waste for wiping; use a lint-free cloth. An air hose can be used to blow off any fine dirt or lint remaining on the parts after wiping. Only clean fresh oil should be used in oiling the parts as they are reassembled. Be sure to replace all the gaskets, oil seals and belts.

The following steps are the recommended sequence of reassembly. Avoid the temptation to add another step of reassembly. Positively follow the sequence as in the following.

I. INSERTING OIL PLUGS.

With the engine setting on its studs, shellac or

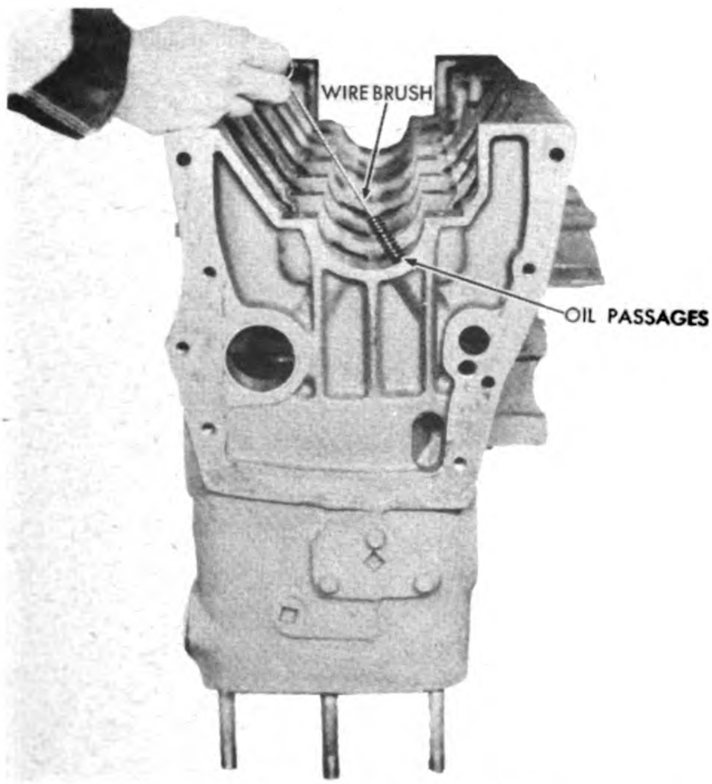


Figure 319. Installing Front Oil Plug.

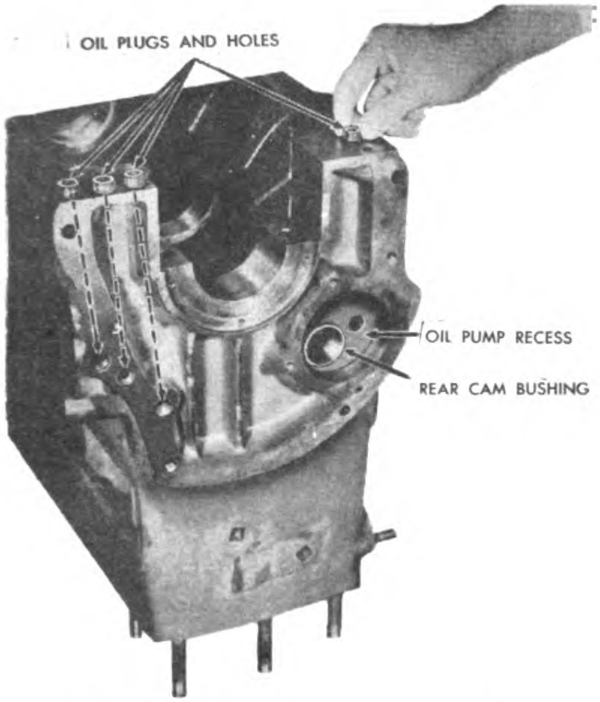


Figure 320. Installing Rear End Oil Plugs.

"permatex" the oil line plugs. Insert one plug in the front end of the main gallery oil line, see Figure 319, three at the rear end of the crankcase, see Figure 320, one at bottom side, rear and two on the outside of the crankcase. Install the oil filter pad, shown in Figure 321. NOTE: The plugs at the front and rear end must be screwed down below the surface of the crankcase so as not to interfere with the surfaces of the flywheel housing and the front support plate.

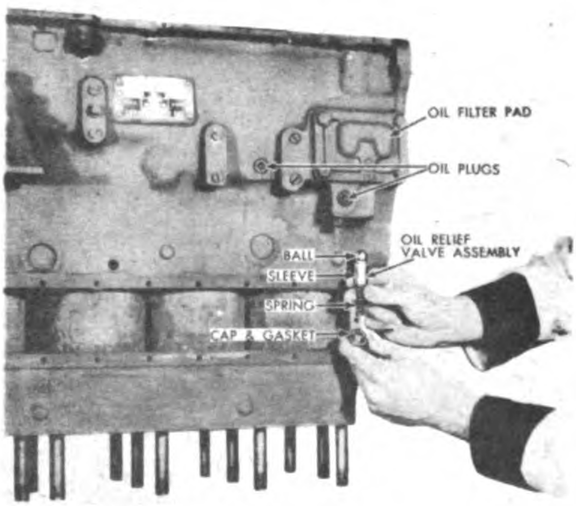


Figure 321. Installing Oil Filter Pad.

2. TIMING GEAR HOUSING.

Insert the two dowel bolts in the front end of the crankcase, permatex the housing gasket and install the gear housing. Make sure the six capscrews holding the gear housing support are tight. **Figure 322.**

3. UPPER HALF BEARINGS.

Unless the four intermediate main bearings are new, insert each bearing shell into the main bearing support from which it was taken. Figure 323. THEIR POSITIONS IN THE SUPPORT MUST NOT BE CHANGED.

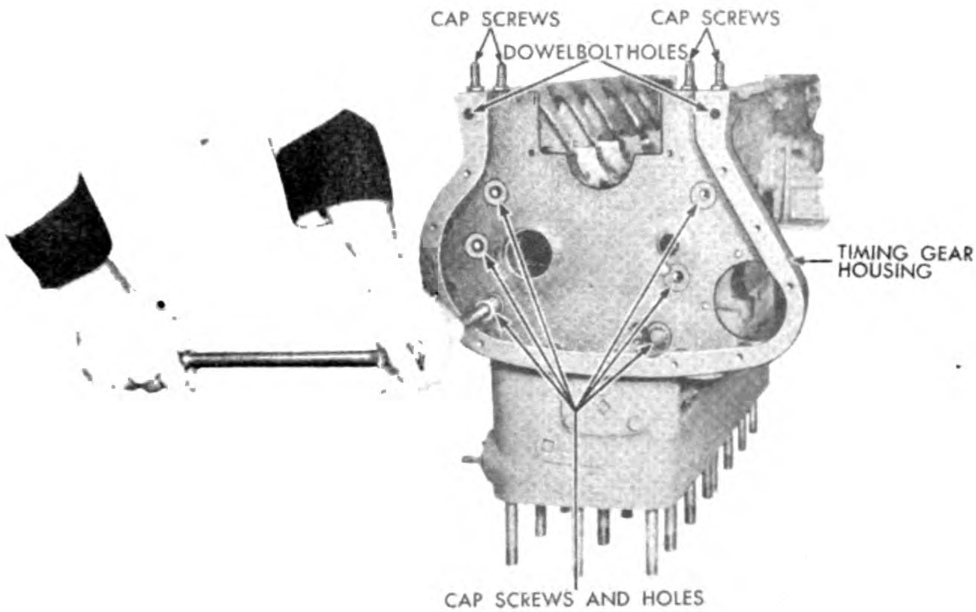


Figure 322. Installing Timing Gear Support.

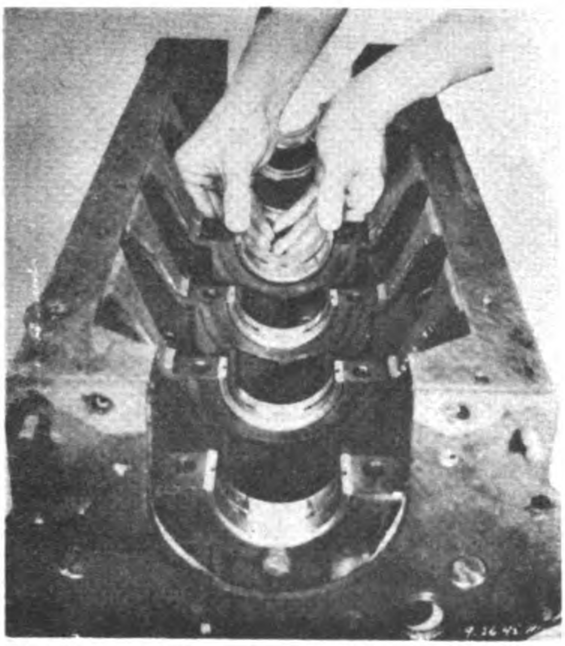


Figure 323. Installing Upper Half of Bearing Shells.

4. INSTALLING UPPER HALF REAR BEARING OIL SEAL.

Install the upper half of the rear bearing oil seal, Figure 324, but first insert enough gaskets to locate the position of the oil seal half way between the crankshaft oil slinger and the flywheel bolt heads. (The accuracy of this position can be checked only after the crankshaft is laid in place).

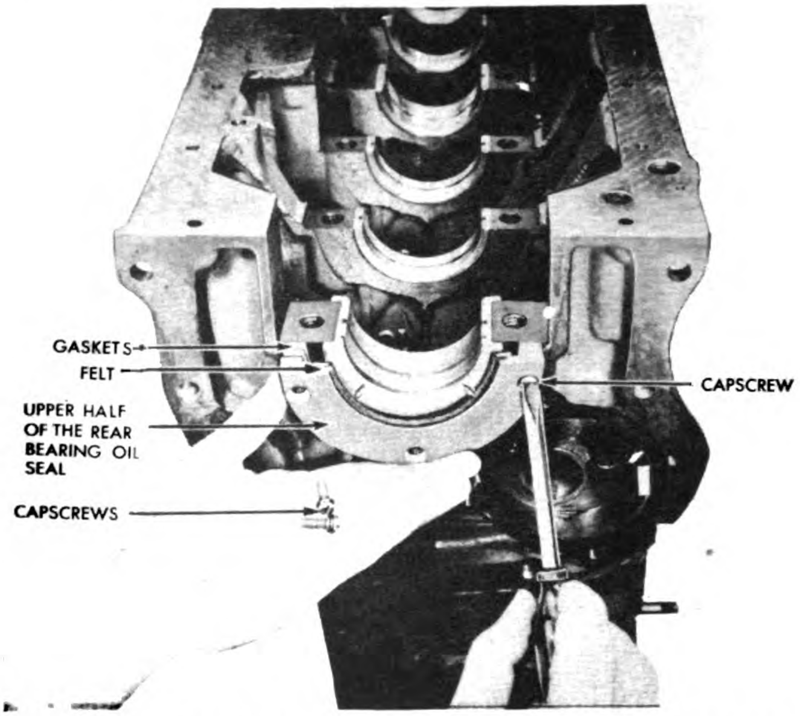


Figure 324. Installing Upper Half of Bearing Shells.

5. SETTING CRANKSHAFT IN PLACE.

With the five flywheel bolts in place in the flywheel flange, lay the crankshaft in place, being careful not to mar the bearing surfaces. Note the extra hole on the crankshaft flange which is for getting at the fillister head screws in the rear bearing oil seal in order to remove the oil seal without having to take out the crankshaft. If a new crankshaft gear is to be installed refer to paragraph 60, Chapter III.

6. CHECKING OIL SEAL.

Now that the crankshaft is in place, check the clearance between the oil slinger on the flywheel flange and the oil seal, Figure 325. The clearance should be between .004" and .008". If not correct lift out the crankshaft and add or remove one or more gaskets to obtain this clearance. THIS SAME CLEARANCE MUST BE OBTAINED AFTER INSTALLING THE LOWER HALF OIL SEAL.

7. INSTALLING LOWER HALF REAR BEARING OIL SEAL.

Attach the lower half of the oil retainer seal to the rear bearing cap. Be sure TO PUT THE COPPER WASHER UNDER THE CENTER FILLISTER HEAD SCREW. Figure 326.

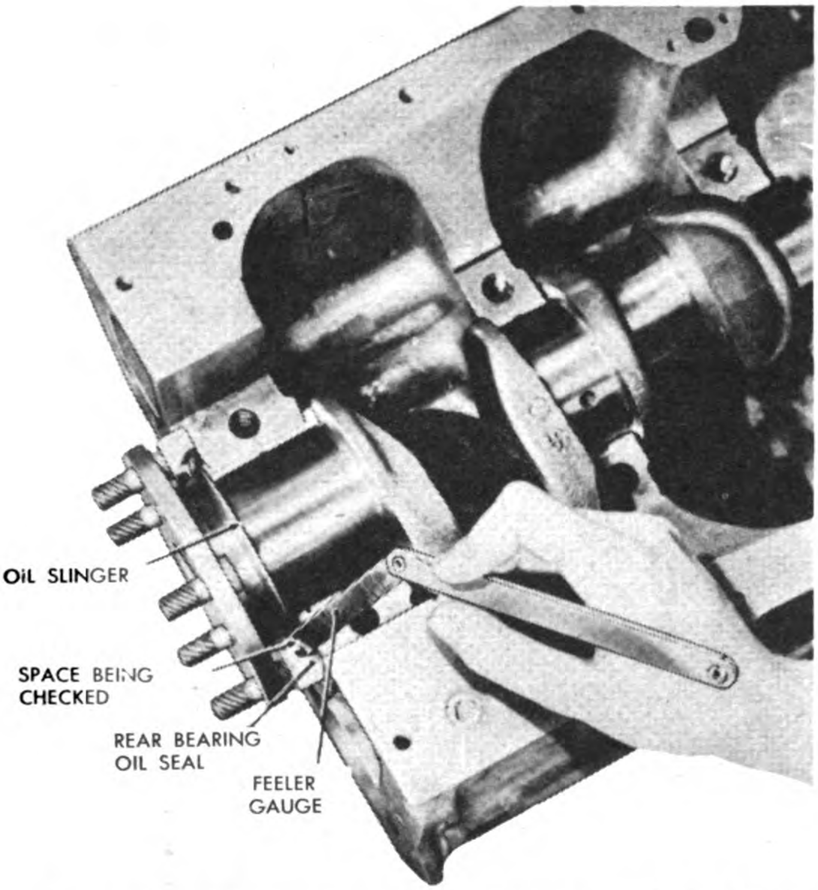


Figure 325. Checking Clearance Between Oil Slinger and Oil Seal.

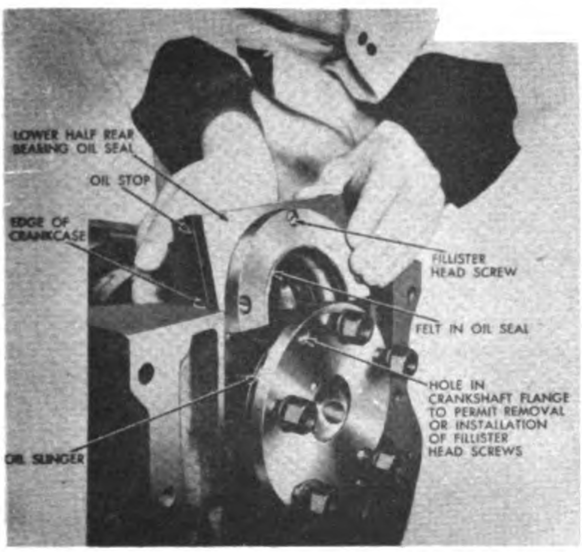


Figure 326. Installing Lower Half of Rear Bearing Oil Seal.

Before installing the new oil studs on the rear bearing cap, be sure there are the same number and thickness of gaskets installed between the rear bearing cap and oil seal as are in the upper cap and seal.

Install the oil stops on the rear bearing cap and install the cap. See Figure 326. After the cap is in place trim the ends of the oil stop flush.

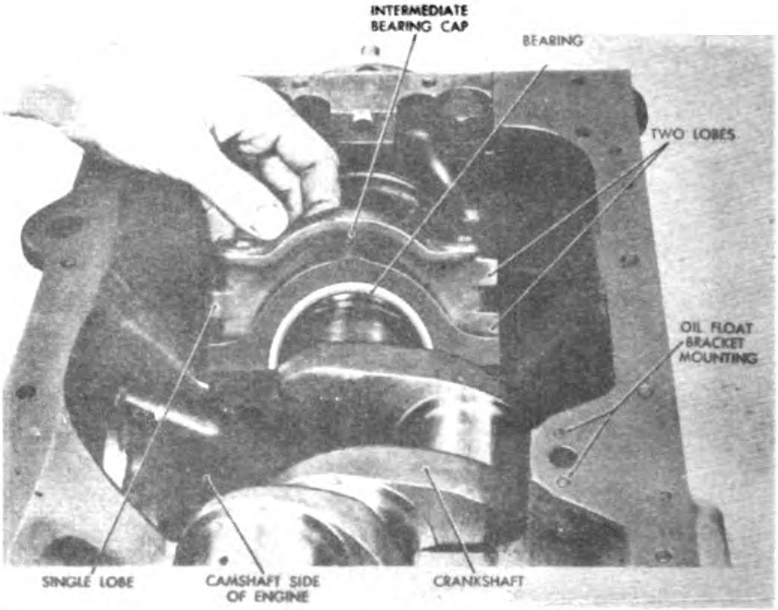


Figure 327. Installing Rear Bearing Caps.

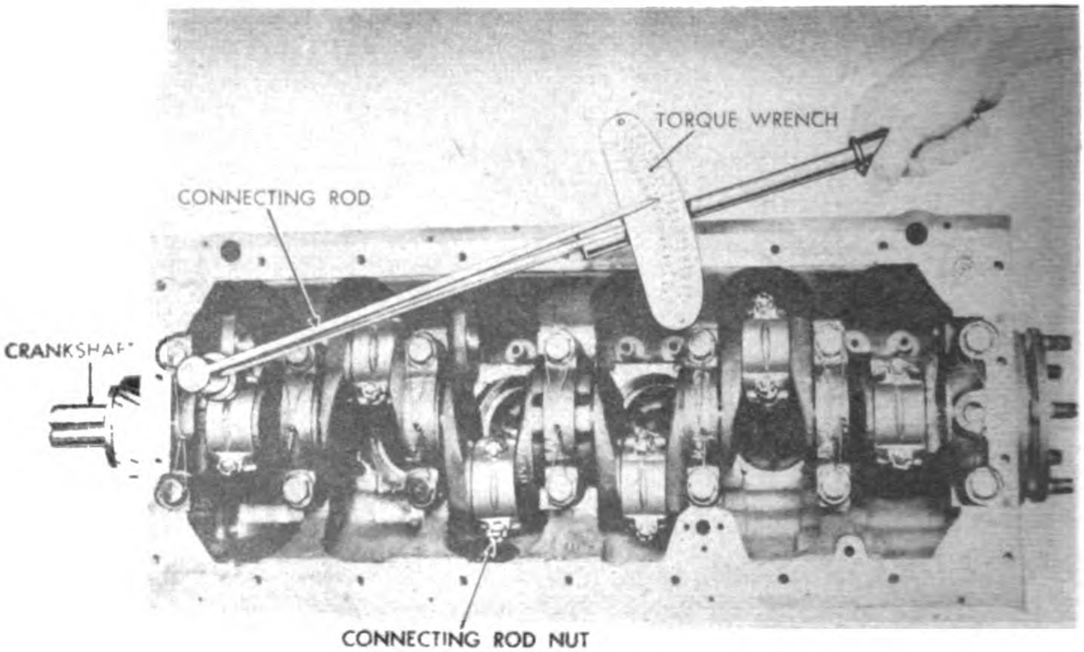


Figure 328. Tightening Main Bearing Capscrews with Torque Wrench.

8. INSTALLING AND TIGHTENING MAIN BEARING CAPS.

The main bearing caps are numbered from one to seven, starting from the timing gear housing at the front end. Place the bearings in their respective places so that the single cast lobe is pointing to the camshaft side of the engine. See Figure 327. Note the dowels in the caps that hold the main bearing in place. Tighten the main bearing capscrews with a torque wrench to a tension of between 125 to 135 pounds feet pressure, as shown in Figure 328. NOTE: Make sure the bolts threads are oiled and clean to get proper tension. Torque each nut to its lowest value and then check to see if the lockwire will go through the hole in the nut. If not, tighten so that the wires can be installed.

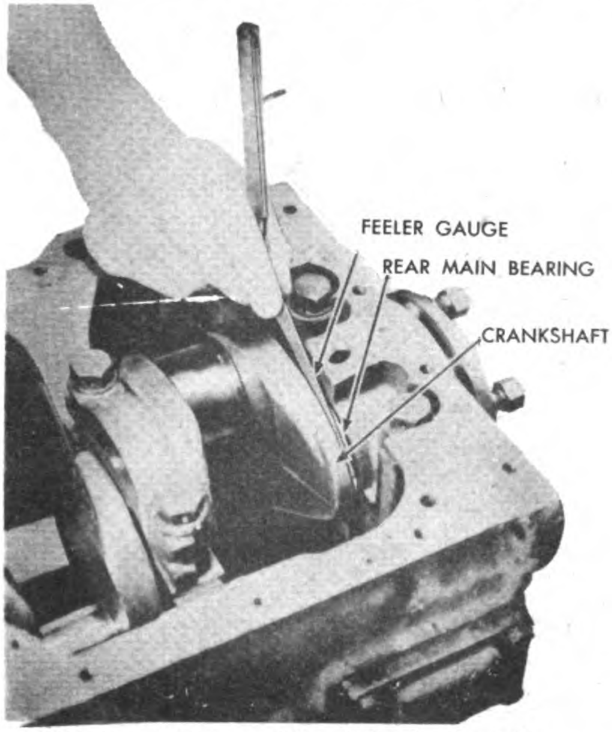


Figure 329. Checking Crankshaft End Play.

However, before installing the lockwires, turn the crankshaft by hand to be sure it is free. Also check the end play by slipping a feeler gauge between the ends of the rear main bearings and the crankshaft, as shown in Figure 329. Run the gauge completely around the shaft. The proper clearance is .003" to .009" desired, .015" permissible. If more, install a new rear main bearing. CAUTION: Before going to the next step, BE SURE LOCKWIRES ARE INSTALLED.

Install the oil baffle plate. See Figure 330.

10. CAMSHAFT.

If camshaft gear was removed for replacement, press the camshaft gear onto the camshaft. Make certain to align the key seat with the key. Slip on the wire retainer ring. Oil the camshaft bearings and install the camshaft into the crankcase. See Figure 331.

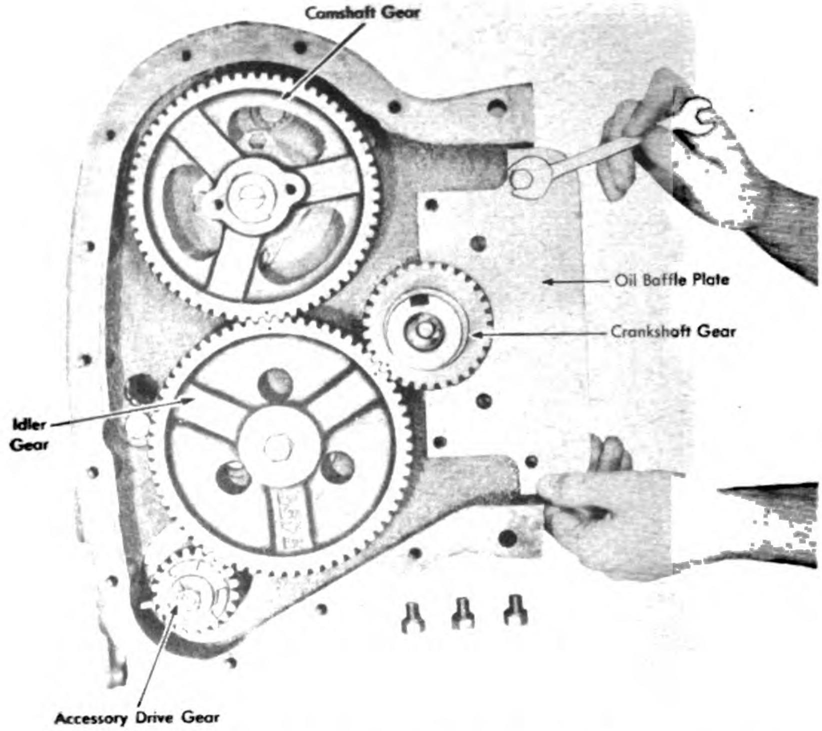


Figure 330. Installing Oil Baffle Plate.

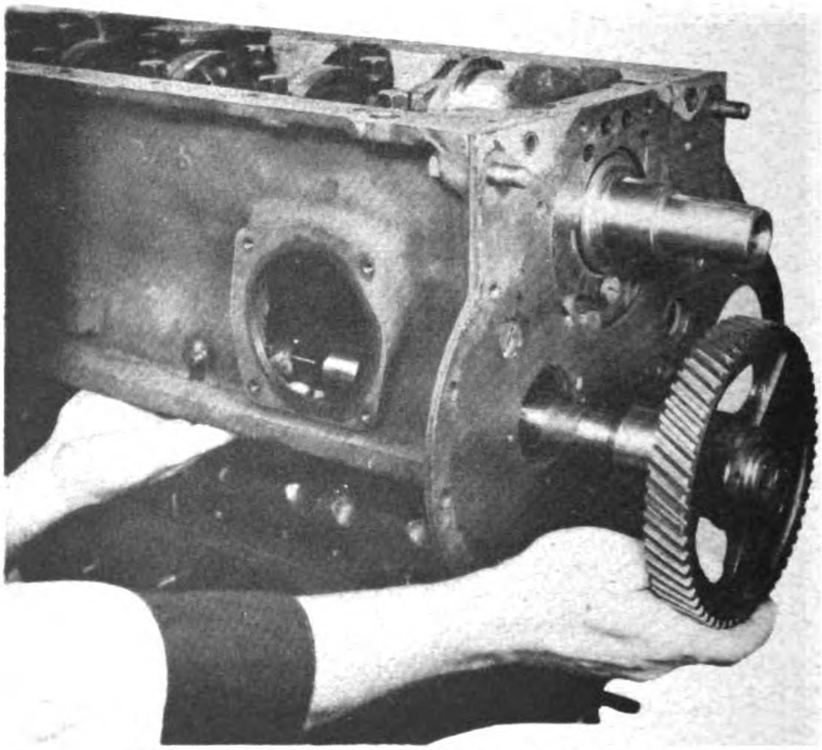


Figure 331. Installing Camshaft.

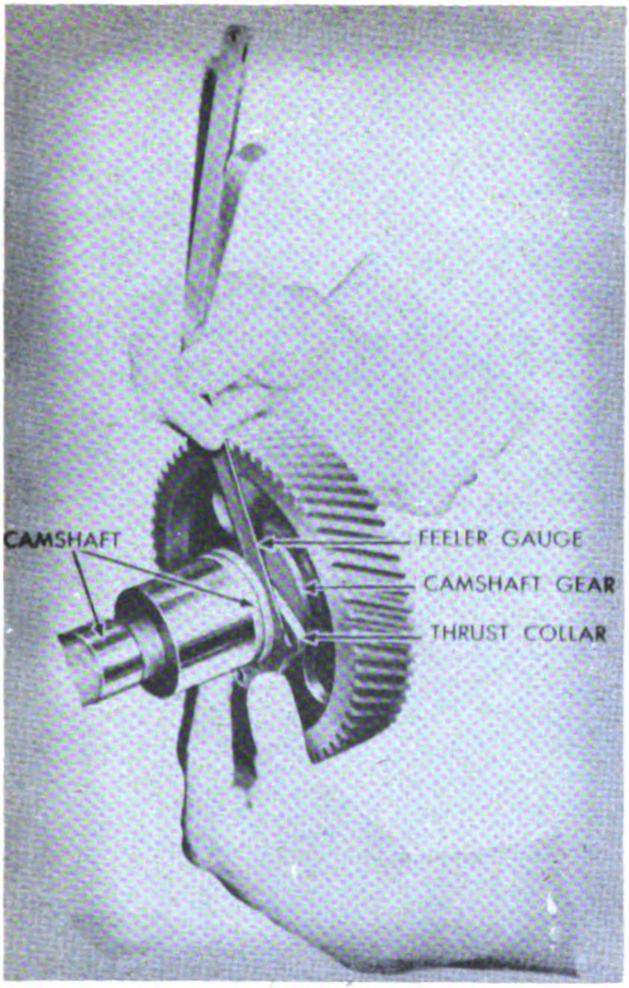


Figure 332. Checking Camshaft End Play.

To check the camshaft end play, measure the space between the hub of the gear and the thrust collar with the shaft pulled forward. See Figure 332. This measurement should be .005" to .008". If excessive, this can be corrected by replacing the gear or the plate or the camshaft. Usually the replacement of the thrust collar will overcome excessive end play.

11. CAMSHAFT COLLAR AND LOCKWIRE.

Install the camshaft thrust collar and lockplate, tighten the capscrews and bend the ends of the lockplate over the sides of the capscrews. See Figure 333.

12. IDLER GEAR SHAFT.

Install the idler gear shaft, using a hammer and block of wood, see Figure 334. Be sure to line up the capscrew hole in the shaft with the setscrew hole in the crankcase. DO NOT MISTAKE THE OIL PASSAGE HOLE FOR THE SETSCREW HOLE. See Figure 335. Install the copper gasket on the setscrew on the outside of the block, install and tighten the acorn lock nut.

Install the idler gear on the idler gear shaft with the number on the outside so that the oil slinger side of the gear is in towards the crankcase. Be sure to line up the two marks on the idler gear in their respective places; one mark with the mark on the crankshaft gear and

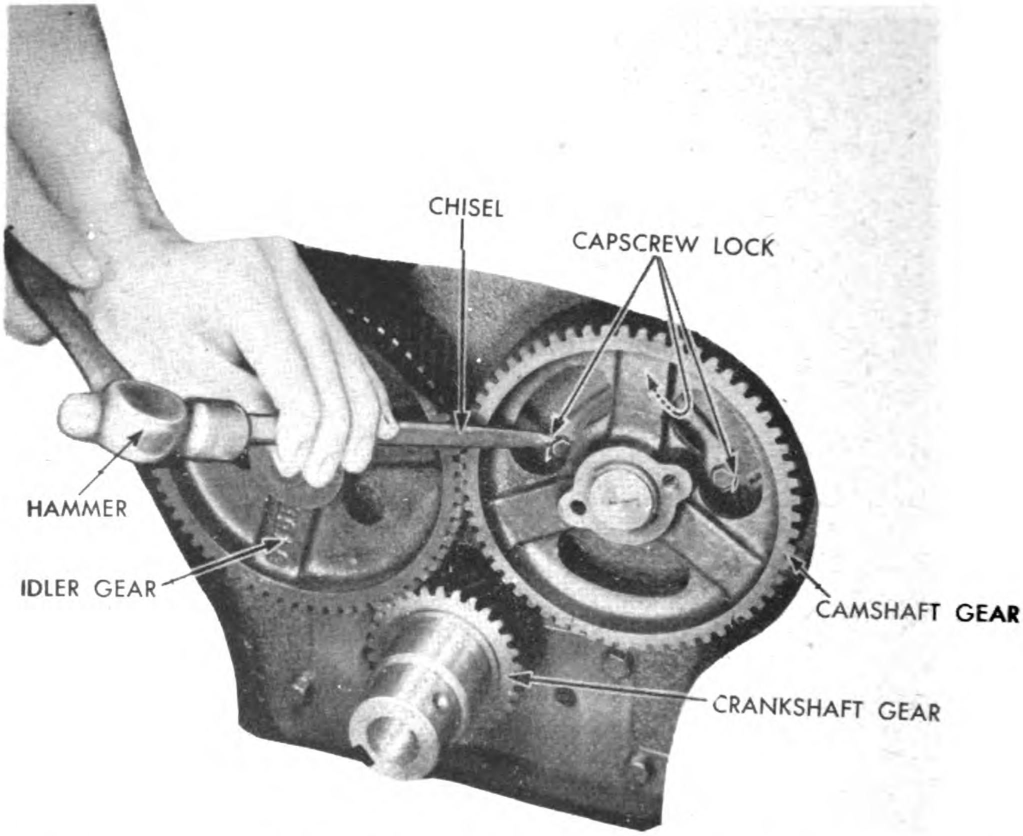


Figure 333. Bending Lockplate over Camshaft Screws.

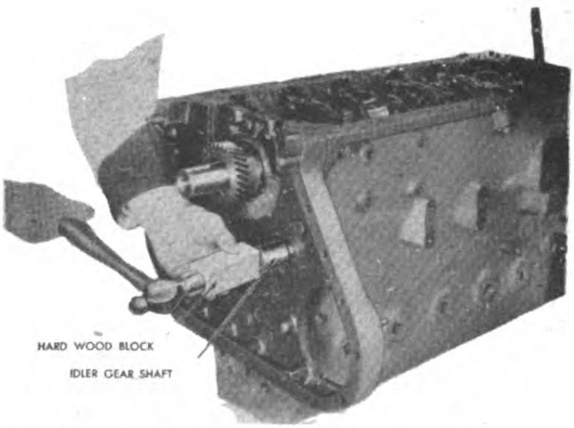


Figure 334. Installing Idler Gear Shaft.

the other mark of the idler gear with the mark on the camshaft gear, as shown in Figure 336. NOTE: If the gears were replaced and the marks were not transferred to the new gears, the timing of the valves cannot be done until the valves are installed. The procedure for timing if this is the case is given in paragraph 31.

Install the idler gear retaining washer and install and tighten the screw. This screw has a left hand thread. Be sure the washer is started on the dowel pin correctly.

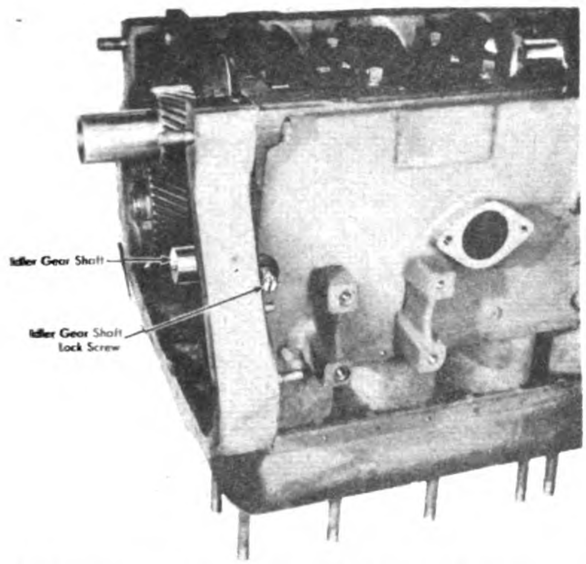


Figure 335. Installing Idler Gear Lock Screw.

To check the idler gear end play, which should be .004" to .007", insert a feeler gauge between the idler gear hub and the retaining washer, as shown in Figure 337.

Also check for backlash between the idler gear at the points where it meshes with the other two gears. If more than .005", replace it with an oversize gear. Figure 338.

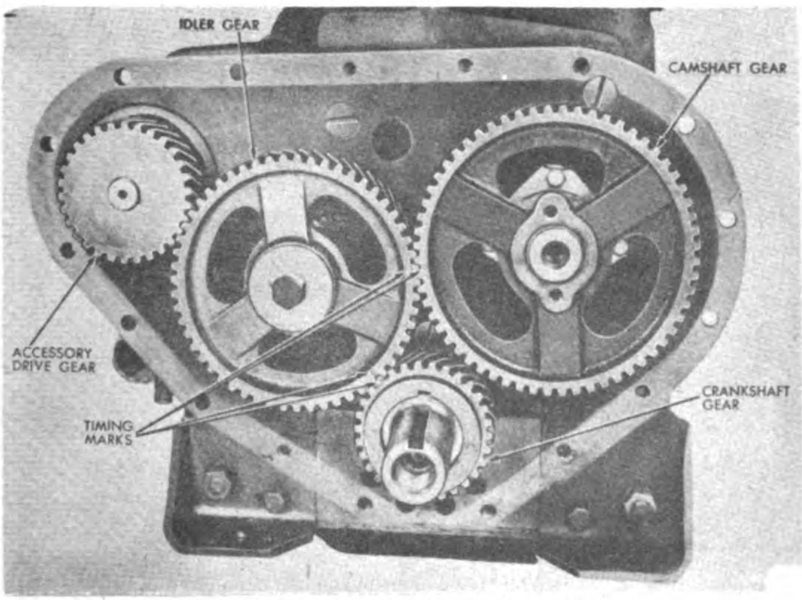


Figure 336. Gears.

13. WATER PUMP ACCESSORY DRIVE.

Install the water pump accessory drive and gear and check for backlash with a dial indicator or by inserting a .005" shimstock feeler between the teeth of the gears, see Figure 339. If the backlash between the idler gear at all the three points where it meshes with the other

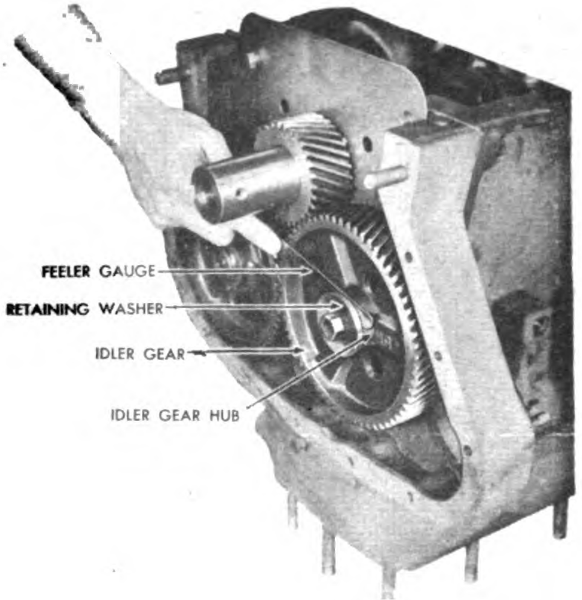


Figure 337. Checking Idler Gear End Play.

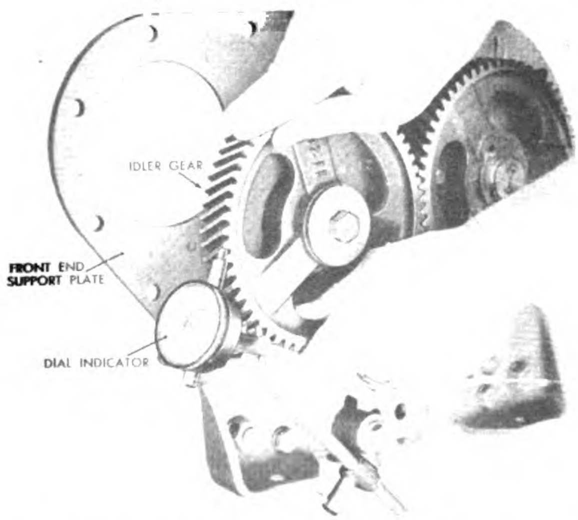


Figure 338. Checking Idler Gear Backlash.

gears is more than .005", replace the idler gear with an oversize gear.

14. FAN PULLEY SPACER.

Install fan pulley spacer on the crankshaft with the shoulder against the crankshaft gear, using a hammer and a block of wood. See Figure 340.

15. OIL PUMP.

Install the oil pump. Be sure to use new copper gaskets in the dowel sleeves, and be sure that they are properly in place. Line up the pin and fork drive and tighten the oil pump in place. See Figure 341.

NOW WITH A CHAIN HOIST, LAY THE ENGINE ON ITS RIGHT SIDE.

16. CLEANING PISTON GROVES.

Clamp the piston and connecting rod assembly in a vise with lead jaws to prevent damaging the connecting rod so that the piston seats tightly against the top side of the jaws. With a narrow strip of clean cloth, clean out each ring groove. If the clearance between the ring lands and the ring have not been checked according to the instructions in paragraph 68, Chapter II, check to be certain that each ring is free in its respective groove.

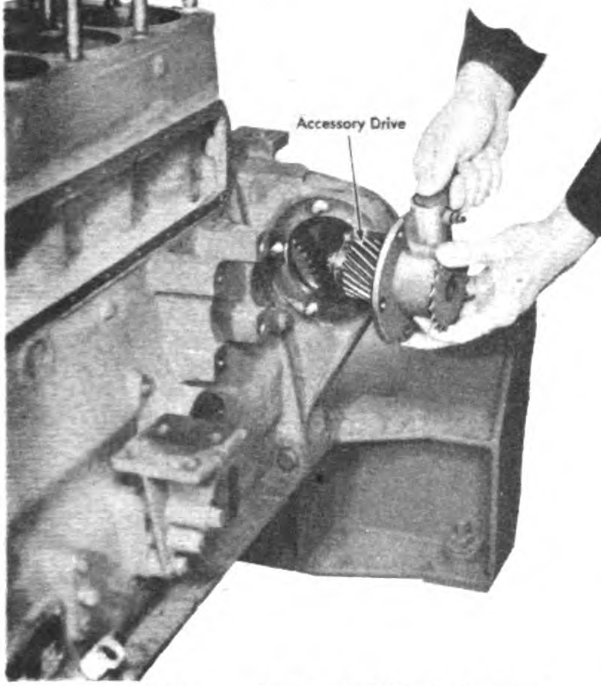


Figure 339. Installing Accessory Drive.

17. INSTALLING PISTON RINGS.

The first ring should be a bigger gap than the second and third rings. The latter two rings must be installed with the plain side up and the undercut side down. Squirt oil on the rings and piston skirt. Figure 342.

Place a ring compressor over the rings as shown in figure 343. Make certain that the rings are wholly in their grooves before tightening the compressor.

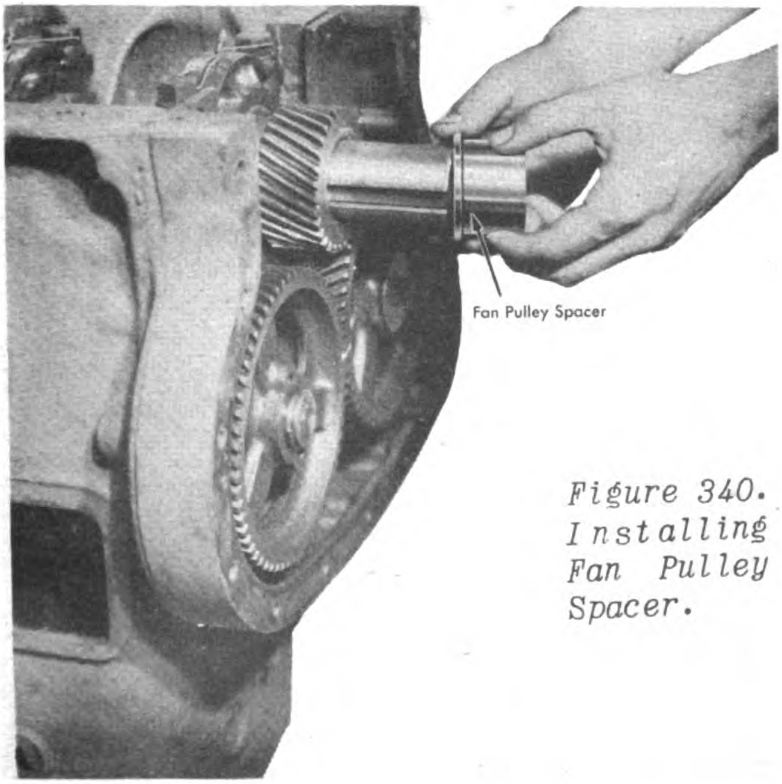


Figure 340. Installing Fan Pulley Spacer.

STEPS OF REASSEMBLY

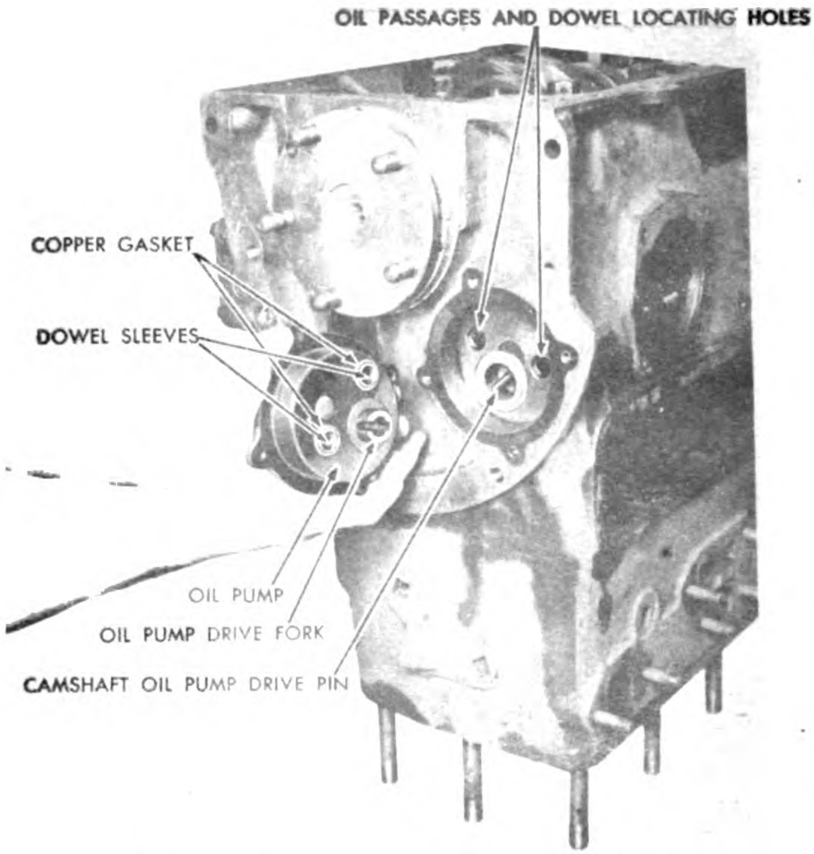


Figure 341. Installing Oil Pump.

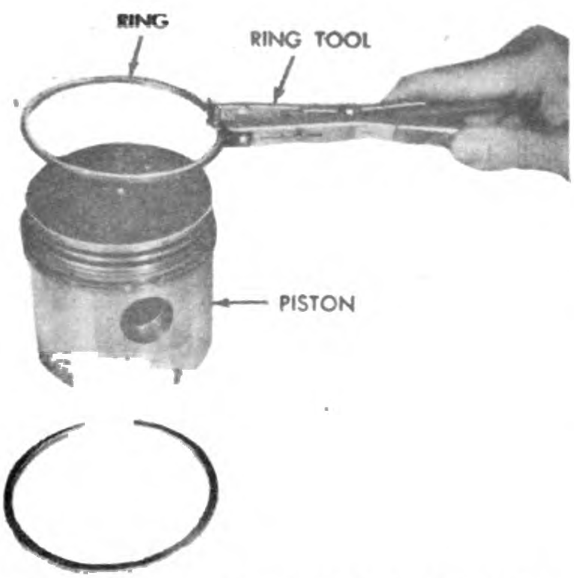


Figure 342. Installing Piston Rings.

Tighten the compressor a little bit at a time - pausing to push the compressor sideways to be certain that the rings are free. Compress as much as possible. Place a wooden guide, shown in Figure 344, over the upper connecting rod bolt to guide the rod into place without marring the bearing surfaces of the crankshaft. Insert the piston and connection rod assembly into its proper cylinder, making certain that No.

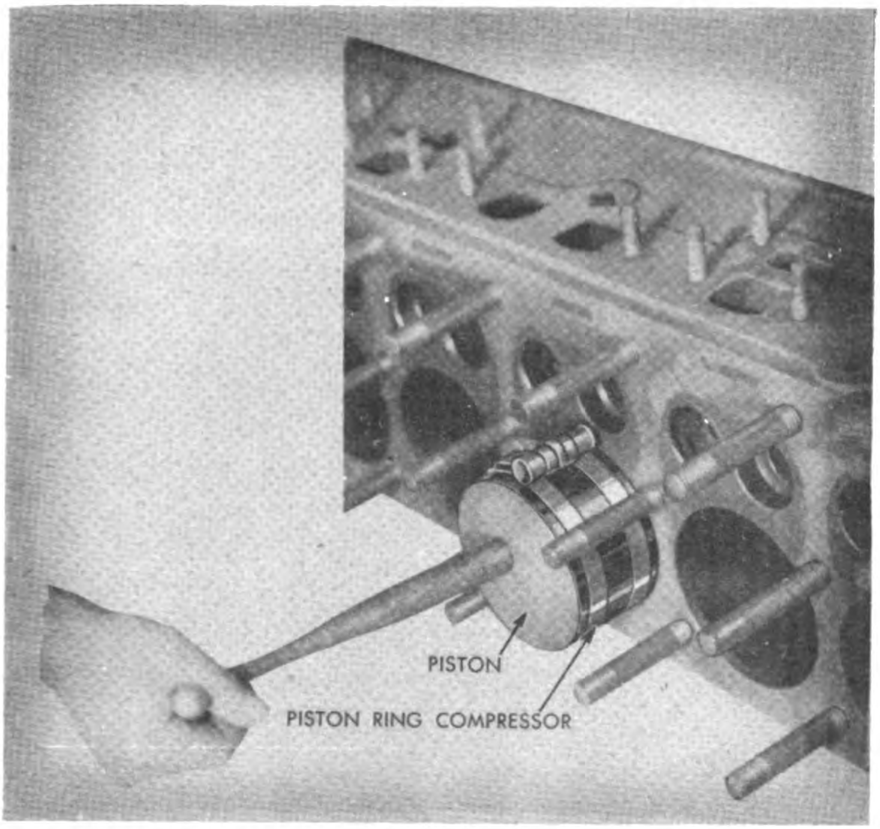


Figure 343. Installing Piston into Crankcase.

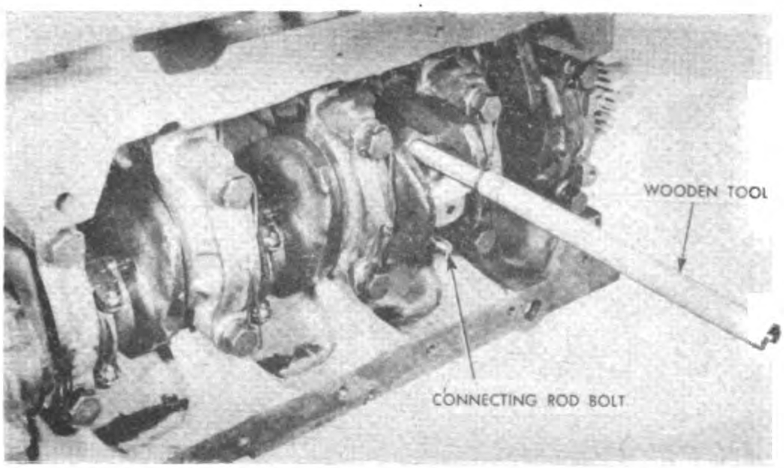


Figure 344. Guiding Connecting Rod into Crankcase.

1 piston is in No. 1 cylinder with the designating number facing the right side of the engine (opposite of the camshaft) and so on for each respective piston and cylinder. Lightly tap the piston and connecting rod assembly into

place with the handle of a hammer. Do not force the piston into the cylinder. If it does not move easily, either the rings are not compressed enough or connecting rod is catching on the crankshaft.

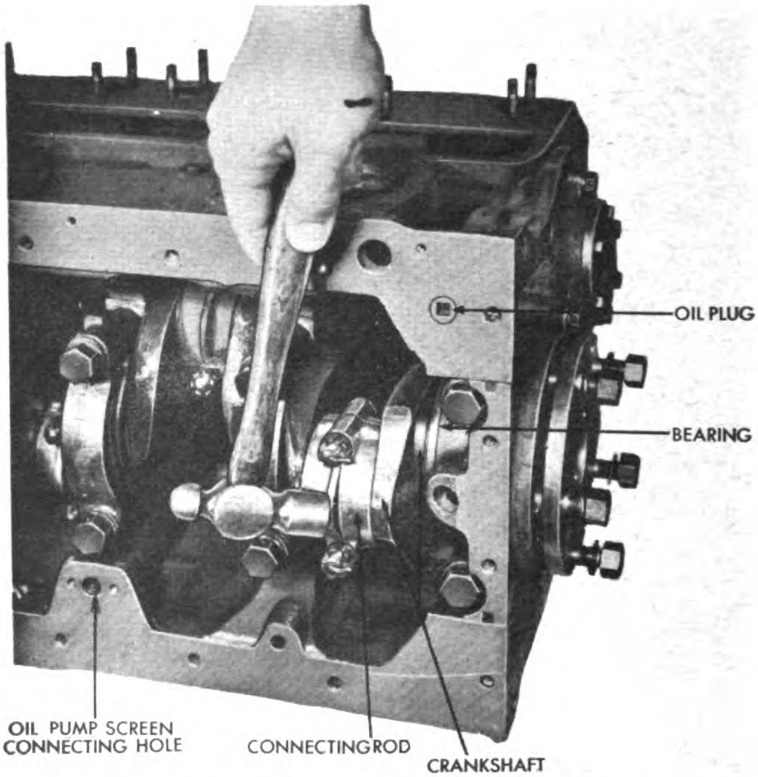


Figure 345. Checking Connecting Rod Side Play.

18. INSTALLING CONNECTING ROD CAP.

Install the connecting rod cap, oiling it and make sure that the number on the cap corresponds and lines up with the number on the rod. The caps are not interchangeable nor must their position be reversed. Tighten each rod separately with a torque wrench to 93 to 105 foot pounds, similar to Figure 328. Check the side play of the connecting rods by tapping each cap lightly. See Figure 345. This side play should be from .004" to .009" Check with a feeler gauge. If there is no side play, the piston and rod must be removed and checked as follows: Place the connecting rod cap on the crankshaft journal to see if it can be moved sideways; if not, the cap and rod must be filed together. Usually a few strokes are sufficient to provide clearance. If there is side play, but the movement is not free when tapping the cap and rod, there is either dirt on the bearing or the bearing is of improper size.

Line up the cotter pin holes and insert pins of a large enough diameter to make a snug fit in the holes. The cotter pins should extend about 3/8" to 1/2" to allow enough length for bending. If longer, cut off the excess length.

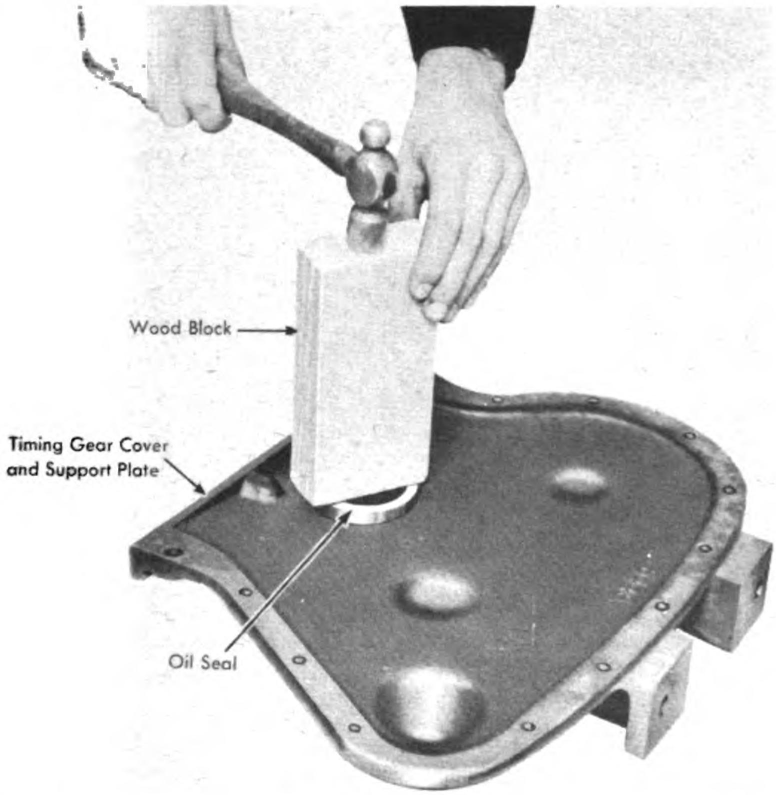


Figure 346. Driving Oil Seal into Gear Case Cover.

19. INSTALLING TIMING GEAR COVER.

Unless the valves have to be timed because the gears were replaced without the timing marks being transferred to the new gears, install the timing gear cover. But first drive the oil seal into the gear case cover as shown in Figure 346, and install timing gear cover.

20. INSTALLING REAR BEARING CAP DRAIN TUBE AND FLOAT.

Install the rear bearing cap drain tube and oil float, Figure 347.

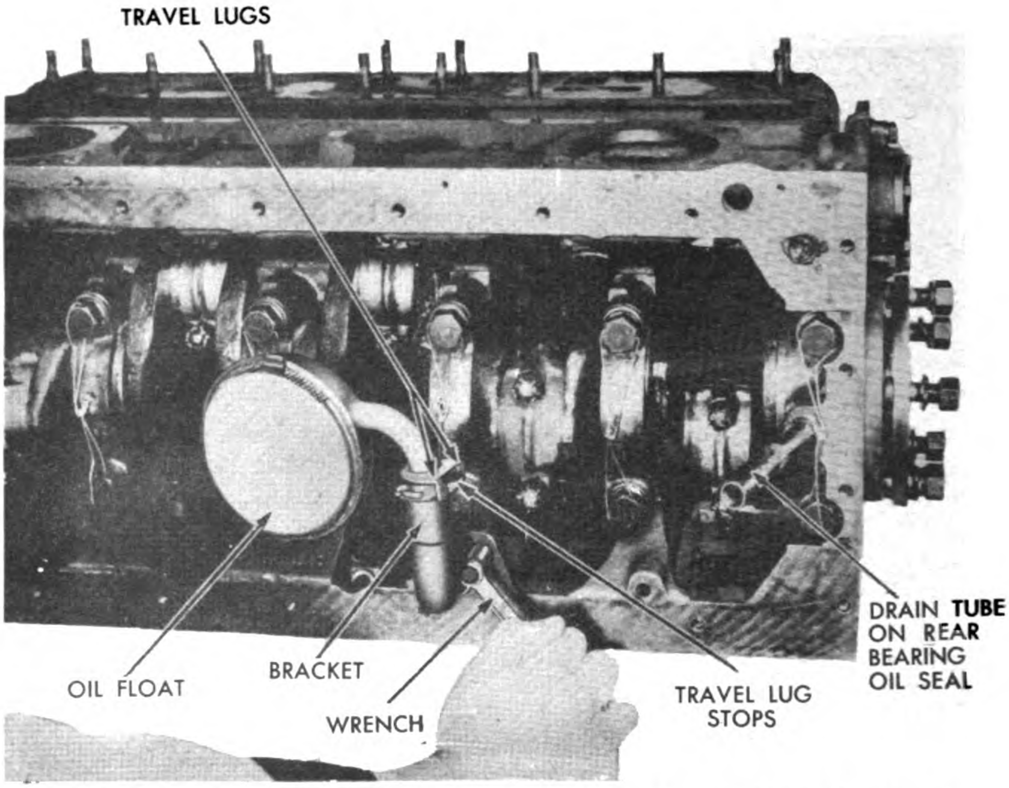


Figure 347. Installing Drain Tube and Oil Float.

21. RECHECK OIL PAN.

Shellac the gasket to the oil pan but before installing the oil pan recheck all the connecting rod cotter pins and main bearing lock wires to see if they are in place and tight.

NOTE: Before installing oil pan, the front gear case cover should be installed as mentioned in paragraph 19, unless the valves have to be timed.

22. INSTALLING FLYWHEEL HOUSING.

With the flywheel housing dust plate assembled to the flywheel housing, install the flywheel housing by slipping it into place on the two dowel bolts. Install the two dowel bolt nuts and the four capscrews and tighten. See Figure 348.

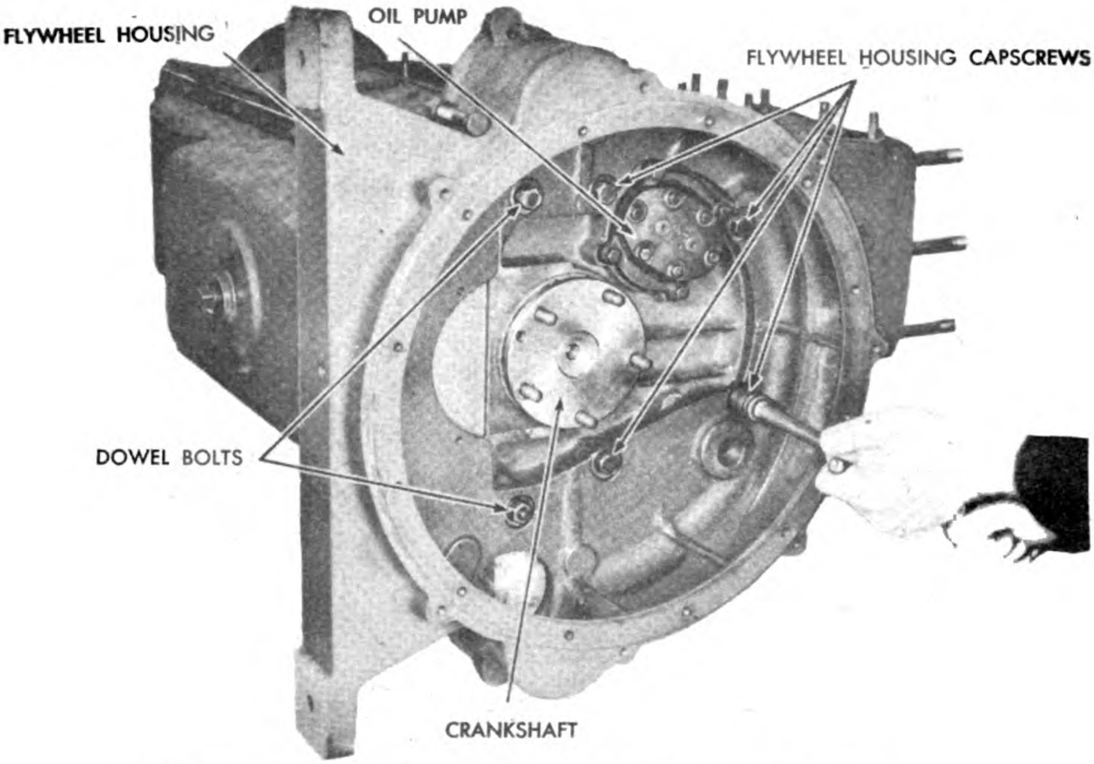


Figure 348. Installing Flywheel Housing.

23. INSTALLING FLYWHEEL.

Before installing the flywheel, make certain that all the dirt has been removed from the crankshaft flange, and the crankshaft flange recess in the flywheel. Feel the surfaces for burrs and nicks. See Figure 349. To facilitate putting on the flywheel, move No. 1 piston, or No. 6, to top dead center. Line up the timing marks on the flywheel with the timing hole in the housing. Because of an offset bolt, the flywheel goes on in one position only. Lift the flywheel into position on the flywheel bolts. Put on the lockwasher and nuts. Be sure to use the special thin lockwashers provided. Tighten the nuts slowly and evenly by tightening each second nut going around several times until the nuts are tightened.

24. CHECKING RUNOUT.

Check the runout of the flywheel with a dial indicator as shown in Figure 350. The maximum total indicator reading should not exceed .008". If more and if there are no burrs or nicks on the flywheel, either the flywheel or the crankshaft will have to be replaced.

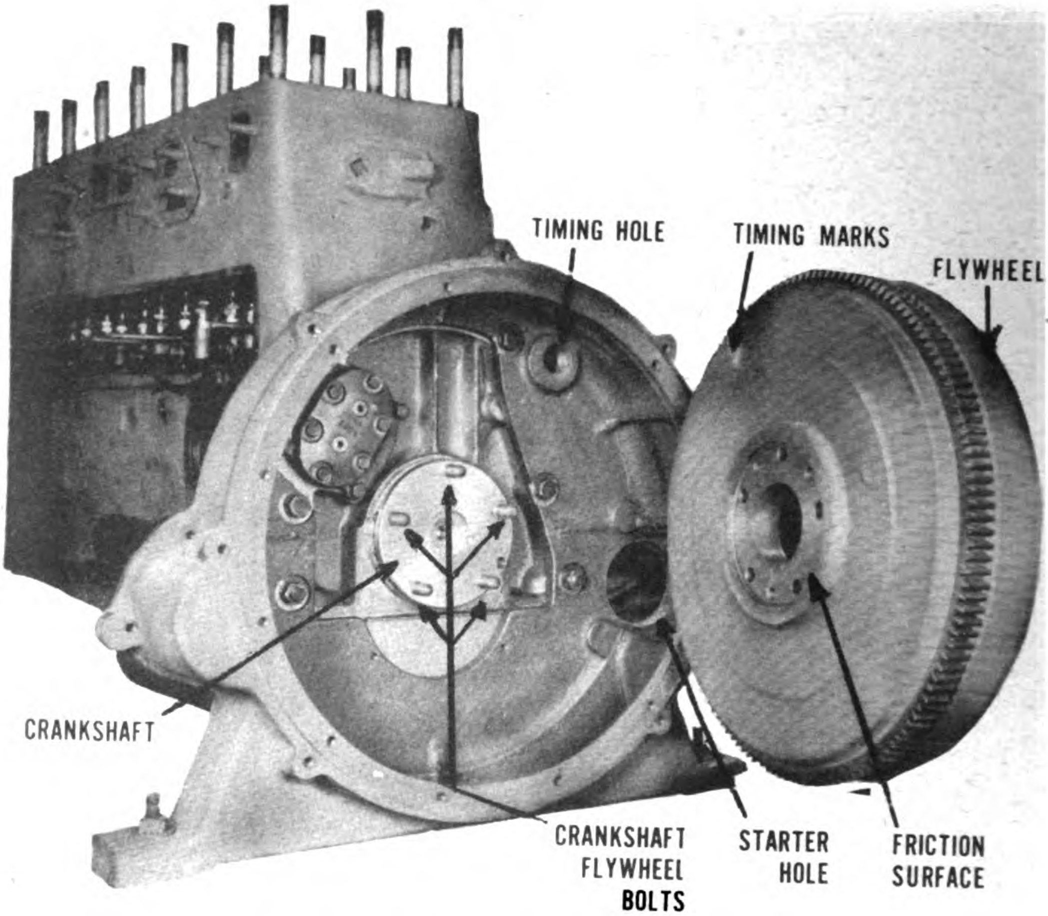


Figure 349. Installing Flywheel.

25. FRONT SUPPORT.

Install the front engine support with bolt head on water pump side of engine. See Figure 351.

26. CHANGE POSITION OF ENGINE.

With a chain hoist, set the engine upright so it rests on the flywheel housing and front engine support.

27. OIL PRESSURE RELIEF VALVE.

Install the oil pressure relief valve making sure that the valve seat balls and springs are clean. See Figure 352.

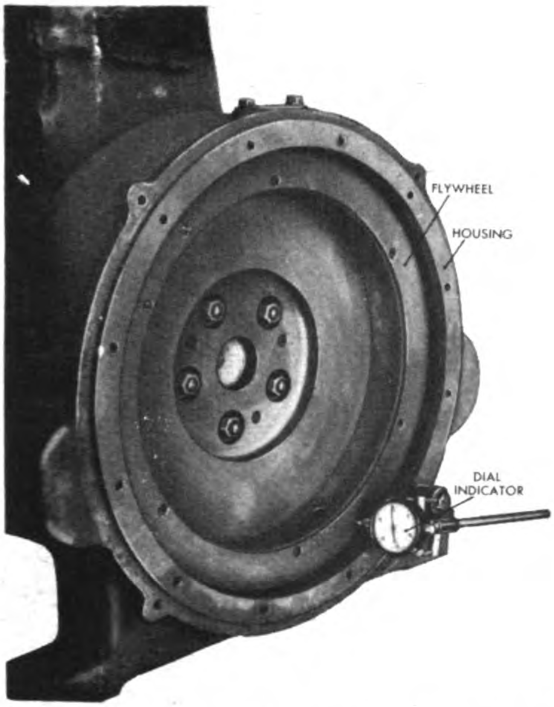


Figure 350. Checking Flywheel Runout.

28. INSTALLING VALVE SPRINGS.

First install cloth in the well to prevent parts of the valve retainers falling into the crankcase. Place the valve spring seats and valve springs in the valve chamber in their proper order and insert the valves in their proper places; the exhaust valves in the exhaust ports; intake valves in their ports. Also make sure that the No. 1 intake valve goes into No. 1 intake port, etc. NOTE: The closest wound end coil should go into the upper

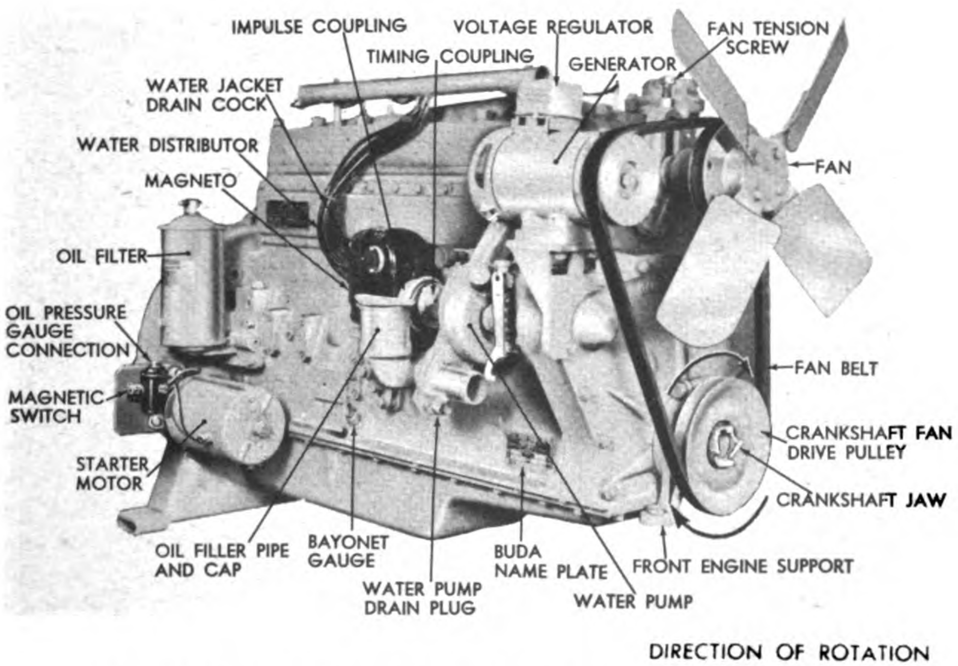


Figure 351. Right side of Engine Showing Front Support.

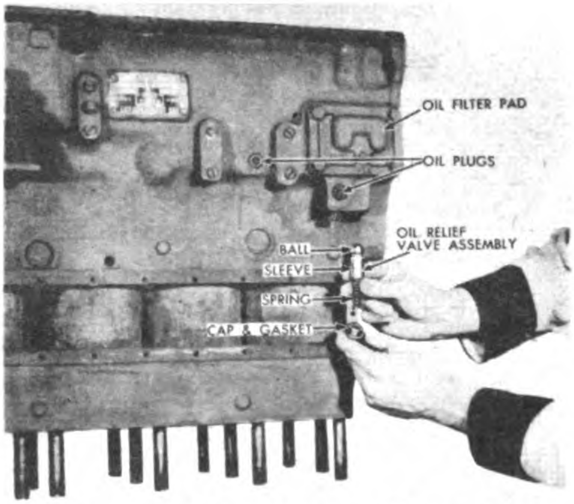


Figure 352. Installing Oil Pressure Relief Valve.

valve spring seat. See Figure 353. Compress the springs with a valve lifter tool and slip in the retainer halves. See Figure 354. IMPORTANT: A coat of grease on the inside of the retainers will make them stick to the stems while compressing the springs. Make certain the retainer halves are firmly seated on the valve stem.

29. INSTALLING VALVE LIFTER BRACKET ASSEMBLY.

Grasp the top of the lifter firmly with the fingers, as shown in Figure 355 and install the assembly. NOTE: It may be necessary to turn the flywheel over in order to set each lifter under the valve assembly.

After the lifters are set properly under the valves, the bracket can be lined up with the holes in the crankcase and the capscrews inserted and tightened.

CAUTION: The holes for the screws holding the assembly in place open into the cylinder bore and if, for any reason, any of the capscrews are replaced, ONES OF IDENTICAL LENGTH SHOULD BE USED, 2" LONG, OTHERWISE THEY WILL SCORE THE PISTON. Install the baffle plate, Figure 356.

30. TEMPORARY ADJUSTMENT OF VALVE CLEARANCE

Since permanent setting of valve clearance can only be done when the engine is warm, make a temporary adjustment of the valve clearance as follows: .010" for the intake valves and .012" for all exhaust valves. Adjustment of tappets and final adjustment is explained in paragraph 58 (test running of engine).

31. TIMING AFTER NEW GEAR INSTALLATION.

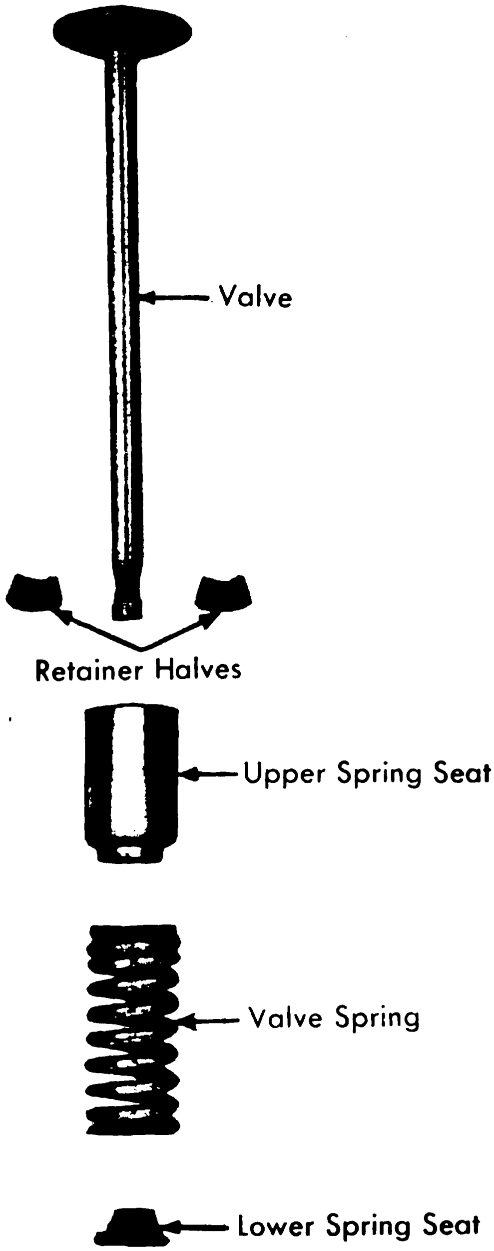


Figure 353. Valve Assembly.

NOTE: In case the gears have been replaced and the punch marks for the purpose of timing were not transferred, the following procedure for timing the valves is necessary:

Be sure that the intake valve lifter No. 1 cylinder (second lifter from the timing gear) is adjusted to the proper clearance of .006". However, since the engine is being reassembled after overhaul the temporary adjustment as indicated in paragraph 30 is sufficient. Final adjustment can be made in the test running of engine. Be sure the idler gear is not in place on the shaft and meshing with the other gears.

Turn the crankshaft until the timing mark on the flywheel, No. 1 cylinder I. O. (intake open) is in the center of the inspection hole in the flywheel housing. See Figure 357.

Turn the camshaft in the direction of rotation (same direction as the crankshaft) until the No. 1 cylinder intake valve lifter takes up the slack between the lifter and the valve stem. This point can be determined by rotating the lifter with your fingers. A slight drag indicates the proper point. Slip the idler gear into mesh

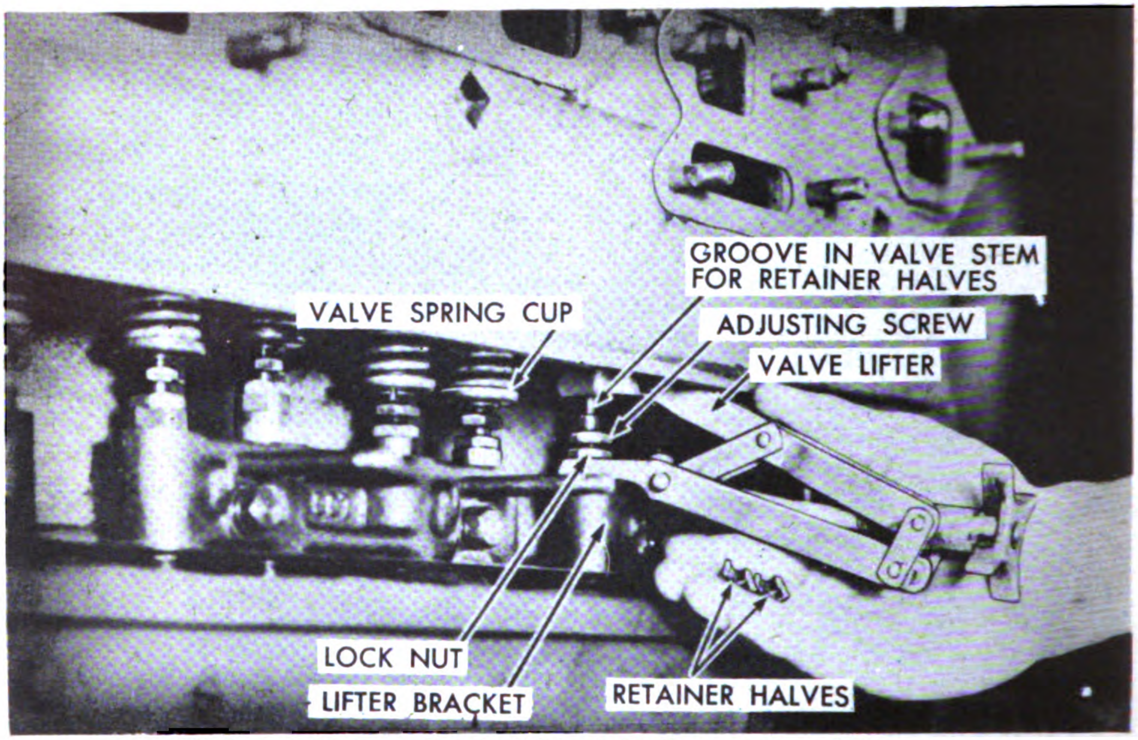


Figure 354. Installing Valve Assembly.

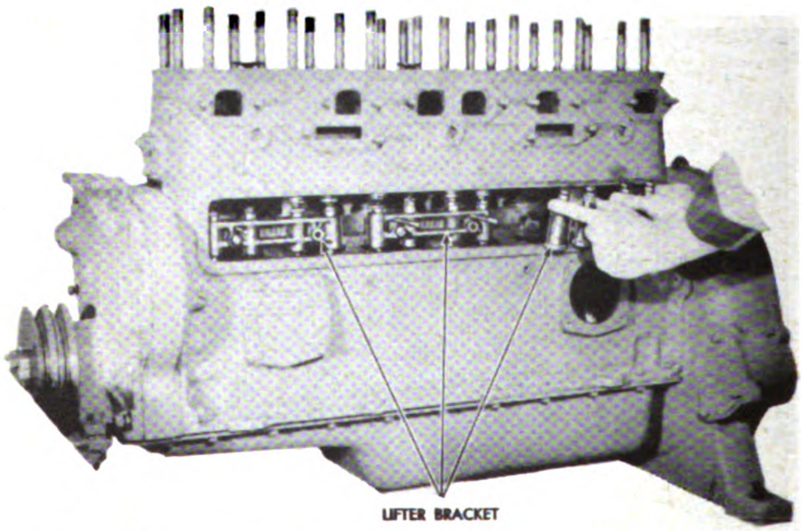


Figure 355. Installing Valve Lifter Brackets.

with the cam and crankshaft gears. Install the camshaft thrust washer and tighten the thrust screw. The ignition can be set externally. See instructions for magneto timing.

To recheck the valve timing, slowly turn the crankshaft almost two revolutions in the direction of its

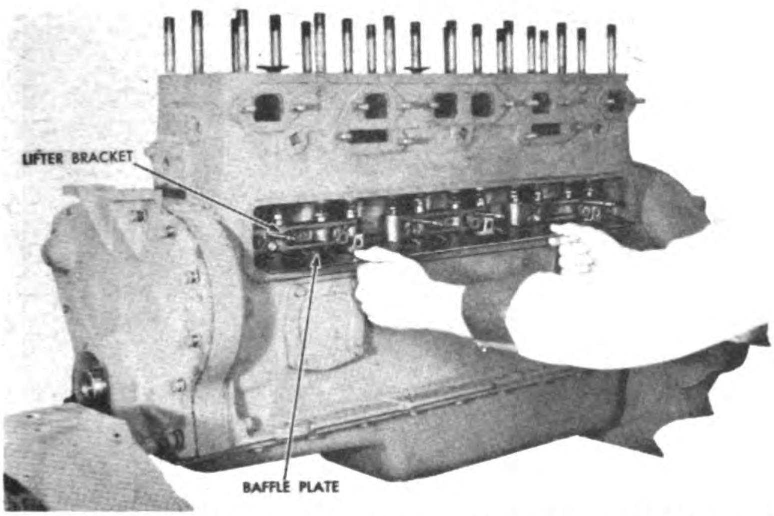


Figure 356. Installing Valve Chamber Baffle Plate.

Figure 357. Timing Hole.

rotation. Toward the latter part of the second revolution, feel the No. 1 cylinder intake tappet. When a slight drag is felt, the timing mark I. O. (intake open) on the flywheel should be in the center of the inspection hole in the flywheel housing.

32. VALVE CHAMBER COVER.

Install the valve chamber cover and tighten the nuts.

33. CYLINDER HEAD AND GASKET.

Install the cylinder head and permatex the gasket (using a new gasket). Tighten according to diagram shown in Figure 358. Tighten cylinder head nuts with a torque wrench from 150 to 160 pounds. Figure 359. CAUTION: Be sure and tighten each nut as per diagram.

STEPS OF REASSEMBLY

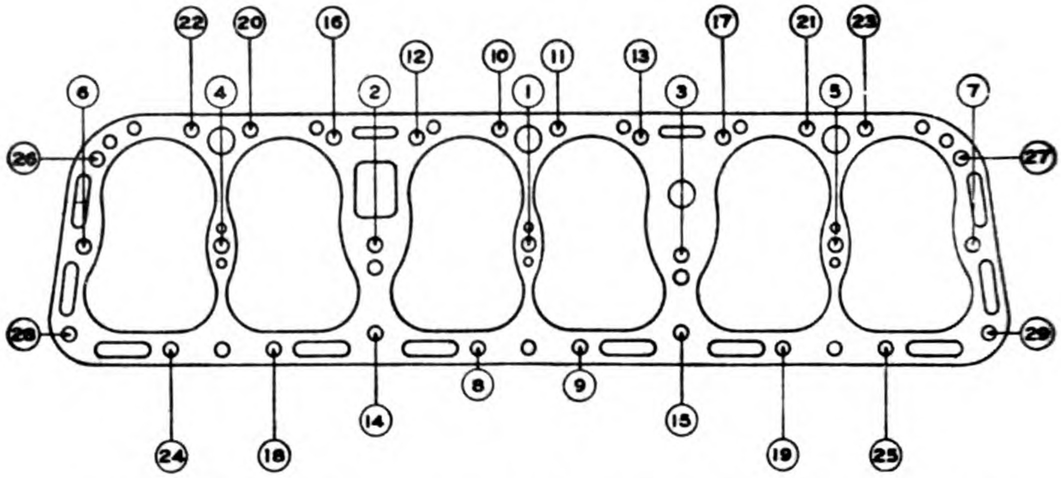


Figure 358. Sequence of Tightening Cylinder Head Stud Nuts.

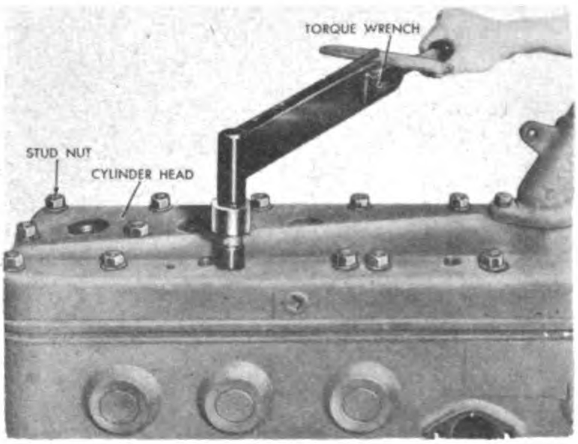


Figure 359. Tightening Cylinder Head Nuts.

34. WATER OUTLET ELBOW, MANIFOLD AND MANIFOLD GASKETS.

Install the water outlet elbow, manifold with gaskets in place. Be sure to permatex the gaskets.

35. FAN DRIVE PULLEY.

Install the fan drive pulley, be sure to line up the **pulley** keyways and drive in the key. See Figure 360. Drive pulley with hammer and block of wood.

36. CRANKSHAFT.

Install the crankshaft jaw and tighten securely with a pipe wrench. See Figure 361.

37. INSTALLING WATER DISTRIBUTOR.

Permatex the water distributor gasket and install the water distributor. See Figure 362.

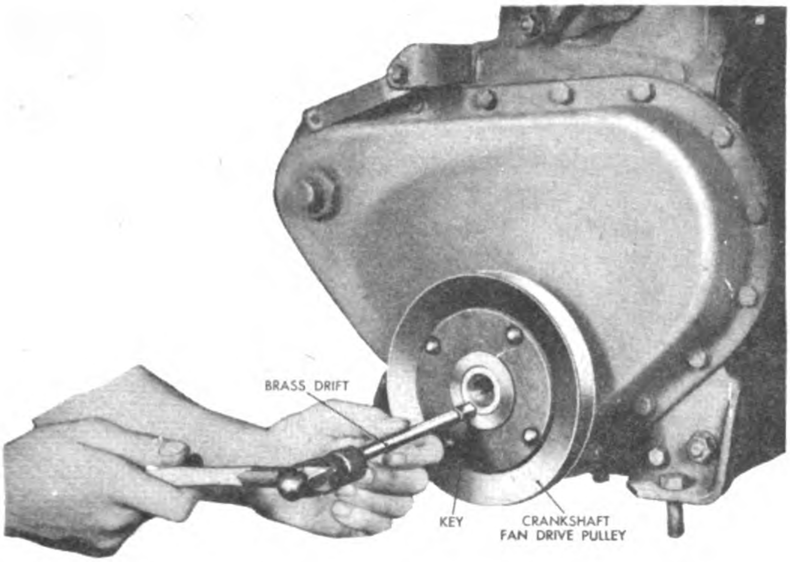


Figure 360. Installing Fan Drive Pulley.

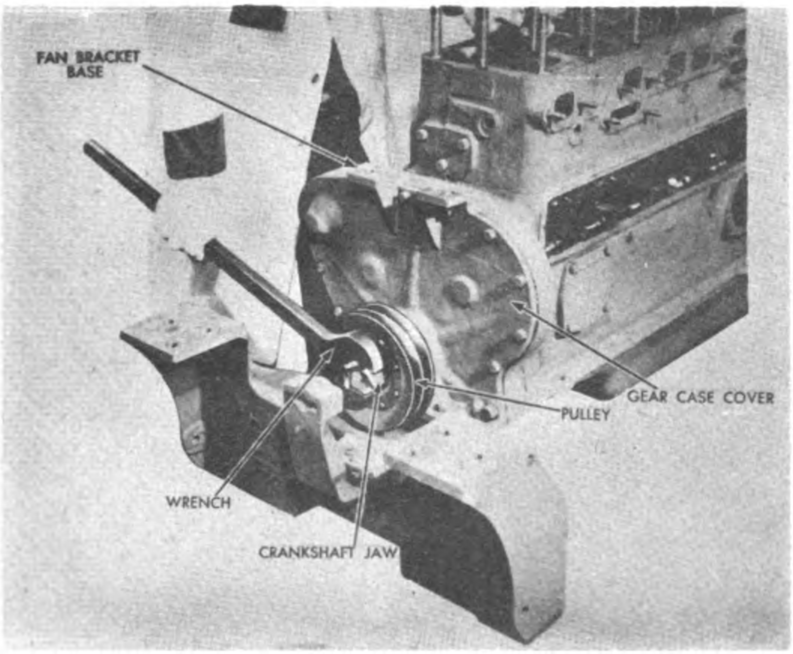


Figure 361. Installing Crankshaft Jaw.

38. INSTALLING FAN BRACKET.

Securely tighten the three bolts that hold the bracket to the engine.

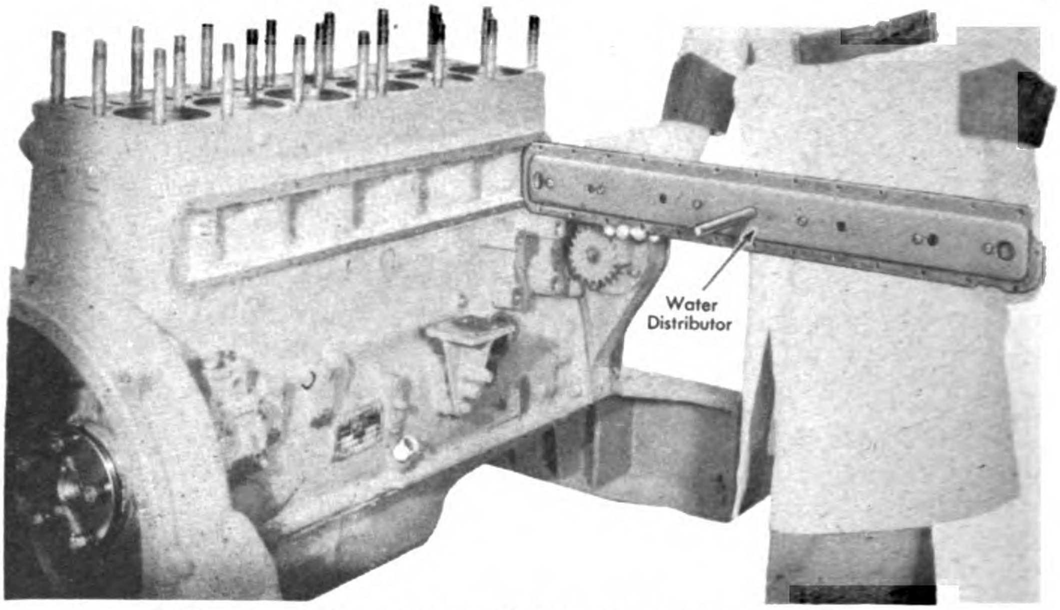


Figure 362. Installing Water Distributor.

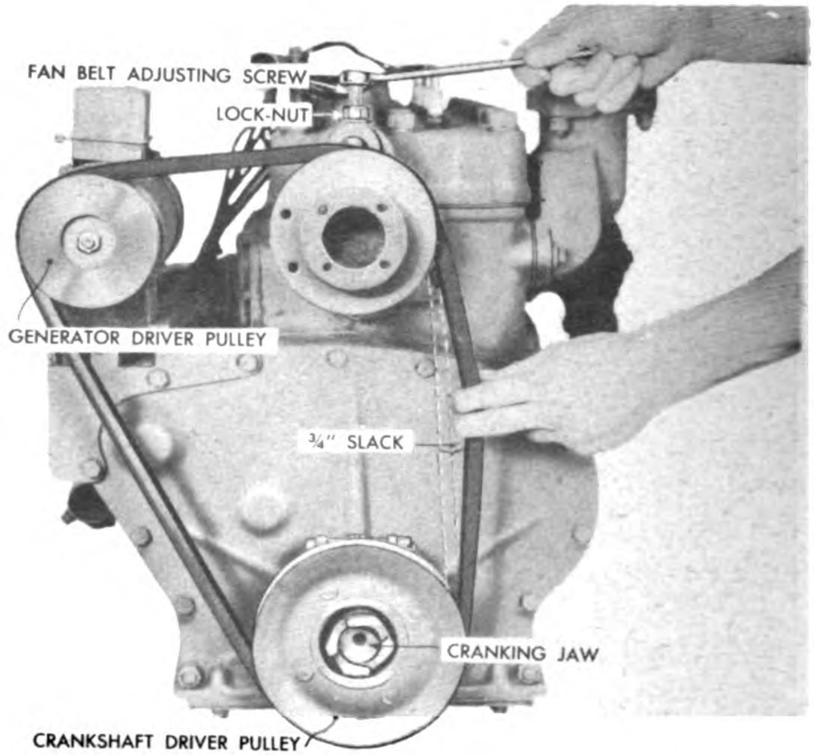


Figure 363. Installing Fan and Belt.

39. INSTALLING GENERATOR BRACKET.

Tighten the three bolts that hold the bracket to the gear case cover, and attach the generator brace to the bracket.

40. INSTALLING FAN AND BELT.

In installing the fan in the fan bracket assembly, tighten the adjusting screw and lock nut as shown in Figure 363. Then install the belt on the generator pulley while the fan assembly is loose.

Tighten the belt by turning down the adjusting screw so that there will be a slack of 3/4" as shown in Figure 363.

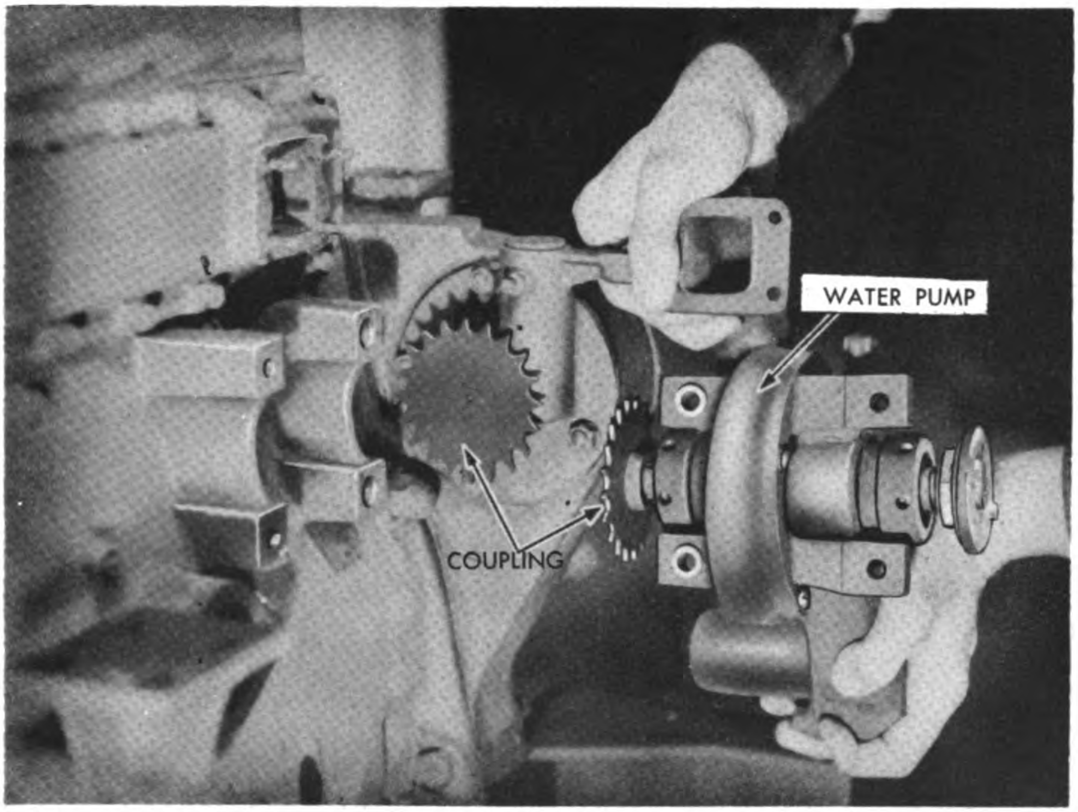


Figure 364. Installing Water Pump and Coupling Chain.

41. INSTALLING OIL FILLER, BREATHER AND GASKET.

Be sure to tighten the capscrews tightly.

42. DRAIN COCK.

Install the drain cock in the side of the crankcase.

43. WATER PUMP AND COUPLING CHAIN.

Install the water pump and coupling chain. Be sure that the blind end of the coupling chain link spring is pointed in the direction of rotation. Figures 106-364.

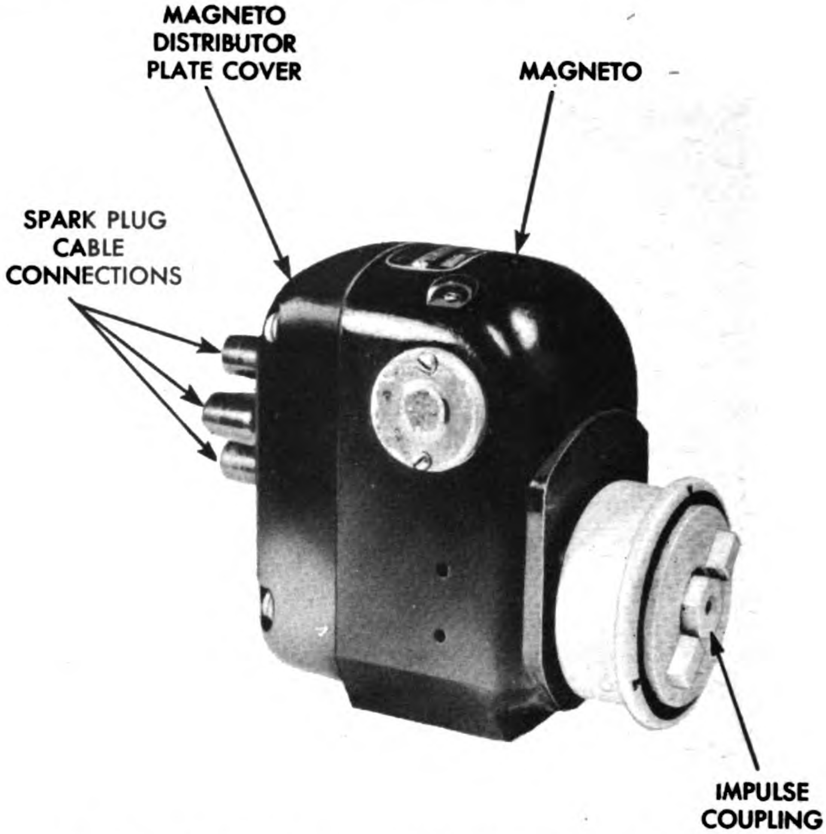


Figure 365. Magneto and Impulse Coupling.

44. INSTALLING MAGNETO BRACKET AND MAGNETO.

Install the magneto bracket and fasten the magneto with impulse coupling attached to it Figure 365 by tightening the capscrews that hold the latter to the bracket. Hook up the impulse coupling with the water pump drive shaft and time the magneto per instructions given in **Chapter IV, Magneto.**

45. SPARK PLUGS.

Install the spark plugs with the gaps adjusted to .025" Follow by installing the high tension cable tube with the cables in place and connect the cables to the spark plugs and proper terminals on the magneto. See Figure 365.

46. FRONT SUPPORT AND RADIATOR.

Connect the front sill or radiator support to the front engine support and install the radiator with top and bottom hose connections. Tighten the hose clamps. Make sure that the rubber mounting pads between the sill and radiator are in place. Connect up the brace rod which runs from the top back of the radiator to the top front of the engine.

47. STARTER MOTOR.

In installing the starter motor, slip the capscrews that hold it to the flywheel housing through the magnetic switch mounting plate and tighten securely. Mount the magnetic switch which is bolted onto the plate.

48. GOVERNOR.

Install the governor and governor gasket and connect the oil line between the governor and the crankcase. See Chapter IV, Par. 178, installing governor.

49. CARBURETOR.

Install the carburetor to the intake manifold and connect the governor link rod between the governor and the governor valve box. Adjust the link rod according to instructions in Chapter IV, Par. 171, carburetor.

50. FUEL PUMP.

Install the adaptor plate and gasket by tightening the four capscrews that hold it to the crankcase. Then install the fuel pump and connect up the copper tubing between the fuel pump and the carburetor inlet.

51. OIL FILTER.

Install the oil filter to the side of the engine and tighten the capscrews. Connect the copper tubing oil lines.

52. TEMPORARY HOOKUP FOR TEST RUN.

Since it was necessary to remove the air cleaner, exhaust pipe, oil drain pipe, oil and gasoline lines, electric wires and cables to permit removal of the power unit from the turntable, temporary installation of these units will have to be made in order to prepare the engine for the test run.

Temporary installation of the oil gauge, ammeter, magnetic switch, push button switch, battery throttle, spark and choke control will also have to be made.

After the test run is completed, permanent installation can be made during installation of the complete power unit in the turntable.

53. PREPARING ENGINE FOR THE TEST RUN.

The engine is now ready for a test run. Fill the crankcase with nine quarts of S. A. E. #10 oil. Oil the generator, the governor ball joints, throttle and choke controls and grease the water pump with special water pump grease. Also the clutch with #3 wheel bearing grease and fill the air cleaner oil cup with engine oil up to the mark indicated inside the oil cup. See lubricating chart. Fill the radiator and start the engine.

54. TESTING THE ENGINE.

Run the engine with no-load from three to eight hours; the length of time depends upon the type of repairs that were made to the engine. The engine should be started slowly, avoiding sudden acceleration. Allow engine to warm up gradually. Observe the oil pressure gauge. If the pressure does not come up during the first 30 seconds, stop the engine and prime the oil pump according to the instructions in paragraph 181. If the gauge still indicates no oil pressure, check back on the assembling of the oil pump and lubricating system. See paragraph 180.

55. ADJUSTING THE CARBURETOR.

An approximate carburetor adjustment should be made after the engine has started, to avoid running with too rich or too lean a mixture. Set the carburetor idle speed and high speed adjustment after the rings have seated, or at the end of the test run. Refer to paragraph 157 and 158 for the carburetor adjustment. While the engine is running, check for oil, water, and gasoline leaks. CAUTION: If the engine is run indoors, the exhaust gases must be piped outside.

56. GOVERNOR ADJUSTMENT.

Near the end of the run, the governor high speed operation can be adjusted. Refer to Figure 276. Turn the surge adjusting screw out until only three or four threads are engaged. Tighten the locknut and leave in this position for the present. Adjust governor for desired speed by turning the high speed adjusting screw. See Figure 279. Turning in will increase speed; turning out will decrease speed. Should the engine surge under load or part load, turn the spring eye adjusting screw out a few turns at a time until surging stops. For sensitive regulation, keep this screw in as far as possible without creating load surge.

Should the governor surge at no load speed, turn the surge adjusting screw in slowly until the surge is overcome. Do not turn this screw in so far as to increase speed.

57. COOLING ENGINE.

Before stopping the engine at the end of the run, deaccelerate it gradually and allow it to idle for a few minutes. This will allow the engine to cool gradually, thus avoiding any damage due to warping because of sudden cooling.

58. FINAL ADJUSTMENT OF VALVE CLEARANCE.

After the engine is stopped, set the valve clearance to .006" for the intake and .009" for the exhaust valves. To check this clearance, turn the engine over by hand until the intake valve closes on the particular cylinder you are checking. Continue to turn the engine one-half revolution to be certain that the cam is out from under the lifters. The piston is now approximately at top dead center and both intake and exhaust valves on the cylinder you are working on can be checked or adjusted.

CAUTION: The position for adjusting and checking is determined by the closing of the intake valve. Therefore, check the ports to be certain that it is the intake valve you are closing to obtain the proper position, as shown in Figure 366. With a feeler gauge, check the clearance. To adjust, lifter must be held rigid while loosening the middle locknut. Turn the top adjusting screw in either direction depending upon the adjustment that is needed until the correct clearance is checked. Tighten the locknut and check to be sure that the adjusting screw has not turned. Repeat this procedure for all the valves and bear in mind that both the intake and exhaust valves can be checked together for that particular cylinder.

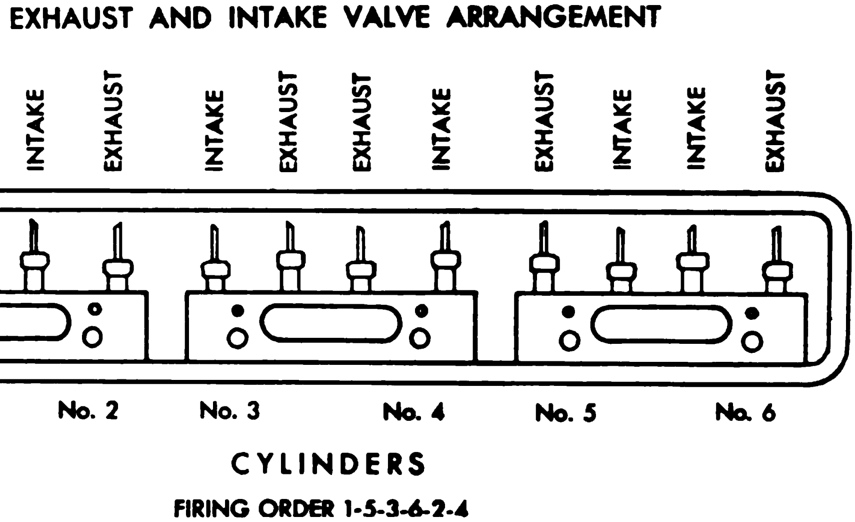


Figure 366. Exhaust and Intake Valve Arrangement.

59. TIGHTENING ENGINE NUTS AND CAPSCREWS

Retighten the cylinder head by tightening the stud nuts according to Figure 358. Tighten the oil pan, manifold, and gear case cover. Drain the oil and water. Refill the crankcase with oil of recommended viscosity for the prevailing temperature and refill the radiator.

60. PAINTING THE ENGINE.

After the engine has been tested or adjusted, wash and dry it thoroughly and apply a coat of engine paint. The engine is now ready to be installed with the rest of the machinery.

61. FINAL ADJUSTMENT OF CARBURETOR AND GOVERNOR.

The carburetor and governor may have to be re-adjusted again, as well as the power take-off, after the engine is operated under load with the rest of the machinery. If this necessity occurs, for the governor adjustments refer to paragraph 56; for the carburetor adjustments refer to paragraph 157 and 158; for the power take-off adjustments refer to paragraph 188.

Chapter VI

ENGINE TUNE-UP

Results obtained from an Engine Tune-Up are often unsatisfactory, because a "hit or miss" method was used instead of a systematic approach to the job. Too often, mechanics are inclined to guess at the cause of faulty operation, when a complete tune-up is actually in order.

The most common cause of poor performance and excessive operating costs is a combination of maladjustments among the fundamental items of engine tune-up. Therefore, the only logical solution is a complete check following the cycle shown in the accompanying instructions and carrying out each step, as follows:

1. SPARK PLUGS.

A. Check to be sure that proper make and type are being used.

B. Clean plugs with an abrasive type spark plug cleaner.

C. Inspect porcelain and if cracked or broken replace with new part.

D. Set gap to dimension recommended in "Specifications" at the end of the Ignition section, using a round feeler gauge. When regapping is necessary adjust side electrode only, never bend center electrode.

E. Be sure that plug is tight when installing and that the gasket is in good condition.

2. IGNITION CABLES.

A. Check ground strap - be sure that both terminals are clean and tight.

B. Check the battery to the starter cable - be sure that both terminals are clean and tight.

C. Check the spark plug and other ignition cables. Terminal on each end must be tight and clean if rubber insulation shows evidence of deterioration it should be replaced.

3. MAGNETO.

A. Check the interrupter points for evidence of pitting or burning. Replace if they cannot be cleaned up with point file. Never use emery cloth to clean distributor points.

B. Check the point opening with feeler gauge. Adjust to dimension shown in Par. 136.

C. Check magneto plate for cracks and replace it cracked or if posts are burned appreciably.

D. Check rotor to be sure the spring contacts secondary terminal, and that point is not burned from arcing.

4. IGNITION TIMING.

A. Check ignition timing to be sure #1 cylinder is firing according to flywheel markings. Par. 137.

5. VALVE CLEARANCE.

A. Check valve lash against clearance shown in "Nominal Clearances". Engine must be thoroughly warmed up before checking.

B. Make visual inspection of valve springs for broken coils.

6. AIR CLEANER.

A. Clean air cleaner as directed in "Fuel System" section.

7. CARBURETOR.

A. Check the carburetor flange and intake manifold gasket for leaks.

B. Check the float level as instructed in "Fuel System" section. Correct the float level height as given in Par. 164X.

C. Adjust idling screw until engine runs evenly and steady with leanest possible mixture. The engine should be thoroughly warmed up before adjusting carburetor.

ENGINE SERVICE DIAGNOSIS

Lack of Power

1. Low or Poor Compression.
2. Ignition System Defective - See "Ignition" Section.
3. Carburetor of Fuel Pump not Functioning Properly - see "Fuel System" Section.
4. Air Cleaner Restricted.
5. Low Octane Fuel.
6. Overheating - see "Cooling System".
7. Improper Grade and Viscosity of Oil.

Poor Compression

1. Incorrect Valve Lash.
2. Valve Stems or Lifters Sticking.
3. Valve Stems or Guides Worn.
4. Valve Springs Weak or Broken.
5. Valve Timing Incorrect.
6. Cylinder Head Gasket Leaking.
7. Piston Rings Broken, Worn or Stuck.
8. Pistons or Rings Improperly Fitted.
9. Piston Ring Grooves Worn.
10. Cylinder Scored or Worn Excessively.

Excessive Cylinder and Piston Wear.

1. Improper Grade and Viscosity of Oil.
2. Lack of Oil.
3. Dirty Oil.
4. Overheating - see "Cooling System."
5. Piston Improperly Installed and Fitted.
6. Piston Rings not Properly Fitted to Piston Groove and Cylinder Wall.
7. Piston Rings Stuck in Piston Grooves or Broken.

8. Air Cleaner not Clean, Allowing Dirt to Enter Combustion Chamber.
9. Carburetor Fuel Mixture too Rich.

Crankshaft Bearing Failure

1. Crankshaft Bearing Journal Out-of-Round.
2. Crankshaft Bearing Journal Rough.
3. Crankshaft Oil Passage Restricted.
4. Bearings Loose.
5. Bearings Improperly Fitted.
6. Bearings Loose in Crankcase.
7. Crankshaft or Bearings Out-of-Alignment.
8. Lack of Oil.
9. Low Oil Pressure.
10. Improper Grade and Viscosity of Oil.

Connecting Rod Bearing Failure

1. Crankshaft Surface Rough.
2. Restricted Oil Passage.
3. Bearings Loose.
4. Improperly Fitted.
5. Loose in Connecting Rod.
6. Bent Connecting Rod.
7. Lack of Oil.
8. Low Oil Pressure.
9. Improper Grade and Viscosity of Oil.

Burned Valve and Seats

1. Improper Valve Lash.
2. Weak Valve Springs.
3. Improper Valve Timing.
4. Excessive Carbon Deposits Around Seat and Valve Head.
5. Valves Sticking in Guides.
6. Improper Type Valves - Use Genuine Parts.
7. Valve Head Too Thin Causing Hot Sections.
8. Valve Seats too Narrow.
9. Fuel Mixture Flow Restricted.
10. Overheating - see "Cooling System".
11. Rocker Arm Stuck, Holding Valve Open.

ENGINE SERVICE DIAGNOSIS

Valve Sticking

1. Incorrect Valve Lash.
2. Insufficient Clearance Between Valve Stem and Guide.
3. Valve Springs Weak or Broken.
4. Valve Stems Scored or Dirty.
5. Valve Lifters Sticking.
6. Use of Fuel with High Gum Content.

Overheating

1. See "Cooling System".
2. Improper Grade and Viscosity of Oil.
3. Fuel Mixture too Lean.
4. Air Cleaner Restricted.
5. Ignition System Defective - see "Ignition" Section.
6. Valve Timing Too Early.

Excessive Oil Consumption

1. Piston Rings Broken, Worn or Stuck.
2. Piston Rings Improperly Fitted.
3. Piston Ring Slots Clogged with Carbon.
4. Cylinder Bore Out-of-Round or Excessive Taper.
5. Cylinder Bore Scored or Badly Worn.
6. Crankshaft and Connecting Rod Bearings Worn or Excessive End Play.
7. Overheating - See "Cooling System".
8. Improper Grade and Viscosity of Oil.
9. Excessive Oil Pressure.
10. Oil Level too High.
11. Oil Leaks at Gaskets and Seals.

Low Oil Pressure

1. Improper Grade and Viscosity of Oil.
2. Oil Pressure Relief Valve Stuck.
3. Oil Pump Screen Clogged.
4. Excessive Crankshaft and Connecting Rod Bearing Clearance.
5. Oil Pump Gear to Housing Clearance Excessive.
6. Oil Pump Worn Excessively.

Popping, Spitting and Spark Knock

1. Defective Ignition System - See "Ignition" Section.
2. Carburetor not Properly Adjusted - See "Fuel System" Section.
3. Valve Lash Adjusted too Close.
4. Exhaust Valve Head too Thin Causing Hot Sections.
5. Excessive Carbon Deposits in Combustion Chamber.
6. Weak Valve Springs.
7. Hot Spots in Cylinder Head, Usually Caused by Clogged Water Passages.
8. Valves Not Seating Properly.
9. Valve Timing Early.
10. Piston and Rings in Poor Condition.
11. Inferior Grade of Oil.

BUDA MODEL K-428 GASOLINE POWER UNIT

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INDEX

PARTS CATALOG

for

BUDA MODEL K428 GASOLINE POWER UNIT

USED ON

KOEHRING COMPANY MODEL 304 CRANE

●

Contents

PREPARATION OF REQUISITIONS

SAMPLE COPY FOR USE IN THE PREPARATION OF REQUISITIONS

Revisions in QMC Form 400 for requisitioning spare parts are confined to new column headings. Until new forms are available all organizations are to continue using the present form and either type or write in corrections indicated in column headings.

Under revised heading "Nomenclature and Unit" list the article and the unit (ea for each; lb for pound, etc.). Under heading "Authorized or Maximum Level" list the authorized depot stock levels or organizational allowances given in Part III of the Corps of Engineers Supply Catalog. The total number on hand for each item is listed under "On Hand". In column headed "Due In" enter the total quantity previously requisitioned but not delivered. For "Initial" and "Replenishment" requisitions, the sum of "Required", "Due In", and "On Hand" should equal the "Authorized or Maximum Level".

On this page is shown a sample requisition on QMC Form No. 400 which conforms to the latest revisions. The marginal notes give instructions for preparing a requisition for spare parts for Engineer equipment. Additional information on this subject is contained in section AA-1 of Part III Engineer Supply Catalog, available from the Engineer Field Maintenance Office, P. O Box 1679, Columbus, Ohio.

State PERIOD designation by use of one of the following terms:
(1) "INITIAL"—first requisition of authorized allowances.
(2) "REPLENISHMENT"—subsequent requisitions to maintain authorized allowances.
(3) "SPECIAL"—requisitions for necessary repairs not covered by allowances.

Type "SPARE PARTS" in upper right hand corner of requisition.

Give complete shipping instructions. Special instructions for packing, marking, routing, etc., should be given at the end of the requisition.

State proper nomenclature of machine, and make, model, serial number and registration number.

Prepare a separate requisition for each different machine.

State basis or authority and date delivery is required, immediately below description of machine.

Double space between items.

Group parts required under group headings as shown in manufacturers' parts catalogs (Technical Manuals).

State manufacturers' parts numbers and nomenclature descriptions accurately and completely. Do not use abbreviations.

SPARE PARTS

WAR DEPARTMENT
Q. M. C. Form No. 400
(Revised 10 Aug. 1943)

(SAMPLE)
REQUISITION

To: Engineer Field Maintenance Office No. of Sheets 1 Sheet No. 1
P.O. Box 1679, Columbus, Ohio
Requisition No. E-908-4-44 Date 10 April 1944 Period Replenishment

SHIP TO Engineer Property Officer, FORT LEWIS, WASHINGTON

MARKED FOR: Supply Officer, 150th Engr. Regiment, FORT LEWIS, WASHINGTON

Requisitioned By (show Signature, Rank, Organization, Destination. If different from "ship to" include address):
Robert E. Roe
Robert E. Roe,
Major, C. E.,
Engineer Property Officer

For the Commanding Officer:
John E. Doe
John E. Doe,
Col., C. E.,
Executive Officer

MFG. NO.	NOMENCLATURE AND UNIT	AUTH. or MAX. LEVEL	ON HAND	DUE IN	REQUIRED	APPROVED
PARTS	FOR KOEHRING 304 CRANE, GASOLINE DRIVEN, BUDA MODEL K-428					
	BASIS: Repair of Disabled Equipment					
	DELIVERY: by May 10, 1944					
	BUDA ENGINE GROUP, ENGINE SERIAL NO. 51004					
K-40254	CAMSHAFT ea	1	0	1	1	
4340	GEAR, Camshaft ea	1	0	1	1	
1307	RETAINER, Camshaft Gear ea	1	0	2	1	
1309	COLLAR, Camshaft Thrust ea	1	0	2	1	
	CRANE, REMOTE GOVERNOR CONTROL ASSEMBLY					
XA-2835	CABLE, Aircraft 7 x 19 Tinned 18 x 17' 0" ea	1	0	1	1	
	*					

*Nonexpendable items such as tools must be accounted for, when requisitioned, by a statement that they have been placed on REPORT OF SURVEY or STATEMENT OF CHARGES.

Emergency requisitions sent by telephone, telegraph, or radio must always be confirmed immediately with requisition marked: "Confirming (state identifying data)."

PREPARATION OF REQUISITIONS

A Sample requisition in the correct form for submission by the Engineer Property Officer is shown on the opposite page.

THIS SHALL BE FOLLOWED IN MAKING OUT REQUISITIONS.

In order to eliminate duplication of work, Property Officers may authorize organizations to prepare requisitions in final form, leaving requisition number space blank for completion by Property Officer.

THE FOLLOWING RULES WILL BE OBSERVED CAREFULLY IN PREPARING REQUISITIONS FOR SPARE PARTS:

a. Prepare a separate requisition for each different machine.

b. Type "SPARE PARTS" in upper right hand corner of requisition form.

c. State PERIOD designation by use of one of the following terms:

(1) "INITIAL"—first requisition of authorized allowances.

(2) "REPLENISHMENT"—subsequent requisitions to maintain authorized allowances.

(3) "SPECIAL"—requisitions for necessary repairs not covered by allowances.

d. Give complete shipping instructions.

e. State proper nomenclature of machine, and make, model, serial number and registration number.

f. State basis or authority, and date delivery is required, immediately below description of machine.

g. Group parts required under group headings as shown in manufacturers' parts catalogs.

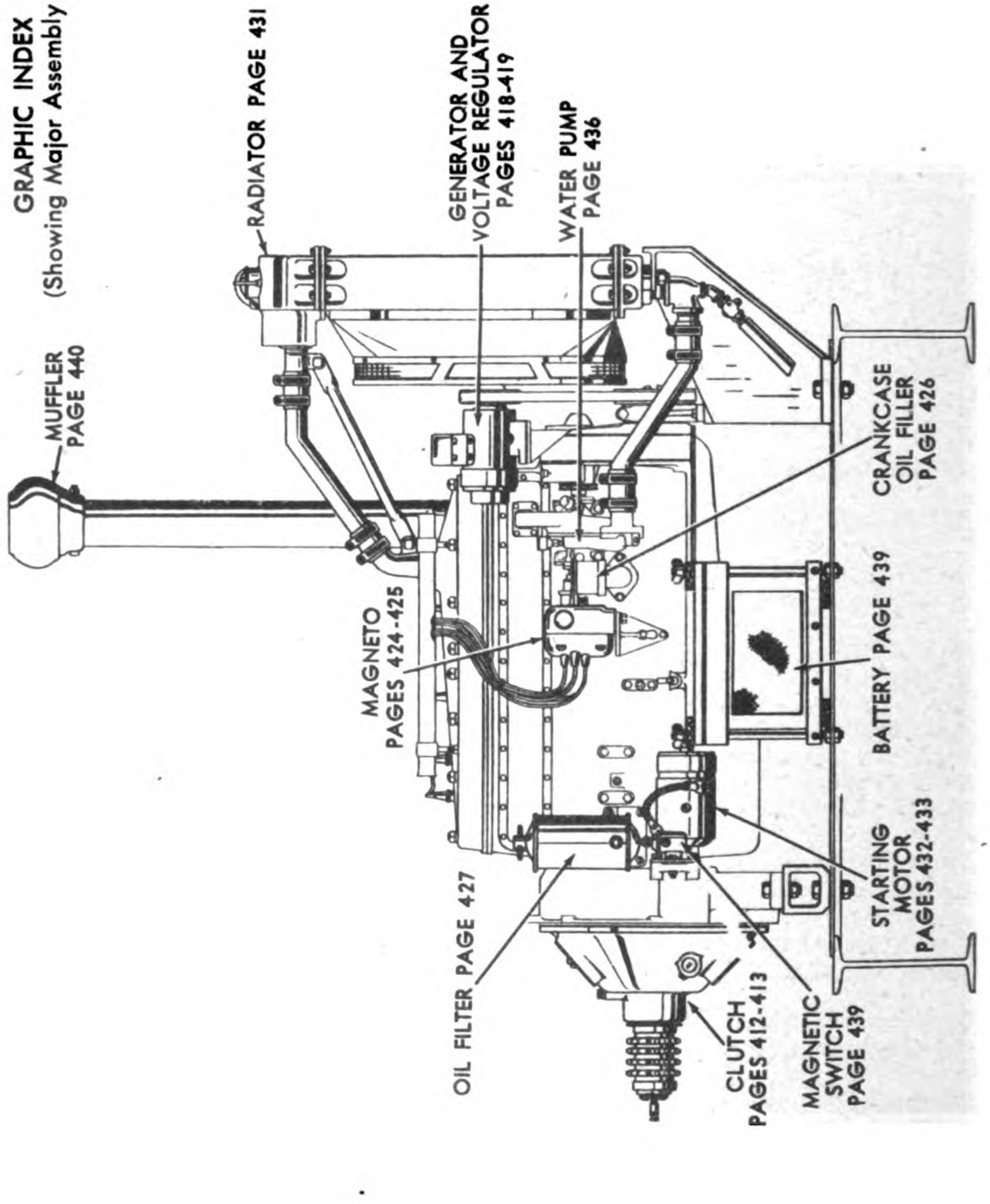
h. State manufacturers' parts numbers and nomenclature descriptions accurately and completely. Do not use abbreviations.

i. Double space between items.

j. Emergency requisitions sent by telephone, telegraph, or radio must always be confirmed immediately with requisition marked: "Confirming (state identifying data)."

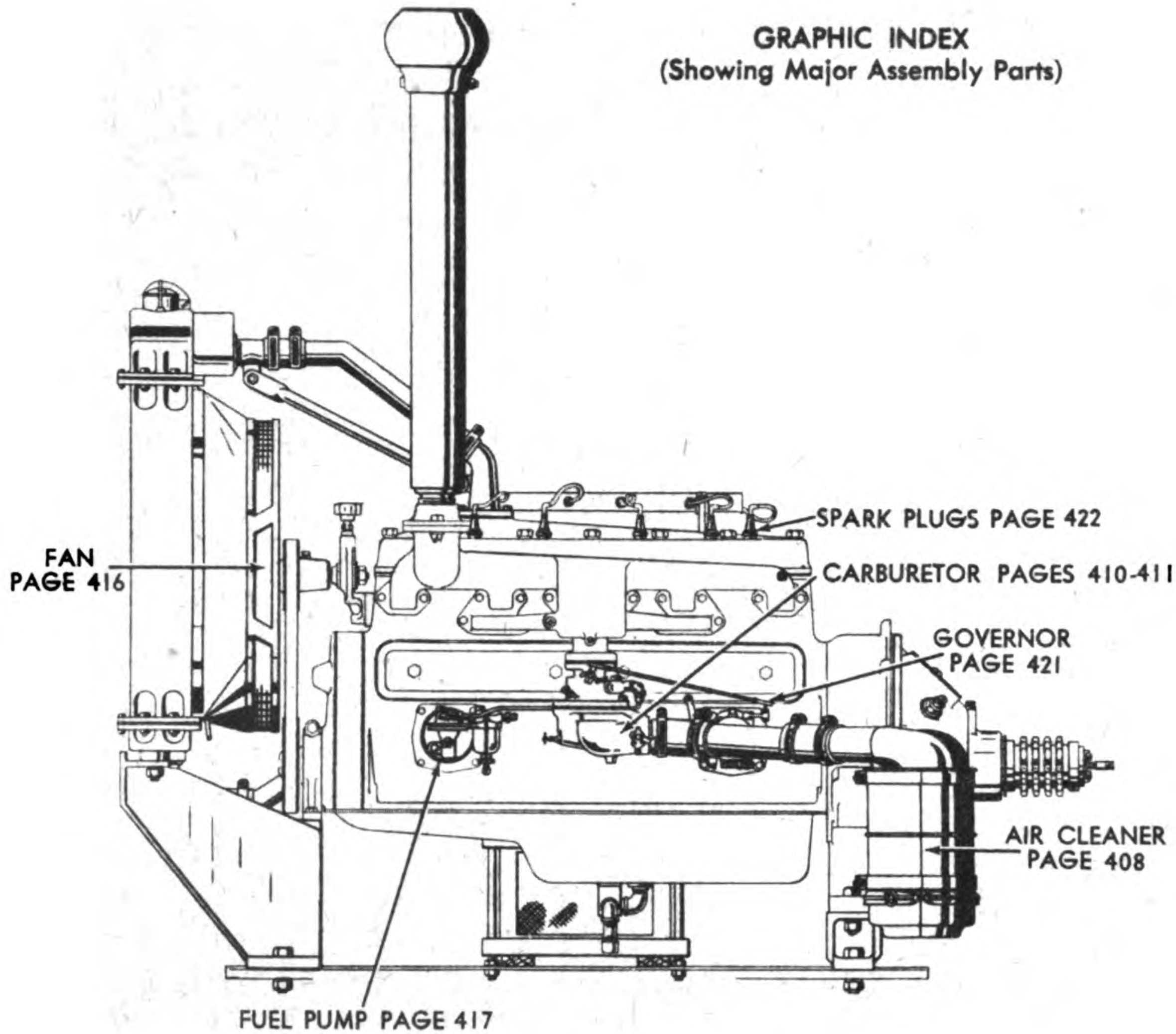
k. Nonexpendable items must be accounted for.

GRAPHIC INDEX
(Showing Major Assembly Parts)



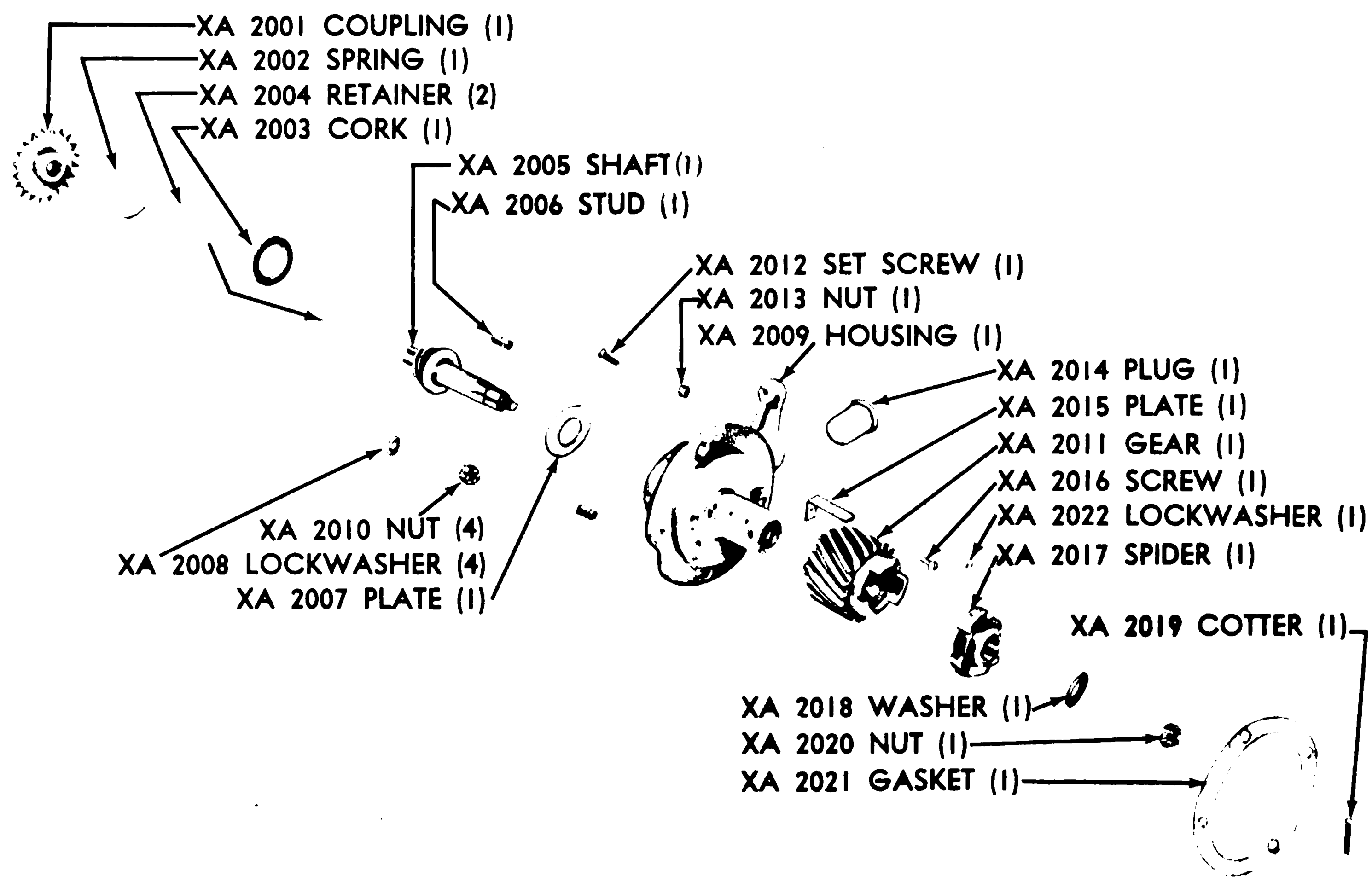
Right side of Buda Model K428 Power Unit with Accessories

GRAPHIC INDEX
(Showing Major Assembly Parts)



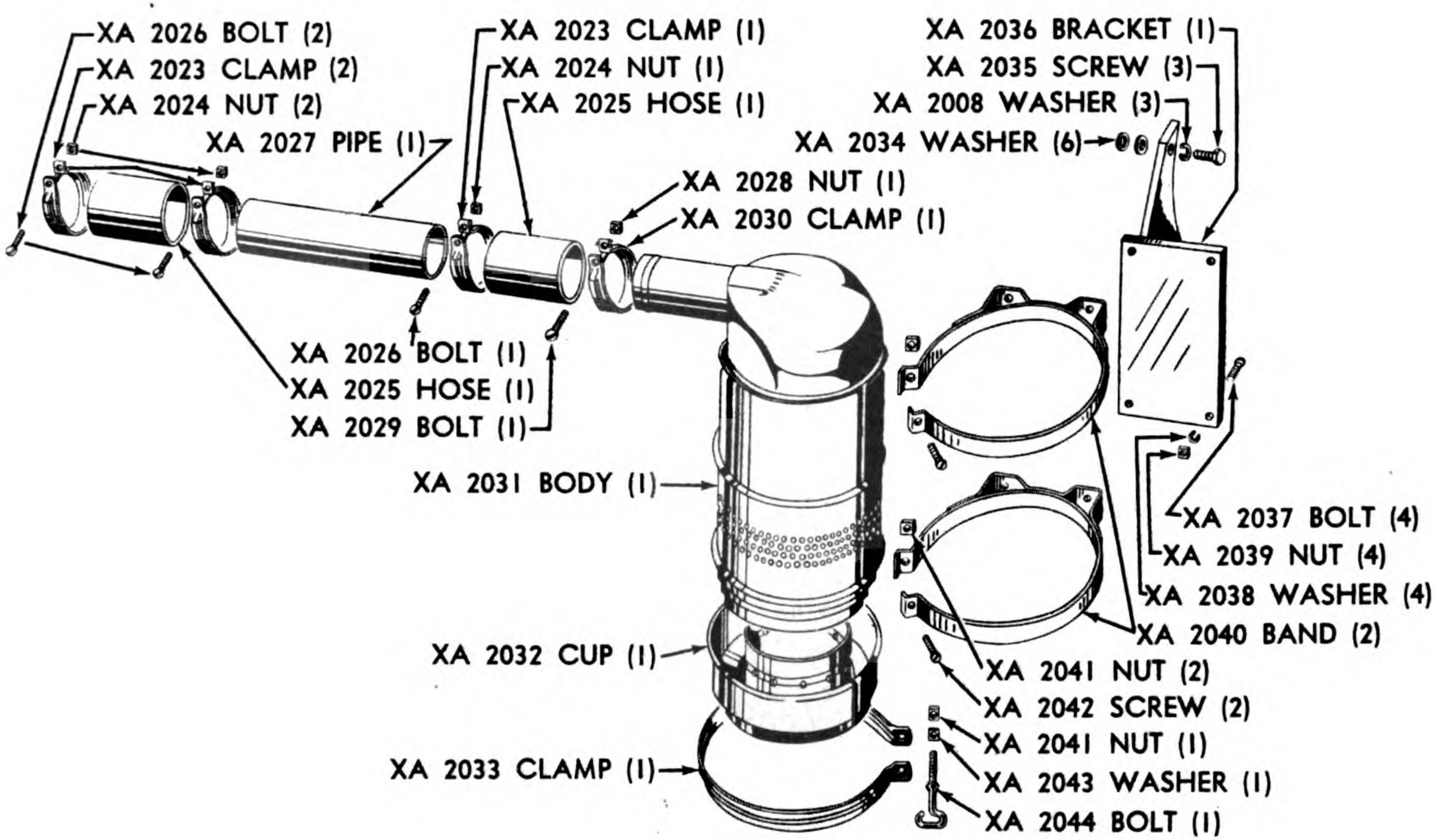
Left side of Buda Model K428 with Accessories

ALPHABETICAL INDEX

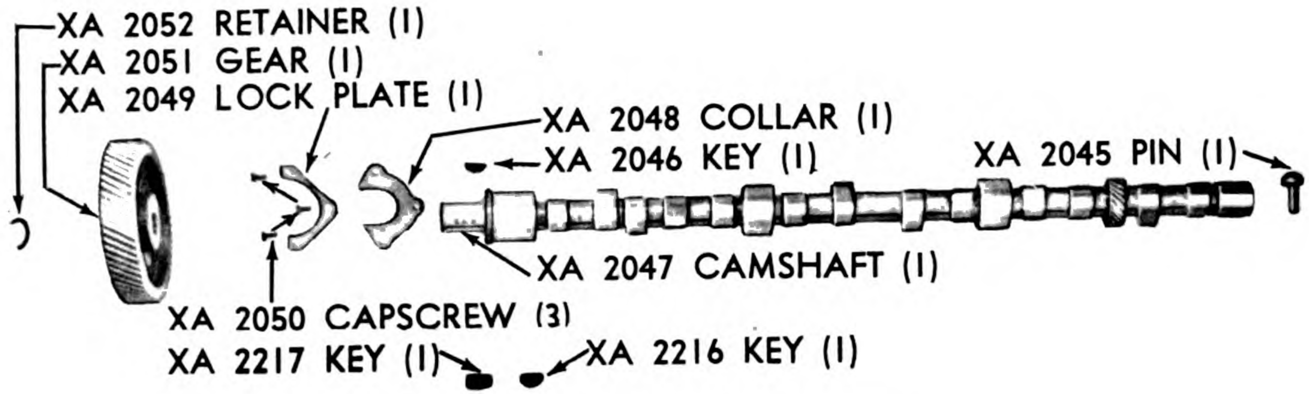


Accessory Drive Assembly

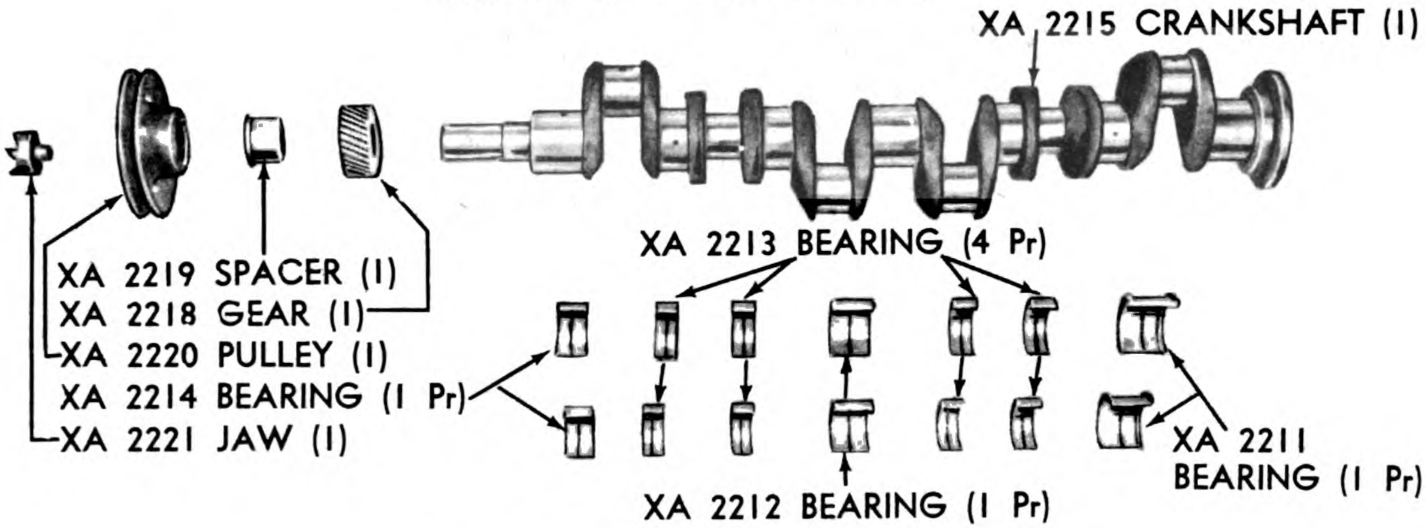
Air Cleaner (Furnished by Koehring Co., Milwaukee, Wis.)



Camshaft Assembly



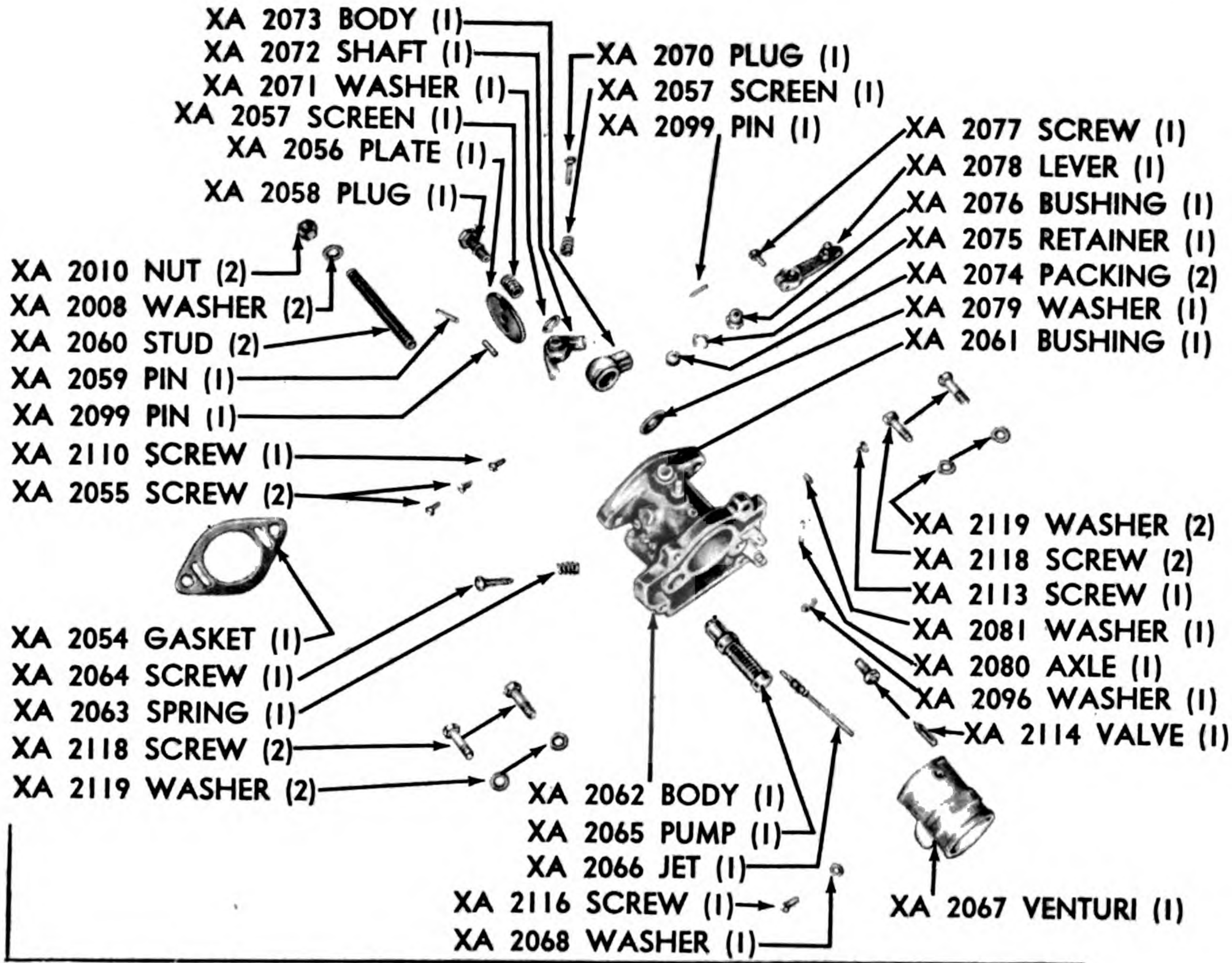
Crankshaft and Main Bearing Assembly

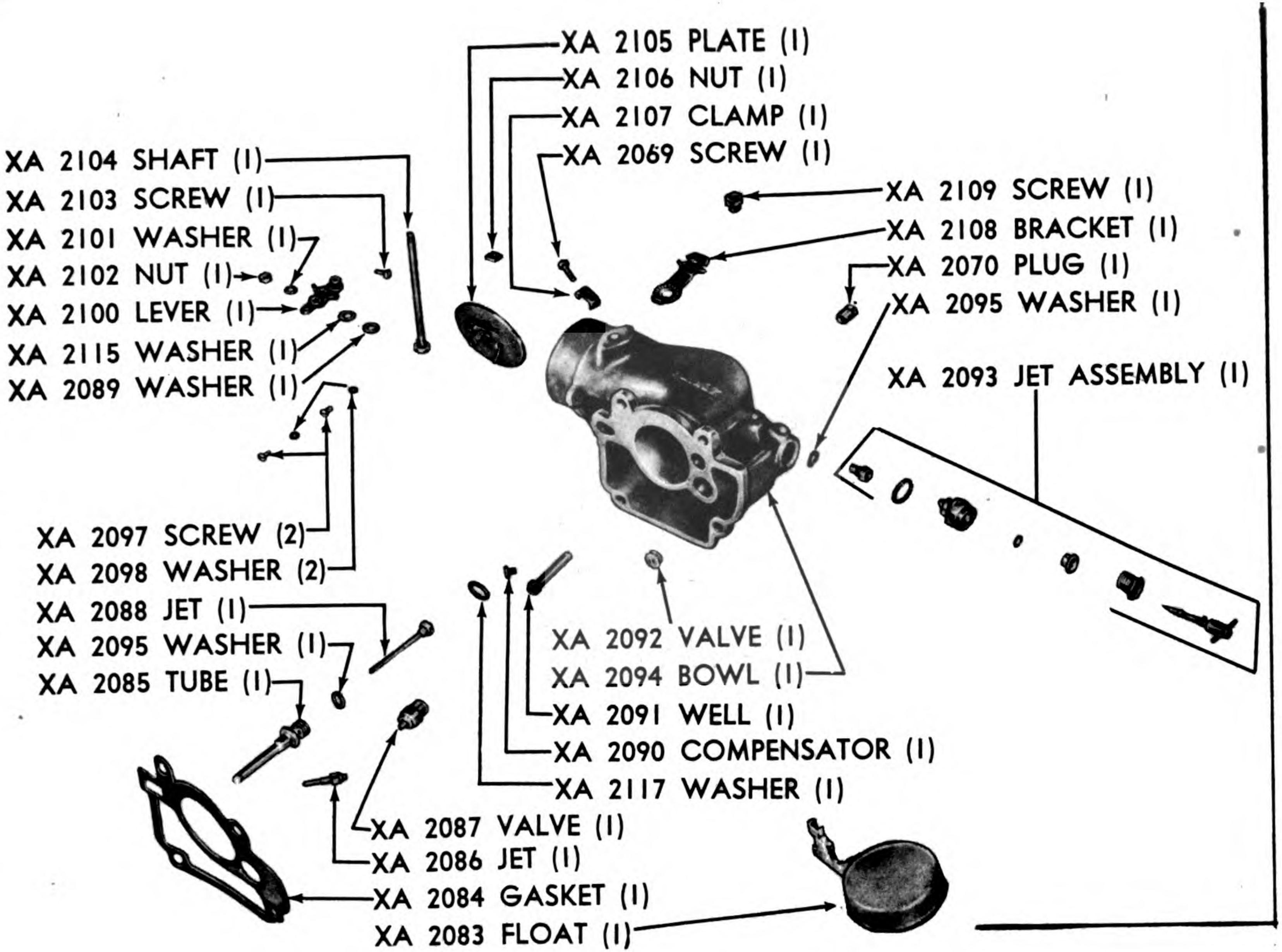


Camshaft, Crankshaft and Main Bearing Assemblies

XA 2053 CARBURETOR ASSEMBLY (1)

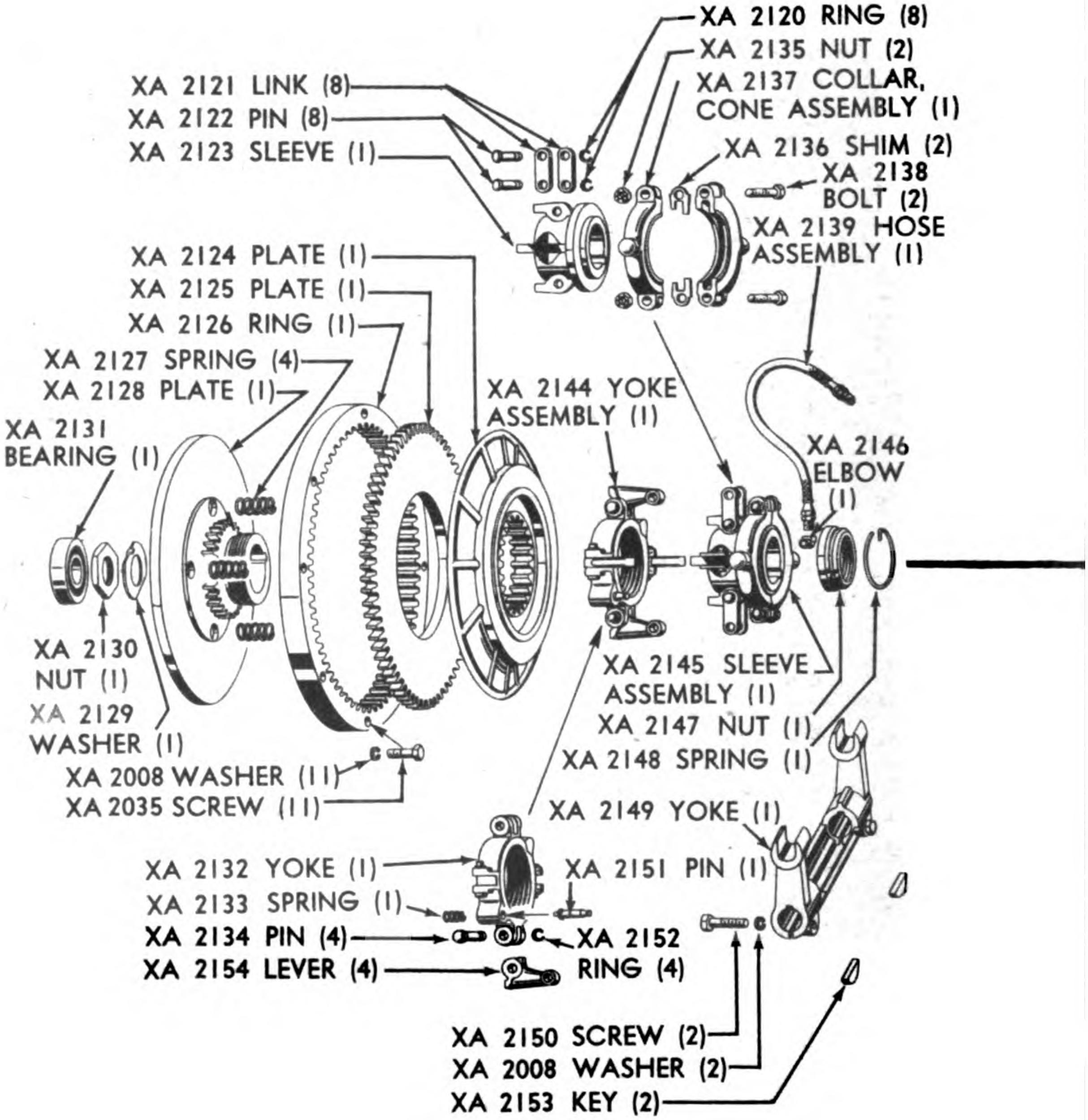
Carburetor Assembly



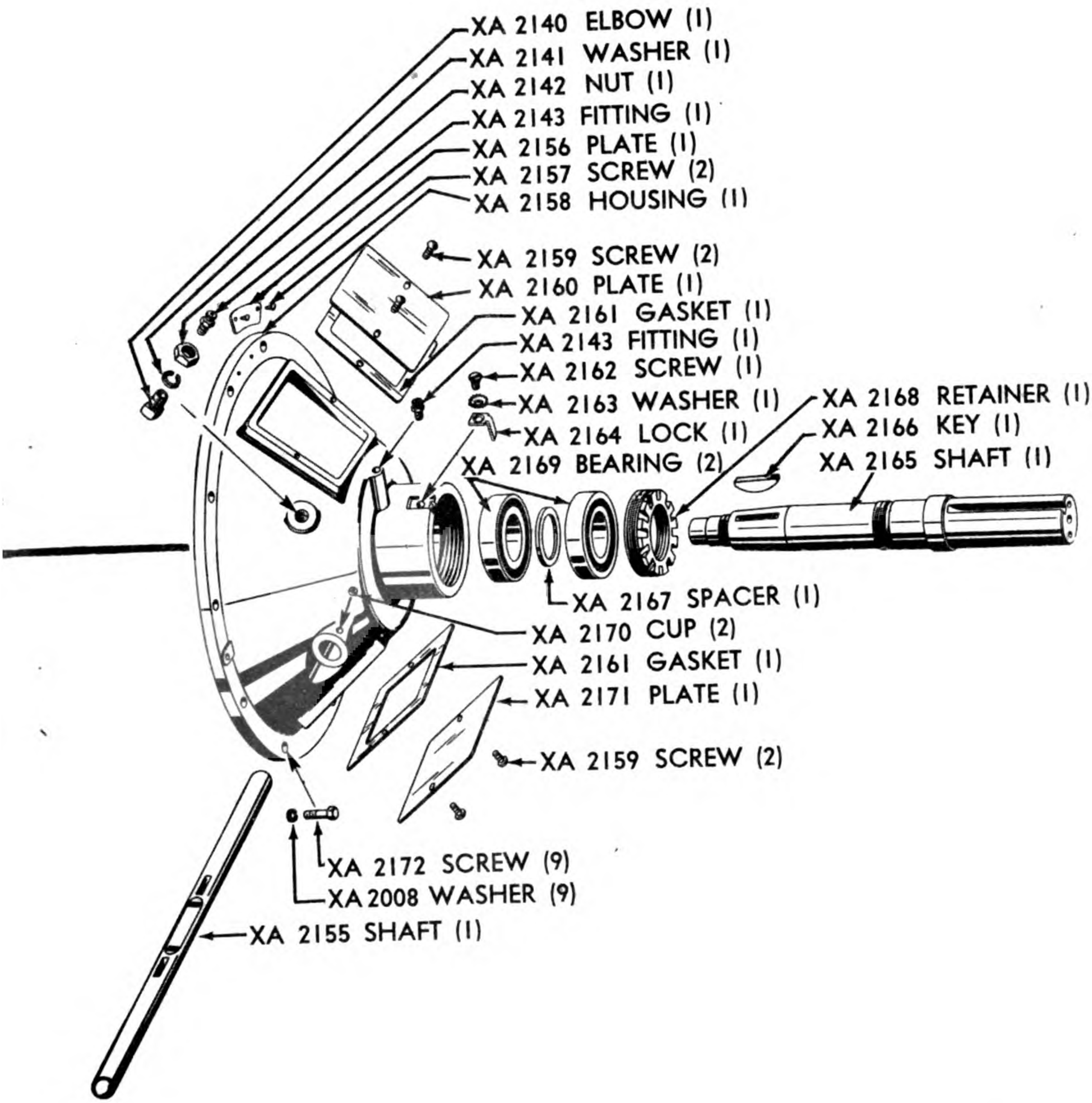


Carburetor Assembly

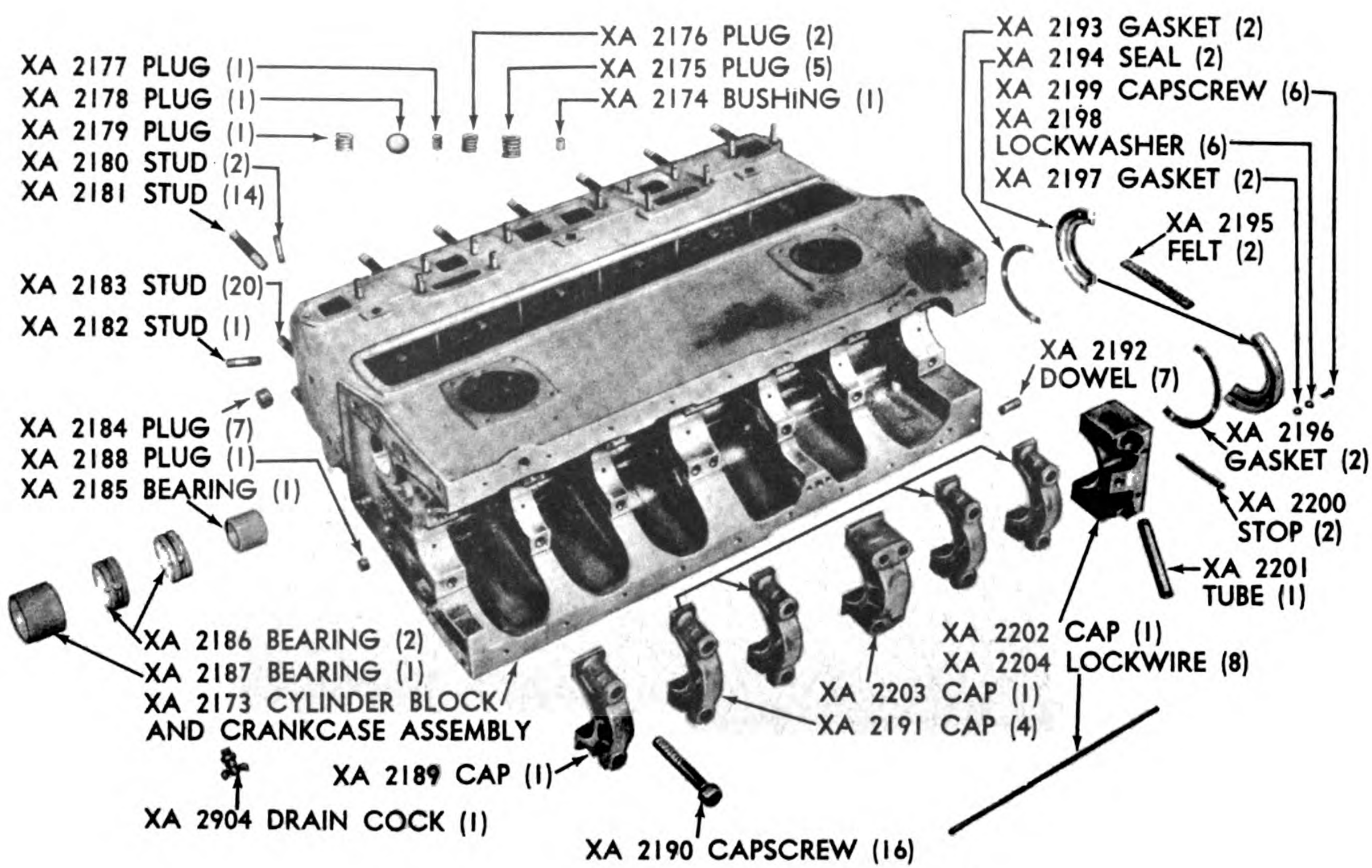
Clutch Assembly



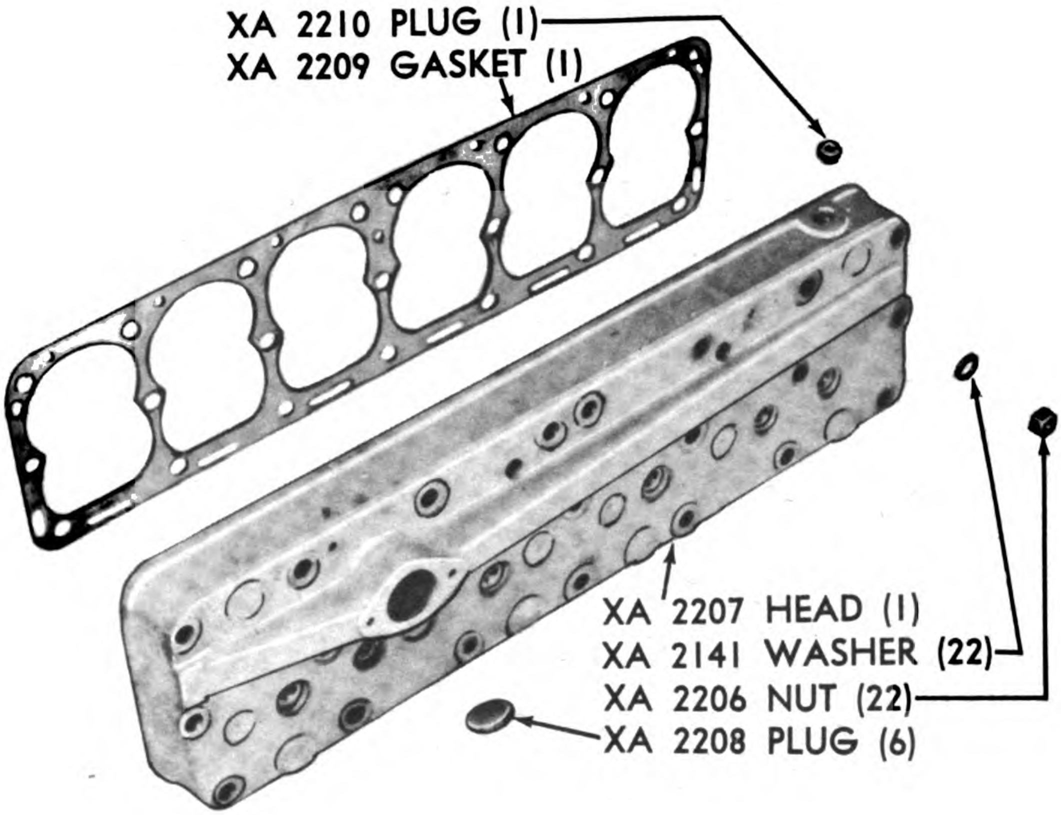
Clutch Assembly (Furnished by Koehring Co., Milwaukee, Wis.)



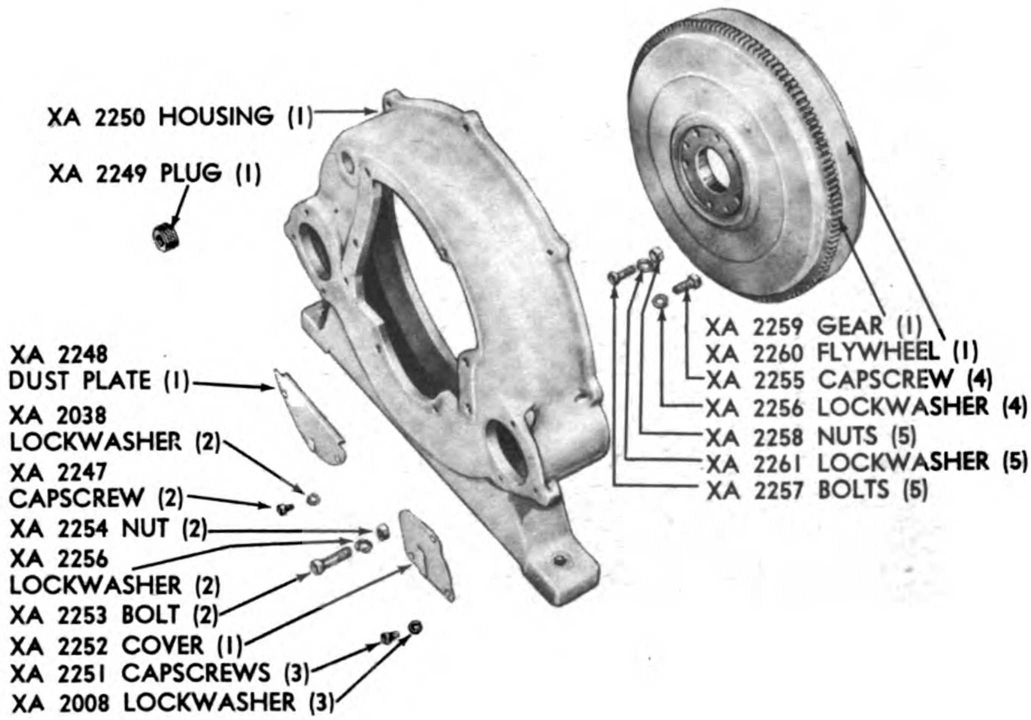
Cylinder Block and Crankcase Assembly



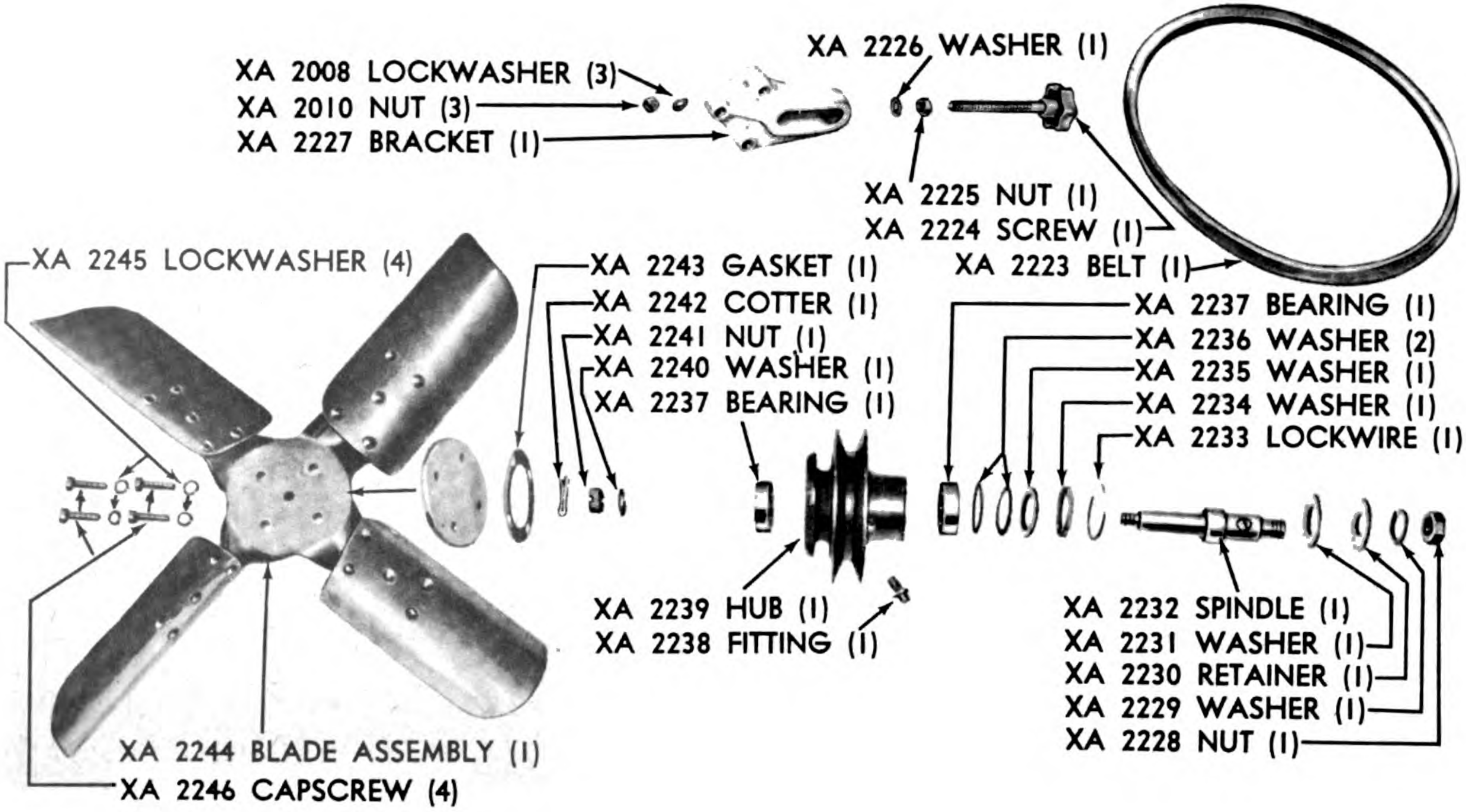
Cylinder Head Assembly



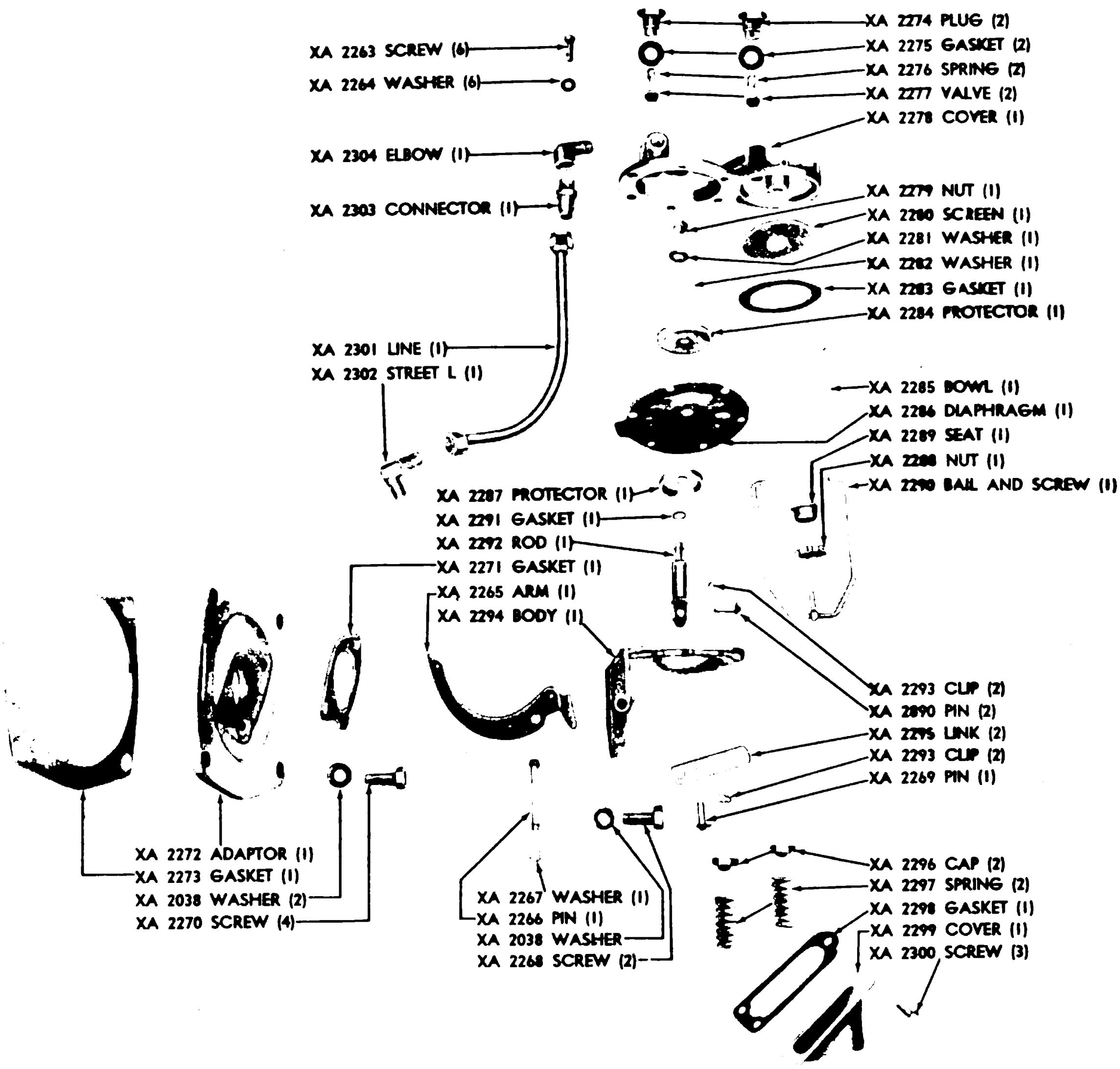
Flywheel and Flywheel Housing Assembly



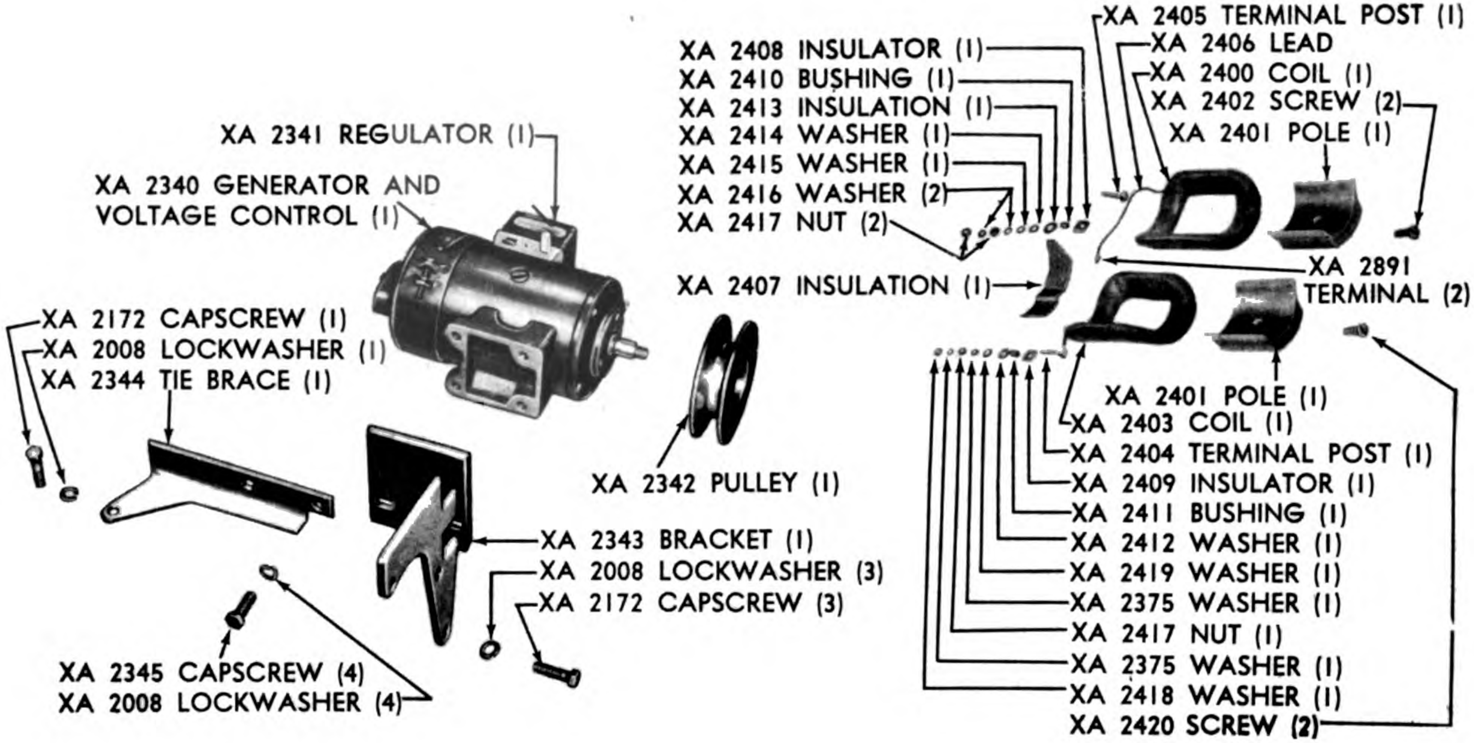
Fan Assembly

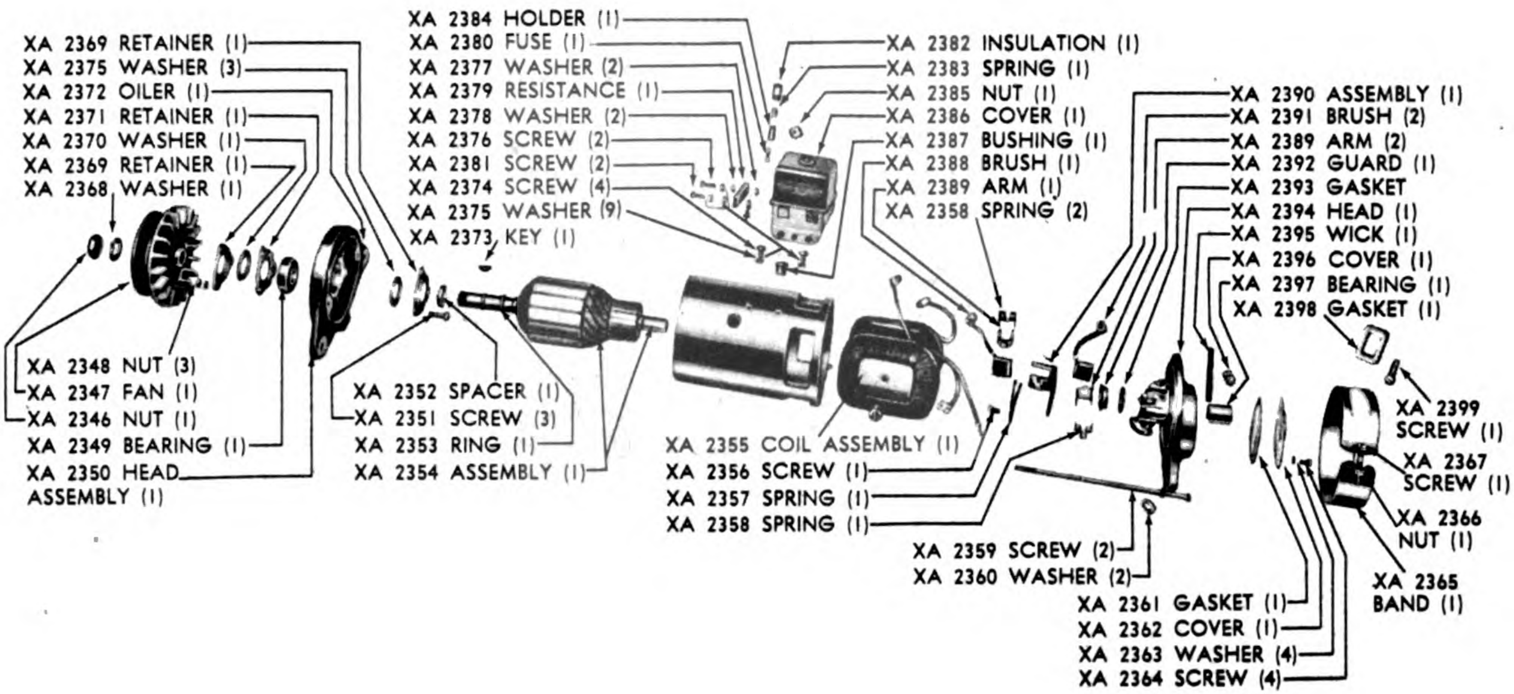


Fuel Pump Assembly



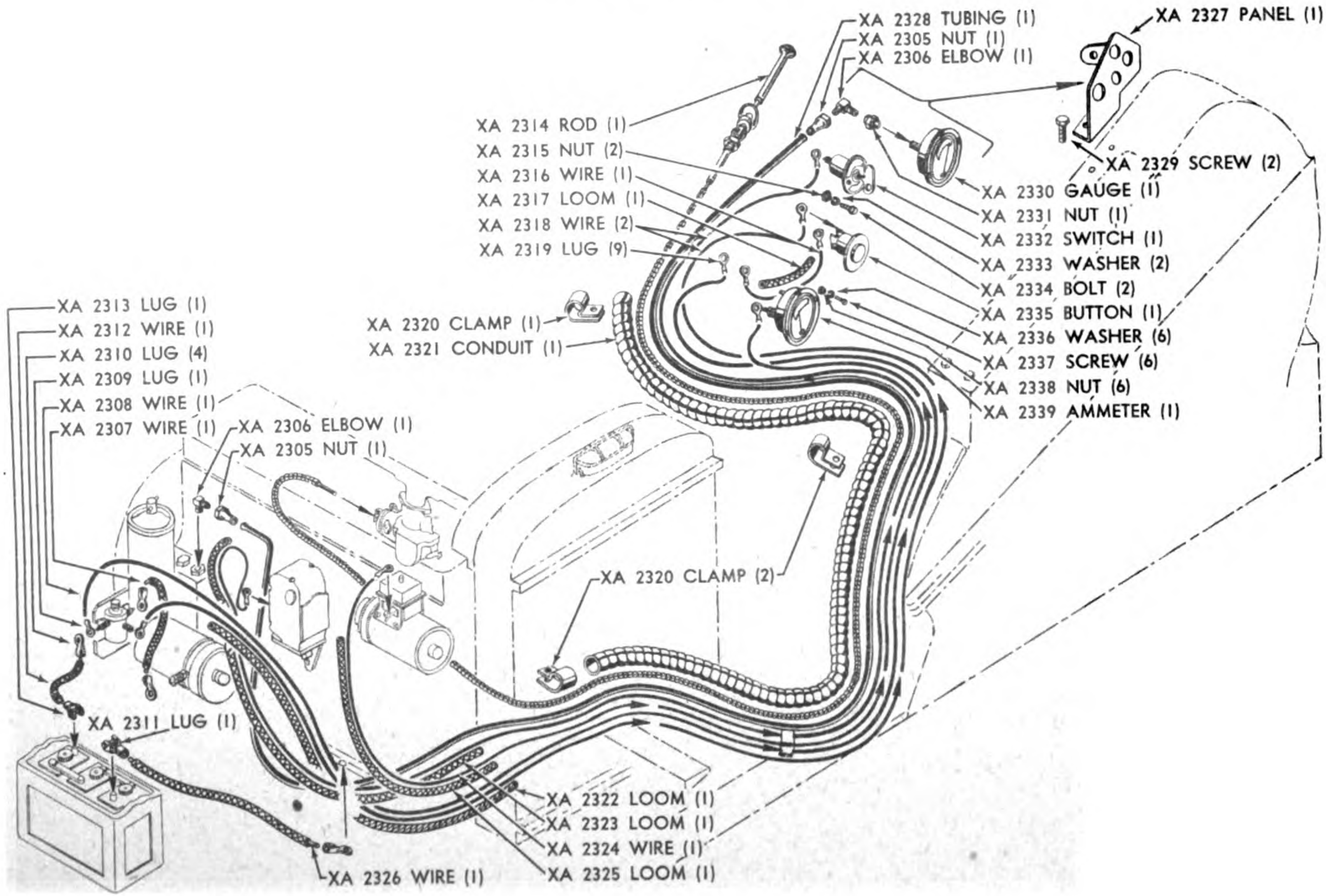
Generator, Voltage Regulator, and Generator Mounting Parts



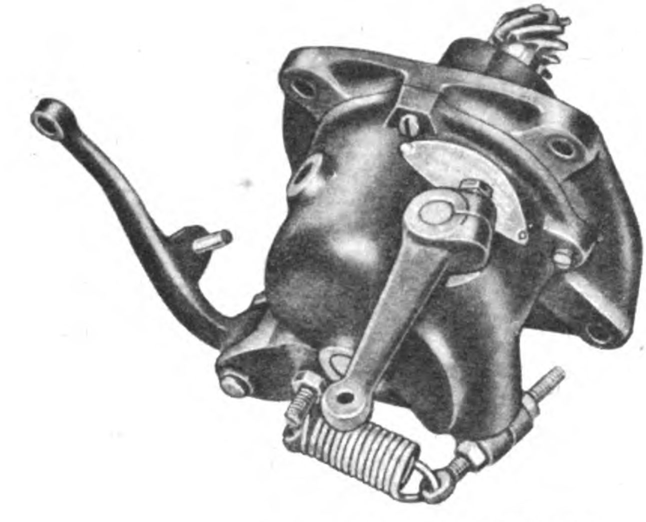


Generator, Voltage Regulator, and Generator Mounting Assembly

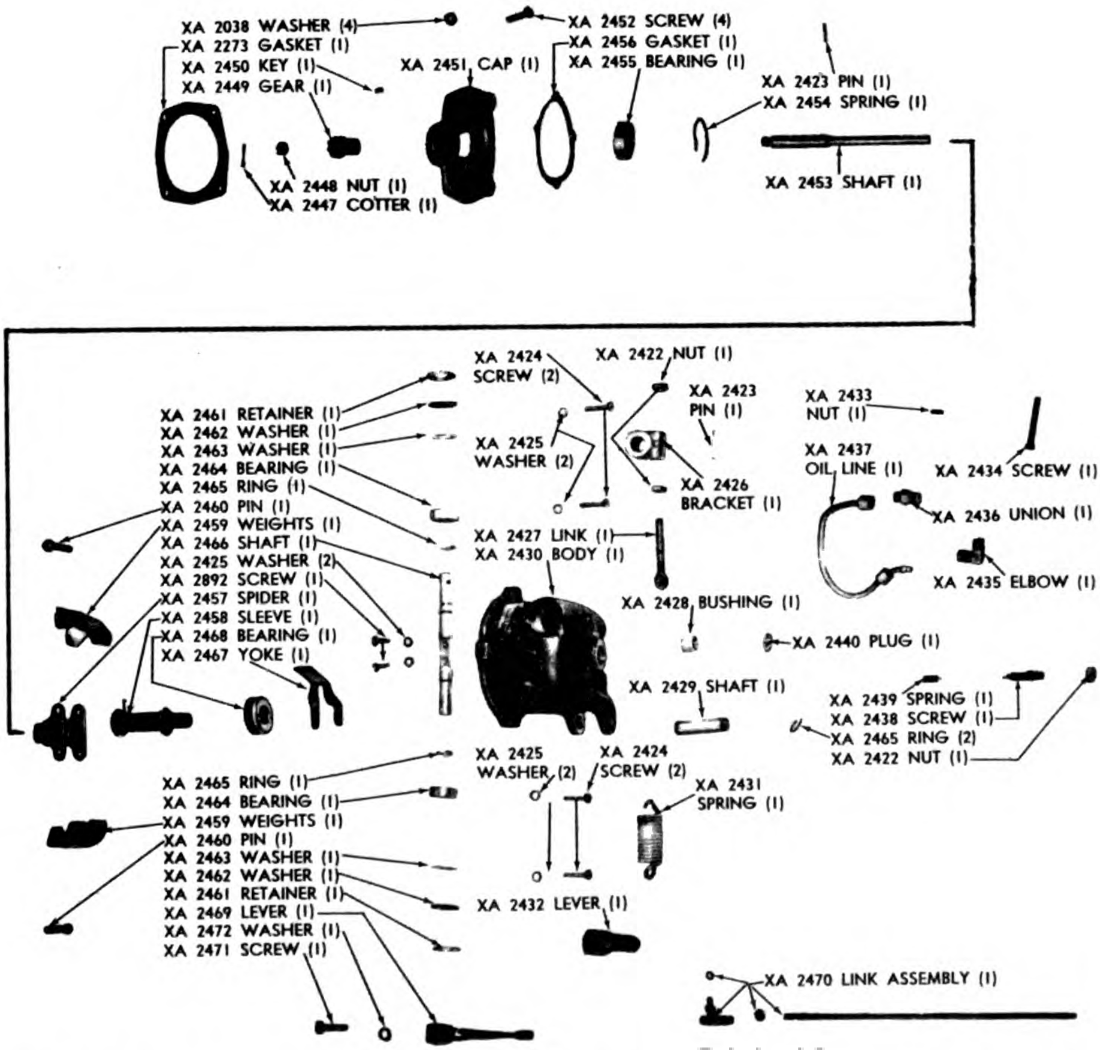
Gauges and Instruments



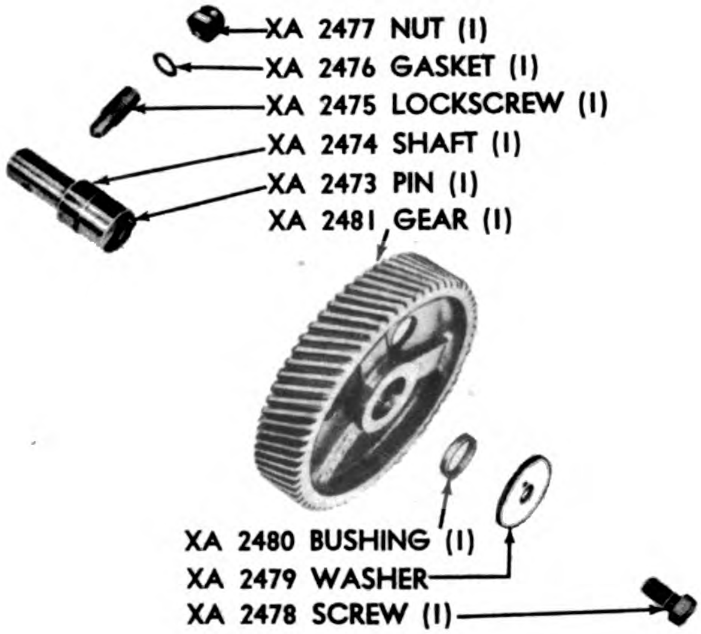
Governor Assembly



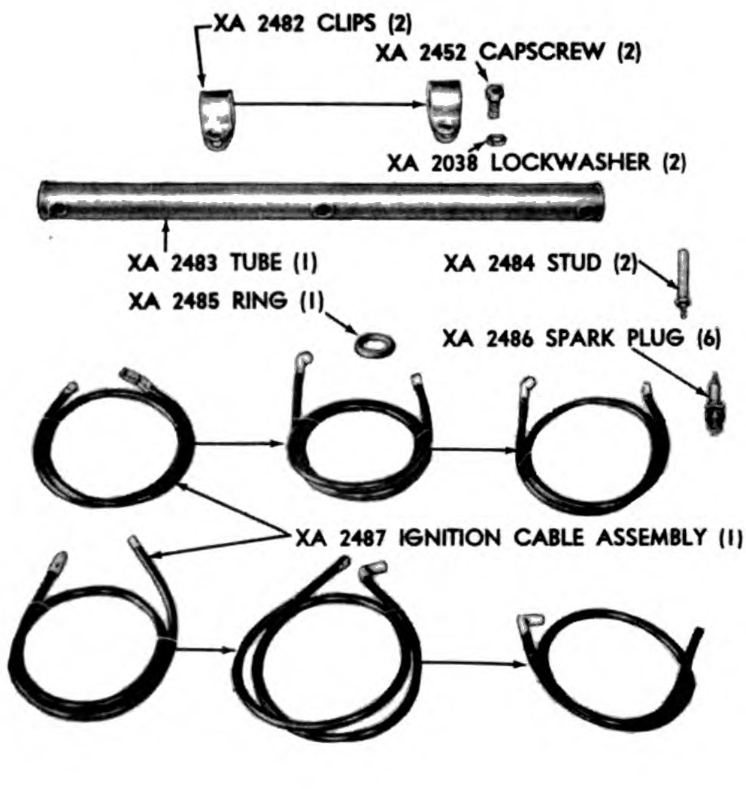
XA 2421 GOVERNOR ASSEMBLY

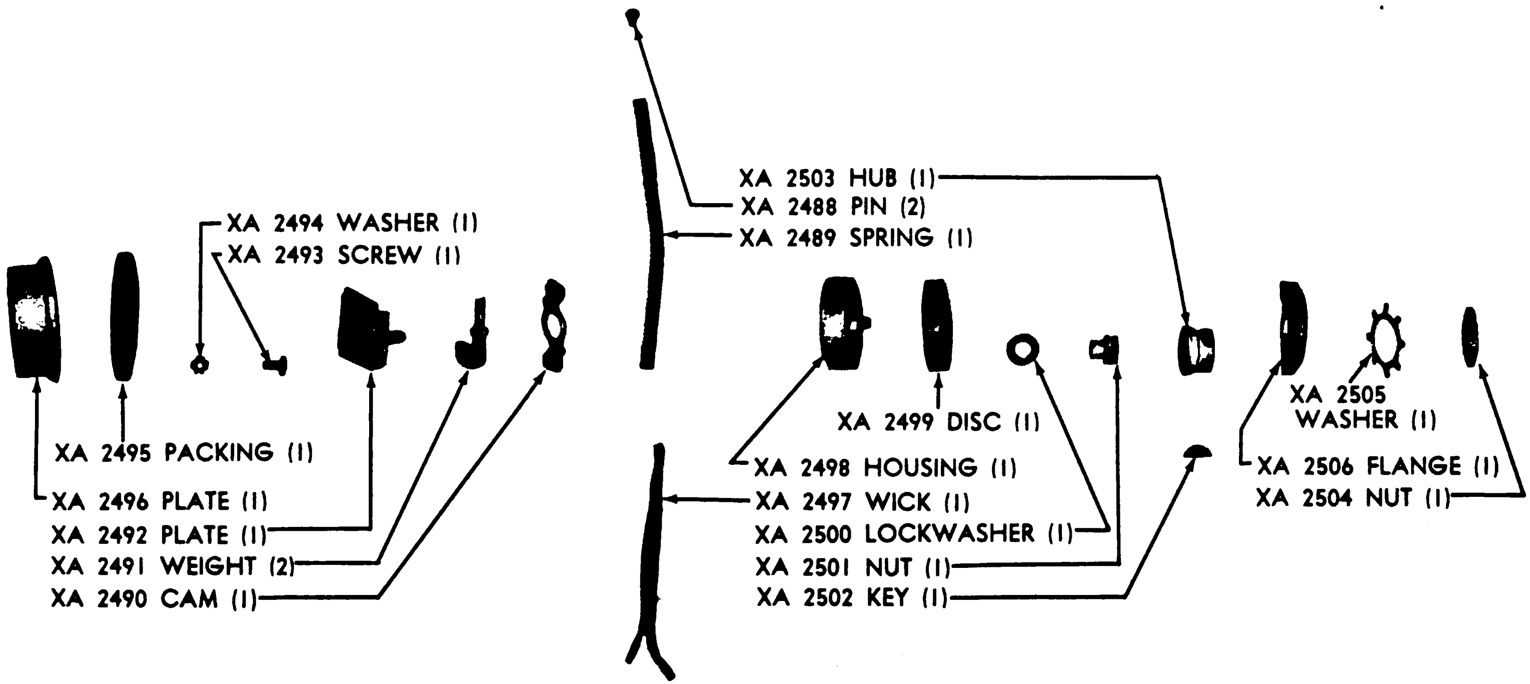


Idler Gear Assembly



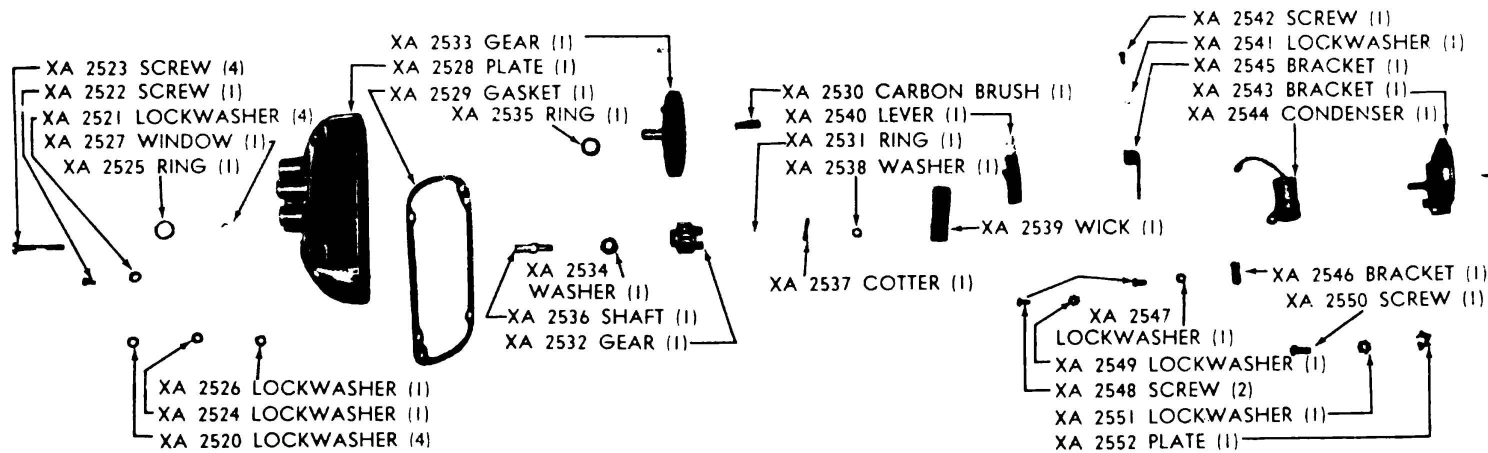
Ignition Accessories

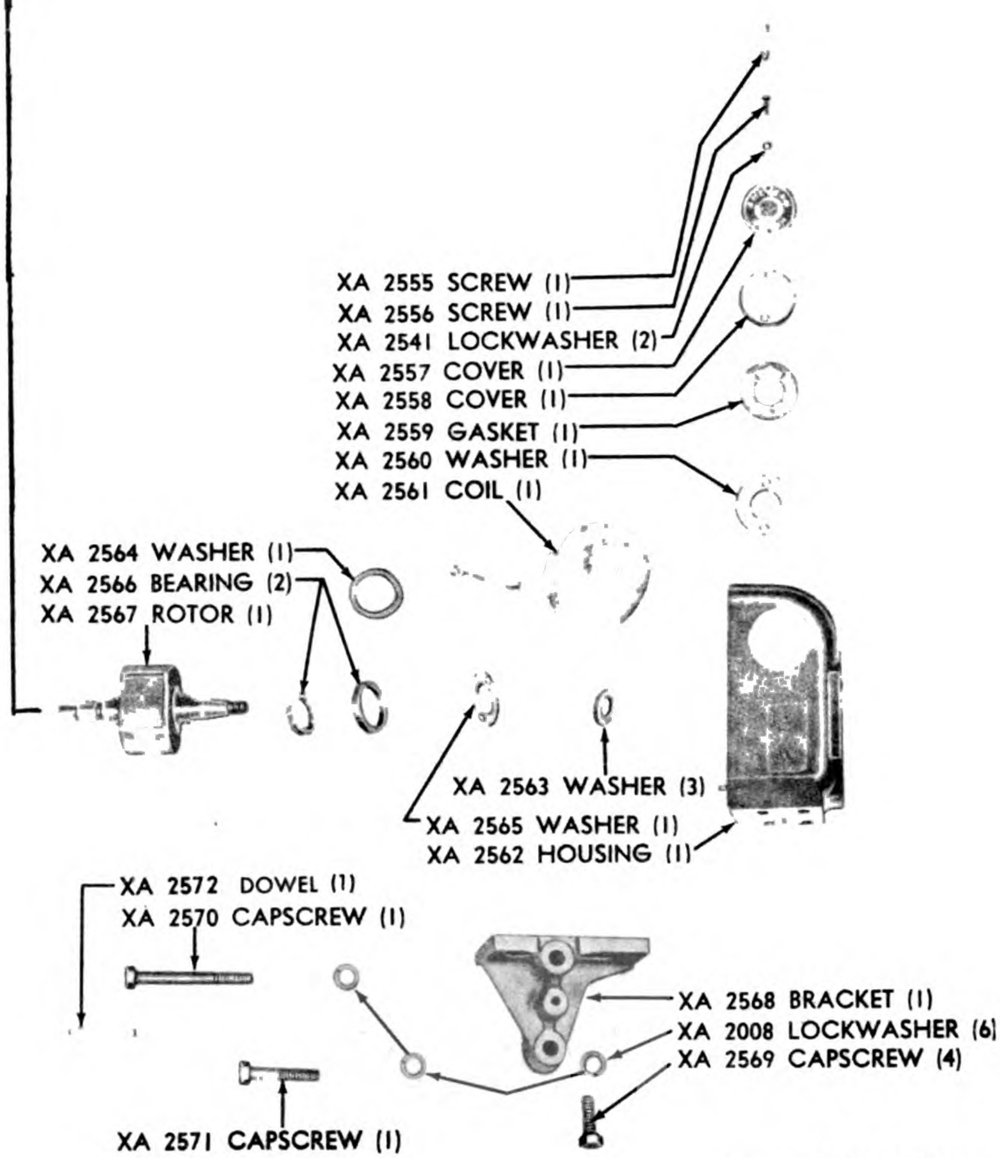




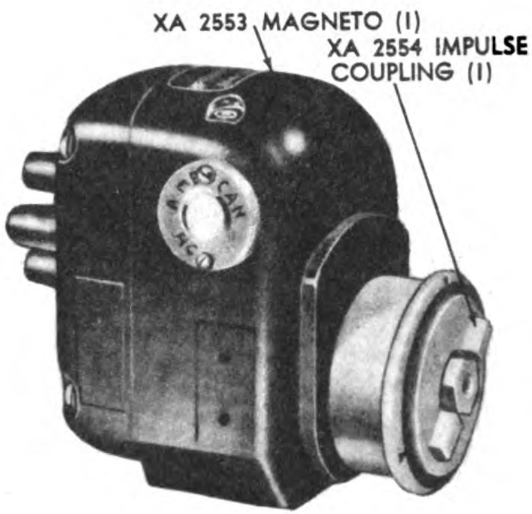
Impulse Coupling Assembly

Magneto Assembly



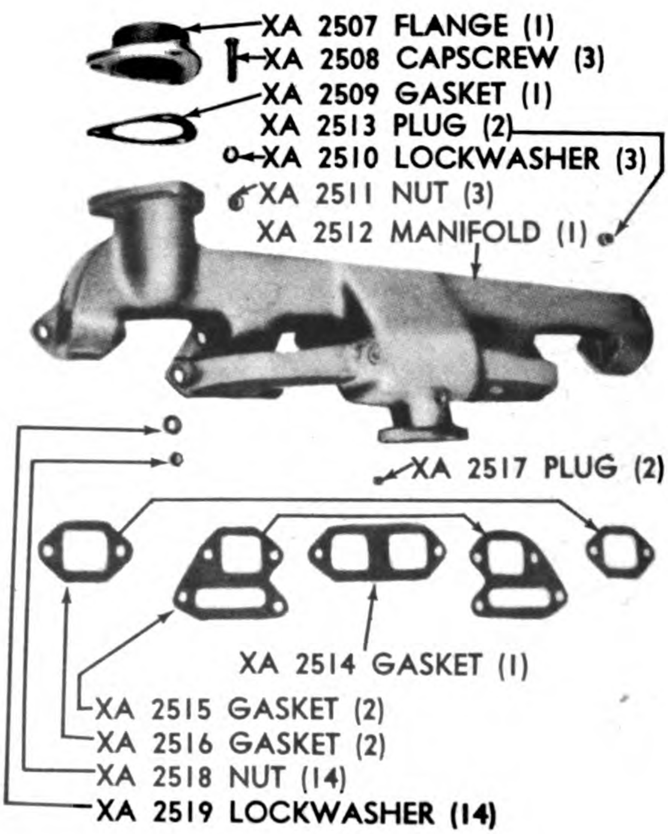


Magneto Assembly

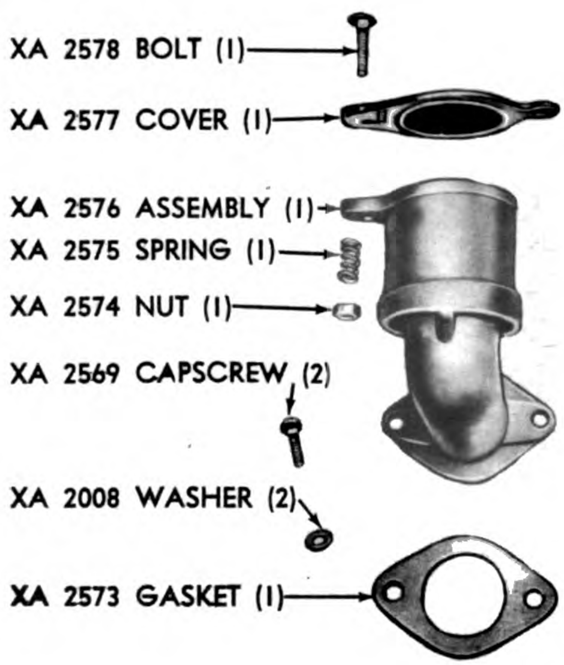


Picture of complete Magneto Assembly XA-2553 and Impulse Coupling Assembly XA-2554.

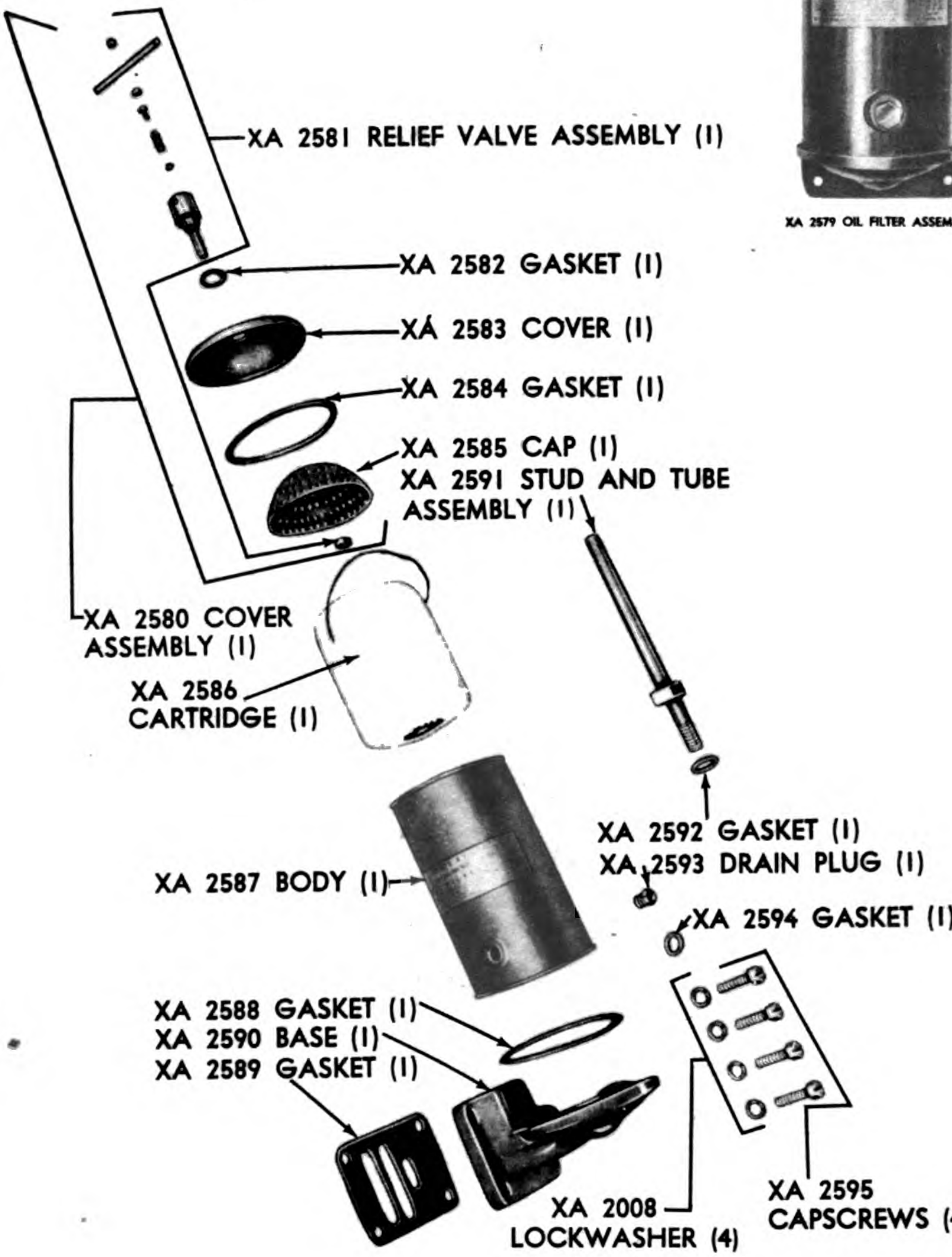
Intake and Exhaust Manifold Assembly



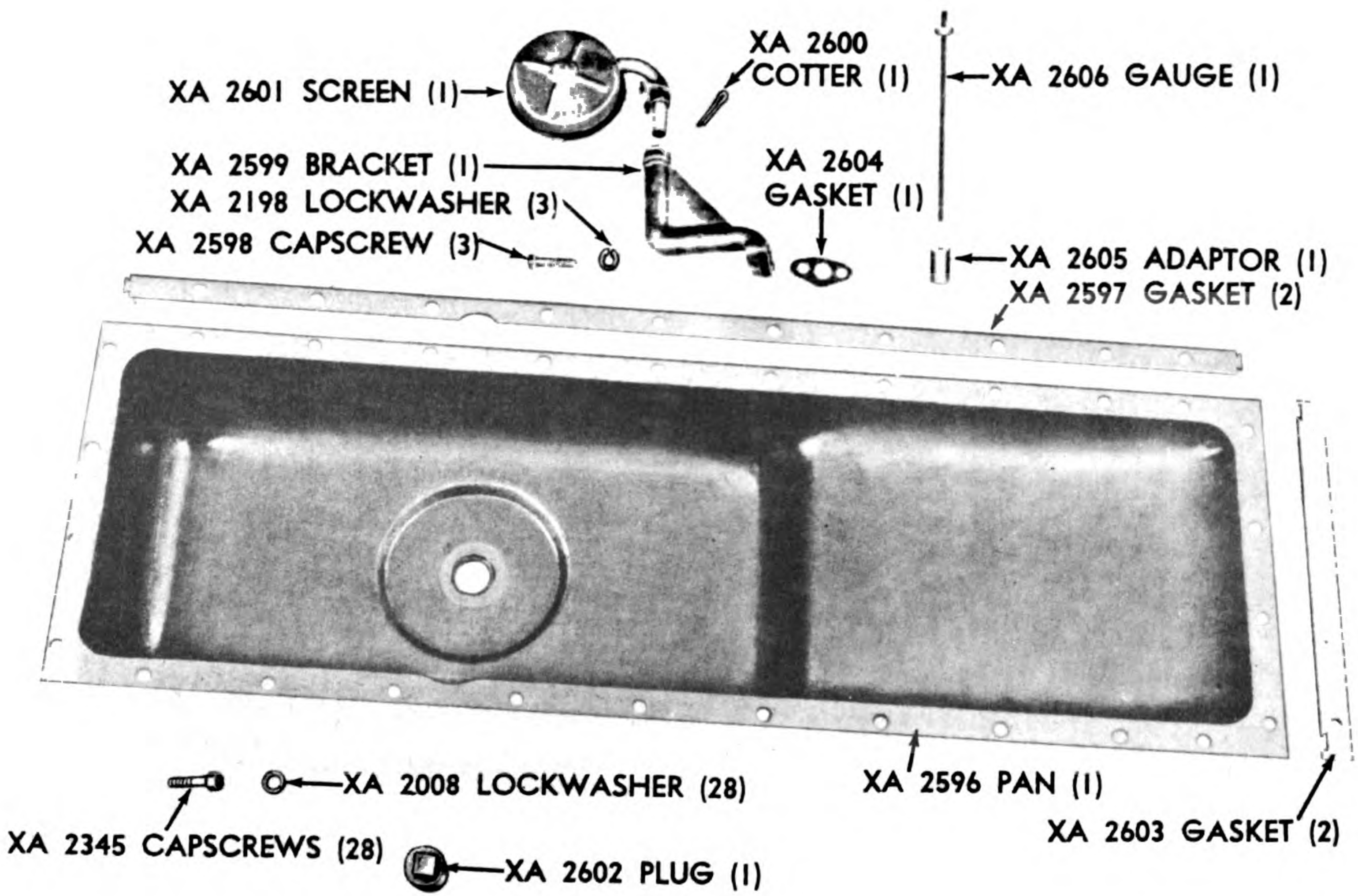
Oil Filler and Breather



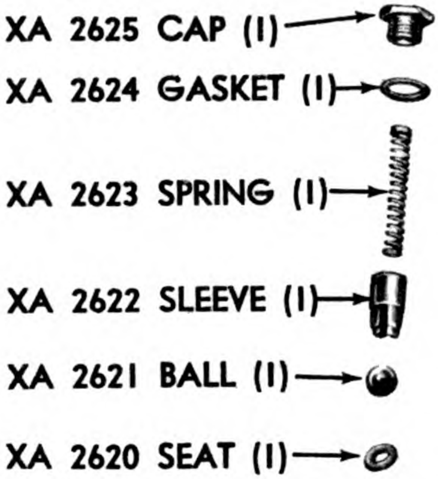
XA 2579 OIL FILTER ASSEMBLY (1)



Oil Pan and Screen

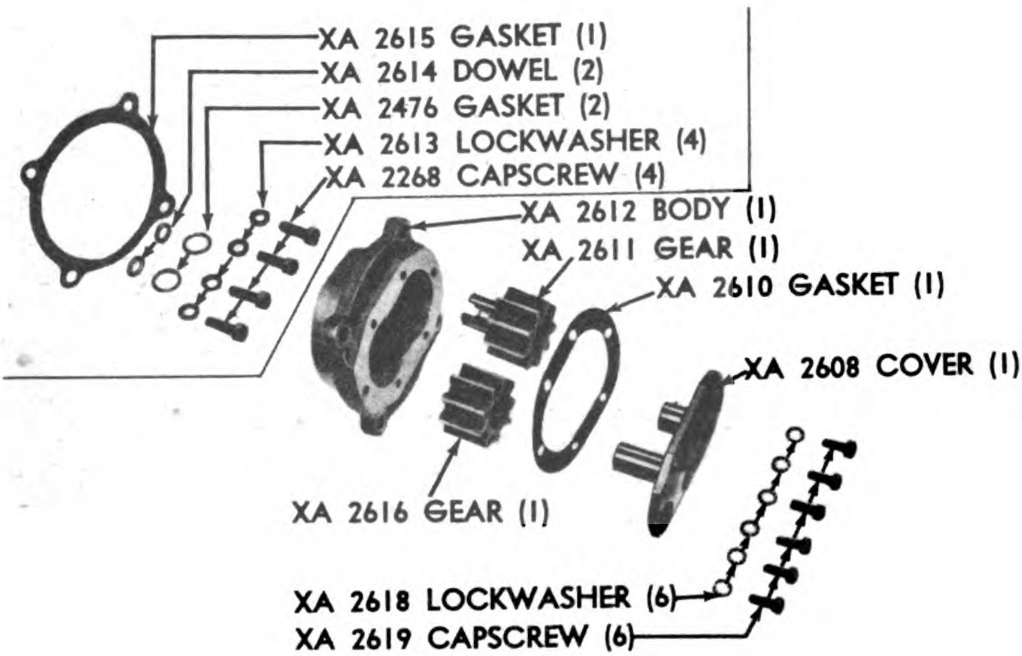


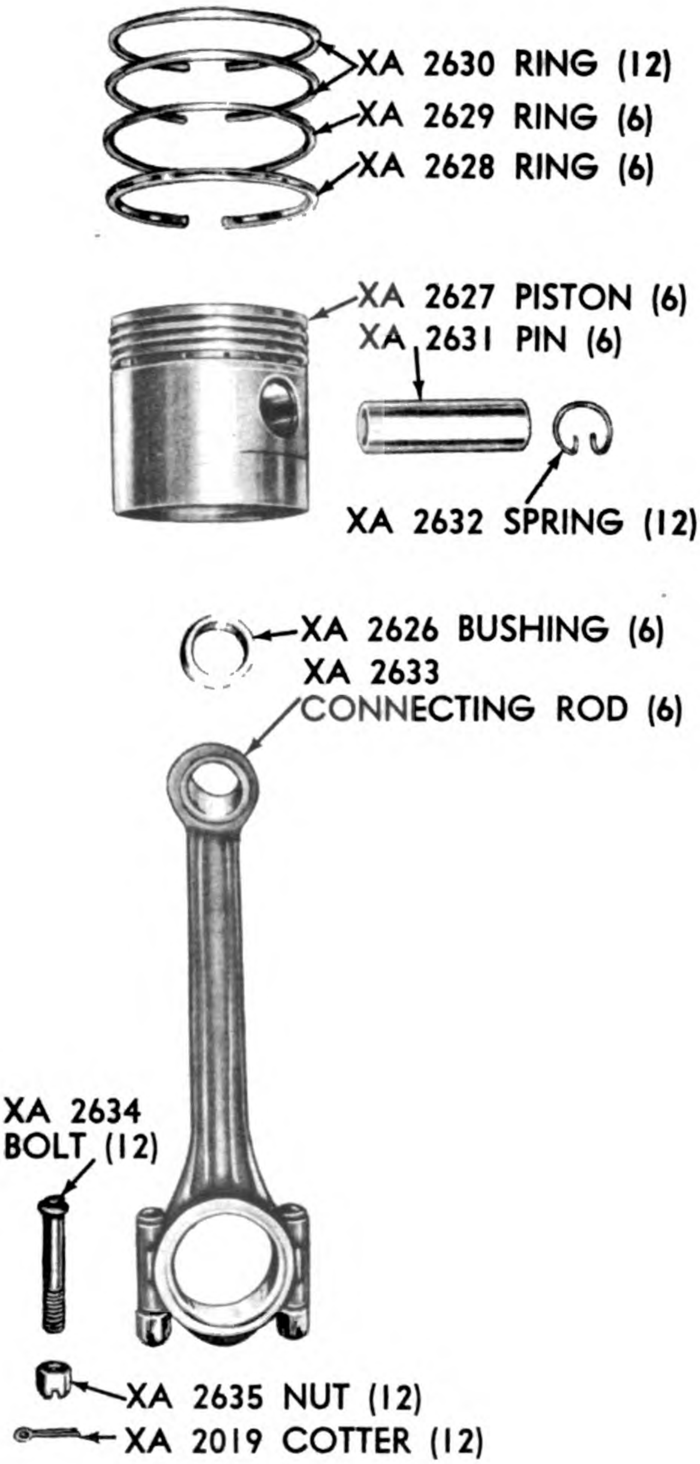
Oil Pump Assembly

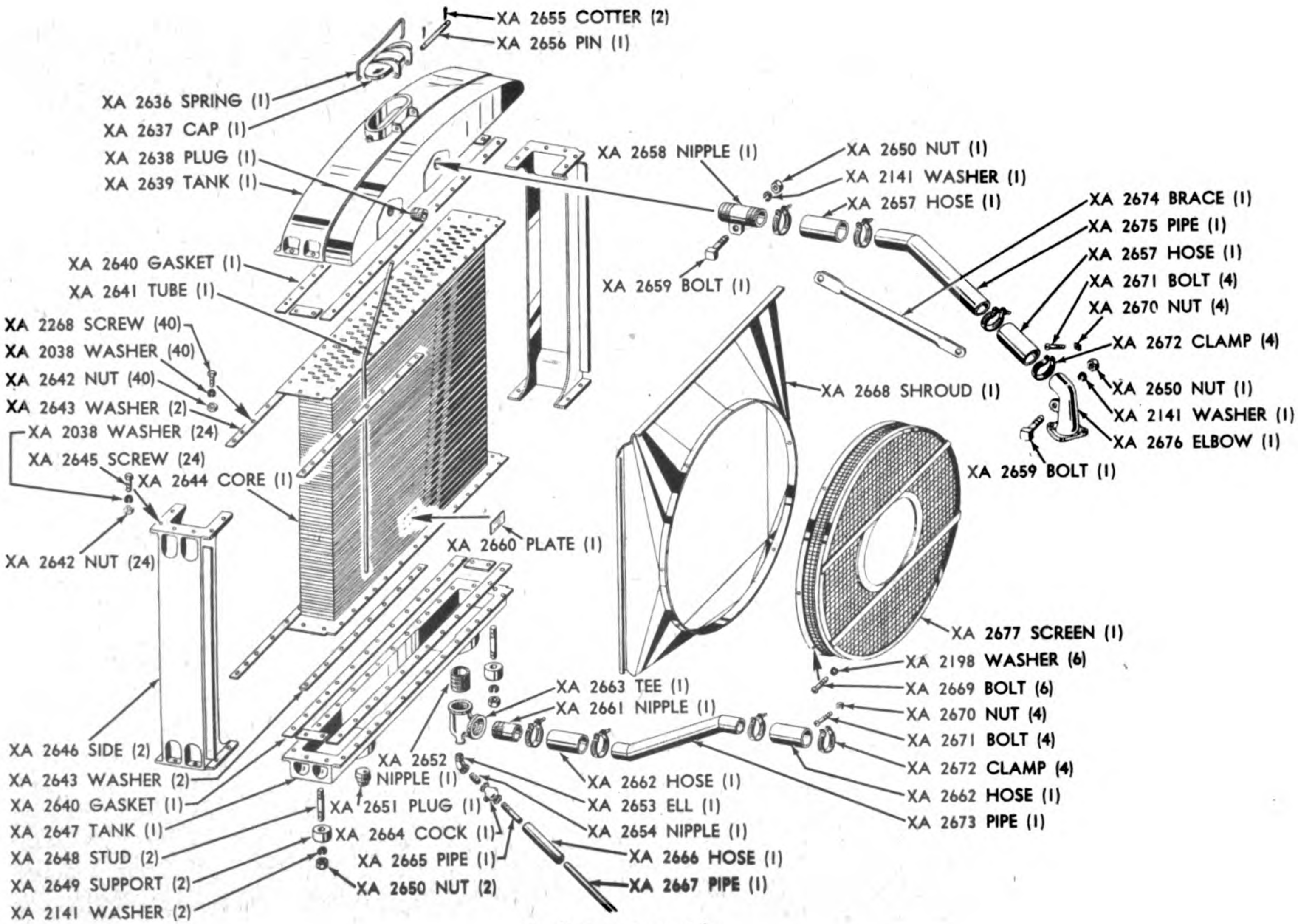


Oil Relief Valve Assembly

Oil Pump Assembly XA-2607 includes all items to right of, and including Body.

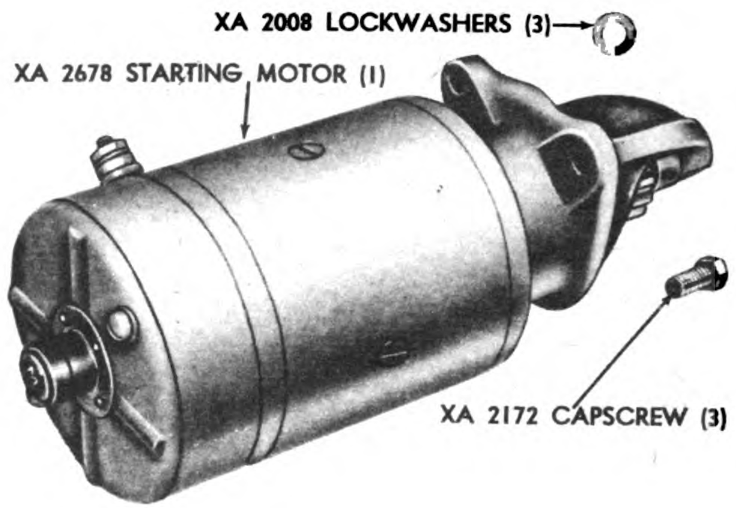


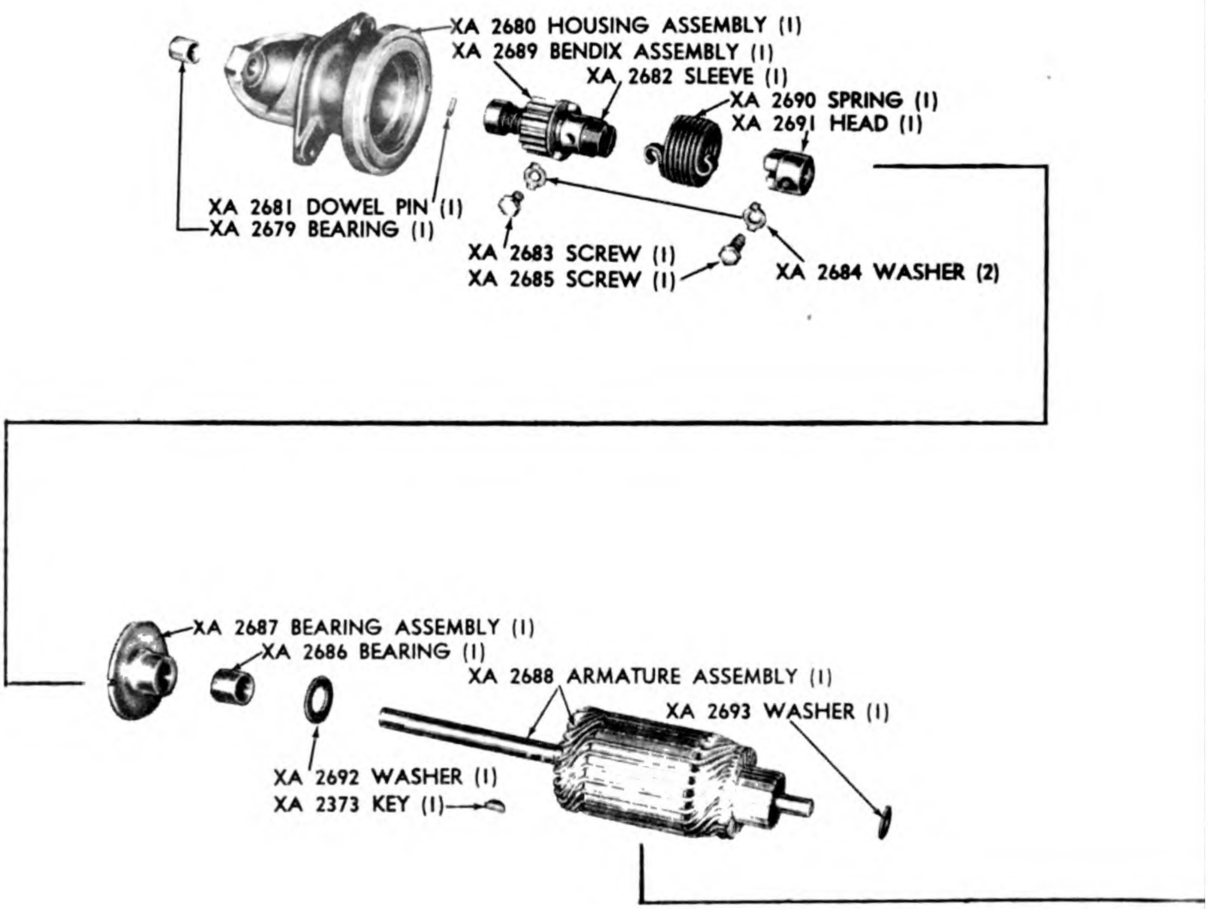

XA 2630 RING (12)
XA 2629 RING (6)
XA 2628 RING (6)
XA 2627 PISTON (6)
XA 2631 PIN (6)
XA 2632 SPRING (12)
XA 2626 BUSHING (6)
XA 2633
CONNECTING ROD (6)
XA 2634
BOLT (12)
XA 2635 NUT (12)
XA 2019 COTTER (12)



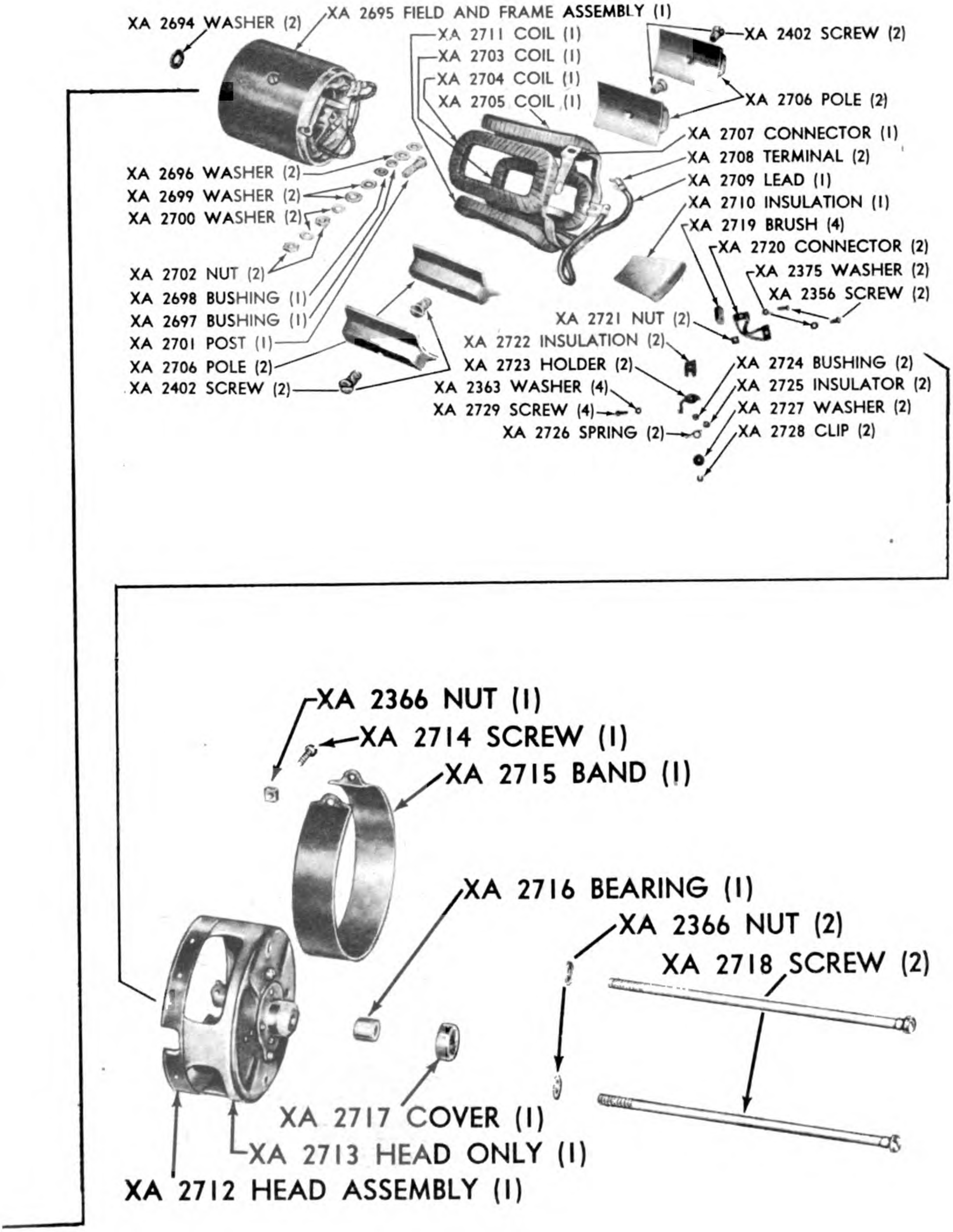
Radiator Assembly

Starting Motor Assembly

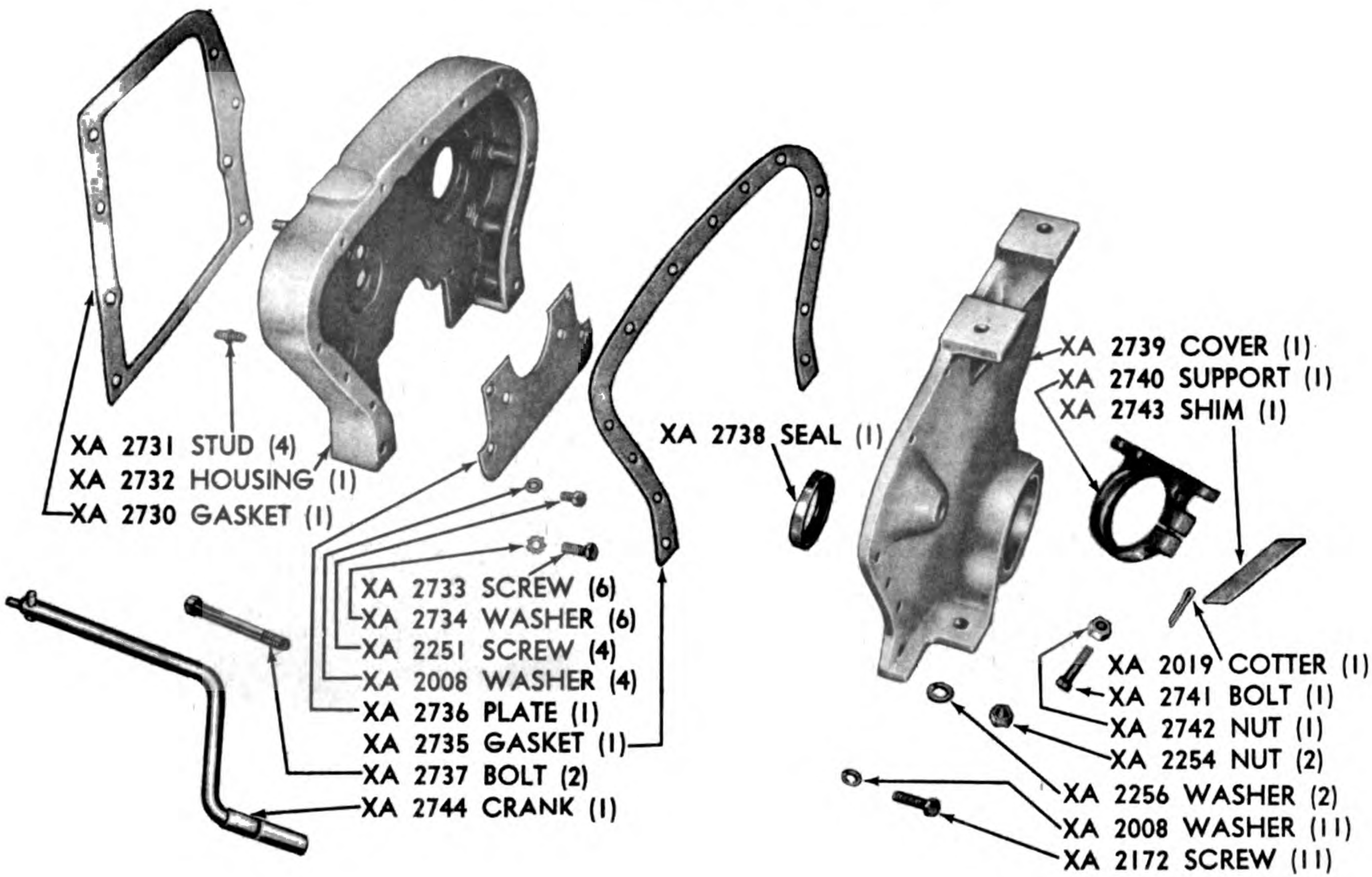




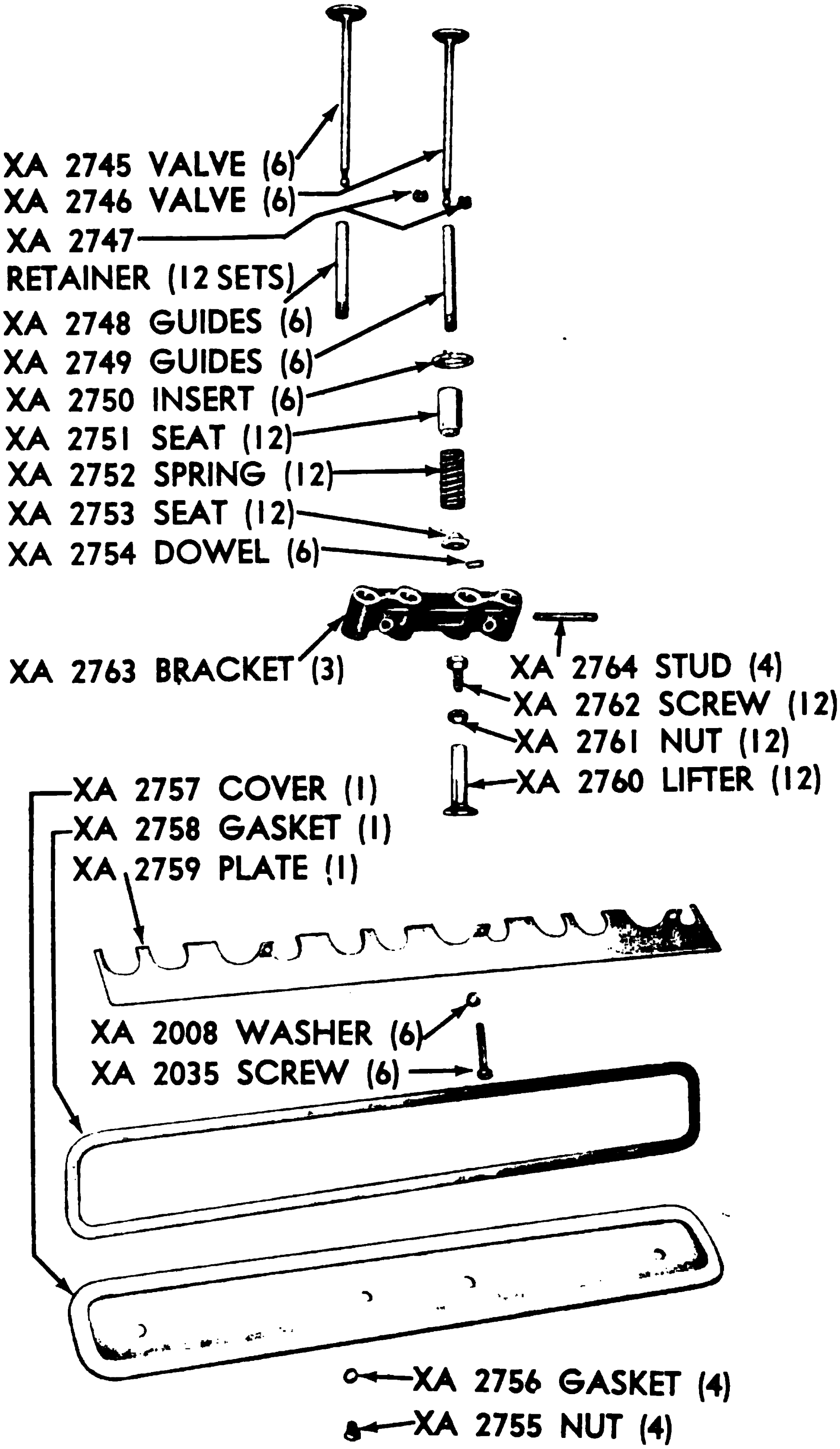
Starting Motor Assembly



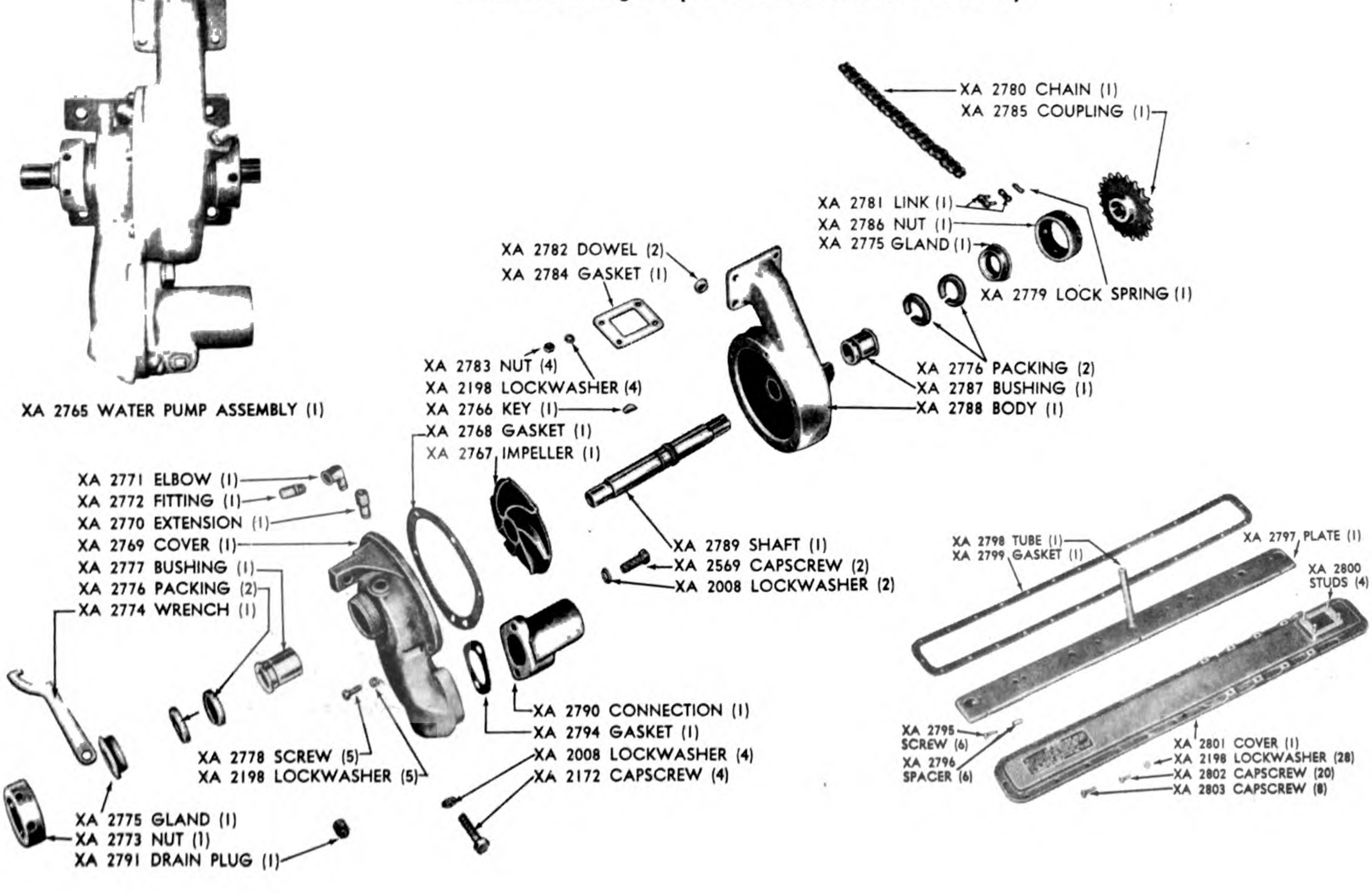
Timing Gear Housing and Gear Cover Assembly

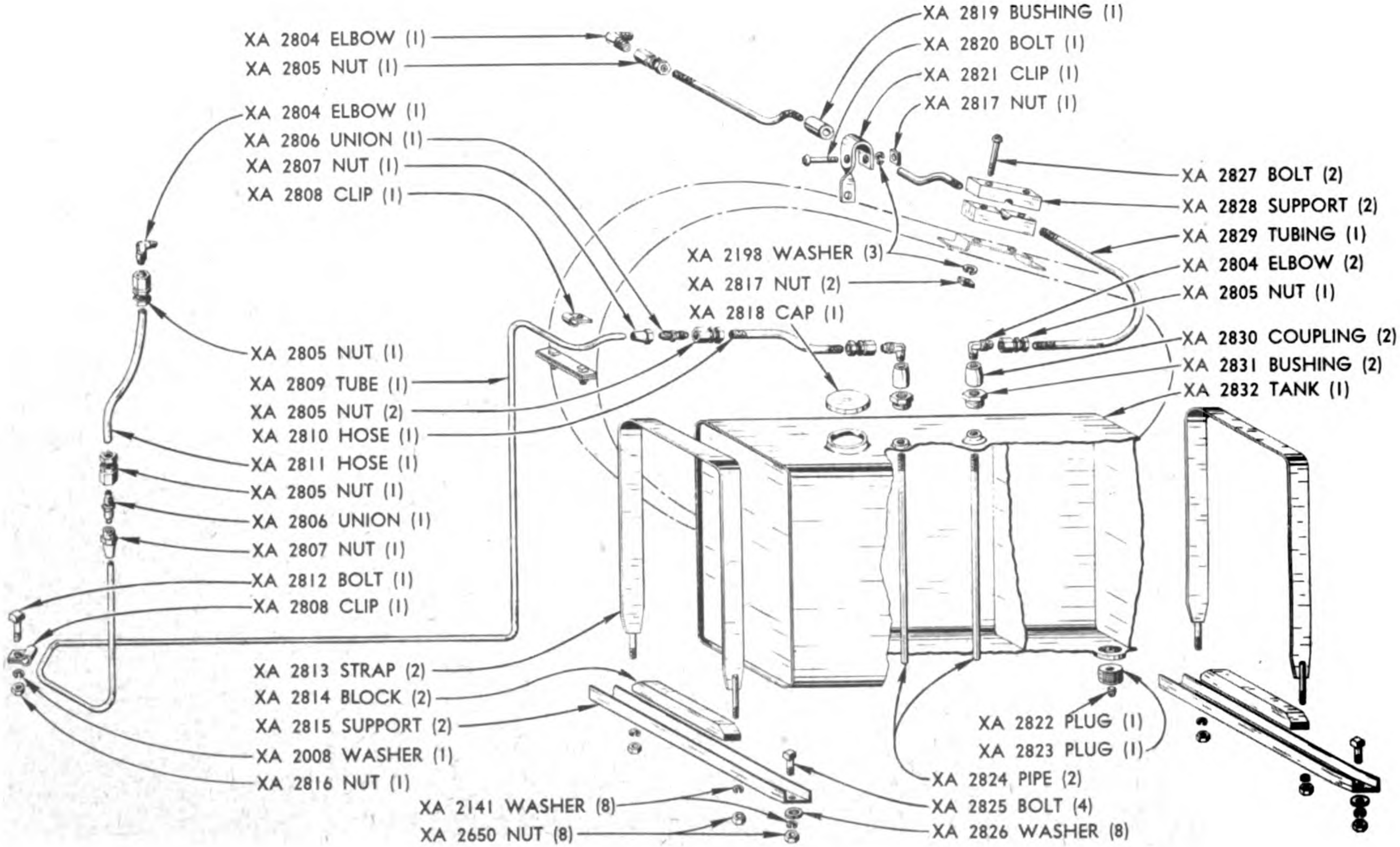


Valve and Bracket Assembly



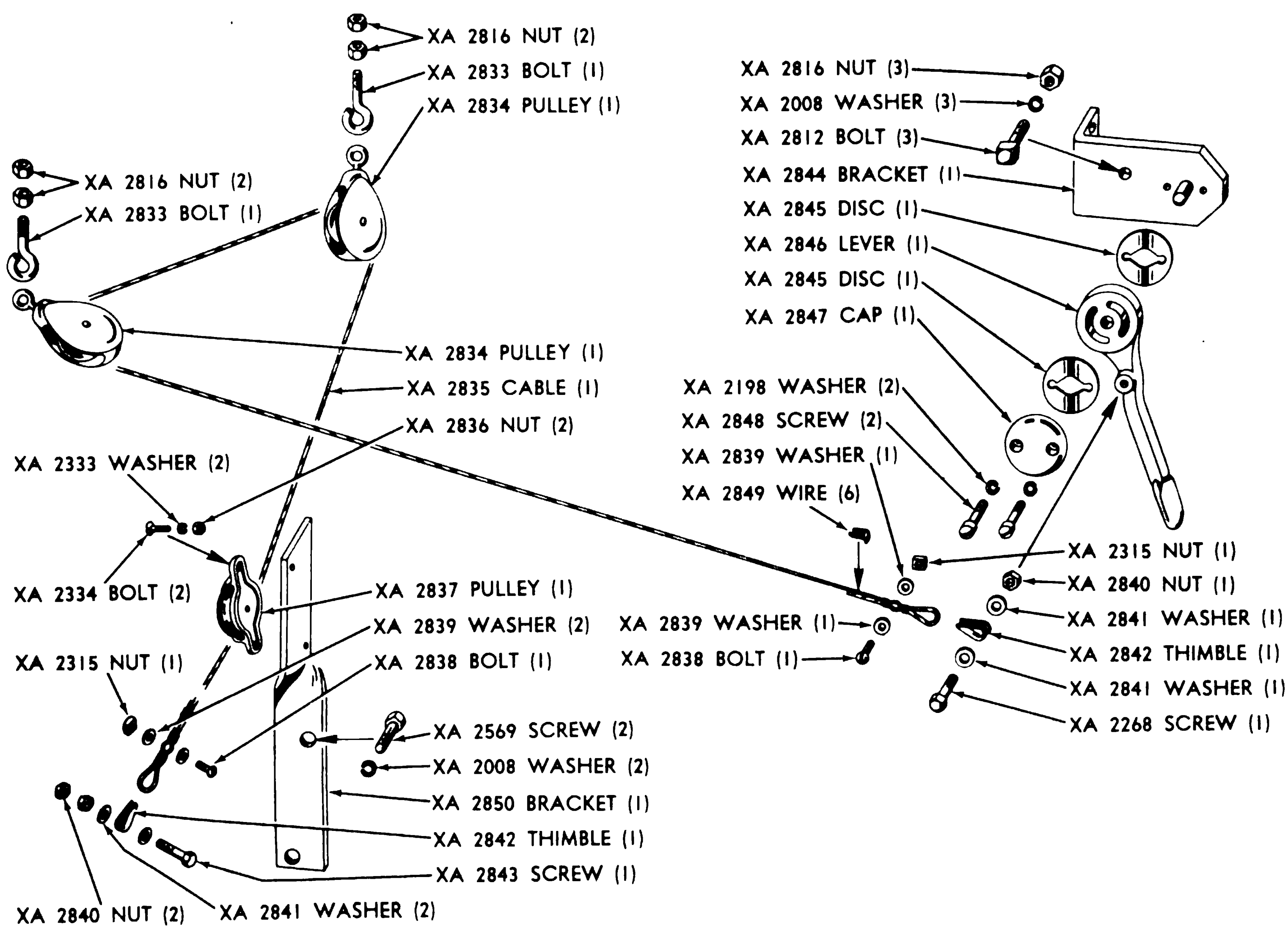
Water Circulating Pump and Water Distributor Assembly

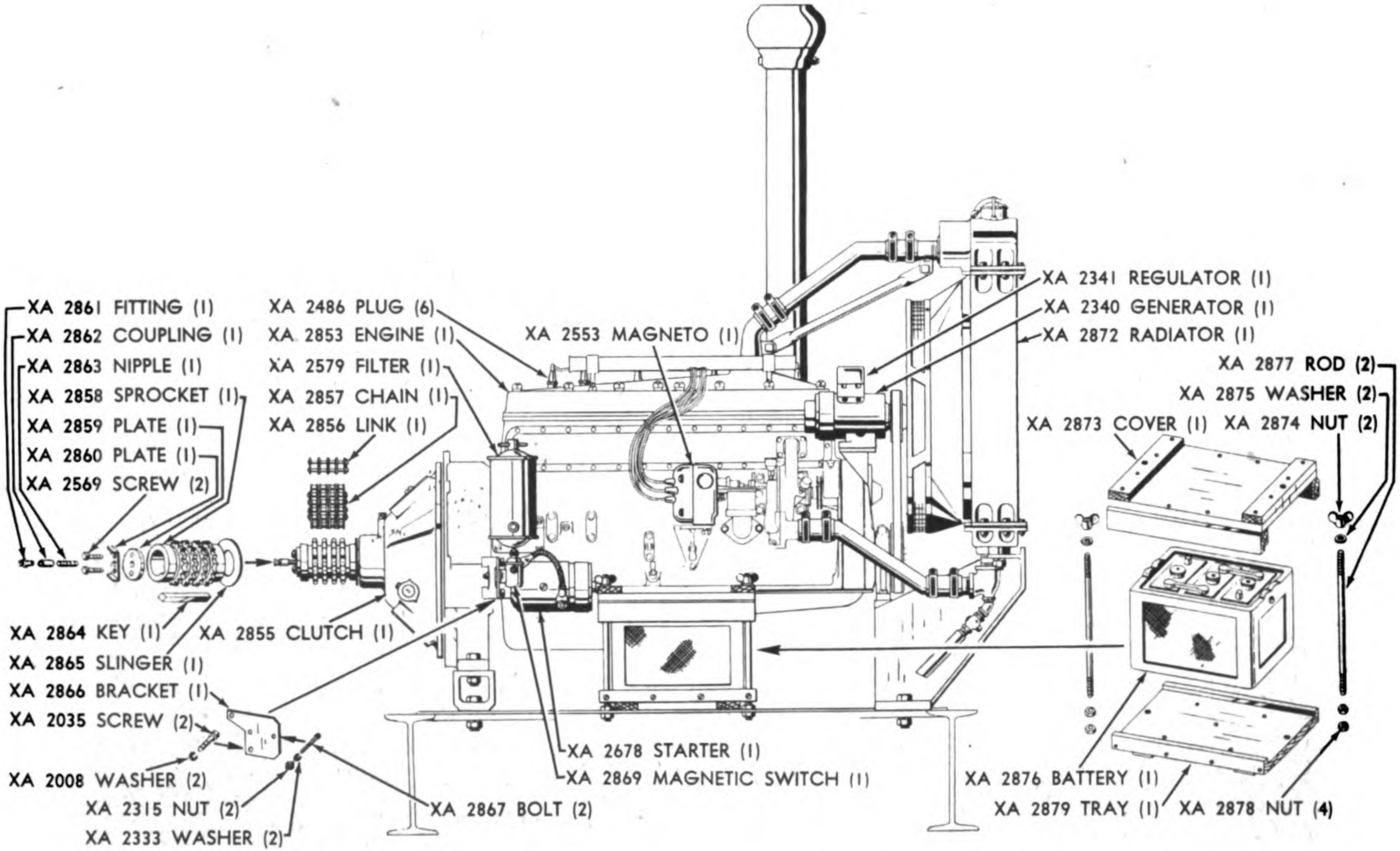




Fuel Tank and Piping

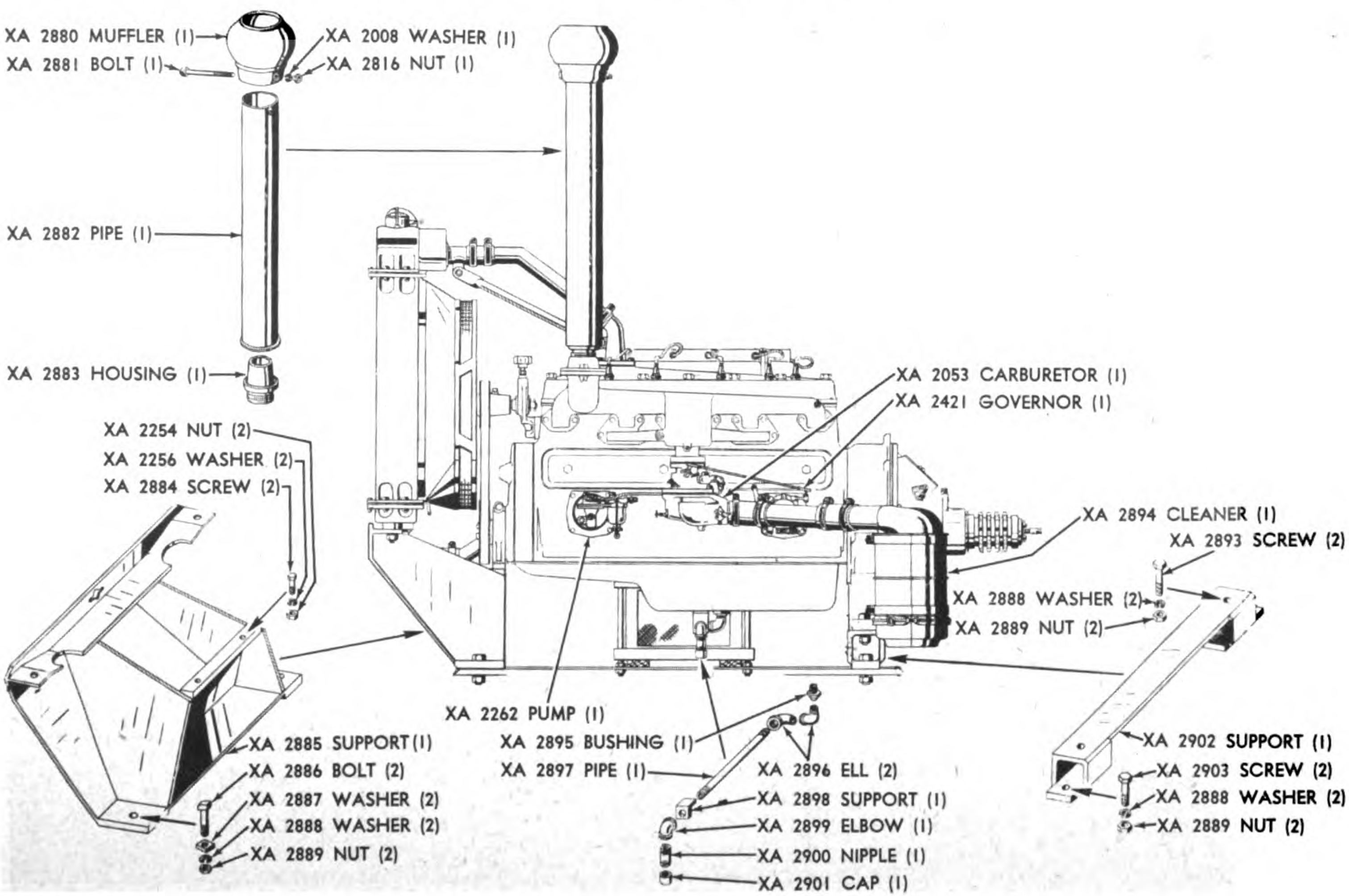
Remote Governor Control Assembly





Engine Accessories (Right side of engine)

Engine Accessories (Left side of engine)



NUMERICAL PARTS LIST

Buda Model K-428 Gasoline Power Unit for Koehring Company Model 304 Crane

The following lists are tabulated numerically by the Koehring part number. To save space the main name of the original manufacturers are listed as follows:

Original manufacturer name and manufacturer's part number are given in DESCRIPTION. All parts without manufacturer's references are standardized hardware or Koehring parts.

AC—A C Spark Plug Division, General Motors Corp., Flint, Michigan (Fuel Pump and Spark Plugs)

ALEMITE—Alemite Division, Stewart Warner Corp., Chicago, Ill. (Grease Fitting)

AUTO-LITE—Electric Auto-Lite Corp., Toledo, Ohio (Starter and Generator)

BOSCH—American Bosch Corp., Springfield, Mass. (Magneto)

BUDA—The Buda Co., Harvey, Ill. (Engine Parts)

CLANCY—J. R. Clancy, Inc., Syracuse, N. Y. (Hose Clamps)

DELUXE—DeLuxe Products Corp., LaPorte, Ind. (Oil Filter)

DIAMOND—Diamond Chain & Mfg. Co., Indianapolis, Ind. (Chain)

DONALDSON—Donaldson Co., Inc., St. Paul, Minn. (Air Cleaner)

EATON—Eaton-Detroit Metal Co., Cleveland, Ohio (Tank Cap)

GLOBE—Globe Union Inc., Milwaukee, Wisc. (Battery)

PERFEX—Perfex Corp., Milwaukee, Wisc. (Radiator)

PIERCE—Pierce Governor Co., Anderson, Ind. (Governor)

PRITZLAFF—Pritzlaff Hdwe. Co., Milwaukee, Wisc. (Swivel Pulley)

ROSS—Ross Gear & Tool Co., LaFayette, Ind. (Lever Parts)

SWITZER — Switzer-Cummings Co., Indianapolis, Ind. (Fan)

TWIN DISC—Twin Disc Clutch Co., Racine, Wisc. (Clutch)

WEATHERHEAD — Weatherhead Co., Cleveland, Ohio (Hose and Fittings)

ZENITH—Zenith Carburetor Div., Bendix Aviation Corp., Detroit, Michigan (Carburetors)

Single Asterisk (*) indicates price per 100 pcs.
Double Asterisk (**) indicates over 200 pcs. per lb.

Koehring Part No.	Name and Description	Illust. on Page	Amt. Rqd.	Weight Lbs.	Price Each
XA2000	ASSEMBLY, Accessory Drive (not shown)—Buda 4420	407	1	8	$23.00
XA2001	COUPLING, Drive—Buda 1415	407	1	½	2.20
XA2002	SPRING, Cork Retainer—Buda RSE-133	407	1	50 per	.06
XA2003	CORK, Housing—Buda 1402	407	1	30 per	.06
XA2004	RETAINER, Cork—Buda GE-745	407	2	50 per	.05
XA2005	SHAFT, Drive—Buda 4422	407	1	1¼	5.00
XA2006	STUD, Drive Shaft—Buda 2423	407	1	40 per	.10
XA2007	PLATE, Bearing Accessory Drive—Buda 4423	407	1	40 per	.25
XA2008	LOCKWASHER, ⅜"—Buda 103321	407	130	200 per	.01
XA2009	HOUSING, Accessory Drive—Buda 4421	407	1	4	7.00
XA2010	NUTS, ⅜"—24 N.F.—Buda 103026	407	9	20 per	.02
XA2011	GEAR, Drive—Buda 4418	407	1	1¼	5.75
XA2012	SETSCREW, Distributor Boss—Buda 106827 ¼"—20	407	1	50 per	.08
XA2013	NUT, Distributor Boss Setscrew ¼"—20—Buda 114501	407	1	100 per	.02
XA2014	PLUG, Distributor—Buda GE-218	407	1	¼	.30
XA2015	PLATE, Baffle—Buda 4425	407	1	40 per	.10
XA2016	SCREW, Baffle Plate No. 10-32x5/16"—Buda 113626	407	1	200 per	.01
XA2017	SPIDER, Drive Shaft Gear—Buda 4419	407	1	¼	1.10
XA2018	WASHER, Drive Shaft Stud—Buda 106263	407	1	100 per	.04
XA2019	COTTER, 3/32"x1"—Buda 103374	407	14	**	.01
XA2020	NUT, ⅜"x24—Buda 122741	407	1	50 per	.06
XA2021	GASKET, Accessory Drive Housing—Buda 4424	407	1	50 per	.04
XA2022	LOCKWASHER No. 10—Buda 106497	407	1	**	.01
XA2023	CLAMP, Hose 2"—4 Ply—Clancy	408	3	¼	.30
XA2024	NUT, Square 5/16" Galvanized	408	3	40 per	.01
XA2025	HOSE, Rubber 2⅜" I.D.x4"	408	2	¼	.20
XA2026	BOLT, Stove Round Head 5/16"x1¾" Galvanized	408	3	15 per	.04
XA2027	PIPE, Connector 200A47	408	1	3¼	.65

Koehring Part No.	Name and Description	Illust. on Page	Amt. Rqd.	Weight Lbs.	Price Each
XA2028	NUT, Square 3/8" Galvanized	408	1	30 per	.01
XA2029	BOLT, Stove Round Head 3/8"x2" Galvanized	408	1	12 per	.04
XA2030	CLAMP, Hose 2-1/4"—4 Ply—Clancy	408	1	¼	.35
XA2031	BODY, Air Cleaner Assembled with Filtering Element—Donaldson—2P3976	408	1	10½	5.75
XA2032	CUP, Oil Assembly—Donaldson P3342	408	1	1¾	1.50
XA2033	CLAMP, Oil Cup Assembled with Bolt—Donaldson P3134	408	1	¼	.50
XA2034	WASHER, Flat 3/8" U.S. Standard	408	6	50 per	.20*
XA2035	SCREW, Cap Hex. Head 3/8"x1½" N.C.	408	22	12 per	.03
XA2036	BRACKET, Air Cleaner 212B18	408	1	7¼	4.00
XA2037	BOLT, Machine 5/16"x¾" N.C.	408	4	20 per	.02
XA2038	WASHER, Lock 5/16"	408	82	* *	.30*
XA2039	NUT, Square 5/16" N.C.	408	4	40 per	.90*
XA2040	BAND, Support Assembled with Screws—Donaldson P2147	408	2	¾	.50
XA2041	NUT, Square—Donaldson P5300	408	3	80 per	.01
XA2042	SCREW, Adjusting—Donaldson P5304	408	2	20 per	.04
XA2043	WASHER, Lock—Donaldson P2949	408	1	100 per	.02
XA2044	BOLT, Adjusting—Donaldson P2690	408	1	12 per	.10
XA2045	KEY, Camshaft Gear—Buda 113782	409	1	100 per	.04
XA2046	PIN, Camshaft Oil Pump Drive—Buda 1308	409	1	50 per	.25
XA2047	CAMSHAFT—Buda K40254	409	1	20¼	39.50
XA2048	COLLAR, Camshaft Thrust—Buda 1309	409	1	¼	.55
XA2049	LOCKPLATE, Camshaft Thrust Collar—Buda 1341	409	1	50 per	.03
XA2050	CAPSCREWS, ¼-20x½—Buda 106972	409	3	50 per	.04
XA2051	GEAR, Camshaft—Buda 4340	409	1	5¾	6.60
XA2052	RETAINER, Camshaft Gear—Buda 1307	409	1	100 per	.04
XA2053	CARBURETOR ASSEMBLY—Buda K-40487	410	1	8½	23.50
XA2054	GASKET, Carburetor—Buda GE-144	410	1	50 per	.08
XA2055	SCREW, Throttle Plate—Zenith C-136-3	410	2	100 per	.05
XA2056	PLATE, Throttle—Zenith C-21-35	410	1	½	1.20
XA2057	SCREEN, Filter—Zenith C-150-1	410	2	* *	.20
XA2058	PLUG, Filter—Zenith C-149-17	410	1	50 per	.40
XA2059	PIN, Stop Lever, Tapered—Zenith CT-63-9	410	2	* *	.05
XA2060	STUD, Valve Box—Zenith DE-3043	410	2	⅛	.45
XA2061	BUSHING, Throttle Shaft—Zenith CR-9-5	410	1	100 per	.10
XA2062	BODY, Throttle Assembly—Zenith B-2-30A-1	410	1	2¾	7.50
XA2063	SPRING, Idle Adjusting Screw—Zenith C111-17	410	1	* *	.10
XA2064	SCREW—Zenith C46-6	410	1	* *	.20
XA2065	PUMP, Carburetor—Zenith C-36-18	410	1	¼	.95
XA2066	IDLE JET, Tole Size 16—Zenith C-54-14	410	1	50 per	.60
XA2067	VENTURI, Size 36—Zenith C-38-14A30	410	1	⅜	2.40
XA2068	WASHER, Venturi Screw—Zenith T-41-10	410	1	* *	.05
XA2069	SCREW, Tube Clamp—Zenith T-1S-8-10	411	1	200 per	.05
XA2070	PLUG, Filter—Bowl and Inlet—Zenith CT-91-3	410	2	100 per	.10
XA2071	WASHER, Fuel Filter Plug—Zenith T-56-10	410	1	* *	.05
XA2072	SHAFT, Throttle—Zenith C-23-217	410	1	16 per	1.10
XA2073	BODY, Union—Zenith C-148-9A	410	1	¼	1.10
XA2074	PACKING, Throttle Shaft—Zenith CT-57-2	410	2	* *	.05
XA2075	RETAINER, Throttle Shaft Pdg.—Zenith C-130-16	410	1	* *	.10
XA2076	BUSHING, Throttle Lever—Zenith CR-9-43	410	1	100 per	.25
XA2077	SCREW, Throttle Lever Clamp—Zenith T-8-S-10-9	410	1	* *	.05
XA2078	LEVER, Throttle—Zenith C-24-10	410	1	20 per	1.20
XA2079	WASHER—Zenith T-56-36	410	1	* *	.05
XA2080	AXLE, Float—Zenith C-120-6	410	1	16 per	.10
XA2081	WASHER, Fuel Inlet Channel Screw, Fibre—Zenith T-56-5	410	1	* *	.05
XA2082	SHAFT AND STOP LEVER, Throttle consisting of Lever, C-23-217 and Shaft C-24-10 (not illustrated)—Zenith C-29-226		1	⅛	1.70
XA2083	FLOAT. Assembly—Zenith C-85-6	411	1	16 per	.90
XA2084	GASKET, Bowl to Body—Zenith C-142-38	411	1	200 per	.26

Koehring Part No.	Name and Description	Illust. on Page	Amt. Rqd.	Weight Lbs.	Price Each
XA2085	TUBE, Discharge Assembly—Zenith C-66-5	411	1	16 per	.75
XA2086	JET, Cap Size 28—Zenith C-57-1-34	411	1	100 per	.40
XA2087	VALVE, Power Jet—Zenith C-97-10	411	1	50 per	.80
XA2088	JET, Accelerating Size 17—Zenith C-51-3-14	411	1	100 per	.75
XA2089	WASHER, Discharge Tube Fibre—Zenith T-56-2	411	1	* *	.05
XA2090	COMPENSATOR, Size 34—Zenith C-52-3-29	411	1	* *	.45
XA2091	WELL, Progressive—Zenith C-76-21	411	1	100 per	.85
XA2092	VALVE, Assembly Check—Zenith C-41-9	411	1	200 per	.25
XA2093	ASSEMBLY, Jet—Zenith C-52-6-30	411	1	100 per	2.40
XA2094	BOWL, Assembly Fuel—Zenith B-3-22E	411	1	4½	11.00
XA2095	WASHER, Main Jet and Compensator—Zenith T-56-24	411	2	* *	.05
XA2096	WASHER, Fuel Valve Fibre—Zenith T-56-23	410	1	* *	.05
XA2097	SCREW, Air Shutter—Zenith T-15-B-6-24	411	2	200 per	.05
XA2098	WASHER, Air Shutter Screw—Zenith T-43-6	411	2	* *	.05
XA2099	PIN, Lever Bushing Taper—Zenith CT-63-2	410	2	* *	.05
XA2100	LEVER, Air Shutter—Zenith C-106-2	411	1	50 per	.35
XA2101	WASHER, Shaft Nut—Zenith T-45-8	411	1	* *	.05
XA2102	NUT—Zenith T-22-S-8	411	1	* *	.05
XA2103	SCREW—Zenith T1S-8-6	411	1	* *	.05
XA2104	SHAFT, Air Shutter—Zenith C-105-86	411	1	200 per	.35
XA2105	PLATE, Air Shutter—Zenith C-101-21	411	1	1	2.10
XA2106	NUT—Zenith T-21-S-8	411	1	* *	.05
XA2107	CLAMP, Tube (Part of C109-2) Assembly—Zenith C110-1	411	1	200 per	.05
XA2108	BRACKET, Air Shutter—Zenith C109-2	411	1	50 per	.35
XA2109	SCREW, Bracket Assembly—Zenith C140-2	411	1	* *	.05
XA2110	SCREW, Stop Lever—Zenith T-8-S-10-13	410	1	* *	.05
XA2111	GASKET, Kit (Not illustrated)—Zenith C-181-168	410	1	1	.85
XA2112	REPAIR PART KIT (Not illustrated)—Zenith C-182-347	410	1	4	4.85
XA2113	SCREW, Fuel Inlet Channel—Zenith C-138-61	410	1	200 per	.05
XA2114	VALVE, Fuel Assembly—Zenith C-81-3-55	410	1	100 per	.75
XA2115	WASHER, Air Shutter Shaft Thrust—Zenith C-130-4	411	1	* *	.05
XA2116	SCREW, Venturi—Zenith T-1-S-10-6	410	1	200 per	.05
XA2117	WASHER, Power Jet—Zenith T-56-48	411	1	* *	.05
XA2118	SCREW, Upper and Lower Body—Zenith T-8-S-31-16	410	4	200 per	.05
XA2119	WASHER, Upper and Lower Body Screw—Zenith T-43-103	410	4	* *	.05
XA2120	RING, Snap—Twin Disc M642	412	8	* *	.01
XA2121	LINK, Lever—Twin Disc 2617	412	8	¾	.22
XA2122	PIN, Lever Link—Twin Disc 1968A	412	8	30 per	.11
XA2123	SLEEVE, Sliding—Twin Disc A1974	412	1	2¼	6.38
XA2124	PLATE, Floating—Twin Disc 5470	412	1	16¼	4.95
XA2125	PLATE, Driving—Twin Disc A5579A	412	1	2¾	7.25
XA2126	RING, Driving—Twin Disc 6625A	412	1	8	5.60
XA2127	SPRING, Release—Twin Disc 113	412	4	50 per	.11
XA2128	PLATE, Hub and Backing—Twin Disc Z5467C	412	1	16½	7.20
XA2129	WASHER, Lock—Twin Disc A1588	412	1	15 per	.06
XA2130	NUT, Lock—Twin Disc 1092A	412	1	⅛	.60
XA2131	BEARING, Pilot—306F—Twin Disc M167	412	1	¾	5.35
XA2132	YOKE, Adjusting—Twin Disc 3322	412	1	1½	3.63
XA2133	SPRING, Adj. Lock Pin—Twin Disc 115	412	1	50 per	.06
XA2134	PIN, Finger—Twin Disc 106A	412	4	* *	.16
XA2135	NUT, Slotted—Twin Disc M645	412	2	50 per	.03
XA2136	SHIM, Collar—Twin Disc 120	412	2	100 per	.11
XA2137	COLLAR, Cone—Assembly with Shims and Bolts—Twin Disc—117	412	1	2	4.40
XA2138	BOLT, Cone Collar—Twin Disc M649	412	2	⅛	.04
XA2139	HOSE, Flexible Assembly with Elbows—Twin Disc A1663	412	1	⅜	1.10
XA2140	ELBOW, 90°—Twin Disc M1283	413	1	⅛	.15
XA2141	WASHER, Lock ⅝"	413	35	* *	.03
XA2142	NUT, Jam—⅝" S.A.E.—Twin Disc M309	413	1	15 per	.05
XA2143	FITTING, Alemite—Twin Disc A1184	413	2	20 per	.12

Koehring Part No.	Name and Description	Illust. on Page	Amt. Rqd.	Weight Lbs.	Price Each
XA2144	YOKE, Adjusting Assembly—Twin Disc A112	412	1	2½	7.50
XA2145	SLEEVE, Sliding Assembly—Twin Disc S-232	412	1	4¾	15.00
XA2146	ELBOW, 90°—Twin Disc M1284	412	1	20 per	.15
XA2147	NUT, Bearing Retainer—Twin Disc 1213	412	1	⅜	1.35
XA2148	SPRING, Lock—Twin Disc 1214	412	1	20 per	.12
XA2149	YOKE, Throwout—Twin Disc 125A	412	1	2	1.85
XA2150	SCREW, Cap—⅜"x1½"—Twin Disc M258	412	2	15 per	.05
XA2151	PIN, Adjusting Lock—Twin Disc 114A	412	1	25 per	.24
XA2152	RING, Snap—Twin Disc M641	412	4	* *	.01
XA2153	KEY, Woodruff No. 15—Twin Disc M291	412	2	40 per	.10
XA2154	LEVER, Finger—Twin Disc 103F	412	4	⅛	.55
XA2155	SHAFT, Operating—Twin Disc 1144A	413	1	4¼	2.20
XA2156	PLATE, Name—Twin Disc A1664	413	1	100 per	.10
XA2157	SCREW, Drive—Twin Disc M422	413	2	* *	.01
XA2158	HOUSING, Clutch—Twin Disc 7352	413	1	44	24.00
XA2159	SCREW, Button Head ¼"—20x½" long—Twin Disc M227	413	4	100 per	.01
XA2160	PLATE, Hand Hole—Twin Disc 2815	413	1	13	.70
XA2161	GASKET, Plate—Twin Disc A1111	413	2	40 per	.28
XA2162	SCREW, Machine—Twin Disc A1352	413	1	80 per	.17
XA2163	WASHER, Lock—Twin Disc M1527	413	1	* *	.01
XA2164	LOCK, Bearing Retainer—Twin Disc 1216A	413	1	25 per	.22
XA2165	SHAFT, Clutch—Twin Disc 4225A7	413	1	11	37.30
XA2166	KEY, Whitney TX—Twin Disc M1089	413	1	10 per	.15
XA2167	SPACER, Bearing—Twin Disc 1215	413	1	⅛	.57
XA2168	RETAINER, Bearing—Twin Disc 1212	413	1	1¾	7.10
XA2169	BEARING, Timken 383A-385—Twin Disc M205	413	2	1½	4.90
XA2170	CUP, Oil—Twin Disc M102	413	2	* *	.06
XA2171	PLATE, Hand Hole—Twin Disc 2816	413	1	41	.22
XA2172	SCREW, Cap-Hex. Head ⅜"x1¼" N.C.	413	31	15 per	.02
XA2173	ASSEMBLY, Cylinder Block and Crankcase—Buda K40357	414	1	373	275.00
XA2174	BUSHING, Cylinder Block—Buda 1034	414	1	30 per	.30
XA2175	PLUG, Cylinder Block Oil—Buda DE4870	414	5	30 per	.06
XA2176	PLUG, ¼" Cylinder Block Pipe—Buda 103884	414	2	20 per	.10
XA2177	PLUG, ⅛" Slotted Cylinder Block Pipe—Buda 103883	414	1	40 per	.02
XA2178	PLUG, ⅛" Square, Cylinder Block Pipe —Buda 103877	414	1	20 per	.04
XA2179	PLUG, ⅜" Cylinder Block Pipe—Buda 103885	414	1	50 per	.04
XA2180	STUD, Cylinder Block Fan Support (long)—Buda 5654	414	2	15 per	.40
XA2181	STUD, Manifold—Buda 3943	414	14	¼	.10
XA2182	STUD, Cylinder Block Fan Support (short)—Buda 1656	414	1	10 per	.06
XA2183	STUD, Cylinder Head—Buda 4083	414	20	⅜	.22
XA2184	PLUG, ¾" Cylinder Head Pipe—Buda 103875	414	7	¼	.10
XA2185	BEARING, Camshaft Rear—Buda DE41504	414	1	¼	.75
XA2186	BEARING, Camshaft Center—Buda 4008	414	2	¼	1.30
XA2187	BEARING, Camshaft Front—Buda DE41417	414	1	½	.90
XA2188	PLUG, Crankcase Special—Buda 4106	414	1	30 per	.06
XA2189	CAP, Front Main Bearing—Buda 4013	414	1	2½	3.60
XA2190	CAPSCREW, Main Bearing—Buda 4015	414	16	½	.35
XA2191	CAP, Intermediate Main Bearing—Buda 4012	414	4	2¼	2.20
XA2192	DOWEL, Upper Bearing—Buda 1030	414	7	40 per	.04
XA2193	GASKET, Rear Bearing Oil Seal (Heavy)—Buda 1438	414	2	200 per	.04
XA2194	SEALPLATE, Rear Bearing Oil, Upper and Lower—Buda DE56131	414	2	½	1.25
XA2195	FELT, Rear Bearing Oil—Buda DE56165	414	2	100 per	.08
XA2196	GASKET, Rear Bearing Oil Seal (light)—Buda 1561	414	2	200 per	.04
XA2197	GASKET, Rear Bearing Oil Seal—Buda DE233	414	2	* *	.02
XA2198	LOCKWASHER, ¼"—Buda 103319	414	57	* *	.01
XA2199	CAPSCREW, ¼x¾" F.H.—Buda 1560	414	6	200 per	.04
XA2200	STOP, Rear Bearing Cap Oil—Buda H11950	414	2	50 per	.15
XA2201	TUBE, Rear Bearing Drain—Buda 1568	414	1	⅛	.24

Koehring Part No.	Name and Description	Illust. on Page	Amt. Rqd.	Weight Lbs.	Price Each
XA2202	CAP, Rear Main Bearing—Buda K40186	414	1	4¼	4.40
XA2203	CAP, Center Main Bearing—Buda 5379	414	1	4¼	2.65
XA2204	LOCKWIRE, Bearing Capscrew—Buda DE5476	414	8	* *	.02
XA2205	GASKET, Complete Set Engine (not illustrated) Buda 5837	414	1 set	1¾	8.40
XA2206	NUT, Cylinder Head 5/8"x18" N.F.—Buda 117053	415	22	⅜	.06
XA2207	CYLINDER HEAD—Buda 4034	415	1	87½	41.00
XA2208	PLUG, Cylinder Head Expansion—Buda 103894	415	6	¼	.04
XA2209	GASKET, Cylinder Head—Buda 4061	415	1	1½	3.30
XA2210	PLUG, ½" Cylinder Head—Buda 112715	415	1	¼	.06
XA2211	BEARING, Rear Main Standard—Buda 4028-4029	409	1 pr.	¾	7.70
XA2212	BEARING, Center Main Standard— Buda 4026-4027	409	1 pr.	½	4.50
XA2213	BEARING, Intermediate Main Standard— Buda 4024-4025	409	4 pr.	⅜	3.60
XA2214	BEARING, Front Main Standard—Buda 4022-4023	409	1 pr.	½	4.00
XA2215	CRANKSHAFT—Buda K40263	409	1	77	120.00
XA2216	KEY, Crankshaft Gear No. D—Buda 113879	409	1	100 per	.04
XA2217	KEY, Crankshaft ½x¼x1¼—Buda D41320	409	1	10 per	.15
XA2218	GEAR, Crankshaft—Buda 4128	409	1	2	4.75
XA2219	SPACER, Fan Pulley—Buda DE41303	409	1	½	1.10
XA2220	PULLEY, Fan—Buda K40271	409	1	7½	4.00
XA2221	JAW, Starting Crank—Buda H12245	409	1	½	2.50
XA2222	FAN ASSEMBLY (Not illustrated)—Switzer 108821	416	1	12	16.00
XA2223	BELT, Fan—Switzer 1E-303	416	1	1	3.75
XA2224	SCREW, Fan Adjusting—Switzer C9776	416	1	⅜	1.50
XA2225	NUT, Fan Adjusting Screw—Switzer C2674	416	1	20 per	.20
XA2226	WASHER, Fan Adjusting Screw—Switzer C2675	416	1	200 per	.01
XA2227	BRACKET, Fan—Buda 1617	416	1	3½	1.10
XA2228	NUT, Fan Shaft (Hex)—Switzer C2673	416	1	⅛	.28
XA2229	LOCKWASHER, Fan Shaft Nut—Switzer C2692	416	1	200 per	.04
XA2230	RETAINER, Cork—Switzer C2388	416	1	15 per	.35
XA2231	WASHER, Cork—Switzer C2389	416	1	30 per	.30
XA2232	SPINDLE, Fan—Switzer C11187	416	1	1¼	5.50
XA2233	LOCKWIRE, Spindle—Switzer C5098	416	1	50 per	.08
XA2234	WASHER, Clamp—Switzer C2736	416	1	⅛	.16
XA2235	WASHER, Clamp—Switzer C2662	416	1	⅛	.16
XA2236	WASHER, Cork—Switzer C3814	416	2	100 per	.18
XA2237	BEARING, Fan Spindle—Switzer C3296	416	2	¼	2.95
XA2238	FITTING, Oil—Switzer C4391	416	1	⅛	.08
XA2239	HUB, Fan—Switzer C108717	416	1	7½	5.50
XA2240	WASHER, Clamp—Switzer C4013	416	1	30 per	.12
XA2241	NUT, Clamp—Switzer C2750	416	1	50 per	.15
XA2242	COTTER—Switzer C2283	416	1	* *	.02
XA2243	GASKET, Spacer—Switzer C2016	416	1	100 per	.15
XA2244	ASSEMBLY, Fan Blade—Switzer F6022	416	1	4½	5.50
XA2245	LOCKWASHER, Fan Blade—Switzer C4240	416	4	* *	.02
XA2246	CAPSCREW, Fan Blade—Switzer C624	416	4	30 per	.04
XA2247	CAPSCREW 5/16x18x½"—Buda 106973	415	2	⅛	.04
XA2248	DUST PLATE, Flywheel Housing—Buda 1078	415	1	⅜	.20
XA2249	PLUG, Flywheel Housing—Buda 103876	415	1	⅛	.16
XA2250	HOUSING, Flywheel No. 2 Pedestal Type—Buda K40257	415	1	85	40.00
XA2251	CAPSCREW, Baffle Plate ⅜—16x½"—Buda 106974	415	7	50 per	.04
XA2252	COVER—Buda 1705	415	1	¼	.16
XA2253	BOLT, ½"x20—1¾"—Buda 4053	415	2	¼	.02
XA2254	NUT, ½"—20 N. F. Buda 103028	415	4	25 per	.04
XA2255	CAPSCREW, Flywheel Housing ½"x13—1¼"— Buda 2074	415	4	¼	.08
XA2256	LOCKWASHER ½"—Buda 103323	415	10	50 per	.01
XA2257	BOLT, Flywheel—Buda H-12111	415	5	⅜	.16
XA2258	NUT, Flywheel ½"—20—Buda 117051	415	5	¼	.04
XA2259	GEAR, Flywheel Ring—Buda 1167	415	1	7	3.85
XA2260	FLYWHEEL, Twin-Disc 307—Buda K-40335	415	1	97	42.00

Koehring Part No.	Name and Description	Illust. on Page	Amt. Rqd.	Weight Lbs.	Price Each
XA2261	LOCKWASHER, ½"—Buda 106500	415	5	50 per	.02
XA2262	FUEL PUMP (not illustrated)—Buda 2903	417	1	3½	5.00
XA2263	SCREW, Fuel Pump Cover—AC 855493	417	6	* *	.01
XA2264	WASHER, Fuel Pump Cover Screw—AC 855064	417	6	* *	.01
XA2265	ARM, Fuel Pump Rocker—AC 856112	417	1	¼	2.20
XA2266	PIN, Fuel Pump Rocker Arm—AC 1521289	417	1	* *	.15
XA2267	WASHER, Fuel Pump Rocker Arm Pin—AC 1521288	417	1	* *	1.50*
XA2268	CAPSCREW, 5/16"—18x1—Buda 100122	417	47	20 per	.04
XA2269	PIN, Fuel Pump Link—AC 855016	417	2	* *	.02
XA2270	CAPSCREW, 5/16"—18—7/8"—Buda 106325	417	4	25 per	.04
XA2271	GASKET, Fuel Pump to Adaptor—Buda 1870	417	1	* *	.05
XA2272	ADAPTOR, Fuel Pump—Buda 1812	417	1	20 per	1.60
XA2273	GASKET, Fuel Pump Adaptor—Buda 1811	417	2	* *	.10
XA2274	PLUG, Fuel Pump Valve—AC 855135	417	2	¼	.10
XA2275	GASKET, Fuel Pump Valve Plug—AC 855136	417	2	* *	.01
XA2276	SPRING, Fuel Pump Valve—AC 856270	417	2	* *	.50*
XA2277	VALVE, Fuel Pump Valve—AC 855003	417	2	⅛	.01
XA2278	COVER, Fuel Pump Valve Seat and Top—AC 1523358	417	1	2 per	1.30
XA2279	NUT, Fuel Pump Pull Rod—AC 855213	417	1	* *	.05
XA2280	SCREEN, Fuel Pump AC 854009	417	1	* *	.05
XA2281	WASHER, Fuel Pump Pull Rod—AC 855390	417	1	* *	.01
XA2282	WASHER, Fuel Pump Diaphragm—AC 855029	417	1	* *	.01
XA2283	GASKET, Fuel Pump Bowl—AC 854003	417	1	* *	.05
XA2284	PROTECTOR, Fuel Pump Upper Diaphragm—AC 1521194	417	1	⅛	.03
XA2285	BOWL, Fuel Pump—AC 854004	417	1	¼	.10
XA2286	DIAPHRAGM, Fuel Pump (4 pieces) AC 855035	417	1	⅜	.25
XA2287	PROTECTOR, Fuel Pump Diaphragm—AC 855078	417	1	⅛	.05
XA2288	NUT, Fuel Pump Bowl Bail—AC 855763	417	1	* *	.05
XA2289	SEAT, Fuel Pump Bowl—AC 854005	417	1	30 per	.01
XA2290	BAIL AND SCREW, Fuel Pump—AC 854016	417	1	⅛	.10
XA2291	GASKET, Fuel Pump Pull Rod—AC 855012	417	1	* *	.01
XA2292	ROD, Fuel Pump—AC 855250	417	1	¼	.15
XA2293	CLIP, Fuel Pump Pull Rod—AC 855017	417	4	* *	.20*
XA2294	BODY, Fuel Pump Rocker Arm—AC 1523352	417	1	⅜	1.15
XA2295	LINK, Fuel Pump—AC 855374	417	2	⅛	.02
XA2296	CAP, Fuel Pump Spring—AC 855532	417	2	50 per	.01
XA2297	SPRING, Fuel Pump Rocker Arm Diaphragm AC 855253	417	2	* *	.02
XA2298	GASKET, Fuel Pump Bottom Cover—AC 855229	417	1	* *	.02
XA2299	COVER, Fuel Pump Bottom—AC 855228	417	1	¼	.30
XA2300	SCREW, Fuel Pump Bottom Cover—AC 132108	417	3	20 per	.50*
XA2301	LINE, Fuel Pump to Carburetor—Buda K40394	417	1	⅜	2.00
XA2302	STREET, L ⅛" Fuel Pump—Buda PA-74	417	1	⅛	.10
XA2303	CONNECTOR, 5/16"x⅛"—Buda 119298	417	1	⅜	.10
XA2304	ELBOW, Carburetor 5/16"x⅛"—Buda 118754	417	1	½	2.20
XA2305	FITTING, Tube ¼"—Weatherhead W41x4	420	2	50 per	.13
XA2306	ELBOW, ¼"x⅛"—Weatherhead W49x4	420	2	30 per	.20
XA2307	WIRE, 7" Long—No. 1 R.C.	420	1	* *	.10
XA2308	WIRE, Anaconda No. 14x10'-10"	420	1	3½	.35
XA2309	LUG, Wire—81074	420	1	* *	.03
XA2310	LUG, Wire—150 Amp.	420	4	15 per	.14
XA2311	LUG, Negative Battery	420	1	¼	.25
XA2312	WIRE, 16" Long—No. 1 R. C.	420	1	* *	.20
XA2313	LUG, Positive Battery	420	1	¼	.25
XA2314	ROD, Choke Control 10'x5" Long "Shakespeare" C1187-4	420	1	1½	2.15
XA2315	NUT, Square 3/16" N.C.	420	6	100 per	.10*
XA2316	WIRE, Anaconda No. 14x6"	420	1	⅛	.05
XA2317	LOOM, ¼"x3"	420	1	150 per	.05
XA2318	WIRE, Anaconda No. 14x10'-10"	420	2	3½	.35

Koehring Part No.	Name and Description	Illust. on Page	Amt. Rqd.	Weight Lbs.	Price Each
XA2319	LUG, Wire—31075	420	9	* *	.04
XA2320	CLAMP, Cable—4225E246-29	420	3	1/4	.40
XA2321	CONDUIT, Greenfield 3/4"x85"	420	1	4 1/4	.70
XA2322	LOOM, 1/4"x38"	420	1	14 per	.10
XA2323	LOOM, 1/4"x36"	420	1	14 per	.10
XA2324	WIRE, Anaconda—No. 14x10'-4"	420	1	3 1/2	.30
XA2325	LOOM, 1/4"x32"	420	1	15 per	.08
XA2326	WIRE, 13" Long—No. 1 R.C.	420	1	* *	.15
XA2327	PANEL, Instrument—4234D162	420	1	3	2.00
XA2328	TUBING, Copper .035 1/4"x11'-0" Long	420	1	1 1/2	.88
XA2329	SCREW, Cap-Hex. Head 5/8"x1" N.C.	420	2	1/4	.06
XA2330	GAUGE, Oil Pressure—Buda AP-3883	420	1	1	2.25
XA2331	NUT, Flared—212A105	420	1	1/8	.45
XA2332	SWITCH, Magneto—Buda AP 5893	420	1	1	1.25
XA2333	WASHER, Lock 3/16"	420	6	* *	.20*
XA2334	BOLT, Stove—Flat Head 3/16"x3/4"	420	4	100 per	.70*
XA2335	BUTTON, Starter—103-SS	420	1	1/4	3.75
XA2336	WASHER, Lock 1/8"—Buda 106495	420	6	* *	.20*
XA2337	SCREW, Machine—Round Head No. 4—40x1/2" Long—Buda 153005	420	6	* *	.01
XA2338	NUT, Hexagon No. 4—40—Buda 103091	420	6	* *	.01
XA2339	AMMETER, 30 Ampere—Buda AP6592	420	1	1	1.50
XA2340	GENERATOR and VOLTAGE REGULATOR—Buda K-40506	418	1	20	40.00
XA2341	REGULATOR, Assembly—Buda TC-4305B	418	1	1 1/4	5.25
XA2342	PULLEY, Generator—Buda K40501	418	1	3	5.00
XA2343	BRACKET, Generator—Buda K-40508	418	1	1	11.00
XA2344	TIEBRACE, Generator Bracket—Buda K40559	418	1	3/4	.02
XA2345	CAPSCREW, 3/8—16x7/8"—Buda 106330	418	30	30 per	.04
XA2346	NUT, 7/16"—Auto-Lite 8x-160	419	1	50 per	.05
XA2347	FAN, Drive End—Auto-Lite SP-230	419	1	3/8	1.00
XA2348	NUT, Retainer Screw No. 10—32—Auto-Lite 8X-173	419	3	* *	.05
XA2349	BEARING, Ball SAE No. 203—Auto-Lite X-295	419	1	1/8	1.15
XA2350	HEAD, Commutator Assembly Partial—Auto-Lite GCJ-1086A	419	1	1 3/4	2.25
XA2351	SCREW, No. 10—32x3/4"—Auto-Lite 8X-316	419	3	* *	.05
XA2352	SPACER, Shaft—Auto-Lite GJ-104	419	1	20 per	.06
XA2353	RING, Armature—Auto-Lite GAR-171	419	1	* *	.02
XA2354	ASSEMBLY, Armature—Auto-Lite GEJ-2055F	419	1	5 1/4	8.75
XA2355	ASSEMBLY, Coil—Auto-Lite CDS-1005C	419	1	1 3/4	2.70
XA2356	SCREW, No. 10—32x3/8"—Auto-Lite 8X-311	419	3	* *	.10
XA2357	SPRING, 3rd Brush Retaining Plate—Auto-Lite GCJ-51	419	1	75 per	.07
XA2358	SPRING, 3rd Brush—Auto-Lite GBW-45	419	3	75 per	.05
XA2359	SCREW, Frame—Auto-Lite GK-20	419	2	150 per	.10
XA2360	WASHER, Lock 1/4"—Auto-Lite X-199	419	2	* *	.05
XA2361	GASKET, C. E. Cover—Auto-Lite GBW-69	419	1	* *	.01
XA2362	COVER, Commutator End—Auto-Lite GBW-1068B	419	1	150 per	.12
XA2363	LOCKWASHER, No. 8—Auto-Lite X-195	419	13	* *	.05
XA2364	SCREW, No. 8—32x5/16"—Auto-Lite 8X-888	419	4	* *	.05
XA2365	BAND, Generator Head—Auto-Lite GCS-1024	419	1	1/4	.25
XA2366	NUT, Head Band No. 10-32—Auto-Lite 8X-794	419	4	* *	.05
XA2367	SCREW, No. 10-32x1 1/4"—Auto-Lite 8X-715	419	1	100 per	.05
XA2368	WASHER, Armature Lock—Auto-Lite 8X-205	419	1	150 per	.05
XA2369	RETAINER, Bearing Generator—Auto-Lite GG-6	419	2	20 per	.05
XA2370	WASHER, Felt Generator—Auto-Lite GG-164	419	2	* *	.01
XA2371	RETAINER, Felt—Auto-Lite GG-176	419	1	75 per	.02
XA2372	OILER, Hinge Top Generator—Auto-Lite X-489	419	1	* *	.05
XA2373	KEY, Shaft 7/16"—Auto-Lite X-261	419	2	25 per	.05
XA2374	SCREW, No. 10-32x5/16"—Auto-Lite 8X-321	419	4	* *	.05
XA2375	WASHER, No. 10—Auto-Lite X-196	419	14	* *	.05
XA2376	SCREW, No. 8-32x9/16"—Auto-Lite 8X-47	419	2	* *	.05
XA2377	WASHER, No. 8,—Auto-Lite 12X-195	419	2	* *	.05

Koehring Part No.	Name and Description	Illust. on Page	Amt. Rqd.	Weight Lbs.	Price Each
XA2378	WASHER No. 8, Auto-Lite 8X-350	419	2	* *	.05
XA2379	RESISTANCE, Regulator Carbon—Auto-Lite TC-51	419	1	100 per	.15
XA2380	FUSE, Generator 5 Amp.—Auto-Lite X-842	419	1	* *	.05
XA2381	SCREW, No. 10-32x3/16"—Auto-Lite 8X-1004	419	2	* *	.05
XA2382	INSULATION, Generator Fuse—Auto-Lite TC-48	419	1	* *	.01
XA2383	SPRING, Voltage Regulator—Auto-Lite TC-49	419	1	100 per	.01
XA2384	HOLDER, Voltage Regulator Fuse—Auto-Lite TC-1050	419	1	50 per	.08
XA2385	NUT, Voltage Regulator Cover—Auto-Lite TC-1079	419	1	* *	.05
XA2386	COVER, Voltage Regulator—Auto-Lite TC-1082C	419	1	1	.30
XA2387	BUSHING, Generator Field Insulation—Auto-Lite GAR-211	419	1	* *	.03
XA2388	BRUSH, 3rd Generator—Auto-Lite GDF-1013	419	1	75 per	.25
XA2389	ARM, Generator Main Brush—Auto Lite GCJ-26	419	3	* *	.02
XA2390	ASSEMBLY, Generator 3rd Brush—Auto-Lite GCJ-1014	419	1	75 per	.40
XA2391	BRUSH, Generator Main—Auto-Lite GDF-1012	419	2	75 per	.25
XA2392	GUARD, Generator Oil—Auto-Lite GBW-72	419	1	* *	.05
XA2393	GASKET, Generator Oil Guard—Auto-Lite GBW-73	419	1	* *	.01
XA2394	HEAD, Generator Drive—Auto-Lite GCJ-2086	419	1	2	P.O.A.
XA2395	WICK, Generator Felt—Auto-Lite GAR-73	419	1	100 per	.03
XA2396	COVER, Generator Wick—Auto-Lite GAR-98A	419	1	100 per	.01
XA2397	BEARING, Generator Commutator—Auto-Lite GBF-79	419	1	35 per	.15
XA2398	GASKET, Generator Cover—Auto-Lite TC-127	419	1	100 per	.02
XA2399	SCREW, No. 10-32x1/4"—Auto-Lite 8x-312	419	1	* *	.05
XA2400	COIL, Left Generator—Auto-Lite GDS-1007A	419	1	3/4	1.35
XA2401	POLE, Generator—Auto-Lite GDS-29	419	2	3/4	.40
XA2402	SCREW, Starter—Generator Pole—Auto Lite GK-38	419	6	50 per	.01
XA2403	COIL, Generator Right—Auto-Lite GDS-1008C	419	1	3/4	1.35
XA2404	TERMINAL POST, Generator Left Coil—Auto-Lite X-1425	419	1	50 per	.05
XA2405	TERMINAL POST, Generator Right Coil—Auto-Lite X-755	419	1	50 per	.05
XA2406	ASSEMBLY, Generator Lead—Auto-Lite GAL-298	419	1	100 per	.09
XA2407	INSULATION, Generator Field Connection—Auto-Lite GAL-44	419	1	* *	.02
XA2408	INSULATOR, Generator Terminal Connection—Auto-Lite GBW-66	419	1	* *	.02
XA2409	INSULATOR, Generator Terminal Connection—Auto-Lite GBW-67	419	1	* *	.02
XA2410	BUSHING, Generator Insulating—Auto-Lite GCT-25	419	1	* *	.02
XA2411	BUSHING, Generator Insulating—Auto-Lite GCY-25	419	1	* *	.03
XA2412	WASHER, Generator Insulating—Auto-Lite GBW-34	419	1	* *	.01
XA2413	INSULATION, Generator Field Connection—Auto-Lite GAA-32	419	1	* *	.01
XA2414	WASHER, Generator Insulating—Auto-Lite GC-26	419	1	* *	.01
XA2415	WASHER, 1/4"—Auto-Lite 8X-361	419	1	* *	.05
XA2416	WASHER, No. 14—Auto-Lite X-193	419	2	* *	.05
XA2417	NUT, No. 14-24—Auto-Lite 5X-177	419	3	* *	.05
XA2418	WASHER, No. 10-32—Auto-Lite 5X-1377	419	1	* *	.05
XA2419	WASHER, No. 10—Auto-Lite BX-349	419	1	* *	.05
XA2420	SCREW, Hex 5/16"-24x5/8"—Auto-Lite X-113	419	2	* *	.05
XA2421	GOVERNOR ASSEMBLY—Buda K-40504	421	1	8	25.40
XA2422	NUT, Hex 1/4"—28—Pierce X-217	421	3	50 per	.06
XA2423	PIN, Taper 1"x7/8"—Pierce X-82	421	2	200 per	.05
XA2424	SCREW, 10-24x3/4"—Pierce X-824	421	4	* *	.06
XA2425	WASHER, No. 10 Governor—Pierce X-540	421	4	* *	.04
XA2426	BRACKET, Adjusting Screw—Pierce G-4203	421	1	1/2	2.40
XA2427	LINK, Spring Eye—Pierce G-3947	421	1	3	.06
XA2428	BUSHING, Drive Shaft—Pierce G-3168	421	1	1/4	.26
XA2429	SHAFT, Lever—Pierce G-4208	421	1	1/2	1.20
XA2430	BODY, Governor—Pierce G-4201	421	1	2	6.90
XA2431	SPRING, Governor—Pierce SN-1270	421	1	3/8	.40
XA2432	LEVER, Governor Adjusting—Pierce G-4619	421	1	1/4	.75
XA2433	NUT, Hex 12-24—Pierce X-888	421	1	50 per	.05

P. O. A.—Price on application.

Koehring Part No.	Name and Description	Illust. on Page	Amt. Rqd.	Weight Lbs.	Price Each
XA2434	SCREW, Fillester Head 12-24x$1\frac{1}{2}$"—Pierce X-846	421	1	200 per	.08
XA2435	ELBOW, Governor Oil Line—Pierce 4776	421	1	5 per	.35
XA2436	UNION, Governor Oil Half Line 48-F—3/16"—Buda 120703	421	1	5 per	.08
XA2437	OIL LINE, Governor Assembly—Buda 3863	421	1	$\frac{1}{2}$	1.25
XA2438	SCREW, Bumper—Pierce G-5113	421	1	* *	.12
XA2439	SPRING, Bumper—Pierce SN-266	421	1	3 per	.15
XA2440	PLUG, Welch—Pierce X-454	421	1	30 per	.06
XA2447	COTTER, 3/23"x$\frac{3}{4}$"—Pierce X-425	421	1	* *	.02
XA2448	NUT, $\frac{3}{8}$"—24—Pierce X-763	421	1	50 per	.05
XA2449	GEAR, Governor—Pierce 2810	421	1	$\frac{1}{8}$	2.00
XA2450	KEY, Woodruff No. 2—Pierce 8X-461	421	1	* *	.12
XA2451	CAP, Governor Body—Pierce G-4200	421	1	$1\frac{3}{4}$	4.50
XA2452	SCREW, 5/16x$\frac{3}{4}$"—Buda 100121	421	6	25 per	.04
XA2453	SHAFT, Spider—Pierce G-4205	421	1	1	1.80
XA2454	SPRING, Bearing Retainer—Pierce G-4159	421	1	* *	.25
XA2455	BEARING, Governor—Pierce X-310	421	1	3 per	1.80
XA2456	GASKET, Governor—Pierce G-4209	421	1	* *	.05
XA2457	SPIDER, Assembly—Pierce A-1938	421	1	$\frac{1}{2}$	1.80
XA2458	SLEEVE, Thrust—Pierce G-4206	421	1	$\frac{3}{8}$	1.80
XA2459	WEIGHTS—Pierce G-4449	421	2	$\frac{3}{8}$	.60
XA2460	PIN, Weights—Pierce G-5950	421	2	* *	.16
XA2461	RETAINER, Bearing—Pierce G-3040	421	2	$\frac{1}{8}$	.03
XA2462	WASHER, Spacing—Pierce G-5210	421	2	* *	.01
XA2463	WASHER, Spacing—Pierce G-3804	421	2	* *	.30
XA2464	BEARING, Governor—Pierce X-328	421	2	$\frac{3}{4}$	.50
XA2465	RING, Snap—Pierce G-3494	421	4	30 per	.30
XA2466	SHAFT, Rocker—Pierce G-6905	421	1	1	.60
XA2467	YOKE, Governor—Pierce G-6026	421	1	$1\frac{1}{4}$	2.16
XA2468	BEARING, Governor Thrust—Pierce X-339	421	1	$\frac{3}{8}$	.90
XA2469	LEVER—Pierce G-4306	421	1	$\frac{3}{8}$	1.10
XA2470	LINK ASSEMBLY—Buda K40155	421	1	$\frac{1}{4}$	1.40
XA2471	SCREW, Hex $\frac{1}{4}$-28x7/8"—Pierce X-557	421	1	$\frac{1}{8}$	.20
XA2472	WASHER, $\frac{1}{4}$" Pierce X-463	421	1	* *	.06
XA2473	PIN, Idler Gearshaft 3/16"x$\frac{1}{2}$"—Buda 103720	422	1	* *	.04
XA2474	STUD SHAFT, Idler Gear—Buda 4452	422	1	$1\frac{1}{4}$	2.60
XA2475	LOCKSCREW, Idler Gearshaft—Buda 1454	422	1	10 per	.20
XA2476	GASKET, Lockwasher $\frac{5}{8}$"—Buda 105453	422	3	100 per	.04
XA2477	NUT, Idler Gearshaft Lock Blind—Buda 2453	422	1	16 per	.22
XA2478	SCREW, Idler Gear Thrust—Buda 1458	422	1	12 per	.10
XA2479	WASHER, Idler Gear Thrust—Buda 3432	422	1	5 per	.30
XA2480	BUSHING, Idler Gear—Buda 4220	422	1	$\frac{1}{2}$	.24
XA2481	GEAR, Idler—Buda 4455	422	1	$8\frac{1}{2}$	6.25
XA2482	CLIPS, Cable Tube—Buda 1710	422	2	4 per	.15
XA2483	CABLE TUBE—Buda 4742	422	1	$1\frac{1}{2}$	1.50
XA2484	STUD—Buda 1709	422	2	8 per	.16
XA2485	RING, Rubber—Buda 3729	422	1	150 per	.05
XA2486	SPARK PLUG—Buda H-11629	422	6	6 per	.65
XA2487	ASSEMBLY, Ignition Cable—Buda 4736	422	1	3 per	2.25
XA2488	PIN, for Spiral Spring—Bosch PN-731	423	2	* *	.05
XA2489	SPRING, Spiral—Bosch SP-736	423	1	$\frac{1}{2}$	.75
XA2490	CAM, Impulse Coupling—Bosch CA-739	423	1	$\frac{1}{2}$	.50
XA2491	WEIGHTS, Impulse Coupling—Bosch SA-65972	423	2	$\frac{1}{2}$	.50
XA2492	PLATE, Impulse Coupling—Bosch HB-7328	423	1	$\frac{1}{2}$	1.50
XA2493	SCREW, Arrester Plate—Bosch SC-732	423	1	* *	.10
XA2494	LOCKWASHER, Arrester Plate—Bosch WA-1116	423	1	* *	.05
XA2495	PACKING, Impulse Coupling—Bosch PK-83361	423	1	$\frac{3}{8}$	.25
XA2496	PLATE, Arrester Packing—Bosch PL-7366	423	1	$\frac{3}{8}$	2.00
XA2497	WICK, Felt Spring—Bosch PK-734	423	1	$\frac{1}{4}$	.05
XA2498	HOUSING, Impulse Coupling—Bosch HG-73120	423	1	$1\frac{1}{8}$	2.60
XA2499	DISC, Impulse Coupling—Bosch DC-739	423	1	3 per	1.00
XA2500	LOCKWASHER, Impulse Coupling Shaft—Bosch WA-5-16	423	1	* *	.05

Koehring Part No.	Name and Description	Illust. on Page	Amt. Rqd.	Weight Lbs.	Price Each
XA2501	NUT, Hex ¾"—Bosch NT-83544	423	1	½	.20
XA2502	KEY, Woodruff—Bosch KY-1004	423	1	¼	.05
XA2503	HUB, Keyed Impulse Coupling—Bosch FL-7323	423	1	1	.85
XA2504	NUT, Hub Impulse Coupling—Bosch NT-75768	423	1	¼	.15
XA2505	WASHER, Star—Bosch WA-75863	423	1	¼	.05
XA2506	FLANGE, Adjustable Coupling—Bosch FL-7325	423	1	¾	1.25
XA2507	FLANGE, Exhaust Manifold—Buda 1352	426	1	3	.15
XA2508	CAPSCREW, Manifold Flange 7/16"—14x1¾"—Buda 100149	426	3	15 per	.06
XA2509	GASKET, Exhaust Manifold Flange—Buda 1353	426	1	30 per	.15
XA2510	LOCKWASHER, Manifold Flange—Buda 103322	426	3	40 per	.01
XA2511	NUT, Manifold Flange 7/16"—14—Buda 115773	426	3	15 per	.20
XA2512	MANIFOLD, Intake and Exhaust—Buda K-40230	426	1	39	35.00
XA2513	PLUG, ⅜" Square Head—Buda 103867	426	2	30 per	.04
XA2514	GASKET, Exhaust Port Center—Buda 4316	426	1	¼	.22
XA2515	GASKET, Manifold Port—Buda 4317	426	2	⅜	.22
XA2516	GASKET, Manifold Port Ends—Buda 4318	426	2	¼	.16
XA2517	PLUG, Pipe ⅛ Square Head—Buda 103865	426	2	⅛	.04
XA2518	NUT, Manifold Stud ⅜"x24"—Buda 114547	426	14	16 per	.08
XA2519	WASHER, Manifold Stud ⅜"—Buda DE-40036	426	14	100 per	.15
XA2520	LOCKWASHER—Bosch WA-288	424	4	* *	.05
XA2521	LOCKWASHER—Bosch WA-98922	424	4	200 per	.05
XA2522	SCREW, Magneto—Bosch SC-24-4CA	424	1	200 per	.05
XA2523	SCREW, Distributor Plate—Bosch SC-1037-CA	424	4	* *	.05
XA2524	LOCKWASHER—Bosch WA-528	424	1	* *	.05
XA2525	RING, Window—Bosch RG-5210	424	1	* *	.05
XA2526	LOCKWASHER—Bosch WA-5280	424	1	* *	.05
XA2527	WINDOW—Bosch WN-521	424	1	30 per	.05
XA2528	PLATE, Distributor—Bosch DP-52234	424	1	½	3.85
XA2529	GASKET, Distributor—Bosch GA-524	424	1	100 per	.15
XA2530	CARBON BRUSH—Bosch BR-529	424	1	100 per	.25
XA2531	RING, Shaft—Bosch SP-5254	424	1	* *	.05
XA2532	GEAR, Rotor—Bosch GE-5252	424	1	⅛	.65
XA2533	GEAR, Distributor—Bosch GE-5283	424	1	½	2.10
XA2534	LOCKWASHER, Rotor Gear—Bosch WA-1070	424	1	200 per	.05
XA2535	RING, Shaft—Bosch SP-1021	424	1	* *	.05
XA2536	SHAFT, Gear—Bosch SD-5249	424	1	100 per	.10
XA2537	COTTER—Bosch PN-1007	424	1	* *	.05
XA2538	LOCKWASHER—Bosch WA-1012	424	1	150 per	.05
XA2539	WICK, Cam—Bosch WK-5231	424	1	* *	.05
XA2540	LEVER—Bosch LE-5236	424	1	50 per	.60
XA2541	LOCKWASHER—Bosch WA-6-3-CA	424	3	* *	.05
XA2542	SCREW—Bosch SC-37-5-CA	424	1	200 per	.05
XA2543	BRACKET—Bosch BK-5259	424	1	50 per	1.30
XA2544	CONDENSER—Bosch CW-5232	424	1	* *	.70
XA2545	BRACKET—Bosch BK-566	424	1	100 per	.85
XA2546	BRACKET—Retaining—Bosch BK-5283	424	1	50 per	.05
XA2547	LOCKWASHER—Bosch WA-5-4	424	1	200 per	.05
XA2548	SCREW, Contact Bracket—Bosch SC-39-5CA	424	2	* *	.05
XA2549	LOCKWASHER—Bosch WA-21-4	424	1	200 per	.05
XA2550	SCREW, Bracket—Bosch SC-41-8CA	424	1	* *	.05
XA2551	LOCKWASHER—Bosch WA-21-5	424	1	* *	.05
XA2552	PLATE, Locking—Bosch PL-52125	424	1	50 per	.05
XA2553	MAGNETO—Buda H-11848	425	1	12	42.50
XA2554	IMPULSE COUPLING—Buda H-11849	425	1	2	9.75
XA2555	SCREW—Bosch SC-1060	425	1	200 per	.05
XA2556	SCREW—Bosch SC-37-8A	425	2	200 per	.05
XA2557	COVER—Bosch NP-5222	425	1	50 per	.10
XA2558	COVER—Bosch CV-52126	425	1	50 per	.15
XA2559	GASKET—Bosch GA-5215	425	1	* *	.05
XA2560	WASHER—Bosch WA-5281	425	1	200 per	.05
XA2561	COIL—Bosch CL-5238	425	1	½	5.15

Koehring Part No.	Name and Description	Illust. on Page	Amt. Rqd.	Weight Lbs.	Price Each
XA2562	HOUSING—Bosch HG-5216	425	1	8	8.25
XA2563	WASHER—Bosch WA-81751	425	3	* *	.05
XA2564	WASHER—Bosch IS-222	425	1	100 per	.05
XA2565	WASHER—Bosch WA-5245	425	1	200 per	.05
XA2566	BEARINGS—Bosch BA-60226	425	2	40 per	1.55
XA2567	ROTOR—Bosch RT-5294	425	1	1½	11.75
XA2568	BRACKET—Buda K-40138	425	1	3	2.50
XA2569	SCREW, ⅜-16-1—Buda 100134	425	16	20 per	.04
XA2570	SCREW, ⅜"-16-3"—Buda 100140	425	1	10 per	.06
XA2571	SCREW, ⅜-16-1-⅝"—Buda 108588	425	1	20 per	.04
XA2572	DOWEL—Buda 117879	425	1	50 per	.04
XA2573	GASKET—Buda 1639	426	1	200 per	.04
XA2574	NUT, ¼"—20—Buda 117060	426	1	30 per	.05
XA2575	SPRING, Oil Filler Cover—Buda RSE-312	426	1	¼	.24
XA2576	ASSEMBLY, Oil Filler and Breather—Buda 4569	426	1	4	3.50
XA2577	COVER, Oil Filler—Buda RSE-311	426	1	3 per	.80
XA2578	BOLT, Oil Filler Cover—Buda 101379	426	1	50 per	.05
XA2579	OIL FILTER, Deluxe—Buda H-11677	427	1	10	16.00
XA2580	ASSEMBLY, Cover—Deluxe CUS-100	427	1	1½	3.75
XA2581	ASSEMBLY, Relief Valve—DeLuxe JCUS-32-34	427	1	1½	1.50
XA2582	GASKET, Relief Valve—DeLuxe JCUS-31	427	1	100 per	.10
XA2583	COVER, Relief Valve—DeLuxe JCUS-21	427	1	¼	1.00
XA2584	GASKET, Relief Valve Cover—DeLuxe JCUS-30	427	1	100 per	.20
XA2585	CAP, Oil Filter Perforated—DeLuxe CUS-24	427	1	¼	1.00
XA2586	CARTRIDGE, Oil Filter—DeLuxe DE-56119	427	1	1¼	1.05
XA2587	BODY, Oil Filter—DeLuxe CS302M	427	1	2	4.75
XA2588	GASKET, Oil Filter Body—DeLuxe CS-56	427	1	100 per	.20
XA2589	GASKET, Base—DeLuxe CS-195	427	1	50 per	.20
XA2590	BASE, Oil Filter—DeLuxe CSB-41	427	1	¾	5.00
XA2591	STUD and TUBE ASSEMBLY—DeLuxe CS-121-49	427	1	1½	1.50
XA2592	GASKET, Stud and Tube—DeLuxe CS-51	427	1	150 per	.05
XA2593	PLUG, Oil Filter—DeLuxe CS-50	427	1	25 per	.26
XA2594	GASKET, Oil Filter Plug—DeLuxe CS-52	427	1	150 per	.09
XA2595	CAPSCREWS—DeLuxe 122133	427	4	15 per	.15
XA2596	PAN, Oil—Buda 4531	428	1	17	12.00
XA2597	GASKET, Oil Pan Sides—Buda 4539	428	2	½	.12
XA2598	CAPSCREWS, ¼"—Buda 2525	428	3	50 per	.04
XA2599	BRACKET, Oil Float—Buda H-12000	428	1	1	2.85
XA2600	COTTER, Float Screen 3/32"x1⅛"—Buda 108636	428	1	200 per	.01
XA2601	SCREEN, Oil Float—Buda DE-3284	428	1	½	1.30
XA2602	PLUG—Buda 103870	428	1	¼	.16
XA2603	GASKET, Oil Pan Ends—Buda 4541	428	2	30 per	.10
XA2604	GASKET, Oil Bracket—Buda 1526	428	1	200 per	.04
XA2605	ADAPTOR, Oil Level Gauge—Buda H-12035	428	1	30 per	.35
XA2606	GAUGE, Oil Lever—Buda K-40249	428	1	10 per	.50
XA2607	OIL PUMP ASSEMBLY (Not illustrated)—Buda 5875	429	1	6½	14.50
XA2608	COVER, Includes Shafts—Buda 5877	429	1	1¼	2.75
XA2610	GASKET, Oil Pump Cover—Buda 1508	429	1	100 per	.05
XA2611	GEAR, Driver—Buda 5879	429	1	½	2.50
XA2612	BODY, Oil Pump—Buda 5876	429	1	2½	4.75
XA2613	LOCKWASHER, Oil Pump to Case 5/16"—Buda 108579	429	4	100 per	.02
XA2614	DOWEL, Oil Pump to Case—Buda 1547	429	2	50 per	.06
XA2615	GASKET, Oil Pump to Case—Buda 1546	429	1	100 per	.04
XA2616	GEAR, Idler—Buda 5880	429	1	½	2.50
XA2618	LOCKWASHER, Oil Pump Cover Star ¼"—Buda 114604	429	6	200 per	.01
XA2619	CAPSCREW, Oil Pump Cover ¼—20x⅝"—Buda 106319	429	6	50 per	.04
XA2620	SEAT, Oil Pressure Relief Valve—Buda DE-40318	429	1	30 per	.35
XA2621	BALL, Oil Pressure Relief Valve—Buda 104924	429	1	20 per	.06
XA2622	SLEEVE, Oil Pressure Relief Valve—Buda DE-40317	429	1	15 per	.28
XA2623	SPRING, Oil Pressure Relief Valve—Buda 3545	429	1	40 per	.05

Koehring Part No.	Name and Description	Illust. on Page	Amt. Rqd.	Weight Lbs.	Price Each
XA2624	GASKET, Oil Pressure Relief Valve—Buda 1530	429	1	50 per	.04
XA2625	CAP, Oil Pressure Relief Valve—Buda 5529	429	1	12 per	.28
XA2626	BUSHING, Connecting Rod (Sold only with Connecting Rod)—Buda 4253	430	6	¼	.50
XA2627	PISTON AND PIN—Buda K40188	430	6	5½	7.20
XA2628	RING, Piston 4th—Buda K40204	430	6	10 per	.26
XA2629	RING, Piston 3rd—Buda K40203	430	6	12 per	.57
XA2630	RING, Piston 1st and 2nd—Buda K40147	430	12	16 per	.30
XA2631	PIN, Piston—Buda 4207	430	6	¾	1.20
XA2632	SPRINGS, Piston Pin Retaining—Buda 4204	430	12	100 per	.08
XA2633	CONNECTING ROD—Buda 4379	430	6	5½	5.50
XA2634	BOLT, Connecting Rod—Buda DE4217	430	12	¼	.35
XA2635	NUT, Connecting Rod Bolt—Buda DE4218	430	12	20 per	.10
XA2636	SPRING, Filler Cap—Perfex G24040	431	1	* *	.15
XA2637	CAP, Radiator—Perfex A-9-1	431	1	2	1.50
XA2638	PLUG, Pipe—Ctsk. Head 1½"	431	1	½	.19
XA2639	TANK, Top—Perfex G1308	431	1	48	22.50
XA2640	GASKET, Cork (5 pieces make up 2 Gaskets)—Perfex G24028	431	2	* *	.18
XA2641	TUBE, Overflow—Perfex G21499	431	1	¼	.90
XA2642	NUT, Hexagon—Perfex G2004	431	64	50 per	.60*
XA2643	WASHER, Core—Perfex G21841	431	4	½	.38
XA2644	CORE, Radiator Assembly—Perfex TC415	431	1	47	43.50
XA2645	SCREW, Cap—Perfex G2038	431	24	20 per	.02
XA2646	SIDE, Radiator—Perfex G5730	431	2	18	8.25
XA2647	TANK, Bottom—Perfex G407	431	1	34½	15.00
XA2648	STUD, Support—Perfex G21141	431	2	¼	.90
XA2649	SUPPORT, Radiator—4206A501	431	2	⅛	.35
XA2650	NUT, Hexagon ⅝" N. C.	431	12	⅛	.03
XA2651	PLUG, Pipe Square Head 1½" Male W.I.	431	1	½	.12
XA2652	NIPPLE, Close 1½" W. I.	431	1	⅜	.13
XA2653	ELL, Street—½"x45° W.I.	431	1	¼	.20
XA2654	NIPPLE, Close ½" W. I.	431	1	14 per	.05
XA2655	COTTER, 1/16"x½"—Perfex 578	431	2	* *	.10*
XA2656	PIN, Hinge—Perfex G21094	431	1	15 per	.08
XA2657	HOSE, Radiator—1-7/8" I.D.x4" Rubber	431	2	¼	.13
XA2658	NIPPLE, Special—212A20	431	1	1¼	1.25
XA2659	BOLT, Machine ⅝"x1¾" N.C.	431	2	¼	.07
XA2660	PLATE, Serial Number—Perfex G24000	431	1	* *	.15
XA2661	NIPPLE, 1½"x3" W.I. Thread on one end	431	1	¾	.16
XA2662	HOSE, Radiator—1-7/8" I.D.x3½" Rubber	431	2	¼	.12
XA2663	TEE, Reducing 1½"x½"x1½" W. I.	431	1	1½	.75
XA2664	COCK, Brass Stop ½"	431	1	¾	1.95
XA2665	PIPE, ½"x1½"—Thread on one end—W.I.	431	1	⅛	.05
XA2666	HOSE, Rubber—¾" I.D.x7"	431	1	¼	.15
XA2667	PIPE, Drain C808-33	431	1	1¼	.20
XA2668	SHROUD, Fan with Screen—Perfex A-11-57	431	1	14	15.00
XA2669	BOLT, Stove—Round Head ¼"x½"	431	6	50 per	.02
XA2670	NUT, Square—¼" Galvanized	431	8	75 per	.01
XA2671	BOLT, Stove—Round Head ¼"x1¾" Galvanized	431	8	30 per	.02
XA2672	CLAMP, Hose—1¾" 3 ply with bolt—Clancy	431	8	¼	.20
XA2673	PIPE, Inlet—212B22	431	1	3¼	3.00
XA2674	BRACE, Radiator—212A21	431	1	1¼	1.60
XA2675	PIPE, Outlet—212B23	431	1	3¼	2.75
XA2676	ELBOW, Outlet—212B24	431	1	2¾	1.85
XA2677	SCREEN, Shroud—Perfex	431	1	8½	7.00
XA2678	STARTING MOTOR—Buda K-40505	432	1	32½	48.00
XA2679	BEARING, Bronze—Auto-Lite MG-77A	432	1	30 per	.20
XA2680	ASSEMBLY, Housing—Auto-Lite PS-1050	432	1	6	4.50
XA2681	DOWEL—Auto-Lite MAB-88	432	1	* *	.01
XA2682	SLEEVE—Auto-Lite EB-7819S	432	1	15 per	.30
XA2683	SCREW (short) Head—Auto-Lite EB-7806	432	1	* *	.08

Koehring Part No.	Name and Description	Illust. on Page	Amt. Rqd.	Weight Lbs.	Price Each
XA2684	WASHER—Auto-Lite EB-108	432	2	* *	.01
XA2685	SCREW, Long—Auto-Lite EB-7807	432	1	150 per	.07
XA2686	BEARING, Bronze—Auto-Lite ML-21A	432	1	25 per	.20
XA2687	ASSEMBLY, Bearing—Auto-Lite ML2027A	432	1	½	1.00
XA2688	ASSEMBLY, Armature—Auto-Lite ML-2035	432	1	9½	17.00
XA2689	ASSEMBLY, Bendix—Auto-Lite EBA-11	432	1	2	5.50
XA2690	SPRING, Drive Bendix—Auto-Lite EB-8705	432	1	½	.55
XA2691	HEAD, Drive Bendix—Auto-Lite EB-8503	432	1	¼	.45
XA2692	WASHER, Armature—Auto-Lite MG-61	432	1	50 per	.05
XA2693	WASHER, Armature—Auto-Lite GK-174A	432	1	100 per	.01
XA2694	WASHER, Frame Screw—Auto-Lite X1014	433	2	* *	.05
XA2695	ASSEMBLY, Field and Frame—Auto-Lite ML-2025	433	1	12	12.50
XA2696	WASHER, Terminal Post—Auto-Lite MG-68	433	2	* *	.01
XA2697	BUSHING—Auto-Lite MG-70	433	1	* *	.02
XA2698	BUSHING, Terminal—Auto-Lite MG-69	433	1	* *	.02
XA2699	WASHER, Terminal—Auto-Lite MG-22	433	2	* *	.01
XA2700	WASHER, 3/8" Terminal—Auto-Lite X-201	433	2	* *	.05
XA2701	WASHER POST, Terminal 3/8—16—Auto-Lite MG-27	433	1	50 per	.15
XA2702	NUT, 3/8"—16 Terminal—Auto-Lite 5X-179	433	2	* *	.05
XA2703	COIL, Field L.R.—Auto-Lite ML-1008	433	1	½	1.00
XA2704	COIL, Field L.L.—Auto-Lite ML-1009	433	1	½	1.00
XA2705	COIL, Field U.R.—Auto-Lite ML-1010	433	1	½	1.00
XA2706	POLE—Auto-Lite MH-29	433	4	½	.80
XA2707	CONNECTOR, Terminal—Auto-Lite MH-28	433	1	* *	.06
XA2708	TERMINAL—Auto-Lite X-983	433	2	* *	.05
XA2709	LEAD, Field Coil—Auto-Lite MO-17	433	1	50 per	.25
XA2710	INSULATION, Field Connection—Auto-Lite MR-32	433	1	* *	.01
XA2711	COIL, Field U.L.—Auto-Lite ML-1007	433	1	½	1.00
XA2712	ASSEMBLY, Head—Auto-Lite ML-2090	433	1	1¼	4.25
XA2713	HEAD, Only—Auto-Lite ML-1090-S	433	1	1	2.25
XA2714	SCREW, Head Band—Auto-Lite X-715	433	1	100 per	.05
XA2715	BAND, Head—Auto-Lite GX-1024	433	1	¼	.25
XA2716	BEARING, Bronze—Auto-Lite MAL-40A	433	1	50 per	.20
XA2717	COVER, C. End—Auto-Lite MG-1084S	433	1	50 per	.05
XA2718	SCREW, Frame—Auto-Lite MH-20	433	2	⅛	.10
XA2719	BRUSH, Commutator—Auto-Lite MH-54	433	4	25 per	.20
XA2720	CONNECTOR, Ground—Auto-Lite MH-53	433	2	100 per	.12
XA2721	NUT, No. 10-32—Auto-Lite X-794	433	2	* *	.05
XA2722	INSULATION, Spacing—Auto-Lite GK-162	433	2	* *	.01
XA2723	HOLDER, Brush—Auto-Lite GT-14	433	2	100 per	.04
XA2724	BUSHING, Insulating—Auto-Lite GT-35	433	2	* *	.04
XA2725	INSULATOR—Auto-Lite GT-32	433	2	* *	.03
XA2726	SPRING, Brush—Auto-Lite MG-74	433	2	* *	.05
XA2727	WASHER, Insulating—Auto-Lite GT-37	433	2	* *	.01
XA2728	CLIP, Brush Post—Auto-Lite GT-41	433	2	* *	.01
XA2729	SCREW, No. 8—32x½"—Auto-Lite 8X-122	433	4	* *	.05
XA2730	GASKET, Timer Gear Housing—Buda 4044	434	1	20 per	.20
XA2731	STUD, Access. Drive Hsg.—Buda 4040	434	4	¼	.06
XA2732	GEAR HOUSING—Buda 4446	434	1	25	17.50
XA2733	CAPSCREWS, Timing Gear Hsg.—Buda 4054	434	6	15 per	.12
XA2734	LOCKWASHER, ½" Shakeproof—Buda 115551	434	6	30 per	.02
XA2735	GASKET, Timing Gear Housing—Buda 4055	434	1	20 per	.35
XA2736	BAFFLE PLATE, Gear Housing—Buda 4447	434	1	½	.10
XA2737	BOLTS, Timing Gear Hsg. Dowel—Buda 4052	434	2	¼	.30
XA2738	OIL SEAL, Timing Gear Cover—Buda PA117	434	1	¼	.85
XA2739	COVER, Timing Gear—Buda 4445	434	1	18	6.60
XA2740	FRONT SUPPORT—Buda 4448	434	1	5½	4.25
XA2741	BOLT, ½"—20—Buda GE284	434	2	30 per	.38
XA2742	NUT, Support—Buda BE 259	434	1	25 per	.10
XA2743	SHIM—Buda CUE 371	434	1	15 per	.06
XA2744	CRANK, Starting—Buda H-12242	434	1	5	3.00
XA2745	VALVE, Intake—Buda 4310	435	6	¼	1.30

Koehring Part No.	Name and Description	Illust. on Page	Amt. Rqd.	Weight Lbs.	Price Each
XA2746	VALVE, Exhaust—Buda 4329	435	6	¼	2.00
XA2747	RETAINER, Valve—Buda 1364	435	12 sets	* *	.08
XA2748	GUIDES, Intake—Buda 1345	435	6	¼	.40
XA2749	GUIDES, Exhaust—Buda 1315	435	6	¼	.40
XA2750	INSERT, Exhaust Valve Seat—Buda 4239	435	6	10 per	1.10
XA2751	SEAT, Valve Spring Upper—Buda 5337	435	12	20 per	.06
XA2752	SPRING, Valve—Buda 5976	435	12	¼	.45
XA2753	SEAT, Valve Spring Lower—Buda 1313	435	12	20 per	.10
XA2754	DOWEL, Valve Lifter Bracket—Buda 1305	435	6	30 per	.08
XA2755	NUT, Valve Cover Stud—Buda 2065	435	4	50 per	.08
XA2756	GASKET, Valve Cover Stud Nut—Buda 1359	435	4	200 per	.02
XA2757	VALVE, Cover—Buda 4070	435	1	5	1.40
XA2758	GASKET, Valve Cover—Buda 4033	435	1	15 per	.24
XA2759	PLATE, Valve Chamber Baffle—Buda D4346	435	1	¼	.65
XA2760	LIFTER, Valve—Buda 5996	435	12	¼	1.90
XA2761	NUT, Valve Lifter Adjusting Screw—Buda 4305	435	12	50 per	.05
XA2762	SCREW, Valve Lifter Adjusting—Buda 4304	435	12	15 per	.35
XA2763	BRACKET, Valve Lifter—Buda 5997	435	3	4½	3.85
XA2764	STUD, Valve Cover—Buda 4357	435	4	¼	.06
XA2765	WATER, PUMP, Assembly—Buda K40365	436	1	16	29.00
XA2766	KEY, Water Pump Shaft Woodruff—Buda 1654	436	1	100 per	.06
XA2767	IMPELLER, Water Pump—Buda 2651	436	1	¾	1.30
XA2768	GASKET, Cover—Buda 1627	436	1	100 per	.05
XA2769	COVER, Water Pump—Buda 2698	436	1	5	5.00
XA2770	EXTENSION, Zerk Elbow ¼" Imperial—Buda 120B	436	1	⅛	.25
XA2771	ELBOW, Zerk 1/9" St'd (Street L)—Buda 120401	436	1	¼	.10
XA2772	FITTING, Zerk No. 1662—Buda 3568	436	1	⅛	.20
XA2773	NUT, Packing Front—Buda 2691	436	1	¼	.55
XA2774	WRENCH, Water Pump Spanner—Buda CUE835	436	1	¼	.20
XA2775	GLAND, Packing—Buda 2692	436	2	⅛	.30
XA2776	PACKING, Water Pump—Buda 2687	436	4	30 per	.12
XA2777	BUSHING, Cover—Buda 3628	436	1	¼	.55
XA2778	SCREW, Cover ¼—20x⅝"—Buda 117471	436	5	50 per	.02
XA2779‡	SPRING, Water Pump Coupling Chain Link—Buda 1406	436	1	* *	.04
XA2780	CHAIN, Water Pump Coupling—Buda 1409	436	1	⅜	1.65
XA2781‡	LINK, Water Pump Coupling Chain—Buda 1407 includes Coupling	436	1	* *	.22
XA2782	DOWEL, Water Pump—Buda 2697	436	2	150 per	.05
XA2783	NUT, Pump to Water Jacket ¼"—28—Buda 120367	436	4	¼	.04
XA2784	GASKET, Pump to Water Jacket—Buda 1625	436	1	⅛	.06
XA2785	COUPLING, Water Pump—Buda 2478	436	1	⅜	1.40
XA2786	NUT, Packing Rear—Buda 2690	436	1	⅜	.55
XA2787	BUSHING, Body—Buda 3627	436	1	¼	.45
XA2788	BODY, with Bushing—Buda 4573	436	1	5¾	5.75
XA2789	SHAFT, Water Pump—Buda 2675	436	1	2	5.50
XA2790	CONNECTION, Water Inlet—Buda 1640	436	1	3½	.85
XA2791	PLUG, Water Pump Inlet Conn. Drain—Buda 103866	436	1	⅛	.04
XA2794	GASKET, Water Inlet—Buda 1645	436	1	30 per	.04
XA2795	SCREWS, Dist. Plate ¼"—28—7/8"—Buda 114402	436	6	40 per	.02
XA2796	SPACER, Distributor Plate—Buda 5897	436	6	50 per	.10
XA2797	PLATE, Distributor—Buda 5058	436	1	3½	2.50
XA2798	TUBE, Distributor—Buda 4069	436	1	¼	.18
XA2799	GASKET, Water Jacket Cover—Buda 4058	436	1	16 per	.30
XA2800	STUDS, Water Pump Connection—Buda 4389	436	4	40 per	.10
XA2801	COVER, Water Jacket—Buda 4387	436	1	⅛	7.70
XA2802	CAPSCREWS, Water Jacket Cover ¼"—20x¾"—Buda 100109	436	20	200 per	.05
XA2803	CAPSCREWS, Water Jacket Cover ¼"—20x1"—Buda 100110	436	8	40 per	.04

‡ Included in XA2780 change. But can be ordered separately.

Koehring Part No.	Name and Description	Illust. on Page	Amt. Rqd.	Weight Lbs.	Price Each
XA2804	ELBOW, 5/16"x⅛"—Weatherhead W49x5	437	4	20 per	.23
XA2805	NUT, ¼"x5/16"—Weatherhead A4125	437	6	15 per	.25
XA2806	UNION, 5/16"—Weatherhead W42x5	437	2	15 per	.23
XA2807	NUT, 5/16"—Weatherhead W41x5	437	2	20 per	.17
XA2808	CLIP, Fuel Line—200A633	437	2	50 per	.30
XA2809	TUBING, Copper 5/16"x8'0" (.049 Wall)	437	1	1	.75
XA2810	HOSE, ¼"x23"—Weatherhead	437	1	10 per	.75
XA2811	HOSE, ¼"x9"—Weatherhead	437	1	25 per	.30
XA2812	BOLT, Machine ⅜"x1" N.C.	437	4	20 per	.03
XA2813	STRAP, Fuel Tank—77FB12	437	2	7¼	2.85
XA2814	BLOCK, Oak—4225D531-3	437	2	½	.30
XA2815	SUPPORT, Fuel Tank—4225D531-4	437	2	8½	1.75
XA2816	NUT, Hexagon ⅜" N.C.	437	8	30 per	.80*
XA2817	NUT, Square—¼" N.C.	437	3	75 per	.40*
XA2818	CAP, Easy-on Filler—Eaton GD 297	437	1	¼	.60
XA2819	BUSHING, Split—200A417	437	1	16 per	.10
XA2820	BOLT, Stove Round Head ¼"x1½"	437	1	40 per	.02
XA2821	CLIP, Fuel Line—4225A925	437	1	¼	.75
XA2822	PLUG, Pipe—Square Head ⅜"	437	1	20 per	.04
XA2823	PLUG, Drain—4225A911	437	1	1¾	.70
XA2824	PIPE, Stand—4225D117-4	437	2	1	1.00
XA2825	BOLT, Machine—⅝"x1¼" N.C.	437	4	¼	.07
XA2826	WASHER, Flat ⅝" St'd	437	8	12 per	.60*
XA2827	BOLT, Stove—Round Head ¼"x2"	437	8	30 per	.02
XA2828	SUPPORT, Fuel Line—4225A701	437	2	16 per	.25
XA2829	TUBING, ¼"x68"—Weatherhead	437	1	¼	2.25
XA2830	COUPLING, Reducer ¼" to ⅛" M.I.	437	2	16 per	.10
XA2831	BUSHING, Reducer 4236A29	437	2	⅛	.30
XA2832	TANK, Fuel 55 Gal. 51PM63D	437	1	100	45.50
XA2833	BOLT, Eye—4236A274	438	2	⅛	.40
XA2834	PULLEY, Swivel—2"—Pritzlaff	438	2	1	.40
XA2835	CABLE, Aircraft—7x19 Tinned 18x17'0"	438	1	1	2.05
XA2836	NUT, Hexagon—3/16" N. C.	438	2	* *	.50*
XA2837	PULLEY, Side—2"—Pritzlaff 25	438	1	¾	.12
XA2838	BOLT, Stove—Round Head 3/16"x⅜"	438	2	100 per	.50*
XA2839	WASHER, Flat—3/16"	438	4	* *	.10*
XA2840	NUT, Hex. Half—5/16" N. C.	438	3	100 per	.70*
XA2841	WASHER, Flat—5/16" U. S. Std.	438	4	100 per	.20*
XA2842	THIMBLE, Cable—Aircraft ⅛"x11/32" I.D.	438	2	150 per	.05
XA2843	SCREW, Cap—Hex. Head 5/16"x1¼" N.C.	438	1	25 per	.01
XA2844	BRACKET, Lever with ½"x¾" Round Head Rivet—212 B 1	438	1	2	1.80
XA2845	DISC, Friction—Ross E-35-DS	438	2	50 per	.10
XA2846	LEVER, Hand—212 D 375	438	1	1¼	2.75
XA2847	CAP, Hand Lever—Ross E-116-E-6692	438	1	⅛	.70
XA2848	SCREW, Cap—Fillister Head ¼"x1" N.C.	438	2	50 per	.03
XA2849	WIRE, Blue Annealed No. 22x8"	438	6	* *	.01
XA2850	BRACKET, Pulley—212B 263	438	1	2¼	.85
XA2853	ENGINE, 6 Cyl. Gas—Buda 212UA1	439	1	1215	620.00
XA2855	CLUTCH, Engine—Twin Disc X735OA	439	1	112	104.50
XA2856	LINK, Connecting—Diamond XTT123304	439	1	¼	.50
XA2857	CHAIN, Drive ¾" Pitch Four Strand, 198 Pitch Length—Diamond XTT123304	439	1	45	62.35
XA2858	SPROCKET, Engine—4234B147	439	1	8¾	24.50
XA2859	PLATE, Retainer—4225A34A	439	1	½	1.50
XA2860	PLATE, Lock 4213A176	439	1	20 per	.30
XA2861	FITTING, Alemite—Alemite A1186	439	1	20 per	.14
XA2862	COUPLING, Pipe ¼" W. I.	439	1	16 per	.10
XA2863	NIPPLE, ¼"x2"	439	1	14 per	.06
XA2864	KEY, Straight—4226A696	439	1	½	.25
XA2865	SLINGER, OIL—4226A554	439	1	¼	.24
XA2866	BRACKET, Magnetic Switch—212A60	439	1	¾	.55

Koehring Part No.	Name and Description	Illust. on Page	Amt. Rqd.	Weight Lbs.	Price Each
XA2867	BOLT, Stove—Round Head 3/16"x½"	439	2	100 per	.50*
XA2869	MAGNETIC SWITCH, Auto-Lite SS 4007	439	1	1¼	3.00
XA2872	RADIATOR, with Shroud—Perfex 4234D140A	439	1	153	56.00
XA2873	COVER, Battery 212UA28	439	1	2¼	3.00
XA2874	NUT, Wing—½" N.C.	439	2	10 per	.06
XA2875	WASHER, Plain—½"	439	2	25 per	.50*
XA2876	BATTERY, 6 Volt—19 Plate—Globe V89	439	1	57	20.95
XA2877	ROD, Tie 200A214	439	2	¾	.35
XA2878	NUT, Hexagon—½" N.C.	439	4	15 per	.02
XA2879	TRAY, Battery—212UA29	439	1	2¾	3.25
XA2880	MUFFLER, Engine 64D931A	440	1	15½	6.35
XA2881	BOLT, Machine ⅜"x5" N.C.	440	1	¼	.05
XA2882	PIPE, Exhaust—212UA14A	440	1	14	6.75
XA2883	HOUSING, Muffler—52-315A	440	1	2½	1.85
XA2884	SCREW, Cap—Hex. Head ½"x1½" N.F.	440	2	⅛	.04
XA2885	SUPPORT, Radiator and Engine—212UA6	440	1	77½	45.00
XA2886	BOLT, Machine ¾"x3" N.C.	440	2	½	.11
XA2887	WASHER, Bevel ¾"	440	2	¼	.06
XA2888	WASHER, Lock ¾"	440	6	25 per	.01
XA2889	NUT, Hexagon—¾" N. C.	440	6	¼	.04
XA2890	PIN, Fuel Pump Link—855016	417	2	* *	.02
XA2891	TERMINAL, Generator Lead X-767	419	2	* *	.02
XA2892	SCREW No. 10—32—7/16"—X-723	421	2	* *	.06
XA2893	SCREW, Cap—Hex. Head ¾"x3" N.F.	440	2	½	.12
XA2894	CLEANER, Air—Donaldson E7764	440	1	9¼	7.25
XA2895	BUSHING, Reducer—1"x¾"	440	1	½	.10
XA2896	ELL, Street ¾"x90°	440	2	½	.20
XA2897	PIPE, ¾"x13½"	440	1	1¼	.40
XA2898	SUPPORT, Pipe 4225A886	440	1	¾	.40
XA2899	ELBOW, ¾"x90°	440	1	¼	.15
XA2900	NIPPLE, Pipe ¾"x2½"	440	1	¼	.08
XA2901	CAP, Pipe ¾"	440	1	¼	.16
XA2902	SUPPORT, Rear Engine 212B 17	440	1	37	20.00
XA2903	SCREW, Cap—Hex. Head ¾"x2½" N.F.	440		½	.11
XA2904	COCK, Water Cylinder Drain—Buda DE 55109	414		15 per	.30

LIGHT PLANT SECTION

OPERATION
AND
MAINTENANCE MANUAL
AND
PARTS CATALOG

MODEL E
KOHLER ELECTRIC PLANT

MANUFACTURED FOR CORPS OF ENGINEERS

THE KOHLER COMPANY
KOHLER — WISCONSIN

INDEX OPERATION SECTION

ILLUSTRATIONS

INDEX MAINTENANCE SECTION

ILLUSTRATIONS

· INDEX PARTS SECTION

DESCRIPTION

The Kohler Electric Plant Model E consists of a direct connected gasoline engine driven generator set.

The engine is a four cylinder valve-in-head unit with a 2" bore and a 3" stroke. Oil bath air cleaner, conventional type carburetor, high tension magneto, and fuel pump are included as standard equipment.

A plunger type oil pump forces oil to main bearings and rocker arms. The rods and cylinders are splash lubricated.

The plant is started by means of a hand crank and operates at a speed of 1000 R.P.M. The generator is compound wound 115 volts, DC, and has a rated capacity of 1500 watts.

The cooling system if of the thermo syphon type with radiator and fan.

SAFETY PRECAUTIONS AND PROPER OPERATING PROCEDURE

When the plant is uncrated, a general inspection should be made to determine whether it has been damaged in transit. The governor operating lever should be checked to observe whether it moves freely, and before the plant is placed in operation, starting instructions should be followed as covered in detail on Page 10.

WARRANTY

We warrant and will replace free of charge for a period of three months from date of delivery of plant to original consumer, all parts of Kohler Electric Plants returned to our nearest branch office, prepaid, which our examination shall disclose to our satisfaction to be defective in manufacture.

This warranty shall not apply to any electric plant which shall have been repaired or altered by anyone other than an employee of the Manufacturer, or which has been improperly installed or repaired, neglected or operated contrary to our instructions.

We make no warranty whatever in respect to the battery or magneto inasmuch as they are warranted by their respective manufacturers.

This warranty is in lieu of all other warranties, obligations, and liabilities on our part, express or implied, and we neither assume nor authorize any other person to assume for us, any other liability in connection with the sale of Kohler Electric Plants.

NOTES

SPECIFICATIONS OF MODEL E

OPERATION -- Designed for hand starting. Self-contained and compact.

ENGINE -- Four cylinder, four cycle, valve-in-head type, bore 2", stroke 3", 1000 R.P.M., 3 horsepower. High tension magneto ignition. Enclosed mechanical governor maintains constant voltage and regulates fuel consumption to load.

GENERATOR -- 1500 watts, 115 volt DC. Four pole, compound wound with self-adjusting brushes. Will operate electric motors up to 1-1/2 H.P.

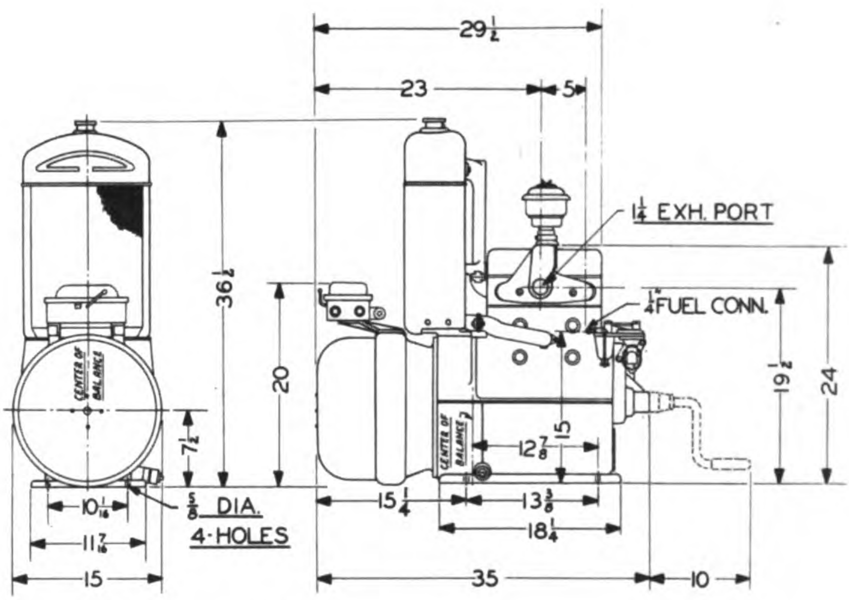
LUBRICATION -- Pressure pump forces oil to rocker arms and main bearings--splash system to cylinders and connecting rods.

COOLING -- Water cooled, with efficient radiator and fan.

FUEL SUPPLY -- Fuel pump to deliver gasoline to carburetor.

WEIGHTS AND MEASUREMENTS

MODEL	PLANT				
	LENGTH INCHES	WIDTH INCHES	HEIGTH INCHES	WEIGHT UNCRATED	WEIGHT CRATED
E	35	15	36 1/2	490 LBS.	600 LBS.



TOTAL WEIGHT------------------------490

WEIGHT AT EACH FRONT MTG. HOLE----10

WEIGHT AT EACH REAR MTG. HOLE---235

FIGURE 1

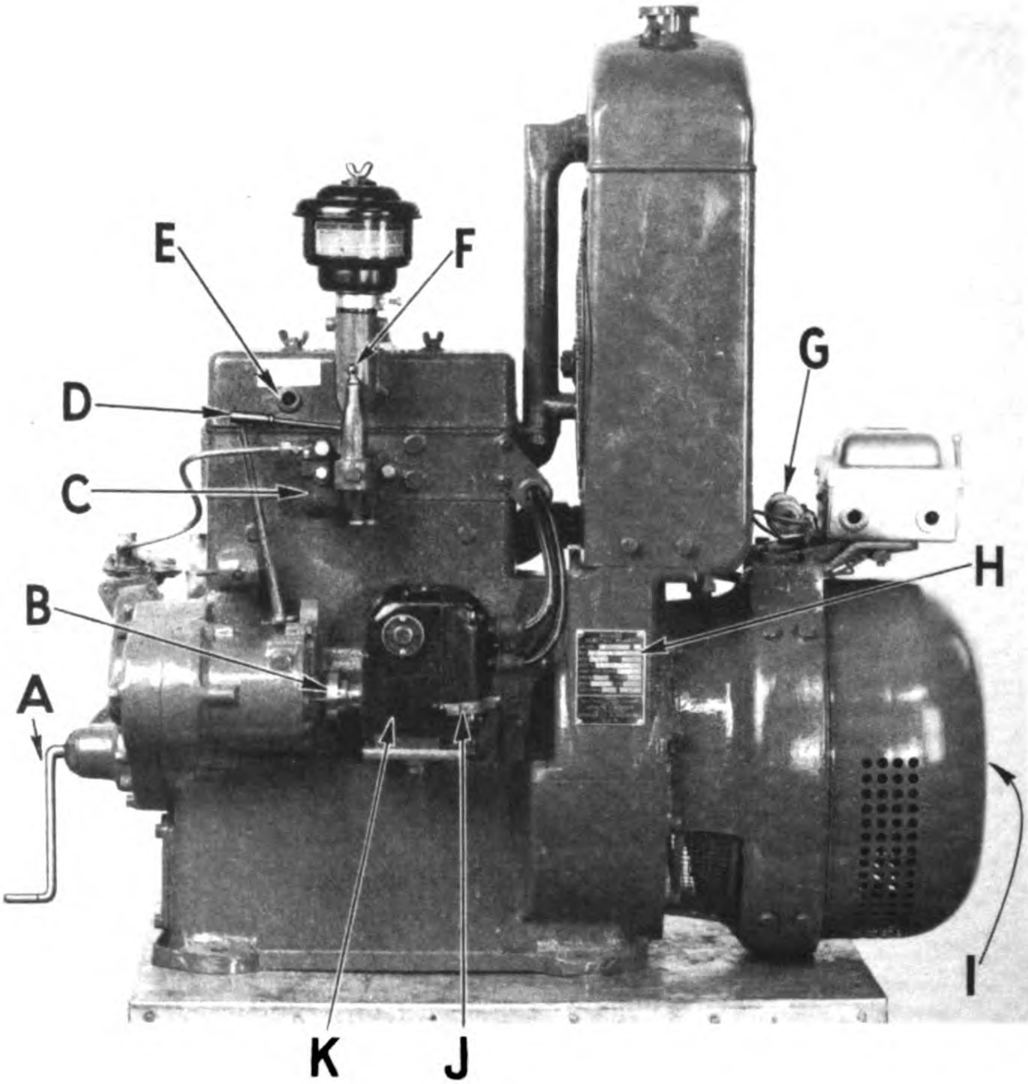


FIGURE 2

MODEL E, MAGNETO SIDE

A. Starting crank
B. Magneto coupling
C. Carburetor
D. Carburetor operating lever
E. Oil sight hole
F. Choker
G. Field resistance
H. Name plate
I. Generator bearing
J. Magneto ground contact
K. Magneto

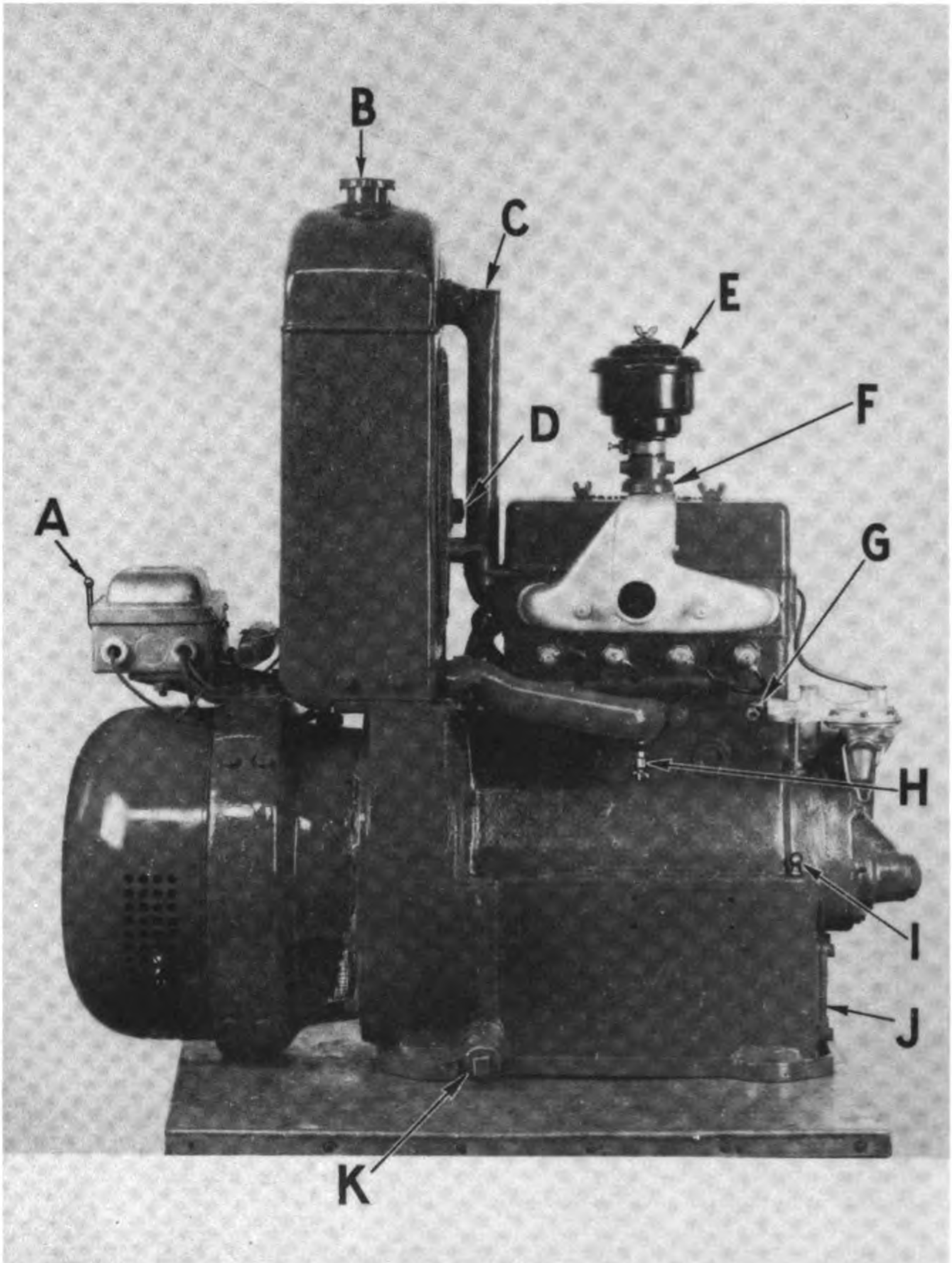


FIGURE 3

MODEL E, EXHAUST SIDE

A. Switch
B. Radiator inlet
C. Water outlet manifold
D. Fan
E. Oil bath air cleaner
F. Oil filler opening
G. Fuel pump inlet
H. Water drain
I. Oil level gauge
J. Clean out plate
K. Oil drain

STARTING A NEW PLANT

Before starting a new plant for the first time, a definite procedure should be observed. We recommend the following:-

FILL THE CRANKCASE: The engine holds approximately seven quarts of oil and is filled through the top of the cylinder head cover marked "OIL FILL HERE". For temperatures above 32° F. use OE-S.A.E. 30 and for temperatures of 32° F. to 0° F. use OE-S.A.E. 10 -- for temperatures below 0° F. refer to EFSB-L-1000-D. Keep the oil level between the marks H and L on the oil level gauge. Plant must set level.
SEE FIGURE 4

FILL RADIATOR with soft water.

GASOLINE SUPPLY: Gasoline for Kohler plant is furnished from fuel tank on engine of prime unit. Gasoline supply tank of engine on machine must be filled to operate the plant. Fresh non-gummy gasoline should be used. A regular is preferable.

EXHAUST LINE: Inspect exhaust line joints to see that they are properly installed and tight.

FUEL LINES: Check all fuel line connections from plant to tank. Connections must be tight.

FUEL PUMP: Operate priming lever of fuel pump until bowl is full.

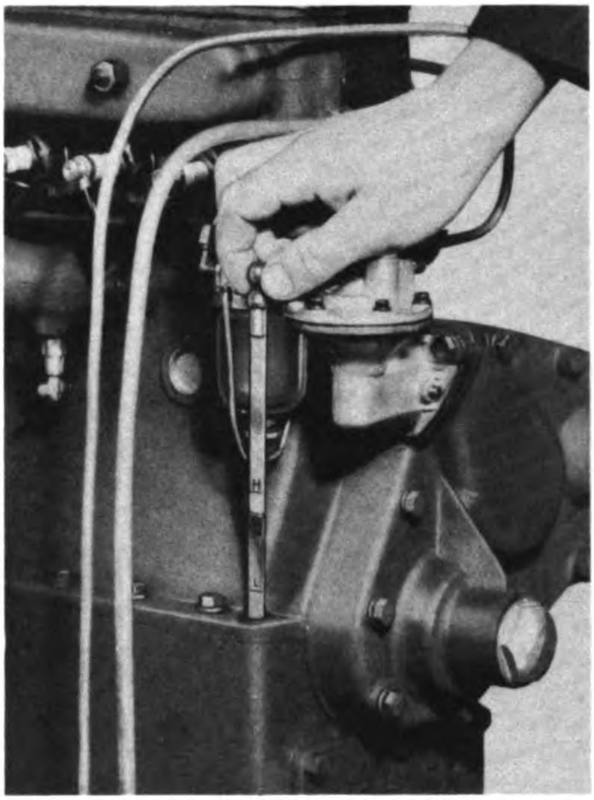


FIGURE 4

Testing Oil Level with Oil Gauge
(Test when plant is idle)

START PLANT: Crank the engine with the hand crank and lift choker while doing so. After plant starts, close the main line switch and turn on lamps or appliances as required.

OIL CIRCULATION: After starting a new plant or after changing oil, look through the small hole in the cylinder head cover and observe whether the oil pump is delivering oil. Oil will be discharged from the copper tubing visible in this opening. In the event the oil is not visible, hold the butterfly valve of the carburetor almost closed so that the plant operates at very slow speed. Do not operate the plant if the oil does not circulate. See "E" Fig. 2

OPERATION AND CARE

To keep your plant in first class operating condition we recommend inspections at regular intervals.

AFTER 8 HOURS OF OPERATION

COOLING SYSTEM: Check the water in the radiator regularly. If the plant is exposed to high temperatures, these inspections must be more frequent. If the plant is exposed to freezing temperatures, use anti-freeze solution.

FAN BELT: Examine the fan belt.

OIL: Check oil level in crankcase.

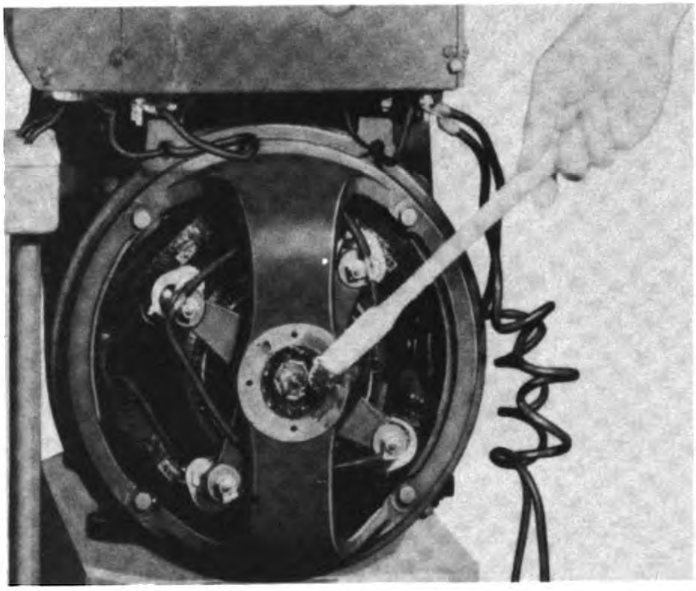


FIGURE 5

Lubrication of Generator Ball Bearing

AFTER 512 HOURS OF OPERATION

MUFFLER: If muffler is used clean if necessary.

VALVE CLEARANCE: Check valve clearances and if necessary adjust clearance, when plant is hot, between .006" and .008".

SPARK PLUGS: Remove, clean and adjust. Plugs with small electrodes should be adjusted to .025" and plugs with heavy electrodes should be adjusted from .030" to .035".

GENERATOR BALL BEARING: Lubricate by applying CG. Do not permit grease to get on commutator.

COMPRESSION: Try the engine for compression and if valves leak, regrind them.

<u>FUEL STRAINERS</u>; Check strainers in fuel line and clean if necessary.

COMMUTATOR: Clean commutator. If necessary, sand brushes and commutator with "00" sandpaper. Adjust spring tension of brushes evenly.

MAGNETO: Check the magneto according to instructions on magneto.

LUBRICATION SYSTEM

The lubrication system provides for forced lubrication to main bearings and rocker arms, and splash to connecting rods, pistons and pins.

Changing Oil: The crankcase holds seven quarts of oil and this should be changed every 128 hours.

FIGURE 6

Filling Oil Base
(Capacity 7 Quarts)

FIGURE 7

Draining Oil Base

TABLE OF CAPACITY AND LUBRICANT TO BE USED

UNIT	CAPACITY (APPROX.)	LOWEST EXPECTED AIR TEMPERATURE		
		ABOVE 32° F.	32° F. TO 0° F.	BELOW 0° F.
CRANKCASE	7 QUARTS	OE SAE-30	OE SAE - 10	REFER TO EFSB L-1000-D

IGNITION SYSTEM

The ignition system consists of a high tension magneto, magneto cables, and spark plugs.

Magneto: The magneto requires attention at regular intervals.

Timing Magneto to Engine: First remove the cylinder head cover and tighten down the cylinder head and rocker arm bolt nuts securely. Next adjust the valve clearance as previously described.

The firing order is 1-3-4-2. The engine cylinder at crank end is No. 1, and numbered in consecutive order, No. 4 being next to the radiator. To place the engine in position, crank the motor until

No. 8 valve (first from radiator) has opened and is almost closed. Now take hold of No. 7 rocker arm (second from radiator) and turn the engine VERY SLOWLY; just keep jarring the handle slightly until the least bit of lost motion is felt in No. 7 and No. 8 rocker arms. The piston in No. 1 cylinder is now at the top of its stroke and in firing position. This can be verified by removing the spark plug from No. 1 cylinder and inserting the little finger, a wire or screwdriver in the spark plug hole.

Next set the magneto for firing No. 1 cylinder, - The exact setting will vary slightly on different engines; if timed too late, loss of power and overheating will result. The best results are obtained by advancing the timing until the engine begins to kick back, and then retarding the magneto one or two teeth. Mesh the coupling teeth together in this position, insert the bolts but leave them slack. Start the plant and the magneto will align itself, then tighten the magneto in place, taking care that the magneto and governor shafts are in line and the coupling is not binding. When the magneto is properly located, a very slight lost motion will be felt in the magneto coupling.

REMOVING AND REPLACING MAGNETO: The magneto may be removed without retiming the engine, by placing timing marks in line when magneto is removed. If the engine is not moved, it will be in proper position when the magneto is replaced. When replacing the magneto, turn until setting marks are in line, and mesh the couplings together in this position.

CLEANING BREAKER POINTS: A film of oil or dirt may at times collect on the contact points, which will prevent perfect short circuiting of the low tension winding. The points are best cleaned with a fine file or with a hone, taking care not to round off the edges. The points must face up SQUARELY OVER THE ENTIRE AREA.

ATTACHING CABLES: The firing order is 1-3-4-2. Attach cables accordingly. If insulation on cables becomes worn or oil soaked, they should be replaced.

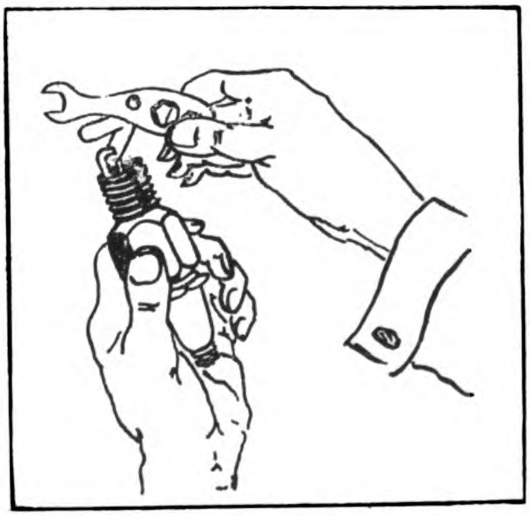


FIGURE 8

Adjust Gap to 1/32 inch

TESTING MAGNETO FOR SPARK: The magneto may be tested when engine is in operation. To do this, disconnect one cable from the spark plug. Start the engine under its own power and hold the end of detached cable within 1/16" of engine frame. The spark for each cylinder may be tested one at a time in this manner. Pliers with insulated handles should be used for holding the cable when making tests with plant in operation, or a slight shock or burn may result.

For further information see pamphlet on magneto.

SPARK PLUGS: Spark plugs are the most common causes of misfiring, and in case of trouble they should be inspected first. Many times the magneto is blamed for trouble which is due entirely to the spark plugs. If the points are too far apart, the windings of the magneto will be forced to carry the burden and the armature, condenser or collector ring may break down.

The distance between points should be .025" for plugs having 1/32" wire electrodes. Heavy duty plugs, having 1/16" wire electrodes should have a gap adjustment of .030" to .035". This is equivalent to 1/32".

If porcelains are chipped or cracked, they must be renewed or new plugs put in. Plugs should be clean inside and out.

HOW TO TEST FOR SPARK: To test whether spark is being furnished, first disconnect magneto ground wire; then remove plug with cable attached. Next hold spark plug against engine frame (do not touch spark plug points to frame). If a spark is being furnished, it will jump across the gap when engine is cranked. If there is no spark and the magneto is suspected, remove cable from plug and hold end of cable 1/32 of an inch from engine frame. If magneto is not at fault, a spark will be observed as crank is turned.

The spark plugs may also be tested when engine is operating by short circuiting between end of plug and engine frame. If the plug is firing, the speed of motor will be reduced. If shorting out the plug has no effect on engine speed, it indicates the plug is not firing. Be careful of shocks when testing in this manner.

When necessary to replace spark plugs, order them from the Kohler Co. so as to secure the correct type, which is important.

COOLING SYSTEM

The cooling system consists of a radiator and fan with a thermo syphon system.

FAN: Check the fan belt. Replace if necessary. See instructions on installing fan belt.

RADIATOR: Check the water in the radiator the same as you do in your car and make sure that the air passages are kept clean and the air around the radiator circulates freely.

If the plant is exposed to freezing temperatures, add anti-freeze accordingly. The cooling system holds approximately 9-1/2 quarts.

ANTI-FREEZE SOLUTION REQUIRED

Per Cent by Volume	Temp. for Alchohol	Temp. for Glycerine	Temp. for Etheline Glycol	Temp. for Prestone
10	+ 27° F.	+ 29° F.		
20	+ 19° F.	+ 21° F.	+ 16° F.	+ 17° F.
30	+ 10° F.	+ 12° F.	+ 3° F.	+ 2° F.
40	- 2° F.	0° F.	- 11° F.	- 12° F.
50	- 18° F.	- 15° F.	- 31° F.	- 35° F.

FUEL SYSTEM

The fuel system consists of fuel pump, carburetor, choker and connecting tubing.

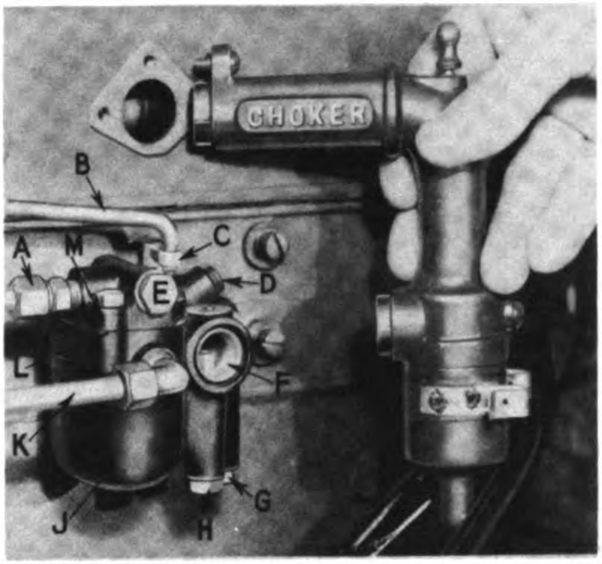
CARBURETOR: The carburetor is not adjustable, except that the mixture can be changed by changing the jets. The jets used are correct for sea level installations and should not be changed unless the plant is installed at a high altitude.

DIRT OR WATER IN THE CARBURETOR: When gasoline is dirty, a tiny speck of dirt may clog the aperture of a jet, and though the engine may continue to work, it does so imperfectly, giving indications of defective carburization. The jets can be quickly cleaned out by holding the hand over the air intake for a few seconds when running the motor fast, or the jets can be taken out by removing the

FIGURE 9

Carburetor

A--Supply Line
B--Governor Operating Lever
C--Butterfly Valve Lever
D--Air Line Opening for Vacuum Tank (not used)
E--Screen in Supply
F--Venturi
G--Compensating Jet
H--Main Jet
J--Bowl
K--Overflow Line
L--Gasket
M--Cover



brass hexagon nuts under the carburetor. If the engine speed and voltage are unsteady, particularly on light loads the jets need cleaning. The carburetor should be washed in gasoline and the jets should be blown clean with compressed air, if available. Water may be removed from the carburetor jets in the same manner, namely, removing the brass hexagon nuts.

FUEL PUMP: The fuel pump requires very little attention and under ordinary operating conditions, will give many hours of service without the replacement of any of the parts. With the average fuel lift, it is not necessary to prime the fuel pump and it will pick up the gasoline at cranking speed. However, if the pump does not pick up the fuel, it is necessary to prime it. This can be done by operating the priming lever.

If the fuel pump fails to operate after the plant has been in service, it should be disassembled and the worn parts replaced. These are illustrated in the parts section and it is not difficult to repair the fuel pump. If it is not convenient to order the parts or repair the fuel pump, the entire assembly may be replaced as the cost of the unit is not excessive.

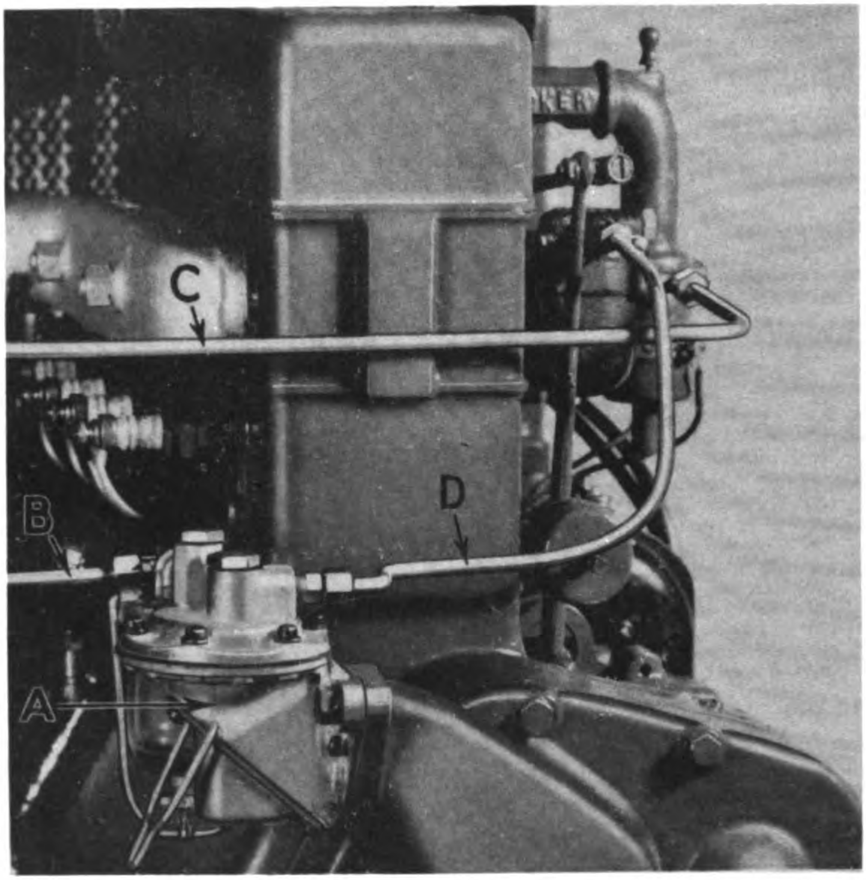


FIGURE 10 FUEL PUMP

A Fuel Pump
B Supply Line from Tank to Pump
C Overflow Line to Tank from Carburetor
D Supply Line to Carburetor from Pump

STARTING SYSTEM

MANUAL PLANTS: A manual plant must be started with the hand crank and the choker must be operated manually.

The ground button on the magneto is used for stopping the plant.

FAILURE TO GENERATE: When first starting a plant, if it fails to generate current at a normal speed (about 1000 R.P.M.), the cause will most likely be due to loss of residual magnetism, due to shock and jars sustained during shipment. To restore the residual magnetism, it is only necessary to form a momentary short circuit between one of the positive and one of the negative brushes on the machine. This can be done by holding a piece of wire so the ends of same will each touch a positive and negative brush, when the plant is operating. The wire must be instantly removed as soon as current is generated.

The residual magnetism can also be restored by connecting the terminals of any low voltage battery between the positive and negative terminals. The battery connection must be removed immediately as soon as the plant generates.

OPERATION UNDER ABNORMAL CONDITIONS

Successful operation depends upon satisfactory operating conditions.

If the plant is exposed to an unusual amount of dust, dirt, or grit, the air cleaner must be given more frequent attention and the plant should be protected insofar as possible.

An effort should be made to keep dust and dirt off of the commutator as this will cause undue wear of commutator and brushes.

If the plant is exposed to low temperatures, the cooling system must be protected against freezing by the addition of an anti-freeze solution.

A good grade of fuel should be used, and ignition system and valves should be checked regularly to facilitate starting.

If the plant is exposed to unusually high temperatures, ventilation should be provided and it may be necessary to install auxiliary fans or air ducts. The coolant should be checked in the cooling system at regular intervals.

If the plant is exposed to excess moisture, an effort should be made to keep the electrical parts as dry as possible by providing ventilation, or operating the plant sufficiently to prevent moisture from accumulating on brush holders, commutator, etc. Moisture is a conductor of electricity and harmful to insulation. Excessive moisture may cause a short circuit or ground.

PREPARATION OF A PLANT FOR STORAGE

If the plant is placed in storage, cylinders should be treated with a non-rusting and non-corrosive lubricant to prevent rusting of cylinder walls, pistons and rings.

Magneto and electrical parts should be protected from oil and moisture.

The cooling system should be protected against freezing by draining and adding a small amount of anti-freeze solution so as to prevent water in the cooling system from freezing.

Exposed machine parts which may become corroded or rusted if exposed to moisture should be protected with a non-rusting solution.

Spark plugs should be removed from engine and a small amount of non-rust non-corrosive lubricant may be placed in the combustion chamber after which the engine can be turned over two or three times with the hand crank so as to properly coat cylinder walls, pistons and rings.

If the plant is exposed to excessive moisture, it may be advisable to remove the magneto and store it in a dry place.

INDEX MAINTENANCE SECTION

ILLUSTRATIONS

SPECIFICATIONS, TOLERANCES, AND CLEARANCES

1.	Intake valve seat	1/32" x 45° Chamfer x 25/32" Dia.
2.	Exhaust valve seat	1/32" x 45° Chamfer x 25/32" Dia.
3.	Intake valve guide side clearance	.002"
4.	Exhaust valve guide side clearance	.002"
5.	Intake valve tappet clearance	.006" Hot
6.	Exhaust valve tappet clearance	.006" Hot
7.	Valve timing	40° Before low dead center
8.	Main bearing diameters	Front brg. 1.3125", Rear brg. 1.251"
9.	Main bearing diametral clearance	Front brg. .00125", Rear brg. .00125"
10.	Main bearing thrust clearance	.004"
11.	Connecting rod bearing diameter	1.249"
12.	Connecting rod bearing diametral clearance	.00075"
13.	Connecting rod bearing side clearance	.0035"
14.	Camshaft bearing diameters	Front 1.500", Rear 1.4375"
15.	Camshaft bearing clearances	Front.00195, Rear .00145"
16.	Cylinder bore	2.000"
17.	Piston clearance	.00175"
18.	Number and type of piston rings per piston	4 Rings (3 plain - 1 oil ring)
19.	Piston ring side and bottom clearance	Side .00125", Bottom .007"
20.	Piston pin diametral clearance	.001"
21.	Ignition timing-maximum degrees advance	Approx. 30°
22.	Recommended types of spark plugs	Champion spark plug No. 7 18 mm or the equivalent

REPAIRS AND ADJUSTMENTS

CAUTION: If the plant does not operate properly and the operator feels that the plant is at fault, he can test it by opening the main line knife switch and operating the plant to determine if the fault lies outside of the machine. However, if the plant does not function as it should, repairs or adjustments are necessary.

OVERLOADING: If properly installed and cared for, the plant can be depended upon to furnish 110 volt current up to its rated capacity. There is a tendency on the part of some operators to put a far greater load on the plant than it was ever designed to carry. This should not be done. While the Kohler Plant is a very rugged and substantially built machine, continued overloading is certain to cause trouble and expense.

SHORT CIRCUITS OR GROUNDS: Short circuits or grounds in the external wiring system will cause trouble. If the plant begins to act erratically and the voltage fluctuates, causing the lights to dim and brighten alternately, either the plant is overloaded or there is something wrong with the wiring, or with some of the power appliances in use.

STOP THE PLANT IMMEDIATELY AND MAKE AN INVESTIGATION: The trouble should be remedied before the plant is again operated.

OPEN CIRCUIT: The plant will not generate if there is an open circuit in the line between the engine and the light or appliance that is turned on. An open circuit in the external wiring will not affect the operation of the plant except that no light will be obtained beyond the point where the circuit is broken.

GROUNDED CIRCUIT: The plant described in this manual is parallel wound, and therefore a ground will not affect the operation, unless there should be a ground on both the positive and negative sides, which would then form a short.

SHORT CIRCUIT: A short circuit is a condition where a large part or the whole of the current generated passes directly from the positive to the negative wire.

TRACING DEFECTS IN WIRING SYSTEM: If the defect is due to an open circuit, the location of the trouble is usually easily found by tracing the various circuits, turning on different lights, until by a process of elimination the place where the circuit is broken can be located. This will usually be a broken wire or a loose connection easily repaired. If the trouble is due to a short circuit, it is not so easily detected.

If there are several circuits, try them separately and watch the performance of the engine, which will usually indicate on which circuit the defect is located. After determining in which circuit the trouble occurs, carefully examine the wiring at all points to find where the wires touch each other, the ground, or some substance which is a conductor of electricity. The trouble will usually be located at some point where the insulation is worn off by chafing against some other substance. If the wires run through metal or a wooden conduit, or should there be junction boxes on the line where moisture is liable to collect, the difficulty will usually be found at one of these places.

The procedure to be followed in all cases will depend on how the system is wired. Defects of this nature can only be discovered by careful examination of the different points where trouble is likely to occur.

REPAIRS TO GASOLINE ENGINE

Repairs or adjustments which may become necessary after a period of operation are included in the following instructions in the approximate order in which these repairs or adjustments may normally occur.

If the plant will not carry its rated capacity load of approximately 15 amperes at 110 volts or 1500 watts, the gasoline engine may lack sufficient power. This trouble may be due to several conditions, and perhaps the one condition which will occur before any other is that of a lack of compression due to leaky valves.

COMPRESSION: To test the engine for compression use the hand crank and turn the engine over very slowly. If the compression is good, there will be a noticeable resistance in rotating the engine as each of the pistons reach the top of the stroke, and the crankshaft will have a tendency to kick backward. When there is a lack of compression in one or more cylinders, the ease of cranking will indicate it. If the exhaust pipe is removed and the ear placed close to the exhaust opening while the motor is revolved by the hand crank, it is possible to judge the compression in this manner. If any of the valves or the piston rings are leaking, the escape of the confined vapor will make a hissing noise as it passes through the leaky valve or by the piston rings.

Following are the causes of poor compression:

1. Leaky valves, particularly exhaust valves.

2. Improper valve clearance. A clearance of .006" to .008" should be maintained.

3. Leaky spark plug - cracked porcelain or leaky gasket.

4. Loose cylinder head - leaky gasket - cylinder head not pulled down evenly.

5. Valves not seating properly, due to excessive carbon deposits or sticky valve stems.

6. Worn or sticking piston rings.

7. Scored cylinders or worn pistons.

The engine will not function properly or deliver its full power if the compression is not good, and in case it is found to be at fault, the valves should be reground, pistons rings replaced, joints made tight, or spark plugs renewed as the case may require.

REMOVING CYLINDER HEAD: Drain all water from cooling system, after which remove all water and gasoline connections. The nuts holding rocker arm brackets to head should then be removed and the entire assembly lifted off. Remove the eight push rods and lay them out carefully, so they can be replaced in their original position. Unscrew the nine nuts holding cylinder head and lift head and carburetor assembly off the engine. Be sure not to injure the copper asbestos cylinder head gasket. Do not pry the head up with a screwdriver. Use a block of wood, tapping gently until the head is loosened. (See Fig. 11.)

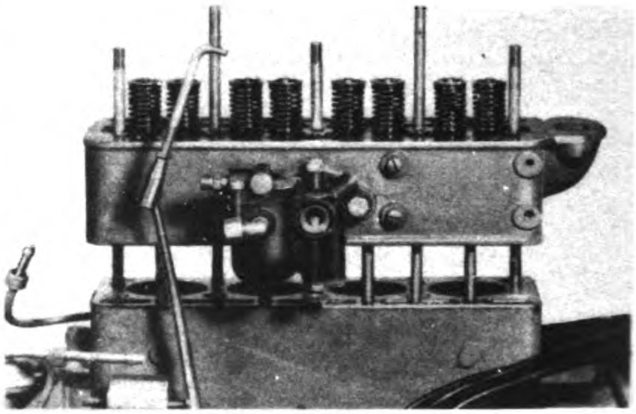


FIGURE 11

Removing Cylinder Head

GRINDING VALVES: Remove valves by depressing the valve spring and pulling keeper out of slot on the end of the valve stem. Observe the marks punched on the cylinder head and valves. Always replace the valves in their respective places.

If, after washing in gasoline, the valves or valve seats are pitted (show black specks) or are not seating properly, they should be "ground-in".

Apply the compound sparingly around the entire valve seat, put a light lifting spring over the stem, lubricate the stem and drop the valve back into its place in the cylinder head. The spring should just barely hold the valve off its seat. A two pronged tool that will fit the valves and a hand brace or a screw driver can be used to grind the valves.

Place the tool in the valve head to be ground. Press down until the valve is seated. Turn the valve a quarter turn, first in one direction, then in the other. Do this three or four times. Release the pressure on the valve and the little spring will lift it off its seat. Now turn the valve about 10 or 15 degrees to another position, and repeat the grinding. Do this until all the compound is rubbed off the valve seat. Withdraw the valve and put on some fresh compound. Repeat the grinding operations.

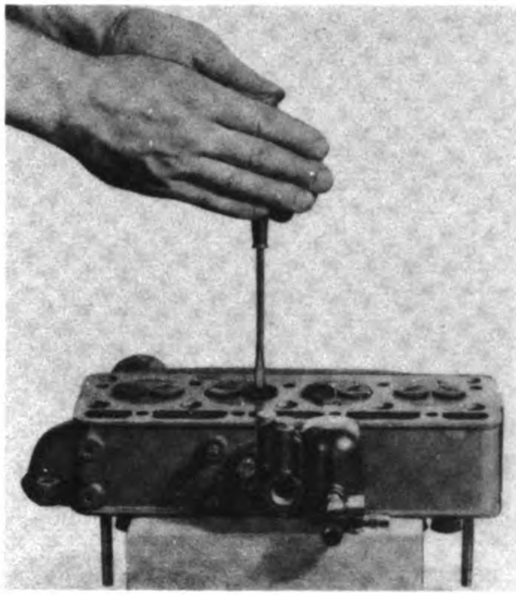


FIGURE 12

Grinding Valves

Clean the valve seat in the cylinder head and the face of the valve with gasoline occasionally to see how the grinding is progressing. To have a good seat it is necessary for both to be free of all pits and grooves and for both seat and valve to show a uniform light gray band all the way around. It is not necessary to have the valve seating across its entire width. If the band is 1/32" wide it will make a good seat. When finally replacing the valve, oil the valve stem and clean out all of the grinding compound from the valve chamber.

REPLACING THE CYLINDER HEAD: To replace the cylinder head, reverse the method given for removing. Carefully clean the joint surfaces and the gasket. Replace the push rods in their original positions, being certain they center in the sockets in tappets. When replacing the nuts holding head to cylinder, tighten down evenly, as there is a danger of wrinkling the gasket, causing a water leak. Replace all water and gasoline connections. Coat gaskets with grease, and be careful to get connections water and air tight.

It is highly important that the proper clearance of .006 to .008" be maintained between the top of valve stem and face of rocker arm. If this distance is too great, the valves will open late and close early; while if it is too small, they will not close at all, thereby causing a great loss of power.

Before proceeding to adjust the valve clearance, tighten down the cylinder head and rocker arm bolts securely. The valve adjustments should be made only when the engine is hot; if made when cold, they will not be accurate, due to the change in temperatures when the engine warms up to a running heat. A .006" gauge is furnished with all plants to be used in adjusting the valve clearance.

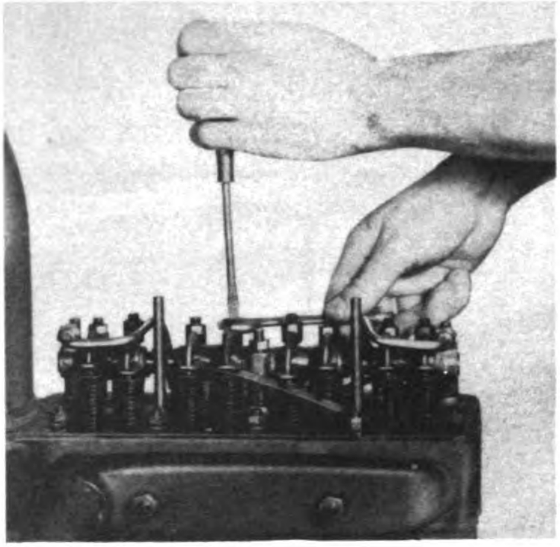


FIGURE 13

Adjusting Valve Clearance

To adjust clearance, proceed as follows: Turn the crank until the cylinder you are working on is on the firing center and both valves are completely closed. Also make sure that valves are not being held open by carbon deposits or a sticky or dirty stem. Then insert a gauge measuring .006" to .008" between the face of the rocker arm and top of the valve stem. The clearance is correct when this gauge or its equivalent can just be moved. If a gauge is not available, send for one.

In making the adjustment necessary to secure the proper clearance, first loosen the upper lock nut on the rocker arm. Then by turning the adjusting screw to the right or left, the clearance can be decreased or increased. Be sure to lock the adjustment securely with the lock nut after adjustment is made. To do this, hold the screw tight with a screw driver while the top nut is tightened. (See Fig. 13.) Valve clearance adjustment should be made while the engine is warm.

INSTALLING ENDLESS FAN BELTS: All new plants are fitted with endless type belts and if practicable to do so, we recommend that the endless belt be used. When the endless belt is to be installed, observe the following instructions: (See Fig. 14.)

1. Remove generator brushes from brush holders.
2. Remove eight cap screws from generator housing.
3. Lift off switch and generator assembly as illustrated.
4. Lower fan and remove old belt.
5. Place endless belt over armature, then on flywheel pulley.
6. Lower fan and slip belt on fan pulley.
7. Tighten fan in position with proper tension on belt.
8. Replace generator and switch assembly, being careful that the outer race of the generator bearing enters squarely into the hole in the armature support bracket.
9. Replace the eight generator cap screws but before tightening them, take a small block of wood and hammer and tap lightly against the armature support bracket above and below the generator ball bearing hole. This together with tightening the cap screws, will force the generator frame

tightly against the engine bell housing, close up the joint and align the generator ball bearing in armature support bracket.

10. Replace generator brushes.

11. After generator is completely assembled start the plant and listen closely to the generator ball bearing. If it is quiet the bearing is in alignment. If it is noisy the bearing is out of alignment. Use a block of wood and hammer and tap lightly above and below the bearing until it runs quietly. If the support bracket is driven in too far the bearing will be out of alignment the other way. The remedy is to insert a screw driver between the end of armature and pry the bracket out slightly.

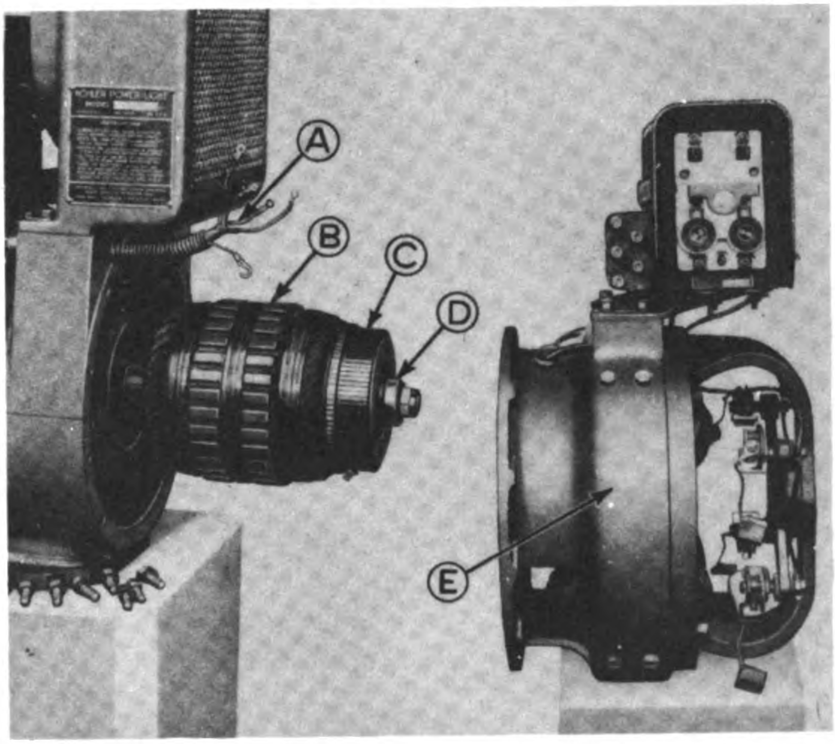


FIGURE 14

Generator and Switch Removed

A Wire Accessory
B Armature
C Commutator
D Generator Ball Bearing
E Generator

Note: - Although the appearance of your plant may differ slightly from the above the instructions can be followed.

Jointed fan belts can be supplied for replacement on plants in the field which have flat belts. It must be remembered that a jointed belt will not give the service that an endless belt will. The life of a jointed belt is approximately only half that of an endless belt. To install jointed belt, lower the fan, pass belt around pulley and join ends with fastener. Then adjust fan to secure proper belt tension. Jointed fan belts are supplied only for the convenience of those who desire them. They are not recommended for long life or continuous service.

MAJOR REPAIRS TO ENGINE

REMOVING CYLINDER BLOCK FROM OIL PAN OR SPLITTING THE PLANT

In case it becomes necessary to make adjustments to the internal parts of the engine such as the main bearings, connecting rod bearings, wrist pins, fit in new pistons or repair the oil pump, it will be necessary to take plant apart in order to obtain access to the parts requiring attention.

The generator and switch may be removed from the engine as previously described under instructions for installing the fan belt. Or, the generator can be left bolted to the upper part of the cylinder block and the engine split by observing the following instructions:

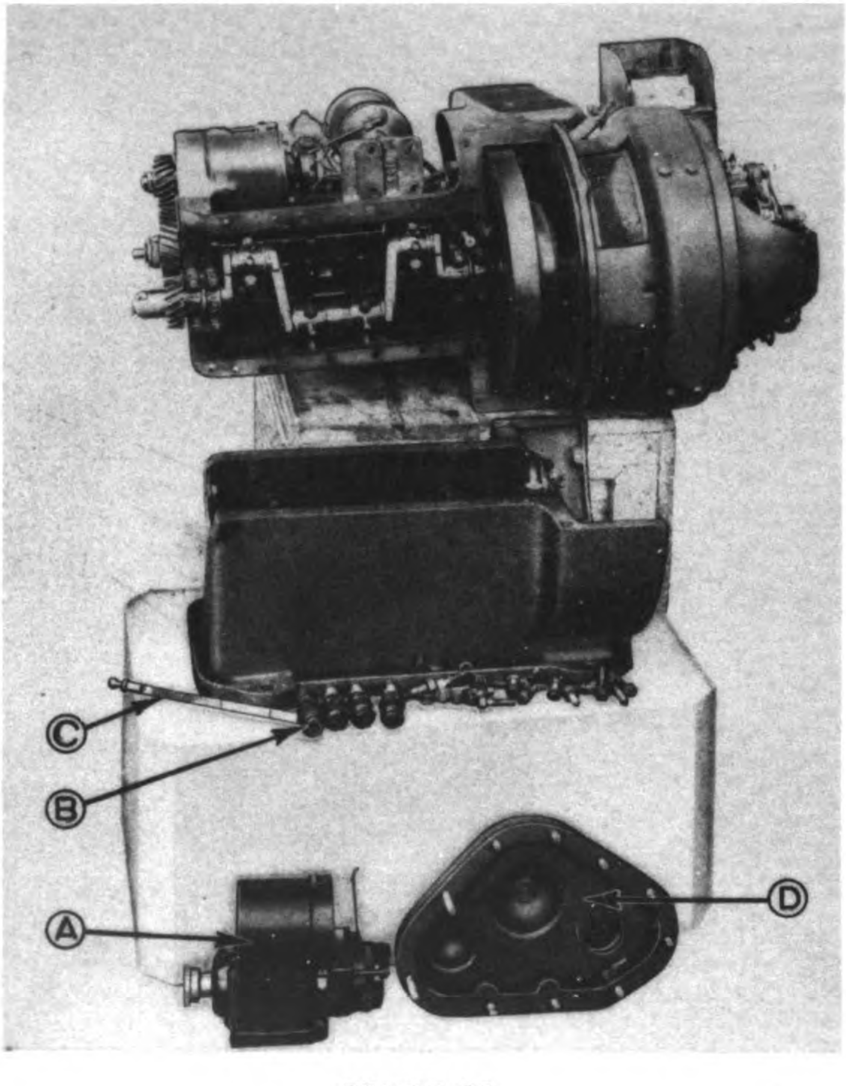


FIGURE 15

Splitting the Plant

A Magneto
B Spark Plugs
C Oil Gauge
D Gear Cover

1. Disconnect the gasoline supply and overflow lines, and wiring. Drain the oil from the crank case, the water from the cooling system, and the gasoline from the fuel pump and carburetor.

2. Remove the ten 5/16" cap screws which hold the cover in place. When the cover is removed the crank gear, cam gear, and magneto drive shaft gear are exposed. See Fig. 15.

Timing marks: All crank and camshaft gears are marked to insure correct valve timing. The system employed by the Kohler Co. is to have the gears so meshed that the single (O) mark on the crank gear will be located between the two teeth bearing the ("O") mark on the camshaft gear.

When removing gear cover careful check should be kept so that the fibre cam thrust plug is not forced out and lost.

3. Disconnect cables and remove spark plugs. Do this before splitting the plant, as it will be impossible to remove them afterward. Removing the spark plugs is very necessary to relieve the compression so the crankshaft can be turned and the pistons withdrawn from the cylinders.

4. Remove the two 3/8" cap screws from bottom of magneto bracket and remove magneto.

5. Remove the thirteen 5/16" cap screws around both sides of cylinder block, (cylinder block oil pan joint.)

6. Remove the four 3/8" cap screws from lower half of generator, (oil pan generator joints).

7. Be careful not to withdraw the camshaft when the plant is in an upright position, or the tappets will drop into the oil base and be difficult to recover.

8. Remove the oil gauge and lay to one side so as not to bend when block is lifted from oil pan.

Arrange a suitable platform about 12 inches high on the exhaust side of the plant; a strong heavy box will do. Then have someone help lift the engine from oil base and lay it on its side, the exhaust side down. Endeavor to place the engine in a position so that the crankshaft and its bearings are accessible, and that there will be room to work and good light. Tie a string or rubber band around the oil pump tappet to prevent it from falling into the case, while working on the engine. Fig. 15 clearly illustrates the various parts after the engine has been split.

CYLINDERS AND PISTONS

Disconnect the connecting rod bearings and withdraw the pistons from the cylinders. Examine the cylinder walls. If they are worn excessively or scored they will have to be reground and new pistons fitted. Clean the pistons and rings with gasoline and examine. If the rings are a good fit they will have a bright, highly polished surface all around each ring. If any ring has dark colored or rusty appearing spots or shows tool marks, it indicates that the ring does not fit the cylinder walls tightly.

An ill fitting ring may cause the engine to pump oil and if this condition is noticed new rings should be put in. The pistons should be fitted .002" smaller in diameter than the cylinder, and with rings removed should fit so they will just fall thru the cylinder of their own weight when engine is in a vertical position. A good way to test the tightness of the pistons, rings and valves is to push the piston, (with rings on) up to the top of its stroke allowing the air above the piston to escape, then with the spark plugs in place and the valves closed, pull the piston down to the bottom of its stroke. This will create a partial vacuum in cylinder and the piston will be hard to withdraw. Hold it in this position for a few seconds and release. If rings and valves are tight the difference in the atmospheric pressure on the two sides of the piston will return the piston back nearly to the top of the cylinder. If the piston does not move part way back toward the top of its stroke there is a leak past the rings, thru the valves, or spark plug hole. The sizes of cylinder bores are stamped on the bosses below the spark plug.

REGRINDING CYLINDERS

Cylinders which are badly seized or scored because of a lack of water or oil should be reground. Semi-finished pistons may be purchased from the Kohler Co. factory or branch offices for reground jobs. After the cylinders have been reground, the pistons should be ground to fit the cylinders.

FITTING PISTONS IN CYLINDER

The cylinders are numbered in consecutive order, No. 1 being next to crank end of plant, and No. 4 being next to radiator. The pistons must be replaced in the cylinders from which they were removed. The connecting rods are numbered 1, 2, 3, 4, to correspond to the cylinders to which they are fitted.

Fig. 16 illustrates the method of using a shim when fitting pistons to obtain the correct clearance of two thousandths inch. When fitting new pistons, the piston should not wedge with the shim, but a noticeable drag should be felt. Pistons can be furnished ground to various oversizes.

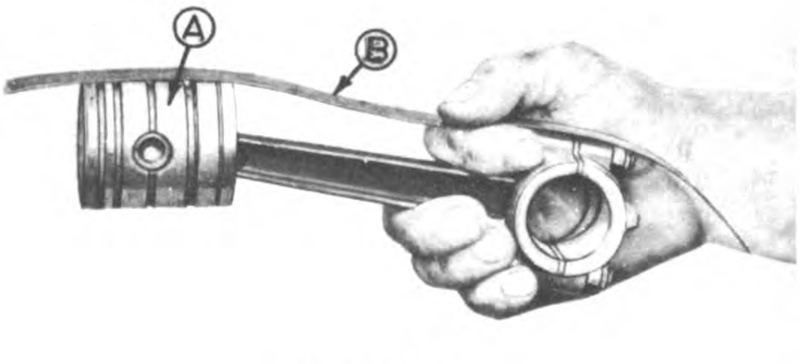


FIGURE 16

Fitting Piston with Shim

A Piston
B Shim (.002")

Semi-finished pistons are also available. These pistons are complete in every detail with the exception of the final grinding. This type of piston is most generally used when cylinder bores have been refinished oversize.

PISTON PINS

It is intended that the wrist pin shall fit more tightly in the piston than in the connecting rod bushing. If the old wrist pins are worn or loose in piston or bushing, new pins or new bushings must be put in. The wrist pin should be a tight hand press fit in the piston. This means it should fit snugly enough so that it can only be forced into the piston by the exertion of considerable strength, or with very light blows with a stick, such as a hammer handle. The wrist pin should be a snug hand press fit in the connecting rod bushing.

Piston pins used on all Kohler plants are so fitted to be full floating; the hardened ground steel pin is fitted to the bronze bushing in the upper end of connecting rod. Tension should be such, that when the pin is clamped in a vise with connecting rod attached, the weight of the rod should be sufficient to allow the rod to drop gradually. The same test is applied when fitting pin in piston as illustrated in Fig. 17.

Method employed to retain piston pin in piston is by spring steel retainers, which are locked in grooves located in the piston. See Fig. 17 (A). After pistons are assembled to connecting rods, they should be lined up with the rods, so they will be parallel with cylinder walls when connecting rod bearings are tightened.

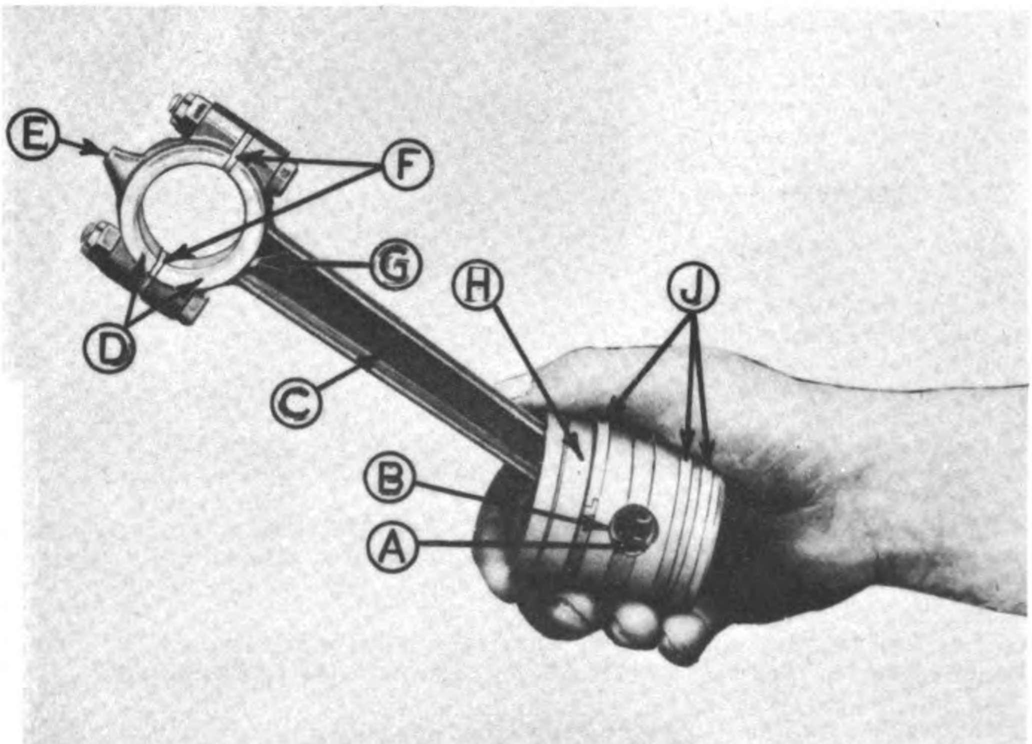


FIGURE 17

Fitting Piston Pin

A Piston Pin Retainer
B Piston Pin
C Connecting Rod
D Bearings
E Oil Dip
F Bearing Shims
G Oil Hole
H Piston
J Piston Rings

FITTING BEARINGS

When fitting new bearings or taking up worn bearing, DO NOT FIT TOO TIGHTLY. After connecting rod bolt nuts have been tightened, the tension of the bearing should be such as to allow the weight of piston and rod to carry the piston and rod downward gradually. See Fig. 18. Do not follow general automotive practice or bearings will be too tight and prevent engine from cranking.

If new main or connecting rod bearings are installed they must be first fitted to the main shaft or crank pin. Wipe the shaft and bearing clean; apply a very little Persian blue or red mixed in oil to the shaft; place the bearing half on the shaft, rock it back and forth, remove and note the impression. With a bearing scraper carefully cut down the high spots where the bearing touched the shaft. Repeat process until you have at least 80 per cent of the bearing touching the shaft.

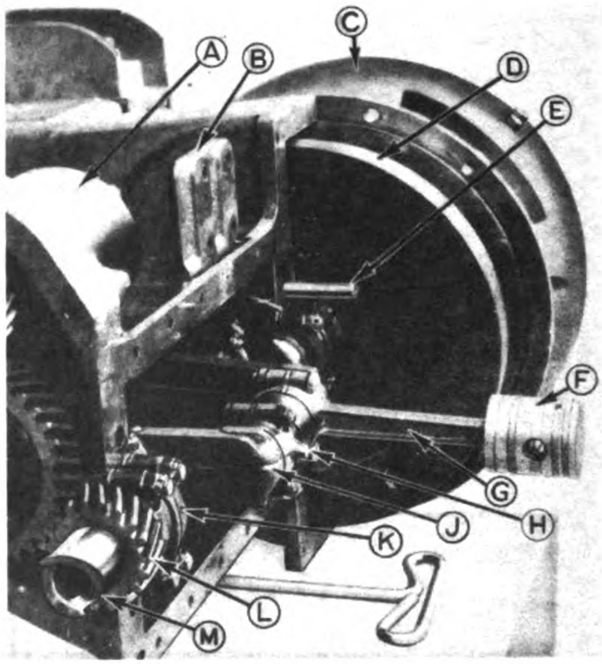


FIGURE 18

Fitting Bearings

A	Governor Housing	G	Connecting Rod
B	Magneto Bracket	H	Connecting Rod Dip
C	Generator	J	Crankshaft
D	Flywheel	K	Main Bearing (Front)
E	Oil Pump Tappet	L	Crankshaft Gear
F	Piston	M	Starting Jaw

MAIN BEARINGS

Remove the main bearing caps one at a time and examine. If cut or scored, scrape to fit if practicable, or replace with new; there should be a clearance of about .002". When adjusted properly there must be no lost motion, and the shaft will easily revolve by taking hold of the flywheel with the hand. Be sure and replace all split pins or wires in main bearing bolts after the nuts are tightened.

CONNECTING ROD BEARINGS

Each connecting rod bearing is numbered to correspond with the cylinder to which it belongs. If scored, scrape the old bearings to fit or put in new ones. When properly adjusted the bearing clearance will be about .002". To adjust, connect them up one at a time, leaving the rod outside the cylinder. Put in sufficient shims or liners, so that when the bolts are tightened the bearing will just move on the crank pin without binding. If, after tightening, the rod be placed in a horizontal position, and it drops to a nearly vertical position by its own weight, the fit will be about right. See Fig. 18. After finding the correct adjustment remove bearing from shaft, attach the piston to the connecting rod, and insert it in the cylinder. When connected you should be able to just move the bearing from side to side on shaft. The shaft should turn easily without sticking or binding in any position, yet there must be no lost motion, or the bearing will be noisy when running. Be sure and replace all wires or split pins in bearing studs after nuts are tightened.

When replacing connecting rod bearing caps they should be so placed, that the oil hole in front of oil dip will face toward the exhaust side of engine. If the caps are not replaced in this position, the bearing will not receive sufficient lubrication.

CAM & GOVERNOR SHAFT BEARINGS

If replacement of cam and governor shaft bearings is necessary, the plant should be shipped to where facilities for renewal are available.

OIL DIP OF CONNECTING ROD

The height of the oil pan is 2-11/16", measured from the level of oil base joint to drain slot ground in ends of oil pan. When the cranks are in the bottom center, the top end of the oil dip must be exactly 2-23/32" below the level of cylinder block joint. This gives a dip of 1/32 when plant is assembled. If new connecting rods are put in, the length of dip must be carefully adjusted to this length. Gauges for this purpose are available. The hole in the oil dip must be to the LEFT looking from the crank end of the plant. If it is put in improperly, the bearing will not be LUBRICATED AND WILL BURN OUT. See Fig. 19.

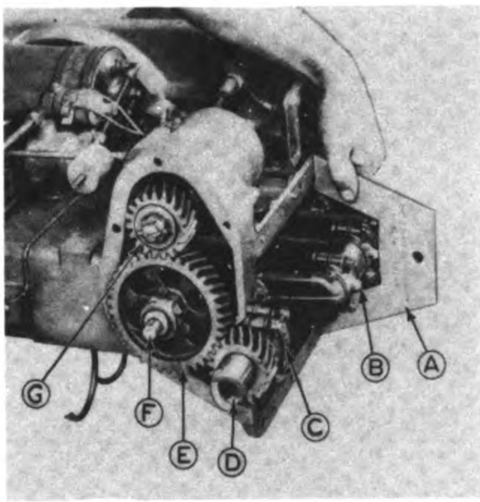


FIGURE 19

Measuring Oil Dip of Connecting Rod

A Connecting Rod Dip Gauge
B Connecting Rod Dip
C Main Bearing (Front)
D Starting Jaw
E Camshaft Gear
F Camshaft Thrust Plug
G Magneto Driveshaft Gear

Fig. 19 illustrates the method of using tool T-943 Connecting Rod Dip Gauge shown at A, for adjusting the Oil Dips to proper length of 2-23/32 inches from the Crank Case Joint.

MESHING OF GEARS

The crank and camshaft gears are marked SOS. They must be so meshed that the two O's will match together. NEVER withdraw the camshaft while the motor is assembled, or the valve tappets will drop down and the camshaft will not go back in place unless you split the plant.

TESTING OIL PUMP

While the motor is apart wash out the oil pump and oil base with kerosene. Operate the oil pump plunger by hand and see that its connections are tight. Examine all bolts and nuts to see that none are loose.

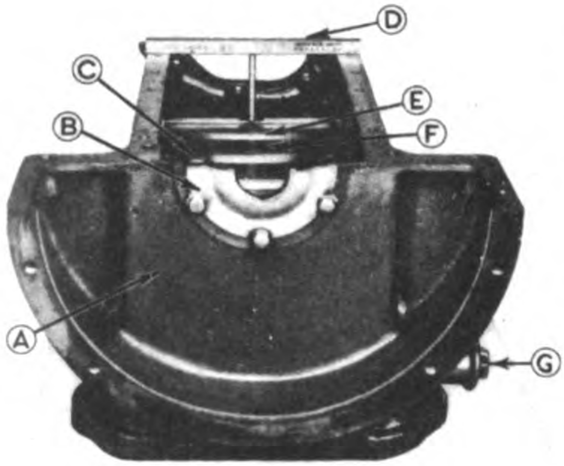


FIGURE 20

Checking Oil Level of Baffle Plate

A—Oil Base
B—Split Cover
C—Oil Pump Plunger
D—Gauge
E—Oil Grooves for Connecting Rod Dip
F—Baffle Plate
G—Oil Drain Plug

Fig. 20 illustrates the method of using tool No. SS-177 to check the height of the baffle plate, which will determine the oil level; this is very important. If the oil level is too high there will be a possibility that the engine will pump oil, due to too much oil being splashed on the cylinder walls. The exact height of the oil level in the baffle plate should be 2-11/16 inches from the top of the oil pan to the high level in baffle plate.

OIL BASE

Fig. 20 is an illustration of the oil base. Notice that the oil level in the baffle is checked with a gauge. The importance of checking this distance cannot be overestimated, because if the oil level is too high, the plant may pump oil, if it is too low, the connecting rod bearing will not receive enough oil and it may burn out. If the oil pump is removed from the base and disassembled, care should be taken to fasten all parts securely. The screen should be cleaned each time the oil is drained. It can be removed from base by removing the oil drain assembly.

REASSEMBLING PLANT

After all internal adjustments are made, clean off both joints of oil pan and cylinder block and examine the gaskets. If any gasket is damaged it must be renewed. If you have none on hand one may be cut from heavy smooth wrapping paper. Scrape the joints clean, coat the face of cylinder block joint with shellac and press the gasket firmly in place, being sure not to blind any of the holes. Pay particular attention to have a good fit at the joint between the halves of the oil retainer ring next to the flywheel. After the gasket has stuck fast apply a little oil to it, remove the string or rubber band from the oil pump tappet and the top part of the engine and set it squarely in place. Great care must be taken not to displace the gasket or an oil leak will result.

Tighten all flange bolts and replace the gear cover, being sure the spring and fibre plug in camshaft are in place.

OIL LEAKS

Should an oil leak develop in the joint between the cylinder block and the oil base, the cap screws in the joint must be tightened. If this does not stop the leak the Plant will have to be split, and a new gasket put on.

Should the leak appear to come from behind the magneto, it may come thru the cap screw holes where the magneto bracket is fastened to the oil base. If this is the case, remove the magneto from the bracket, take out the screws one at a time, apply some shellac or thick paint to the treads and replace the screws.

If the oil drips from the drain hole under the flywheel housing, there is an oil leak between the halves of the splitcover, or past the cap screws that hold the split-cover to the cylinder block or oil base. To gain access to the split-cover and cap screws, it is necessary to remove the generator cover, generator frame, generator ball bearing, armature, spacer, and flywheel. With these parts removed, operate the engine and note the location of the oil leak.

If the leak is in the joint, remove the upper half of the split-cover and put in a new paper gasket. If the leak is thru the cap screw holes remove the screws one at a time, apply shellac or thick paint to the threads, and replace. The clearance between shaft and split-cover must be .004" to .006".

Do not attempt to repair an oil leak in the split-cover by splitting the plant. For should the oil leak be in the cap screw holes of upper half of split cover, access is only obtainable by removing flywheel from shaft.

TESTING AND REPAIRING GENERATOR

GENERATOR TROUBLES

Trouble seldom occurs within the generator and it is usually indicated by low or high voltage, fluctuation of lights, failure of plant to give light, etc. Since these troubles may occur because of a failure of another part of the plant, before proceeding to work on the generator the cause of the trouble should be located. The gas engine may be tested with the brushes removed, and if it operates normally the brushes may be replaced; a change in the plant's operation will indicate the generator is at fault.

TESTING GENERATOR IN GENERAL

The following order of procedure should be used to test the generator: - Remove the generator cover and disconnect the wires from the switch; which are three in number, (1) Generator lead--negative (2) Shunt Field lead, attached to field resistance back of switch (3) Generator lead--positive.

To test the generator with the switch disconnected, connect one side of a test lamp to the positieve brush, (upper left) and the other side to the negative brush (upper right) and the shunt field lead. If light is generated with these connections when the plant is in operation, the generator is not at fault. If no light is generated, the generator is not functioning and the next step is to determine the cause of the trouble.

TESTING GENERATOR FOR GROUNDS

This type of plant is parallel wound; neither side of the circuit is grounded to the frame and it is an easy matter to ascertain if a ground exists, by alternately short circuiting between the positive brush holder and the generator frame, or between the negative brush and the generator frame while the plant is in operation. If a ground exists it will be indicated by sparking; its location can be found by testing the field coils separately, and the brush rigging.

TESTING FIELD COILS

In order to test the field coils, current from some source must be available to secure a flow thru the windings. As the plant will not be running, storage battery or dry cell current must be used. If available, a test light of proper voltage or a bell may be used as an indicator. If a test light or a bell is not at hand, connect one end of the coil to the battery terminal (use 4 to 6 volts) and note if there is a spark. When flowing current thru the coils without some resistance in the line as a test light, the contact must be only momentary on account of the danger of overheating and damaging the coil.

TESTING FIELD COILS FOR GROUNDS

Remove all wiring from switch terminals; ground one end of the test wire on generator frame; apply other end to coil terminals if current flows, one or more of the coils are grounded. To determine which, raise each of the coils separately from the frame with a screw driver after loosening cap screws. If the ground is removed when one of the coils is raised in this manner, it will be an indication that it is grounded to the frame. Place insulating paper, oiled muslin, or mica between the coil and frame, and after tightening cap screws test again. If it is impossible to correct the ground by this method, it will be necessary to remove the generator from the machine, disconnect the coils from each other, and try each coil separately.

REMOVING GENERATOR

Follow the procedure on installing fan belt Figure 14 for removing the generator.

HOW TO REPAIR GROUNDED FIELD COILS

Grounded field coils which cannot be repaired without being removed should be repaired by dissembling the generator and removing the grounded coil. Examination will usually show where the insulation is cut or worn thru. After testing the coil and finding the ground, insulate the bare spot and put the coil back in service.

TESTING BRUSH RIGGING FOR GROUNDS

To test the brush rigging for grounds, disconnect all wires from the brush terminals and remove the brushes from the commutator. The brush must not touch the rigging or armature support bracket while making the test. With one end of the test wire grounded to the generator, connect the other end to the brush holder; if the circuit is completed the brush holder is grounded. Test each brush holder in this manner.

TO REPAIR GROUNDED BRUSH HOLDER

To repair a brush holder that is grounded, it is necessary to remove it from the rigging and install a new fibre bushing and fibre washers.

TESTING FIELD COILS FOR OPEN CIRCUIT

Remove all wiring from the switch terminals. Attach test wire to terminal on coil 767, apply other end of test wire to terminal on coil 764. If current flows, the circuit is complete. If current does not flow there is an open circuit in one or more of the coils, to determine which, unsolder the pig tails and test out the winding of each separately. An open circuit is something that rarely occurs within the coil itself, unless the coil has been burned out as a result of a bad ground or a short circuit. They are more likely to occur where the pig tails are soldered together.

HOW TO REPAIR OPEN CIRCUIT IN FIELD COILS

If the open circuit is in the pig tail connections it can easily be repaired by resoldering the taping, but if the wire is broken inside the coil, the insulation will have to be removed, the coil opened up and the ends of the wires joined. In such cases it is better to put in a new coil, as it would be a difficult job to open up and rewind a coil in the field.

SHORT CIRCUIT IN COILS

A short circuit between the windings of the field coils will be indicated by overheating of the coil, and low voltage when the machine is operating at a normal R.P.M. If the place where the wires are fused together is near the surface, the insulation may be removed, the wires separated and insulated from each other. A repair of this kind is difficult in the field and should only be attempted when new coils are not available.

GENERATOR FRAME ASSEMBLY

The mechanical construction of the generators used on Kohler 4-cylinder plants is such that all parts are interchangeable and can be replaced without any special fitting. This includes the generator frame, pole pieces, armature support bracket, brush holders, and brush holder rigging.

Re-assembly: After field coils have been replaced, assemble brush holder rigging to armature support bracket, with the filister head screw on the right side, head up.

REPLACING ARMATURE SUPPORT BRACKET

Armature support bracket is held in place by four 3/8 inch cap screws.

Wire connections: Single lead from coil 767 (upper left) is attached to the upper left and the lower right brush holders. Armature lead wire (return) or the wire on the right hand side of generator, is fastened to the two negative brushes (upper right and lower left.)

BRUSHES AND THEIR ADJUSTMENT

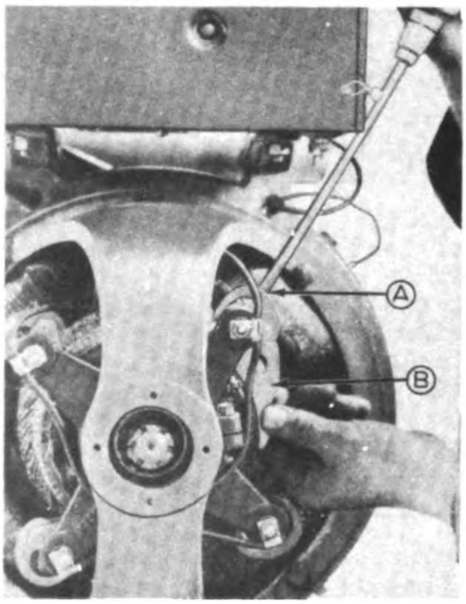


FIGURE 21
A-SCREWDRIVER
B-GAUGE

The brushes must fit their holders so they are free to move without sticking or binding, yet not so loose that they will chatter or get out of alignment.

The end of the brush must be sand papered till it fits the radius of the commutator on which it rests. After a period of use a gummy substance will collect on the brushes; this comes from the wearing of the brushes, also from dirt and dust drawn into the generator. The brushes may be withdrawn from their holders and cleaned with gasoline or alcohol.

The spring tension should be sufficient to press each brush against the commutator with a uniform tension. It is very important that each brush have an equal pressure. If one of the springs is too weak, the opposite brush will have to take more than its share of the load and sparking and damage to the commutator will result. The tension should not be too strong or it will cause rapid wear on both the brush and the commutator.

Brushes should be adjusted with tool No. SS-143, to insure proper angle with commutator.

ADJUSTMENT OF BRUSH RIGGING AND SPACING OF BRUSHES

The brush rigging is adjustable. Its position may be changed by loosening the holding screw, advancing or retarding the brushes to secure the most favorable cranking torque and generating effect. The position of the brush rigging is accurately located at the factory and marked, and should not be altered from this position. It is important that the brush holders be securely fastened in a position at which the brushes will be equally spaced around the circumference of the commutator surface. A discoloration of every third bar is an indication that the brushes are not equally spaced. A strip of paper, the exact length of the commutator circumference, divided into four equal parts, may be placed on the commutator for ascertaining if the brushes are equi-distantly spaced from each other.

The setting of the brush rigging should be such that the distance between the edge of the armature support bracket, to center of upper right hand brush holding screw, is never greater than 3/4 to one inch.

SPARKING AT BRUSHES

In case sparking occurs at the brushes, the cause may be determined by the nature of the spark.

A red spark is caused by dirty brushes or dirty commutator.

A blue spark indicates improper brush contact which may be due to insufficient spring tension, or a rough commutator surface. The latter may be caused by high mica, or low or high bars.

A green spark indicates a loose armature lead which will soon discolor the bar. As soon as this condition is noted the lead should be resoldered or the wings peened shut.

Rim fire is a continuous ring of fire that follows around the commutator, and it is caused by oil soaked mica which is allowing the bars to short circuit through the insulation.

If mica becomes oil soaked and it cannot be dried out, it will be necessary to send the armature to the factory.

In all cases where sparking at the brushes occurs, a remedy must be applied to correct the trouble or in time the commutator will be injured.

COMMUTATOR

While the commutator is part of the armature, it is necessary to consider it separately, for it is here that the current generated by the dynamo is collected by the brushes and forced out on the main line to be utilized for light or power. If, for any cause, the operating conditions are not correct the symptoms will be indicated at the commutator by the sparking at the brushes. (See "Sparking at Brushes" page 37.)

HIGH MICA

Mica is used for insulation between the commutator bars. When the armature is constructed the mica is cut away to a depth of about 1/32 inch below the surface of the bars. In time the surface of the bars will wear down to the level of the mica. As the mica is harder substance than copper, it forms ridges which cause the brushes to jump and prevents them from making good contact with the commutator. If the mica is even with or projects above the bars, it should be cut away to a depth of 1/32 inch. A hack saw blade is a good tool for this purpose.

CARE OF THE COMMUTATOR

The commutator and brushes are the only parts of the generator which are subject to wear, and they must be given the necessary attention to maintain them in their highest state of efficiency. Under proper conditions of cleanliness and adjustment, the commutator takes on a mahogany colored finish which is highly desirable for satisfactory operation.

As the generator is cooled by means of currents of air through the holes in the generator cover, it is very necessary that the plant be protected from flying dirt or dust which would be drawn into the machine, collect on the commutator and brushes and cause them to wear rapidly. Dirt, oil, and water are very injurious to any kind of electrical machinery.

The only care that the commutator should have is to keep it clean. Do not put oil or other lubricant on it. Wipe it off with a clean cloth occasionally. If the commutator gets gummy or sticky it may be cleaned with a cloth dipped in gasoline or alcohol. Do not operate after cleaning with gasoline or alcohol till dry, as a spark may ignite the volatile gases. Should the surface of the commutator bars become rough, or worn unevenly, it will cause the brushes to jump and the lights to flicker. If the condition is not too serious, it may be sandpapered until smooth; or it may be necessary to remove the armature, true it up in a lathe, and undercut the mica.

TESTING ARMATURE

If the field coils are not at fault, and the plant fails to generate, the armature should be tested.

A simple test to determine whether the armature is the cause of a plant failing to generate when the gasoline engine is functioning, is as follows:

Remove the brushes. Take a piece of flexible insulated wire (#8 drop cord or heavier) about 24" long, and while engine is in operation, touch the bare ends of this wire on the commutator. The spacing of the wire should be 90 deg. or 1/4 distance on face of commutator as indicated in the picture. If an arc is produced it can be taken for granted that the armature is not at fault. See Fig. 22.

If the test shows the armature to be at fault it should be removed, tested, and repaired as instructed on the following pages.

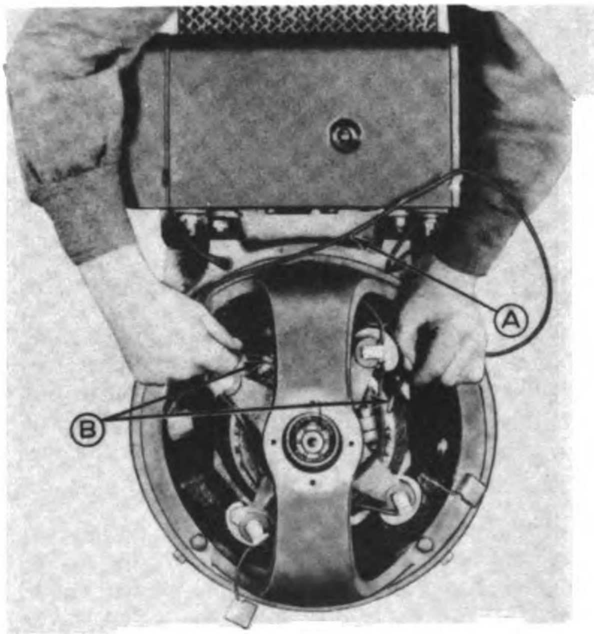


FIGURE 22

Testing the Armature

A Insulated Wire
B Bare Ends of Wire on Commutator

REMOVING THE ARMATURE

Remove the cotter pin. Hold armature from turning with brake holder tool. Use socket wrench, to remove armature nut. DO NOT USE an open end or monkey wrench as this may spring the crankshaft and throw it out of line.

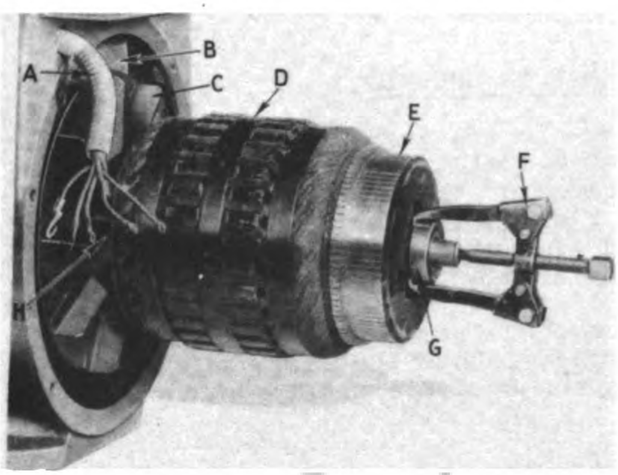


FIGURE 23

Removing Generator Ball Bearing

A Wire Accessory
B Fan Belt
C Generator Fan
D Armature
E Commutator
F Bearing Puller
G Generator Ball Bearing
H Armature Spacer

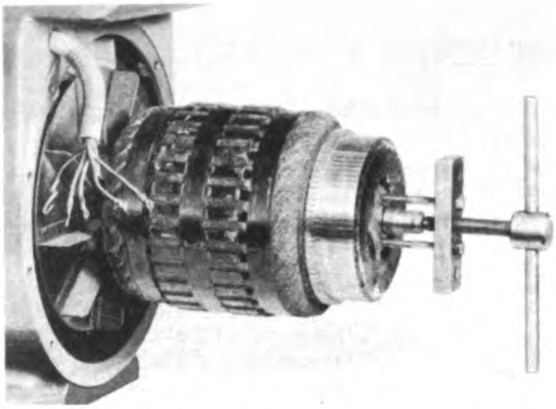


FIGURE 24 REMOVING ARMATURE

Note the special tool which is used. This can be furnished. If required, write for quotations.

REMOVING GENERATOR BALL BEARING FIGURE 23

Fig. 23 shows the method of removing the generator ball bearing with a bearing puller. After the bearing is removed it should be carefully washed and examined, if worn excessively it must be replaced. A worn race, cracked or nicked ball will cause the bearing to be noisy. Grease the bearing well with CG. before replacing. Grease bearing every 512 hours.

REMOVING THE ARMATURE FIGURE 24

The end of the armature is drilled and taped for two 5/16 x 18" cap screws; fasten the two long 5/16" cap screws through the armature puller. Turning in main drive screw will cause armature to be drawn from the shaft.

TESTING THE ARMATURE FOR GROUNDS

Grounds in the armature are generally at the top of the coils next to the core, or between the commutator and core. If a Centry Bar Tester, or similar instrument, which will locate the exact coil, is not available, the armature may be tested by the following method:-Use a test cord with a lamp, bell, or buzzer in series and connect from battery terminals so as to obtain from 4 to 6 volts. Hold one end of the test wire on the armature core and the other end on the commutator. If the armature is grounded the circuit will be closed. To locate the ground, remove one top lead from the copper segments, turn the armature half way around, and remove a top lead directly across from the one which has been removed; with the test cord test each half of the armature for the ground. If both halves of the commutator are still grounded, the ground may be between the copper bars and the lock ring. If only one half of the commutator is grounded, keep dividing the grounds until the grounded coil is found.

REPAIRING ARMATURE GROUNDS

If the ground is due to a break in the insulation, pry the coil away from the discs by means of a small thin gauged chisel, inserted between the old insulation and the disc. Remove the chisel and place a piece of mica or fish paper in the opening and test the coil again. If the ground is removed, insulate the repaired spot with air drying varnish or shellac.

The coil leads can easily be removed from the copper segments by using a blunt chisel or punch the width of the slot, and a hammer. Do not use a sharp chisel or punch to drive the leads out.

Grounds under the commutator bars and the core next to the lock ring usually cause burnt spots on the ends of the copper bars. They are due to moisture, minerals in the mica rings, and mineral particles which may have been in the air. They are easily repaired by removing the eight screws at the end of the armature and taking off the commutator lock ring.

After the lock ring has been removed, examine the mica rings. If a burnt spot is noticeable, it should be scraped off with a knife and replaced with a new piece of mica. If the ground is over the entire front of the armature, an entirely new mica ring should be installed. Replace the lock ring and tighten the screws securely. It may be advisable to have the commutator trued up after the lock ring has been replaced.

TESTING THE ARMATURE FOR SHORT CIRCUITS

The armature may become short circuited if it is water or oil soaked, damaged by rough handling, if there is broken insulation between coils, foreign substance between commutator bars, or if wings of commutator bars are crushed. A short circuit will tend to burn through and will be discovered by blackened commutator bars, or burnt insulation.

REPAIRING SHORT CIRCUITS IN ARMATURE

Coils which have burned through must be replaced, the burnt insulation removed and replaced with new. Armatures which are oil or water soaked must be dried out or replaced.

REPAIRING OPEN CIRCUIT IN ARMATURE

Remove a sufficient amount of insulation and wire to make a good soldering connection. Solder securely and test armature after it has been repaired.

REMOVING AND REPLACING FLYWHEEL, SPLIT COVERS, AND GENERATOR

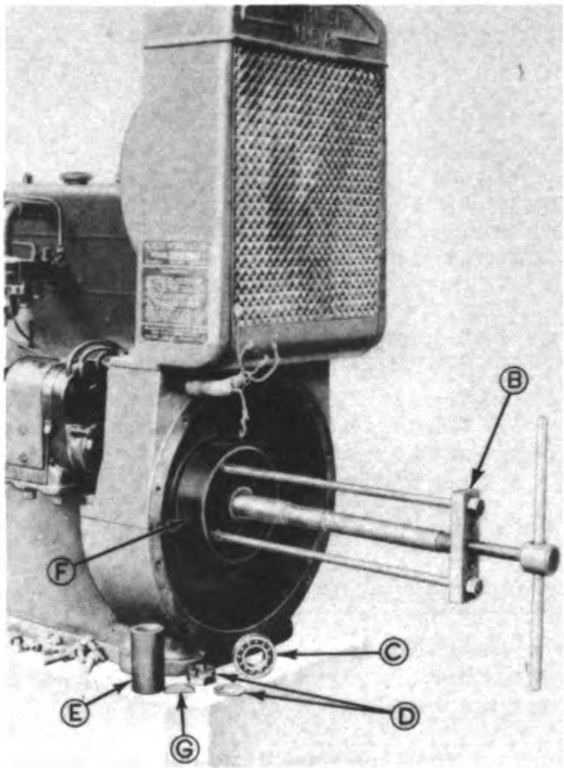


FIGURE 25

REMOVING THE FLYWHEEL

B Flywheel Puller
C Generator Ball Bearing
D Washer and Nut
E Armature Spacer
F Flywheel
G Woodruff Key

REMOVING FLYWHEEL

After the armature has been removed as shown in Fig. 24 the flywheel may be removed as illustrated in Fig. 25.

Before removing the flywheel, it is necessary to remove the woodruff key from the crankshaft, the armature spacer, and the fan belt. When removing the woodruff key, do not burr or cut the groove in which it fits. If the edges are burred, the burrs must be removed from both the grooves and the key before the key is replaced. The fan belt may be removed by loosening the fan holding nut and permitting the fan to drop lower in the radiator housing. This will decrease the tension on the belt to such an extent that the belt can be lifted over the fan blades and removed from the plant.

The flywheel has two holes drilled and tapped for the special long bolts furnished with the puller, tool No. SS-170. These holes should be cleaned of all foreign particles before the bolts are turned in. Turn the bolts in as far as possible, because if they are held with only one or two threads, they may break loose before the flywheel is moved.

Note the armature spacer, generator ball bearing, armature nut and washer lying on the block at the engine base. Fig. 25.

SPLIT COVERS (OIL RETAINERS)

After the flywheel has been removed the split covers will be exposed as illustrated in Fig. 26.

The split covers or oil retainers, are die cast metal so designed and fitted as to prevent oil from leaving the oil base. They are held in place by six 1/4" cap screws and copper asbestos packing washers. Packing washers are used to prevent oil from leaking out the threads of the cap screws. The split joint, (D Fig. 26) is kept oil proof by gaskets. The clearance between the crankshaft and the oil retainers, ("A" Fig. 26) should be between four and six thousandths inches. If these covers are not fitted correctly there will be an oil leak at this point, and oil will run from the base, at the flywheel housing.

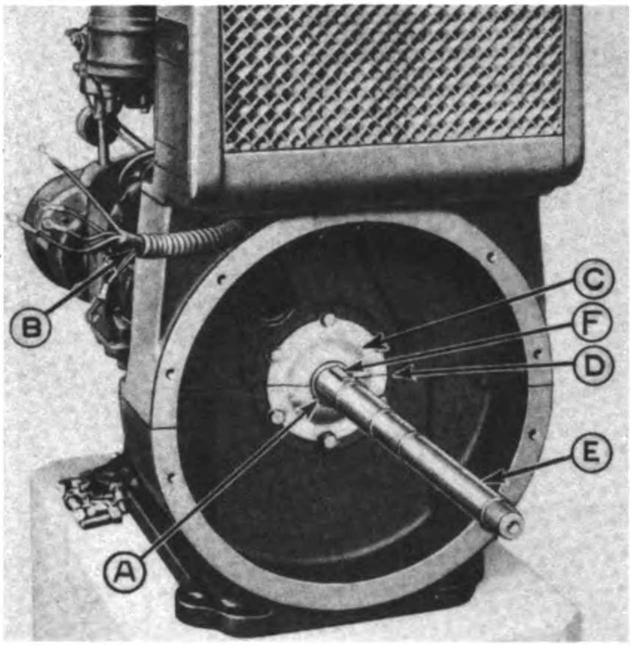


FIGURE 26

SPLIT COVERS (FLYWHEEL REMOVED)

A Opening between Split Cover and Crankshaft
B Wire Accessory
C Split Cover
D Joint between Upper & Lower Split Cover
E Crankshaft
F Woodruff Key

The covers are fitted in pairs, the lower half having an oil return notch or drain. To test for oil leak at this point, remove the generator, armature, and flywheel and operate the gasoline engine.

When starting with hand crank be careful when cranking. Regulate the engine speed by hand to about 1000 R.P.M. If there is an oil leak at split cover joint, or at cap screws, it will soon be noticeable and the gasket can be renewed or covers adjusted to overcome it.

REPLACING THE FLYWHEEL

When replacing the flywheel on crankshaft, be careful to have flywheel keyway line up true with key in shaft. Tool No. SS-131 steel tubing and armature driver, tool No. SS-207 should be used to drive flywheel in position.

After flywheel has been replaced, replace the fan belt.

REPLACING THE ARMATURE FIG. 27

After flywheel and fan belts are in place, replace armature spacer, and insert armature key; next placing driving screw of armature driver on end of shaft. The armature can now be slipped on shaft. Carefully check that key way in armature lines up with key in shaft, armature can then be forced in place with armature driver. Use brake (leather belt on bar) for holding armature and prevent it from turning. Be sure armature is forced on shaft until it is tight against armature spacer. If this is not done the brushes will not ride in their proper path on the commutator.

After armature has been driven in place, replace generator ball bearing and fasten with washer and nut. Use special armature nut socket wrench for tightening nut. Lock nut with cotter pin.

Face of commutator must run true. Factory limit on this variance is .007 inch.

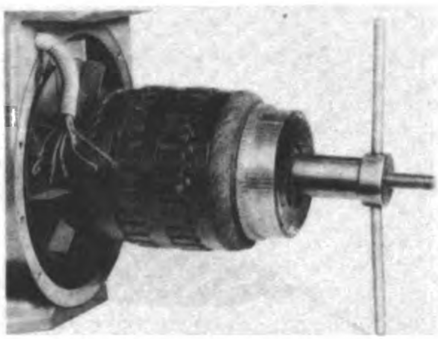


FIGURE 27
REPLACING ARMATURE

REPLACING GENERATOR FRAME ASSEMBLY

After armature has been securely fastened and checked for trueness, the generator frame can be replaced.

When mounting generator frame all the generator brushes must be removed from brush holders. Particular attention should be paid that commutator is not damaged when replacing generator frame.

Generator ball bearing must be entered true, generator frame should just fit, and it should not be necessary to draw or force generator frame into position. When generator frame is seated fasten in place with eight 3/8" cap screws. Always replace generator screens (held in place by the lower cap screws on each side). Brush holders and brushes should be checked for alignment and setting.

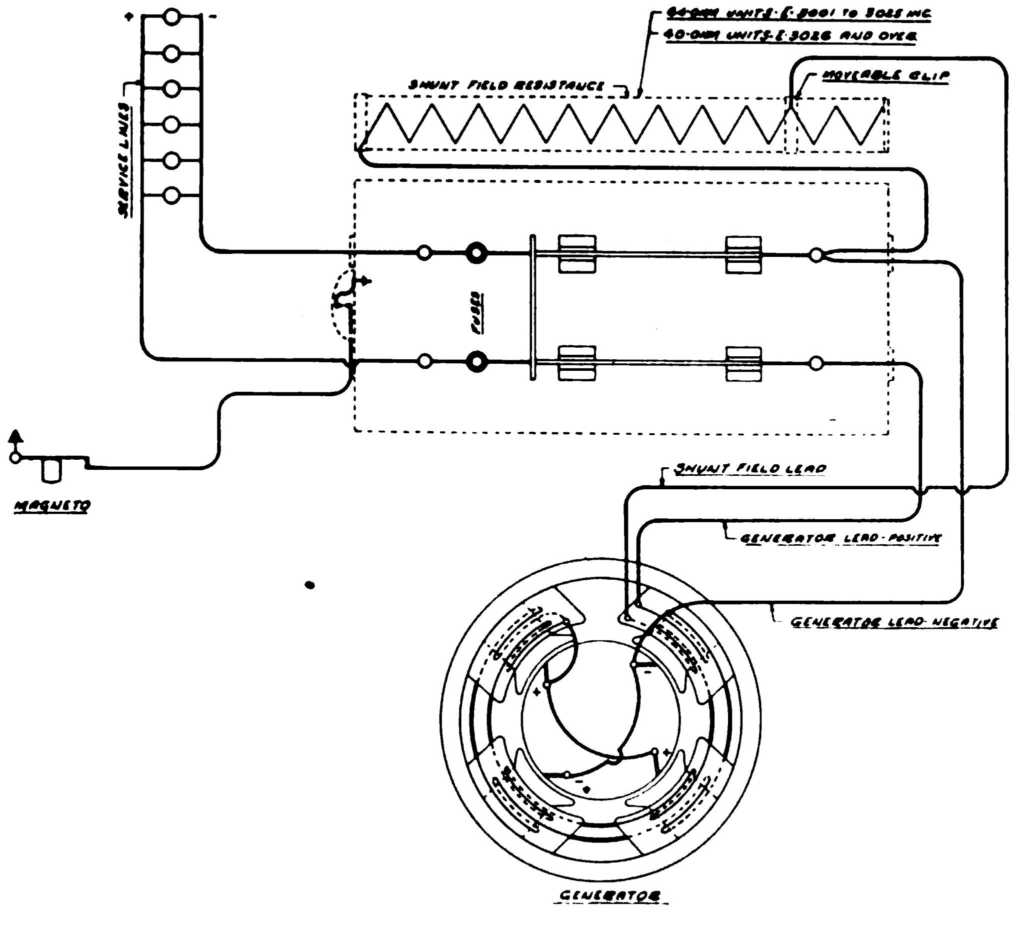


FIGURE 28

WIRING DIAGRAM MANUAL PLANTS

DIAGNOSES OF TROUBLES AND THEIR REMEDIES

Kohler Electric Plants are correctly designed and constructed of the best material by skilled mechanics under the supervision of engineers who have had years of experience in the construction of gasoline engines and electrical equipment. Each plant is thoroughly tested before shipment is made from factory.

If installed under proper operating conditions and given the care which all machinery of this kind must have, they will give long, dependable, and economical service.

If, however, the plant is not properly installed under conditions that are reasonably favorable for its operation, or does not receive proper care, satisfactory results cannot be expected and sooner or later trouble will be experienced.

If conditions are not right and the plant is not functioning properly, certain symptoms will appear. In the following pages are given various symptoms and the causes that are responsible for them and the remedy to apply.

Do not proceed blindly. If the plant does not operate as it should, note carefully how it acts. Turn to the symptom exhibited, find the cause and apply the correct remedy. Remember that cold weather, dirt in the supply line strainers or carburetor jets, water in the gasoline, fouled spark plugs or choked exhaust pipe or muffler, are responsible for most of the difficulties experienced with gasoline engines. Do not take the machine apart until you have located the trouble.

Remember that a low or inferior grade of gasoline will not permit the plant to start promptly during cold weather.

I. ENGINE FAILS TO CRANK

Engine does not turn freely, due to: (1) pistons corroded and seized; (2) water in cylinder; (3) crankshaft out of alignment; (4) foreign matter between armature and generator; (5) tight bearings; (6) congealed lubricating oil.

II. ENGINE FAILS TO START FIRING

1. Lack of fuel. Failure of plant to receive a supply of fuel may result from the following causes: (1) cold weather, particularly if low test gasoline is used; (2) water in gasoline; (3) no gasoline in the supply tank; (4) leaky or punctured supply tank; (5) clogged supply line, due to dirty strainers in the supply tank or carburetor; (6) air leaks in supply line connections. If main fuel tank is not properly vented, fuel will not be drawn freely.

2. Clogged carburetor. (1) sticking of needle valve in the carburetor; (2) excessive choking, due to sticking, rusted or bent valve or stem; (3) clogged main or compensating jet, due to foreign substances in fuel. Avoid use of varnish or paint cans as fuel containers.

3. Fuel pump at fault.

4. Defective magneto due to: (1) over-oiling, which causes dirty distributor brushes; (2) dirty rotating disc; (3) dirty collector ring; (4) worn or improperly adjusted breaker points; (5) loose or defective cables; (6) short circuit between brushes, caused by crack in distributor plate; (7) burnt out armature or condenser.

5. Defective, cracked or fouled spark plugs. Points not adjusted to 1/32" gap.

6. Excessive choking due to: (1) bent or unadjusted choker valve stem; (2) body of choker out of alignment; (3) screw in hot air manifold not removed in hot weather; (4) choker manifold out of alignment.

7. Improper timing. Instructions for timing are given on page 12. Check engine in accordance with directions given.

8. Improper valve adjustment due to: (1) worn or bent push rods; (2) worn or broken rocker arm adjusting screws: (3) broken rocker arm support bracket; (4) sticky rocker arms; (5) loose cylinder head. Check valve clearance in accordance with instructions given on page 24.

9. Engine too cold, combined with use of low grade of fuel.

10. Water in cylinders, due to: (1) leaky cylinder head gasket; (2) cracked cylinder block or head; (3) condensation from a long exhaust not fitted with a water drain.

III. ENGINE STARTS BUT MISFIRES

Caused by the following: (1) dirty, defective, or unadjusted spark plugs; (2) defective or crossed magneto cables (firing order is 1-3-4-2); (3) defective magneto: (4) improper timing (check timing in accordance with instructions); (5) poor compression, caused by scored cylinders, leaky valves, worn or defective piston rings, leaky spark plug gaskets, defective cylinder head. (6) tappets out of adjustment, giving too much or too little clearance for the valves; (7) weak or broken valve springs; (8) bent, worn, or sticking valve stems: (9) air leak between intake manifold and carburetor; (10) water in gasoline; (11) excessive lubrication; (12) mixture too lean (main compensating jet or spray nozzle should be set in center of venturi tube;)(13) choker valve caught up, causing too rich mixture; (14) water in cylinder.

IV. ENGINE BACKFIRES THROUGH CARBURETOR

The following are some causes for backfiring; (1) cold motor; (2) mixture too lean, due to clogging or improper setting of main compensating jet; (3) poor grade of gasoline; (4) air leak between the carburetor and cylinder head; (5) dirty gasoline; (6) leaky or improperly adjusted intake valves, due to bent or worn push rods, broken rocker arm adjusting screws, bent or defective valve stems, excessive carbon deposit on valve seat or stem; (7) improper timing (See article on timing); (8) water in gasoline; (9) choker not functioning properly; (10) obstruction in exhaust line due to collection of carbon or foreign matter, frozen or condensed water, or exhausting of gas into closed area; (11) spray nozzle not in center of venturi tube or carburetor; (12) air leak from push rod clearance passage into intake manifold, due to crack or sand hole in casting.

V. ENGINE KICKS BACK WHEN BEING CRANKED

This condition may be caused by the following: (1) magneto advanced too far; (2) improper meshing of crankshaft gears and marking within the letters "O" and "S", which should coincide with the crank and cam gears; (3) water in cylinder.

VI. ENGINE KNOCKS

Knocking in engine may be due to the following causes: (1) excessive carbon in cylinders from using poor grade of fuel, obstruction in exhaust line, leaky piston rings or defective spark plugs; (2) magneto inqorrectly timed; (3) connecting rod or main bearing burned out; (4) loose piston pin or bushing; (5) loose piston; (6) loose generator ball bearings, due to lack of lubrication, wear or improper alignment; (7) loose gears on crankshaft, camshaft or magneto drive shaft; (8) loose magneto coupling, (9) heavy overload; (10) weak spring in oil pump; (11) weak valve springs.

VII. ENGINE LACKS POWER

The following may cause this condition: (1) mixture too rich, due to obstructions of needle valve, leaky float or bent or worn needle valve or axle; (2) mixture too lean, due to partial obstruction in gas supply; (3) low grade or dirty fuel; (4) cold motor; (5) poor compression; (6) excessive carbon; (7) improper valve adjustment; (8) choked exhaust pipe or muffler; (9) defective or broken spark plugs; (10) defective magneto; (11) weak or broken valve springs; (12) bent or sticking valve stem or rocker arm; (13) lack of lubrication because of no oil, oil lines clogged or pump not operating; (14) tight bearings; (15) carburetor lever adjusted so as to run plant slowly.

VIII. GOVERNOR SURGES

This may be due to the following causes; (1) partial obstruction in the gas supply; (2) cold motor; (3) leak between carburetor and cylinder head; (4) governor mechanism sticking or out of line.

IX. UNIT RUNS BUT FAILS TO GENERATE

Test for the following: (1) poor brush contacts on the commutator, due to dirty commutator, sticking or worn brushes or high mica between bars; (2) open circuit in the internal wiring system; (3) open circuit in field coils.

X. LIGHTS FLICKER AT NORMAL SPEED

The following are causes for this condition: (1) dirty or rough commutator; (2) sticking or tight brushes; (3) high mica; (4) faulty ignition due to defective spark plugs or defective magneto; (5) high or low commutator bars; (6) clogged muffler; (7) valves out of adjustment; (8) not enough ventilation; (9) irregular load.

XI. LOW VOLTAGE

(1) Cold motor; (2) speed too low, due to carburetor operating lever not being adjusted properly; (3) excessive back pressure in exhaust line, due to muffler being clogged with carbon; (4) binding or sticking condition in governor mechanism preventing throttle valve from moving freely; (5) overload, short circuit or ground.

XII. ENGINE RUNS TOO FAST

(1) A sticky or binding condition of throttle valve mechanism preventing the governor from giving accurate control; (2) carburetor throttle lever not adjusted properly.

XIII. ENGINE OVERHEATS

This may be caused by the following: (1) lack of water in radiator; (2) poor circulation in radiator due to deposit of mineral scale (this scale may be removed from radiator by use of a solution of sal soda and water and flushing); (3) fan belt slipping or fan blades bent; (4) excessive carbon, causing pre-ignition; (5) improper timing; (6) lack of lubrication.

XIV. PISTONS PUMPING OIL

This may be due to: (1) leaky valves; (2) oil level too high; (3) piston rings sticky, broken or ineffective, due to loss of tension; (4) cylinder walls scored or worn; (5) rings fit too loosely in pistons; (6) oil dip of connecting rods too great; (7) poor quality of oil or dilution of oil by fuel; (8) defective ignition, either spark plug or magneto; (9) oil soaked magneto cables causing defective insulation and ignition leaks; (10) air or oil leak from push rod clearance passage into intake manifold; (11) oil leak around intake valve guides.

XV. ENGINE RUNS TOO SLOW

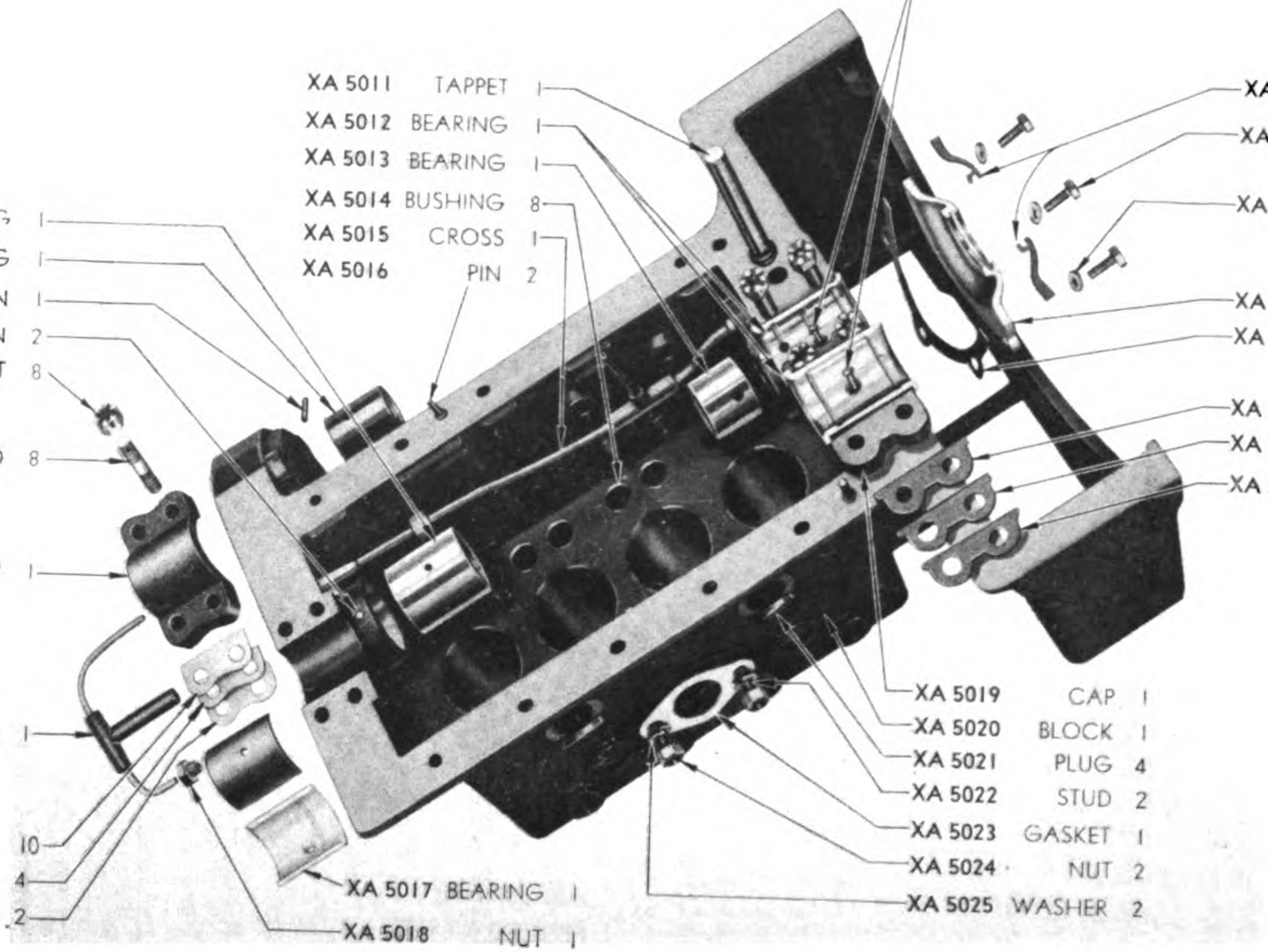
This condition may be due to: (1) misadjustment of throttle arm to carburetor feeding insufficient gas; (2) poor compression; (3) retarded spark; (4) defective ignition; (5) obstruction in gas supply.

XVI. LACK OF FUEL

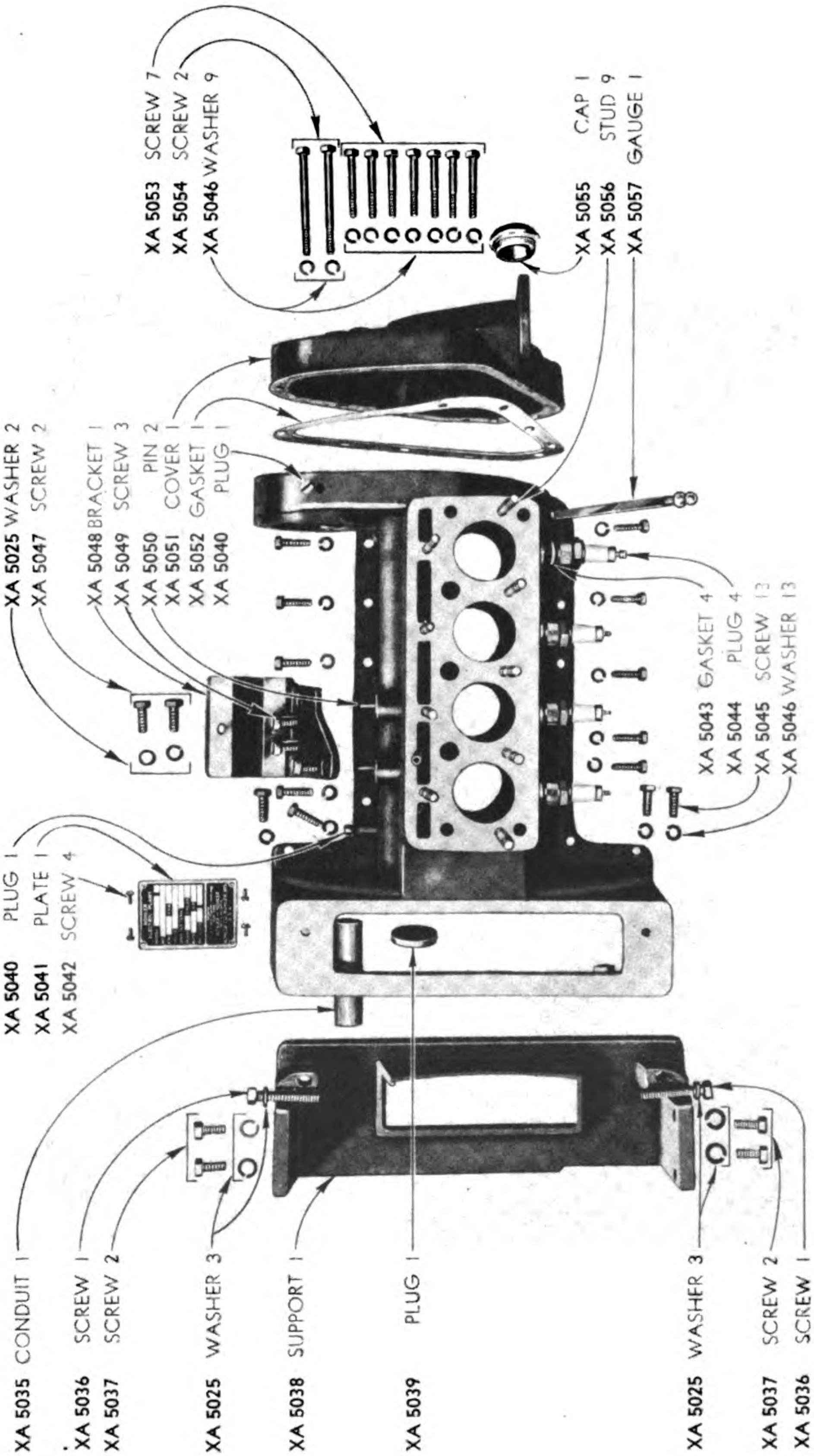
This may be due to: (1) storage tank empty; (2) air leak in supply pipe or connection; (3) too great a gasoline lift; (4) fuel pump defective.

NOTES

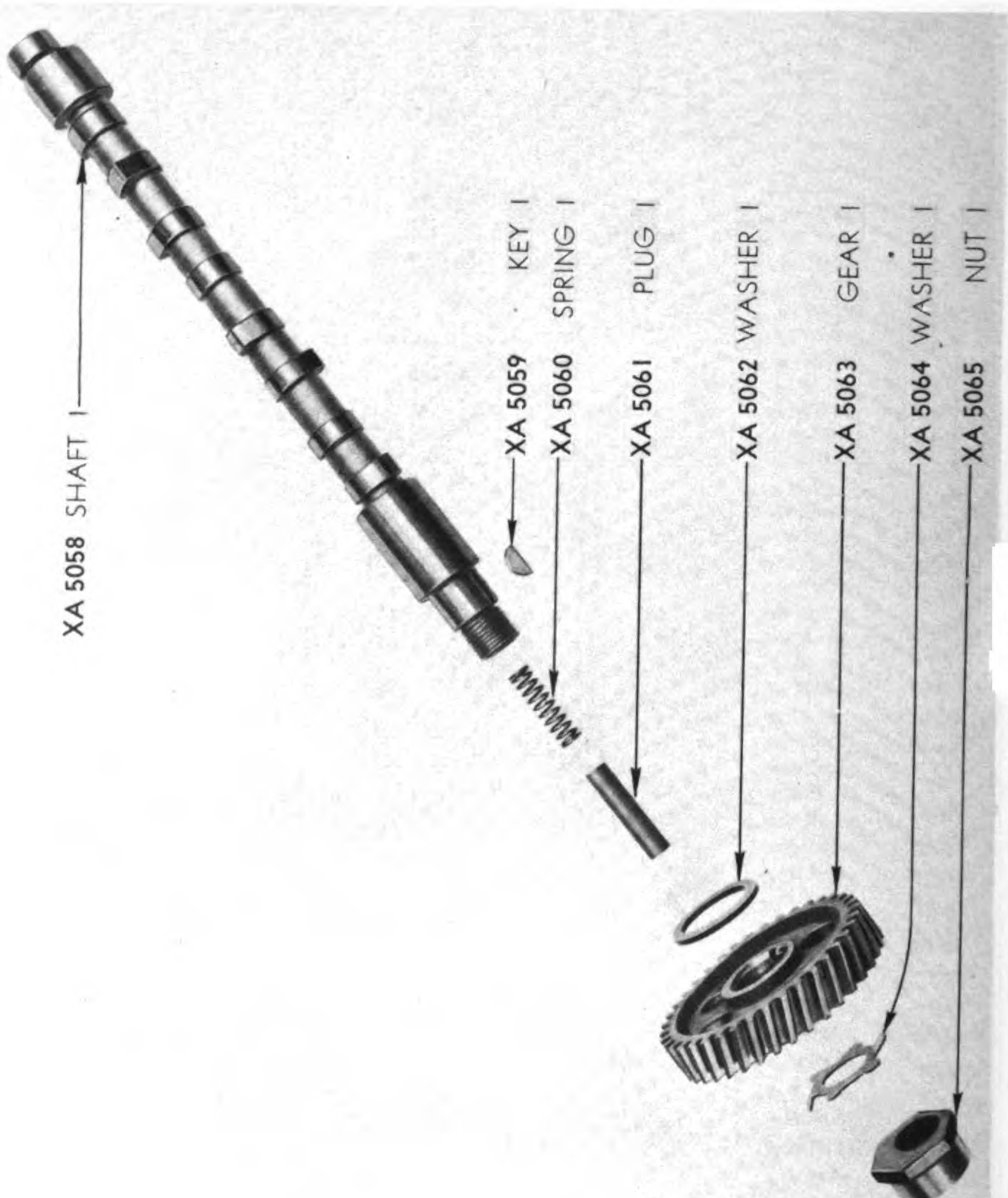
INDEX PARTS SECTION



CYLINDER BLOCK - BOTTOM VIEW



CYLINDER BLOCK - TOP VIEW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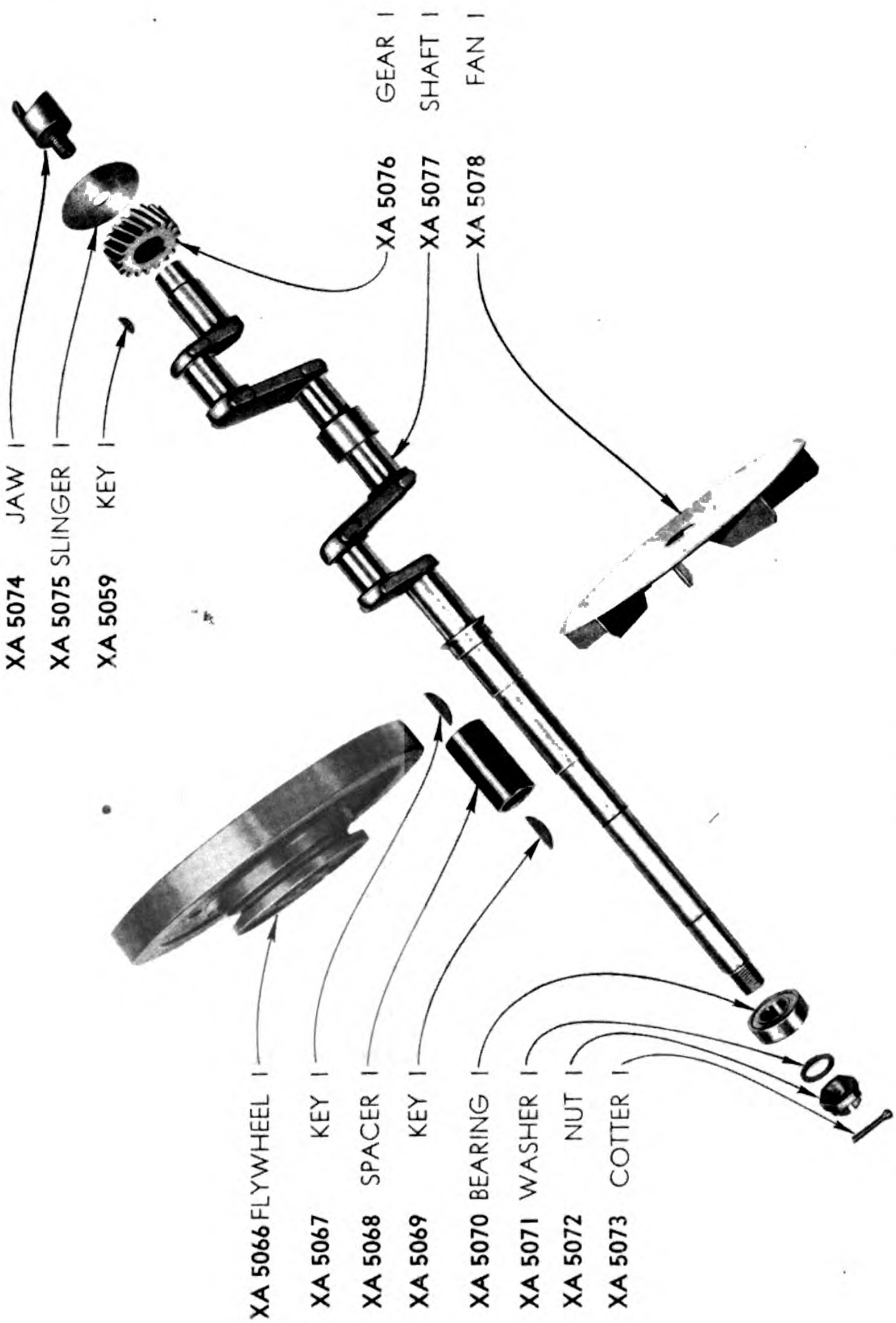
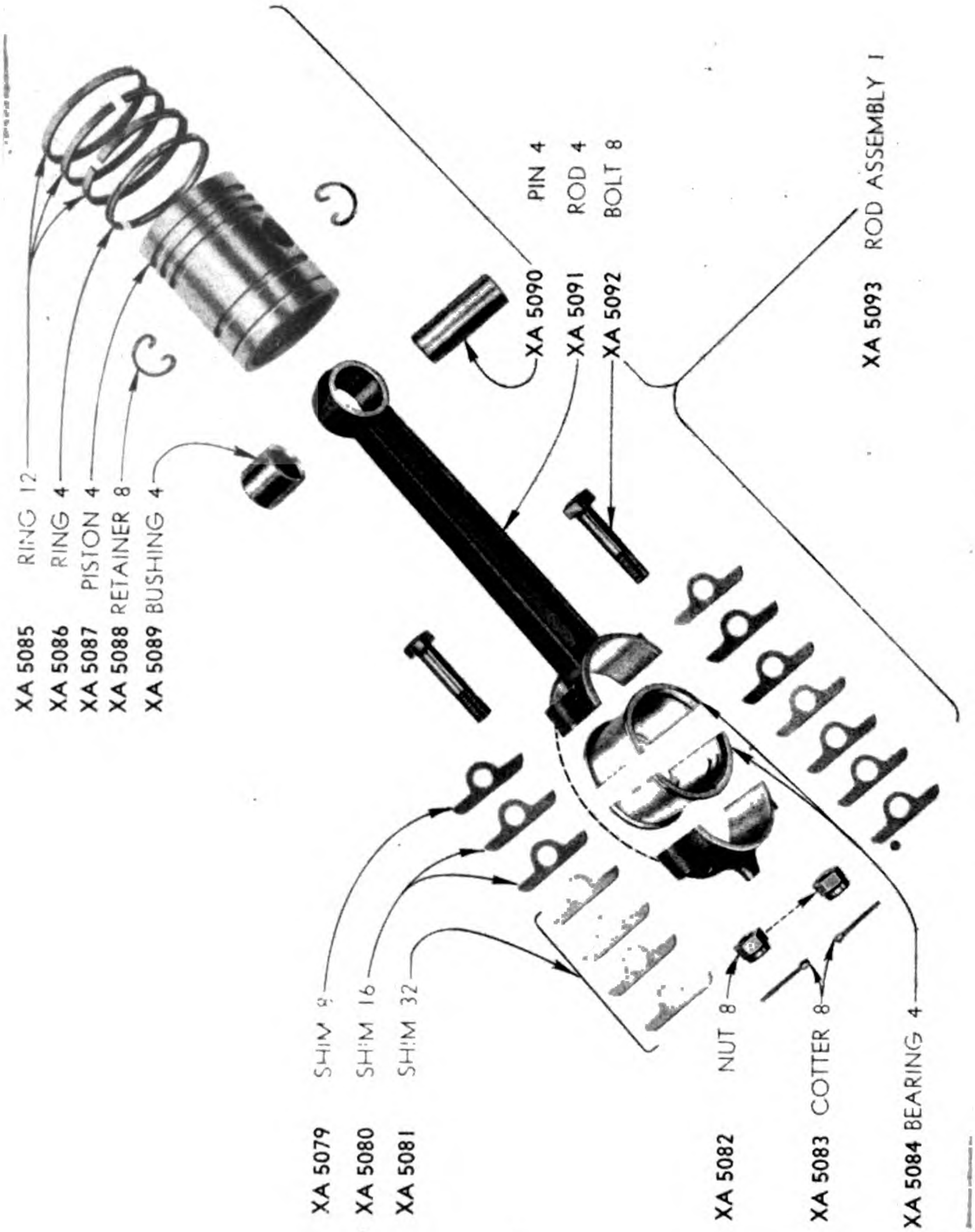
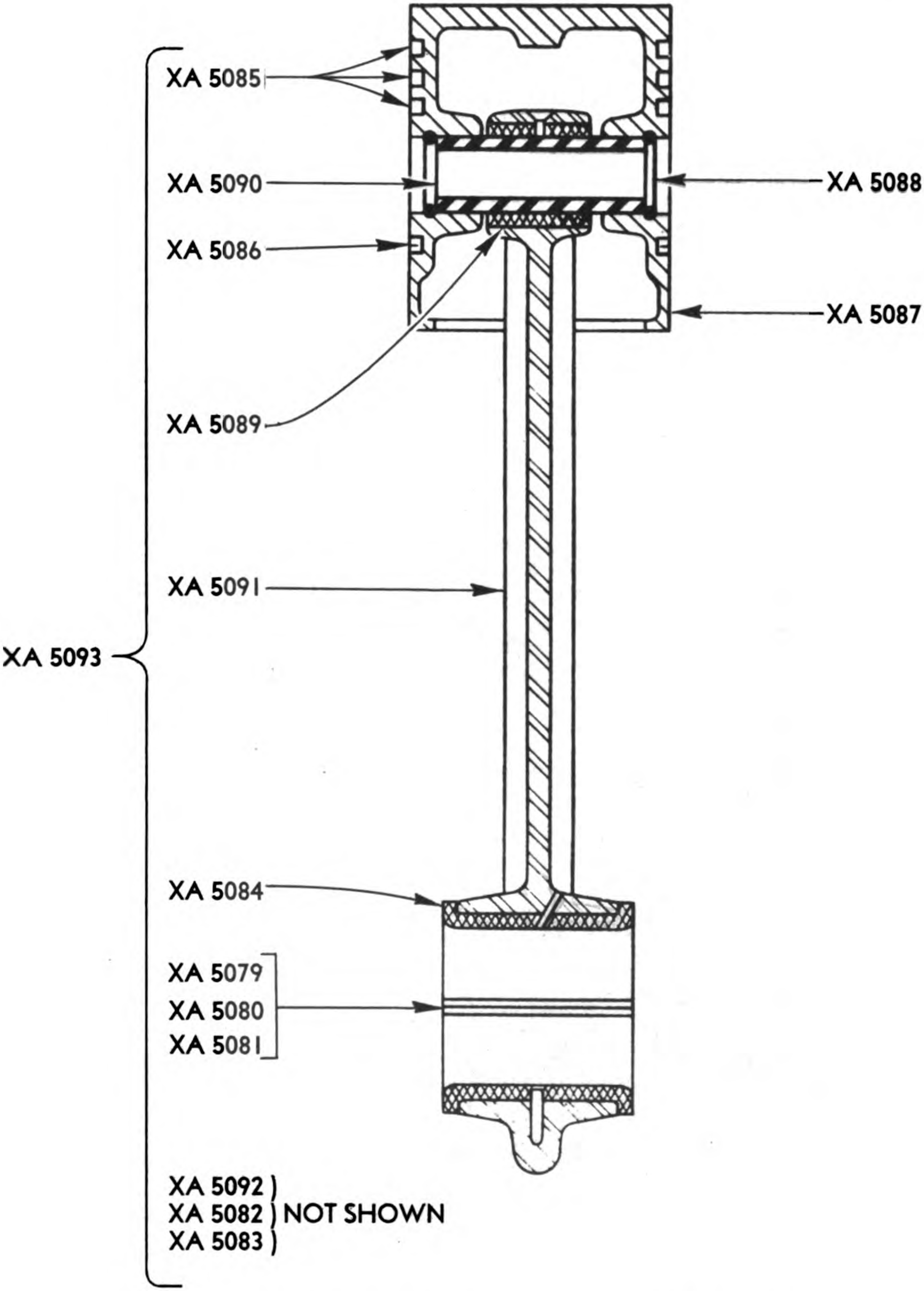


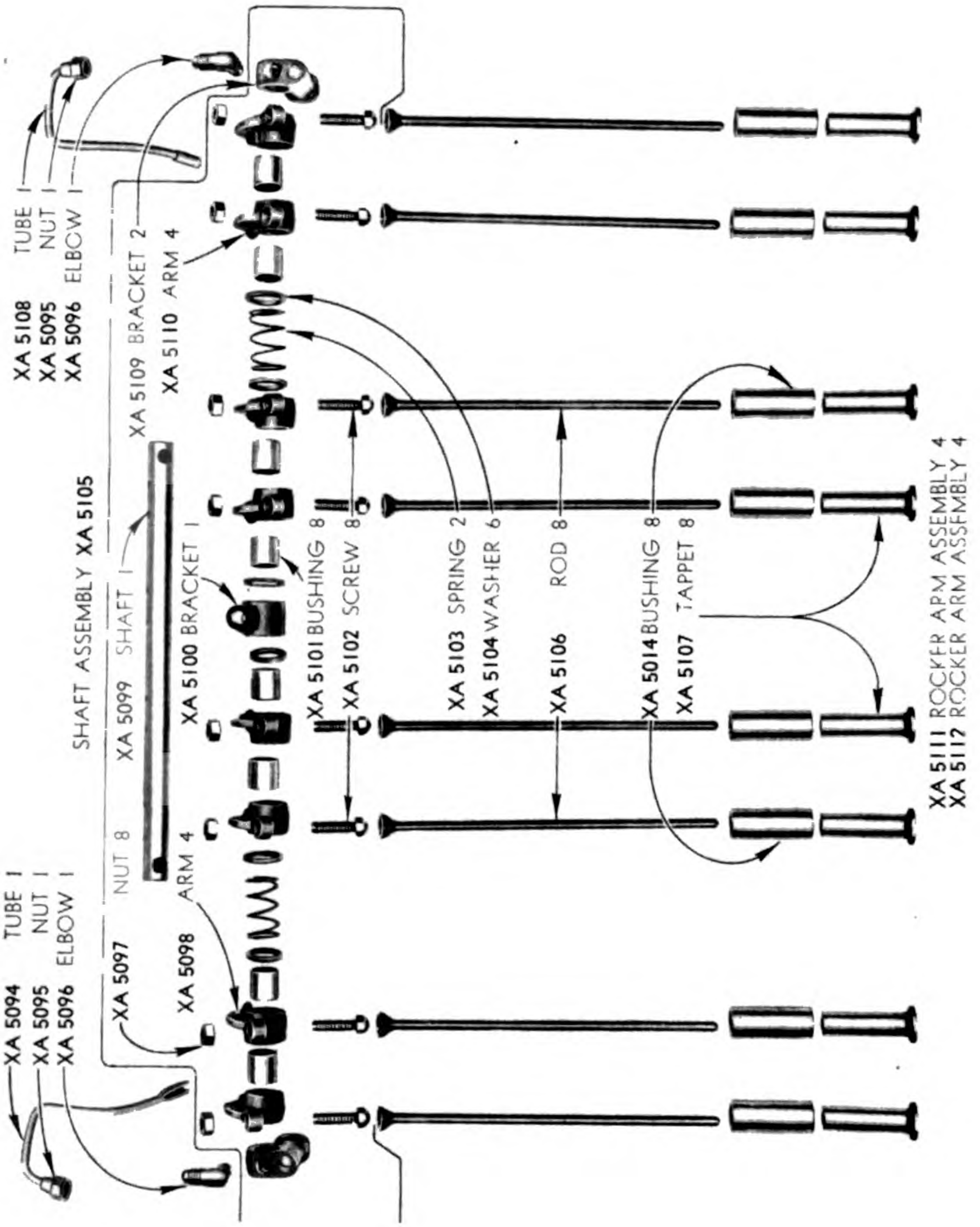
CRANKSHAFT AND FLYWHEEL



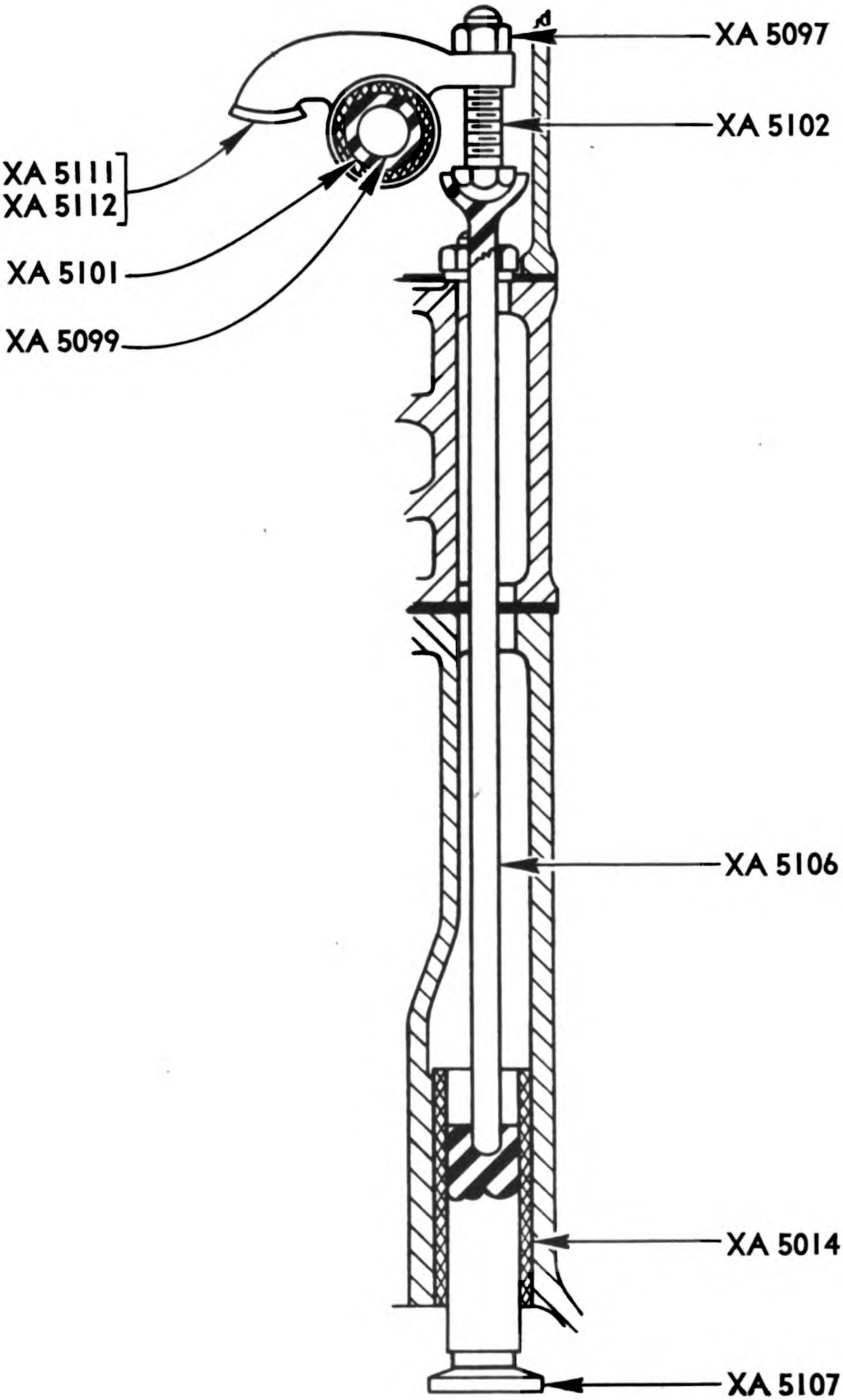
CONNECTING ROD AND PISTON ASSEMBLY



CONNECTING ROD AND PISTON - CROSS SECTION



PUSH RODS AND ROCKER ARMS



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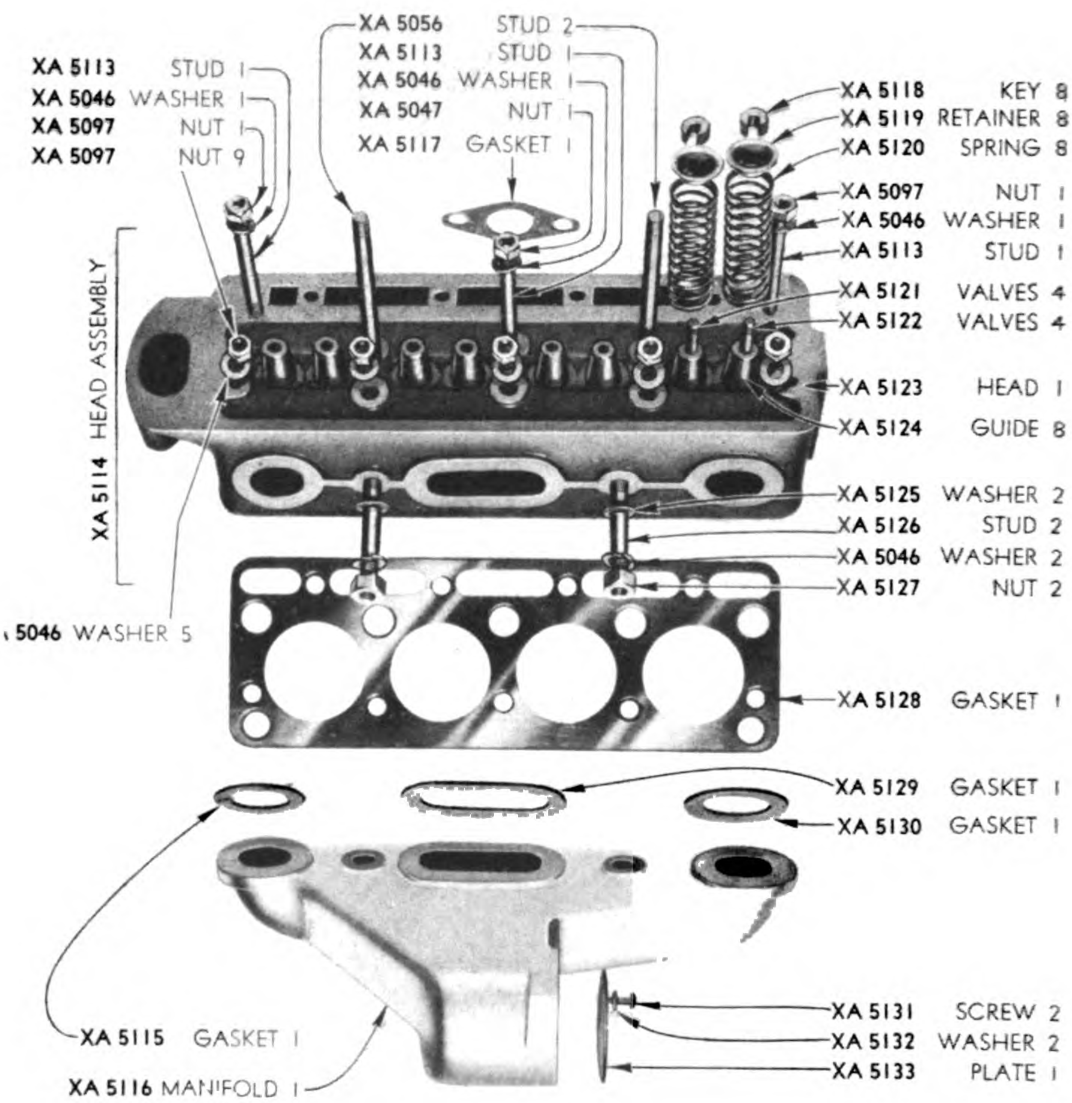
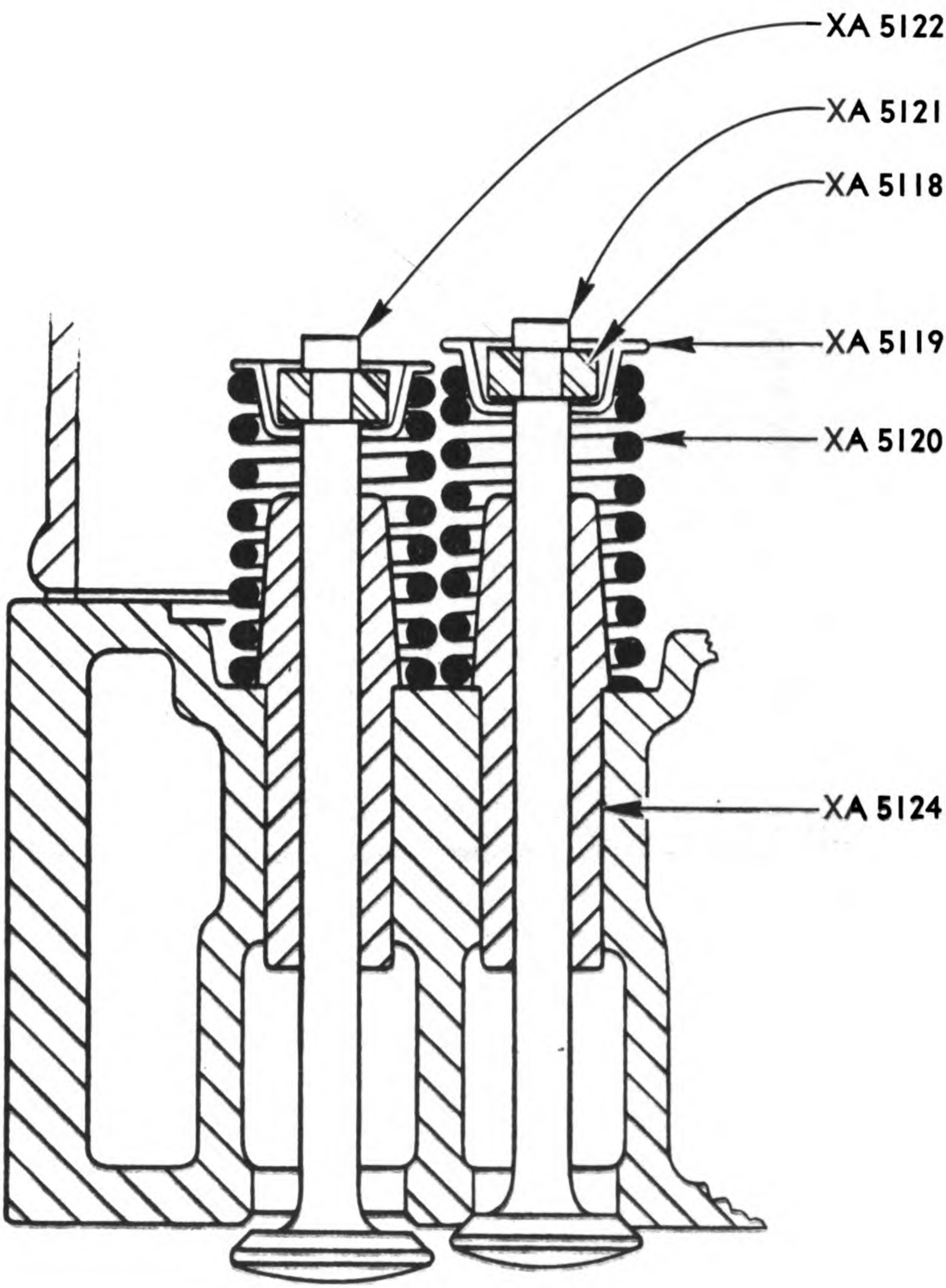


CYLINDER HEAD - VALVES AND EXHAUST MANIFOLD



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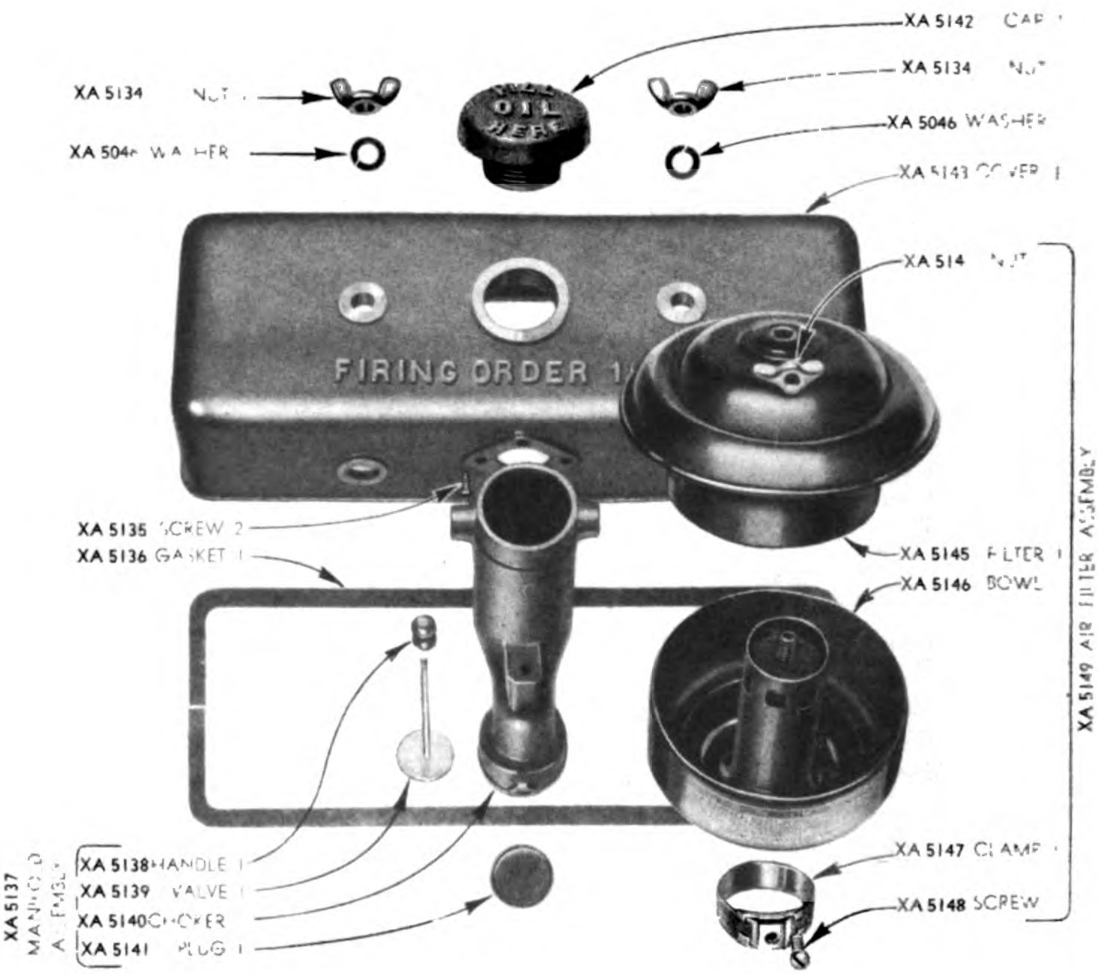
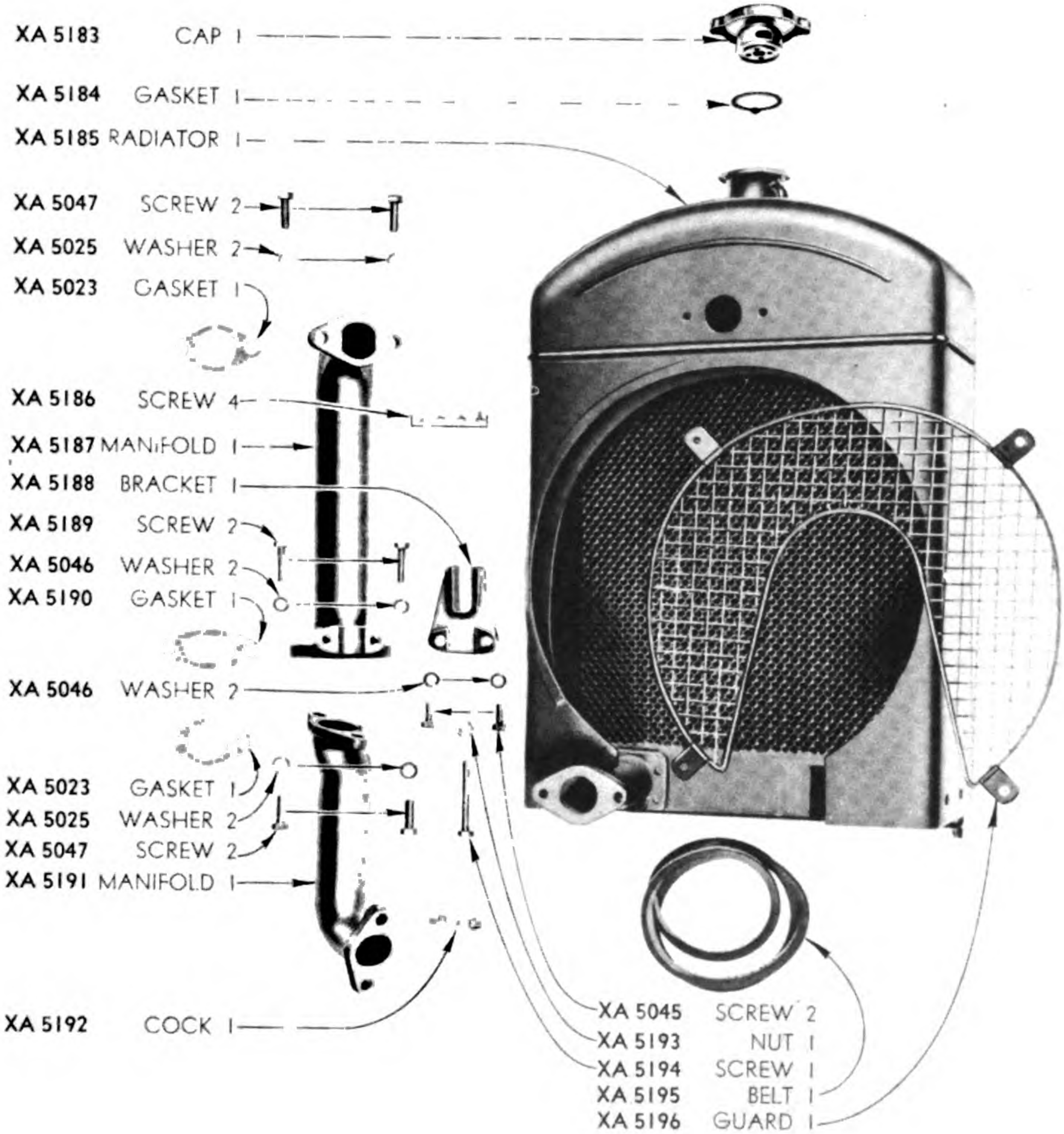
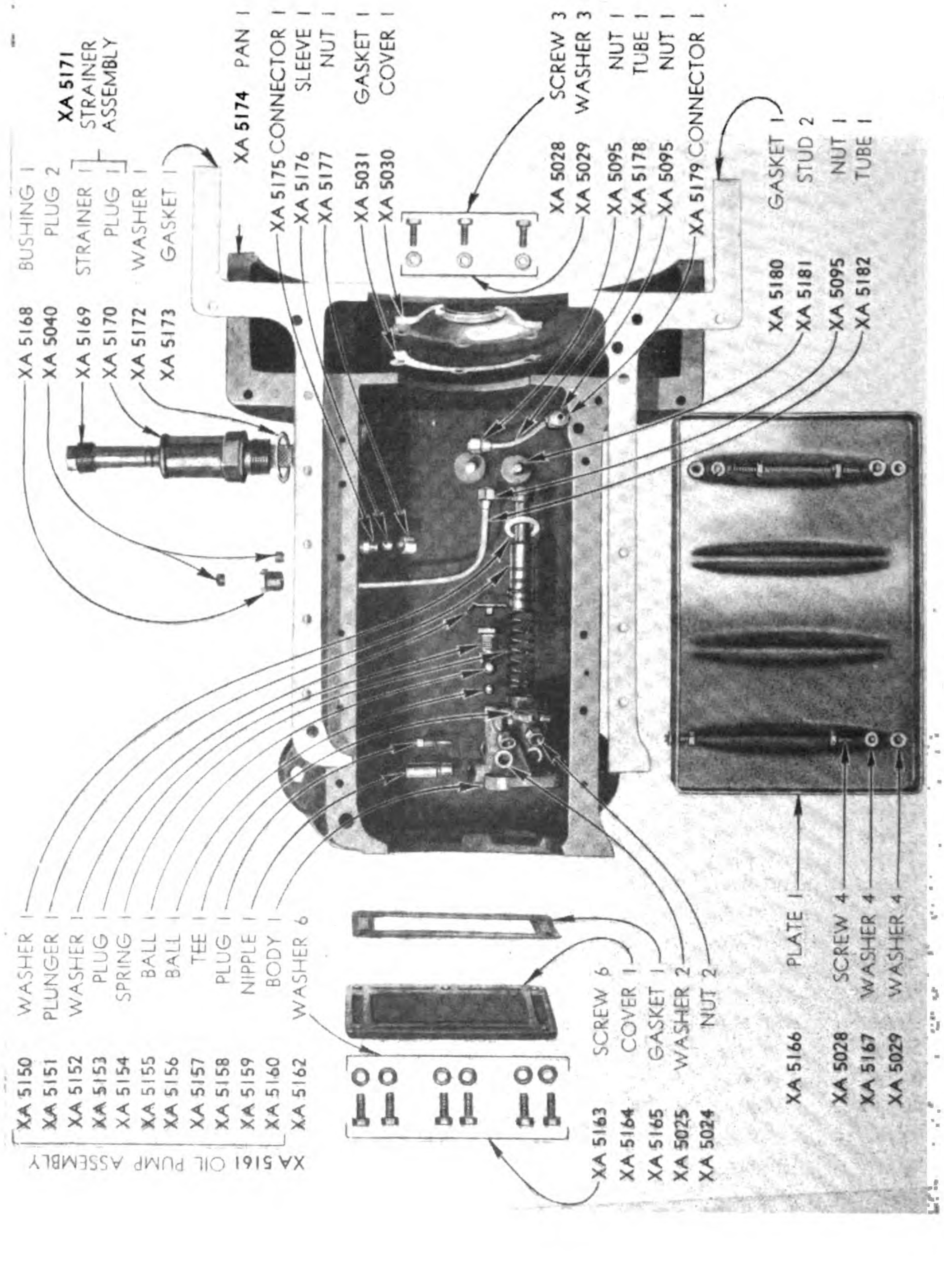


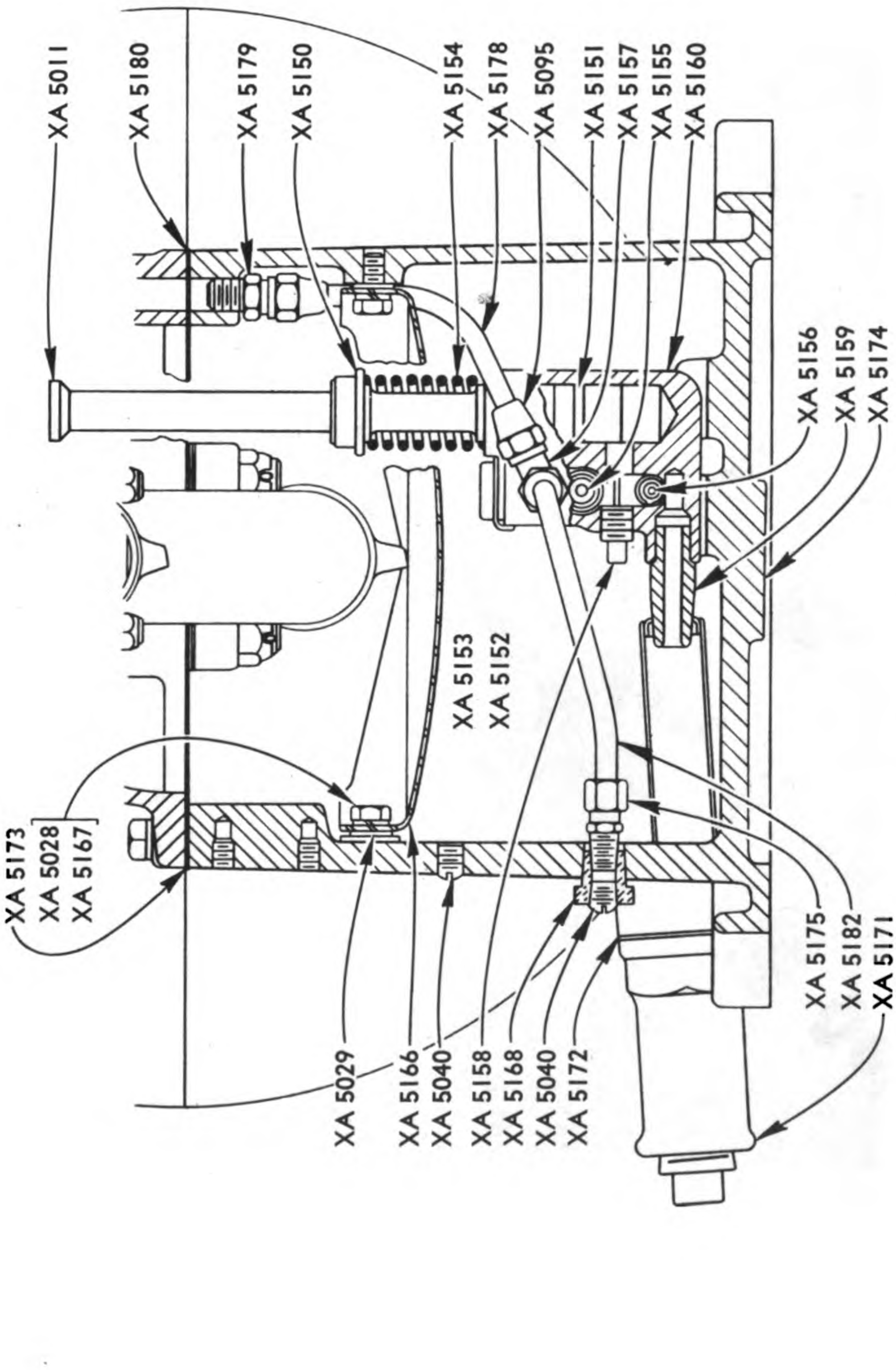
CYLINDER HEAD COVER AND AIR CLEANER



RADIATOR AND FAN BELT



PAN AND OIL PUMP



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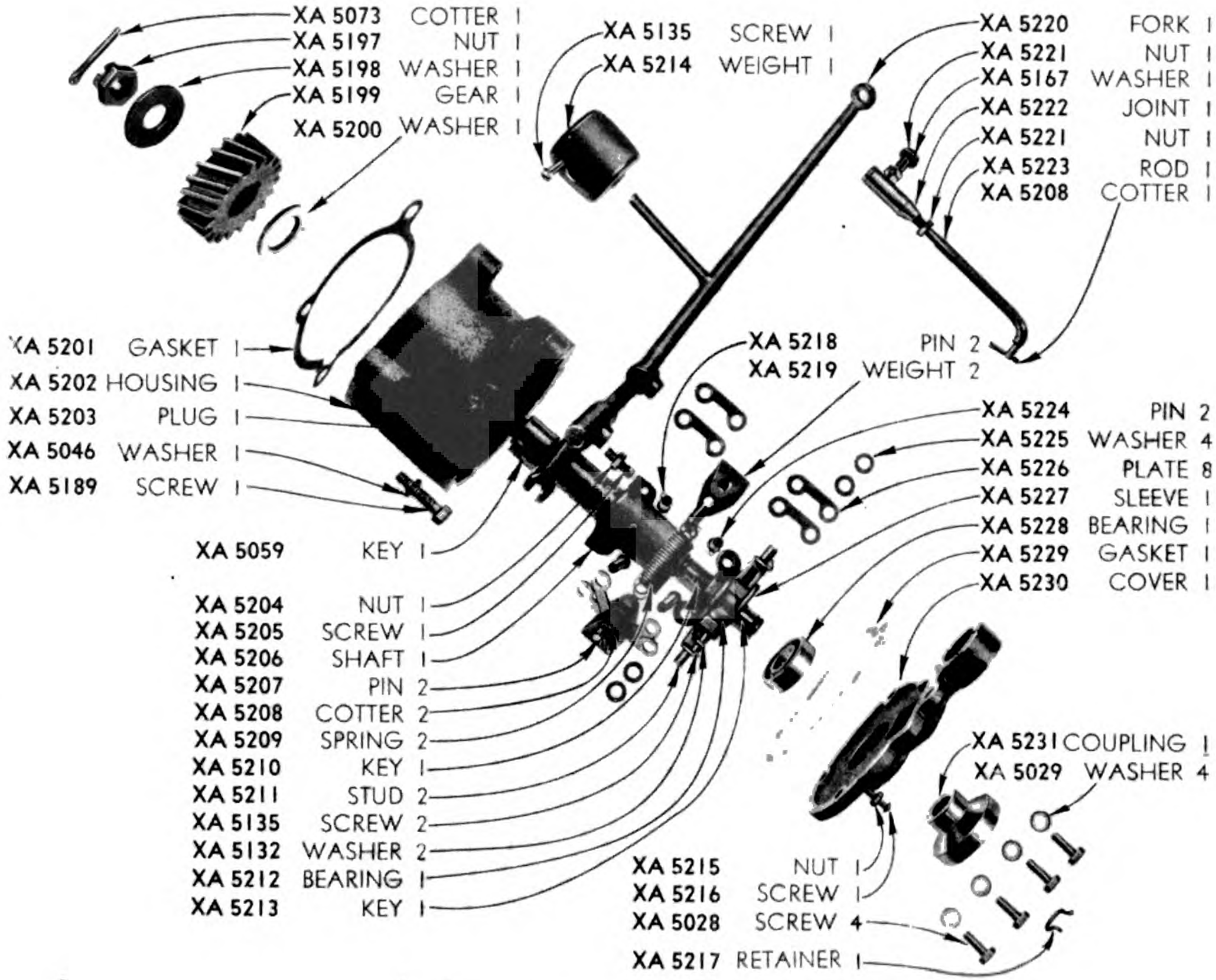
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XA 5219 WEIGHT 2
XA 5224 PIN 2
XA 5225 WASHER 4
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XA 5213 KEY 1
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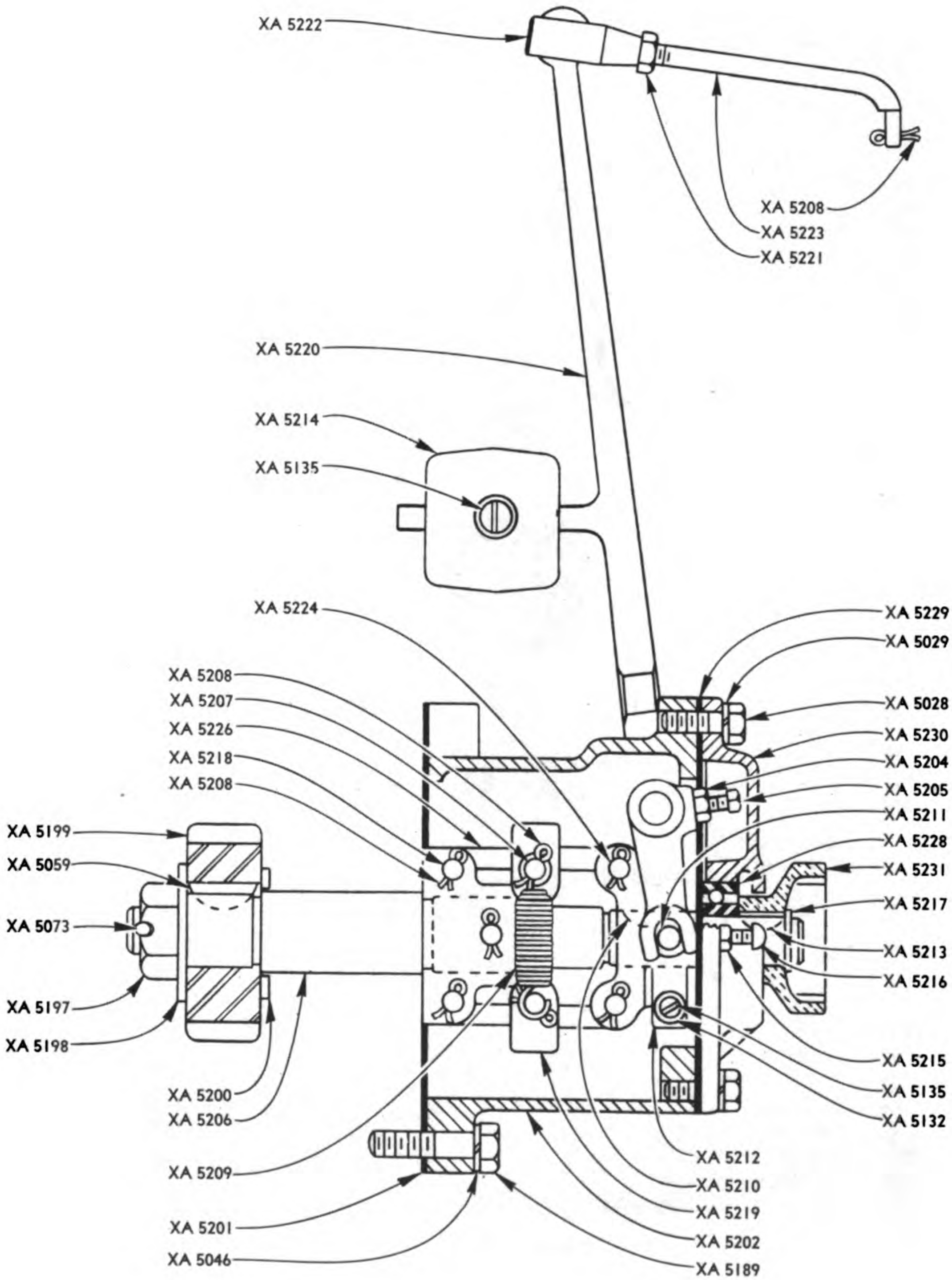
XA 5028 SCREW 4
XA 5217 RETAINER 1

GOVERNOR



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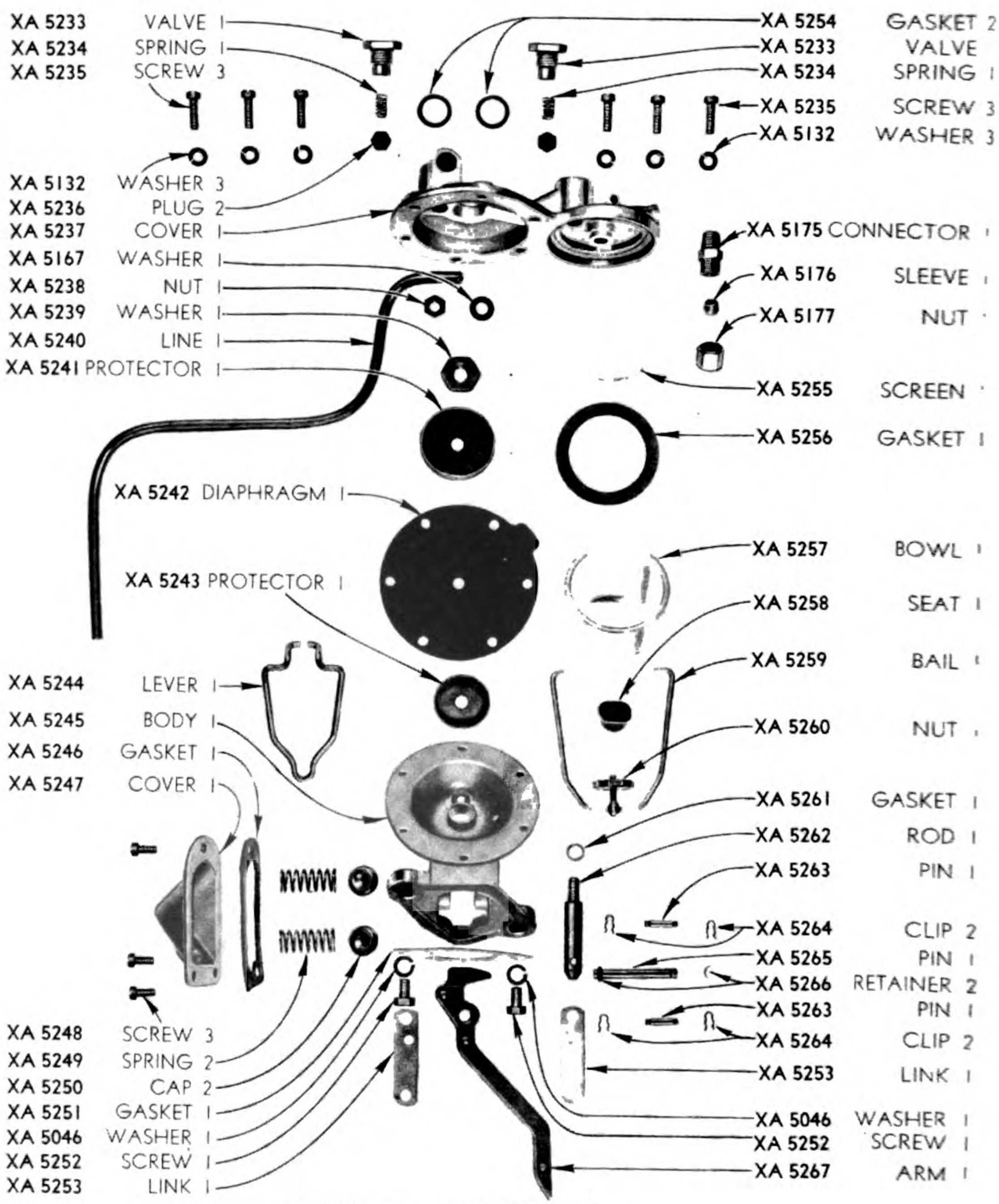
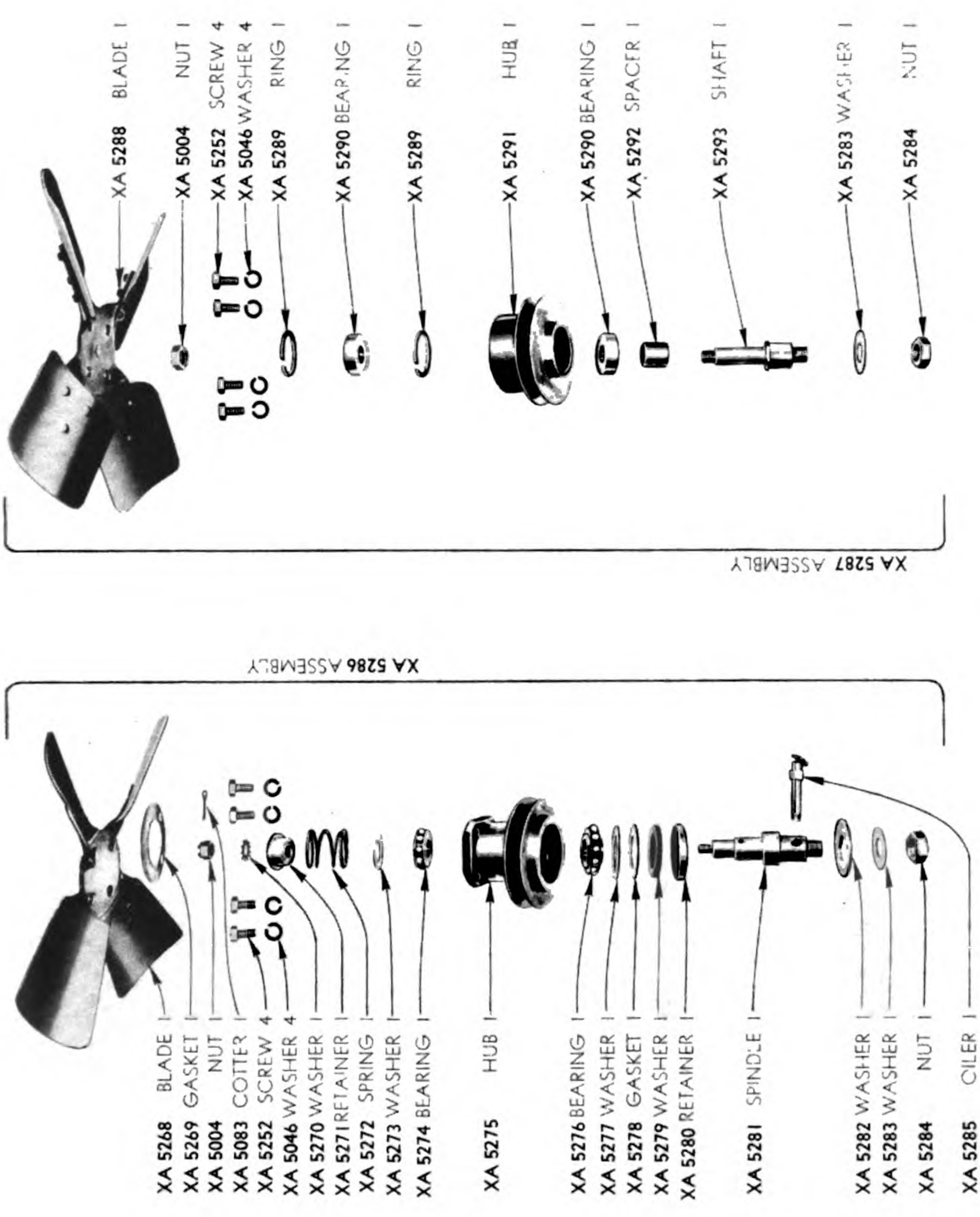


XA 5232 FUEL PUMP ASSEMBLY

FUEL PUMP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XA 5280 RETAINER 1
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XA 5287 ASSEMBLY
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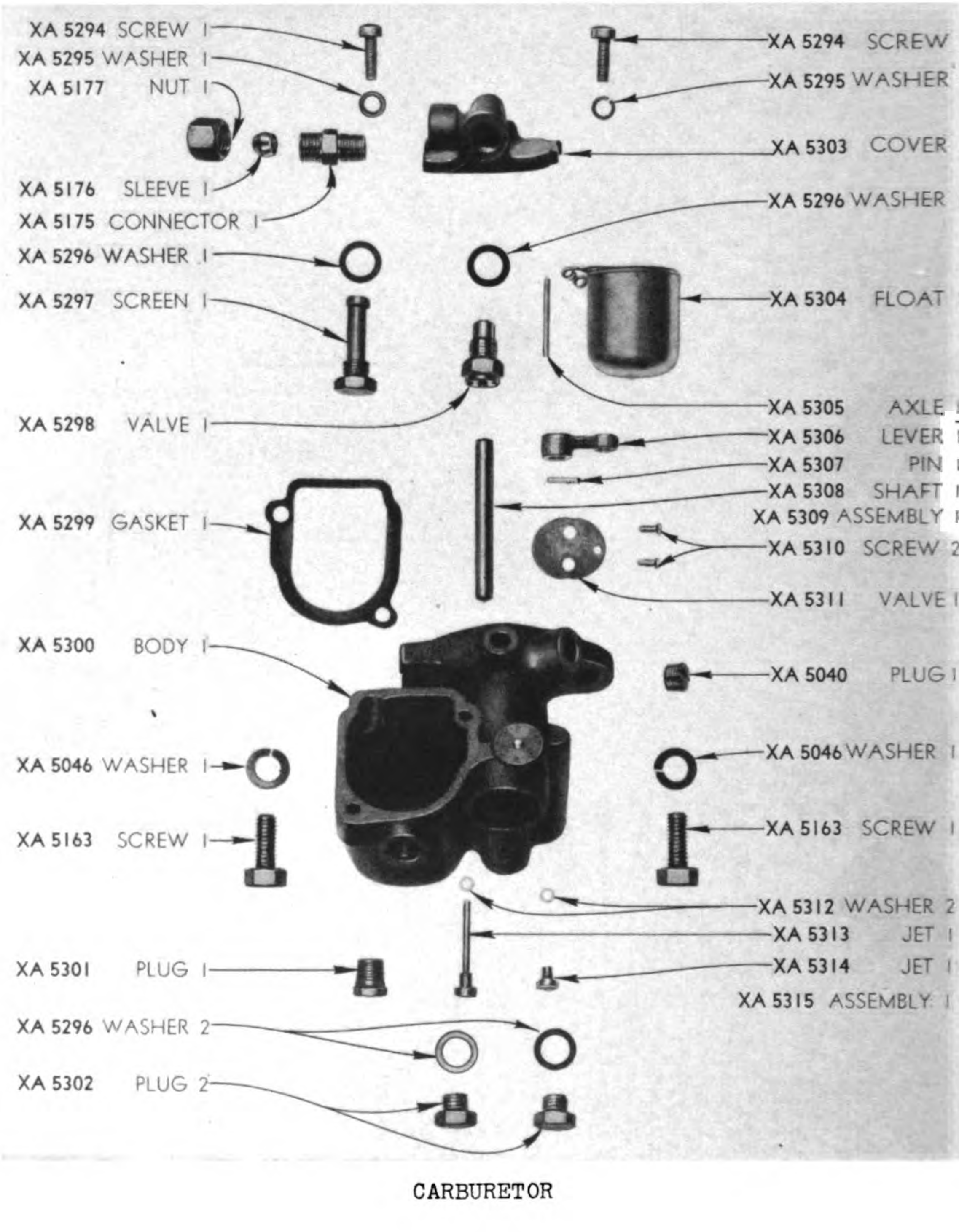
ENGINE FAN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XA 5296 WASHER 2
XA 5302 PLUG 2
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XA 5295 WASHER 1
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XA 5304 FLOAT 1
XA 5305 AXLE 1
XA 5306 LEVER 1
XA 5307 PIN 1
XA 5308 SHAFT 1
XA 5309 ASSEMBLY 1
XA 5310 SCREW 2
XA 5311 VALVE 1
XA 5040 PLUG 1
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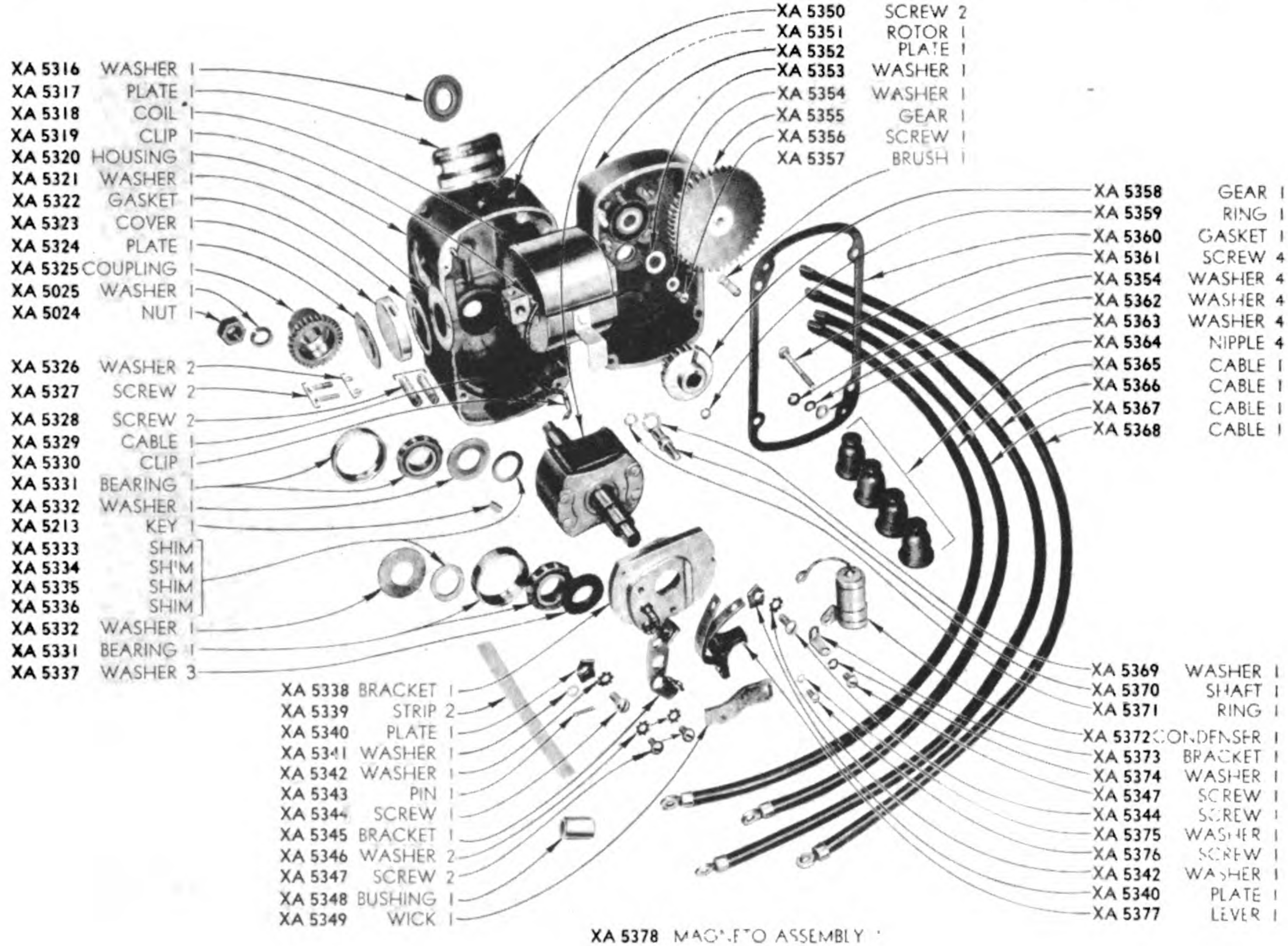
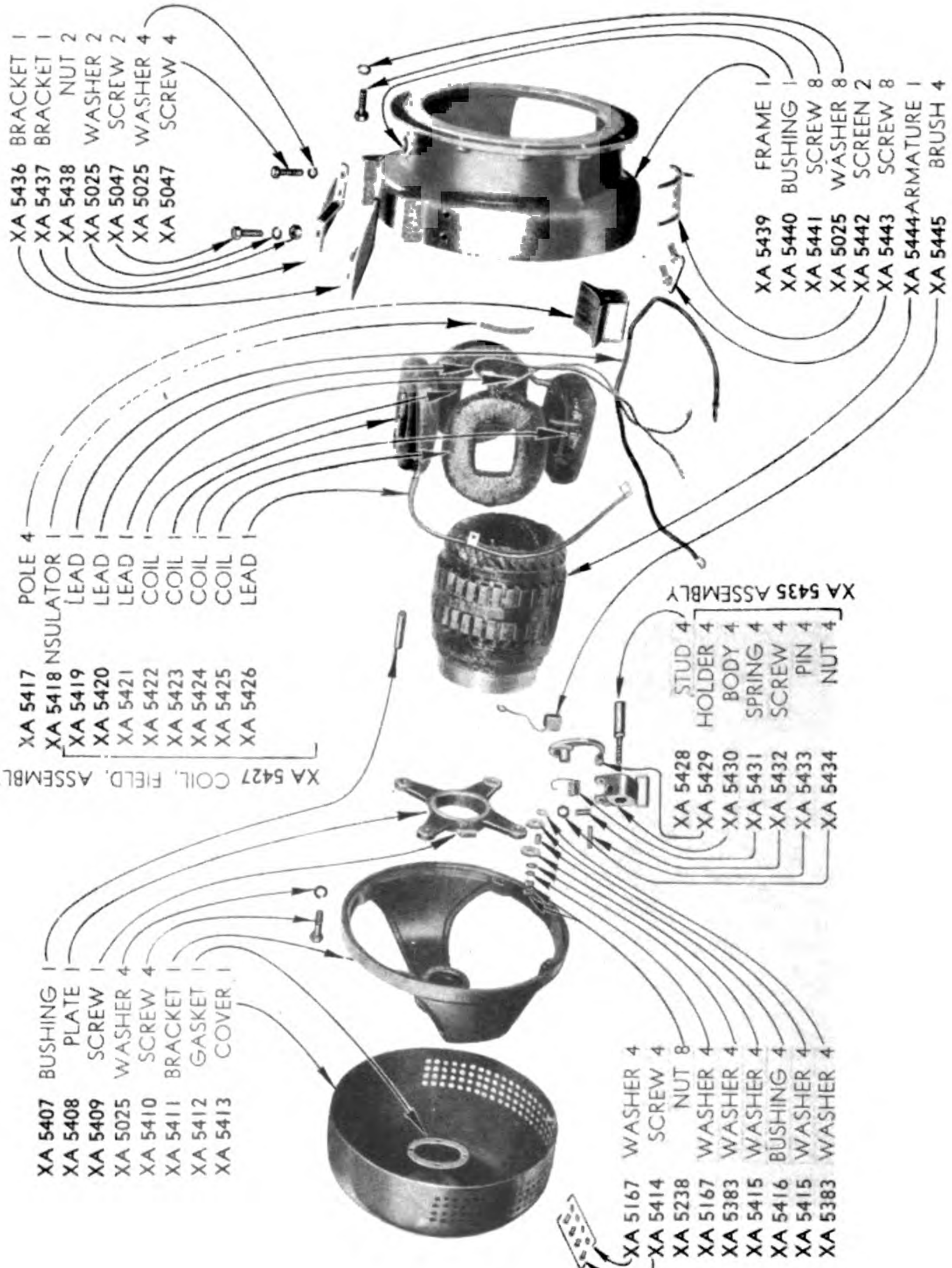
XA 5313 JET 1
XA 5314 JET 1
XA 5315 ASSEMBLY 1

CARBURETOR



XA 5378 MAGNETO ASSEMBLY 1

MAGNETO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XA 5440 BUSHING 1
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XA 5025 WASHER 8
XA 5442 SCREEN 2
XA 5443 SCREW 8
XA 5444 ARMATURE 1
XA 5445 BRUSH 4
XA 5417 POLE 4
XA 5418 INSULATOR 1
XA 5419 LEAD 1
XA 5420 LEAD 1
XA 5421 LEAD 1
XA 5422 COIL 1
XA 5423 COIL 1
XA 5424 COIL 1
XA 5425 COIL 1
XA 5426 LEAD 1
XA 5427 COIL, FIELD, ASSEMBLY
XA 5428 STUD 4
XA 5429 HOLDER 4
XA 5430 BODY 4
XA 5431 SPRING 4
XA 5432 SCREW 4
XA 5433 PIN 4
XA 5434 NUT 4
XA 5435 ASSEMBLY
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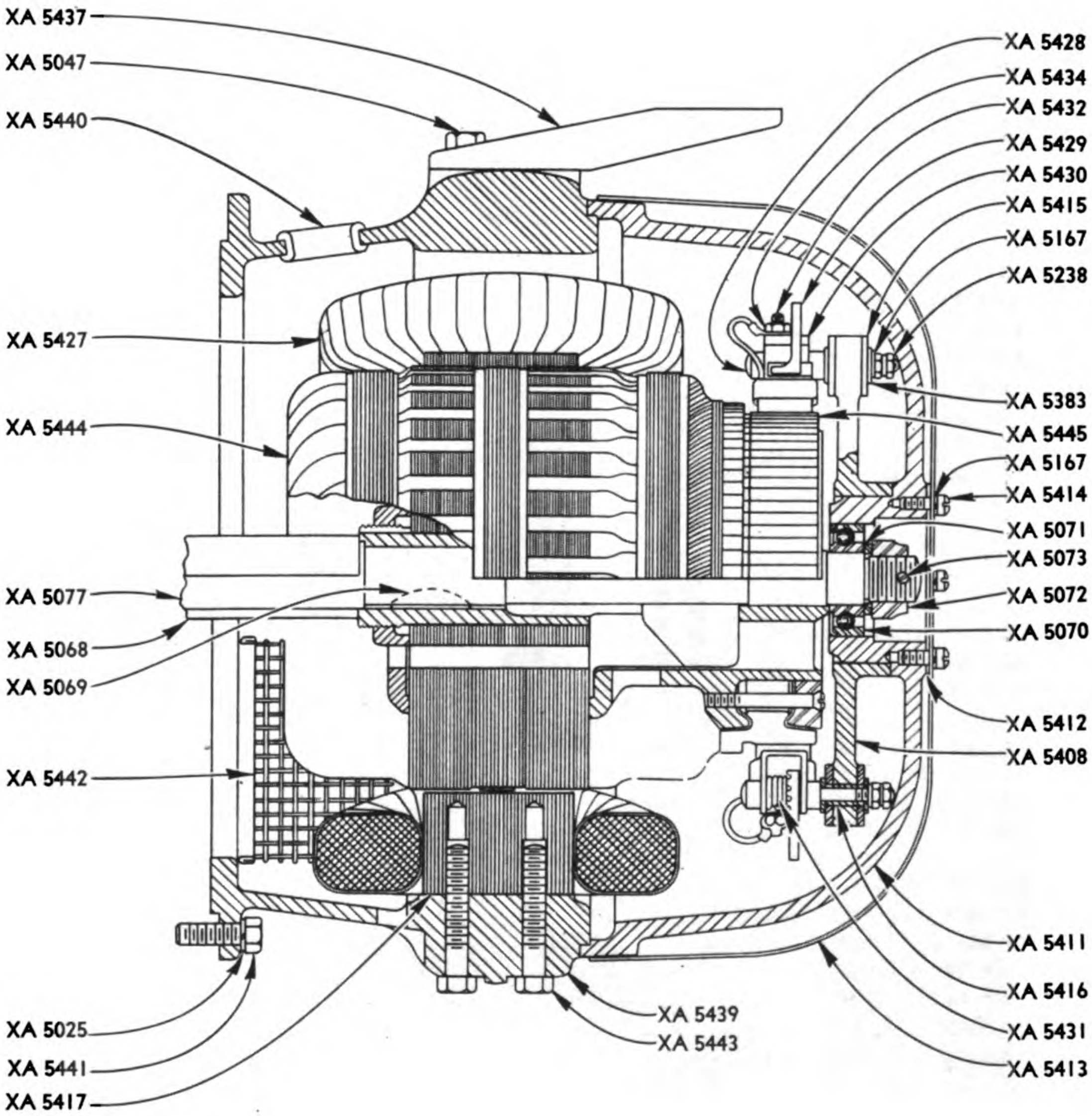
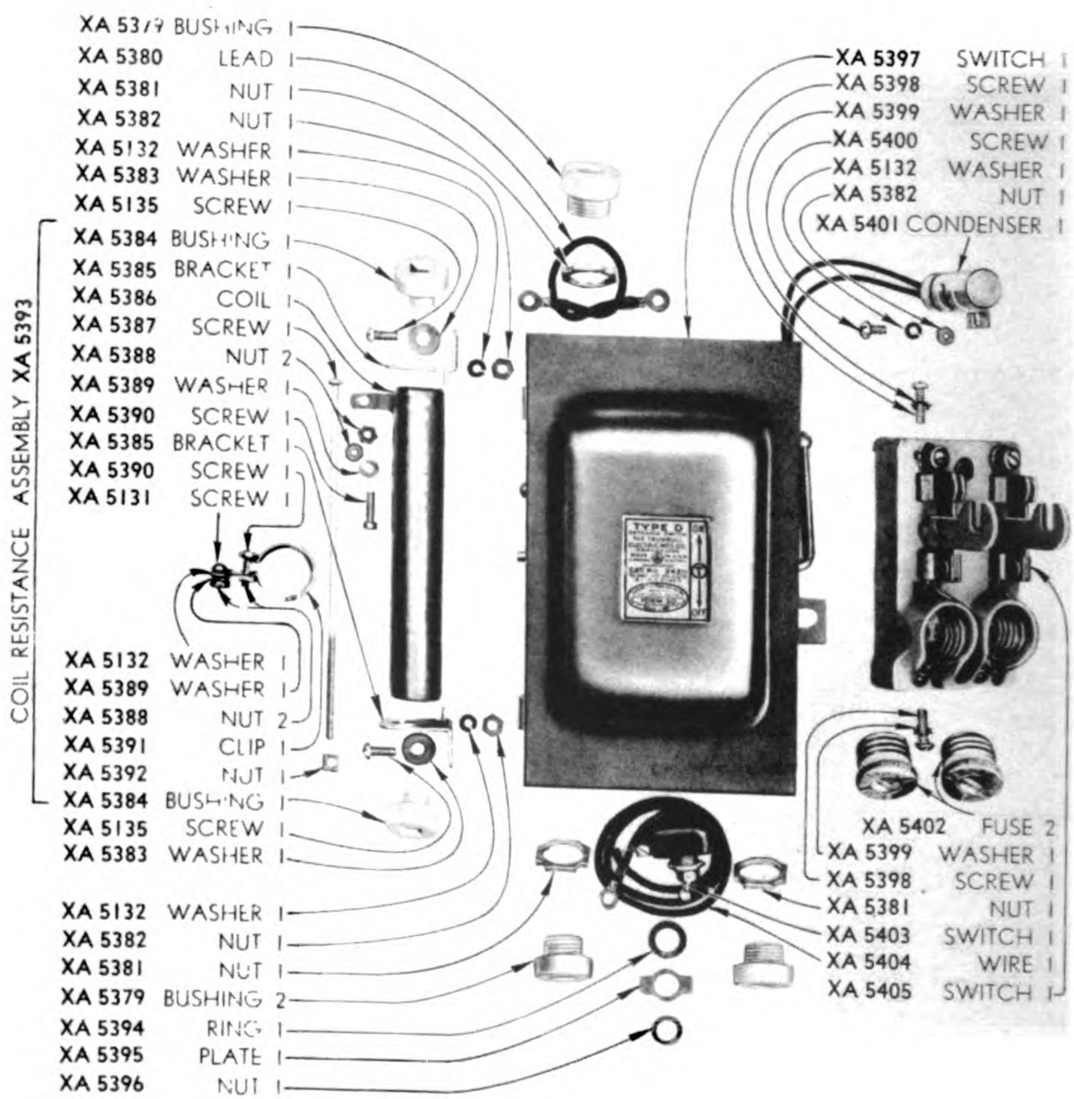
XA 5408 PLATE 1
XA 5409 SCREW 1
XA 5025 WASHER 4
XA 5410 SCREW 4
XA 5411 BRACKET 1
XA 5412 GASKET 1
XA 5413 COVER 1
XA 5167 WASHER 4
XA 5414 SCREW 4
XA 5238 NUT 8
XA 5167 WASHER 4
XA 5383 WASHER 4
XA 5415 WASHER 4
XA 5416 BUSHING 4
XA 5415 WASHER 4
XA 5383 WASHER 4

GENERATOR

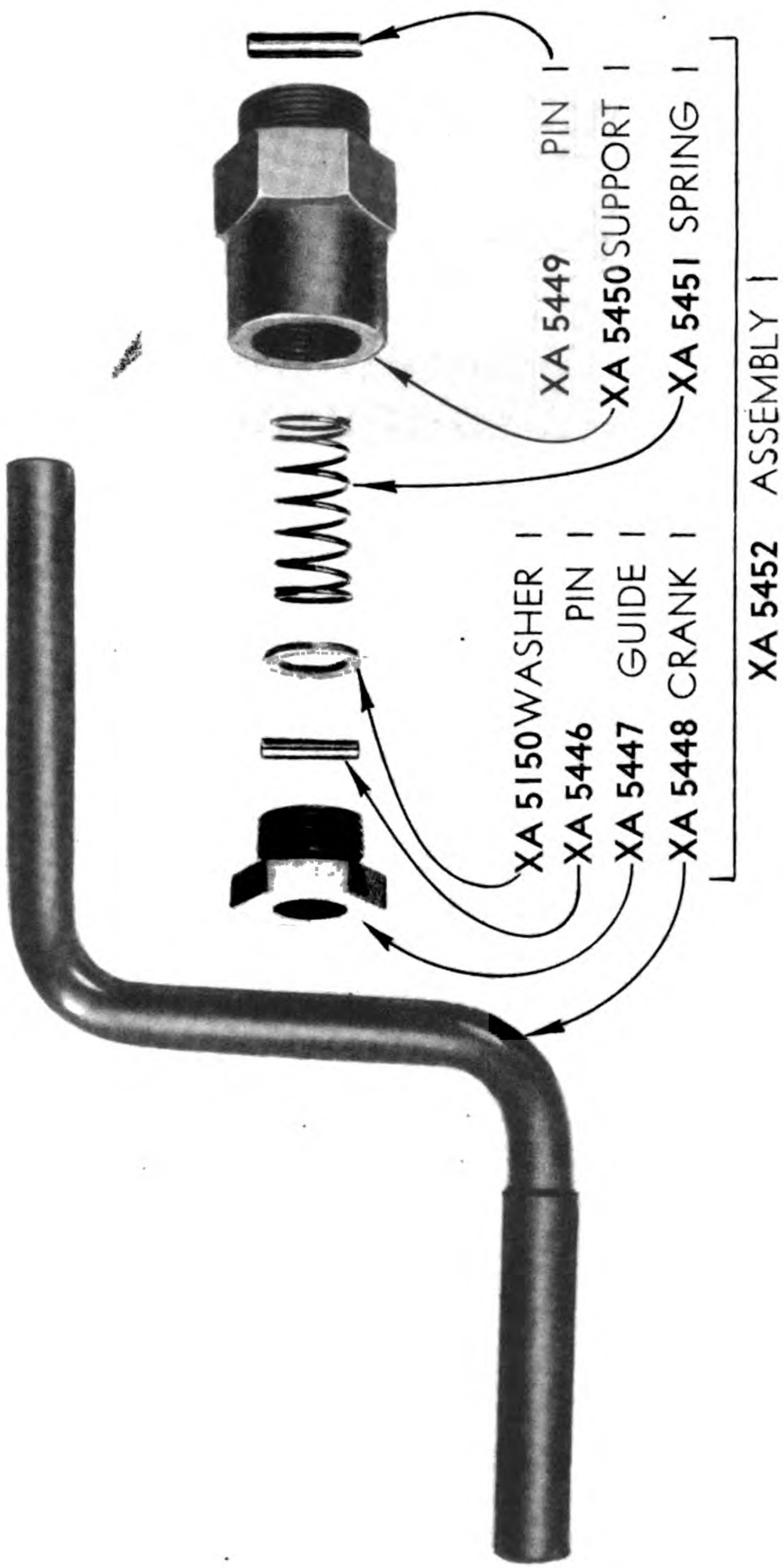


GENERATOR - CROSS SECTION

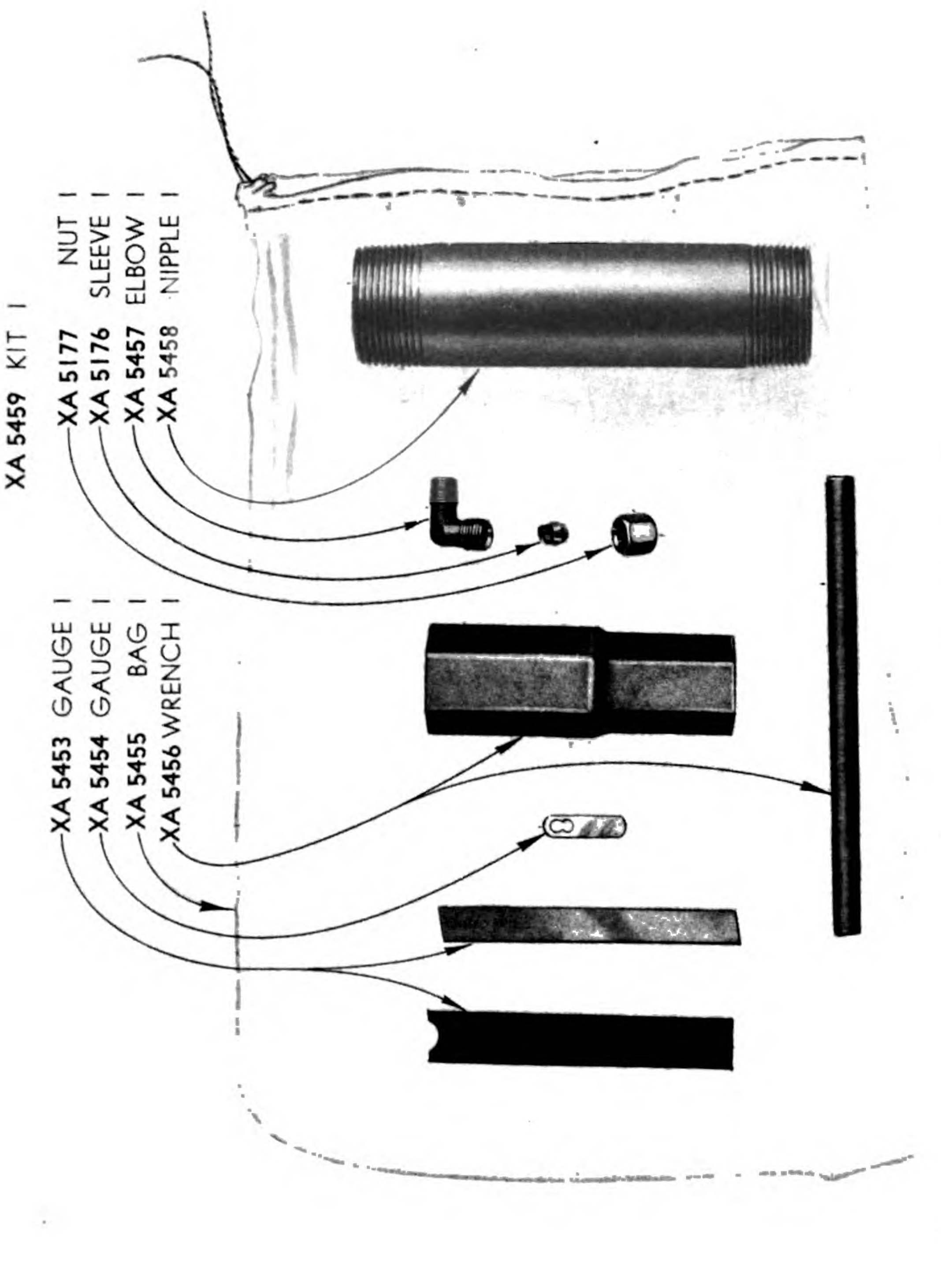


XA 5406 SWITCH ASSEMBLY 1

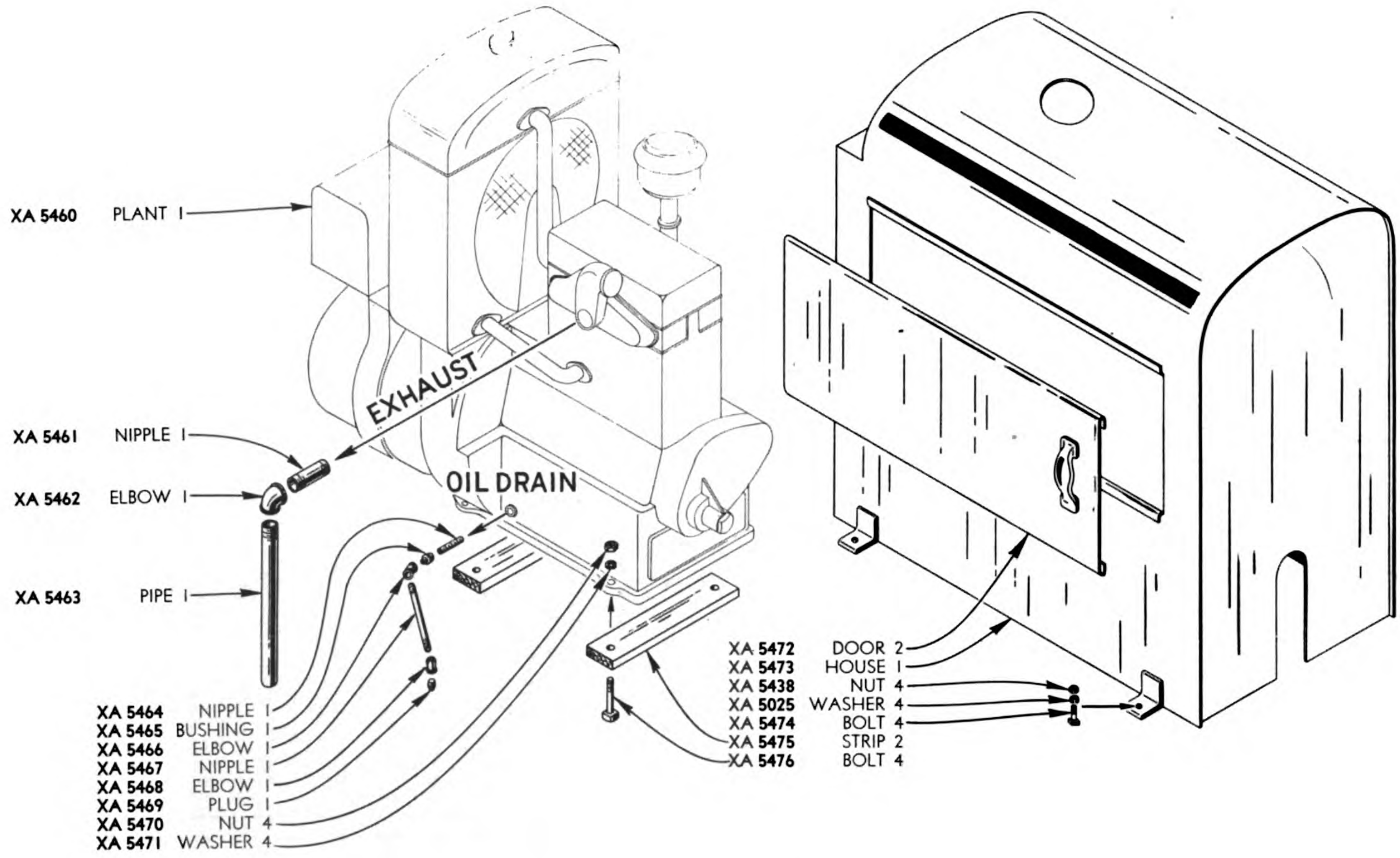
MANUAL SWITCH



ENGINE CRANK


XA 5459 KIT 1
XA 5177 NUT 1
XA 5176 SLEEVE 1
XA 5457 ELBOW 1
XA 5458 NIPPLE 1
XA 5453 GAUGE 1
XA 5454 GAUGE 1
XA 5455 BAG 1
XA 5456 WRENCH 1

TOOL KIT



HOUSE - EXHAUST PIPE AND DRAIN PIPE

PARTS LIST
FOR
STANDARD MODEL E KOHLER LIGHT PLANT ASSEMBLY

SYMBOL IDENTIFICATION

CH - Champion Spark Plugs
AC - Spark Plugs and Fuel Pump
AB - American Bosch Magneto Corp.
ND - New Departure - Bearings
SC - Switzer-Cummins Co. - Fans
UA - United Air Cleaner Co.
Z - Zenith Carburetor Co.
K - Kohler Co.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 5000	Bearing, front camshaft K-A-519	1	1/2#	$ 1.10	52
XA 5001	Bushing, magneto drive shaft - K-A-631	1	4 pcs.1#	.70	52
XA 5002	Pin, magneto shaft bearing K-A-798	1	200 pcs.1#	.03	52
XA 5003	Pin, camshaft bearing K-A-797	2	xx	.03	52
XA 5004	Nut, castle 3/8" NF	9	64 pcs. 1#	.03	
XA 5005	Stud, crankshaft bearing K-A-527	8	20 pcs. 1#	.05	52
XA 5006	Cap, crankshaft bearing front - K-A-525	1	1/2#	.30	52
XA 5007	Tee, oil line dash assembly - K-D-2516	1	5 pcs. 1#	.60	52
XA 5008	Shims, crankshaft front bearing .002 - K-A-549	10	xx	.03	52
XA 5009	Shims, crankshaft front bearing .008 - K-A-548	4	xx	.03	52
XA 5010	Shims, crankshaft front bearing .094 - K-A-547	2	43 pcs.1#	.03	52
XA 5011	Tappet, oil pump - K-A-573	1	5 pcs. 1#	.35	52
XA 5012	Bearing, crankshaft rear - K-A-515	1	3 pcs. 1#	.80	52
XA 5013	Bearing, camshaft rear K-A-520	1	5 pcs. 1#	.80	52
XA 5014	Bushing, valve tappet K-A-545	8	7 pcs. 1#	.15	
XA 5015	Cross, oil line - assembly - K-D-2517	1	3 pcs. 1#	.70	52
XA 5016	Pins, dowel 3/16"x5/8" K-A-761	2	xx	.03	52
XA 5017	Bearing, crankshaft front - K-A-1-513	1	3 pcs.1#	.72	52
XA 5018	Nut, oil line split K-A-610	1	50 pcs. 1#	.10	52
XA 5019	Cap, crankshaft bearing rear - K-A-526	1	3/4#	.25	52
XA 5020	Block, cylinder - assembly - K-A-1-501	1	62½#	52.00	52
XA 5021	Plug, casting vsdyinh - 1" - K-A-806	4	60 pcs.1#	.03	52

xxOver 200 Pcs. per Lb. +As required *Price per 100 Pcs.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 5022	Stud, 3/8" - 16 and 24x1-3/16" NC NF K-A-583	2	26 pcs.1#	$ .03	52
XA 5023	Gasket, water manifold K-A-656	3	xx	.05	
XA 5024	Nut, hex. 3/8" NF K-X-83-1	9	70 pcs.1#	.03	
XA 5025	Washer, Lock 3/8" - K-X-22-1	37	xx	.03	
XA 5026	Screw, flat hd. #8x3/8" NC - K-X-31-1	4	xx	.03	52
XA 5027	Gasket, split cover joint K-A-579	2	xx set	.03	52
XA 5028	Screw, hex. cap 1/4"x 5/8" NC - K-X-5-1	14	69 pcs. 1#	.03	
XA 5029	Washer, packing 1/4" K-A-536	14	xx	.03	
XA 5030	Cover, rear split - upper and lower - K-A-556	2	5/8#	.85	
XA 5031	Gasket, rear split cover K-A-555	2	xx	.05	
XA 5032	Shims, crankshaft rear bearing .094 - K-A-550	2	30 pcs.1#	.03	52
XA 5033	Shims, crankshaft rear bearing .008 - K-A-551	4	xx	.03	52
XA 5034	Shims, crankshaft rear bearing .002 - K-A-552	10	xx	.03	52
XA 5035	Conduit, wire accessory K-B-694	1	30 pcs. 1#	.15	53
XA 5036	Screw, hex. cap 3/8x2" NC - K-X-7-3	2	13 pcs.1#	.03	53
XA 5037	Screw, hex. cap 3/8"x3/4" NC - K-X-7-8	4	26 pcs.1#	.03	53
XA 5038	Support, radiator K-K-576	1	6-3/8#	3.10	53
XA 5039	Plug, cylinder casting - large - K-A-681	1	200 pcs.1#	.05	53
XA 5040	Plug, pipe - headless K-X-75-17	5	142 pcs. 1#	.03	
XA 5041	Plate, name - K-151482	1	18 pcs. 1#	.30	53
XA 5042	Screw, drive #4 - K-X-67-2	4	xx	.03	53
XA 5043	Gasket, spark plug - K-A-675	4	xx	.03	53
XA 5044	Plugs, spark AC-87S or CH-7	4	5 pcs. 1#	.65	53
XA 5045	Screw, hex. cap 5/16" x 1" N.C. - K-X-6-7	15	33 pcs. 1#	.03	
XA 5046	Washer, lock 5/16" - K-X-21-1	49	xx	.03	
XA 5047	Screw, hex. cap 3/8"x1" N.C. - K-X-7-1	12	22 pcs. 1#	.03	
XA 5048	Bracket, magneto support K-A-676	1	2#	.55	53
XA 5049	Screw, fill.hd. - K-A-759	3	29 pcs. 1#	.05	53
XA 5050	Pins, dowel 1/4"x5/8" - K-X-56-1	2	122 pcs. 1#	.03	53

xxOver 200 Pcs. per Lb. +As required *Price per 100 Pcs.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 5051	Cover, gear - K-D-521	1	8-1/2#	$4.20	53
XA 5052	Gasket, gear cover K-A-650	1	192 pcs. 1#	.05	53
XA 5053	Screw, hex. cap 5/16" x 2-1/4" NC - K-X-6-3	7	18 pcs. 1#	.03	53
XA 5054	Screw, hex. cap 5/16" x 3-3/4" NC - K-X-6-4	2	11 pcs. 1#	.05	53
XA 5055	Cap, starting crank hole K-A-598	1	4 pcs. 1#	.20	53
XA 5056	Studs, cylinder head 5/16" x 3-7/8" NC NF K-A-557	11	12 pcs. 1#	.03	
XA 5057	Gauge, oil - K-A-584	1	19 pcs. 1#	.10	53
XA 5058	Shaft, cam - K-A-506	1	4-1/4#	6.25	54
XA 5059	Key, Woodruff #9 - K-A-45-1	3	110 pcs.1#	.03	
XA 5060	Spring, camshaft thrust plug - K-A-592	1	80 pcs.1#	.03	54
XA 5061	Plug, camshaft thrust K-A-591	1	58 pcs. 1#	.10	54
XA 5062	Washer, camshaft thrust K-A-590	1	22 pcs.1#	.15	54
XA 5063	Gear, camshaft - K-A-523	1	2#	2.20	54
XA 5064	Washer, camshaft lock K-A-633	1	42 pcs.1#	.03	54
XA 5065	Nut, cam - K-D-3576	1	1/2#	.60	54
XA 5066	Flywheel - K-5272	1	31#	5.10	55
XA 5067	Key, Woodruff #128 - K-X-47-1	1	25 pcs. 1#	.05	55
XA 5068	Spacer, generator K-A-661	1	5/8#	.30	55
XA 5069	Key, Woodruff #127 K-X-46-1	1	32 pcs. 1#	.05	55
XA 5070	Bearing, ball - ND-7505	1	3 pcs. 1#	2.05	55
XA 5071	Washer, lock nut - K-A-663	1	54 pcs. 1#	.05	55
XA 5072	Nut, Castle 7/8" NF K-A-662	1	9 pcs. 1#	.15	55
XA 5073	Pin, cotter 1/8" x 1¼" K-X-37-1	2	xx	.03	
XA 5074	Jaw, starting crank K-D-597	1	1/2#	.80	55
XA 5075	Slinger, oil - K-D-3583	1	10 pcs.1#	.05	55
XA 5076	Gear, crankshaft- K-A-522	1	3/4#	1.15	55
XA 5077	Shaft, crank - K-A-505	1	12½#	17.30	55
XA 5078	Fan, generator - K-K-833	1	2#	.95	55
XA 5079	Shims, connecting rod .063 - K-A-617	8	148 pcs. 1#	.03	56
XA 5080	Shims, connecting rod .008 - K-A-618	16	xx	.03	56
XA 5081	Shims, connecting rod .002 - K-A-619	32	xx	.03	56
XA 5082	Nut, Castle 5/16" NF K-X-86-1	8	86 pcs. 1#	.03	56
XA 5083	+Pin, cotter 1/16"x¾" K-X-36-2	9	xx	.03	
XA 5084	Bearing, connecting rod - K-A-1-517	4	3 pcs. 1#	.90	56

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Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 5085	Ring, comp. - Std. (For oversize see 5482, 5483, 5484 and 5485) - K-A-826	12	xx	$ .15	56
XA 5086	Ring, oil - standard (For oversize see 5486, 5487, 5488 and 5489) - K-D-2448	4	xx	.20	56
XA 5087	Piston, specify size (See 5478) - K-D-508	4	3/4#	1.25	56
XA 5088	Retainer, piston pin K-D-966	8	xx	.03	56
XA 5089	Bushing, connecting rod K-A-512	4	19 pcs. 1#	.15	56
XA 5090	Pin, piston - standard (For oversize see 5479, 5480 & 5481) K-A-510	4	11 pcs. 1#	.15	56
XA 5091	Rod, connecting - K-A-507	4	3/4#	1.65	56
XA 5092	Bolts, connecting rod K-A-601	8	30 pcs. 1#	.05	56
XA 5093	Rod, connecting assembly K-A-1-507	4	1-1/4#	2.40	56
XA 5094	Tube, oil return assembly K-A-1-606	1	12 pcs. 1#	.15	58
XA 5095	Nut, oil line - K-A-616	5	35 pcs.1#	.05	
XA 5096	Elbow, oil line - K-A-607	2	20 pcs. 1#	.10	58
XA 5097	Nut, hex. 5/16" NF K-X-82-1	20	118 pcs. 1#	.03	
XA 5098	Arm, rocker - R.H. K-A-533	4	5 pcs. 1#	.45	58
XA 5099	Shaft, rocker arm - K-A-1-537	1	2 pcs. 1#	1.45	58
XA 5100	Bracket, rocker arm shaft center - K-A-539	1	4 pcs. 1#	.85	58
XA 5101	Bushing, rocker arm - K-A-542	8	32 pcs. 1#	.05	58
XA 5102	Screw, rocker arm - K-D-535	8	34 pcs. 1#	.10	58
XA 5103	Spring, rocker arm - K-A-540	2	106 pcs. 1#	.03	58
XA 5104	Washer, rocker arm spacing K-A-541	6	78 pcs. 1#	.03	58
XA 5105	Shaft, rocker arm assembly - K-A-2-537	1	2 pcs. 1#	1.45	58
XA 5106	Rods, push - K-D-600	8	8 pcs. 1#	.20	58
XA 5107	Tappet, valve - K-A-543	8	5 pcs. 1#	.30	58
XA 5108	Tube, oil pump - K-A-1-611	1	10 pcs. 1#	.30	58
XA 5109	Bracket, rocker arm shaft - end - K-A-538	2	5 pcs. 1#	.80	58
XA 5110	Arm, rocker - L.H. K-A-534	4	6 pcs.1#	.40	58
XA 5111	Arm, rocker assembly (with bushing) R.H. K-A-1-533	4	5 pcs. 1#	.45	58
XA 5112	Arm, rocker assembly (with bushing) L.H. K-A-1-534	4	5 pcs. 1#	.45	58

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Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 5113	Stud, 5/16" x 2-5/8" NC & NF - K-B-897	3	18 pcs. 1#	$ .05	60
XA 5114	Head, cylinder -assembly complete - K-K-2-502	1	20-1/4#	17.25	60
XA 5115	Gasket, exhaust manifold front - K-A-695	1	100 pcs. 1#	.05	60
XA 5116	Manifold, exhaust- K-5451	1	4-7/8#	1.40	60
XA 5117	Gasket, carburetor flange K-A-657	1	xx	.05	60
XA 5118	Key, valve spring K-A-532	8	107 pcs. 1#	.03	60
XA 5119	Retainer, valve spring K-A-531	8	100 pcs. 1#	.03	60
XA 5120	Springs, valve - K-A-530	8	22 pcs. 1#	.05	60
XA 5121	Valves, intake - K-D-529	4	10 pcs. 1#	.30	60
XA 5122	Valves, exhaust - K-S-120	4	10 pcs. 1#	.60	60
XA 5123	Head, cylinder (with valve guides)K-A-1-502	1	18½#	13.65	60
XA 5124	Guides, valve stem K-A-528	8	5 pcs. 1#	.15	60
XA 5125	Washer, copper 3/8" K-D-972	2	xx	.05	60
XA 5126	Studs, exhaust man.3/8"x 2-5/8" NC - K-A-558	2	13 pcs. 1#	.03	60
XA 5127	Nut, exhaust man. stud 3/8" N.C. brass K-A-559	2	41 pcs. 1#	.05	60
XA 5128	Gasket, cylinder head K-A-649	1	5 pcs. 1#	.40	60
XA 5129	Gasket, exhaust manifold center - K-A-696	1	63 pcs. 1#	.05	60
XA 5130	Gasket, exhaust manifold - rear - K-A-697	1	82 pcs. 1#	.05	60
XA 5131	Screw, Rd.Hd. Mach. #8x 3/8" NF - K-X-51-12	3	xx	.03	
XA 5132	Washer, Lock 3/16" - K-X-19-1	14	xx	.03	
XA 5133	Plate, exhaust manifold K-5452	1	11 pcs. 1#	.05	60
XA 5134	Nut, wing 5/16" NF - K-A-589	2	51 pcs. 1#	.03	62
XA 5135	Screw, Rd.Hd. Mach. #10 x 1/2" NF - K-X-50-1	7	xx	.03	
XA 5136	Gasket, cylinder head cover - K-A-653	1	72 pcs. 1#	.05	62
XA 5137	Manifold - assembly K-5519-M	1	2#	3.40	62
XA 5138	Handle, choker valve K-B-920	1	82 pcs. 1#	.05	62
XA 5139	Valve, choker assembly K-5525	1	31 pcs. 1#	.25	62
XA 5140	Manifold - choker K-5521-1	1	1-3/4#	2.45	62
XA 5141	Plug, cylinder casting 1-1/8" - K-A-806-A	1	50 pcs. 1#	.05	62
XA 5142	Cap, oil filler K-A-621	1	4 pcs. 1#	.15	62
XA 5143	Cover, cylinder head K-A-511	1	5-1/2#	1.50	62

xx Over 200 Pcs. per Lb. +As required #Price per 100 Pcs.

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 5144	Nut, wing 1/4" NC UA-AC-1782	1	89 pcs. 1#	$ .05	62
XA 5145	Filter and cover UA-AC-1779	1	5/8#	6.50	62
XA 5146	Bowl, air cleaner UA-AC-1778	1	5/8#	3.50	62
XA 5147	Clamp, air filter UA-AC-1789	1	20 pcs. 1#	.35	62
XA 5148	Screw, fill. hd. #12 x 5/8" NC - K-X-52-25	1	119 pcs. 1#	.03	62
XA 5149	Filter, air - assembly (H40-12145) UA-AC-1788	1	1-1/4#	10.00	62
XA 5150	Washer, oil pump spring K-D-566	2	61 pcs. 1#	.03	64
XA 5151	Plunger, oil pump K-D-564	1	3/8#	.40	64
XA 5152	Washer, ball retainer K-D-996	1	188 pcs. 1#	.03	64
XA 5153	Plug, oil pump passage K-D-995	1	16 pcs. 1#	.10	64
XA 5154	Spring, oil pump plug K-D-565	1	22 pcs. 1#	.05	64
XA 5155	Ball, oil pump outlet 1/2" - K-D-624	1	54 pcs. 1#	.03	64
XA 5156	Ball, oil pump inlet 3/8" - K-D-623	1	137 pcs. 1#	.03	64
XA 5157	Tee, compression - K-D-227	1	21 pcs. 1#	.20	64
XA 5158	Plug, oil pump lead K-D-588	1	49 pcs. 1#	.15	64
XA 5159	Nipple, oil pump K-D-571	1	6 pcs. 1#	.10	64
XA 5160	Body, oil pump - K-D-561	1	1-1/2#	1.15	64
XA 5161	Pump, oil - assembly K-D-560	1	2#	2.30	64
XA 5162	Washer, copper 5/16" K-D-997	6	xx	.03	64
XA 5163	Screw, hex. cap 5/16"x 3/4" N.C. - K-X-6-11	10	38 pcs. 1#	.03	
XA 5164	Cover, oil base end K-D-973	1	1-5/8#	.25	64
XA 5165	Gasket, end cover K-D-974	1	30 pcs. 1#	.05	64
XA 5166	Plate, oil pan baffle K-D-504	1	1-1/2#	.25	64
XA 5167	Washer, lock 1/4" K-X-20-1	14	xx	.03	
XA 5168	Bushing, reducer - K-D-228	1	14 pcs. 1#	.15	64
XA 5169	Strainer, oil assembly K-D-1012	1	3 pcs. 1#	.50	64
XA 5170	Plug, oil strainer K-D-568	1	7/8#	.20	64
XA 5171	Strainer, oil assembly K-D-1-567	1	1-1/4#	.60	64

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Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 5172	Washer, oil drain plug K-A-569	1	130 pcs. 1#	$ .03	64
XA 5173	Gasket, oil base right K-A-651	1	180 pcs. 1#	.05	64
XA 5174	Pan, oil - K-A-503	1	50#	11.40	64
XA 5175	Conn. comp. (1/8" I.P. 1/4" tubing) - K-A-823	3	25 pcs. 1#	.10	
XA 5176	Sleeve, comp. (1/4" tubing) - K-A-825	4	xx	.03	
XA 5177	Nut, comp. (1/4" tubing) K-A-824	4	xx	.05	
XA 5178	Tube, oil pump assembly K-A-1-615	1	11 pcs. 1#	.15	64
XA 5179	Connector, oil line 7/16" NF - K-A-605	1	27 pcs. 1#	.10	64
XA 5180	Gasket, oil base left K-A-652	1	188 pcs. 1#	.05	64
XA 5181	Stud, oil pump 3/8" x 1-5/16" NC NF - K-A-574	2	26 pcs. 1#	.03	64
XA 5182	Tube, pump to block K-D-224	1	13 pcs. 1#	.30	64
XA 5183	Cap, radiator - K-K-580-2	1	4 pcs. 1#	1.50	63
XA 5184	Gasket, radiator cap K-A-843-3	1	xx	.10	63
XA 5185	Radiator (includes cap and gasket) - K-K-577-3	1	17#	21.70	63
XA 5186	Screw, sheet metal #10 K-X-67-3	4	xx	.03	63
XA 5187	Manifold, water outlet K-K-582	1	3-3/8#	1.50	63
XA 5188	Bracket, fan support K-5424	1	1/2#	1.50	63
XA 5189	Screw, hex. cap 5/16" x $1\frac{1}{4}$" N.C. - K-X-6-2	3	28 pcs. 1#	.03	
XA 5190	Gasket, water manifold K-A-655	1	188 pcs. 1#	.05	63
XA 5191	Manifold, water inlet K-K-581	1	2-5/8#	1.05	63
XA 5192	Cock, drain 1/8" - K-A-599	1	18 pcs. 1#	.20	63
XA 5193	Nut, hex. 5/16" N.C. K-X-82-2	1	51 pcs. 1#	.03	63
XA 5194	Screw, fan adjusting K-5423	1	18 pcs. 1#	.10	63
XA 5195	Belt, fan - K-5446	1	4 pcs. 1#	.85	63
XA 5196	Guard, fan - K-5422	1	1/2#	1.50	63
XA 5197	Nut, drive shaft - K-A-627	1	22 pcs. 1#	.10	66
XA 5198	Washer, magneto drive shaft - K-A-628	1	22 pcs. 1#	.03	66
XA 5199	Gear, magneto drive K-A-524	1	3/4#	1.15	66
XA 5200	Washer, thrust - K-A-629-1	1	24 pcs. 1#	.20	66
XA 5201	Gasket, governor housing K-A-659	1	xx	.05	66
XA 5202	Housing, governor K-D-1301	1	2#	1.50	66

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Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 5203	Plug, governor housing K-D-1307	1	xx	$ .03	66
XA 5204	Nut, hex. - galv. 1/4" NC - K-B-936	1	161 pcs. 1#	.03	66
XA 5205	Screw, set 1/4"x3/4" sq. hd. - K-X-60-10	1	99 pcs. 1#	.05	66
XA 5206	Shaft, magneto drive (includes hub & pin) K-A-1-630	1	1-1/4#	3.05	66
XA 5207	Pin, fly weight - K-A-639	2	40 pcs. 1#	.03	66
XA 5208	Pin, cotter 1/16"x½" K-X-36-1	14	xx	.03	66
XA 5209	Spring, governor - K-A-646	2	57 pcs. 1#	.10	66
XA 5210	Key, Woodruff #6 - K-X-44-1	1	xx	.03	66
XA 5211	Stud, sliding sleeve K-A-638	2	119 pcs. 1#	.03	66
XA 5212	Bearing, sliding sleeve-assembly - K-A-1-642	1	8 pcs. 1#	1.05	66
XA 5213	Key, Woodruff #3 - K-X-43-1	2	xx	.03	
XA 5214	Weight, governor lever K-A-837	1	3/4#	.25	66
XA 5215	Nut, hex. - brass #8 NC K-X-72-2	1	xx	.03	66
XA 5216	Screw, rd. hd. #8 x 1" NC - K-X-51-3	1	40 pcs. 1#	.03	66
XA 5217	Ring, lock - K-A-654	1	xx	.05	66
XA 5218	Pin, link - K-A-851	2	69 pcs. 1#	.03	66
XA 5219	Weight, governor fly K-A-635	2	6 pcs. 1#	.25	66
XA 5220	Fork, governor with lever assembly K-D-1312-1	1	5/8#	2.00	66
XA 5221	Nut - K-A-861	2	xx	.03	66
XA 5222	Joint, ball - K-A-774	1	18 pcs. 1#	.20	66
XA 5223	Rod, ball joint - K-D-1308	1	20 pcs. 1#	.15	66
XA 5224	Pin, governor link K-A-640	2	64 pcs. 1#	.03	66
XA 5225	Washer, link plate K-A-645	4	xx	.03	66
XA 5226	Plate, link - K-A-664	8	105 pcs. 1#	.03	66
XA 5227	Sleave, sliding - K-A-641	1	5 pcs. 1#	.70	66
XA 5228	Bearing, ball - ND-3202	1	10 pcs. 1#	1.15	66
XA 5229	Gasket, governor housing cover - K-D-1306	1	xx	.03	66
XA 5230	Cover, governor housing K-D-1302	1	1-1/8#	1.00	66
XA 5231	Coupling, magneto - female - K-A-669	1	5 pcs. 1#	.75	66
XA 5232	Pump, fuel assembly AC-1521799	1	2-1/8#	2.95	68
XA 5233	Valve - AC-855003	2	27 pcs. 1#	.03	68
XA 5234	Spring, valve- AC-856270	2	xx	.03	68

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Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 5235	Screw, fill. hd. #10 x 5/8" NF - K-X-15-1	6	180 pcs. 1#	$ .03	68
XA 5236	Plug, valve - AC-855135	2	xx	.20	68
XA 5237	Cover, valve seat - assembly - AC-1523358	1	5/8#	1.30	68
XA 5238	Nut, hex. - brass 1/4" NF - K-X-76-1	9	188 pcs. 1#	.03	
XA 5239	Washer, diaphragm alignment - AC-855029	1	151 pcs. 1#	.05	68
XA 5240	Line, fuel - K-D-3710	1	7 pcs. 1#	.20	68
XA 5241	Protector, diaph.-upper AC-1521194	1	32 pcs. 1#	.25	68
XA 5242	Diaphragm - AC-855035	1	65 pcs. 1#	.25	68
XA 5243	Protector, diaph.- lower - AC-855078	1	46 pcs. 1#	.25	68
XA 5244	Lever, priming - AC-1522280	1	27 pcs. 1#	.35	68
XA 5245	Body, fuel pump AC-856122	1	5/8#	2.50	68
XA 5246	Gasket, bottom cover AC-855229	1	xx	.03	68
XA 5247	Cover, bottom -AC-855228	1	8 pcs. 1#	1.50	68
XA 5248	Screw, fill. hd. #10 x 3/8" NF - K-X-15-3	3	xx	.03	68
XA 5249	Spring, rocker arm AC-855253	2	130 pcs. 1#	.05	68
XA 5250	Cap, spring - AC-855532	2	xx	.10	68
XA 5251	Gasket, fuel pump - K-D-3713	1	xx	.05	68
XA 5252	Screw, hex. cap 5/16" x 1/2" NC - K-X-6-1	6	47 pcs. 1#	.03	
XA 5253	Link - AC-855374	2	44 pcs. 1#	.25	68
XA 5254	Gasket, valve plug - AC-855136	2	xx	.03	68
XA 5255	Screen - AC-854009	1	xx	.10	68
XA 5256	Gasket, bowl - AC-854003	1	xx	.03	68
XA 5257	Bowl, glass - AC-1522092	1	6 pcs. 1#	.15	68
XA 5258	Seat, bowl - AC-854005	1	140 pcs. 1#	.10	68
XA 5259	Bail, with screw AC-1522090	1	15 pcs. 1#	.20	68
XA 5260	Nut, bail - thumb AC-855763	1	49 pcs. 1#	.10	68
XA 5261	Gasket, pull rod AC-855012	1	xx	.03	68
XA 5262	Rod, pull - AC-855250	1	21 pcs. 1#	.25	68
XA 5263	Pin, link - AC-855016	2	xx	.05	68
XA 5264	Clip, link pin - AC-855017	4	xx	.05	68
XA 5265	Pin, rocker arm - AC-1521289	1	45 pcs. 1#	.05	68
XA 5266	Washer, rocker arm AC-1521269	2	xx	.03	68
XA 5267	Arm, rocker - AC-1521986	1	6 pcs. 1#	1.85	68
XA 5268	Blade, fan - SC-B-1954	1	1#	1.15	69
XA 5269	Gasket, fan hub - K-D-783	1	xx	.10	69
XA 5270	Washer, lock 3/8" shake-proof - K-X-22-8	2	xx	.03	69

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Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 5271	Retainer, shaft spring SC-C-2495	1	76 pcs. 1#	$ .30	69
XA 5272	Spring, shaft cone adj. SC-C-2498	1	38 pcs. 1#	.15	69
XA 5273	Washer, shaft cone clamp SC-C-2496	1	121 pcs. 1#	.15	69
XA 5274	Bearing, fan shaft SC-C-2814	1	16 pcs. 1#	2.65	69
XA 5275	Hub, fan - SC-C-19147	1	4 pcs. 1#	2.50	69
XA 5276	Bearing, fan shaft SC-C-2815	1	7 pcs. 1#	2.65	69
XA 5277	Washer, felt retainer SC-C-2493	1	44 pcs. 1#	.15	69
XA 5278	Gasket, felt retainer SC-C-3837	1	xx	.10	69
XA 5279	Washer, felt - SC-C-2494	1	xx	.15	69
XA 5280	Retainer, fan hub felt SC-C-2492	1	26 pcs. 1#	.40	69
XA 5281	Spindle, fan - SC-C-19148	1	xx	2.40	69
XA 5282	Washer, fan shaft SC-C-3793	1	12 pcs. 1#	.20	69
XA 5283	Washer, fan shaft nut SC-C-1263	1	48 pcs. 1#	.05	69
XA 5284	Nut, hex. 5/8" N.F. K-X-85-2	1	21 pcs. 1#	.03	69
XA 5285	Oiler, fan - SC-C-8650	1	24 pcs. 1#	.15	69
XA 5286	Fan, assembly (Old Style) K-5425	1	4 lbs.	7.15	69
XA 5287	Fan, assembly - K-7004	1	4-3/8 lbs.	7.15	69
XA 5288	Blade, fan - SC-F-4801	1	1-1/8 lbs.	2.40	69
XA 5289	Ring, fan bearing snap SC-C-114071	2	40 pcs. 1#	.10	69
XA 5290	Bearing, fan - SC-C-1140692	2	9 pcs. 1#	2.65	69
XA 5291	Hub, fan - SC-B-114067	1	2-1/4#	1.45	69
XA 5292	Spacer, fan bearing SC-C-114070	1	19 pcs. 1#	.25	69
XA 5293	Shaft, fan - SC-C-114068	1	3 pcs. 1#	1.65	69
XA 5294	Screw, assembly - Z-T-1-S10-7	2	181 pcs. 1#	.05	70
XA 5295	Washer, screw assem. lock - Z-T-11-10	2	xx	.03	70
XA 5296	Washer, lower plug Z-T-56-23	4	xx	.05	70
XA 5297	Screen, filter - assembly Z-C-140-24	1	62 pcs. 1#	.30	70
XA 5298	Seat, fuel valve, assembly Z-C-81-26	1	29 pcs. 1#	.75	70
XA 5299	Gasket, cover- Z-C-144-10	1	xx	.05	70
XA 5300	Body, carburetor assembly Z-B-21A	1	1-1/4#	7.50	70
XA 5301	Plug, overflow - K-D-3654	1	73 pcs. 1#	.25	70
XA 5302	Plug, lower - Z-C-138-23	2	xx	.35	70
XA 5303	Cover, carburetor - assembly - Z-C-6-14	1	5 pcs. 1#	3.15	70

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Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 5304	Float - assembly Z-C-85-8	1	44 pcs. 1#	$ .65	70
XA 5305	Axle, float - Z-C-120-4	1	xx	.10	70
XA 5306	Lever, throttle - K-A-832	1	56 pcs. 1#	.78	70
XA 5307	Pin, throttle lever K-A-1573	1	xx	.10	70
XA 5308	Shaft, throttle-K-A-1566	1	41 pcs. 1#	.55	70
XA 5309	Shaft, butterfly arm Z-C-29-494	1	22 pcs. 1#	1.40	70
XA 5310	Screw, butterfly retainer Z-C-136-1	2	xx	.05	70
XA 5311	Valve, butterfly Z-C-21-8	1	68 pcs. 1#	1.20	70
XA 5312	Washer, carburetor jet Z-T-56-24	2	xx	.05	70
XA 5313	Jet, compensating #11 Z-C-52-3	1	xx	.55	70
XA 5314	Jet, main #8 - Z-C-52-24	1	200 pcs. 1#	.60	70
XA 5315	Carburetor - complete Z-0-10042	1	1-5/8#	12.50	70
XA 5316	Washer, rotor felt ret. AB-WA-5245	1	175 pcs. 1#	.05	70
XA 5317	Plate, name - type AB-NP-521	1	105 pcs. 1#	.10	71
XA 5318	Coil, high tension AB-CL-5238	1	1#	5.15	71
XA 5319	Clip, coil cable term. AB-EC-5224	1	xx	.05	71
XA 5320	Housing, magneto AB-HG-5216	1	4-1/2#	8.29	71
XA 5321	Washer, ventilator cover AB-WA-5281	1	140 pcs. 1#	.05	71
XA 5322	Gasket, ventilator cover AB-GA-5215	1	xx	.05	71
XA 5323	Cover, ventilator - AB-CV-52126	1	25 pcs. 1#	.15	71
XA 5324	Plate, name - ventilator cover - AB-NP-5222	1	123 pcs. 1#	.10	71
XA 5325	Coupling, magneto male K-A-670	1	5 pcs. 1#	.75	71
XA 5326	Washer, lock - AB-WA-6-3-CA	2	xx	.05	71
XA 5327	Screw, vent cover AB-SC-37-8-CA	2	xx	.05	71
XA 5328	Screw, magneto coil lock AB-SC-1060	2	100 pcs. 1#	.05	71
XA 5329	Cable, coil - specify length - AB-KL-100057	1	151 pcs. 1#	.05	71
XA 5330	Clip, terminal - AB-EC-1012	1	xx	.05	71
XA 5331	Bearing, ball - AB-BB-60226	2	13 pcs. 1#	1.55	71
XA 5332	Washer, bearing spacing AB-WA-1034	2	130 pcs. 1#	.05	71
XA 5333	Shim, bearing .0126 AB-WA-61	+	xx	.05	71

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XA 5334	Shim, bearing .0071 AB-WA-106	+	xx	$ .05	71
XA 5335	Shim, bearing .0040 AB-WA-107	+	xx	.05	71
XA 5336	Shim, bearing .0197 AB-WA-1009	+	xx	.05	71
XA 5337	Washer, rotor felt AB-WA-81751	3	xx	.05	71
XA 5338	Bracket, interrupter assembly - AB-BK-5259	1	3 pcs. 1#	1.30	71
XA 5339	Strip, packing ball bearing - AB-IS-504	2	xx	.05	71
XA 5340	Plate, locking - AB-PL-52125	2	xx	.05	71
XA 5341	Washer, interrupter lever stud - AB-WA-1012	1	xx	.05	71
XA 5342	Washer, interrupter brkt. lock - AB-WA-21-5	2	xx	.05	71
XA 5343	Pin, interrupter lever stud - AB-PN-1007	1	xx	.05	71
XA 5344	Screw, interrupter bracket - AB-SC-41-8-CA	2	xx	.05	71
XA 5345	Bracket, contact - with point - AB-BK-566	1	52 pcs. 1#	.85	71
XA 5346	Washer, contact brkt. lock - AB-WA-21-4	2	xx	.05	71
XA 5347	Screw, contact brkt. AB-SC-39-5-CA	3	xx	.05	71
XA 5348	Bushing, cable - K-150595	1	72 pcs. 1#	.10	71
XA 5349	Wick, cam oiler AB-WK-5231	1	xx	.05	71
XA 5350	Screw, name plate AB-SC-121-4CA	2	xx	.05	71
XA 5351	Rotor, magneto AB-RT-52105	1	1-3/8#	11.75	71
XA 5352	Plate, distributor AB-DP-52254	1	5/8#	3.50	71
XA 5353	Washer, distr. gear spacing AB-WA-528	1	xx	.05	71
XA5354	Washer, lock - AB-WA-288	5	xx	.05	71
XA 5355	Gear, distributor AB-GE-5282	1	9 pcs. 1#	2.40	71
XA 5356	Screw, magneto grd. AB-SC-24-4CA	1	xx	.05	71
XA 5357	Brush, carbon & spring AB-BR-529	1	xx	.20	71
XA 5358	Gear, rotor AB-GE-5238	1	6 pcs. 1#	.85	71
XA 5359	Ring, shaft spring AB-SP-1021	1	xx	.05	71
XA 5360	Gasket, distributor plate - AB-GA-524	1	137 pcs. 1#	.10	71
XA 5361	Screw, distr. plate AB-SC-1037-CA	4	84 pcs. 1#	.05	71
XA 5362	Washer, fastening screw AB-WA-98922	4	xx	.05	71
XA 5363	Washer, sealing AB-WA-5280	4	xx	.05	71
XA 5364	Nipple, rubber insul. AB-IS-82927	4	126 pcs. 1#	.05	71

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Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 5365	Cable, magneto #1 K-D-3011-1	1	13 pcs. 1#	$ .20	71
XA 5366	Cable, magneto #2 K-D-3011-2	1	13 pcs. 1#	.20	71
XA 5367	Cable, magneto #3 K-D-3011-3	1	16 pcs. 1#	.20	71
XA 5368	Cable, magneto #4 K-D-3011-4	1	13 pcs. 1#	.20	71
XA 5369	Washer, rotor gear spacing - AB-WA-1070	1	xx	.05	71
XA 5370	Shaft, rotor gear AB-SD-5249	1	48 pcs. 1#	.10	71
XA 5371	Ring, shaft spring AB-SP-5254	1	xx	.05	71
XA 5372	Condenser - AB-CW-5232	1	23 pcs. 1#	.70	71
XA 5373	Bracket, wick ret. AB-BK-5283	1	xx	.10	71
XA 5374	Washer, lock - AB-WA-5-4	1	xx	.05	71
XA 5375	Washer, fastening screw lock - AB-WA-6-3-CA	1	xx	.05	71
XA 5376	Screw, conducting lead AB-SC-37-5-CA	1	xx	.05	71
XA 5377	Lever, interrupter AB-LE-5236	1	86 pcs. 1#	.60	71
XA 5378	Magneto - assembly (less XA-5325) K-D-3001	1	8-1/4#	35.00	71
XA 5379	Bushing, conduit K-C-1217	3	32 pcs. 1#	.03	74
XA 5380	Lead - K-5959	1	74 pcs. 1#	.10	74
XA 5381	Nut, bushing lock K-C-1218	3	114 pcs. 1#	.03	74
XA 5382	Nut, hex. #10 NF K-X-70-3	3	xx	.03	74
XA 5383	Washer, flat 1/4"K-D-1509	10	xx	.03	
XA 5384	Bushing, insulating K-E-1237	2	33 pcs. 1#	.15	74
XA 5385	Bracket, coil support K-E-1236	2	42 pcs. 1#	.25	74
XA 5386	Coil, resistance K-E-1234	1	3 pcs. 1#	.15	74
XA 5387	Screws, rd. hd. mach. #6x7 NC - K-X-4916	1	46 pcs. 1#	.03	74
XA 5388	Nut, hex. #8 NC K-X-72-4	4	xx	.03	74
XA 5389	Washer, flat 3/8" O.D. 5/32" I.D. - K-X-25-9	3	xx	.03	74
XA 5390	Screw, rd.hd. mach. #8 x 5/8" NC - K-X-51-9	2	xx	.03	74
XA 5391	Clip, adjustable - K-E-1235	1	80 pcs. 1#	.20	74
XA 5392	Nut, hex. #6 NC K-X-71-2	1	xx	.03	74
XA 5393	Coil, resis. assembly K-E-1233	1	4 pcs. 1#	1.75	74
XA 5394	Ring, lock - K-1515-11	1	xx	.05	74
XA 5395	Plate, instruction K-151508	1	xx	.30	74
XA 5396	Nut, lock - K-151523	1	xx	.10	74
XA 5397	Switch, manual (includes XA-5405) E1206 K-C-1200-1	1	4#	5.90	74

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Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 5398	Screw, rd.hd.mach. #10x 11/16" NC K-X-50-31	2	164 pcs. 1#	$ .03	74
XA 5399	Washer, lock shakeproof K-X-22-9	2	xx	.03	74
XA 5400	Screw, rd. hd. mach. #10x3/8" NF K-X-50-2	1	xx	.03	74
XA 5401	Condenser - K-AC-1539	1	12 pcs. 1#	.50	74
XA 5402	Fuse - 25 ampere K-A-804	2	17 pcs. 1#	.10	74
XA 5403	Switch, snap - K-151510-2	1	20 pcs. 1#	1.00	74
XA 5404	Wire, magneto ground K-E-816	1	36 pcs. 1#	.10	74
XA 5405	Switch, knife - complete K-E-1206	1	1-1/8#	2.25	74
XA 5406	Switch, manual - assembly K-E-1200	1	6-1/8 lbs.	7.75	74
XA 5407	Bushing, insulating K-D-1511	1	60 pcs. 1#	.10	72
XA 5408	Plate, brush support K-D-1502	1	2#	1.10	72
XA 5409	Screw, fill. hd. 5/16" x 1" NC - K-X-53-3	1	40 pcs. 1#	.03	72
XA 5410	Screw, hex. cap 3/8" x 1-5/8" NC - K-X-7-4	4	16 pcs. 1#	.03	72
XA 5411	Bracket, armature support K-D-716	1	14#	6.30	72
XA 5412	Gasket, generator ball bearing - K-B-903	1	xx	.03	72
XA 5413	Cover, generator - K-D-730	1	2-1/2#	1.60	72
XA 5414	Screws, fill.hd. 1/4" x 1/2" NC K-X-52-1	4	96 pcs. 1#	.05	72
XA 5415	Washer, insulating - K-D-1508	8	188 pcs. 1#	.05	72
XA 5416	Bushing, insulating K-D-1507	4	xx	.05	72
XA 5417	Pole, Field - assembly K-D-1-722	4	3-1/4#	1.35	72
XA 5418	Insulator, lead - K-D-234	1	xx	.02	72
XA 5419	Lead, negative - K-D-975	1	6 pcs. 1#	.25	72
XA 5420	Lead, shunt field - K-D-960	1	39 pcs. 1#	.03	72
XA 5421	Lead, series field - K-E-958	1	19 pcs. 1#	.30	72
XA 5422	Coil, field - lower left K-E-766	1	4-1/4#	4.55	72
XA 5423	Coil, field - upper left K-E-767-1	1	4-1/4#	4.55	72
XA 5424	Coil, field - lower right K-E-765	1	4-1/4#	4.55	72
XA 5425	Coil, field - upper right K-E-764-1	1	4-1/4#	4.55	72
XA 5426	Lead, brush - K-D-1130	1	20 pcs. 1#	.05	72
XA 5427	Coil, field assembly K-E-1-723	1	17-1/8#	18.20	72
XA 5428	Studs, brush holder K-D-1505	4	11 pcs. 1#	.10	72

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XA 5429	Arm, brush holder K-D-947-2	4	18 pcs. 1#	$ .20	72
XA 5430	Body, brush holder K-D-946-3	4	6 pcs. 1#	.30	72
XA 5431	Spring, brush holder K-D-948	4	100 pcs. 1#	.05	72
XA 5432	Screw, set - brass 5/16"x 5/8" NC - K-D-950	4	92 pcs. 1#	.03	72
XA 5433	Pin, brush holder - K-D-949	4	105 pcs. 1#	.03	72
XA 5434	Nut, hex. brass 5/16" NC - K-D-951	4	xx	.03	72
XA 5435	Holder, generator brush K-D-741-2	4	8 pcs. 1#	.55	72
XA 5436	Bracket, switch support L.H. - K-D-980	1	7/8#	.30	72
XA 5437	Bracket, switch support R.H. - K-D-979	1	7/8#	.30	72
XA 5438	Nut, hex. 3/8" NC K-X-83-2	2	34 pcs. 1#	.03	
XA 5439	Frame, generator - K-D-714	1	68#	10.05	72
XA 5440	Bushing, rubber K-D-229	1	63 pcs. 1#	.10	72
XA 5441	Screw, hex. cap 3/8"x 1-1/4" NC - K-X-7-2	8	19 pcs. 1#	.03	72
XA 5442	Screen, generator frame K-D-860	2	10 pcs. 1#	.15	72
XA 5443	Screw, hex. cap 3/8" x 2-1/2" NC - K-X-7-5	8	11 pcs. 1#	.03	72
XA 5444	Armature - K-D-768	1	56#	30.00	72
XA 5445	Brush,generator - K-D-742	4	29 pcs. 1#	.35	72
XA 5446	Pin,starting crank spring K-C-1204	1	64 pcs. 1#	.03	75
XA 5447	Guide, starting crank K-C-1202	1	4 pcs. 1#	.10	75
XA 5448	Crank, starting K-C-593	1	2 lbs.	.90	75
XA 5449	Pin, starting crank K-A-596	1	35 pcs. 1#	.03	75
XA 5450	Support, starting crank K-C-1201	1	7/8#	.35	75
XA 5451	Spring, starting crank K-C-1209	1	42 pcs. 1#	.03	75
XA 5452	Crank, starting - assembly - K-C-1-593	1	3-5/8#	1.55	75
XA 5453	Gauge, valve feeler .006 K-B-1-913	1	133 pcs. 1#	.03	76
XA 5454	Gauge, point setting AB-GG-552	1	xx	.05	76
XA 5455	Bag, tool - K-B-915	1	xx	.10	76
XA 5456	Wrench, spark plug (1 x 1-1/8" hex.) K-D-831	1	5/8#	.30	76
XA 5457	Elbow, compression - comp. (1/8" I. P. 1/4" tubing) K-A-822	1	20 pcs. 1#	.15	76
XA 5458	Nipple, pipe 1-1/4" x 4" I.P. - K-A-48	1	2-3/4#	.25	76

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XA 5459	Kit, tool - K-D-965	1	5-1/4#	$ .90	76
XA 5460	Plant, light - Type E 110 volts, 1500 Watts	1	475#	421.00	77
XA 5461	Nipple, 1¼" x 3"	1	2 pcs. 1#	.13	77
XA 5462	Elbow, 1¼" x 90°	1	1#	.40	77
XA 5463	Pipe, 1¼"x26"-thread one end	1	5#	1.15	77
XA 5464	Nipple, 3/8" x 2"	1	10 pcs.1#	.05	77
XA 5465	Bushing, reducer - 3/4" x 3/8" W. I.	1	10 pcs. 1#	.07	77
XA 5466	Elbow, 3/8" x 45° - W.I.	1	7 pcs. 1#	.14	77
XA 5467	Nipple, 3/8" x 7"	1	3 pcs. 1#	.11	77
XA 5468	Elbow, 3/8" x 90° - W.I.	1	6 pcs. 1#	.14	77
XA 5469	Plug, pipe - 3/8"	1	20 pcs. 1#	.04	77
XA 5470	Nut, hexagon - 1/2" N.C.	4	14 pcs. 1#	.02	77
XA 5471	Washer, lock - 1/2"	4	80 pcs. 1#	.60*	77
XA 5472	Door, house - 22SM162	2	10#	3.25	77
XA 5473	House, light plant 211UA16	1	103#	45.00	77
XA 5474	Bolt, machine - 3/8" x 1" N.C.	4	19 pcs. 1#	.03	77
XA 5475	Strip, mounting - 4225A739	2	2 pcs. 1#	.55	77
XA 5476	Bolt, machine - 1/2" x 3¾" N.C.	4	4 pcs. 1#	.05	77
XA 5477	Pan, oil assembly less XA5173 & XA5180 K-A-2-503	1	54#	17.75	

OVERSIZE ENGINE PARTS

Part No.	Name and Description of Part	Qty.	Approx. Weight	Price Each	Page No.
XA 5478	Piston, semi-finished K-D-508-1	-	3/4#	$1.05	
XA 5479	Pin, piston - .003 oversize - K-A-510-3	-	11 pcs.1#	.15	
XA 5480	Pin, piston-.005 over-size - K-A-510-5	-	11 pcs.1#	.15	
XA 5481	Pin, piston-.010 over-size - K-A-510-10	-	11 pcs.1#	.15	
XA 5482	Ring, comp. - .005 oversize - K-A-826-5	-	xx	.15	
XA 5483	Ring, comp. - .010 oversize - K-A-826-10	-	xx	.15	
XA 5484	Ring, comp. - .020 oversize - K-A-826-20	-	xx	.15	
XA 5485	Ring, comp. - .030 oversize - K-A-826-30	-	xx	.15	
XA 5486	Ring, oil - .005 oversize - K-D-2448-5	-	xx	.20	
XA 5487	Ring, oil - .010 oversize - K-D-2448-10	-	xx	.20	
XA 5488	Ring, oil - .020 oversize - K-D-2448-20	-	xx	$ .20	
XA 5489	Ring, oil - .030 over-size - K-D-2448-30	-	xx	.20	

xxOver 200 Pcs. per Lb. +As required *Price per 100 Pcs.

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