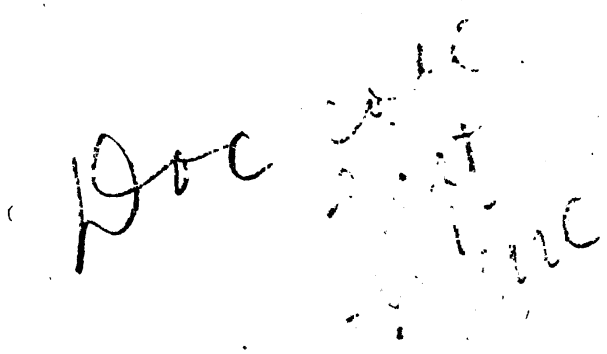
TM 10-510

WAR DEPARTMENT

U.S. Dept. of Agriculture

TECHNICAL MANUAL

THE MOTOR VEHICLE



TECHNICAL MANUAL
No. 10–510

WAR DEPARTMENT,
WASHINGTON, *October 1, 1940.*

THE MOTOR VEHICLE

Prepared under direction of
The Quartermaster General

262001°—40——1

SECTION I

AUTOMOTIVE NOMENCLATURE

1. General.—The following listed nomenclature for automobile parts and assemblies includes definitions pertinent to them or to engineering or commercial automotive practices as standardized by the Society of Automotive Engineers:

a. Where the terms "front" and "rear" are used, "front" should always be toward the front end of the car. Sometimes these terms are confused with regard to parts which are mounted on the dash. The front side of the dash is always the side next to the engine.

b. Where parts are numbered, No. 1 should be toward the front of the car. For instance, No. 1 cylinder is the one nearest the radiator (in conventional construction).

c. "Right" and "left" are to the right and left sides of a vehicle when looking forward from the driver's seat.

d. Studs, screws, and bolts take names from the parts they serve to hold in place, although they are assembled with other parts. For example, the cylinder stud is permanently screwed into the crankcase but holds the cylinder in place.

e. The term "engine" should be used rather than "motor" to avoid confusion with electric motors.

2. Classification by divisions and groups.—For ease in classifying parts and assembles, they are separated into primary divisions, then further subdivided into groups. The detailed itemization of each and every part under the group headings is then shown.

a. Division I.—cylinders.

(*1*) *Group 1—cylinders.*

Cylinder
L-head (valves on one side of cylinder).
T-head (valves on opposite side of cylinder).
I-head (valves in cylinder head).
F-head (one valve in head, other on side directly operated).
(Cast in block, not "cast en bloc.")
(Cylinders of **V**-type engines should be numbered 1R, 1L, 2R, etc.)
Inlet valve cap.
Exhaust valve cap.
Valve cap gasket.
Cylinder head.
Cylinder head:
Gasket.
Plug.
Water jacket:
Top cover.
Top cover gasket.
Side (or front or rear) cover.

Valve spring:
Cover.
Cover gasket.
Cover stud.
Valve stem guide.
Priming cup.

(2) *Group 2—crankcase.*

Crankcase.
Barrel type crankcase.
Split type crankcase (split horizontally at or near center line of crankshaft).
Crankcase upper half.
Crankcase lower half (used only when lower half contains bearings. A crankcase of either barrel or split type in which all bearings are mounted directly on part to which cylinders are attached is called a "crankcase", with terms "upper half" and "lower half" not being used.)
Oil pan (used for lower part of split type or barrel type crankcase, whether this serves as an oil-reservoir or not).
Oil pan drain cock (or plug).
Breather.
Oil pan gasket
Crankshaft:
Front bearing (upper half and lower half).
Front bearing cap.
Bearing cap stud (screw or bolt).
Front bushing support (sometimes used in barrel type crankcase).
Rear bearing.
Rear bearing shims (other shims accordingly).
Center bearing (if only three bearings or if all except end bearings are alike).
Second bearing, etc. (if more than three bearings, for example, front bearing, second bearing, third bearing, fourth bearing, rear bearing).
Hand hole cover.
Hand hole cover gasket.
Timing gear cover.
Timing gear cover gasket.
Flywheel housing.
Generator bracket (other brackets take name of part supported).

(3) *Group 3—crankshaft.*
Crankshaft.
Flywheel.
Crankshaft timing gear (or sprocket).
Crankshaft timing gear key.
Flywheel starter gear.
Crankshaft starter sprocket.
Flywheel bolts.
Clutch spring stud.
Crankshaft starting jaw (or pin).
Crankshaft damper.

(4) *Group 4—starting crank.*
Starting crank.
Starting crank:
Jaw.
Shaft.
Shaft spring.
Handle.
Handle pin.

(5) *Group 5—connecting rods.*
Connecting rod.
Straight connecting rod } V-type engine.
Forked connecting rod }
Connecting rod:
Cap.
Bushing (upper half and lower half).
Cap stud (or bolt).
Cap nut.
Bearing shims.
Dipper.
Piston pin bushing.

(6) *Group 6—pistons.*
Piston:
Pin.
Pin lock screw (in connecting rod or piston).
Ring.
Ring groove.

b. Division II—valves.

(1) *Group 1—camshaft.*
Camshaft.
Eccentric shaft.
Camshaft:

Timing gear.
Timing gear key.
Idler gear.
Oil pump gear.
Ignition distributor gear
Timer drive gear.
Exhaust cam.
Inlet cam.
Oil pump eccentric (or cam).

(2) *Group 2—valves.*—Valves should be numbered 1 Ex, 1 In, 2 Ex. 2 In, etc., according to the number of the cylinder. On V-type engines the numbers should be 1REx, 1LEx, etc.

Poppet valve.
Inlet valve.
Exhaust valve.
Valve spring.
Valve spring:
Retainer.
Retainer lock.
Valve lifter.
Valve lifter:
Guide.
Guide clamp.
Roller.
Roller pin.
Valve:
Adjusting screw.
Adjusting screw nut.
Rocker (either at cam or at overhead valve; if both, upper and lower).
Push rod (intermediate between lifter and valve in I-head engine).

c. Division III—cooling system.

(1) *Group 1—fan.*

Fan.
Fan:
Bracket.
Spindle.
Hub.
Hub bushing (or bearing).
Blades.
Pulley.
Belt.
Driving pulley.

(2) *Group 2—radiator.*—(*a*) *Radiator cores.*

1. *Individual fin and tube core.*—An assembly of fluid tubes of any cross-sectional form to each of which are attached gills or fins of circular, square, or other shape, each tube and its fin or fins forming a separate unit.

2. *Continuous fin and tube core.*—An assembly of fluid tubes of any cross-sectional form, the tubes being joined together by radiating fins or plates common to all tubes or groups of the tubes.

3. *Ribbon cellular core.*—A number of fluid passages made by joining metal ribbons at the edges and grouped to form a cellular structure. Parts of the cellular structure may be of formed or flat ribbon which is not a part of the fluid passage.

4. *Air tube cellular core.*—An assembly of air tubes nested in such a way as to form fluid passages between the tubes, the passages being sealed at the ends of the tubes. In this type the fluid may flow transversely as well as vertically around the tubes.

(*b*) *Shell-type radiators.*

1. *Radiator core and tank assembly.*

Radiator:
- Core.
- Core header sheets.
- Upper tank.
- Filler neck.
- Filler neck sleeve.
- Filler cap.
- Filler cap gasket.
- Tie rod fitting.
- Baffle.
- Inlet fitting.
- Lower tank.
- Outlet fitting
- Drain flange.
- Drain cock.
- Anchor stud or bolt.
- Anchor stud or bolt plate.
- Overflow tube.
- Side bolting member.
- Shell anchorage clips.

2. Radiator shell.
Radiator:
Supports.
Anchor studs or bolts.
Support reenforcement.
Hinge rod fitting.
Brace rod fitting.
Hood ledge liner strip.
Starting crank hole cover.

(*c*) *Cast-type radiators.*
1. Radiator assembly.
Radiator:
Clamping strips.
Clamping bolts or studs.
Overflow tube.
Sides.
Header gasket.
Hood ledge liner strip.

2. Radiator core assembly.
Radiator core.
Radiator core:
Upper header.
Lower header.
Overflow jacket tube.

3. Radiator upper tank.
Radiator:
Filler cap.
Filler cap gasket.
Filler cap hinge pin.
Filler cap fastener.
Tie rod fitting.
Hinge rod fitting.
Inlet fitting.
Inlet gasket.
Inlet studs or cap screws.

4. Radiator lower tank.
Radiator:
Anchor studs or bolts.
Outlet fitting.
Outlet gasket.
Outlet studs or cap screws.
Drain cock or plug.

(3) *Group 3—water pump.*
Water pump.
Water pump:
Impeller.
Impeller key.
Body (in case of doubt, body is member mounted on engine).
Cover.
Shaft.
Gland (part in contact with packing, whether threaded or not).
Gland nut (or screw, or other part used to compress gland).
Shaft gear.
Shaft bushing (or bearing).
Packing.

(4) *Group 4—pipes and hose.*
Engine water outlet.
Engine water inlet.
Radiator hose (upper and lower).
Radiator water fitting (upper and lower).
Water pump outlet pipe.

d. Division IV—fuel system.

(1) *Group 1—carburetor and inlet pipe.*
Carburetor.
Inlet manifold (more than one connection to cylinder).
Inlet pipe (only one connection to cylinder).
Inlet manifold or pipe gaskets (at cylinder).
Carburetor gaskets.

(2) *Group 2—carburetor control.*
(Throttle control rods will take names from parts they connect, shafts by location or arrangement, and brackets by parts they support.)
Accelerator pedal.
Accelerator pedal:
Bracket.
Pin.
Rod.
Rod end pin.
Carburetor mixture hand regulator.
Carburetor choke.

(3) *Group 3—carburetor air heater.*
Carburetor air heater.
Carburetor hot air pipe.
(4) *Group 4—fuel tank.*
Fuel tank.
Fuel reserve tank.
Fuel gage.
Fuel gage:
Float.
Glass.
Fuel tank:
Outlet strainer.
Outlet (flange, fitting, etc.).
Pressure flange (or fitting).
(5) *Group 5—fuel pipes and feed systems.*
Main fuel valve.
Reserve fuel valve.
Fuel:
Pipe, main tank to auxiliary tank (or names of other parts connected).
Pressure pump (power pump).
Hand pump.
Pressure gage pipe.
Pressure gage tee.
Pressure pipe to tank.
Pressure pump pipe.
Hand pump pipe.
Hand pump tee.
Pressure gage.
e. Division V—exhaust system.
(1) *Group 1—exhaust manifold.*
Exhaust manifold.
Exhaust manifold gasket.
(2) *Group 2—exhaust pipe and muffler.*
Muffler.
Exhaust pipe (extends from exhaust manifold to muffler. If in more than one part, name sections front and rear. For V-type engines with two pipes, name right and left.).
Muffler outlet pipe.
f. Division VI—lubrication system.

(1) *Group 1—oil pan or reservoir.*
Oil pan.
Oil tank (when separate).
Oil filler strainer.
Oil filler cap.
(2) *Group 2—oil pump.*
Oil pump.
Oil pump:
Body (any type of pump).
Plunger.
Plunger spring.
Inlet valve.
Outlet valve.
Shaft.
Shaft gear (outside the pump).
Shaft gear (inside the pump).
Following gear.
Cover.
(3) *Group 3—oil pipes, strainers, and gages.*
(Oil pipes should be named from the parts they connect, as "oil pump to pressure gage pipe.")
Circulating oil strainer.
Oil strainer cap.
Sight feed.
Sight feed glass.
Oil level gage.
Oil level gage:
Float.
Glass.
Oil pressure gage.

g. Division VII—ignition system.
(1) *Group 1—spark plugs, cables, and switches.*
Spark plugs.
Spark-plug cables (numbered according to cylinders).
Coil high tension cable.
(Low tension cables should be named from the parts they connect, as "storage battery to ignition switch cable." In case of more than one conductor, the cable should be designated as double, triple, etc.).
Ignition coil.
Ignition switch.
Dry cell (two or more cells make a dry battery).

(2) *Group 2—battery ignition equipment.*
Ignition set.
Ignition coil.
Ignition switch.
Timer distributor.
Breaker arm.
Movable breaker contact.
Stationary breaker contact.
Breaker cam.
Distributor rotor.
Distributor rotor:
Brush.
Electrode.
Distributor cap.
Timer distributor shaft.
Timer distributor shaft gear.
Ignition drive shaft.
Ignition drive shaft gear.
Manual advance arm.
Automatic advance element.
Ignition unit, magneto base mounting.
(3) *Group 3—magneto.*
Magneto:
Distributor.
Breaker box.
Breaker arm.
Fixed breaker point.
Breaker arm point.
Distributor brush.
Collector ring brush.
Coupling:
Pump end.
Center member.
Magneto end.

h. Division VIII—starting and generating equipment.—(1) *General.*—A single-unit system comprises a starter generator. A separate-unit system comprises a generator and a starting motor separately mounted. A combined-unit comprises a duplex starter generator, an ignition generator, or an ignition starter generator. Direction of rotation is clockwise or counterclockwise as determined by the driven shaft for magnetos, generators, starter generators, and by the driving shaft for starting motors. Methods of mounting units are: Flange, base, strap, and sleeve

(2) *Group 1—generator.*
Generator.
Generator:
Main brush.
Main brush holder.
Third brush.
Third brush holder.
Field frame.
Field fuse.
Driving gear or sprocket.
Shaft.
Coupling (members as indicated under magneto coupling).

(3) *Group 2—Starting motor.*
Starting motor.
Starting motor:
Brush.
Brush holder.
Pinion.
Intermediate gear.
Intermediate gear shaft.
Intermediate pinion.
Manual shift.
Screw shift.
Magnetic shift.

(4) *Group 3—starter generator* (parts covered by groups 1 and 2 above).

(5) *Group 4—Ignition generator* (parts covered by div. VII, group 2 and group 1 above).

(6) *Group 5—ignition starter generator* (parts covered by div. VII, group 2, and groups 1 and 2 above).

(7) *Group 6—storage battery.*
Storage battery.
Terminal post.
Case:
Wood.
Rubber (monobloc).
Composition (monobloc).
Tray (alkaline batteries only).
Jar.
Cover.
Cell connector.
Vent plug (filling plug).

Group:
Positive.
Negative.
Plates:
Positive.
Negative.
Post strap:
Positive.
Negative.
Separators:
Wood.
Rubber.
Wood, with rubber retainer.
Post gasket.
Sealing nut.
Separator hold-down.
Battery hold-down.
Handles:
Plate.
Wire.
Terminals:
Clamp lug.
Taper thimble.
Cable.
Through bolt.
Jar spacer.
Sealing compound.
Electrolyte (not exceeding 1.300 in specific gravity).

i. Division IX—miscellaneous electrical equipment.

(1) *Group 1—lamps and wiring.*—(*a*) *Lamps.*

1. Head.—A lighting unit on front of vehicle intended primarily to illuminate road ahead of vehicle.

2. Side.—A lighting unit mounted on either side of vehicle and intended primarily as a marker to indicate location of vehicle. Side lamps cover such types as are generally known as bullet, cowl, fender or parking, pillar or windshield lamps.

3. Tail.—A lighting unit used to indicate rear end of vehicle by means of a ruby light.

4. Backing.—A lighting unit mounted on rear end of vehicle and intended to illuminate road to rear.

5. Spot.—A lighting unit, mounted on a manually operated adjustable bracket, which has one focusing type reflector and one focusing type light source.

6. Instrument.—A lighting unit mounted on instrument board and intended to illuminate instruments.

7.—Dome.—An interior lighting unit mounted in top of vehicle.

8. Panel.—A lighting unit mounted either in rear panel or in corners of closed vehicle.

9. Tonneau.—A lighting unit mounted in back of front seat in open or closed vehicles.

10. Step.—A lighting unit mounted on exterior of vehicle and intended primarily to illuminate step or running board.

11. Hood.—A lighting unit mounted under hood of vehicle to illuminate engine compartment.

12. Inspection.—A portable lighting unit connected by extension cord to lighting system of vehicle.

(*b*) *Wiring.*

Inspection lamp:
- Cord.
- Plug.
- Socket.

Head lamp support tie rod.

Tail lamp support.

(Cables and conduits should be named from the parts they connect.)

Junction box (wires not attached to box).

Junction box:
- Screw.
- Cover.

Fuse:
- Box.
- Box cover.
- Block.
- Clip.
- (Designated by name of part fed by circuit.)

Junction panel.

(2) *Group 2—switches and instruments.*

Lighting switch.

Starting switch.

Starting button.

Ignition switch.

Combined switch (such as lighting ignition).
Starting ignition switch.
Ammeter.
Voltmeter.
Voltammeter.
Charging indicator.
Cut-out relay.
Cut-out relay:
Contacts.
Armature.
Shunt coil.
Series coil.
Current regulator.
Voltage regulator.
Current voltage regulator.
Load limit controller.
Starting switch:
Contacts.
Contactor.
Plunger (lever or button).
Through the board mounting.
Front of board mounting.
Ground return wiring.
Insulated return wiring.

(3) *Group 3—horn.*
Motor-operated horn.
Vibrator horn.
Hand horn.
Horn:
Projectors.
Diaphragm.
Sound ratchet.
Motor.

(4) *Group 4—miscellaneous* (includes any additional electrical equipment such as electrical gearshift).

j. Division X—clutch.—(1) *General.*
Plate clutch (one plate clamped between two others).
Disk clutch (more than three disks).
Dry disk clutch.
Lubricated disk clutch.
Expanding clutch.

(2) *Group 1—clutching parts.—(a) Disk clutch.*

Clutch:

Case (rotating member).
Housing (nonrotating member).
Cover.
Housing cover.
Driving disk.
Driven disk.
Driving disk stud.
Pressure plate (front and rear; if two—used on both disk and plate clutches).
Driven spider (or drum; driving and driven, if two).
Cork insert.
Facing.
Facing spring.
Spring.
Shaft (not attached to crankshaft).
Pilot bearing (in flywheel).

(*b*) *Plate clutch.*

Clutch:

Driven plate.
Driving plate.
Pressure levers.

(Others parts as under disk clutch.)

(*3*) *Group 2—Releasing parts.*

Clutch release:

Sleever.
Shoe or bearing housing.
Bearing.
Yoke.
Yoke shaft.

Clutch:

Pedal shaft.
Pedal adjusting link.
Release yoke lever.
Pedal.
Pedal pad.
Brake.
Brake facing.

k. Division XI—transmission.

(1) *Group 1—transmission.*

Transmission:
- Case.
- Case cover (when used as cover plate).
- Main drive gear.
- Main drive gear:
  - Bearing (front and rear, if two).
  - Bearing adapter.
  - Bearing retainer.
- Second and high main shaft gear.
- Low and reverse main shaft gear.
- Main shaft.
- Main shaft:
  - Rear bearing.
  - Rear bearing adapter.
  - Rear bearing retainer.
- Countershaft.
- Countershaft:
  - Gear cluster.
  - Drive gear.
  - Second speed gear. } If a built-up cluster.
  - Low speed gear.
  - Reverse gear.
- Reverse idler gear.
- Reverse idler-gear:
  - Bushing (or bearing).
  - Shaft.
- Main shaft pilot bushing (or bearing).
- Countershaft:
  - Front bushing (or bearing).
  - Front bearing retainer.
  - Rear bushing (or bearing).
  - Rear bearing retainer.

(2) *Group 2—shifting mechanism.*

Control housing (when used to mount control lever or control lever and shifting mechanism).

Control shift frame (when used to mount shifting mechanism only).

Transmission second and high shift:
- Fork.
- Rail.

Transmission low and reverse shift:
Fork.
Rail.
Transmission:
Poppet.
Poppet spring.
Interlock rail.

(3) *Group 3—control.*
Control lever.
Control lever:
Ball handle.
Ball handle insert.
Fulcrum ball.

(4) *Group 4—propeller shaft.*
Propeller shaft.
Propeller shaft:
Front universal joint (assembly propeller shaft may be omitted).
Rear universal joint (assembly propeller shaft may be omitted).
Front bearing (with enclosed shaft).
Transmission shaft universal joint flange (substitute name of any other shaft on which flange is mounted).
Universal joint:
Flange yoke.
Slip yoke.
Plain yoke.
Center cross (ring or block).
Bearing bushing.
Pin (may be designated as long and short, straight and shoulder, etc.).
Inner casing.
Outer casing.
Casing packing.
Casing nut.
Trunnion (for trunnion type joint).
Trunnion block.

(5) *Group 5 (special)—transfer case (tentative; not SAE).*
Transfer case:
Housing.
Low speed driven gear.
Idler gear.

Driven gear.
Low speed sliding gear.
Direct driving gear.
Shift lock.
Low speed gear shift shaft.
Idler shaft.
Main drive shaft.
Main driven shaft assembly.
Attaching flange to transmission and front axle.
And emergency brake flange.
Speedometer drive unit.

Front axle:
Declutching unit (sliding and driving members).
Declutching shift fork.
Transfer gear shift fork.
Declutching shift lever.
Declutching shaft.

Power take-off:
Housing.
Declutching unit (sliding and driving members).
Shift fork.
Shift lever.
Shift shaft.
Shift shaft lock plunger.
Shaft.

l. Division XII—rear axle.—(*1*) *General types.*

(*a*) *Dead axle.*—An axle carrying road wheels with no provision in the axle itself for driving them.

(*b*) *Live axle.*—General name for type of axle with a concentric driving shaft.

(*c*) *Plain live axle.*—Has shafts supported directly in bearings at center and at ends, carrying differential and road wheels (the plain axle is practically obsolete).

(*d*) *Semifloating axle.*—Has differential carried on separate bearings, the inner ends of the shafts being carried by the differential side gears, and the outer ends supported in bearings. The semifloating axle shaft carries torsion, bending moment, and shear. It also carries tension and compression if the wheel bearings do not take thrust, and compression, if they take thrust in only one direction.

(*e*) *Three-quarter floating axle.*—Inner ends of shafts carried as in semifloating axle. Outer ends supported by wheels, which depend

on shafts for alinement. Only one bearing is used in each wheel hub. The three-quarter floating axle shaft carries torsion and the bending moment imposed by the wheel on corners and uneven road surfaces. It also carries tension and compression if the wheel bearings are not arranged to take thrust.

(*f*) *Full-floating axle.*—Same as three-quarter floating axle except that each wheel has two bearings and does not depend on shaft for alinement. The wheel may be driven by a flange or a jaw clutch. The full-floating axle shaft is relieved from all strains except torsion, and, in one possible construction, tension and compression.

(*g*) *Types of axle drive.*—The different types of live axle can be driven by bevel gear, spiral bevel gear, worm, double-reduction gear, or single chain. In other constructions, the rear wheels are driven by double chains, internal gears, or jointed cross-shaft.

(2) *Group 1—Housing.*

Rear axle housing (if one piece).
Right and left halves (if two pieces).
Bevel (or worm) gear housing
Right real axle tube } (if three pieces).
Left rear axle tube
Rear axle housing cover.
Differential carrier (bolted to housing).
Rear axle spring seat.
Axle brake shaft bracket (right and left).
Wheel brake support, right and left ("wheel" may be omitted).
Wheel brake shield ("wheel" may be omitted).

(3) *Group 2—torque arm and radius rods.*

Radius rods.

(4) *Group 3—drive pinion.*

Axle drive bevel pinion (or worm).
Axle drive pinion (or worm) shaft.
Axle drive pinion (or worm) carrier.
Axle drive pinion:
- Front bearing.
- Rear bearing.
- Thrust bearing.
- Front bearing adjuster.
- Front bearing adjuster lock.
- Rear bearing adjuster.
- Rear bearing adjuster lock.
- Adjusting sleeve (containing both bearings).

(5) *Group 4—differential.*—(*a*) *Four-pinion two-piece case bevel drive.*

Differential (comprises a case and internal parts only).
Bevel drive pinion (or worm). (May be of either the bored or the shaft type.)
Bevel drive gear.
Bevel drive gear rivet or screw.
Differential:
- Case flange half.
- Case plain half.
- Bearing sleeve.
- Case bolt.
- Side gear.
- Spider pinion.
- Spider.

(*b*) *Two-pinion one-piece case, bevel drive.*

Differential (comprises a case and internal parts only).
Bevel drive pinion (or worm). (May be of either the bored or the shaft type.)
Bevel drive gear.
Bevel drive gear rivet or screw.
Differential:
- Case.
- Bearing sleeve.
- Side gear.
- Cross pin pinion.
- Cross pin.
- Cross pin lock.
- Side gear spacer.

(*c*) *Worm gear drive.*

Differential (comprises a case and internal parts only).
Worm (or bevel drive pinion). (May be of either the bored or the shaft type.)
Worm gear.
Worm gear rivet or screw.
Differential:
- Case, right hand.
- Case, left hand.
- Bearing sleeve.
- Case bolt.

Differential:
Side gear.
Pinion.
Spider or cross pin.
Cross pin lock.
Side gear spacer.

(6) *Group 5—axle shafts.*
Axle shaft (right and left).
Axle shaft wheel flange (or clutch).

(7) *Group 6 (special)—bogie axle (tentative; not SAE).*
Differential carrier assembly (forward and rear).
Housing (same as single rear axles).
Drive pinion—rear axles same as single axle except the following:
Drive pinion through shaft.
Drive pinion through shaft bearings (front and rear).
Differential (same as single rear axles).
Axle shafts (same as single rear axles).
Propeller shaft joining forward and rear axles (same as main propeller shafts).

m. Division XIII—braking system.—(1) *General.*—In the following list of brake parts the terms "outer" and "inner" are used, being applicable to any case of two sets of brakes on the rear wheels. Where the brakes are external and internal, these terms may be substituted for "outer" and "inner." Where one brake is located at the wheels and the other at the transmission, the terms "wheel brake" and "transmission brake" should be substituted. With other concentric or side-by-side brakes the terms "outer" and "inner" should be retained, "outer" indicating in the latter case the ones nearer the wheels. The list is made up for external contracting and internal expanding brakes. If both brakes are of one type, the necessary changes will be obvious. The designation of brake parts on the rear axle as foot brake or hand brake parts, or by equivalent terms, is too remote to be clear, especially in the case of stock axles whose brakes may be connected either way according to chassis design. Nearly the same condition prevails in regard to designating parts on the chassis according to whether they are connected to the inner or outer brakes at the axle. The terms "service brake" and "emergency brake" should not be used. "Foot brake" and "hand brake" are better designations; or if both brakes are foot operated, "right foot brake" and "left foot brake."

(2) *Group 1—outer brake.*
Outer brake:
Band.
Band lining.
Band adjusting nut (yoke, etc.).
Band lever.
Lever shaft.
Shaft inner end lever.
Shaft outer end lever.
(3) *Group 2—inner brake.*
Inner brake:
Shoe (or band).
Shoe (or band) lining.
Toggle (link, etc.).
Toggle lever.
Toggle shaft.
Cam.
Camshaft.
Camshaft (or toggle shaft) lever.
(4) *Group 3—pedal (or outer) brake control.*
Outer brake rod.
Outer brake rod yoke.
Outer brake intermediate shaft (or tube):
Right and left.
Right lever.
Left lever.
Center lever.
Outer brake equalizer lever:
Right.
Left.
Outer brake equalizer.
Brake pedal.
Brake pedal:
Rod.
Rod yoke.
Pad.
Shaft.
(5) *Group 4—hand (or inner) brake control.*
Inner brake rod.
Inner brake rod yoke.

Inner brake intermediate shaft (or tube):
Right and left.
Right lever.
Left lever.
Center lever.
Inner brake equalizer lever:
Right.
Left.
Inner brake equalizer.
Brake hand lever rod.
Brake hand lever rod yoke.
Brake hand lever.
Brake lever or sector.
Brake lever latch.
Brake latch:
Spring.
Button.
Spoon.
Rod.

(6) *Group 5 (special)—hydraulic brakes (tentative; not SAE).*

Wheel cylinder.
Wheel cylinder:
Bleeder screw.
Boot (front and rear).
Piston (front and rear).
Piston stem (front and rear).
Piston cup (front and rear).
Piston spring.
Hydraulic brake:
Flexible hose.
Tubing.
Check valve.
Master cylinder (with or without reservoir).
Master cylinder boot.
Master cylinder piston.
Master cylinder piston:
Plunger.
Primary cup.
Secondary cup.
Return spring.
Hydraulic brake fluid reservoir.
Hydraulic brake fluid reservoir breather plug.

(7) *Group 6 (special)—electric brakes (tentative; not SAE).*

Electric brake:
- Cam lever.
- Cam lever lug.
- Armature.
- Spring contact.
- Electromagnet.
- Wiring.
- Controller.
- Control lever.

(8) *Group 7 (special)—air brakes (tentative; not SAE).*

Air brake chamber:
- Dish plate.
- Mounting dish plate.
- Diaphragm.
- Diaphragm spring.
- Piston.
- Push rod.
- Push rod yoke.

Air brake slack adjuster:
- Arm.
- Camshaft.
- Worm gear.

Air brake relay valve.

Air brake relay valve:
- Body.
- Cover.
- Spring.
- Diaphragm.
- Diaphragm spring.
- Guide.
- Blanking flange.
- Air brake emergency valve.

Air brake emergency valve:
- Body.
- Cover.
- Spring.
- Diaphragm.
- Diaphragm spring.

Air brake quick release valve.

Air brake quick release valve:
- Body.
- Cover.
- Diaghragm.
- Diaphragm spring.

Air brake valve:
- Body.
- Cover.
- Lever.
- Lever spring.
- Piston.
- Diaphragm.
- Diaphragm spring.

Air brake valve intake valve.

Air brake valve intake valve:
- Body.
- Cover.
- Spring.

Air brake valve exhaust valve.

Air brake valve exhaust valve:
- Body.
- Cover.
- Spring.

Air brake reservoir.

Air brake reservoir:
- Safety valve.
- Drain cock.

Air brake air supply valve.

Air brake pressure gage.

Air brake governor:
- Casing.
- Cover.
- Tube.
- Tube bracket.
- Valve body.
- Valve stem.
- Valve spring.
- Lower valve.
- Upper valve.

Air brake:
Compressor.
Compressor suction strainer.
Flexible hose.
Service line.
Service line tag.
Emergency line.
Emergency line tag.
Hose coupling.
Cut-out cock.
Dummy coupling.

n. Division XIV—front axle and steering.

(1) *Group 1—axle center.*
Front axle center.
Front spring seats.
Front axle bushing.

(2) *Group 2—steering knuckles.*
Right steering knuckle.
Left steering knuckle.
Steering knuckle:
Bushing (upper and lower).
Pivot.
Pivot nut.
Thrust bearing.
Right steering knuckle arm.
Left steering knuckle arm.
Steering knuckle gear rod arm.

(3) *Group 3—steering rods.*
Steering knuckle tie rod.
Steering knuckle tie rod:
End.
Clamp bolt.
Pin.
Steering gear connecting rod.

(4) *Group 4—steering gear.*
Steering gear:
Case.
Case cover.
Bracket.
Arm.
Shaft (if separate from sector or other operating member).

Steering wheel:
Rim.
Spider.
Tube (or shaft).
Spark and throttle sector.
Spark and throttle sector tube.
Spark hand lever.
Spark hand lever tube (or rod).
Throttle hand lever.
Throttle hand lever tube (or rod).
Steering column tube (stationary).
Steering column cowl (or dash or floor) bracket.

NOTE.—The various bushings in the steering column take names from parts to which they are permanently fitted, being further distinguished, as upper and lower, inner and outer, if necessary. Bushings in the steering gear case take names from the worm and sector or other main operating parts which they support, as steering gear worm upper bushing, although the steering wheel tube may be the member which turns inside the bushing.

Steering worm.
Steering worm:
Sector (or gear) (worm and sector gear).
Shaft.

(5) *Group 5 (special)—live front axle (tentative; not SAE).*—Live front axles are essentially the same as live rear axles except for the constant velocity universal joints.

Constant Velocity Universal Joint.

Universal joint:
Ball cage.
Pilot pin.
Pilot pin seat.
Pilot pin plunger.
Pilot plunger spring.
Pilot.
Shaft retainer.
Inner race.
Outer race.
Buffer spring.
Screw.
Balls.
Trunnion end.

o. Division XV—wheels.

(1) *Group 1—front wheels.*

Front wheel:
- Felloe.
- Felloe band.
- Rim.
- Hub.
- Hub flanges.
- Hub cap.

Rim bolts.
Rim clamps.
Front wheel outer bearing.
Front wheel outer bearing:
- Inner race.
- Outer race.
- Balls.
- Ball retainer.
- Rollers.
- Roller cage.

Front wheel inner bearing (parts same as outer bearing).
Front wheel bearing:
- Spacer.
- Nut.
- Lock nut.
- Locking washer.

Front wheel brake drums (if front wheel brakes are used).

(2) *Group 2—rear wheels.*

Rear wheel:
- Hub.
- Hub flange.
- Hub cap.
- Outer bearing.
- Inner bearing.
- Brake drum.

(For names of other parts see front wheel parts.)

p. Division XVI—frames and springs.

(1) *Group 1—frame.*

Frame side member (right and left).
Front cross member.
Rear cross member.
Center cross member.
(As above if only three cross members, as below if more than three.)

First cross member.
Second cross member, etc.
Subframe side member (right and left).
Subframe cross member (front and rear).
Right rear gusset (upper and lower).
(Gussets at other cross members named according to member).

(2) *Group 2—frame brackets and sockets.*
Front spring front bracket (right and left).
Front spring rear bracket (right and left).
Rear spring front bracket (right and left).
Rear spring rear bracket (right and left).
Running-board bracket (front, right, etc., if not duplicates).
Running-board bracket brace.
Engine front support bracket.
Engine rear support bracket.
Torque arm bracket.
Radius rod bracket.

(3) *Group 3—front springs.*
Front spring (right and left).
Front spring:
Shackle.
Shackle bolt (upper and lower).
Front bolt.
Rebound clip.
Seat.
Seat pad.
Clip.
Clip plate.
Center bolt.

(4) *Group 4—rear springs.*
Rear springs (upper and lower for elliptic and three-quarter elliptic).
Rear spring pivot bolt (or pin) } (for half elliptic cantilever
Rear spring pivot seat } spring).
Rear spring double shackle }
Rear side spring } (for platform spring).
Cross spring. }
(Other parts as for front springs.)

q. Division XVII—hoods, fenders, and shields.

(1) *Group 1—Hood.*
Hood.

Hood:
Sill.
Handle.
Fastener.
Fastener bracket (spring, lever, etc.).

(2) *Group 2—engine shield.*
Engine shield.
Engine shield:
Fastener.
Bracket (spring, etc.).

(3) *Group 3—fenders and running-boards.*
Running board (right and left).
Running board:
Linoleum covering.
Outside binding.
Inside binding.
Front binding.
Rear binding.
Shield (right and left).
Right front fender.
Left front fender.
Right rear fender.
Left rear fender.
Fender support socket.
Right front fender front support.
Right front fender rear support.
(Other fender supports accordingly.)

(4) *Group 4—windshield.*—Names for windshield parts have not been selected.

r. Division XVIII—body and top.—Types of body.

(1) *Roadster.*—An open type body having one cross seat. A compartment in the rear deck accommodates business equipment or luggage. The top is of weathter-proof fabric and may be folded. Equipment includes removable side curtains, and provision is usually made for folding the windshield.

(2) *Phaeton.*—An open type body with two cross seats. Folding type windshield and folding weatherproof fabric top with removable side curtains are usual equipment.

(3) *Touring car.*—Generally longer bodies than the phaeton, permitting the use of auxiliary seats in the tonneau for the accommodation of additional passengers. In other respects similar to the phaeton.

(4) *Coupe.*—An enclosed single compartment body. Passenger capacity varies with arrangement of seats or length of wheelbase. Two doors are provided; back panels and top are permanent, and the rear deck accommodates a luggage compartment. It may or may not be provided with quarter windows.

(5) *Sedan.*—An enclosed 4-door type of body with permanent back panels and top. A full width cross seat in front and rear. May or may not be provided with windows in the rear quarters. Variations from the standard sedan type may be variously designated as: 2-window sedan, 3-window sedan, club sedan, closed coupled sedan, landaulet sedan, etc., but there is not sufficient uniformity in these variations to justify specific standardization.

NOTE.—Military types of motor vehicles are listed in section V.

s. Division XIX—accessories.

(1) *Group 1—speedometer.*

(2) *Group 2—tire pump.*

SECTION II

AUTOMOTIVE TERMINOLOGY

3. Definitions.—The words, phrases, terms, and abbreviations commonly used in automotive practices with a brief definition are listed below:

Abrasion.—The result of rubbing or wearing away by friction.

A. C.—Alternating current.

Acceleration.—The average rate of change of an increasing velocity or speed.

Ampere.—Unit of measurement of flow of electrical current. An ampere is the current that will flow with 1 volt potential (pressure) through a conductor of 1 ohm resistance.

Annealing.—The softening of metals by heating and slowly cooling, resulting in a change of grain structure.

Anticlockwise.—Rotation opposite to that of the hands of the clock. Counterclockwise expresses the same meaning.

Axle.—A cross bar supporting a vehicle and on or with which its wheel or wheels turn. Live axles while carrying loads also transmit power to the wheels. Dead axles only carry loads.

Backlash.—Play between teeth of two gears which are in mesh (or engaged).

Back pressure.—The result of resistance to the normal flow of gases and liquids.

Bogie.—A unit consisting of two axles joined by a single cross piece (trunnion axle). Usually used with the rear 4 wheels of a 6-wheeled vehicle.

Bore.—The interior diameter of an engine cylinder. (*See* Stroke.)

Brake horsepower (b. hp.).—The amount of net available power produced by an engine as measured at the crankshaft. (*See* Horsepower.)

British thermal unit (B. t. u.).—A unit for measuring heat. One British thermal unit equals 778 foot-pounds of work (or energy). It represents the heat required to change the temperature of 1 pound of water through 1° F.

By-pass.—A separate passage which permits a liquid or gas to take a course other than that normally used.

Camber.—To curve or bend; the amount, in inches or degrees, that the front wheels of an automotive vehicle are tilted outward from a true vertical at the top. Motorcycles do not have camber.

Calorific value.—Heat value of fuel.

Carburetion.—The metering and mixing of fuels with air and passing the mixture to the engine.

Caster.—The backward tilt (or inclination) of the front axle from a vertical plane.

Center of gravity.—Point of vehicle about which all parts are balanced. With reference to vertical dimensions, there is an imaginary point within the length and width of a vehicle, where all weights balance, known as the vehicle's center of gravity.

Check valve.—A device that permits passage of a fluid or gas in one direction only. It stops (or checks) flow if movement is reversed.

Centrifugal force.—The force acting on a rotating body which tends to throw it farther from the center of its rotation.

Cetane rating.—A system of numbers for indicating the ignition quality of Diesel fuels.

Chamfer.—A beveled corner.

Chassis.—The framework of a motor vehicle; usually includes power plant (engine), power transmission units, axles, and wheels. Cab and body are excluded.

Chemical compound.—A solid, liquid, or gas, resulting from the reaction between chemicals.

Circuit.—A path through which electrical current flows.

Clearance.—The space between a moving and a stationary part usually allowed to provide for expansion and contraction and for lubrication.

Clockwise.—Rotation in the same direction as the hands of a clock.
Coefficient.—A ratio—a known factor or quantity that is a constant.
Cumbustion chamber.—The space within the cylinder in which the fuel mixture is burned; all the space between the top of the piston at top dead center and the head of the cylinder.
Compression.—To be pressed into smaller space; to be condensed or reduced in size or volume.
Compression pressure.—The amount of pressure resulting from the compression stroke of a piston when it has reached top dead center.
Concentric.—Having a common center.
Condensation.—The process by which a vapor is reduced to a liquid.
Conductor.—A material through which electricity will flow.
Constant.—A property or quality which remains the same under the same conditions.
Contraction.—Becoming smaller in size; usually, in metals, a result of cooling or a lowering of temperature.
Cooling system.—The particular group of units that carries off and dissipates the unused heat generated in the engine.
Counterclockwise.—Rotation in a direction opposite to that of the hands of a clock. Anticlockwise means the same.
Cowl.—The portion of the body or cab which surrounds the dash and forms a partial enclosure and supports the instrument board.
Current.—The flow of electricity.
Cycle.—A series of events, operations, or movements that repeat themselves in an established sequence.
Cylinder in block.—A group of cylinders cast as one piece.
D. C.—Direct current.
Dash or dash panel.—The partition which separates the engine compartment from the driver's compartment.
Deceleration.—The average rate of change of a decreasing velocity or speed.
Decomposition.—Act of separating anything into its original parts or elements by chemical action or natural decay.
Density.—Compactness of matter.
Detonation.—A knock in an engine resulting from the too rapid burning of a fuel in the combustion chamber.
Dilution.—Making thinner or weaker, as with water, gasoline, etc.
Dowel pin.—A pin which alines or secures two parts to prevent movement between them.
Eccentric.—A circle having a different center than another within it; a device mounted off-center for converting rotary motion into reciprocating motion.

Electrical system.—Usually consists of the starting, lighting, ignition, generating, and horn circuits, and includes all electrical units of each and every circuit.

Electrolyte.—A solution of sulphuric acid and distilled water, normally having a specific gravity of 1.300 and used in storage batteries.

Electromagnet.—A magnet formed by passing a current of electricity through wire wound around a core.

Element.—The simplest form to which a substance may be reduced. Analogy: an ordinary lead pencil may be said to have four elements; (1) the wooden case or shell, (2) the lead or graphite core, (3) the rubber (or eraser), and (4) the metal ferrule which holds the rubber to the wooden case.

E. M. F.—Electromotive force (voltage or potential).

Energy.—Capacity for doing mechanical work.

Energy, kinetic.—Energy due to motion.

Energy, potential.—Energy due to position.

Engine.—A machine which produces power to do work, particularly one that converts heat into mechanical power. The term "engine" should be used in referring to the power plant of a motor vehicle, and the term "motor" should be used in connection with electric motors.

E. P.—Extreme pressure; refers to a lubricant compounded to withstand the extreme presures encountered in some present day transmission and rear axle gears.

F-*head.*—Used to describe an engine with one set of valves (usually intake) placed overhead and the other (usually exhaust) in the side of the cylinder block.

Field.—A space influenced by magnetic lines of force; as a generator field.

Field coil.—Coil of insulated wire which magnetizes a field.

Fits.—As applied to automotive maintenance may be considered as "drive", "press", or "force" fits, where some external force may be used. Examples: hammering or sledging for a "drive" fit; use of an arbor press to make a "press" fit. A "hand" fit is made by the pressure exerted by a man's hand, usually the palm (or heel).

Foot-pound.—The work done in lifting 1 pound 1 foot; a measurement of torque, force, or work. When used in connection with torque, the expression is sometimes changed to read "pounds feet."

Frame.—A metal support for the body, power unit, and running gear; the backbone structure around which the vehicle is assembled.

Freeze (or seize).—To stick by reason of expansion usually caused by heat, corrosion, or rust.

Friction.—The action between two bodies at the surfaces of contact which opposes their movment.

Friction horsepower (f. hp.).—The horsepower consumed by the engine in turning itself; the friction losses within the engine.

Front.—That part of a motor vehicle which is foremost or forward and in advance.

Fuel system.—Mechanical equipment and devices used on a motor vehicle to store fuel and deliver it to the engine as required.

Gear ratio.—The ratio at which gears can transmit speed or torque. When speed is increased, torque is decreased, and vice versa. For example, a 60-tooth gear driving a 12-tooth gear gives a ratio of 1–5, which means that the driven gear revolves five times as fast as the driving gear, increasing speed and reducing torque. On the other hand, a 12-tooth gear driving a 60-tooth gear gives a ratio of 5–1, which means that the driven gear revolves one-fifth as fast as the driving gear, increasing torque and decreasing speed.

Governor.—A device used to control speed of a motor vehicle by limiting the revolutions per minute (r. p. m.) at which the engine is allowed to operate.

Ground.—Connection of an electrical unit to the engine, frame, etc., to return the current to its source.

Heat.—A form of energy which is evidenced by a rise in temperature.

Heat units.—The unit of heat (1 British thermal unit (B. t. u.)).

Helical.—A term used to describe gears shaped like a helix.

Helix.—A line shaped like a screw thread.

Horsepower.—A unit for measuring power. It is the rate of doing work at 33,000 foot-pounds per minute.

Hotchkiss drive.—An axle drive system in which axle torque reactions are absorbed by the springs.

Hydraulics.—The pressure application of liquids in the transmission of power.

Hydraulic analogy.—A method of explaining electrical theory by using the flow of water for an example.

I-*head* (*or valve-in-head*) *engine.*—Designates an engine with its valves placed in the cylinder head directly above the cylinder bore.

Idling.—Engine running without load at the slowest speed possible without stalling.

In block.—Two or more cylinders cast as one piece, i. e., 2, 4, 6, 8 cylinders cast "in block."

Indicated horsepower (i. hp.).—Total power developed by the engine; or brakehorsepower (b. hp.) added to friction horsepower (f. hp.). Example: If an engine tested at 2,000 r. p. m.'s develops 34 b. hp. and 26 f. hp., it would be rated as having 60 indicated horsepower at 2,000 revolutions per minute.

Inertia.—The tendency of a body at rest to remain at rest and of a body in motion to persist in motion.

In line.—Indicates that all the cylinders of an engine are in the same plane and in sequence within the cylinder block, starting at the front with No. 1, then No. 2, etc. Other blocks are known as V-type, pancake type, radial-type, etc.

Insulation.—A protective covering on wires or electrical parts to prevent short circuits, or on pipes to prevent temperature changes.

Integral.—The whole made up of parts; constituting a part of a whole necessary to completeness.

Intermittent.—Occurring at intervals.

Jump spark.—A spark jumping or bridging a gap in a high voltage circuit.

Kilowatt.—1,000 watts (approximately 1⅓ horsepower).

L-*head.*—Designates an engine with all the valves, cams, lifters, and other moving parts of the valve mechanism in and on one side of the cylinder block.

Laminated.—Built up in thin layers.

Left.—The left side of a vehicle, looking forward from the driver's seat.

Lines of force.—Invisible lines in a space (field) along which magnetic forces flow.

Louver.—Opening or vent in the hood, fender panel, or cowl, intended to ventilate the compartment.

Magnetic field.—The space around a magnet through which the magnetic lines of force travel.

Mechanical efficiency.—The ratio between the brake horsepower (b. hp.) and the indicated or total horsepower (i. hp.).

Meshing.—The mating or engaging of the teeth of two gears.

Misfire.—A failure of the engine to fire regularly or to complete its cycle of operation.

Momentum.—The quantity of motion in a moving body.

M. P. H.—Miles per hour.

Motor.—Technically applied to an electric motor. Incorrect usage also applies it to the power plant of a motor vehicle. The term "engine" should be used in referring to the power plant of a motor vehicle.

Negative terminal (pole).—The usually accepted terminal to which the current returns after passing through the circuit.

North Pole.—The pole of a magnet from which the lines of force emanate (or leave).

Octane rating (or number).—The antiknock rating given a gasoline. Obtained by comparison with a standard or reference fuel.

Ohm.—A unit of measurement of electrical resistance. One ohm allows 1 ampere of current to flow through a conductor at 1 volt potential.

Open circuit.—A circuit through which no current can pass.

Oscillate.—To move or swing back and forth with a pendulum like motion.

Otto cycle.—A cycle of four events which occur in a gasoline engine in the following order: (1) intake, (2) compression, (3) power, and (4) exhaust.

Pinion.—The smaller of two mating (or matching) gears.

Piston displacement.—The amount of space displaced during one stroke of the piston. Example: Assuming that with piston at top of stroke there is a volume of 10 cubic inches in the combustion space and that with piston at bottom of stroke the volume is increased to 63 cubic inches, the piston displacement would then be 63 minus 10, or 53 cubic inches for one cylinder. The formula for calculating piston displacement is as follows:

$$d^2 \times .7854 \times S \times N = \text{piston displacement.}$$

d^2 is diameter or bore squared or multiplied by itself (as 5×5); this result is then multiplied by the constant .7854 (the area of a cylinder 1 inch in diameter); this result by S, the stroke in inches; and this result by N, the number of cylinders.

Poppet valve.—A valve opened by the action of a cam and closed by a strong spring. This type of valve is used almost exclusively in the automotive industry. Its action is comparable to the popping up and down of puppets (corrupted to "poppet") of Punch and Judy shows.

Ports.—Openings in a cylinder block (or sleeve) for intake, exhaust, water, oil, etc.

Positive terminal (pole).—The usually accepted terminal from which the current enters the circuit.

Potential.—Ability to exert energy. Expressed electrically by voltage.

Power.—The capacity to do work. Capacity to perform mechanical work as measured at the rate it is being done.

Power plant.—The engine.

Power transmission group.—A group of units transmitting power from the engine (power plant) to the wheels. It consists of clutch, transmission, propeller shafts, universal joints, differentials, and driving axle shafts.

Precision.—Extreme accuracy.

Preignition.—Ignition which occurs earlier than intended. This usually occurs under abnormal conditions.

Radius rods.—Rods attached to axles to prevent misalinement or twisting.

Rear.—A place or position at the back of or behind a person or thing.

Reciprocating.—A back and forth (or up and down) linear motion, such as the action of pistons in the engine.

Right.—The right side of a vehicle looking forward from the driver's seat.

Rotary.—Revolving or circular. Rotary motion is considered the opposite of linear reciprocating (up and down or back and forth) motion in power transfer.

R. P. M.—Revolutions per minute.

SAE.—Society of Automotive Engineers, a technical organization which has aided the automotive industry by advocating standardization of parts and nomenclature and by scientific investigation.

Scored.—Marred by ridges or grooves.

Seat (valve).—That part of the combustion chamber upon which the valve face rests.

Seize (or freeze).—To stick because of expansion caused by heat or friction or scoring.

Shim.—Spacer (usually metal) to regulate the distance between two objects, as bearings.

Sleeve valve.—The ports or slots cut into sliding cylinders (or sleeves) of an engine which open and close by moving up and down to admit the fuel mixture or to expel the exhaust gases.

South Pole.—The end of a magnet at which the lines of force enter (return); opposite to North Pole.

Spark coil.—A device used to raise (or "step up") the voltage by electro-magnetic induction.

Specific gravity.—Weight of a given volume of substance compared to that of an equal volume of chemically pure water at 4° C. (39.2° F.). Example: Pure commercial sulphuric acid has a specific gravity of 1.8 as compared to distilled water which has a specific gravity of 1.00.

Stress.—The forces exerted on, within, or by a body during either tension or compression. The opposing reaction of the interior elements of a solid body against forces tending to deform them.

Stroke.—The length or distance the piston travels up or down inside the cylinder.

Stud.—A rod (bolt) with threads cut on both ends. Studs, having one end screwed into an engine cylinder block, secure the cylinder head to the block by means of nuts on the other threaded end.

Synchronize.—To make two or more events or operations occur at the proper time with respect to each other.

T-*head.*—Used to describe an engine that has the intake valves on one side of the cylinder and the exhaust valves on the other.

Taper.—To make gradually smaller toward one end; a gradual reduction of size in a given direction.

Tappet (*valve lifter*).—That portion of a valve operating mechanism which rides against the cam and lifts the valve or push rod. It can usually be adjusted for valve stem clearance.

Temperature.—The intensity (or degree) of heat.

Tension.—A stress or strain caused by pulling.

Thrust.—A stress or strain caused by pushing.

Toe-in.—The degree (usually expressed in fractions of an inch) to which the forward part of the front wheels are closer together than the rear part, measured at hub height with the wheels in the normal "straight ahead" position of the steering gear.

Tolerance.—An allowable variation in dimensions. For example: A standard measurement of .025 with a tolerance of minus .003 or plus .003 indicates that dimensions between .022 and .028 are allowable.

Torque.—A twisting or wrenching effort. Torque is the product of force multiplied by the distance from the center of rotation, at which it is exerted. For example: A force of 40 pounds applied on the end of a 1-foot pipe wrench would be 40 pounds×1 foot, or 40 foot-pounds of torque. Similarly, 40 pounds of force exerted on the end of a 2-foot pipe wrench would be 40 pounds×2 feet, or 80 foot-pounds of torque. This indicates why it is easier to unscrew a pipe coupling with the 2-foot wrench than with the 1-foot wrench—the torque incident to the 2-foot lever (wrench) is greater.

Torque tube.—A tubular member rigidly attached to the rear axle housing and enclosing the propeller shaft, which is also attached to the frame or transmission and prevents movement of the axle housing through drive torque reactions.

Torsion.—The deformation in a body caused by twisting.

Trunnion Axle.—A supporting axle, which carries a load with other axles attached to it. Its use as part of a "bogie" permits independent wheel action in a vertical plane and within designed limits.

Universal joint.—A device which provides for the transmission of power through an angle.

V-type.—Two rows (or banks) of engine cylinders arranged in V-form. Any other object having a V-shape such as a V-block.

Vacuum.—Result of reducing atmospheric pressure.

Valve lifter (tappet).—That portion of a valve operating mechanism which rides against the cam and lifts the valve or push rod. It can usually be adjusted for valve stem clearance.

Valve seat.—That part of the combustion chamber upon which the valve face rests.

Valve seat insert.—A ring of special, hard material fastened into the cylinder to form the valve seat.

Velocity.—The rate of motion or speed of a body at any instant; usually measured in miles per hour or feet per second or minute.

Vibration damper.—A device to regulate the torsional (twisting) vibration of a multiple cylinder engine crankshaft.

Viscosity.—Internal resistance to flow; the thickness or body of a fluid.

Volatility.—Ability of a liquid to vaporize or turn into a gas.

Volt.—A unit of electrical measurement of potential (electro motive force); the potential necessary to cause a current of 1 ampere to flow through a conductor of 1-ohm resistance.

Watt.—Unit of electric measurement of power. One watt of power equals 1 ampere of current times 1 volt of potential.

Wear.—To abrade or rub away the surface.

Work.—The expenditure of energy necessary in overcoming resistance.

SECTION III

CLASSIFICATION OF MILITARY MOTOR VEHICLES

4. General.—Military motor vehicles are divided into three groups based on the use for which they are designed and developed.

5. General purpose vehicles.—*a.* These vehicles are used for hauling general cargo, ammunition, personnel, and equipment, as well as for towing trailers, guns, and other wheeled equipment. Examples: cargo trucks, dump trucks, passenger cars, and ambulances.

b. The Quartermaster Corps is responsible for the design, development, procurement, maintenance, storage, and issue of all vehicles in this group. It collaborates with the Medical Department in developing and designing ambulances.

6. Special purpose vehicles.—These vehicles are usually grouped in three subdivisions. (General purpose chassis and vehicles should be used whenever practicable to reduce the number of types and models of vehicles in this group.)

a. Special vehicles are intended for special or technical duty and are not suitable for general purposes. Examples: Air Corps trailers, crash trucks, and fuel trucks. The Secretary of War, in approving a project, designates the using arm or service responsible for designing, developing, and maintaining vehicles in this subdivision.

b. Combat and track-laying vehicles are primarily intended for combat and have specially designed chassis and equipment. They are usually not suitable for general purpose use. They are customarily armored and carry weapons. Examples: tanks, combat cars, and scout cars. The Ordnance Department is responsible for all vehicles in this subdivision.

c. Special equipment vehicles have the same chassis as general purpose vehicles, but their bodies and/or their equipment are designed for special technical needs. Examples: wrecking trucks and shop trucks. The Quartermaster Corps is responsible for the vehicles in this subdivision, but the using arm or service is responsible for the special equipment used on these vehicles.

7. Plant vehicles.—*a.* These are any power-operated vehicles used at manufacturing arsenals, depots, proving grounds, and airdromes (including those used for flying field upkeep).

b. The arm or service operating an arsenal, depot, or establishment is responsible for all plant vehicles, except general purpose vehicles, which will be purchased through the Quartermaster Corps.

SECTION IV

PROCUREMENT OF MILITARY MOTOR VEHICLES

8. General policy.—*a.* Procurement of all vehicles except combat vehicles will be limited to reasonably priced models produced commercially by two or more competing companies. The using arm or service to which the vehicle is allocated must plan its military characteristics with minimum deviation from standard commercial chassis.

b. The number of makes, models, and types of motor vehicles will be held to the minimum consistent with laws and regulations. General purpose vehicles should be used unless such chassis definitely will not meet technical or combat requirements.

c. Gross weight, width, height, as well as axle, wheel, and track loads are limited by instructions based on highway and bridge capacities. These are prescribed in current War Department orders and cannot be exceeded except by specific approval of the Secretary of War in each case.

SECTION V

DESIGNATION AND DESCRIPTION OF MILITARY MOTOR VEHICLES

9. Ambulances.—Wheeled vehicles designed or intended for transport of sick and wounded.

10. Armored cars.—Wheeled combat vehicles designed primarily for reconnaissance.

11. Carriers, cargo or personnel.—Full track, half track, or convertible (track or wheel) combat vehicles designed for carrier use.

12. Combat cars and tanks.—Track-laying or convertible (track or wheel) armored combat vehicles.

13. Command cars.—Wheeled vehicles designed for use of commanders and staff of units in the field.

14. Motorcycles.—Wheeled vehicles designed or intended for messenger, reconnaissance, and repair crew use or for traffic control purposes. They include: solo motorcycles, motorcycles with side cars, and motor tricycles.

15. Passenger cars.—Wheeled vehicles designed for passenger use.

16. Semitrailers.—Wheeled vehicles without motive power, resting on and attached to the chassis of the truck-tractor by means of a fifth-wheel arrangement. They can be detached at will from the latter.

17. Scout cars.—Wheeled armored combat vehicles designed primarily as personnel carriers or for reconnaissance.

18. Tractors.—Vehicles designed primarily for towing or combat service. They may be full or half track laying, convertible, or wheeled. The Ordnance Department is responsible for all combat and track-laying tractors; the Quartermaster Corps, for all wheeled general purpose tractors; and the using arm or service, for special tractors.

19. Trailers.—Wheeled vehicles without motive power, but provided with suitable drawbars or tongues for attaching them to trucks or other towing vehicles.

20. Trucks.—Wheeled or track vehicles designed primarily for carrying cargo or equipment. They may be used for carrying personnel or for towing.

21. Truck-tractors.—Wheeled vehicles, equipped with a fifth wheel arrangement, designed for towing semitrailers.

SECTION VI

REGISTRATION OF MILITARY MOTOR VEHICLES

22. General.—Under current Army Regulations all military motor vehicles must be registered by make, model, engine, and serial number in the War Department motor vehicle central records office, which is maintained and operated by The Quartermaster General.

23. Grouping for registration.—For the purpose of registration all vehicles are grouped under the following types and classes:

a. General service.

Type	*Class*	*Pay-load capacity*
1	Cars, passenger (open and closed models)	2 to 7 passengers.
2	Trucks, utility (pick-up, panel, or light delivery).	¼ to 1 ton.
3	Trucks, light (cargo, dump, or tractor-truck)	1¼ to 2 tons.
4	Trucks, medium (cargo, dump, or tractor-truck).	2½ to 4 tons.

Type	Class	Pay-load capacity
5	Trucks, heavy (cargo, dump, tractor-truck, or tank carrier).	5 tons and over.
6	Motorcycles (solo, with sidecars, and motor tricycles).	1 to 3 passengers.
8	Tractors, wheeled (light, medium, or heavy).	
20	Trucks, reconnaissance	All sizes.

b. General and special service.

Type	Class	Pay-load capacity
0	Trailers, wheeled, motor drawn (cargo, spare parts, horse van, generator, lathe, milling machine, and similar).	All sizes.
	Semitrailers, wheeled, motor drawn (pigeon, bomb, photographic, and platform).	All sizes.

c. Special service.

Type	Class	Pay-load capacity
7	Ambulances (field and metropolitan)	All sizes.
9	Tractors, track laying (light, medium, and heavy).	
00	Trucks, maintenance (light repair, small-arms, repair, and wrecking).	All sizes.
10	Trailers, kitchen, motor drawn	1½ tons.
50	Trucks, fire (fire and crash)	All sizes.
60	Vehicles, special and technical (radio, office, generator, searchlight, sterilizing, water purification, and similar).	All sizes.
80	Trucks, tank and sprinkler (tank; also light and heavy duty refueling).	All sizes.

d. Combat.

Type	Class	Pay-load capacity
30	Tanks, track laying (light, medium, and heavy).	
40	Vehicles, track laying (combat, cargo carrying, and wire laying).	All sizes.
Special ordnance.	Vehicles, combat, special and technical, wheeled (scout and armored cars).	All sizes.

24. Registration numbers.—*a. Method.*—The first or first two digits of the United States Army registration number, which are italicized in the examples given below, indicate vehicle types only. The remaining digits indicate the numerical sequence in which the vehicle has been added to the type group. A vehicle registration number gives only the type of the vehicle; in order to clarify this example the number has been amplified by a word description to indicate the make and model. The "W" is used to designate War Department vehicles.

b. Examples.

U. S. Army registration number	
W–*1*1111	Passenger car: Chevrolet, sedan.
W–*2*7543	Utility truck: International ½-ton, pick-up (fig. 2).
W–*3*1075	Light truck: Mack 1½-ton, dump (fig. 5).
W–*4*1754	Medium truck: Autocar 4-ton, cargo (fig. 6).
W–*5*1741	Heavy truck: Hug 7½-ton, cargo (fig. 7).
W–*6*3741	Motorcycle: Harley-Davidson, solo (fig. 8).
W–*7*547	Ambulance: Henny, Metropolitan (fig. 11).
W–*8*14	Tractor, wheeled: Chevrolet 1½-ton (fig. 14).
W–*9*63	Tractor, track-laying: Caterpillar 5-ton.
W–*0*116	Trailer: Laverne 1-ton, cargo (fig. 13①).
W–*00*116	Truck: Chevrolet 1½-ton, light repair (fig. 15).
W–*5*0463	Fire truck: crash (fig. 17).
W–*6*0477	Command car: Dodge, 5-passenger (fig. 18).
W–*8*0551	Tank truck: Mack, 1,500 gallons, heavy duty, refueling.

SECTION VII

TERMINOLOGY OF CHARACTERISTICS OF MILITARY MOTOR VEHICLES

25. Pay load.—*a. Ton capacity* is the pay load of a cargo vehicle and is expressed in tons to the nearest half ton.

b. Gallon capacity is the pay load of tank trucks.

c. Passenger capacity is the pay load of passenger vehicles including operating personnel.

26. Chassis weight.—*a.* In passenger cars it is indicated by the term "light" or "medium."

b. The chassis weight of other vehicles is usually expressed in pounds, as given by the manufacturer.

27. Chassis type.—This is shown by indicating the number of wheels and number of driving wheels. Dual wheels will be considered single wheels for this purpose. Examples:

a. Semitrailer and trailer chassis types will be indicated by the term "2W" for vehicles with two wheels or "4W" for those with four wheels.

b. Other vehicle chassis types will be indicated by the number of wheels, the letter "x", and the numbr of driving wheels; "4 x 2" shows four wheels with two driving; "4 x 4" shows four wheels with all four driving.

c. Dual wheels and tires will be indicated by their number followed by "dt" in parentheses. Thus (2dt) indicates a vehicle having two dual wheels and tires. To carry this a little further in connection with chassis type, a 6 x 4 (4dt) vehicle would be one with 6 wheels, 4 of them driving and four having dual tires.

28. Track.—A track is an endless belt device with metal, rubber, or processed blocks, or metal links driven by sprockets and guided by rollers.

a. Full track vehicles are entirely supported, driven, and steered by a track which replaces all wheels.

b. Half track vehicles are supported and steered by wheels on the front end, and are supported and driven by a track on the rear end. Some half track vehicles, in addition to having these driving tracks, are also equipped with front driven axles.

c. Convertible vehicles can be changed to operate either on full or half track or on wheels.

29. Purpose.—This is indicated by the general characteristics of the body or the use for which the vehicle is designed. Examples:

Ambulances—field, metropolitan.
Cars —command, roadster, coupe, sedan, limousine.
Trucks —cargo, light repair, dump, tank, cargo and dump, wrecking, pick-up.

30. Make.—Name of vehicle manufacturer or producer.

31. Model.—Year or other designation adopted by manufacturer, producer, or purchaser to identify vehicle, its design, unit assemblies, and parts.

32. Gross weight.—This is expressed in tons to the nearest half ton and is usually shown as "gross ____ tons." The gross weight of a vehicle is defined as the chassis weight, plus the weight of the cab and the entire body fully equipped and serviced for operations, plus the maximum allowable pay load and weight of *all* operating personnel.

33. Angle of approach.—Angle of clearance between foremost part of front tire near point of contact with the ground and forward edge of lowest front part, generally the front bumper. The angle must be sufficient to permit vehicles to come out of steep banked

depressions without burying the front of the vehicle into the embankment, as it may prevent traction by lifting the front wheels off the ground.

34. Angle of departure.—Angle of clearance between rearmost part of rear tire near point of contact with the ground and rear edge of lowest rear part, generally the pintle, mud shields, or rear bumpers. The angle must be sufficient to permit negotiation of steep banks without catching the rear of the vehicle on the edge of the bank, as it may prevent traction by keeping the rear wheels off the ground.

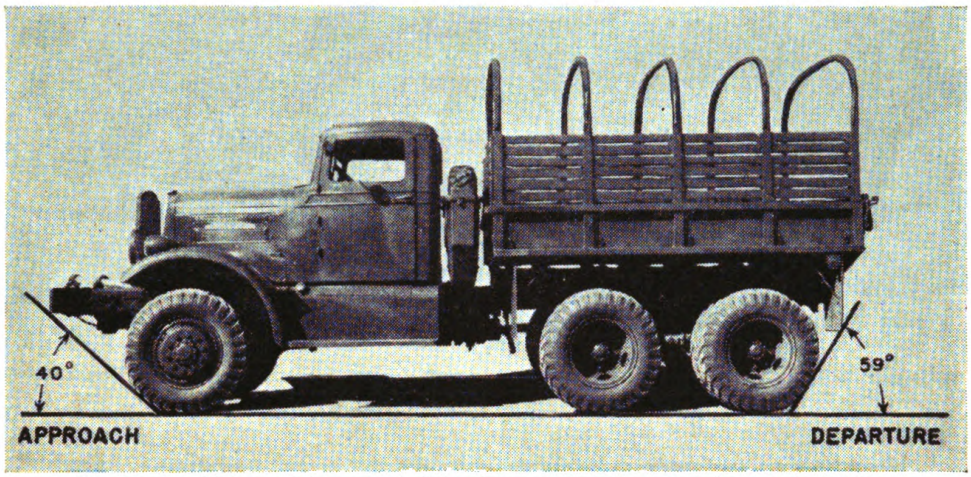


FIGURE 1.—Motor vehicle marked to show angles of approach and departure.

35. Types of military motor vehicles.—Figures 2 to 18 illustrate various types of military motor vehicles and terminology.

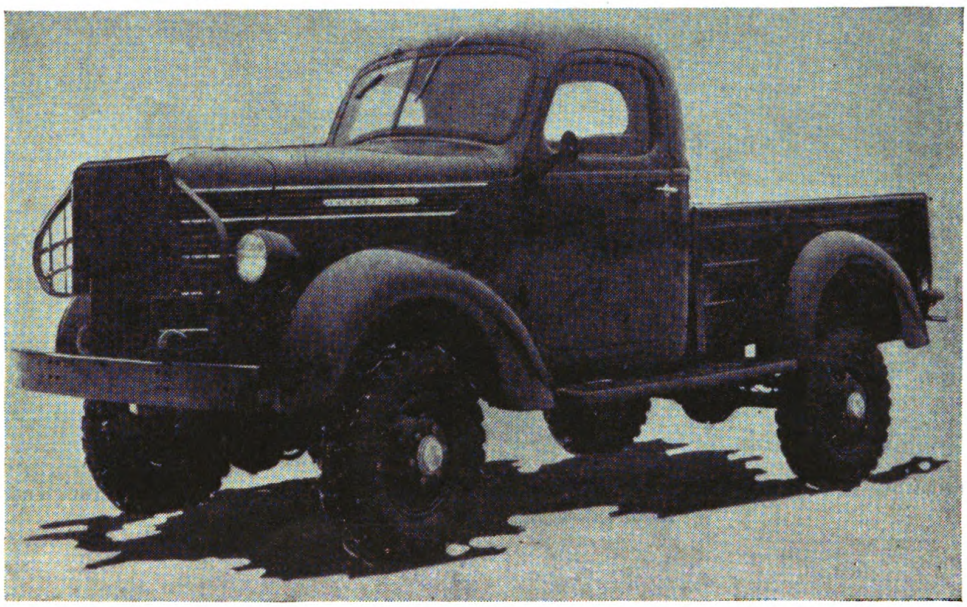


FIGURE 2.—Truck, ½-ton, 4 x 4, pick-up (closed cab), International 1940 (type 2 vehicle).

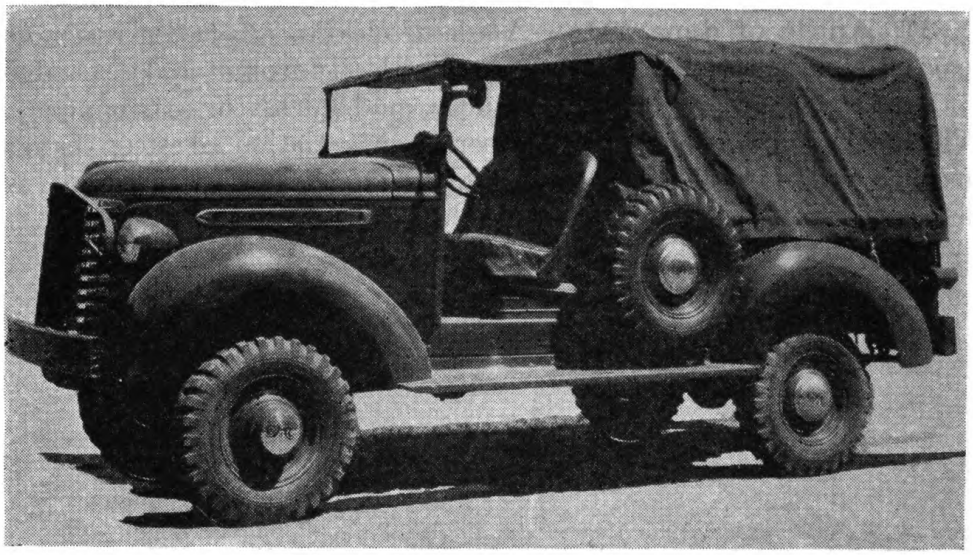


FIGURE 3.—Truck, ½-ton, 4 x 4, pick-up (open cab), G. M. C. 1939 (type 2 vehicle).

FIGURE 4.—Truck, 1½-ton, 4 x 4 (2dt), cargo (closed cab), Dodge 1940, with front end mounted winch (type 3 vehicle).

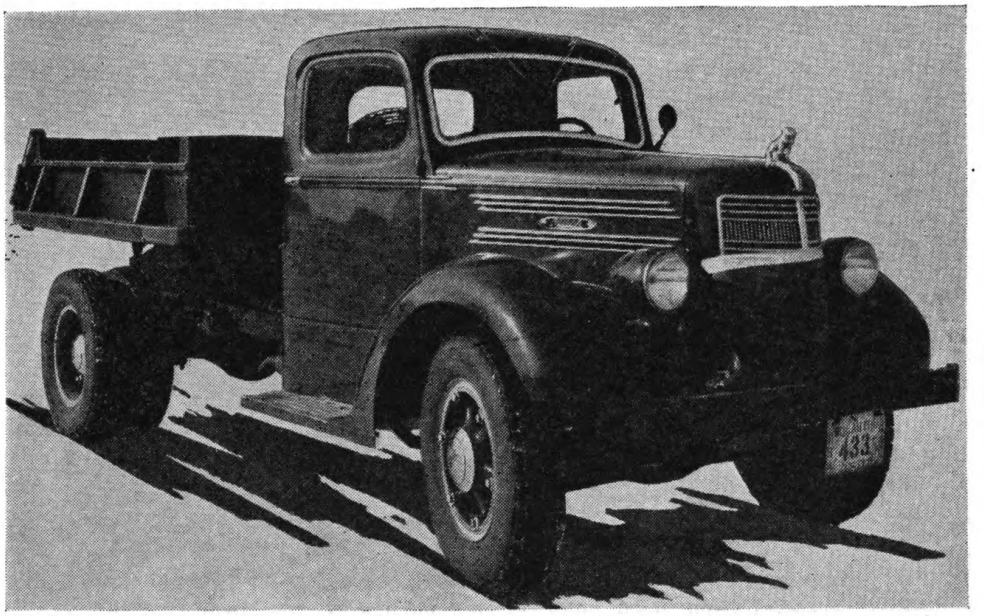


FIGURE 5.—Truck, 1½-ton, 4 x 4 (2dt), dump (closed cab), Mack 1940 (type 3 vehicle).

FIGURE 6.—Truck, 4-ton, 6 x 4 (4dt), cargo (open cab), Autocar 1940, with front end mounted winch (type 4 vehicle).

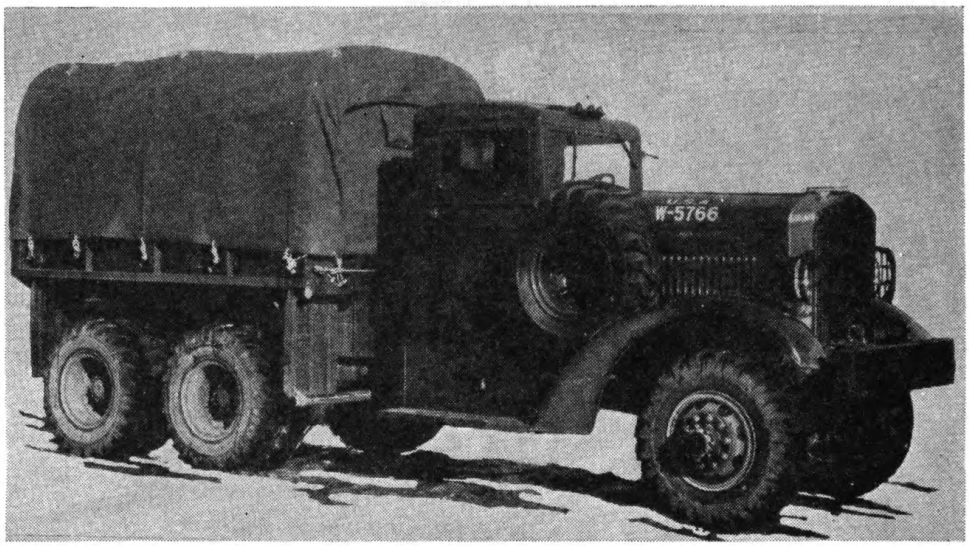


FIGURE 7.—Truck, 7½-ton, 6 x 6 (4dt), cargo (closed cab), Hug 1940 (type 5 vehicle).

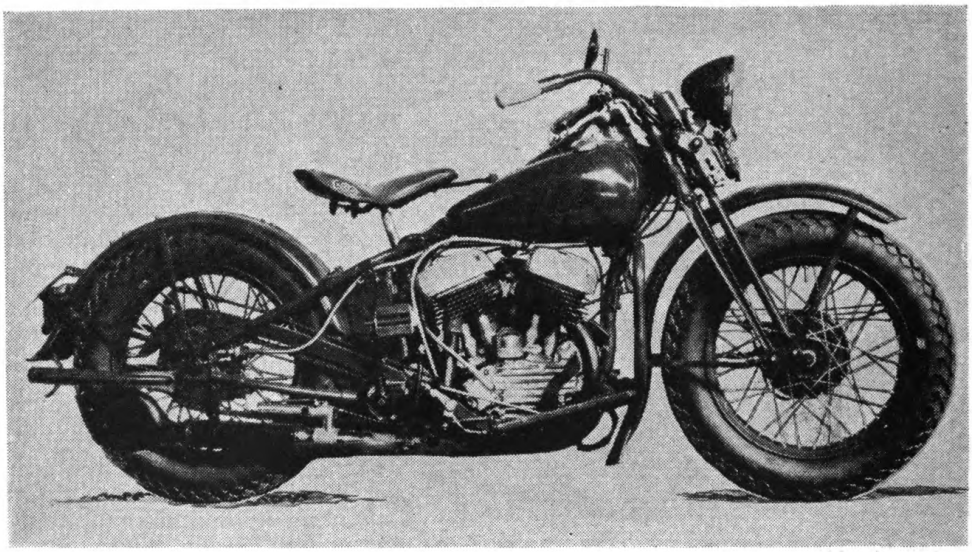


FIGURE 8.—Motorcycle, solo, 2 x 1, Harley-Davidson 1939 (type 6 vehicle).

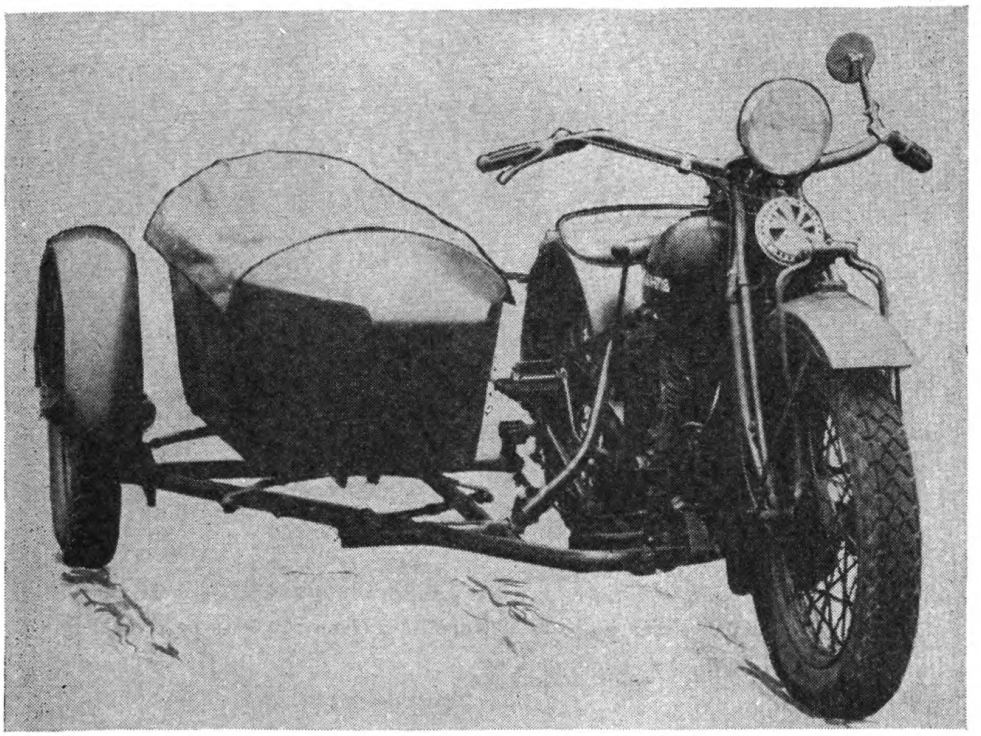


FIGURE 9.—Motorcycle, with sidecar, 3 x 1, Indian 1936 (type 6 vehicle).

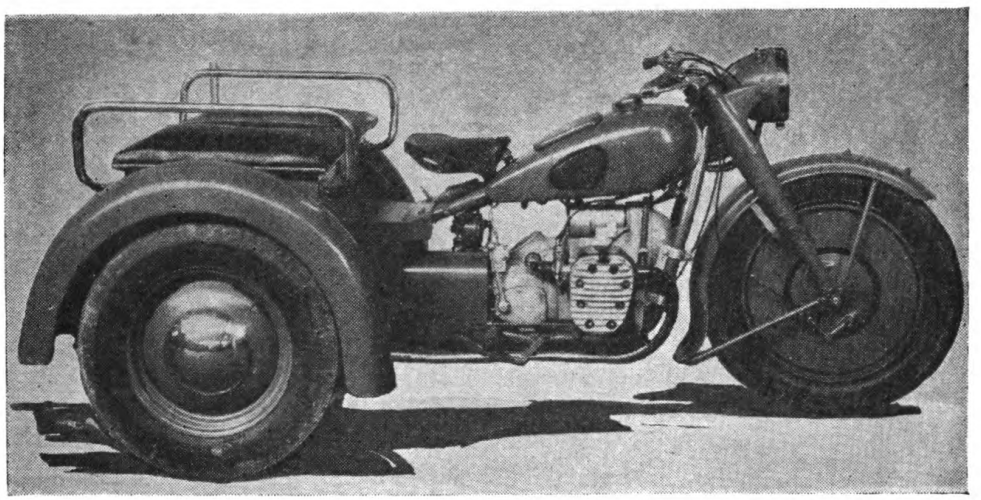


FIGURE 10.—Motor tricycle, 3 x 2, Delco 1940 (type 6 vehicle).

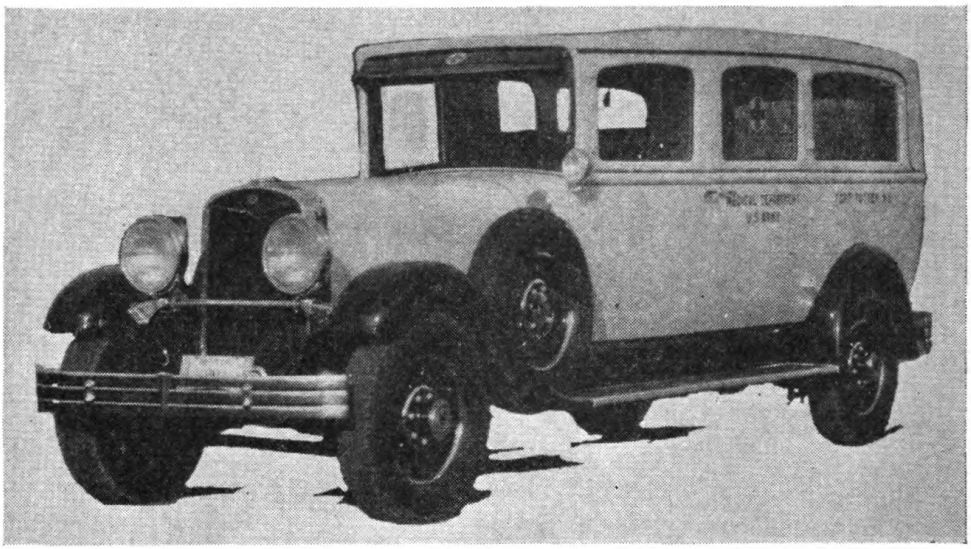


FIGURE 11.—Ambulance, heavy, 4 x 2, Metropolitan, Henny 1930 (type 7 vehicle).

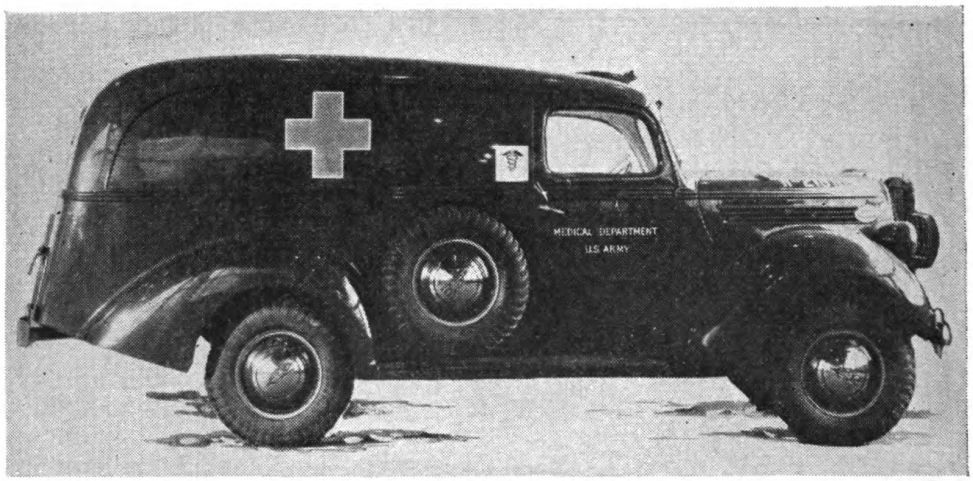
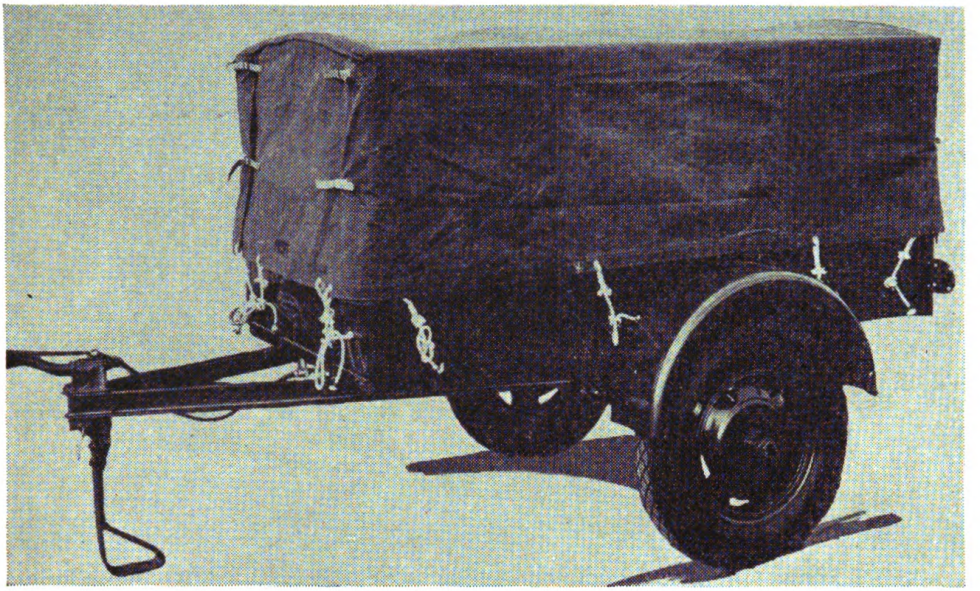
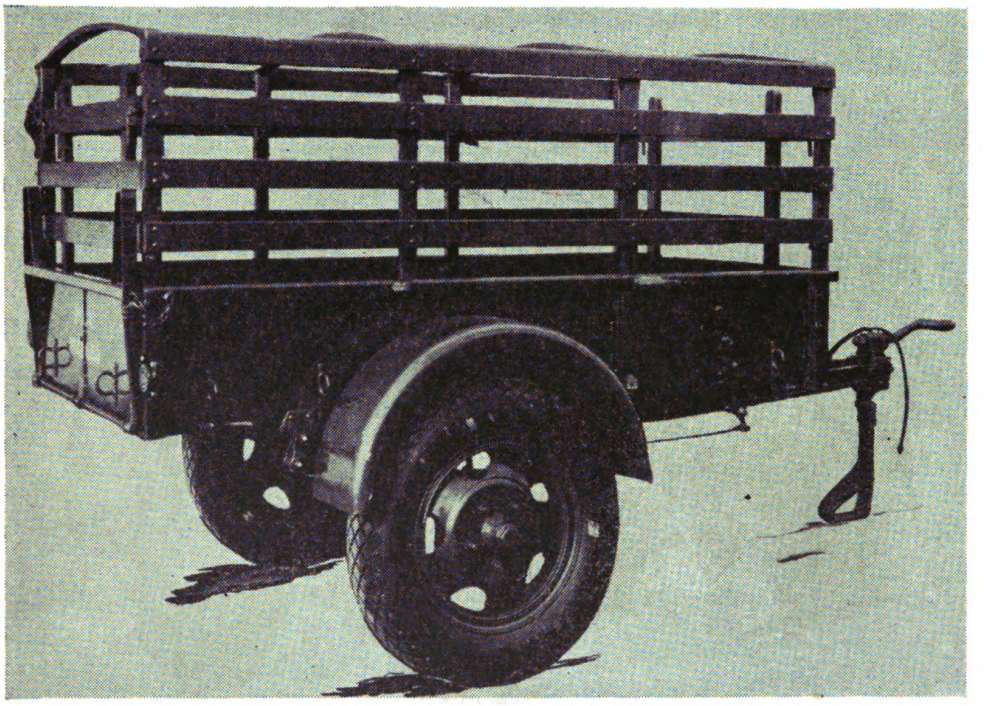


FIGURE 12.—Ambulance, 1½-ton, 4 x 4, Field, Marmon-Herrington, 1940 (type 7 vehicle).



① With canvas cover.



② Without canvas cover (wood cover frame showing).

FIGURE 13.—Trailer, 1-ton, 2 W, cargo, Laverne 1939 (type 0 vehicle).

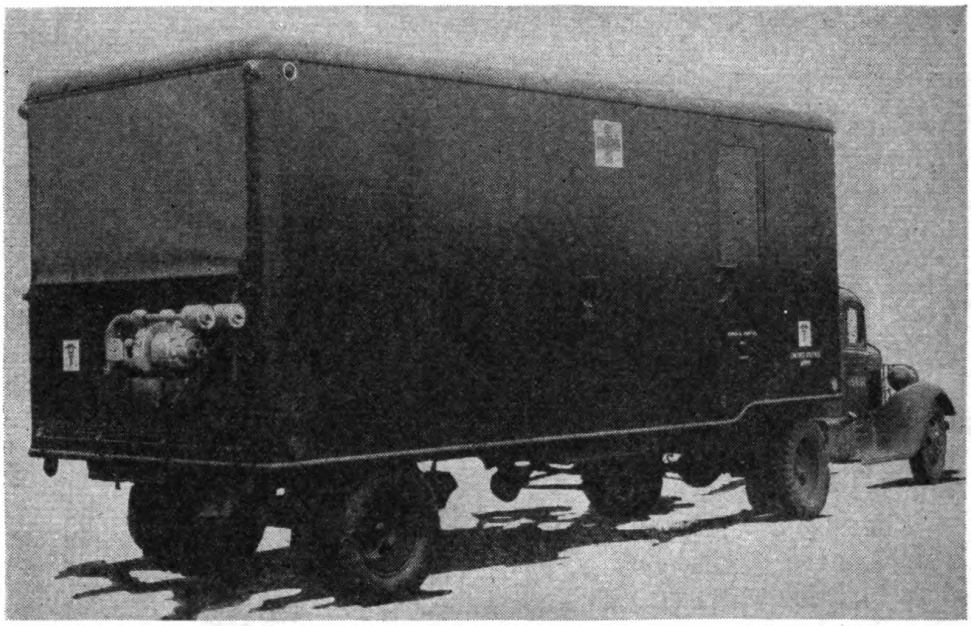


FIGURE 14.—Semitrailer, 2 W (2dt), surgical hospital unit, Spencer 1939 (type 0 vehicle).

NOTE.—Towing vehicle in front of semitrailer is a light wheeled tractor-truck, 1½-ton, 4 x 2 (2dt), with fifth wheel under forward part of semitrailer; Chevrolet 1936 (type 8 vehicle).

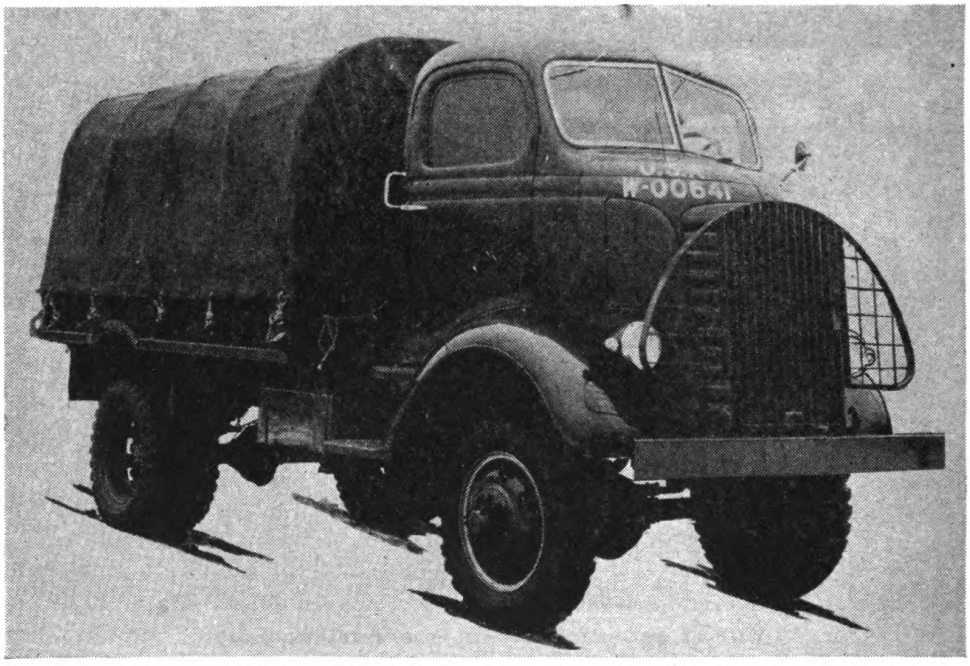


FIGURE 15.—Truck, 1½-ton, C. O. E. (cab over engine), 4 x 4 (2dt), light repair (closed cab), Chevrolet 1939 (type 00 vehicle).

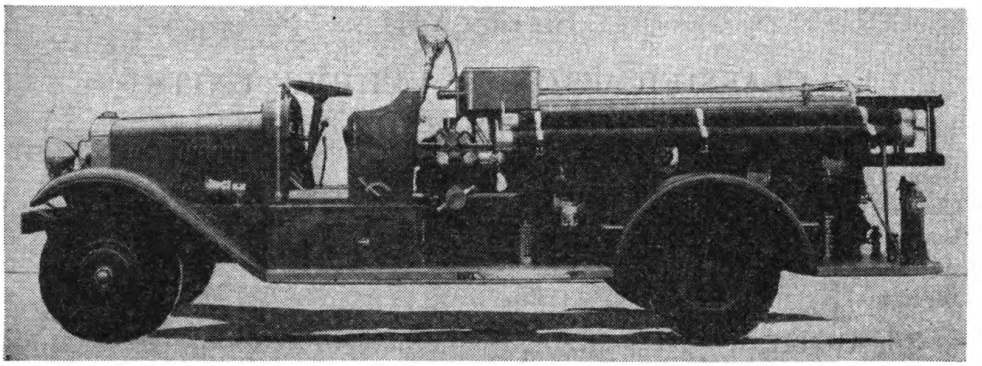


FIGURE 16.—Truck, heavy, 750-gallon, 4 x 2 (2dt), fire (type 50 vehicle); manufactured at Holabird Quartermaster Depot, Baltimore, Md.

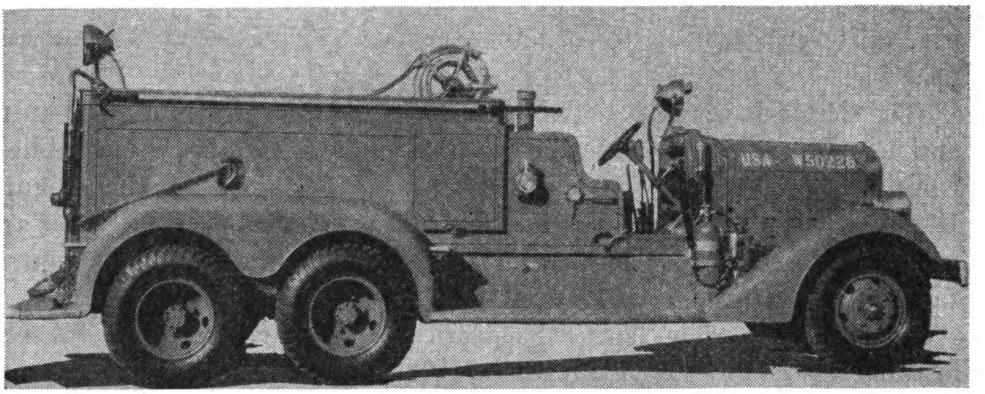


FIGURE 17.—Truck, heavy, 6 x 4 (4dt), crash (type 50 vehicle; chemical fire apparatus usually assigned to airdromes and flying fields); manufactured at Holabird Quartermaster Depot, Baltimore, Md.

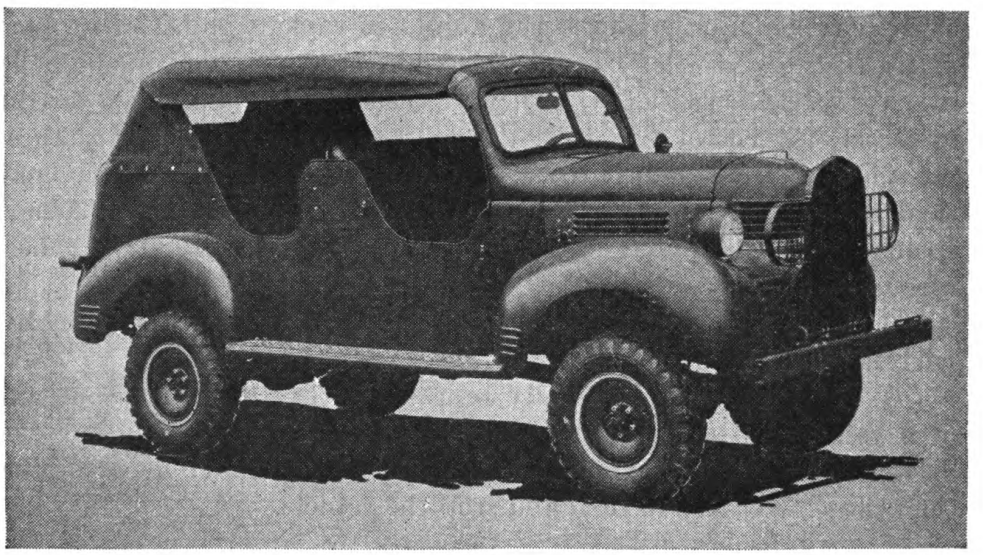


FIGURE 18.—Car, command (or staff), 5 passenger, 4 x 4, Dodge 1940 (type 60 vehicle; based on use of a ½-ton chassis, under standardization program, may be considered a type 2 vehicle).

SECTION VIII

CLASSIFICATION OF VEHICLE UNITS AND ASSEMBLIES

36. General.—There are many methods of grouping vehicle units and assemblies, but it is usual to have two primary groupings, the chassis group and the body group. These may be divided into subordinate units, assemblies, and accessories according to functional use, unit or assembly to which attached, or customary automotive practice.

37. Chassis group.—This primary group consists of the units and assembles briefly described below under the major assemblies, running gear, and power plant, with their respective units. Figure 19 shows only one combination of units and assemblies. There are many others, varying according to engineering design and manufacturing problems.

a. Running gear.—This consists of frame, springs, axles, wheels, braking system, and steering mechanism. Some vehicles may also use torque tubes or torque arms and radius rods.

(1) The *frame* is the structural unit about which a motor vehicle is assembled. It maintains proper relation between component parts of the vehicle and distributes the weight to various points of support.

(2) *Springs* are flat or coiled flexible support units mounted between the frame and axles. They are designed to absorb shocks due to vehicle movement over irregular road surfaces. In some instances, springs are also designed to absorb driving forces; this applies particularly to the "Hotchkiss drive." Shock absorbers and auxiliary springs are often used to improve riding qualities and to check rebound action.

(3) *Axles* may be either dead (nondriving), figure 20, or live (driving), figure 21.

(*a*) The dead axle is usually represented by the solid front axle of a vehicle, all axles of trailers, and the axles of a chain sprocket driven vehicle. This type of axle usually has no moving parts other than those necessary to turn and stop the vehicle.

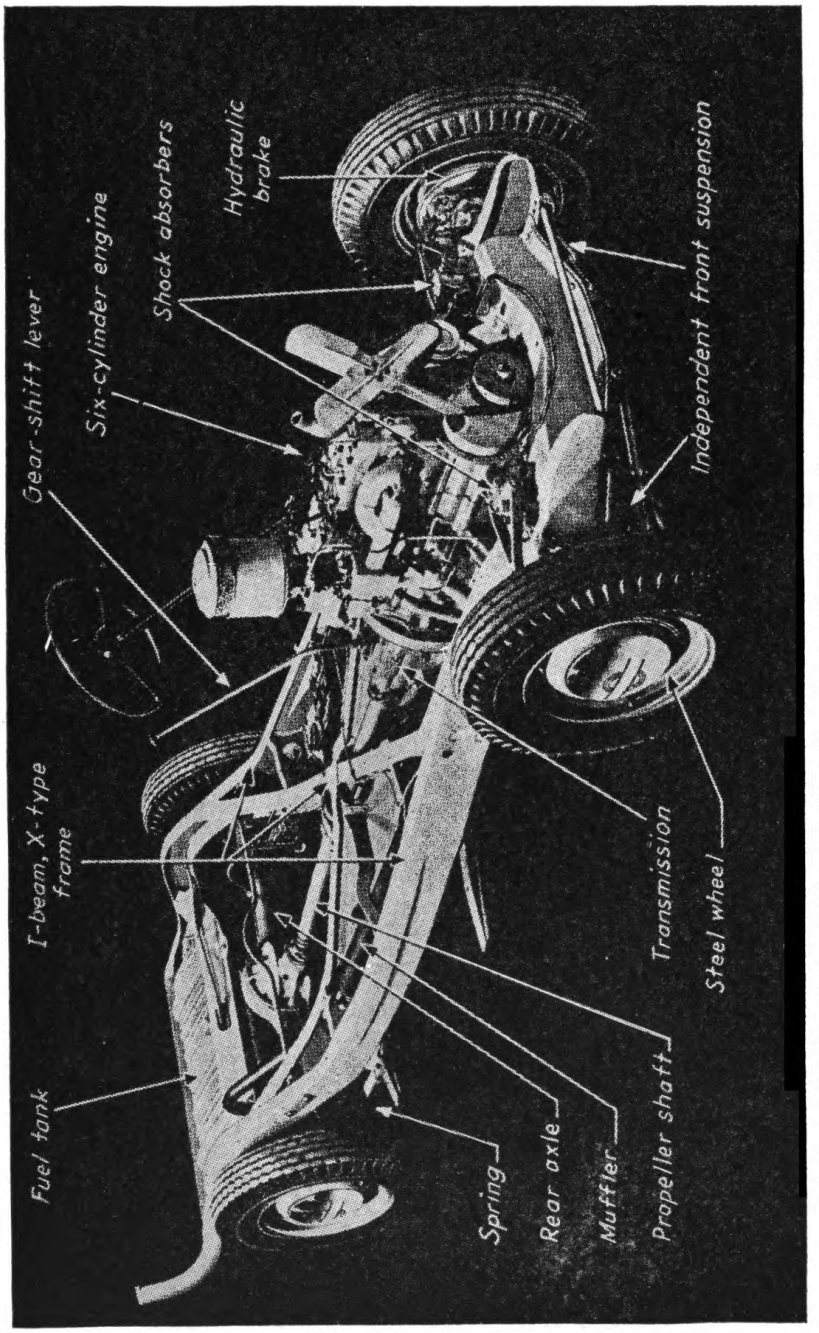


FIGURE 19.—Modern gasoline engine-driven passenger car chassis showing its various parts.

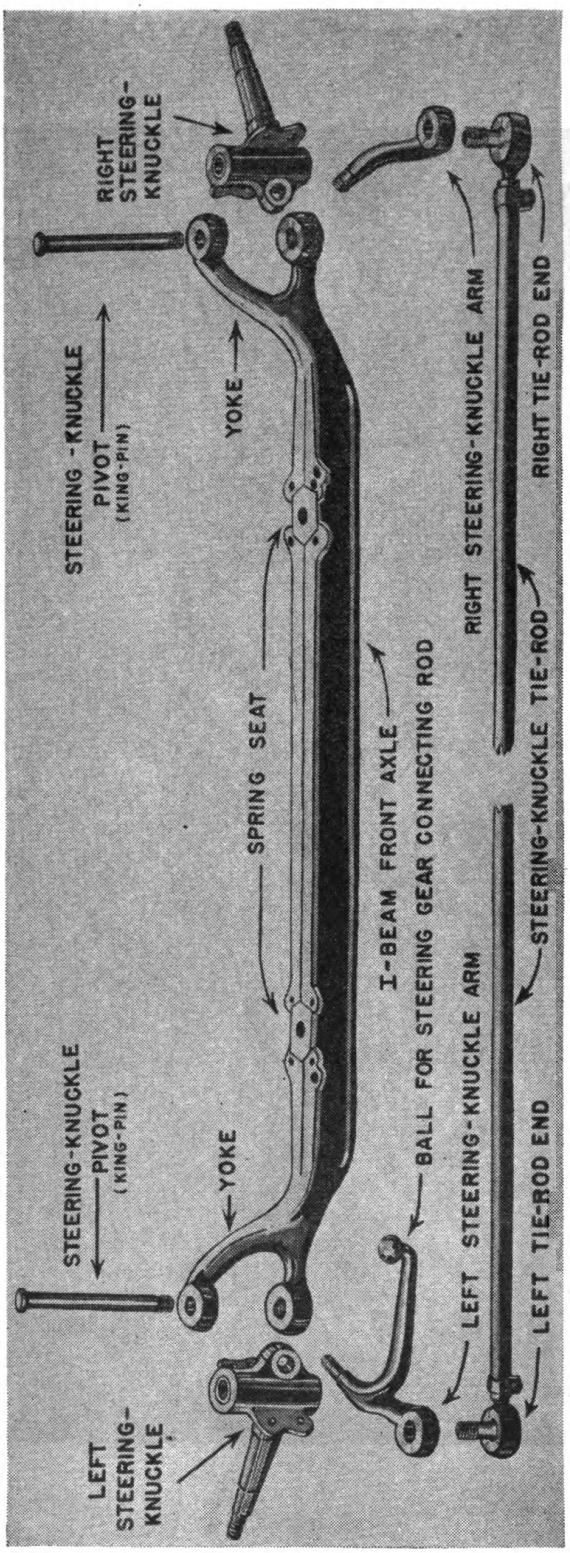


FIGURE 20.—An I-beam type front axle (dead, nondriving) and attached steering parts.

(*b*) The live axle contains the final driving mechanism that moves the vehicle. It normally consists of a housing, differential gear, and two axle shafts.

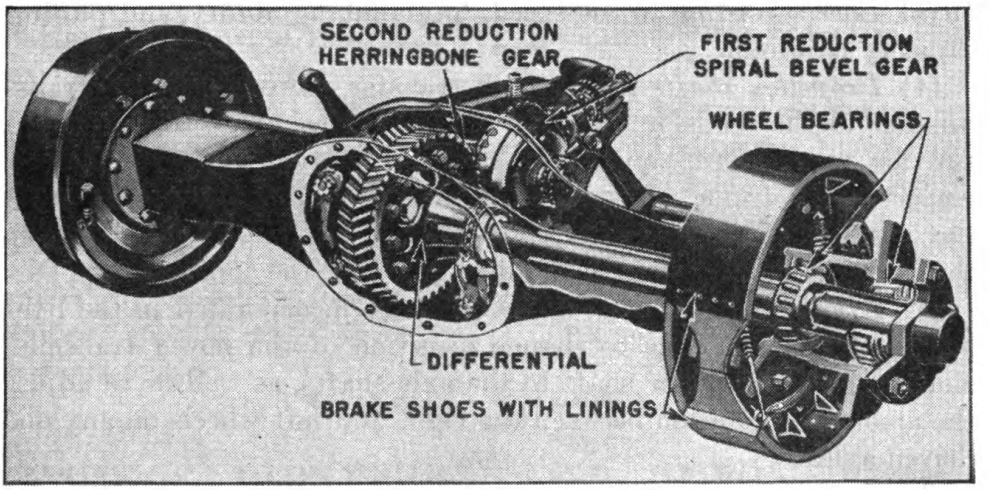


FIGURE 21.—Live (driving) rear axle unit with double reduction bevel and herringbone (combination) gears.

(4) *Wheels* support the vehicle and are the means for moving it over the highway.

(5) *Braking systems* are designed either to slow down or to stop a vehicle. When parking brakes are applied they prevent vehicle movement. A vehicle usually has brakes on at least 2 rear and 2 front wheels. However, any combination may be used.

(6) *Steering mechanism* connects the steering wheel in the operator's cab (or compartment) to the front wheels and provides a means for directing the vehicle.

(7) *Torque tubes or torque arms and radius rods* may be attached to or made a part of the axle housing and frame or the frame members. They resist the force from propeller (drive) shaft or from any brake action which tends to rotate the axle.

b. Power plant.—This assembly consists of engine assembly, clutch, transmission, and transfer mechanism (the latter usually on heavy duty vehicles), propeller shaft or shafts with universal joint or joints, and differential and final drive units.

(1) *Engine assembly* is the source of motive power. It converts heat units into mechanical power by the internal combustion of a fuel.

(2) The *clutch unit* engages or disengages the engine from the transmission. When engaging, it permits the load on the engine to be "picked up" gradually. It may also be disengaged so that none

of the developed engine power is transmitted to the driving (or live) axles.

(3) *Transmission and transfer mechanisms*, by use of gear trains, allow the power developed in the engine to be applied to the driving (live) axles according to the speed, hill-climbing ability, and pulling capacity required.

(4) *Propeller shafts* are used to transfer power from the transmission to the transfer case and to the driven axles. In order to provide angular (up and down or side) motion of the axle with respect to the frame, one or more universal joints may be used with the shafts. Universal joints are capable of transmitting power through angles within fixed angular limits of the joints.

(5) *Differential and final drive units* are incorporated in the live-axle units and combine to change direction of the power transmission from the propeller shaft to the axle shafts, as well as to adjust the amount of rotation between the right and left wheels on any one driven axle.

38. Body group.—This primary group consists of the units and assemblies briefly described below and illustrated in figure 22.

a. The *cab assembly* is the compartment usually provided for the operator (driver) of the vehicle.

b. Controls and instruments required for the operation of the

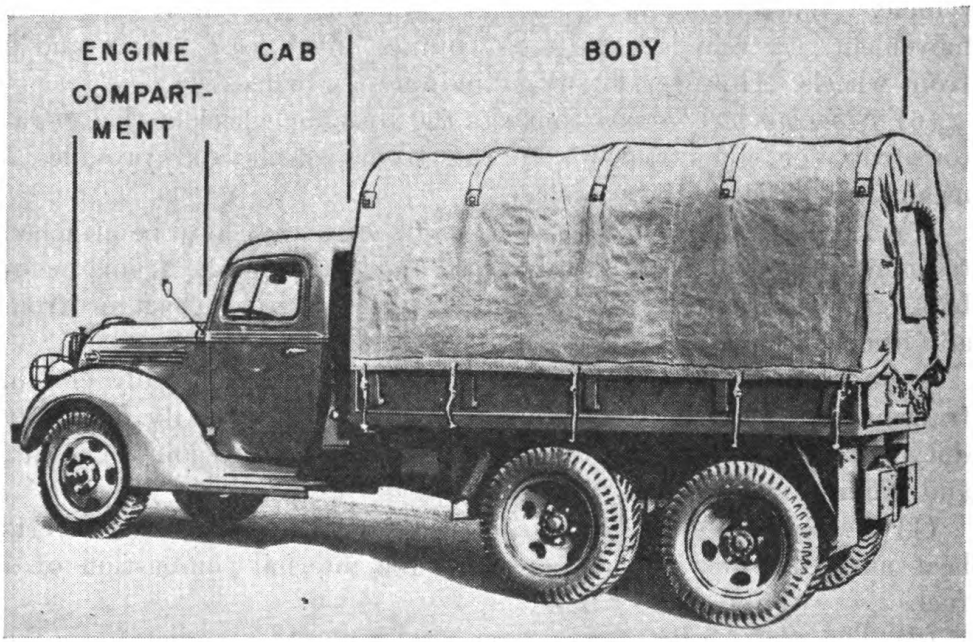


FIGURE 22.—Cargo vehicle showing engine compartment, cab, and body.

vehicle are usually located in the cab and on an instrument panel mounted on the dash.

c. Cargo body or platform provides space for the payload.

d. Sheet metal housing (fenders, hood, cowl, and similar metal parts) reduces wind resistance by "streamlining" and protects vital parts from the weather.

39. Accessories.—These are units which, depending upon custom and practice, are not considered necessary for the proper functioning of a unit or assembly but which are often desirable. They usually include oil filters, air filters, and other special equipment.

40. Electrical system.—For convenience, automotive electricity should be considered under the single heading "electrical system", without specific regard to individual units or assemblies with which it functions.

SECTION IX

UNITS OF MOTOR VEHICLES AND THEIR FUNCTIONS

41. Axles.—The principal function of the axle is to carry the weight of the vehicle to the wheels. An axle which performs this function only is a dead axle (fig. 20). It may be of tubular or I-beam construction.

a. Live axles.—These axles carry the weight of the vehicle and also transfer power (or driving force) to the wheels. They are of tubular construction. The outer shell carries the weight of the vehicle and forms a housing for the driving axle shaft and the differential units. In addition to these functions, the outer ends of axles usually carry the fixed parts of the braking system and absorb the forces resulting from brake applications. Figure 23 shows a typical rear axle assembly.

b. Front axles.—These axles incorporate a portion of the steering mechanism in addition to carrying the load. In many instances they provide power transmission, especially in tactical vehicles.

c. Independent springing.—Where "knee action" or similar methods of independent springing are used, the center section of the axle, as well as the entire axle structure, is sometimes eliminated. The load is passed from the frame to the wheel spindles by means of two or more flat or coil springs and transverse linkages.

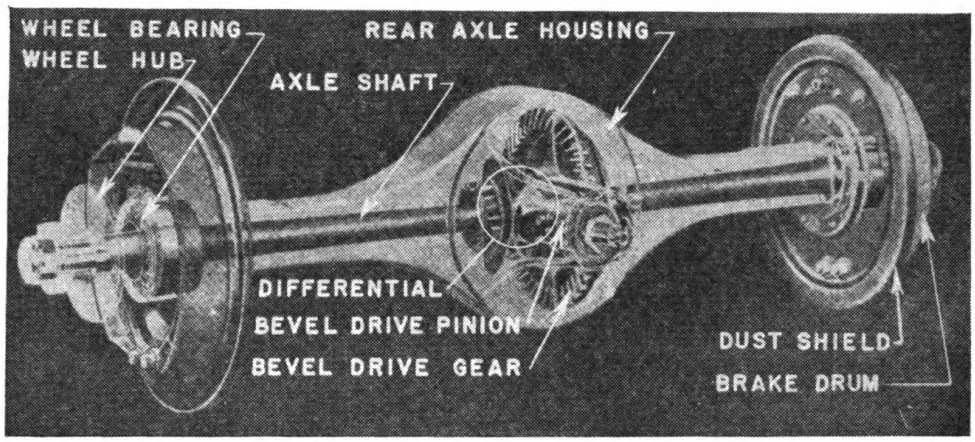


FIGURE 23.—Phantom view of live rear axle with axle shafts and differential assembly in darker color.

d. Shock absorbers.—Shock absorbing devices are used to control the action and reaction of the springs between the axles and the sprung load. These may be either single or double acting. The single acting shock absorber acts only on the rebound of the spring, while the double acting acts on both compression and rebound movements. Shock absorbers are normally used on all four wheels of passenger cars, but only on the front wheels of commercial vehicles. Figure 24 shows a shock absorber in place.

42. Differential and final drive units.—Since power is transmitted to the axle at right angles, it is necessary to change its direction of movement. This is accomplished by bevel gear drives, spiral bevel gears, or worm gears. The worm gear type of drive is occasionally used in the heavy duty trucks because of its high gear reduction. Straight spur gearing is seldom used except in the case of a double reduction drive where a combined bevel and spur gear unit is used. A dual ratio final (axle) drive (with differential) is shown in figure 25. A dual ratio is provided by a system of planetary or spur gears between the final drive gear and the differential case. A two-position control in the cab allows the operator to select either of the two gear ratios.

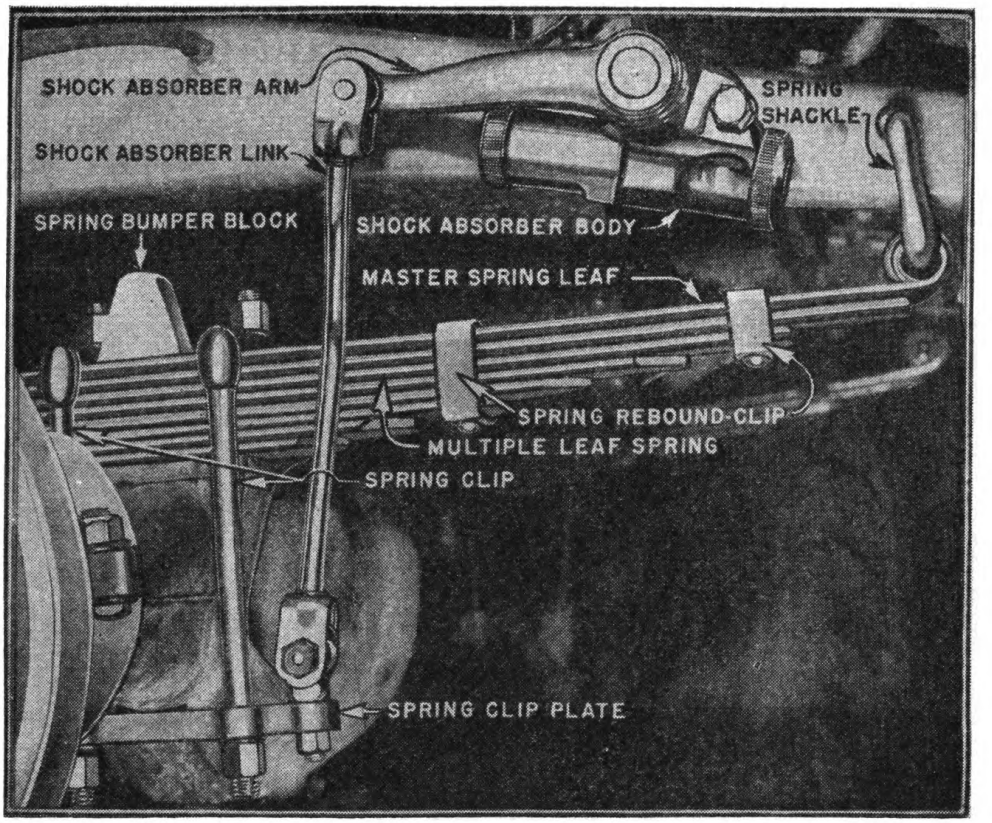


FIGURE 24.—Double action type shock absorber showing how it is mounted to act between frame and axle.

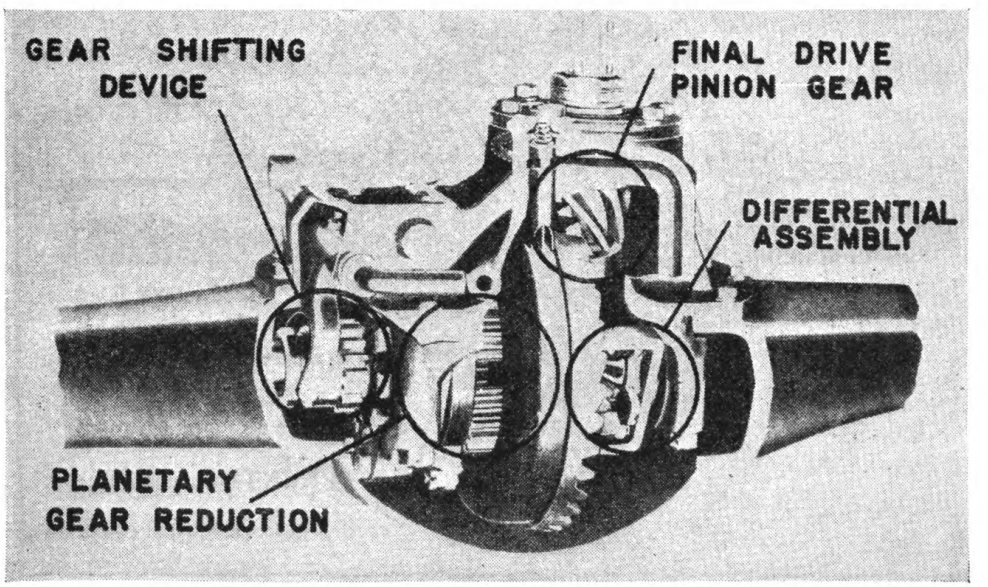


FIGURE 25.—Dual ratio final (axle) drive with differential assembly. Planetary gearing for gear reduction is shown at left center, while shifting arrangement is shown at extreme left.

a. Power enters the driven axle through the propeller shaft or rear universal joint. A short pinion shaft is used to convey the power to the drive assembly which, in turn, drives the differential assembly. In dual ratio axles the power is transmitted through an additional set of gears between the pinion drive and the differential assembly.

b. In a single ratio final drive the bevel (or worm) gear is assembled on the differential case. Figure 26 shows a bevel gear type of axle drive with differential.

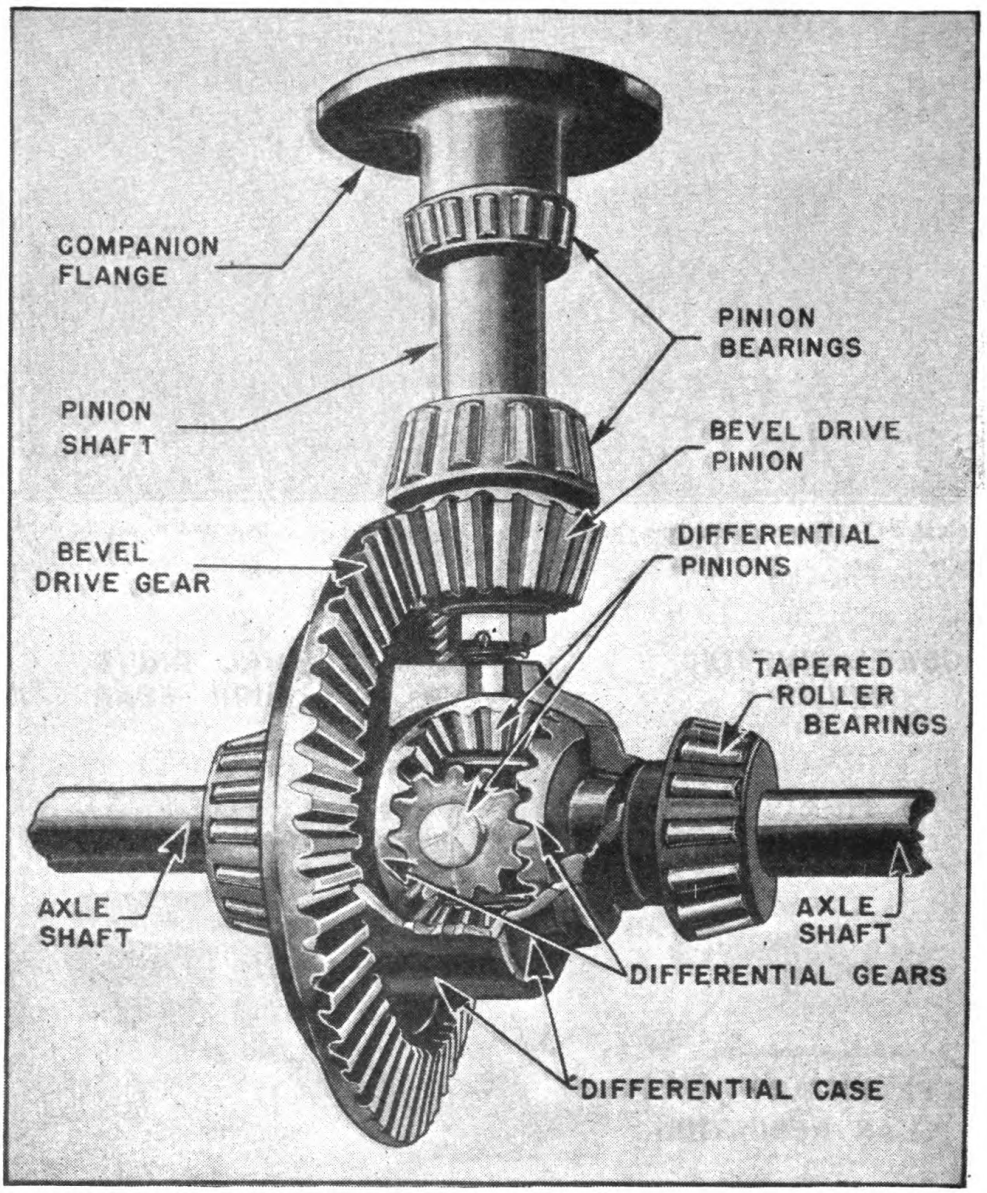


FIGURE 26.—Bevel gear and pinion type of final (axle) drive assembled to differential unit.

c. Hypoid gearing is a comparatively recent development in final (axle) drives. In a hypoid gear the axis of the pinion gear is either above or below the center line of the bevel gear. Its principal advantages are greater tooth area in contact, quieter operation, and increased chassis clearance above the propeller shaft. This increased clearance permits construction of vehicles with chassis closer to the ground. Figure 27 shows the use of hypoid gears in final drive.

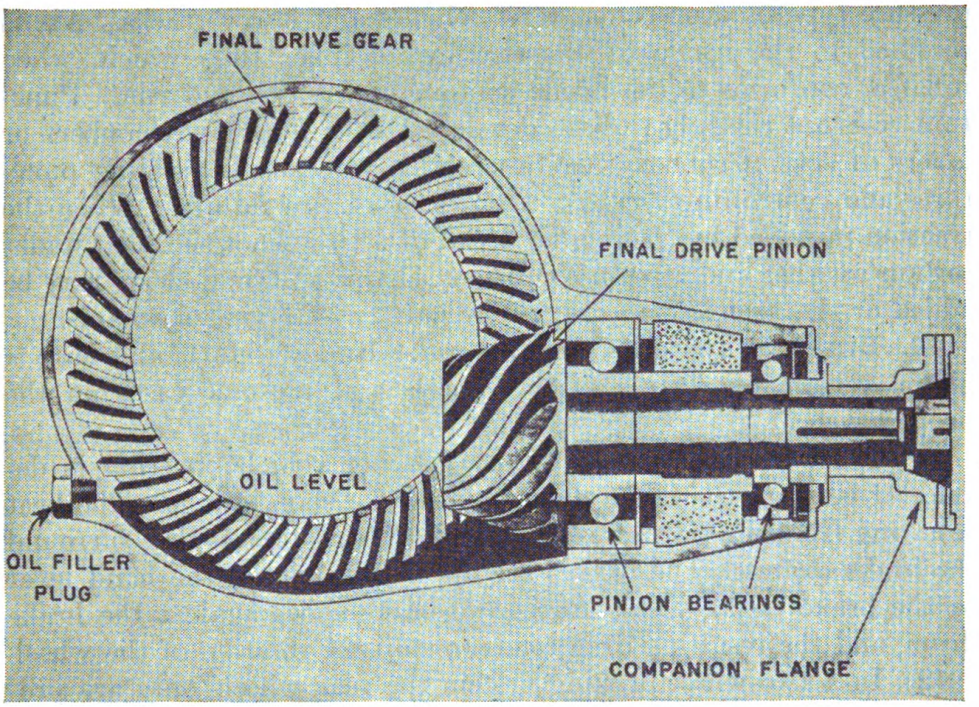


FIGURE 27.—Hypoid gear type of final drive showing relation of pinion to final drive gear.

d. When a motor vehicle turns a corner, the outside wheel, due to the longer distance it must travel, revolves faster than the inside wheel. If both wheels are mounted on rotating axle shafts driven by a common source of power, it is necessary to provide for this difference in their turning speeds. This is done by an assembly of gears known as a differential. The parts and arrangement of a differential assembly are shown in figure 26.

43. Wheels and tires.—The wheels of a motor vehicle must be light, yet strong enough to transmit driving power from the axles to the tires, carry the load, and resist side strains caused by skidding and rapid turning on curves and at corners. Wheels are made of wood, pressed steel, or of cast metal. The hub in the center of a wheel is the means by which the wheel is mounted on the spindle or axle shaft.

a. Rims secure the tires to the wheels. They are usually of the demountable, quick detachable, or drop center types.

b. Tires may be either solid, cushion, or pneumatic.

(1) Solid and cushion tires are still used to some extent on motor vehicles. Their principal use is on interior plant vehicles.

(2) Pneumatic tires are used almost exclusively on modern motor vehicles. They vary from the wide, thin wall, and low pressure balloon type on passenger cars to the heavy, thick wall, high air-pressure type used on commercial vehicles and heavy trucks. Air is confined to the inside of the tire by an inner tube which, when inflated, conforms to the inside contour of the tire and rim. Puncture resistant tubes have been developed with inner air chambers or layers of special rubber, thereby creating a means for sealing punctures and controlling escaping air in case of tire failure. When the traction provided by the regular tread of a tire is not sufficient under certain weather and terrain conditions, chains and mud cleats may be added or the vehicle may use full or half track laying mechanism.

44. Braking systems.—*a. General.*—Brakes retard and stop a motor vehicle by acting on the wheels and in some cases on the propeller shaft.

(1) In order to stop or retard a moving vehicle, friction is developed between the brake drums and brake shoe linings. The heat resulting from the friction is dissipated by air currents that surround the brake drums. The brakes are applied by use of the hand lever or the brake pedal. This forces the brake shoes against the brake drum, and the resulting drag tends to stop the rotation of the wheel.

(2) In a two-wheel braking system the rear wheels only are provided with brakes. In a four-wheel braking system all four wheels are equipped with brakes. The propeller shaft brake is usually known as a hand (or parking) brake.

(3) Braking action is usually initiated by operation of the foot pedal or hand lever by the driver. The pressure of the driver's foot on the brake pedal moves levers, rods, and cables in mechanical braking systems; a column of liquid (braking fluid) from the master cylinders in hydraulic braking systems; or air pressure from tanks in air-brake systems. Booster devices are frequently used to increase initial brake pressures. Many combinations of braking systems are available. Hydraulic brakes are commonly used on light motor vehicles; air brakes on many heavy duty vehicles. The hand lever usually operates a parking brake.

(4) Brake types based on location and action of the braking surfaces may be classified as external contracting or internal expanding.

The contracting type is seldom used as wheel brakes on modern motor vehicles because it is open to dirt and water. Figure 28 shows the brake shoe arrangement of an internal expanding brake of the hydraulic type.

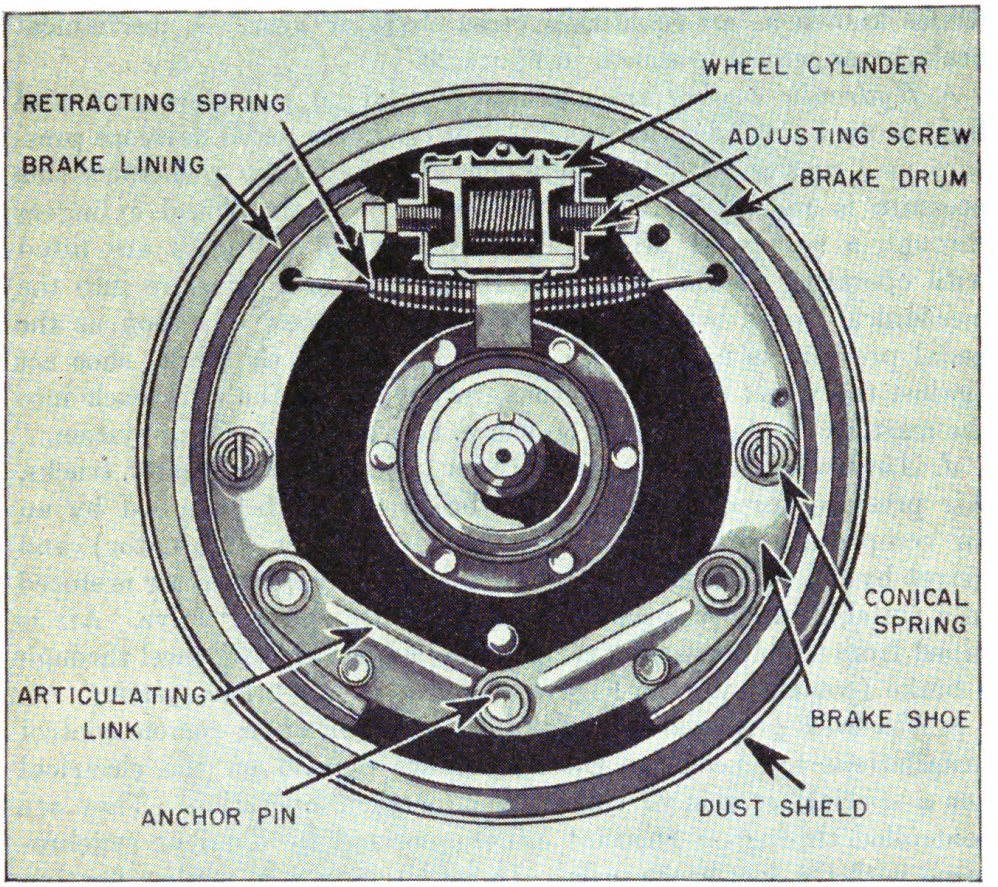


FIGURE 28.—Hydraulic actuated internal expanding brake shoes and related parts shown assembled in place.

(5) The type of lining chosen for a brake system is important because it must operate efficiently. Molded linings are generally considered better than woven linings because their water and oil repellent properties allow them to maintain a more constant coefficient of friction over a greater period of time. However, where high unit pressure or high operating temperatures are encountered, the woven lining may give better service. Braking surfaces of cast iron against steel or bronze against iron are used in some large and heavy vehicles. These may or may not require lubrication, depending upon their design or application. Lining combinations are many, and brake servicing instructions should always be consulted.

b. Mechanical brakes employ cables or rods to distribute the braking effort to the wheels. Pressure applied by the operator at the brake pedal is multiplied by the ratio of the lengths of the various brake arms before it is transmitted to the operating shafts. Most mechanical systems equalize the braking action on each wheel by a device known as an equalizing cross shaft or arm. A mechanical brake arrangement is shown in figure 29.

c. Hydraulic brakes are extensively used on passenger cars and light or medium weight trucks. Use of the brake pedal develops pressure in a master hydraulic cylinder. By hydraulic principles this pressure is increased and applied to each of the wheel cylinders through a system of brake tubes. The wheel cylinders are fitted with operating pistons that convert the hydraulic pressure into the mechanical power which expands the brake shoes. As soon as the pedal pressure is released, the return springs of the brake shoe act against the wheel cylinder pistons, forcing the brake fluid back into the master cylinder. Figure 30 shows a hydraulic braking system.

d. Air brakes are used primarily on buses and heavy-duty trucks. Air pressure for operating an air brake system is supplied by an air compressor equipped with pressure governor (regulator) and driven by the vehicle engine (power plant). Compressed air is stored in a suitable tank (reservoir) equipped with a safety valve. Air is piped from the storage tank to a brake chamber at each wheel through a brake (control) valve. Figure 31 shows an air brake system.

e. Electrical brakes are suitable for trailers or where remote control installations are needed. Electric brakes depend on the electrical (or a special) system of the vehicle for their operation. They are controlled through a rheostat either operated by hand or synchronized with the foot brake pedal. In actual operation, while a floating ring type electromagnet engages a rotating armature ring (or disk), a lug on the electromagnet engages a cam which applies the brakes. A sectional view of an electric brake unit is shown in figure 32.

f. Booster systems are often used to assist the operator in applying additional pressure when operating the brake. The commonest of these are the vacuum, mechanical, and servo-systems. The servo-system utilizes forces built up in the brake shoe itself to apply additional pressure.

45. Steering mechanism.—*a.* A motor vehicle is steered by turning both front wheels. The wheels, which are mounted on movable steering knuckles, turn in vertical yokes at the ends of the front axle. The steering knuckles are held in the yokes by steering knuckle

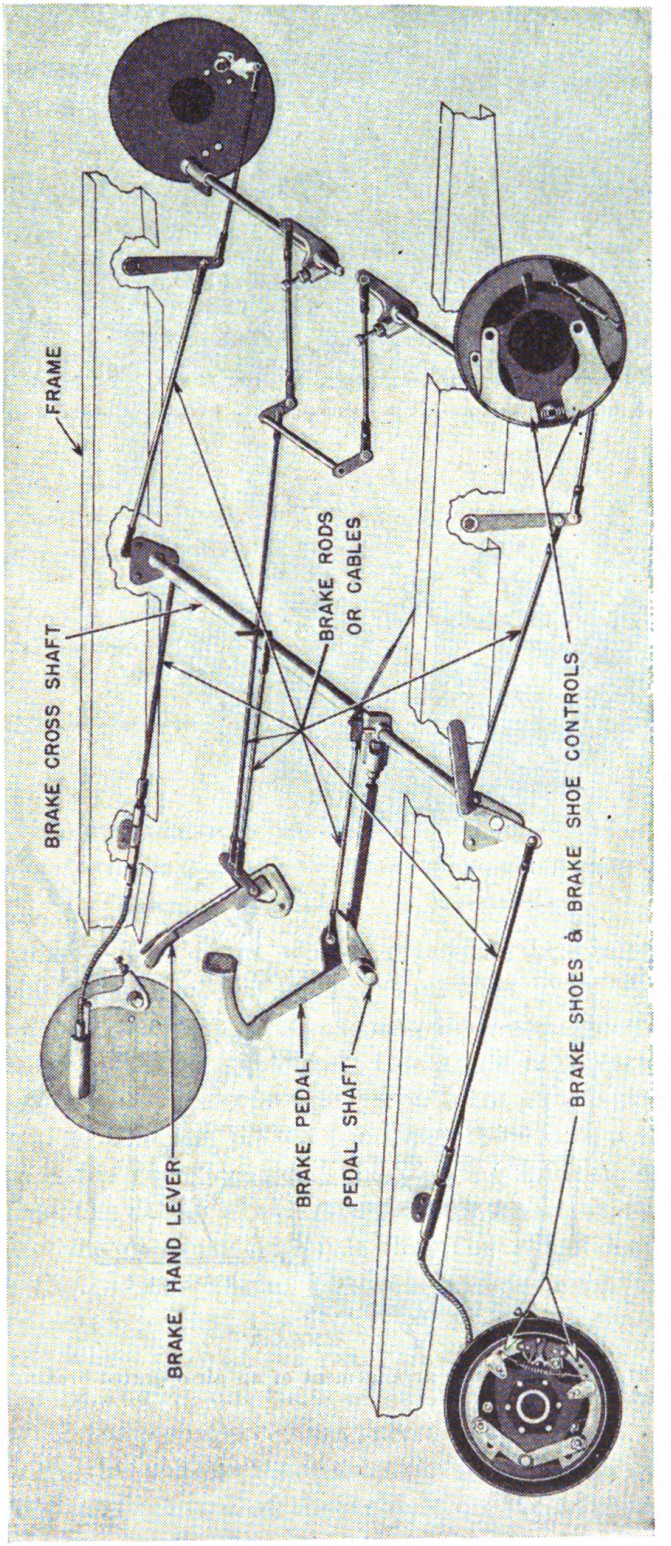


FIGURE 29.—Linkage and controls for a mechanical brake system.

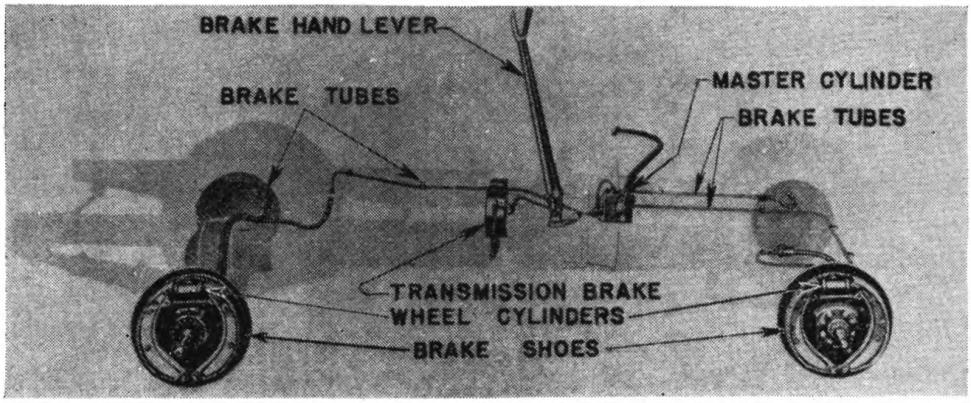


FIGURE 30.—Diagrammatic arrangement of a hydraulic braking system.

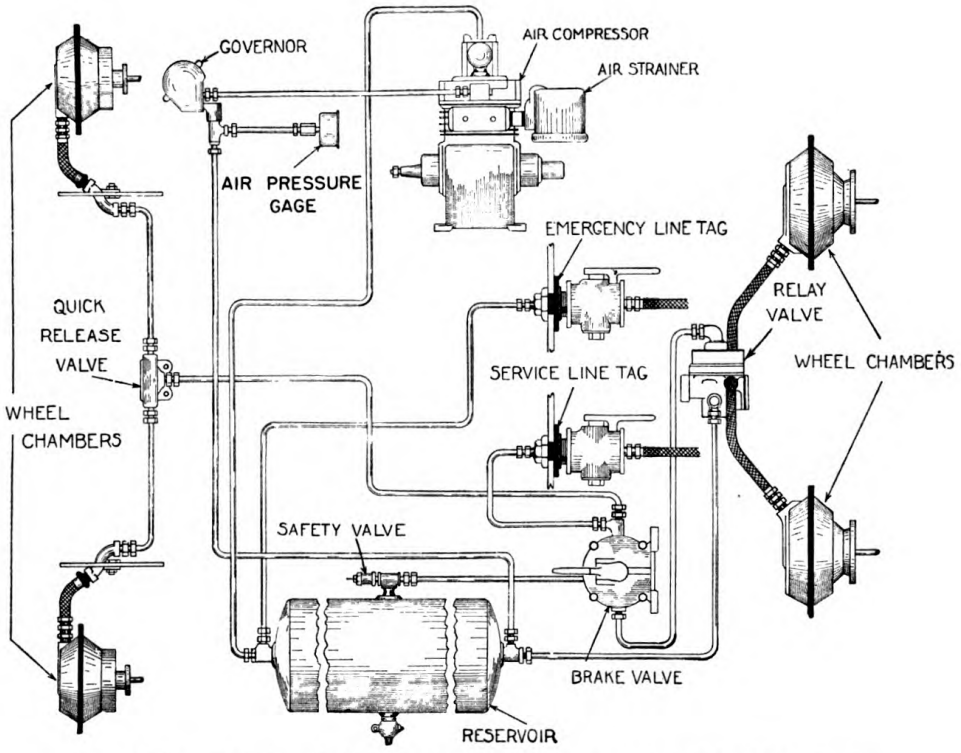


FIGURE 31.—Diagrammatic arrangement of an air-operated braking system.

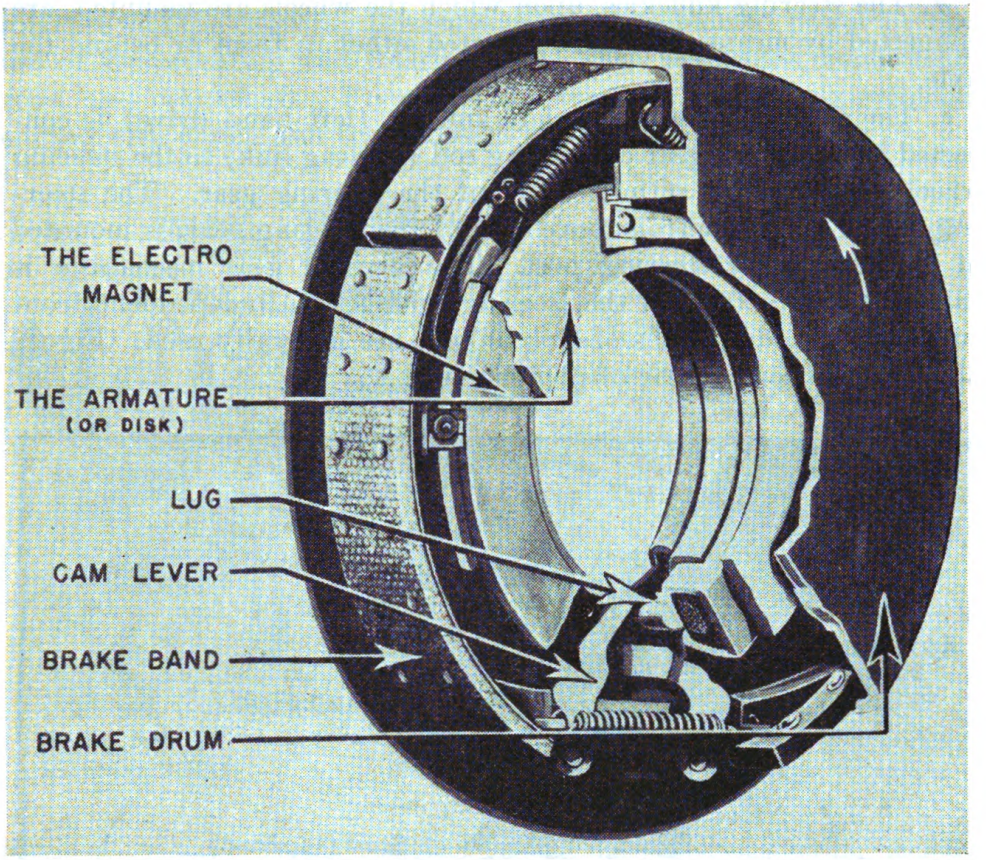


FIGURE 32.—View of electrically operated wheel brake showing electromagnet and actuating parts.

pivots (kingpins). The front wheels rotate on bearings which are mounted on the spindles of the steering knuckles.

b. The steering knuckle pivots (kingpins) are generally set at an angle with the plane of the wheel; this angle is referred to as the pivot (or kingpin) inclination angle. The front axle is rotated backward at the top so that the pivots (or kingpins) have a slight backward tilt; this is the caster angle. The steering knuckle spindles are so adjusted that the front wheels are farther apart at the top than at the bottom; this distance or angle that the wheel leans outward at the top is the camber angle. The tie rod between the steering knuckles is adjusted so that the front wheels are closer together at the front of the wheel than at the rear; this is the toe-in.

c. This series of angles and their adjustments are called the steering geometry of the vehicle. They must be properly coordinated as designated by the vehicle manufacturer in order to obtain satisfactory steering and control of the vehicle. (Manufacturer's specifications should be consulted.)

d. The steering knuckles, upon which the wheels are mounted, are connected by means of a tie rod located either in front or behind the axle.

e. The steering arm on the left knuckle (left hand drive) is connected by a steering gear connecting rod (or drag link) to the steering wheel gear arm (or pitman arm) of the steering gear. The steering wheel, which controls movement of the steering gear, is mounted at the top of the steering post. The steering gear mechanism is carried at the bottom of the steering column. In independent front suspension, modifications of this linkage are generally used. Figure 33 shows a steering gear of popular type.

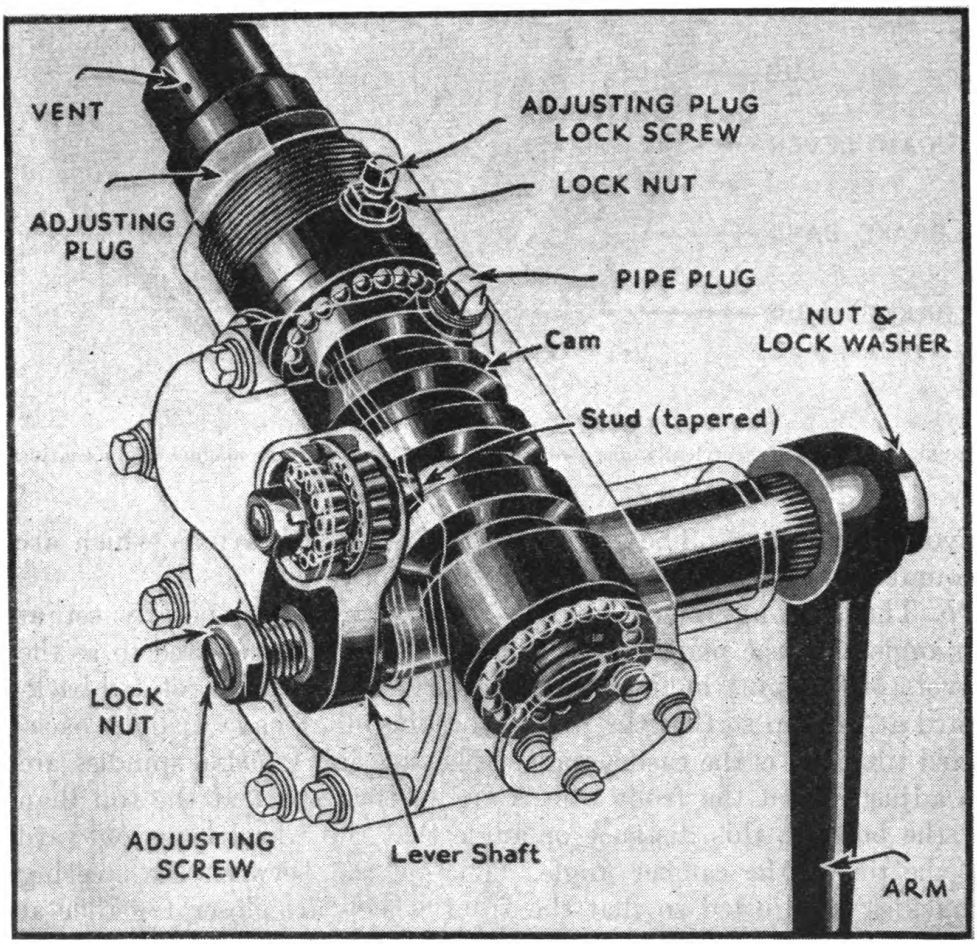


FIGURE 33.—Steering gear unit of cam and lever type.

46. Engine assembly.—The motive power for the modern motor vehicle is usually furnished by an internal combustion engine in which a mixture of fuel and air is burned. The burning fuel-air

mixture and the resulting pressures develop mechanical power by the use of reciprocating and rotating parts, such as pistons, connecting rods, and crankshaft. Figure 34 illustrates a modern six-cylinder engine with clutch and transmission attached.

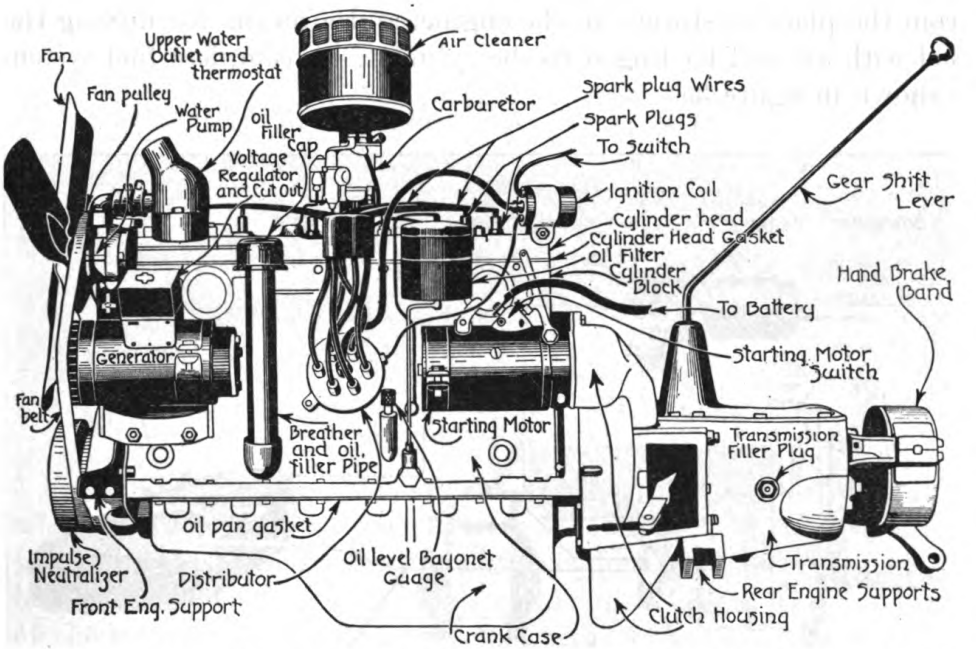


FIGURE 34.—Typical engine and transmission assembly showing external parts, equipment, and accessories.

a. Types of engines.—(1) *The gasoline engine* functions by feeding a proportioned mixture of vaporized and atomized gasoline and air into the cylinders where it is compressed. An electric spark ignites the mixture and causes combustion. This type of engine is referred to as the Otto-cycle engine. Four events are required to complete each cycle of operation: intake, compression, power, and exhaust. In the two-stroke cycle engine the four events are completed in one revolution of the crankshaft, and in the four-stroke cycle engine, such as is used in most motor vehicles, the four events require two revolutions of the crankshaft for completion.

(2) The Diesel is another type of internal combustion engine. A charge of air is highly compressed in the cylinder; the fuel is injected and is ignited by the heat generated during the compression of the air. Diesel engines require no ignition system.

(3) The semi-Diesel or oil engine is an adaptation of gasoline and Diesel engines. It operates at lower compression pressures than Diesel engines, and consequently the fuel has to be ignited by an electric spark as in the gasoline engine.

(4) Both Diesel and semi-Diesel engines require four events for the completion of each cycle and are manufactured in two- or four-stroke types.

b. Fuel system.—This system supplies the engine with fuel. It necessitates a place for fuel storage, a method of transferring the fuel from the place of storage to the engine, and a means for mixing the fuel with air and feeding it to the cylinder. A complete fuel system is shown in figure 35.

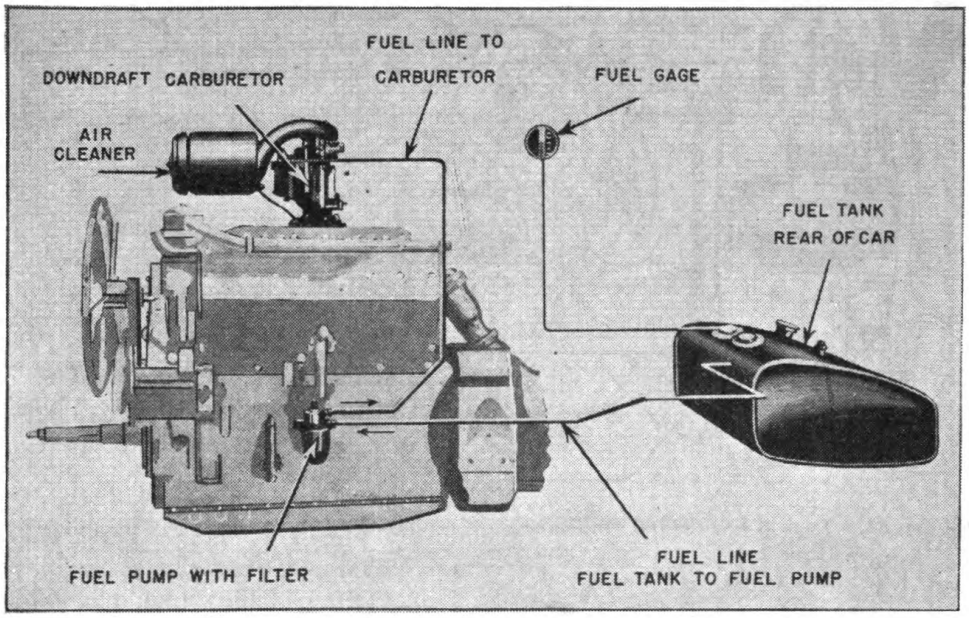


FIGURE 35.—Typical fuel system for gasoline engine of motor vehicle.

(1) *Fuel pump method.*—In most modern vehicles the fuel is transferred from the fuel tank to the engine by a fuel pump. Starting from the storage tank the fuel passes through fuel lines or tubes, through a filter and fuel pump to the carburetor, where it is mixed with air and passed through the inlet port into the cylinder.

(2) *Other methods.*—Gravity, air pressure, and the vacuum are other means utilized to move the liquid fuel from the tank to the carburetor.

(3) *Fuel injector method.*—In the Diesel engine the fuel is sprayed into the cylinder by a fuel injector.

c. Exhaust system.—This system conducts the hot exhaust gases from the engine to the rear of the vehicle and discharges them into the atmosphere after the noise produced by their rapid expansion has been controlled and quieted. Exhaust noises are minimized by piping the gases through a chamber known as the muffler, which to a

great extent allows the gases to expand and cool before being discharged. In the older type of mufflers a labyrinth is provided for the gas to pass through. The newer types allow the gases to pass "straight through" as they are cooled and toned by surrounding chambers. A muffler of the straight through type is shown in figure 36.

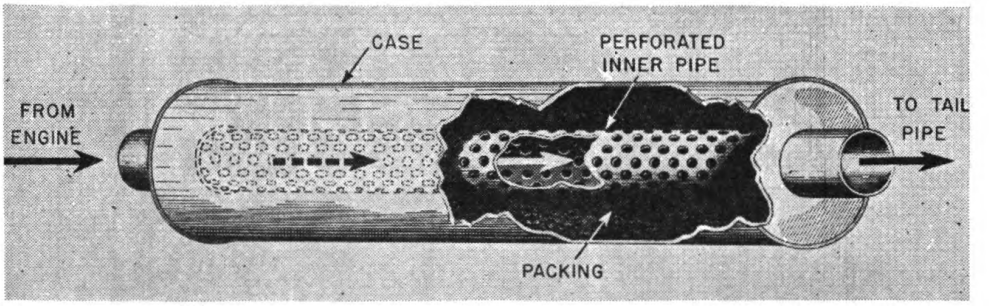


FIGURE 36.—Straight through type muffler having mineral wool or other insulating packing between case and perforated pipe.

d. Cooling system.—This system includes those units of the vehicle which are used for the specific purpose of carrying away and dissipating the heat from the combustion chamber that is not transferred into power. The metal parts of the engine, which absorb the heat of the burning fuel, not only contract and expand over a wide temperature range, but also have different coefficients of expansion at the same temperature. In order to prevent damage to parts by preignition of the fuel and incorrect working clearances, it is necessary that excess heat be dissipated.

(1) Water (or other liquid) is the usual agent for cooling engines. It is circulated through a water jacket around the cylinders and combustion chambers and absorbs the heat carried by the metal cylinder head and walls.

(2) The cooling system includes a fan for creating air currents and a water pump for positive and forced circulation of the cooling agent. In most instances a thermostat control device prevents circulation of the liquid until correct operating temperatures have been reached. Figure 37 shows a typical liquid cooling system. The air stream drawn through the radiator actually cools the liquid during its passage down through the radiator core.

(3) Air, without the use of a liquid as an intermediate agent, cools some engines by being forced in large quantities over the cylinders, which have been provided with metal cooling fins having high heat conductivity.

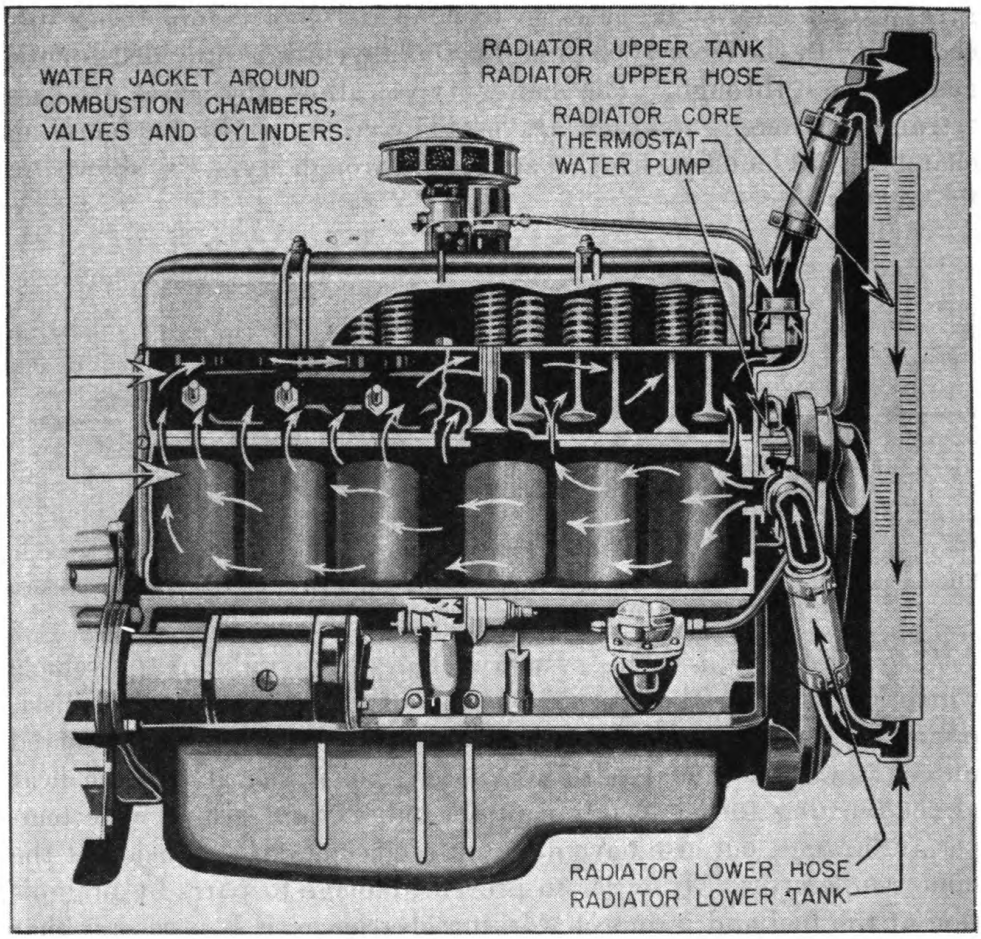


FIGURE 37.—Water circulation of cooling system showing how water is taken from bottom of radiator and circulated through engine, returning to top of radiator to be recooled.

47. Engine lubrication.—Friction in the modern close-fitted, high-speed engine is great and can be controlled only by proper lubrication. An oil-distributing system for engine lubrication is necessary in order to maintain a film of oil on cylinder walls, bearings, and other points where moving parts come in contact. This may be a force feed (pump pressure) type, splash type, or a combination of both.

a. In the force feed type, oil is pumped under pressure from the crankcase through oil tubes to all crankshaft bearings. In a full force feed system, the oil is pumped to the piston pin through the connecting rods.

b. In the splash type, oil in the crankcase is splashed and converted into a fine mist by small devices called "dippers" located on the extreme lower end of each connecting rod bearing. Usually the oil is pumped into troughs directly under each connecting rod. The splashed oil settles on all moving parts and lubricates them.

c. An oil filter is often added to pressure systems to filter all or part of the circulated oil each time it passes through the pump.

d. Oil coolers are also used on some engines to assist in cooling the lubricant for more efficient lubrication.

e. A lubricating system of the full force feed type is shown in figure 38.

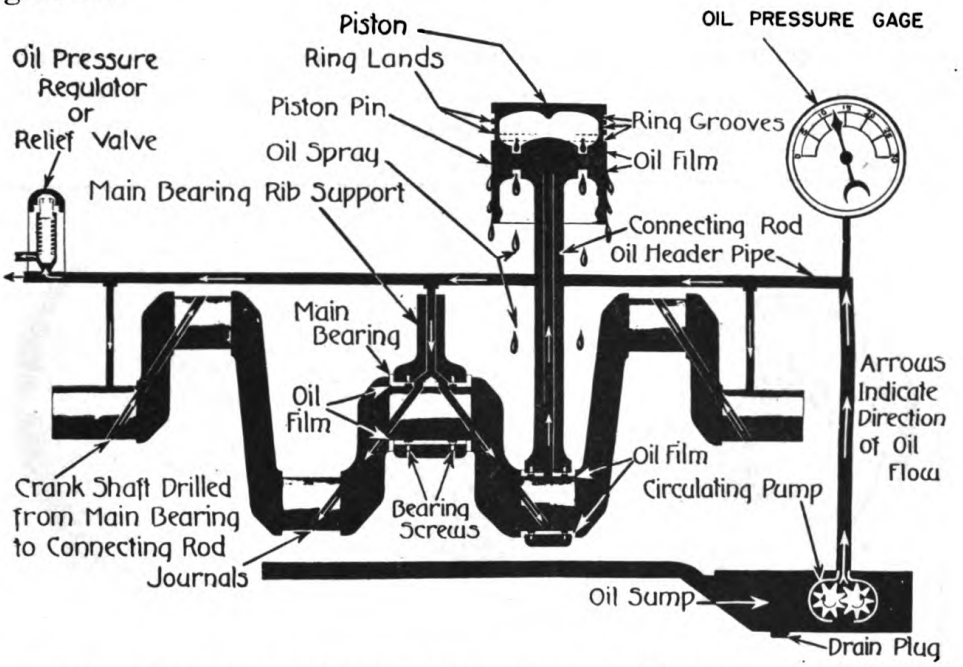


FIGURE 38.—Diagram of basic units and oil passages of full pressure feed lubricating system.

48. Power transmission system.—The power generated by the engine of a motor vehicle is delivered to the driving wheels or tracks through the power transmission system. The clutch, transmission, transfer case, universal joints, propeller shaft, differential, and axle shafts comprise this system.

a. Clutch.—(1) In order that the operator may control his vehicle properly, it is necessary that he be able at will to connect or disconnect the engine from the propulsion units. This is accomplished by an assembly known as the clutch. When the clutch is engaged, it functions by means of the friction created between its driving and driven members. A popular type of clutch is shown in figure 39.

(2) The faces of the clutch disk are covered with a friction material similar to woven brake lining. The disk is held between the face of the flywheel and the clutch-pressure plate, which is spring-loaded and rotates integrally with the flywheel. Other types of clutches are cone, hydraulic, multiple disk, and single and multiple disk clutches running in oil.

b. Transmission mechanism.—(1) The power requirements of a motor vehicle vary with the speeds of the vehicle, road conditions, and loads. Since an engine develops only a small fraction of its total power at low speed (revolutions per minute), it is necessary for starting and for the lower speeds of vehicle movement to provide a variable gear ratio by sets of different transmission gear combinations. It is common practice to provide at least three forward gear (speed) changes on passenger cars, plus neutral and reverse positions, and as many as five or more forward changes on trucks. A typical transmission case having three speeds forward and one reverse is shown in figure 40.

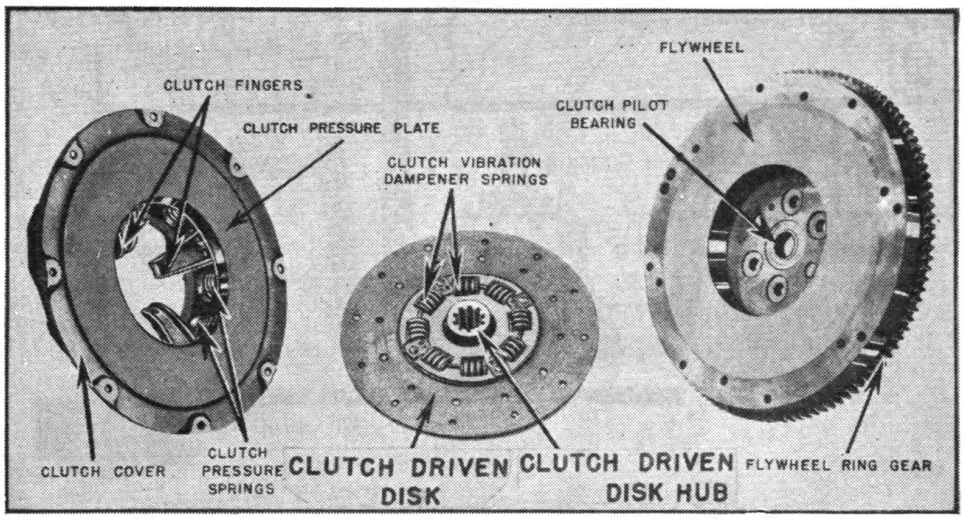


FIGURE 39.—Single plate dry clutch with clutch cover and pressure plate assembly; clutch driven disk (plate); and flywheel.

(2) The lubricating system of a transmission gear assembly is usually self-contained. The assembly is in a closed case known as the transmission case and runs in a constant bath of oil.

c. Auxiliary transmission and transfer mechanism (or case).—(1) Heavy duty vehicles require a greater selection of gear changes than the transmission normally affords in order to meet power requirements ranging from a no-load condition on level highways to a full load condition on steep hills or rough terrain. In order to meet these exceptional requirements an extra gear case, usually known as an auxiliary transmission, is used between the regular transmission and the driven axle to provide additional gear changes.

(2) The transfer mechanism (or case), usually located off center with relation to the engine and transmission, provides the means of driving both front and rear axles. A declutching device to disconnect the front driven axle is usually included.

(3) "Power take off" for driving winches, hoists, and similar special equipment may also be included as part of these units.

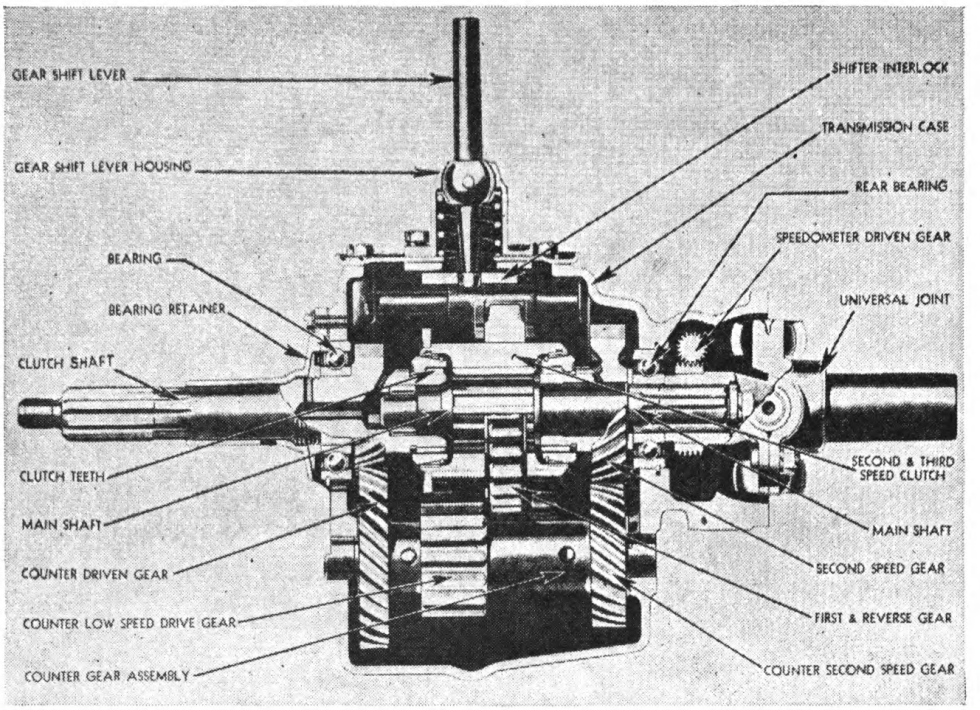


FIGURE 40.—Typical three-speed forward transmission synchromesh type showing principal speed change gears (counter indicates countershaft).

(4) In all-wheel driven vehicles, the auxiliary transmission (subtransmission) and the transfer mechanism may be combined in one unit. A sectional view of such a unit is shown in figure 41.

d. Propeller shaft and universal joint.—(1) Power transmission between transmission cases and transfer cases or driven axle units is accomplished through universal joints and propeller shafts. A propeller shaft may be either a shaft running in the open between universal joints or an enclosed shaft (torque tube) type. It must be provided with a sliding or slip joint (spline) and universal joint to overcome the variations in angles and distances between units rigidly mounted in the vehicle frame (transmissions and transfer mechanisms) and units mounted on the driven axle (pinion gears, spur gears, differential, or other final drive mechanism). These variations are caused by the flexing springs under road and weight (load) shocks. Unless provision is made to offset these changes in the location of the driving axle and related units, mechanical or structural failure will result. Figure 42 shows a portion of a propeller shaft, its slip spline, and universal joint.

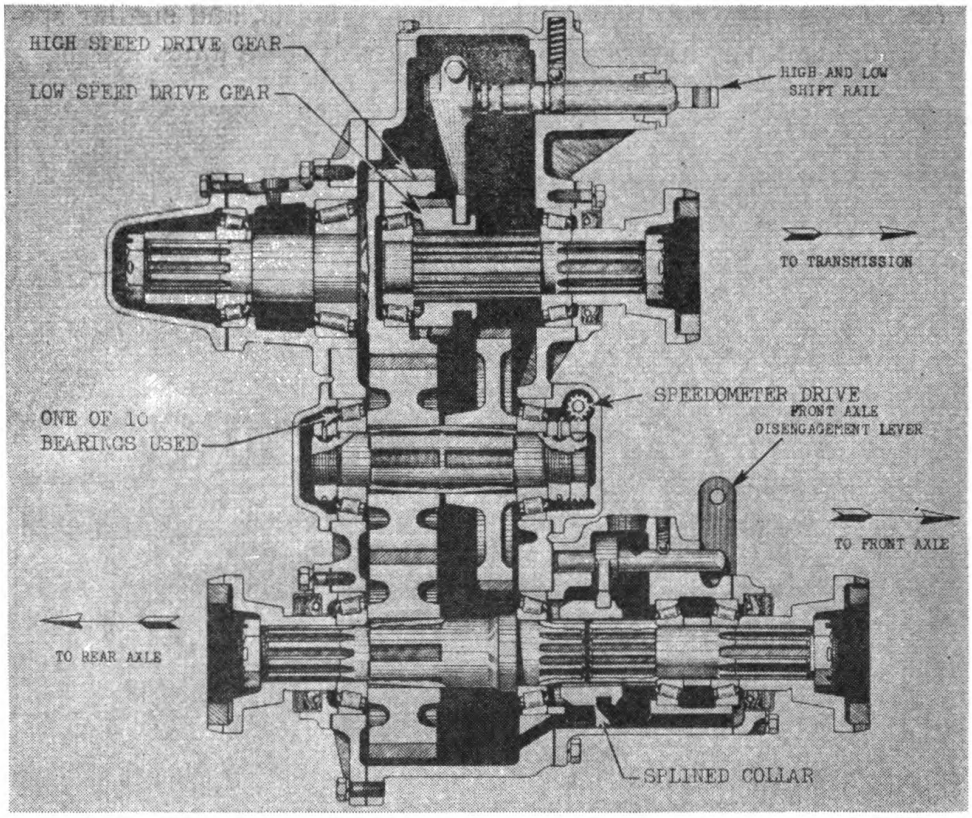


FIGURE 41.—Typical two-speed transfer case showing relation to driving and driven units and disengaging feature for front axle.

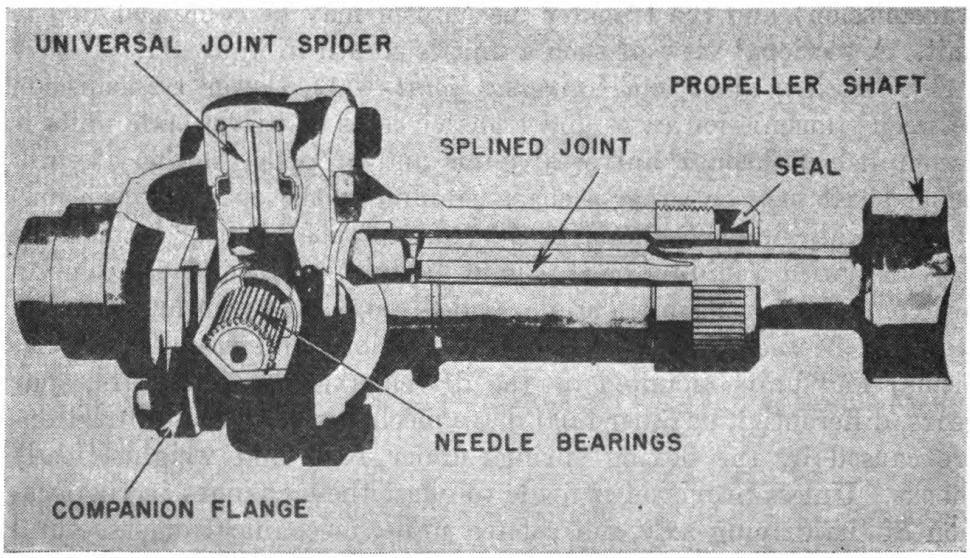


FIGURE 42.—Universal joint at end of propeller shaft showing slip spline joint.

(2) The ideal power transmission would be in a straight line. The driving axle, however, is generally set somewhat lower than the transmission, necessitating that the propeller shaft run down to the axle at an angle. This requires the use of one or more universal joints. A universal joint is substantially a double hinged joint with the pins of the hinges set at right angles. Several different methods are used to achieve this, but in each case, the basic principle is the same.

49. Bodies.—Vehicle bodies must afford comfort and safety to the operator and passengers. In passenger cars the body must also help support or stiffen the frame. Bodies are composite or all metal. However, composite bodies of steel, wood, and fabric are being rapidly replaced by all steel bodies. A typical all steel body unit is shown in figure 43.

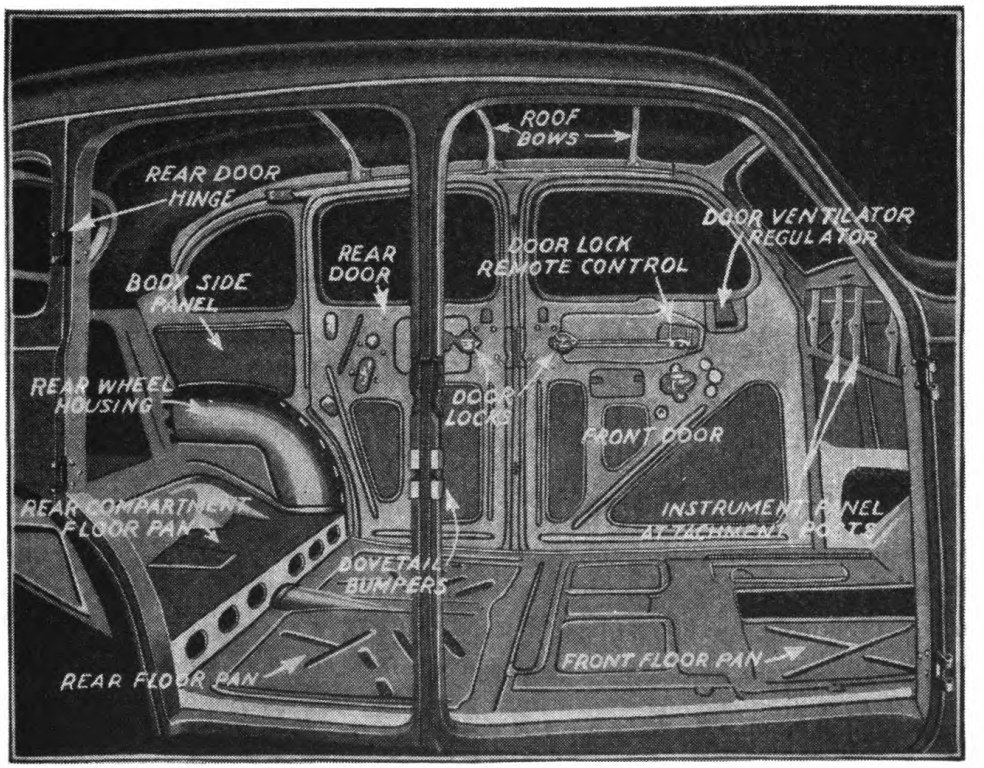


FIGURE 43.—All steel body construction showing panels, stampings, and fittings.

a. The complete body assembly of a truck is considered as two distinct parts: the cab or operator's compartment and the cargo body. In panel delivery bodies the cab and cargo body are usually separated by a panel or wall. In many of the larger type trucks used for long distance highway hauling, space is provided for a bed in the operator's cab for a relief driver. This is usually found in the wheeled tractor type unit used for trailer work.

b. The instrument panel, across the front of the cab within easy reach and vision of the operator, contains operating gages and instruments as well as engine controls. Figure 44 shows a modern truck cab and a view of the instrument panel.

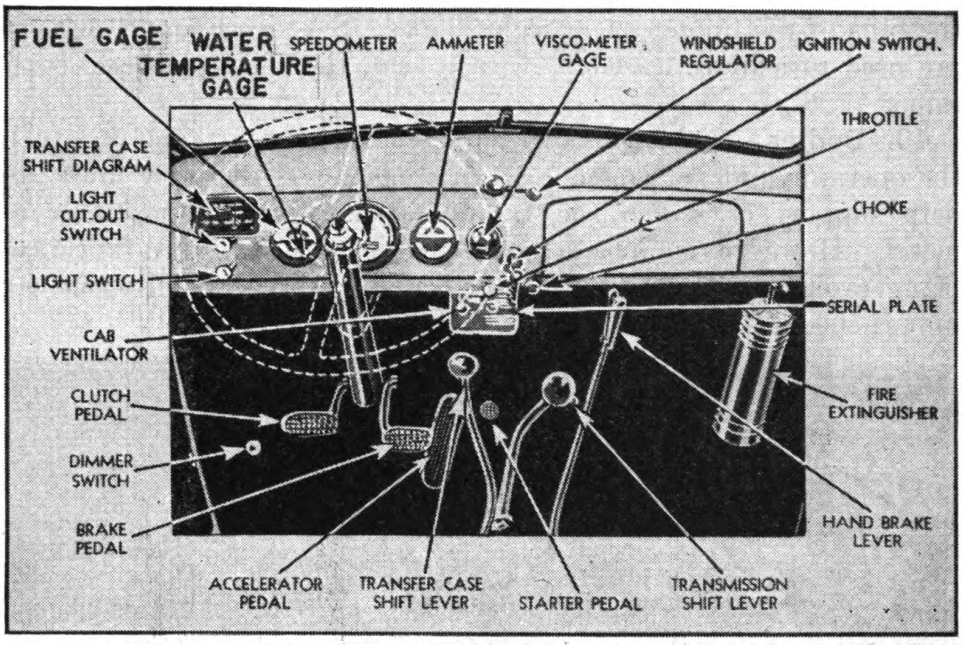


FIGURE 44.—Interior view of truck cab showing instruments and controls.

c. Many special types of cargo bodies have been produced but the commonest are the platform, stake, panel, cargo, and tank types.

50. Electrical system.—Any electrical unit of automotive equipment on the motor vehicle should be considered as part of the complete electrical system. This equipment is generally grouped by circuits according to functional use: storage battery; generating and lighting; ignition; starting motor; horn; protective devices; and miscellaneous, such as lamps, switches, and special devices. A typical wiring diagram of these circuits is shown in figure 45.

a. Storage battery.—This unit may be considered the heart of the electrical system of a motor vehicle. It furnishes electrical energy for cranking the engine and also for the electrical units of the vehicle when the generator output is insufficient. It is charged by any excess current from the generator. A wet cell battery of the lead acid type has an inherent potential of approximately 2 volts per cell. Thus a 6-volt system will use a 3-cell battery composed of 3 individual cells in series mounted together in a container and connected as a single unit. A sectional view of a lead acid storage battery cell is shown in figure 46.

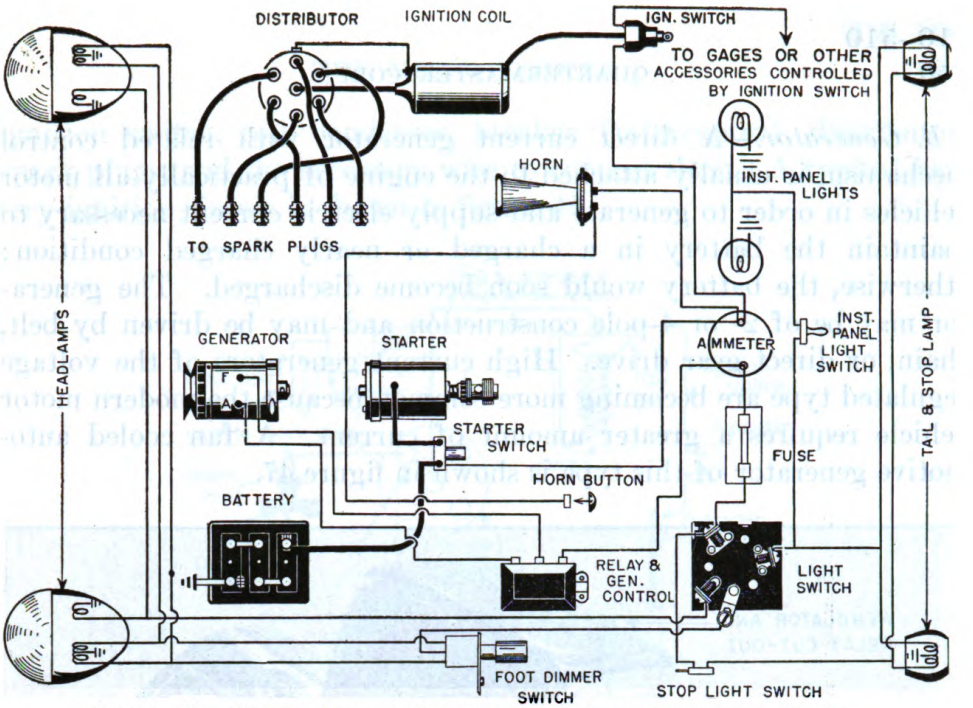


FIGURE 45.—Wiring diagram of car showing principal units and circuits.

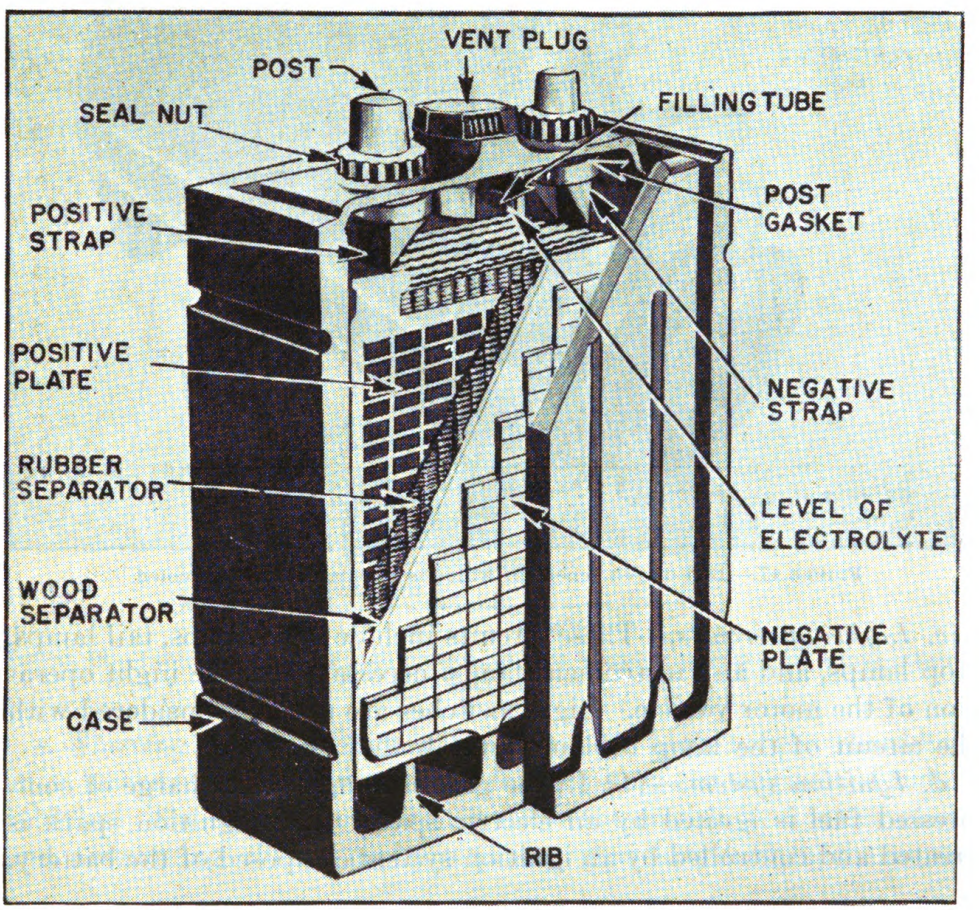


FIGURE 46.—One cell of lead acid storage battery showing relationship of plates, insulators, and terminals.

b. Generator.—A direct current generator with related control mechanism is usually attached to the engine of practically all motor vehicles in order to generate and supply electric current necessary to maintain the battery in a charged or nearly charged condition; otherwise, the battery would soon become discharged. The generator may be of 2- or 4-pole construction and may be driven by belt, chain, or direct gear drive. High current generators of the voltage regulated type are becoming more common because the modern motor vehicle requires a greater amount of current. A fan cooled automotive generator of this type is shown in figure 47.

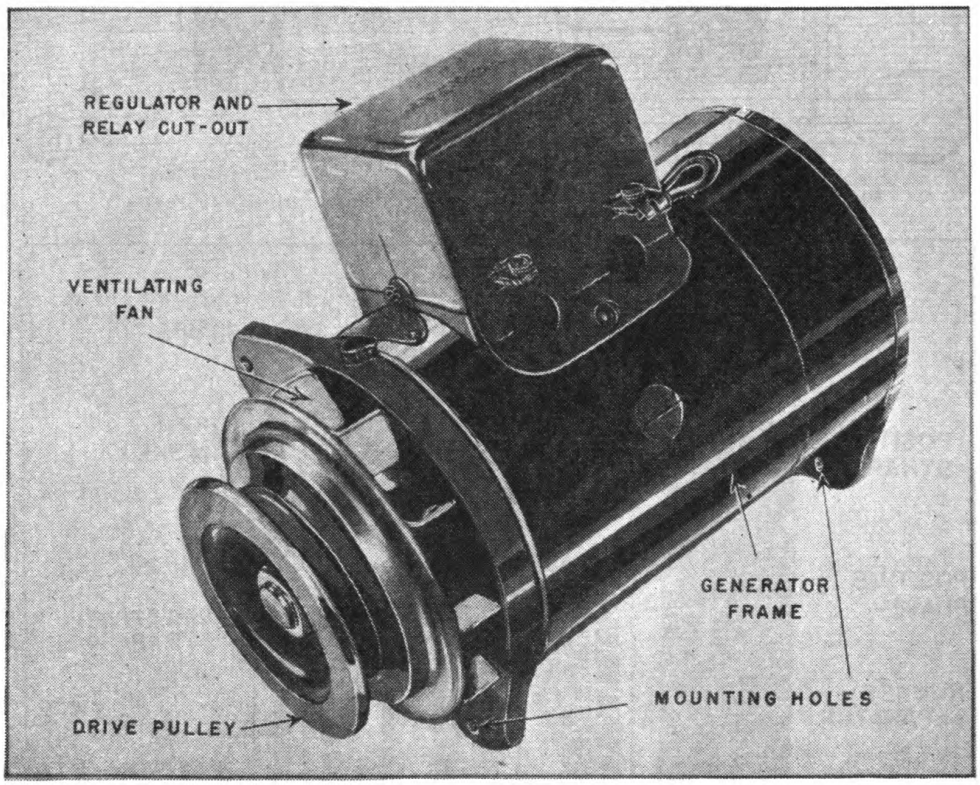


FIGURE 47.—Belt driven generator which is ventilated and fan cooled.

c. Lighting circuits.—These circuits include head lamps, tail lamps, stop lamps, and any instrument lamps necessary for the night operation of the motor vehicle. Light switches are usually considered with the circuit of the lamp or lamps which they control.

d. Ignition system.—(1) In the gasoline engine the charge of compressed fuel is ignited by an electric spark. This ignition spark is created and controlled by an ignition system composed of the battery,

ignition switch, coil, condenser, breaker (interrupter), distributor, spark plugs, and the necessary wire to connect them. A typical battery ignition circuit is shown in figure 48.

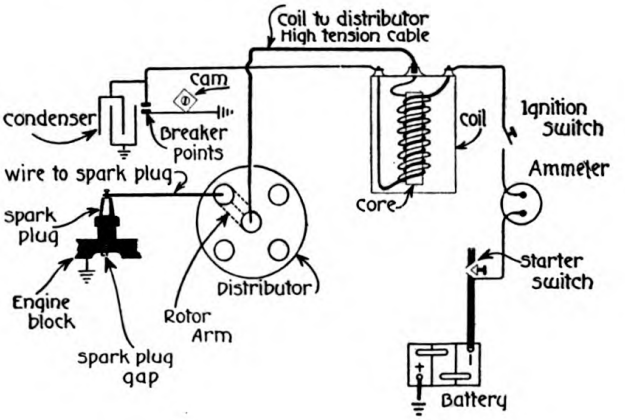


FIGURE 48.—Wiring diagram of battery ignition circuit.

(2) The magneto is another type of ignition system frequently used. It is self-contained, as the current that is ordinarily supplied by the battery (in a battery ignition system) is generated within the magneto. Figure 49 shows a typical magneto circuit.

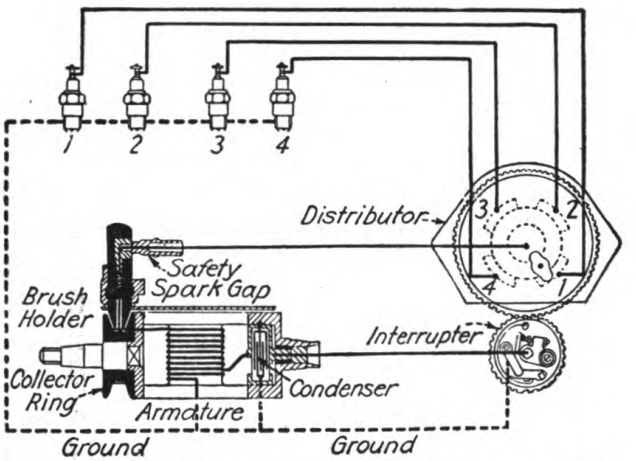


FIGURE 49.—Circuit diagram of high tension ignition magneto arranged for a four-cylinder engine.

e. Starting motor.—Electric motors with high torque characteristics are used almost universally for cranking the engines of motor vehicles. The starting motor may drive the engine by a silent chain and overruning clutch, or by a pinion gear attached to the motor

armature shaft, which is brought into mesh with teeth cut on the rim of the engine flywheel. However, the pinion method is used almost exclusively. The pinion gear is engaged with the flywheel either by being shifted along the armature shaft by a combined shifting yoke and switch operating mechanism or by being run into mesh along a screw shaft through a driving spring as the armature picks up speed. The latter type is known as a Bendix drive. This type of drive assembled on a starting motor shaft is shown in figure 50.

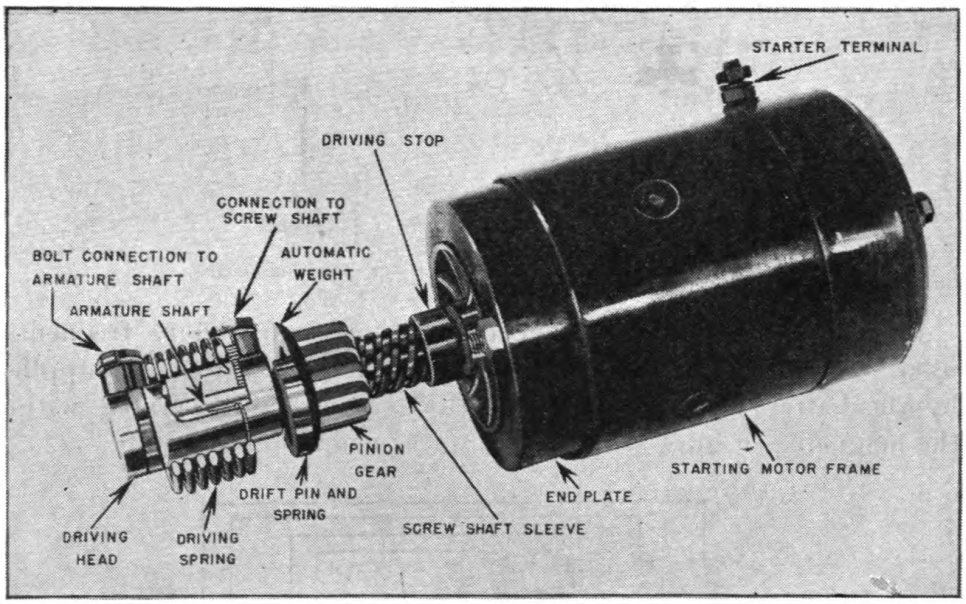


FIGURE 50.—Starting motor with sectional view of Bendix drive assembly.

f. Horns.—Horns or warning devices on motor vehicles are normally operated by electricity. Usually they consist of an electromagnet equipped with an interrupter device and arranged in such a way that the electromagnet vibrates a thin metal diaphragm. A projector or bell placed over the diaphragm amplifies the sound and directs it forward.

g. Protective devices.—Devices such as fuses or magnetic circuit breakers are placed in the electrical circuits of the motor vehicle to protect the wiring and battery from overloads or short circuits. Too heavy a current will melt the fuse and open the circuit or will separate (open) the points of the circuit breaker.

h. Miscellaneous.—This group includes lamps, fuel gages, turn indicators, and other electrical accessories, or special devices operating from the motor vehicle electrical system.

SECTION X

BIBLIOGRAPHY

51. Bibliography.—In the preparation of this manual the following sources have been consulted for illustrations and text material. They contain more detailed information on motor vehicles than is contained herein, and it is suggested that it would be advantageous for the student to consult them as collateral reading.

Circular No. 1–10, Office of The Quartermaster General.
AR 850–15.
S. A. E. Handbook (1939), published by the Society of Automotive Engineers, New York, N. Y.
The Gasoline Automobile, by Ben G. Elliot and Earl L. Consoliver (Fifth Edition, 1939); published by the McGraw-Hill Book Company, New York, N. Y.
Automotive Essentials, by Ray F. Kuns (Revised Edition, 1938); published by the Bruce Publishing Company, New York, N. Y.
Dyke's Automobile and Gasoline Engine Encyclopedia, by A. L. Dyke (Eighteenth Edition, 1939); published by the Goodheart-Wilcox Company, Chicago, Illinois.
Audel's New Automobile Guide, by Frank D. Graham (1938); published by Theo. Audel and Company, New York, N. Y.

[A. G. 062.11 (5–11–40).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

E. S. ADAMS,
Major General,
The Adjutant General.

U. S. GOVERNMENT PRINTING OFFICE: 1940

For sale by the Superintendent of Documents, Washington, D. C. . . . . Price 15 cents