TM 10-515

WAR DEPARTMENT

U.S. Dept. of Army

TECHNICAL MANUAL

THE MOTORCYCLE

September 25, 1942

U.S. War Dept.

TECHNICAL MANUAL

THE MOTORCYCLE

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WAR DEPARTMENT
WASHINGTON 25, D. C., 30 June 1945

TM 10-515, 25 September 1942, is changed as follows:

27. Operating a side-car motorcycle.

* * * * * * *

*c. **Sharp right turn.*** Reduce the speed * * * make the turn. o not accelerate or turn too quickly on a sharp right turn, because e side-car wheel will tend to lift off the ground and turn the vehicle 'er.

*d. **Sharp left turn.*** In making a sharp left turn, reduce the speed, ift into second and steer to the left, helping the vehicle turn by celerating slightly. A sharp left turn can be made faster than a ght turn.

* * * * * * *

[AG 300.7 (21 May 45)]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL
Chief of Staff

FFICIAL:
J. A. ULIO
Major General
The Adjutant General

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WAR DEPARTMENT,
WASHINGTON, September 25, 1942.

THE MOTORCYCLE

SECTION I
GENERAL

1. General.—*a.* The motorcycle is generally thought of as just a small two-wheeled edition of the automobile, or as a heavy bicycle

*This manual supersedes TM 10-515, December 13, 1940.

which has an engine instead of foot pedals. Perhaps that is why the motorcycle is said to be the least understood and the most abused vehicle in the Army. The fact is, a motorcycle, having smaller parts and fewer devices to maintain its efficiency, requires more frequent and careful servicing than larger motor vehicles; as for its similarity to a bicycle, there is more to riding a motorcycle than learning how to start it and stop it.

b. A military motorcyclist must ride over good roads and difficult terrain with equal skill. He will be expected to service his motorcycle, make minor adjustments and repairs, and discover and report signs of failure before they actually occur, so that it will always be ready for use. In short, he must be an expert rider and a practical mechanic as well. He will need a thorough knowledge of motorcycle operation, performance, construction, and maintenance. He will need practice and experience and, most of all, the *will* to excel in his assigned duty.

c. This manual is intended to provide the motorcyclist with basic information on the operation, maintenance, and construction of military motorcycles. The first four sections are concerned with the primary responsibilities of a motorcycle operator, whereas the rest of the manual explains how the vehicle is constructed and how the various mechanisms operate. It outlines tolerances, clearances, and servicing of various parts which are beyond the facilities of the driver or even the motorcycle mechanic. Such additional information will help the motorcyclist to understand the practices of higher echelons when accompanying the motorcycle for monthly and semiannual maintenance inspections.

d. Some sections of the manual have been divided into parts in order to cover both chain-driven and shaft-driven motorcycles now in service. The first part of the section deals with chain-driven models and the second deals exclusively with shaft-driven models. However, many points common to both models have not been repeated in the second part.

e. For definitions of terms used throughout the manual, see appendix I.

2. Qualifications of a military motorcyclist.—*a.* To become an efficient motorcyclist a man must first be an excellent soldier. He must be interested in his vehicle; be a quick, logical thinker; have initiative and mechanical ability; be strong, and have an excellent sense of balance. He must know the rules of the road, the principles of safety, and how to control the vehicle under all conditions.

b. As a driver, he should know what a motorcycle can and cannot do;

the names of its parts, how to operate it (use of controls), and when and how to perform first and second echelon motorcycle inspection and maintenance under all conditions. (See TM 10-545.)

c. As a messenger (or courier), he must be able to receive and transmit verbal or written messages correctly, read maps accurately, avoid delays, and complete the assigned task.

d. As a traffic policeman, he must be proficient in map reading; he must be able to recognize serious traffic jams, analyze their causes and correct them; he must anticipate, recognize, and take protective measures against hazards to march columns such as railroad crossings,

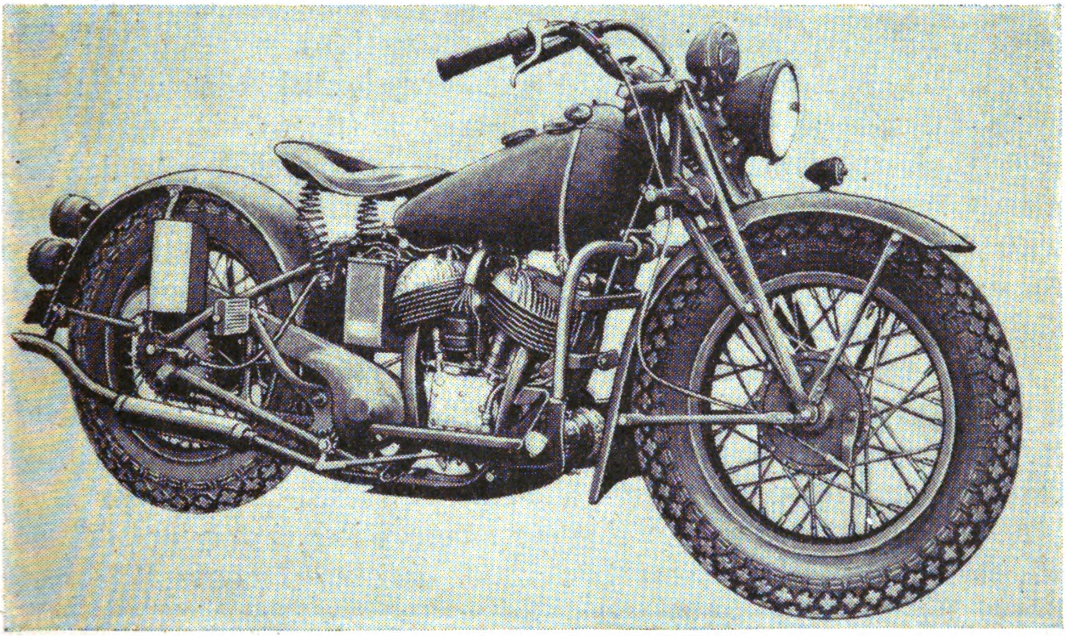


FIGURE 1.—Solo motorcycle (chassis type—2 x 1).

bad turns, sharp curves, dangerous intersections, bad detours, icy or slippery roads, steep grades, reckless driving, and heavy opposing traffic streams; he should be qualified to render first aid; he must be cooperative and must keep traffic moving.

3. Construction.—*a.* In many respects, a solo motorcycle (fig. 1) is similar in appearance to a bicycle. Two wheels support and are connected by a frame. The vehicle is steered by handle bars which turn the front wheel. The rider sits on a saddle which is mounted on the frame, above and in front of the rear wheel. A chain or shaft transmits the power to the rear wheel. All shaft-driven motorcycles being supplied to the Army are solo models.

b. Driving power is developed by an air-cooled internal combustion engine, mounted on the frame. A transmission permits selection of gear ratios between the engine and the drive wheel; a clutch provides for engaging or disengaging the engine power without undue strain or jerking; a fuel system delivers fuel to the engine; a generator and battery supply electricity for the ignition, lights, and other electrical units.

c. The entire structure of a motorcycle must be heavy and strong enough to accommodate the engine and its accessories and withstand the usage for which it was designed. The "body" or frame is of tubular steel. The steering forks and handle bars are similar to those of a bicycle.

d. The motorcycle may be divided into unit assemblies, such as chassis, engine, power train, electrical system, instruments, accessory equipment, and side car. Details of the construction and characteristics of these units are considered in subsequent sections.

e. There are two variations of the motorcycle still in service: motorcycle with side car (fig. 2); and motor tricycle (fig. 3).

4. Uses and limitations.—*a.* The solo motorcycle is intended primarily for transporting one person. As such it provides the Army with fast, flexible, motorized transportation which is well adapted for scouting and patrolling. It is also widely used for liaison purposes and traffic control.

b. The motorcycle with side car and the motor tricycle are being replaced by the ¼-ton, 4 x 4, reconnaissance car as tactical units. Side car motorcycles and motor tricycles still in service are used as administrative vehicles at posts, camps, and stations.

c. The fact that a solo or side car motorcycle has only one driving wheel is perhaps its most important limiting factor. Relatively light and with limited tractive ability, the motorcycle is normally restricted to good, hard-surfaced highways, roads, and trails. For cross-country travel it is hampered by mud, sand, soft or rocky stream bottoms, deep ditches, heavy roots, bad bumps, holes, and underbrush. In order to meet such conditions, it is advisable to have an extra rider along for assistance. Operation on icy, wet, or other slippery surfaces is difficult and extremely hazardous because, under these conditions, the motorcycle tends to go out of control or skid at the slightest change of speed or direction.

5. Visual aids.—The following War Department training film and film strips will be helpful in becoming acquainted with the motorcycle:

TF 10-654. Description and function of motorcycles.

FS 10-62. Command, maintenance, and technical inspections of motorcycles.

FS 10-84. Lubrication of Indian chain-driven models.
FS 10-90. Lubrication of Harley-Davidson chain-driven models.

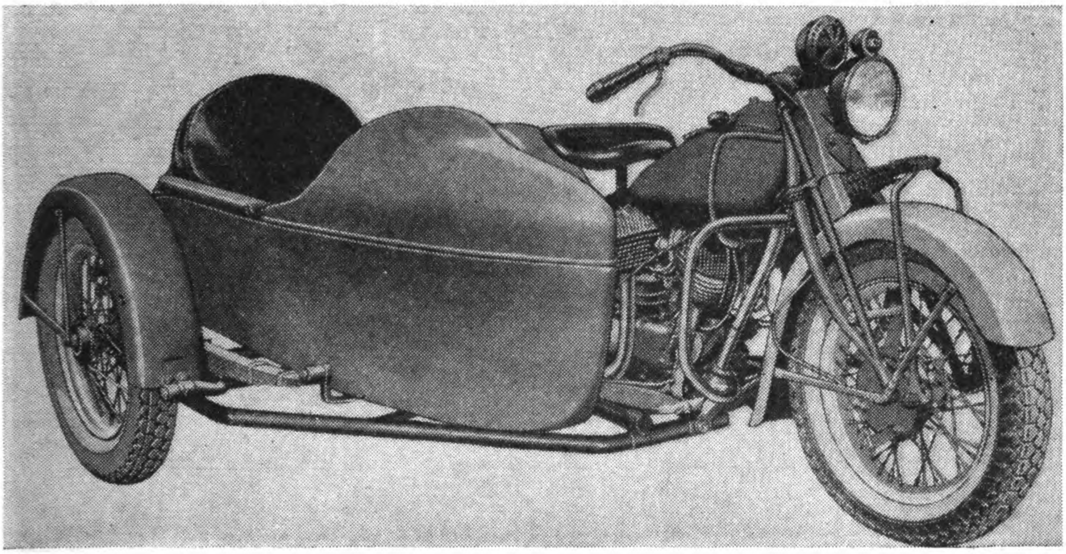


FIGURE 2.—Motorcycle with side car (chassis type—3 x 1).

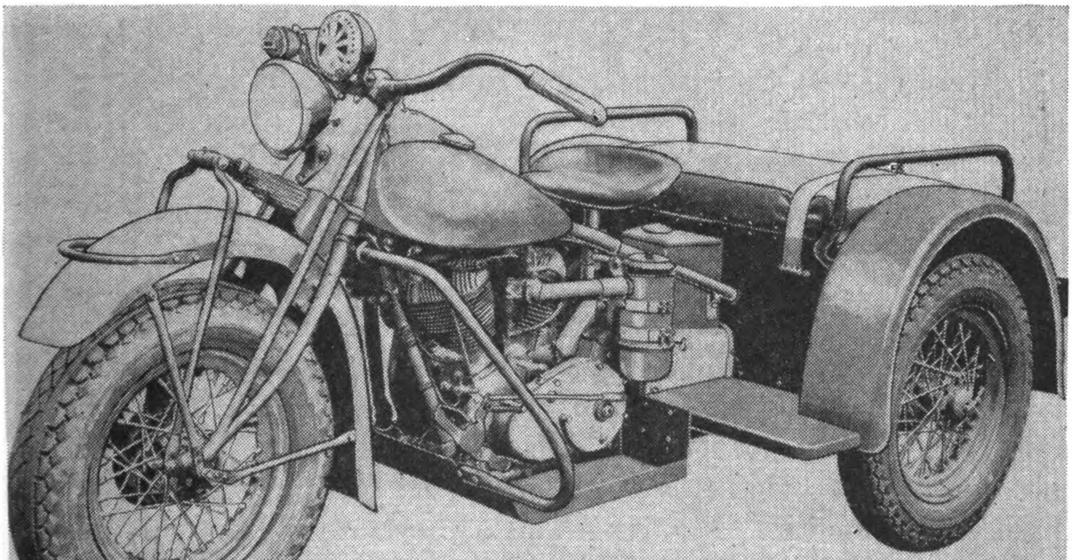


FIGURE 3.—Motor tricycle (chassis type—3 x 2).

Section II

LOCATION AND USE OF CONTROLS

CHAIN-DRIVEN MODELS

CHAIN-DRIVEN MODELS

6. General.—*a.* Superior performance of one motorcycle over another, when both are in the same type of service, is usually the direct result of the motorcyclist's diligence in practicing approved operating and maintenance methods. Seldom is the original quality and construction of one motorcycle much better than another. Practice in the approved operating methods outlined in this section will obtain the most satisfactory performance from the assigned motorcycle.

b. The motorcyclist must first become familiar with the location of the various controls on the two makes of motorcycles used by the Army—the Indian and the Harley-Davidson—and also with the differences between the shaft-driven (second part of this section) and the chain-driven models. Figures 4 and 5 illustrate the controls on the Indian and Harley-Davidson chain-driven models respectively.

7. Fuel tank shut-off valves.—Gasoline shut-off valves are provided on both the main and reserve tanks. Operate the motorcycle on one tank at a time, keeping a supply of reserve fuel in the other. Use only the grade of fuel recommended by the manufacturer's maintenance manual.

8. Throttle.—*a.* The throttle on chain-driven models is operated by twisting the left (Indian) or right (Harley-Davidson) handlebar grip. Turning the grip inward opens the throttle and increases the engine speed; turning it outward closes the throttle and decreases the speed. When the carburetor needle valves are adjusted correctly, the engine will continue to run at idling speed with the throttle grip in a fully closed position.

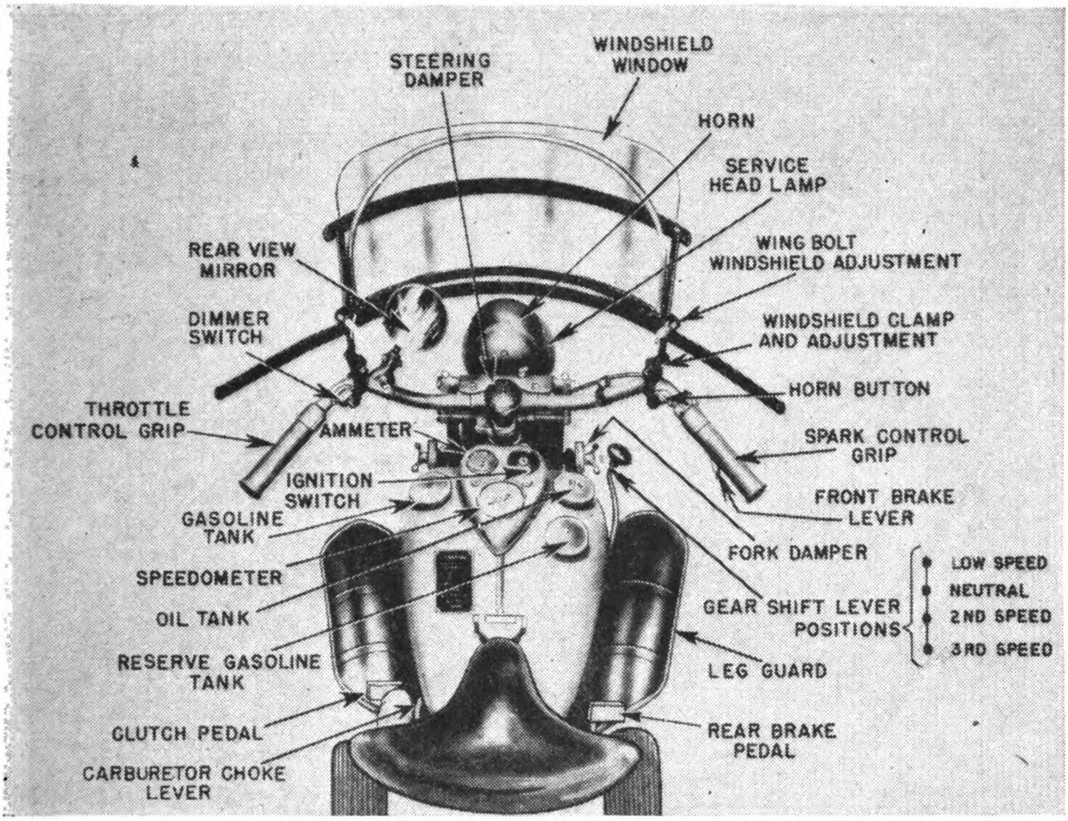


FIGURE 4.—Controls—Indian motorcycle.

b. When slowing down or coming to a standstill, close the throttle. When shifting gears, use the throttle to synchronize the engine speed with the transmission speed.

c. At sustained high road speeds, snap the throttle closed at frequent intervals to facilitate lubrication and cooling within the cylinders. This is necessary because, at high speeds, with the throttle wide open, a great pressure is built up in the combustion chamber which tends to prevent oil from reaching the upper piston surfaces and rings.

d. When the throttle is closed, the pressure above the piston is lowered on the intake stroke. The lower pressure above the piston, combined with the increased pressure below the piston, tends to draw up the oil, past the top rings, providing lubrication and cooling.

9. Choke lever.—*a.* The choke lever, located on the carburetor at the left side of the motorcycle, operates a valve which controls the flow of air from the air cleaner to the carburetor. When the choke is

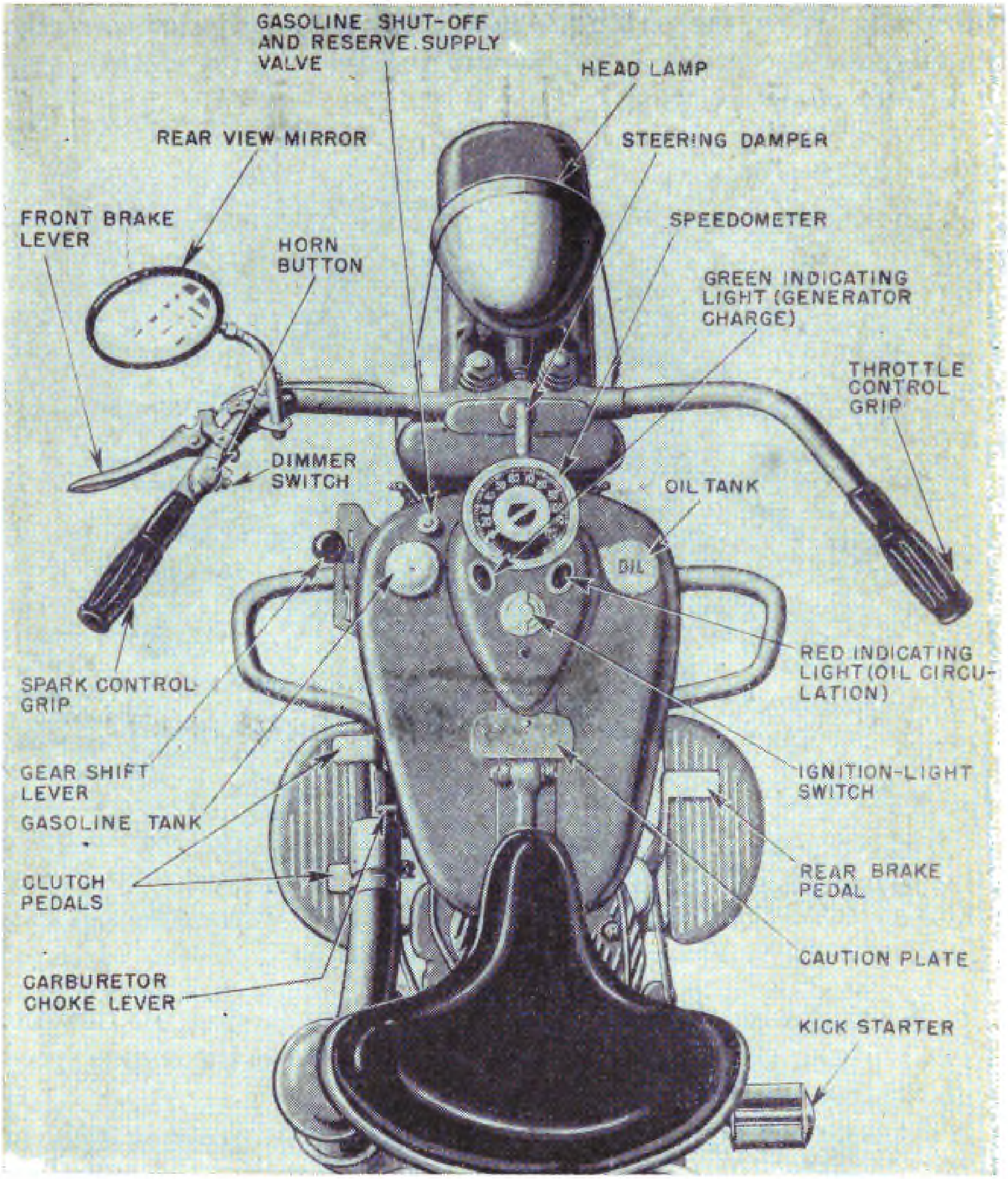


FIGURE 5.—Controls—Harley-Davidson motorcycle.

closed (lever turned down, Indian; up, Harley-Davidson) a large portion of gasoline and a small amount of air are drawn into the cylinders. Therefore, the lever should be in this position *only* when starting the engine. As soon as the engine starts, turn the choke lever to a point about midway between closed and normal running positions.

b. It is best to try to start a warm engine without choking it; then use the choke if the engine fails to start after several kicks. If the engine will not operate properly while driving with the choke lever in normal position, the carburetor is probably out of adjustment and a unit mechanic or motorcycle mechanic should adjust it.

10. Spark control.—*a*. Like the throttle, the spark advance is controlled by a handle-bar grip (right side, Indian; left side, Harley-Davidson). Turn the spark control grip inward to advance the spark; turn it outward to retard the spark. A simple rule to remember is that on either make of motorcycle, *turning both the throttle and the spark control grips inward increases the engine speed; turning both grips outward decreases the speed.*

b. Under normal operations the spark should be fully advanced. If the engine labors during a hard pull, it may be advisable to retard the spark slightly to prevent detonation or "knock." It may be advisable, on some motorcycles, to retard the spark slightly when starting, to avoid a kick-back in the kick starter. Motorcycles vary somewhat; by carefully manipulating the spark control, one point can be found at which the engine will start easily and more quickly.

11. Clutch.—*a*. The clutch control on chain-driven models is located at the left footboard. On the Harley-Davidson, when the forward end or toe of the clutch pedal is depressed as far as it will go, the clutch is engaged; and when the rear end or heel of the pedal is pressed down, it is disengaged. On the Indian, the action is exactly opposite.

b. It is absolutely necessary to depress the clutch far enough to completely disengage it while shifting gears. Failure to do so may shear the teeth off the transmission gears and cause other serious damage.

c. In starting from a standstill, the clutch should be engaged very gently for smooth starting. The friction disks and tension spring should be tight enough to prevent the clutch pedal from creeping back from a disengaged position when the foot is removed from the pedal.

12. Gear-shift lever.—Positions of the gear-shift lever for the various speeds are shown on the shifter guide located on the left fuel tank of the Harley-Davidson. These positions on the Indian are shown in figure 4. Before starting an engine, always place the gear-shift lever in neutral position. Whenever shifting gears, disengage the clutch before moving the shifting lever. Failure to declutch may result in stripping or shearing the teeth of the transmission gears.

13. Kick starter.—The kick starter or engine cranking arm is located on the right side of the motorcycle, just below the saddle. Before using the starter, be sure the gear-shift lever is in neutral and the clutch is engaged. After turning the ignition switch on, push the starter pedal vigorously with the foot, all the way down. A part-way push is likely to result in the engine backfiring before the starter has disengaged itself at the bottom of its swing. If this happens, injury may result.

14. Rear brake.—*a.* The rear brake pedal is located near the footboard on the right side of motorcycles. The foot pedal should be adjusted to travel a short distance before it starts to actuate the brake. It is good practice to spin the rear wheel before lifting it off the stand, to make sure the brake is not too tight or dragging.

b. The levers which connect the brake pedal to the rear brake multiply any force exerted on the brake pedal. Therefore, depress the pedal lightly and cautiously. The rear brake will lock when the pedal is pressed down all the way. A finer, quicker braking action is produced by pressing the pedal only far enough to drag the rear wheel to a stop. A locked rear wheel will slide and may cause a dangerous skid. Expert use of the foot brake will add greatly to the life of the tire.

15. Front brake.—*a.* The front-wheel brake is controlled by a hand lever on the handle bar (left, Harley-Davidson; right, Indian). The brake is released when the hand lever is in its natural position. Squeeze or press it toward the handle bar to apply the front wheel brake.

b. The front brake is properly adjusted when it will not lock the front wheel except on loose dirt or gravel. With this adjustment the hand lever will move freely about one-quarter of its full travel before the front wheel brake begins to take effect. If its free movement is less, the brake is likely to drag. Keep the brake control cable well oiled for easy action.

c. The front brake should be used *only* in conjunction with the rear wheel brake when bringing the motorcycle to a stop. It is effective to apply the front brake with a series of brief applications rather than with a steady, hard pull.

d. Under normal conditions on the highway, the front brake provides only a dragging action on the front wheel. However, on loose cinders or sand, apply the front brake cautiously since the traction of the wheel to the ground will not be great enough to prevent locking. Use extra caution in applying the front brake on turns at high speed.

16. Steering damper.—The steering damper is located at the handle-bar top, just ahead of the instrument panel. Its purpose is to increase the stability of the motorcycle under hard, fast riding. Under normal conditions this control should be left fairly loose. It can be adjusted best while riding. It should never be tightened so much that the handle bars turn too hard, but only to a point where it is easiest to handle the motorcycle.

SHAFT-DRIVEN MODELS

17. Throttle.—The left handle-bar grip constitutes the throttle or gasoline control on both the Indian and Harley-Davidson shaft-driven models. Turning the grip inward opens the throttle valve and increases the engine speed; turning it outward closes the throttle valve and decreases the engine speed. If the throttle control and carburetor adjustments are correct, the engine will continue to run at idling speed with the left handle-bar grip in a fully closed position. The right handle bar is a dummy grip and controls no mechanism. The throttle must be closed each time the gears are shifted.

18. Clutch.—*a.* The clutch is controlled manually by the lever at the right handle bar on both makes of motorcycles. The clutch is fully engaged when the lever is free. It is disengaged when the lever is compressed toward the handle bar. The clutch must be fully engaged when starting the engine; fully disengaged while shifting gears.

b. When the clutch control is correctly adjusted, the end of the lever will move freely about 1 inch before the driver can feel that the clutch is being released. The release cable near the handle bar should be inspected for broken strands.

19. Gear shift.—Shaft-driven models are shifted by foot rather than by a manual gear-shift lever as in the case of chain-driven models. The shifter pedal is located on the left side on both makes. Always shift into neutral before stopping the motorcycle.

a. The Indian shifter (fig. 6) has a toe and a heel pad. The heel pad is used when shifting into higher speeds; the toe pad when shifting into lower speeds. A spring returns the foot lever to its normal position when the foot weight is taken off either the heel or toe pad.

(1) Shifting into higher speeds is accomplished by depressing the heel pad as follows:

First speed—depress heel pad once and release it.
Second speed—depress heel pad twice and release it.
Third speed—depress heel pad three times and release it.
Fourth speed—depress heel pad four times and release it.

(2) Shifting from high to low is accomplished by reversing the procedure with the *toe* pad as follows:

Third speed—depress toe pad once and release it.
Second speed—depress toe pad twice and release it.
First speed—depress toe pad three times and release it.
Neutral—depress toe pad four times and release it.

b. The Harley-Davidson foot shifter (fig. 7) has consecutive gear positions like the Indian model, but is equipped with only a toe pad which is either lifted (pushed up) with the top of the foot for shifting to higher speeds, or depressed with the ball of the foot for shifting to lower speeds. Each time the foot pressure is released from the toe pad after shifting gears, a spring returns the pad to its normal position.

(1) Since the neutral position in the Harley-Davidson model is

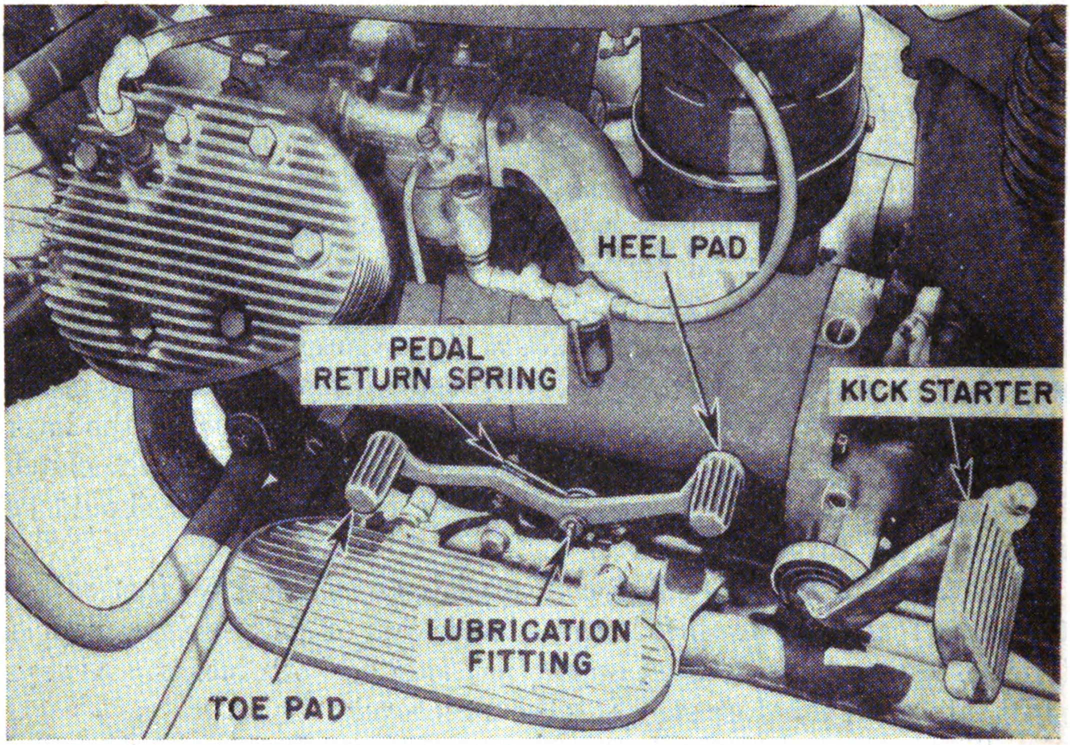


FIGURE 6.—Indian gear-shift pedal.

located between first and second speeds, the sequence for shifting to higher speeds is as follows:

First speed—depress toe pad once and release it.

Neutral—lift toe pad twice and release it.

Second peed—lift toe pad three times and release it.

Third speed—lift toe pad four times and release it.

Fourth speed—lift toe pad five times and release it.

(2) Shifting from high to low is accomplished by depressing the toe pad in a reverse procedure as follows:

Third speed—depress toe pad once and release it.

Second speed—depress toe pad twice and release it.

Neutral—the auxiliary hand lever on the right side of the motorcycle is provided as a positive means of shifting into neutral. However, after practicing, this shift should be made without the hand lever by giving the toe pad a partial downward stroke.

First speed—depress toe pad three times and release it.

20. Brakes.—The rear brake is controlled by a foot pedal above the right footboard; the front brake by a hand lever at the left handle

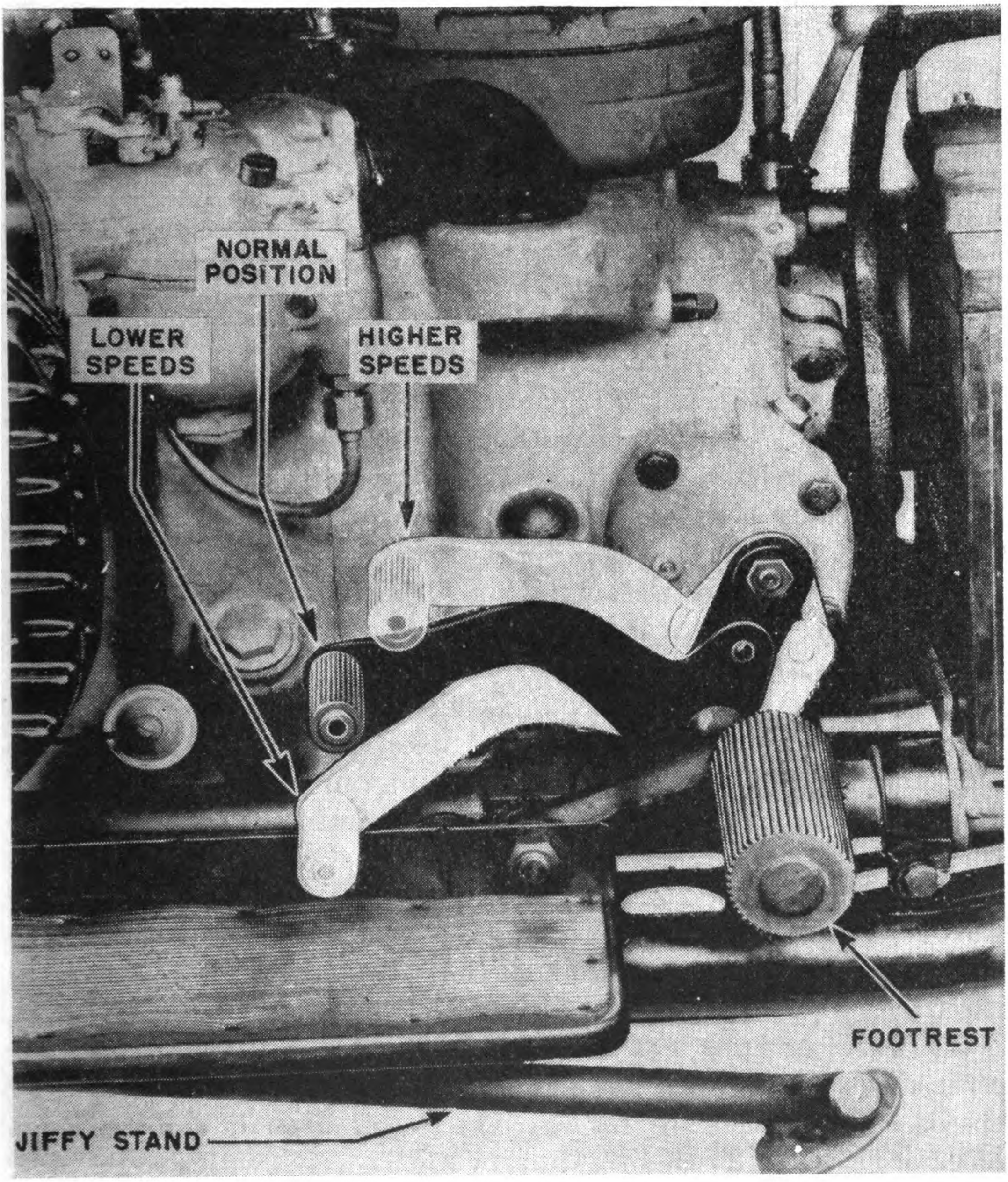


FIGURE 7.—Harley-Davidson gear-shift pedal.

bar. The brake is released when it is in its natural position. The front wheel brake is brought into operation by putting pressure on the hand brake lever, which should move freely about one-quarter of its full range before the brake begins to take effect. If the lever is adjusted with less free movement, the brake is likely to drag. Keep the brake-control wire well oiled for easy action. Always use the rear brake in conjunction with the front brake when bringing the motorcycle to a stop.

SECTION III

SUGGESTIONS ON HOW TO RIDE

21. General.—*a.* There is a great deal of difference between riding a motorcycle and driving a truck or passenger car. A truck or passenger car is guided by merely turning the steering wheel. In guiding a motorcycle, balance as well as steering by the handle bars must be coordinated; the body is used as a balance and a skilled coordination of mind and muscle is developed.

b. Riding a motorcycle surely and dependably over all kinds of terrain requires practice and a coordination of mind and muscles until every action is automatic and natural. Read the suggestions here, then go out and practice them. Read these instructions again and practice some more. With sufficient knowledge and practice, little difficulty will be encountered in completing an assigned mission, regardless of the condition of the terrain over which it is necessary to ride.

c. Avoid sudden starts. A motorcycle can take off from a standing start somewhat faster than other motor vehicles. Therefore, to keep the motorcycle under control at all times, use caution in opening the throttle.

22. Driving over wet hard roads.—*a.* Three kinds of roads are especially slippery when wet and travel on them should be at reduced speeds. These roads are wet clay, wet smooth asphalt, and wet wood block or brick. All roads are slippery when covered with a slight mist, as at the beginning of a rainstorm or fog, because under these conditions oil dripping from motor vehicles forms a greasy surface on the road. After rain has continued long enough to wash away the oil, the roads become less slippery and driving is safe at increased speeds. However, the dark "oil drip" line and the painted traffic line are always slippery when wet and should be avoided.

b. When riding on wet roads of any kind, open the throttle slowly. *Never accelerate quickly.* Let the engine act as a brake when desiring to slow down. A motorcycle engine has less weight to carry in proportion to its power than other vehicles and will promptly provide a braking force when the throttle is being closed. Therefore, use the

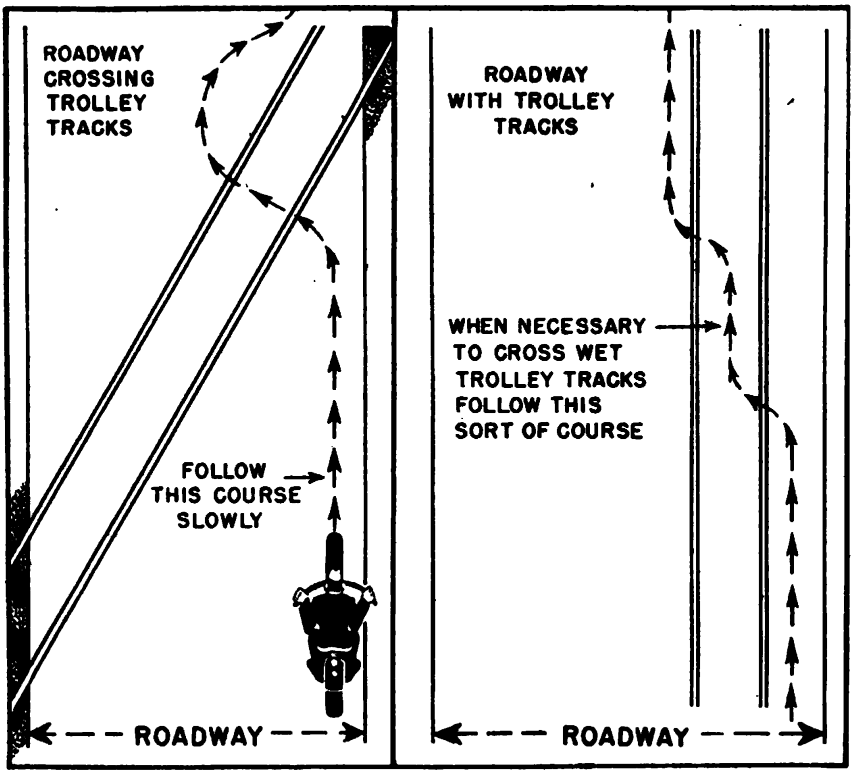


FIGURE 8.—How to cross wet railroad and trolley car tracks.

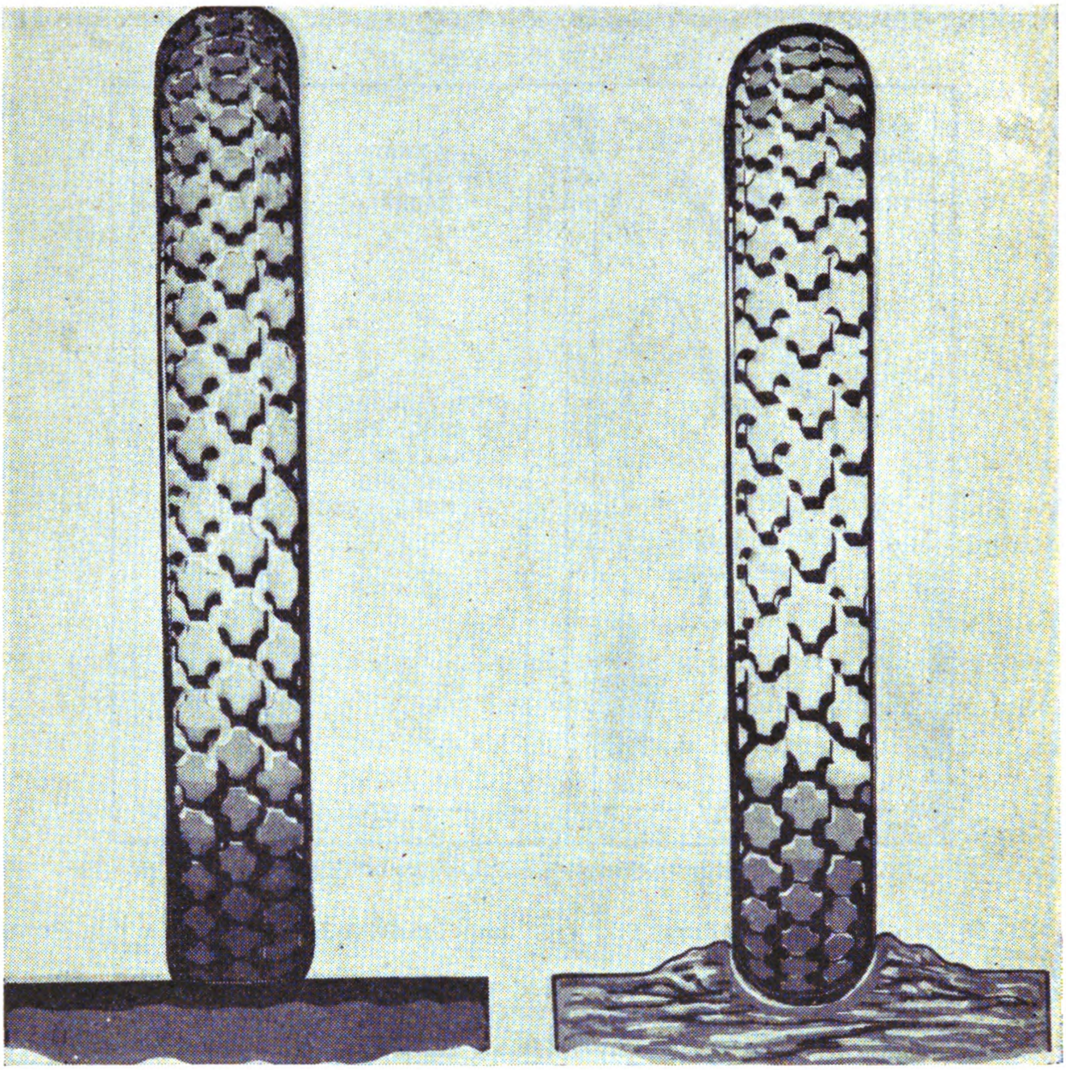
brakes easily and sparingly. Use the front-wheel brake with great caution.

c. If necessary to ride fast on wet roads, let about 2 pounds of air out of the front tire and 4 pounds out of the rear tire to increase the traction. This, however, should be done only under extreme emergency conditions, because under-inflated tires are easily damaged. The air pressure must be restored as soon as the roads are dry.

d. Figure 8 illustrates the proper method of crossing wet railroad or trolley car tracks. Study the illustrations and notice the angles at which the tracks should be approached.

23. Driving over sand, dirt, and gravel.—There is considerable difference between riding over hard-surfaced roads and riding through mud, sand, and gravel. Figure 9 shows how the tires of a motorcycle meet hard and soft roads.

Figure 9① shows the road surface hard or paved. Figure 9② shows how the tires sink slightly into soft ground and roll the dirt to both sides. On surfaces of this type, the motorcycle has a slightly different feel and it seems to weave or drift from side to side. This is even more pronounced in loose sand than in deep mud. The vehicle requires much more steering effort than it does on hard surfaces. Nevertheless, once the motorcyclist learns to compensate for this unsteady feeling by steering strongly, it is easy to ride in deep mud or sand without putting the feet on the ground to brace the motorcycle. If the steering damper is adjusted fairly loose while driving in soft terrain, the motorcycle can be more readily controlled.



① Hard or paved road. ② Soft dirt road, as fresh gravel.

FIGURE 9.—How motorcycle tires contact the ground on different types of roads.

e. *How to sit.*—When riding over anything but hard-surfaced roads, the motorcyclist should make the vehicle a part of himself. Some competent motorcyclists do this by gripping it with the feet and knees, and by keeping the back upright and remaining firmly seated in the saddle. Never try to ride gravel or loose dirt roads while relaxed in the saddle. However, the position should not be too tense. Figure 10 shows an approved posture for riding solo under normal conditions.

b. Operation on sandy terrain.—The actual operation of motorcycles on sandy, desert-like terrain requires unusual physical exertion and concentration, resulting in fatigue. Considerable training is needed to accustom drivers to the heat, wind, barren terrain, and lack of water in such regions. Goggles and dust respirators are essential during dust storms. Good sun glasses will reduce glare and mirage. A cloth will protect the back of the neck from intense sun rays.

Intelligent use of momentum, careful advance selection of gears, gradual application of throttle and brakes, and proper setting of the steering-head damper make it possible to cross sandy areas. Large dunes should be detoured and smaller ones rushed. Tracks of preceding vehicles should not be followed since the crust may break and result in loss of traction. Air pressures in the tires must be varied to suit the type of ground surface.

24. Driving over muddy and wet clay roads.—*a.* Wet clay and muddy roads are perfectly safe for motorcycle riding at slow speeds, if the driver is alert. One advantage of the solo motorcycle is that it can be steered around deep mudholes, whereas four-wheeled vehicles are usually obliged to go directly through the worst part of the road. Motorcycles can ride on a strip of relatively harder ground between ruts, and can even take to the fields in an emergency. Brake lightly, use engine compression instead of the brakes as much as possible, and leave the front-wheel brake alone.

b. Figure 11 shows how a motorcycle can be steered by leaning the body to one side. Suppose the motorcycle is headed for a deep, muddy rut. To avoid skidding which might occur if the front wheel is turned too sharply, lean away from the rut, as the driver in figure 11 is doing, and the motorcycle will naturally follow the body. In extreme cases it is even possible to stand on the footboards to lean out farther.

c. On wet dirt roads it is sometimes necessary to travel in second or low gear and use both feet to "walk the motorcycle." This should only be done under extremely slippery conditions, *never when in dry sand or gravel.*

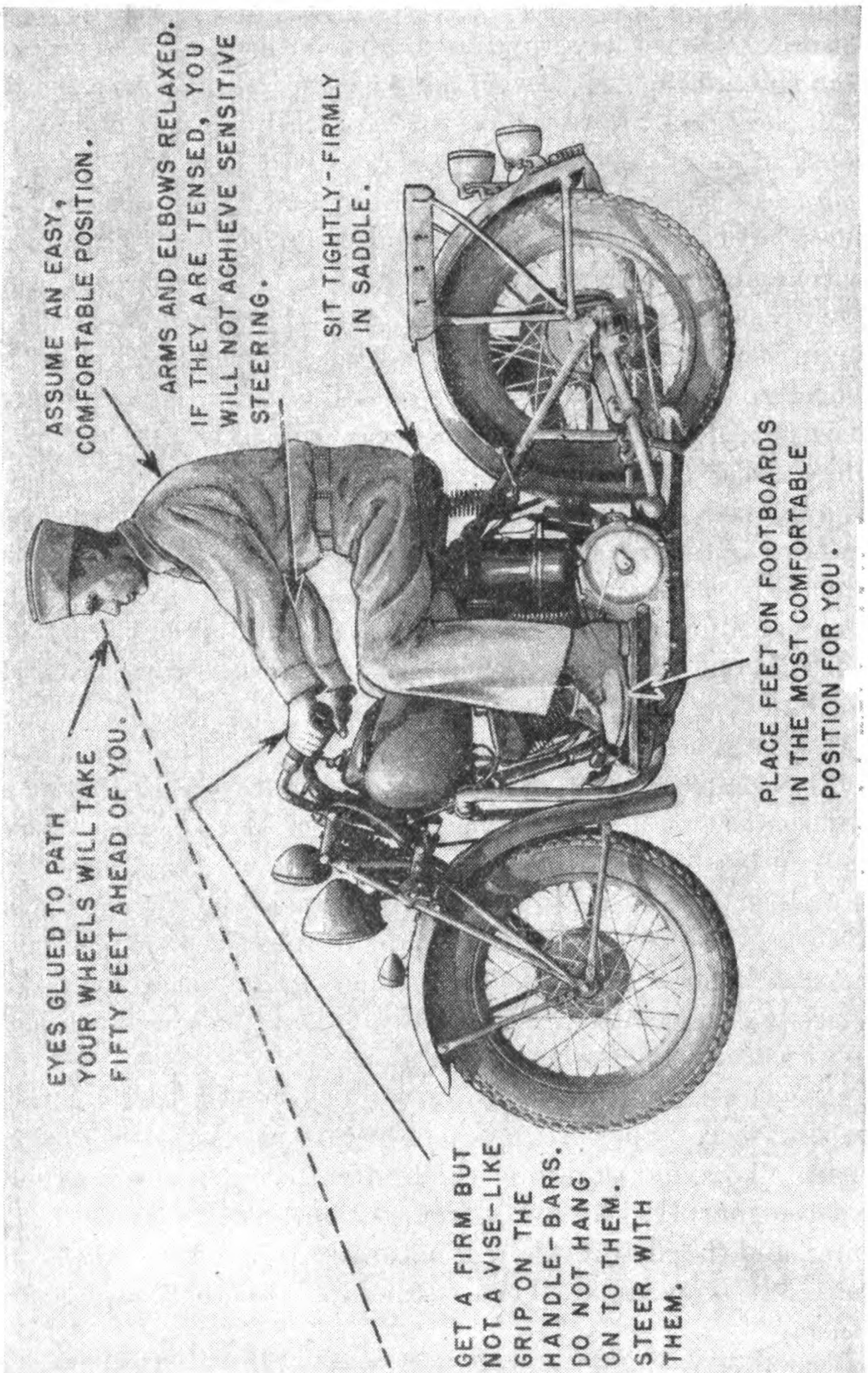


FIGURE 10.—Normal riding position.

25. Gaining extra traction.—If the rear wheel spins on snow, mud, or grass while accelerating, extra traction can easily be secured by sliding off the saddle onto the rear fender. If the vehicle has a side-car, ask the passenger to sit up on the back of the side-car seat or lean over on the rear fender of the motorcycle as shown in figure 12. This extra load on the rear wheel will increase the traction.

FIGURE 11.—How to steer a motorcycle by balancing.

26. Hill climbing with a solo motorcycle.—Always climb a steep grade in as straight a line as possible. Fix the eyes on a mark high up on the hill and drive directly toward it. If the engine stalls or the rear wheel starts to spin on a hill, hold fast to the motorcycle, remain in the saddle with both hands on the handle bars and use both brakes, keeping the left foot on the ground to prevent the vehicle from rolling backward. If the right foot instead of the left is used as a ground support, the foot brakes cannot be used; then if the motorcycle starts rolling it will keep on rolling. Figure 13 shows correct and incorrect riding on an upgrade.

a. Stopping on a slope.—Before stopping on a slope, turn the front

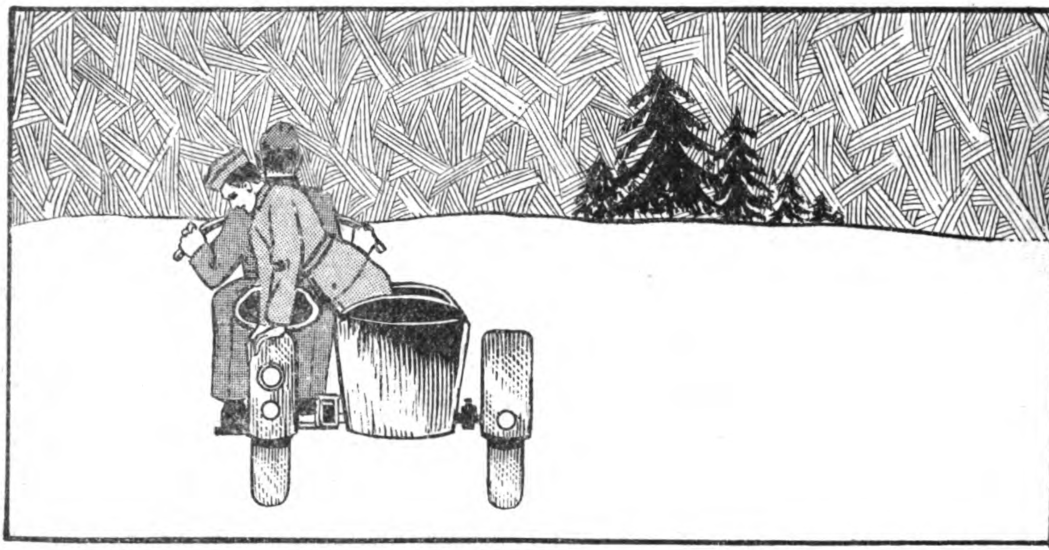


FIGURE 12.—Increasing traction on the driving wheel.

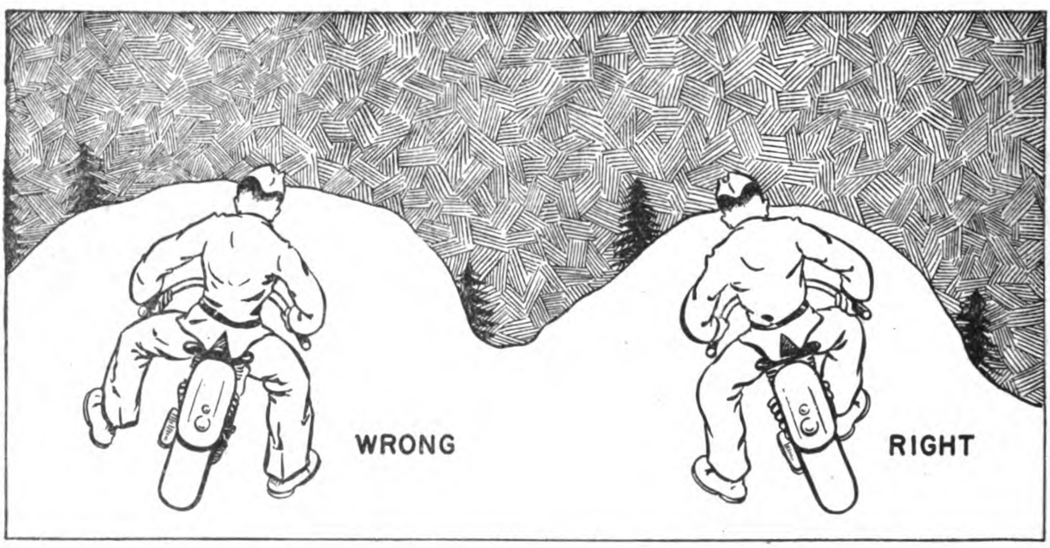


FIGURE 13.—Handling a solo motorcycle on an upgrade.

wheel as far as possible toward the right; the motorcycle will then be on a more gentle grade and will be less inclined to roll back easily. At the same time the left foot can be placed upward on the slope and the right foot kept on the brake as in figure 14. Never turn to the left just before stopping because then the right foot must be placed on the ground (preventing use of rear wheel brake) or the motorcycle will tip sideways down the hill. Disengage the clutch shortly before stopping to avoid stalling the engine.

b. Turning on a slope.—To turn around, roll the motorcycle back a little, steering it so that it will face downward. (See fig. 15.) If

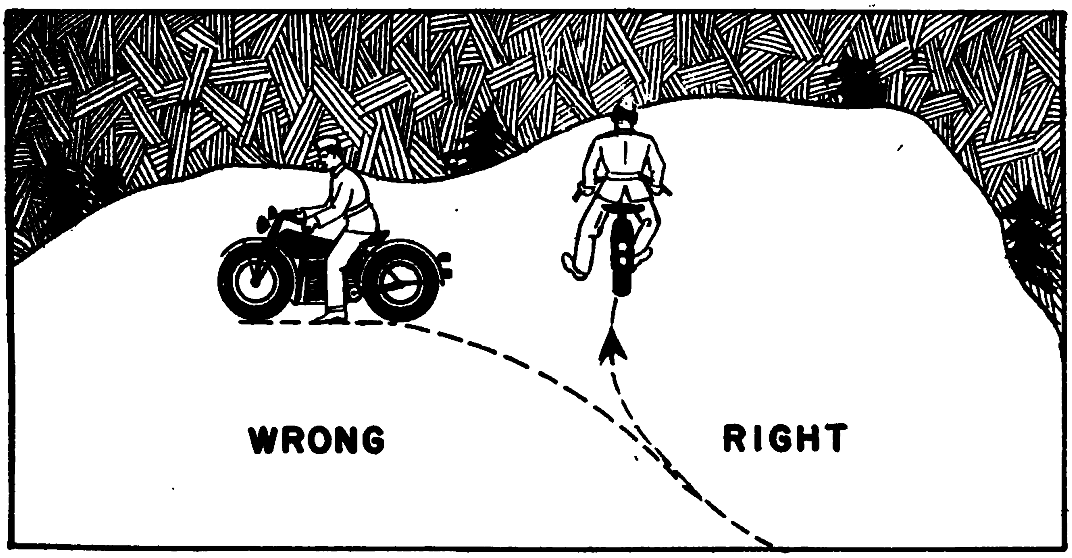


FIGURE 14.—Stopping a solo motorcycle on a slope.

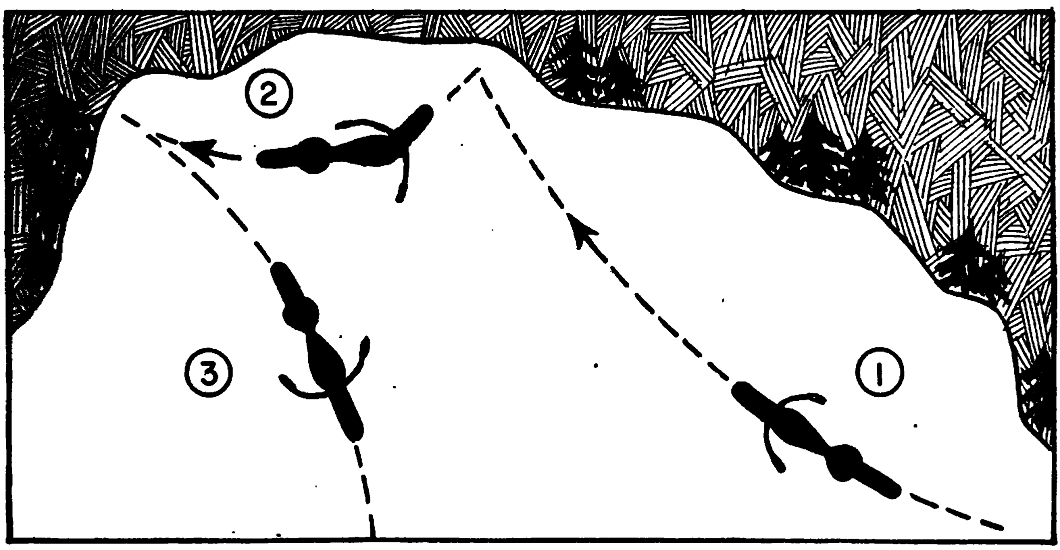


FIGURE 15.—Turning a solo motorcycle on an upgrade.

for any reason the motorcycle cannot climb the slope, do not attempt to turn around while mounted. Stop the engine and gently lay the vehicle on its side, facing uphill; then pull on the front wheel and turn the vehicle around so that the front wheel points downhill. Lift the vehicle, mount it, and start downhill. The downhill momentum is usually sufficient to start the engine when the clutch is engaged.

c. Falling.—Usually a fall with a solo motorcycle, even on a steep slope is not dangerous. It can be dangerous, however, if the fall is downhill, because the vehicle may land on the driver. Try to fall on the "uphill side," as shown in figure 16.

27. Operating a side-car motorcycle.—*a. Starting.*—When starting a side-car vehicle, the side car will exert a drag which pulls the vehicle to the right. To overcome this tendency, steer slightly to the left.

A side car increases the load on the engine, so the throttle must be opened a little more and the clutch eased in a trifle more gradually than when riding a solo motorcycle. It is also necessary to shift from high to second more often.

b. Turning.—To turn a side-car combination, simply turn the

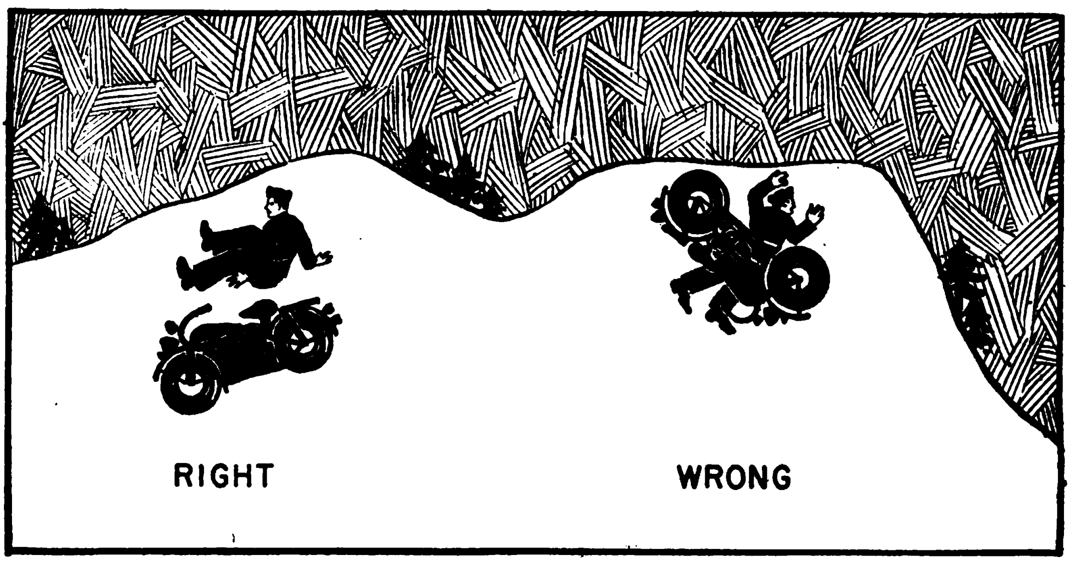


FIGURE 16.—How to fall from a solo motorcycle.

handle bars in the desired direction. Leaning the body (as in solo riding) does not assist in turning a side-car combination. However, at very high speeds, leaning toward the turn increases roadability by counteracting centrifugal forces.

Whenever it is necessary to turn the vehicle around on a roadway or in a narrow space, first look back to make sure there is no oncoming traffic. Then, shifting to low gear, turn left, bringing the side car around on the outside of the turn. If the turn is too fast, the rear wheel will leave the ground, tipping the vehicle forward and throwing off the driver. Therefore, until absolutely familiar with the side-car combination (both loaded and empty), turn slowly and to the left.

c. Sharp left turn.—Reduce the speed to about 15 miles per hour, using both the front and rear brakes if the ground is firm. Shift into second gear and make the turn. Do not accelerate or turn too quickly on a sharp left turn, because the side-car wheel will tend to lift off the ground and turn the vehicle over.

d. Sharp right turn.—In making a sharp right turn, reduce the speed, shift into second and steer to the right, helping the vehicle turn by accelerating slightly. A sharp right turn can be made faster than a left turn.

e. Gradual turns.—In turning gradually to the right, take advantage of the crown of the road by hugging the inside of the curve toward the ditch. This keeps the side car down and allows the motorcycle to lean slightly toward it. If the curve is to the left, take advantage of the crown of the road without moving too far to the left side, so that the motorcycle will be slightly below the side car and will lean slightly away from it, making steering easier.

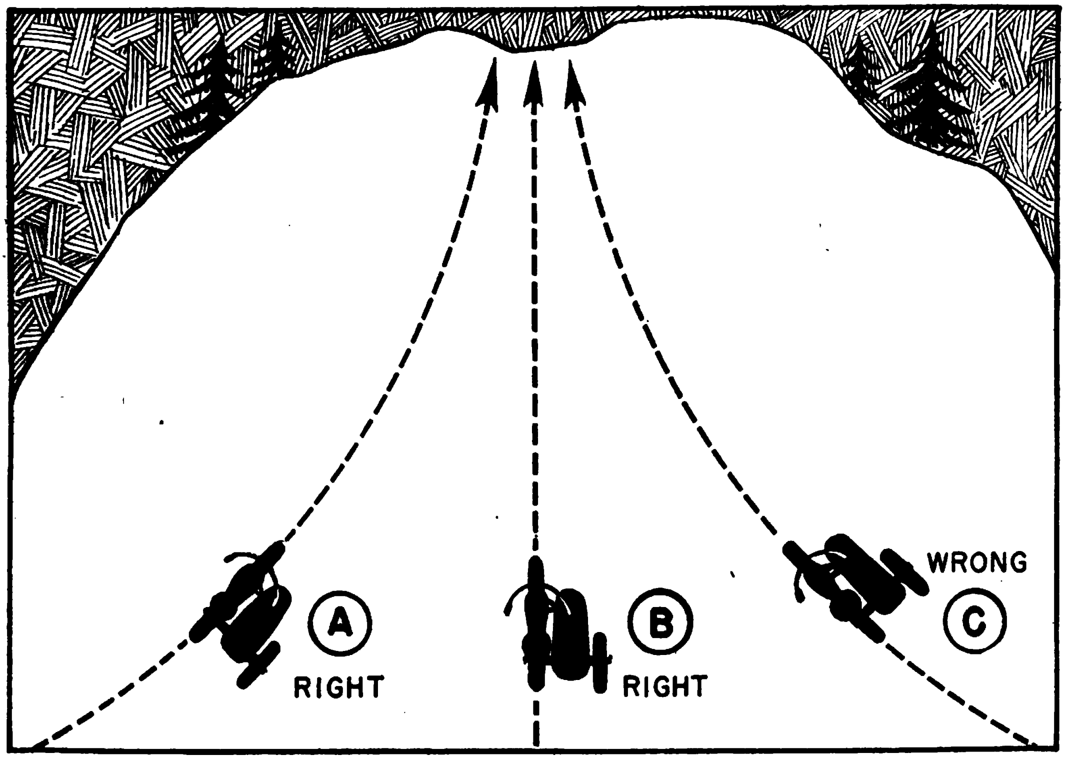


FIGURE 17.—How to climb a steep slope with a side-car combination.

f. Riding and turning on steep slopes.—When climbing a steep slope, drive so that the side car is *never* above the motorcycle or the vehicle will almost certainly keel over. In figure 17, the routes of riders A and B are well chosen, but that of rider C is incorrect. If a side-car combination stalls on a steep slope, or it is desired to turn it around, let it roll back a little, turning the front wheel so that the side car is always below the motorcycle, as in figure 18.

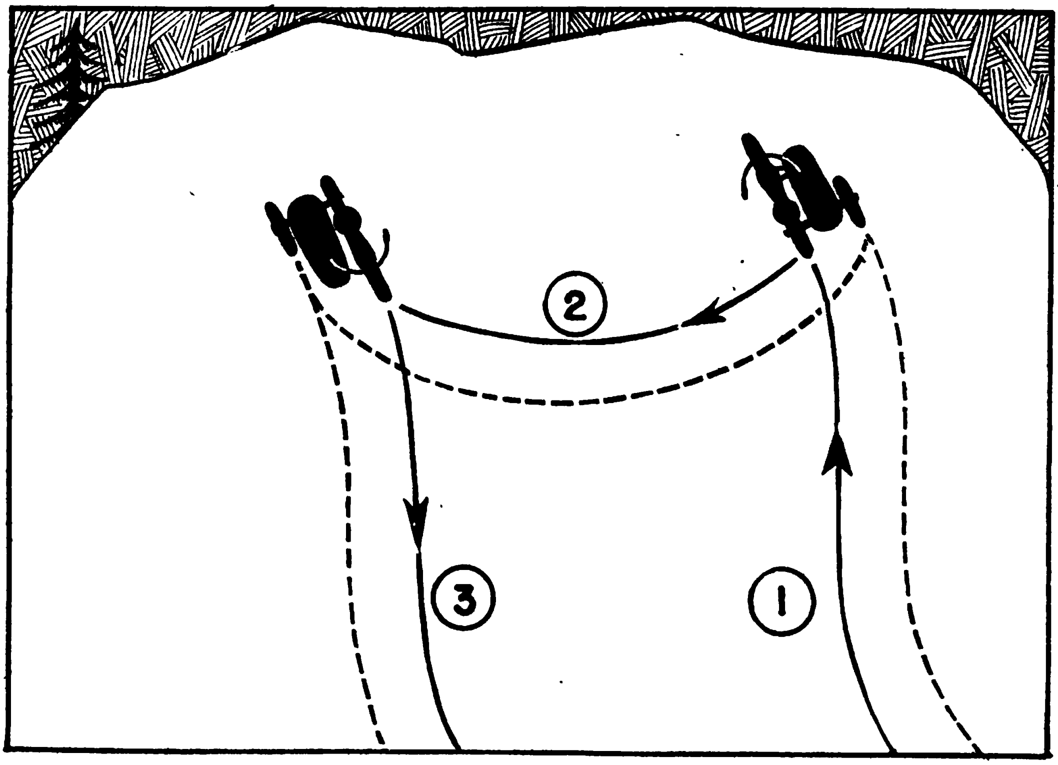


FIGURE 18.—Maneuvering a side-car combination on a hill.

SECTION IV

PREVENTIVE MAINTENANCE

28. General.—*a.* More than in any other Army motor vehicle, the life and usefulness of a motorcycle depend on maintenance and preventive maintenance inspections. This is due primarily to the basic differences in design between a motorcycle and other vehicles. Its size and weight make fine adjustments and close clearances necessary. The engine design is such that its operation is uneven, producing constant vibration under high operating temperatures. Constant lubrication, maintenance, and adjustment are essential to maximum efficiency because the engine is mounted near the ground, exposed to dust, brush, and weather.

Bearings on the frame, forks, and other members are small, yet they are sturdy enough to permit traveling through deep mud, sand, and dust, and in many instances fording creeks and shallow rivers. However, these small bearings must be lubricated and adjusted more frequently than those on larger Army motor vehicles.

b. The motorcycle assigned must be operated even though adequate facilities and time for servicing will not always be available. For this reason, maintenance routines are doubly important when the motorcycle is "off duty." It may mean the difference between a vehicle ready for duty and one that will fail in service and cripple the military unit of which the motorcyclist is a part. Therefore, a military motorcyclist should not only be able to ride well, but also be competent to care for his vehicle, make simple adjustments, and undertake first and second echelon maintenance duties. It is only through the efforts of capable, conscientious motorcyclists that faults (barring accidents) may be corrected before they develop into major failures.

29. Preventive maintenance schedules.—A series of preventive maintenance schedules (PMS) for military motorcycles, providing a regular routine of inspection and service at prescribed intervals of time are given in TM 10–545. If these schedules are followed regularly, the best performance should be obtained from the motorcycle.

a. When vehicle is assigned.—For his own safety, as well as to make sure he is not held responsible for defects which already exist, the motorcyclist should inspect and thoroughly service any motorcycle assigned to him before using it. This should be done whether the motorcycle is new, returned after repair or overhaul (by a higher echelon), or assigned to him under any other circumstances.

b. After operation.—When coming in from a motor march, or when halting for the night, the operator may have in mind, if not on paper, several defects in the motorcycle that need attention. Since more time is available after the march than at any other part of the day, use this time to make a thorough inspection and perform whatever service is needed. The motorcycle should then be ready to roll on short notice. If there are any conditions or defects which cannot be corrected with tools and supplies at hand, they should be reported to the organization motor sergeant.

c. Before operation.—Check the motorcycle briefly before beginning a new mission, making sure it is in excellent running order.

d. Weekly.—Weekly preventive maintenance covers repairs which could not be made after each day's mission. Weekly maintenance also establishes a routine of regular and thorough lubrication and inspection. At the conclusion of the weekly maintenance the motorcycle should be in normal working order.

30. Breaking-in procedure.—A new vehicle requires more careful attention during the "first miles" or "breaking-in" period than at any other time in its operation. For best results, motorcycles should not be driven at excessive speeds during the first miles. A little extra care and attention during the "breaking-in" period will be fully repaid in longer service and more satisfactory performance.

a. Speeds.—(1) For the first 100 miles, avoid long, steep hills, and run at speeds between 20 and 35 miles per hour. Do not exceed 40 miles per hour, even in spurts or when passing other vehicles.

(2) For the next 400 miles, do not exceed 40 miles per hour.

(3) For the next 500 miles, do not exceed 50 miles per hour.

b. Inspections.—At the end of 500 miles and again at 1,000 miles, the vehicle should be thoroughly inspected. Give special attention to tightening cylinder head studs and nuts, crankcase cap screws, and manifold nuts; also to proper adjustment of valve lifters and drive chains. Check lubrication of the primary chain. Check transmission mounting cap screws and the entire vehicle for loose cap screws, bolts, nuts, etc.

c. After 1,000 miles.—When the engine has been properly broken in, after 1,000 miles of operation, it can be run at higher speeds. After the vehicle has run 1,000 miles, then checked and properly adjusted, it should be capable of fast acceleration. If it is still stiff, the breaking-in period must be prolonged.

31. Cold weather operation.—Motorcycles are impractical for use in deep snow because of insufficient traction and difficult steering. However, they may be used successfully in cold climates where the snowfall is light, if certain preparations and precautions are taken.

a. Crankcase.—In cold weather the crankcase of all internal combustion engines is a virtual chemical factory. The combustion of fuel produces water vapor and traces of acid. These vapors are normally expelled from the engine through the breather. However, if the engine is not allowed to idle sufficiently after starting, the water vapor will condense into liquid water and drain into the crankcase. The water will then circulate with the oil in the valve mechanism, oil passages, or oil tank, and may freeze causing serious damage to the engine. The acid in the water and oil produces sludge which corrodes and pits the highly polished surfaces and bearings in the engine and can be removed only by draining the crankcase. It is best, therefore, to change engine oil frequently in cold climates. A small amount of kerosene added to the oil increases its fluidity and makes it easier to start the engine.

b. Carburetor.—In cold weather, the carburetor idling or low-speed adjustment should be set so that the engine idles fairly rapidly with the throttle closed. Avoid excessive choking since it will flood the cylinders and wash away the protective lubricant before the oil begins to circulate. The fuel strainer and carburetor bowl should be cleaned and drained daily. Always close the shut-off valves underneath the fuel tanks and allow the carburetor to drain dry before stopping the engine to avoid ice formation in the carburetor and fuel lines.

c. Spark plug gaps.—These should be checked and new plugs installed if necessary. The breaker points should also be checked and filed or renewed if they are in bad condition.

d. Valves.—Sticky and sluggish valves will make starting difficult. To remedy this, raise the valve-tappet covers and pour a little kerosene or other solvent around the valve springs and stems.

e. Leg shields.—These should be attached to the motorcycle so as to help keep the engine warm.

f. Power train.—If a wet-type clutch drags or does not release fully in cold weather, the cause is probably the presence of heavy, congealed oil in the primary drive. Wait until the engine warms up, then if the clutch still drags and all controls are proper, it is an indication that the oil is too viscous for the temperature. A slipping clutch will prevent spinning a cold engine and cause difficult starting in cold weather. Adjust the clutch so that it does not slip at any time. Transmission gears also may clash in cold weather, if the oil is too thick.

g. Battery.—In below-freezing weather it is especially important to keep the battery well charged so that it will not freeze. Add water to a battery just before driving the motorcycle. This will allow the water to mix with the acid and avoid freezing. If the battery should freeze solid, due to discharged plates, the case may crack and break and the plates will be damaged due to the loss of active material leaking through the cracked case. Plates once frozen will never produce more than 50 percent of their normal capacity. Keep all connections tight and coated with grease to prevent corrosion. Increase the generator charging rate.

h. Controls.—It is extremely important that the controls be in good working order at all times. In cold climates, snow and slush are likely to freeze and form ice on the brake, clutch, and gear-shift linkages and affect their operation. The handle-bar controls may also become locked. Therefore, as a policy of safety, stop and clean the control linkages frequently and keep them well lubricated.

32. Engine overheating.—*a. Dirt on engine.*—Exposed cylinder fins of an air-cooled engine must be kept free of dirt, heavy paint, or similar insulating substances. This is important because anything which reduces transfer of heat from the engine into the atmosphere or which diverts the air stream from around the engine raises its operating temperature. Gloss Motor Gray Enamel (Specification ES. No. 680, class 26) does not materially affect engine cooling.

b. Slow speeds, frequent stops and starts.—(1) These cause the motorcycle to heat up rapidly. Therefore, from a maintenance point of view, make stops and starts as short and as few as possible. If conditions permit, travel faster than 35 miles per hour to provide a constant flow of air past the engine.

(2) If the engine is to be run for some time while the vehicle is not in motion after an overhaul or for some other reason, place large electric fans on each side so as to provide an air stream to cool the engine. The engine can be ruined quickly; pistons and bearings may be damaged and valves may be burned and pitted.

c. Oil circulation.—Keep a close check on oil circulation by removing the oil tank cap and observing whether bubbles appear near the top of the return tube on the Indian, or by noting the red indicating light on the instrument panel of the Harley-Davidson.

33. Operation on sandy terrain.—Take advantage of every opportunity when driving in desert-like areas to inspect the motorcycle and follow prescribed maintenance schedules. Without adequate protection from sand, the carburetors will become choked, fuel and oil lines clogged, cylinders scored, circuit breakers damaged, and exposed moving parts prematurely worn.

a. Refueling.—Unless proper precautions are taken, sand will enter the crankcase and the fuel and oil lines. If necessary, use a truck, tarpaulin, boulder or other windbreak when refueling during sandstorms. A motorcyclist must make it an invariable habit to wipe all sand from the caps and spouts of containers before they are used. A piece of clean cloth will be helpful in straining the fuel or oil when refilling the supply tanks. Do not fill the fuel tank to its normal level. Otherwise, heat will cause expansion and loss of fuel when the motorcycle is left standing. The venthole in the fuel tank cap will require frequent cleaning. Vapor locks will occur often and it may be necessary to insulate fuel lines that are too near hot areas of the engine.

b. Lubrication.—(1) It is necessary to give more attention to lubrication during desert operation than during normal operation. Lubricant on moving parts tends to accumulate dust and sand, which cause rapid wear. Frequent addition of new lubricant forces out the dust-filled oil, thus cleaning the parts while lubricating them. Consult the latest official publications for the vehicle on the proper oils and greases to use.

(2) The oil-bath air cleaner, if properly serviced, will protect the engine considerably. It is necessary to remove and clean thoroughly the oil cup and filter element daily. The cup should be refilled with fresh oil daily. It is good practice to remove and clean the carburetor bowl every 250 miles of operation. If the vehicle has a fuel filter, it should be cleaned daily.

c. Bolts and nuts.—Excessive jolting during operation over rough terrain causes bolts and nuts to work loose. Therefore, check and tighten them frequently. Vibration as well as sand and dust will cause failure of instruments if they are not carefully sealed and mounted. Scotch tape may be used for this purpose.

d. Cooling the engine.—It is advisable to remove the leg shields in desert-like regions to allow maximum air circulation around the engine. Always stop the engine at halts. Turn the motorcycle into the wind as a means of cooling the engine. Do not operate in low gear more than is necessary.

e. Battery.—A high generator charging rate should be avoided as it tends to heat the battery. Keep all terminals tight and check the electrolyte level daily. Drinking water containing salt cannot be used in the battery.

Section V

CHASSIS

CHAIN-DRIVEN MODELS

34. General.—The chassis, which might be called the "skeleton" of the motorcycle, consists of wheels, frame, front suspension and steering, saddle and seat posts, and other parts. It has everything necessary for a complete motorcycle except a means of propelling itself.

35. Wheels.—A motorcycle wheel assembly consists of a tire, a rim, spokes, nipples, and hub. Figure 19 shows a typical wire-spoke motorcycle wheel with a drop-center rim; its brake assembly has been removed. This type of wheel is interchangeable between the front and rear.

a. Tires used on motorcycles differ little from those used on other motor vehicles. The front, rear, and side-car tires are interchangeable on motorcycles of the same size. A tire is mounted on the rim with the balance mark at the valve stem. Correct tire pressure must be maintained. Under-inflated tires allow drifting on turns and create a riding hazard. Low or high pressures will reduce tire life. Inflate

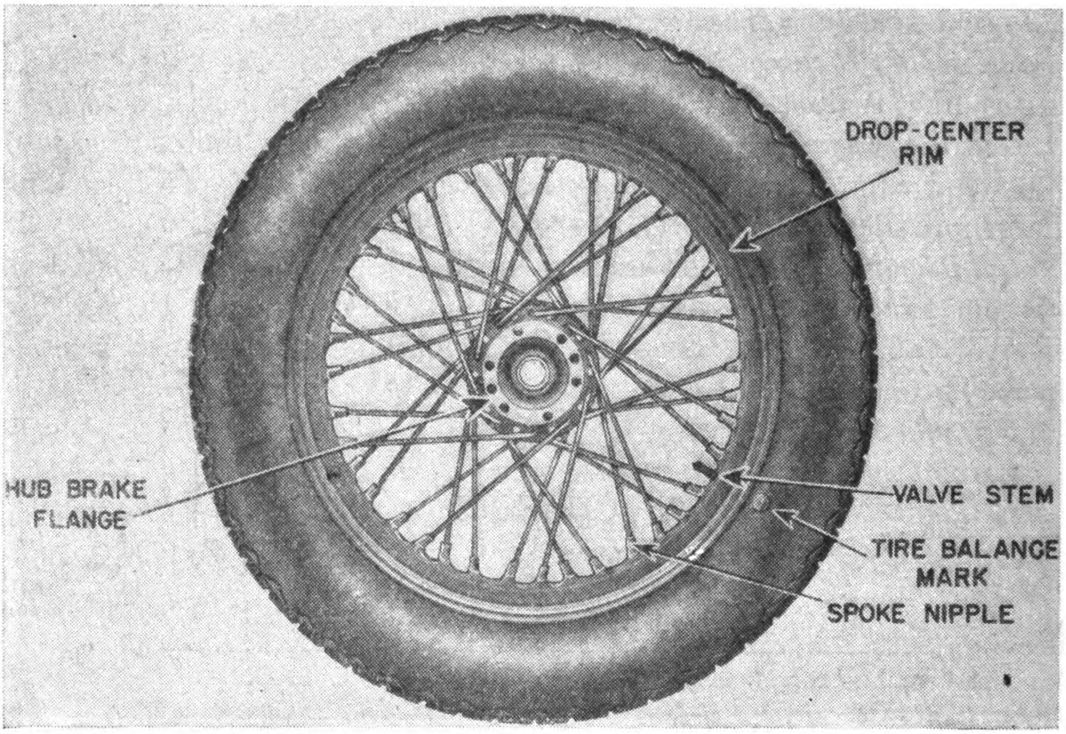


FIGURE 19.—Typical motorcycle wheel with brake assembly removed.

the tires to manufacturer's recommendations for maximum life and best riding qualities.

b. There are four sets of ten spokes each (40 in all) on a motorcycle wheel. The spokes are of strong steel wire which absorbs shock. One end of the spoke is enlarged; the other is threaded. The enlarged head anchors the spoke in a hole on the hub flange or on the brake drum. The threaded end screws into a nipple which is inserted in a countersunk hole in the well of the rim. The nipples are usually staggered so that the holes will not weaken the rim. The spokes are tightened to equal tension so that the wheel runs true. Since loose spokes may ruin the wheel in time, they should be checked carefully and wheels should be "trued up" every 6,000 miles by motorcycle mechanics. Figure 20 illustrates the method of tightening loose spokes. The wheel stand is authorized in a Harley-Davidson special tool set which will be available for third and fourth echelon maintenance units in the near future.

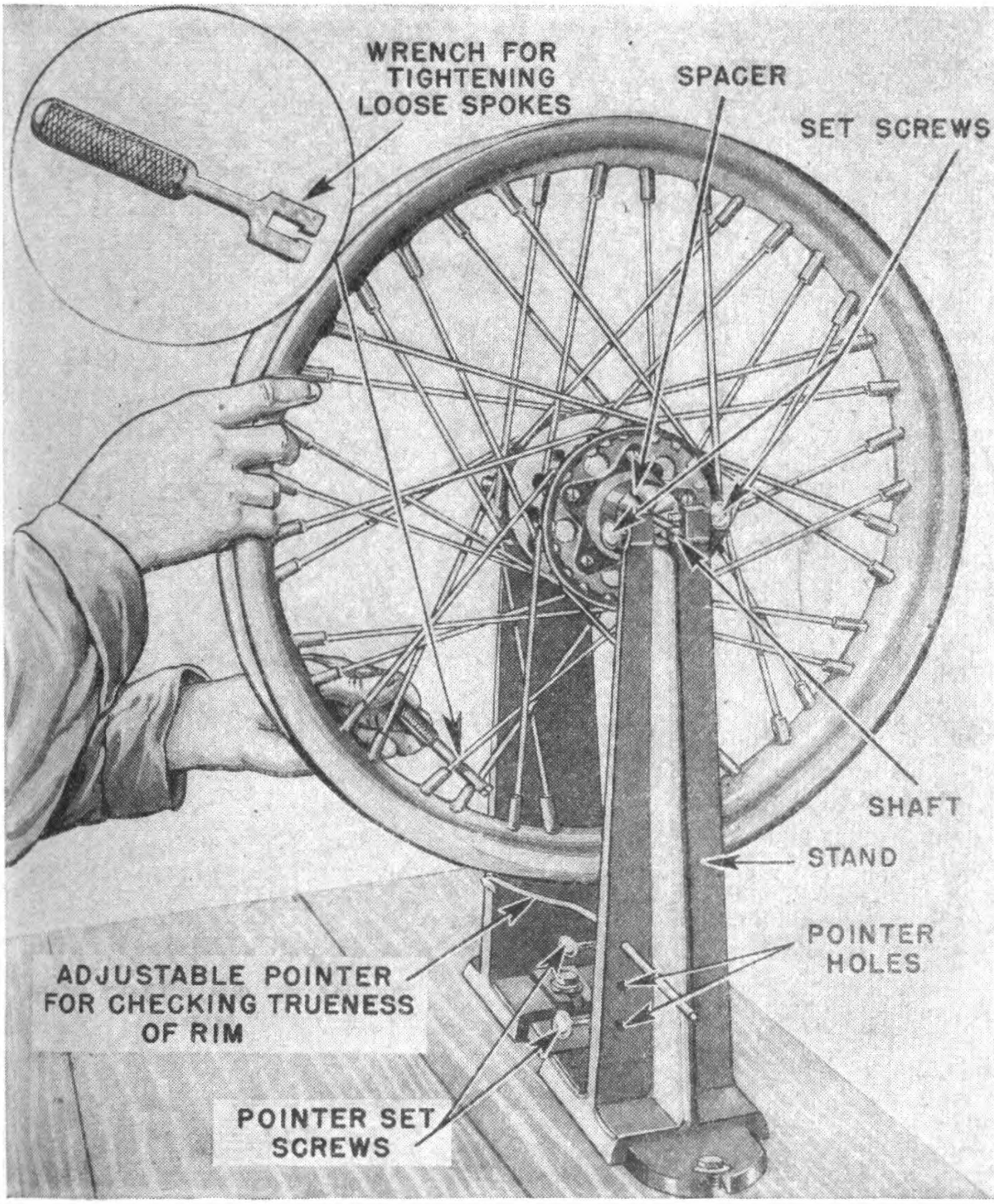


FIGURE 20.—Tightening loose spokes.

c. Wheel hubs vary in construction on different military motorcycles. Figure 21 shows one with plain roller bearings. Any excessive end play that may develop in this type of hub is taken up by removing the thrust bearing outer cover and adding more shims. Be careful not to add too many shims; they will cause the thrust bearing sleeve to bind when the cover screws are securely tightened. Since the cork grease retainer interferes to some extent with the free movement of the thrust bearing sleeve, it is best to leave it out while

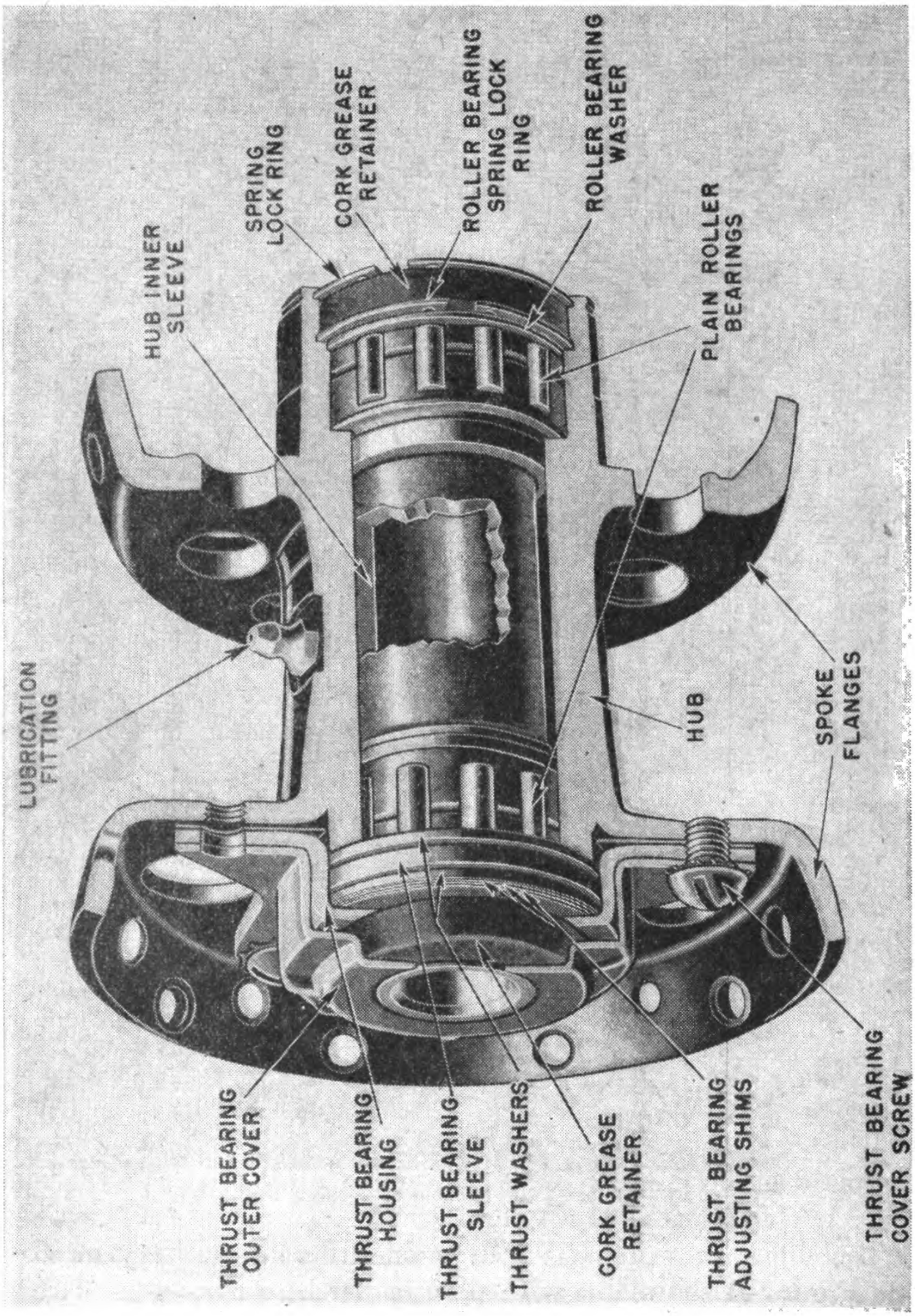


FIGURE 21.—Plain roller-bearing wheel hub.

checking the adjustment. Excessive radial (up and down) play caused by wear can be taken up by installing oversize rollers. The taper roller-bearing wheel hub (fig. 22) automatically takes care of thrust and therefore needs no adjustment because of wear. If correctly lubricated every 1,000 miles, this type of bearing will probably last about 20,000 miles. When these bearings wear excessively, new bearings must be installed. Figure 23 shows a wheel hub with a double-row roller bearing on one side and a ball bearing on the brake drum hub. The roller bearing requires greasing every 500 miles; the ball bearing should be lightly greased every 2,500 miles. Be cautious when greas-

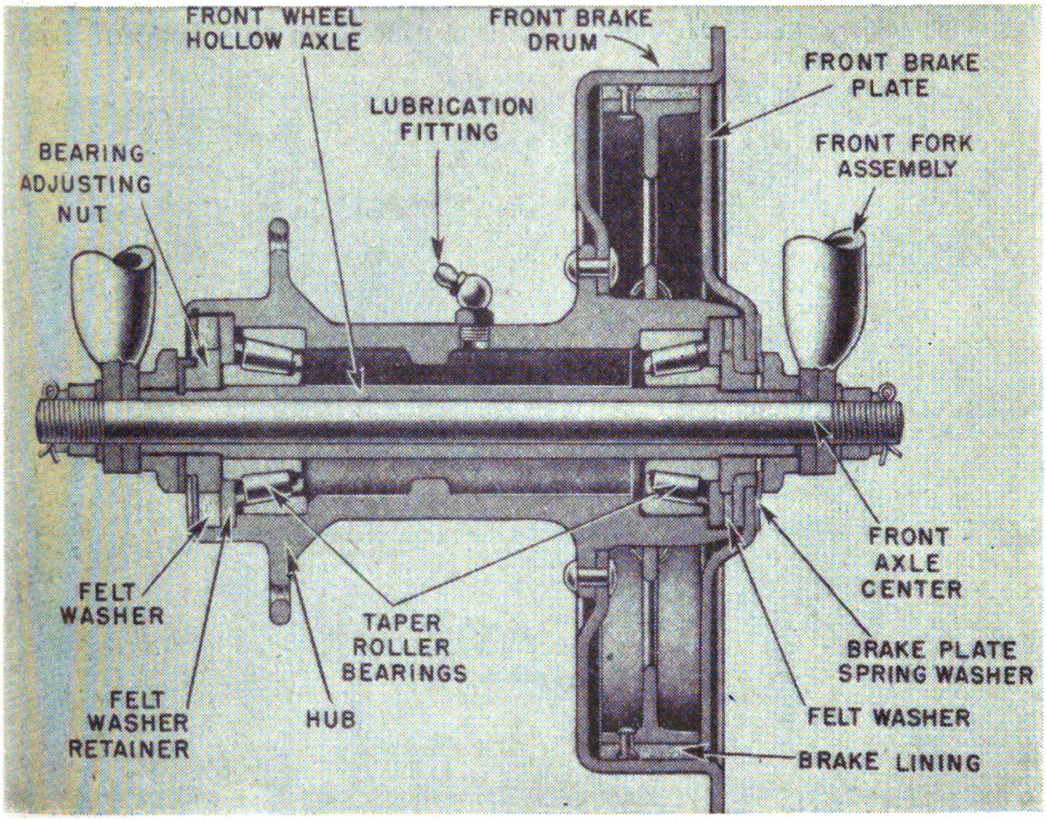


FIGURE 22.—Taper roller-bearing wheel hub.

ing wheel hubs which have pressure lubrication fittings; forcing too much lubricant into the wheel will break the seals and will allow grease to escape and saturate the brake linings, making them ineffective. It is better to hand-pack the bearings with grease. Wheel hubs should be refitted only by mechanics who are thoroughly familiar with this service, because they can be refitted too tight.

36. Frames.—The backbone of a motorcycle is its frame. It is made of drop-forged fittings and seamless-steel tubing, welded together to form a well-reinforced and rigid structure. It is heat-treated to increase its strength further. At the front of the frame is a steering head to support the front wheel fork. The rear wheel fits securely into the fork at the rear of the frame. Motorcycle

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frames may be classified in three types: single-loop, double-loop, and open-loop.

a. Single- and double-loop frames (figs. 24 and 25) are rigid supporting structures complete in themselves. In a single-loop frame, the lower member consists of one tube; in the double-loop frame, there are two tubes. The engine is bolted to the frame. A skid plate underneath the frame protects the engine.

b. The open-loop (or keystone) frame (fig. 26) is not a complete rigid structure in itself. An engine mounted on this type of frame

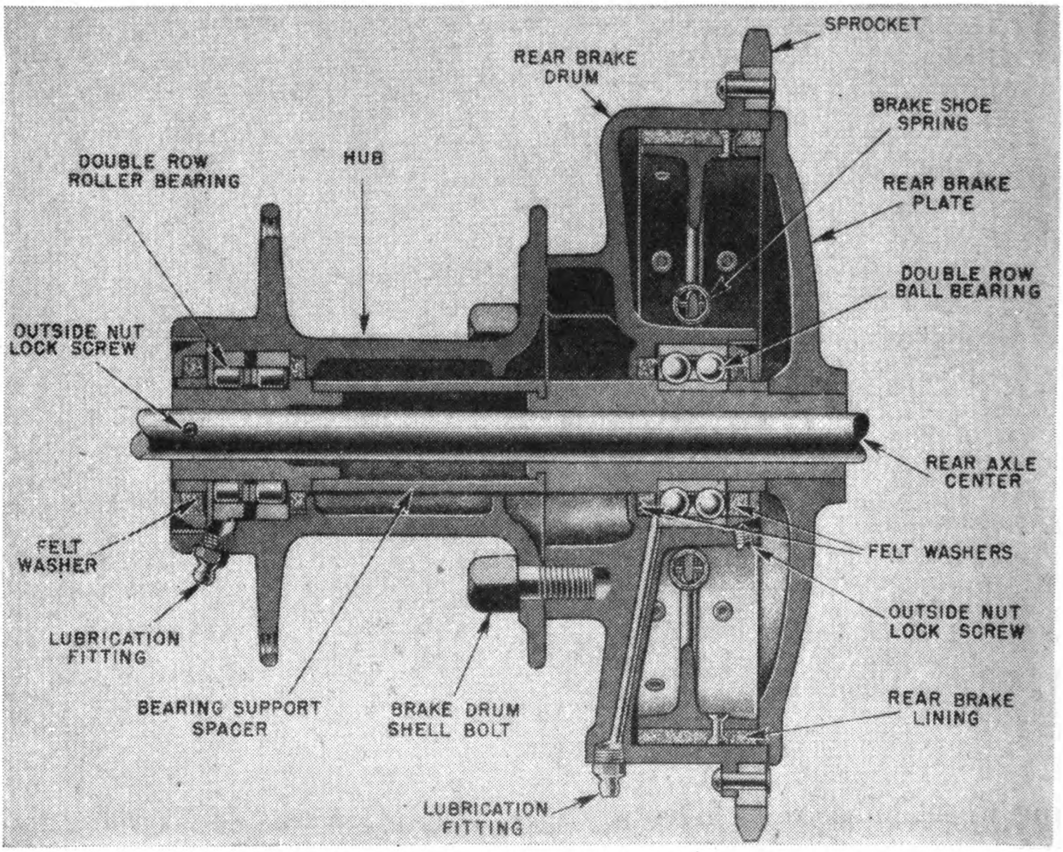

FIGURE 23.—Combination ball- and roller-bearing wheel hub.

has a heavier crankcase or is provided with side plates to complete the frame structure and afford rigid support when the engine is mounted.

c. The double-loop frame (fig. 27) is another type of frame construction. Coil springs, mounted on the rear-wheel fork, cushion the frame from road shocks very much like the knee-action unit on an automobile. The rear-wheel axle fits into the brackets on the slipper cylinders (spring housings). The slipper cylinder is set at a very slight angle so that the rear wheel is free to move up and down without stretching the final drive chain. The load (lower) springs carry the weight of the motorcycle; the recoil (upper) springs check the rebound of the rear wheel. The springs normally require greasing monthly or every 1,500 miles.

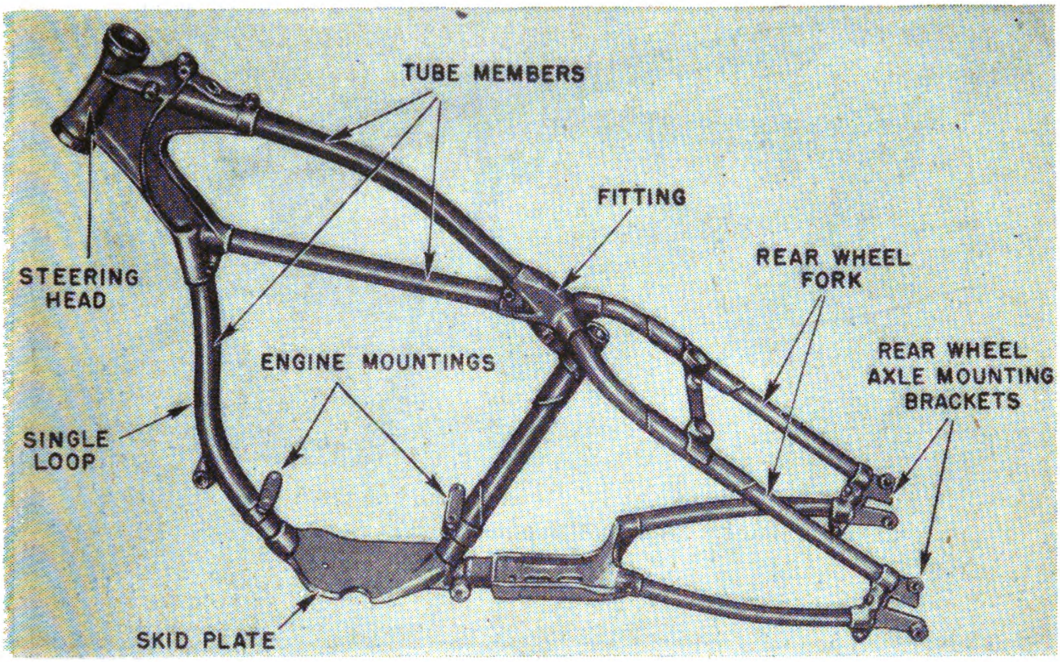

FIGURE 24.—Single-loop frame.

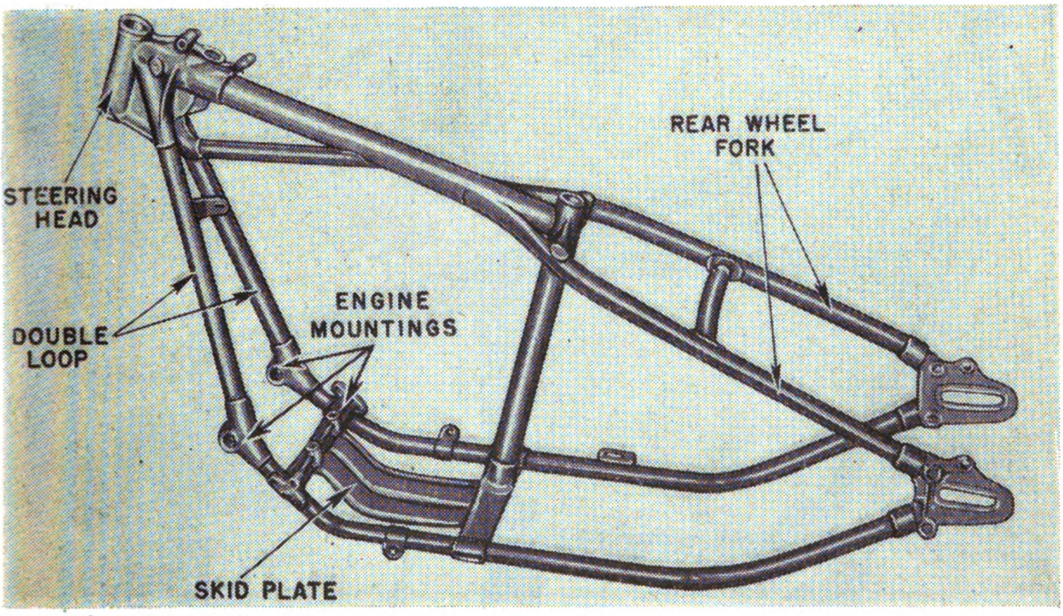

FIGURE 25.—Double-loop frame.

d. Ordinarily, no fault occurs in a frame unless it has been damaged in an accident. If it is not too badly bent, it can be straightened cold. Heat should *never* be used on the frame of chain-driven models. Usually a strong press is necessary for straightening.

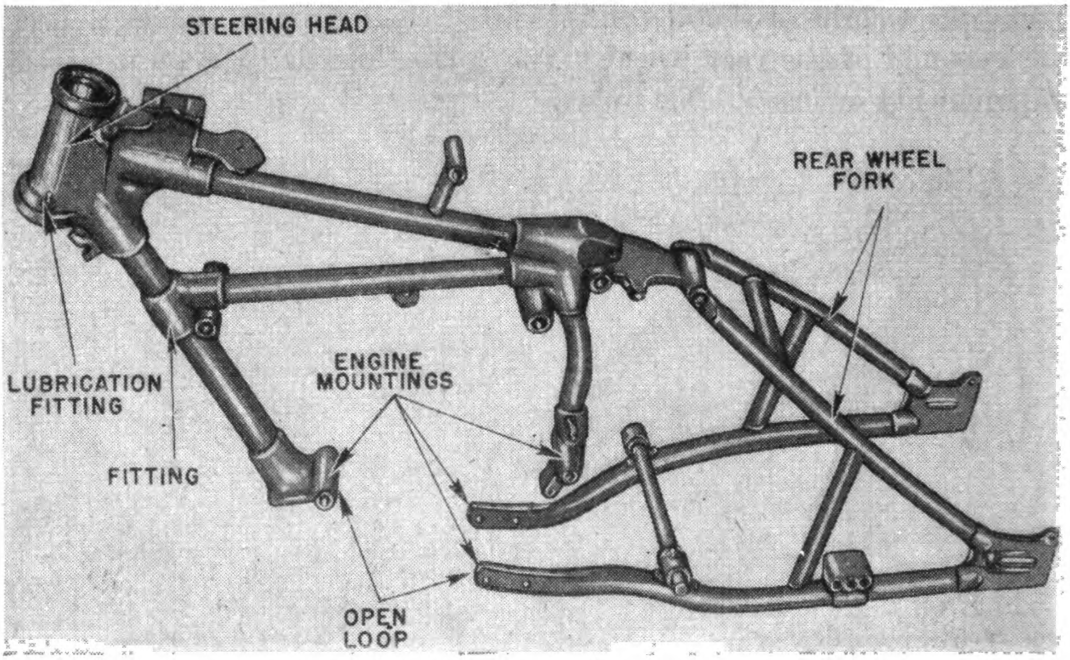

FIGURE 26.—Open-loop or keystone frame.

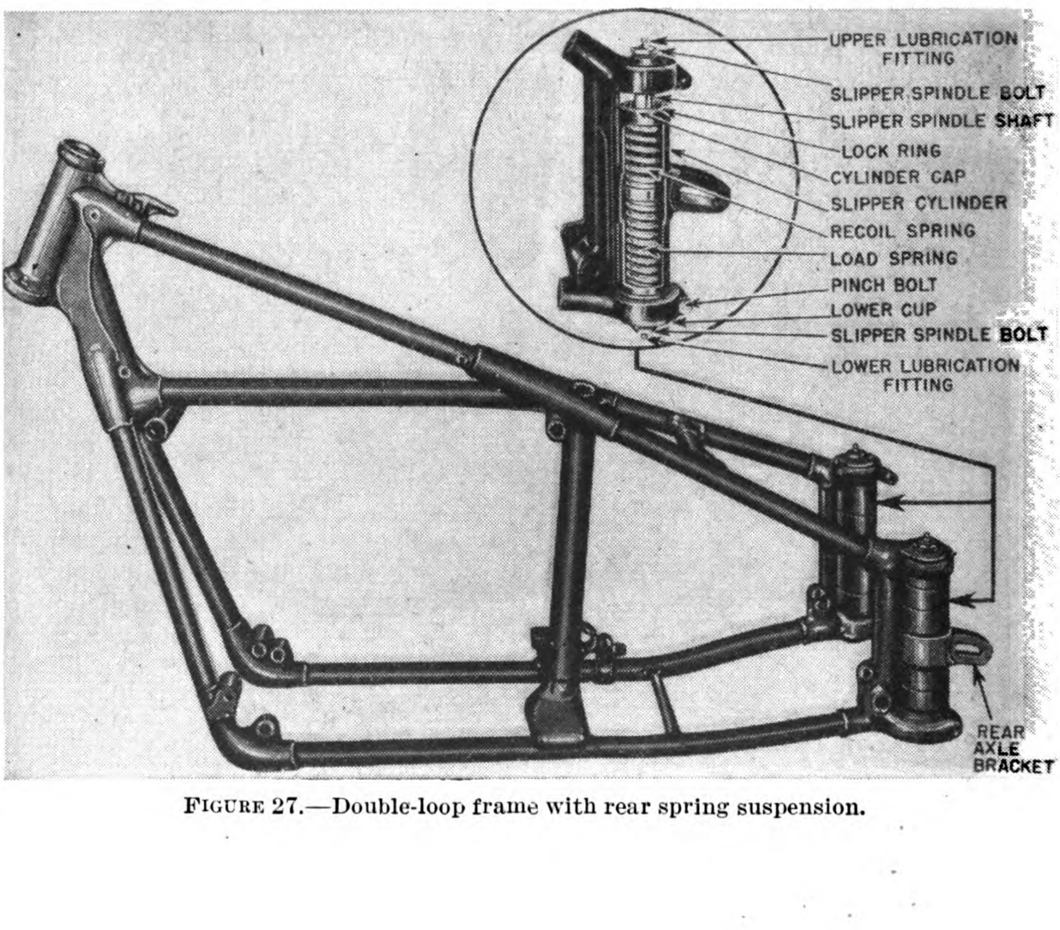

FIGURE 27.—Double-loop frame with rear spring suspension.

37. Front suspension and steering.—*a. Front fork.*—The front fork (fig. 28) is assembled to the steering head of the frame. With the handle bars, it forms the front suspension and the steering control

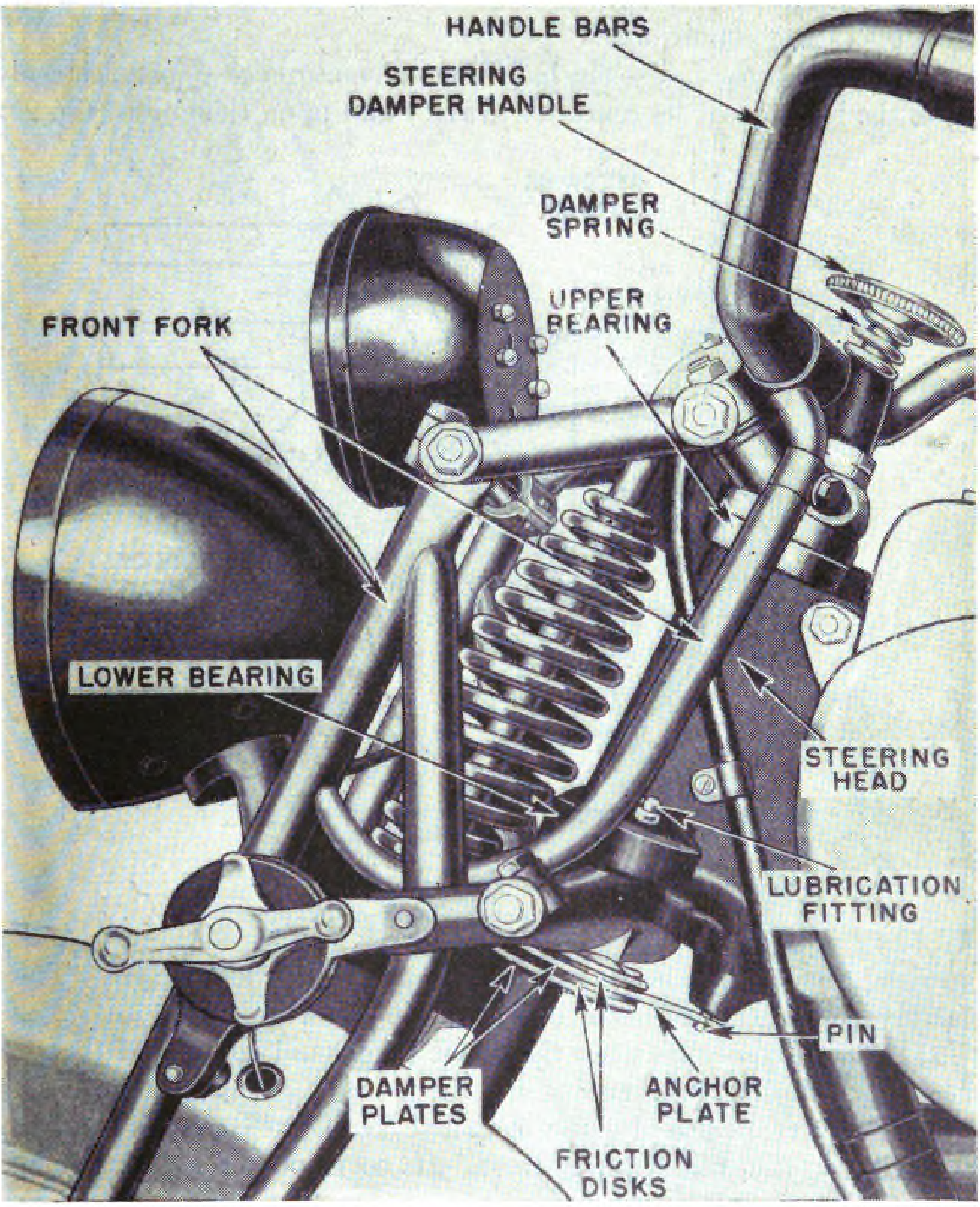

FIGURE 28.—Front fork and steering damper.

of the motorcycle. The steering head has upper and lower bearings to provide easy action. These bearings should be greased every week. Check them for looseness at every monthly or 1,000-mile inspection. If the bearings are too loose, the front end of the motorcycle will wobble. If they are too tight, they will bind, causing difficult steering. In either case, the bearing cones and cups will be pitted and damaged.

b. Steering damper.—Some motorcycles have a steering damper which may be drawn up or tightened to apply a light friction to the handle-bar movement, preventing front wheel wobble and shimmy at high speed and over rough terrain. The damper may be adjusted to local operating conditions.

c. Factors in steering.—The handling of a motorcycle depends largely upon the location of its center of gravity and upon the angle (fig. 29)

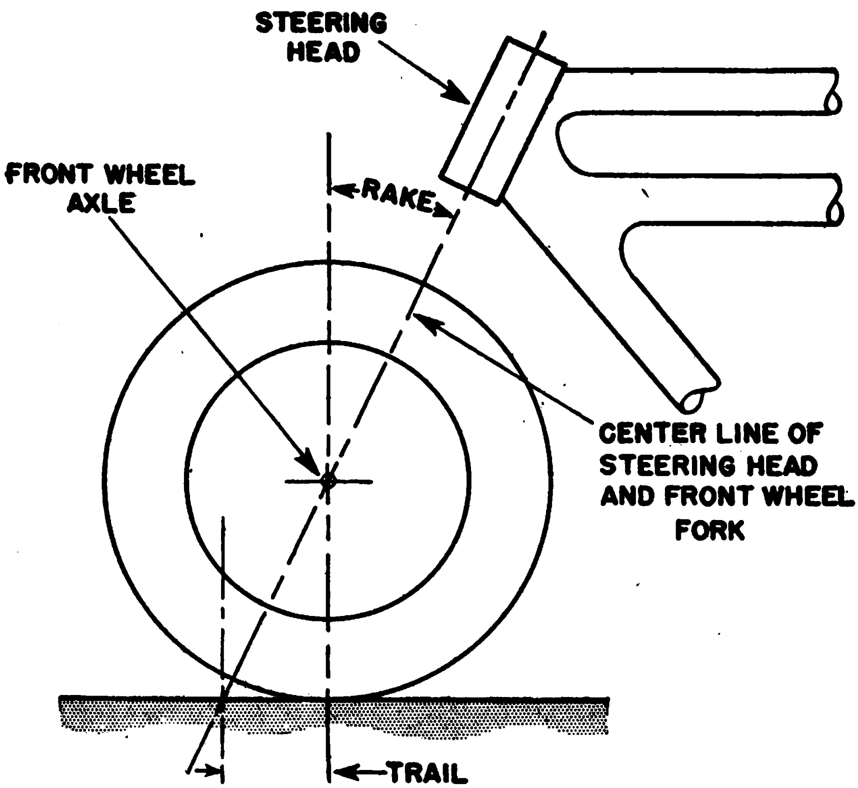

FIGURE 29.—Front-fork rake and trail.

at which the steering head, front fork, and front wheel are set. These factors are determined in the design of the motorcycle.

(1) The distance between the point of ground contact of the projected steering head center line and the point of ground contact of the front axle's vertical center line is called "trail." "Rake" is the angle formed by the two center lines. It corresponds to "caster" in automobiles.

(2) The front-wheel suspension must permit a free up-and-down motion of the wheel without allowing side motion. A side movement of the frame may cause a skid, or throw the rider from the motorcycle when taking curves at high speed.

(3) On some motorcycles the front axle is pivoted on rocker arms to

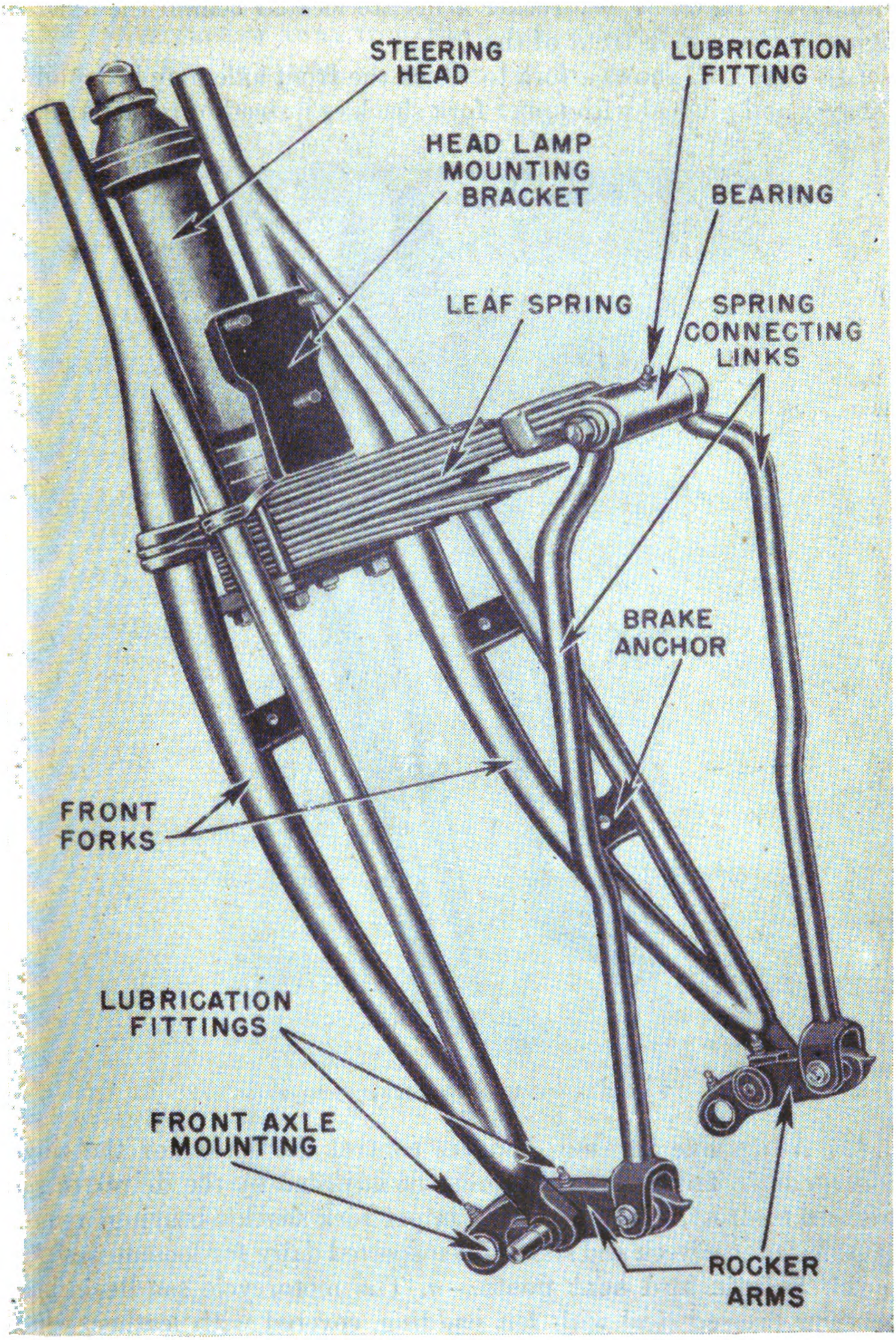

FIGURE 30.—Leaf-spring front end suspension.

reduce the amount of vertical movement transmitted to the motorcycle frame. In figure 30, the rocker arms are located behind the axle; in figure 31 they are in front of the fork.

(4) Figure 32 shows a fork to which the front axle may be mounted directly and pivoted with upper fork shackles instead of rocker arms.

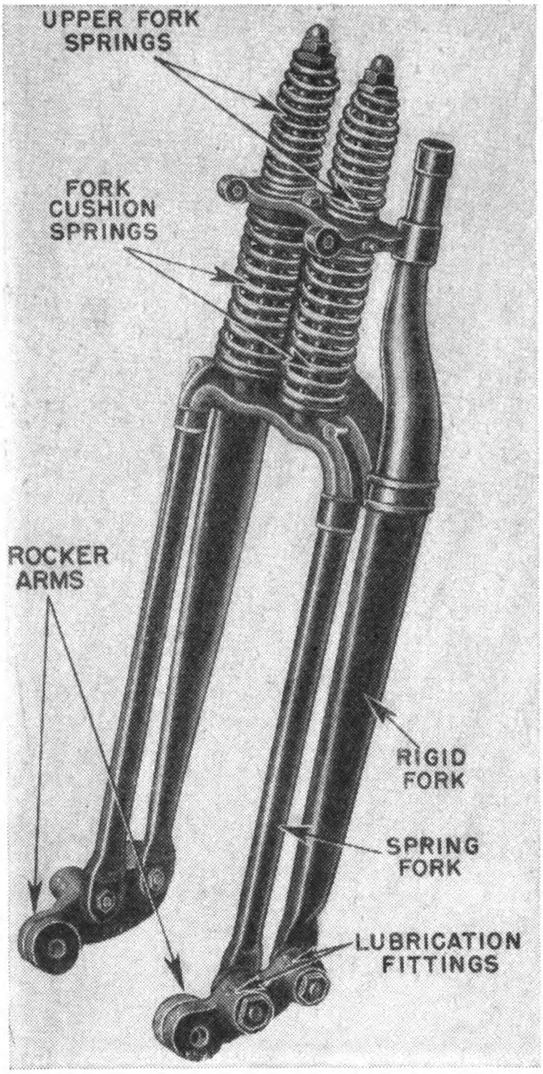

FIGURE 31.—Coil-spring front end suspension.

(5) Adjustable friction dampers control the action of the single coil spring. These dampers should be adjusted by the driver to suit his own comfort. Rocker arm or upper fork shackle bearings require greasing once a week and should be inspected daily for looseness.

38. Saddle and seat posts.—*a.* The motorcycle saddle is built on light pressed steel with felt padding, covered with leather, which is stretched and riveted to the edges of the frame. Its raised front (pommel) and rear (cantle) are somewhat like a cavalry saddle. By removing the front and rear saddle mounting units (fig. 35), the saddle can be slid toward or away from the handle bars, to the position most comfortable for the driver.

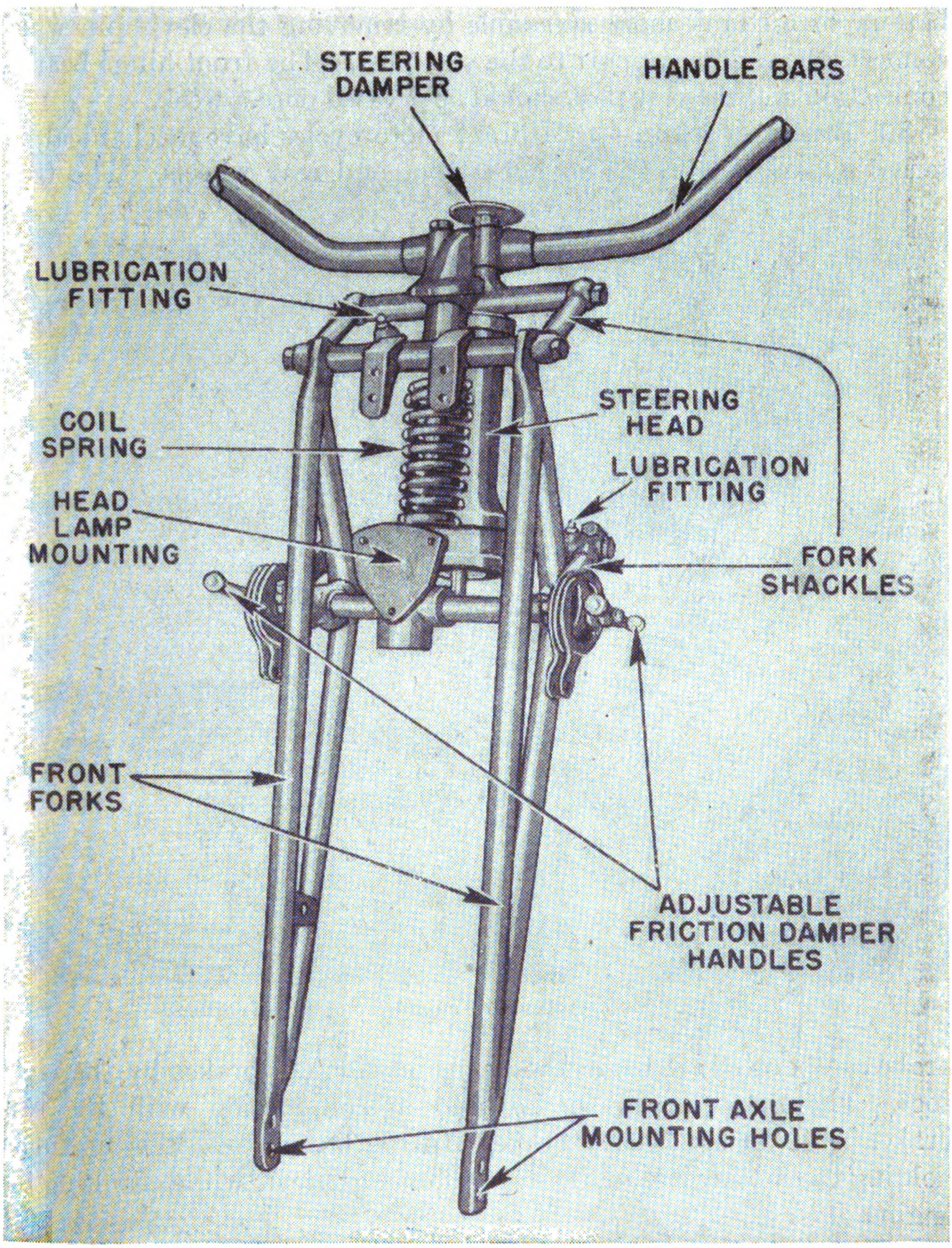

FIGURE 32.—Front-end suspension having upper fork shackles.

b. The forward end of the saddle support is usually hinged to the motorcycle frame. Figure 33 shows the rear of the support cushioned on two coil springs which are mounted on a bracket attached to the motorcycle frame. Figure 34 shows another type with the center of the support fastened to a seat post. The lower end of the post, resting on a coil spring, is free to slide up and down in a tube of the motorcycle frame. The cantle of this saddle can be raised (fig. 35) to make the battery or oil tank more accessible by removing the clevis pin which connects the saddle support to the seat post. The front hinge bearing connection and the seat post should be greased once a week.

39. Brake system.—*a.* Military motorcycles have mechanical, internal expanding brakes on both front and rear wheels. The front

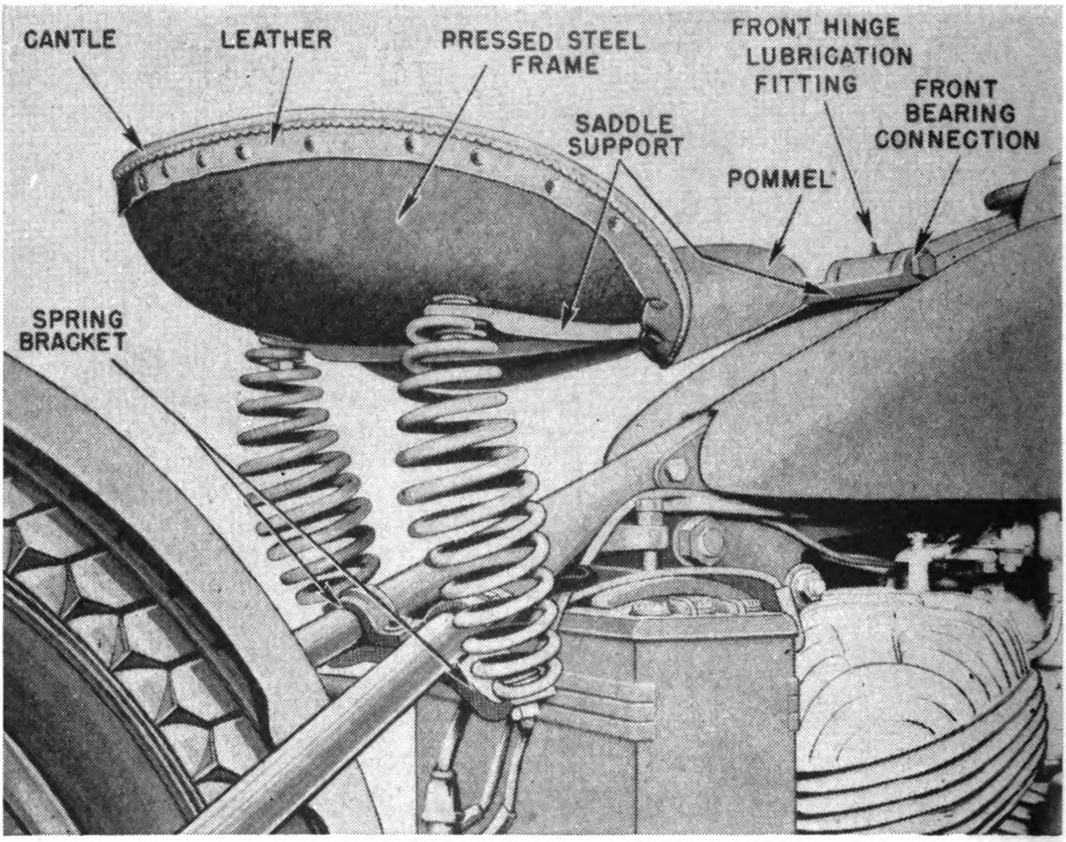

FIGURE 33.—Motorcycle saddle mounted on two coil springs.

brake is operated by hand, the rear and side-car brakes by the right foot. The front brake can be used in conjunction with the rear brake, or as an emergency brake. In the latter case, it is useful in holding the motorcycle while stopped on a grade or while cranking the engine.

b. Figure 36 illustrates various parts of a typical motorcycle brake. The two cast-iron shoes are pivoted, at one end, on a stud secured to the brake plate. A cam separates the shoes on the opposite side. Turning the cam spreads the brake shoes farther apart and causes the brake lining to bear against the brake drum, slowing or stopping the motorcycle. Coil springs hold the shoes in constant contact with the stud and the cam.

c. Figure 37 shows the operating linkage of front and rear brakes. The front or rear brake is adjusted by shortening or lengthening the brake linkage at the clevises.

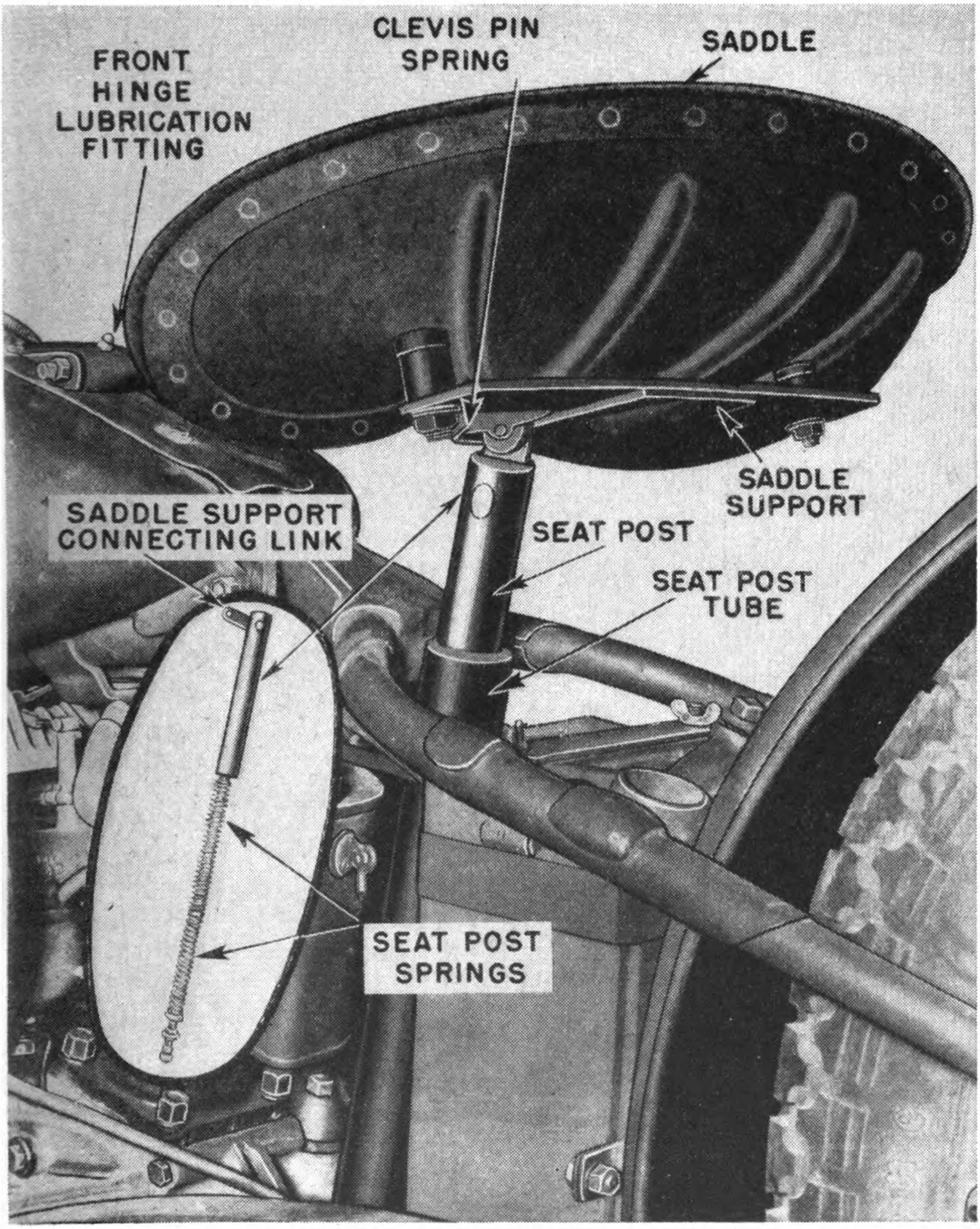

FIGURE 34.—Saddle mounted on seat post.

d. Always keep the brakes free from dirt and grease and properly adjusted. Motorcycle brakes require adjustment more frequently than automobile brakes. Apply brakes carefully, especially the front. Worn, oily, or wet linings, loose adjustments, worn brake drums, or improper equalization of the shoes will cause slippage. Loose shoes

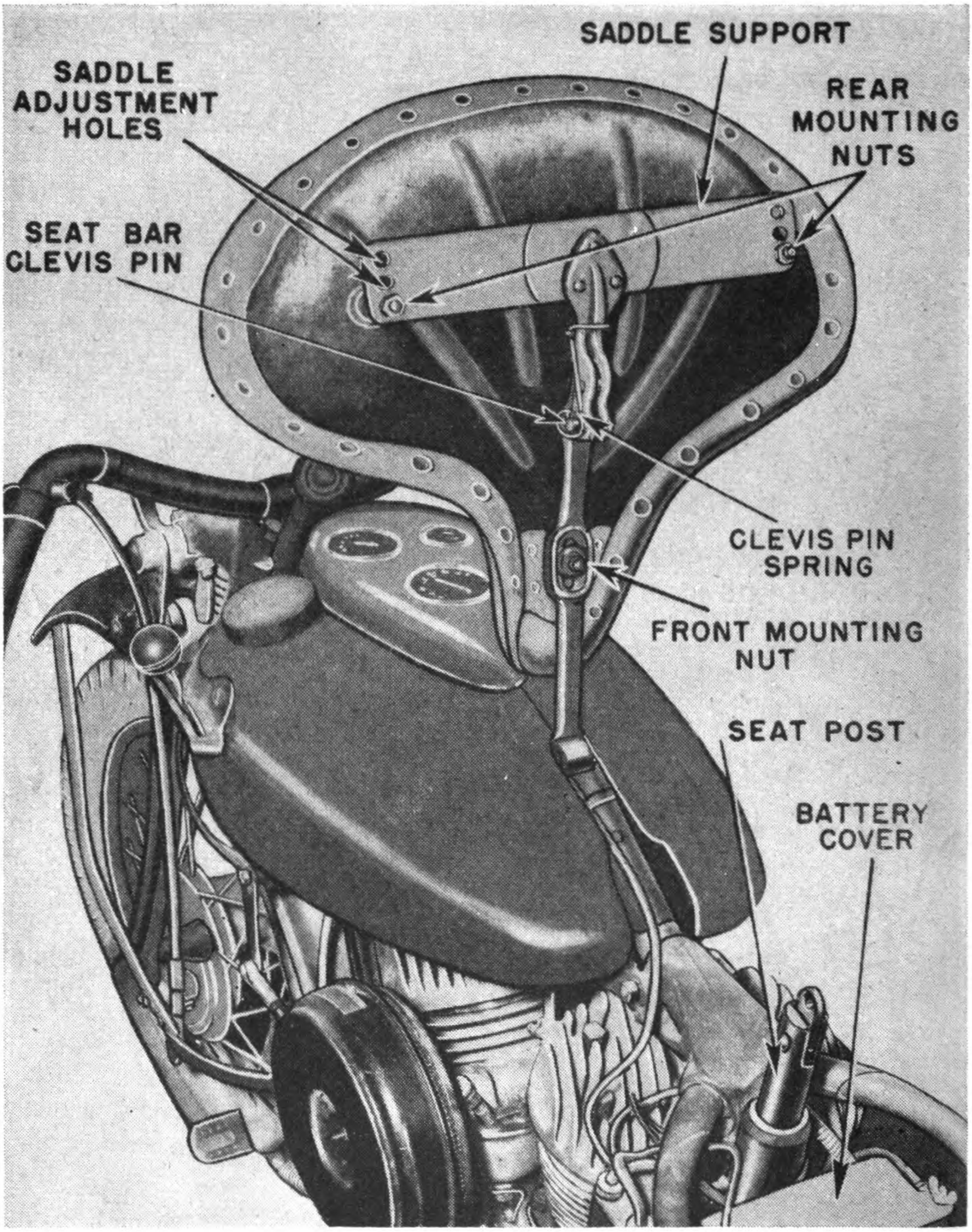

FIGURE 35.—Saddle raised.

and other loose parts of the braking system will cause chattering. Rear-axle nuts must be tight and brake operating rods must be as straight as possible.

e. Hard, glazed linings often chatter. Frequently this chattering can be eliminated by filing down the engaging end of the linings about $\frac{1}{16}$ inch, a distance of $1\frac{1}{2}$ inches from the ends. Squeaky brakes are usually caused by glazed or unequalized linings, sometimes because the engaging ends need filing or because the lining material is too hard or too soft for the particular brake system. Fuller's earth will take glaze off the linings and tend to lap them in. Adjust a squeaky brake so that the wheel is "just free" to turn. Very often a treatment of glycerin or prepared lining fluid will improve the action of the linings and stop

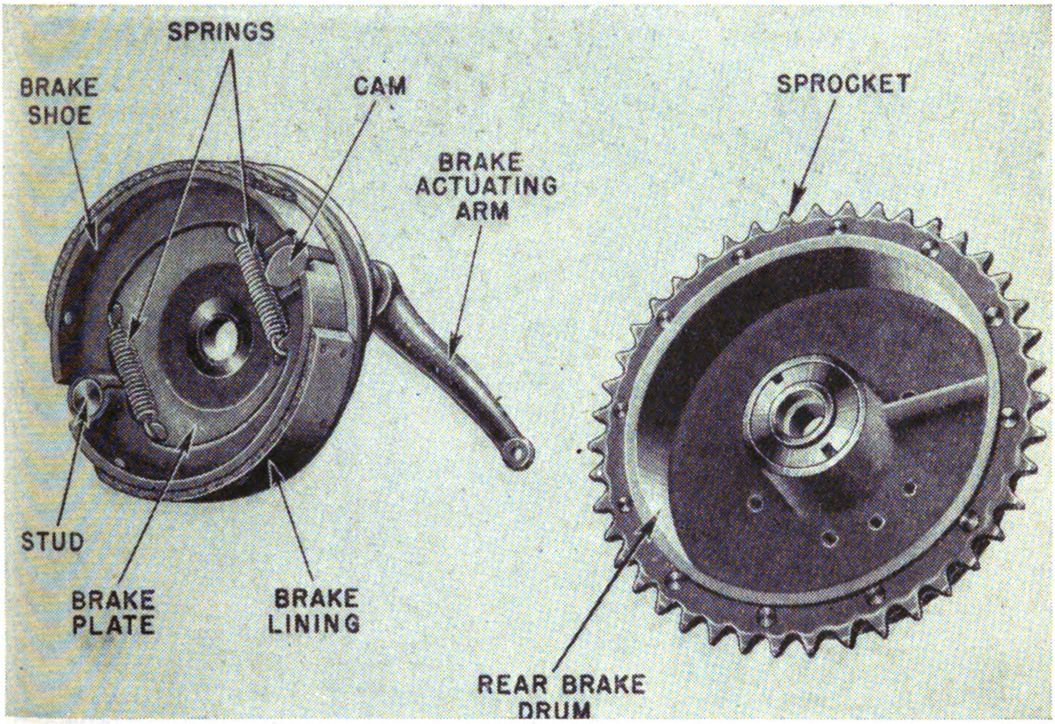

FIGURE 36.—Disassembled motorcycle brake.

squeaking. However, this treatment is not a cure-all for every brake ailment, and brakes must be kept clean.

SHAFT-DRIVEN MODELS

40. Frames.—*a*. Double-loop type frames (fig. 27) are used on the shaft-driven models. They are made of light-weight steel tubing which may be heated slightly for straightening. (Frames of the chain-driven models must be straightened cold.) Welds are used in place of fittings to join the frame tubing, further reducing weight and increasing strength.

b. The rear suspension is of the coil-spring type explained in paragraph 36*c*. However, these coils have the load (heaviest) spring at the top (instead of at the bottom as in chain-driven models) of the slipper hub, as shown in figure 38. They are serviced in the same way as the rear suspension of chain-driven models.

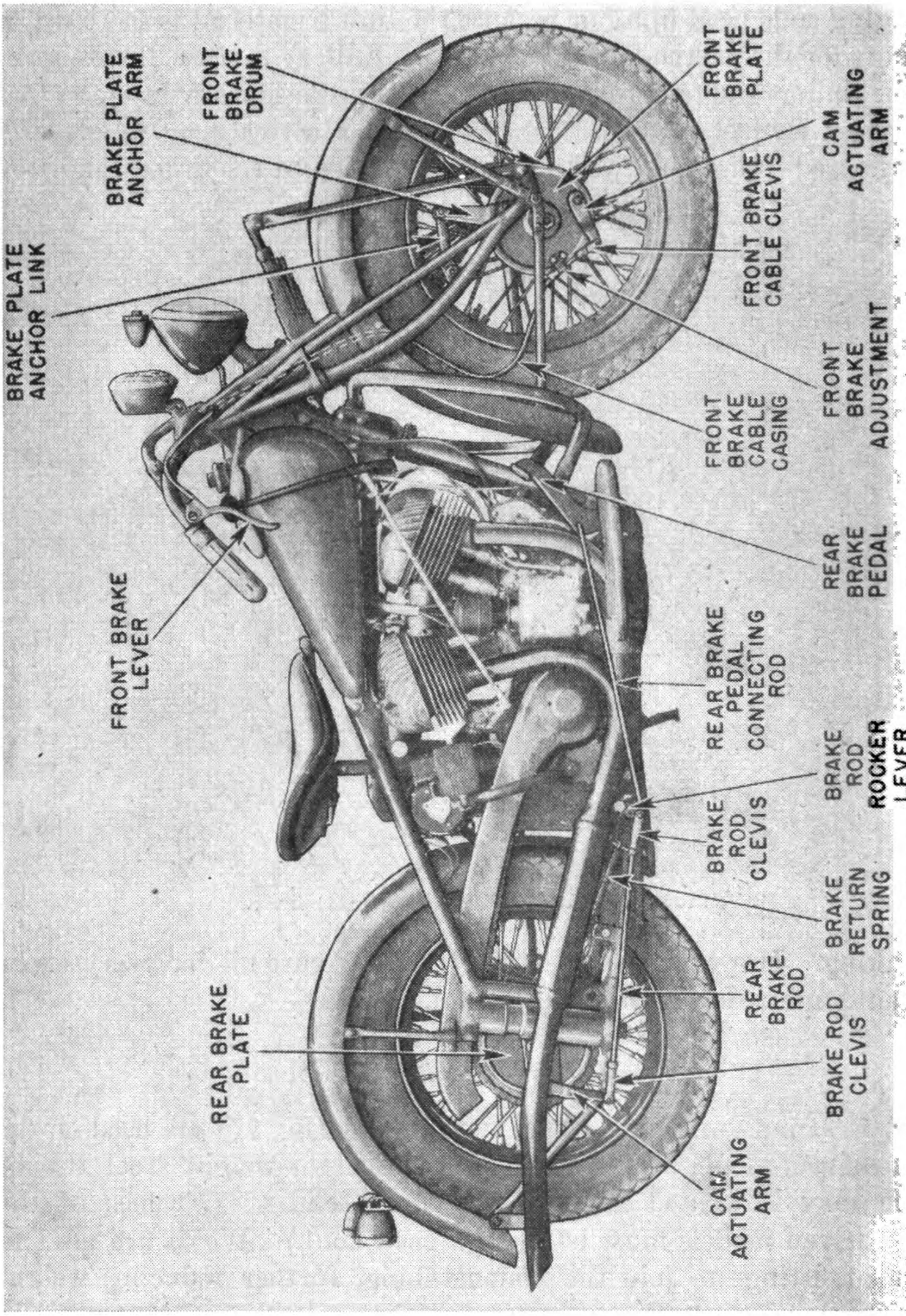

FIGURE 37.—Front and rear brake linkage.

41. Front suspension and steering.—*a.* The front suspension of the shaft-driven models is the same as that of chain-driven models, except that a hydraulic shock absorber has been introduced on the

Indian. Its function is to produce a smoother ride by checking the rebound of the two coil springs on the front fork.

The shock absorber consists of a single cylinder and plunger operating in oil. The cylinder (stationary) end is attached to the fork-stem bracket by a pin connection as shown in figure 39. The movable or plunger end is connected to the lower fork link. Removal or replacement of the shock absorber does not require the removal of the

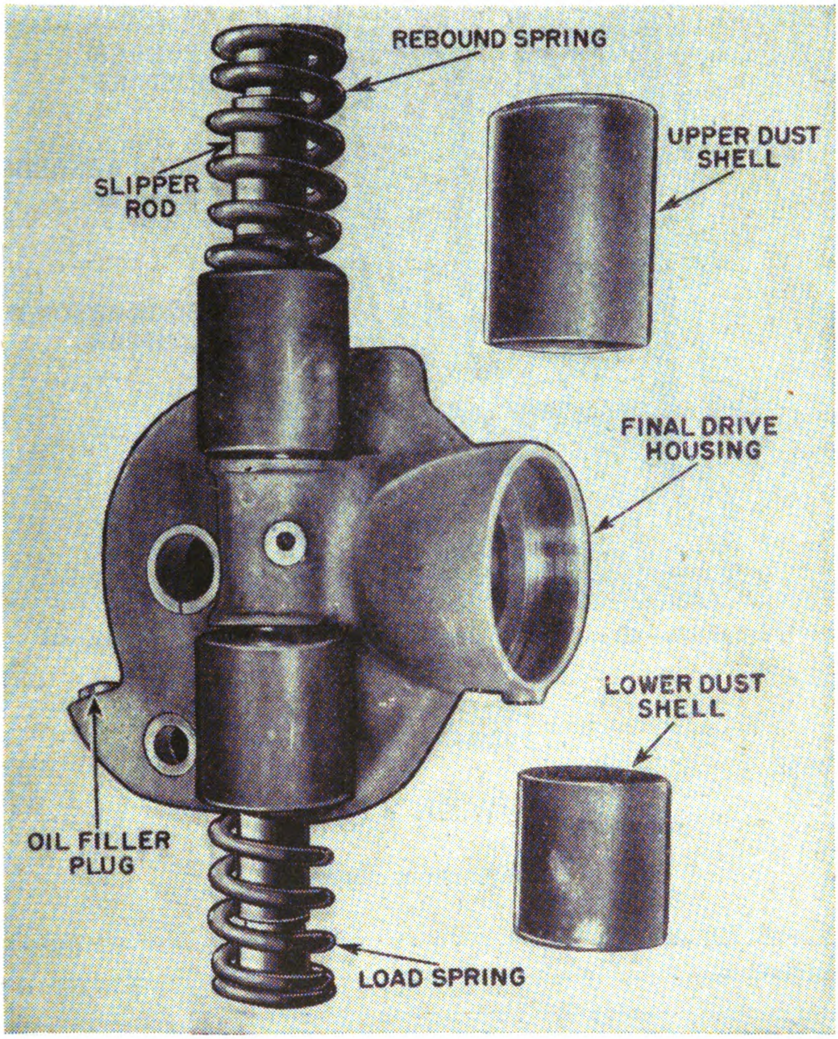

FIGURE 38.—Rear suspension of shaft-driven models.

front fork or springs, but merely taking out the pins at the upper and lower connections.

b. Figure 39 shows that the handle bars of the Indian are secured to the front fork by rubber bushings mounted on the front-stem bracket. The rubber bushings, which are held in place by steel washers, absorb small vibrations so that a minimum of road shock is transmitted to the rider's arms.

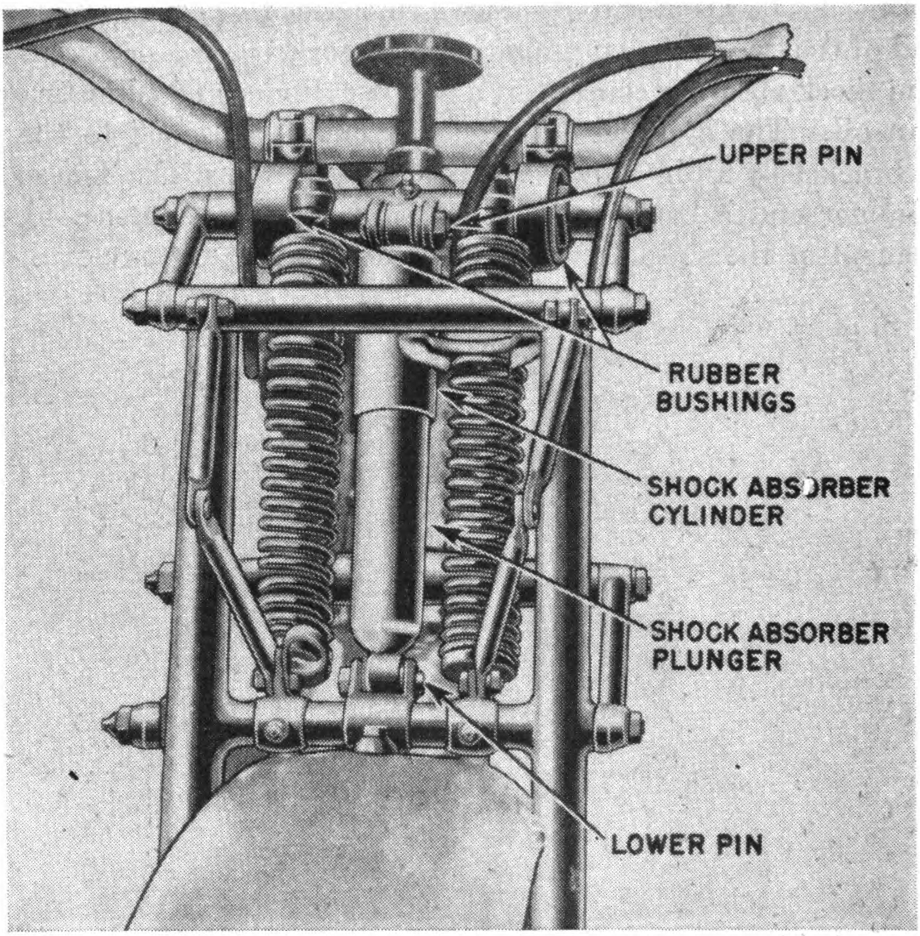

FIGURE 39.—Front suspension of Indian shaft-driven motorcycle.

SECTION VI

POWER TRAIN

CHAIN-DRIVEN MODELS

SHAFT-DRIVEN MODELS

CHAIN-DRIVEN MODELS

42. General.—*a*. The power developed by the engine is transmitted to the rear wheel through a power train, which consists of a primary drive, a clutch, a transmission, and a final drive. Figure 40 illustrates the location of these units with respect to each other. The primary drive sprocket is mounted on the flywheel main shaft. When it turns, the power is transmitted by the primary drive chain to the clutch sprocket. With the clutch engaged, the power is transmitted through the clutch to the transmission and the final drive sprocket. A single-row chain connects this sprocket with the rear-wheel sprocket, thus delivering the power to the rear wheel.

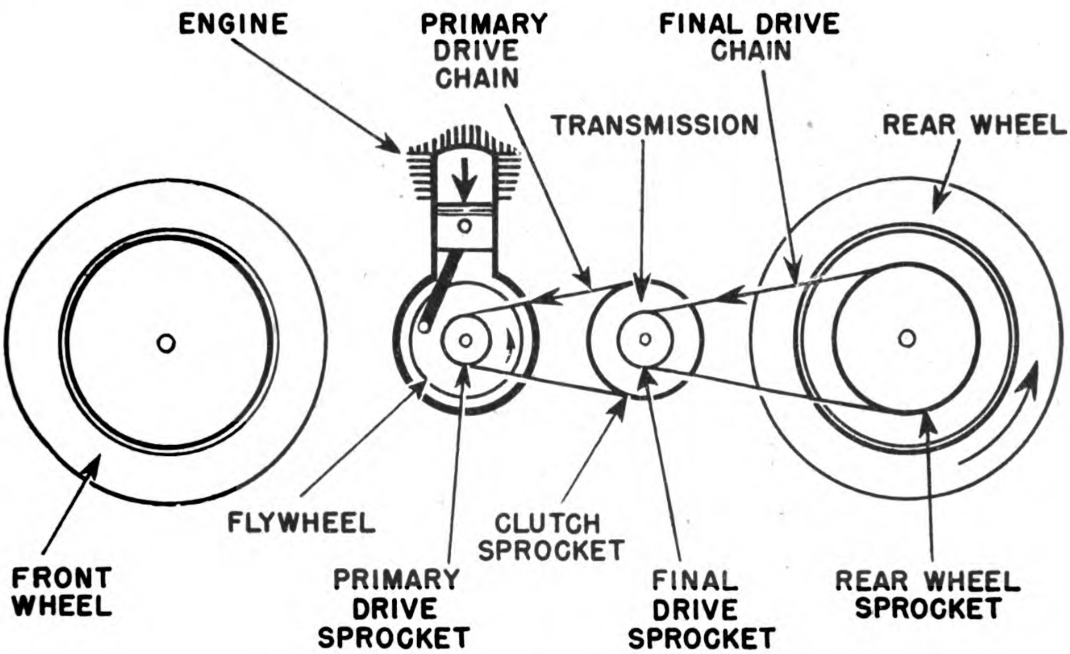

FIGURE 40.—Motorcycle power train.

b. Due to the differences in size between the primary drive and clutch sprockets, and between the final drive and rear-wheel sprockets, the engine revolves a greater number of times than the rear wheel. This difference, together with other speed reductions in the transmission, increases the torque or turning effort of the rear wheel. The chains are designed to conform with the pitch of the sprockets. Pitch is the distance from the tip of one tooth to the tip of the next tooth.

43. Primary drive.—Two systems of primary drives are used on military motorcycles: the wet type and the dry type.

a. *Wet type*.—Figure 41 (Indian) shows the sprockets and chain operating in a bath of oil. Teeth in the inner row on the clutch sprocket are machined down so that one row of the three-row primary drive chain can mesh with the generator drive sprocket. To adjust the chain tension, vary the height of the swinging shoe over which the chain rides at the bottom of the case.

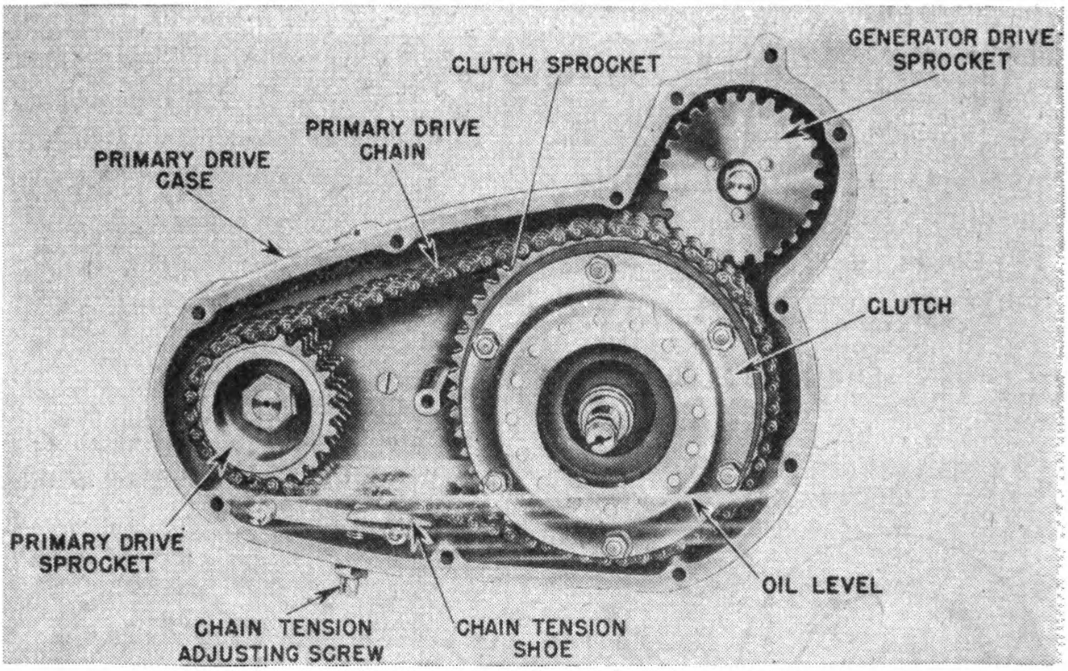

FIGURE 41.—Primary drive, oil bath lubrication.

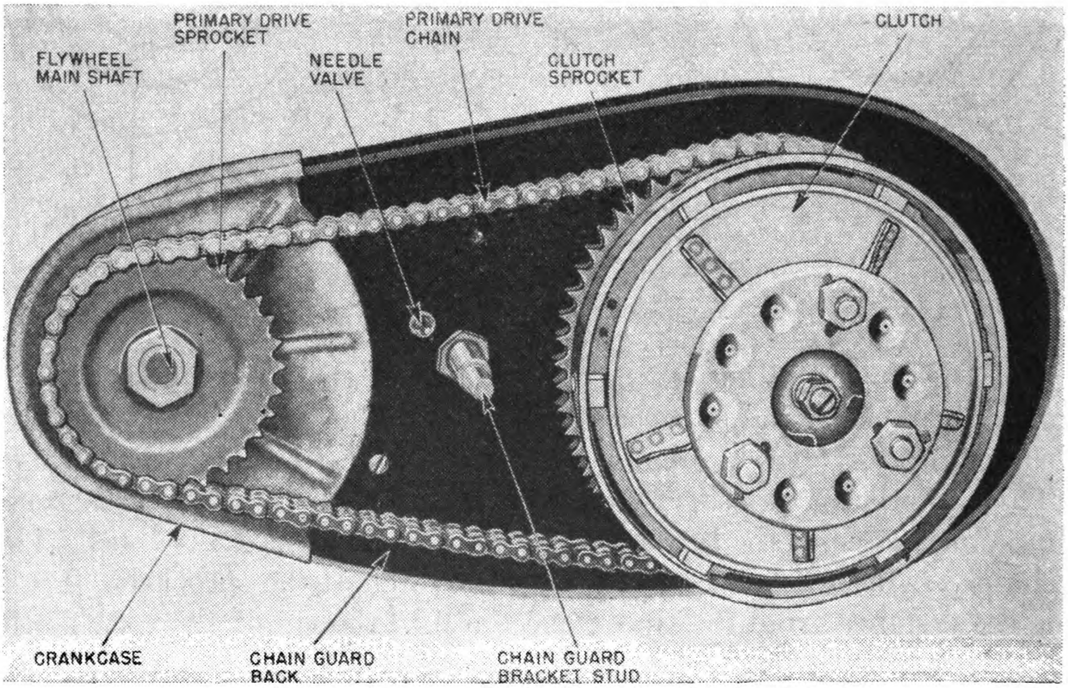

FIGURE 42.—Primary drive, oil pressure lubrication.

b. Dry type.—The primary drive shown in figure 42 (Harley-Davidson) operates in a dry case. An adjustable needle valve, connected to the engine lubrication system, directs a stream of oil at the chain.

To vary the chain tension of this drive, loosen the mounting nuts and the cap screw underneath the transmission, then move the transmission case forward or backward in the motorcycle frame. Moving the transmission also affects adjustment of the gear-shift lever, clutch, and rear brake controls. Therefore, each time the primary drive chain is adjusted, all these controls should be checked and adjusted if necessary.

c. Servicing.—Properly adjusted and lubricated primary drive chains will last as long as the motorcycle. Therefore, form the habit of occasionally checking the lubrication of the chain.

44. Clutch.—The clutch is introduced in the power train to provide a means of smoothly and gradually engaging the rapidly turning engine and primary drive with the transmission and final drive.

a. Disks.—Motorcycle clutches on chain-driven models are of the multiple disk type (figs. 44 and 45). Steel plates and fiber-lined plates are set alternately in the clutch housing. One set of plates (driving disks) is keyed to the primary drive driven sprocket and the other set (driven disks) is keyed to the main shaft of the transmission. On the Indian, which has an oil-bath primary drive, "wet" type disks operate in oil. On the Harley-Davidson, which has a pressure-lubricated primary drive, "dry" type disks operate without oil.

b. Plates.—When the clutch is fully engaged, strong coil springs force the plates together and cause them to turn as a unit, transmitting the power without appreciable loss. If the force which the clutch springs exert is relieved somewhat, there is slippage between the two sets of clutch plates. This slippage permits the engine to run at a higher speed than the transmission and rear wheel. In the disengaged position, the springs are compressed and the force they exert on the disks is completely relieved. The driving and driven disks then move independently of each other.

c. Linkage.—The clutch is engaged or disengaged by moving the push rod on the Harley-Davidson (fig. 44) and by rotating the release worm on the Indian (fig. 45). Both the push rod and the release worm are actuated by a clutch release lever connected by a clevis pin to a clutch release rod and pedal on the outside of the primary drive case (fig. 43). It is necessary to allow about $\frac{1}{16}$- to $\frac{3}{32}$-inch play in the operating linkage so that the disks are perfectly free and not dragging when the clutch is engaged. The amount of play can be adjusted by turning the clevis at the end of the clutch release rod. Figure 43 shows that the clutch pedal itself has two pads, the toe pad (forward) and the heel pad (to the rear). In figure 43 (Indian), the clutch is shown in an engaged position; the heel pad is depressed almost to the footboard. In a disengaged position, the toe pad should be pressed forward as far as possible. On the Harley-Davidson, the operation is reversed. Clutch pedals are provided with friction disks and a tension spring (fig. 43) which hold the clutch in any position. This enables the rider to disengage the clutch and use both feet to maintain a balance when stopping, without danger that the clutch will snap back into engaged position. It also allows him to hold the clutch in an engaged position when starting the engine.

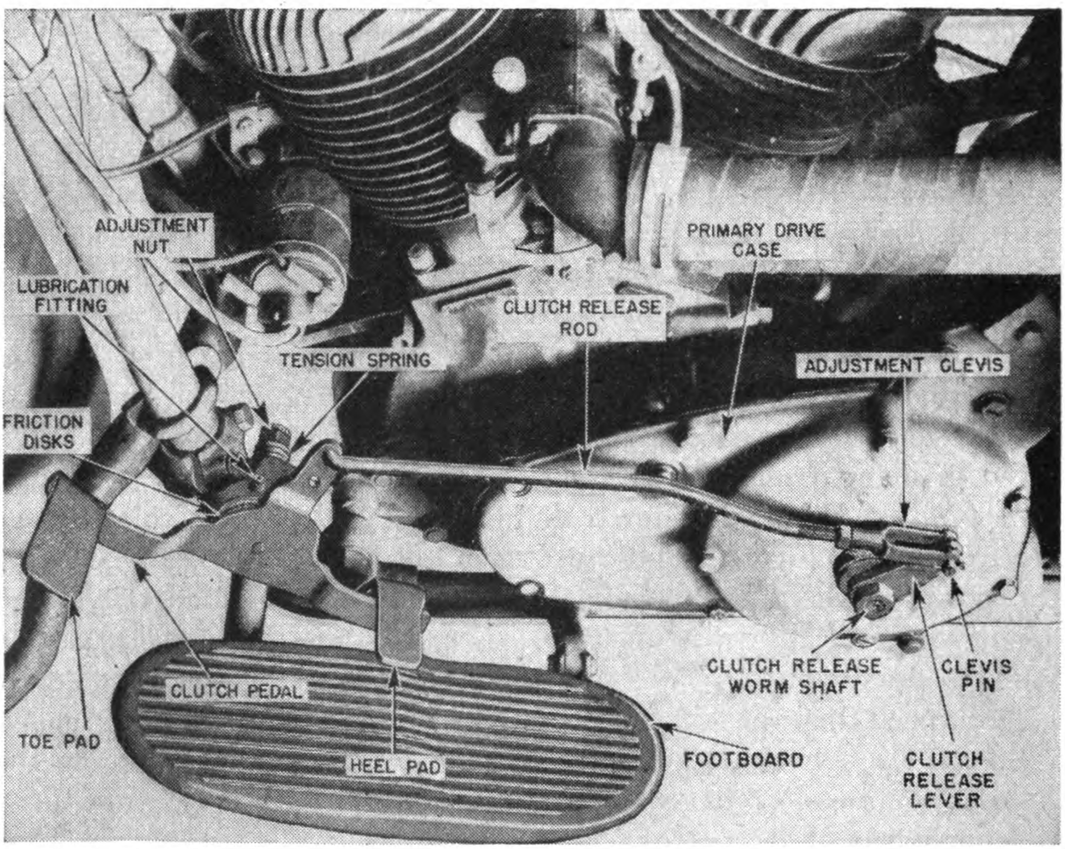

FIGURE 43.—Clutch operating linkage.

d. Servicing.—The clutch pedal should always be left in a fully engaged position when the motorcycle is idle, to prevent the clutch springs from taking a "set" and thus losing their tension. "Creeping" (tendency to engage) of the clutch when the engine is running may be corrected by tightening the clutch pedal friction disks or replacing the disks if worn. If the clutch continues to slip after correct adjustment for play in the clutch release rod, the slippage may be remedied by replacing disks or clutch springs, or by increasing the spring tension. Excessive slipping creates heat which turns the steel disks blue and glazes fiber disks. Clutch drag (failure to release fully when in disengaged position) may be due to improper clutch release rod play, too much or uneven clutch spring tension, too heavy oil in a wet-type clutch, worn keyways and disk teeth, or disks binding.

45. Transmission.—The transmission, introduced in the power train, provides means for selecting various speed reductions between the engine and the drive wheel. It consists of three sets of gears (each set providing a different ratio) and a means for connecting these sets so that whichever set is selected will transmit the power. The gears and shifting mechanism are inclosed in an aluminum housing directly underneath the saddle, and are manually operated by a lever which extends from the case. The transmission may be of either the selective or progressive type. In the progressive transmission on the Harley-Davidson, when shifting from the lowest to the highest speed or back again, it is necessary to pass through the intermediate speed. In the selective transmission on the Indian, shift can be made directly from any speed to neutral. The selective transmission is commonly used on automotive vehicles.

a. Progressive type.—The transmission illustrated in figure 44 is of the constant-mesh progressive type with three speeds forward. The main shaft gears and mating countershaft gears float on their shafts and are in constant mesh. Power from the clutch shaft is transmitted through the gears by sliding jaw clutches which engage with slots in the gear hubs. These clutches are permanently keyed to the splined main shaft. Proper road speeds are obtained by sliding the clutches into engagement with gears which provide the desired speed reduction. These gears then become driving members. The shifter forks which move the sliding clutches are actuated by the rotation of a shifter cam. As this cam is rotated slightly by the gear shift linkage, shifter fork pins following inclined slots cut in the cam move the fork back and forth. The function of the gears and flow of power for various speeds is as follows:

(1) The two sliding clutches used to fix the floating gears to the main shaft are disengaged. No power flows from the clutch sprocket to the final drive sprocket.

(*a*) *First* (*low*) *gear position.*—The power from the clutch is transmitted by the main shaft to the countershaft by constant mesh gears. Then it is transmitted back to the first gear on the main shaft through the sliding jaw clutch and out the main shaft to the final drive sprocket.

b. Second (*intermediate*) *gear position.*—The power flows as in the first gear, except that the second gear instead of the first is made fast to the main shaft by the sliding clutch.

(*c*) *Third* (*high*) *gear position.*—Here the clutch shaft is made fast to the main shaft by the sliding clutch. Power flows straight through the clutch and main shaft as if the connection were direct.

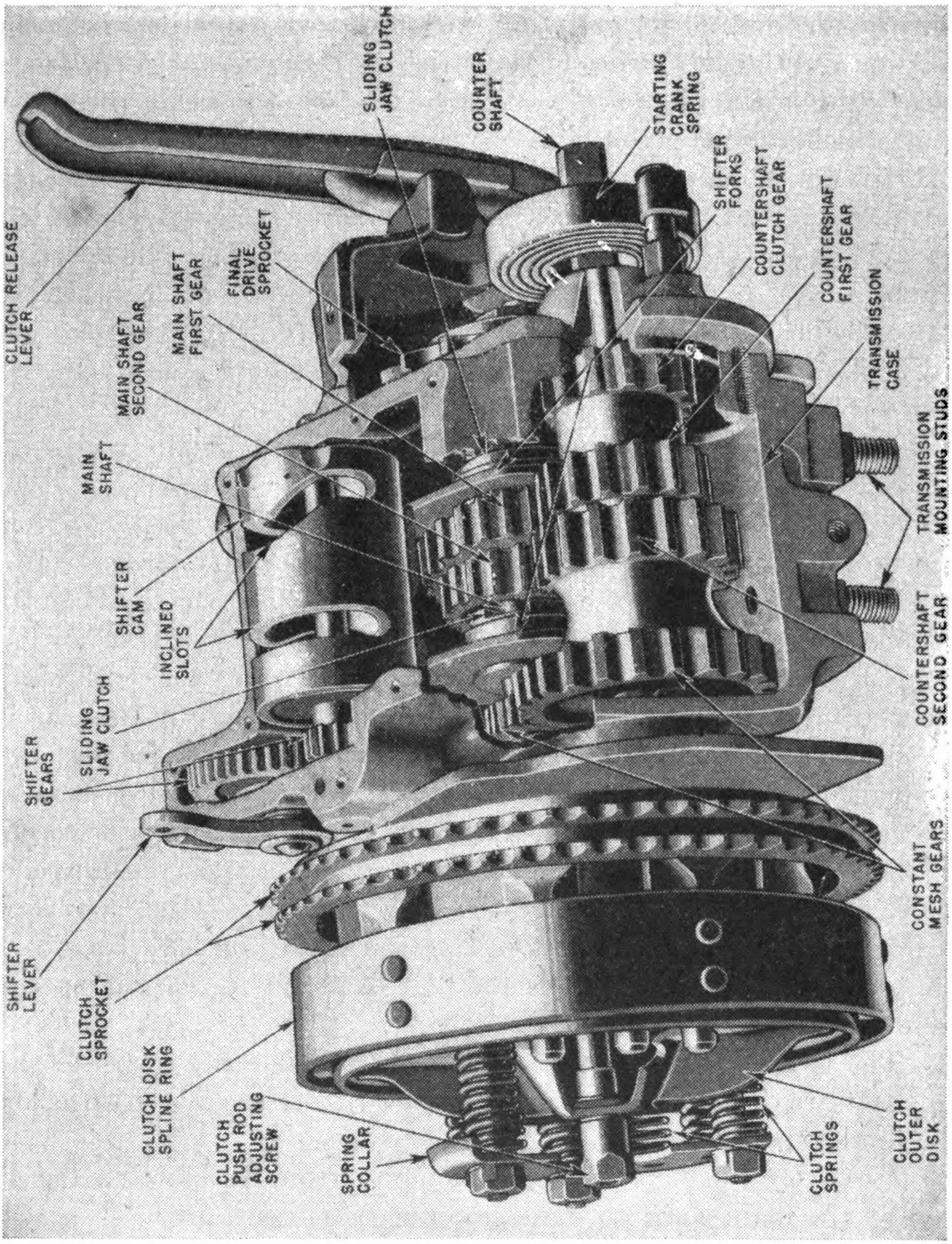

FIGURE 44.—Three-speed progressive transmission.

(2) To fill this transmission properly with lubricating oil, the motorcycle should be standing upright. Remove the plug and fill the case until the oil just appears in the filler neck.

b. Selective type.—Figure 45 shows a three-speed selective transmission. Gears are shifted by a shifter fork which operates sliding gears on the main shaft that are selective for first, second, and high speeds. Lubrication is furnished to the transmission through drilled passageways between the transmission case and the primary drive case. Lubrication of the primary drive case automatically lubricates and furnishes the proper level of oil in the transmission. A drain plug is located on the underside of the transmission case.

c. Servicing.—Transmission troubles are almost invariably the result of improper clutch adjustment, improper operation of the clutch,

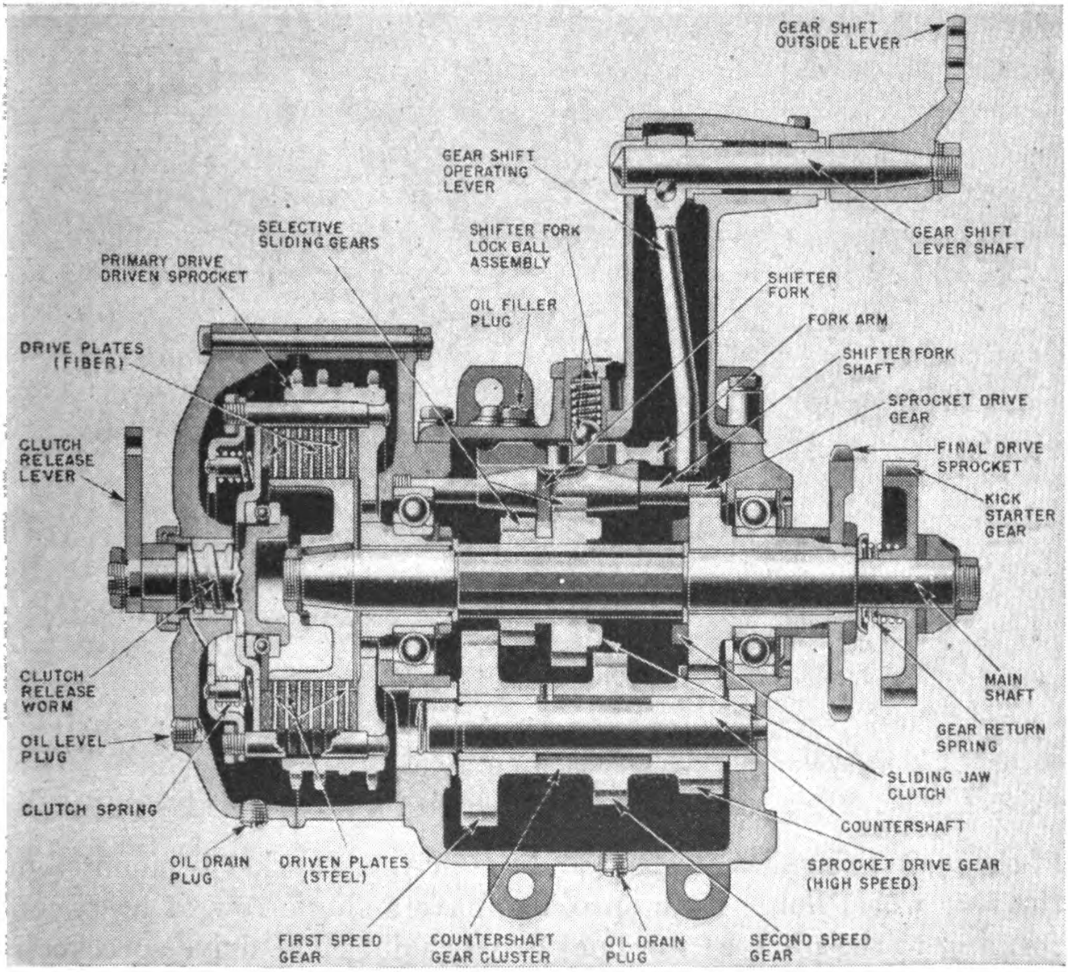

FIGURE 45.—Three-speed selective transmission.

or improper shifting of the gears. Transmission cases, gears, and shifter clutches are frequently damaged or broken because of one or more of these bad practices. Damaged transmissions are usually replaced as a unit. Both types of transmission use the same grade of oil as the engine. Check the transmission oil level frequently. The filler plug opening in the transmission case on the Harley-Davidson and the oil level hole in the clutch case of the Indian are the correct oil levels when the vehicles are standing upright on a level surface.

Heavy strains suffered by motorcycle transmissions cause them to leak more quickly than any other motor vehicle transmission. A low oil level will cause roughened gear teeth, noise, and possible bearing damage.

46. Final drive.—*a. Construction.*—(1) The final drive is completely exposed except for a chain guard which protects the leg from the moving chain. The drive sprocket is keyed to the outer extension

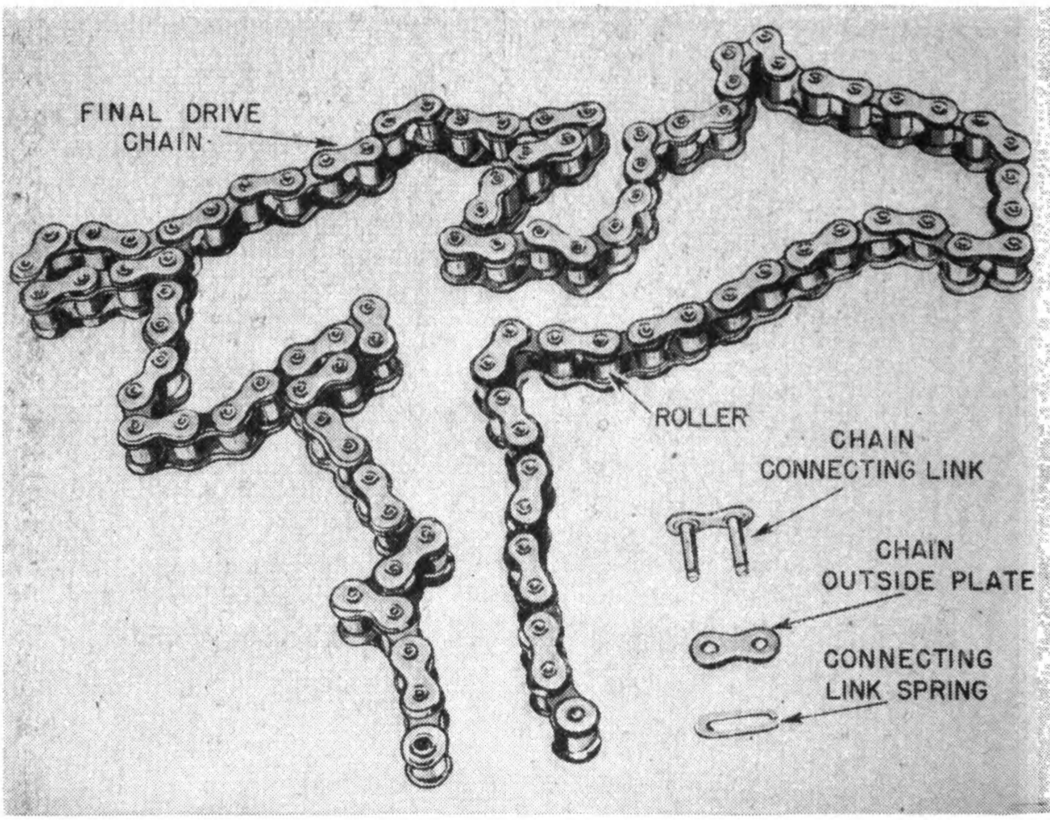

FIGURE 46.—Final drive chain.

of the main transmission shaft and the driven sprocket is mounted on the rear wheel hub. Both sprockets have a single row of teeth conforming to the pitch of the final drive chain. The drive sprocket is smaller in diameter than the rear wheel (driven) sprocket in order to produce more torque at the rear wheel.

(2) The final drive chain is constructed with rollers on single row connecting links as shown in figure 46. A master connecting link permits installing or removing the chain easily. The master link differs from the other links in that its outside plate is easily removable and it has a connecting link spring for locking the chain. The chain is lubricated by hand and its tension is adjusted by moving the rear wheel forward or backward as required. Adjusting screws on the

rear axle mounting of the motorcycle frame are provided for this purpose. Proper adjustment requires about ½-inch free up-and-down play of the chain halfway between the sprockets. It is necessary to check and readjust the rear brake linkage whenever the chain is adjusted.

b. Servicing.—Final drive chains operate most of the time at high speed. Being exposed, without automatic lubrication, they collect dust and grit which work their way into the chain parts, causing stiffness and excessive wear. Nonfluid grease smeared on the chain does not penetrate into the pins and bushings. Dust and grit adhering to the chain cause it to stretch and become stiff. If the chain is not cleaned frequently, dirt will work into the pins and bushings, score the hardened surfaces and do irreparable damage. A properly cleaned and lubricated final drive chain has twice the life expectancy of a dry and dirty chain. Therefore, in addition to daily and weekly maintenance (see item 24-1, app. II) the following procedure is recommended every 1,000 miles or whenever the chain becomes exceptionally dirty.

(1) Remove the chain, put it in a shallow pan on a wire screen or other support which will hold it about ½ inch above the bottom of the pan. Cover the chain with kerosene, and soak it overnight if possible. When the dirt and old oil have been dissolved, shake the chain well in clean kerosene. Be sure every joint is flexible and free from dirt.

(2) Hang up the chain, and after it is dry, soak it in engine oil for a short time. Move the chain so that the oil will reach all inside parts. Then take the chain out, and wipe off all the surplus oil from the surface.

(3) Hang up the chain to drip until it is dry. With this procedure, thorough lubrication is provided at all vital wearing parts. A well-lubricated chain, with exposed surfaces dry, will collect less road dirt and give longer satisfactory service.

SHAFT-DRIVEN MODELS

47. General.—The power train of shaft-driven motorcycles consists of the same fundamental units (clutch, primary drive, transmission, and final drive) as chain-driven models. However, these units differ in construction on the two models as described in the paragraphs below.

48. Clutch.—*a.* Shaft-driven motorcycles have a single plate clutch similar to those in automotive practice. These clutches are of the dry disk type, need no lubrication, and consist primarily of a backplate, a friction plate, and a pressure plate as shown in figure 47. The backplate or flywheel is keyed to the crankshaft; the friction plate is splined to the primary drive shaft and is free to slide back and forth on it, and the pressure plate floats freely on the primary drive shaft. Coil springs on the back face of the pressure plate force it against the friction plate which in turn is pressed against the rotating backplate.

NOTE.—Indian springs come in sets to provide proper balance of the clutch. Therefore, when replacing springs it is necessary to obtain another matched set.

Thus, when all three plates are pressed together, they operate as a single unit, transmitting power from the engine to the primary drive

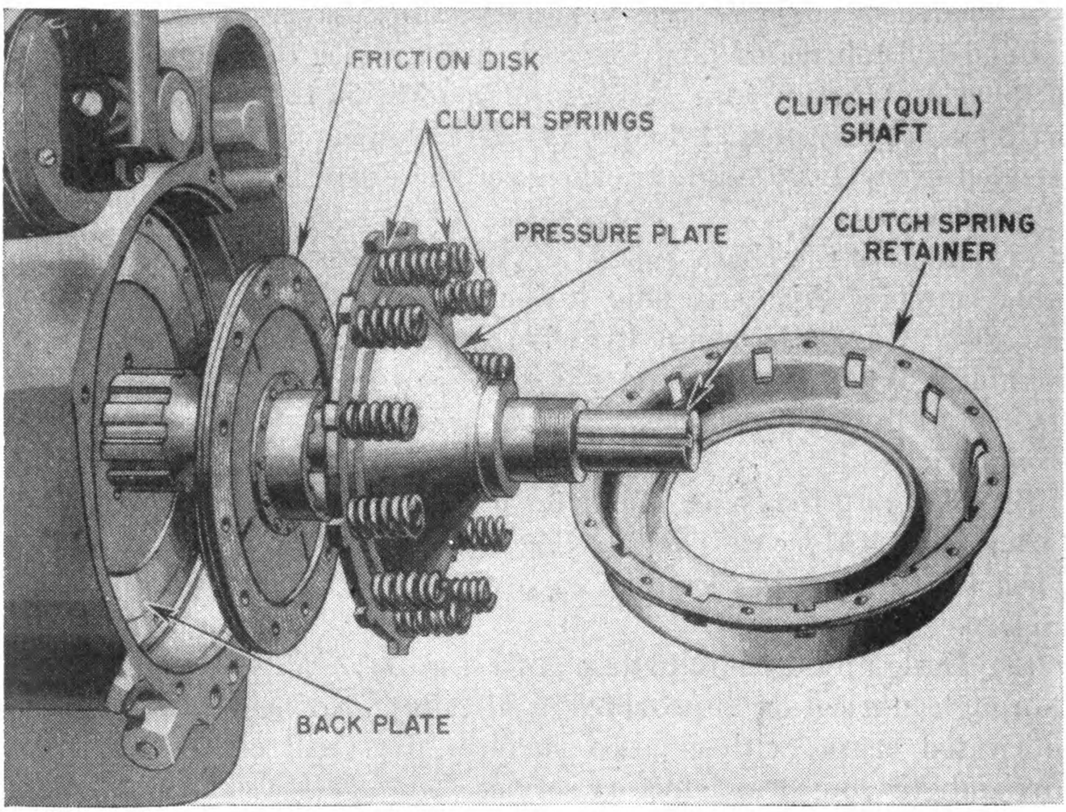

FIGURE 47.—Single plate dry disk clutch.

(Indian) or transmission (Harley-Davidson). The clutches of both makes of shaft-driven models are operated manually by a lever on the right handle bar.

b. Figure 48 shows how the clutch on the Harley-Davidson is released. The small push rod in the center of the hollow transmission main shaft is pushed inward by linkage whenever the clutch-release lever on the handle bar is applied. The push rod then forces the backplate against the coil springs, freeing the friction plate.

c. The Indian clutch is released by a forked (throw-out) yoke (fig.

49) pivoted in the clutch housing. The yoke is turned forward by a crank arm controlled by the clutch-release lever on the right handle bar. This causes clutch throw-out bearing between the clutch pressure plate and yoke arms to push the pressure plate against the coil springs.

49. Primary drive.—*a.* A multiple-row roller chain on the Indian (fig. 50) transmits the power from the clutch to the transmission. It

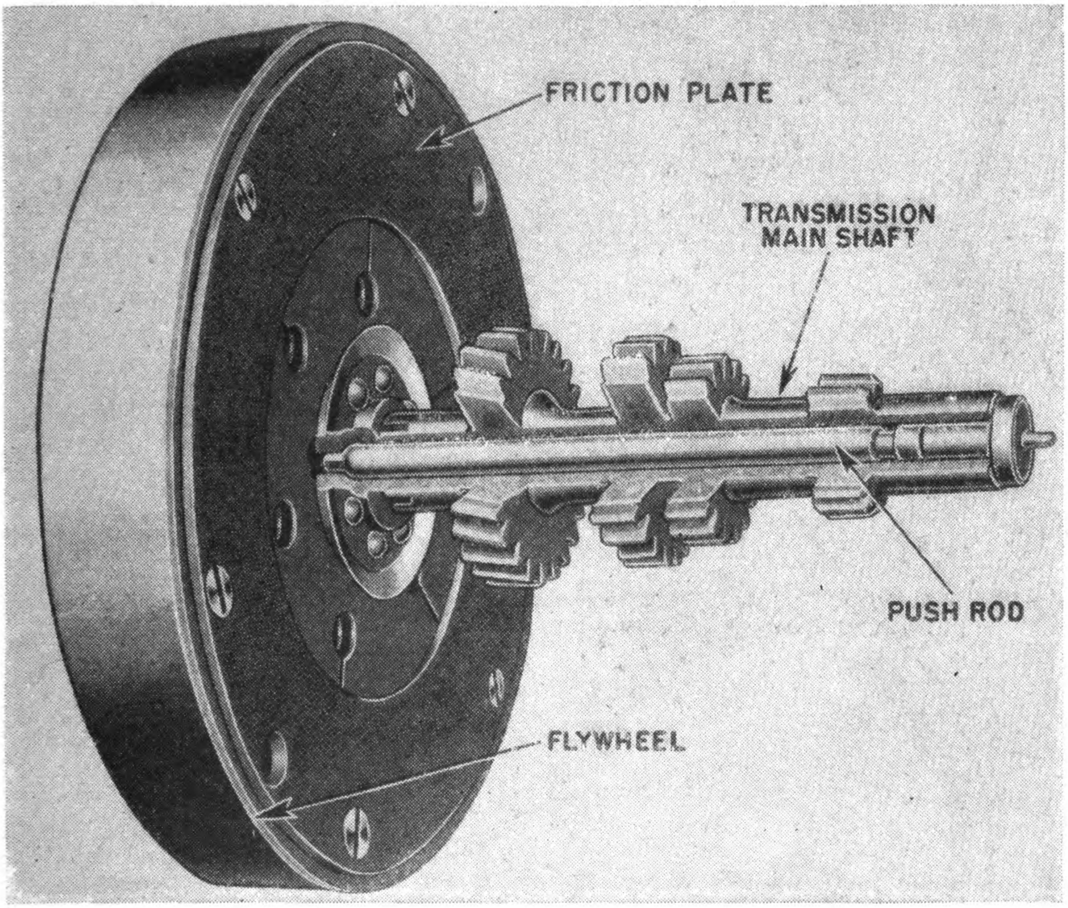

FIGURE 48.—Clutch-release mechanism on shaft-driven Harley-Davidson.

operates in a bath of oil in the same manner as previously described models. Ordinarily, the chain does not require tension adjustment. However, should adjustment become necessary, proper chain tension can be obtained by tightening the adjusting screw as far as it will go, then turning the screw back one and one-half turns.

b. The Harley-Davidson has no primary drive chain. The clutch friction plate fits on the splined end of the transmission main shaft. Thus, the power is delivered directly from the clutch to the transmission.

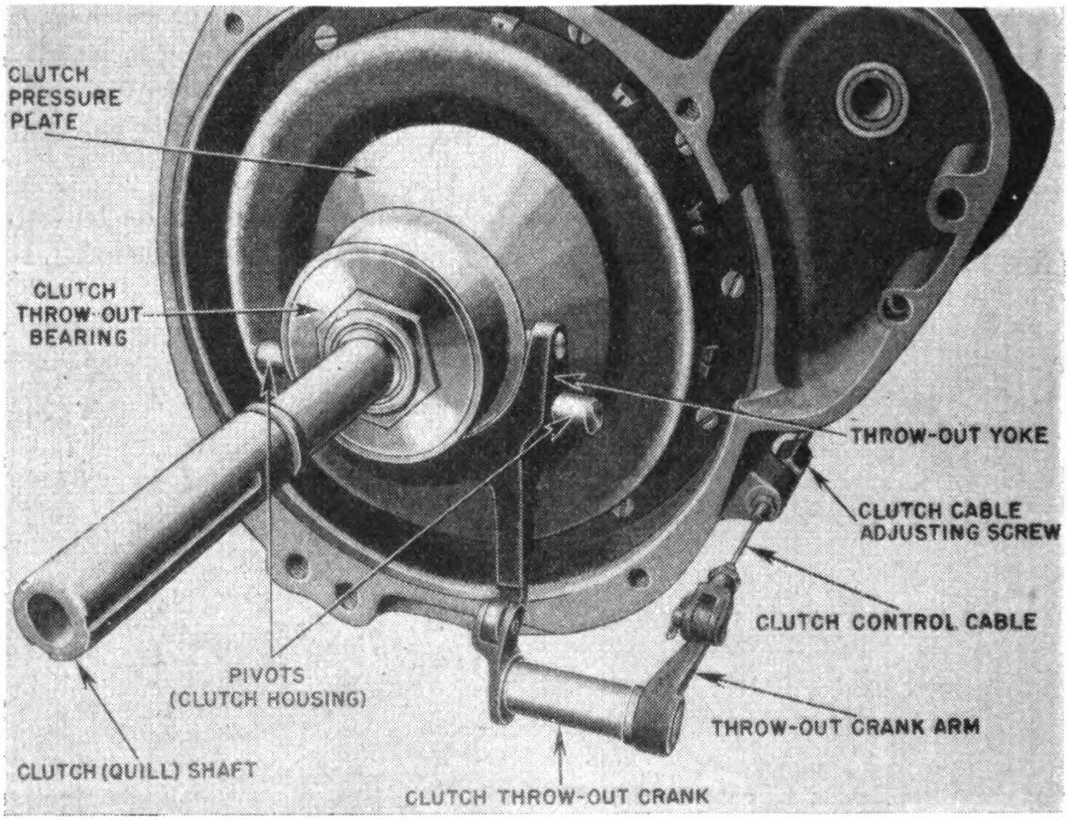

FIGURE 49.—Clutch-release mechanism on shaft-driven Indian.

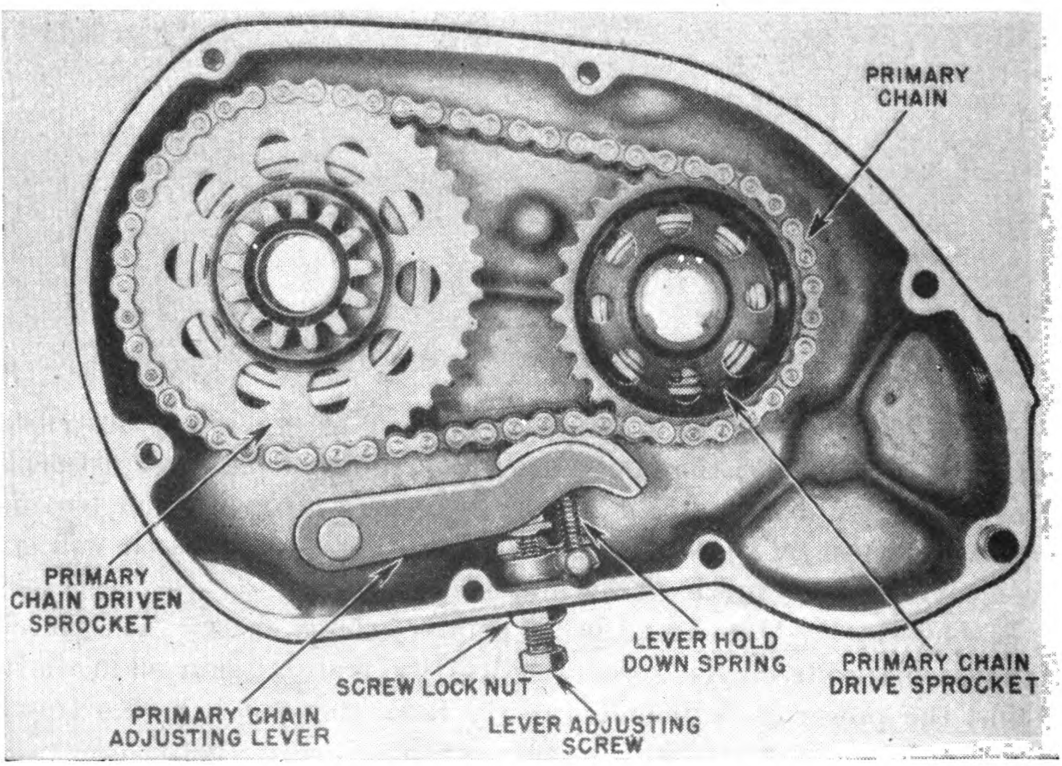

FIGURE 50.—Primary drive on shaft-driven Indian.

50. Transmission.—*a.* The transmissions of shaft-driven motorcycles have four forward speeds. They are of the progressive type and are operated by a foot pedal.

b. The Indian transmission is shown in figure 51. The first, second, and third speed-driven gears float on the splined countershaft, but are not in constant mesh. As the shifter cam is rotated slightly by the gear shift linkage, the shifter fork pins following the inclined slots cut in the cam, move the proper countershaft gears in mesh with

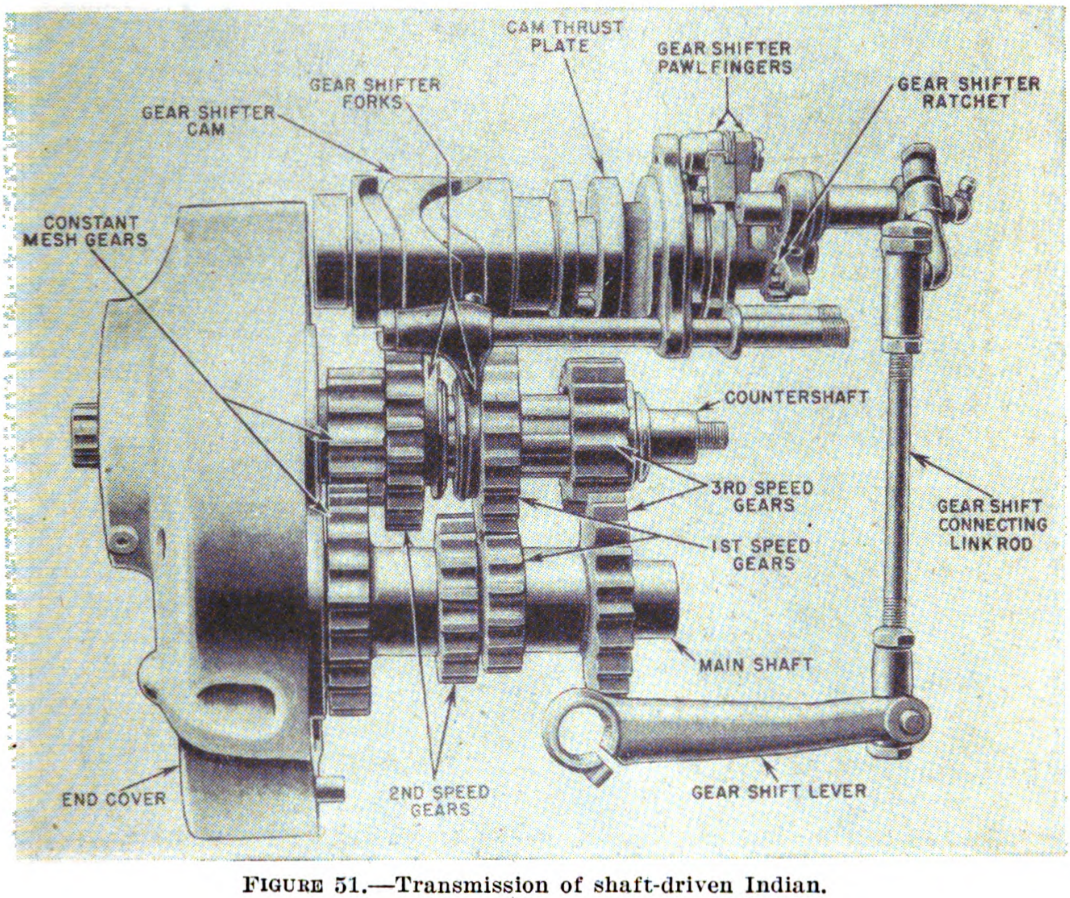

FIGURE 51.—Transmission of shaft-driven Indian.

their mating main-shaft gears. The fourth speed is a direct drive inasmuch as the power is transmitted directly from the clutch to the countershaft, engaging the jaw clutches of the sliding fourth speed gear with the transmission drive pinion.

c. The Harley-Davidson constant mesh transmission is illustrated in figure 52. A cam plate moves the shifter fork which in turn moves the jaw clutches splined to the countershaft. The driven gears have mating jaw clutch hubs so that, when the clutches are engaged, power is transmitted from the main-shaft gears to the countershaft gears and to the countershaft. There is no direct drive in this transmission as the power for all four speeds is transmitted from the main shaft through the countershaft.

51. Final drive.—*a.* The shaft-driven final drive was developed to overcome the frequent servicing and high mortality of chain drives in military operations. It consists of a propeller shaft connected to

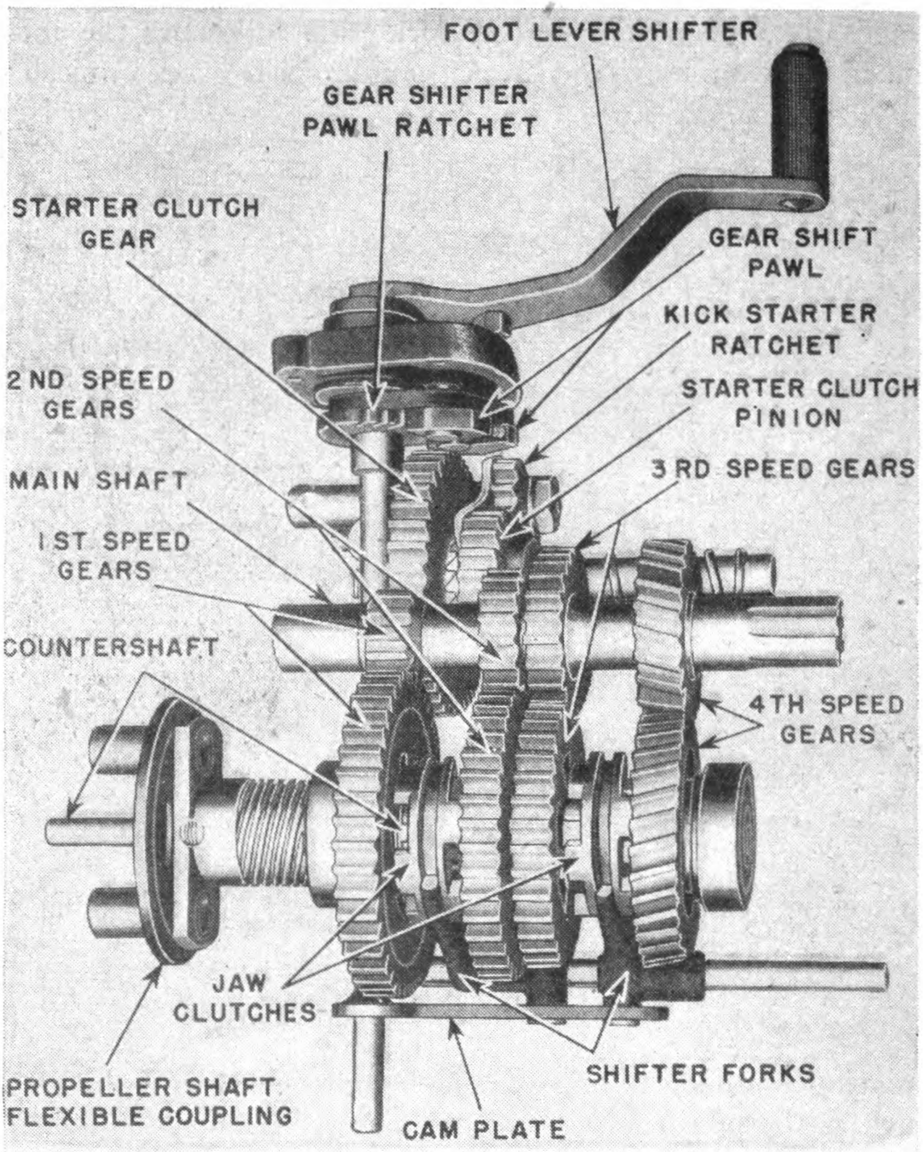

FIGURE 52.—Transmission of shaft-driven Harley-Davidson.

the transmission which drives a bevel gear attached to the hub of the rear wheel as shown in figure 53.

b. Both ends of the propeller shaft have needle-bearing universal joints to permit free vertical movement of the rear wheel when traveling over irregular terrain. The front universal joint is connected to the transmission main shaft by a flexible coupling (Harley-Davidson) or a spline (Indian). The rear universal joint is splined to the rear drive pinion shaft. These connections permit the propeller shaft to increase in length as its angle changes. The joints on the Harley-Davidson are exposed except for a sheet-metal guard which prevents clothing from catching on the rotating shaft. Therefore, it is necessary to clean the joints frequently to remove grass and other materials. The universal joints on the Indian are fully inclosed by dust shields.

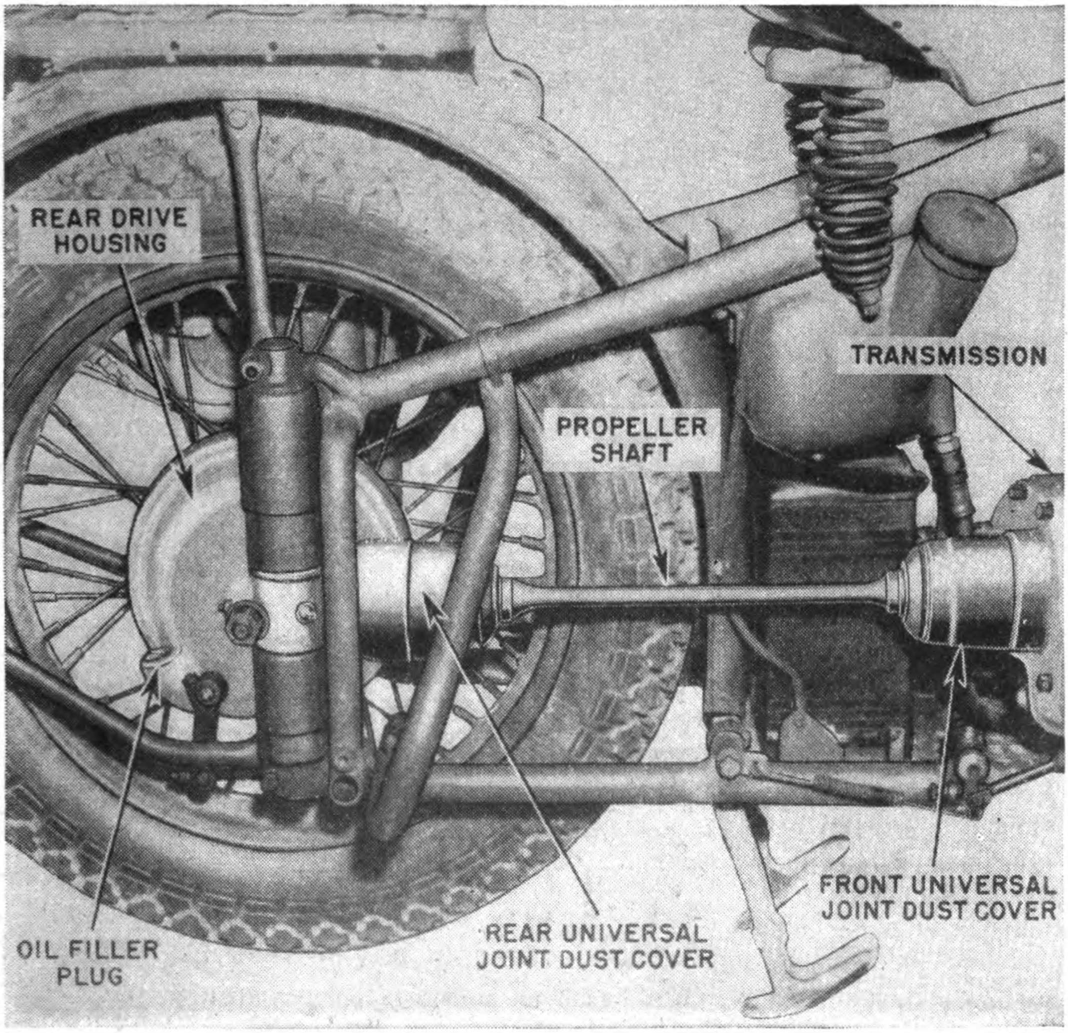

FIGURE 53.—Final drive of shaft-driven motorcycle.

c. The final drive bevel gear housing is supported by the slipper bracket of the rear suspension on the right side of the motorcycle. It incloses the spiral bevel pinion and ring gear shown in figure 54. Bearings on both sides of the pinion support the pinion shaft in the housing. The ring gear is bolted to a hub flange. The hub rotates on bearings on the stationary axle shaft. The gears operate in a bath of universal gear lubricant carried in the gear end of the housing. Periodic inspections should be made to make sure that the lubricant is up to the oil-level plug.

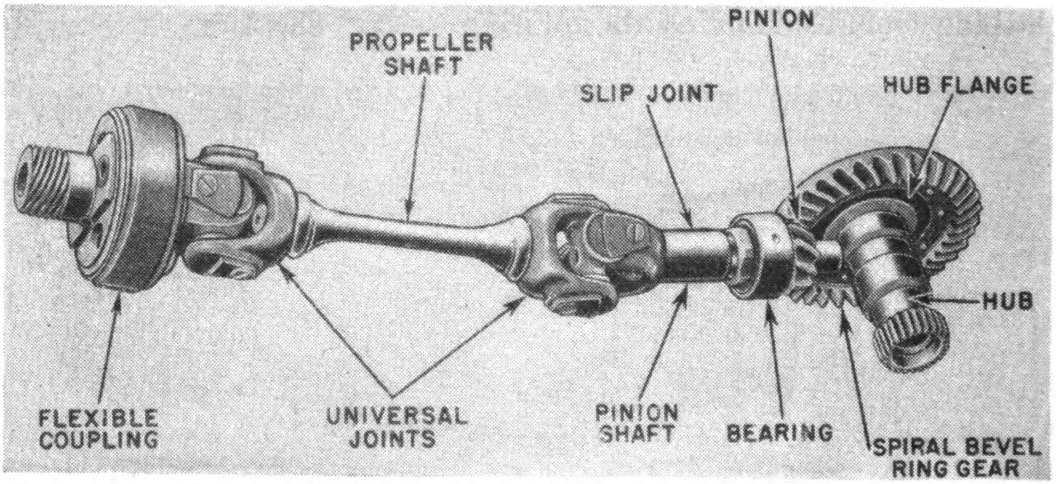

FIGURE 54.—Final drive, disassembled.

SECTION VII

ENGINE

CHAIN-DRIVEN MODELS

CHAIN-DRIVEN MODELS

52. General.—*a.* The motorcycle is powered by a four-stroke cycle internal-combustion engine, which operates on the same principle as the gasoline engine commonly used in automobiles. (See TM 10-570.)

A combustible mixture of air and gasoline is drawn through an inlet valve, into the cylinder, by the downward movement of the piston. The inlet valve closes and the piston (on its upward stroke) compresses the fuel mixture which is ignited when a high-tension current jumps the gap between the spark plug electrodes. The explosion drives the piston down on its power stroke. Then the exhaust valve opens and the piston, again moving upward, drives the burned gases from the cylinder. This constitutes the four strokes of the cycle: intake, compression, power, and exhaust.

b. Military motorcycle engines are of the two-cylinder, L-head, air-cooled design. The cylinders are arranged in a V-shape. They have the operating characteristic, common to all air-cooled engines, of running extremely hot. This is because they rely partly upon the movement of air over the cylinder walls and head fins, and partly upon the circulation of oil to carry away the heat. Operating temperatures of 350° to 450° Fahrenheit are common for motorcycle engines, particularly in hot weather. Contrast this with the average automobile or truck engine which operates at from 160° to 180° F.

c. At present the Army uses two sizes of motorcycle engines: the small "45" (solo model) and the large "74" (side-car model). The model numbers refer to piston displacements in cubic inches. These engines develop maximum horsepower at about 4,600 rpm.

d. The two cylinders on chain-driven models are placed on the crankcase at an angle (V) of 45° in Harley-Davidson and 42° in Indian motorcycles. The connecting rods for both cylinders are attached to a single crankpin, as shown in figure 55. Because of this V-type construction in a two-cylinder engine, it is impossible to obtain even firing and smooth engine operation, as will be apparent after studying the diagram of operation in figure 55.

(1) Assume the rear piston in figure 55① is at top dead center (T.D.C.), just commencing its power stroke; the front piston is therefore on its intake stroke. The crankpin is at X. In ②, both pistons are at bottom dead center (B.D.C.). The rear piston is about to begin the exhaust stroke and the front piston is about to begin the compression stroke with the crankpin at Y. For the front piston to reach T.D.C., from position in ①, the crankpin must continue rotating 45° past point X to point Z. This means that the flywheel rotates a total of 405° from the beginning of the rear piston power stroke to the beginning of the front piston power stroke.

(2) Likewise, when the front piston commences its power stroke, as in ④, the rear piston commences its intake stroke. When both pistons have reached B.D.C., as in ⑤, the front piston is about to begin

480601°—42——5

its exhaust stroke and the rear piston is beginning its compression stroke. In ⑥, the rear piston is ready to start its power stroke. However, the flywheel has rotated only 315° from the beginning of the front piston power stroke. This is 45° less than a full (360°) revolution.

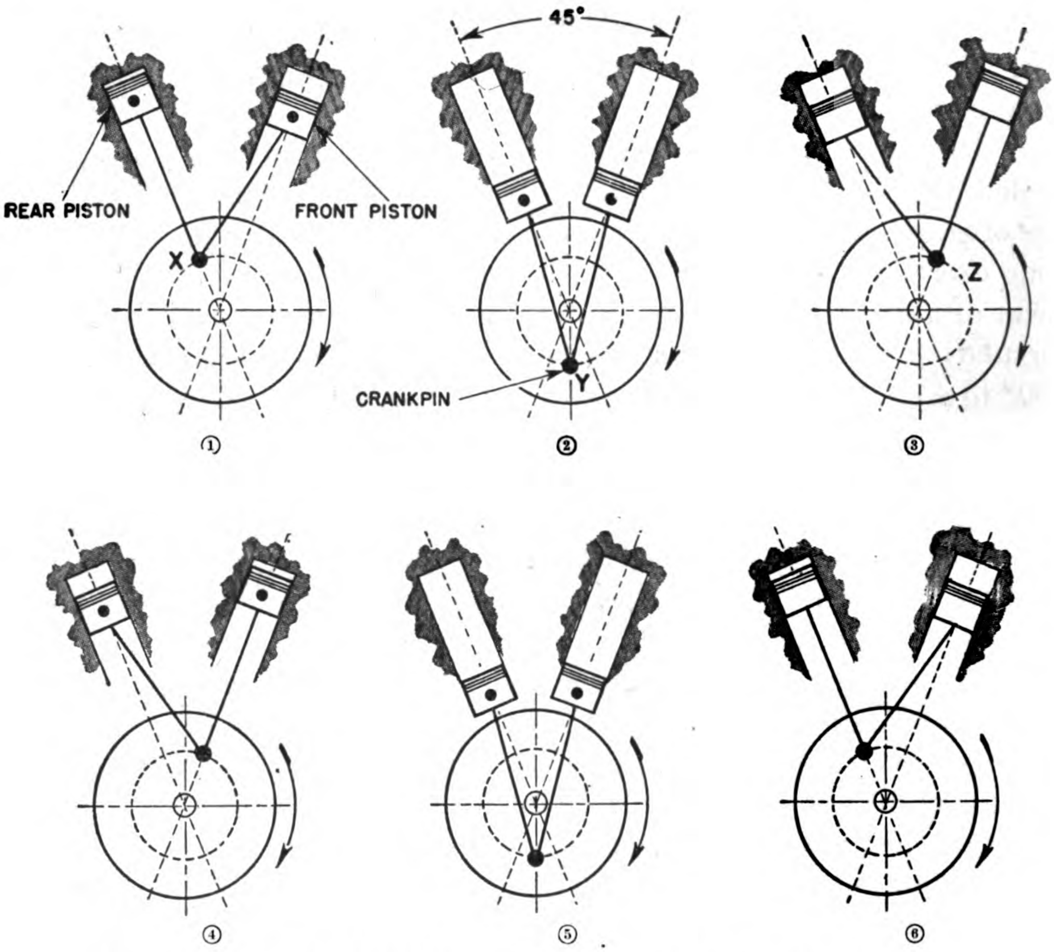

FIGURE 55.—Irregularity of power stroke of two-cylinder V-type engine.

(3) The above difference in travel (405° and 315°) causes a difference in timing of the power delivery on alternate strokes and explains the uneven operation of a two-cylinder, V-type engine.

53. Crankcase, cylinders, and cylinder heads.—*a.* The separate units are bolted together in the engine assembly, as shown in figure 56. The crankcase is of airtight design in order to maintain an oil pressure. The cylinders are cast iron, while the crankcase and the cylinder heads are usually aluminum alloy. The cylinders and heads are deeply finned to dissipate the heat more readily.

b. Figure 57 shows the general design of a modern flathead cylinder with a removable head. The combustion chamber is so shaped that the turbulence of the gases assists combustion and speeds up ignition without detonation or knocking. Cylinder bores are honed and sometimes burnished to a gun-barrel finish.

54. Pistons.—Motorcycle pistons are made of cast iron or an aluminum alloy. Aluminum pistons will develop some slap until they are warmed up, because the clearance between the piston and the cylinder is greater when the engine is cold. Figure 58 shows two types of

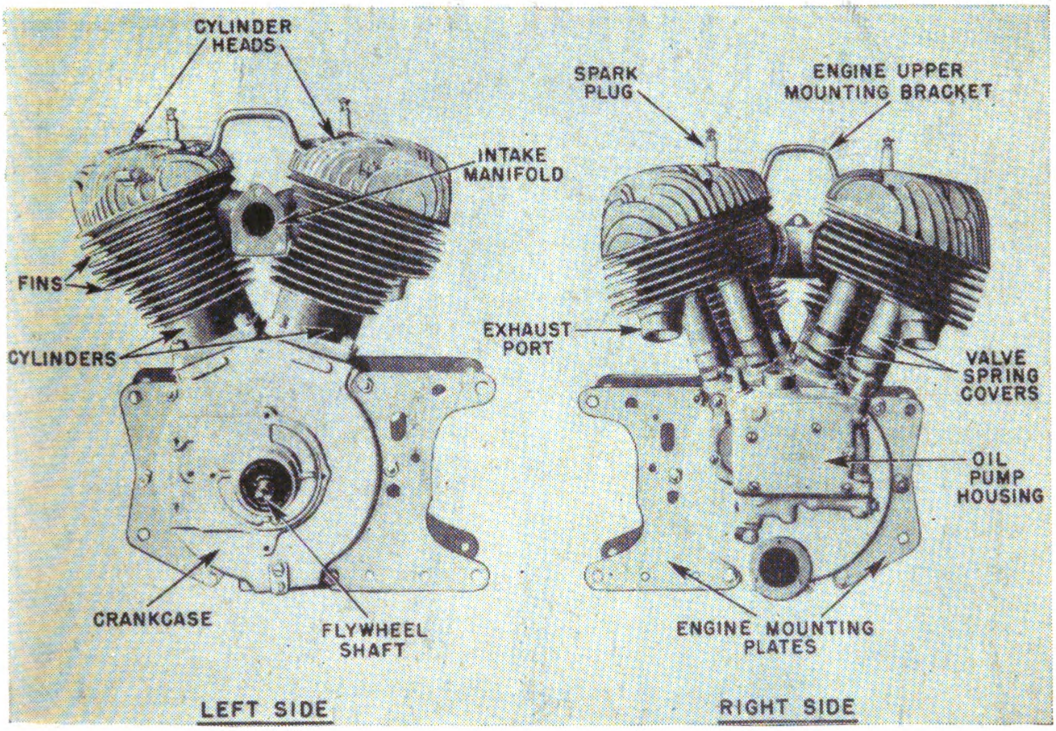

FIGURE 56.—Engine assembly.

cam-ground pistons. These are oval in shape instead of circular, with the greatest diameter at right angles to the piston pin. When the engine is cold, the greatest diameter reduces the slapping action; as the engine heats, horizontal or T-slots enable the piston to do most of its expanding on what was formerly the smaller diameter. Thus the heated piston is approximately circular and will not seize in the cylinder. Low-expansion nickel-iron inserts are often molded into aluminum alloy pistons to compensate for the high expansion of aluminum.

a. Piston rings in motorcycles are similar to rings in automobiles, except that they are slightly narrower ($1/16$- to $5/32$-inch wide). Straight-cut and bevel-joint rings are most common in today's motorcycle engines. Step-joint rings do not withstand intense heat and therefore are seldom used. Usually, there are two or three compression rings and one oil-control ring. They are of cast iron and are located above the piston pin. The ring gap will depend upon the size and make of the engine. A safe and satisfactory ring gap is a minimum

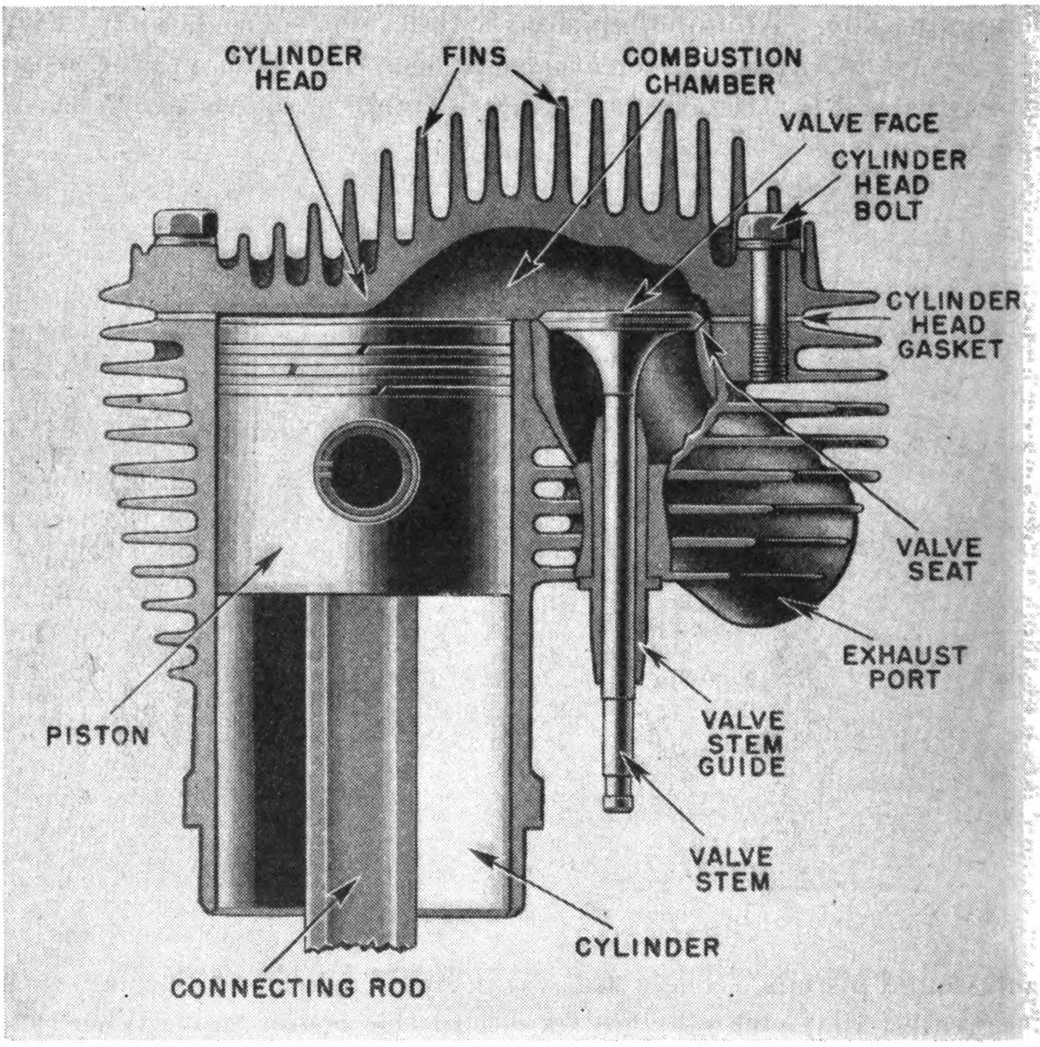

FIGURE 57.—Cross section of typical cylinder and head.

of 0.010 to a maximum of 0.020 of an inch. Less than this might cause the rings to close up or jam.

b. The life of pistons and rings varies widely with service conditions, care given the engine, and operation. Principal factors which tend to shorten the life of pistons and rings are overheating due to extremely hard use or to an improperly tuned engine; neglecting the carburetor air cleaner when operating on dusty or sandy roads; using poor quality oil or not changing oil frequently enough; accelerating to high speeds (especially in low and second gear) directly after starting a cold engine; excessive carburetor choking; faulty spark plugs; running with retarded spark.

c. As piston clearance increases with wear, slapping becomes more pronounced. However, a fairly loud slap is not a serious fault as long as good compression indicates that the piston rings are in good condition. When a slap becomes very loud, it indicates excessive wear or possibly a scored or overheated and collapsed piston skirt. When compression is lost and oil consumption is high, it indicates that the rings are worn or damaged. In such cases the pistons should be removed at once, regardless of mileage; and the cylinders, pistons, and rings should be very carefully inspected and measured. Any necessary new parts must be fitted to specifications.

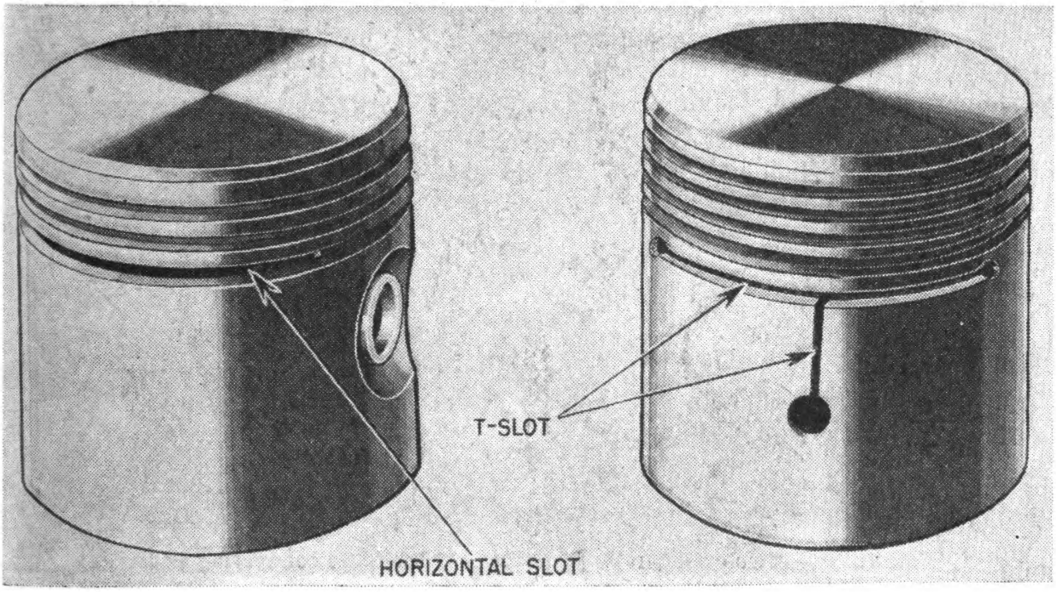

FIGURE 58.—Two types of cam-ground pistons.

d. Piston pins are of the full-floating type, retained in the piston by snap rings. They are made of alloy steel with a glasslike finish. Pins for aluminum alloy pistons are fitted to just drag in the piston boss holes. This is a very important fit and requires care in assembling. If the pin is too tight in the holes, it will bind and pull the piston out of shape. If it is too loose, it will "pound" within the holes and cause noise, as well as wear the holes to an oval shape.

e. Any new parts necessary must be fitted to specification.

f. Piston pins are normally fitted with about one thousandth (0.001) of an inch clearance in the bronze bushing of the upper connecting rod end. This means that a properly fitted pin will have just a noticeable "shake." Pins may have up to 0.002 of an inch bearing clearance before it is necessary to refit. The correct pin fit in aluminum pistons is a light hand press fit.

55. Connecting rods.—*a.* The connecting rods of two-cylinder, V-type motorcycle engines are of the fork (male and female) type, assembled to one crankpin on a roller bearing (fig. 59). The female rod is fitted to the front or rear piston depending on the make of motorcycle. These positions are not interchangeable in a particular make.

b. Replaceable bronze piston-pin bushings are fitted in the upper ends of the connecting rods. Small holes through the tops of the rods and bushings allow lubricating oil, thrown up to the under side

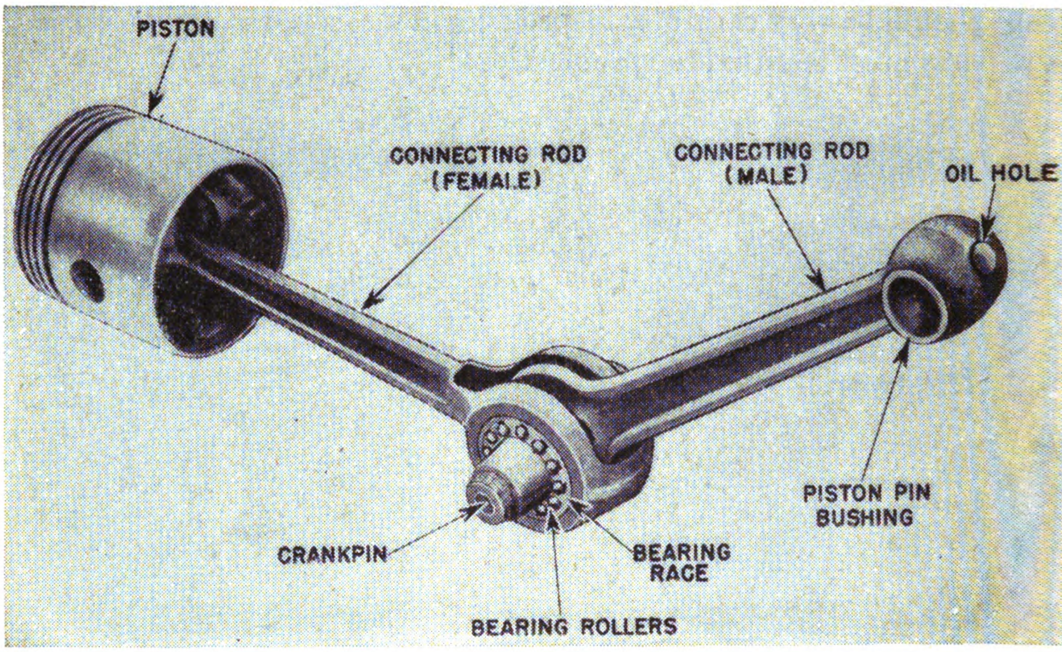

FIGURE 59.—Two-cylinder V-type motorcycle engine connecting rods.

of the piston heads, to reach the piston pins. The bushings can be replaced if necessary when new pins are fitted.

c. The lower, or crankpin bearing, of the connecting rod is the most important bearing in the engine. The rollers, which have slightly rounded ends, must be fitted accurately. For this reason, rollers are available in sizes varying 0.0001 of an inch. Connecting rods are originally fitted approximately 0.001 of an inch loose on the rollers and crankpin. The upper ends of the rods have a maximum of $\frac{1}{16}$-inch "side shake" with 0.001 inch lower bearing clearance. To allow free movement of parts at high speed, the connecting rods must have some play between the flywheels when the flywheels are drawn up tightly on the crankpin. The play is increased by installing thinner thrust washers between the bearings and the flywheels. (See fig. 60.)

d. When a connecting rod is badly bent, twisted, cracked, or otherwise unsuitable for further dependable service, it should be replaced.

e. Check alinement of connecting rods (by means of a square at the piston skirt) before the cylinders are put on the engine.

56. Crankshaft.—The crankshaft is a built-up assembly. It consists of two concentric main shafts carrying two flywheels which are separated by the crankpin, on which the connecting rods are fitted.

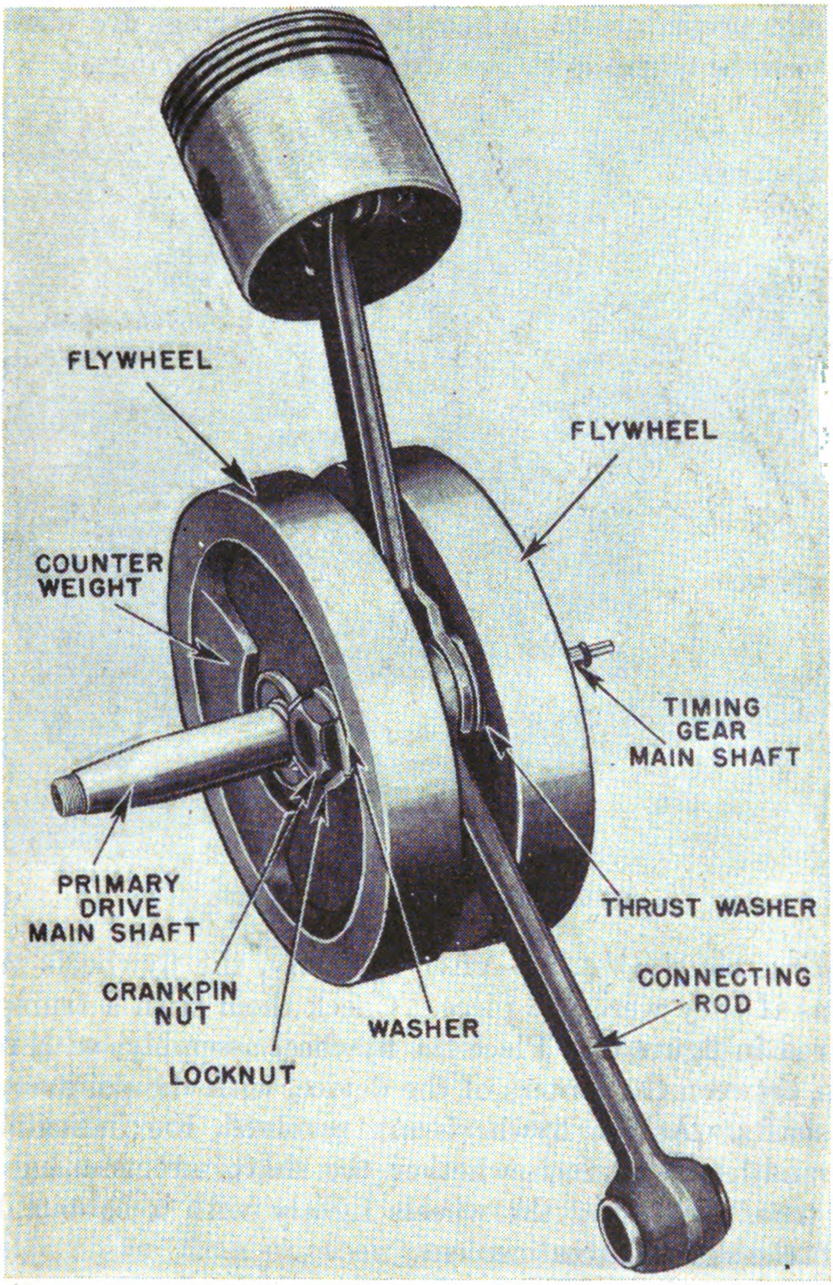

FIGURE 60.—Crankshaft-flywheel assembly.

Thus the flywheels are actually the arms of a single throw crankshaft as illustrated in figure 60. The flywheels are of high tensile strength cast iron (alloy) or cast steel. Counterweights are cast integrally on the flywheels, opposite the crankpin bosses to balance the crankpin weight.

One main shaft carries the drive sprocket of the primary drive; the other shaft carries the drive gear of the timing mechanism. Both shafts are supported by roller bearings. Unless they run true within 0.001 of an inch, the flywheels will wobble, cause vibration, and wear the bearings prematurely. When the main bearings are worn, excess clearance can be taken up by installing oversize bearings.

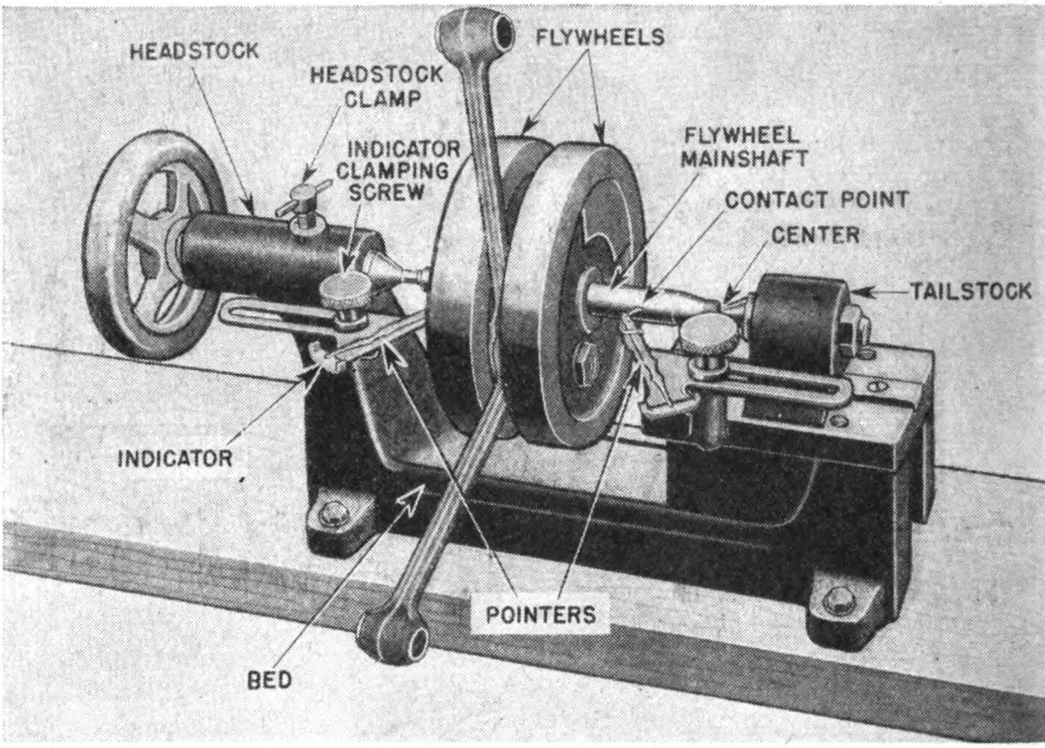

FIGURE 61.—Flywheel truing device.

a. Truing the flywheels.—After assembly, the flywheels must run as true as if they were one piece. Check them with a truing device as pictured in figure 61. Place the flywheel assembly, with rods and bearings, between the centers of the device, with the pointers bearing on the shafts. As the flywheels are revolved, the indicators show in thousandths of an inch whether the shafts are running true or "out of true." Striking the wheels lightly with a babbitt hammer will shift the shafts into alinement.

b. Balancing.—Flywheels are balanced at the factory according to the service intended for the motorcycle. However, if the flywheel balance has been changed by a replacement of pistons, rods, or other parts, it may be checked by the method shown in figure 62. Use both connecting rods and bearings on the crankpin, as well as one piston with rings and piston pin. For proper balance, when the flywheel shafts are supported on perfectly parallel rails or ways, the wheels should stay in any position. If they do not, a perfect balance can be effected by drilling holes in the flywheel rim on the heavy side. If very much metal is to be removed, take a like amount from each wheel

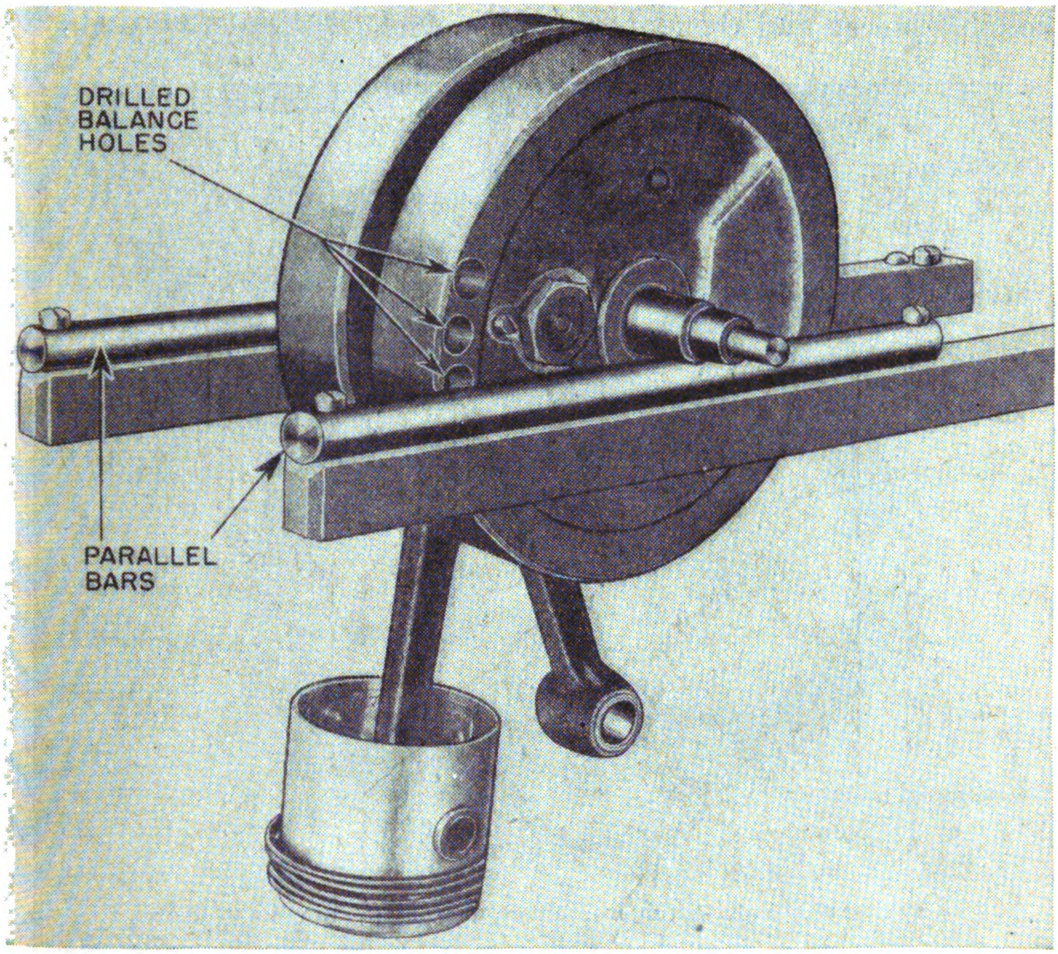

FIGURE 62.—Set-up for flywheel balancing.

so as not to weaken one wheel too much. Bear in mind that the rails must be perfectly level.

57. Valves and timing mechanisms.—Valves and timing mechanisms of motorcycles are similar in principle to those used in automobiles. (See TM 10–570.) However, lifts of motorcycle valves are usually higher than in other gasoline engines. Since motorcycle engines turn at very high speeds (about 4,600 rpm) the cams are designed to lift the valves and close them as rapidly as possible. At the same time, the cams must not act so abruptly as to break springs or valves.

a. The Indian military motorcycle engine (fig. 63) employs two cam gears. Each cam operates the inlet valve and exhaust valve of one cylinder through the lifter lever motion. The Harley-Davidson (fig. 64) uses a cam gear for each individual cam, lifting the valves directly through rollers and lifter pins. It is possible with the latter system to time the opening and closing of each valve independently of the others.

b. The intake and exhaust valves are timed to obtain the greatest possible power and economy from the fuel. Instead of opening or

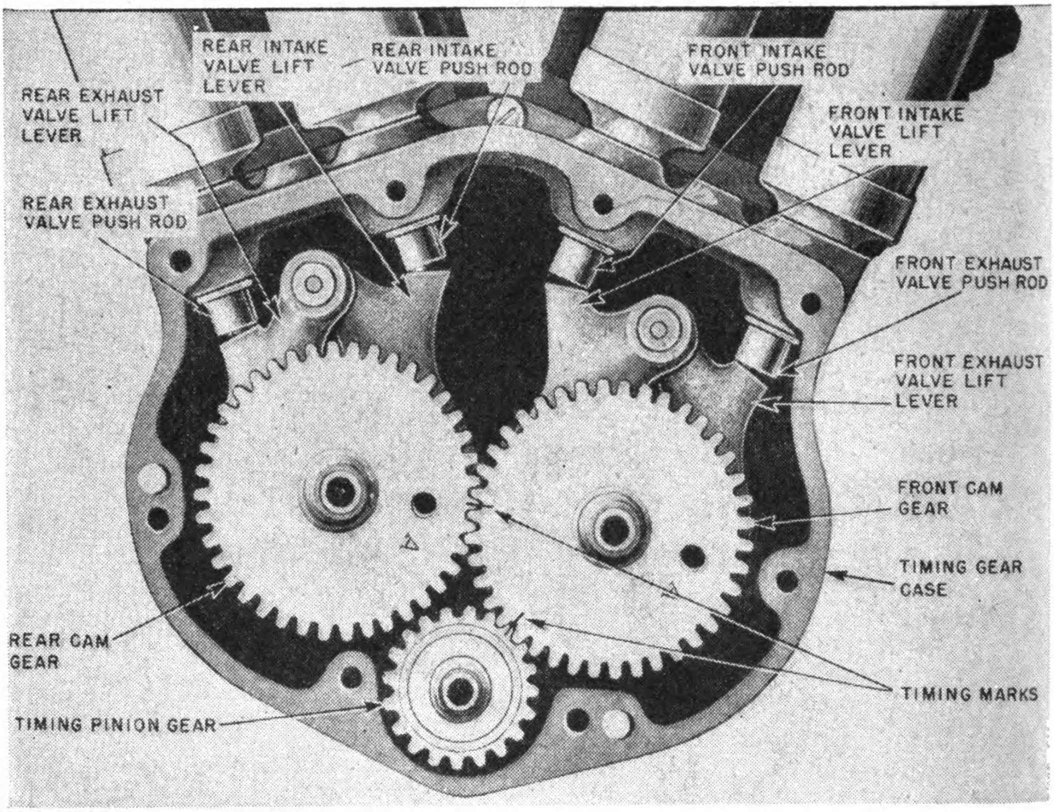

FIGURE 63.—Valve-lifting mechanism and timing gear train of Indian.

closing at exactly top or bottom dead center, the valves are timed as follows:

(1) At the end of the intake stroke, the piston has passed B. D. C. and started on the compression stroke before the intake valve closes. This enables the moving gases to assist in packing the cylinder full of fuel.

(2) As the piston moves through the compression stroke and into the power stroke, both valves are closed and the spark occurs just before the piston reaches T. D. C. on the compression stroke. (Timing of the ignition is discussed in section IX.)

(3) Before the piston reaches B. D. C. on the power stroke, the exhaust valve opens, permitting burned gases to start to escape before

the piston begins to actually drive them out on the exhaust stroke. The potential power lost in this premature opening of the exhaust

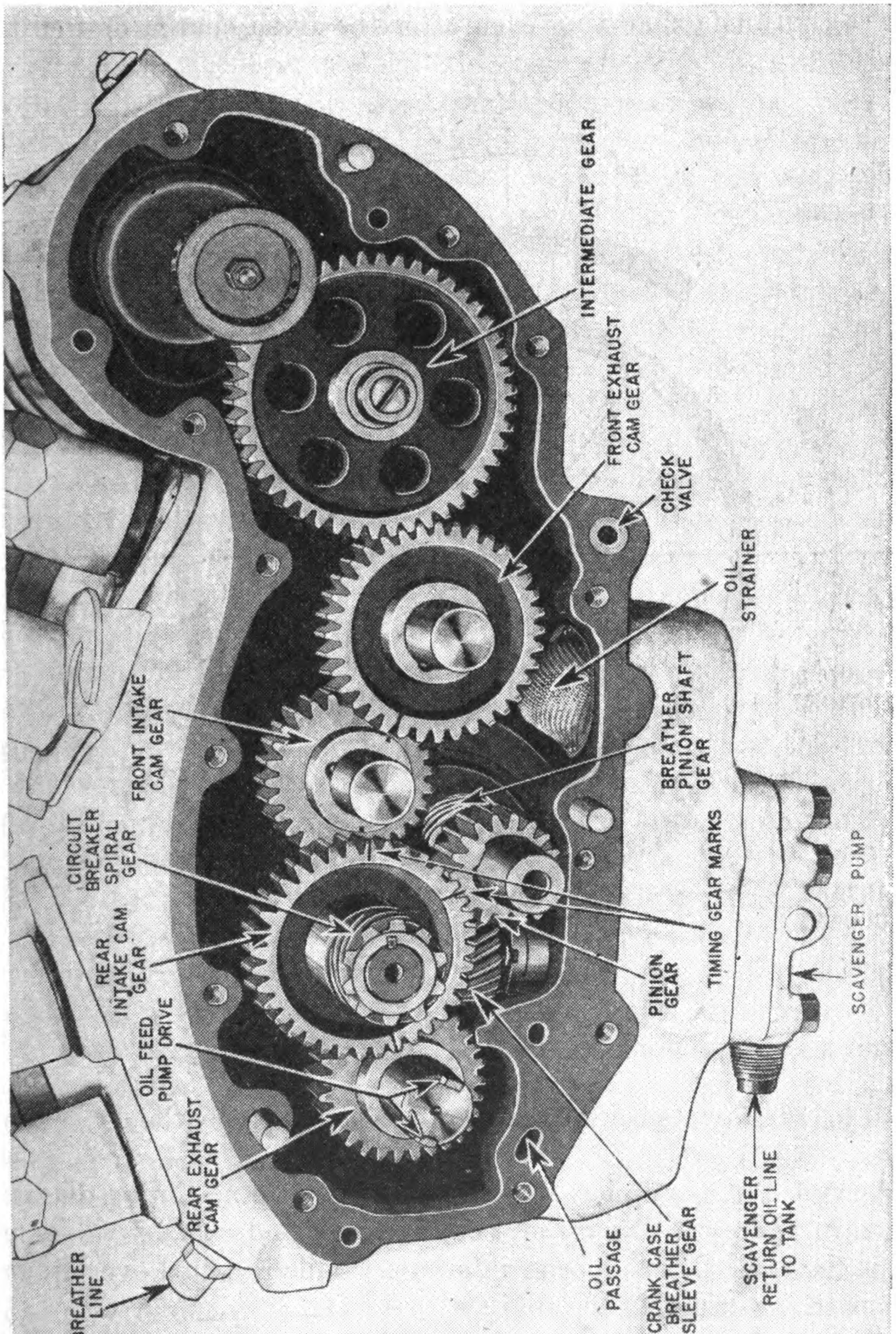

FIGURE 64.—Valve timing gear train of Harley-Davidson.

valve is negligible and is compensated for to some extent in the exhaust stroke, where less force is required to drive the remaining gases out of the cylinder.

(4) The exhaust valve remains open until the piston has passed T. D. C. on the exhaust stroke, although the intake valve opens *before* the piston reaches T. D. C. The momentum of escaping gases causes them to continue exhausting even after the fresh charge of fuel has

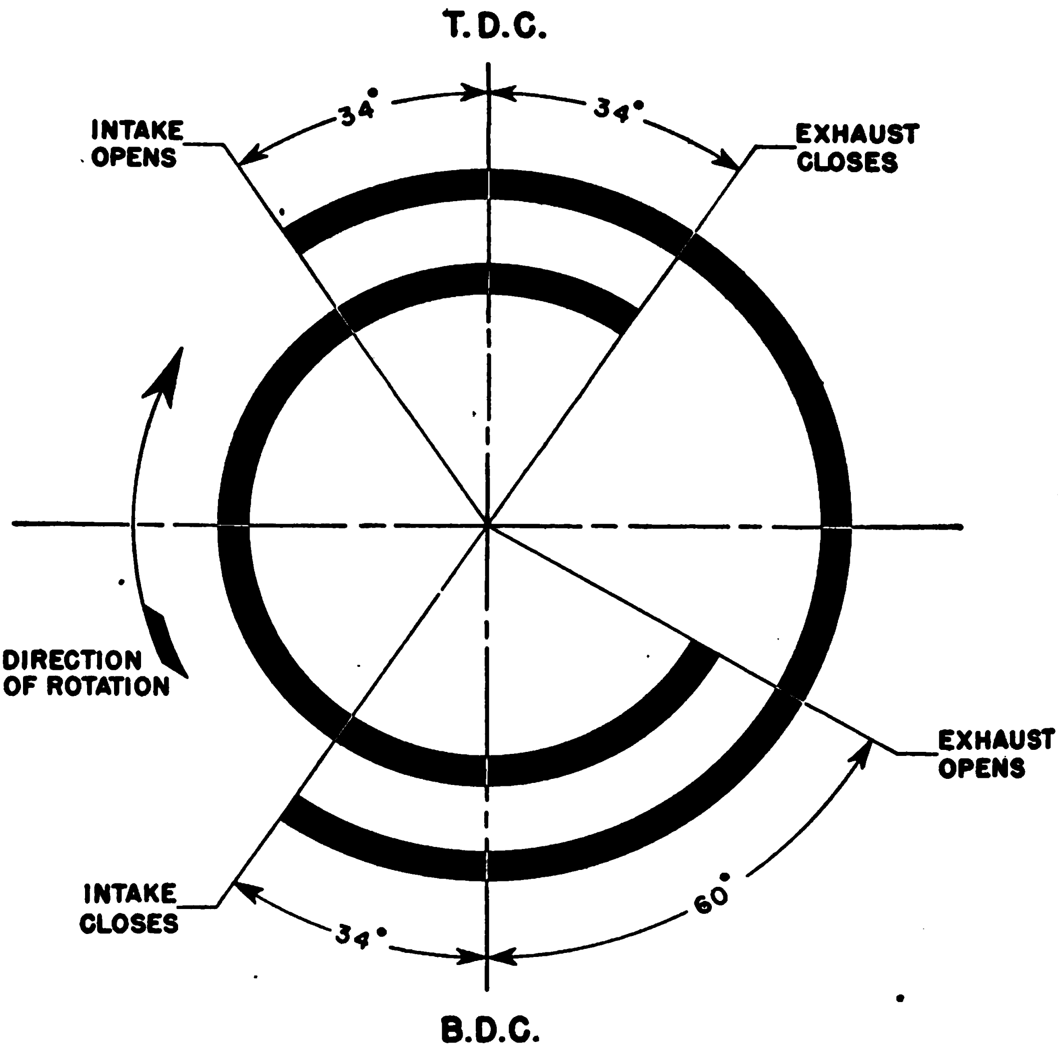

FIGURE 65.—Typical motorcycle valve timing diagram.

started to enter and is being drawn into the cylinder by the descending piston.

c. A typical two-cylinder, V-type motorcycle engine-timing diagram is given in figure 65. Note that both the inlet and exhaust valves are open at the same time for brief intervals. This is called overlap and varies with the design of the engine.

d. Motorcycle practice differs from automotive practice in the matter of valve settings and adjustments. Motorcycle valves are adjusted when the engine is cold and the tappet clearance is less than allowed on automotive engines. Because of the extreme heat at which valves are required to function (1,200° to 1,400° F.), valve springs weaken easily and must be replaced at regular intervals. Valve guides are subject to more frequent replacement in motorcycles than in automobiles. Valve faces and seats should be checked and if necessary reconditioned whenever the cylinders are removed from the engine. Properly seated valves with good compression seals are very important for best engine performance. Valve guides and stems are usually fitted with 0.003- to 0.004-inch clearances. Guides and stems should not be allowed to develop more than double their original clearances before the guides (or possibly the guides and valves) are replaced.

e. Every engine, regardless of make or model, is assembled with marked gears (fig. 63) to facilitate timing when making engine repairs or adjustments. The timing pinion gear either is mounted directly on the flywheel shaft or is driven from this shaft through a stub shaft. Regardless of diameter, the pinion gear will have half as many teeth as the cam gears. (It operates at twice the speed of the cam.) The pinion gear is keyed to the flywheel shaft so that it cannot get out of time and is the master gear. Timing gears require very little attention. If they become noisy, it may be desirable to replace them when the engine is overhauled. Loose and exceptionally noisy bushings must be replaced promptly to avoid damage to the crankcase.

58. Lubrication.—See FS 10–84, Lubrication of Indian Motorcycle and FS 10–90, Lubrication of Harley-Davidson Motorcycle. The motorcycle engine depends upon its lubricating oil to carry away at least 35 percent of the heat created; hence the lubrication system is very important in cooling as well as oiling the engine.

a. The bearings, piston rings, cylinder walls, bushings, and gears are lubricated by a combination force feed and splash system which is controlled by a feed pump and a scavenger pump. The feed pump circulates oil to the various parts of the engine and the scavenger pump returns the oil to the tank. The oil is cooled as it flows through exterior return pipes. Some motorcycles have a separate oil tank, mounted on the frame in back of the seat post, as shown in figure 66. On other models, the reserve fuel tank has a small built-in compartment with a separate filler neck for storing the oil. (See fig. 79.)

b. The motorcycle crankcase does not carry a constant level or "bath" of oil at any time; therefore, oil must be fed to the bearings constantly under pressure. This is a "dry-sump" type system.

c. In the Indian, the feed pump and the scavenger pump are inclosed in the same housing (fig. 67). The feed pump is a reciprocating and rotating plunger type. A worm gear, driven by the engine timing gear train, forms the lower part of the plunger. An inclined slot, cut around the plunger, bears on a fixed pin which projects from the pump housing. The inclination of the slot causes the plunger to move up and down as it rotates. In the top of the plunger is a well; at the bottom of the well, a cross channel or hole leads to the outside. On the downward (suction) stroke of the plunger the cross channel meets an inlet opening in the pump barrel connected to the oil tank. This allows oil to flow by gravity through the cross hole into the well and the clearance space above the plunger. As the plunger continues

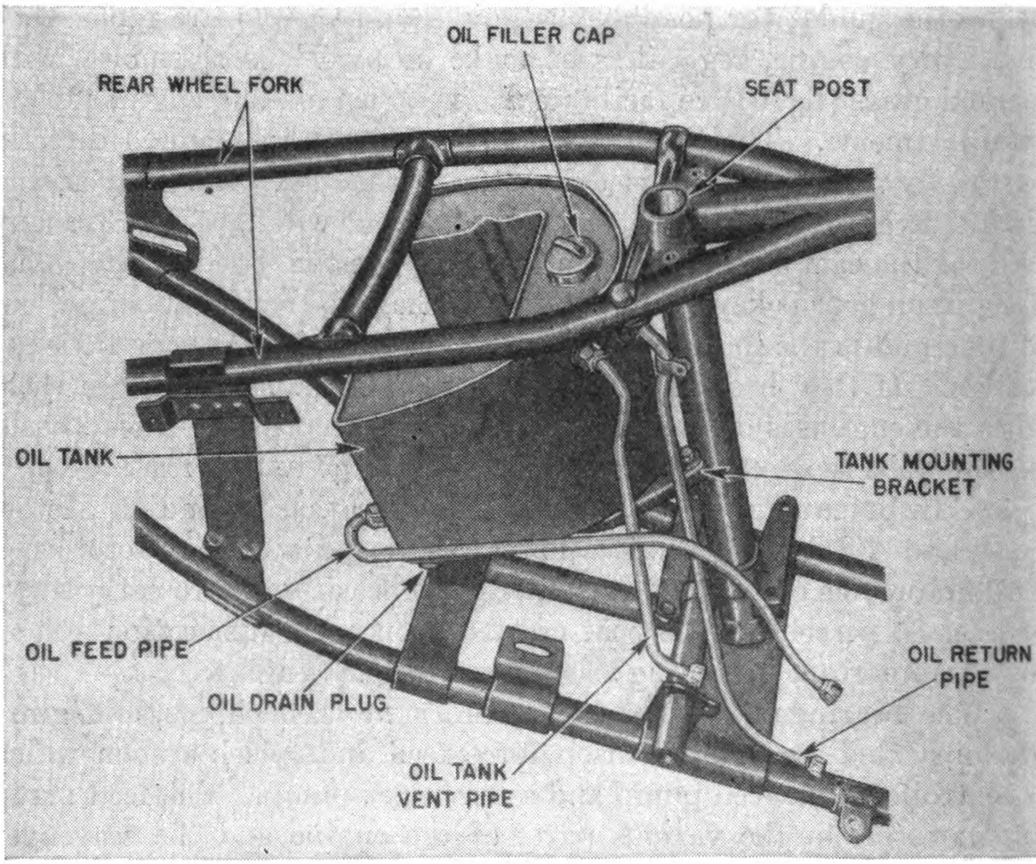

FIGURE 66.—Separate oil tank mounted under seat.

to rotate, it begins its upward (compression) stroke and the cross hole meets an outlet opening in the pump barrel. The oil contained in the well and the clearance space is forced into this outlet hole, which leads to the crankshaft main bearing and connecting rod lower bearing. From here the oil is thrown off by the splash method to the other bearings, pistons, and cylinders. The oil then drains into a recess (sump) in the bottom of the crankcase, from which it is withdrawn by the scavenger pump and returned to the oil tank.

d. The gear-type scavenger pump is driven by the distributor shaft. A crankcase sump valve, connected to the inlet of the scavenger pump, prevents oil from flowing back into the crankcase when the engine is stopped. In this valve, the suction created by the scavenger pump, lifts a valve disk against a valve spring, allowing oil from the crankcase to flow into the sump valve housing, where a wire screen filters it. When the scavenger pump stops, the suction ceases and the disk

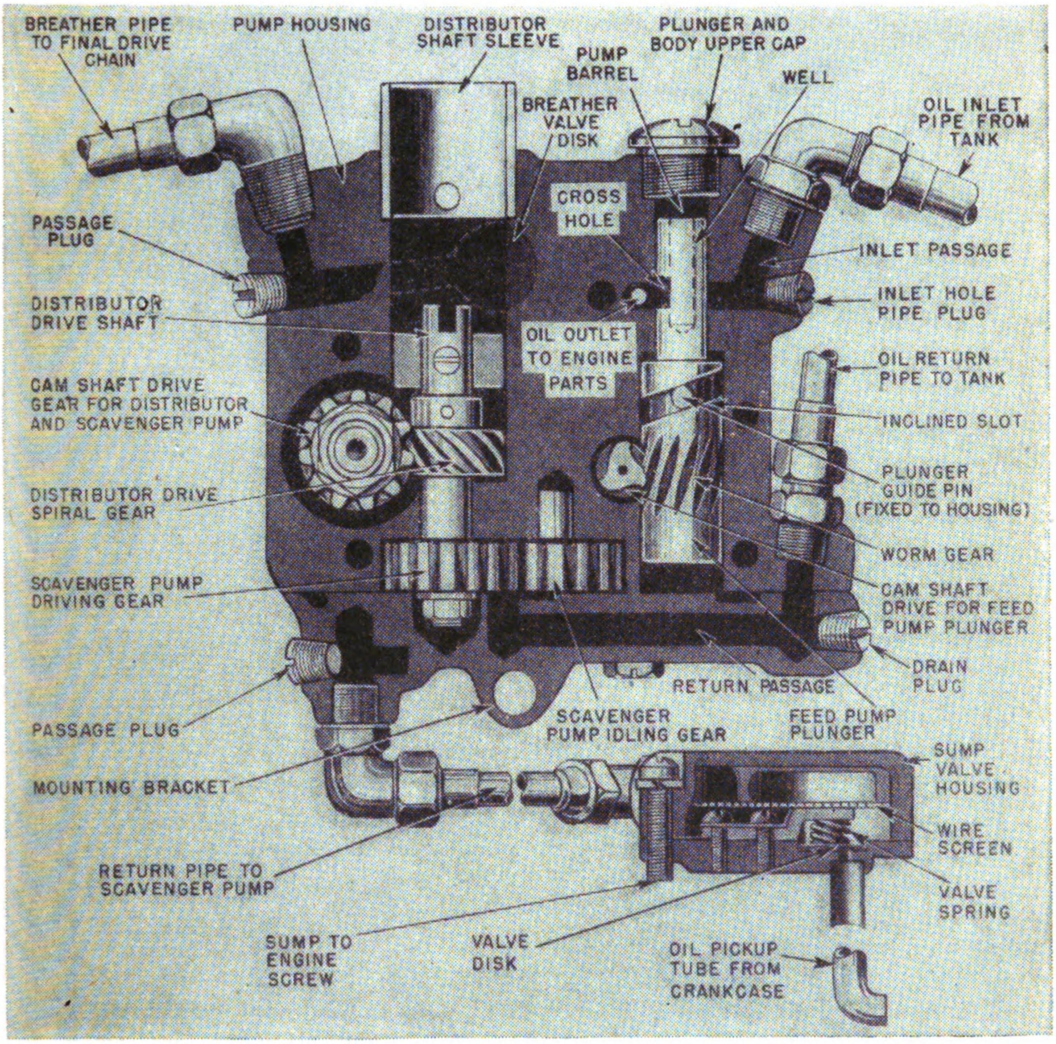

FIGURE 67.—Combination feed and scavenger pump.

drops to its seat, stopping the flow of oil into the crankcase. The capacity of the scavenger pump is considerably greater than that of the feed pump to keep the crankcase free from any oil accumulation. A cam case breather is installed on the back side of the pump housing.

e. Figure 68 (Harley-Davidson) shows the feed pump and the scavenger pump as separate units. The feed pump is a vane-type unit. A rotor, driven by the rear exhaust cam gear, causes two sliding blades (vanes) to revolve within a slightly eccentric chamber. The gear-type scavenger pump, mounted below the timing gear case, is also driven by the rear exhaust cam gear.

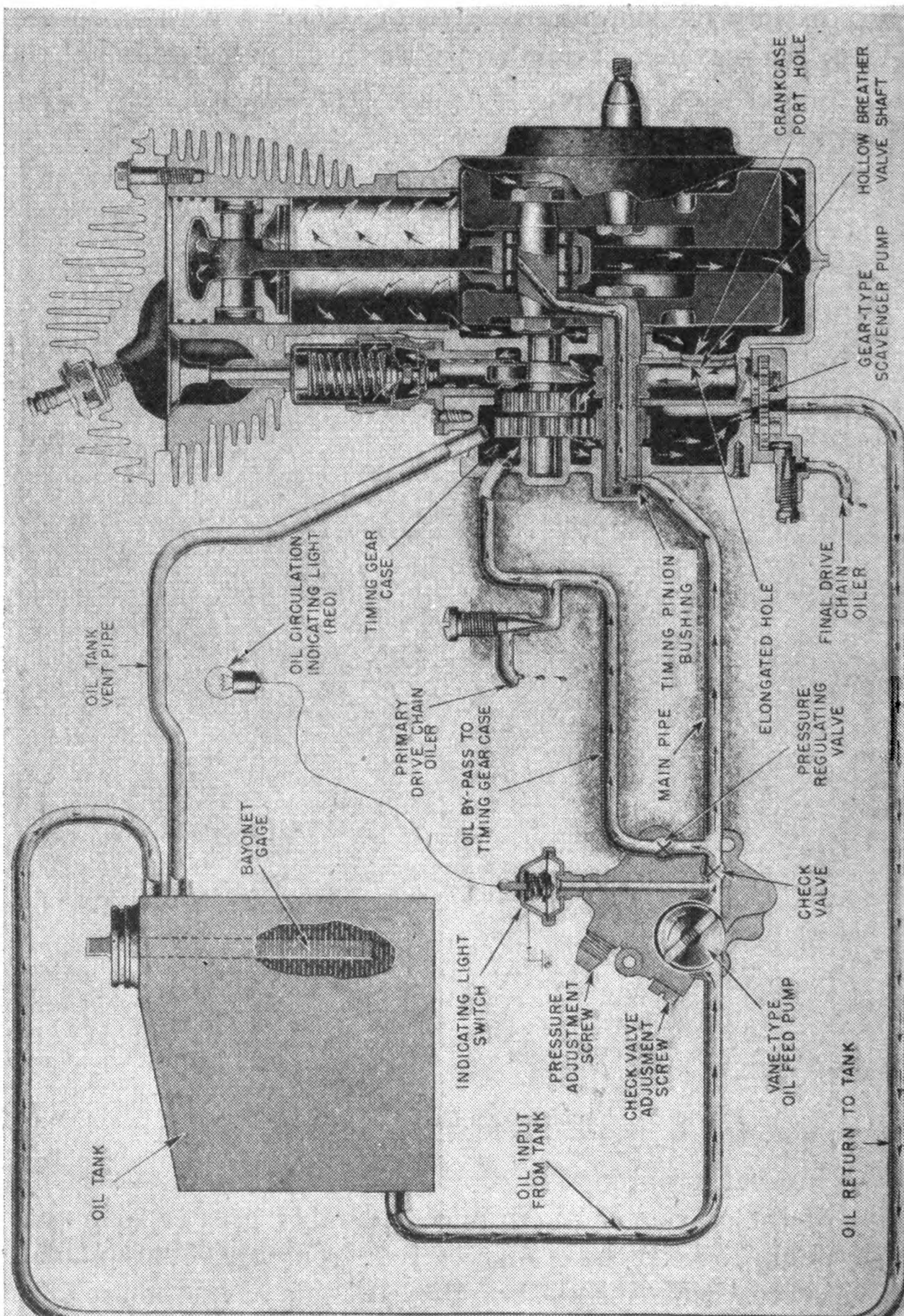

FIGURE 68.—Lubrication system of engine with separate feed and scavenger pumps.

f. Oil is forced by the feed pump through the main pipe to a hole in the timing-pinion bushing. A cross hole, located in the flywheel timing-gear shaft, registers with the bushing hole as it passes on every upward stroke of the pistons. This allows oil to flow through the passageways of the flywheel shaft, flywheel, and crankpin, to the lower connecting-rod bearings. As the piston moves upward, it draws with it drops of oil (forced out of the connecting-rod bearings), which lubricate the cylinder walls and the piston pins.

g. When the piston begins to move down, the timing-pinion bushing hole is closed and pressure builds up back of the feed pump, opening

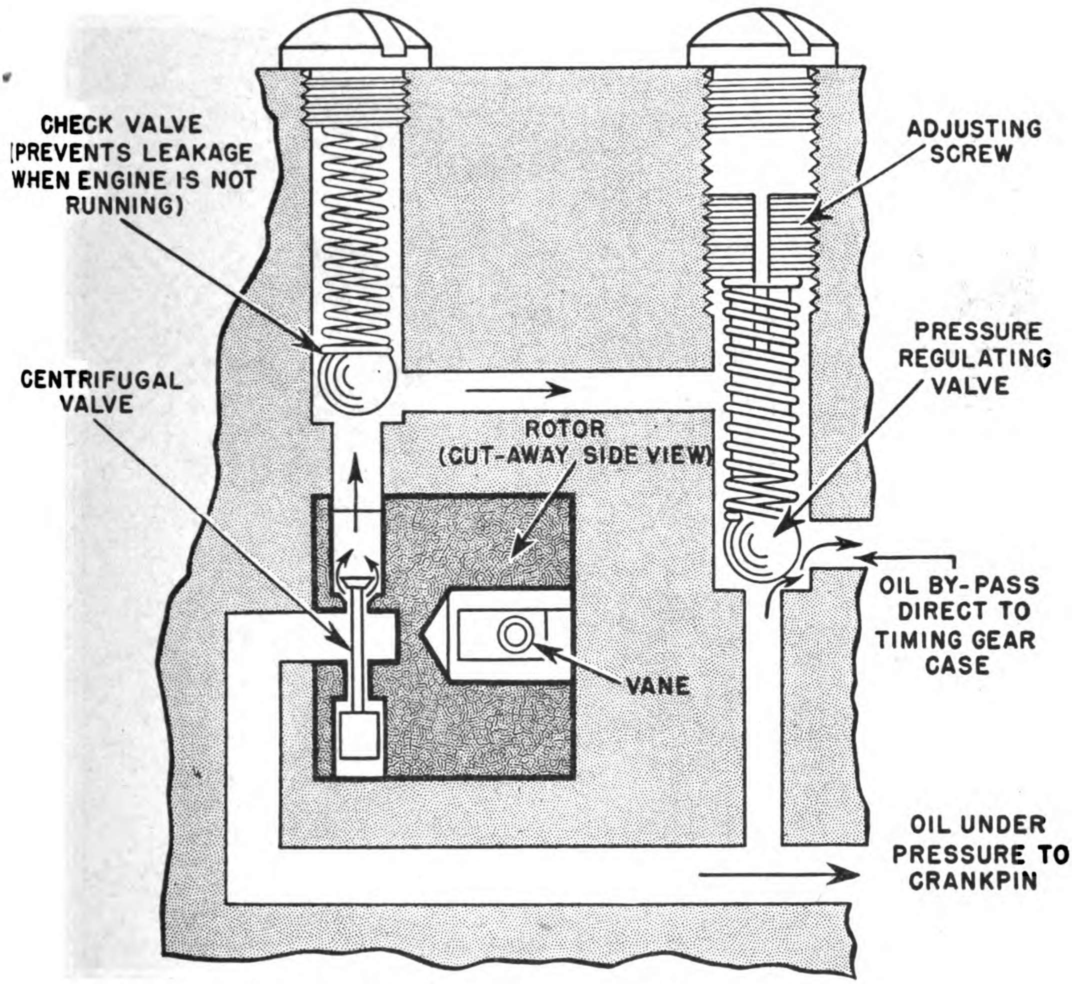

FIGURE 69.—Centrifugal valve in feed pump rotor for regulating oil pressure.

a pressure regulating valve which by-passes the oil to the timing gear case. Here the oil lubricates the timing gear train as it drains to the bottom of the case. At the same time, the downward movement of the piston blows oil and air out of the engine crankcase, into a large elongated hole in the hollow breather valve shaft. This shaft is accurately timed so that the elongated hole registers with a crankcase porthole only when the crankcase is under pressure (downward stroke). The scavenger pump then returns the oil to the oil tank to be recirculated.

h. On recent military motorcycles using a vane-type feed pump, a centrifugal valve (fig. 69) has been built into the rotor of the pump. At low and intermediate speeds, this valve remains open, by passing oil to the pressure regulated valve leading to the timing gears. Thus the oil pressure on the crankpin is limited at low speeds. The centrifugal valve closes tighter at higher speeds, gradually increasing the oil pressure to the limit for which the pressure regulating valve

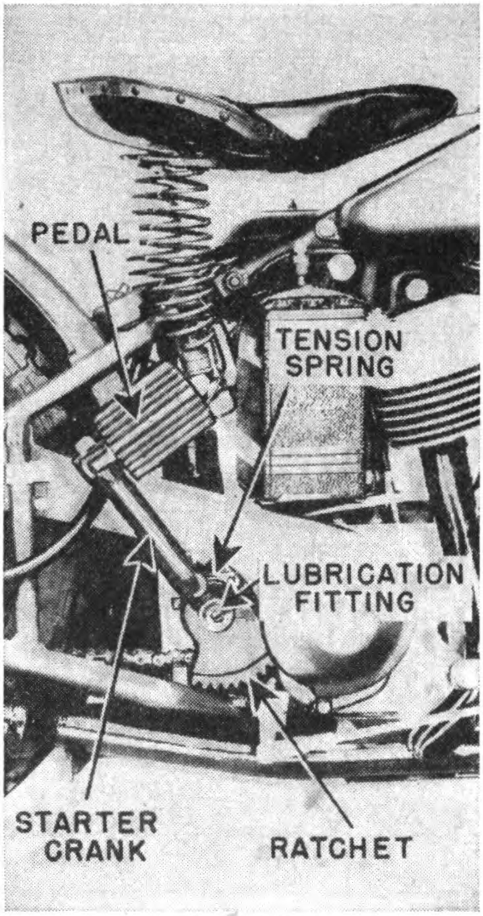

FIGURE 70.—Kick starter.

is set. With oil pressure at the crankpin determined by the engine speed and the setting of the pressure regulating valve, more oil is fed to the engine at high speeds when it is most desirable, and oil accumulation in the engine crankcase is prevented at low speeds.

59. Kick starter.—The kick starter or starter crank by which the engine is cranked, is usually located at the right side of the motorcycle just below the saddle, as shown in figure 70. The kick starter is geared (by a ratchet) to the transmission so that a full swing will turn the engine several revolutions. A rubber pedal provides a nonslipping foothold. To start the engine, place the foot on the starter pedal and throw the weight on it, forcing it down to the bottom of its natural swing. A spring automatically returns the kick starter to the "up" position when pressure is removed.

SHAFT-DRIVEN MODELS

60. General.—The two-cylinder, air-cooled engines used on shaft-driven models are mounted crosswise in the frame so that the crank-

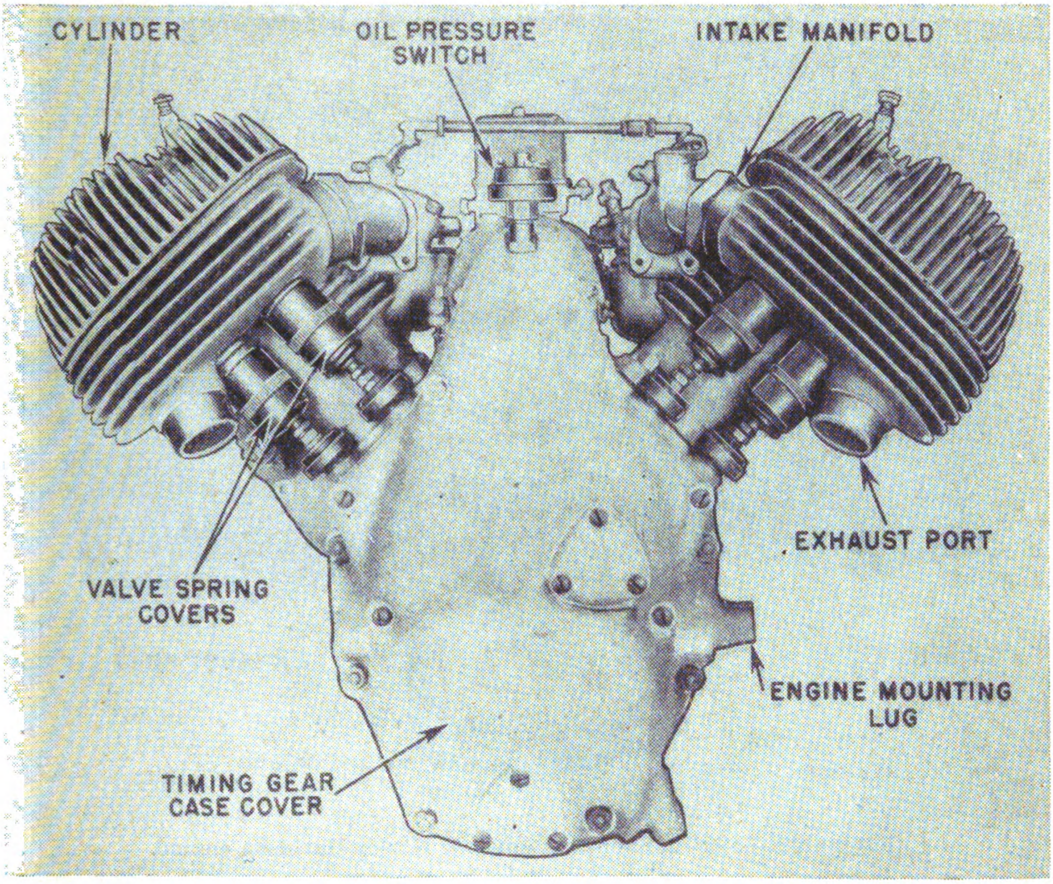

FIGURE 71.—90° V-type Indian engine.

shaft is lengthwise to the motorcycle. The cylinders project into the air stream and are thereby more efficiently and more evenly cooled than on chain-driven models, where the air passage around the rear cylinder is blocked by the front cylinder. This construction also facilitates the removal of cylinder heads for top overhaul of the engine.

61. Crankcase, cylinders, and cylinder heads.—*a.* The cylinders of shaft-driven models are set on the crankcase at angles different from those on chain-driven models. The cylinders on the Indian engine (fig. 71) are at right angles to each other (90°, V-type). The Harley-Davidson engine (fig. 72) has horizontally opposed cylinders (180°

apart). These two arrangements of cylinders reduce the irregularity of power stroke explained in paragraph 52*d*.

b. The left cylinder on the Harley-Davidson engine is placed slightly forward with respect to the right cylinder. This offset is necessary since a two-throw type crankshaft is used, and therefore the connecting rods and pistons of the two cylinders operate in different vertical planes.

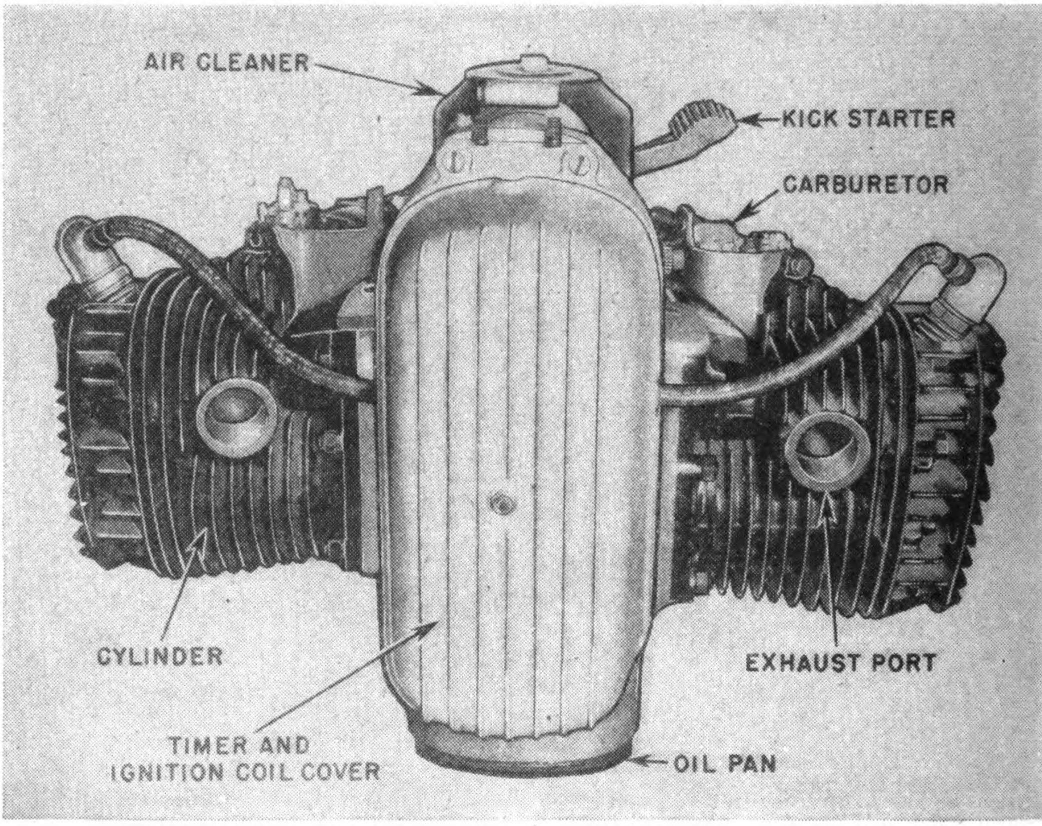

FIGURE 72.—180° horizontally opposed Harley-Davidson engine.

c. At the bottom of the cylinders (inside) on the Indian engine are two semicircular baffle plates. Their purpose is to prevent the amount of oil reaching the cylinder walls from becoming excessive.

d. The crankcase is cast with an opening at the bottom, where a sheet-metal oil pan is bolted forming an oil reservoir in the same manner as on automotive engines.

62. Connecting rods.—The two automotive-type connecting rods of the Harley-Davidson engine are mounted on roller bearings on separate journals of the two-throw crankshaft as shown in figure 73. The bearings are of the split type (upper and lower halves) which are easy to replace. The connecting rods and caps are originally paired and lapped in sets by the manufacturer and are not interchangeable. If either a cap or a rod requires renewal, replace with a complete new connecting-rod assembly.

63. Crankshaft and flywheel.—*a.* The Harley-Davidson crankshaft is very much like automotive crankshafts except that it has only two throws instead of four or six. The arms and journals are not assembled of individual parts as in chain-driven models, but are constructed as one piece. The front and rear main bearings supporting the shaft are of the same size ball type. The front end of the crankshaft carries the timing gear train pinion.

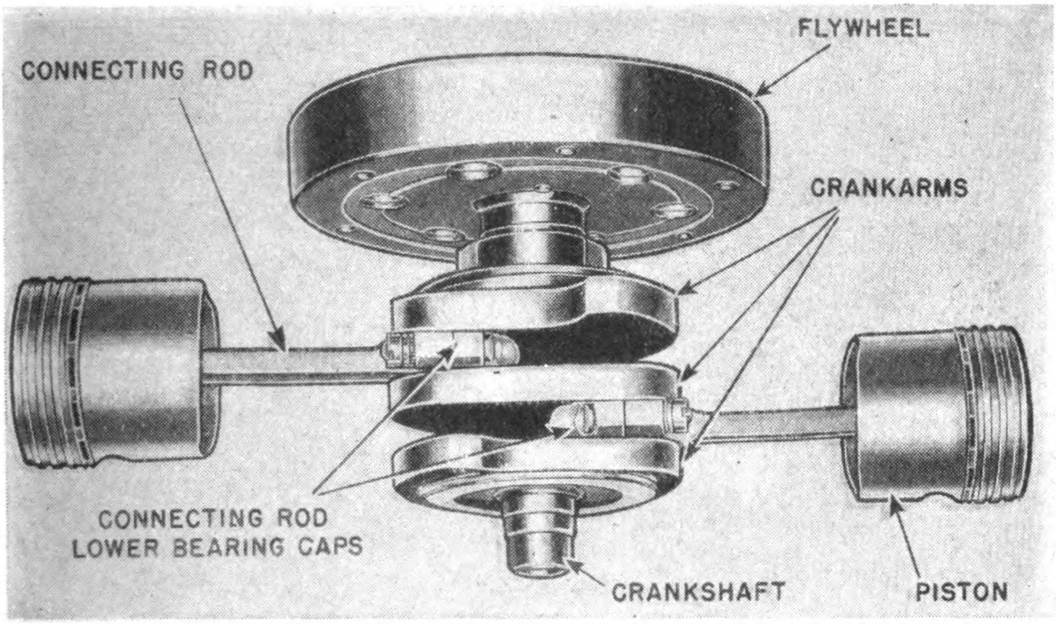

FIGURE 73.—Connecting rod and flywheel assembly (Harley-Davidson).

b. Only one flywheel is used on the Harley-Davidson engine. It is keyed to the rear end of the crankshaft (fig. 73) and forms the backplate or driving face of the clutch assembly.

64. Valves and timing mechanisms.—*a.* The timing gear trains of shaft-driven models are located in front of the engines and are accessible by removing a cover plate. Figure 74 shows two camshafts (one for each cylinder) which operate the intake and exhaust valves on the Indian engine. Harley-Davidson has a single camshaft (fig. 75) operating the valves of both cylinders.

b. The valve tappets of both shaft-driven models are accessible from the outside. To adjust the valve tappet clearance, be sure the engine is cold, and rotate the flywheel, lining up the timing marks on the timing gears.

65. Lubrication.—*a. Indian.*—(1) The feed pump and scavenger pump of the dry-sump lubrication system on the Indian motorcycle are inclosed in a single housing, divided by a cast-in wall inside the cam case cover (fig. 76). The gear diameters of the two pumps are equal, but the scavenger pump is four times as wide as the feed pump. This means that the capacity of the scavenger is greater than that of the feed pump, enabling it to prevent oil from accumulat-

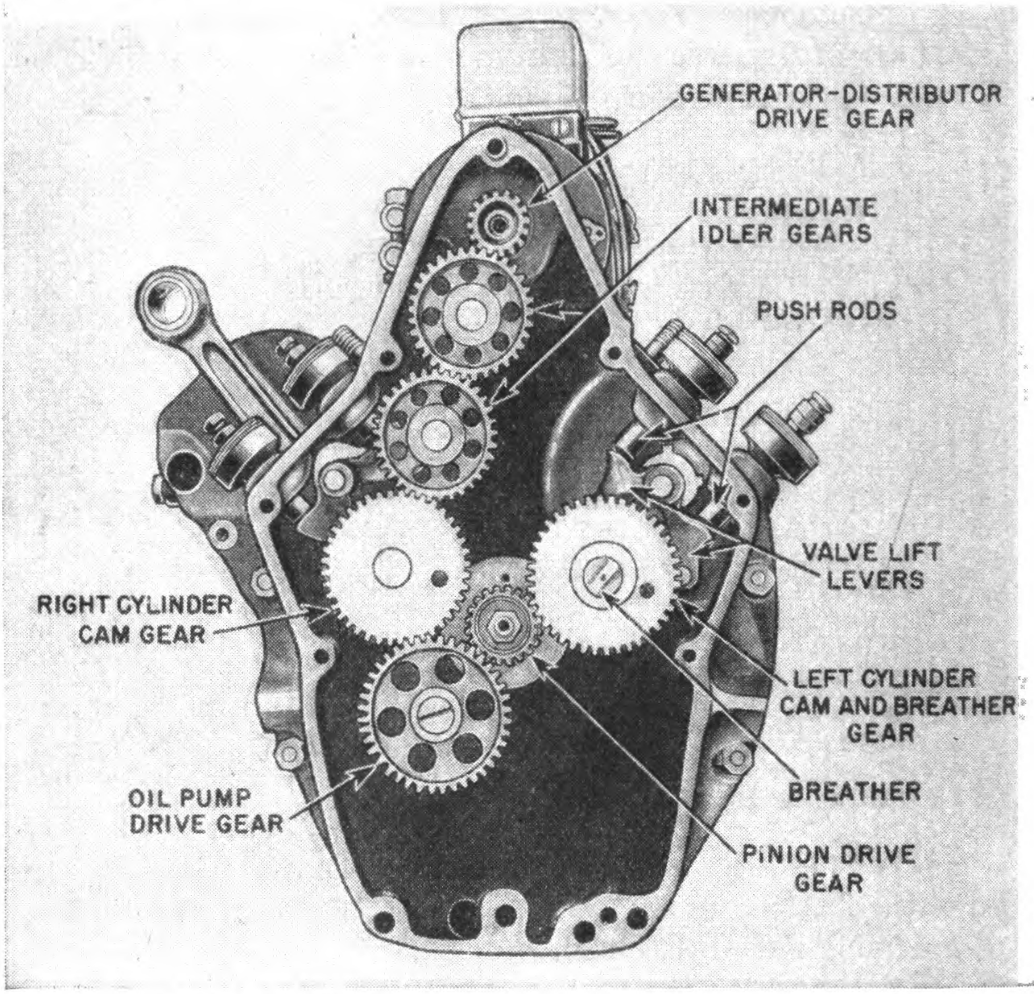

FIGURE 74.—Timing gear train of Indian shaft-driven model.

ing in the crankcase. Both pumps are driven by a shaft slotted to the oil-pump drive gear shown in figure 74.

(2) A small ball check valve on the inlet side of the feed pump, which closes when the engine stops, prevents oil from flowing from the tank into the pump and consequently flooding the crankcase. A $\frac{1}{16}$-inch hole or orifice (metering jet) leading into the oil passage of the flywheel pinion shaft restricts the amount of oil circulated through the engine. When more oil is being pumped than can flow through the orifice, pressure is built up and another ball check valve on the discharge side of the feed pump opens. This allows the excess oil to be

by passed into the discharge line of the scavenger pump and returned to the oil tank.

(3) A red signal light on the instrument panel indicates whether or not oil is being circulated. When the oil pressure is built up to 2 or 3 pounds, a switch at the top of the cam case opens and breaks contact, turning out the red lamp. If the red lamp does not go out after

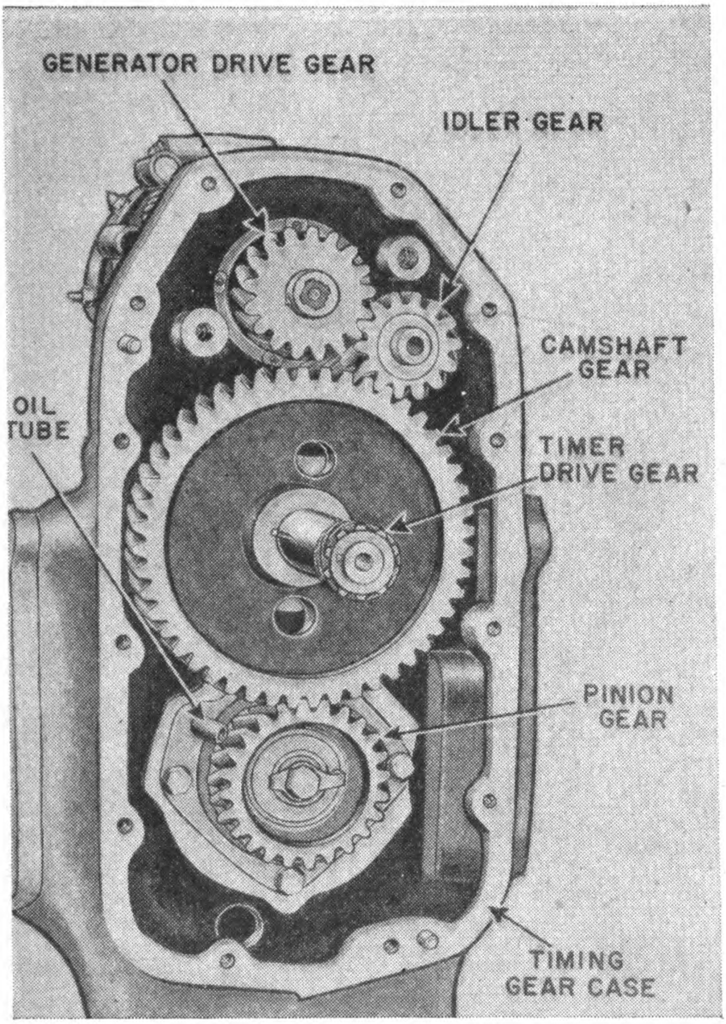

FIGURE 75.—Timing gear train of Harley-Davidson shaft-driven model.

the engine has operated a few minutes, then either the oil is not being circulated or the wiring is defective.

(4) A breather pipe along the lower left side of the motorcycle is screwed into an air hole at the bottom of the cam case. This hole extends up to the sleeve (fig. 76) into which a projection of the left-cylinder camshaft fits snugly. The sleeve has two opposing slots. One slot is alined with the airhole, and the other is alined with a hole in the cam case. The projection of the camshaft (fig. 77) is

milled flat at opposite sides of its circumference. Hence the slotted holes in the breather sleeve are alternately covered and uncovered as the shaft rotates. The uncovering of the holes occurs on the downward stroke of the pistons, thus forcing the foul air from the cam case through the sleeve, and out through the breather pipe.

b. Harley-Davidson.—(1) The Harley-Davidson engine has a "wet-sump" automotive type of lubrication system. In this system, oil

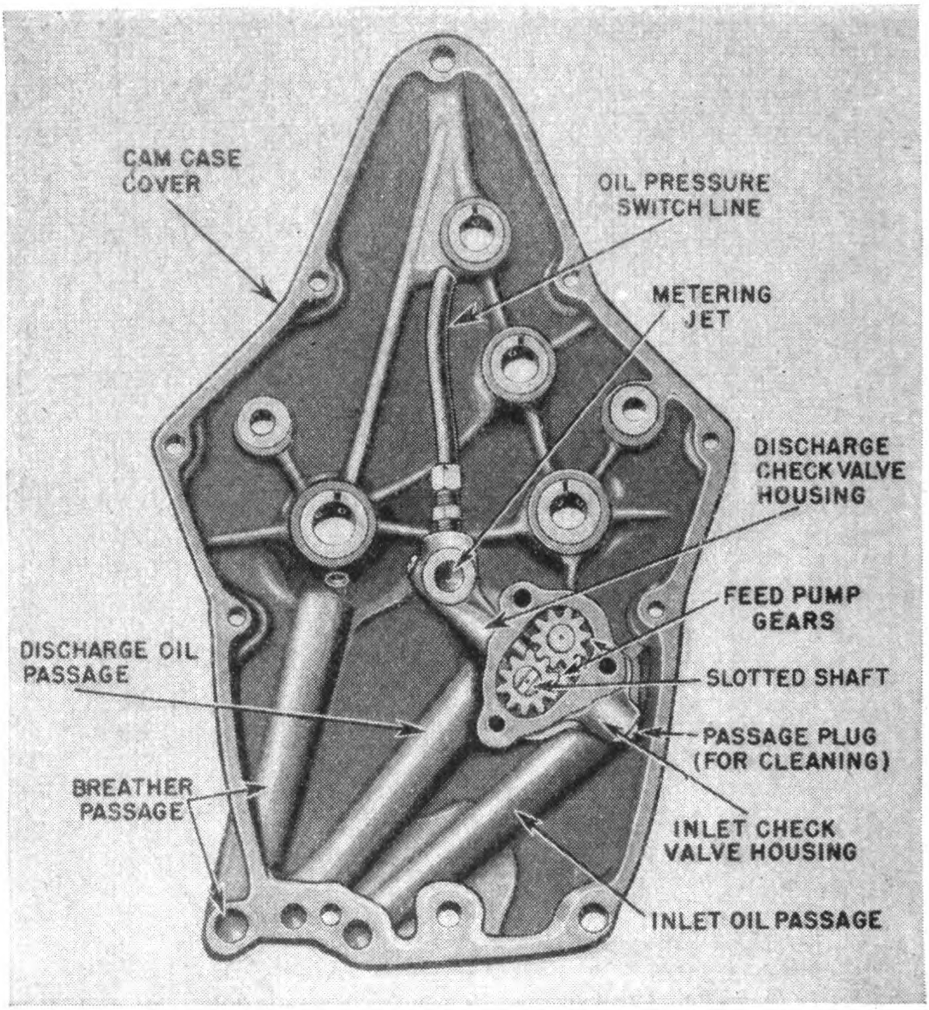

FIGURE 76.—Feed and scavenger pumps of Indian shaft-driven motorcycles.

is stored at the bottom of the crankcase instead of in a separate oil tank. The scavenger pump is omitted since the oil returns to the crankcase by gravity. The gear type feed pump is located in the lower part of the crankcase and is driven by an extended shaft geared to the camshaft. The pump draws the oil from the crankcase through a screen and forces it to the main and connecting rod bearings. The cylinder walls and piston pins are lubricated by splash as the crankshaft rotates in oil and by a spray from the connecting rod lower bearings. Holes in the crankcase walls catch excess oil and direct it to bearings not lubricated by pressure or splash. The timing gears are lubricated by oil flowing through a tube and dripping on the timing gear pinion.

(2) A sheet steel oil pan is bolted to the lower open portion of the crankcase. It has an oil drain plug on its under side, and an oil filler plug on the left side. A bayonet gage for reading the oil level is attached to this filler plug.

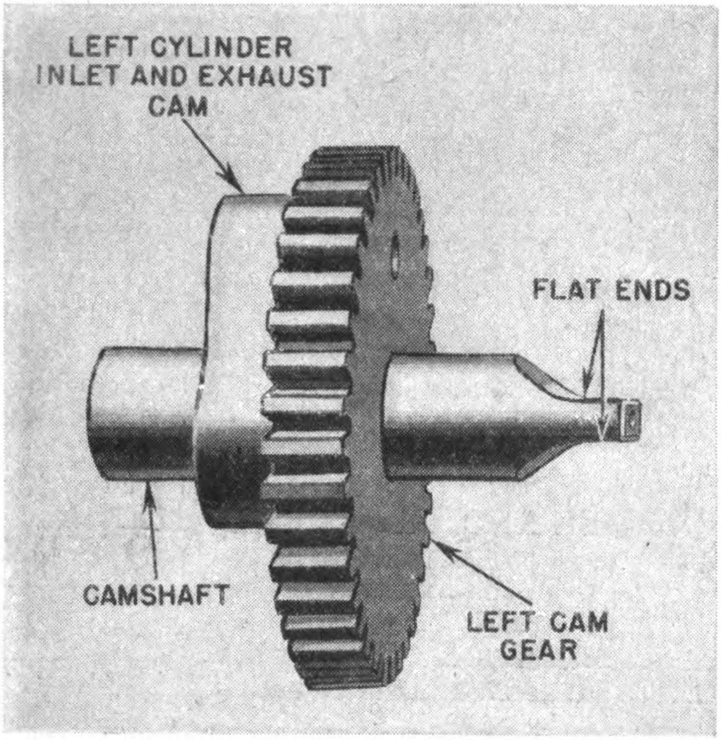

FIGURE 77.—Indian camshaft breather valve.

(3) The breather valve (fig. 78) fits around the front end of the camshaft, and the small-diameter end of the valve fits into a bushing hole in the timing-gear cover. A flange on the large end of the breather valve has several air holes about its edge. The flat surface of this flanged end fits against the face of the camshaft gear, and a small pin on this gear (fig. 75) turns the breather valve when the engine is running. The foul air in the timing gear case enters the flange holes and is expelled through the hole in the small end of the valve.

(4) Oil circulation is indicated by a small red lamp on the instrument panel in the same manner as on the chain-driven model.

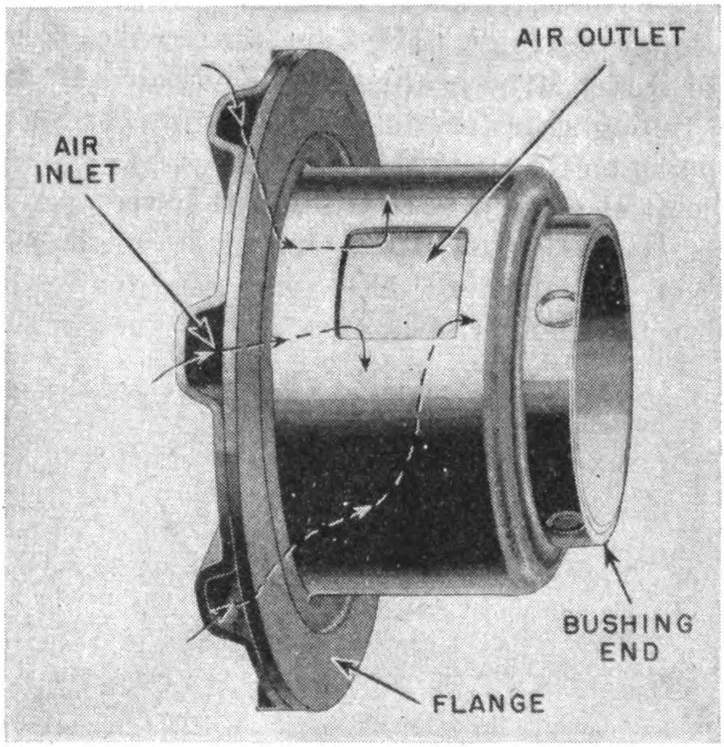

FIGURE 78.—Breather valve on Harley-Davidson engine.

SECTION VIII

FUEL AND EXHAUST SYSTEMS

CHAIN-DRIVEN MODELS

CHAIN-DRIVEN MODELS

66. General.—The motorcycle fuel system delivers a clean, metered, atomized, combustible mixture of air and gasoline to the engine cylinders. It includes fuel tanks, piping, a carburetor, and an air cleaner. Gravity causes the gasoline to flow from the tanks to the carburetor. Accurate metering, proper mixture, and freedom from dirt, dust, and foreign matter in the fuel charge are essential to efficient engine performance.

The exhaust system carries the burned gases from the cylinders to the atmosphere. It consists of an exhaust pipe and a muffler.

67. Fuel tanks.—The motorcycle fuel tank is made of pressed light-gage sheet-metal sections, which are soldered together. Two separate containers, placed side by side and bolted to the top frame member as shown in figure 79 make up the complete fuel tank. One

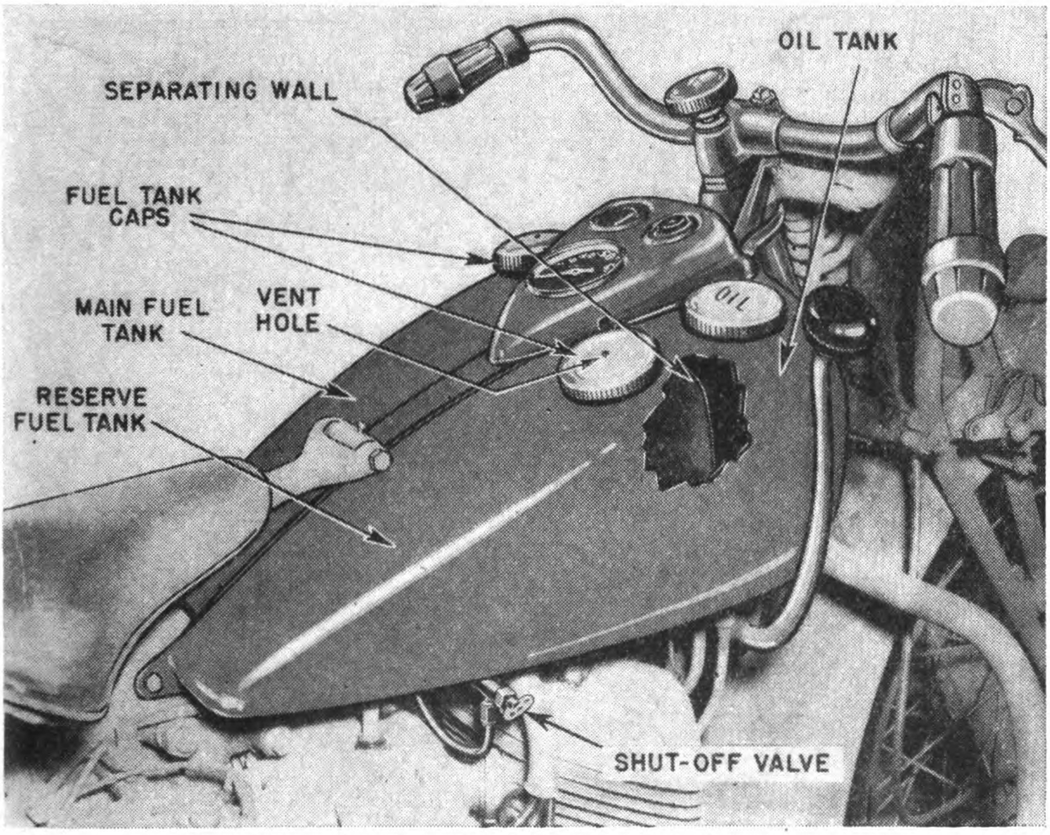

FIGURE 79.—Location of gasoline and oil tanks.

of the containers serves as a main fuel tank while the other carries a reserve of fuel. If leaks develop, the tanks should be removed and, after draining, repaired. Gasoline dripping on a hot engine is a serious danger.

a. Reserve tank.—On some motorcycles the reserve tank is divided into two parts, one of which is used as an oil container. The gasoline and oil caps should *not* be interchanged on this type of tank. There are small ventholes in the gasoline tank caps. The oil tank cap, which is the shorter cap, has no vent. If it is used on the gasoline tank, a vacuum builds up in the tank and the gasoline cannot run freely at high speed, with the result that the engine becomes sluggish and stops. Plugged-up ventholes in the gasoline tank cap will give the same result.

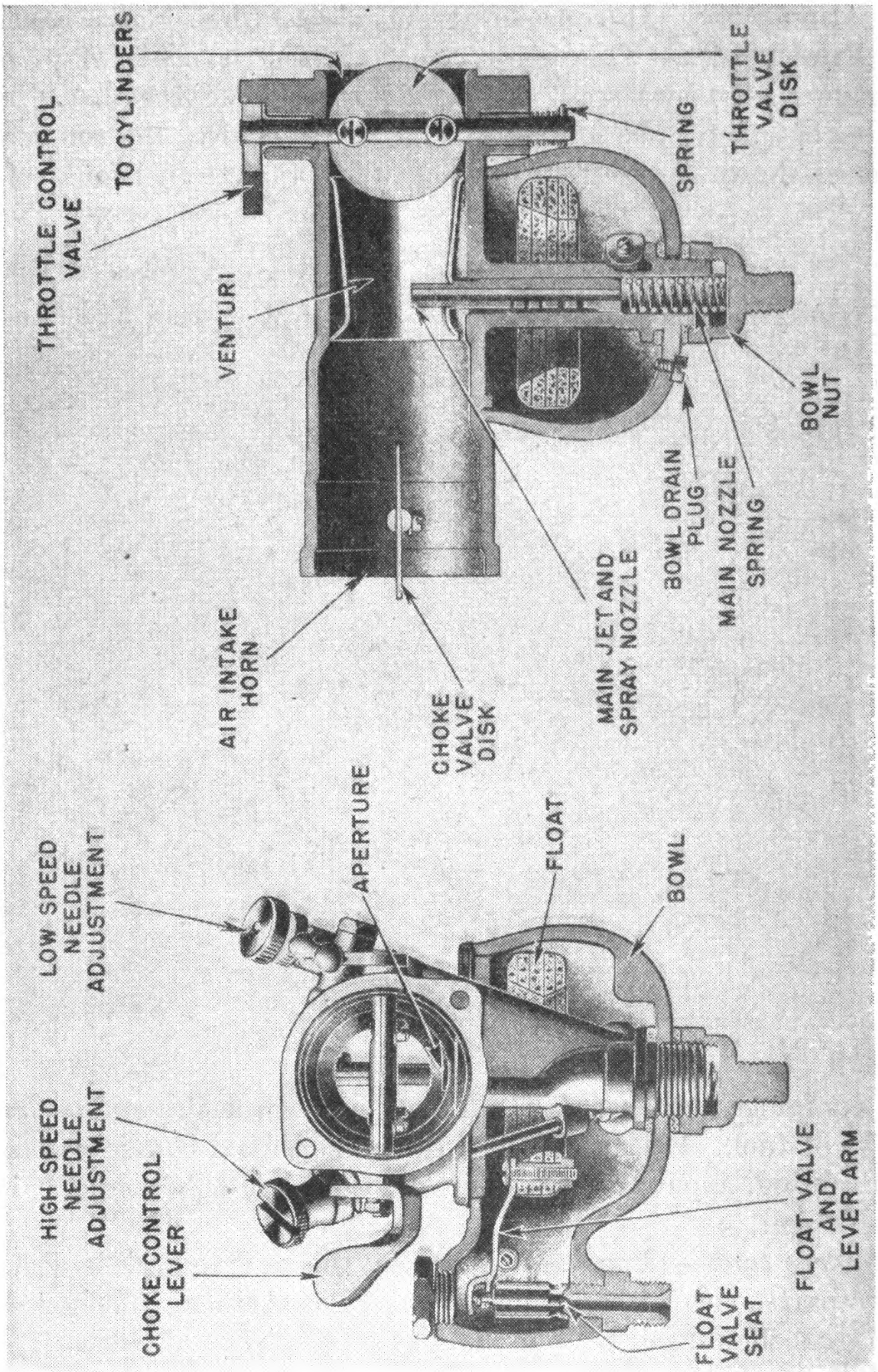

FIGURE 80.—Sectional views of a plain tube carburetor.

b. Shut-off valve.—At the bottom of each tank is a separate shut-off valve (fig. 79) connected to a single pipe leading to the carburetor on the left side of the engine. These will stop the gravity flow of gasoline to the carburetor.

68. Carburetion.—The carburetor has four functions. It accurately meters, atomizes, and mixes the gasoline with the correct quantity of air, and delivers this mixture (fuel charge) to the engine cylinders. The plain tube (side-draft) type of carburetor (fig. 80) has been found more adaptable for motorcycles than the up-draft or down-draft types used on automobiles.

a. Operation of carburetor.—(1) The fuel charge is mixed in the carburetor and delivered to the cylinders as indicated in figure 81.

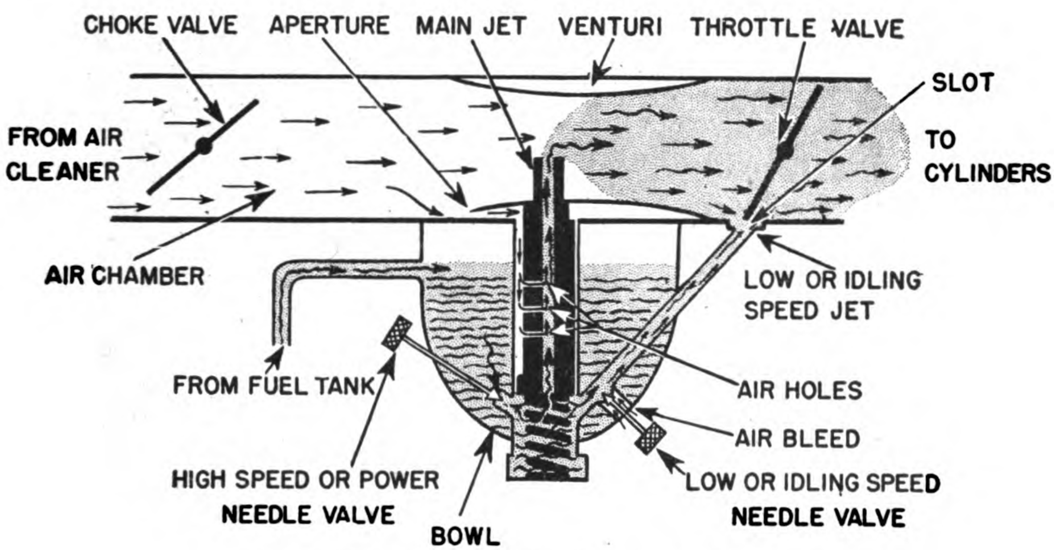

FIGURE 81.—Operation of a plain tube carburetor.

The flow of the air stream into the carburetor is controlled by the choke valve; flow of the fuel charge out of the carburetor is controlled by the throttle valve. (See figs. 80 and 81.)

(2) A small part of the main air stream is by passed through a small aperture in the venturi and enters the main jet through small airholes. As this air turns upward, it helps to lift and atomize the gasoline in the main jet.

(3) Gasoline is admitted from the carburetor bowl to the bottom of the main jet by the high-speed needle valve. This flow of gasoline is due principally to the vacuum created by the main air stream passing over the top of the jet. The high-speed needle valve on Harley-Davidson motorcycles is fixed at the factory by a setscrew for the most efficient engine performance. It should not be readjusted except by a motorcycle mechanic. On the Indian, it is adjusted by a thumbscrew.

(4) The main jet fuel charge cannot enter the engine cylinders when

the throttle valve is closed. Therefore, to enable the engine to run at idling speed (throttle closed), gasoline is by-passed from the bottom of the main jet through a jet at the side of the carburetor to a small slot at the throttle valve. Part of the slot is between the closed throttle valve and carburetor outlet. An adjustable low or idling speed needle valve regulates the quantity of gasoline. Air seeps through a bleed in this valve and helps to lift and atomize the gasoline in the by-pass passage.

(5) One of the most important features of the plain tube carburetor is the venturi, which is placed in the main air stream. It is a constricting or narrowing device which speeds the flow of air as it passes over the main jet. The suction thus created draws gasoline from the main jet and atomizes it into a fuel mixture.

(6) The choke valve controls the volume of air drawn through the carburetor from the air cleaner. When it is partly closed, the proportion of air in the mixture is decreased, producing a richer mixture for starting and warming up the engine.

(7) The throttle valve controls the amount of fuel mixture passing from the carburetor to the engine, thereby regulating the engine speeds.

b. Proportion of mixture.—The performance of the engine varies with the amount of the mixture delivered, and also with the proportion of air and gasoline in the mixture.

(1) In a correctly proportioned mixture, the air provides just enough oxygen to burn the fuel. If the proportion of gasoline is greater, the mixture is called "rich." If the proportion of gasoline is less, the mixture is called "lean." The ideal mixture contains about 15 parts of air to one part of gasoline by volume. The engine may operate, however, with such extreme mixtures as 8 to 1 (rich) or 20 to 1 (lean).

(2) A very lean mixture causes a light blue exhaust flame. A rich mixture causes a sort of yellow flame. The proper mixture of 15 to 1 will give an intense, white-blue exhaust flame.

(3) Results of different mixtures may be summarized as follows:

(*a*) *Very rich mixture* (8:1 to 11:1).—Loss of power, much carbon formation, sooty spark plugs, sluggish engine performance, and excessive fuel consumption.

(*b*) *Correct mixture* (15:1).—Good power and fuel economy, clean exhaust and spark plugs.

(*c*) *Lean mixture* (15:1 to 17:1).—Less power, more fuel economy, clean exhaust, hotter running engine.

(*d*) *Very lean mixture* (17:1 to 20:1).—Low power output, good fuel economy, more sluggish engine performance; overheating and possible ruining of engine with continued high-speed running.

NOTE.—Aluminum alloy pistons may reach melting temperatures with lean mixture at sustained top speed.

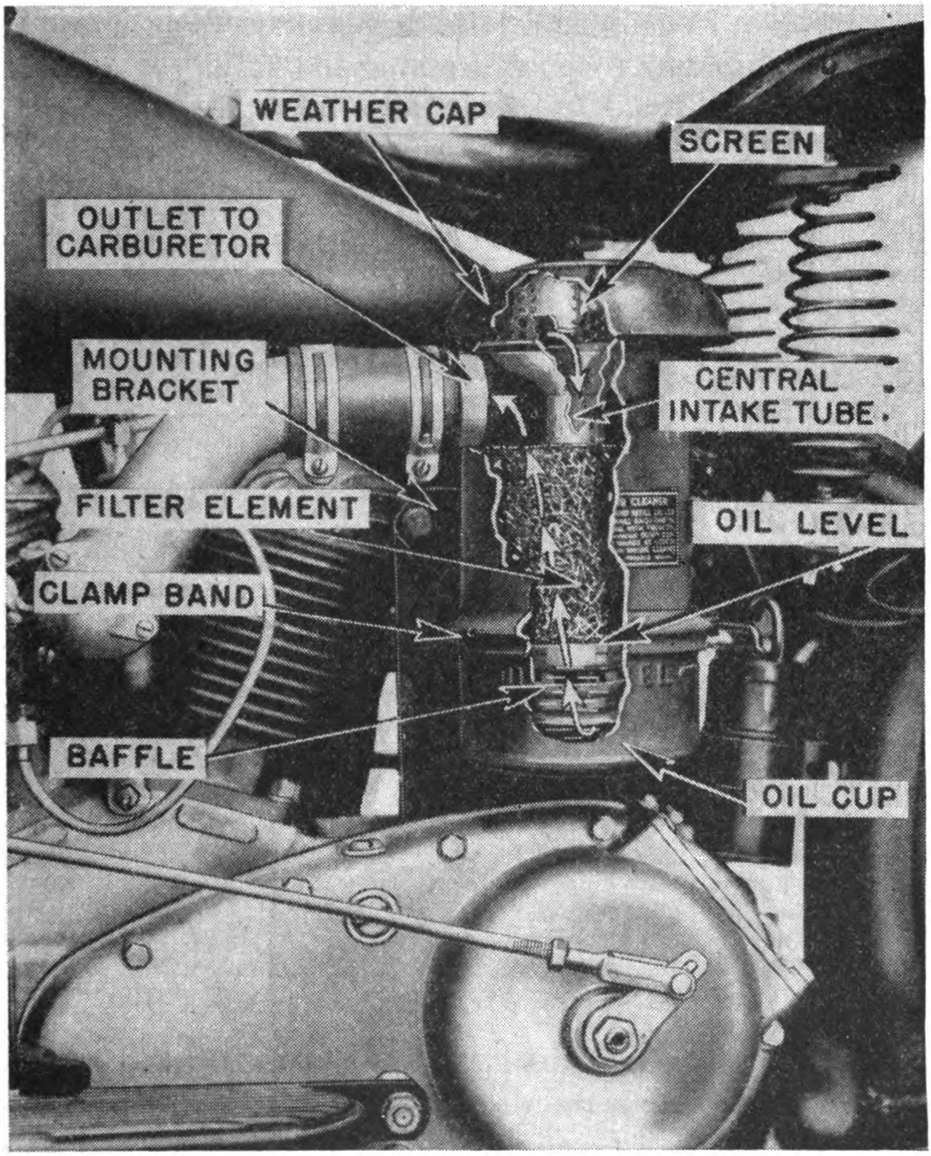

FIGURE 82.—Oil bath air cleaner.

c. Carburetor servicing.—(1) Although the low and high speed jets on most military motorcycles are adjustable, it is not advisable to tamper constantly with carburetor adjustments. If the engine does not start or run just right, look elsewhere for trouble before condemning the carburetor or changing its adjustment. The trouble may be defective spark plugs, as the carburetion and ignition are very closely allied. When starting and warming up are difficult, it may be that the circuit breaker points are set incorrectly or are dirty. When carburetors wear out, they should be replaced or repaired.

(2) It is good pactice to have the carburetor cleaned from time to time by a motorcycle mechanic. The most common cause of carburetor trouble, besides improper adjustment, is water and dirt in the float bowl. Some late model motorcycles have a drain plug in the bottom of the bowl to facilitate frequent draining and flushing.

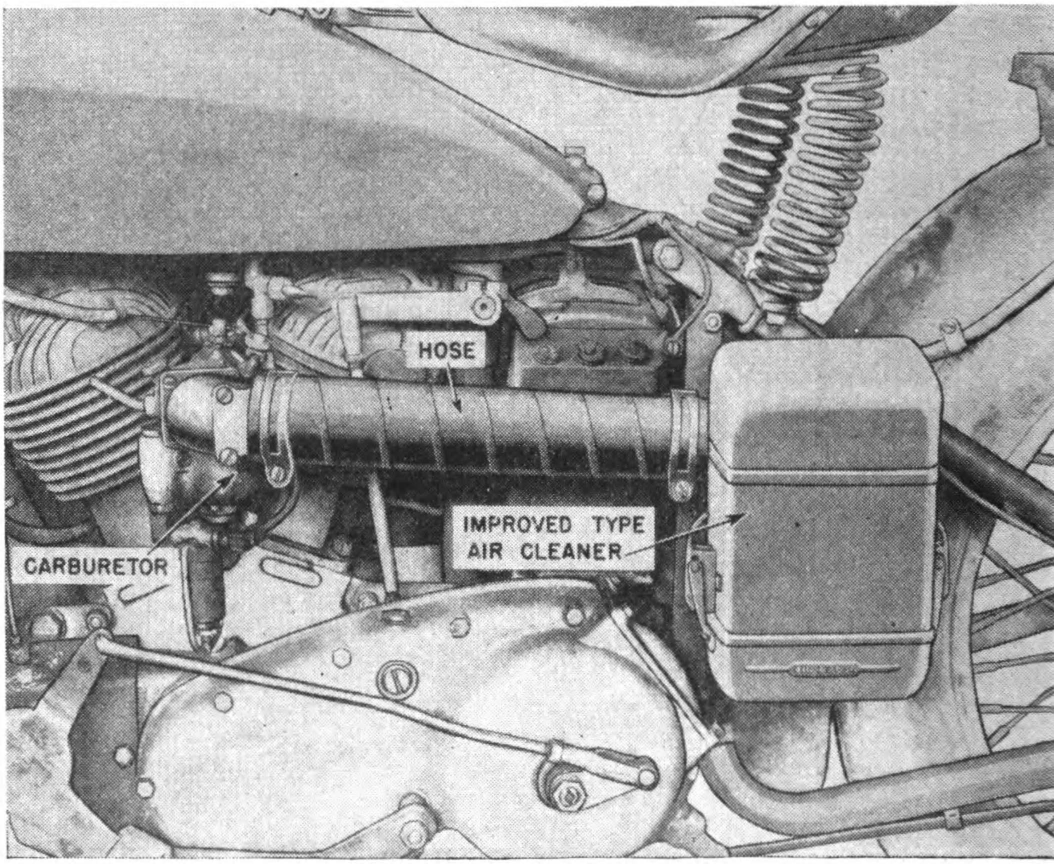

FIGURE 83.—Improved type of oil bath air cleaner.

69. Air cleaner.—*a.* The air cleaner, connected to the choke end of the carburetor, filters the dust and dirt from the air before it reaches the carburetor. By eliminating all foreign matter, it prevents excessive internal engine wear.

b. Oil bath cleaners (figs. 82 and 83) are used on all military motorcycles. In this type, air enters the central intake tube through a screen and is drawn through the oil which soaks the dust and other foreign matter. As the air turns upward, the wire wool filter element filters out this oil-soaked dust and foreign matter, so that only clean air enters the carburetor. Figure 83 shows an improved type of oil bath air cleaner having several features that are advantageous in military service. Its rectangular shape takes up less space. The air inlet consists of horizontal openings or louvers near the top of the cleaner body. They are placed on the side of the cleaner facing the motorcycle so that when the motorcycle is laid on its side the cleaner will not scoop up and draw in dirt and sand. The two wire wool filter elements (fig. 84) can be quickly removed for replacement or cleaning in gasoline. The oil reservoir is fastened to the bottom of the cleaner body by two side clamps. The cleaner is shielded to prevent the oil from draining out when the motorcycle is lying on its side.

c. The oil reservoir on either type of air cleaner should be removed, cleaned, and refilled each time oil is drained from the supply

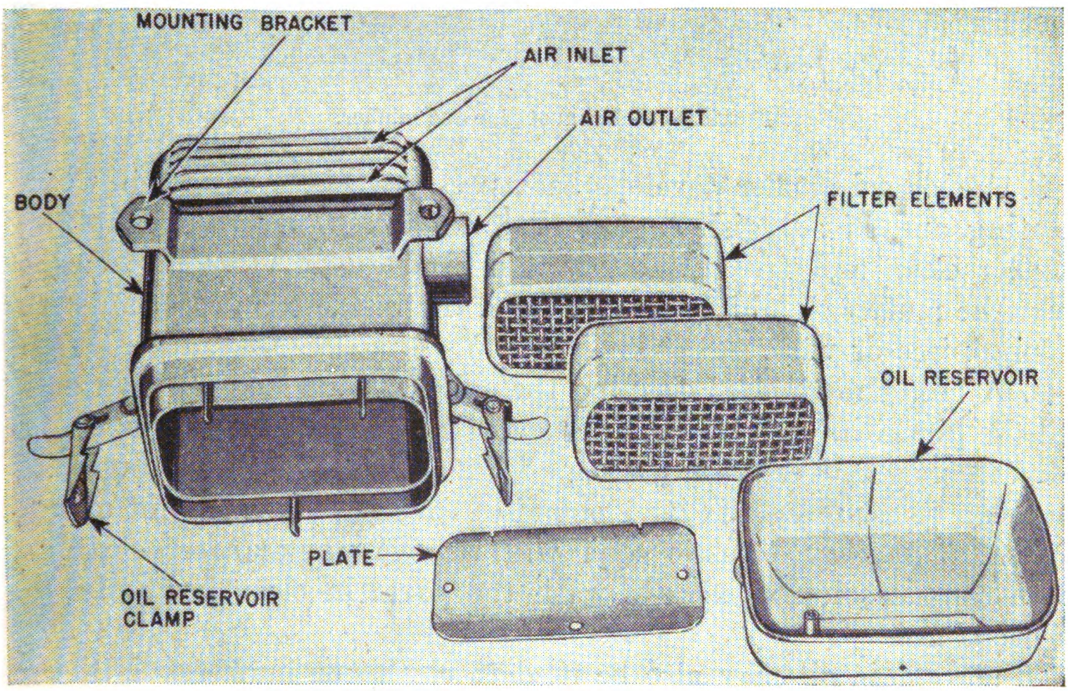

FIGURE 84.—Improved type of oil bath air cleaner, disassembled.

tank of the motorcycle. If the motorcycle is operated under extremely dusty conditions, the filter element should be cleaned and refilled with fresh oil more frequently.

d. Disassemble the entire cleaner occasionally and wash all parts thoroughly in clean gasoline. Always refill the reservoir with the same grade of oil used in the engine.

70. Exhaust pipe and muffler.—*a.* A muffler is an expansion box in which exhaust gas pressures decrease to nearly atmospheric pressure before they are released into the air. This reduces the noise. In the conventional muffler (fig. 85), a series of baffle plates or tubes pass the gases back and forth before they reach the tail outlet. Some mufflers use wire wool to deaden and absorb the noise. The exhaust pipe and muffler are attached to the side of the motorcycle frame by brackets.

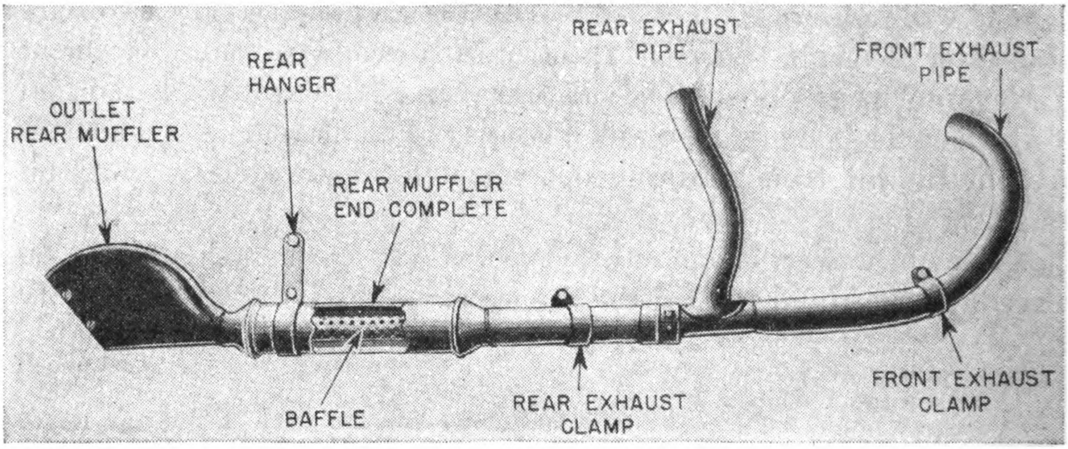

FIGURE 85.—Exhaust pipe and muffler.

b. A clogged muffler develops back pressure which results in overheating and in sluggish engine performance. Therefore, keep the muffler clean and free from soot and road dust. Once or twice a year the muffler should be removed and the inside scraped clean with a long piece of wire.

c. A better method of cleaning the exhaust pipe is to cork an end, fill the pipe with a good cleaning solution, and churn it for a while. Mufflers may be treated in the same manner. A strong cleaning solution can be made by mixing 1 pound of caustic soda in 1 pint of hot water. ***Caution:*** Caustic soda will remove paint; after cleaning with caustic solution, always wash the parts in clear hot water to prevent rust.

d. Paraffinic oil may also be used to clean out mufflers. Fill the muffler with this oil, allow it to stand overnight, then shake vigorously, drain the oil off, and clean the muffler with kerosene.

SHAFT-DRIVEN MODELS

71. Carburetion.—*a.* Dual carburetion (one carburetor for each cylinder) is employed on both makes of shaft-driven models. The two carburetors are synchronized in order to deliver an equal quantity of the air-fuel (ratio) mixture to the two cylinders. If this is not done, the engine operation will be rough. The throttle and choke settings may be regulated on the left side of the motorcycle and are synchronized by means of the adjustable setscrews on the cross linkages connecting the two carburetors as shown in figure 86. The throttle control linkage of this carburetor is operated by turning the left handle-bar grip in the same manner as the throttle on chain-driven motorcycles.

b. Shaft-driven motorcycles use the same type of plain tube carburetors as the late chain-driven models. However, a nozzle spring thrust screw (fig. 87) has been added to the carburetor bowl. This screw holds the main jet or nozzle in place when the bowl nut is

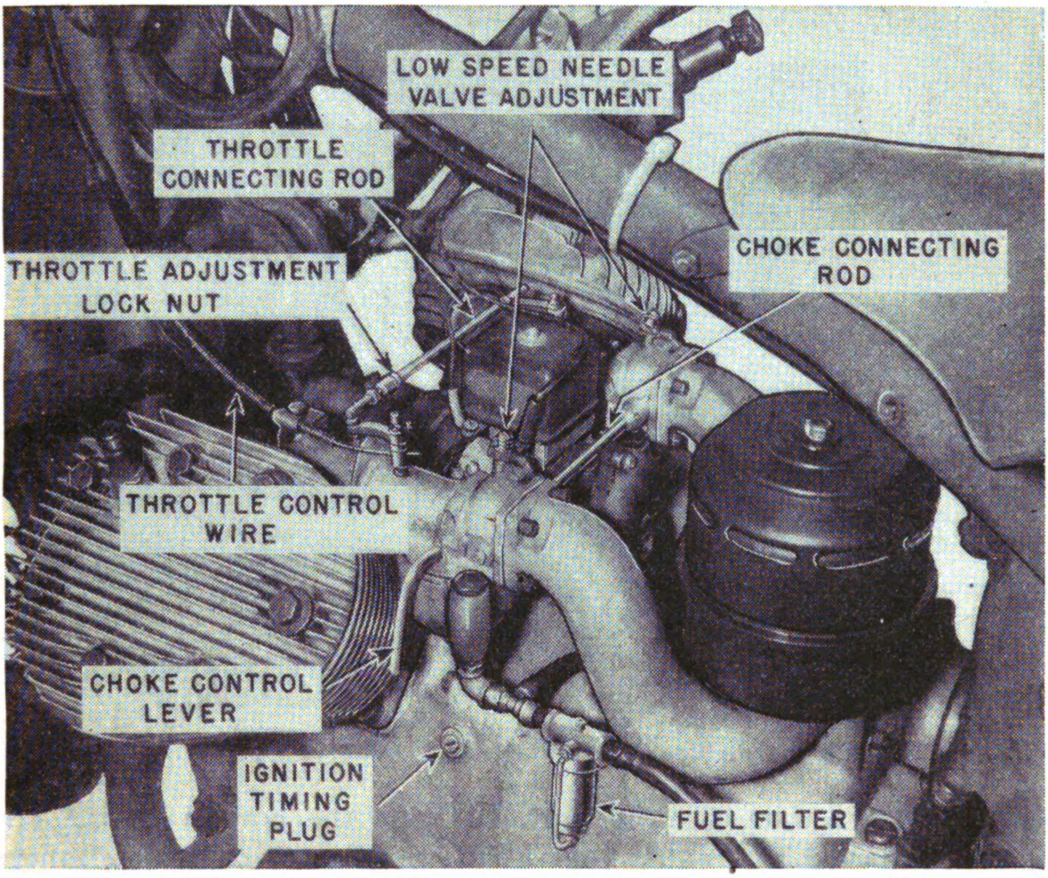

FIGURE 86.—Dual carburetors mounted on Indian motorcycle.

taken off. It thus prevents losing the jet when the bowl is removed for cleaning. The knurled nut for adjusting the low-speed needle valve now has a stop which limits its turning and thus restricts the maximum and minimum low-speed setting. This overcomes the difficulty of turning the nut too far if adjustments are made while driving. Only the low-speed needle valve can be adjusted manually on the shaft-driven models. The high-speed needle valve is a "fixed metering jet" and requires no adjustment.

c. A screen-type of filter connected to the fuel line between the main fuel tank and carburetors removes foreign matter from the fuel before it reaches the carburetors. This fuel filter should be removed and cleaned periodically to insure proper filtering. It can be removed by turning a knurled nut that holds the filter body in place.

72. Air cleaner.—The upper part of the Harley-Davidson transmission case contains a large air chamber separated from the gear housing by a cast-in wall (fig. 88). The top of the case has three holes. The carburetor air-intake hoses are connected to the two

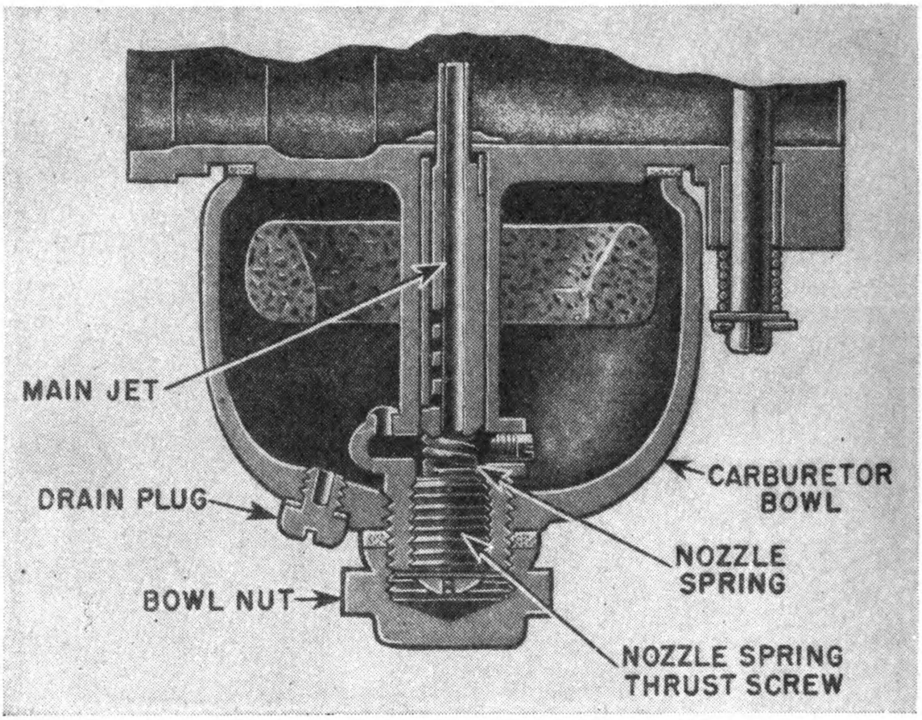

FIGURE 87.—Cutaway view showing nozzle spring thrust screw.

outer holes. A boss projects upward from the bottom of the air chamber, toward the center hole, and supports the oil-bath cleaner. Air entering the cleaner flows through the air chamber and into the carburetors. Two small drain screws are provided at the two lower rear corners of the air chamber in order to drain oil or moisture that may accumulate in it.

73. Exhaust pipe and muffler.—Each cylinder on shaft-driven models has its own exhaust pipe and muffler (dual exhaust system). This system not only prevents the exhaust pressure of one cylinder from entering the other cylinder, but also aids in cooling the engine. The low forward position of the pipes makes them susceptible to damage when operating over very rough terrain.

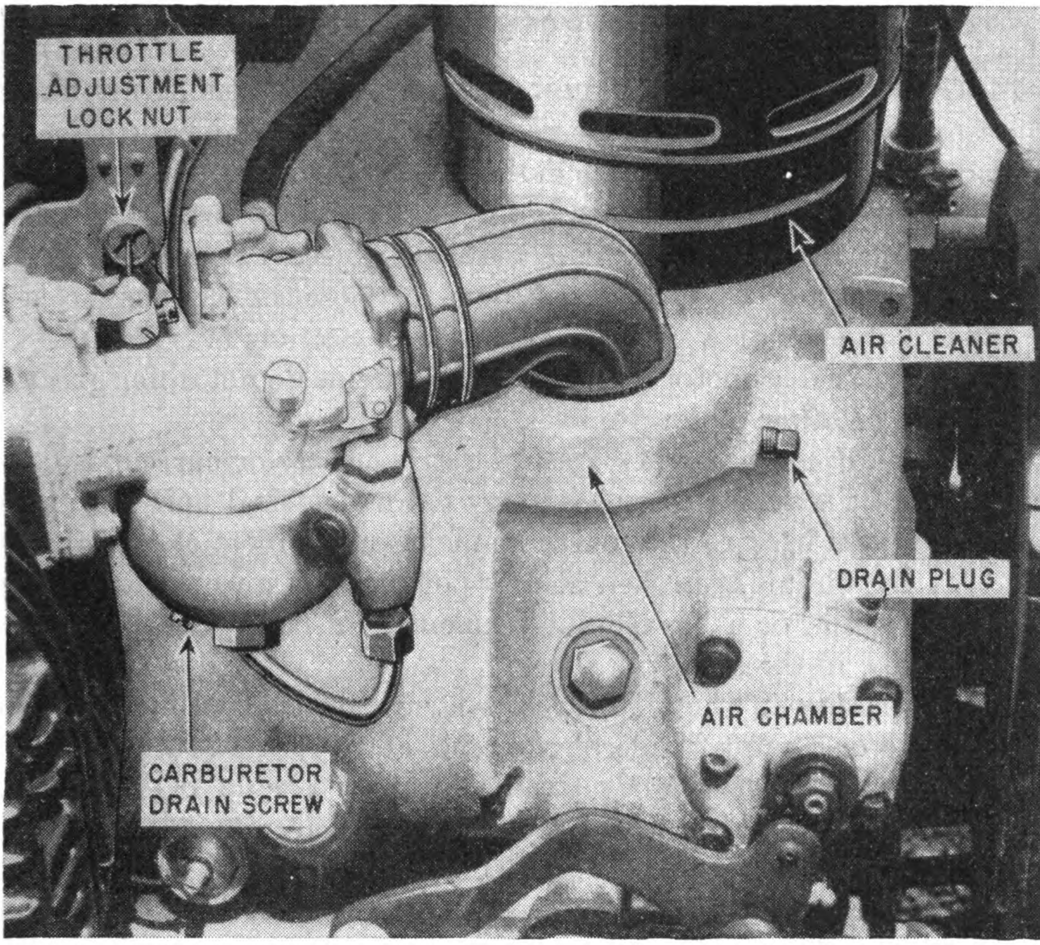

FIGURE 88.—Air cleaner mounting on Harley-Davidson shaft-driven motorcycle.

SECTION IX

ELECTRICAL SYSTEM

CHAIN-DRIVEN MODELS

74. General.—In order to know where electrical troubles are likely to occur and what to do to correct them, some basic knowledge is needed of where electricity flows in the motorcycle, what happens when it flows, and what happens when it fails to flow in the proper manner. The hard service to which a motorcycle is subjected makes necessary a frequent check of the electrical system for loose connections, broken wires, and cracked or worn wire insulation. Section IV, TM 10–580, should be studied as motorcycle electrical systems do not differ greatly from those of other motor vehicles.

a. Electrical circuits.—(1) When electric energy or current is conducted from a source such as a battery to an electrical unit such as a lamp, and then back to the source, it makes a complete electrical circuit. If the circuit is broken at any point, as by an open switch, a loose connection, or a burned-out filament in a lamp, the electricity ceases to flow in the circuit.

(2) Electricity in the motorcycle system is conducted by wires on the positive or "supply" side of a circuit and returned to the source through the frame on the negative or "grounded" side of the circuit. Switches are provided to complete or break the circuits.

(3) The wiring diagram (fig. 89) illustrates the lay-out of the various electrical circuits on the two makes of military motorcycles used in the Army. Electricity produced by the generator is stored in the battery. From the battery, current is supplied to the ignition circuit, service light circuit, blackout light circuit, horn circuit, and any other units which require electricity in their operation. Connecting wires are insulated to prevent leakage or "shorting" of the circuit and are protected against abrasion or other damage to the wire by the insulation.

b. Locking switch.—(1) Latest Army motorcycles are equipped with a key locking switch (fig. 90) for the ignition and lights. It uses the standard military No. H–700 key. With this switch it is not necessary to leave the key in its position during operation. After the switch is unlocked, the key may be removed, leaving it unlocked. However, the switch should be locked before leaving the motorcycle. A hinged cover protects the switch from moisture and dust when the key is removed.

(2) When the winged knob is turned as far as possible to the left, the switch is in "off" position and no current flows in any circuit of the electrical system. Turning the knob one notch to the right closes

the ignition circuit so the engine can be started. Two notches to the right closes the blackout lighting circuit as well as the ignition circuit.

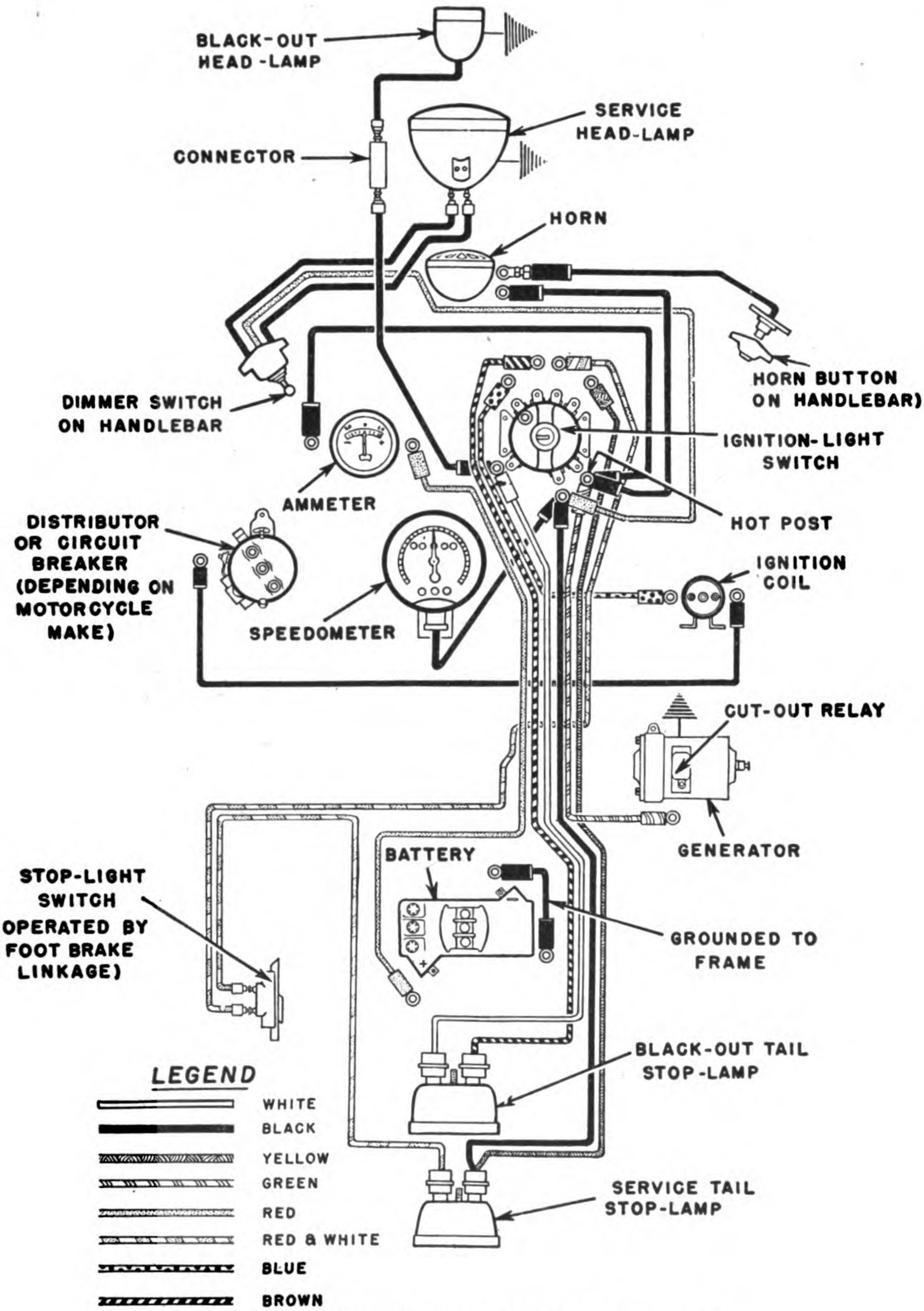

FIGURE 89.—Wiring diagram of military motorcycles.

(3) To switch to the service lighting circuit, the small safety button on the switch face must be depressed, which releases the knob so it can

be turned to the next notch at the right. In this position only the ignition circuit, service headlight circuit, and taillight circuit are closed. The dimmer switch on the left handle bar is introduced in the service headlight circuit for dimming the light.

75. Battery and generator circuit.—This circuit is the source of current for the electrical system. The current is produced by the generator which charges the battery. The battery then delivers the current to the various circuits.

76. Battery.—*a. Construction.*—The storage or wet cell battery construction in a motorcycle is similar to that used on other motor

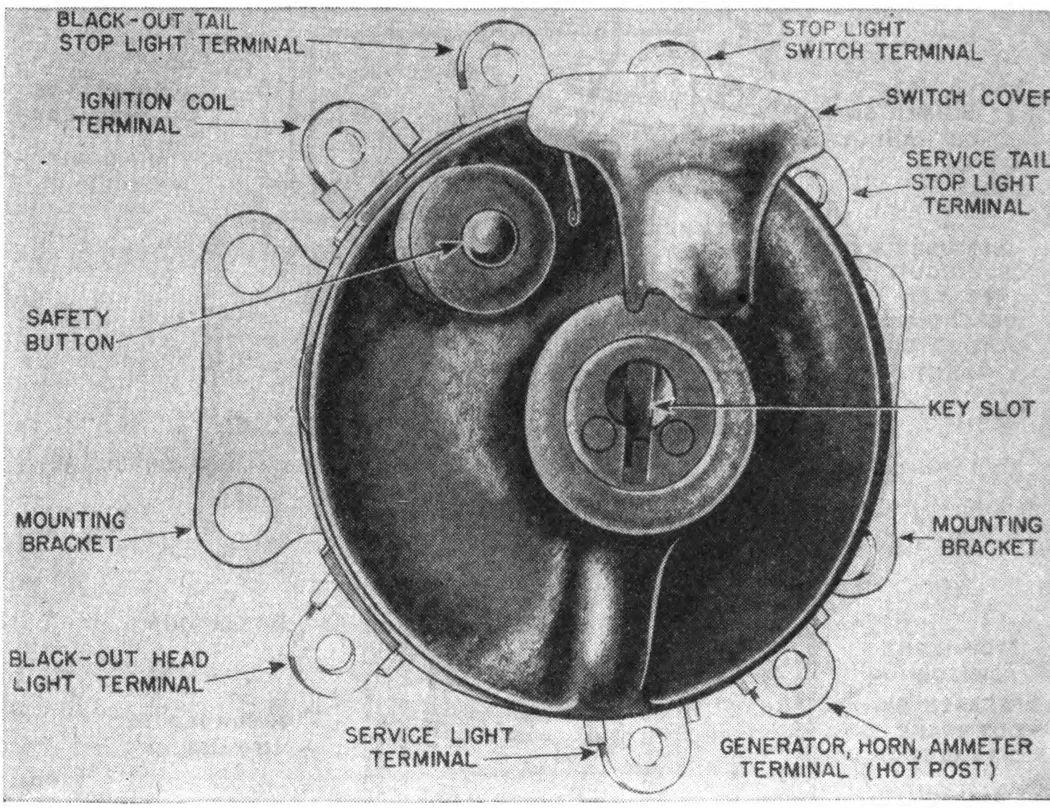

FIGURE 90.—Standard military motorcycle ignition and lighting switch.

vehicles. It is an electro-chemical device through which the generator cannot pass more than 8 volts. Therefore, when the battery is in good condition and is securely connected in the circuit, there is no danger of high voltage reaching the various electrical units in the system. A motorcycle battery must be able to withstand exposure and extreme vibration. For this reason, some batteries are protected by a welded cover. The military motorcycle is equipped with a 6-volt, 29-ampere hour capacity battery. It is mounted on brackets underneath the saddle where it can be serviced or removed easily. It is grounded to the frame.

b. Servicing.—The frequent tilts and falls of motorcycles often cause the electrolyte to spill out of the battery, increasing the need for frequent checking and servicing. Check the battery with a hydrometer once a week and then add water if necessary. After the water is added, the hydrometer will not give a true reading, since the acid and water will not have had time to mix. When the specific gravity of the battery drops to 1.215, the battery should be recharged at a rate of 3 amperes until the reading rises to between 1.285 and 1.300. Keep a

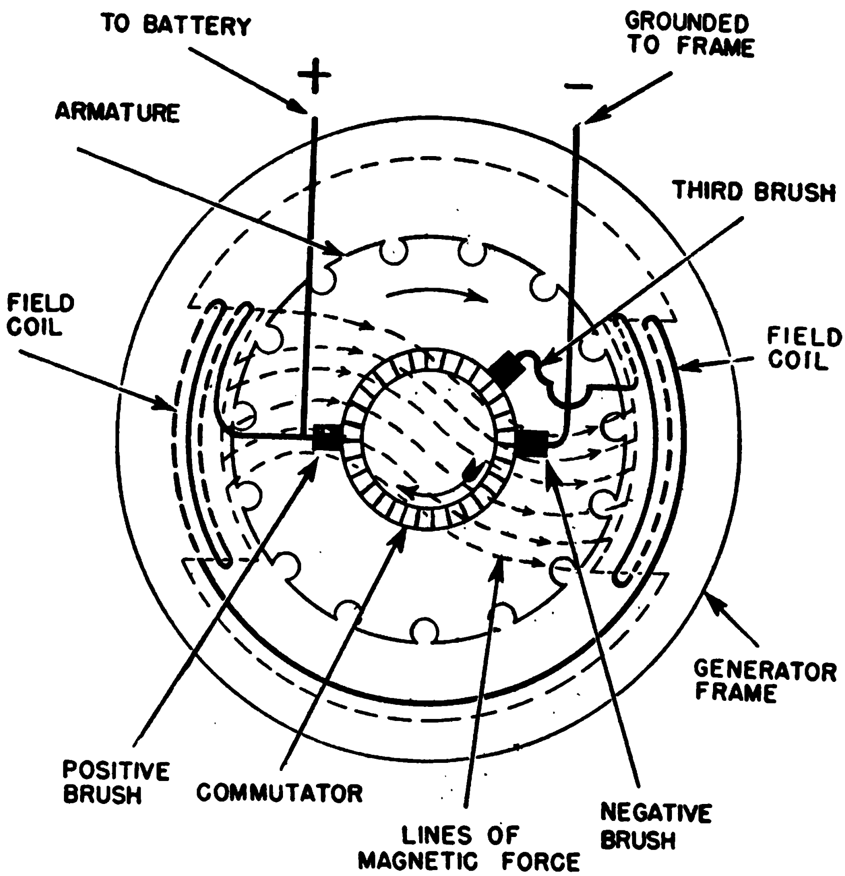

FIGURE 91.—Function and location of third brush.

close check on the battery while charging to prevent overheating. If the specific gravity of the battery will not rise, it is permissible to dump out the old electrolyte and add new acid of 1.345 which, when it cools off in the battery, will read approximately 1.295. When mixing concentrated sulphuric acid with water to form a 1.345 solution, always *add the acid to the water;* otherwise, the concentrated acid may spatter and cause serious burns.

77. Generator.—The generator is a machine designed to produce electricity. In its simplest form, an electrical pressure is induced in a loop of wire (armature) between the poles of a magnet (magnetic field). The current is taken off one end of the loop, passes through an electrical circuit, and is returned to the other end of the loop. The generator on the motorcycle is merely a development of this simple machine. Its armature has many loops of wire terminating on a ring or commutator at the end of the armature shaft. (See fig. 91.) The magnetic field is created by field coils, which are coils of wire wound around soft iron coils (poles) which become magnetized when a current flows through the wire.

a. Brushes.—Electricity is taken off the commutator by brushes. Some of it is diverted or shunted to the field coils. Two of these brushes are located diametrically opposite each other and are stationary. A movable third brush, located near the negative stationary brush, also rests on the commutator.

(1) Since the armature is driven by the engine, its speed varies with the speed of the engine, from one extreme to another, and the generator's output likewise tends to vary greatly. The function of the third brush is to keep the generator's output within certain limits. It is so located that when a certain distortion occurs in the magnetic field, the current taken off by the third brush and shunted to the field coils decreases as the armature speed increases.

(2) The extent to which the third brush affects the amount of current shunted to the field coils is determined by its distance from the negative brush. To decrease current output, the third brush is shifted away from the negative brush in the opposite direction to armature rotation. With the third brush in this position, fewer active armature loops are feeding the field coils. Since the magnetism produced by the field coils causes the armature to generate electric current, any change in the magnetic field will influence the generator current output accordingly. Thus, the third brush offers excellent voltage regulation to prevent the generator from burning up when driving at high speeds.

b. Harley-Davidson generator.—(1) The generators of the Indian and Harley-Davidson motorcycles are substantially the same. However, the Harley-Davidson generator is connected so that the output is almost doubled when the light switch is turned on. Thus the same amount of current is available for the battery whether the lights are turned on or off.

(2) Figure 92 illustrates how a Harley-Davidson generator is connected internally. One of the field coils is connected to the positive brush and the third brush. The shunt field coil is connected to the grounded brush and the hot post (live terminal) on the lighting switch. When the light switch is turned off, the first field coil func-

tions like any generator, giving an output of 4 to 5 amperes. When the light switch is turned on, the shunt field coil is connected directly to the battery current and becomes active, increasing the magnetic field and thereby increasing the current output.

c. Mounting.—Generators are mounted on the crankcase or motorcycle frame. They are driven by the flywheel main shaft through a

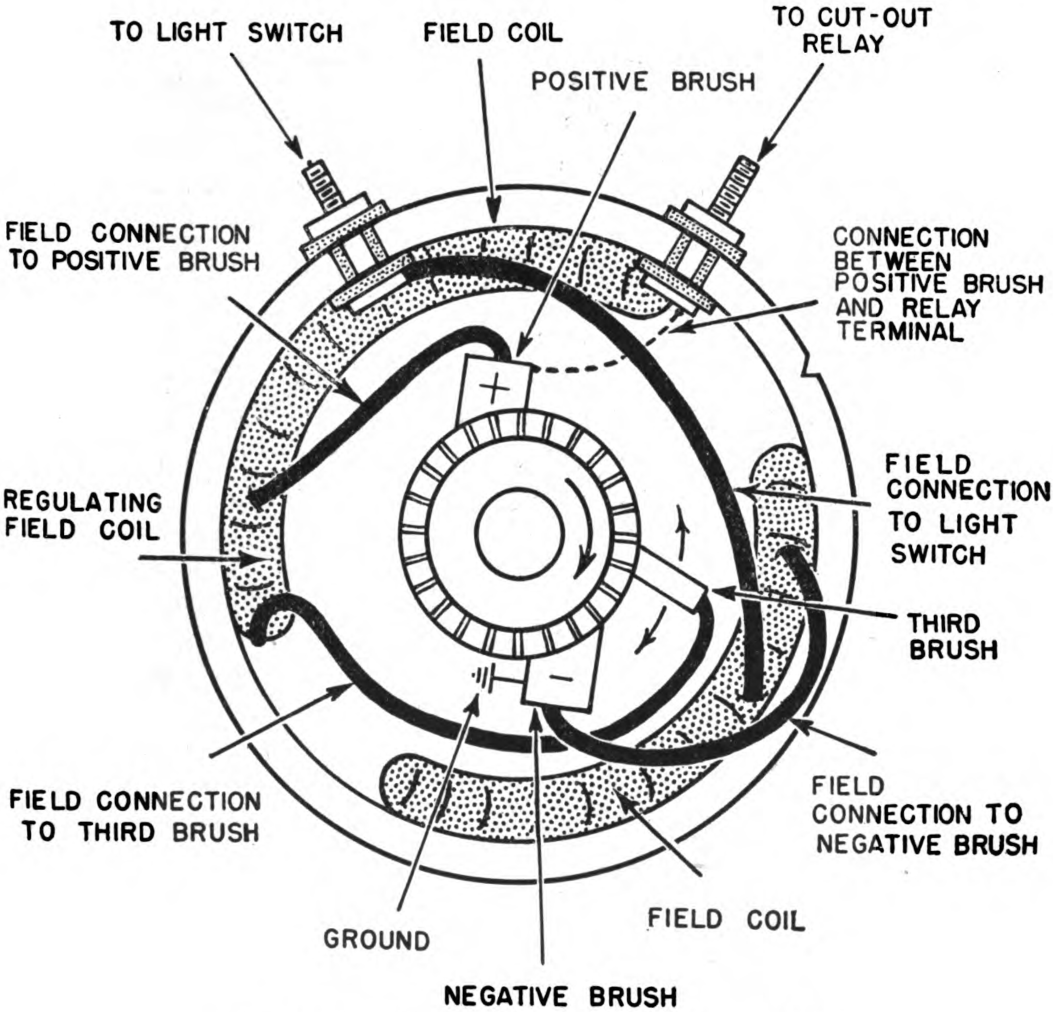

FIGURE 92.—Harley-Davidson shunt-coil generator.

gear train (fig. 93) or a chain or belt (fig. 94). A chain- or belt-driven generator may be moved forward or back by an adjustment screw and frame bolt to correct the tension of the chain or belt. The chain is inclosed, and lubricated by a breather line running from the oil tank to the chain cover (cover removed in fig. 94).

d. Servicing.—Generators should be checked and cleaned every 1,000 miles, or oftener under adverse operating conditions. Clean the armature and commutator, replace the brush springs if they are weak, and install new brushes. It is cheaper to replace brushes frequently than to buy new armatures or replace those which have been "burned" or "shorted out" by worn brushes. Serious damage to the generator, relay switch, and other electrical units may occur if the battery is accidentally disconnected from the charging circuit; therefore, check all connections. Lubricate the commutator end bearings according to the manufacturer's recommendations.

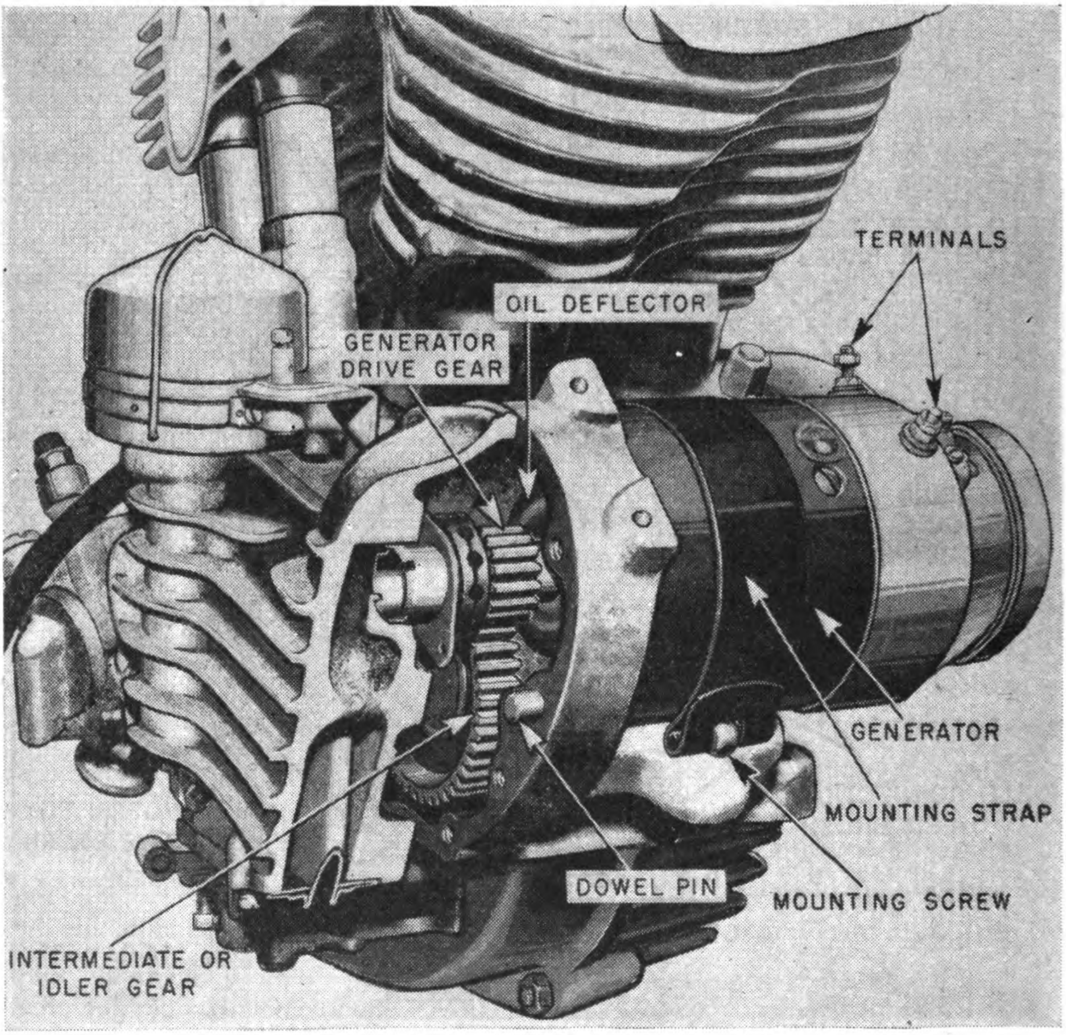

FIGURE 93.—Gear-driven generator.

e. Cut-out relay.—The cut-out relay (figs. 94 and 95) is a magnetic device connected directly between the battery and generator to open and close the circuit, depending upon whether or not the generator is charging. When the generator runs at very low speed or is not running at all, the current from the battery will keep the points open. When the generator is running fast enough to generate more than the battery voltage, the points will close and the battery will be connected in the circuit. There are two windings on a relay magnet core: shunt and series. The shunt is a very fine winding taking only about $1/10$ ampere. The heavy series winding must carry the full generator charge rate. Current coming from the generator will cause both windings to pull on the armature and keep the points closed. Current coming from the battery will divide at the series and shunt windings and cause the magnet to release the armature and its spring tension will open the points. Cut-out relays are usually located on the generator frame and are adjusted to maintain a charging rate of about 4 amperes when driving 30 miles per hour. They

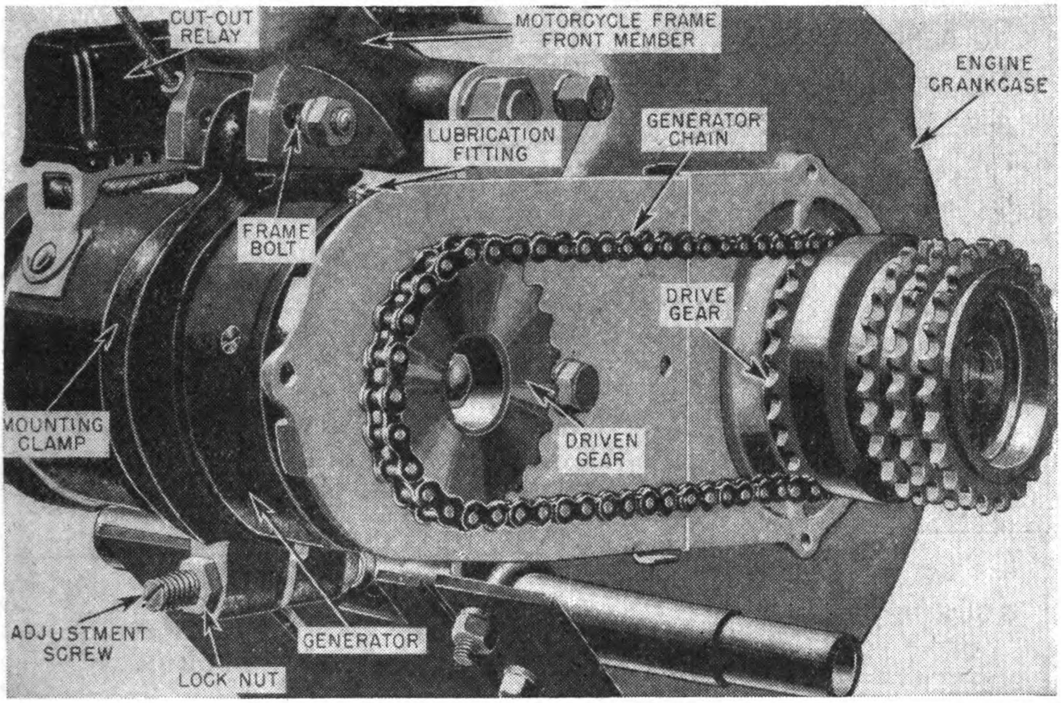

FIGURE 94.—Chain-driven generator with chain cover removed.

prevent the generator from discharging the battery at low speeds and overcharging it at high speeds, to the detriment of the battery.

78. Ignition system (fig. 96).—*a.* The ignition system supplies and controls high-voltage electrical energy to the spark plugs in order to ignite fuel vapors in the combustion chambers. This requires precision-built electrical and mechanical parts which operate efficiently. In addition to its source of electrical energy (battery or generator), the system includes an ignition switch, timer (circuit-breaker), ignition coil, condenser, and spark plugs. On the Indian, an automotive type distributor is also used.

b. There are two distinct circuits in the ignition system: primary and secondary. Keeping these circuits in mind should aid in understanding the operation of the system. The primary (low tension) circuit includes the source of electrical energy, ignition switch, primary winding of the ignition coil, timer, and condenser. The secondary (high tension) circuit includes the secondary winding of the ignition coil, distributor rotor and cap (if used), and the spark plugs. These ignition circuits function in the following manner:

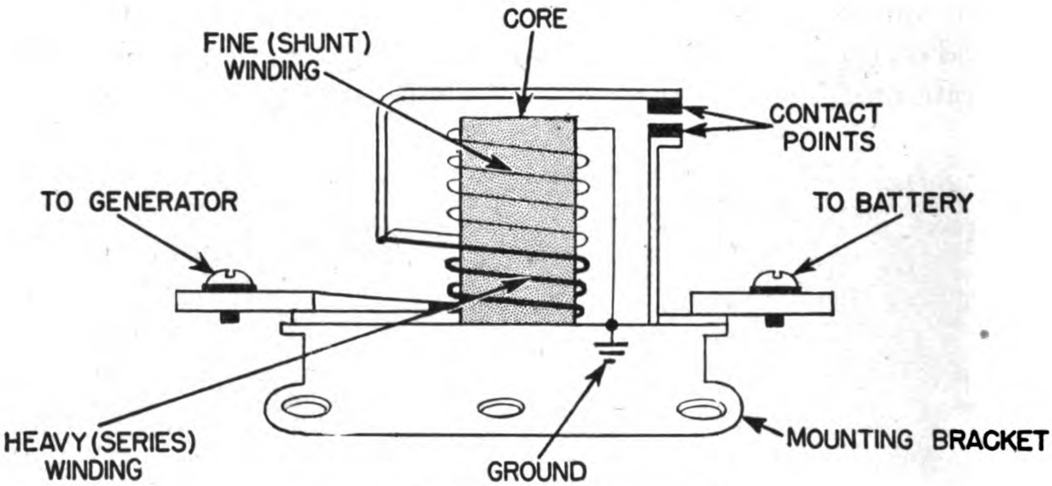

FIGURE 95.—Wiring of cut-out relay.

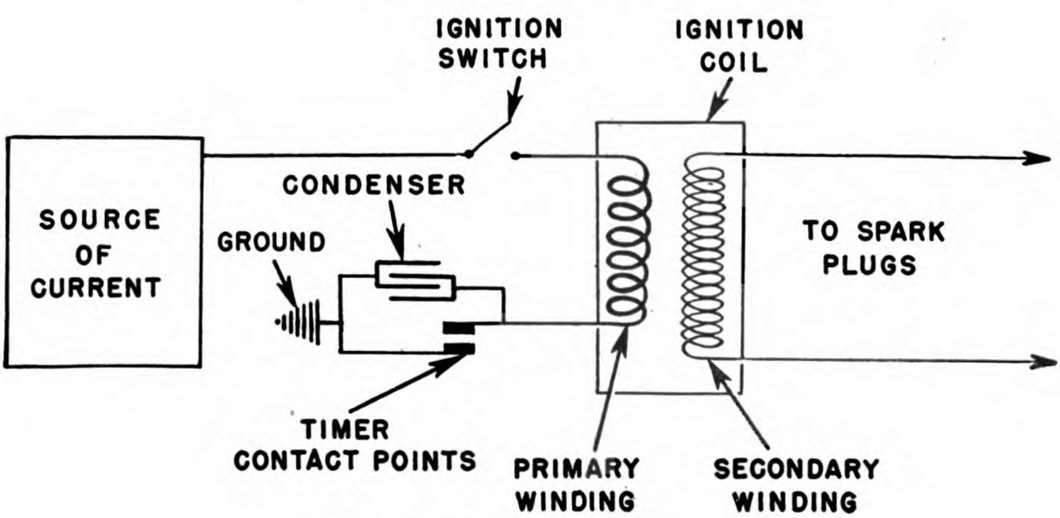

FIGURE 96.—Wiring of ignition system.

(1) After the ignition switch is turned on, the primary circuit is alternately closed and opened by the timer, causing a build-up and collapse of a magnetic field in the ignition coil which in turn causes a high-tension (12,000 to 14,000 volts) current in the secondary circuit. When the timer-contact points open, the current has a tendency to continue flowing and forms an arc across the points.

(2) The condenser, which is connected across the contact points, reduces this arc because it has capacity to store up electrical energy.

The current flows into the condenser and charges it. The condenser action causes a quick reduction of current flowing in the primary circuit. This results in a rapid collapse of the ignition coil magnetic field which induces a high voltage in the secondary winding. This high-voltage current is then delivered to the spark plug.

79. Timer.—*a.* It is evident that motorcycle ignition, like other motor vehicle ignition, must be timed to fire at the proper point before T. D. C. on the compression stroke of the proper cylinder. This is accomplished by the timer (circuit-breaker) which opens and closes the primary circuit. Manufacturer's marks on the flywheel and timing gear indicate the correct setting of the circuit-breaker to give the best engine performance.

b. A cutaway view of a typical timer is shown in figure 97. The contact points consist of a stationary point and a movable point (breaker arm). The stationary point is grounded and completes the circuit when the points are in contact. The breaker arm is connected to the primary winding of the ignition coil. The terminal end of the arm is pivoted and a small spring tends to hold the point of the arm in contact with the stationary point. A fiber block fastened to the center of the breaker arm rides on the timer cam. As the cam rotates, its high lobe lifts the breaker arm, breaking the circuit at the contact points. The cam forms the upper part of the timer shaft. A spiral gear is cut in the lower end of the shaft. This gear meshes with the rear intake valve cam gear of the engine, which gives it power for driving the timer.

c. An adjusting band which fits tightly around the timer housing is fastened to an advance and retard lever. This lever is connected by a wire cable to the spark control grip on one of the handle bars. Turning the grip one way or another moves the lever and rotates the timer housing with respect to the timer cam. A stop prevents the housing from rotating too much in either direction. Thus if necessary, the spark can be advanced or retarded slightly while driving.

d. Have a qualified motorcycle mechanic check the timing and condition of the breaker points monthly or every 1,000 miles. The fiber on the breaker arm often wears down in hard service and retards the timing; this, in turn, causes the engine to overheat and operate sluggishly. File the breaker points and readjust the gap when inspection shows they are burned or pitted.

80. Condenser.—*a.* Early condensers were located within the ignition coil, but present practice places them inside the ignition timer or circuit breaker as shown in figure 97. One condenser side is grounded with the stationary contact point. The other condenser terminal connects with the movable contact point (breaker arm). The condenser is made of two strips of tin foil insulated with paraffined paper or mica.

b. Condensers may be "punctured" by excessive voltage and be damaged beyond repair. Because they develop open circuits when hot, they are located at the coolest possible place, away from the engine heat.

c. If the condenser fails, it must be replaced. Hard starting, missing, and abnormal burning and pitting of the circuit breaker

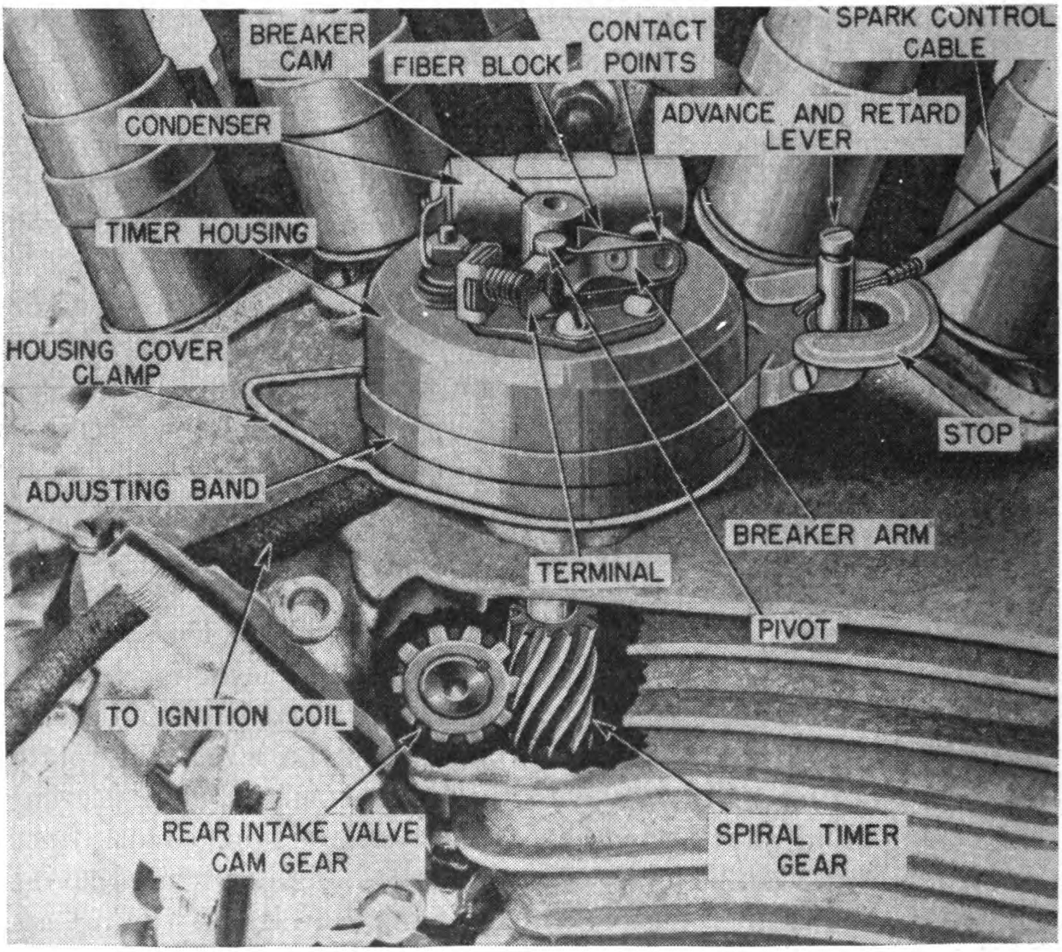

FIGURE 97.—Typical ignition timer.

points possibly indicate condenser failure. However, the cause may be an excessively high generator charging rate or a faulty wiring connection, which causes the electrical system to build up abnormally high voltages.

81. Ignition coil.—The ignition coil (fig. 98) is composed of a primary winding and a secondary winding around a soft iron core. The primary winding has approximately 200 turns of heavy wire.

The secondary winding may have as many as 14,000 turns of very fine wire. The only connection between the two windings is magnetic induction. There is no physical contact. The windings are insulated by tar in an airtight metal container. If an ignition coil fails, it must be replaced.

a. "Waste spark" system.—On the Harley-Davidson, both terminals of the secondary winding are connected directly to the spark plugs.

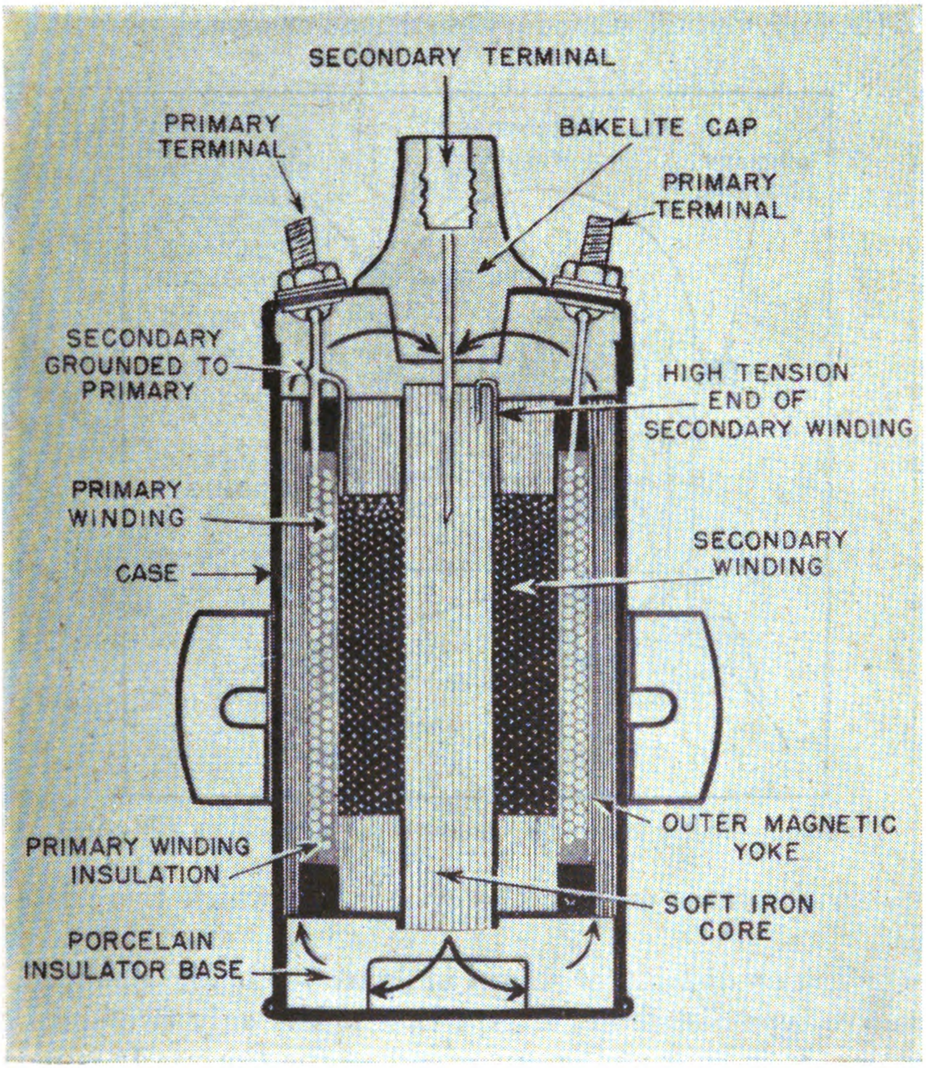

FIGURE 98.—Ignition coil with secondary winding next to core.

One wire goes to the spark plug in the front cylinder and the other wire to the spark plug in the rear cylinder. Thus, a spark occurs at both plugs at the same time. However, the exhaust valve is open on one cylinder while the fuel charge is being ignited in the other cylinder. This means that every other spark of each plug is not used. This method of voltage distribution to the spark plugs is sometimes called "waste" or "double" spark.

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b. Timer-distributor system.—On the Indian, one terminal of the secondary winding of the ignition coil is grounded as shown in the wiring diagram (fig. 99), and the other terminal is connected to the central terminal of a timer-distributor unit. This unit contains the timer (circuit-breaker) which opens and closes the primary circuit and the distributor which supplies the secondary current to the spark plugs in their proper firing order.

82. Distributor.—The distributor is a revolving switch which directs the high voltage secondary current to one spark plug at a time.

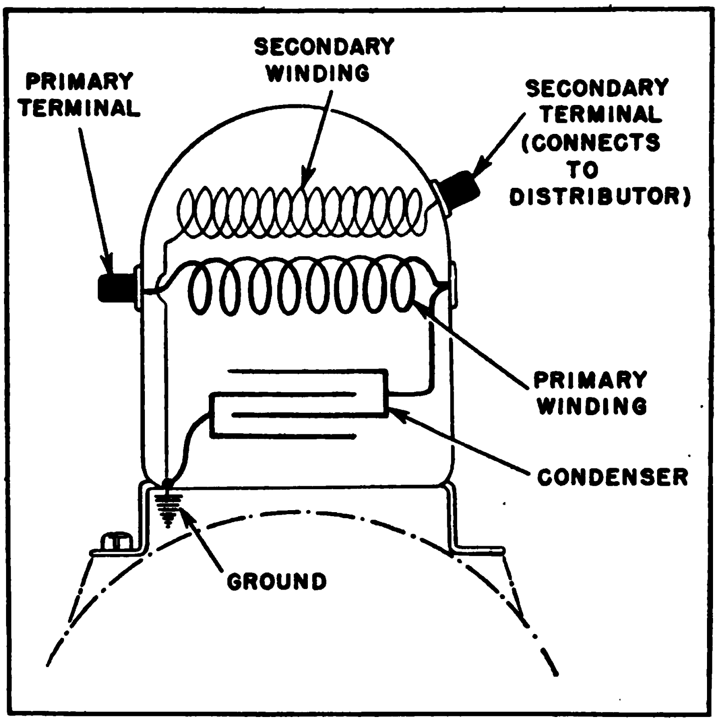


FIGURE 99.—Wiring of ignition coil used in conjunction with distributor.

Thus a spark occurs only in the cylinder in which there is a fuel charge.

a. The Indian distributor shown in figure 100 is like a conventional automotive type distributor except that it has only two spark plug terminals. It is built at the upper end of the timer. It is mounted at the left side of the engine and is driven by an upper extension of the scavenger oil pump shaft. Its essential parts are a rotor and a cap.

b. The distributor head is made of a highly insulating plastic. It is usually held in place by spring clips which snap on only when the head is in its proper position. Thus, the head can easily be removed to inspect or adjust the rotor or the time cam with no danger of replacing it incorrectly. The head has a central terminal (connected to the secondary winding of the ignition coil) and two outer terminals (one for each spark plug). These terminals are made of a metal alloy molded into position so that their under side is either in the form of a button flush with the inside surface of the head, or in the form of a pin.

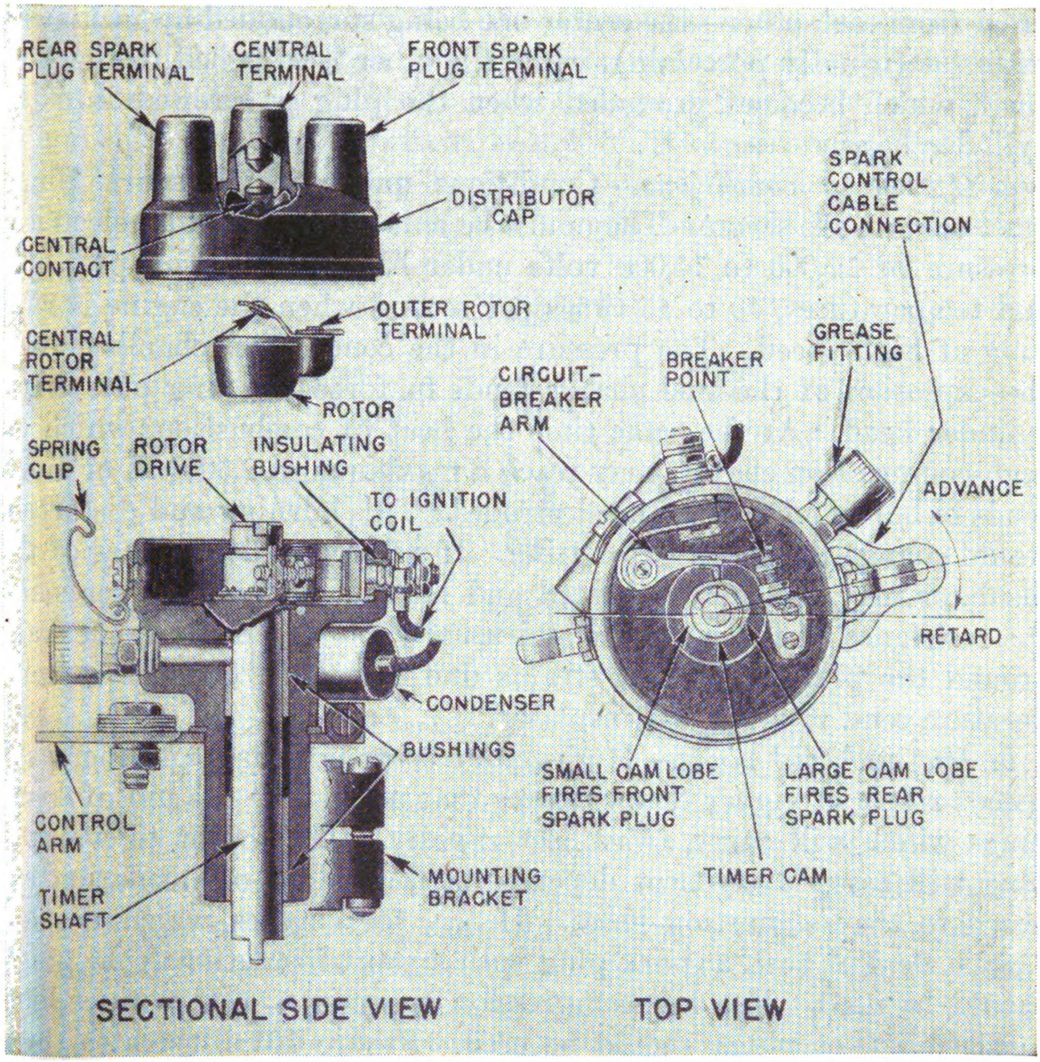


FIGURE 100.—Circuit-breaker and distributor assembly.

c. The distributor rotor must be well insulated to prevent grounding of the high-voltage current; consequently, it is molded from an insulating material similar to that used in the distributor head. It is usually designed to fit over the top of the timer shaft in one position only. This prevents its installation in a position which would throw it out of time with the circuit-breaker. The center of the rotor is in constant contact with the central terminal of the distributor head. The terminal at the outer end of the rotor comes in contact once in every revolution with each of the outer distributor head terminals thereby completing the secondary circuit successively with each spark plug.

83. Spark plugs.—The spark plugs provide suitable electrodes inside the cylinder, which can be jumped by a high voltage from the ignition coil to ignite the fuel mixture. The two electrodes are insulated from each other—the center one being surrounded by insulating material (usually porcelain), while the other is attached to the steel shell, which becomes grounded when the plug is screwed into the cylinder head.

a. Operating conditions.—Conditions under which spark plugs must operate are severe. They must be able to withstand an electrical pressure of 12,000 to 14,000 volts under high-compression pressures and temperatures, 40 to 45 times per second when the engine is running at high speed. The pressure in the combustion chamber from the explosion of the fuel charge tends to force the plug out of the cylinder head. At the same time the heat of combustion, which on high-compression engines may reach a maximum of 2,500° F. or more, tends to burn and distort the electrodes. This burning and distortion would change the spark-gap setting. In addition, the surfaces of the insulator may become overheated and burned, materially decreasing the resistance of the insulator and usually causing electrical leakage around the plugs. Internal strains due to sudden changes in temperature tend to crack the insulator.

b. Hot and cold plugs.—High-compression pressures and increased speeds result in higher temperatures that necessitate the use of spark plugs which will carry away heat rapidly. The extent to which a plug will carry away heat depends on the length of insulation exposed to the combustion gases. Hence, for engines which develop a great deal of heat, a spark plug with a short insulation (cold plug) should be used. For low-compression engines, a plug with a long insulation (hot plug) should be used. Figure 101 illustrates three plugs of various heat ranges and also the path of heat conduction. However, the heat of an engine is not the only consideration in selecting a spark plug. The conditions under which the motorcycle is operated have an important bearing on the type of plug needed. Exceptionally severe service, such as continuous runs in mountainous country or running at high speeds for long distances, will require a cooler plug than that used for ordinary service.

c. Servicing.—Inspect spark plugs every 500 miles. If they are dirty or glazed, clean them (with a sand blast cleaner), and reset the gaps. Spark-plug life is shorter on an air-cooled engine than on a water-cooled engine. Overheating caused by a defective lubricating system or lean carburetor adjustment will materially shorten spark-plug life. Since military motorcycles are called upon to operate under widely varying conditions, it is best the vehicle maintenance manual be consulted when selecting and installing spark plugs.

84. Service-light circuit.—This circuit consists of a service head lamp, dimmer switch, tail lamp, stop lamp, and a stop-lamp switch which is operated by the rear brake linkage. The lamps are turned on and off by the ignition-light switch on the instrument panel.

a. The service head lamp is usually mounted on a bracket on the front wheel fork in front of the handle bars. It has a separate

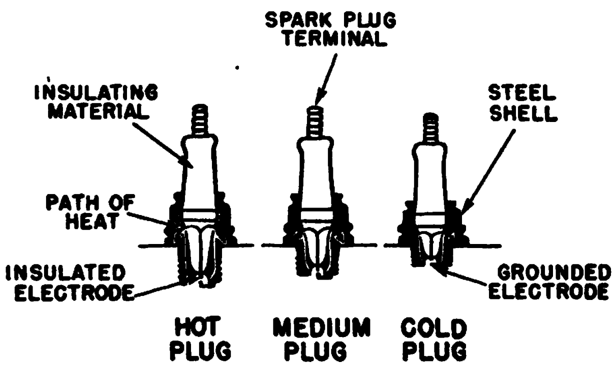


FIGURE 101.—Heat conductivity of various types of spark plugs.

reflector, lens, lens gasket, lens retaining ring, and bulb. These parts are shown in the head lamp illustrated in figure 102. The bulb is of the prefocus type and therefore is in constant focus. The layer of the two bulb filaments is located close to the focal point to provide a good beam for driving on the highway, while the second filament is placed just off the focal point to provide a depressed beam for passing other vehicles and for city driving. To adjust the direction of the light beam it is necessary to change the lamp position on the bracket.

b. A toggle type dimmer switch on the handle bar changes the flow of current from one filament to the other.

c. Tail and stop lamps are ordinarily combined in a single housing with a red lens. Usually a large bulb (about 21 candlepower) is used for the stop lamp and a small lamp (about 3 candlepower) for the tail lamp. Sometimes the tail and stop lamps are inclosed in a single bulb which has a double filament. The tail lamp burns whenever the lighting switch is in the "on" position. The stop-lamp switch is actuated by the brake pedal through mechanical linkages, so that it goes on whenever the rear brake is applied. The tail and stop lamps are mounted on the rear fender as shown in figure 103.

85. Blackout light circuit.—*a*. Military motorcycles are equipped with two blackout lamps. The blackout head lamp is mounted on the front fender and the blackout tail and stop lamp is mounted on the rear fender, figure 103. The blackout head lamp has a small housing similar in appearance to an automobile parking light. The blackout tail and stop lamps are combined in the same housing. A shutter somewhat like a venetian blind is placed in front of the lens on a

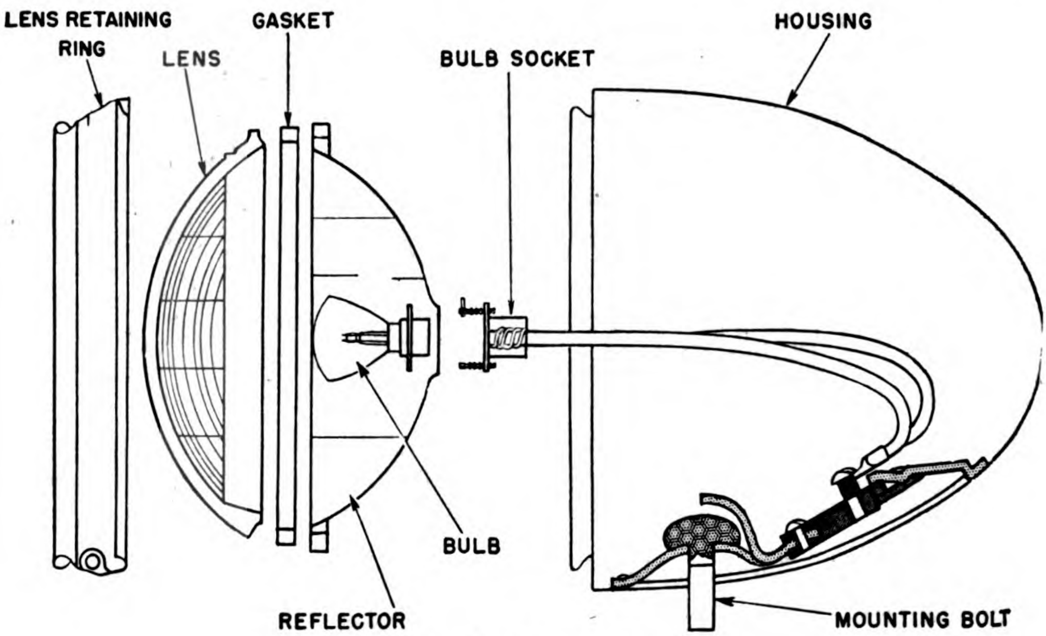


FIGURE 102.—Head-lamp construction.

blackout lamp to prevent any light from being projected upward. Blackout lamps operate in the same manner as the service lamps. When the winged knob of the ignition-light switch is turned to the blackout position, all the service lamps are automatically turned off.

b. Blackout lamps are used to enable a convoy to move at night without being observed from the air. These lamps provide sufficient illumination to enable units in a convoy to keep in line while progressing at slow speeds.

86. Horn.—The horn is mounted on the front wheel fork near the handle bars. It is an electromagnetic vibrator with a tone adjusting screw. One of its terminals is connected by a lead to the hot post of the ignition-light switch. The other terminal is connected to a button on the handle bar. Pressing the button closes the horn circuit and causes the horn to sound.

87. Instruments.—The instrument panel (fig. 104) is located on top of the fuel tank where it can easily be seen when driving the motorcycle. It is a sheet metal housing which incloses the ignition-light switch, ammeter, speedometer and odometer, and (on the Harley-Davidson) lights indicating oil pressure and battery charging. Each instrument is individually lighted.

a. Ammeter or generator light.—(1) The Indian has an ammeter connected to the positive terminal of the battery and the hot post or live terminal of the ignition-light switch. In a d-c (battery-ignition)

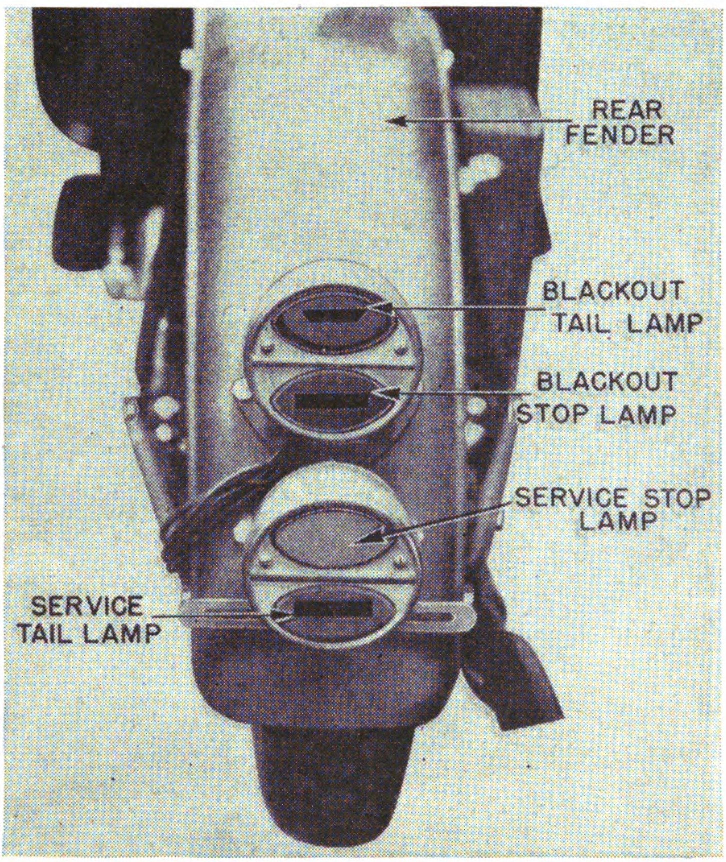


FIGURE 103.—Tail and stop lamps.

circuit as used on motorcycles, it also indicates the direction in which the current is flowing—from positive to negative or vice versa. Thus it can be determined whether the battery is being charged or discharged by the generator. Generators usually do not attain sufficient voltage to charge the battery until the engine reaches a speed equivalent to a road speed of 12 miles per hour.

(2) In place of an ammeter the Harley-Davidson is equipped with a small green light connected to the hot post of the ignition-light switch and a relay spring contact at the generator. When the generator is

not charging, the relay closes the circuit and the green light burns. When generator is charging, the relay opens the circuit and no light appears.

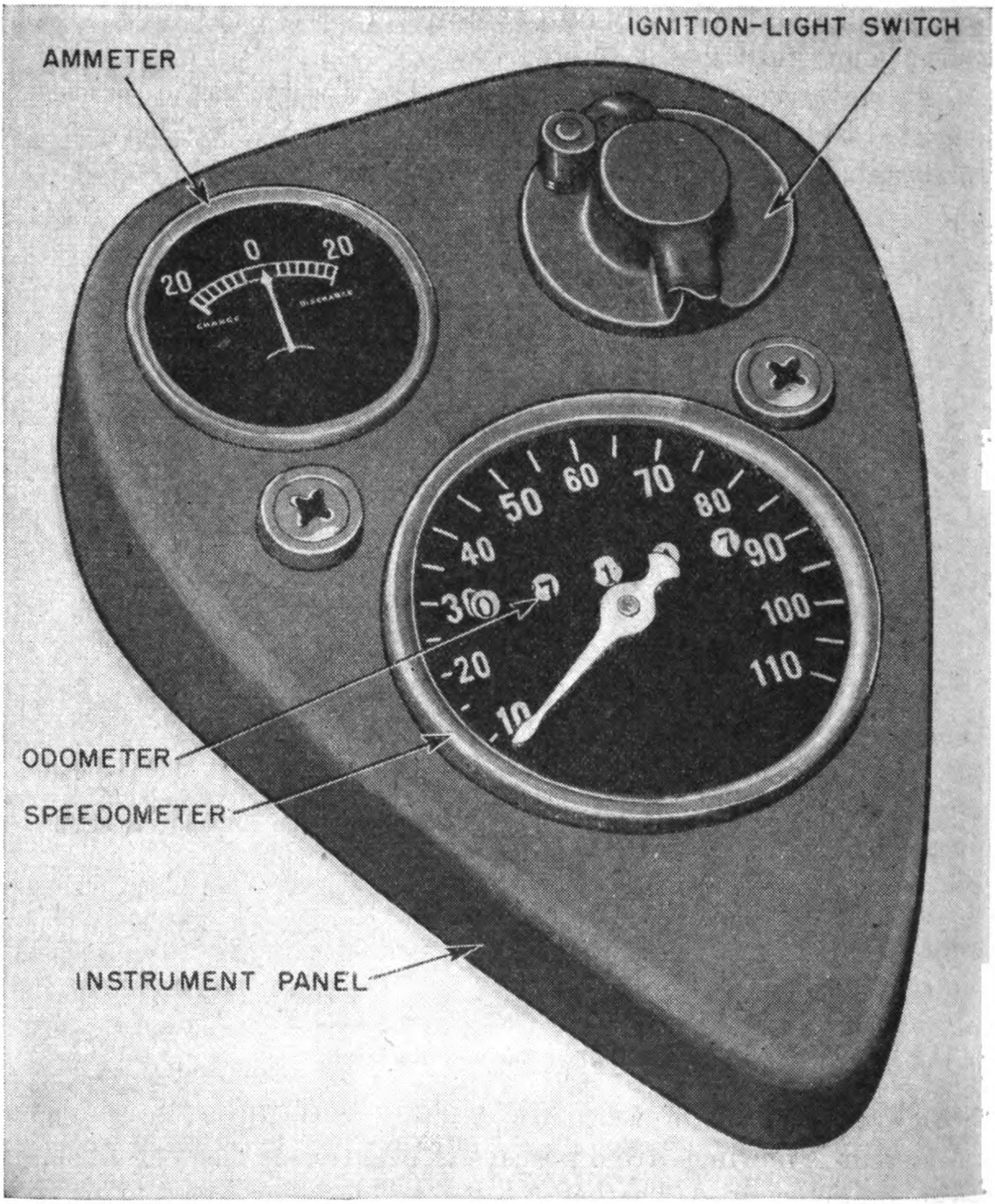


FIGURE 104.—Motorcycle instrument panel (Indian).

b. Speedometer and odometer.—The speedometer indicates the speed of the vehicle, and the odometer, which is part of the same unit, shows the mileage traveled, actuated by a wire cable driven by a gear mounted on either the front or rear wheel hub. In construction, the unit is similar to an automotive speedometer.

c. Oil pressure light.—(1) Lack of oil pressure is indicated on the Harley-Davidson motorcycle by a small red light on the right side of the instrument panel. To check the oil circulation in the Indian motorcycle, it is necessary to remove the filter cap of the oil tank and observe whether or not the oil pulsates at the return tube. The red light works on much the same principle as the green light indicating the battery charge.

(2) An oil-pressure diaphragm is connected directly in the oil feed line at the bottom of the gear case. (See fig. 68.) When oil pressure is developed, the diaphragm rises, breaking the contact and causing the light to go out. However, if the oil pressure against the diaphragm drops, the diaphragm returns to the rest position and grounds the wire leading to the indicating light. This causes the red light to burn.

(3) The oil pressure (red) and generator charging (green) indicating lights operate independently of the service and blackout lamps. Therefore, it is customary in combat zones to paint the glass of these indicators so that only a small dot of light appears. This reduces the possibility of detecting motorcycles by aerial observation.

SHAFT-DRIVEN MODELS

88. Ignition system.—*a.* Both the Harley-Davidson and Indian shaft-driven models have an automatic spark advance which eliminates the manual spark control on the handle bars. It consists of two centrifugal weights placed around the rotor of the timer or circuit-breaker, as shown in figure 105. When the engine speed increases, these weights spread out and in so doing turn the rotor slightly ahead. This changes the relative position of the breaker cams and advances the time of spark occurrence. When the engine slows down, small springs pull the weights inward and retard the spark.

b. The shaft-driven models are shielded to permit installation and use of radios. The shielding is merely an electrical insulator to protect the radio from static electricity developed in the ignition system. The Harley-Davidson uses a small cover which fits over the spark plugs as illustrated in figure 106. Figure 107 shows a shielding cover placed on top of the distributor cap on Indian motorcycles.

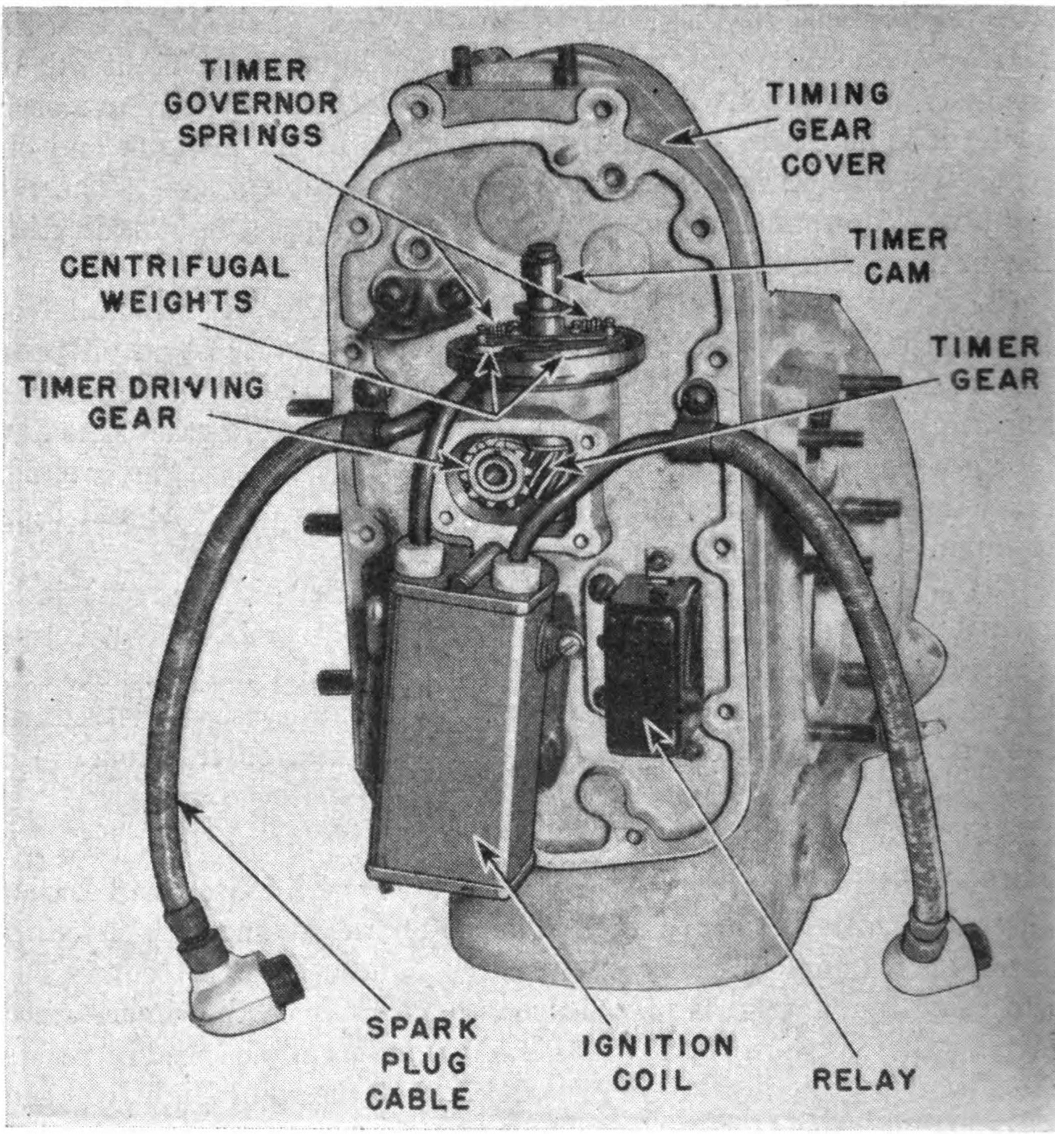


FIGURE 105.—Automatic spark advance on circuit-breaker.

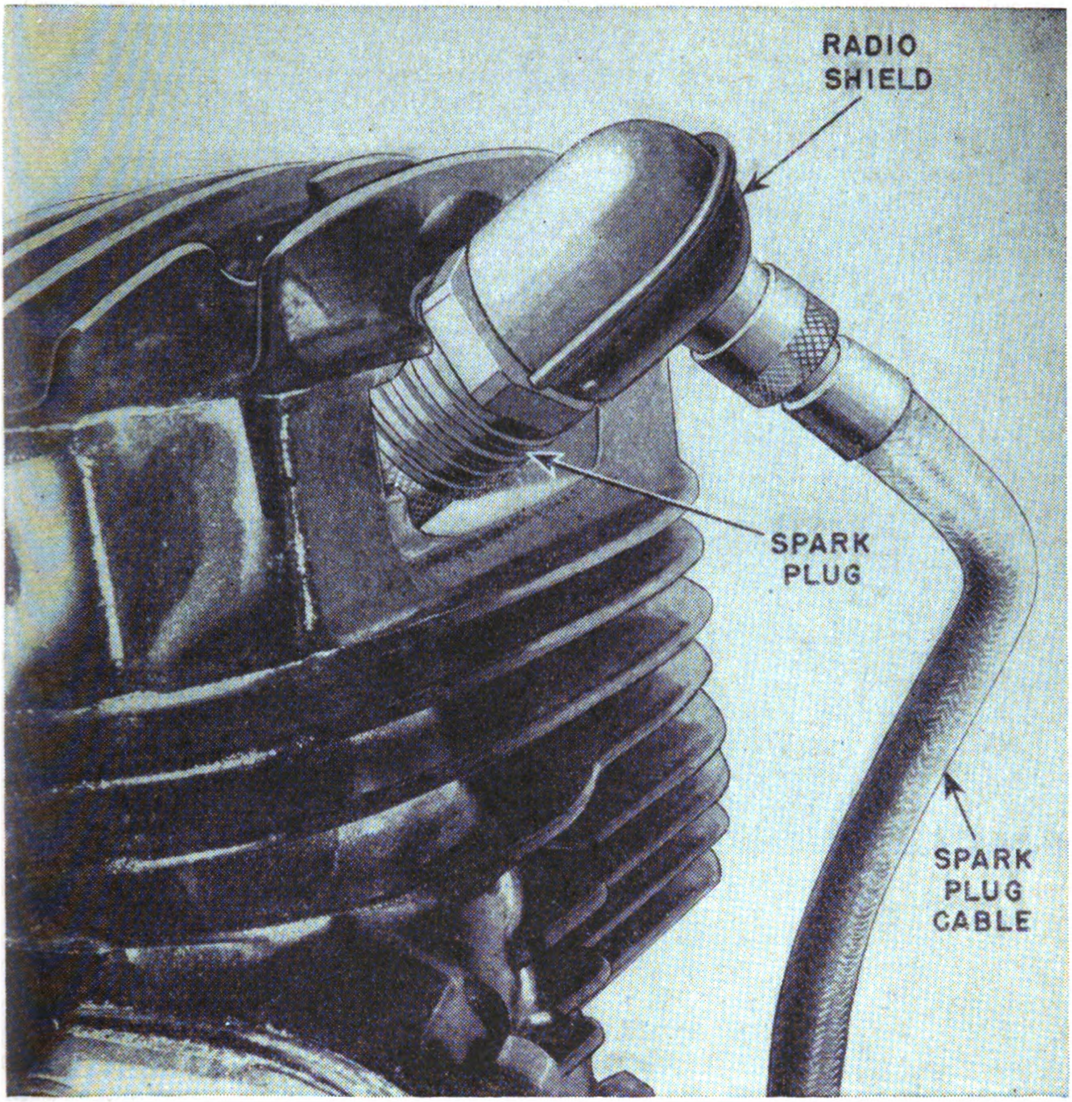


FIGURE 106.—Harley-Davidson radio shield.

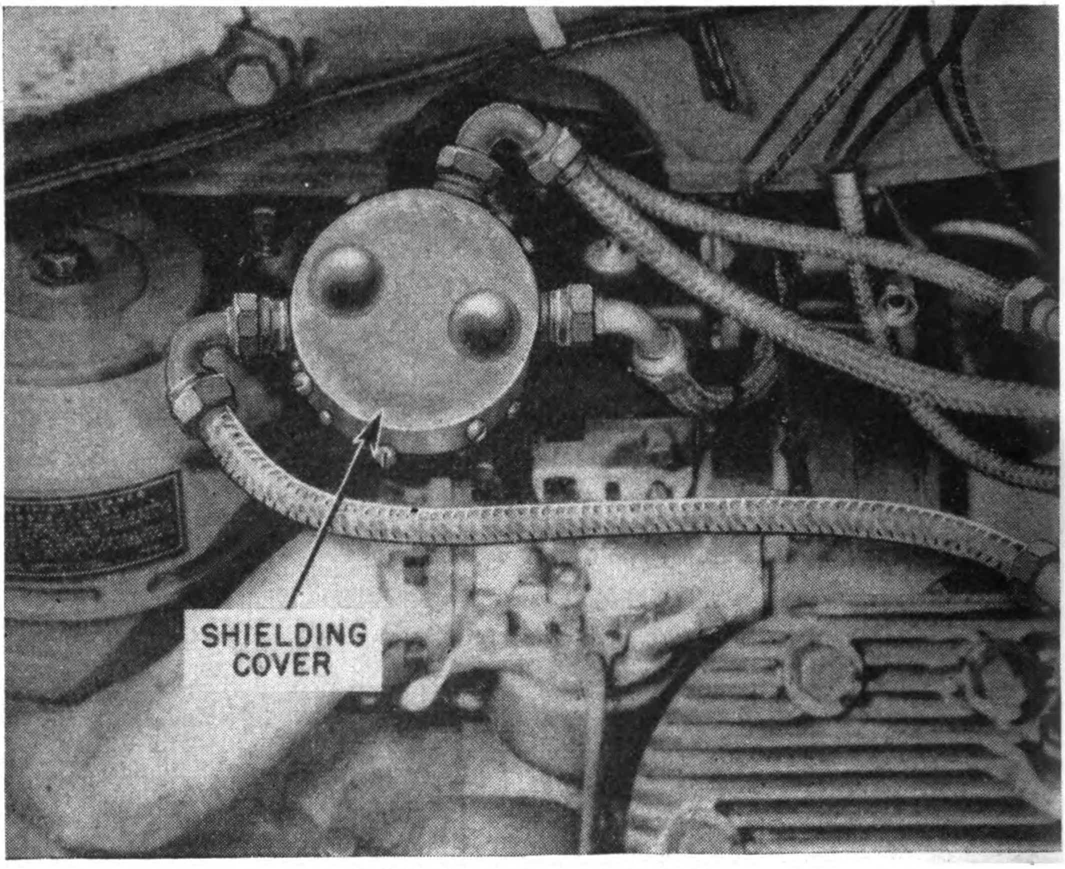


FIGURE 107.—Indian radio shield.

SECTION X

ACCESSORY EQUIPMENT

89. Fenders.—*a.* The front fender is always of one-piece construction; on some models the rear fender is of two-piece construction so that the rear portion of the fender may be raised to allow removal of the rear wheel for servicing.

b. The *front fender* is braced from the axle mounting and fastened to the fork with a single bolt. A leather washer is installed between the top of the fender and the fork. The fender braces are riveted together at the axle mounting and are bolted to brackets which are spot welded to the fender.

c. The *rear fender* is braced from the rear fork and is clamped to the frame directly behind the transmission. The brace connections on the fender are spot welded to the fender.

d. The fenders of military motorcycles provide the greatest possible clearance between the wheel and the fender.

90. Stands.—Three kinds of stands are used to hold the solo motorcycle in an upright position when it is not in motion: center, rear, and "jiffy." They are all hinged so that they can be raised from the ground to a "traveling" position when the motorcycle is moving.

a. Rear stand.—A rear stand, similar to a bicycle stand, is provided on some motorcycles. Hinged at the rear axle, it is held in a traveling

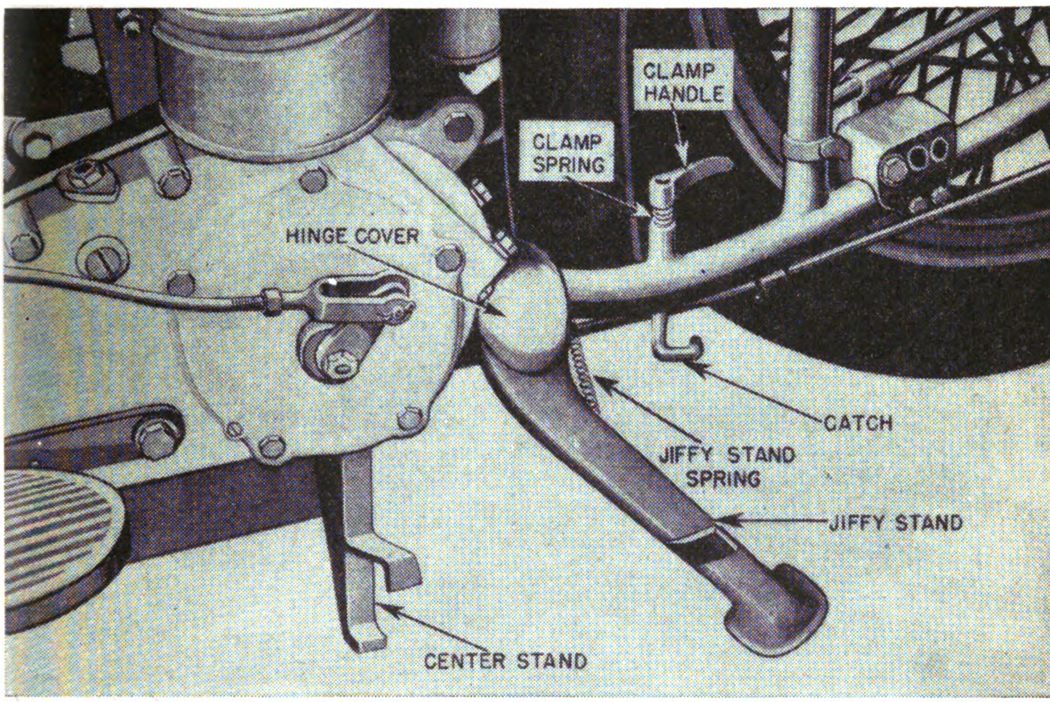


FIGURE 108.—Center and "jiffy" stands.

position by a spring clip which is bolted to the back of the rear fender. With the spring clip released, the rear stand automatically drops to the ground. When the rider pulls up and backward on the motorcycle, the rear wheel is raised off the ground and the motorcycle is supported on the stand. Pushing the motorcycle forward moves it off the stand so that the stand can be returned to traveling position.

b. Center stand.—On some motorcycles a center stand takes the place of the rear stand. It is located directly under the frame (fig. 108), slightly to the rear of the engine. It is hinged to the frame and is held in a traveling position by a clamp at the lower side of the rear fender. When the clamp is pushed down and turned out, the stand drops to the ground. When the motorcycle is pulled up and backward, the rear wheel is raised off the ground and the motorcycle is supported on the stand. To take the vehicle off the center stand, push the motorcycle forward, raise the stand, and secure it in the hooked end of the clamp.

c. "Jiffy" stand.—The "jiffy" stand (fig. 108) is located on the side of the motorcycle just to the rear of the footboard. It is anchored to

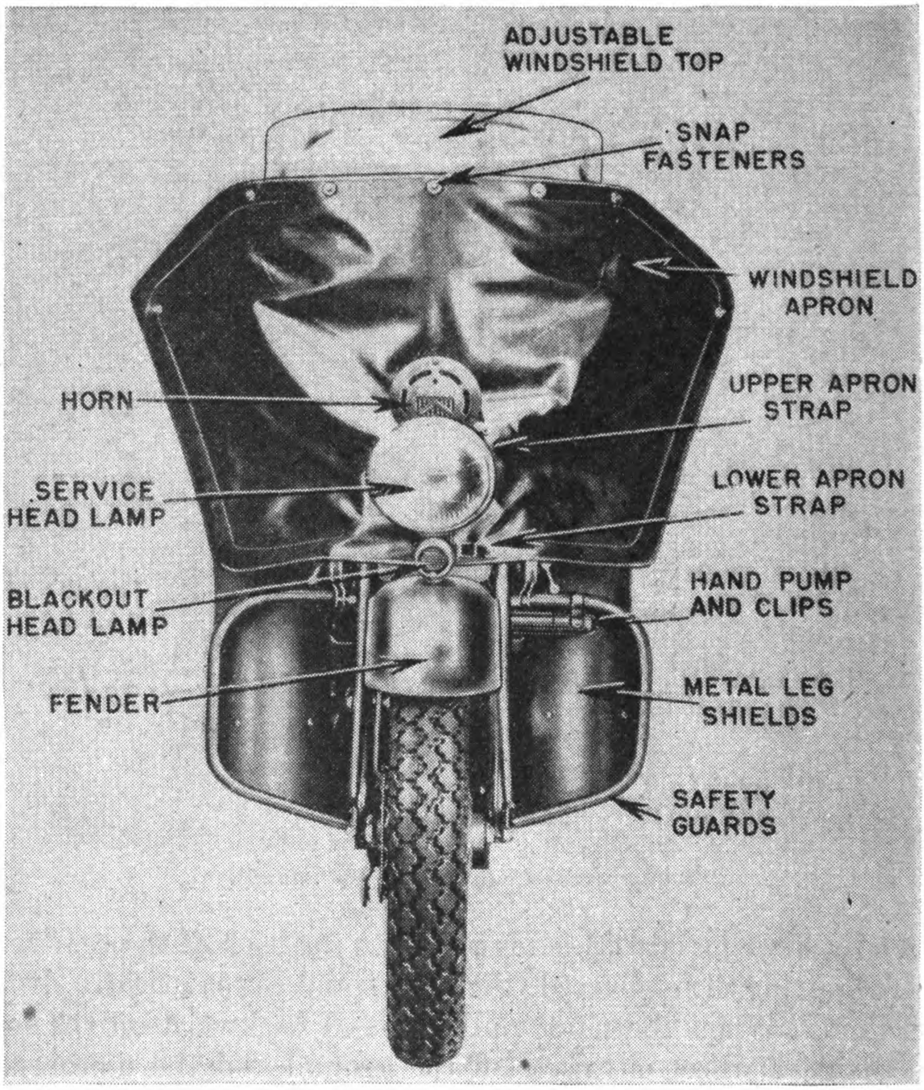


FIGURE 109.—Fully equipped motorcycle—front view.

the frame and held in position by a spring. To release the "jiffy" stand, bring it outward and away from its normal riding position. It will support the motorcycle at a slightly tilted position.

91. Footboards.—Motorcycles are provided with footboards or rests on each side (fig. 43). They are of molded rubber-to-steel construction, bolted to cleats which are anchored and held by clevis pins to the lower members of the frame. They may be raised to a vertical position.

92. Equipment.—*a. Miscellaneous.*—Military motorcycles are equipped with certain extra equipment for protection and comfort, such as safety guards, leg shields, and windshield (fig. 109).

(1) Safety guards of steel tubing are clamped securely to the frame by U-bolts. They protect the legs if the motorcycle should

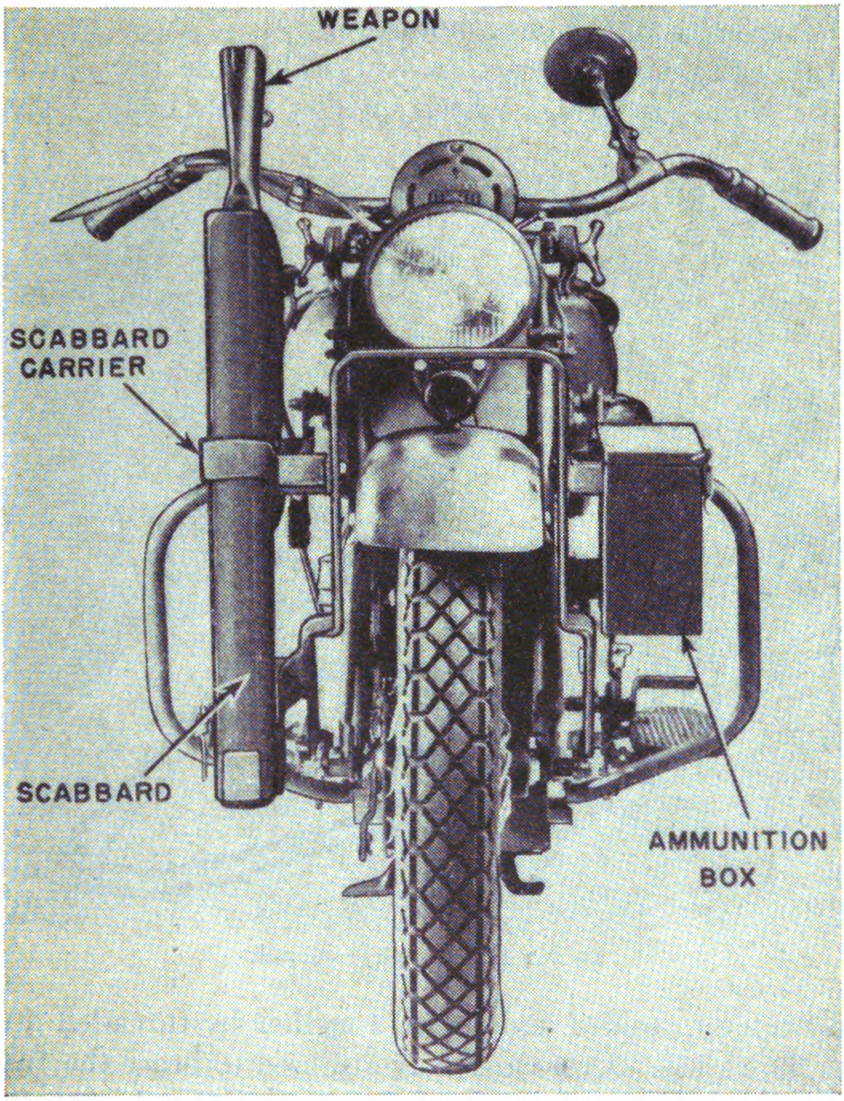


FIGURE 110.—Front view of a military motorcycle.

fall. Some solo motorcycles are equipped with two pairs of safety guards, front and rear. Usually each pair is "split" so that, if either the left or right guard is damaged, it can be replaced.

(2) Leg shields are of sheet metal, attached to the front safety guards. They act as brush guards and provide protection against wind and rain.

(3) The windshield is a curved transparent window, mounted in a light steel frame which is clamped to the handle bars. The window section is adjustable both as to height and angle of tilt by wing screws. Leather aprons may be fastened to the windshield frame to afford greater protection from the weather.

b. Tactical.—Present military motorcycles are equipped with saddle bags, luggage carrier, ammunition box, and submachine gun (or other weapon carrier). Figure 110 shows an ammunition box and scabbard carrier mounted on a motorcycle.

93. Side car.—*a. Construction.*—(1) The side car consists primarily of a frame, an axle, a wheel, springs, and a body. The frame

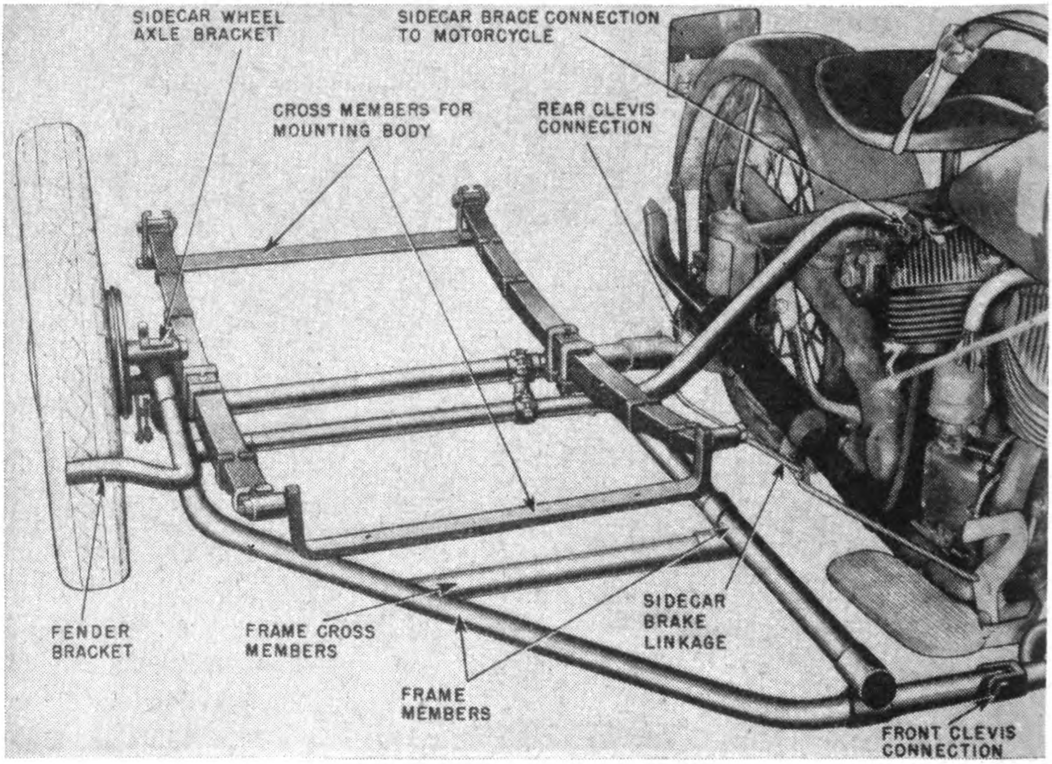


FIGURE 111.—Side-car chassis.

is of steel tubing, welded and joined together by threaded fittings as shown in figure 111. Cross members are used to brace the frame. A bracket secures the side-car wheel axle to the right side of the frame in line with the rear wheel of the motorcycle. The side-car wheel is exactly like the front wheel of the motorcycle and on some models is also interchangeable with the rear motorcycle wheel.

(2) The side-car wheel brake is connected by linkage to the motorcycle brake pedal and acts in conjunction with the rear brake of the motorcycle.

(3) Two rather long semielliptical springs are mounted on brackets

parallel to the frame. Front and rear cross members extend across the spring shackles. The side-car body is bolted to these cross members. It is built of sheet steel with an upholstered leather seat back and cushion. Both the seat back and cushion are removable. Flexible connections are provided between the side car and motorcycle to improve handling and for better riding. Motorcycles equipped with a side car have more powerful engines and a greater gear reduction than solo models to provide more driving power. Side cars are always connected to the right side of motorcycles.

b. Servicing.—In connecting a side car to a motorcycle, be sure to lubricate the ball joint or other flexible connections. Keep side-car springs lubricated with kerosene and light oil. Lubricate other shackle fittings with a pressure grease gun.

Appendix I

GLOSSARY

The following definitions apply to terms as used in this manual:

Acceleration.—Average rate of increase in velocity or speed, as feet per second per second. The opposite of deceleration.

Ampere.—A unit for measuring the rate of flow of electricity.

Axis.—A center line. A line about which something rotates or about which it is evenly arranged.

Bearing.—(1) A part in which a shaft, pivot, or pin turns or revolves. (2) A part on or in which another part slides.

Bore.—The interior diameter of an engine cylinder.

Bottom dead center (*B. D. C.*).—The lowest position of the pistons in the engine cylinder.

Bushing.—A detachable lining of bronze, babbitt or other antifriction metal used as a bearing for a shaft, spindle, or pivot.

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

Cam.—An eccentric projection on a revolving shaft, shaped so as to give some desired linear motion to a follower.

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

Choke.—The valve which controls the flow of air into the carburetor from the air cleaner.

Circuit.—The entire course through which an electric current flows.

Combustion 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.—Act of pressing into a smaller space or reducing in size or volume by pressure.

Concentric.—Having the same center, as circles or spheres, one within another. Opposed to eccentric.

Core.—An iron mass, generally the central portion of an electromagnet or armature around which wire is coiled.

Current.—The flow of electricity.

Cycle.—A series of events, operations, or movements that repeat themselves in an established sequence.

Deceleration.—Average rate of decrease in velocity or speed, as feet per second per second. The opposite of acceleration.

Dowel pin.—A pin usually of circular section fitting into corresponding holes in mating pieces, and acting as a temporary or permanent fastening to keep them in their proper relative position.

Eccentric.—(1) Having different centers, as circles or spheres, one within another.

(2) A device mounted off-center for converting rotary motion into reciprocating motion.

Electrolyte.—A conducting liquid which is decomposed by the passage of an electrical current. In a storage battery it is a solution of sulphuric acid and water.

Energy.—Capacity for doing work; may be either mechanical or electrical.

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

Fit.—Desired clearance between the surfaces of machine parts.

Force.—The action that one body exerts upon another to change its motion or shape. Forces between bodies are always equal in amount and opposite in direction. Forces are measured in pounds.

Friction.—The resistance to relative motion between two bodies in contact. If the bodies are in sliding contact, the resistance is called sliding friction; if they are in rolling contact, it is called rolling friction.

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 to 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 to 1, which means that the driven gear revolves five times as slowly as the driving gear, increasing torque and decreasing speed.

Heat.—A form of energy.

Helical.—In the shape of a helix, which is the shape of a screw thread or coil spring.

Horsepower.—A unit for measuring power, which is 550 foot-pounds per second or 33,000 foot-pounds per minute.

Idler gear.—A gear placed between a driving and driven gear to make them rotate in the same direction. It does not affect the gear ratio.

Insulation.—A protective covering on wires or electrical parts to prevent short circuits.

Integral.—Of the same piece as distinguished from a separate part that is fastened on.

Lap.—To work two metal surfaces together, with or without abrasives, until a very close fit is produced.

L-*Head.*—Designates an engine with all the valves, cams, lifters, and other moving parts in and on one side of the engine cylinders.

Magnet.—A material that has the ability to attract and repel iron.

Member.—Any essential part of a machine or structure.

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

Needle valve.—A small plain or threaded rod having a tapered point. Its position can be changed with respect to its seat to regulate the flow of fuel in the carburetor.

Pinion.—The smaller of two mating or meshing gears.

Play.—Free movement to take up slack.

Power.—The capacity to do work or the rate at which it is done. It is measured in horsepower.

Radial.—Originating from or acting upon a common center, as the spokes in a wheel.

Ratio.—The numerical relation between two things expressed as the division of one quantity by the other. Thus the ratio of 48 to 12 is represented by 48/12 or 48 : 12, or 4 to 1, as in gear ratio.

R. P. M.—Revolutions per minute.

Shackle.—A swinging support for the end of a spring that permits it to vary in length as it deflects. (See fig. 96.)

Shim.—Spacer (usually metal) used to regulate the fit or clearance between two objects, such as bearings.

Short circuit.—A circuit, purposely or accidentally made, through a small resistance which shunts electrical current around a circuit of comparatively large resistance.

Shunt.—Parallel connection with a portion of a circuit.

Specific gravity.—The weight of a substance compared to the weight of an equal volume of chemically pure water at 4° C. (39.2° F.).

Splines.—Parallel keys integral with a shaft, mating with corresponding grooves cut in a hub or fitting, which are also called splines.

Spur gear.—A gear having straight teeth.

Stress.—(1) The forces exerted on, within, or by a body during tension of compression.

(2) The opposing reaction of the interior elements of a solid body against forces tending to deform it.

Tappet (valve lifter).—That portion of a valve-operating mechanism which rides against the cam and lifts the valve or push rod.

Tension.—A stress caused by pulling.

Throttle valve.—An adjustable plate (butterfly) or other type valve placed in the carburetor to regulate the flow of fuel-air mixture from the carburetor. The throttle valve controls engine speed.

Thrust.—A force tending to push a body out of alinement. A force exerted endwise through a member upon another member.

Top dead center (*T. D. C.*).—The highest position of the pistons in the engine cylinders. (See fig. 55.)

Torque.—A twisting or wrenching effort. Torque is the product of force multiplied by the radial distance from the center of rotation to the point at which it is applied. It is usually measured in foot-pounds.

Torsion.—The act of twisting or the state of being twisted. The deformation of a body caused by twisting.

Velocity.—The rate of motion or speed at any instant. Usually measured in miles per hour, feet per second, or feet per minute.

Venturi.—A throatlike constriction placed in the carburetor body to increase the speed of the main air stream as it passes a fuel jet or nozzle. (See figs. 80 and 81.)

Work.—The use of energy expended to overcome resistance.

Worm.—A short revolving screw, the threads of which mesh with the teeth of a worm gear.

Worm gear.—A gear having concave, helical teeth that mesh with the threads of a worm. Also called a worm wheel.

APPENDIX II

MOTORCYCLE FIRST ECHELON TOOL SETS

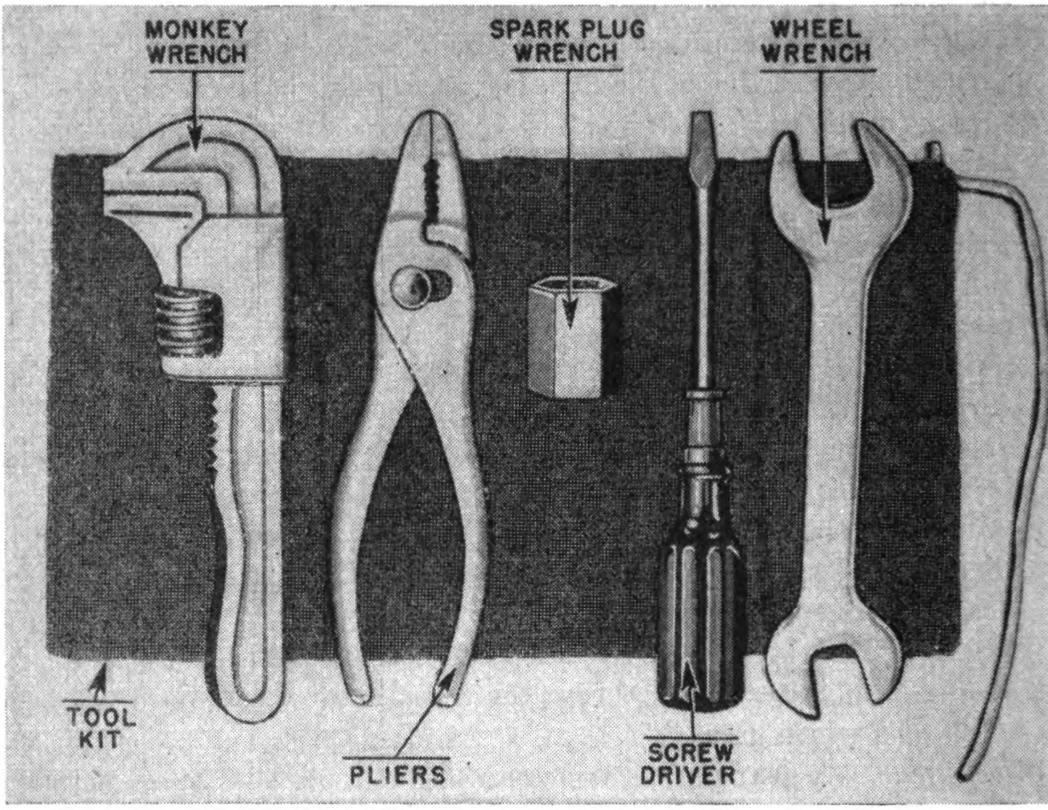


FIGURE 112.—Indian, model 45.

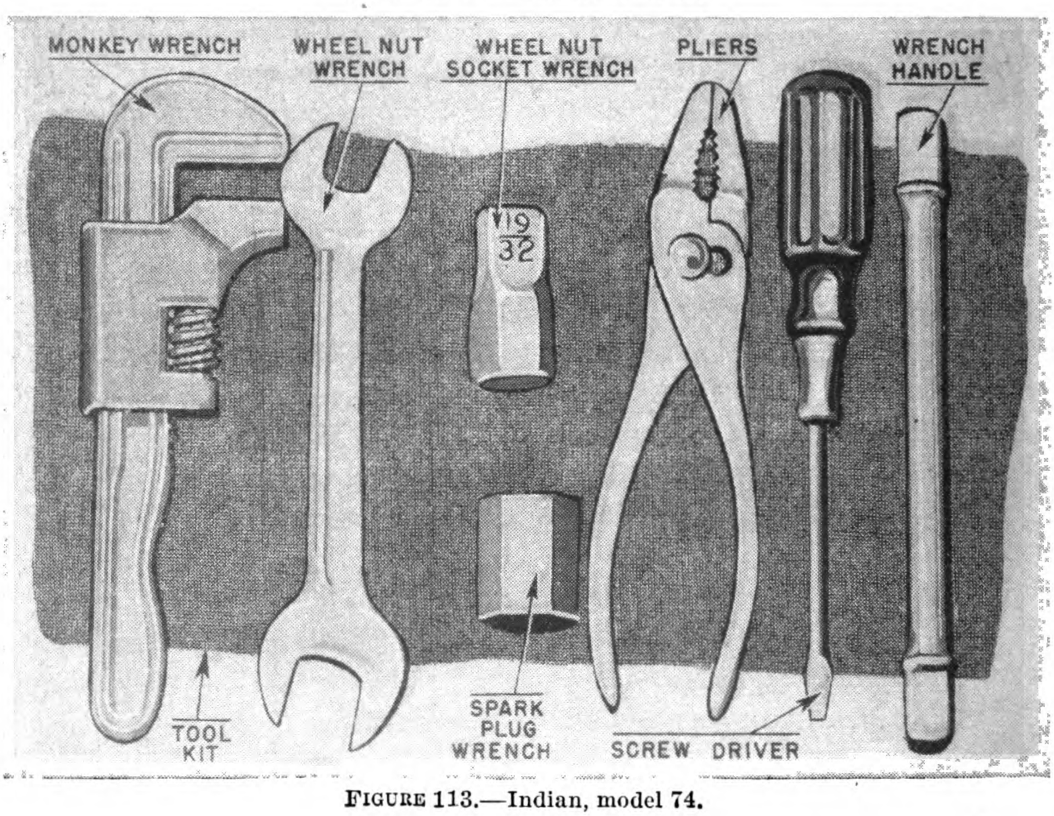


FIGURE 113.—Indian, model 74.

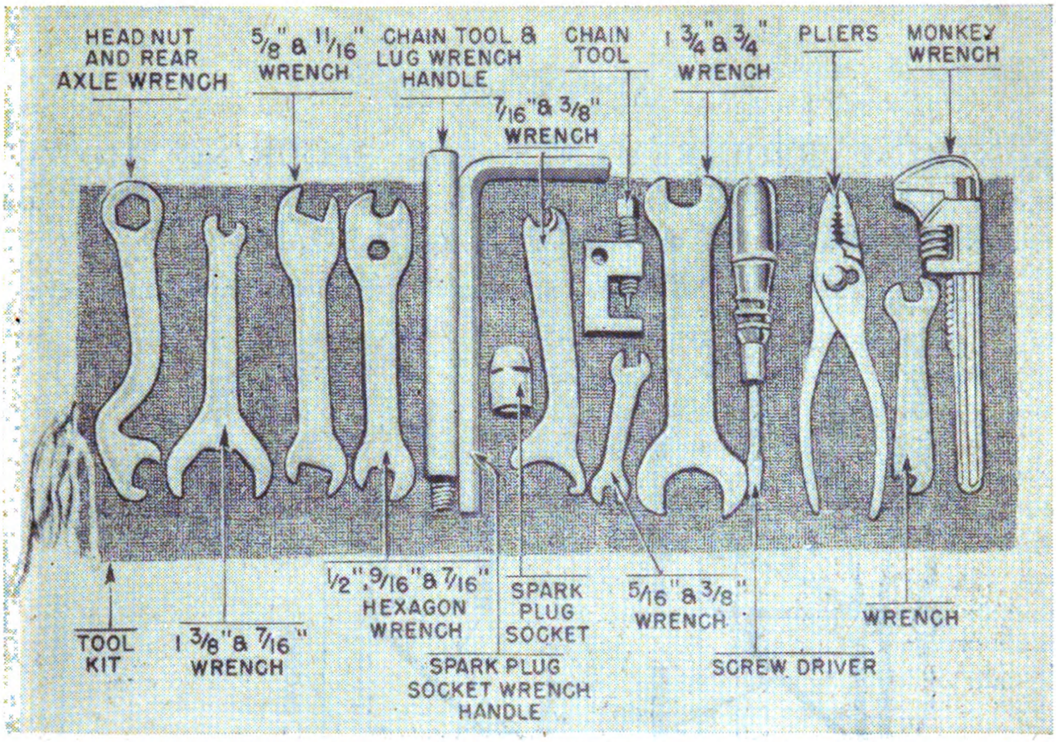


FIGURE 114.—Harley-Davidson, model 45.

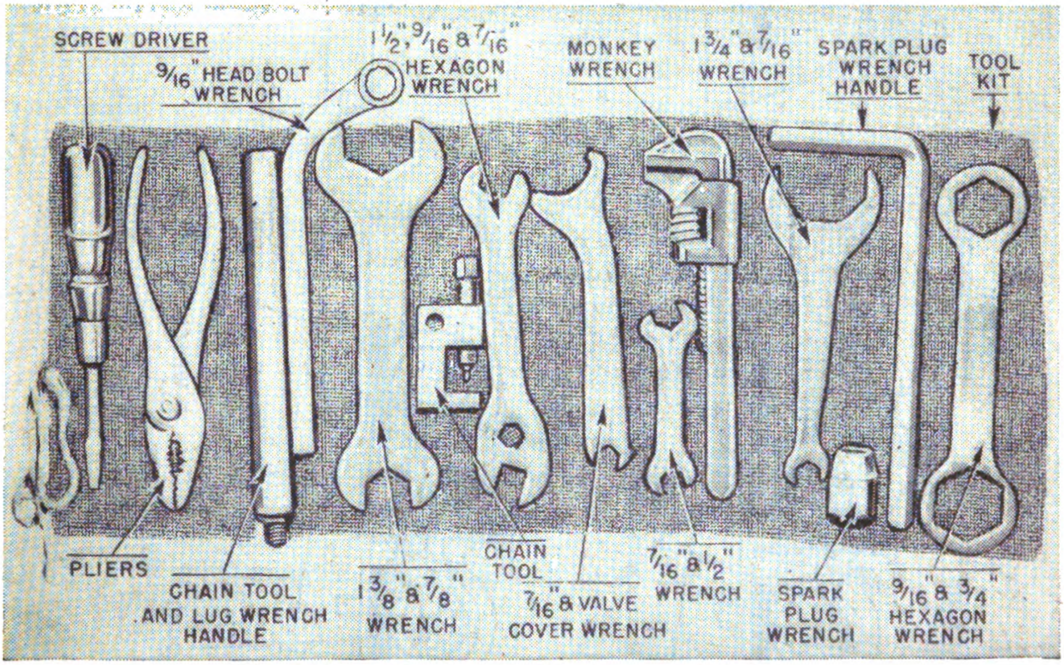
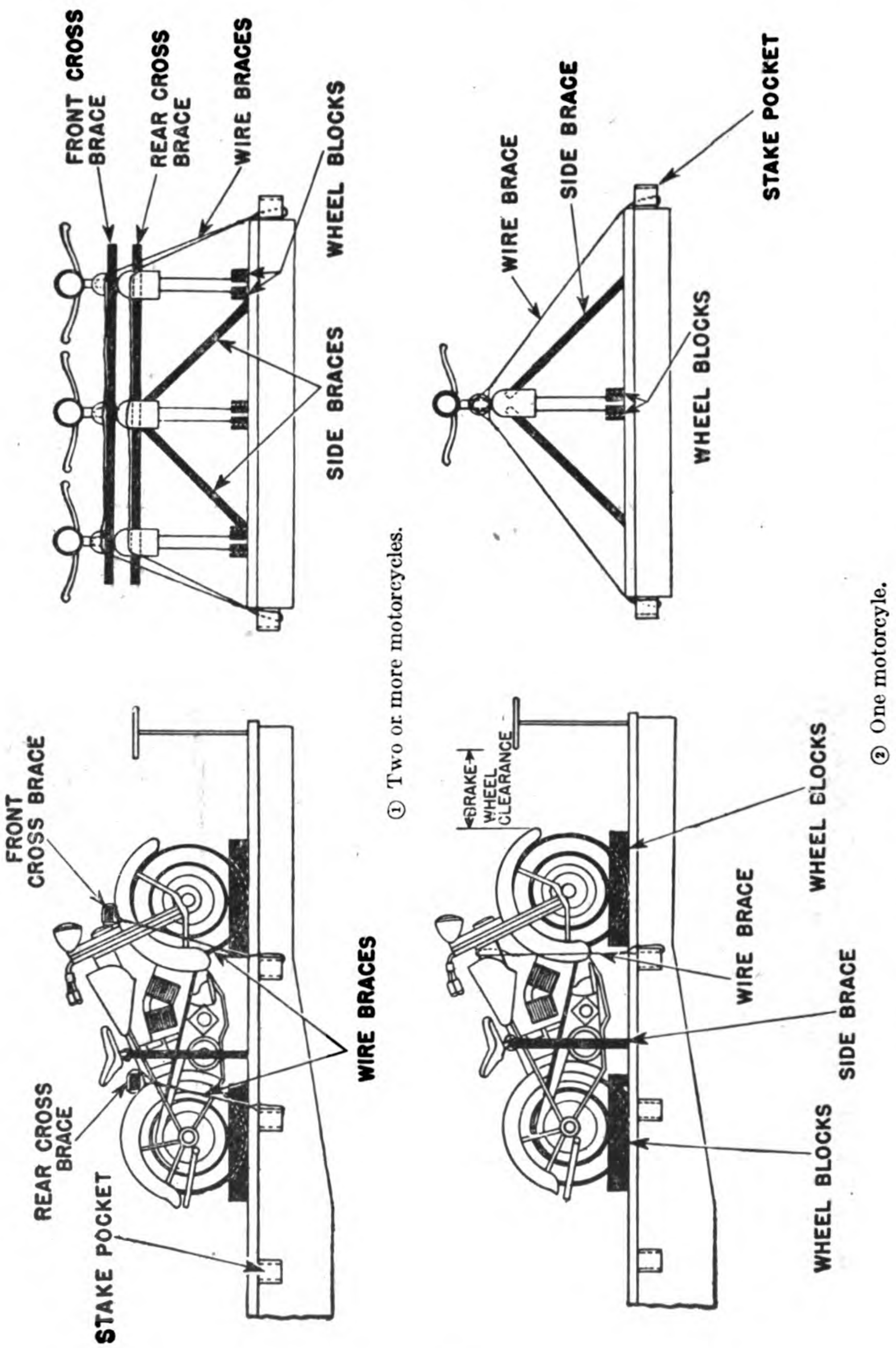


FIGURE 115.—Harley-Davidson, model 74.

APPENDIX III

MINIMUM REQUIREMENTS FOR SECURING MOTORCYCLES TO RAILWAY FLATCARS, ESTABLISHED BY ASSOCIATION OF AMERICAN RAILROADS

NOTE.—Brakes must be applied and gasoline drained from all motorcycles.



① Two or more motorcycles.

② One motorcycle.

FIGURE 116.—Method of securing one or more solo motorcycles to a railway flatcar.

SOLO MOTORCYCLES (see fig. 116).

Material	*No. of pieces*	*Procedure*
Wheel blocks	Two each wheel	Nail to car floor with 20d (4-inch) nails. For specifications, see figure 117.
Cross braces (front and rear).	Two	*When two or more motorcycles are loaded side by side* (fig. 116①).—Cross braces should be 2 by 4 inches, and long enough to extend 8 inches beyond the two outside motorcycle frames. Secure braces to frame of each motorcycle with sufficient wire to prevent slipping. This wire should be nailed to the braces with sufficient 20d nails to prevent the wire from slipping.
Wire braces (front and rear).	One of each	*When two or more motorcycles are loaded side by side* (fig. 116①).—Use two strands, one wrapping, No. 8 gage black annealed wire. Place wire under and over front and rear cross braces, at each vehicle, and attach to nearest stake pocket at each side of car.* Twist-tie each side with rod or bolt.
Side braces	One each side of motorcycle.	*When motorcycles are loaded singly or side by side* (fig. 116① or ②).—Use boards 2 by 4 inches, length as needed. Nail one end to car floor with three 20d nails, and securely wire top end to motorcycle frame at rear seat post.
Wire brace	One each motorcycle.	*When motorcycles are loaded singly* (fig. 116②).—Use four strands, two wrappings, No. 8 gage black annealed wire. Loop wire around steering head just in rear of handle bars and attach to nearest stake pocket at each side of car. Twist-tie at each side with rod or bolt.

*Stake pockets should be padded to keep them from wearing through the wire.

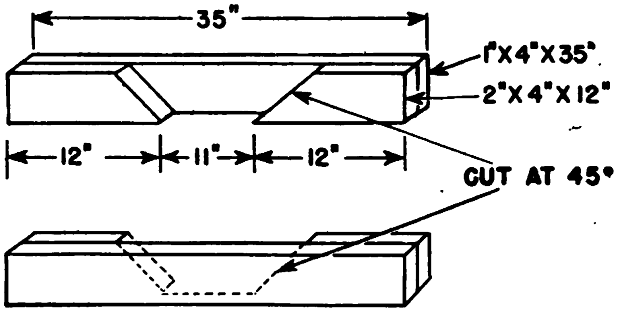
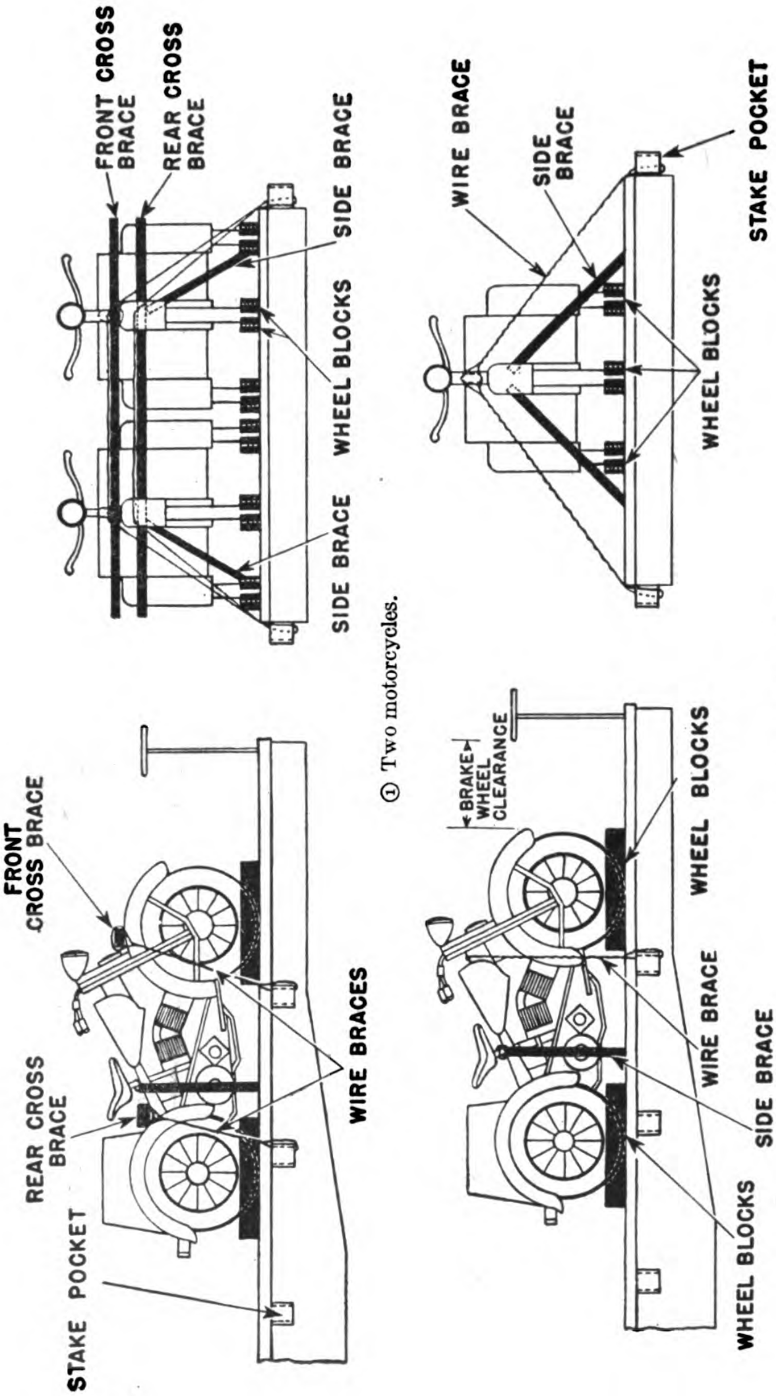


FIGURE 117.—Wheel blocks.



① Two motorcycles.

② One motorcycle.

FIGURE 118.—Method of securing one or more three-wheeled motorcycles to a railway flatcar.

THREE-WHEELED MOTORCYCLES (see fig. 118).

Material	*No. of pieces*	*Procedure*
Wheel blocks	Two each wheel.	Nail to car with 20d nails. For specifications, see figure 117.
Cross braces (front and rear).	Two	*When two vehicles are loaded side by side* (fig. 118①).—Cross braces should be 2 by 4 inches and long enough to extend 8 inches beyond the two outside vehicle frames. Secure braces to frame of each motorcycle with sufficient wire to prevent slipping. This wire should be nailed to the braces with sufficient 20d nails to prevent it from slipping.
Wire braces	Two	*When two vehicles are loaded side by side* (fig. 118①).—Use four strands, two wrappings, No. 8 gage black annealed wire. Pass under and over cross braces, at each vehicle and attach to nearest stake pocket at side of car. Twist-tie at each side with rod or bolt.
Side brace	One each vehicle loaded as in figure 118①. One each side of vehicle, loaded as in figure 118②.	Use boards 2 by 4 inches, length as needed. Nail one end to car floor with three 20d nails and securely wire top end to vehicle frame in rear of seat post. When loaded as in figure 118①, these braces should be applied to vehicles on side nearest the side of flatcar. When loaded as in figure 118②, they should be on both sides.
Wire brace	One each vehicle	*When vehicles are loaded singly* (fig. 118②).—Use four strands, two wrappings No. 8 gage black annealed wire. Loop around steering head of motorcycle just in rear of handle bars and attach to nearest stake pocket at each side of car. Twist-tie at each side with rod or bolt.

Appendix IV

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(For explanation of symbols see FM 21-6.)

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