J. E. ADAMS
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Reprinted
August 1942

OPERATION and MAINTENANCE MANUAL

HARLEY-DAVIDSON MILITARY MOTORCYCLE

Model 42WLA-Solo

*

Built for the United States Army

*

Contract Numbers

W-398-QM-10530

W-398-QM-11702

*

U. S. A. Registration Numbers

W69 [illegible] to W69,959 incl.

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*

Harley-Davidson Motor Co.

Milwaukee, Wisconsin, U. S. A.

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WAR DEPARTMENT
Washington, September [illegible], 1941

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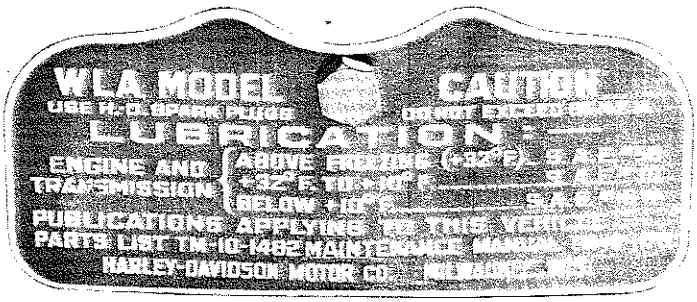
By order of the Secretary of War:

G. C. MARSHALL,
Chief of Staff.

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

OPERATION and MAINTENANCE MANUAL

HARLEY-DAVIDSON
MILITARY MOTORCYCLE
MODEL 42 WLA—SOLO
BUILT FOR
THE UNITED STATES ARMY



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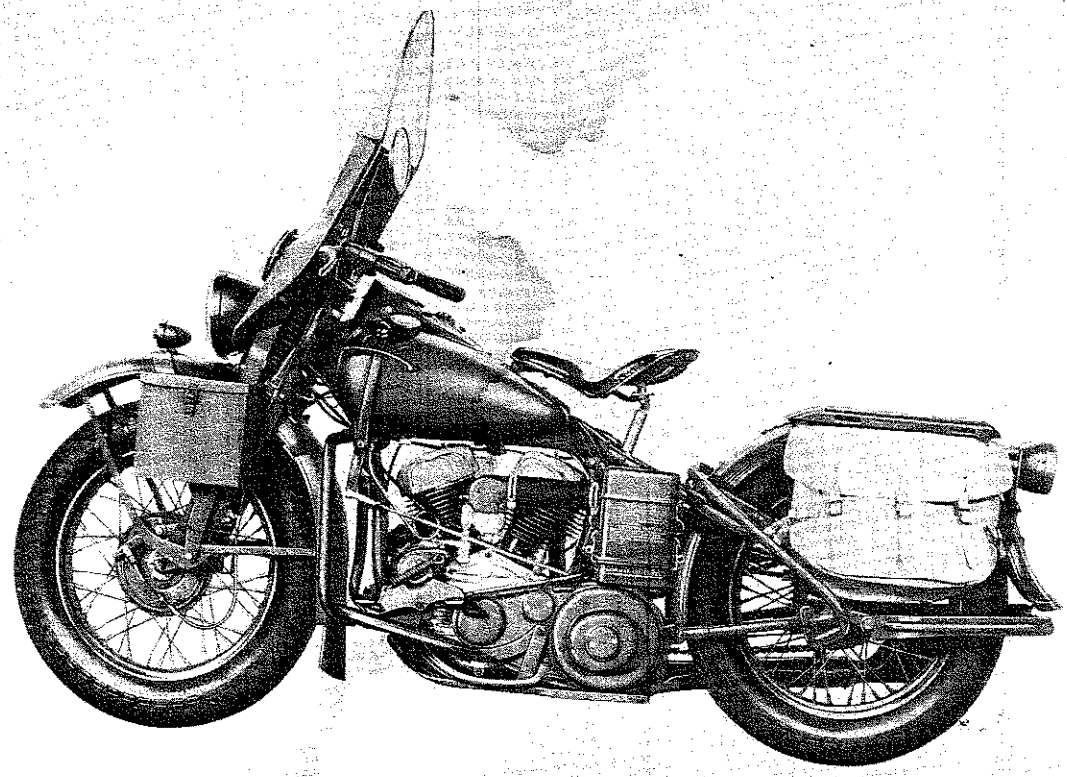
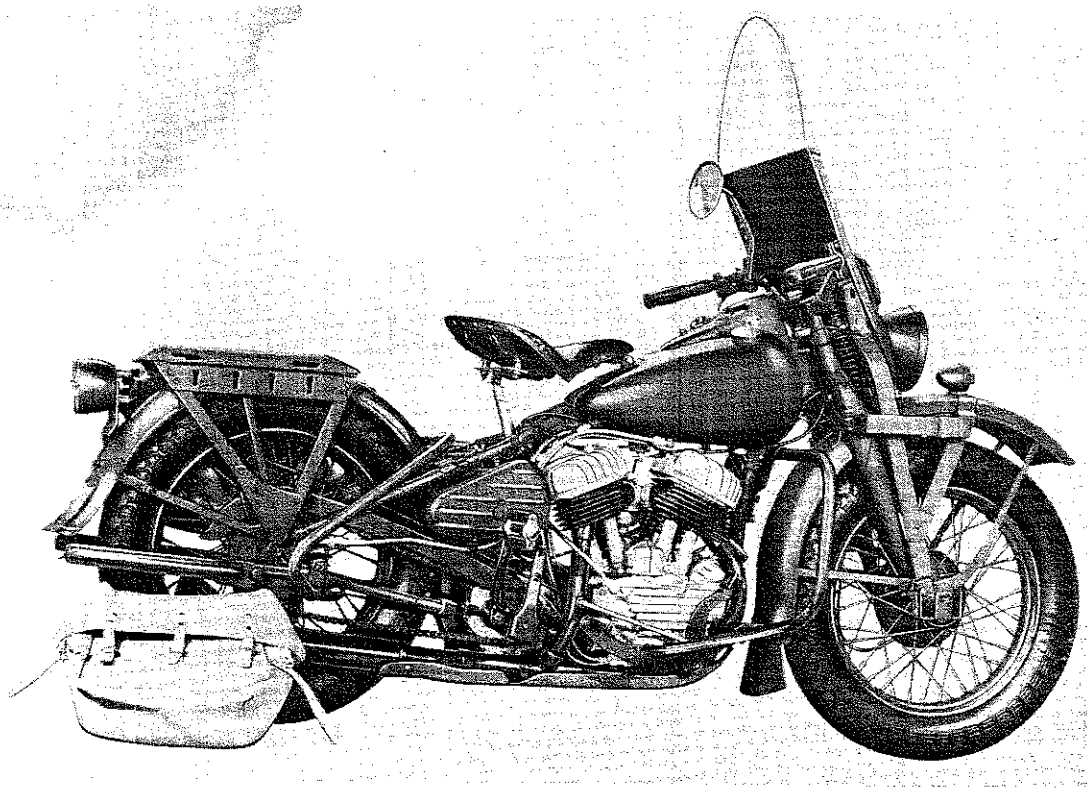


ILLUS. 1
LEFT SIDE VIEW—1942 WLA MODEL, WITH EQUIPMENT



ILLUS. 2
RIGHT SIDE VIEW—1942 WLA MODEL, WITH EQUIPMENT

GENERAL INDEX

INDEX TO SECTION ONE

(Operation and Care)

INDEX TO SECTION TWO
(Maintenance)

GENERAL SPECIFICATIONS

Type of Engine	Two cylinder, L-head, "V" engine
Cylinder Bore	2¾ in.
Stroke	$3\frac{13}{16}$ in.
Piston Displacement	45.12 cu. in.
Compression Ratio	5.0 to 1
Horsepower (N.A.C.C. Rating)	6.05
Wheel Base	57½ in.
Engine Sprocket	31 tooth
Countershaft Sprocket	17 tooth
Rear Wheel Sprocket	41 tooth
High Gear Ratio	4.59 to 1

ENGINE (SERIAL) NUMBER

In identifying a motorcycle as to its year and model, do not trust simply to knowledge of original differences in equipment and general appearance of one year's model as compared with another. Always identify by Engine (Serial) Number.

Example: 42WLA 2222	42	WLA	2222
	Year	Model	Serial Number

TIRE INFLATION PRESSURES
(4.00" x 18")

Front	16 pounds
Rear	18 pounds

NOTE: Above tire inflation pressures are for average load and service. Increase pressure 2 pounds or more per tire for combined load of rider and equipment over 175 pounds or for maintained high speed riding.

GASOLINE AND OIL CAPACITIES

OIL TANK: Oil tank, completely empty, holds one U.S. gallon. When oil level is down to "REFILL" mark, two quarts may be added.

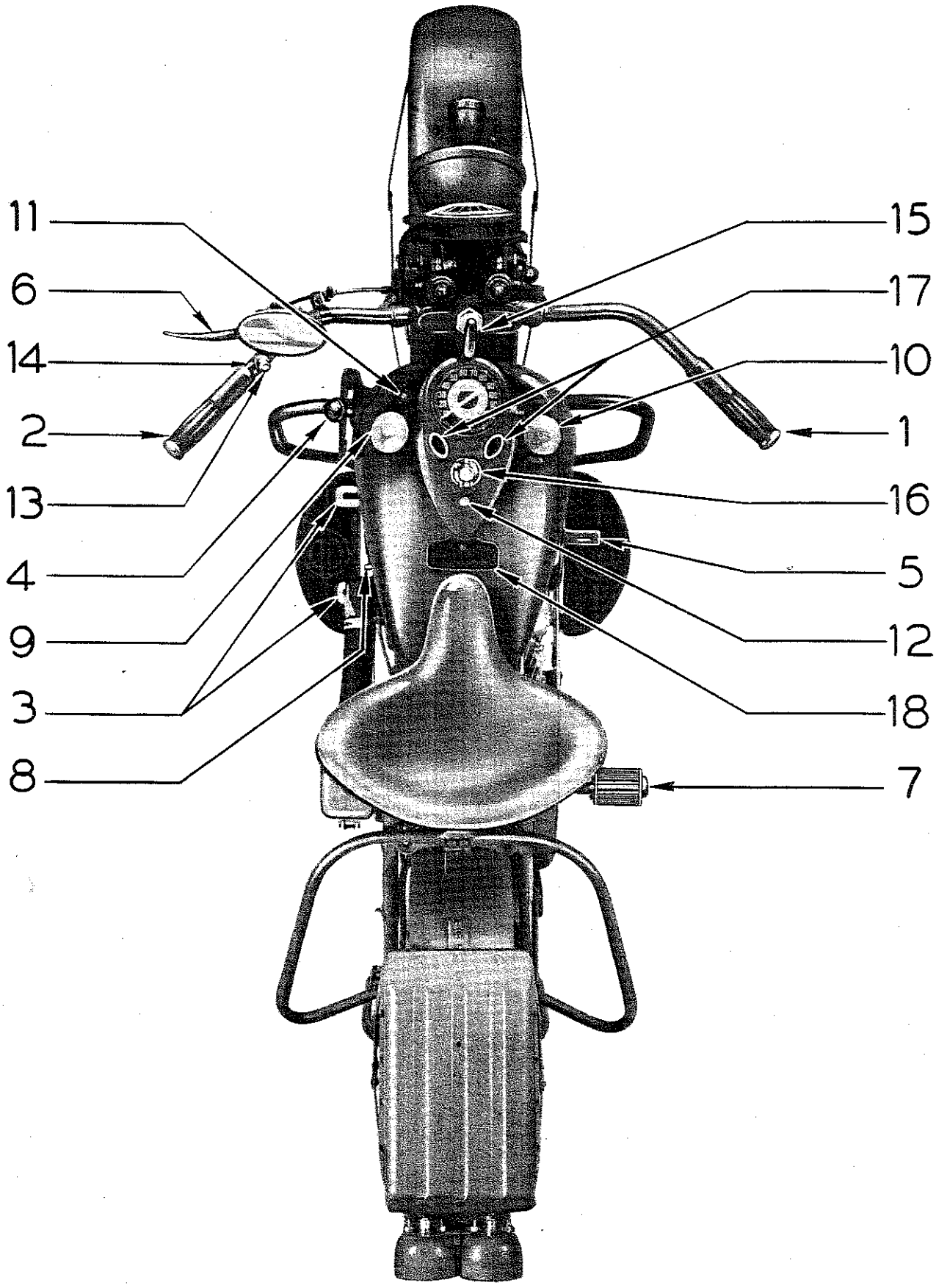
TRANSMISSION: 1941 and later—¾ pint; 1940 and earlier—½ pint.

GASOLINE TANK: Slightly over three U.S. gallons, including reserve supply.

RESERVE GASOLINE SUPPLY: About three U.S. quarts.

FOREWORD

The more satisfactory and dependable performance of one motorcycle over another, when both are in the same type of service, is not generally due to any appreciable variation in original quality and construction. Experience has proven that it is usually the direct result of the operator's knowledge of correct operating methods and his diligence in applying this knowledge.



ILLUS. 3
TOP VIEW, DETAILS 1 TO 18

Top View, Details 1 to 18

(CONTROLS AND THEIR OPERATION)

1. THROTTLE CONTROL GRIP—Turn *inward* to *open* throttle; turn *outward* to *close* throttle. With throttle control and carburetor adjustments correct, engine will continue to run at idling speed with grip in fully closed position. Any needed readjustments should be made by the unit mechanic.

2. SPARK CONTROL GRIP—Turn *inward* to *advance*, turn *outward* to *retard* spark. Under normal operation, carry full spark advance. To avoid knocking and improve performance when engine is laboring under a hard pull, retard spark slightly. Some engines start better with spark slightly retarded.

3. CLUTCH FOOTPEDAL—Clutch is *engaged* with *toe down, disengaged* with *heel down*. Clutch must be engaged when cranking engine (see Details 4 and 7). When starting motorcycle in motion, engage clutch with an easy movement; a quick engagement will "kill" engine or spin rear wheel. If friction adjustment is correct, clutch pedal, with foot removed, will remain in any position within the range of its movement and yet may be rocked without undue effort on the part of the operator. Clutch pedal adjustment should be made by the unit mechanic.

4. GEAR SHIFTER LEVER—Gear positions are indicated on tank shifter guide. Lever must be in *neutral* and clutch *engaged* when starting engine. Fully release clutch before shifting.

5. REAR BRAKE FOOTPEDAL—Brake rod must be adjusted so brake doesn't take effect until pedal is pushed down about an inch. Brake should take full effect at least an inch before pedal bottoms. Spin rear wheel to make sure brake is not too tight and dragging. When brake adjustments are necessary, they should be made by the unit mechanic (see Detail 53).

6. FRONT WHEEL BRAKE HANDLEVER—When properly adjusted, lever will move freely about one-quarter of its full range of movement before brake begins to take effect; if adjusted with less free movement brake is likely to drag. Keep brake control wire well oiled for easy action.

Always use rear brake in conjunction with front brake when bringing motorcycle to a stop. It is better to apply brake with a series of brief applications, rather than with a steady, hard pull. Don't use on sharp turns. Use to hold motorcycle on a grade, etc.

Brake adjustments should be made by the unit mechanic (See Detail 27).

7. FOOT STARTER CRANK—Shifter lever must be in *neutral* and clutch *engaged* when operating starter (See Details 3 and 4).

Operate starter with a vigorous, full stroke; a half-hearted, part-way kick is likely to result in engine backfiring before starter has disengaged at bottom of stroke. When this happens, the force of the backfire is transmitted, through the crank, to the operator's leg.

8. CARBURETOR CHOKE LEVER—When choke lever is in fully closed position, a large portion of gasoline and little air is drawn into the cylinders; this position is for the purpose of priming *only*. Always have ignition switch "OFF" when cranking engine to prime; one or two strokes of starter are usually sufficient. Choke lever is in full prime position when *way up* and in normal running position when *way down*. See "Starting Engine," Page 13.

9. GASOLINE TANK—Tank capacity slightly over three U. S. gallons. Use fuel of 74 octane rating or higher. In order to prevent a vacuum lock of gasoline flow to carburetor, gasoline tank cap is vented. Oil tank cap will fit gasoline tank but is not vented. For this reason, it is important to avoid interchanging tank caps. Drain plug underneath tank.

10. OIL TANK—Oil level gauge rod located directly below tank cap. Tank completely empty holds one U. S. gallon; is considered full with oil level about one inch from top, as some air space is needed for expansion. When oil level is down to "Refill" mark on gauge rod, 2 U. S. quarts may be added. Oil tank cap is not vented; do not interchange with gasoline tank cap. See "Engine Lubrication," Page 25; read very carefully.

11. GASOLINE SHUT-OFF AND RESERVE SUPPLY VALVE—Gasoline is shut off when valve is turned down, finger tight, against its seat; unscrew valve, but do not lift, to use main gasoline supply; lift valve to the limit of its movement to use reserve supply of approximately 3 U. S. quarts.

12. SPEEDOMETER LAMP SWITCH—Operated by turning knob to right or left. Speedometer lamp can be lighted only when service lights are "ON."

13. HORN BUTTON—Operates by pressing.

14. HEADLAMP DIMMING SWITCH—After turning on service lights with main light switch in instrument panel, headlamp beam is raised and lowered by flipping this switch from one side to the other. Light beam should always be lowered at the approach of another vehicle.

15. STEERING DAMPER—Applies steering friction to steady front wheel and prevent wobble in rough going and at higher speeds. For all normal service, keep handle in left side (free) position; move handle to right to apply desired friction.

Steering damper should be adjusted so it does not take noticeable effect until handle is nearly straight back. Fork must turn freely when lever is in released position.

16. IGNITION-LIGHT SWITCH—Switch "OFF" in straight-ahead position. Turn to *first right* position for ignition only; *second right* position for ignition and blackout lights. After pressing down *lockout button*, switch can be turned to *third right* position for ignition and service lights. Bear in mind that turning lights "ON" when engine is not running also turns ignition "ON."

Switch is provided with a lock and key to permit locking, if desired, when motorcycle is not in use. It can be locked only in "OFF" position. When switch is unlocked and motorcycle is in use, key should be removed from lock.

17. INSTRUMENT PANEL SIGNAL LIGHTS—

When switch is turned "ON" preparatory to starting engine, both lights should go "ON." (*Exception:* When switch is turned "ON," immediately after engine has been primed by cranking, *red* oil pressure signal may not light, but will light after a few seconds. This is due to oil pressure built up by cranking, and is most likely to be noticed in cold weather.)

With engine running, both lights should go "OFF." See "Instrument Panel Signal Lights," Page 12.

18. CAUTION PLATE—Manufacturer's oil and spark plug recommendations. See Page 1.

Left Side View, Details 19 to 38

(GENERAL DESCRIPTION—CARE REQUIRED)

19. BLACKOUT MARKER LAMP—Lamp is "ON" with ignition-light switch in *second* right position.

20. HORN—Horn button on handlebar.

21. SERVICE HEADLAMP—Lamp is "ON" with ignition-light switch in *third* right positon (See Detail 14).

22. REAR VIEW MIRROR.

23. OIL BATH AIR CLEANER—The oil bath air cleaner separates abrasive particles of dirt and dust from the air drawn through the carburetor, thus preventing abrasive matter from being drawn into the engine and causing rapid wear of cylinder walls, rings, pistons and other moving parts. Giving air cleaner regular attention will assure normal life of engine parts.

With motorcycle in normal use on hard-surfaced roads, clean and refill air cleaner oil cup at least each time engine oil tank is drained and refilled. Service more frequently under dusty conditions; *daily under extremely dusty conditions.* See "Servicing Air Cleaner," Page 17.

24. BLACKOUT STOP-TAIL LAMP (RIGHT SIDE)—

Top unit is blackout stop lamp, controlled by stop lamp switch (Detail 47).

Bottom unit is regularly used blackout tail lamp, controlled by ignition-light switch (Detail 16).

25. SERVICE STOP-TAIL LAMP WITH SPARE BLACKOUT TAIL LAMP (LEFT SIDE)—

Top unit is *service* stop and tail lamp (double filament bulb). Tail lamp filament is controlled by ignition-light switch (Detail 16); stop lamp filament is controlled by stop lamp switch. (Detail 47). Stop light does not operate in daytime when *ignition only* is turned "ON."

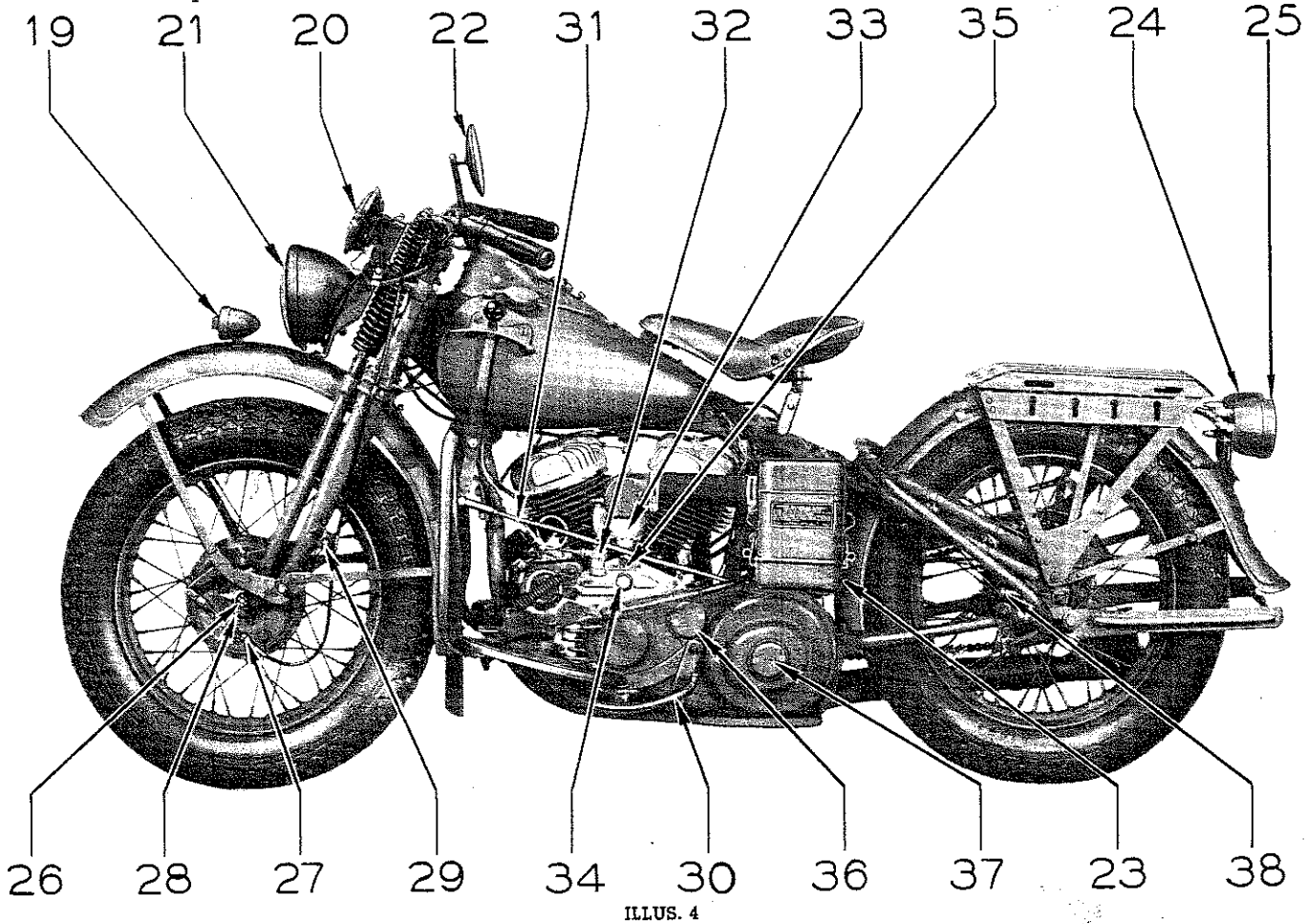
Bottom unit is *spare* blackout tail lamp. In case regularly used (right side) blackout tail lamp fails, its socket plug can be transferred to this tail lamp socket.

26. FRONT AXLE NUT.

27. FRONT WHEEL BRAKE CONTROL ADJUSTMENT—Loosen adjusting sleeve lock nut and turn adjusting sleeve as necessary to attain correct free movement of handlever. (See Detail 6.)

28. BRAKE STABILIZER—Slot in stabilizer plate must register on extended end of left front rocker plate stud. (See "To Remove Front Wheel," Page 70.)

29. BRAKE SHACKLE BOLT—See "To Remove



ILLUS. 4
LEFT SIDE VIEW, DETAILS 19 TO 38

Front Wheel," Page 70.

30. JIFFY STAND—To use, fold outward and forward with toe. It is advisable to leave motorcycle in gear while using jiffy stand, especially when parking with motorcycle facing downgrade; otherwise, if motorcycle rolls forward, jiffy stand may fold back. Always fold jiffy stand back before starting in motion.

31. GEAR SHIFTER ROD—After each readjustment of front chain, also whenever any irregularity is noticed with shifting and positive engagement in different gear positions, adjustment of this rod must be checked. Checking and necessary readjusting should be done by the unit mechanic.

32. GASOLINE STRAINER—Turn off lower end, remove screen, clean and flush at least twice a month, or oftener if need is indicated by irregular carburetion.

33. CARBURETOR—Remove bowl drain screw, drain and flush at least twice a month, or oftener if need is indicated by irregular carburetion.

Carburetor adjustments are to be made only by the unit mechanic.

34. TIMING INSPECTION HOLE PLUG—Provides access to ignition timing mark on flywheel. Timing should be done only by a technically qualified mechanic.

35. ENGINE (SERIAL) NUMBER—Specifies year, model and serial number. See "Engine Serial Number," Page 6.

36. FRONT CHAIN INSPECTION HOLE COVER—Inspect front chain every week and have it readjusted if necessary. Chain should not be allowed to run loose enough to strike guard; neither should it be taut.

A properly adjusted chain has ½" or slightly more free movement up and down, midway between sprockets. See "Adjusting Drive Chains," Page 20. Chain readjustments should be made, or at least checked, by the unit mechanic.

Front chain is automatically lubricated by the engine oil feed pump. If inspection shows chain dry or insufficiently oiled, have oil feed adjustment checked by the unit mechanic. See "Care and Lubrication of Drive Chains," Page 20.

37. CLUTCH INSPECTION HOLE COVER—Provides access to clutch push rod adjusting screw; push rod adjustments should be made by the unit mechanic. See "Adjusting Clutch Control," Page 21.

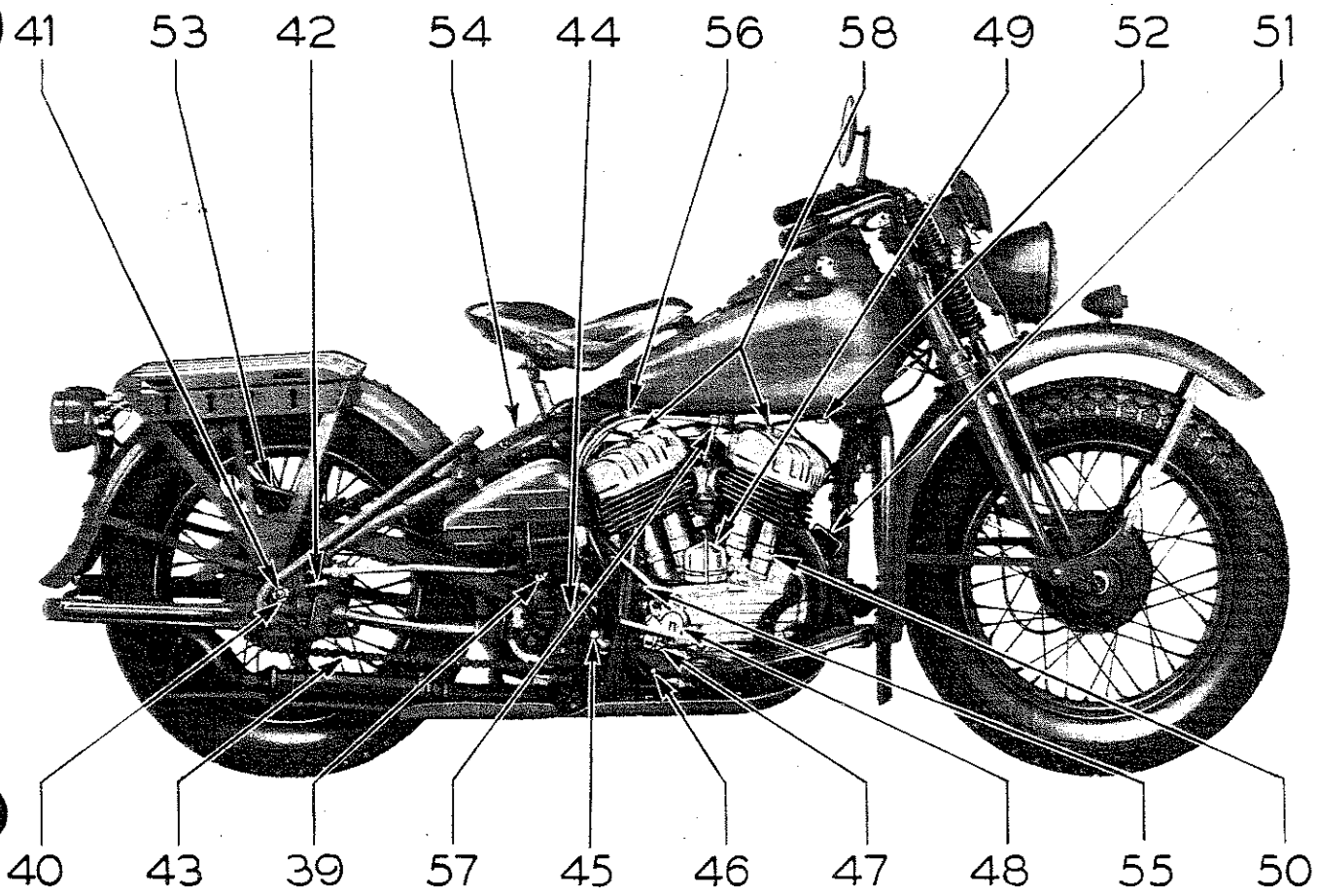
38. REAR WHEEL ADJUSTING SCREW, LEFT SIDE—By means of this screw and a like screw on the *right side*, rear wheel is moved to adjust rear chain, after loosening rear axle nut (Detail 41) and brake sleeve nut (Detail 40). See "Adjusting Drive Chains," Page 20.

Chain adjustments should be made, or at least checked, by the unit mechanic.

Right Side View, Details 39 to 58

(GENERAL DESCRIPTION—CARE REQUIRED)

39. BRAKE ROD LOCK—Provides means of locking rear brake in fully-applied position to prevent brake shell and sprocket from coming off of brake



ILLUS. 5
RIGHT SIDE VIEW, DETAILS 39 TO 58

assembly while removing rear wheel. See "To Remove Rear Wheel," Page 70.

After wheel is re-installed, be sure brake rod lock is secured in a position on brake rod where it will not catch on anything or interfere in any way with full free movement of brake rod and brake footpedal.

40. BRAKE SLEEVE NUT.

41. REAR AXLE NUT.

42. REAR WHEEL ADJUSTING SCREW, RIGHT SIDE—(See Detail 38).

43. REAR DRIVE CHAIN—When motorcycle is in daily use, inspect rear chain daily for adjustment, broken or missing rollers, loose pins and cracked side plates. If chain is very dirty, clean with brush or piece of waste and kerosene.

Chain must not be allowed to run loose enough to strike guard or other chassis parts. When checking chain for need of readjustment, place motorcycle on rear stand and rotate rear wheel until position where chain is tightest is determined. At this point a properly adjusted chain has about ½" free movement up and down, midway between sprockets. See "Adjusting Drive Chains," Page 20.

Chain adjustments should be made, or at least checked, by the unit mechanic.

Note whether chain appears to be getting ample lubrication; if not, see the unit mechanic about readjusting chain oiler.

44. CLUTCH RELEASE LEVER—When clutch footpedal is in fully engaged position, this lever should have between ⅛" and ¼" free movement on end of control cable. When footpedal is in fully disengaged position, lever must clear sprocket cover stud and nut by about $\frac{1}{16}$". Adjustment, if needed, should be made by the unit mechanic.

45. TRANSMISSION OIL FILLER PLUG—Check oil level every two weeks and add oil as necessary. If motorcycle is run unusually long distances, inspect more frequently. Fill to level of filler opening with motorcycle standing straight up, not leaning on jiffy stand. Use same grade of oil used in engine, summer and winter. If difficulty is caused by oil congealing in extremely cold weather, thin oil with a small amount of kerosene.

46. OIL PRESSURE SWITCH—(See Detail 17).

47. STOP LAMP SWITCH—(See Details 24 and 25).

48. OIL FEED PUMP—(See Detail 17). Any pump adjustments are to be made only by a technically qualified mechanic.

49. IGNITION CIRCUIT BREAKER—Advanced and retarded by left handlebar grip (See Detail 2). Breaker points must be kept clean and properly adjusted to .022" with breaker lever fibre on highest point of cam. Keep breaker cam *very lightly* greased. Circuit breaker adjustments to be made only by the unit mechanic.

50. VALVE TAPPETS AND SPRING COVERS—Tappet clearances should be inspected every 1000 to 1500 miles, and adjusted, if necessary, by the unit mechanic.

51. GENERATOR RELAY—Automatically closes and opens generator-battery circuit when engine starts and stops. Does not normally require any attention.

Should there be any indication that attention is needed, it should be checked only by a technically qualified mechanic.

52. OIL TANK DRAIN PLUG—See "Engine Lubrication," Page 25. (Gasoline drain plug in corresponding position in left tank.)

53. REAR BRAKE ROD ADJUSTMENT—(See Detail 5).

54. BATTERY—*Negative* terminal on *right* side is grounded to motorcycle frame. *Positive* terminal is on *left* side. When there is reason to remove battery, be sure it is re-installed with terminals in these positions. Keep terminal connections tight and free from corrosion. Oil terminal felt washers frequently and replace if deteriorated. Lack of proper attention to battery connections may result in burned-out light bulbs and damage to other electrical equipment. Inspect level of battery solution at least once a week and add pure distilled water if needed. See "Care of Storage Battery," Page 52.

55. OIL TANK VENT PIPE CONNECTION.

56. FEED PUMP OIL PIPE CONNECTION.

57. SCAVENGER PUMP OIL PIPE CONNECTION.

58. SPARK PLUGS—Keep clean and gap between electrodes adjusted to .025" to .030". Do not take apart for cleaning; clean with sand-blast cleaner. Defective spark plugs are indicated by engine missing, overheating, knocking excessively and lacking normal power.

All Harley-Davidson V-engine military 45 models are originally equipped with Harley-Davidson number 3 spark plugs. Use only this spark plug when replacement is needed.

INSTRUMENT PANEL SIGNAL LIGHTS

Green light in left side of instrument panel indicates whether or not generator is charging.

Red light in right side of instrument panel indicates whether or not oil is circulating.

When switch is turned "ON," preparatory to starting engine, both lights should go "ON." (Exception: When switch is turned "ON," immediately after engine has been primed by cranking, *red* oil pressure signal may not light, but will light after a few seconds. This is due to oil pressure built up by cranking and is most likely to be noticed in cold weather).

With engine started and running at a fair idling speed, both lights should go "OFF." At slow idling speed or under about 20 miles per hour road speed in high gear, generator signal light will normally flash "ON" and "OFF" because at that speed generator output is very low and unsteady.

Should generator signal fail to go "OFF" at speeds above approximately 20 miles per hour, generator is either not charging at all or its output is not up to normal and it should be inspected at once.

Should oil circulation signal fail to go "OFF" at speeds above idling, it is most likely due to: Empty oil tank; oil supply badly diluted, or using very light grade of oil and pump not building up normal pressure; if freezing weather, oil feed pipe may be clogged with ice or sludge. However, it may be: Grounded oil signal switch wire; faulty signal switch; or oil pump in bad order. Give due attention to oil supply and, if signal still does not operate normally, check to see if oil returns to tank. To do this, remove oil tank cap and, with engine running, look for

pulsating return of oil. A small flashlight is an aid in making this check. If oil *is* returning, motorcycle may be ridden slowly to the closest point where service is available. If oil *is not* returning, further operation of engine will very likely lead to serious damage.

STARTING ENGINE

(REFER TO DETAILS 2, 3, 4, 7 AND 8, PAGE 9)

When starting engine, gear shifter handlever must be in *neutral* and clutch fully *engaged*. Spark should be fully *advanced* or nearly so.

Starting Cold Engine: Set choke lever in fully-closed position (way up), open throttle wide, and with ignition switch "OFF," prime cylinders by operating starter crank once or twice.

Then, with choke lever set ¼ or ½ closed in mild weather, ¾ or fully closed in extremely cold weather, and throttle slightly open, turn ignition switch "ON" and start engine with vigorous strokes of starter.

Caution: It is only in extremely cold weather that engine may start best with choke fully closed and, even then, it will have to be moved from this position immediately after engine starts. Under no conditions will engine continue to run with full choke.

As soon as engine starts, set throttle for moderate idling speed while warming up or until ready to set motorcycle in motion.

As engine warms up and misfires due to an over-rich mixture, gradually move choke lever downward. After engine has thoroughly warmed up, move choke lever to open position (way down).

Starting Warm Engine: This applies to engine half way between hot and cold. Raise choke lever to ¼ closed position (first upward position) and with throttle closed, operate starter once or twice. Then, with throttle ¼ to ⅓ open, turn ignition switch "ON" and operate starter. Soon after engine starts, choke lever should be moved back to fully open position. *Remember:* This procedure calls for having throttle *part way* open during starting strokes after switch has been turned "ON."

Starting Hot Engine: If engine has been shut off for only a brief period and is at about normal running temperature, it is not necessary to use choke lever. Simply close throttle, turn ignition switch "ON" and operate starter. With some engines, depending on carburetor adjustment, hot starting is more dependable if starter is given one stroke before turning ignition switch "ON."

When a hot engine does not start readily, that is, with two or three starter strokes, it is usually due to an over-rich (flooded) condition, and the proper procedure then is to open throttle wide so more air can enter, closing it quickly as engine starts.

To Stop Engine

Stop engine by turning ignition switch "OFF." If engine should be stalled or stopped in any other way than with switch, turn switch "OFF" at once to prevent battery from being discharged through circuit breaker points.

Running In New Engine

Don't run new motorcycle faster than 30 miles per hour the first 100 miles; 35 miles per hour the next 200 miles; 40 miles per hour the next 400 miles; 50 miles per hour the next 500 miles. Avoid running at or near top speed for long distances below 2000 miles.

After a new motorcycle has been run 500 to 1000 miles it needs to be thoroughly checked over and any loose screws and nuts tightened. Particular attention must be given to those that secure engine and transmission; also to rear wheel mounting socket screws. See that this attention is given.

Both chains should be checked for ample lubrication and chain oilers readjusted if necessary by the unit mechanic.

High Speed Tips

Develop the habit of frequently snapping throttle shut for an instant when running at high speed. This draws additional lubrication to pistons and cylinders and helps cooling.

In cold weather run engine slowly until it is thoroughly warmed up, to avoid possible damage to piston rings, pistons and other parts before oil is warm enough to circulate freely.

A motorcycle run long distances at high speed must be given closer than ordinary attention to avoid overheating and possible consequent damage. Engine must be kept well tuned, especially as concerns valve seating, good compression, spark plugs and ignition timing. Carburetor should be adjusted moderately rich, rather than too lean. This applies particularly when motorcycle is equipped with handlebar windshield and legshields.

Don't idle engine unnecessarily with motorcycle standing.

TROUBLE CHART

If engine fails to start, it may be due to one or more of the following conditions:

1. Gasoline tank empty.
2. Gasoline valve shut off.
3. Discharged battery or loose or broken battery terminal connection. Check by turning light switch "ON."
4. Fouled spark plug.
5. Spark plug cables in bad condition.
6. Badly oxidized ignition circuit breaker points.
7. Circuit breaker points badly out of adjustment.
8. Wiring connections loose at coil or circuit breaker.
9. Clutch slipping and starter not turning engine over.
10. Sticking valves or tappets too tight.

If engine starts but runs irregularly or misses:

1. Spark plugs in bad condition or partially fouled.
2. Spark plug cables in bad condition and "leaking."
3. Circuit breaker points out of adjustment or in need of cleaning.
4. Condenser connections loose.
5. Battery nearly discharged.
6. Loose connection, possibly at one of battery terminals.
7. Intermittent short circuit due to damaged wiring insulation.
8. Water or dirt in fuel system and carburetor.
9. Gasoline tank cap vent plugged and tank air bound.
10. Carburetor tampered with and badly out of adjustment.

SUMMARY OF OPERATING INSTRUCTIONS

Before Starting:

1. Fill oil tank.
2. Fill gasoline tank.
3. Open gasoline shut-off valve.

Starting Engine:

1. Straddle motorcycle.
2. Shift into "neutral" and engage clutch.
3. Place carburetor choke lever in "prime" position.
4. Open throttle fully.
5. Operate kick starter once or twice to prime engine.
6. Place carburetor choke lever in proper starting position.
7. Advance spark and set throttle slightly open.
8. Turn ignition switch "ON"; note whether *red* and *green* signal lights go "ON" as they should.
9. Operate starter crank with vigorous strokes. When engine starts, set throttle to moderate idling speed and set choke lever in proper warm-up position.
10. High engine speed, with motorcycle either in motion or standing, must be avoided until engine is thoroughly warmed up and choke lever is in normal running position (way down).

Operation:

1. Transfer weight to right leg, fold back jiffy stand and disengage clutch.
2. Shift into "low."
3. Slowly engage clutch.
4. When clutch starts to take hold, open throttle sufficiently to maintain engine speed.
5. Accelerate gradually to about 12 to 15 miles per hour in "low."
6. Close throttle and disengage clutch.
7. Shift into "second."
8. Re-engage clutch and accelerate to about 25 miles per hour.
9. Close throttle and disengage clutch.
10. Shift into "high."
11. Re-engage clutch and accelerate to desired speed.

To Stop Motorcycle:

1. Close throttle and disengage clutch.
2. Apply brakes to slow motorcycle.
3. Just before coming to a complete stop, shift into "neutral" and engage clutch, or, if an immediate restart is to be made, shift into "low" and allow clutch pedal to remain in released position.
4. Continue brake application to complete stop. As motorcycle slows to point where it can no longer be balanced by steering, place left foot on ground to maintain balance until right foot can be removed from brake pedal.

Parking:

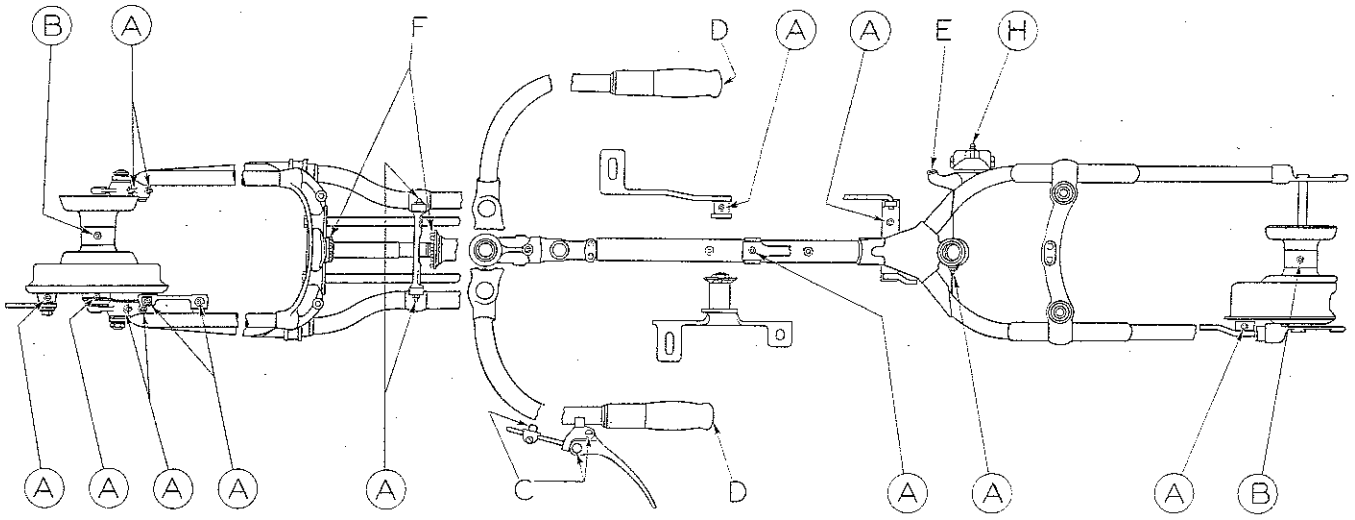
1. Stop engine by turning switch "OFF."
2. Lean motorcycle on jiffy stand, shift into "low" and engage clutch so motorcycle cannot roll.
3. Shut off gasoline by turning shut-off plunger down finger tight against its seat.

OPERATOR MAINTENANCE SCHEDULE AND PREVENTIVE MAINTENANCE INSPECTION

Daily

1. Clean motorcycle.
2. Fill gasoline and oil tanks.
3. Check gasoline and oil pipes for leaks.
4. Clean and refill air cleaner oil cup if motorcycle has been used under dusty conditions since air cleaner was last serviced.
5. Check running lights.
6. Note that *green* light in left side of instrument panel goes "OFF" above about 20 miles per hour, indicating that generator is charging.
7. Note that *red* light in right side of instrument panel goes "OFF" above idling speed, indicating that oil is circulating under pressure.
8. Inspect motorcycle for loose or missing screws and nuts, also broken springs, etc.
9. Check wheel mounting socket screws for tightness.
10. Check front wheel and rear wheel for loose or broken spokes and rim damage.
11. Inspect tires for bruises, under-inflation and pointed objects that may have been picked up.
12. Check wiring for damage or loose connections, particularly at battery terminals.
13. Check spark control and make sure it advances fully.
14. Inspect rear chain for ample lubrication, broken or missing rollers, loose pins and cracked side plates. If chain is very dirty, clean it (See Detail 43, Page 12).
15. Check adjustment of rear chain and, if readjustment is needed, see that this attention is given. (Check adjustment of front chain weekly.)
16. Check front and rear brake action to determine if adjustment is needed.
17. Check clutch action to determine if adjustment is needed.
18. See that motorcycle chassis is lubricated regularly as per Lubrication Chart.
19. Under dusty conditions, engine oil should be changed at shorter than normal intervals.
20. Check tool kit for presence of all tools.
21. Report any unusual performance irregularities or mechanical noises that may indicate developing trouble.

LUBRICATION CHART



ILLUS. 6
(LETTERS IN CIRCLES INDICATE GREASE GUN CONNECTORS)

Greasing and Oiling Intervals

(Numbers in ( ) indicate how many times each letter appears on diagram.)

A—(11)—500 miles; oftener in wet weather.

B— (2)—1500 miles.

C— (1)—500 miles; oftener in wet weather.

D— (2)—Once a year.

E— (1)—Transmission filler plug. Check oil level every two weeks and add oil as necessary to keep oil level up to filler opening.

F— (1)—50,000 miles.

H— (1)—500 miles.

AIR CLEANER—See Detail 23, Page 10.

Type of Lubricant To Be Used

A, D, H —Grease, General Purpose
No. 1 above +32° F.
No. 0 or No. 1 below +32° F.

B, F —Grease, General Purpose
No. 2 above +10° F.
No. 0 or No. 1 below +10° F.

C —Lubricate with oil can, using either same grade oil used in engine or a lighter oil.

E —Use same grade oil used in engine summer and winter. In extremely cold weather, if shifting becomes difficult, thin with kerosene.

ENGINE—Engine Oil
S.A.E. 50 above +32° F.
S.A.E. 30 between +32° F. and +10° F.
S.A.E. 10 below +10° F.

Drain engine oil tank and refill with fresh oil at least every 1000 miles. In dusty service and in winter weather, change oil oftener. See "Engine Lubrication," Page 25, and very carefully read complete information given.

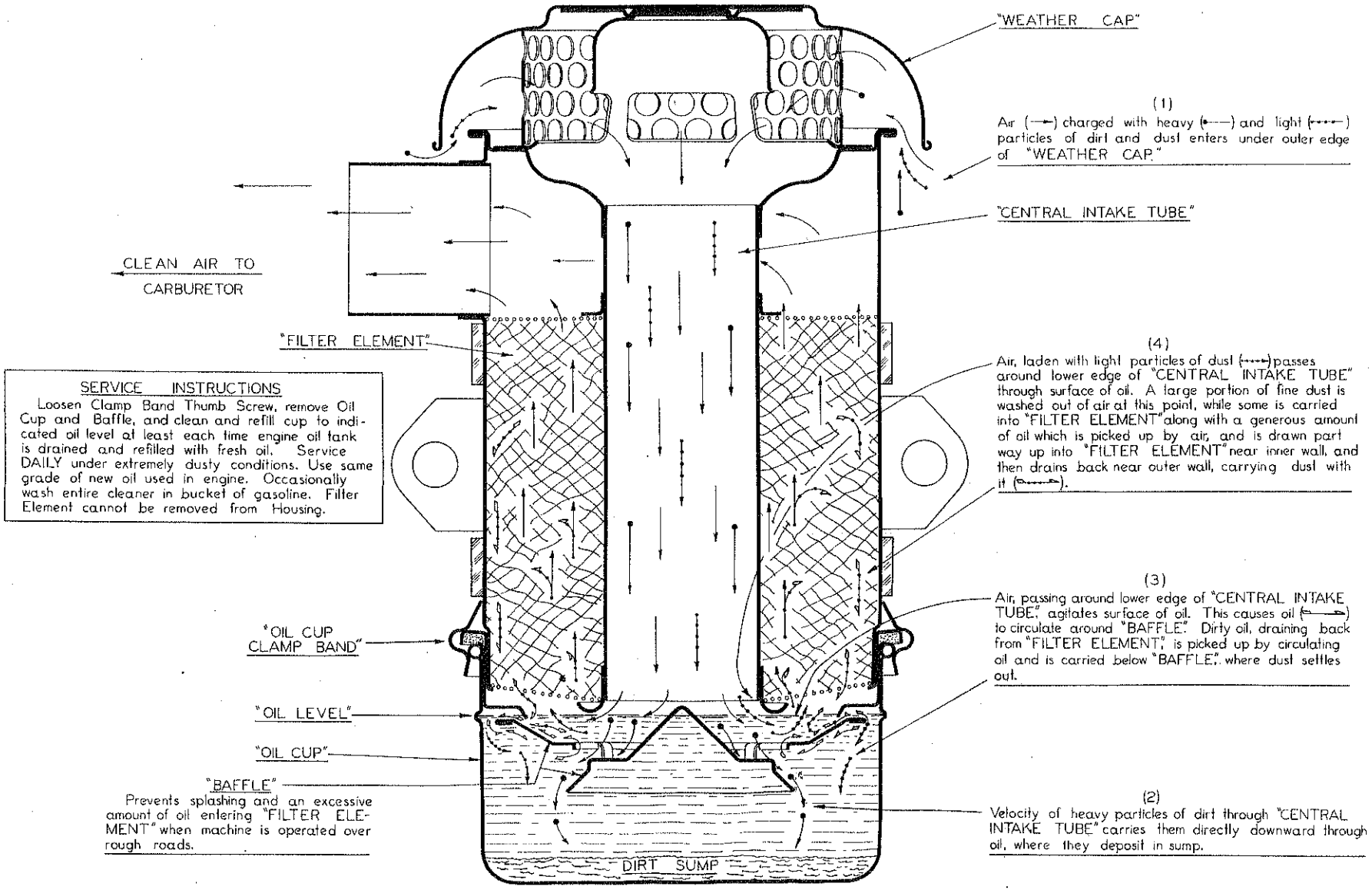
Lubricate generator commutator end bearing every 5000 miles or at least once a year with General Purpose No. 2 Grease. See "Lubricating Commutator End Armature Bearing," Page 52.

To keep controls working freely, all control joints which are not fitted with grease gun connector should be oiled regularly with oil can, particularly after washing motorcycle or operating in wet weather. Spark, throttle and front brake control wires should also be oiled at ends of control wire housings near circuit breaker, carburetor and front brake respectively.

Drive Chains: Front and rear chains are automatically supplied with lubrication by engine oil pumps. Chain oilers are adjustable (See "Lubricating Drive Chains," Page 20.)

Be careful about over-greasing wheel hubs, brake operating cams and front brake cover bushing, as excess grease working out of these bearings or bushings not only develops a messy condition, but is also likely to get onto brake linings, which will greatly reduce efficiency of brakes.

Air operated grease gun number 11662-40, obtainable from the manufacturer, is designed to eject a smaller amount of grease than the conventional automobile chassis grease gun—just the right amount for ample lubrication of motorcycle chassis bearings, with no waste of grease.



ILLUS. 7

SCHEMATIC DIAGRAM SHOWING AIR FLOW THROUGH OIL BATH AIR CLEANER

Servicing Air Cleaner

With motorcycle in normal use on hard-surfaced roads, clean and refill air cleaner oil cup at least each time engine oil tank is drained and refilled. Service more frequently under dusty conditions; *daily under extremely dusty conditions.*

To service round type cleaner:

Loosen oil cup clamp band thumb screw, remove oil cup and baffle, thoroughly wash and clean oil cup and baffle and refill oil cup to indicated oil level with same grade of new oil used in engine.

In reassembling, observe that oil cup gasket is in place and be sure oil cup and baffle are properly seated against gasket and secured to cleaner housing. Careless assembly is likely to result in an oil and air leak between cup and cleaner housing and possibly a lost cup.

Occasionally, at time of servicing oil cup, complete cleaner should be removed from motorcycle and immersed for a time in a bucket of gasoline or kerosene (or available solvent). Cleaner element, which cannot be removed from housing, must be thoroughly flushed to wash out accumulated dirt. After flushing, dry thoroughly (use an air hose if available) and apply a few squirts of engine oil to inside of cleaner element, using oil can.

To service rectangular type cleaner:

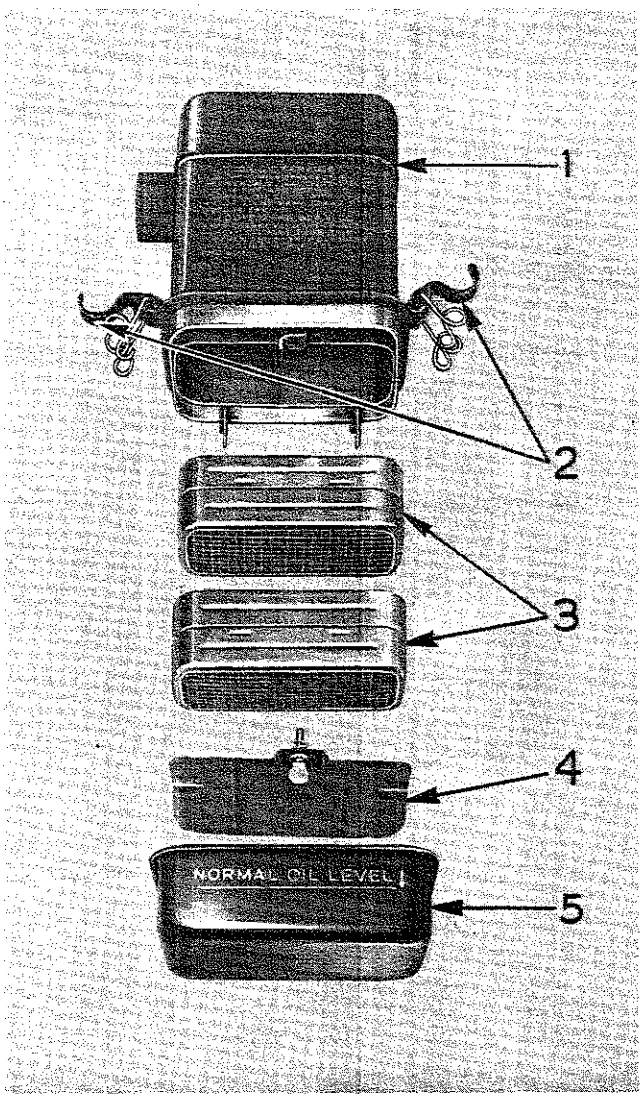
Release oil cup retaining clips and remove oil cup. Thoroughly wash and clean oil cup, refill to indicated oil level and re-install.

In reassembling, observe that oil cup gasket is in place and that oil cup retainer clips are fully engaged in lip of cup and hold oil cup securely to body.

Occasionally, at time of servicing oil cup, unscrew baffle plate thumb screw and remove baffle plate. The two filter elements are then free to be removed from bottom of air cleaner.

Thoroughly flush filter elements in gasoline or kerosene (or avaliable solvent) to wash out accumulated dirt. Allow units to dry out (use an air hose if available) and with an oil can, apply a few squirts of engine oil to each filter element.

NOTE: Observe instructions on air cleaner body.



ILLUS. 8
RECTANGULAR TYPE AIR CLEANER, DISASSEMBLED

1. Air cleaner body.
2. Oil cup retaining clips.
3. Filter elements.
4. Baffle plate.
5. Oil cup.

SECTION TWO
(Maintenance)

INITIAL SERVICING OF NEW MOTORCYCLE

To Be Done By the Unit Mechanic

At First 250 Miles

1. At the first 250 miles, check front and rear drive chains to make sure they are receiving required amount of oil for ample lubrication. If necessary, readjust chain oilers. See Page 20.
2. Check adjustment of chains. Readjust if needed.

At First 500 Miles

1. Drain oil tank and refill with fresh oil. Thereafter, in average service change oil at intervals not exceeding 1000 miles. In extremely dusty service, or when service is exceptionally hard, also in winter weather, oil must be changed at much shorter than normal intervals. See "Engine Lubrication," Page 25.
2. Check level of oil in transmission and add oil if needed. Use same grade of oil used in engine.
3. Lubricate all points indicated for 500-mile attention on Lubrication Chart.
4. Oil all control joints, namely, clutch, gear shifter, brakes, spark and carburetor control wire housings.
5. Inspect air cleaner. Service if needed. See "Servicing Air Cleaner," Page 17.
6. Check adjustment of chains and readjust if needed. Again, check lubrication of chains and readjust chain oilers if found necessary.
7. Check adjustment of brakes. Readjust controls if needed.
8. Check wheel mounting socket screws and tighten if needed. These screws must be kept very tight.
9. Check axle nuts and fork rocker plate stud nuts for looseness.
10. Check level of battery solution and add distilled water if needed. See that terminals are clean and connections tight.
11. Inspect all wiring connections and tighten any found loose. Check switches, lights, etc.
12. Road test motorcycle to check carburetor adjustment and all-around performance.

At First 1500 Miles

1. Drain oil tank and refill with fresh oil.
2. Check level of oil in transmission and add oil if needed. Use same grade of oil used in engine.
3. Lubricate all points indicated for 500-mile attention on Lubrication Chart.
4. Lubricate wheel hubs at 1500-mile intervals as indicated on Lubrication Chart.
5. Oil all control joints, namely, clutch, gear shifter and brakes; also ends of spark and carburetor control wire housings.
6. Check adjustment of chains. Readjust if needed. Again, check lubrication of chains. Check rear chain for broken rollers, loose pins or cracked side plates.
7. Check gear shifting controls for adjustment. Readjust if needed.
8. Check clutch and clutch control adjustments. Readjust if needed.
9. Check brakes and brake control adjustments. Readjust if needed.
10. Check all nuts, bolts, and screws and tighten any found loose. Particular attention should be given to engine mounting bolts, cylinder head bracket bolts, transmission mounting stud nuts, and wheel mounting socket screws.
11. Check front and rear wheel for loose or broken spokes and rim damage.
12. Check level of battery solution and add distilled water if needed.
13. Engine should be given a complete tune-up including: Checking circuit breaker points, ignition timing, valve tappets, spark plugs, draining and flushing carburetor bowl, cleaning and flushing gasoline strainer, carburetor adjustment, and cleaning muffler outlet. Service air cleaner.
14. Road test motorcycle to check carburetor adjustment and all-around performance.

Preceding three service jobs conclude what is considered initial servicing. Further servicing should be given according to schedule of "Regular Interval Inspection and Maintenance."

REGULAR INTERVAL INSPECTION AND MAINTENANCE

To Be Done By the Unit Mechanic

After schedule of initial servicing of new motorcycle has been completed, this maintenance schedule is then to be followed at regular intervals not exceeding 1500 miles.

1. Check oil in tank. Drain and refill with fresh oil if condition of old oil indicates this is necessary.
2. Check level of oil in transmission and add oil if needed. Use same grade of oil used in engine.
3. Lubricate all points indicated for 500-mile attention on Lubrication Chart.
4. Lubricate wheel hubs at 1500-mile intervals as indicated on Lubrication Chart.
5. Oil all control joints, namely, clutch, gear shifter and brakes; also ends of spark and carburetor control wire housings.
6. Inspect air cleaner and service if needed.
7. Remove rear chain, inspect and then clean and lubricate as per instructions under "Lubricating Drive Chains," Page 20. Check front chain for ample lubrication. Adjust chains.
8. Remove chain oiler adjusting screws, being very careful not to lose any of their adjusting washers. Then, flush out screw seat and oil passage with gasoline and blow out with compressed air. Replace screws and adjusting washers. See "Lubricating Drive Chains," Page 20.
9. Check clutch and clutch control adjustments. Readjust if needed.

10. Check brakes. Readjust controls if needed.
11. Check all nuts, bolts, and screws and tighten any found loose.
12. Check wheel mounting socket screws.
13. Check axle nuts and fork rocker plate stud nuts for looseness.
14. Check front and rear wheel for loose or broken spokes and rim damage.
15. Clean and flush gasoline strainer.
16. Remove carburetor bowl drain plug and flush bowl.
17. Check level of battery solution and add distilled water if needed.
18. Inspect all wiring connections. Check switches and lights.
19. Completely tune up engine, including: Checking circuit breaker points, ignition timing, valve tappets, spark plugs, carburetor adjustment, and cleaning muffler outlet.
20. Note that generator *(green)* and oil pressure *(red)* signal lights, in switch panel, go out when engine is running above idling speeds.
21. Road test motorcycle to check carburetor adjustment and all-around performance.

Once every 5000 miles, or at least once a year (if total yearly mileage is less than 5000 miles), lubricate commutator end bearing of generator with General Purpose No. 2 Grease.

HIGHER ECHELON INSPECTION

To Be Made at Intervals of About 2000 Miles

This inspection consists of a thorough check of all parts of the motorcycle, as follows:

1. Engine: . . . . . Check—Ignition system, including cleaning spark plugs and circuit breaker contact points.
Ignition timing.
For knocks or unusual sounds.
Compression.
Valve clearances. Sticking or gummy valves.
Carburetor adjustment. Manifold air leaks.
Air cleaner, gasoline strainer, and carburetor bowl.
Engine support bolts and cylinder head bracket bolts.

2. Lubrication: . . . . . Check—Condition of oil in tank to determine if oil change is needed.
Oil pressure signal system to make sure it is functioning properly.
Oil lines for breaks or loose connections.
Chains and chassis for proper lubrication.

3. Clutch: . . . . . Check—For correct adjustment, slippage, or wear.
Controls and their adjustment.

4. Transmission: . . . . . Check—For unusual noises indicating worn bearings.
Transmission mounting stud nuts.
For worn sprockets.
For worn or loose chains.
Shifter lever and controls for proper adjustment.

5. Wheels: . . . . . Check—For alignment, loose or broken spokes, damaged rims.
Brakes and brake control adjustments.
Wheel mounting socket screws for tightness.
For worn bearings.
For worn sprockets.
Tires for cuts, bruises, or pointed objects.
Axle nuts.

6. Frame and Forks: . . . Check—For breaks in tubing.
Springs for broken coils.
Tanks for leaks.
Gasoline line for breaks or loose connections.
Bent or damaged mudguards for tire clearance.
Rocker plate stud nuts.
Adjustment of frame head bearing.
Handlebar controls for lubrication and ease of operation.

7. Miscellaneous: . . . . . Check—Generator charging rate if battery condition indicates there is reason to do so.
Level of electrolyte in battery and condition of charge.
Lamps.
Horn.
Rear stand and jiffy stand.
Electrical system for loose connections, broken wires, poor insulation, etc.
Entire motorcycle for loose nuts, bolts, and screws.

CARE AND LUBRICATION OF DRIVE CHAINS

Adjusting Drive Chains

Front Chain: Loosen the *three* transmission mounting stud nuts underneath transmission. This permits moving transmission backward or forward by means of adjusting screw, head of which protrudes through frame fitting at rear of transmission. Turn adjusting screw to *right to tighten* chain, to *left to loosen* chain. When chain is correctly adjusted (See Detail 36, Page 11), securely tighten stud nuts and recheck chain, as tightening stud nuts sometimes changes chain adjustment.

Readjusting front chain changes adjustment of rear chain, so both must be readjusted.

Moving transmission to readjust front chain also affects adjustment of gear shifter and clutch controls. Therefore, each time front chain is readjusted, these controls will have to be readjusted or at least their adjustment will have to be checked.

Rear Chain: Remove rear axle nut and lock washer and loosen brake sleeve nut. Also loosen rear wheel adjusting screw lock nuts.

Turn adjusting screws as necessary to correctly adjust chain. (See Detail 43, Page 12.) Turn each screw an equal number of turns in order to keep wheel aligned. Check correct alignment of wheel by noting that tire runs midway between lower rear frame tubes and also that rear sprocket runs centrally in chain. When adjustment is completed, be sure to tighten adjusting screw lock nuts, brake sleeve nut and rear axle nut. Then recheck adjustment, as tightening brake sleeve nut and axle nut sometimes changes chain adjustment.

After tightening rear chain, rear brake may be found too tight. Check and readjust if necessary.

Lubricating Drive Chains

Both the front and rear chains are automatically lubricated by engine oil pumps. Chain oilers are adjustable and may need occasional readjustment to meet lubrication requirements of varied operating conditions. See Illustration 9. Inspect chains frequently to be sure they are getting ample lubrication. Inspection hole cover (Detail 36, Page 11) must be removed to permit inspection of front chain.

Readjustment of chain oilers should be made only by the unit mechanic as chains under any operating conditions require only a very small amount of oil for ample lubrication and therefore chain oilers require very fine adjustment to supply just enough but no waste oil. If inspection shows either chain getting not enough or too much oil, readjust as follows: For *more* oil, *add* thin (.002") washers under head of adjusting screw; *remove* thin washers for *less* oil. It is advisable to add or remove only one thin washer at a time and inspect chain again after motorcycle has run approximately another hundred miles to determine whether or not further adjustment is needed. A few extra thin (.002") adjusting washers are furnished in tool kit.

Occasionally, adjusting screws should be removed, taking care that none of the adjusting washers are lost from either screw, and the screw seat and oil passages flushed with gasoline and blown out with compressed air. Replace adjusting screws and turn down tight, but not extremely tight, against washers.

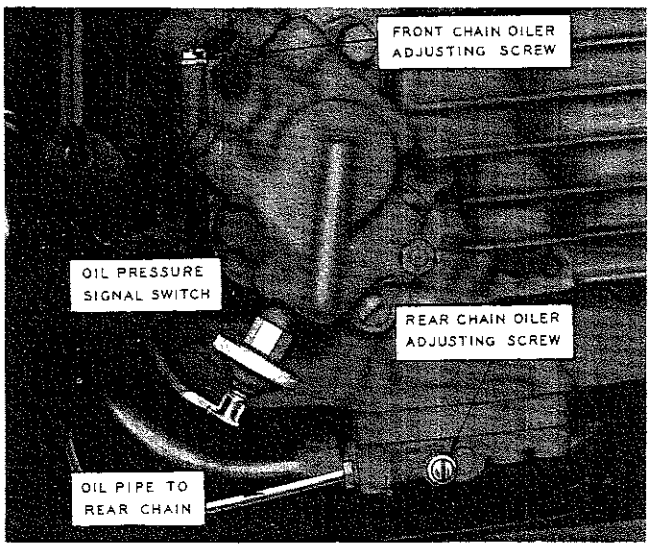
Every 1500 miles, rear chain should have additional lubrication as follows:

Remove chain from motorcycle. Soak and wash thoroughly in a pan of kerosene. After removing chain from kerosene, hang it up for a time to allow kerosene to drain off.

Immerse for a short time in a pan of grease heated to consistency of light engine oil. If grease and facilities for heating are not at hand, substitute S.A.E. 10 engine oil. While immersed, move chain around to be sure that hot grease or oil works through to all inside parts.

After removing from hot grease or oil, allow chain to drain and wipe all surplus grease or oil from surface of chain.

Re-install chain on motorcycle. Inspect connecting link and spring clip closely for good condition. Be sure spring clip is properly and securely locked on pin ends.

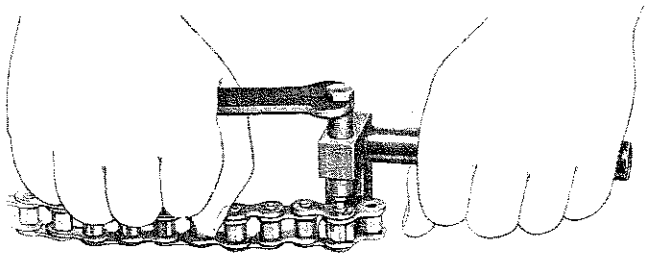


ILLUS. 9
CHAIN OILER ADJUSTING SCREWS AND OIL SIGNAL SWITCH

Repairing Drive Chains

When necessary to repair a chain, remove damaged link or links by pushing out pins with chain repair tool. Then, fit necessary repair links, noting that spring clips are properly and securely locked on pin ends.

Front chain is a double row or duplex chain; rear chain is a single row chain. The chain tool furnished in the tool kit is designed to accommodate both.



ILLUS. 10
USE OF CHAIN REPAIR TOOL

CLUTCH AND GEAR SHIFTER

Need for attention to clutch and controls is indicated by clutch slipping under load or dragging in released position. In either case, the first thing to be checked is adjustment of controls; this is the attention usually needed.

The first warning or indication of shifter controls being out of correct adjustment is transmission "jumping" out of engagement when accelerating under heavy pull. This warning must not be disregarded.

Checking and Adjusting External Shifter Controls

A. See that control joints from *transmission* gear shifter lever (See Illustration 54, Page 69) to gear shifter hand lever (Detail 4, Page 9) are well oiled and free-working.

B. Check handlever center pivot bolt nut for tightness.

C. Observe whether there is binding or interference with shifter rod (Detail 31, Page 11) at any point in the shifting range; this is sometimes found as a result of bent rod.

D. Check to determine whether or not shifter rod is correctly adjusted so that when *handlever* is moved to any gear position in tank shifter guide, *transmission* lever moves to just the right position to fully engage shifter clutch and shifter cam spring plunger (inside transmission).

E. *Readjust as follows:* Set *handlever* in *neutral* position, disconnect shifter rod from handlever and, with slight backward and forward movement, carefully "feel" *transmission* lever into exact position where shifter cam spring plunger (inside transmission) seats fully in retaining notch. Next, see that *handlever* is in exact *neutral* position and readjust length of shifter rod so shifter rod end hole lines up with hole in *handlever*. Insert bolt and tighten nut. It is advisable to repeat this check in low and second gears to be sure of having best all-around adjustment.

Caution: Shifter controls must be kept in correct adjustment; otherwise, driving dogs on shifter clutches will not fully engage in the different positions and are likely to become damaged from jumping out of engagement under driving load.

When shifter clutches become worn or damaged to the extent of jumping out of engagement under driving load, even though shifter controls are correctly adjusted, transmission must be serviced as explained under "Overhauling Transmission and Clutch," Page 66.

Adjusting Clutch Control

Refer to Illustration 11 and note location of following parts:

1. Foot clutch cable tube (felt oil washer in each end).
2. Push rod adjusting screw.
3. Push rod adjusting screw lock nut.
4. Spring tension adjusting nuts (three).
5. Spring tension adjusting nut locks (three).

16. Footpedal.
21. Footpedal cable.

With footpedal (16) in *fully disengaged position,* clutch release lever (Detail 44, Page 12) must clear sprocket cover stud and nut by about $\frac{1}{16}$". This adjustment is attained by adjusting length of footpedal cable (21). With footpedal in *fully engaged position,* clutch release lever must have between ⅛" and ¼" free movement on end of footpedal cable. If it has *less* than ⅛", loosen adjusting screw lock nut (3) and turn adjusting screw (2) to the *left* to *increase* amount of free movement. If it has *more* than ¼", turn adjusting screw (2) to *right* to *decrease* amount of free movement. Tighten adjusting screw lock nut (3) securely.

Caution: If end of clutch release lever has no free movement as explained above, clutch will not hold properly. If too much free movement is allowed, clutch will drag when in disengaged position and consequently transmission will shift hard, clash and eventually become damaged.

Adjusting Clutch Spring Tension

(REFER TO ILLUSTRATIONS 11 AND 12)

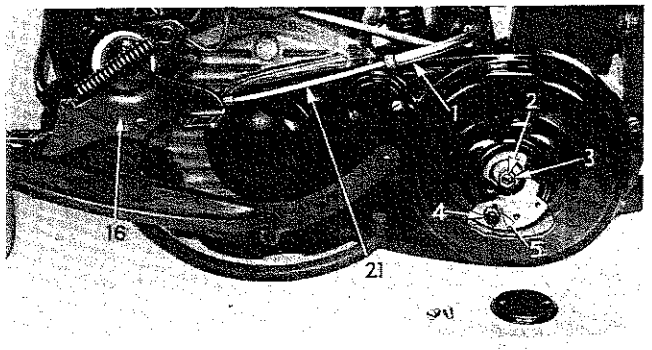
If clutch slips after controls have been correctly adjusted, increase spring tension by tightening (turn right) the three nuts (4) after removing chain guard and bending away locks (5).

Tighten all three nuts, one-half turn at a time, until clutch holds. Test after each half turn by cranking engine; usually a clutch that holds without any noticeable slippage when cranking engine also holds on the road.

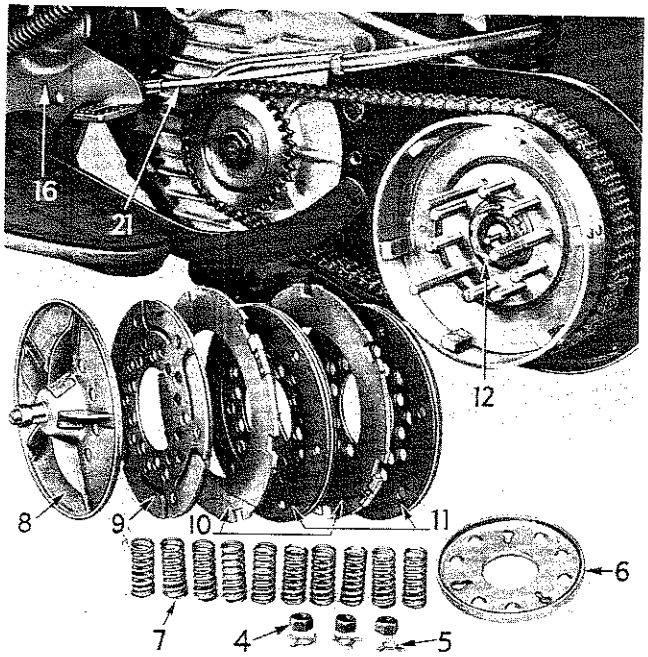
Do not increase spring tension any more than actually required to make clutch hold. As a new clutch is originally assembled and adjusted, the distance from inner edge of shoulder on spring collar (6) to outer surface of outer disc (8) is $1\frac{1}{32}$". In any case, do not tighten nuts (4) to the point where inner edge of shoulder on spring collar (6) is closer than ⅞" to surface of outer disc (8). If compressed more, clutch probably cannot be fully released.

(A nut on the end of clutch gear adjusts spring tension of the 1940 clutch. Thrust cap must be removed to expose adjusting nut. Normal adjustment—$\frac{3}{32}$" from face of spring collar to shoulder on thrust cap studs.)

If clutch still does not hold, after making sure of correct control adjustments and increasing spring tension, it will have to be taken apart for inspection of discs and springs.



ILLUS. 11
CLUTCH CONTROL ADJUSTMENTS



ILLUS. 12
CLUTCH DISASSEMBLED

4. Spring tension adjusting nuts (three).
5. Spring tension adjusting nut locks (three).
6. Spring collar.
7. Clutch springs (ten).
8. Outer disc.
9. Sprung disc, to smooth clutch engagement. Friction disc riveted to *inner* side.
10. Steel discs (two). Outer side marked "OUT."
11. Lined friction discs (two).
12. Clutch hub nut (right thread).

Disassembling Clutch

With outer chain guard removed, simply bending away nut locks (5) and turning off nuts (4) allows clutch to come apart as shown in Illustration 12. However, unless springs may need inspection and possibly renewal, it is not necessary to release them. Spring compression collar (6), springs (7) and releasing disc (8) can be removed as an assembly. This manner of disassembly makes reassembly a much simpler job than with springs released.

To remove these parts as an assembly, first obtain a flat washer with approximately the following dimensions: ⅛" thick, 1¾" outside diameter and ⅜" center hole. Remove push rod adjusting screw lock nut (3) and fit flat washer over adjusting screw (2). Then turn lock nut onto adjusting screw against washer and tighten lock nut until adjusting nuts (4) are free. Bend away nut locks (5), remove nuts (4) and assembly can be pulled off, freeing the other discs.

To remove clutch shell and sprocket, it is necessary to first remove engine sprocket. Then front chain and clutch sprocket assembly can be taken off.

If there is reason to remove clutch hub, refer to "Removing Clutch Hub," Page 67, and "Installing Clutch Hub," Page 68.

Reassembling Clutch

Inspect all parts carefully. If fibre discs are not badly worn but are oil-soaked, wash them thoroughly in clean gasoline and dry with compressed air or heat. If discs are found worn to rivet heads, replace with new lined steel discs; it is impractical to reline old discs.

If clutch has been badly overheated as a result of slippage, springs may be found shrunken and in need of replacement.

Reassemble clutch in the reverse order of disassembly. Be sure steel friction discs are assembled with sides stamped "OUT" facing outward. Also, splineways with anti-rattle devices should be staggered on splines in hub shell. Illustrations 12 and 52 show parts in their correct order.

Adjusting Front Wheel Brake

(Refer to Detail 6, Page 9).

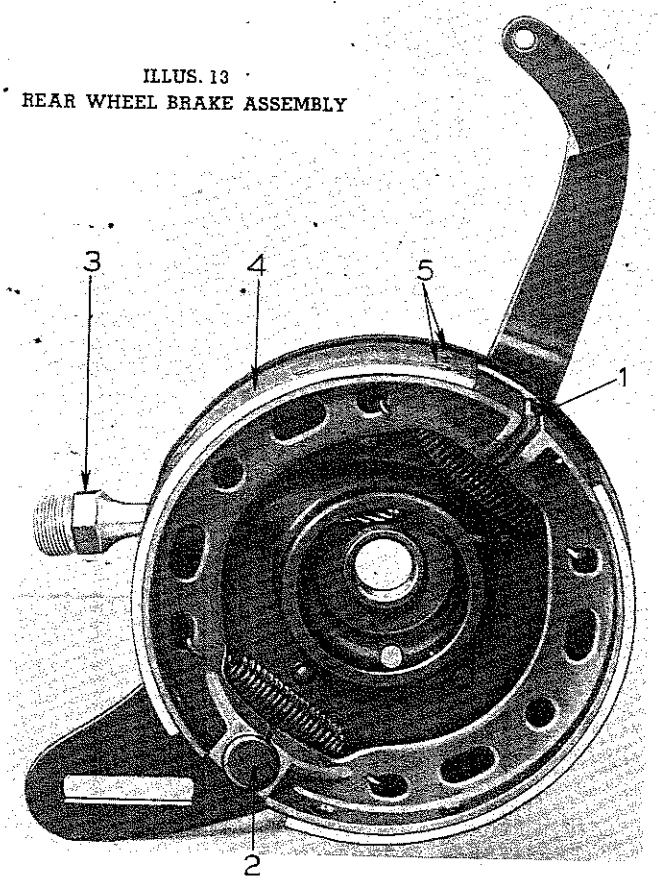
Adjusting Rear Wheel Brake

(Refer to Detail 5, Page 9).

Rear Brake Assembly

1. Operating cam.
2. Adjustable pivot stud. After relining brake and reassembling in motorcycle, loosen nut on this stud, apply brake hard and, while holding it applied, tighten nut. This centers shoe assembly in drum.
3. Speedometer drive.
4. Brake liner (2 used). Part number: (1940) 4114-35 Set of liners and rivets. (1941 and later) 4114-41 Set of liners and rivets.
5. Liner rivets (14 used). Part number: (1940; also 1941 and later) 4046-31 Rivet.

ILLUS. 13
REAR WHEEL BRAKE ASSEMBLY



ADJUSTING CARBURETOR

Before attempting to correct faulty engine performance by readjusting carburetor, give the following attention:

A. See that throttle and spark controls are correctly adjusted.

B. Remove drain screw from bowl of carburetor. Drain and flush bowl to eliminate dirt and water.

C. Drain and flush gasoline strainer.

D. Check air cleaner to be sure passage of air through cleaner is not restricted by oil cup oil level being too high or by an excessive accumulation of dirt in filter element or elements.

E. Check manifold packing nuts and carburetor mounting screws for tightness.

F. See that spark plugs are clean and correctly adjusted. If condition of spark plugs is questionable, install new ones.

G. Check adjustment of valve tappets.

H. Check compression of both cylinders by operating starter pedal slowly.

I. Check condition and adjustment of circuit breaker contact points.

J. Check for poor or loose connections in wiring, particularly at battery terminals, switch terminals and circuit breaker condenser.

K. Check battery to be sure it is not nearly discharged.

L. Check for intermittent short circuit due to damaged wiring insulation.

M. Check gasoline tank cap to be sure air vent is not plugged.

A carburetor, once properly adjusted, should require little, if any, readjusting. At the most, it should not be necessary to adjust the needle more than one or two notches richer or leaner to correct mixture for changes in weather conditions.

Needle adjustment controls only idling and low speed fuel mixture. Needle turns down (to right) to make mixture leaner; backing it out (to left) makes mixture richer. Needle is held in whatever position it may be turned to by a spring-and-ball plunger which engages notches in the needle adjusting screw.

A carburetor that is badly out of adjustment may be readjusted as follows: First, make sure carburetor control wire is adjusted so throttle opens and closes fully with handlebar grip movement. Turn the low speed needle (on rear side of carburetor) all the way down (to right). Then back needle up (to left) about 3 turns. With needle in this position, engine will start but mixture will probably be too rich. Start engine and, after choke lever has been moved to *open* position and engine is normally hot, correct adjustment of needle.

Turn needle down (to right) one notch at a time until mixture becomes so lean that engine misses and is inclined to stop; then back up needle five to ten notches, or until engine fires regularly with spark advanced and throttle closed or as nearly closed as it can be set and still have engine run at idling speed.

Next, adjust throttle lever stop screw as may be necessary to make engine idle at proper speed with throttle fully closed. Turning screw to *right* makes engine idle *faster*. Turning screw to *left* makes engine idle *slower*. Do not idle engine at the slowest possible speed, because an extremely slow idling adjustment causes hard starting. Changing idling speed with throttle stop screw is likely to change low speed mixture to some extent; therefore it will be necessary to again check and correct low speed needle adjustment by the same procedure followed in making the initial adjustment.

Starting and all-around carburetion will be better with low speed adjustment slightly rich rather than extremely lean.

High speed fuel mixture is governed by a *fixed jet*. See "Carburetor Service," Page 58.

ADJUSTING VALVE TAPPETS

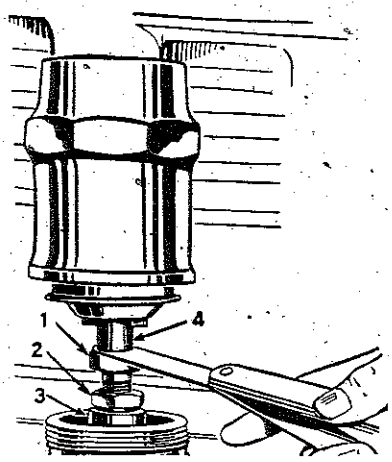
To get maximum power and best all around performance from an engine, keep valve tappets properly adjusted. They must be adjusted after grinding valves and should be inspected and, if necessary, readjusted about every 1500 miles thereafter.

Adjust tappets with engine cold. As each tappet is readjusted, first make sure it is at its lowest position by turning engine ahead until like tappet in other cylinder is at its highest position (valve fully open).

The inlet valves are those nearest the carburetor.

Adjust tappets so there is .004" to .005" clearance between inlet valve stems and tappets and .006" to .007" clearance between exhaust valve stems and tappets. An accurate thickness gauge should be used to measure these clearances. If no gauge is available, use one thickness of ordinary writing paper to gauge inlet tappet clearance and two thicknesses of the same paper to gauge exhaust tappet clearance.

Before turning down valve spring covers, inspect paper gasket between each cover and tappet guide. If broken or damaged, fit a new gasket to prevent an oil leak.



ILLUS. 14
VALVE TAPPET
ADJUSTMENT

1. Tappet adjusting screw with which readjustment is made, after loosening nut (2).
2. Tappet adjusting screw lock nut.
3. Tappet body.
4. Valve stem.

Servicing Circuit Breaker and Ignition Timer

Circuit breaker points that are burned or pitted should be renewed or dressed with a clean fine-cut contact point file. The file should not be used on other metals and should not be allowed to become greasy or dirty. *Never use emery cloth to clean points.* Contact surfaces, after considerable use, may not appear bright and smooth but this is not necessarily an indication that they are not functioning satisfactorily.

Point faces must seat squarely against each other. If bent, square up by bending contact plate.

Point gap with breaker lever fibre on highest point of cam, should be .022". Wrong gap affects ignition timing. Readjust by loosening the two lock screws and shifting adjustable contact plate. Measure gap with accurate thickness gauge before retightening lock screws and recheck gap after tightening lock screws.

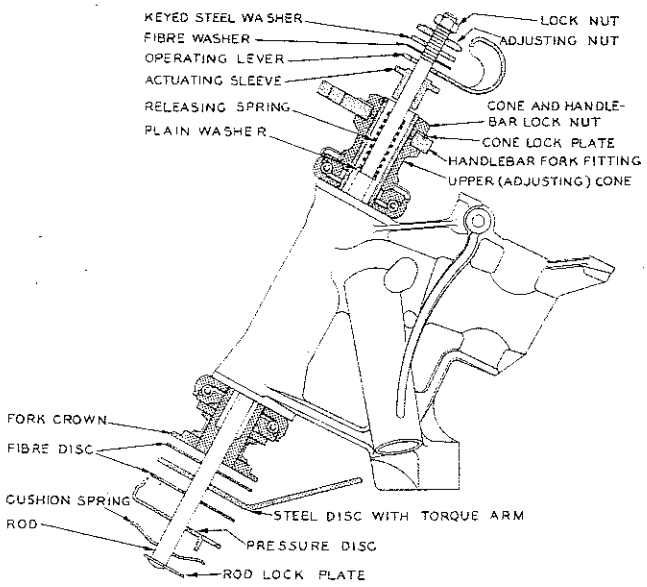
Keep breaker cam *very lightly greased.*

Steering Damper

(SEE DETAIL 15, PAGE 9)

Assemble in the order shown in Illustration 15. Be sure torque arm registers in slot underneath frame head. Lips on pressure disc must fit into slot in fork crown and slot in rod lock plate. Turn actuating sleeve all the way into fork stem and then back it up ½ turn or more. Register operating lever on actuating sleeve and see that lever has full left movement without bottoming sleeve.

Adjust by setting adjusting nut so that operating lever must be moved nearly straight back from free (left side) position, before damper takes noticeable effect. Tighten lock nut.



ILLUS. 15
STEERING DAMPER ASSEMBLY

Servicing Handlebar Controls

To lubricate control parts, or to replace a throttle or spark control wire, or a damaged control wire housing, proceed as follows:

Insert a large heavy screwdriver through hole in end of grip and turn out end nut by using a wrench on screwdriver. Sometimes this nut is difficult to remove. In this case, insert a punch into slot in nut and strike it two or three sharp blows to start it. After removing grip spiral, working parts are accessible. Remove plain roller, roller block, and roller pin. Disconnect control wire at carburetor or timer. Plunger, with control wire attached can now be removed. Wire is fastened into end of plunger by means of a hexagon head screw with a hole through it.

If control wire housing is to be removed, first remove above named parts. Next, remove the small set screw underneath handlebar, just ahead of spiral locating shoulder on bar (on left bar, this screw is under headlamp dimmer switch). Control wire housing can now be pushed out through end of bar.

When reassembling control parts to handlebars, apply a light coat of grease or a few drops of engine oil to control wire as it is inserted into control housing, and lubricate remaining parts with grease (See "Lubrication Chart," Page 15). Overgreasing of these parts will cause a messy condition around bars.

Grip spiral nut can best be started, without danger of crossing threads, by holding spiral back with slight pressure against nut while starting nut with screwdriver. In this manner, shoulder on nut is held squarely against end of spiral sleeve. Always tighten nut securely.

After handlebars and controls are completely assembled, connect control wires at carburetor and timer. Adjust controls so throttle closes and opens fully with carburetor control grip movement and so timer fully advances when its control grip is turned to inward position.

Replacing Front Brake Control Wire

Remove control wire lower clevis clamp nut and pull wire out of clevis. Next, remove cotter pin and flat washer from handlever hollow pin and pull pin out of lever. Control wire can now be pulled out through pin hole in handlever.

Insert new control wire, reversing procedure in which old wire was removed. Apply grease or engine oil to new wire as it is being inserted. Handlever hollow pin must be reassembled before lower end of wire is connected. Narrow slot in pin straddles wire. Replace flat washer and cotter pin at end of hollow pin.

Adjust wire housing to nearly maximum slack by turning adjusting sleeve (Detail 27, Page 10) almost through the boss into which it is threaded. Insert end of wire through clevis nut, then through hole in clevis and back through clamp nut again. Pull wire snug through clevis and secure by tightening clevis nut. Excess wire can be cut off.

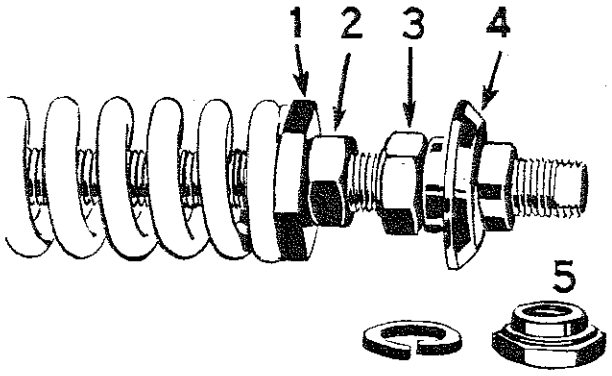
Adjust control, by means of adjusting sleeve, so that handlever moves freely about one-quarter of its full range of movement before brake begins to take effect. Tighten adjusting sleeve lock nut.

Servicing Saddle Spring Post

Illustration shows following parts of spring seat post assembly:

1. Spring tension adjusting nut.
2. Adjusting nut lock nut.
3. Rod nut lock nut.
4. Rod nut.
5. Post clamp nut.

After raising saddle, remove saddle post clamp nut (5), which is located underneath frame at bottom end of post tube. Post assembly can then be pulled out. When post assembly is inserted in frame tube, see that flat side machined on post rod nut (4) registers in flat side of hole in bottom of tube. Cushion spring assembly (three lower springs) is adjusted 11½" to 12" long. Adjustment can be changed for lighter or heavier than average rider and also different springs can be obtained if desired.



ILLUS. 16
SADDLE SPRING POST ASSEMBLY

ENGINE LUBRICATION

Engine lubrication system is a circulating system. A vane-type feed pump draws oil from the tank and delivers it to crankshaft under pressure. Pressure can be regulated. A gear-type scavenger pump returns oil from engine base to tank. Refer to schematic diagrams of Oil Feed Pump and Engine Oiling System, Pages 26 and 27; also to Detail 10, Page 9, for information concerning oil tank, oil tank capacity, etc.

Oil circulation is indicated by *red* signal light in right side of instrument panel going "OFF" when engine is running.

A motorcycle engine, being air cooled, requires a high quality lubricating oil. Use S.A.E. 50 when temperature is above freezing (+32° F.). Use S.A.E. 30 between freezing and +10° F. Use S.A.E. 10 when temperature is below +10° F.

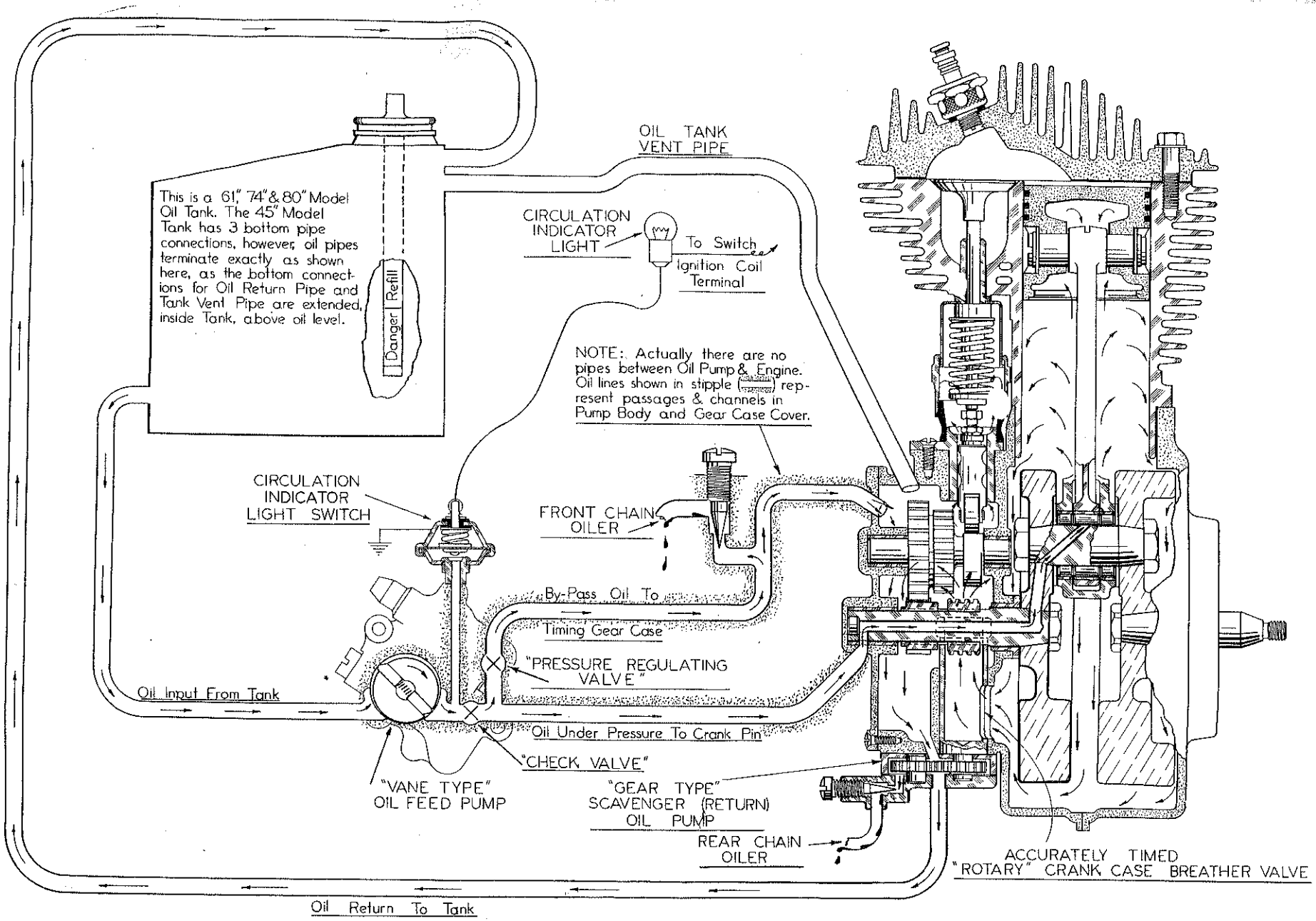
Oil mileage normally varies from 200 to 400 miles per U. S. quart, depending on nature of service, operating speed and condition of engine as regards both tuning and wear. If oil mileage is not within this range, report to the unit mechanic.

Remove gauge rod and check oil supply not more than 300 miles after each complete refill. If oil level is found not very far above "Refill" mark on gauge rod, add oil; when level is down to "Refill" mark, two U. S. quarts may be added. Oil supply runs cooler and mileage somewhat higher with oil level well up in tank. If oil tank is not kept well filled, frequent checking will be necessary as a safeguard against running dry.

Completely drain oil tank and refill with fresh oil after new engine has run its first 500 miles. Thereafter, under average service conditions in warm or hot weather, drain and refill at intervals not exceeding 1000 miles. If service is extremely hard or under extremely dusty conditions, change oil at shorter intervals. It is not necessary to drain crankcase as it does not accumulate used oil. At the time of the first oil change and at least with every second change thereafter, thoroughly flush and clean out oil tank with kerosene. This will remove any sediment and sludge that may have accumulated. Unit service facilities usually include a means of quickly flushing and cleaning oil tank.

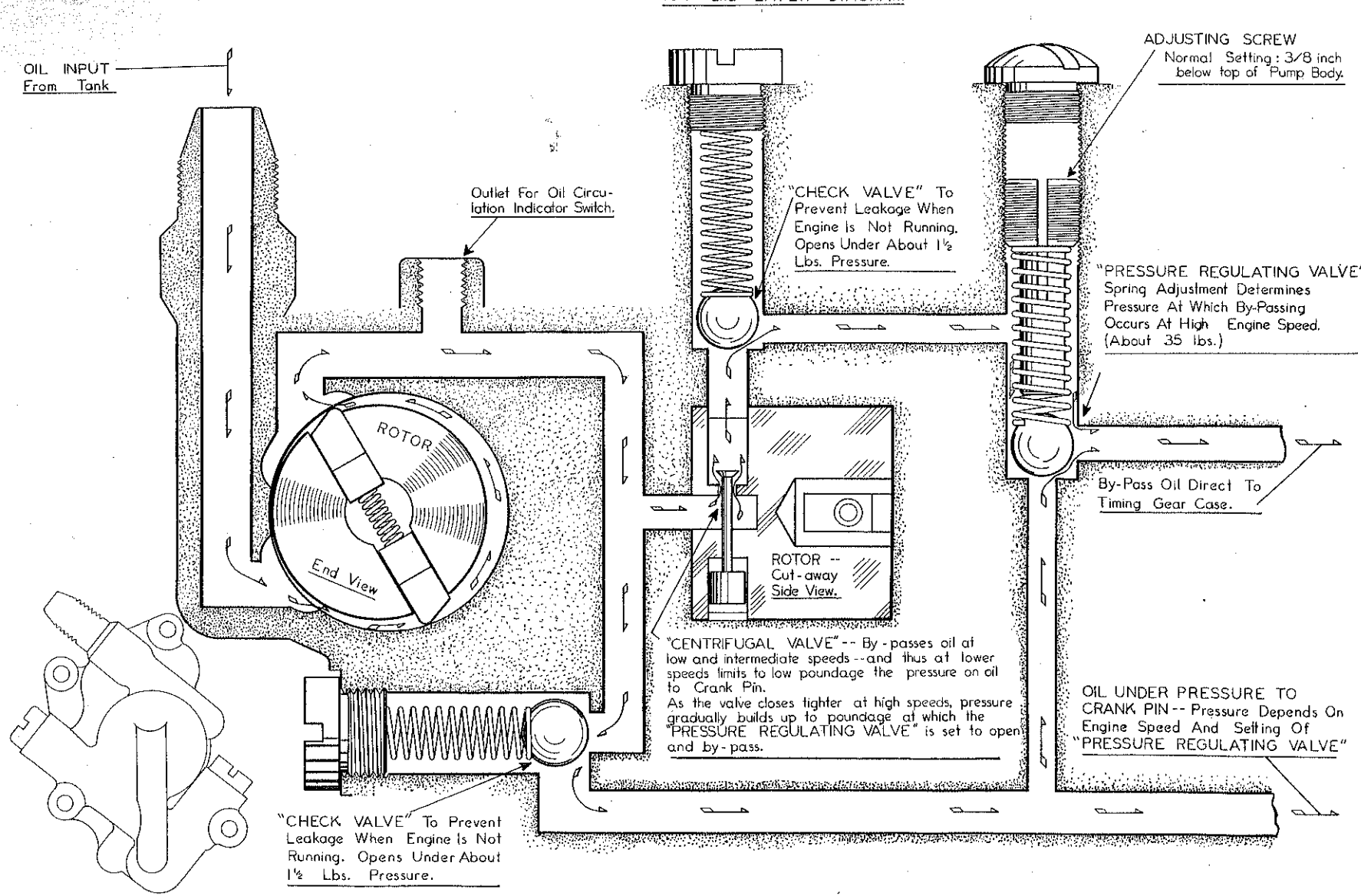
Winter Caution: Water is a by-product of combustion in any internal combustion engine. In a condensed state, the water vapor formed would equal approximately the quantity of gasoline burned. Some of this water vapor escapes past the rings into the crankcase. When starting and warming up in cold weather, especially in freezing or colder weather, considerable of the vapor that gets into crankcase condenses to water before crankcase is hot enough so that it no longer acts as a condenser and exhausts the vapor, without inside condensation, through outside breather. If engine is driven enough to get crankcase thoroughly warmed up frequently, most of this water is again vaporized and blown out through outside breather. However, a moderately driven engine, making only short runs now and then and seldom thoroughly warmed up, is likely to accumulate an increasing amount of water in oil tank. This water will, in freezing weather, become slush or ice and, if allowed to accumulate too long, may block oil lines with resulting damage to engine. Also, water mixed with oil for some time, forms a heavy sludge of considerable acid content that is very harmful to bearings and other internal engine parts.

To sum it up briefly, an engine that is used only for short runs during freezing weather requires frequent oil changes along with thorough flushing of tank to remove any accumulated sludge.



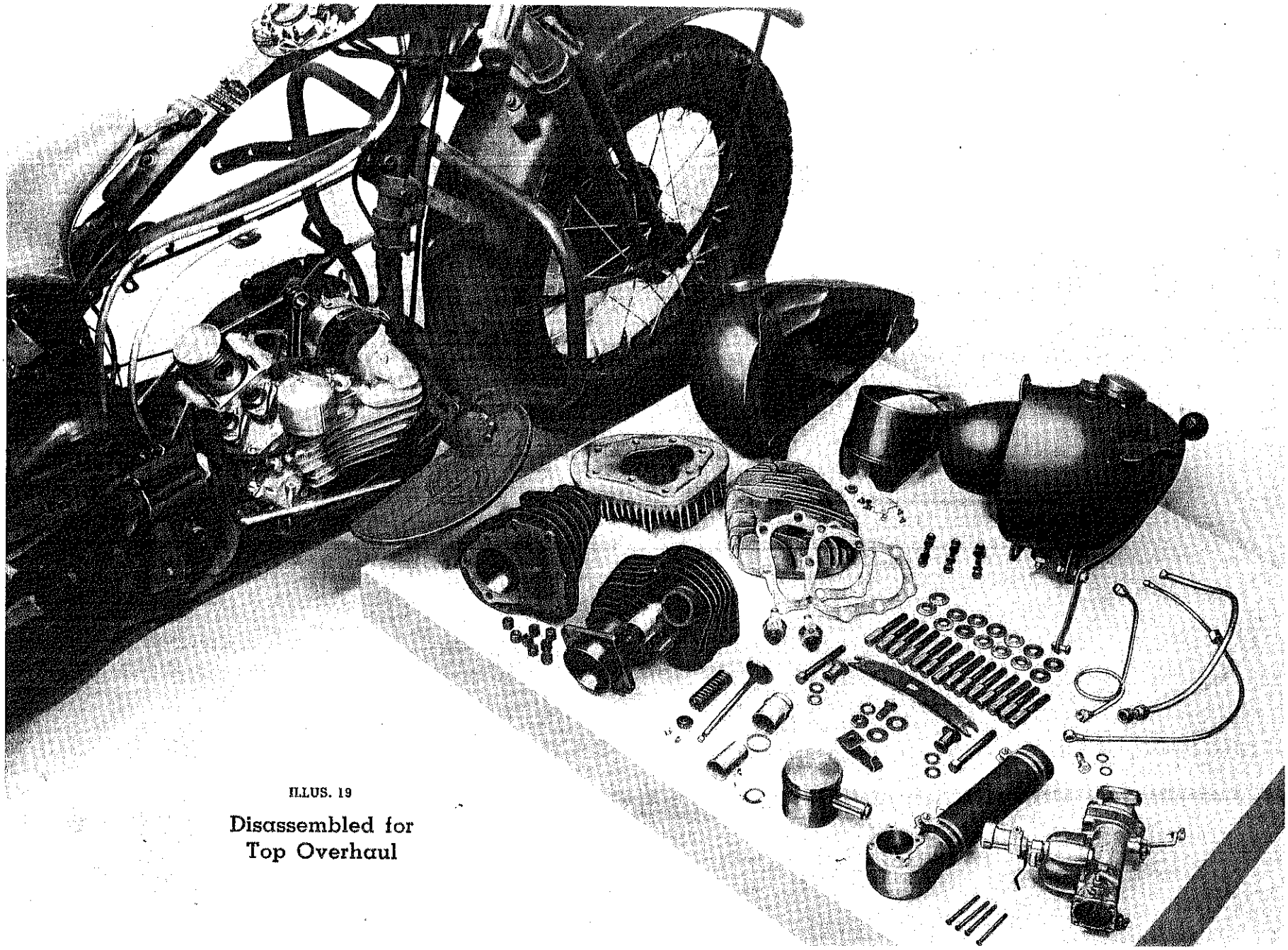
ILLUS. 17

SCHEMATIC DIAGRAM—SIDE BY SIDE VALVE "V" TYPE ENGINE OILING SYSTEM



ILLUS. 18

SCHEMATIC DIAGRAM—1941 AND LATER SIDE BY SIDE VALVE "V" TYPE ENGINE OIL FEED PUMP



ILLUS. 19

Disassembled for
Top Overhaul

OVERHAULING ENGINE

When an engine needs repair, it is not always possible to definitely determine beforehand whether repair can be made with only upper end disassembled or whether engine must be completely disassembled for lower end repair.

Most commonly, only upper end repair is needed (valves, rings, pistons, etc.) and it is recommended procedure to *first* disassemble upper end only, allowing engine base to remain in frame and following procedure outlined under "Disassembling Engine for Top Overhaul Only."

After disassembling upper end only, it may be found that lower end repair is necessary; this requires removal of engine base from frame as outlined under "Removing Engine Base for Overhaul."

In cases where it has been definitely determined beforehand that lower end repair is necessary, engine, completely assembled, should be removed from frame as outlined under "Removing Assembled Engine From Chassis for Complete Overhaul," Page 30.

Disassembling Engine for Top Overhaul Only

1. Disconnect battery ground connection.
2. Remove instrument panel cover; this requires removal of speedometer lamp switch knob, front hexagon-head screw, two side screws and side cover plate with its two mounting screws.
3. Disconnect shifter lever bottom bolt.
4. Shut off gasoline; remove gasoline pipe.
5. Remove oil pipes, except scavenger pump pipe, which can be disconnected at upper end only. Install oil nipple cap (manufacturer's part number 3583-15) on oil tank feed pipe nipple to prevent oil from running out.
6. Remove gasoline and oil tanks; this requires removal of two front end bolts and one rear end bolt.
7. Remove cylinder head bracket to frame lug bolt; this also frees clamp holding front spark plug cable. Pay particular attention to shim washers between cylinder head bracket and frame lug; these will have to be refitted when reassembling.
8. Remove spark plugs to avoid damaging; use manufacturer's wrench number 11929-40.
9. Remove cylinder heads; use manufacturer's wrench number 12047-30A.
10. Remove manifold and carburetor as follows: Disconnect throttle control wire at carburetor. Disconnect aluminum air intake hose connection fitting from carburetor (4 screws) and leave attached to hose. Loosen hose clamp at air cleaner and remove hose with casting. Unscrew manifold nuts from cylinder nipples, using manufacturer's wrench number 12003-X, and remove manifold with carburetor attached.
11. Clean crankcase around cylinder bases to prevent dirt from getting into engine when lifting cylinders.
12. Unscrew lower valve covers, using manufacturer's wrench number 11806-31.
13. Disconnect spark control wire at circuit breaker.
14. Remove the two generator relay mounting screws, leaving wires connected.
15. Free front exhaust pipe clamp.
16. Remove cylinders as follows: Remove all cylinder base stud nuts, except one on rear cylinder (use manufacturer's wrench number 12650-29). Raise front cylinder and piston enough to place rag over crankcase opening; this is to prevent dirt and pieces of broken rings from falling into crankcase. Then, with piston at bottom of stroke, lift front cylinder free.

Remove remaining stud nut from rear cylinder and remove rear cylinder in same manner front was removed.

See "Piston and Pin," Page 43, "Emergency Piston and Ring Service," Page 43, and "Installing and Fitting Connecting Rod Upper Bushing," Page 44.

Checking Connecting Rod Lower Bearing for Excessive Wear and Looseness

Check rods for up and down play and upper end side shake. To make this check with accuracy, pistons should first be removed. When appreciable up and down play is found and either or both rods have ⅛" or more side shake at extreme upper end, lower bearing should be refitted. This requires removing and disassembling engine.

Of course, in connection with emergency piston and ring service, which is usually a service job that, under the circumstances, can be done only well enough to take an engine through a further short period of use, after which it is to be completely overhauled as needed, somewhat more than normal maximum lower end looseness should be allowed to pass.

Removing Engine Base for Overhaul

(AFTER FIRST DISASSEMBLING FOR TOP END INSPECTION AND FINDING THAT BASE ALSO NEEDS ATTENTION)

17. Disconnect rear brake front rod from bell crank (on right side of rear footboard support rod). Remove right footboard, sidebar and brake pedal assembly.
18. Lower rear end of bottom skid plate. In some cases this requires removing only the two rear mounting bolts; in other cases it will be found that there is also a U-clamp around front frame tube that must be freed.
19. Removing skid plate right mounting bolt (Step 18) also frees muffler front hanger. By removing rear hanger frame bolt, entire muffler and exhaust pipe assembly can be removed as a unit.
20. Remove oil pipe from scavenger pump.
21. Disconnect clutch release cable at footpedal by removing cotter pin and washer. Then remove left footboard, sidebar and clutch pedal assembly.
22. Remove outer front chain guard.
23. Remove engine sprocket nut (right hand thread) using manufacturer's wrench number 12731-29. It will be necessary to strike wrench with a hammer to loosen nut. Remove engine sprocket by giving flat surface, near outer edge, a light but sharp rap with hammer, being careful not to strike teeth.
24. Remove the two screws that secure inner chain guard to crankcase.
25. With $\frac{13}{16}$" open end wrench, remove rear foot-

board support rod nut (located back of inner chain guard) and remove support rod.

26. Disconnect the following wires: Circuit breaker to coil wire from coil rear terminal, generator cable wires from generator and relay terminals, and oil pressure signal light wire from pressure switch terminal.

27. Remove all engine mounting bolts, excepting the one under generator; this bolt cannot be removed without removing generator; merely push it up to clear frame engine lug.

28. Remove engine base from *right* side of frame.

Removing Assembled Engine From Chassis for Complete Overhaul

When it is obvious that engine needs a complete overhaul, rather than possibly only an upper end job, proceed as follows:

1. Disconnect battery ground connection.

2. Disconnect brake front rod from bell crank (right side of rear footboard support rod) and remove right footboard, sidebar and brake pedal assembly.

3. Lower rear end of bottom skid plate. In some cases this requires removing only the two rear mounting bolts; in other cases it will be found that there is also a U-clamp around front frame tube that must be freed.

4. Remove muffler rear hanger frame bolt and remove entire muffler and exhaust pipe assembly as a unit.

5. Remove oil pipes. Install nipple cap (manufacturer's part number 3583-15) on oil tank feed pipe nipple to prevent oil from running out.

6. Disconnect spark control wire at circuit breaker and free cylinder base control clamp.

7. Disconnect brake rear rod from bell crank.

8. Disconnect red wire and black wire from front end of relay; also green wire from generator terminal.

9. Remove spark plugs to avoid damaging; use manufacturer's wrench number 11929-40.

10. Remove cylinder head bracket to frame lug bolt; this also frees front spark plug cable clamp. Pay particular attention to shim washers between cylinder head bracket and frame lug; these will have to be refitted when re-installing engine.

11. Disconnect shifter lever bottom bolt.

12. Shut off gasoline; remove gasoline pipe.

13. Disconnect throttle control wire at carburetor. Disconnect air intake hose connection fitting from carburetor (4 screws) and leave attached to hose.

14. Disconnect clutch release cable at footpedal by removing cotter pin and washer. Then remove left footboard, sidebar and clutch pedal assembly.

15. Remove outer front chain guard. If motorcycle is equipped with oil bath air cleaner, it may be necessary to remove oil cup from air cleaner before chain guard can be removed.

16. Remove sprocket nut (right hand thread) using manufacturer's wrench number 12731-29. It will be necessary to strike wrench with hammer to loosen nut. Remove engine sprocket by giving flat surface near outer edge a light but sharp rap with a hammer, being careful not to strike teeth.

17. Remove two screws that hold inner chain guard to crankcase.

18. With $\frac{13}{16}$" open end wrench, remove rear footboard support rod nut (located back of inner chain guard) and remove support rod.

19. Disconnect circuit breaker to coil wire from coil terminal and oil pressure signal light wire from pressure switch terminal.

20. Remove all engine mounting bolts, excepting the one under generator; this bolt cannot be removed without removing generator; merely push it up far enough to clear frame engine lug.

21. Remove engine from *right* side of frame.

Disassembling Engine

(AFTER REMOVING FROM CHASSIS COMPLETELY ASSEMBLED)

*1. **Remove upper end parts*** as outlined under "Disassembling Engine for Top Overhaul Only," Page 29.

*2. **Remove pistons.*** See "Piston and Pin," Page 43.

*3. **Remove generator*** as outlined under "Removing Generator," Page 48.

*4. **Remove oil feed pump.*** Oil pump is secured by one hexagon-head screw and three nuts. Two of the nuts are extra long to provide wrench clearance and their location should be noted so they will be put back where they belong. After removing screw and nuts, pump can be pulled off.

Unless a new gasket is available, be very careful not to damage or break the old one. This is a very special gasket as concerns both thickness and holes for oil channels. It is not advisable to attempt to replace it with a "home made" gasket. Leaving out one hole or getting one in the wrong location is enough to put the entire oiling system out of order. When a new gasket is used, it should be one obtained from the manufacturer.

*5. **Remove circuit breaker and timer assembly*** from timing gear case cover. See Illustration 20. To remove, take off circuit breaker cover (2) and unlatch cover retainer (1) ends from holes in timer head (4). Head and also head seating tension (ground) spring (3) underneath base are now free and head can be lifted off, exposing two screws (5) that secure base to gear case cover. After removing these screws and lock washers (6), base (7) with shaft and drive gear can be lifted out of cover. Be careful that gasket (8) and head seating tension (ground) spring are not misplaced.

*6. **Remove gear case cover.*** Take out all remaining timing gear case cover screws and cover is then free to be removed. Cover is located on dowel pins which fit rather snugly and it must be worked off these pins carefully to avoid damage to cover and joint faces. *Do not* pry off with screwdriver inserted between joint faces. Use a hammer and a block of wood and tap lightly at the ends where the cover projects beyond the gear case.

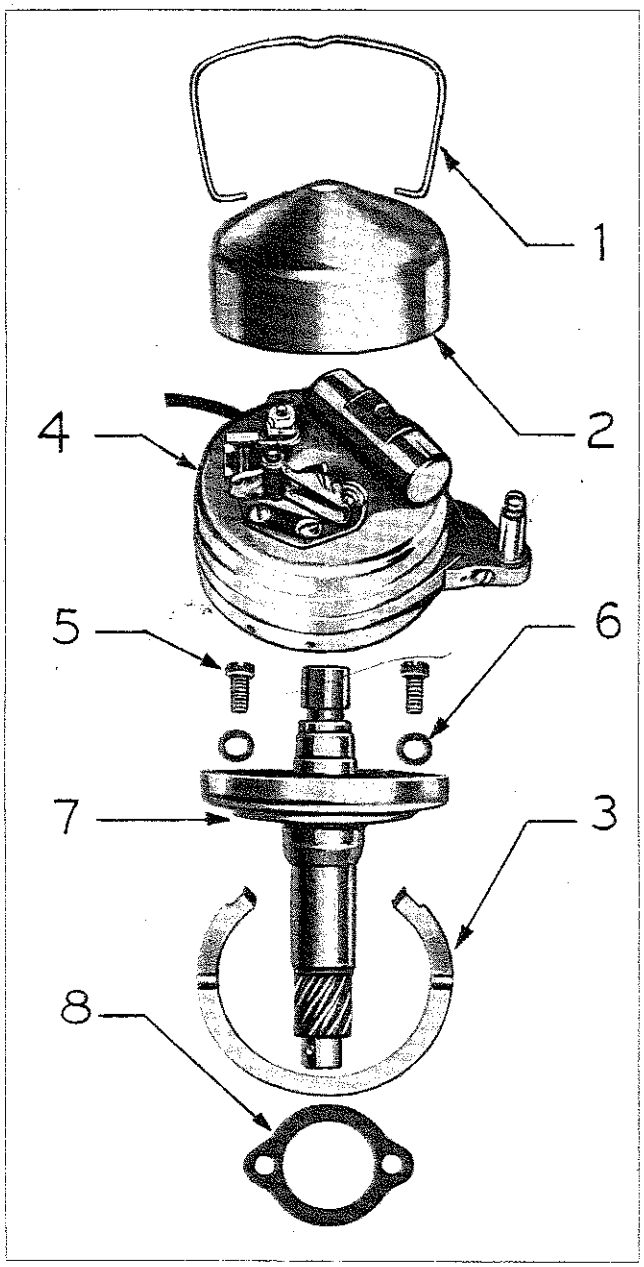
The thin steel shim washers assembled on outer ends of front cylinder cam gears may come off with the cover; be careful that they are not lost. Be careful also that cover gasket is not damaged, as this gasket, like the oil feed pump gasket, is very special and should not be replaced with other than a gasket obtained from the manufacturer.

*7. **Remove scavenger pump and crankcase breather valve.*** Scavenger pump is secured underneath gear case with four studs and nuts. Remove nuts and pump can then be pulled off the studs.

Breather valve is an integral part of scavenger pump. Be careful that screen between breather valve and crankcase port is not lost when pump is removed.

*8. **Remove timing gears.*** All pinion shaft fittings (See Illustration 28) and timing gears can now be removed. Be careful that the thin steel shim washers behind cam gears are not lost.

*9. **Disassemble crankcases.*** Crankcases are held together with two cap screws, and five studs with a nut on each end. The two cap screws enter through the *left* case and thread into *right* case. Take out cap screws and remove nut from *one* end of each stud. Three of these studs, the one at top between cylinders and two at bottom, are a tight fit and will have to be driven out with a drift of somewhat smaller diameter than studs. With all studs and screws removed, crankcases can be separated. If they don't come apart freely, tap at mounting lugs, using a block of wood and a hammer. Main bearing parts shown in Illustration 28 are now exposed.



ILLUS. 20
CIRCUIT BREAKER AND TIMER ASSEMBLY
SEE "DISASSEMBLING ENGINE," STEP 5, PAGE 30

*10. **Disassemble flywheels.*** Remove lock washer and nut from *right* end of crank pin. Tilt flywheel assembly on *left* flywheel and strike rim of *right* wheel with soft hammer about 90° away from pin. One or two sharp blows will usually loosen wheel. *Do not* strike wheel on its side, as doing so might either break flywheel or damage the tapered hole. With flywheels apart, connecting rods and roller bearing assembly can be removed from crank pin. Note that female (forked) rod is for the rear cylinder and male (single end) rod is for the front cylinder.

In connection with a complete overhaul, where all main bearings as well as connecting rod lower bearings are to be refitted, remove all shafts from flywheels. When crank pin is removed from *left* flywheel, it will be noted that this end of pin is a taper fit in flywheel, the same as the other end, but in addition is keyed. The purpose of this key is to locate the drilled oil passage in crank pin so that when wheels are assembled it will register exactly with drilled oil passage in *right* flywheel.

*11. **Strip cylinders.*** Compress valve springs (use manufacturer's tool number 12053-30) and remove split keys from ends of valve stems. Valve spring collars, valve springs, valve covers and valves can then be removed. It is customary to reassemble valves in the same cylinders from which they were removed; therefore, before removing, mark them in some manner to identify them with front or rear cylinder.

FITTING AND REASSEMBLING ENGINE

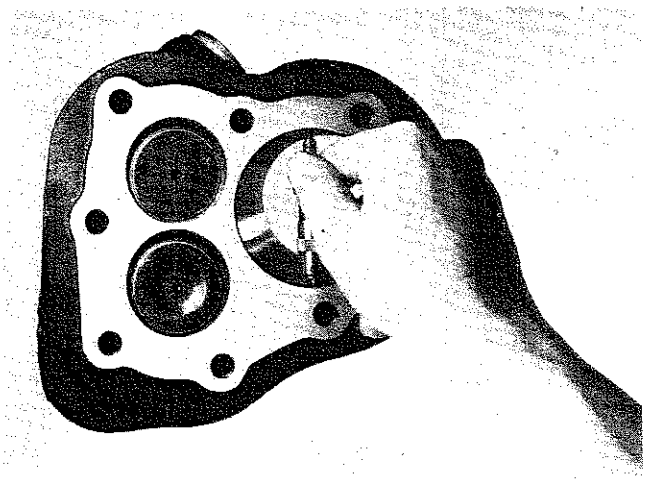
Cleaning and Inspecting Parts

First thoroughly wash all parts and inspect them for wear and damage. Clean out oil passages in pinion shaft, right flywheel and timing gear case cover, with a piece of wire, and compressed air. Clean dry shellac from crankcase center joint and register with a scraper. Do this carefully to avoid any deep scratches that may allow oil leakage when cases are reassembled.

Clean outside of cylinder and head with wire brush to remove dirt, rust, etc., getting in between cooling fins as much as possible. Scrape carbon from cylinder head, top of cylinder around valves, top of bore above ring path and inlet and exhaust valve ports. When scraping carbon, be careful about deeply scratching or nicking cylinder and head joint faces, as a deep scratch may result in a leak. Blow off loosened carbon, dirt, rust, etc., with compressed air and wipe cylinder bore and joint faces with a clean rag.

Carefully clean carbon from pistons. If a tool for cleaning ring grooves is not available, sharpen end of a broken ring to a chisel edge. Avoid scratching or damaging sides of ring grooves.

Carefully examine all shafts and bearing races for damaged and pitted surfaces and measure shafts with micrometer for extent of wear. If any parts are found with rough or pitted surfaces, renew them.



ILLUS. 21
MEASURING CYLINDER

Also renew races that are found worn .0005" or more. Renew any shafts that show any trace of wear shoulder at sides of roller paths or are worn .0005" or more.

Examine roller retainers for cracks and extent of wear; compare with new retainer. If retainer backs are worn thin or retainers are worn to any noticeable extent otherwise, renew them.

Refinishing Cylinders Oversize and Fitting New Pistons

In reconditioning an engine, cylinders must be accurately measured with micrometers for extent of wear. By subtracting piston measurement from bore measurement amount of piston-cylinder clearance is obtained. (See Illustrations 21, 22 and 27.)

Bore measurements of a used and worn cylinder should be taken ½" from top of cylinder, in ring path, measuring front to rear, where thrust faces of piston bear.

In connection with only a *top overhaul,* if cylinders are not scored and are worn less than .002", it is not usual practice to refinish oversize at that time; this operation is left to be done in connection with next *complete overhaul.* However, in this case, if the total piston clearance is as much as .006", new standard piston or piston of the same oversize to which the cylinder was last refinished should be fitted to reduce clearance and effect reasonably quiet operation.

See "Emergency Piston and Ring Service," Page 43.

If, in *completely overhauling* engine and putting it in *like-new condition* for a long period of further service, cylinders show more than .001" wear, they should be refinished to the next oversize step and fitted with new pistons.

When refinishing cylinders oversize, first add the oversize step apparently required to clean up bore to standard cylinder bore size; this gives the exact size to which cylinder should be refinished; example: 2.745" (standard bore) plus .020" (oversize) equals 2.765" (size to which cylinder should be refinished). Check carefully with accurate micrometers to be sure of refinishing to this size. If this is accurately done, oversize pistons furnished in various oversize steps by the manufacturer will fit with normal clearance.

Pistons are regularly supplied in the following oversizes: .005", .010", .020", .030" and .040". Larger oversizes up to .070" can be obtained on special order. Oversize pistons have their size stamped on head.

Cylinders can be refinished oversize either with a hone only, or with a boring bar followed by a finishing hone. In general practice only cylinders not scored and not badly worn are refinished entirely with a hone. Cylinders badly worn or deeply scored are first rebored to nearly the required oversize and then are finish-honed to exact size. When cylinders must be rebored to beyond .070" oversize to clean up, their oversize limit has been exceeded and the cylinders must be replaced with new ones.

Valve Guides

Clean valve guides with reamer (manufacturer's tool number 12623-26) and check for wear and valve stem clearance. Standard valve stem-valve guide clearance is .0035" to .0055". See Illustration 27. Clearance should not be allowed to exceed .008" before renewing guide or, possibly, both valve and guide.

Valve guides are pressed into cylinders. Therefore, when necessary to remove, they must be pressed or driven out.

New valve guides, as supplied by the manufacturer, are reamed to correct size. However, when guides are pressed into cylinders, they may close up slightly; also, the ends may be burred. Therefore, after new guides are in place, they should be sized and cleaned up with reamer—manufacturer's tool number 12623-26.

After installing new guides, valve seats must be refaced to true them with the new guides.

Valves

Before refacing valves, clean carbon from valve head and stem, using a knife and wire wheel—never a file or other hard tool that will scratch or nick metal. Polish valve stem with very fine emery cloth or steel wool. Check the valve stem for excessive wear; standard valve stem diameter is .339" to .340". If valve is warped, this will be indicated when face is reground.

Valve face angle is 45° and valve refacing grinder must be adjusted exactly to this angle. It is important not to remove any more metal than is necessary to clean up and true valve face. If grinding leaves edge of valve thin or sharp, valve should be discarded; a valve in this condition does not seat normally, will burn easily and may cause pre-ignition. There is also danger of cracking.

If end of valve stem shows uneven wear, it should be trued on valve refacer, using V-block provided for that purpose.

Valve Seats

Valve seats, like valves, are subject to wear, pitting and burning and should be refaced with cutter or grinder each time valves are refaced. Be careful that no more metal is removed than absolutely necessary to completely clean up and true valve seats.

As valves and seats are refaced from time to time, the valve seats widen and valves seat in lower posi-

tion when fully closed. Also, passage around valve when fully open is somewhat restricted. To correct this condition, additional clearance will need to be cut above cylinder seat so top edges of angular valve face and cylinder seat match exactly. This is illustrated on Page 38, Illustration 27.

If seat is refaced with a cutter it will not be as smooth as when refaced with a grinder and a greater amount of lapping will be necessary to attain a perfect seat.

When a new valve guide is installed, it is not likely to have exactly the same relation that the old guide had to valve seat. Therefore, it is especially important, after fitting new guides, that seats be carefully refaced to make them concentric with guides and assure perfect alignment and matching of valve face and valve seat.

Testing Valve Seating

If valve seats and valve faces have been smoothly and accurately refaced with grinders available for this purpose, very little grinding or lapping will be required to complete seating operation. Apply a light coat of fine compound to valve face, insert it in cylinder and give it a few oscillations with a screwdriver—just enough to give face and seat a lapped finish. Remove valve, wash valve face and seat thoroughly with clean gasoline and allow to dry, or dry with compressed air. If inspection shows an unbroken lapped finish around both valve face and seat, valve is well seated. If lapped finish is not complete around either valve or seat, further seating is required.

Valve Springs

Inspect each spring in comparison with a new one; if a spring is shrunken more than 1/8", replace with a new one.

Re-installing Valve Assemblies

To re-install valve assembly in cylinder, reverse removal procedure. Be sure all parts are clean. Valve seats and stems should be lightly oiled. Install new seals between upper valve covers and guides; also, if needed, new packing between valve covers.

Caution: Intake and exhaust valves are of different materials and must not be interchanged. Intake valves are marked (IN) on head; exhaust valves are marked (EX).

Timing Gear Shaft Bushings

Check timing gear shaft bushings in right side crankcase and timing gear case cover for extent of wear. These bushings normally do not require renewal until an engine has run extremely high mileage. However, if engine has been run under dusty conditions and, as a result of lack of attention to air cleaner, considerable road dust has been taken into engine through carburetor, abnormal wear may be found at any mileage.

Specified clearance for camshaft bearings is .0005" to .001". When bushings are worn to the extent of increasing clearance to .002" or more, they should be renewed, as the cam gears are likely to become very noisy with excessive clearance in these bearings. Worn bushings in case and cover, *with both ends open,* can be pushed out with an arbor press, supporting case or cover on a suitable collar or sleeve at the flanged end of bushing. Bushings in cover, *with one end blind,* must be pulled with manufacturer's special tool number 11952-36.

Before removing old bushings, note location of oil transfer hole in pinion shaft bushing in timing gear case cover. New bushing must be installed with oil transfer hole in same location (30° ahead of vertical center line), as normal function of oiling system depends upon correct location of this hole.

After new bushings have been pressed in they must be dowel pinned to prevent them from turning, by drilling a hole with a number 31 drill through bushing flange and into aluminum. The hole should be of a depth so when dowel pin (part number 661-31) is driven in and bottomed, its end will be slightly below face of bushing flange. Peen bushing around dowel pin hole to prevent pin from coming out. Oil holes for lubrication of cover bushings will have to be drilled in three of the bushings, according to holes already in bushing bosses.

Attach cover to right case and line-ream with special reamers, manufacturer's numbers 12135-37, 12133-37 and 12132-36.

Valve Tappets and Valve Tappet Guides

Inspect valve tappets for excessive clearance in guides. Also check tappet rollers for excessive bearing looseness and damaged roller faces.

Tappets and tappet guides are normally long-life parts that seldom require replacement. Tappets are originally fitted with .0005" to .001" clearance in guides. Guides are a light press fit in crankcase and are secured with screws. To remove a tappet, it is first necessary to pull tappet guide out of crankcase. After removing screws, heat case around guide, and pull with manufacturer's tool number 11960-38. Cam gear must be assembled in case for tappet to butt against when using puller.

Excessive tappet-guide clearance is serviced by fitting new tappet, and new guide if needed. It is also recommended practice to renew tappet complete

ILLUS. 22
MEASURING PISTON

when only the roller is excessively loose or otherwise in bad order; however, it is possible to renew only the roller, roller bushing and pin. If this is done, roller must turn freely and have about .008" sideplay after new roller pin is securely riveted in tappet.

Truing and Sizing Main Bearing Races

(LAPPING ARBOR NUMBER 11954-40)

Before refitting worn main bearing, lap outer races to true them and remove any trace of wear shoulder at sides of roller paths. A race that is worn .0005" or more should be renewed.

When renewing main bearing races, heat cases around races. Heating expands cases slightly and less force is required to press old races out and new races in. New races, after installation, should also be lapped to smooth, true and align them, and to size them so that specified bearing clearance can be attained with roller sizes available.

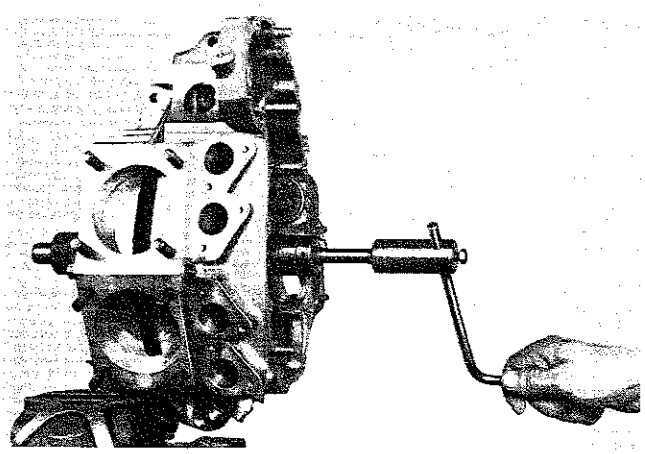
When lapping main bearing races, right and left cases must be assembled and three or more studs securely tightened as in final assembly; this is to assure perfect alignment between left and right races in final assembly. Lap first one side and then the other, guiding lap by means of pilot bushing in opposite race. Adjust lap snugly in race and use only a light application of fine lapping compound. A loose lap and the use of excessive compound results in a tapered bearing surface.

Fitting Main Bearings

When fitting main bearings, the shafts that are to be used when flywheels are reassembled can be used as gauges with which to determine when bearings are fitted to correct clearance. Use the largest roller size that will allow shaft *just noticeable* shake in bearing. Bearing must not be fitted so tight that shaft has no shake at all. In making this check, all bearing parts must be perfectly *clean* and *dry;* oil in the bearing will take up some clearance and make bearing feel tighter than it is actually fitted.

After main bearing fitting is completed, crankcases with roller and retainer assembly can be set aside until flywheels are assembled.

Mainshafts (sprocket and pinion shafts) can now be fitted to their respective flywheels. Shaft tapers and flywheel tapers must be perfectly *clean* and *free of oil.* Be sure keys are in place. Tighten nuts very tight (use manufacturer's wrench number 12645-29) and install lock washers. Lock washers can be installed either side up and either lock screw hole may be used. If lock screw can not be inserted with lock washer in any of its various positions, turn nut tighter rather than looser to bring lock washer to position where screw holes line up. Tighten lock screw very tight.



ILLUS. 23
TRUING AND SIZING MAIN BEARING RACES

After right side (pinion) shaft is installed check oil passage through shaft and side of flywheel with compressed air, to be sure passage is open.

Fitting Connecting Rod Lower End Bearing

First give attention to flywheel washers (Item 19, Illustration 28). If washer in either flywheel is worn and grooved to any extent, it should be renewed. This hardened steel washer fits into recess in flywheel face around crank pin and takes side thrust of lower connecting rod bearing. Washer is a close fit in recess and is secured by punching flywheel metal tight against it at several points around washer.

To remove washer, it is ordinarily necessary to drill a small hole at the outer edge of washer to permit getting a pointed tool underneath and prying it out. This hole should be small and should be drilled only to slightly greater depth than thickness of washer. Drilling hole too large or too deep weakens flywheel and it may crack at that point. Before installing new washer, scrape outer edge of recess where metal was punched against old washer and thoroughly clean recess, as new washer must seat fully against recess bottom. If washer is carelessly installed and does not seat fully in recess, female (forked) rod is not likely to have required sideplay when flywheels are assembled.

Crank pin can now be fitted in *left* flywheel. Pin taper and flywheel taper must be *clean* and *free of oil.* Be sure key is in place. Tighten nut very tight (use manufacturer's wrench number 12731-29). Install lock washer. Washer can be installed either side up as it best matches lock screw hole. If necessary, tighten nut a trifle more to make lock screw holes match. Install lock screw and tighten securely.

Install right flywheel temporarily and check oil passage through pinion shaft, right flywheel and crank pin, with compressed air. Be sure this passage is open.

Truing and Sizing Connecting Rod Lower Races

(LAPPING ARBOR NUMBER 11944-X)

In lapping a set of worn rods, lap until no trace of wear shoulder is left at sides of roller path; also lap both rods to fit same size rollers.

When rod lower races are damaged or worn beyond truing up and refitting with largest oversize rollers, rods must be replaced with new or returned to the manufacturer for refitting with new lower races. It is not practical for other than the manufacturer to renew these races as they are distorted considerably when pressed into rods and the initial truing must be done with a grinder; lap is intended only for smoothing up and resizing races worn or not exactly the right size.

Refer to Illustration 24. Turn lap in lathe 150 to 200 R.P.M. When means of turning lap are not at hand, hold in vise and turn rod. Adjust lap to snug

fit in race before applying lapping compound; a loose lap will "bell mouth" bearing race. Apply *light* coat of *fine* lapping compound. To avoid grooving or tapering lap, work rod back and forth along its full length.

New rods ordered from the manufacturer or used rods returned to the manufacturer for rebushing are usually ordered fitted with crank pin and rollers. If not, they also are likely to need lapping to fit available rollers with specified clearance.

After it has been determined that lower end races are in condition to be lapped and refitted, upper end bushings should be inspected for need of attention. Check bushings for looseness in rods as well as pin clearance (See "Installing and Fitting Connecting Rod Upper Bushing," Page 44).

Rods that have been returned to the manufacturer for new lower end races will be found also fitted with new upper end bushings, reamed to correct clearance for standard pin. This, of course, also applies to new rods.

Determining Correct Lower Bearing Fit

(See "Checking Connecting Rod Lower Bearing for Excessive Wear and Looseness," Page 29, for information on checking lower bearing in connection with *Top Overhaul* and how much looseness may be allowed before bearing must be refitted).

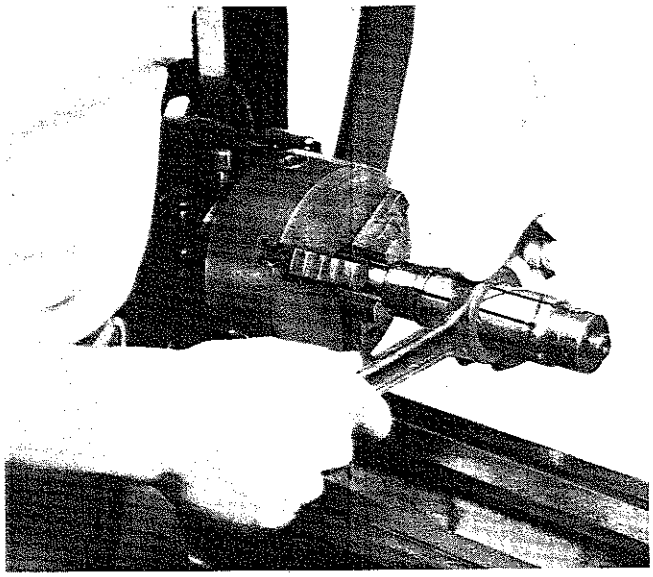
After lapping lower races of used rods as necessary, to smooth and true them, or replacing rods with a set with new lower races, install set of rollers and retainers on crank pin; rollers must always be new. Check fit of rods on bearing assembly. In making this check, flywheel sprocket shaft should be gripped tightly between copper-faced vise jaws to hold flywheel firmly in a horizontal position. If neither rod will start over bearing, select a smaller set of rollers. If they go over easily and there is considerable shake at top end of rods, install a larger set of rollers. If lower end of one rod is found to be slightly larger than the other, it is customary to select roller size that comes closest to correctly fitting larger rod and then lap smaller rod to bring it up to same size, rather than fit with rollers of two sizes.

When rods are properly fitted with required looseness, extreme upper end of female (forked) rod will have just noticeable side shake; upper end of male (single end) rod will have $\frac{1}{32}$" to $\frac{3}{64}$" side shake. This check should be made with bearings *clean* and *free of oil.* Fitting tighter is likely to result in a seized and damaged bearing shortly after engine is put back in service.

Overall width of roller retainer assembly must be less than width of female rod end. Check to be sure of this.

Assembling Flywheels and Rods

After connecting rod bearing fit is attained, thoroughly oil bearing, observe that rods are correctly assembled (female rod—rear; male rod—front), and install *right* flywheel. Bear in mind that pin taper and flywheel taper must be *clean* and *free of oil.* Align wheel as nearly as possible concentric with left wheel by means of straight-edge held against outer face of wheel rims, 90° from crank pin. Turn nut on crank pin and tighten lightly. Check rim faces again with straight-edge and, if tightening nut has



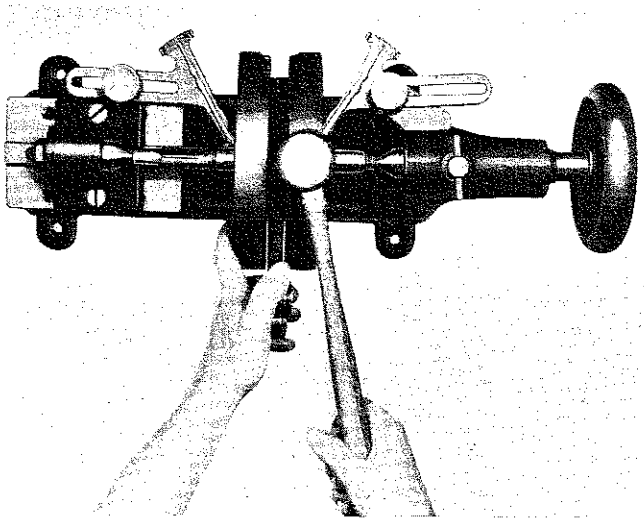
ILLUS. 24
TRUING AND SIZING CONNECTING ROD LOWER RACE

shifted wheel, correct its position by striking rim of wheel with a lead or copper hammer. *Do not* use steel hammer. Turn nut tighter and repeat straight-edge check. To prevent flywheel assembly from turning in vise while tightening nut, insert rod of suitable size and length through holes in flywheels and shift flywheels in vise jaws so that rod bears against some part of vise.

After nut has been turned fairly tight, install flywheel assembly in truing device as shown in Illustration 25 and true according to indicators (See "Truing Flywheels," Page 36).

Remove wheels from truing device, again hold in vise as before and securely tighten crank pin nut. Pull this nut very tight. Now check the sideplay of female (forked) rod between flywheels. Sideplay should be .006" to .010". Check with thickness gauge. Push rod end tight against one wheel and insert thickness gauge between other flywheel and rod. If it is found that there is *too much* sideplay, probably all or most of the excess play can be taken up by pulling crank pin nuts a little tighter. If there is *not enough* play, it is due to one of the following conditions: Flywheels and crank pin assembled with oil on tapers and nuts overtightened (crank pin nuts must be pulled very tight but, of course, tightening can be overdone); new flywheel washers installed and not fully seated (See "Fitting Connecting Rod Lower End Bearing," Page 34); tapered holes enlarged as a result of flywheels having been taken apart and reassembled several times in connection with previous overhauling; a flywheel cracked at tapered hole.

In a case like this, the first thing to do is recheck flywheel washers. If these washers are found fully seated and secured in flywheels, the next best thing to do is determine which flywheel seats farthest on crank pin taper, due to enlarged tapered hole or crack, and replace that wheel with a new one. Another thing that can be tried is exchanging crank pin for another new one. However, there is ordinarily very slight variation in length of crank pins. As a last resort, side faces of forked rod lower end can be ground off as necessary to gain required side-



ILLUS. 25
TRUING FLYWHEEL MAINSHAFTS

play. If this is done, backs of retainers may also need to be ground off slightly as retainer assembly must, in every case, be narrower than forked rod.

After rod sideplay has been checked and adjusted, crank pin nut pulled very tight and nut lock washer fitted, again install wheel assembly in truing device and recheck for trueness.

Caution: After flywheels and rods are assembled, make final check to be sure oil passage is open to rod bearing. Apply compressed air to hole in side of pinion shaft, near its outer end, and observe that air escapes around connecting rod lower end. If this passage becomes blocked in some manner and engine is assembled and put in service with it blocked, engine will get no lubrication, except in timing gear case. This is not likely to be detected until serious damage has been done, as the oil circulation indicator in instrument panel will give no warning when the oiling system is blocked in this passage.

Truing Flywheels

Bear in mind that, while a straight-edge across rim faces is used when assembling flywheels to keep them as near as possible true with each other, final truing is a matter of truing sprocket shaft and pinion shaft to perfect alignment with each other, rather than truing flywheel rims. Install wheel assembly in truing device (manufacturer's number 11962-X) and adjust so that centers are *just snug* (wheels must turn freely). If flywheel assembly is either loose between centers or is squeezed, indicators will not indicate accurately. Indicators should be adjusted as closely as possible to flywheels, and so that pointers rest about in the middle of graduated scales.

Turn flywheels and observe the movement of indicator pointers. Movement of pointers *toward* flywheels indicates *high* points of shafts. Find highest point of each shaft and mark flywheel rims at those points. Loosen device centers *slightly*, just enough so it can be detected that flywheel assembly is a trifle loose. Turn high point of first one flywheel and then the other to the top and strike rim of wheel one or more sharp blows with a lead or copper hammer. The number of blows required and how hard they should be depends, of course, on how far shafts are out of true. Remember that device centers should be *loosened* slightly before striking flywheels. However, they should not be loosened to the extent of allowing flywheels considerable play between centers, as making them very loose is likely to result in broken or damaged centers.

After striking wheels with hammer as explained above, readjust device centers to *just snug* and again turn wheels and check with indicators. Repeat the truing operation until indicators show within .001" of true. Each graduation on indicator scale is approximately .002"; therefore, when shafts are true within requirements, neither indicator will move more than about one-half graduation.

In the case of a flywheel assembly that is considerably out of true and which cannot be trued up by following the procedure described, it may be due to crack at one of the flywheel shaft holes or a damaged and enlarged tapered hole. If used sprocket and pinion shafts are assembled in flywheels, it may be due to one of these shafts being worn considerably out of round at the point where indicator takes bearing against it.

Assembling Crankcases

Flywheels are now ready to be assembled into crankcases which have already been given due attention as concerns main bearing fitting, (See "Fitting Main Bearings," Page 34). A strong rack or box with an opening about 8"x 8" and at least 4" deep should be available, on which to place right crankcase on its side. Insert bearing washer and bearing in the order shown in Illustration 28.

Select two flywheel thrust collars (Item 12). Place thrust collars over sprocket and pinion shafts and fit them on flywheel hubs. Be sure they register on dowel pins and seat fully against wheel faces. These collars come in various thicknesses to permit adjusting flywheel endplay between crankcases. The only way to determine exactly what collar thickness is required is to try one set and then another until the correct endplay is attained. The average thickness of collars used in new engine assembly is about .080". Both collars should be approximately the same thickness in order to keep flywheels centered in crankcases and connecting rod upper ends centered between piston bosses.

When a set of collars has been selected and installed on wheels, fit flywheel assembly into right crankcase. Install roller bearing and bearing washer on sprocket shaft in the order shown in Illustration 28, and install left crankcase. No gasket is used on crankcase center joint, and joint should not as yet be shellacked. Insert the two cap screws at top of cases and two studs at bottom of cases and tighten to clamp cases securely together.

Now, by pushing back and forth on ends of sprocket and pinion shafts, check flywheel endplay. If no endplay is found, cases will have to be taken apart and thinner thrust collars fitted. Reassemble and again check endplay. If it is found that flywheels now have endplay, check with flywheel endplay gauge (manufacturer's tool number 11967-38) and a thickness gauge to determine just how much play exists. When this has been accurately determined, it is then a simple matter to calculate how

much thinner or how much thicker thrust collars must be fitted to attain correct endplay (.012" to .014").

After selecting and installing thrust collars of correct thickness, oil main bearings and proceed with final assembly.

Now give both faces of crankcase center joint a moderate application of shellac.

After allowing shellac to air-dry a few minutes, assemble crankcases, install all studs and cap screws and tighten securely. Remember, three of the crankcase studs, the one at top center and the two bottom studs, are drive fit studs that locate crankcases in exact relation to each other. These studs must not be replaced with loose-fit studs. After crankcase assembly is completed, recheck to be sure flywheels have at least the specified minimum endplay.

Installing Generator

Install idler gear. Inspect generator drive end gasket and, if damaged, replace with a new one. Install generator on engine with original number of paper shims between generator and its cradle. Be sure holes in shims line up with drain hole in generator frame and hole in cradle, so drainage will not be blocked. Assemble curved washer, lock washer and nut on strap end, but do not tighten securely as yet.

Insert, temporarily, the two long screws that secure generator to timing gear case. Inasmuch as gear case cover is not yet installed, its thickness will have to be taken up by suitable spacers (nuts or collars) under screw heads to permit screws to be tightened. Pull these screws up snugly and then tighten generator strap. Now loosen end screws to allow generator to adjust itself, and then tighten screws securely.

Check lash between generator drive gear and idler gear. Try this at several points around gears. If it is found that gears have considerable lash, remove one or more paper shims from underneath generator. Gears must not, however, be meshed so deeply that no noticeable lash can be felt between all teeth as gears are turned.

Assembling Scavenger Pump and Crankcase Breather

Assemble all fittings on pinion shaft as per Illustration 28. Install scavenger pump and crankcase breather valve. Don't overlook screen that assembles between breather valve and crankcase port. Time breather valve as per instructions under "Timing Crankcase Breather Valve."

Caution: Breather valve controls the scavenging of oil from crankcase. Unless it is accurately timed as per instructions, oiling system will not function normally.

Be careful that timing gears are not pulled out of mesh, permitting timing to change, while assembling valve timing gears.

Timing Crankcase Breather Valve

(SEE ILLUSTRATION 26)

1. Flywheel timing mark; exactly in center of timing inspection hole in left side crankcase.

2. Breather pinion shaft gear (spiral gear). Gear and shaft are spline-engaged and gear is a slip fit on shaft. A bearing oil seal ring and spring are assembled behind it. Spring pushes spiral gear outward, tight against pinion gear and bearing oil seal ring inward, tight against crankcase bearing bushing. A mark is cut in one side of spiral gear. Assemble with marked side outward (against pinion gear).

3. Set and hold pinion gear with its outer face exactly $\frac{5}{16}$" from gear case joint face, as this is the running position of gear when gear case cover is in place.

4. Timing hole in breather sleeve; registers *in center* of slot in breather bushing.

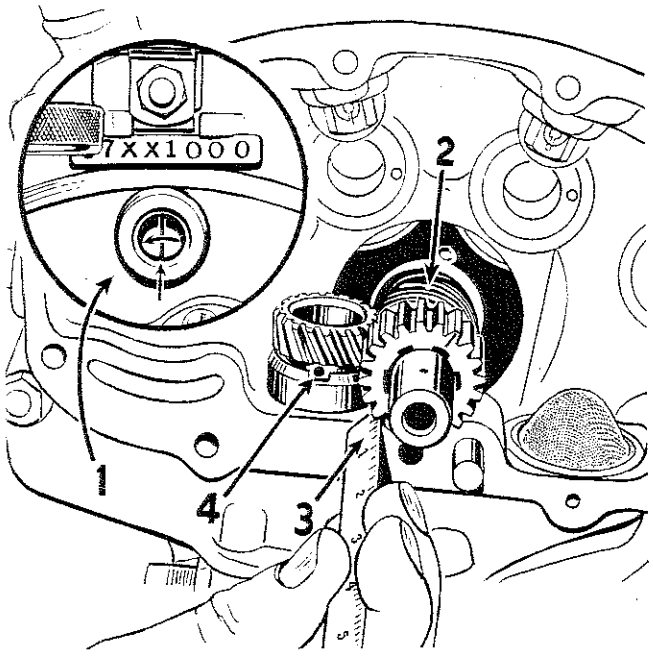
Summarizing the above: Spiral gear (2) must be so engaged with breather sleeve gear that when flywheel mark is in center of inspection hole and pinion gear $\frac{5}{16}$" from joint face, timing hole (4) in breather sleeve registers as shown.

Caution: The breather is a part of and drives scavenger oil pump underneath gear case. If there is occasion to remove scavenger pump, breather will of course come out with it. Removing does not require taking off gear case cover. However, it must be remembered that in order to reassemble with breather timed, it is necessary to take off gear case cover and follow the foregoing timing instructions.

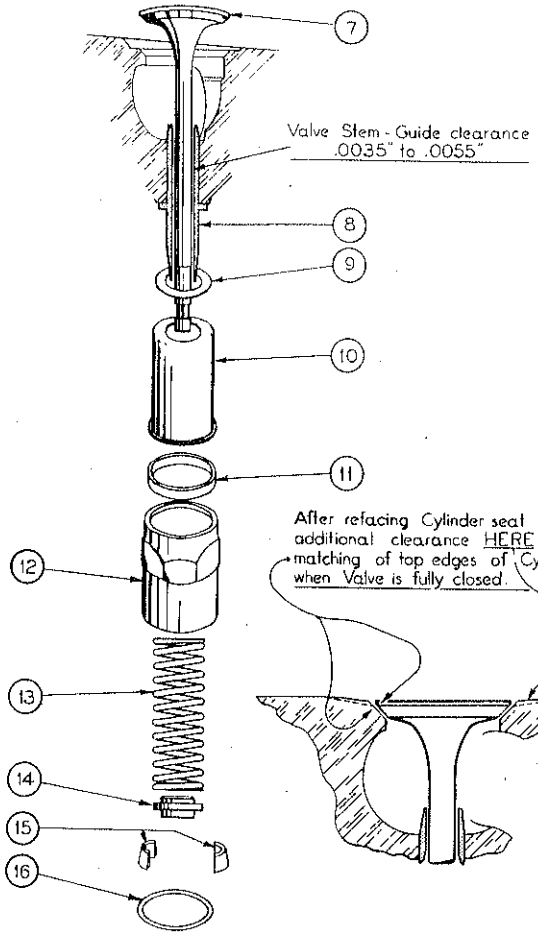
Assembling Timing Gears

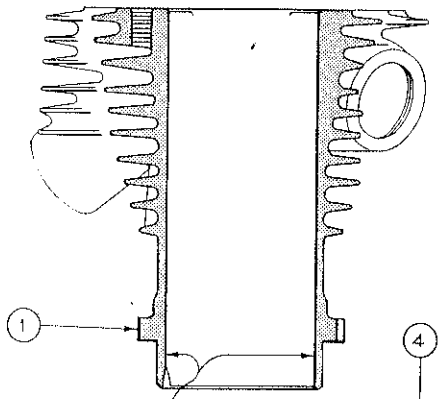
(SEE ILLUSTRATION 29)

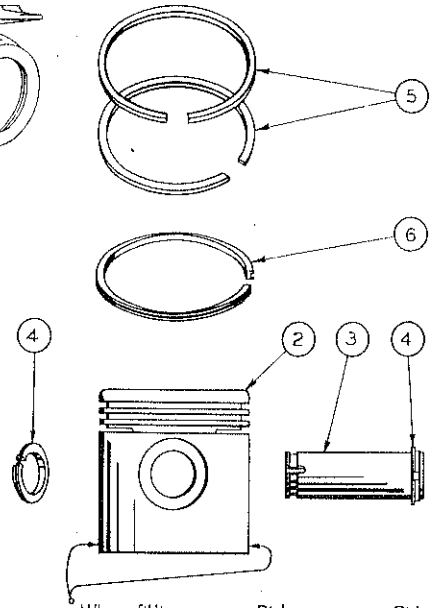
Assemble timing gears in case with marks in alignment, including mark on pinion shaft gear, as per Illustration 29. These gears are ordinarily assembled with one steel shim washer behind each of the four cam gears and in front of the two front cylinder cam gears. Now and then an engine may be found that was originally assembled with more than one spacing shim at one or more points. In this case, reassemble with the same number of washers found when disassembling.



ILLUS. 26
TIMING CRANKCASE BREATHER VALVE







When fitting a new Piston, measure Piston with micrometer at bottom of skirt, front to rear (across thrust faces). Measure Cylinder bore with inside micrometer. Piston should be .001" to .002" smaller than Cylinder. If a fit within these limits cannot be attained with parts and facilities at hand, it is preferable to allow more clearance rather than less.

Note: Inside and outside micrometers used for Cylinder-Piston fitting should first be checked together to be sure they are adjusted to read exactly the same.

ITEM NUMBER	PART NUMBER	NUMBER USED	DESCRIPTION
1	2-40M	1	FRONT CYLINDER — Standard bore 2.7445" to 2.7455"
	3-40M	1	REAR CYLINDER — Oversize limit .070"
2	253-29A	2	PISTON (Complete with items 3,4,5 & 6). Oversize Pistons available: .005", .010", .020", .030", .040", .050", .060" & .070" to .001" to .002" clearance in Cylinder.
3	275-32	2	PISTON PIN Diameter .7915". Light hand press fit in Piston. .001" clearance in Connecting Rod bearing. Oversize Pins available: .002", .004", .006", .008", .010" & .012".
4	280-32	4	PISTON PIN LOCK RING Do not re-use Lock Rings after removing from Pin; replace with new.

ITEM NUMBER	PART NUMBER	NUMBER USED	DESCRIPTION
5	260-34	4	PISTON COMPRESSION RING — Fit with .010" to .020" gap; .004" side clearance in grooves. Oversizes same as Piston, Item 2.
6	263-38	2	PISTON OIL CONTROL RING
7	165-32	2	EXHAUST VALVE — Intake & Exhaust Valves same dimensions but must not be interchanged. Head dia. 1 5/16"; face angle 45°; stem dia. .339" to .340"; clearance in Guide .0035" to .0055".
	163-32	2	INTAKE VALVE
8	166-32	4	VALVE GUIDE - 1940 — Press fit in Cylinder. .3435" to .3445" Ream.
	166-41	4	VALVE GUIDE - 1941 & Later
9	167-38	4	SPRING COVER ASBESTOS GASKET
10	173-31	4	UPPER COVER - 1940
	173-41	4	UPPER COVER - 1941 and Later
11	175-29	4	COMPOSITION GASKET Between Upper and Lower Covers
12	174-31	4	LOWER COVER
13	168-32	4	VALVE SPRING-1940. Free length 2 3/16". 85 to 95 pounds @ 1 5/16".
	168-41	4	VALVE SPRING-1941 & Later. Free length 2 1/32". 95 to 105 pounds @ 1 1/16".
14	170-30	4	SPRING COLLAR
15	172-30	4	SPLIT KEY (PAIR)
16	176-26	4	LOWER COVER SEAT GASKET

45 "V" TYPE ENGINE
UPPER END ASSEMBLY

ILLUS. 27