

OPERATION and MAINTENANCE MANUAL

HARLEY-DAVIDSON MILITARY MOTORCYCLE

Model 42WLA-Solo

Built for the United States Army

Control Numbers:

W-398-QM-10330

W-398-QM-11732

U.S.A. Registration Numbers:

W60-205-5614, 5659 and

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Harley-Davidson Motor Co.

Milwaukee, Wisconsin, U.S.A.

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WAR DEPARTMENT

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Chief of Staff

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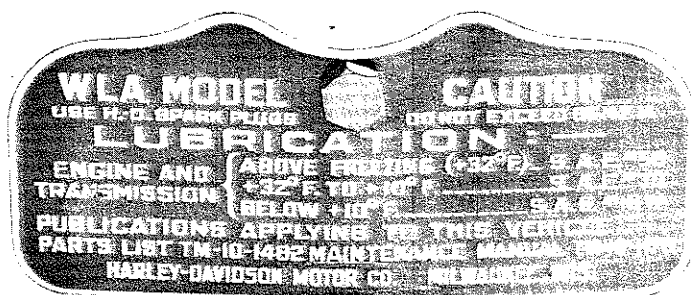
E. S. ADAMS

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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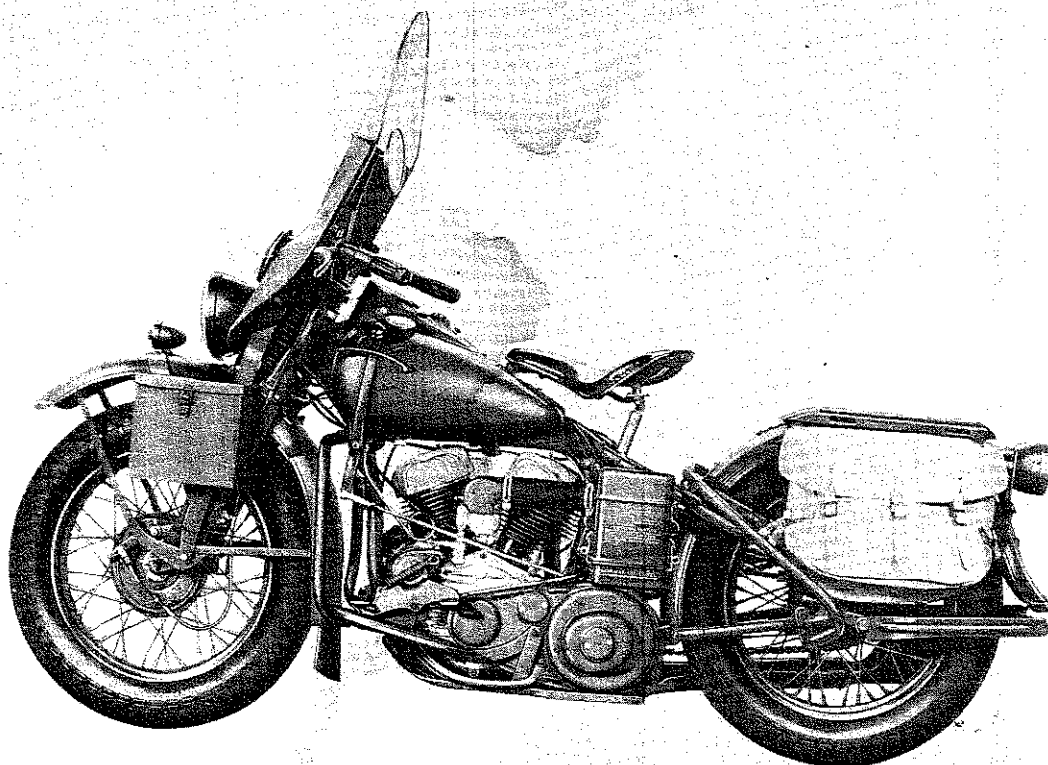
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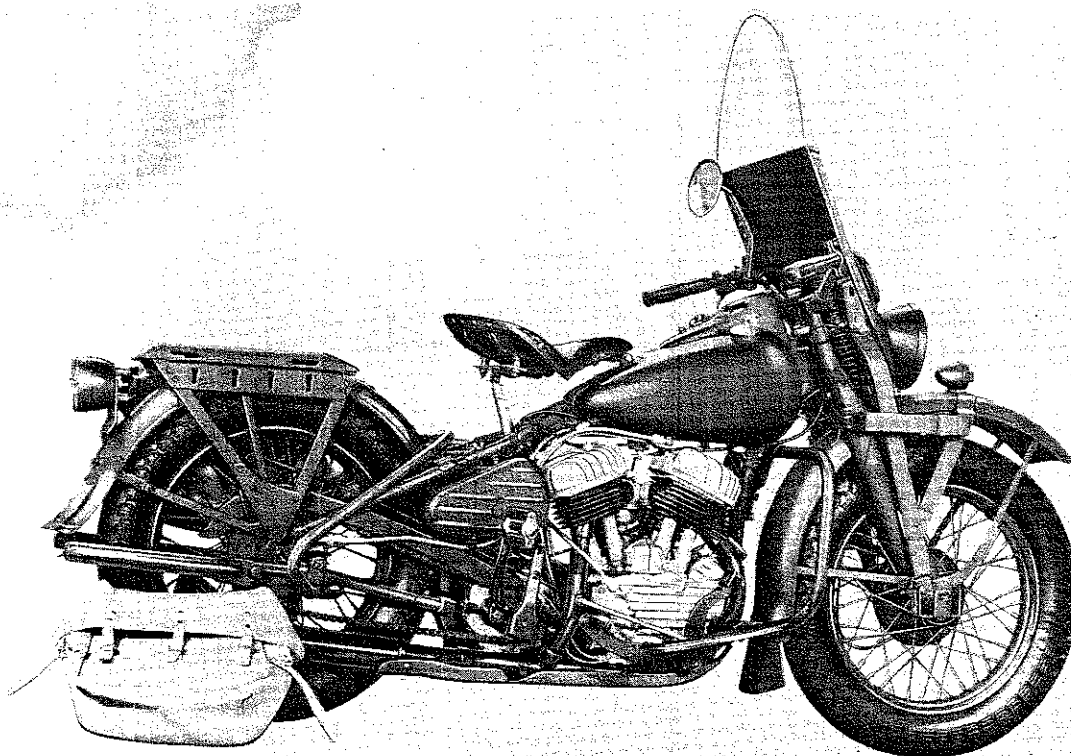
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This Manual supersedes
TM 10-1175, issued
November, 1941.



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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
Year

WLA
Model

2222
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.

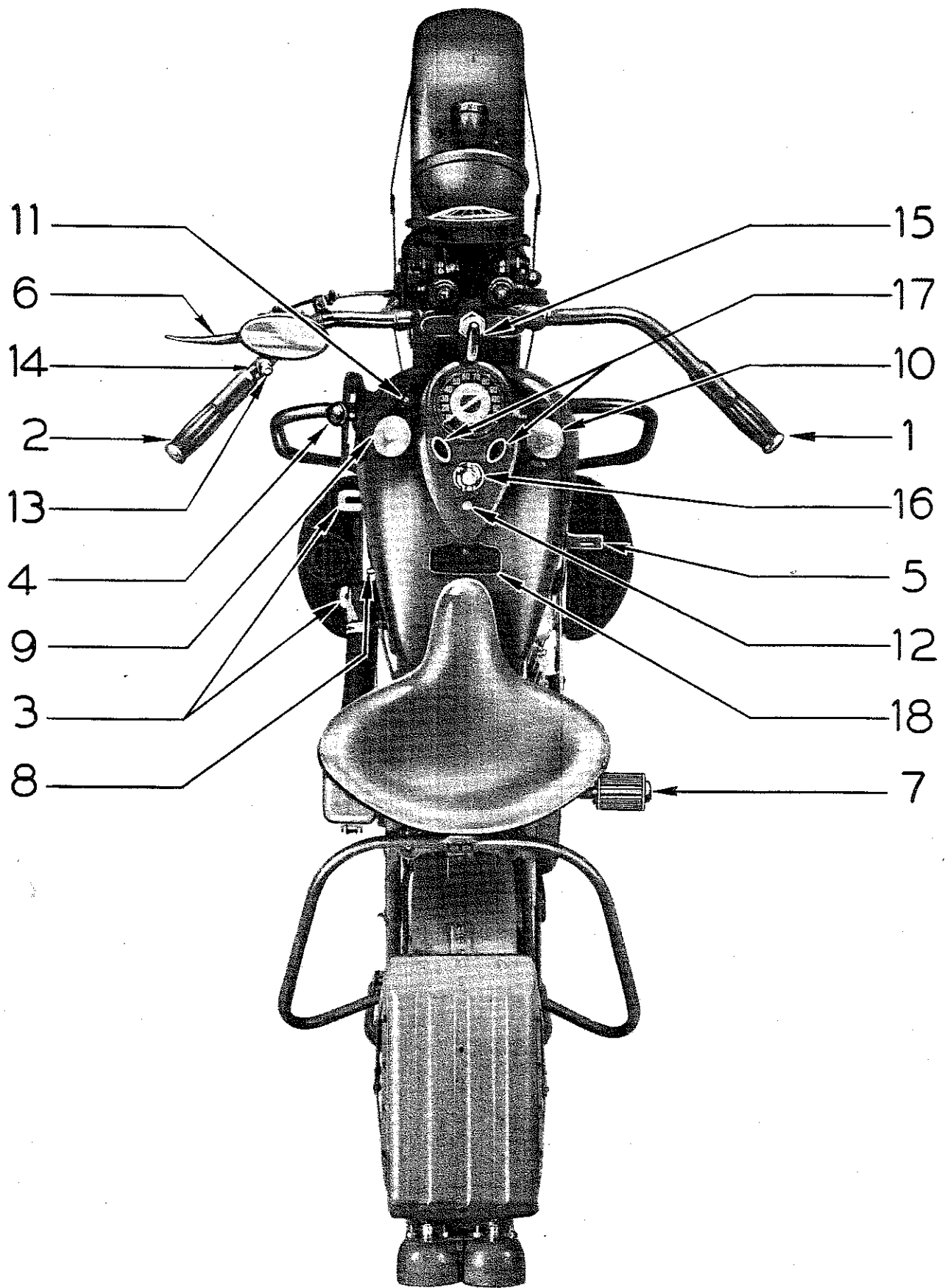
TRANSMISSION: 1941 and later—¾ pint; 1940 and earlier—½ pint.

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

SECTION ONE

NOMENCLATURE
OPERATION
CARE

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 position (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."

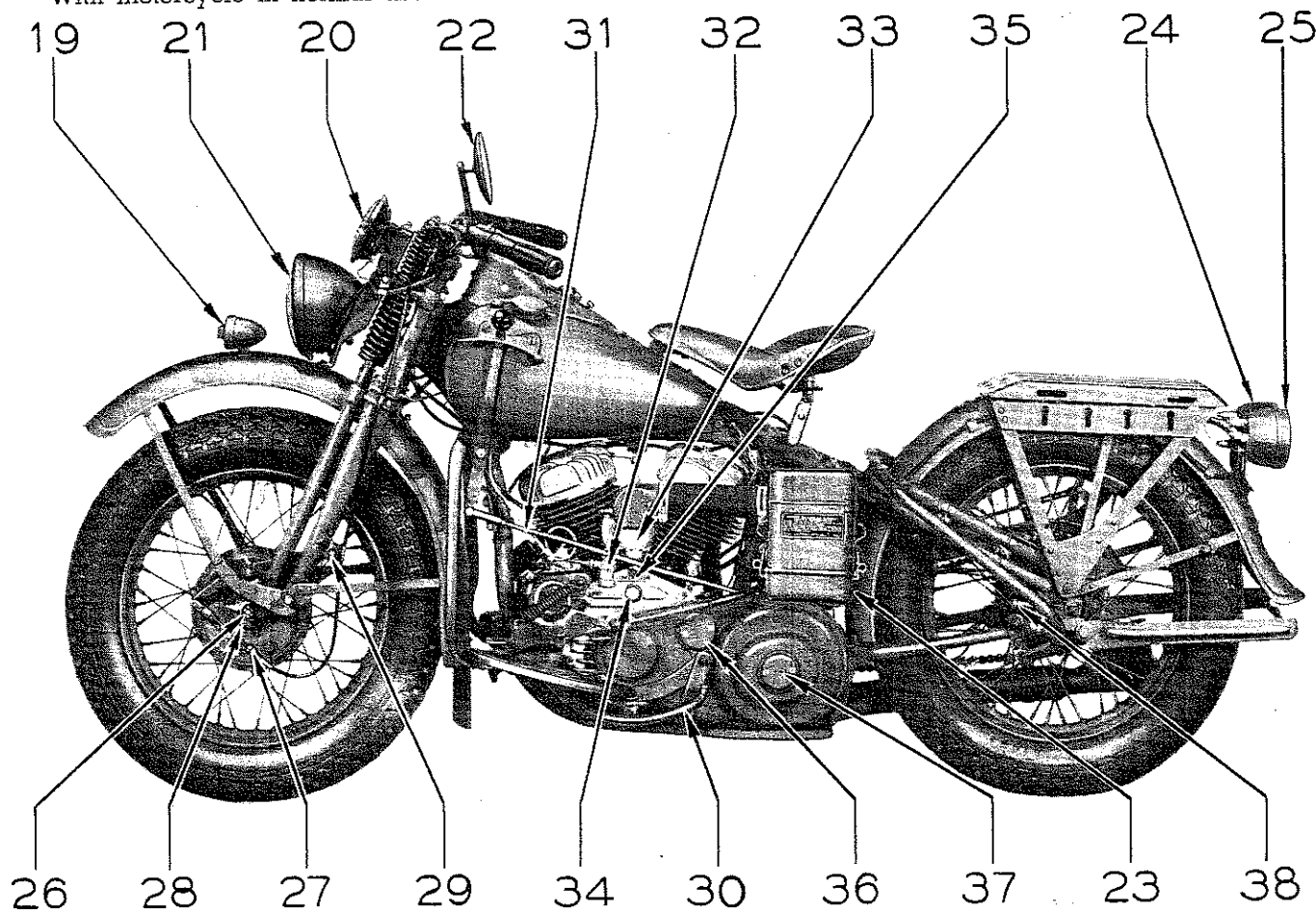
Bottom unit is spare blackout tail lamp. In case regularly used (right side) blackout tail lamp fails, its socket plug can be transferred to this tail lamp socket.

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 read-

justed if necessary. Chain should not be allowed to run loose enough to strike guard; neither should it be taut.

A properly adjusted chain has $\frac{1}{2}$ " 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.

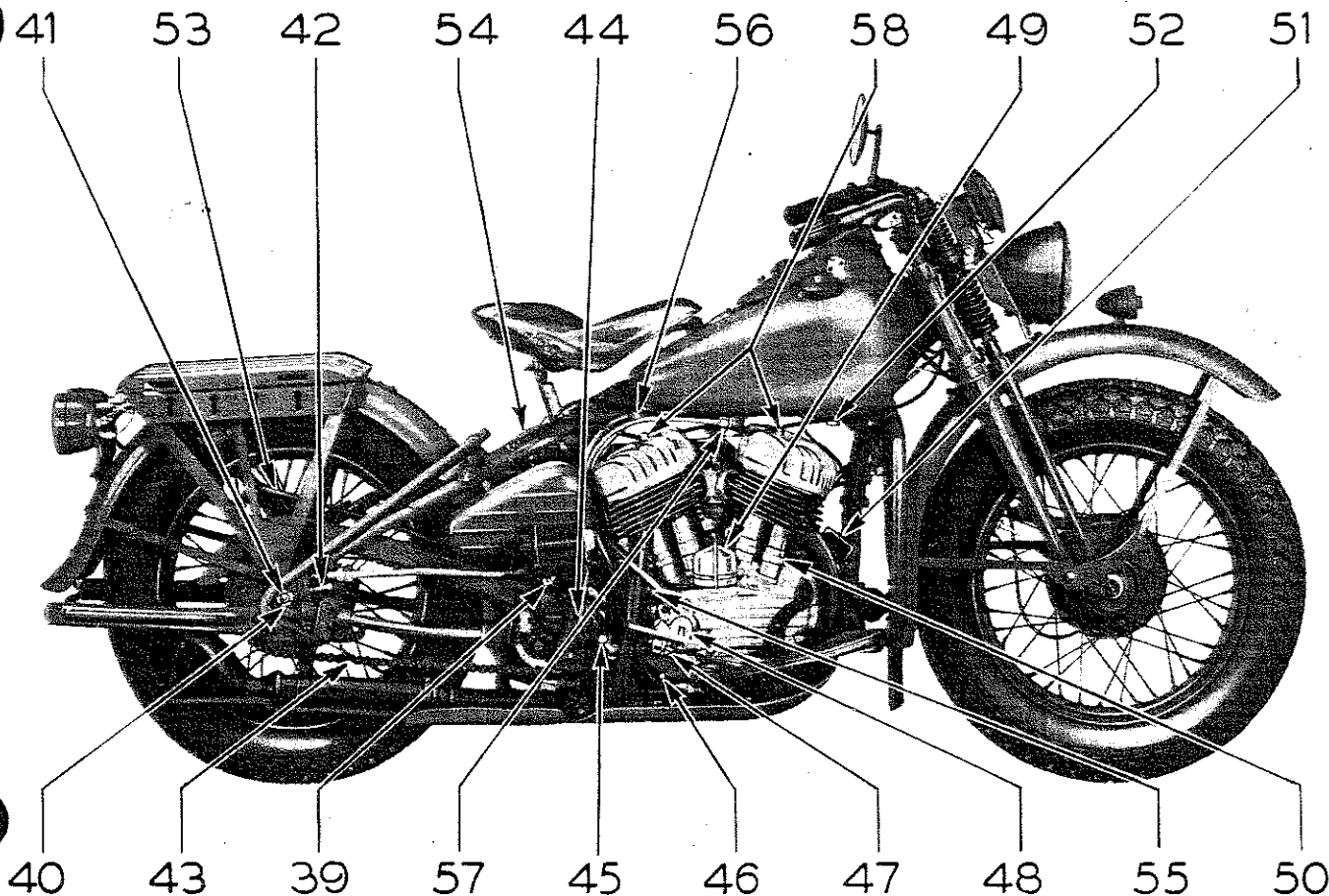
38. REAR WHEEL ADJUSTING SCREW, LEFT SIDE—By means of this screw and a like screw on the right side, rear wheel is moved to adjust rear chain, after loosening rear axle nut (Detail 41) and brake sleeve nut (Detail 40). See "Adjusting Drive Chains," Page 20.

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 $\frac{1}{2}$ " 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 re-adjusting chain oiler.

44. CLUTCH RELEASE LEVER—When clutch footpedal is in fully engaged position, this lever should have between $\frac{1}{8}$ " and $\frac{1}{4}$ " 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 gen-

erator 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 handle lever 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 $\frac{1}{4}$ or $\frac{1}{2}$ closed in mild weather, $\frac{3}{4}$ 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 $\frac{1}{4}$ closed position (first upward position) and with throttle closed, operate starter once or twice. Then, with throttle $\frac{1}{4}$ to $\frac{1}{2}$ 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:

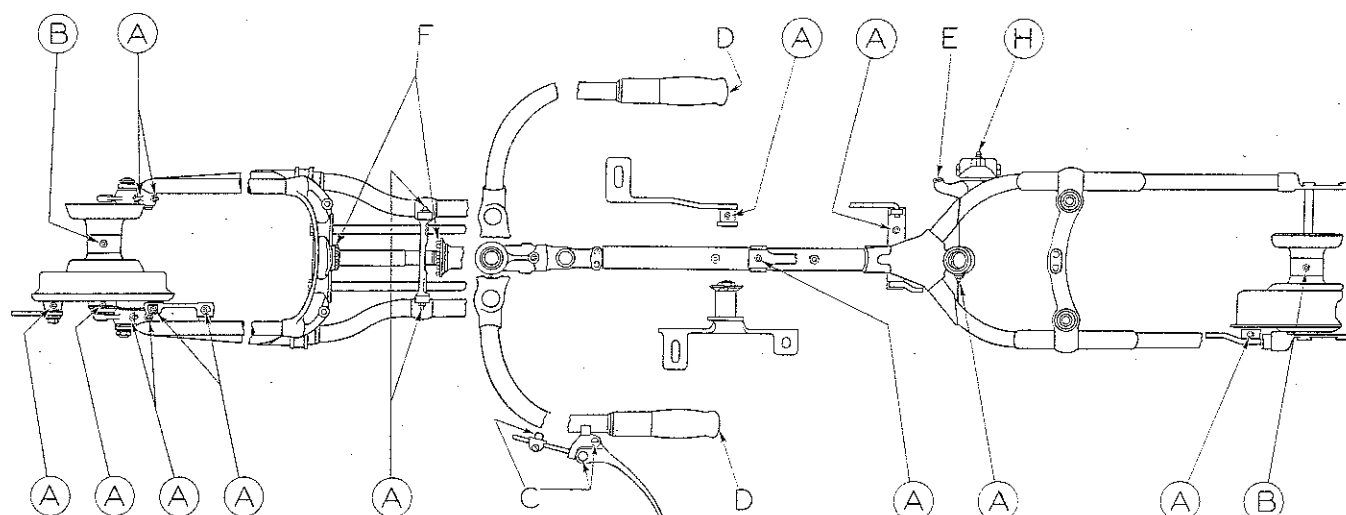
1. Stop engine by turning switch "OFF."
2. Lean motorcycle on jiffy stand, shift into "low" and engage clutch so motorcycle cannot roll.
3. Shut off gasoline by turning shut-off plunger down finger tight against its seat.

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 $+32^{\circ}$ F.
No. 0 or No. 1 below $+32^{\circ}$ F.
- B, F —Grease, General Purpose
No. 2 above $+10^{\circ}$ F.
No. 0 or No. 1 below $+10^{\circ}$ 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 $+32^{\circ}$ F.
S.A.E. 30 between $+32^{\circ}$ F. and $+10^{\circ}$ F.
S.A.E. 10 below $+10^{\circ}$ 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.

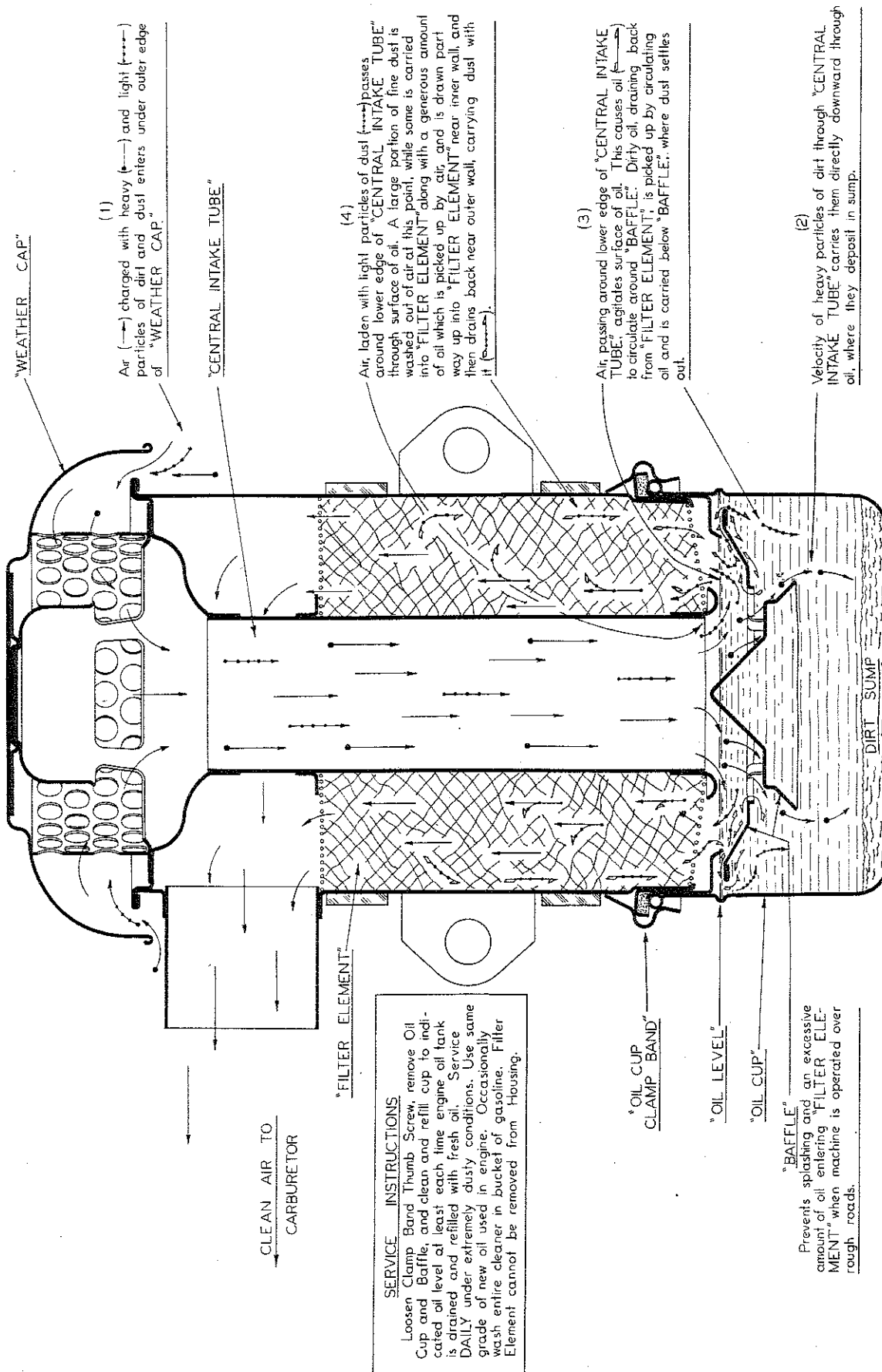
Lubricate generator commutator end bearing every 5000 miles or at least once a year with General Purpose No. 2 Grease. See "Lubricating Commutator End Armature Bearing," Page 52.

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:

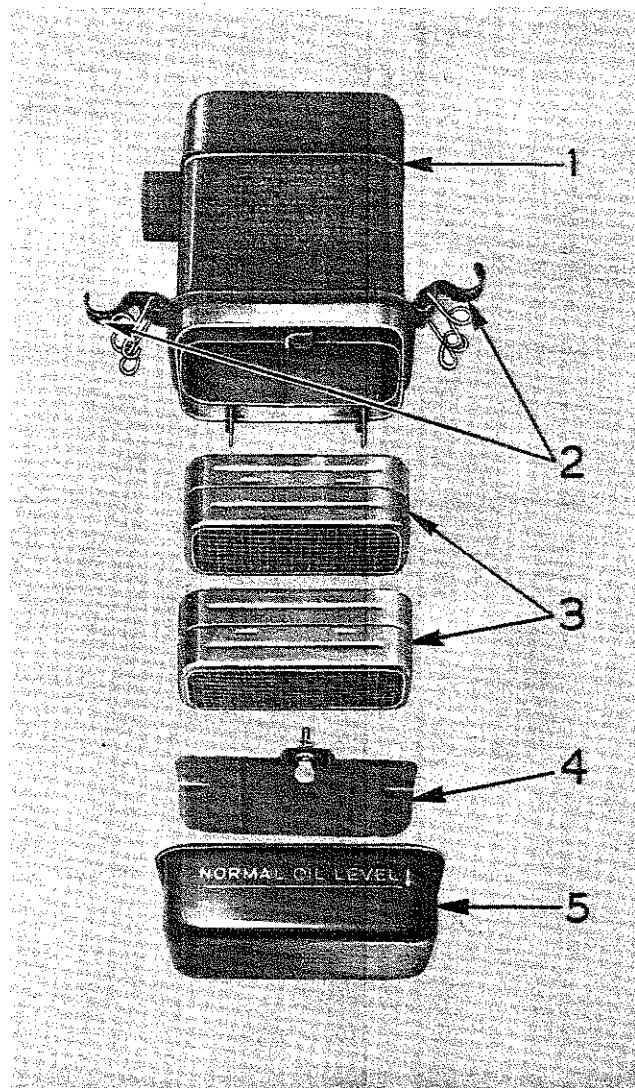
Release oil cup retaining clips and remove oil cup. Thoroughly wash and clean oil cup, refill to indicated oil level and re-install.

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 available 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 fre-

quently 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.

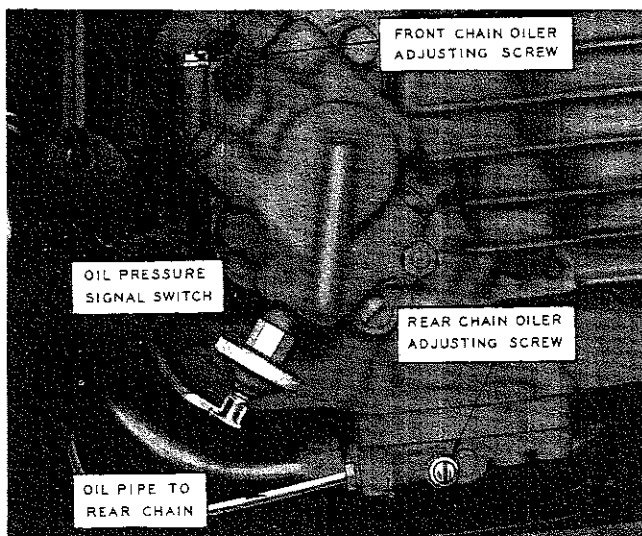
After removing from hot grease or oil, allow chain to drain and wipe all surplus grease or oil from surface of chain.

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.

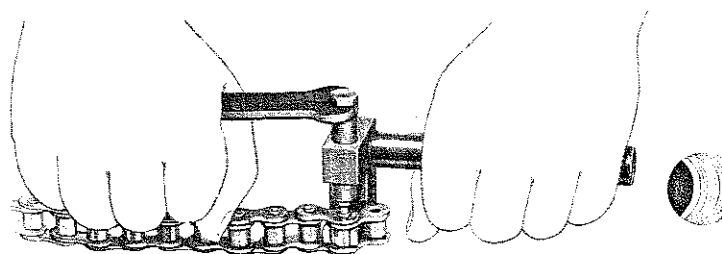
Repairing Drive Chains

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. 9
CHAIN OILER ADJUSTING SCREWS AND OIL SIGNAL SWITCH



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 $\frac{1}{8}$ " and $\frac{1}{4}$ " free movement on end of footpedal cable. If it has less than $\frac{1}{8}$ ", 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 $\frac{1}{4}$ ", 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)

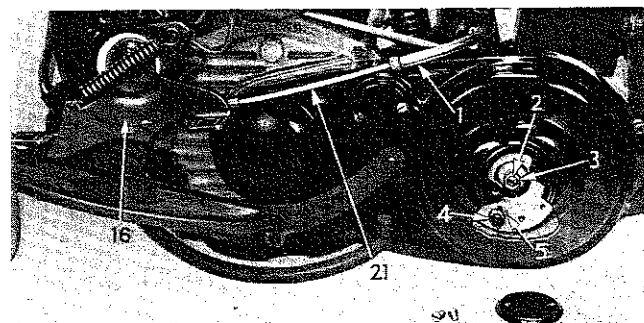
If clutch slips after controls have been correctly adjusted, increase spring tension by tightening (turn right) the three nuts (4) after removing chain guard and bending away locks (5).

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.

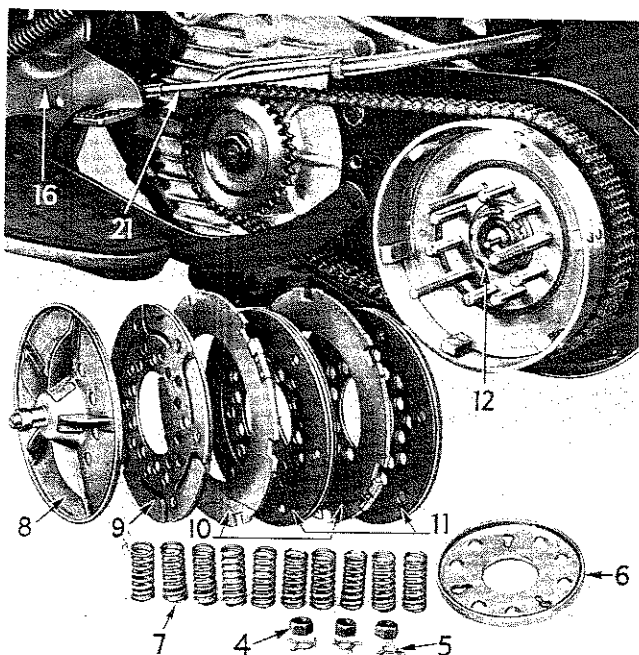
Do not increase spring tension any more than actually required to make clutch hold. As a new clutch is originally assembled and adjusted, the distance from inner edge of shoulder on spring collar (6) to outer surface of outer disc (8) is $1\frac{1}{2}$ ". In any case, do not tighten nuts (4) to the point where inner edge of shoulder on spring collar (6) is closer than $\frac{7}{8}$ " 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: $\frac{1}{8}$ " thick, $1\frac{3}{4}$ " outside diameter and $\frac{3}{8}$ " 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 thor-

oughly 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 relined 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).

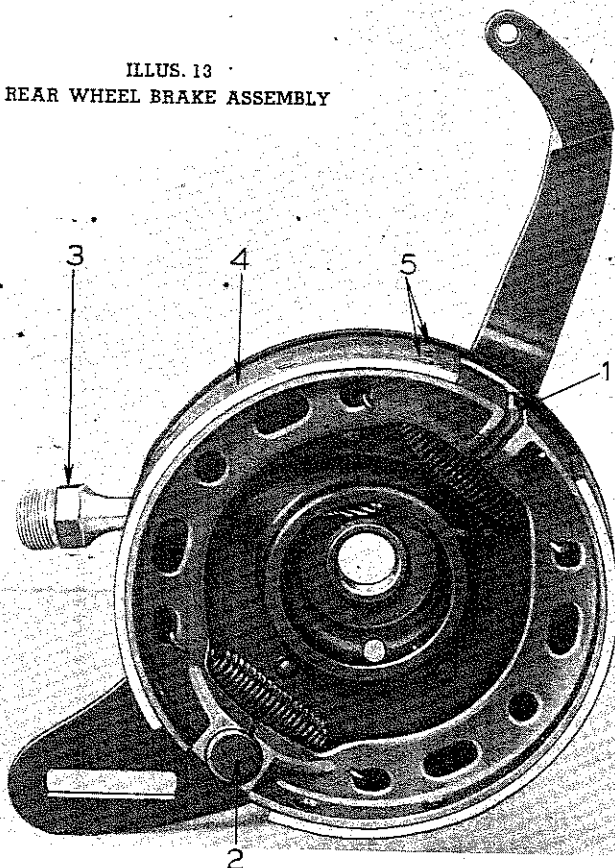
Adjusting Rear Wheel Brake

(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).

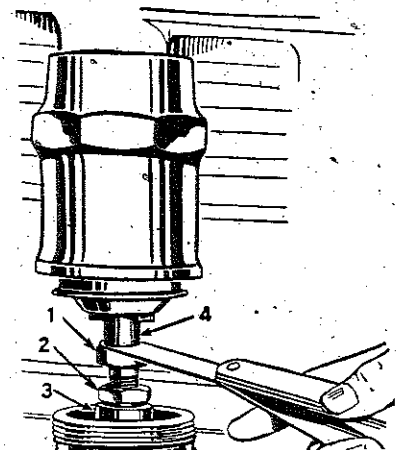
The inlet valves are those nearest the carburetor.

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.

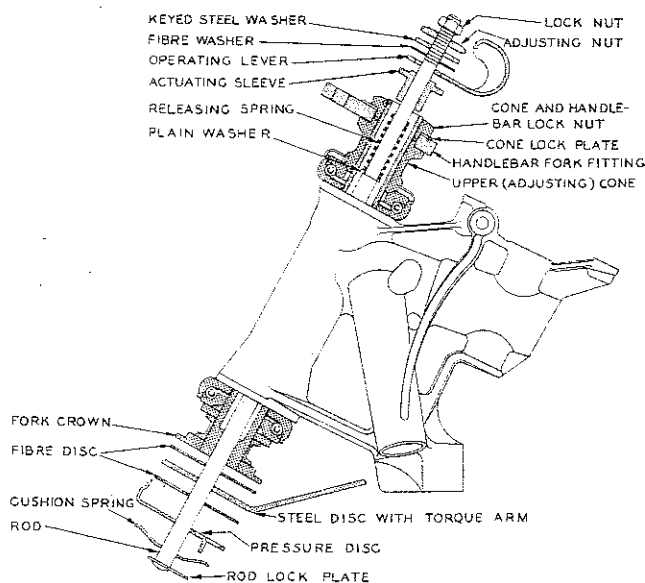
Keep breaker cam very lightly greased.

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 handlebar hollow pin and pull pin out of lever. Control wire can now be pulled out through pin hole in handlebar.

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. Handlebar 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.

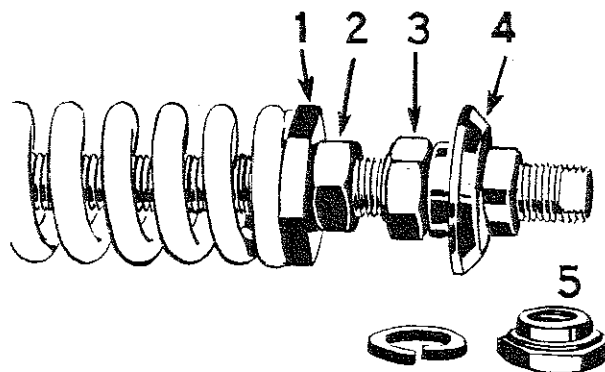
Adjust control, by means of adjusting sleeve, so that handlebar moves freely about one-quarter of its full range of movement before brake begins to take effect. Tighten adjusting sleeve lock nut.

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.

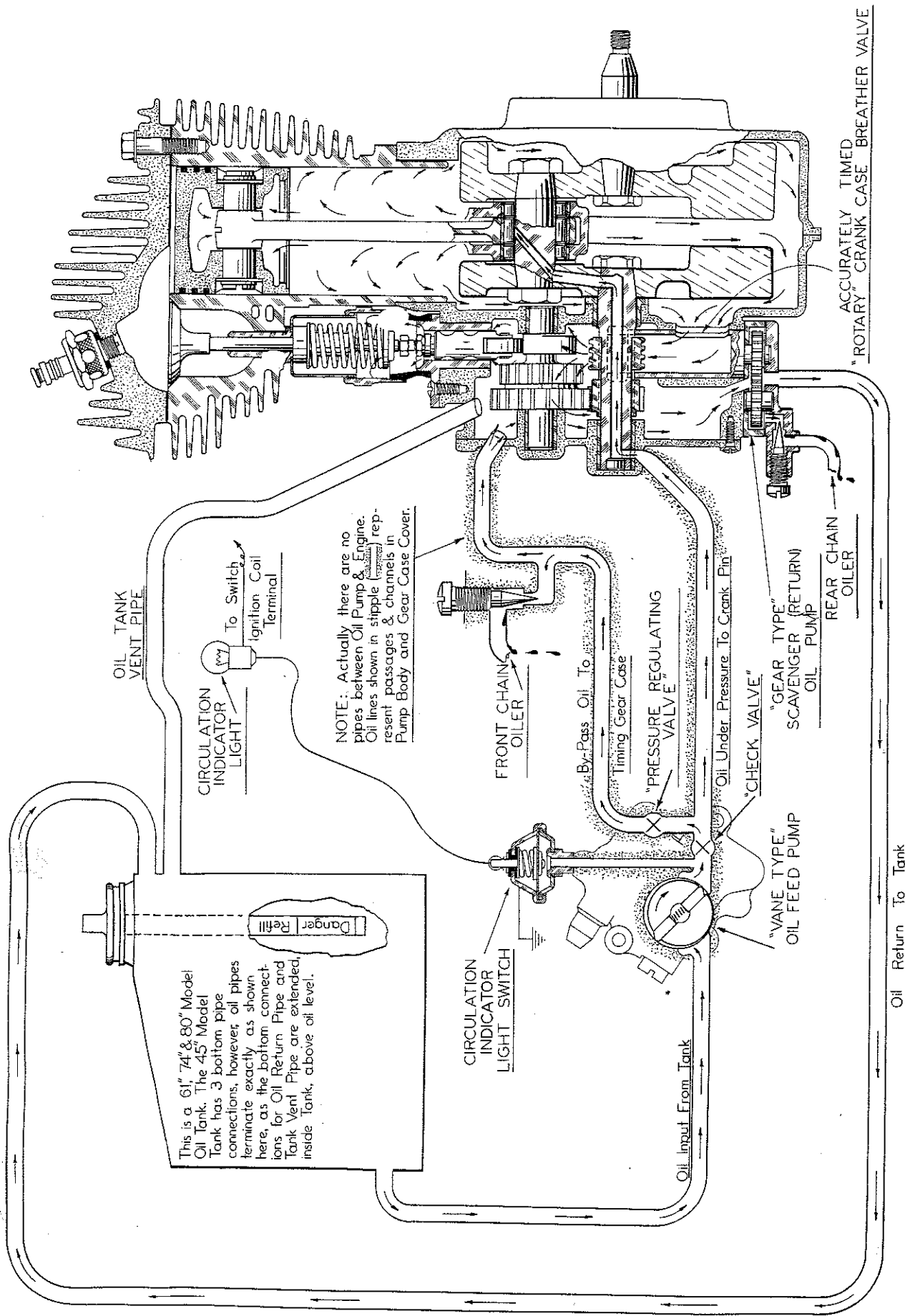
Remove gauge rod and check oil supply not more than 300 miles after each complete refill. If oil level is found not very far above "Refill" mark on gauge rod, add oil; when level is down to "Refill" mark, two U.S. quarts may be added. Oil supply runs cooler and mileage somewhat higher with oil level 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.

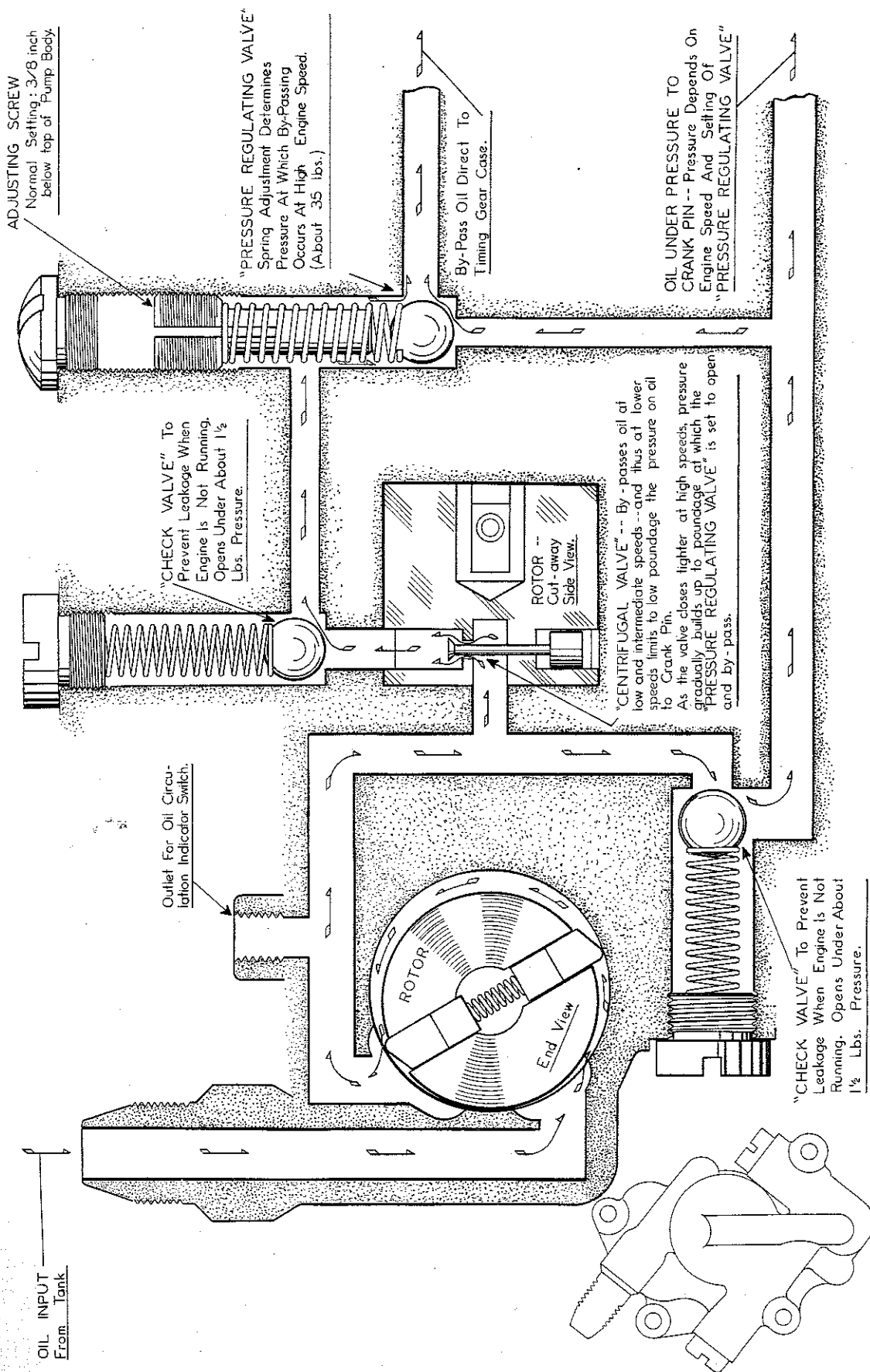
Winter Caution: Water is a by-product of combustion in any internal combustion engine. In a condensed state, the water vapor formed would equal approximately the quantity of gasoline burned. Some of this water vapor escapes past the rings into the crankcase. When starting and warming up in cold weather, 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.



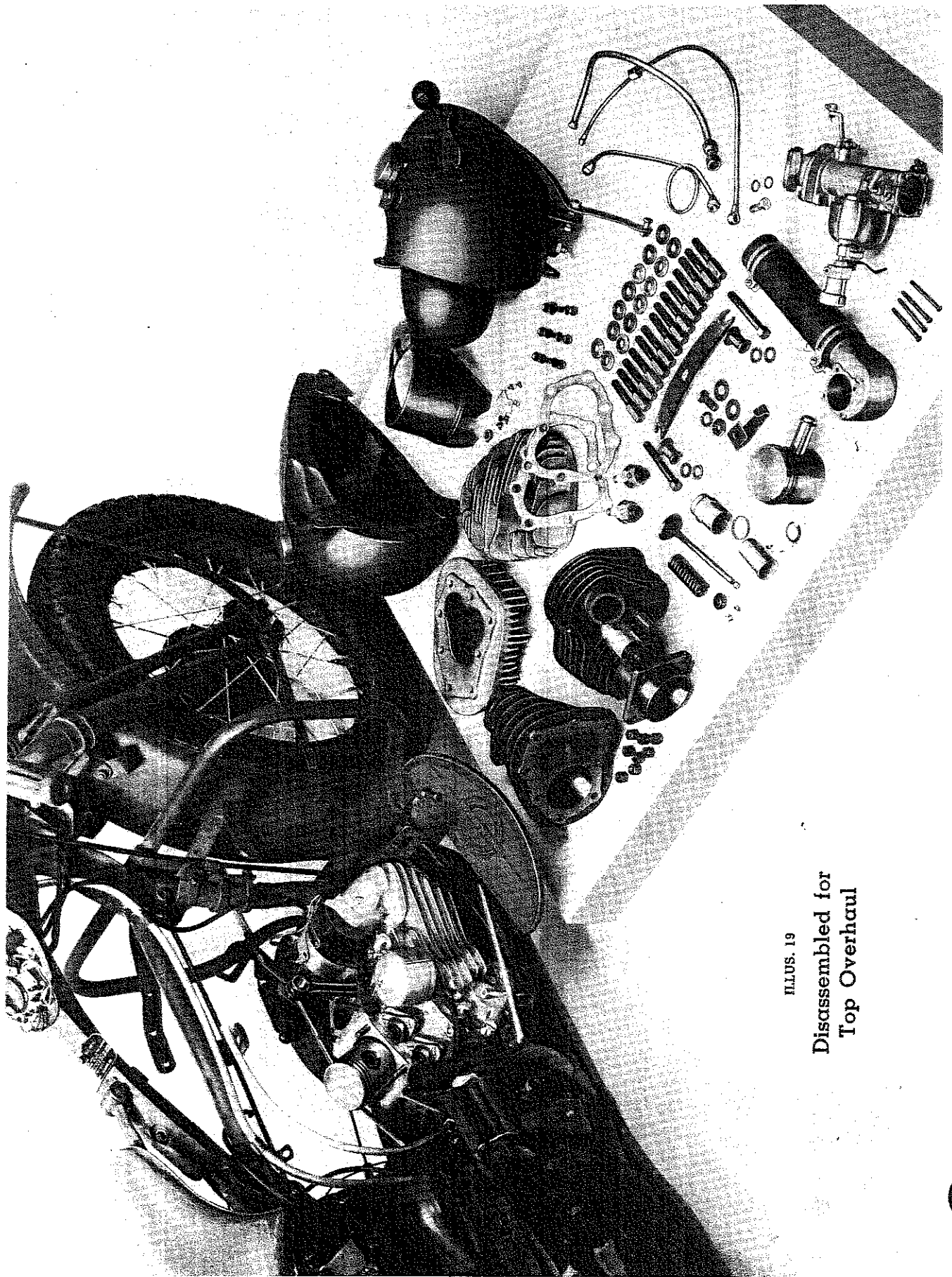
ILLUS. 17

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



ILLUS. 18

SCHEMATIC DIAGRAM—1941 AND LATER SIDE 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 $\frac{1}{8}$ " 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 foot-

board 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.

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

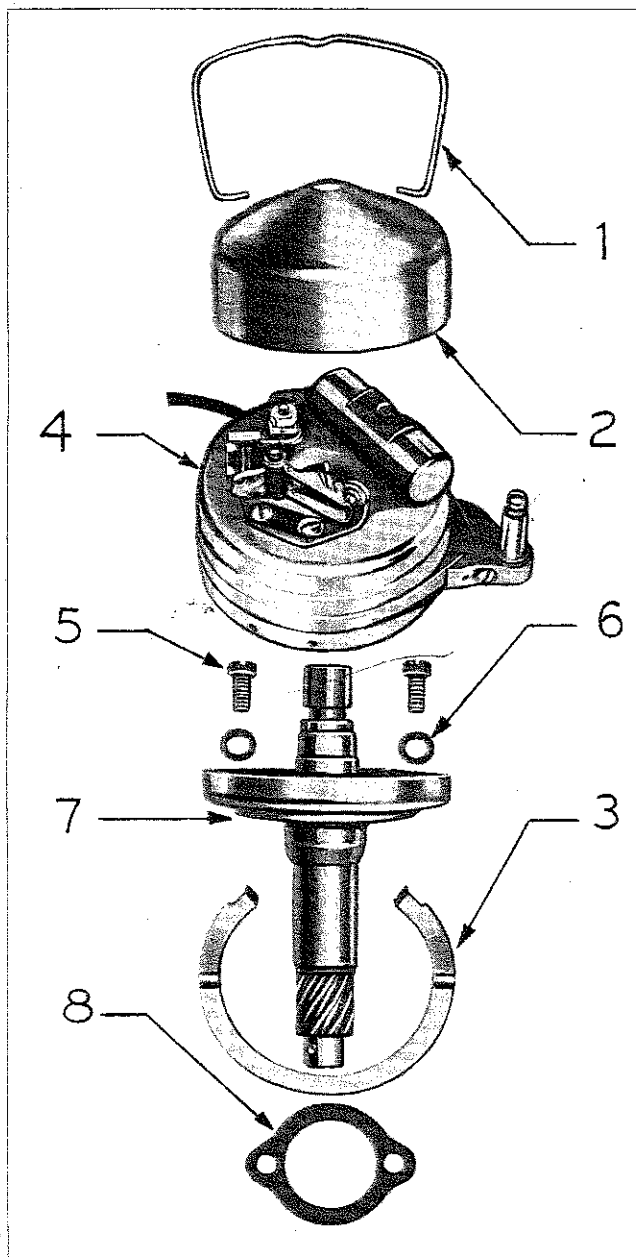
Cleaning and Inspecting Parts

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.

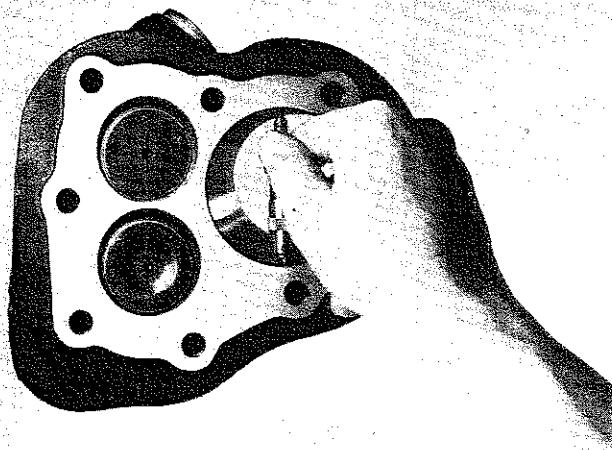
Clean outside of cylinder and head with wire brush to remove dirt, rust, etc., getting in between cooling fins as much as possible. Scrape carbon from cylinder head, top of cylinder around valves, top of bore above ring path and inlet and exhaust valve ports. When scraping carbon, be careful about deeply 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. 20
CIRCUIT BREAKER AND TIMER ASSEMBLY
SEE "DISASSEMBLING ENGINE," STEP 5, PAGE 30



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 $\frac{1}{2}$ " 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 $\frac{1}{8}$ ", 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.

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.

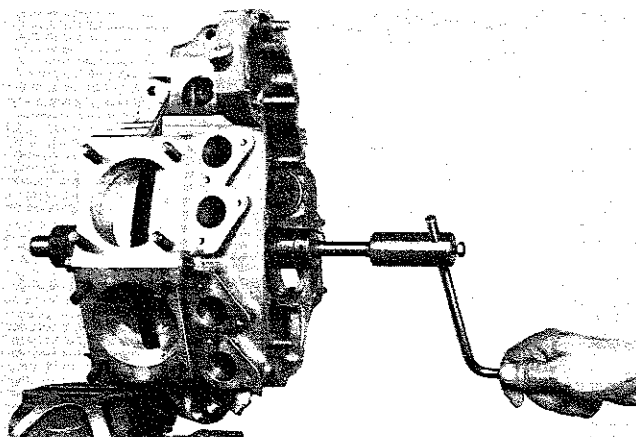
Truing and Sizing Connecting Rod Lower Races

(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



ILLUS. 23

TRUING AND SIZING MAIN BEARING RACES

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).

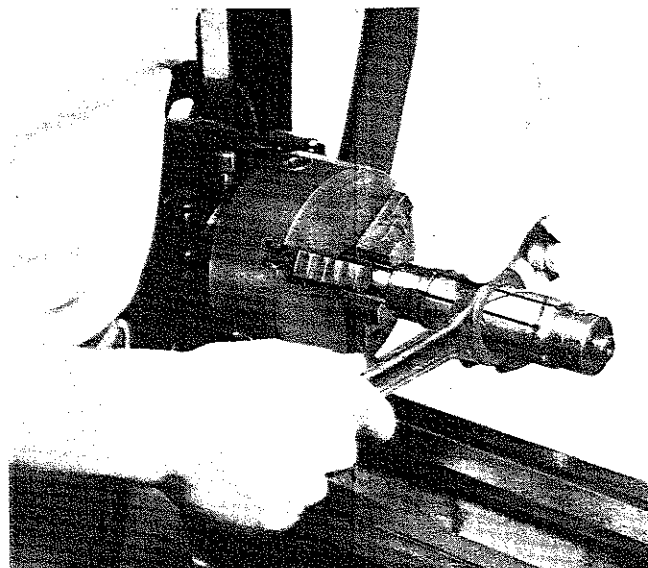
After lapping lower races of used rods as necessary, to smooth and true them, or replacing rods with a set with new lower races, install set of rollers and retainers on crank pin; rollers must always be new. Check fit of rods on bearing assembly. In making this check, flywheel sprocket shaft should be 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

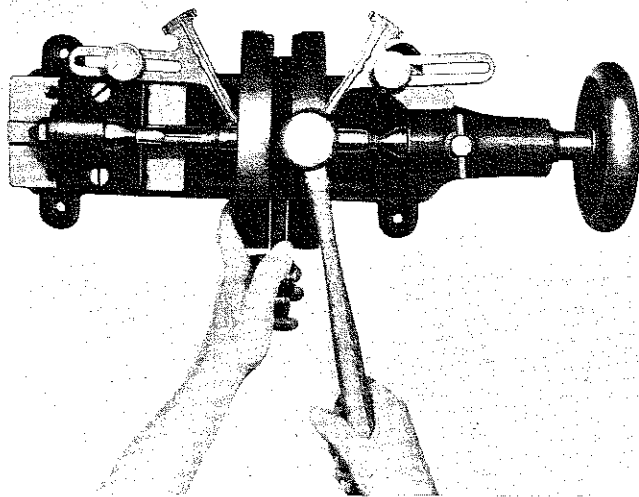
TRUING AND SIZING CONNECTING ROD LOWER RACE

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"x8" 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.

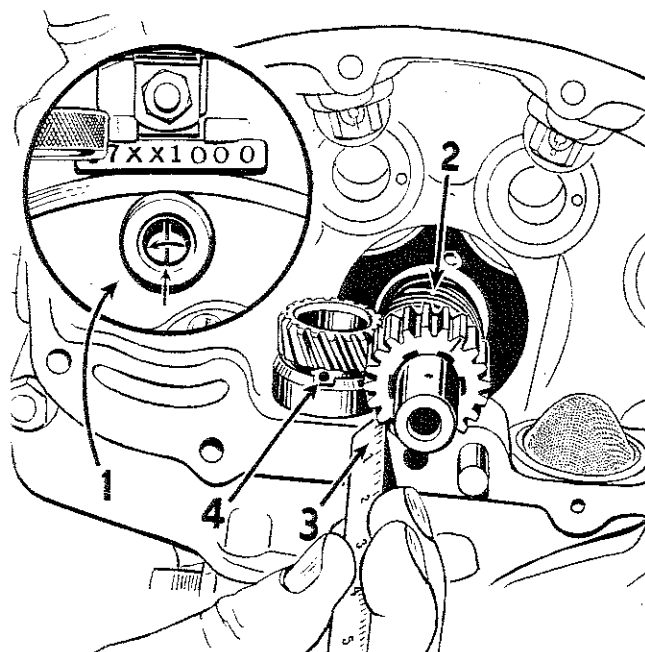
Summarizing the above: Spiral gear (2) must be so engaged with breather sleeve gear that when flywheel mark is in center of inspection hole and pinion gear $\frac{5}{16}$ " from joint face, timing hole (4) in breather sleeve registers as shown.

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

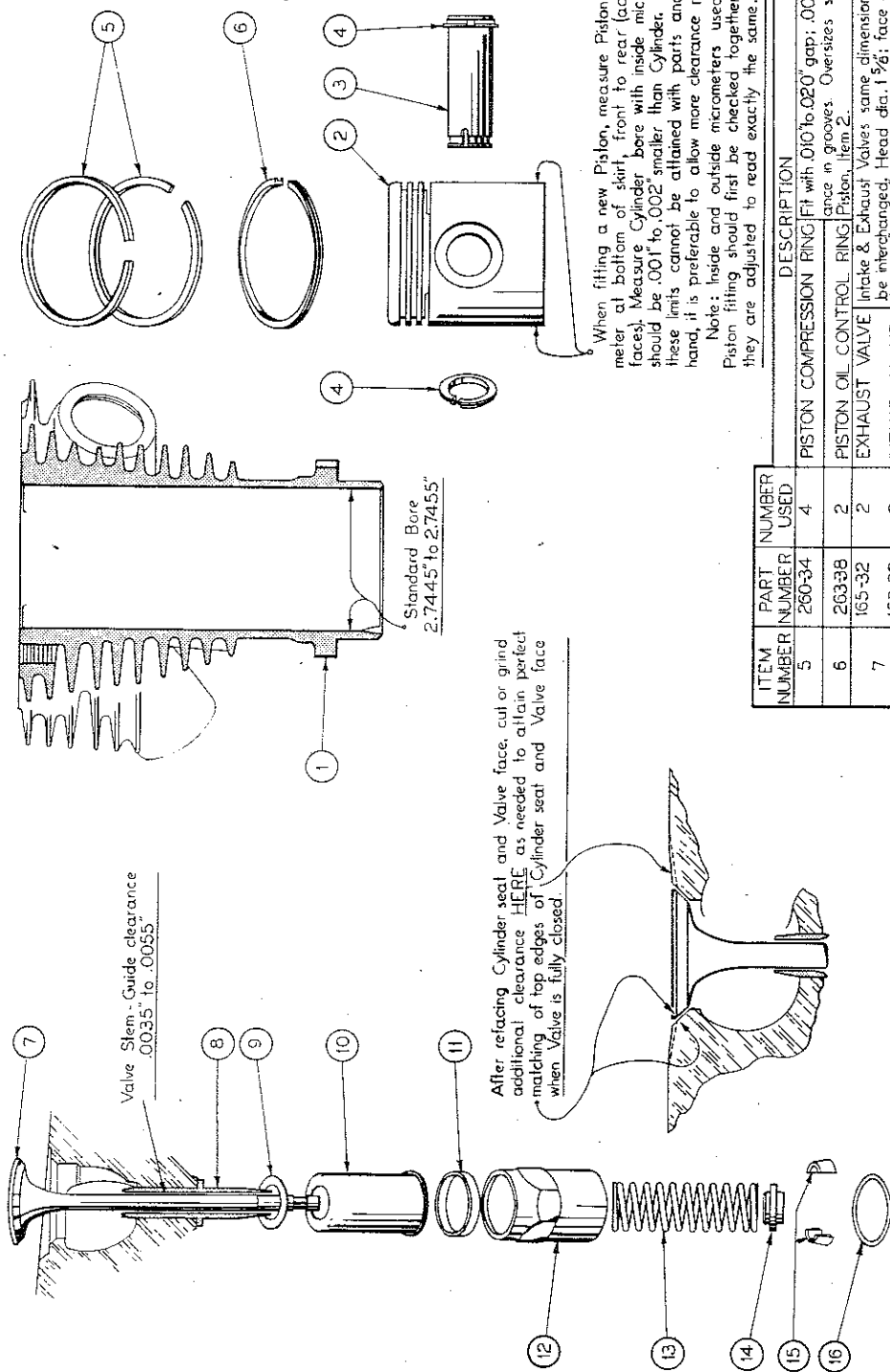
(SEE ILLUSTRATION 29)

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



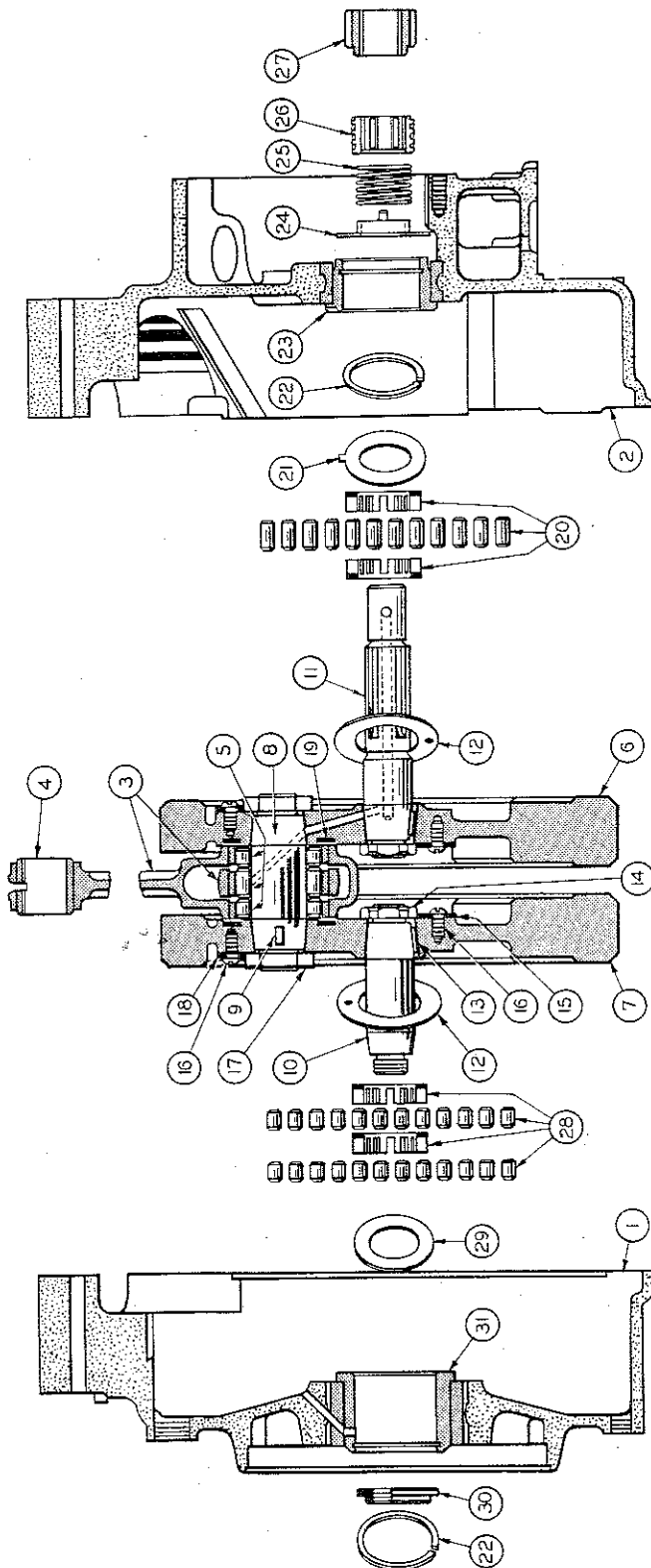
When fitting a new Piston, measure Piston with micrometer at bottom of skirt, front to rear (across thrust faces). Measure Cylinder bore with inside micrometer. Piston should be .001 to .002 smaller than Cylinder. If a fit within these limits cannot be attained with parts and facilities at hand, it is 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
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 (Piston, Item 2)
7	165-32	2	INTAKE VALVE (Intake & Exhaust Valves same dimensions but must not be interchanged; Head dia. 1 1/8"; face angle 45°; stem dia. .339 to .340; clearance in Guide .0035 to .0055)
8	163-32	2	EXHAUST VALVE (Intake & Exhaust Valves same dimensions but must not be interchanged; Head dia. 1 1/8"; face angle 45°; stem dia. .339 to .340; clearance in Guide .0035 to .0055)
9	166-32	4	INTAKE VALVE GUIDE - 1941 & Later (Press fit in Cylinder. .3435" to .3445" Ream)
10	166-41	4	EXHAUST VALVE GUIDE - 1941 & Later (Press fit in Cylinder. .3435" to .3445" Ream)
11	173-31	4	SPRING COVER - 1940
12	173-41	4	UPPER COVER - 1941 and Later
13	175-29	4	COMPOSITION GASKET Between Upper and Lower Covers
14	174-31	4	LOWER COVER
15	168-32	4	VALVE SPRING - 1940; Free length 2 1/8" 85 to 95 pounds @ 1 1/8"
16	168-41	4	VALVE SPRING - 1941 & Later; Free length 2 3/8" 95 to 105 pounds @ 1 1/8"
17	170-30	4	SPRING COLLAR
18	172-30	4	SPLIT KEY (PAIR)
19	176-20	4	LOWER COVER SEAT GASKET

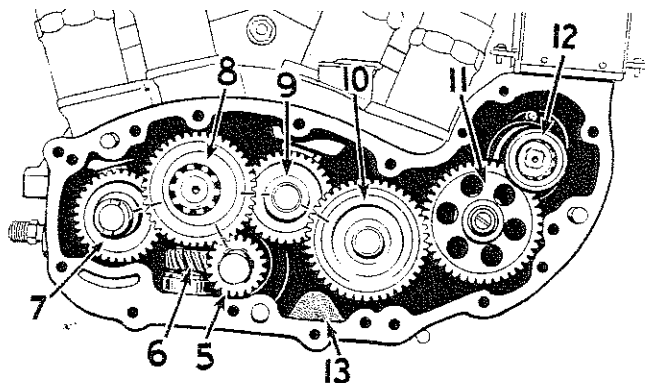
45 "V" TYPE ENGINE UPPER END ASSEMBLY

ILLUS. 27



ITEM NUMBER	PART NUMBER	NUMBER USED	DESCRIPTION	ITEM NUMBER	PART NUMBER	NUMBER USED	DESCRIPTION
1	403-37	1	SET OF CRANK CASES - NOTE: When only one-half case is damaged and needs to be replaced, return good half to the factory to be properly matched with a new half case.	17	364-37	2	CRANK PIN NUT
2	289-32	1	SET CONNECTING RODS With Crank Pin & Roller Bearing. Complete includes items 5 & 8. Forked Rod-Flywheel sideplay .006" to .010"	18	368-12	2	LOCKWASHER CRANK PIN NUTS
3	293-36	2	PISTON PIN BUSHING - Ream or hone to fit pin .001" loose.	19	372-21	2	FLYWHEEL STEEL WASHER
4	309-29	1	CRANK PIN ROLLER BEARING COMPLETE - Fit this bearing .0007" to .001" loose. See "FOOTNOTE."	20	414-37	1	GEAR SHAFT ROLLER BEARING COMPLETE - Fit this bearing .0008" to .002" loose. See "FOOTNOTE."
5	339-37	1	RIGHT FLYWHEEL When assembled, allow .012" to .014" endplay in.	21	414-39A	1	GEAR SHAFT BEARING WASHER
6	338-32	1	LEFT FLYWHEEL Crank Case. Adjust endplay with Thrust Collar "12."	22	423-39	2	BEARING SPRING RING
7	348-29	1	CRANK PIN	23	413-39A	1	RIGHT CRANK CASE ROLLER BEARING BUSHING - .0025" Press fit in Case
8	1650-18	1	CRANK PIN KEY	24	355-39	1	GEAR SHAFT BEARING OIL SEAL RING
9	352-29	1	SPROCKET SHAFT	25	355-37B	1	BEARING SEAL RING SPRING
10	355-37	1	GEAR SHAFT	26	689-37B	1	BREATHER VALVE AND SCAVENGER PUMP DRIVE GEAR
11	357-26	2	FLYWHEEL THRUST COLLAR .066" to .102" in steps of .004"	27	604-37A	1	PISTON GEAR
12	361-12	2	SHAFT KEY	28	419-29	1	SPROCKET SHAFT ROLLER BEARING COMPLETE - Fit this bearing .0005" to .001" loose. See "FOOTNOTE."
13	364-29	2	SHAFT NUT	29	422-39	1	SPROCKET SHAFT BEARING WASHER
14	368-29	2	LOCKWASHER, SPROCKET & PINION SHAFT NUTS	30	421-39	1	OIL RETAINING BUSHING - Press fit in Bushing "31."
15	368-29	2	LOCKWASHER SCREW	31	416-39	1	LEFT CRANK CASE ROLLER BEARING BUSHING - .0025" Press fit in Case.
16	030	4					

"FOOTNOTE" Referring to items Nos. 5, 20 & 28: Diameter of standard roller is .250". Complete bearings are available with rollers .001" undersize to .001" oversize in steps of .0002".



ILLUS. 29

Valve and Ignition Timing Gears

(SHOWING GEAR MARKS IN CORRECT ALIGNMENT)

5. Pinion gear. Gear and shaft are spline-engaged and gear is a slip fit on shaft.
6. Crankcase breather sleeve gear; also drives scavenger pump.
7. Rear exhaust cam gear; also drives oil feed pump.
8. Rear intake cam gear; also drives ignition circuit breaker.
9. Front intake cam gear.
10. Front exhaust cam gear.
11. Intermediate or idler gear (not marked).
12. Generator drive gear with breather exhaust oil separator ring (not marked).
13. Oil screen.

Refer to paragraphs 4, 5 and 6 under "Disassembling Engine," Page 30, for information on removing timing gear case cover.

Installing Timing Gear Case Cover

Before installing cover, lay engine on its side and pour about $\frac{1}{4}$ pint of engine oil over timing gears.

Unless old timing gear case cover gasket is in good condition, fit a new gasket. Do not use a "home made" gasket as this gasket has holes for oil passages, and if a hole is left out or put in wrong location, oiling system will not function normally.

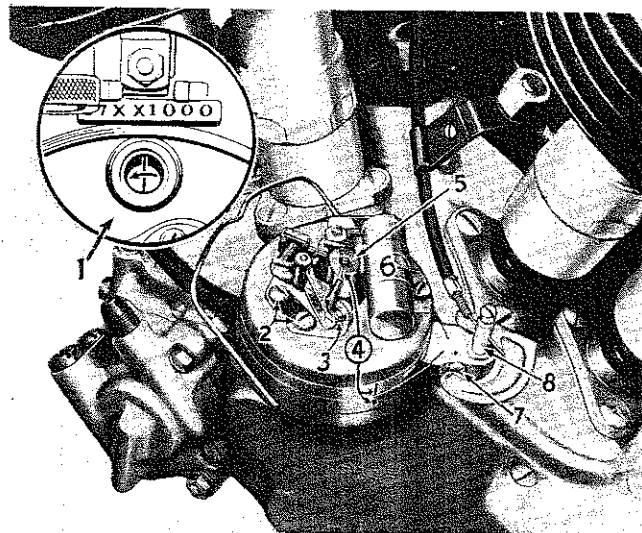
After all gear cover screws, except hexagon-head bolt which also holds oil feed pump, are installed and pulled up tight (this includes generator screws), turn engine and note whether or not it turns freely. If considerable drag is felt, possibly too many steel shim washers have been fitted to one or more cam gear shafts. In this case make necessary correction. Cam gear endplay should be from free running to .005".

Installing Oil Feed Pump

If condition of oil feed pump gasket is in the least questionable, use a new "factory" gasket. Never use a "home made" gasket on oil feed pump as leaving out one hole or getting a hole in the wrong location may put oiling system completely out of commission.

Start pump onto its three mounting studs, turn engine slowly and press lightly against pump until

driving dogs on cam gear shaft line up with and drop into driving slot in oil pump rotor. Insert hexagon-head bolt and lock washer and install the three lock washers and nuts on pump mounting studs. Pull all up tight. Note that two of these nuts are long extension nuts. These nuts should be put back on same studs from which they were originally removed.



ILLUS. 30

IGNITION CIRCUIT BREAKER AND TIMER

Ignition Circuit Breaker and Timer and Flywheel Timing Mark

1. Flywheel timing mark, in center of inspection hole in crankcase. Arrow shows direction in which engine runs.
2. Adjustable contact point lock screws. Loosen these screws to readjust point gap.
3. Contact point gap. Gap fully open (breaker lever fibre on highest point of cam) should be .022". Wrong gap affects time of ignition. See "Servicing Circuit Breaker and Ignition Timer," Page 24.
4. Mark on breaker cam (registers with breaker lever fibre), and marks on timer head, indicating original factory timing.
5. Breaker cam. Narrow cam times front cylinder; wide cam times rear cylinder. Cam should be lubricated occasionally with a very light application of grease.
6. Condenser.
7. Adjusting band screw. After loosening this screw and thus loosening adjusting band, timer head can be shifted to readjust timing.
8. Advance and retard lever; inward position is advanced.

Installing Circuit Breaker and Timing Ignition

(REFER TO ILLUSTRATIONS 20 AND 30)

Turn engine in direction in which it runs until taps indicate front cylinder is on compression stroke (directly after front intake valve closes). Continue turning engine slowly until flywheel timing mark is in center of inspection hole in left crankcase.

Install gasket and timer head tension (ground) spring on timer shaft base assembly and insert shaft and shaft gear *all the way down* into place in timing gear case cover. Do not secure with timer base screws as yet.

Install timer head with control lever (8) within advance and retard quadrant as shown. Do not install cover retainer until later. *Fully advance* lever (8) (push inward) and observe how closely mark (4) on breaker cam lines up with breaker lever fibre. If it does not line up, lift timer base and turn shaft gear so its engagement with its driving gear is changed one tooth. Check again according to breaker cam mark. Repeat this procedure until gear engagement is attained which closely aligns mark (4) and breaker lever fibre. When this has been accomplished, note that base is turned so ignition coil wire is toward rear of engine and secure base with screws and lock washers.

Re-install head on base and secure with ground spring and cover retainer. Be sure ground spring is in its proper place so when cover retainer ends are fitted through holes in timer head, they also fit into spring locating notches. Otherwise, spring will have no tension and timer head will be loose on its base. Contact points and condenser are grounded through timer base and this spring holds the head in close contact with the base, thus insuring a good ground.

Provided mark on side of timer head and hole in adjusting band are still in alignment; also breaker point gap is correctly adjusted, engine is now timed according to original factory setting.

Recommended Recheck of Ignition Timing

Even though all marks are in perfect alignment, same as engine was originally timed, timing may change somewhat after engine has been in service for a time, due to normal wear and seating of the various moving parts that affect timing.

Since accurate ignition timing is the first essential to good engine performance, it is advisable, after ignition has been timed according to marks as explained above, to recheck as follows:

Refer to Illustration 30. See that circuit breaker points are properly adjusted with a gap of .022". Make sure breaker lever (8) is advanced all the way. Turn engine in direction in which it runs until front cylinder is on compression stroke and continue to turn it ahead slowly until narrow cam (the one with timing mark), *just starts* to open breaker points.

An accurate check as to when points just start to break can be made with a test lamp as follows:

If engine is not installed in chassis, connect a test battery in series with test lamp and circuit breaker. While points are closed, lamp will remain lit; as points start to open, lamp will go out.

If engine is installed in chassis, connect one wire of test lamp to coil rear terminal along with circuit breaker wire, connect other wire to ground and turn ignition switch "ON." As long as points are closed, lamp will remain out; as points start to open, lamp will light.

When exact position is found, where points just start to open, flywheel mark should be in center of inspection hole. If it is not, readjust timing as necessary by loosening screw (7), which loosens adjust-

ing band, and shift timer head in band.

If flywheel timing mark shows forward of center in inspection hole, timing is slow. To correct, shift timer head *against* rotation of breaker cam. If flywheel mark is to rear of center of inspection hole, timing is fast and timer head must be shifted with rotation of breaker cam, to correct timing.

With ignition timing correct, front piston is $\frac{9}{32}$ " before top center, on compression stroke, when points just start to open and cause spark to occur, firing front cylinder.

Ignition timing should be checked in this manner every 2000 miles.

Installing Pistons

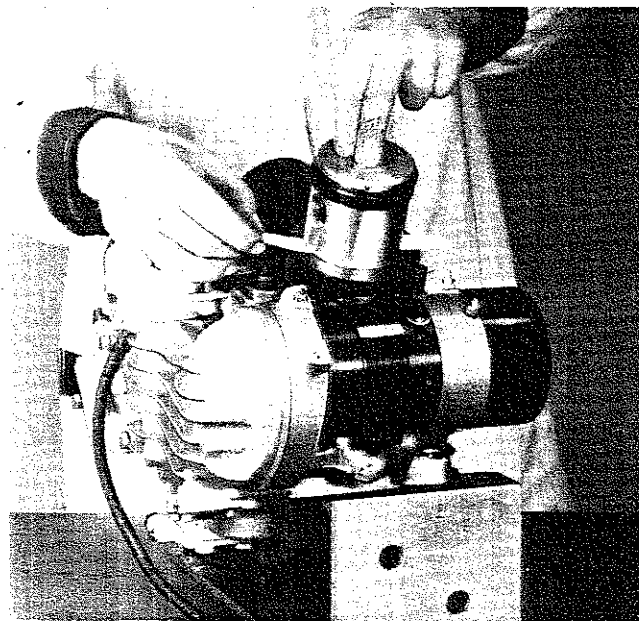
It is assumed that piston-cylinder fitting, also pin and ring fitting have already been given due attention as per information under "Refinishing Cylinders Oversize and Fitting New Pistons," Page 32, "Emergency Piston and Ring Service," Page 43 and "Piston Rings," Page 44. Whether new or used pistons are being installed, the rings should be new. It is not practical to reassemble an engine with used rings, even though rings may not be very badly worn.

Install pistons according to instructions under "Piston and Pin," Page 43. Handle pistons carefully so they will not be burred, cracked or otherwise damaged.

Aligning Rods

In refitting and reassembling connecting rods, and finally fitting pistons, rods may possibly be bent or twisted, throwing upper bearing and lower bearings out of alignment with each other to some extent. Therefore, after pistons have been fitted, rods must be checked and re-aligned as may be necessary. If a rod is left bent or twisted, piston has a cocked relation to cylinder bore and the result is excessive noise and rapid wear.

Check rod alignment by means of piston squaring plate (manufacturer's number 12655-26) as shown in Illustration 31. Be sure crankcase face is clean and



ILLUS. 31
PISTON CHECK FOR ROD ALIGNMENT

J. E. ADAMS
275 WILSON DRIVE
MTN. HOME, IDAHO 83647

free from burrs so that squaring plate seats fully.

If a rod is in perfect alignment, piston bottom will rest squarely on plate with flywheels turned so that crank throw is in either forward or rear position. Bear in mind that this check, to be accurate, depends upon checking with crank throw in both forward and rear positions, as it is the change of rod angle, resulting from changing crank throw from one position to the other, that influences the seating of piston on squaring plate and thus indicates whether or not rod is in alignment.

Rather than depend entirely upon visual check, as to when piston seats squarely upon plate, insert narrow strips of paper of equal thickness underneath piston, one on each side, below piston pin, as shown in Illustration 31. Press piston down *lightly* with finger tips resting on center of piston head and pull first one paper, then the other, partially from underneath piston. If piston is perfectly square (rod in alignment), both will have the same amount of drag.

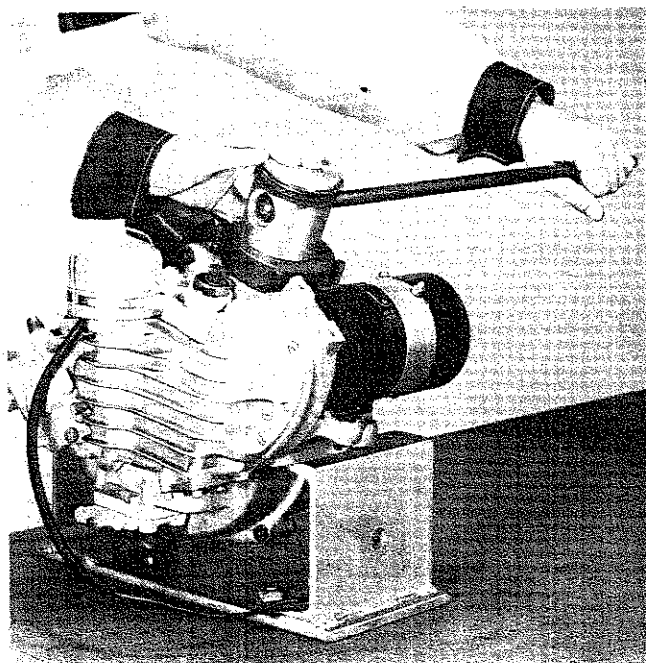
If rod proves to be out of alignment, it can be straightened by means of a bar inserted through piston pin, as shown in Illustration 32. Use bar of largest diameter that can be inserted through pin.

To straighten a *bend*, insert straightening bar through *low* end of piston pin and apply upward force.

To straighten a *twist*, insert straightening bar through *high* end of piston pin and pull away from crank throw.

The manner in which piston seats on squaring plate indicates as follows:

1. Piston high on same side, both crank throws; rod is bent.
2. Piston high on opposite sides as crank throw is changed; rod is twisted.
3. Piston square or nearly square with crank throw in one position and high on one side with crank throw in other position; rod is bent and twisted. In this case, remove bend first and then remove twist.



ILLUS. 32

SQUARING PISTON (STRAIGHTENING CONNECTING ROD)

After rods have been aligned, check to see that pistons center in crankcase cylinder opening, without side pressure on rod upper ends. If rod ends are offside enough to interfere with pistons centering, they must be corrected by one of the following methods: Further re-aligning; dressing off end of rod bearings with a file; fitting a different combination of thrust collars (Item 12, Illustration 28) to shift complete flywheel and rod assembly sideways.

Installing Cylinders

Lubricate cylinder walls, pistons, pins and rod upper bushings generously with engine oil. Also pour about $\frac{1}{4}$ pint of oil onto rod lower ends. This is an initial crankcase supply to take care of lubrication requirements while oiling system is building up normal pressure and circulation, directly after starting an overhauled engine the first time.

Space ring gaps about equidistant around piston but do not locate any gap near exhaust valve port, as in this position ring ends may be overheated and burned.

Turn engine until crank pin is at bottom center. See that crankcases are clean and fit cylinder base gaskets. Also note that valve cover gaskets on tappet guides are all in place and in good order. If any are damaged or broken, replace them. Cylinders with valves and valve covers assembled can now be installed over pistons and rings being careful not to change ring gap location. Work cylinders carefully down over rings to avoid any possibility of ring breakage. Install rear cylinder first and as cylinder seats, turn engine so tappets are at their lowest position. Turn on cylinder base nuts and pull them down just snug, not tight. Follow same procedure with front cylinder. In connection with a top overhaul only which does not require removing muffler, insert exhaust pipes into cylinders as they are seated.

Check intake manifold packing bushings to see that they are in good condition. Assemble nuts and bushings to manifold after applying a light coat of oil or grease so bushings will freely adjust themselves to manifold and cylinder nipples as nuts are tightened. Turn nuts onto cylinder nipples and tighten securely with special wrench (manufacturer's number 12003-X). Unless manifold packing bushings are in good condition and manifold nuts securely tightened there are likely to be air leaks around manifold-cylinder joints. With this condition it will not be possible to get a satisfactory low speed carburetor adjustment.

After manifold is tight, loosen cylinder base nuts slightly to allow final shifting and lining up of cylinders and manifold, then tighten base nuts securely, using special wrench (manufacturer's number 12650-29).

Installing Cylinder Heads

It is recommended that new cylinder head gaskets be used each time heads are re-installed. This assures leak-free joints. Old gaskets should be re-used only in an emergency when new gaskets are not available, as in some cases a leak-free joint cannot be obtained with used gasket. Apply a light coat of engine oil or grease to both sides of gaskets. Make

sure tops of cylinders are clean and install gaskets.

Place heads on cylinders and install heavy washers and head bolts (See Illustration 19). Attach cylinder head-frame bracket with the two long bolts, spacers and flat washers. Spacers go between heads and frame bracket. A flat washer goes under the head of each long bolt above bracket and some engines have flat washers between spacers and bracket.

Head bolts must be tightened evenly to attain a tight joint. First turn bolts down just snug; then tighten each of them $\frac{1}{8}$ to $\frac{1}{4}$ turn at a time until all are securely tightened. Use special head bolt wrench (manufacturer's number 12047-30A).

Adjusting Valve Tappets

Valve tappets must be checked and readjusted each time cylinders are removed and re-installed. See "Adjusting Valve Tappets," Page 23.

Installing Carburetor

After servicing carburetor as needed according to information under "Carburetor Service," Page 58, install it on manifold. Note that engine equipped with a $\frac{1}{2}$ " spacer between manifold and carburetor should be fitted with three heavy (asbestos) manifold gaskets. One gasket is placed between manifold and spacer, and two between spacer and carburetor.

Engine not equipped with spacer between manifold and carburetor may be fitted with either one heavy gasket or a paper gasket, between manifold and carburetor.

Install lock washers on carburetor-manifold screws and tighten screws securely. If these screws are not tight, an air leak will result, causing carburetion to be erratic. Attach carburetor support bracket to bowl nut extension. Tighten securely.

Disassemble gasoline strainer. Clean thoroughly before installing.

Installing Engine in Chassis

In connection with top overhaul only, engine is already in chassis and completing assembly is a matter of reversing the procedure followed in disassembly as outlined under "Disassembling Engine for Top Overhaul Only," Page 29.

In the case of a complete engine to be installed in chassis, reverse procedure followed in removing engine from chassis as outlined under "Removing Assembled Engine From Chassis for Complete Overhaul," Page 30.

In either case, pay close attention to the following: Install required number of shim washers to fill space between cylinder head bracket and frame lug and securely tighten the bolt through these fittings; bear in mind that clamp for front spark plug cable is also attached with this bolt. Be sure throttle and spark control clamps are tightened securely and check very closely to see that throttle opens and closes fully with grip movement and that spark advances fully with grip in inward position. Check clutch, gear shifter and brake controls for correct adjustment. Make close final inspection to be sure all nuts, bolts, screws, etc., are tight.

Emergency Piston and Ring Service

Need of replacement of rings, or possibly pistons and rings, is indicated by loss of normal compression, overheating, loss of power, abnormal oil consumption, excessive exhaust smoke and piston slap or knock.

As explained under "Refinishing Cylinders Oversize and Fitting New Pistons," Page 32, when pistons develop excessive clearance and slap due to wear or damage and cylinders are found worn more than .002", it is recommended regular practice to smooth and true up cylinder bore by honing, or boring and honing, to the next regular oversize piston step.

However, piston slap alone, due to wear and excessive cylinder-piston clearance, does not necessarily mean otherwise very poor and undependable performance. A good compression seal is the requirement of prime importance for good performance. Therefore, in rendering emergency or field service, when and where oversize pistons and facilities for refinishing cylinders oversize are not at hand, the main things to be considered are whether or not cylinders are deeply scored and piston ring grooves badly worn sideways.

Even though cylinders and pistons may be worn to the extent of very pronounced piston slap, if cylinders are in smooth condition so a new and reasonably good compression seal can be effected by fitting new rings, or new pistons and rings if ring grooves are badly worn, engine will be good for a further period of dependable performance.

See "Checking Connecting Rod Lower Bearing for Excessive Wear and Looseness," Page 29.

Piston and Pin

(REMOVING AND INSTALLING)

Piston pin, properly fitted, is a light hand press fit in piston and has .001" clearance in connecting rod upper bearing. The pin is secured in piston by means of a spring lock ring at each end of pin. Lock rings fit into grooves in pin and grip pin with considerable tension.

In removing piston pin, first remove lock ring from end of pin that is slotted. These slots permit getting a screwdriver underneath lock ring and forcing it off. Use end of special tool specified below as a rest for screwdriver. Pin can then be driven out of piston. Use a drift of proper size to avoid damaging end of pin and piston boss and strike *light* hammer blows to avoid bending connecting rod.

When reassembling piston to rod, after giving due attention to correct fit of pin in both, piston and rod upper bearing, clean lock ring groove and install lock ring on end of pin that is *not* slotted. Start slotted end of pin into piston boss and drive through in the same manner in which pin was removed.

If the piston (but not the pin) is heated about as hot as it can be handled before pin is started, pin will drive through easier than with piston at room temperature. After pin is in place, clean lock ring groove and install the other lock ring. It is important that manufacturer's special tool number 12052-32 be used for installing lock rings, as with this tool lock ring is expanded just enough to go over end of pin. Other means of installing may over-expand ring and

possibly crack it. Note that ring seats firmly in its groove; if it doesn't, discard it and install another new one. A lock ring loosely installed will rapidly loosen further in service and finally will come off pin, resulting in both piston and cylinder soon being damaged beyond repair. Never re-install a used lock ring; always use a new one.

Standard size pistons and those in the lower oversize steps have two horizontal slots, one front and one rear, in bottom ring groove. Oversize pistons in the larger steps are slotted horizontally and also have a vertical slot in one thrust face. Pistons with only the horizontal slots may be fitted with either thrust face to the front. Pistons with vertical slot in one thrust face must be fitted with that thrust face to the front.

Pistons obtained from the manufacturer, standard or oversize, are fitted with pin correctly fitted and piston rings installed. Piston pin lock rings are also supplied, one assembled on pin, the other one loose. Check ring gaps in cylinder being refitted.

Piston Rings

Piston rings are of two types; the two upper rings on each piston are plain compression rings. The bottom ring on each piston is an oil control ring, having a channel in its face.

Piston rings must have proper side clearance in ring grooves. In new assembly, this is .004". Check with thickness gauge. Maximum permissible side clearance is .008".

Gap between ends of rings, when inserted squarely in cylinder bore, must be .010" to .020". If gap is less than .010", ring ends may butt under expansion and rings may be scored or broken. Gap may be increased by filing with a fine-cut file.

Installing and Fitting Connecting Rod Upper Bushing

Connecting rod upper end bronze bushing may need to be renewed either due to wear and excessive pin clearance or due to becoming loose in rod.

Inspect for both conditions.

When bushing is found tight in rod but is worn to excessive pin clearance (.002" or more) it is, of course, possible to service it by reaming oversize and fitting an oversize pin. However, it is better practice to install a new bushing and ream it to fit a standard pin, except when piston to be used has previously been fitted with oversize pin or pin is loose in bosses, necessitating fitting with larger pin. The principal objection to fitting upper end oversize is that, in the event of emergency field service requiring quick fitting of pistons, considerably more time is required for the job if upper end bearing is oversize. New pistons obtained from the manufacturer are supplied correctly fitted with standard pin, and installing one is a short job if the rod bushing is already reamed to standard size. If bushing has been reamed oversize, either new bushing must be installed and reamed to standard size or piston must be reamed oversize to fit an oversize pin, which involves extra time.

When installing new upper end bushings in rods disassembled from engine, an arbor press, if available, is usually used to press out old bushings and press in the new.

When renewing bushings in connection with only a top overhaul, use special manufacturer's tools shown in Illustration 33. Bushing tool is number 12057-X; rod holding fixture is number 12058-X. Be careful to start new bushings with oil slot in alignment with oil slot in rod.

Ream new bushing to size, or, preferably, ream nearly to size and finish to exact size with a hone (reamer number 11915-X; hone number 11844-X). A properly fitted pin should have .001" clearance; with this clearance, pin will have just noticeable shake in bushing. Fitting tighter is likely to result in a seized pin or bushing loosened in rod.

Oversize piston pins are available in the following oversizes: .002", .004", .006", .008", .010" and .012".

After installing new connecting rod upper end bushings in connection with only a top overhaul, connecting rod alignment must be checked the same as when an engine is completely overhauled. See "Aligning Rods," Page 41.



ILLUS. 33
INSTALLING NEW ROD BUSHING

SUMMARY OF ENGINE SPECIFICATIONS

(Fitting and Adjusting)

CYLINDER: Standard bore—2.7445" to 2.7455".

PISTON CLEARANCE IN CYLINDER: .001" to .002", measuring piston at bottom of skirt, front to rear.

Warning: This fitting clearance applies only to manufacturer's taper-cam ground piston, which is .0025" smaller at top of skirt, underneath lower ring, than at bottom of skirt. This clearance (.001" to .002") is not sufficient for straight-cam ground piston obtained from some other source.

PISTON-CYLINDER HEAD CLEARANCE: $\frac{1}{16}$ " to $\frac{3}{32}$ " with piston at top center.

PISTON PIN IN PISTON: Light hand press fit.

PISTON PIN IN CONNECTING ROD UPPER BUSHING: .001" clearance.

PISTON RING GAP: .010" to .020".

PISTON RING SIDE CLEARANCE IN GROOVES: .004".

CONNECTING ROD LOWER END BEARING: .0007" to .001" loose.

CONNECTING ROD LOWER END SIDE PLAY: Forked rod must have .006" to .010" play between flywheels. Roller and retainer assembly must be narrower, but not more than .010" narrower, than forked rod.

PINION GEAR SHAFT: .0008" to .0012" loose in roller bearing and .0005" to .001" loose in timing gear cover bushing. (Note: When new cover bushing is installed, oil transfer hole in bushing must be located 30° ahead of top center).

SPROCKET SHAFT: .0005" to .001" loose in roller bearing; .006" to .007" loose in oil retaining bushing.

FLYWHEEL ASSEMBLY: .012" to .014" endplay in crankcase.

CAM GEARS: .0005" to .001" clearance in crankcase and gear case cover bushings; free to .005" endplay.

VALVE STEM-VALVE GUIDE CLEARANCE: .0035" to .0055".

TAPPET GUIDES: .0005" to .001" press fit in crankcase.

VALVE TAPPET-TAPPET GUIDE CLEARANCE: .0005" to .001".

TAPPET CLEARANCES: Engine cold. Intake .004" to .005"; exhaust .006" to .007".

CIRCUIT BREAKER POINTS: .022" gap with breaker lever fibre on highest point of cam.

SPARK TIMING: $\frac{1}{4}$ " to $\frac{3}{32}$ " before top center; time according to flywheel mark. (See Page 40.)

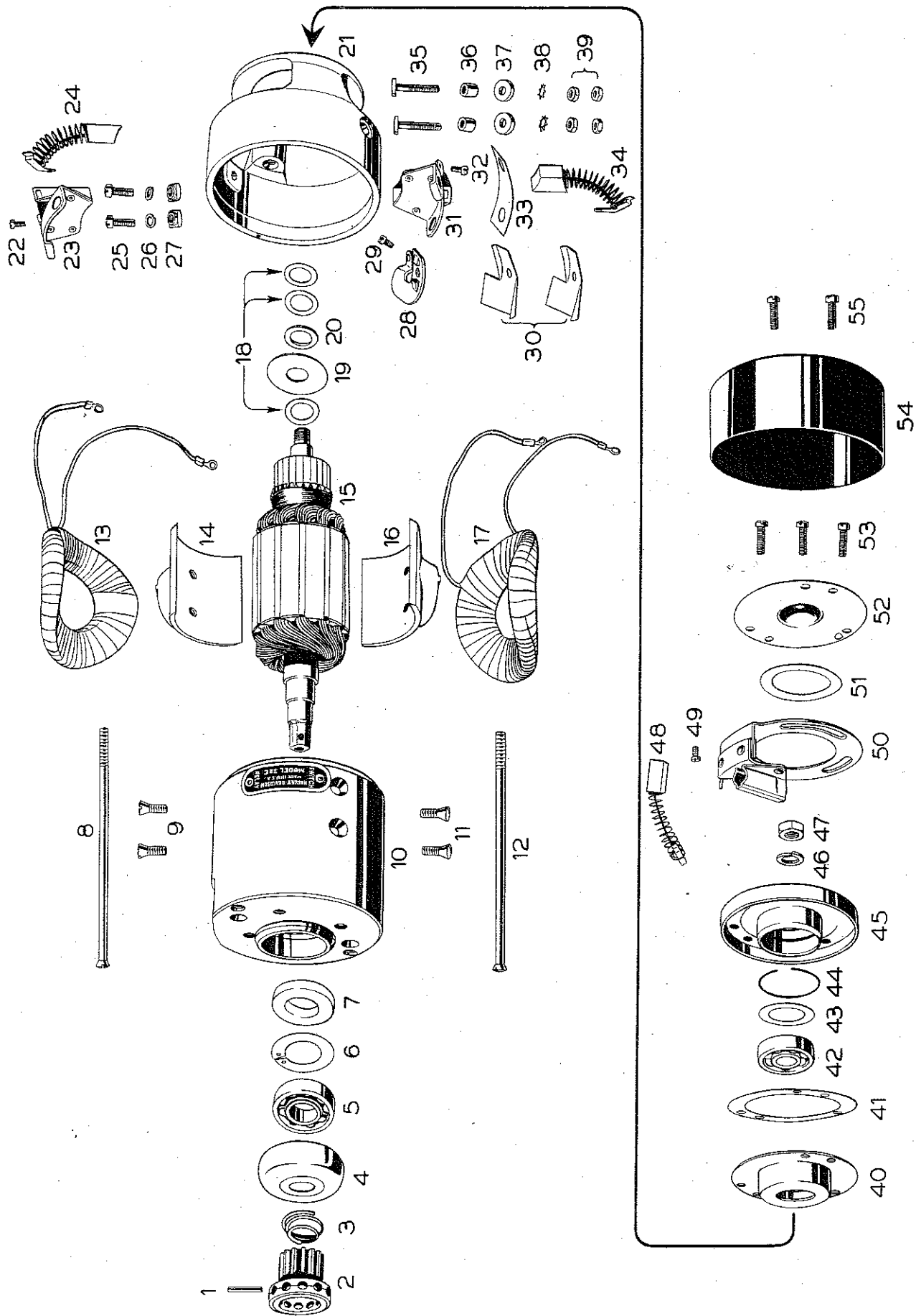
CRANKCASE BREATHER TIMING: See Page 37.

VALVE TIMING: Time according to gear marks (See Page 40). Tappets to be adjusted first. Intake opens $\frac{5}{32}$ " to $\frac{7}{32}$ " before top center; intake closes $\frac{3}{16}$ " to $\frac{1}{16}$ " after bottom center. Exhaust opens $\frac{3}{16}$ " to $\frac{1}{16}$ " before bottom center; exhaust closes $\frac{5}{32}$ " to $\frac{7}{32}$ " after top center.

OIL PUMP ADJUSTMENT: Normal setting—Head of pressure regulating valve adjusting screw $\frac{3}{8}$ " from face of pump body.

FRONT CHAIN OILER ADJUSTMENT: Initial factory setting—Adjusted with the required washers under adjusting screw head to hold screw point $1\frac{1}{8}$ turns off its seat. Make further adjustments as needed to meet actual service requirements (See Page 20).

REAR CHAIN OILER ADJUSTMENT: Initial factory setting—Adjusted with the required washers under adjusting screw head to hold screw point $\frac{1}{2}$ turn off its seat (See Page 20).



ILLUS. 34

GENERATOR—SHOWING ALL PARTS IN CORRECT ORDER OF ASSEMBLY

GENERATOR ASSEMBLY

(ITEM NUMBERS REFER TO ILLUSTRATION 34)

ITEM	NUMBER USED	PART NUMBER	NAME
1	1	634-32	Drive Gear Pin
2	1	632-37	Drive Gear
3	1	1647-31B	Spring
4	1	1646-31	Oil Deflector
5	1	1644-30	Drive End Bearing (large)
6	1	1647-31D	Spring Ring
7	1	1647-31C	Felt Oil Retainer
8	2	1506-32	Frame End Screw (Same as Item 12)
9	4	1512-18	Pole Shoe Screw (Same as Item 11)
10	1	1504-32	Frame
11	(See Item 9)	-	-
12	(See Item 8)	-	-
13	1	1507-32	Shunt Field Coil (White identification mark)
14	2	1511-30	Pole Shoe (Same as Item 16)
15	1	1636-32	Armature
16	(See Item 14)	-	-
17	1	1508-32	Regulating Field Coil (Orange identification mark)
18	3	1643-29	Armature Steel Spacer (.025")
19	1	1642-29	Armature Bakelite Washer
20	1	1643-30	Armature Steel Spacer (.072")
21	1	1505-32	Frame End
22	4	010	Terminal Screw (Same as Items 29, 32 and 49)
23	2	1661-32	Brush Holder (Same as Item 31)
24	2	1669-32	Brush (Same as Item 34)
25	2	036	Brush Holder Bolt
26	2	0254	Lock Washer
27	2	1667-32	Nut
28	1	1663-32B	Shunt Field Coil Terminal
29	(See Item 22)	-	-
30	2	1663-32A	Shunt Field Coil Terminal Insulation
31	(See Item 23)	-	-
32	(See Item 22)	-	-
33	1	1663-32	Positive Brush Holder Insulation
34	(See Item 24)	-	-
35	2	1664-32	External Terminal Bolt
36	2	1665-32	Terminal Bolt Bushing
37	2	1666-32	Insulating Washer
38	2	0354	Lock Washer
39	4	0105	Nut
40	1	1641-30A	Grease Retainer, Inner
41	1	1697-30	Gasket
42	1	1644-18	Commutator End Bearing
43	1	1639-18	Spacing Shim (.020")
44	1	1647-29A	Spring Ring (1- $\frac{5}{16}$ " diameter)
45	1	1647-32	Bearing Housing
46	1	0261	Lock Washer
47	1	0129	Armature Shaft Nut
48	1	1671-26	Third (regulating) Brush (small)
49	(See Item 22)	-	-
50	1	1662-32	Third (regulating) Brush Holder
51	1	1642-30	Gasket
52	1	1641-33	Grease Retainer, Outer
53	5	037	Screw (Same as Item 55)
54	1	1696-32	End Cover
55	(See Item 53)	-	-

ELECTRICAL SYSTEM

Electrical system is a 6 volt, one wire, ground return system, with negative ground. Generator is third brush and "lamp load" regulating type. Lamp load regulation is accomplished by connecting "shunt" field winding in the lighting circuit. When lights are turned "ON," this field is energized and generator output is increased to carry load of lighting equipment.

When Generator Fails to Charge

When generator apparently quits charging (indicated by green signal light in switch panel staying lit or battery going dead), the trouble may be of such nature that repairs can be made without removing generator. Follow procedure outlined below, step by step, until the trouble is located.

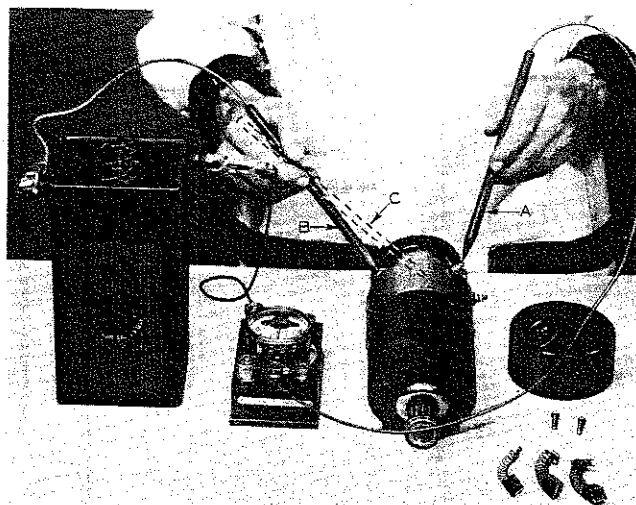
1. Test the battery and if its condition is questionable, replace with fully charged battery before making further tests.
2. Remove left footboard, footboard sidebar and clutch footpedal assembly.
3. Remove generator end cover and inspect brushes to make sure they are not worn out, broken, or gummy and sticking in brush holders.
4. See that commutator is not excessively oily, dirty or gummy.
5. Make sure brush holders are not bent and possibly striking shoulder on commutator.
6. If the fault is not found through above checks, it may be in the cut-out relay, or in wiring between generator and battery.

To check whether trouble is in generator, relay, or wiring between relay and battery:

1. Connect an ammeter between battery negative terminal and ground.
2. Disconnect wires from "relay" terminal of generator and battery positive terminal, and connect a jumper wire directly between these two terminals.
3. Start and speed up engine and check reading of ammeter. If generator shows normal charge, trouble is in cut-out relay (See "Cut-out Relay," Page 52) or in wiring between relay and battery (See "Wiring Details," Page 54). If generator shows no charge, it must be removed for further attention.

Removing Generator

1. Disconnect wires from generator "switch" and "relay" terminals.
2. Remove the two long screws, through timing gear case cover, that secure end of generator against gear case.
3. Remove nut, lock washer and curved washer from end of strap that clamps generator in its cradle on crankcase.
4. Lift strap high enough to permit raising generator so oil slinger (on end of generator gear) will clear adjacent gear and allow generator to be removed from engine.
5. Be sure to observe and count number of paper shims between generator and cradle. Lay these shims aside to be used again when generator is re-installed. Also, note location of hole in shims for oil drain. These shims were required in original assembly to adjust driving gears for proper mesh and, if left out, gears are still likely to mesh too deeply and howl, even though they have seen considerable service.
6. Unless a new generator gasket is available, to be used when generator is re-installed, be careful about damaging the old one.



ILLUS. 35

TESTING REGULATING FIELD COIL

Testing Field Coils and Brush Holders Without Disassembling Generator

Caution: Overloading ammeter, due to short circuit or otherwise, will damage it. Overload is indicated by needle going beyond range of calibrated scale; direct "short" is indicated by needle swinging violently to extreme limit of its travel. In either case, contact must be broken *instantaneously* to avoid damaging or burning out ammeter. Therefore, in making the following tests with ammeter, first make only a momentary contact to determine if a short exists. If ammeter needle does not go beyond calibrated scale, it is safe to make continuous contact and proceed with test as described.

As an added precaution, in making tests with ammeter, always work on a bench with an insulated top. This will prevent shorting through bench top.

Never touch test points together.

Connect a *fully charged* battery to suitable test ammeter and test points as shown in Illustration 35.

Remove the three brushes from their holders (See "Inspecting or Replacing Generator Brushes," Page 51). Removing main brushes requires removing screws connecting field coil terminal wires to brush holders. These wires must be reconnected before tests can be made.

Testing regulating field coil (see Illustration 35):

1. Touch test point "A" to "relay" terminal of generator and test point "B" to third (regulating) brush holder as shown in Illustration 35. The ammeter should read between 1.4 and 1.9 amperes. If ammeter shows no reading, field coil is open (See that terminal connections are tight and field coil wires are not broken at terminals). If reading is appreciably higher than 1.9 amperes, field coil is shorted internally.

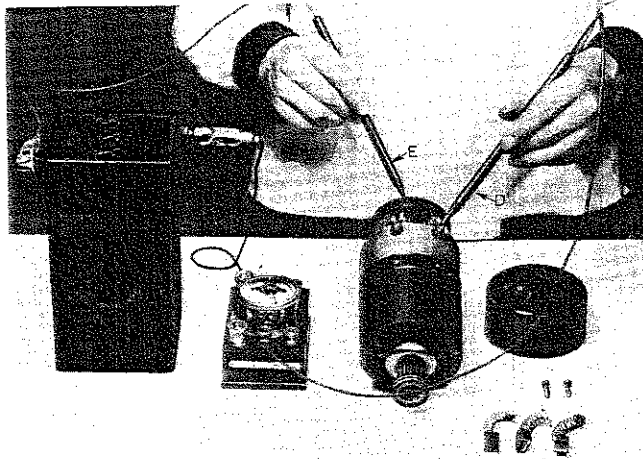
2. With test point "A" still on "relay" terminal, ground other test point by moving it to generator frame, as indicated by dotted lines "C," Illustration

35. Ammeter should show no reading on this test. If ammeter registers a reading, field coil, "relay" terminal, positive brush holder or third brush holder is grounded.

If test shows ground, disconnect field coil wire from third brush holder. If trouble is eliminated, third brush holder is grounded. If ground still exists, disconnect field lead from positive brush holder. If trouble is now eliminated, ground is in field coil. If ground still exists, the positive brush holder or "relay" terminal is grounded.

Testing shunt field coil (See Illustration 36):

Touch test point "D" to "switch" terminal and test point "E" to negative brush holder (this brush holder is grounded) or on generator frame as shown in Illustration 36. Ammeter should read from .6 to 1.0 ampere. If ammeter shows no reading, coil is open (See that terminal connections are tight and field coil wires are not broken at terminals). If reading is appreciably higher than 1.0 ampere, coil is shorted internally or grounded, or "switch" terminal is grounded.



ILLUS. 36
TESTING SHUNT FIELD COIL

Disassembling Generator

(ITEM NUMBERS REFER TO ILLUSTRATION 34)

A. End cover and brushes have already been removed for previous checking and testing.

B. Disconnect field wires from brush holders. Closely observe how field coil wires are arranged to keep them in the clear so they will not be damaged by armature. Two are pulled between generator frame and frame end screws and one is brought over the outside of aluminum frame end. Also, excess slack is avoided by winding wires together, where they cross at brush holders. Note this arrangement and arrange wires in the same manner when reassembling.

C. Remove pin from drive gear; remove gear, spring and oil deflector (Items 1, 2, 3 and 4).

D. Clamp armature shaft in copper-faced vise jaws, with generator in upright position.

E. Take out three end screws and remove outer grease retainer, gasket and third brush holder (Items 50, 51, 52 and 53).

F. Remove armature shaft nut and lock washer (Items 46 and 47); use $\frac{9}{16}$ " socket wrench.

G. Remove bearing housing, gasket, bearing, and

inner grease retainer (Items 40, 41, 42 and 45).

H. Remove steel and fibre washers from armature shaft (Items 18, 19 and 20).

I. Take generator out of vise and remove frame end screws (Items 8 and 12). If gasket is still on end of generator frame, it will have to be removed to uncover the heads of these screws. Before turning screws all the way out, tap them lightly to drive aluminum frame end (Item 21) off frame (Item 10).

J. Remove armature (Item 15) from frame by tapping drive end of shaft lightly with a soft hammer.

K. Drive end bearing can now be removed; also spring ring and felt oil retainer (Items 5, 6 and 7).

L. Do not remove pole shoes and field coils (Items 13, 14, 16 and 17) unless tests previously made proved one or both of the field coils in bad order. They should be removed only for good reason, as difficulty may be experienced in reassembling so they allow specified armature clearance. When a pole shoe and field coil must be removed, clamp generator frame lightly in vise and remove screws with a large screwdriver. These screws are very tight and difficulty will be experienced in removing them unless screwdriver bit is in good shape and seats fully in slot.

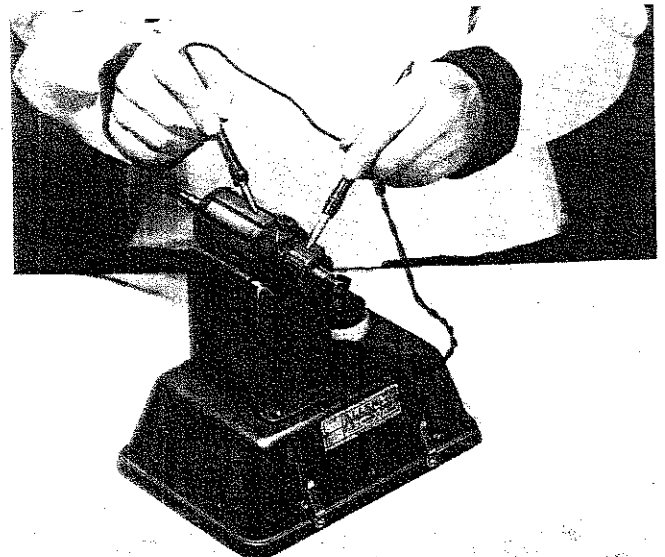
Testing Armature

(REFER TO ILLUSTRATIONS 37, 38 AND 39)

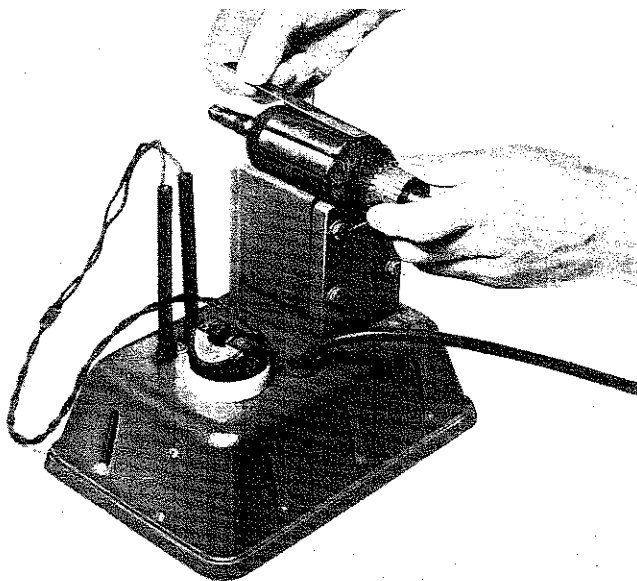
To test for "ground":

If growler with test points is available, test as shown in Illustration 37. If this means of testing is not available, test with battery and ammeter hook-up, same as used for testing field coils (shown in Illustrations 35 and 36). Contact commutator with one test point and armature core with the other. If circuit is completed, armature is grounded.

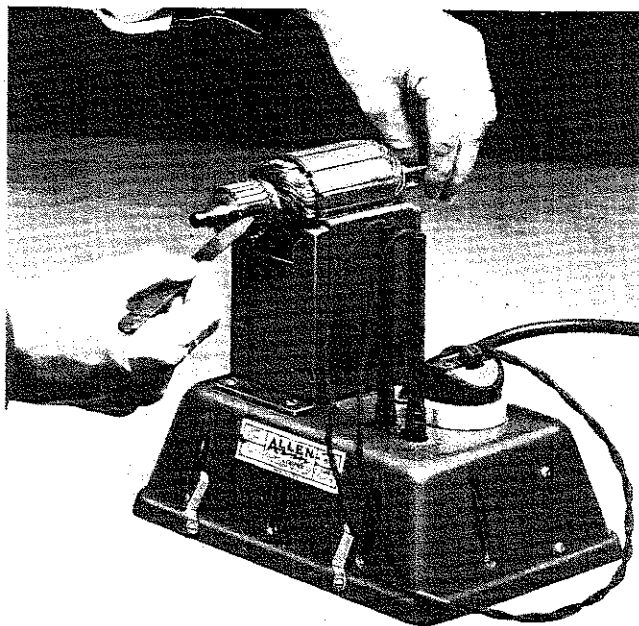
If armature is found to be grounded, make sure commutator is free from carbon and copper dust deposits. After cleaning thoroughly between segments and at ends of commutator and blowing off thoroughly with compressed air, repeat test. If ground still exists, armature must be replaced with a new one.



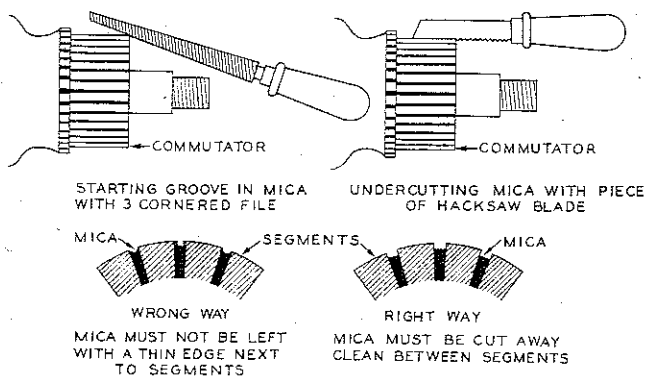
ILLUS. 37
TESTING ARMATURE FOR GROUND



ILLUS. 38
TESTING ARMATURE FOR "SHORT"



ILLUS. 39
TESTING ARMATURE FOR "OPEN"



ILLUS. 40
UNDERCUTTING COMMUTATOR MICA

"Growler" test for "short":

Place armature in "growler" and hold piece of hacksaw blade in loose contact with armature core as shown in Illustration 38. Turn "growler" "ON." Rotate armature slowly one or more full turns. If armature is shorted, hacksaw blade will be attracted to armature core and will vibrate violently at one or more points around armature.

If short is found, thoroughly clean commutator as described under "ground" test and test again. If short still exists, armature must be replaced with a new one.

"Growler" test for "open":

Place armature in "growler" as shown in Illustration 39 and turn "growler" "ON." Insert tip of hacksaw blade between segments that are closest in alignment with the point of contact of armature core and "growler" V. Make and break contact between segments with hacksaw blade.

A strong flash should be seen as contact is broken. No flash or a very weak flash indicates an open circuit.

Repeat this test between all segments, turning armature so that each test is made on the line of contact between armature core and "growler" V. If an open circuit is found, check for loose or broken wires at commutator connections. If none are found that can be repaired, armature must be replaced with a new one.

Turning Down Commutator

If commutator is found worn and irregular, it should be turned down in a lathe and smoothed with 00 sandpaper. When turning, mount armature shaft on its bearing seats; do not mount on shaft centers.

Undercutting Commutator

After commutator has been turned down, the mica insulation between segments must be undercut to a depth of approximately .025". Unless mica is properly undercut, brushes will not seat firmly against commutator segments and generator output will not be normal. Also, there will be excessive arcing at brushes.

Undercutting is usually done with a special undercutting machine. However, if such a machine is not available, it can be done as shown in Illustration 40.

After undercutting is completed, again smooth commutator with 00 sandpaper. It is also advisable to repeat "growler" check for "short" as there is a possibility of developing a "short" during the turning and undercutting operations. If so, it can very likely be corrected by more thorough cleaning between segments and at ends of commutator.

Reassembling Generator

(ITEM NUMBERS REFER TO ILLUSTRATION 34)

1. If one or both field coils have to be reassembled, do this first. Remember that field coils are not alike and must not be interchanged. If one has to be replaced, be sure it is replaced with one of same type (See Illustration 41).

Thoroughly clean generator frame where pole shoe seats and also clean face of pole shoe that seats against frame. Tighten pole shoe screws as tight as possible, with a large screwdriver that fits well into

screw slot. Unless screws are very tight, there will not be the required clearance (.007" or more) between armature and each pole shoe (this clearance is to be checked later when armature is assembled into frame).

2. Proceed with further assembly of generator, reversing order of disassembly as outlined under "Disassembling Generator," Page 49.

3. If felt oil retaining washer (Item 7) is worn, renew it.

4. Thoroughly wash and closely inspect both the drive end and commutator end bearings. If either is found worn to any extent, or pitted and rough, renew it. The commutator end bearing particularly should be replaced if it shows any appreciable wear, as a loose bearing allows commutator to run eccentric and chatter, even though commutator itself is perfectly true. Pack both bearings with General Purpose No. 2 Grease.

5. **Gauging armature pole shoe clearance:**

(This operation is not required unless one or both pole shoes and field coils have been removed and replaced).

Select a sheet of paper .007" thick or use a double sheet totalling this thickness. Cut a piece as wide as length of armature core and long enough to wrap nearly, but not quite, around armature.

Assemble armature in frame with this paper around it, inserting shaft through drive end bearing. If pole shoe clearance is up to the required .007" or more on each side, armature can be inserted and will turn freely. If it binds, pole shoe or shoes removed and replaced must be pulled tighter to frame with pole shoe screws. Possibly parts were not well cleaned and there are particles of dirt between shoe and frame, preventing full seating.

Specified pole shoe clearance is necessary to allow for expansion of armature when hot and for play that normally develops due to bearing wear. Taking a chance on less than specified clearance may result in armature striking pole shoes and damaging both the armature and pole shoes. An armature damaged in this manner is usually grounded and must be renewed.

6. **Installing frame end:** Generator frame end fits over register in frame and is located by a dowel pin in frame and a corresponding hole in frame end. Frame end must be a snug fit on frame register or a new end must be fitted. If frame end is loose on frame, armature-pole shoe clearance is affected and the likely result is a damaged armature. Tighten screws securely.

7. Complete assembly of generator. Be sure drive gear pin is well riveted at both ends to prevent it from coming out in service and causing serious damage to timing gears and other parts. Measure the distance from face of oil slinger on generator drive gear to end of generator frame (gasket removed). This distance should be $1\frac{5}{8}$ " to $1\frac{7}{8}$ ". Adjust if necessary by removing or adding an armature spacer (Item 18, Illustration 34).

Connect field coil wires according to Illustration 41 and paragraph "B" under "Disassembling Generator," Page 49.

Test generator on test stand if this equipment is available. If not, install on engine and test. Generator output can be adjusted by moving third brush (See "Generator Charging Rate").

Reassembling Generator to Engine

Reverse the operations followed in "Removing Generator," Page 48; also refer to "Installing Generator," Page 37.

Make sure same number of paper shims are used in reassembling as were found underneath generator when it was removed. After an engine has seen considerable service and gears have worn to some extent, they have possibly developed enough lash or play to permit safely removing one or more of the original shims and thus effecting closer meshing and quieter operation. However, this should not be done unless timing gear case cover is removed so gear mesh and lash can be carefully checked.

Make sure all external wire connections are correct and tight.

Generator Charging Rate

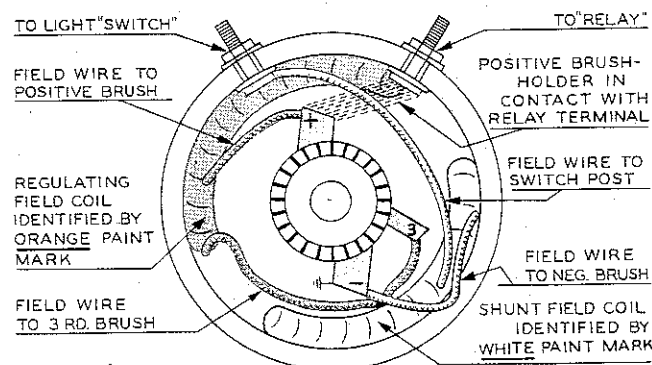
A maximum charging rate of about 4 amperes (with regular equipment lamps lighted) is the standard factory setting. This should be sufficient to keep battery in a good state of charge under normal service conditions. At average driving speeds, the charging rate is about the same with lights either "ON" or "OFF", because, when lighting switch is turned "ON", generator output is automatically boosted enough to take care of the standard lighting equipment. The charging rate can be readjusted higher or lower as desired to meet unusual service conditions, but bear in mind that a higher than normal charging rate is likely to overcharge, overheat, and damage battery.

When it is found necessary to readjust charging rate, proceed as follows: Remove generator end cover, and loosen screws that hold the regulating brush (small brush) plate assembly to generator frame end. Then, shift regulating brush to the right, to increase charging rate—to the left, to decrease charging rate. Shift brush only a little at a time, until desired maximum charging rate is obtained.

Inspecting or Replacing Generator Brushes

Remove the two screws in generator end cover and pull off cover, exposing the commutator and brushes. Brushes can be taken out after unfastening spring retainers. To unfasten small brush spring retainer, simply press it downward and outward. Remove fastening screw from each of large brush spring retainers.

Brushes are worn out and should be renewed when longest side of brush measures $\frac{3}{8}$ " or less.



ILLUS. 41
SCHEMATIC DIAGRAM, SHOWING GENERATOR INTERNAL WIRING CONNECTIONS AND LOCATION OF FIELD COILS AND BRUSHES IN RELATION TO EXTERNAL TERMINALS

Be sure to insert brushes into holders so that concave face of brush fits curve of commutator.

Lubricating Commutator End Armature Bearing

(ITEM NUMBERS REFER TO ILLUSTRATION 34)

To lubricate this bearing (Item 42) it is necessary to first remove end cover (Item 54). Then bearing can be oiled through hole in outer grease retainer (Item 52) or outer grease retainer can be shifted to expose bearing and permit greasing as follows:

Take out two of the three outer grease retainer screws (Item 53) and loosen the third screw *slightly* to permit shifting outer grease retainer to one side. Pack bearing with General Purpose No. 2 Grease. After greasing, replace outer grease retainer. *Caution:* If outer grease retainer is completely removed or two of the screws are removed and the third screw is made very loose, regulating brush (Item 50) is free to move and thus change charging rate. Therefore, before re-tightening outer grease retainer screws, be sure that regulating brush has remained in its original position.

If not convenient to grease bearing at specified interval, at least lubricate with a few drops of engine oil. Be careful that this bearing is not over-lubricated, as excess oil will very likely work out of bearing and some may get onto commutator and brushes.

Generator drive gear end bearing requires no attention as it is lubricated by the oil that circulates through engine.

Cut-out Relay

If relay fails to function normally, it should be referred to a qualified electrical service man or replaced with a new one. Checking and adjusting this unit requires not only a thorough knowledge of its functioning principles but also closely-calibrated instruments.

Specifications:

Armature-Core Air Gap (points closed)..... .015"
Point Gap020"
Closing Voltage 6.3 to 6.8 Volts

Cut-out relay must be grounded; therefore, mounting screws must be tight.

Care of Storage Battery

It is the care given a battery, rather than time and miles in service, that has most to do with determining its life. Don't neglect it.

1. Inspect battery every week. Add pure distilled water as often as necessary to keep solution above the plates. (See "Adding Water to Battery").

2. Remove battery and have it given a charge from an outside source, when the hydrometer shows that this attention is needed. Allowing battery to remain in a discharged condition for any length of time shortens its life.

It is especially important that battery be kept well charged in below freezing weather as a low or discharged battery is very likely to be frozen and ruined.

3. Keep battery clean, and terminal connections tight. Oil the terminal felt washers frequently and replace immediately if deteriorated or lost.

Battery Constant Charge Rate 2 Amperes

When charging a battery from an outside source, the charging rate is constant and should not be allowed to go over 2 amperes. A higher rate will

heat and damage the battery. **CAUTION**—Therefore, don't allow battery to be charged in the same line with automobile batteries, at a high charge rate.

Adding Water to Battery

Motorcycle should be standing straight up, not leaning on jiffy stand, when adding water to battery.

Turn off wing nuts, and remove battery cover and rubber mat. Take out the three screw-in filler plugs, and with a hydrometer or syringe add enough water to each cell to raise the level of the solution about $\frac{5}{16}$ " above the plates and separators.

CAUTION: If battery is filled to a higher level, some of the solution will be forced out through vent holes when battery is charging. This not only weakens battery solution but also damages parts near battery.

Ignition Coil

When hard starting or missing indicates some fault in the ignition system, the first thing to do is check condition of battery. Coil will not function normally with battery in a nearly discharged condition. If it is found that lamps light with full brilliancy and horn blows, indicating that battery is in at least fair condition, try new spark plugs. If new plugs do not correct performance, inspect circuit breaker points and install new condenser. If the fault still exists, try a new coil without removing old coil. Simply attach new coil temporarily at any convenient point near old coil (coil will function without being securely grounded), transfer terminal wires to new coil, and after detaching old coil plug cables from spark plugs, attach new coil cables.

If new coil corrects performance, proving that the fault is in the old coil, inspect plug cables for cracked or damaged insulation, particularly at sealing nuts where cables enter coil. The insulation on cables sometimes becomes cracked or otherwise damaged, allowing high tension current to short to metal parts with which cables come in contact. Trouble due to this condition is most noticeable when operating in wet weather or just after motorcycle has been washed.

Replacing plug cables is the only repair that can be made to an ignition coil. If faulty performance is not corrected by installing new cables, coil is beyond repair and must be replaced with a new one.

When inspection indicates that coil trouble is very likely due to faulty condition of plug cables, they can be replaced as follows: Warm coil *slightly* to soften sealing compound so old cables can be pulled out easily, and without breakage. The usual way to warm a coil is to flow current through it by either turning "ON" ignition switch, or connecting a battery to coil terminals. This generates heat in coil winding. Have new cables ready to be inserted immediately when old cables are pulled out. New cable ends that insert into coil should be trimmed and rounded so they will follow through the holes left in sealing compound by old cable without catching and jamming. After coil is warm (not hot) turn off cable seal nuts and pull out cables one at a time. As each cable is pulled out, quickly transfer nut, steel washer and rubber packing washer to new cable. Insert a piece of stiff wire into coil and measure the distance from coil end to cable seat. Mark new cable accordingly. Dip end of cable in very light oil or gasoline and push into coil. Be sure it is pushed all the way into

its seat as per mark made on cable. After cables are inserted, turn seal nuts down against rubber packing washers to secure cables and to prevent water from getting inside coil.

When replacing plug cables do not heat coil to a higher degree than *just warm* as doing so will soften sealing compound to the extent that cable holes through compound will close up as the old cables are pulled out, blocking the insertion of new cables. In this case it is necessary to allow coil to cool and then form new cable holes by means of a piece of tubing with saw teeth filed in one end. Tubing should be of slightly larger diameter than cable. Holes through compound must be open so cables can be inserted all the way to their seats, where they contact high tension winding terminals; otherwise there is a gap in the high tension circuit and coil will not function.

Servicing Ignition-Light Switch

See "Wiring Details," Page 54 for information on switch operating positions.

1. After removing instrument panel cover, disconnecting wires and removing switch from panel, a faulty switch can be disassembled for inspection and repair as follows:

2. (All switch part positions mentioned below apply with switch *up-side-down* and with *lock-out button* away from you. Switch must be in "OFF" position and unlocked).

3. Remove cotter pin, plain washer, coil spring and spring support plate from end of center pin. (Note: Spring support plate will be found only on earlier switch with bakelite movable contact plate; later switch, with all-metal movable contact plate, as shown in Illustration 42, does not require this plate.)

Movable contact plate is now free to come off of center pin. Note that two contact buttons on this plate are toward *right* side of switch.

4. Grasp end of center pin with pliers and pull and move sideways to release contact bar from retaining notch in center pin. If switch has bakelite movable contact plate, note that end of contact bar with small extension is on left side of switch.

5. After contact bar has been released and removed, stationary contact plate with seven terminals attached can be removed. Note that side with four terminals is toward lockout button.

6. Contact bar holder assembly with spring and center pin can now be removed from switch housing by sliding either one of its fibre plate extensions out of retaining slot in switch housing and then sliding opposite extension out of other slot. Note that plain washer is assembled between head of center pin and end of spring.

7. Switch frame and lock plate can now be removed from switch housing. Note that narrow end of elongated hole in lock plate, and also lug on lock tumbler assembly which fits into hole in lock plate, are toward lockout button.

8. Lock assembly can now be lifted out of switch housing. Avoid separating lock tumbler assembly from its housing.

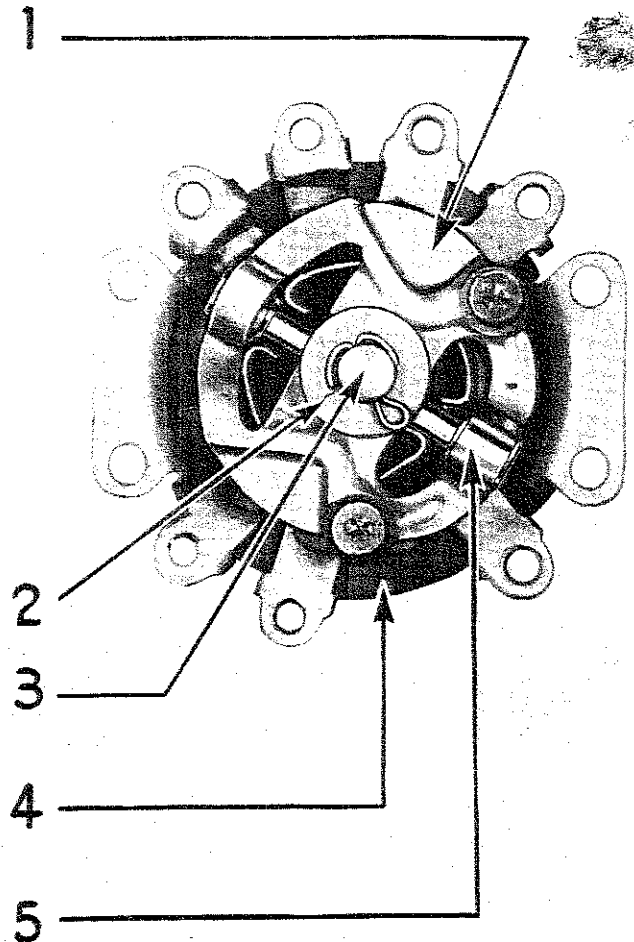
9. Inspect switch parts, particularly contact bar and contact plates, for excessive wear of contact bar and contact buttons or otherwise faulty condition. Contact bar and contact buttons may be found worn to the point where they no longer make positive con-

tact. Extreme wear of these parts may allow head of center pin to "short" against switch lock plate. Loosened terminals on stationary contact plate may also develop a "short."

10. Obtain new parts for any found worn or damaged. In servicing early type switch originally fitted with bakelite movable contact plate, it is recommended that bakelite plate be replaced with improved all-metal contact plate. In this case, original contact plate, spring support plate, contact bar, coil spring and plain washer should be discarded and replaced with corresponding new type parts. These are included in replacement part set number 4539-41M.

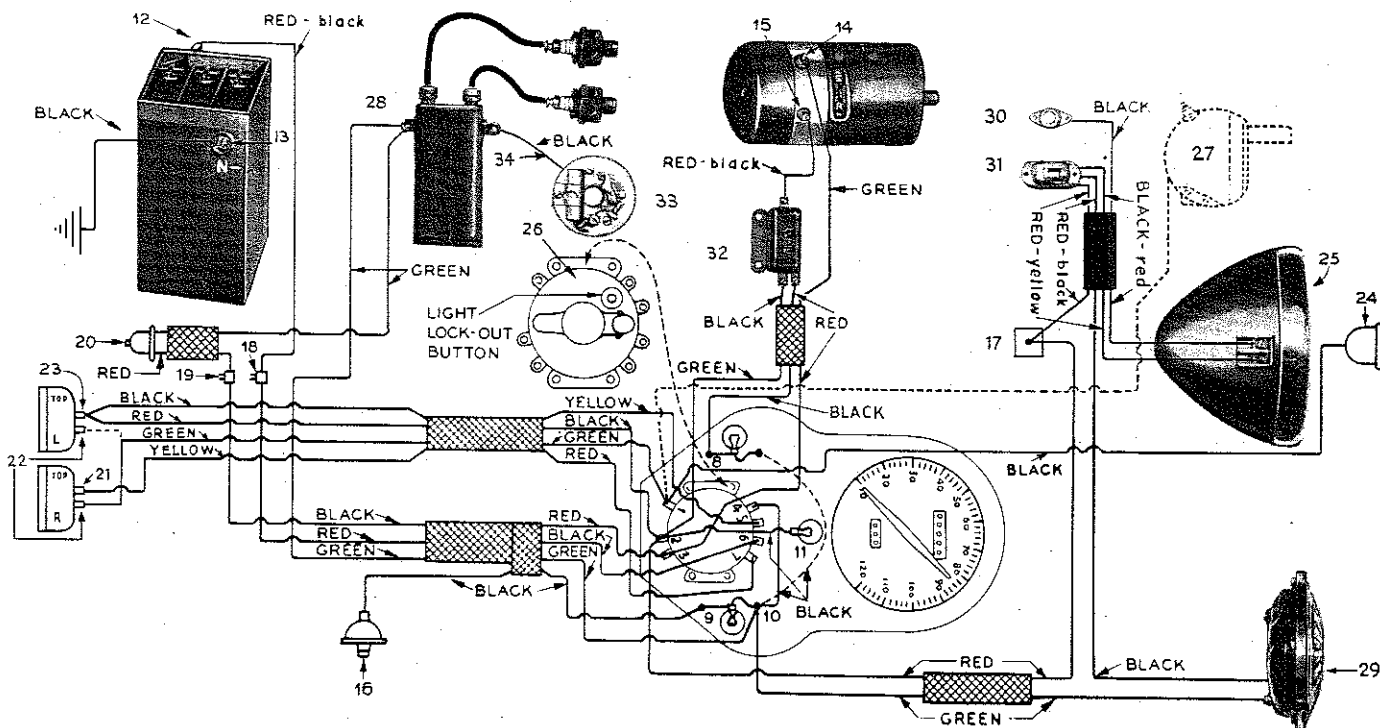
Scrape off any rust that may be found on head of center pin, apply a light coat of oil or grease to head of pin and lock plate, contact bar and contact buttons and proceed with reassembly, reversing order of disassembly.

11. Bear in mind that if lock tumbler assembly has been taken out of its housing, it must be reinstalled in correct position in relation to housing. Otherwise, it will be found, after switch is completely reassembled, that switch cannot be locked. To reassemble correctly, insert lock tumbler assembly into its housing with tumblers in any one of the four registers. While pressing tumbler assembly into its housing with finger tip, insert key and turn as *far to right* as possible. Remove key.



ILLUS. 42
BOTTOM VIEW OF IGNITION-LIGHT SWITCH

- | | |
|---------------------------|------------------------------|
| 1. Movable contact plate. | 3. Center pin. |
| 2. Plain washer. | 4. Stationary contact plate. |
| 5. Contact bar. | |



ILLUS. 43

WIRING DIAGRAM FOR WLA MODEL MOTORCYCLES WITH U. S. A. REGISTRATION NUMBERS BELOW 618,025. NOTE THAT THIS WIRING HARNESS HAS TWO-WIRE CABLE FROM SWITCH TO SERVICE HEADLAMP AND HORN. DOTTED LINE INDICATES WIRING FOR BLACKOUT HEADLAMP.

Wiring Details

1. SWITCH TERMINAL (Three wires connected)—Black wire from blackout marker lamp 24; tail lamp cable green wire from blackout tail lamp 22; single wire direct from blackout headlamp as shown by dotted line in Illustration 43, or horn and headlamp cable black wire from junction terminal 35 as shown in Illustration 44.
2. SWITCH TERMINAL (Four wires connected)—Generator and relay cable green wire from "switch" terminal (14) of generator; tail lamp cable black wire from service stop and tail lamp (23); horn and headlamp cable red wire from junction terminal 17; black wire from speedometer lamp (11).
3. SWITCH TERMINAL (Two wires connected)—Generator and relay cable red wire from terminal marked "BAT" on relay; coil and battery cable red wire from junction terminal 18.
4. SWITCH TERMINAL (One wire connected)—Black wire from oil signal lamp terminal (10).
5. SWITCH TERMINAL (One wire connected)—Tail lamp cable yellow wire from blackout stop lamp (21).
6. SWITCH TERMINAL (One wire connected)—Battery and coil cable black wire from junction terminal 19.
7. SWITCH TERMINAL (One wire connected)—Tail lamp cable red wire from service stop and tail lamp (23).
8. GENERATOR SIGNAL LAMP TERMINAL (One wire connected)—Generator and relay cable black wire from relay right front terminal.
9. OIL PRESSURE SIGNAL LAMP TERMINAL (One wire connected)—Black wire from oil pressure switch (16).
10. SIGNAL LAMP TERMINAL (Four wires connected)—Black wire (under switch panel) from generator signal lamp terminal (8); black wire from switch terminal (4); battery and coil cable green wire from coil front terminal; horn and headlamp cable green wire from horn.
11. SPEEDOMETER LAMP—Black wire from switch terminal 2.
12. BATTERY POSITIVE TERMINAL (LEFT SIDE)—Red wire with black tracer from junction terminal 18.
13. BATTERY NEGATIVE TERMINAL (RIGHT SIDE)—Black wire from ground clamp on frame.
14. "SWITCH" TERMINAL OF GENERATOR—Generator and relay cable green wire from switch terminal 2.
15. "RELAY" TERMINAL OF GENERATOR—Red wire with black tracer from relay rear terminal.
16. OIL PRESSURE SIGNAL SWITCH—Black wire from signal lamp terminal 9.
17. JUNCTION TERMINAL (BAKELITE TERMINAL PLATE ON HORN MOUNTING)—Horn and headlamp cable red wire from switch terminal 2; red wire with black tracer from handlebar toggle switch (31).
18. FRONT JUNCTION TERMINAL (in motorcycle frame, under saddle)—Coil and battery cable red wire from switch terminal 3; red wire with black tracer from battery positive terminal (12).
19. REAR JUNCTION TERMINAL (in motorcycle frame, under saddle)—Coil and battery cable black wire from switch terminal 6; red wire from stop lamp switch (20).
20. STOP LAMP SWITCH—Red wire from junction terminal 19; green wire from coil front terminal.
21. BLACKOUT STOP LAMP (Top socket in right tail lamp)—Tail lamp cable yellow wire from switch terminal 5.
22. BLACKOUT TAIL LAMPS—Tail lamp cable green wire from switch terminal 1. (As new motorcycle is assembled by manufacturer, plug is in bottom

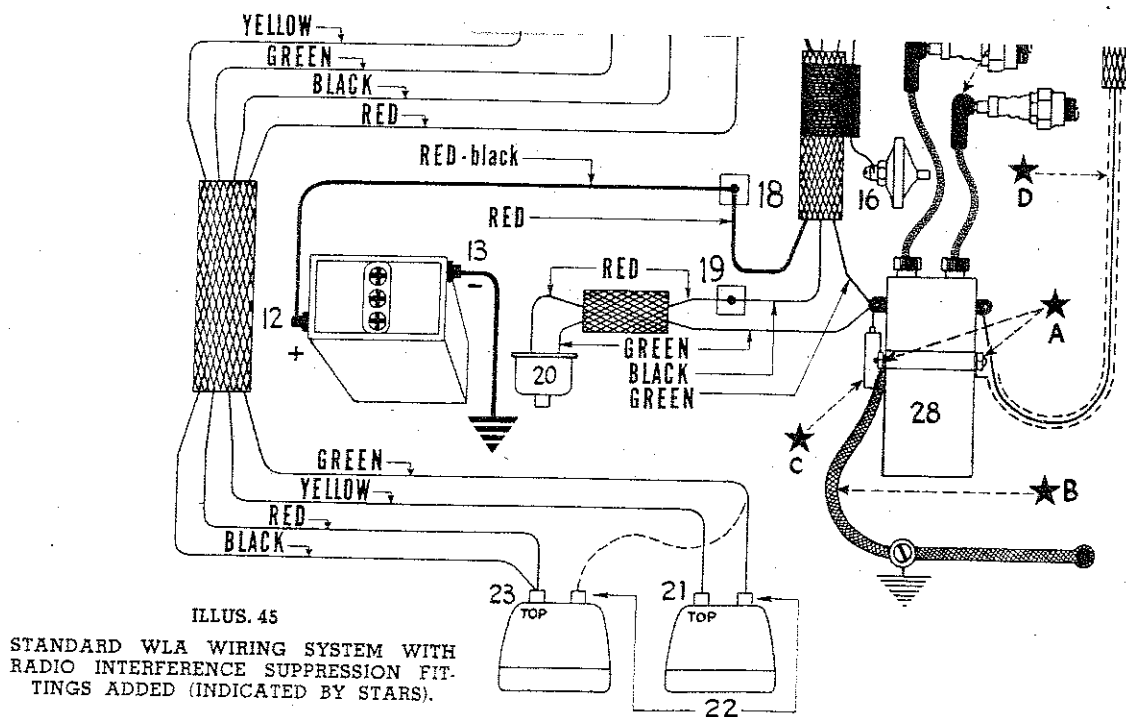
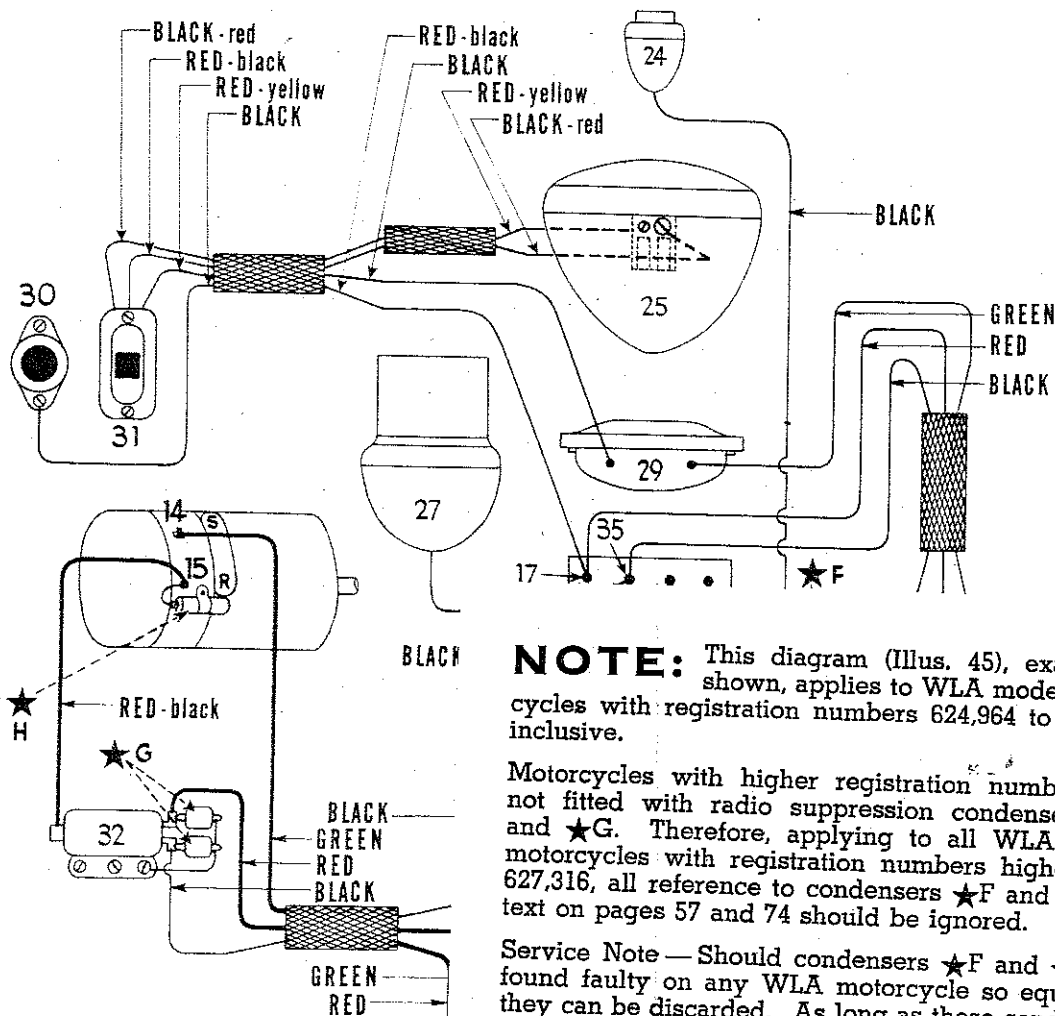
31. **HANDLEBAR TOGGLE SWITCH**—Black wire with red tracer from service headlamp terminal with large terminal screw; red wire with yellow tracer to service headlamp terminal with small terminal screw; red wire

32. CUT-OUT RELAY—*Red* wire with *black* tracer from "relay" terminal of generator to relay rear terminal; generator and relay cable *red* wire from switch terminal 3 to relay terminal marked "BAT"; generator and relay cable *black* wire from terminal 8, to relay right front terminal.
33. IGNITION CIRCUIT BREAKER AND TIMER—Low tension wire (34) from coil rear terminal.
34. CIRCUIT BREAKER-TO-COIL LOW TENSION WIRE—See Description 33.
35. JUNCTION TERMINAL ON BAKELITE TERMINAL PLATE (Illustration 44 only)—Horn and headlamp cable *black* wire from switch terminal 1; wire from blackout headlamp (27).



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Radio Interference Suppression System

Radio interference suppression can be applied to the electrical system of any WLA motorcycle by the addition of suppression-devices indicated by stars in Illustration 45 and described below.

All WLA model motorcycles originally equipped with radio interference suppression-devices, or to which suppression-devices have been added, can be identified by a large letter S stenciled on left and right sides of instrument panel cover.

***A—GROUND TERMINALS ON COIL HOUSING** (Harley-Davidson part number 1730-42M)—Terminal posts are attached to metal strip which is soldered to coil housing. Terminals are grounded through flexible braid conductor (*B).

***B—FLEXIBLE BRAID CONDUCTOR** (Harley-Davidson part number 1743-42M)—Connected to front ground terminal (*A) on coil housing and grounded to saddle post frame tube at clutch control mounting bracket and to crankcase at rear, upper crankcase bolt.

***C—CONDENSER** (Harley-Davidson part number 1629-30)—Mounting bracket grounded to front ground terminal (*A) on coil housing. End terminal connected to coil low tension wire front terminal by short metal strip.

***D—SHIELDED CIRCUIT BREAKER-TO-COIL LOW TENSION WIRE** (Harley-Davidson part number 1613-42M)—Upper end of shielding grounded to rear ground terminal on coil housing. Lower end of shielding grounded to one of circuit breaker base mounting screws.

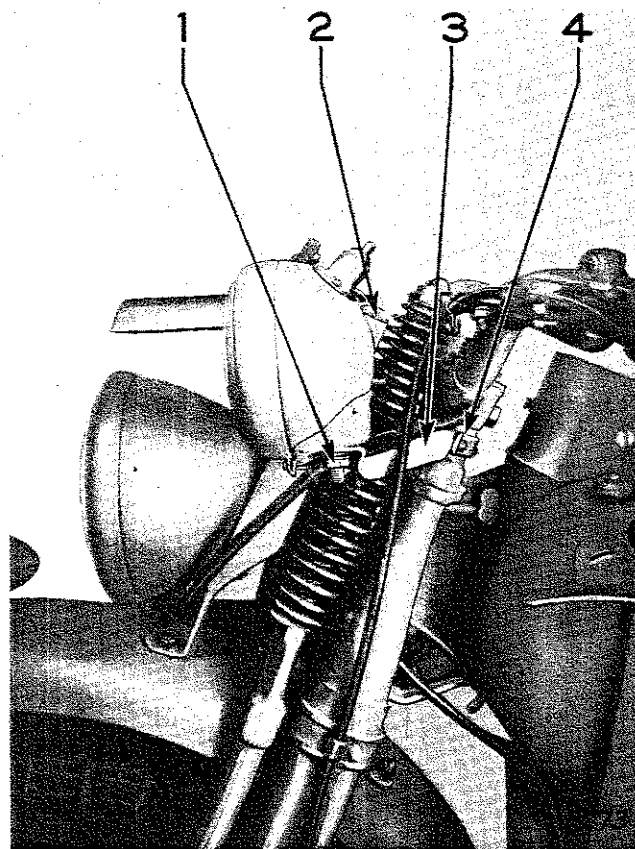
***E—SPARK PLUG SUPPRESSORS** (Harley-Davidson part number 1600-42M)—Attached to ends of spark coil high tension leads and secured to spark plug terminals by snap connections.

***F—CONDENSER** (Harley-Davidson part number 4788-42M)—One terminal of condenser connected to signal lamp terminal 10. Other terminal grounded to switch panel base (Pinched under speedometer bracket).

***G—CONDENSERS** (Harley-Davidson part number 4788-42M)—One condenser connected to each relay front terminal. Both condensers grounded to relay base through condenser mounting bracket.

***H—CONDENSER** (Harley-Davidson part number 1629-30)—Mounting bracket grounded to generator frame end. End terminal connected to "RELAY" terminal of generator by short wire.

If suppression-equipped WLA motorcycle causes radio interference, check electrical system as described under "Servicing Radio Interference Suppression System," Page 74.



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Blackout Headlamp Installation

1. MOUNTING STUD NUT (Curved washer and lock washer mounted between bracket and stud nut).
2. BAKELITE TERMINAL PLATE—Applying to WLA model motorcycles with U.S.A. registration numbers 618,025 and higher, connect lamp wire to second terminal from left. See Detail 35, Illustration 44.
- Applying to WLA model motorcycles with U.S.A. registration numbers below 618,025, connect lamp wires directly to ignition-light switch terminal 1. See Detail 27, Illustration 43.
3. MOUNTING BRACKET—Before installing blackout headlamp on motorcycle, clean paint from left upper fork end, just below handlebar, to insure a good ground connection for mounting bracket.
4. MOUNTING BRACKET FORK SIDE CLAMP.

Horn

Horn operating (ground) button is on left handlebar. Tone adjusting screw is in back side of horn.

If a horn fails to operate and moving adjusting screw does not remedy the trouble, it will probably be necessary to disassemble horn and clean contact points. When reassembling, tighten all bolts securely and then readjust tone by means of adjusting screw. Do not change position of adjusting screw in diaphragm.

Adjusting Service Headlamp

To get the greatest efficiency from headlamp and to meet the requirements of law, adjust as follows: Adjustment should be made in a darkened room or at night. Have motorcycle standing on a level surface about 25 feet away from, and headed toward a wall or screen upon which a horizontal line has been drawn at exactly the same height as lamp center. Motorcycle must be resting on both wheels and front wheel must be in straight-ahead alignment.

Turn light switch "ON," set handlebar thumb switch in "bright" position, and check light beam for height and direction. The top of main beam of light should register on wall or screen even with, but no higher than the horizontal line mentioned. After loosening the clamp nut underneath lamp bracket, lamp can be tilted up or down to properly aim it in relation to horizontal line, and at the same time can be turned right or left to direct beam of light straight ahead.

Lamp Bulbs

	Contact	C.P.	Mazda Number	Harley-Davidson Part Number
1940 and later				
Service headlamp—Pre-focused	D.C.	32-21	2320L	4925-35
Blackout marker lamp	S.C.	3	63	4927-15
Speedometer lamp	S.C.	3	63	4927-15
Generator signal lamp	S.C.	3	63	4927-15
Oil pressure signal lamp	S.C.	3	63	4927-15
1941—				
Service stop and tail lamp	D.C.	21-3	1158	5058-34
Blackout stop lamp	S.C.	3	63	4927-15
Blackout tail lamp	S.C.	3	63	4927-15
1942 and later (bulb units)			Guide Number	
Service stop and tail lamp	D.C.	21-3	5933104	5077-42MB
Blackout stop lamp	S.C.	3	5933121	5077-42MA
Blackout tail lamp (2)	S.C.	3	5933078	5077-42M
Blackout headlamp			5934473	4909-42

CARBURETOR SERVICE

The following Model "M" Linkert carburetors are used on Military motorcycles: M-64, M-65, M-84, M-88, M-90, M-97 and M-641. Model numbers are stamped on top of carburetor.

M-64 and M-65 models have external or outside nozzle and bowl vents; air bleed to nozzle and bowl are from external holes drilled in body casting. These two models are exactly alike except that one has a different size fixed high speed jet than the other. (See "Carburetor Specifications," Page 61). These two models are used with a standard (not oil bath) air cleaner.

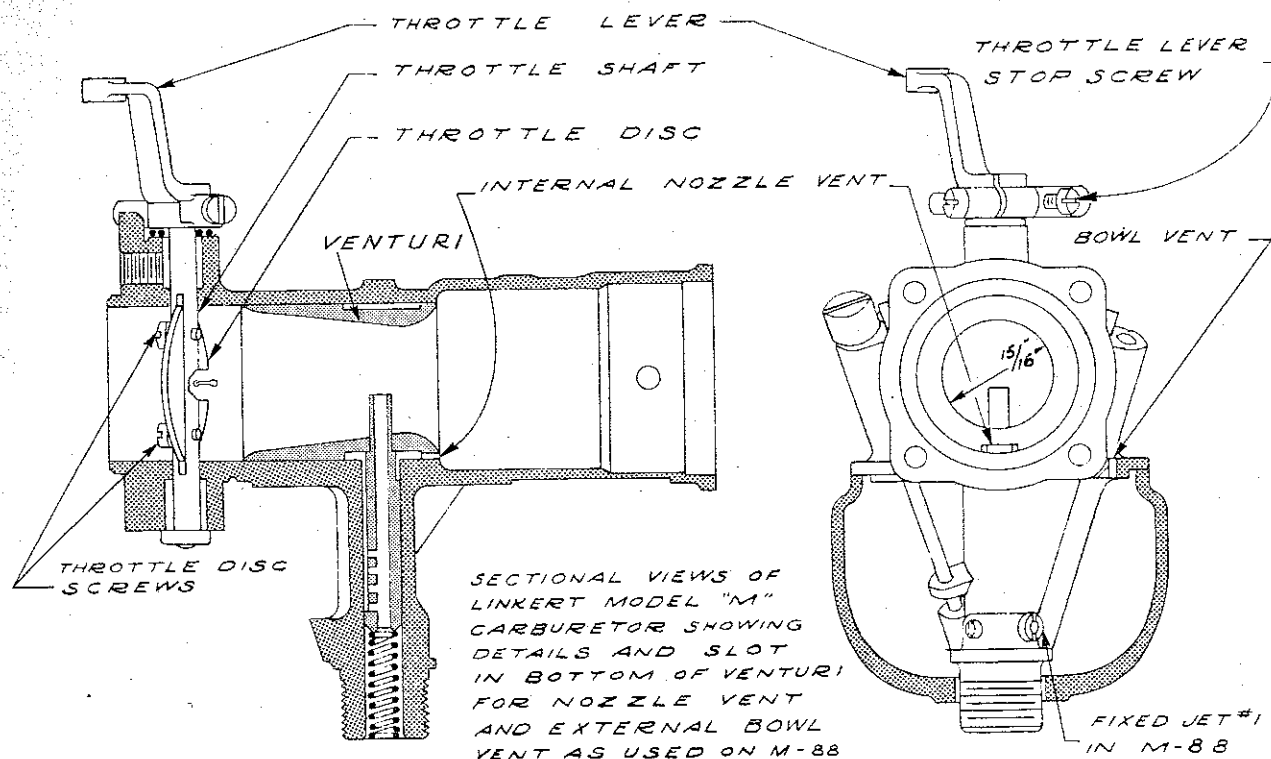
M-84 model has internal vent in the form of a tube extending back of venturi and pointing into air stream. This vent supplies the air bleed to nozzle. Bowl is vented through hole drilled in body and opening externally. This model is used with oil bath air cleaner and is equipped with fixed high speed jet (See "Carburetor Specifications," Page 61).

M-88 model has internal vent to nozzle in the form of a slot cut in lower side of venturi on air intake end. Bowl vent is external and same as in M-64, M-65 and M-84. This model is equipped with fixed high speed jet (See "Carburetor Specifications," Page 61)

and is used with oil bath air cleaner.

M-90 model has internal vent to nozzle in the form of a slot cut in lower side of venturi on air intake end. Bowl vent is external and same as in M-64, M-65, M-84 and M-88. This model is equipped with fixed high speed jet (See "Carburetor Specifications," Page 61) and is used with oil bath air cleaner. Bowl on M-90 model is different than on M-64, M-65, M-84 and M-88 in that this bowl uses a special gasket between upper edge of bowl and lower face of body. This gasket must always be located in its proper place to seal bowl to the body. Use a new gasket if old one is the least damaged or defective. If gasket is not properly located, gasoline leakage at bowl will result.

M-97 model has internal vent in the form of a tube extending into air stream and back of venturi. This vent supplies both the air bleed for the nozzle and the vent for the bowl. There are no external vents on this model. Special bowl gasket between the upper edge of bowl and lower face of the body must always be properly located and in place to seal bowl to the body. Use a new gasket if the old one is the least damaged or defective. If this gasket is not



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correctly assembled, leakage of air will take place at bowl edge and will cause internal nozzle and bowl vent to be inoperative. This model is used with oil bath air cleaner and is equipped with fixed high speed jet (See "Carburetor Specifications," Page 61). Use M-90 model when replacement carburetor is needed.

M-641 model has the same arrangement of vents as M-88 and is used with an oil bath air cleaner. M-641 carburetor is not equipped with a fixed high speed jet. It has a standard high speed needle adjustment (adjusting needle near air intake end of carburetor and to left, looking at air intake end). This adjustment should be set to $1\frac{1}{4}$ turns open for initial adjustment and then set in operation to best setting for power, being sure not to adjust it too lean, thus causing excessive engine heating.

M-64, M-65, M-84, M-88, M-90, and M-97 carburetors with fixed high speed jet are equipped with a special short needle valve to shut off the opening provided for variable high speed adjusting needle which is standard instead of fixed jet for all commercial motorcycle carburetors and also applies to M-641 Army carburetor. A locking plug screwed in above it locks it in place. This needle valve and its locking plug are located in same place as just described for high speed adjustment in M-641 model. This needle valve in M-64, M-65, M-84, M-88, M-90 and M-97 carburetors must always be fully seated or screwed down to a tight seat and the locking plug must be screwed down firmly to hold this needle valve in place. All high speed fuel in these models is delivered through high speed fixed jet and there is no other adjustment for the high speed mixture.

All models have exactly the same bowl, both in casting shape and in the complete float mechanism, except the M-90 and M-97 which both use the same

special bowl. However, this special bowl contains the same parts as for all of the other carburetors.

Effect of Crust Formation

These notes apply to carburetors which have been in service for some time and have become dirty, full of "crust" in the throttle barrel, and are found to be difficult to get adjusted properly. Usually the effect of excessive dirt or "crust" formation in the carburetor throttle barrel, around the throttle disc and in the fuel mixture passageways, is to cause the carburetor to have a lean spot off idle. This "crust" should be removed, particularly when a lean spot comes in at speeds off idle up to 30 M.P.H. with the low speed (idle) adjustment set properly for idling. Idle adjustment should not be set to the very lean side when checking this point, but to a point about five to ten notches rich from the setting where the engine dies from leanness.

How to Remove Crust

1. Back off throttle lever stop screw so throttle disc closes tightly. With a sharp pointed tool like a sharp pen knife or scribe, scratch a line deeply on closed throttle disc and also on throttle barrel so lines on disc and on barrel meet. These lines should "jibe up" again when disc is replaced. Remove throttle lever, throttle disc and shaft, idle hole body plug next to idle holes in throttle barrel, body plugs in carburetor flange and carburetor body idle channels, and low speed (idle) lift lever and needle valve assembly. Also remove venturi and nozzle.

2. Scrape out caking or "crust" in throttle barrel with a scraper or knife, being sure not to cut into the metal.

3. Clean up throttle disc by rubbing both sides on emery cloth on a flat plate and clean edge of the disc all around, being careful not to round the corners or cut into the metal.

4. Clean out idle holes in throttle barrel next to the disc with proper size drills of clean-up tool set described on Page 61. Proper sizes for both holes are listed in "Carburetor Specifications," Page 61.

5. Clean out the slot of all models by inserting tool with .009" blade through slot between the two idle holes.

6. Clean out idle channels with #42 drill. When cleaning vertical idle channel do not completely bottom drill as doing so may damage low speed needle seat.

7. Clean out low speed (idle) needle valve seat hole with correct size drill. The M-64, M-65, M-84, M-88, M-90, and M-97 carburetors are cleaned with #53L drill. The M-641 is cleaned with #53L#2 drill which has a smaller handle. (This tool has two rings around its handle).

8. Blow out all channels and holes with compressed air and wash all parts in gasoline.

9. Reassemble parts, being sure lift lever spring seat (washer) is between the spring and carburetor body when assembling the low speed lift lever and needle valve assembly back into place. This spring seat or washer limits the air bleed to the idle system and must be in place; otherwise carburetor cannot be adjusted for satisfactory engine idling.

Be sure throttle disc is properly assembled in barrel and closes off tight. Have correct side of disc up or toward flange and with the lines previously scratched lining up with each other exactly. Push up shaft collar (on throttle shaft) firmly against body before tightening throttle disc screws. Throttle lever should be clamped to shaft with disc wide open, with throttle lever "wide-open" stop against body lug and with wear take-up spring between throttle lever and bearing.

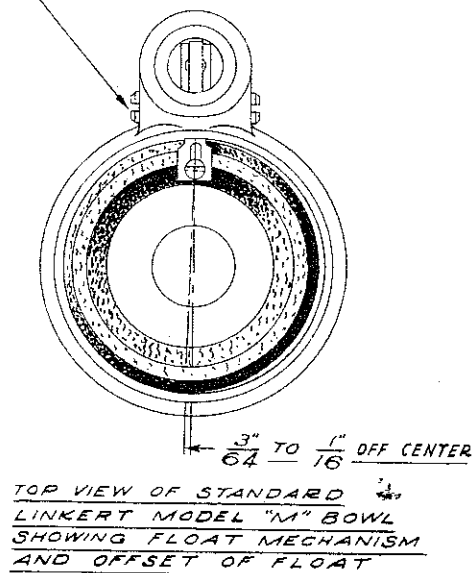
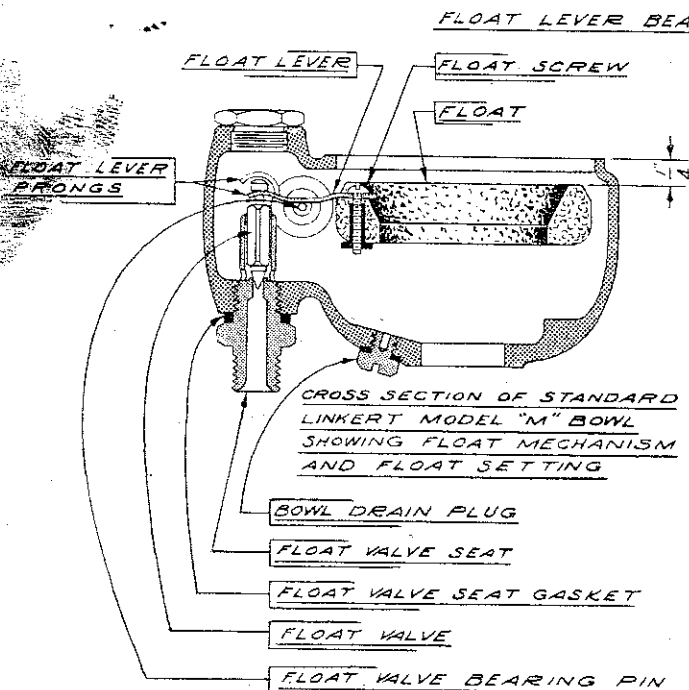
Attention to Carburetor Bowl

10. If carburetor bowl continually leaks or runs over, remove it from carburetor body and first remove all dirt by cleaning it out with gasoline and compressed air. Hold bowl up-side-down so that float valve closes and suck on bottom of float valve seat. Valve and seat should hold this suction. If valve and seat leak after repeated testing, replace with new float valve and float valve seat.

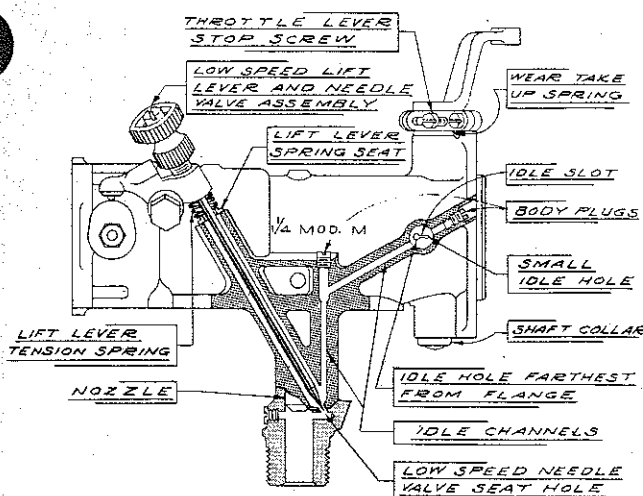
11. If float is damaged or "logged" replace with a new one. Remove old float by cutting seal around float screw which fastens float to float lever. This seal can be cut with a pocket knife. Remove float screw and assemble new float to lever. This should be done with float valve, float valve lever, float hinge pin and screws, float valve seat and gasket assembled in bowl. Before tightening float screw securely, adjust as follows: Looking down on bowl with gasoline inlet side away from you, pull float toward you to the limit of slot in float lever and about $\frac{1}{16}$ " to left of center line. This provides necessary body clearance. Tighten float screw and cement top of float screw to float with Dupont Household Cement, with a mixture of celluloid dissolved in acetone, or with thick shellac. When cement has dried thoroughly, check float height and adjust as explained in 12.

12. Check float level and, if necessary, reset to $\frac{1}{4}$ ". Measure directly opposite float lever with bowl held up-side-down (top of float to top of bowl). When readjusting carburetor float, do not attempt to do so by simply bending float lever upward in some manner, without disassembling from bowl. Readjusting in this manner bends and spreads fingers between which head of float needle fits, and thus develops lost motion between float and needle. Float and lever assembly should be removed from bowl, and lever then bent as required.

Before reassembling, see that needle head is a good free fit between lever fingers with not more than approximately .003" play. This clearance can



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VIEW OF LINKERT MODEL "M" CARBURETOR SHOWING LOW SPEED NEEDLE VALVE, LIFT LEVER SPRING SEAT, LOW SPEED NEEDLE VALVE SEAT HOLE, IDLE HOLES AND SLOT, BODY PLUGS AND IDLE CHANNELS

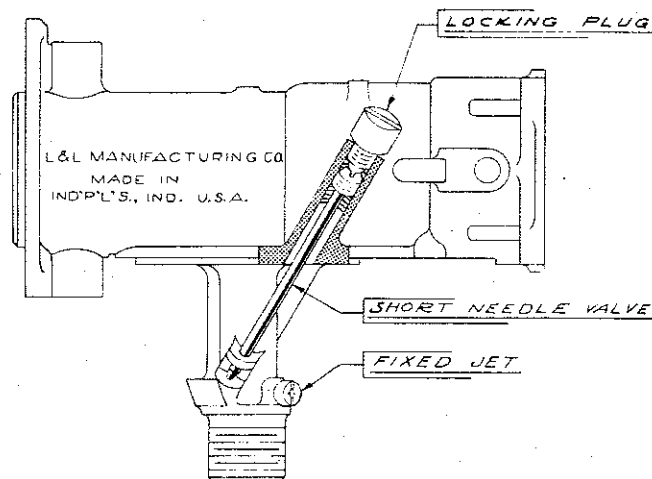
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also be checked after lever is assembled in bowl, by carefully placing a small screw driver or a small rod against the valve head in such a position that it will hold the valve firmly against the seat and yet not bind the lever. Moving the lever up and down will then show the amount of actual clearance between the valve head and fingers. If this clearance is excessive, the float mechanism will not feed properly. After assembling note that float is approximately square with top of bowl.

13. Bowl drain plug now being used in Model "M" carburetors can be removed for quick flushing of bowl. Before removing this plug, turn off gasoline at tanks. Be sure to pull this screw up tight when replacing.

Carburetor Adjustments Provided

A needle is provided to right of carburetor air intake end for variable low speed adjustment. Most military model carburetors have fixed high speed jet as listed in the specifications below. This applies to Models M-64, M-65, M-84, M-88, M-90 and M-97. Fixed high speed mixture in these carburetors is effected by replacing one of the small drill hole plugs, near lower end of carburetor body, with special jet plug. Size of hole in jet plug varies with carburetors of different models. Bear in mind, however, that this special jet plug cannot be duplicated by simply drilling a hole with a drill of certain size through one of the regular drill hole plugs; several



VIEW OF LINKERT MODEL "M" ARMY CARBURETOR SHOWING FIXED JET, SHORT NEEDLE AND LOCKING PLUG

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plugs drilled with same drill will vary considerably in the amount of fuel they flow. Therefore, each jet made at carburetor factory must be tested individually on a flow meter to be sure of uniform flow or in other words, uniform carburetor adjustment. In no case should jets be manufactured or re-drilled to different size. If a new jet is needed, order by number from manufacturer.

All fixed jets are numbered on the face next to the screw slot. Be very careful in handling. Particularly do not mar screw driver slot. Use a screw driver blade that fits slot and pull up jet so that the taper end of jet seats lightly in carburetor body. Always place fixed jet in carburetor body hole pointing to rear of motorcycle.

After a carburetor has been apart for clean-up service, readjust it according to instructions applying to carburetor that is badly out of adjustment (see "Adjusting Carburetor," Page 23).

To set the high speed adjustment on the M-641 model, see the instructions given in the note about this model on Page 59.

Carburetor Clean-up Tools

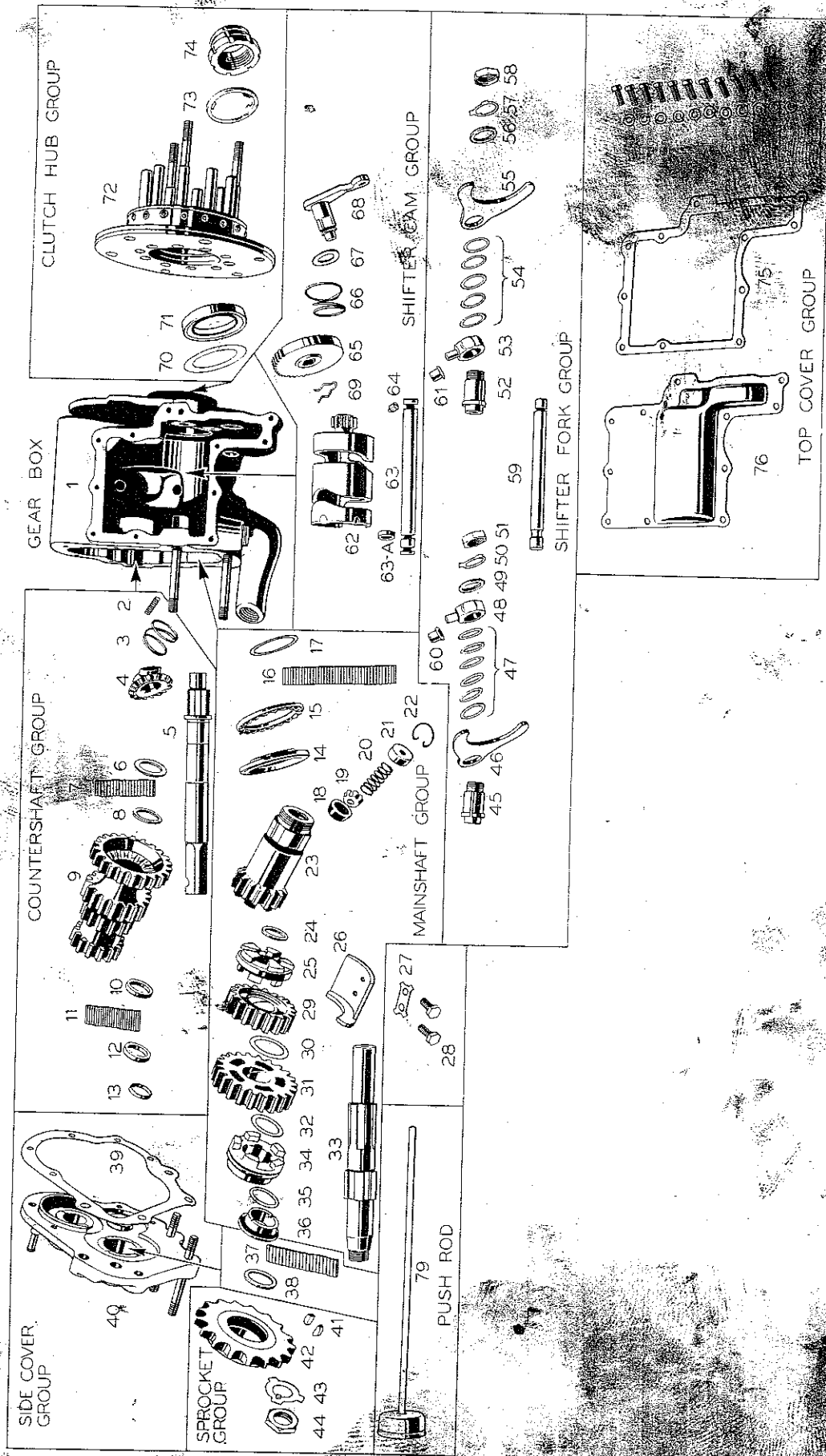
A complete kit of carburetor clean-up tools, including all drills and slot cleaners, required for Army motorcycle carburetors, is available (manufacturer's number 12012-38). This kit does not include tools for disassembling and assembling carburetors.

Carburetor Specifications

Model (Stamped in Top of Carb. Body)	Venturi Size	Small Idle Hole Nearest Mani- fold-Flange (Drill Size)	Idle Hole Farthest From Manifold Flange (Drill Size)	Slot Width	Fixed Jet Number
M-64	1-1/16"	#70	#55	.009"	#4
M-65	1-1/16"	#70	#55	.009"	#5
M-84	1-1/16"	#70	#55	.009"	#5
M-88	1-5/16"	#70	#55	.009"	#1
M-90	1-5/16"	#70	#55	.009"	#1
M-97	1-1/16"	#72	#55	.009"	#5
M-641	1-1/16"	#70	#55	.009"	—

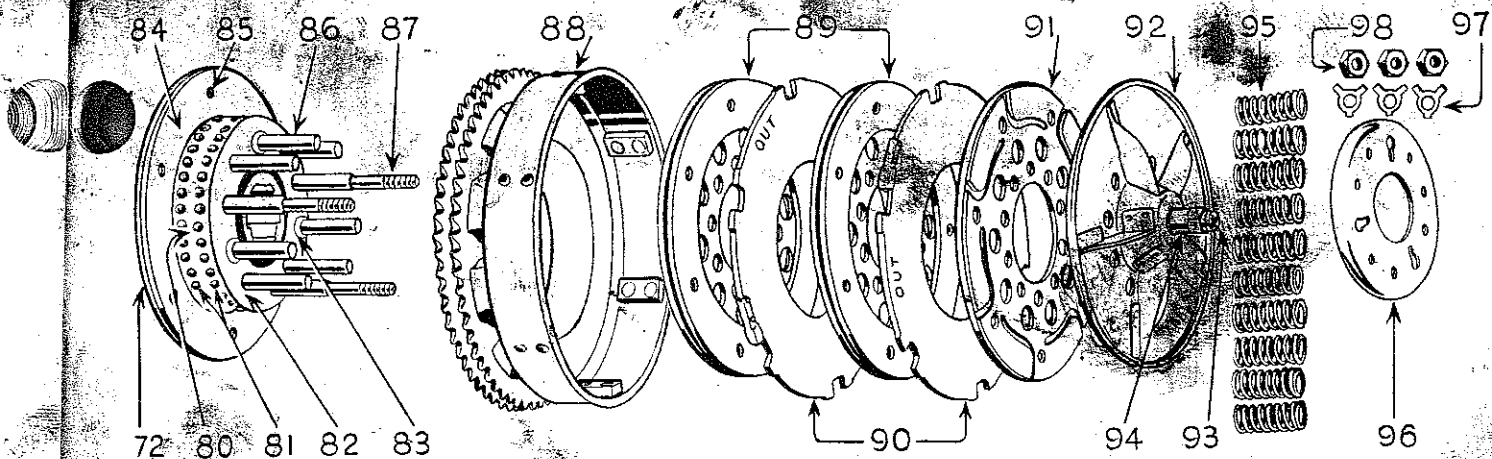
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MTN. HOME, IDAHO 83647



ILLUS. 51
TRANSMISSION—SHOWING ALL PARTS IN CORRECT ORDER OF ASSEMBLY

Illustrations 51 and 52 are of the 1941 and later transmission and clutch. 1940 transmission and clutch are almost identical in general construction and assembly. The few differences in parts and adjusting specifications are fully explained in the following parts list and overhauling instructions.



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CLUTCH—SHOWING ALL PARTS IN CORRECT ORDER OF ASSEMBLY

TRANSMISSION ASSEMBLY

ITEM	NUMBER USED		PART NUMBER		NAME
	1940	1941 AND LATER	1940	1941 AND LATER	
1	1	1	2258-40	2258-41	Transmission Case, as shown include the following seven items assembled in case: Mainshaft Bearing Outer Roller Race Countershaft Bushing Shifter Cam Plunger Ball Shifter Cam Plunger Ball Spring Shifter Cam Plunger Cap Screw Tripper Bolt Tripper Bolt Nut
2	1	1	2168-26	2168-26	Countershaft End Spring
3	1	1	2166-26	2166-26	Starter Clutch Spring
4	1	1	2165-32	2165-32	Starter Clutch
5	1	1	2300-33	2300-41	Countershaft
6	1	1	2308-33	2308-33	Countershaft Gear End Washer Inside Diameter— $1\frac{3}{8}$ " Outside Diameter— $1\frac{3}{16}$ " Thickness—.080"
7	19	19	2306-32	2306-32	Left Bearing Roller Standard Size—.152"x $\frac{5}{8}$ "; available from .001" undersize to .001" oversize in steps of .0002".
8	1	1	2305-33	2305-33	Roller Bearing End Washer Inside Diameter— $1\frac{3}{8}$ " Outside Diameter— $1\frac{5}{64}$ " Thickness—.092"
9	1	1	2303-33	2303-41	Countershaft Gear
10	2	2	2305-39	2305-39	Roller Bearing End Washer (Same as Item 12) Inside Diameter— $1\frac{3}{8}$ " Outside Diameter—1" Thickness—.180"
11	24	24	2289-39	2289-39	Right Bearing Roller Standard Size—.114"x $\frac{3}{4}$ "; available in .0004" and .0008" oversizes only.
12	See Item 10	—	—	—	—
13	—	1	2262-39	2262-39	Cover Rubber Oil Seal
14	—	1	2522-33	2522-41	Thrust Bearing Race
15	—	1	2521-33	2521-41	Retainer and Balls
16	31	40	2306-32	2289-36	Clutch Gear Bearing Roller 1940—(Same roller as Item 7) 1941—Standard Size .125"x .615"; available in .0004" and .0008" oversizes only.

ITEM	NUMBER USED		PART NUMBER		NAME
	1940	1941 AND LATER	1940	1941 AND LATER	
17	1	1	2520-33	2520-41	Roller Bearing End Washer
18	2	1	2552-29	(Complete Oil Seal Set— 2461-41D 2461-41B 2513-41 2516-41	Seal
19	1	1	0208		Metal Cup or Disc
20	1	1	2461-36B		Spring
21	1	1	2551-29		Push Rod Guide
22	0	1	—		Push Rod Guide Spring Ring
23	1	1	2513-33	2513-41	Clutch Gear
24	1	1	2516-26	2516-41	Mainshaft Endplay Adjusting Spacer. 1940—Inside Diameter— $\frac{11}{16}$ " Outside Diameter— $\frac{7}{8}$ " Thickness—.090" to .140" in steps of .005" 1941—Inside Diameter— $\frac{3}{4}$ " Outside Diameter— $\frac{15}{16}$ " Thickness—.078" to .113" in steps of .005"
25	1	1	2298-39A	2298-41	Shifter Clutch for Second and High Gears
26	1	1	2299-39	2299-41	Second Gear Retaining Bracket
27	1	1	2299-33A	2299-33A	Bracket Bolt Lock Washer
28	2	2	1123-29	1123-29	Bracket Bolt
29	1	1	2295-39	2295-41	Second Gear
30	1	1	2294-39A	2294-41A	Low and Second Gear Endplay Adjusting Washer 1940—Inside Diameter— $1\frac{1}{64}$ " Outside Diameter— $1\frac{3}{8}$ " Thickness—.029" to .041" in steps of .003" 1941—Inside Diameter— $1\frac{5}{64}$ " Outside Diameter— $1\frac{7}{16}$ " Thickness—.040" to .075" in steps of .005"
31	1	1	2294-39	2294-41	Low Gear
32	1	1	2292-33	2294-41B	Low Gear End Thrust Washer 1940—Inside Diameter— $\frac{7}{8}$ " Outside Diameter— $1\frac{7}{64}$ " Thickness—.052" 1941—Inside Diameter— $\frac{15}{16}$ " Outside Diameter— $1\frac{7}{32}$ " Thickness—.052"
33	1	1	2272-33	2272-41	Mainshaft
34	1	1	2298-36	2298-41B	Shifter Clutch for Low Gear
35	1	1	2292-33	2292-33	Thrust Washer Inside Diameter— $\frac{7}{8}$ " Outside Diameter— $1\frac{7}{64}$ " Thickness—.052"
36	1	1	2296-33A	2296-33A	Spacing Collar
37	21	21	2306-32	2306-32	Mainshaft Bearing Roller Standard Size .152"x $\frac{5}{8}$ "; available from .001" undersize to .001" oversize in steps of .0002"
38	1	1	2291-33	2291-33	Roller Bearing End Washer Inside Diameter— $\frac{29}{32}$ " Outside Diameter— $1\frac{3}{16}$ " Thickness—.063"
39	1	1	2262-33	2262-41	Side Cover Gasket
40	1	1	2260-39	2260-41	Side Cover
41	2	2	2279-26	2279-26	Sprocket Key
42	1	1	2035-33	2035-41	Sprocket
43	1	1	2278-26	2278-26	Lock Washer
44	1	1	364-12	364-37	Sprocket Nut
45	2	2	2249-36	2249-41	Shifter Fork Bushing (Same as Item 52)
46	1	1	2247-33	2247-41	Shifter Fork for Low Gear
47	Varies	Varies	2253-33A 2253-33B	2253-33A 2253-33B	Spacing Shim—.014" } (Same as Item 54) Spacing Shim—.007" }

ITEM	NUMBER USED		PART NUMBER		NAME
	1940	1941 AND LATER	1940	1941 AND LATER	
48	2	2	2248-36	2248-36	Shifter Finger (Same as Item 53)
49	2	2	2253-33	2253-33	Spacing Shim— $\frac{3}{8}$ " thick (Same as Item 56)
50	2	2	2251-33	2251-33	Bushing Lock Washer (Same as Item 57)
51	2	2	2250-33	2250-33	Bushing Nut (Same as Item 58)
52	See Item 45	—	—	—	—
53	See Item 48	—	—	—	—
54	See Item 47	—	—	—	—
55	1	1	2246-33	2247-41	Shifter Fork for Second and High Gear
56	See Item 49	—	—	—	—
57	See Item 50	—	—	—	—
58	See Item 51	—	—	—	—
59	1	1	2245-38	2245-41	Shifter Fork Shaft
60	2	2	2248-39	2248-39	Shifter Finger Roller (Same as Item 61)
61	See Item 60	—	—	—	—
62	1	1	2243-40	2243-41	Shifter Cam
63	1	1	2244-38	2244-41	Shifter Cam Shaft
63A	1	1	2245-36A	2245-36A	Cam Shaft Rubber Oil Seal
64	1	1	2244-38A	2244-38A	Cam Shaft Lock Screw
65	1	1	2241-38	2241-41	Shifter Gear
66	1	1	2166-26	2166-26	Shifter Shaft Spring
67	1	1	2245-26	2245-26	Shifter Shaft Leather Washer
68	1	1	2242-40	2242-40	Shifter Lever and Shaft
69	1	1	2242-38A	2242-38A	Shifter Gear Retaining Spring
70	0	1	—	2520-41A	Left Bearing Retaining Washer
71	1	1	2524-36	2512-41	Oil Seal
					1940—Pressed in clutch hub 1941—Pressed in transmission case
72	1	1	2528-33	2472-41A	Clutch Hub Complete as shown in Illustration 52
73	1	1	2530-33	2515-41A	Clutch Hub Nut Lock Washer
74	1	1	2531-33	2515-41	Clutch Hub Nut
75	1	1	2271-38	2271-41	Inspection Cover Gasket
76	1	1	2270-38	2270-41	Inspection Cover
77	9	11	0253	0253	Lock Washer
78	9	11	032	032	Inspection Cover Screw
79	*	1	—	2446-41	Push Rod Bearing Complete

*Concerning Item 79: Push Rod and Bearing for 1940 model are separate items. Push Rod—2446-33; Bearing—2448-36; one of each used.

Concerning Bearing Rollers (2306-32): When ordering replacement rollers, note that this roller is used in three bearings in the 1940 transmission (Items 7, 16 and 37) and in two bearings in the 1941 transmission (Items 7 and 37). In the 1940 transmission there is a total of 71 2306-32 rollers; in the 1941 transmission there is a total of 40.

Caution Regarding Fitting of Oversize Rollers: Fitting oversize rollers to take up radial clearance also takes up circumferential clearance. Therefore, care must be taken to avoid crowding of rollers. Assemble specified number of rollers and observe whether last roller goes into place freely without any effort to force it; if it doesn't go into place freely, leave it out.

CLUTCH ASSEMBLY

ITEM	NUMBER USED		PART NUMBER		NAME
	1940	1941 AND LATER	1940	1941 AND LATER	
72	1	1	2528-33	2472-41A	Clutch Hub Complete, with sprockets, bearing, studs, etc., as illustrated.
80	*	1	*	2473-41A	Ball Bearing Retainer
81	*	60	*	2472-41B	Ball— $\frac{7}{8}$ "
82	*	1	*	2475-41A	Bearing Retaining Plate
83	0	3	—	2458-38	Retaining Plate Lock Ring
84	0	1	—	2482-41A	Hub Disc Lining
85	0	6	—	2485-41	Lining Rivet
86	0	7	—	2478-41A	Pin
87	4	3	2549-34	2477-41A	Stud
88	1	1	2039-40M	2039-41A	Sprocket Complete with Disc Spline Ring

ITEM	NUMBER USED		PART NUMBER		NAME
	1940	1941 AND LATER	1940	1941 AND LATER	
89	*	2	*	2481-41A	Lined Disc
90	*	2	*	2487-41A	Plain Steel Disc
91	0	1	—	2481-41C	Sprung Steel Disc with Lining
92	1	1	2544-34	2479-41A	Releasing Disc
93	1	1	2463-34	2463-41A	Push Rod Adjusting Screw
94	1	1	2465-26	2465-41	Adjusting Screw Lock Nut
95	12	10	2511-30	2511-41	Clutch Spring
96	1	1	2547-34	2505-41A	Spring Compression Collar
97	4	3	0259	2512-41A	Stud Nut Lock Washer
98	4	3	0117	0117	Stud Nut

Additional Parts Required for 1940 Clutch

NUMBER USED	PART NUMBER	NAME
1	2548-40	Spring Tension Adjusting Nut
1	2550-34	Push Rod Thrust Cap

Corresponding 1940 Clutch Parts

	NUMBER USED	PART NUMBER	NAME
*Corresponding with 1941 sprocket bearing— (Items 80, 81 and 82):	1	2536-33	Bearing Race (in sprocket)
	1	2537-33	Bearing Race (in clutch hub)
	1	2538-33	Bearing Washer
	1	2539-33	Bearing Spacer
	96	2540-33	Ball— $\frac{5}{32}$ "
*Corresponding with 1941 clutch discs and linings— (Items 89 and 90):	1	2533-26	Sprocket Lining
	6	2485-29	Lining Rivet
	2	2535-29	Plain Steel Disc
	3	2534-29	Splined Fibre Disc

OVERHAULING TRANSMISSION AND CLUTCH

Removing Transmission From Chassis

A. Lower rear end of bottom skid plate. In some cases it will be found necessary to remove only the two rear mounting bolts; in other cases a U-clamp holding skid plate to front frame tube will have to be removed.

B. Remove left footboard, sidebar and clutch pedal assembly in one unit. Release cable must first be disconnected from clutch footpedal by removing cotter pin and washer.

C. Remove oil bath air cleaner and mounting plate; this requires loosening hose clamp at carburetor hose connection fitting and removing the three bolts attaching mounting plate to frame.

D. Remove outer front chain guard.

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

F. Free inner front chain guard by removing the two mounting screws.

G. Remove tool box from mounting bracket by removing the two mounting bolts from inside of box; then remove mounting bracket from frame.

H. Remove brake rear rod.

I. Remove rear chain.

J. Remove rear chain guard.

K. Remove battery box as follows: Disconnect battery terminal wires and remove battery. Loosen

two nuts securing rear safety guard center connection to mounting studs. Unscrew mounting studs to free plate clamping battery box bracket to frame. Remove battery box front bolt and two rear bottom bolts. Remove battery box from left side of frame.

L. Remove clutch release cable and tube.

M. Remove shifter rod.

N. Remove three bottom mounting stud nuts and lift transmission to permit removal of front chain adjusting screw.

O. Loosen U-bolts on ignition coil and swing coil as far as possible toward the front.

P. Remove transmission and clutch assembly as follows: Lift unit to free mounting studs from frame slots, rotate top of transmission backward about a quarter turn and remove from left side of frame.

Disassembling Transmission

A. Disassemble and remove clutch as described under "Disassembling Clutch," Page 22, and "Removing Clutch Hub," Page 67.

B. Remove starter crank.

C. Remove sprocket cover.

D. Remove top inspection cover (Item 76).

E. Remove shifter cam (Item 62) by unscrewing lock screw (Item 64) and pulling out shifter cam shaft (Item 63).

F. Remove shifter fork assemblies by drifting shaft (Item 59) out through hole in transmission side cover.

Caution: Bear in mind that shifter fork assemblies are not interchangeable; note exact arrangement of

parts before disassembling. This precaution can save needless gauging and adjusting when reassembling.

G. Remove sprocket (Item 42) using manufacturer's wrench number 12731-29. It will be necessary to strike wrench with a hammer to loosen nut (Item 44). Remove sprocket from taper by giving it a light but sharp rap with a hammer, near outer edge, being careful not to strike teeth.

H. Remove transmission side cover (Item 40); all gears, shafts, etc., are now free to be removed from open side of case.

Note: Do not remove clutch gear oil seal and bearing retaining washer (Items 70 and 71—1941 and later only) unless inspection shows them damaged or worn.

Removing Clutch Hub

Remove clutch hub nut (Item 74). On 1940 models use manufacturer's wrench number 12745-26 with adapter number 12745-26A; on 1941 and later models use wrench number 12745-41.

1940 model: Clutch hub can be removed from taper by giving it a light but sharp rap with a hammer and soft punch, striking close to center but being careful not to strike bearing.

1941 and later models: Clutch hub is a press fit on splined end of clutch gear. Puller number 12022-41 is needed to remove it.

Inspection of Parts

Inspect all parts and determine which must be renewed. Check all gears for extent of tooth wear; also inspect all bushings and bearing races.

Give especially close attention to possibly battered or rounded condition of engaging dogs on shifter clutches and clutch gear and engaging slots in other gears. This condition results from shifting abuses or possibly from poorly adjusted clutch that does not release fully.

Damaged engaging dogs and slots try to creep out of engagement under steady driving load. This creeping action develops tremendous side pressure that finally results in serious damage to shifting mechanism and all thrust points along the mainshaft assembly. Therefore, in doing a thorough and dependable transmission overhaul, it is of prime importance that all gears and shifter clutches with badly rounded engaging dogs and slots be replaced with new.

Installing Clutch Gear

A. Assuming that oil seal (Item 71) and bearing retaining washer (Item 70) are already assembled in case, install roller bearing end washer (Item 17) in roller race next. Assemble rollers (Item 16) in roller race after applying sufficient grease to race to hold rollers in place.

B. Insert oil seal tool (manufacturer's tool number 12747-41) through oil seal from the outside so that it will be in place to meet clutch gear when it is inserted through bearing from the inside. It is necessary that this oil seal tool be used to facilitate assembly and avoid damaging oil seal. Assemble thrust bearing race (Item 14) and retainer and balls (Item 15) on clutch gear. Now insert clutch gear through bearing from inside of case. Be sure end of

gear is engaged with oil seal tool before pushing it through seal.

Adjusting Mainshaft Endplay

A. Install mainshaft in case with mainshaft spacer (Item 24), thrust washer (Item 35) and spacing collar (Item 36) in place.

B. Install roller bearings (Item 37) in side cover bearing race, holding them in place by means of light coat of grease.

C. Install side cover and gasket on transmission case. In checking endplay, it is important to tighten cover screws and stud nuts just as tight as in final assembly; otherwise endplay in final assembly will not be the same as this check shows. Check endplay as indicated in Illustration 53; it should be .003" to .005". Increase or decrease endplay as necessary by fitting mainshaft spacer (Item 24) of required thickness.

D. After correct mainshaft endplay has been established, remove mainshaft from case and set aside spacer washer selected, to be sure it goes into final assembly.

Adjusting Endplay of Low and Second Gears Between Retaining Bracket and Transmission Side Cover

A. Assemble only the following parts on mainshaft: From left (clutch) end—low gear end thrust washer (Item 32), low gear (Item 31), endplay adjusting washer (Item 30), second gear (Item 29), mainshaft spacer (Item 24); from right (sprocket) end—thrust washer (Item 35) and spacing collar (Item 36).

B. Install roller bearings in side cover and install gasket and cover on case. Tighten cover just as tight as in final assembly.

C. Check endplay of low and second gears between sidecover (Item 40) and second gear retaining bracket (Item 26), as indicated in Illustration 53. Measure by means of thickness gauge inserted between second gear retaining bracket and second gear. Endplay should be .005" to .007". Adjust as necessary by fitting endplay adjusting washer (Item 30) of required thickness.

After correct endplay adjustment has been attained, remove mainshaft assembly from transmission. Be sure selected endplay washer remains with the assembly.

Assembling Transmission

After mainshaft spacer (Item 24) and endplay adjusting washer (Item 30) in their required thicknesses have been selected, complete assembly of transmission can proceed, reversing order of disassembly.

If new shifter clutches (Items 25 and 34) are required, see that they fit free on mainshaft and slide on shaft splines without binding. Shifting will be difficult unless these parts work freely.

When assembling shifter cam, two things must be watched very closely: First, shifter finger rollers must be in place on shifter fingers; second, shifter cam gear and shifter lever gear must be correctly timed. Small gear has one tooth chamfered at end. This tooth must engage with space marked "3" between teeth of large gear. See Illustration 54.

Adjusting Shifter Clutches

With shifter cam (Item 62) in *neutral* position and highest points on driving dogs overlapping about $\frac{1}{8}$ " (See Illustration 54), the following clearances should exist:

Shifter fork to low gear—

1940248" to .253"
1941 and later283" to .288"

Shifter clutch to clutch gear—

1940030" to .037"
1941 and later053" to .058"

Suitable strips of metal dressed down to the above thicknesses will serve as gauges for these adjustments.

Relative adjustment between shifter fingers (Items 48 and 53) and shifter forks (Items 46 and 55) is determined by spacing shims (Items 47 and 54). By increasing or reducing number of these shims between shifter forks and shifter fingers (Items 48 and 53) a corresponding change is effected in clearance of shifter clutches. These adjusting shims are .007"

and .014" in thickness. Transfer shims as necessary to properly locate clutches. Reassemble shifter fork assemblies to transmission and recheck clearances.

Before installing transmission inspection (top) cover, pour about $\frac{3}{4}$ pint of oil (same grade as used in engine) into case; 1940 and earlier holds $\frac{1}{2}$ pint.

Installing Clutch Hub

Clutch hub and clutch may be installed either before or after transmission is installed in frame.

1941 and later clutch hub is a light press fit on splined end of clutch gear. Drive hub onto splines with a hammer and a block of wood or piece of tubing of required diameter. Install lock washer (Item 73), tighten nut (Item 74) securely and lock by setting washer into one of the nut wrench slots with a punch.

If sprocket bearing (Items 80 and 81) and bearing retaining plate (Item 82) have been removed from hub, re-install them first. Bearing retaining plate is held in place against hub face by spring rings (Item 83) pushed onto three short studs and tight against

MAINSHAFT ENDPLAY .003" TO .005". ADJUST WITH SPACER (ITEM 24) OF REQUIRED THICKNESS.

SPACER (ITEM 24) ASSEMBLED BETWEEN MAINSHAFT SHOULDER AND END OF CLUTCH GEAR DETERMINES MAINSHAFT ENDPLAY.

THRUST WASHER (ITEM 30) ASSEMBLED ON MAINSHAFT BETWEEN LOW AND SECOND GEARS DETERMINES ENDPLAY OF THESE GEARS BETWEEN RETAINING BRACKET (ITEM 26) AND GEAR BOX SIDE COVER. ADJUST ENDPLAY TO .005" TO .007" WITH WASHER OF REQUIRED THICKNESS.

SECOND GEAR RETAINING BRACKET (ITEM 26).

ILLUS. 53
TRANSMISSION ENDPLAY ADJUSTMENTS

CLEARANCE BETWEEN SHIFTER FORK AND LOW GEAR MUST BE PROPERLY ADJUSTED. SEE "ADJUSTING SHIFTER CLUTCHES."

CLEARANCE BETWEEN DRIVING DOGS OF SHIFTER CLUTCH AND CLUTCH GEAR MUST BE PROPERLY ADJUSTED. SEE "ADJUSTING SHIFTER CLUTCHES."

WHEN ASSEMBLING SHIFTER GEARS, CHAMFERED TOOTH ON SMALL GEAR MUST LINE UP WITH PROPER MARK ON LARGE GEAR. SEE "ASSEMBLING TRANSMISSION," PAGE 67.

SHIFTER LEVER IN NEUTRAL.

ILLUS. 54
SHIFTER CLUTCH CLEARANCES AND SHIFTER GEAR TIMING

plate. Spring rings should be spaced as nearly equidistant as possible; do not install spring rings on long studs.

1940 clutch hub is mounted on tapered end of clutch gear. When installing, see that tapers are clean and key is in place. Install lock washer (Item 73) so inner ear engages hole in clutch hub. Tighten lock nut (Item 74) securely and lock by setting one of the lock washer outer ears into one of the lock nut wrench slots.

1940 clutch sprocket bearing is secured by peening hub shoulder over bearing race. It should be removed only when it requires replacement.

Installing Clutch

Before installing clutch shell and sprocket, apply a very small amount of grease to ball bearing. Proceed with the assembly of clutch according to

instructions under "Reassembling Clutch," Page 22, and Illustrations 12 and 52. Adjust clutch as per instructions under "Adjusting Clutch Spring Tension," Page 21.

Installing Transmission in Chassis

Installation is a reverse procedure of removal. See "Removing Transmission From Chassis," Page 66.

In replacing any parts attached by a number of bolts, such as the battery box, get all bolts in place before tightening any one. Draw all down evenly to preserve alignment.

Chains, rear brake, clutch controls and shifter controls must be carefully readjusted. Securely tighten transmission mounting stud nuts.

Caution: Be sure transmission is filled to level of filler opening with oil of the same grade used in engine.

SUMMARY OF TRANSMISSION SPECIFICATIONS

(Fitting and Adjusting)

ALL ROLLER BEARINGS: .0006" to .001" loose; .0008" preferred.

MAINSHAFT IN CLUTCH GEAR BRONZE BUSHING: .0015" to .0025" clearance; .002" preferred.

COUNTERSHAFT IN TRANSMISSION CASE BRONZE BUSHING: .0015" to .0025" clearance; .002" preferred.

COUNTERSHAFT IN TRANSMISSION CASE SIDE COVER: .0005" to .0015" clearance; .001" preferred.

MAINSHAFT ENDPLAY: .003" to .005".

LOW AND SECOND GEAR ENDPLAY BETWEEN SECOND GEAR RETAINING BRACKET AND TRANSMISSION CASE SIDE COVER: .005" to .007" (check between side of second gear and retaining bracket in transmission case).

SECOND AND HIGH GEAR SHIFTER CLUTCH SIDE CLEARANCE: Check with shifter cam in neutral position, and highest points on driving dogs overlapping about $\frac{1}{8}$ "—

1940..... .030" to .037"

1941 and later..... .053" to .058"

LOW GEAR SHIFTER CLUTCH SIDE CLEARANCE: Check between sides of shifter fork and low gear, with shifter cam in neutral position.

1940..... .248" to .253"

1941 and later..... .283" to .288"

SHIFTER CAM ENDPLAY: Free to .005". If, when fitting new shifter cam or new transmission case, cam is tight endways, file boss in case. If too much endplay, fit shim washer of required thickness.

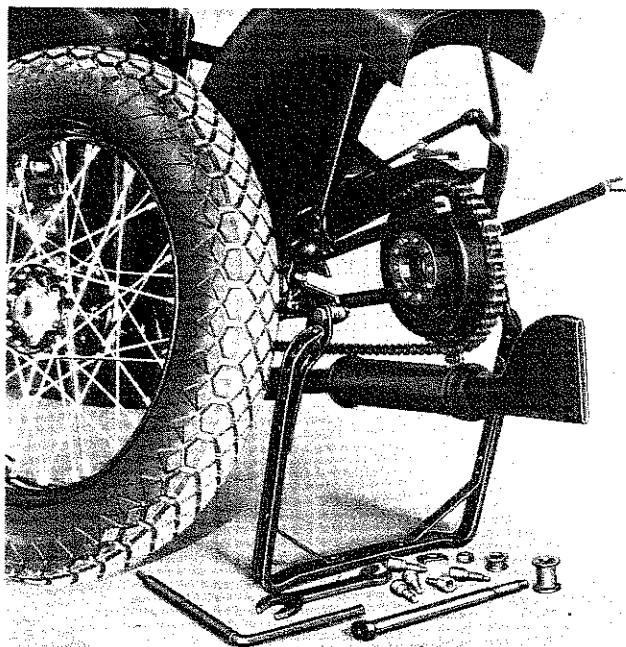
CLUTCH SPRING TENSION ADJUSTMENT:

1940 clutch—Distance from face of spring collar to shoulder on thrust plate mounting studs should be $\frac{3}{32}$ ".

1941 and later clutch—Distance from inner edge of spring collar to surface of outer disc should be $1\frac{1}{32}$ ".

WHEELS, HUBS AND TIRES

Wheels normally require little attention other than ample lubrication of hubs. See "Lubrication Chart," Page 15. Occasionally, set motorcycle on rear stand, block up front end of motorcycle to raise front wheel, and check adjustment of hubs. Adjustment is all right when only a small amount of side shake can be found at rim of wheel. Also check spokes and tighten any found loose.



ILLUS. 55
REAR WHEEL REMOVED

To Remove Front Wheel

Raise front end of motorcycle by blocking up under frame loop. Remove brake shackle bolt from rigid fork. Remove axle nut. Wheel is then free to come out by pulling out axle. After rolling wheel forward, brake assembly can be removed from drum, leaving brake assembly attached to control wire and housing.

Caution: Before removing axle, note how slot in brake stabilizer plate is fitted over extended end of left front rocker plate stud. In re-installing wheel, make sure this slot is again fitted properly.

To Remove Rear Wheel

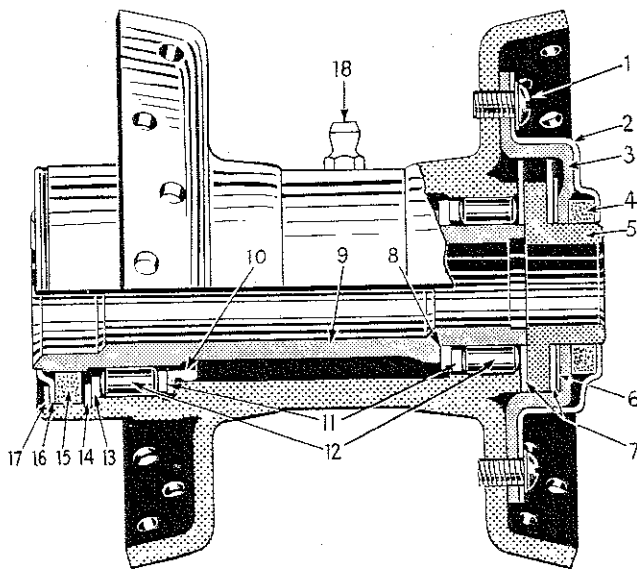
Set motorcycle on rear stand. Loosen and raise rear end of mudguard. Remove five wheel mounting socket screws that secure wheel to brake assembly. (Use manufacturer's wrench number 12025-35). Wrench can be inserted only directly to the rear of axle and wheel must be turned to bring each screw into position for removal.

To prevent brake shell and sprocket from coming off of brake assembly while wheel is being removed, apply rear brake and lock it by shifting brake rod lock back against some stationary part of motorcycle.

Remove axle nut, pull out axle, remove spacer from between wheel hub and left side of frame and wheel is then free to come out.

When replacing wheel, reverse operations of removal. Securely tighten wheel mounting socket screws before tightening axle nut. Double check socket screws; if they loosen in service due to careless tightening, considerable damage to hub may result.

Before riding motorcycle, be sure to secure brake rod lock 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.



ILLUS. 56

Rear Wheel Hub

1—Thrust bearing cover screws (five); 2—Thrust bearing outer cover; 3—Thrust bearing housing; 4—Cork grease retainer; 5—Thrust bearing sleeve; 6—Thrust bearing adjusting shims (each shim .002" thick; use as many as necessary to adjust so that sleeve (5) has .003" to .005" endplay); 7—Thrust washers; 8—Left roller retainer thrust washer; 9—Hub inner sleeve; 10—Right roller retainer thrust washer (pressed into hub shell); 11—Roller retainer; 12—Bearing rollers; 13—Roller bearing washer; 14—Roller bearing spring lock ring; 15—Cork grease retainer; 16—Cork retaining washer; 17—Spring lock ring; 18—Grease connector.

Adjusting Rear Wheel Hub

(SEE ILLUSTRATION 56)

To take up only excessive sideplay that may develop, it is not necessary to take hub completely apart. Simply take out screws (1) and complete thrust bearing assembly comes off end of hub and can be taken apart. One or more shims (6) as required can then be added, and the assembly reassembled on hub. Be careful about adding too many shims and thus binding thrust sleeve (5). It must still be free with cover screws (1) securely tightened. It is best to leave cork retainer (4) out of thrust assembly while determining correct adjustment of thrust sleeve, and put it back in when readjustment is completed. Cork retainer interferes to some extent with free movement of thrust sleeve and, therefore, makes it difficult to determine whether or not sleeve is altogether free between thrust washers (7).

Excessive radial (up and down) play in wheel hub bearings, due to wear, can be taken up by fitting oversize rollers (12). To take hub completely apart for attention to roller bearings, first remove thrust

assembly as explained above. Next, remove spring lock ring (17), washer (16), cork retainer (15) and pull out inner sleeve (9). Rollers and retainers can then be taken out. It is necessary to remove spring lock ring (14) and washer (13) before brake side bearing can be removed.

In fitting oversize rollers, care must be exercised to avoid fitting too tight. With hub assembled, roller bearings must turn freely and have slight play or shake.

Adjusting Front Wheel Hub

Remove wheel from motorcycle, and then remove cone lock nut and washer from right side of hub. Cone can then be turned to obtain proper adjustment. Adjust so that just slight play or shake can be detected, and wheel turns freely. Check adjustment after cone lock nut has been replaced and securely tightened. To remove and inspect cones and balls, turn right side cone all the way off axle bushing. There are 26, $\frac{5}{16}$ " balls in hub—13 on each side.

Removing and Installing Tires

Wheel rims are of the drop-center type, having a depression or well in center of rim. Rim-well, being smaller in circumference than rest of rim, allows one casing bead to fit loosely in it while other bead is being worked over edge of rim. Bear in mind the importance of keeping one bead in rim-well while other bead is being worked onto or off of rim.

To Remove Tire from Rim

1. Remove wheel from motorcycle and lay wheel on its side. (See "To Remove Front Wheel" and "To Remove Rear Wheel," Page 70.)
2. Remove valve cap and valve core to free all air from tube.
3. Press casing bead into rim-well to within a short distance of each side of valve.
4. Using tire tool (not a sharp instrument), start bead over edge of rim at valve. Don't use force when starting bead over edge of rim with tire iron, because bead wires may be broken or stretched and tire ruined. With first bead in rim-well, second bead can be started over edge of rim easily.
5. After a portion of second bead is started over rim edge, casing can be further removed from wheel without aid of tire iron.
6. It isn't always necessary to completely remove casing from rim. Removing one side only, allows inner tube to be removed and re-installed and also allows inside of casing to be inspected.

To Install Tire on Rim

1. Before applying casing to rim, see that rubber rim strip is in place in rim-well and that rim strip valve hole registers with valve hole in rim.
2. Start either bead of casing over rim edge, working around wheel until entire bead is on rim.
3. Place inner tube in casing. Note: Inner tube may be placed in casing before or after first bead of casing is on rim. Insert valve stem, through hole in rim and start valve stem lock nut.
4. While pressing first bead into rim-well, work remaining bead over edge of rim, starting directly opposite valve stem. Work both ways around wheel toward valve.

5. Inflate tire. See "Tire Inflation Pressures," Page 6.
6. Re-install wheel.

CAUTION: Tire casings are balanced and must be applied to rim with balance mark located at valve stem. On Firestone tires, the balance mark is a red triangle and on Goodyear tires a red dot.

Wheel Spokes and Nipples

Front Wheel: The 20 spokes used on the brake shell side for the front wheel are (manufacturer's part No. 3945-30N), $5\frac{5}{16}$ " long. The 20 spokes used on the opposite side of the front wheel hub are (manufacturer's part No. 3943-30N) $8\frac{3}{8}$ " long. 40 spoke nipples (manufacturer's part No. 3947-16N) are used in the front wheel.

Rear Wheel: All 40 of the rear wheel spokes are of the same length and size. Rear wheel spokes (manufacturer's part No. 3943-36N) are .161" diameter, $8\frac{5}{8}$ " long. 40 spoke nipples (manufacturer's part No. 3947-29N) are used for rear wheel spokes.

Centering Wheel Rims

When respoking and truing a wheel, the rim must be properly centered in relation to hub for correct alignment and "tracking" of front and rear wheels. Illustration 57 shows method of using a straight edge to determine correct centering of both front and rear wheel rims. Measurements shown in illustration apply to wheels with 4" tire rims.

Straight edge should be a perfectly straight metal bar.

Front Wheel (4" tire rim)—Lay straight edge across face of brake shell and measure distance of straight edge from rim. When rim is correctly centered, this distance will be $1\frac{7}{16}$ ".

Rear Wheel (4" tire rim)—Lay straight edge across brake side spoke flange of hub and measure dis-

tance from straight edge to rim. When rim is correctly centered, this distance will be $\frac{3}{4}$ ".

Should there be occasion to service wheel with rim for 5" tire, following method of measuring and measurements given will apply:

Front Wheel (5" tire rim)—Lay straight edge across brake shell and measure distance of straight edge from rim. When rim is correctly centered, this distance will be $1\frac{1}{8}$ ".

Rear Wheel (5" tire rim)—Lay straight edge across rim on brake side and measure the distance to brake-side spoke flange of hub. When rim is correctly centered, this distance will be $\frac{11}{16}$ ".

Rough Check for Fork Alignment

The rigid fork may be rough checked for alignment as follows: Referring to Illustration 58, use a perfectly straight $\frac{7}{16}$ " diameter round bar, about 30" long passed through the hole in fork center stem to determine if fork sides are parallel with center stem. As shown in illustration the fork side tips should be $3\frac{3}{8}$ " from the sides of test bar.

Upper end fork sides and fork stem must be spaced to fit handlebar mounting holes.

Fork sides can be checked for relative alignment by using two perfectly straight $\frac{5}{16}$ " diameter round bars at least 18" long. Referring to Illustration 59, note that fork is to be supported in horizontal position on level blocks or by clamping center stem in a vise. Insert one rod through holes in lower fork tips and lay the other squarely across upper end of forks. Sight across two rods and note their relative alignment. If they are not in close alignment, either one or both of the fork sides are not straight, or possibly the fork sides are straight enough, but they are out of alignment with each other, or across the fork, due to a twist in the fork crown.

This method of checking fork alignment is recommended only in connection with emergency repair. Except in emergency, fork straightening and aligning should be referred to a base shop where any needed straightening equipment and more accurate aligning gauges are available.

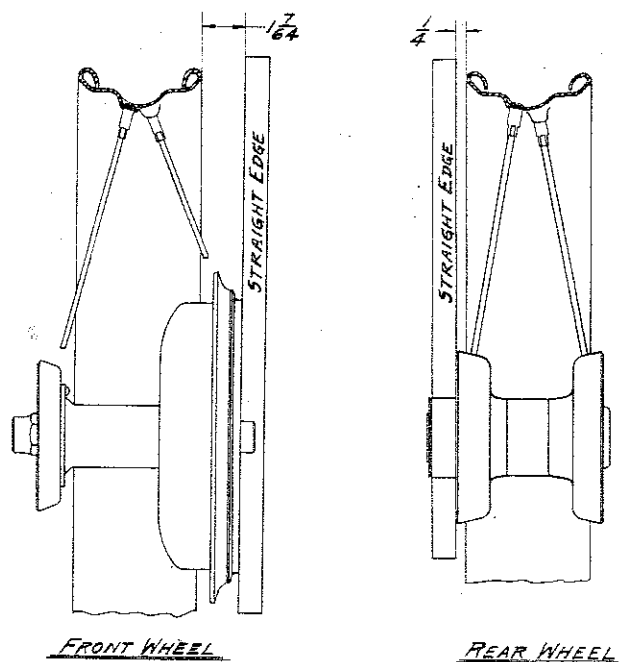
Rough Check for Frame Alignment

Sketch (Illustration 60) shows a satisfactory method of rough checking a frame that is not visibly badly damaged but there is doubt as to its possible alignment. This check will determine whether or not frame is far enough out of alignment to require either a major re-aligning job or replacement. Straightening a badly bent frame requires special tools and fixtures for holding, bending and gauging.

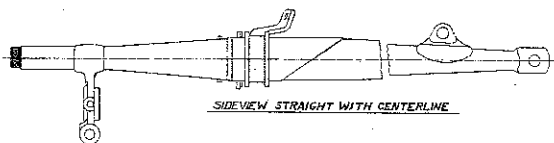
The straight edge may be any convenient size of square, rectangular or round bar stock, just so it is perfectly straight and of sufficient cross section so that it is rigid. Its length should be 5 ft. or more. The shim to be inserted between straight edge and frame seat post tube must be $\frac{1}{16}$ " thick.

The round bar for head must be $\frac{3}{4}$ " in diameter and at least 26" long. A shoulder or pin may be provided at top end of bar to prevent it from passing all the way through frame head. Bearing cups are left in frame head when using test bar.

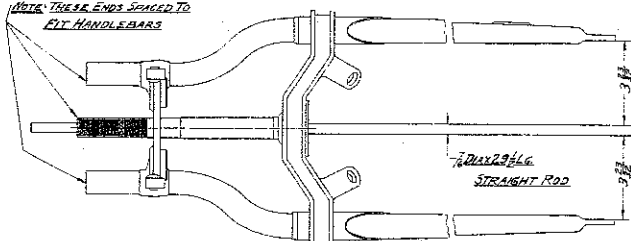
Sketch includes measurements for checking alignment.



ILLUS. 57
WHEEL RIMS CORRECTLY CENTERED (4" TIRE RIMS)

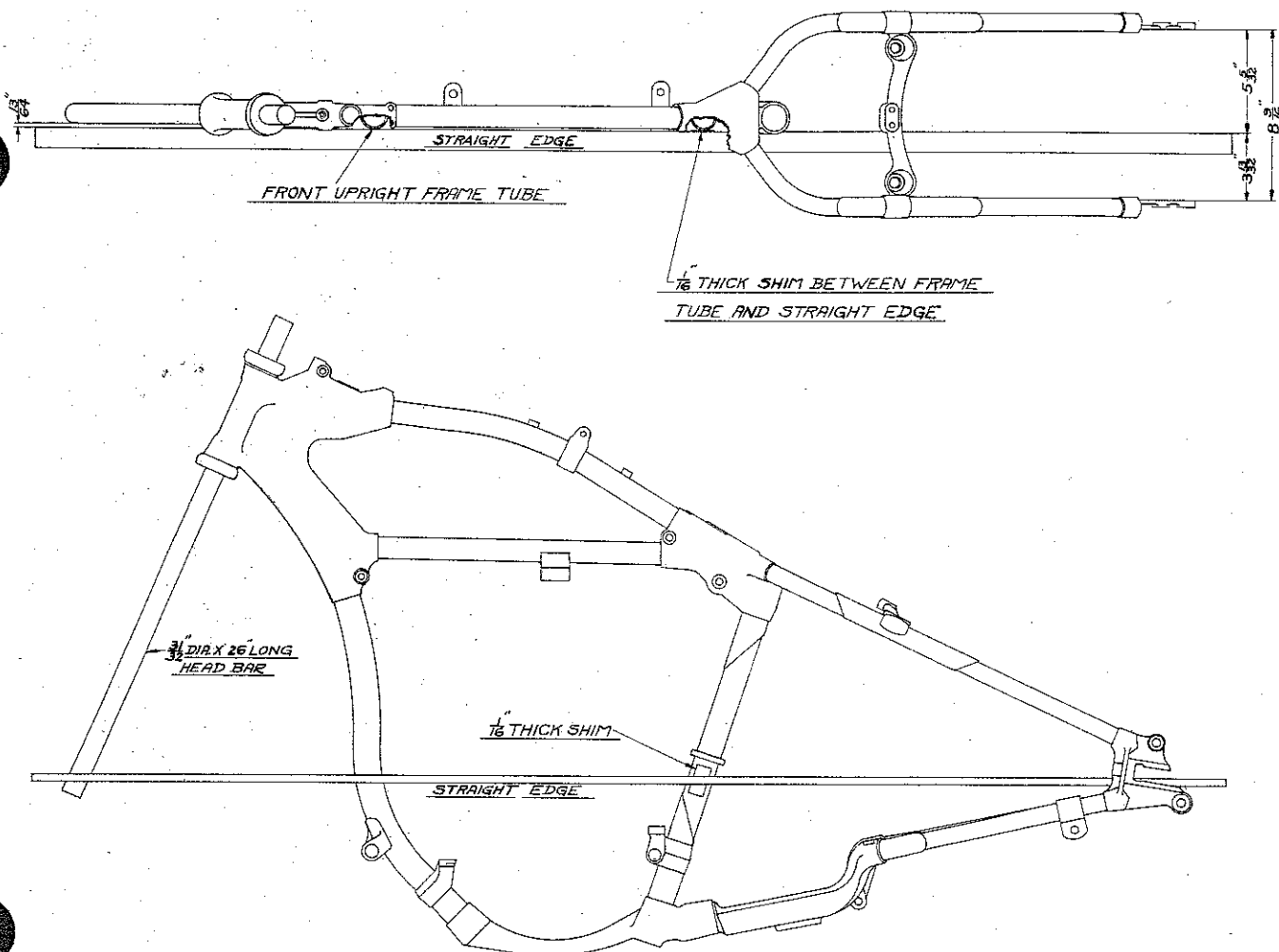
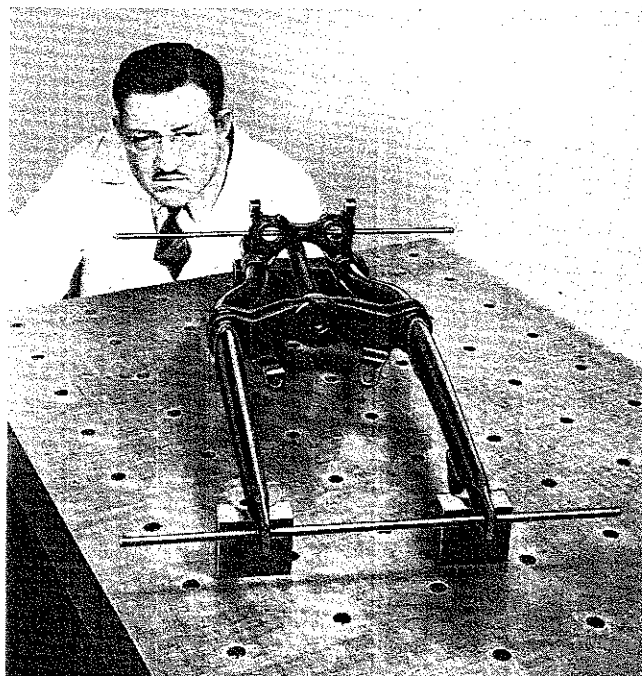


NOTE: THESE ENDS SPACED TO
FIT HANDLEBARS



ILLUS. 58 (ABOVE)—CORRECT ALIGNMENT OF FORK SIDES
WITH FORK STEM.

ILLUS. 59 (RIGHT)—VISUAL CHECK OF FORK SIDE RELATIVE
ALIGNMENT.



ILLUS. 60

USE OF STRAIGHT EDGE IN ROUGH-CHECKING FRAME FOR ALIGNMENT

SERVICING RADIO INTERFERENCE SUPPRESSION SYSTEM

(Refer to Radio "Interference Suppression System," Page 57)

Should it be found that electrical system on radio suppression equipped motorcycle produces radio interference noise it does not necessarily mean that suppression-devices are at fault. Before checking and replacing suppression-devices, check entire electrical system for loose, corroded or poor connections. See that battery connections are clean and tight and that battery solution level is above plates. Excessively worn generator brushes and commutator, dirty commutator and poor circuit breaker or relay contacts may be the cause of radio interference.

Radio interference may also be caused simply by loose fittings, bolts, nuts and screws on any part of the motorcycle.

Suppression-devices on the WLA model come under three classifications for trouble-shooting purposes:

1. Bonding and shielding (*A, *B and *D)
2. Condensers (*C, *F, *G and *H)
3. Resistors (*E)

If it has been determined that the motorcycle electrical system is responsible for radio noise then check each of the three above listed groups, outlined as follows: Replace suspected faulty parts with

new ones, one at a time, and test for radio noise after each change.

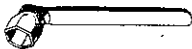
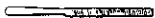
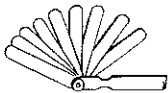
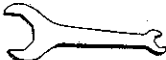


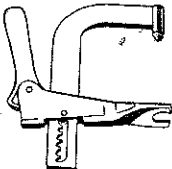

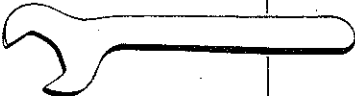

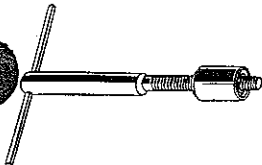
1. Check bonding and shielding. See that flexible braid conductor (*B) used to ground spark coil housing, air cleaner bracket and engine base to frame, is tight at all connections (shake-proof washers used). Circuit breaker-to-coil wire (*D) is enclosed in metal shielding. See that ends of shielding are securely grounded to coil housing and inside of timer housing.





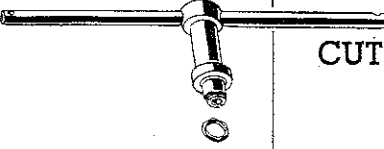




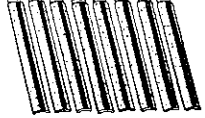
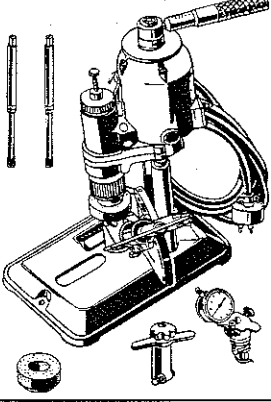

2. Metal encased suppression-condensers are used on generator (*H) and spark coil (*C). The surface of the terminal post which supports condenser on spark coil housing and also end of flexible braid conductor, should be kept clean to insure good contact. Mica suppression condensers are used on cut-out relay (*G) and in instrument panel (*F). All suppression condensers are readily accessible and are easily replaced. Should a condenser be suspected of being faulty, it should be replaced by a new one, the motorcycle being checked again for radio noise.



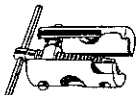
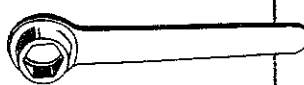
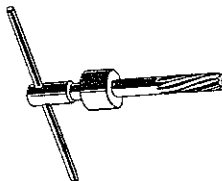

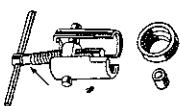
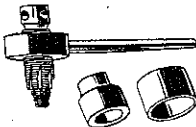
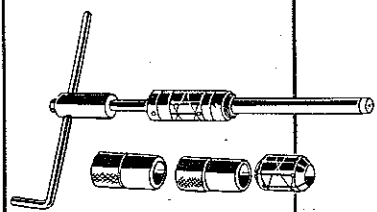
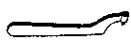
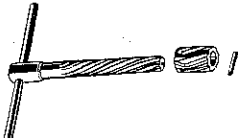
3. Resistor-suppressors (*E) are screwed onto ends of spark plug cables. Keep these suppressors clean and tight. Examine for cracks or scorched condition. Faulty suppressors must be replaced with new ones.

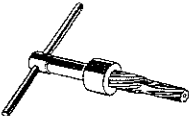
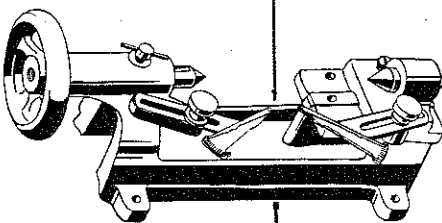


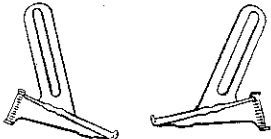

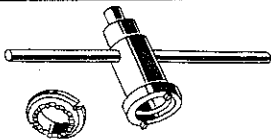
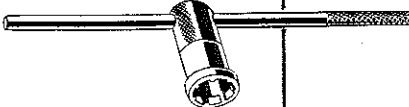
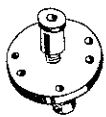



SPECIAL TOOLS FOR SERVICING WLA (SOLO) MODEL HARLEY-DAVIDSON MILITARY MOTORCYCLE

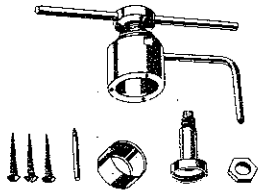
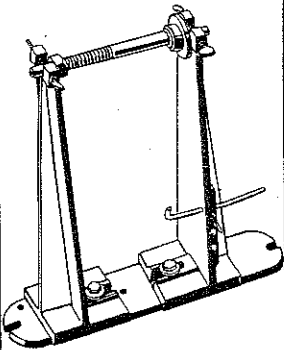


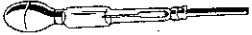
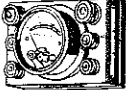
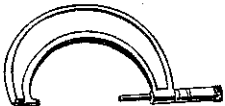

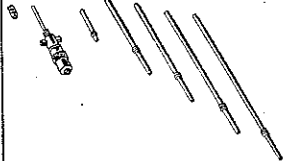

THIS LIST COVERS REQUIRED HARLEY-DAVIDSON SPECIAL TOOLS. IT DOES NOT INCLUDE STANDARD SHOP TOOLS NEEDED SUCH AS STANDARD OPEN END AND SOCKET WRENCHES AND OTHER MISCELLANEOUS TOOLS.

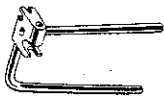


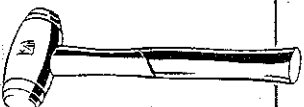

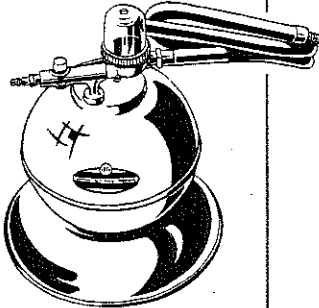
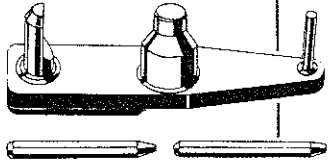


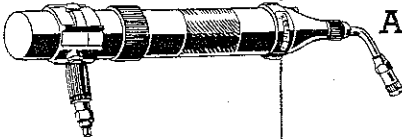
TOOL ILLUSTRATION	NAME OF TOOL	FEDERAL STOCK NO.	HARLEY-DAVIDSON NO.
	SPARK PLUG WRENCH	41-W-3334	11929-40
	TUNGSTEN POINT FILE	41-D-1410	11840-X
	THICKNESS GAUGE	41-G-407	11974-X
	VALVE COVER WRENCH		11806-31
	SET OF VALVE TAPPET ADJUSTING WRENCHES	41-W-3573	11904-X
	HEAD BOLT WRENCH	41-W-1525	12047-30A
	VALVE SPRING COMPRESSOR	41-L-1410	12053-30
	VALVE KEY TOOL	41-R-2403	12054-30
	MANIFOLD WRENCH	41-W-1570-10	12003-X
	CYLINDER BASE NUT WRENCH	41-W-872-10	12650-29
	PISTON PIN BUSHING TOOL	41-T-3305	12057-X

TOOL ILLUSTRATION	NAME OF TOOL	FEDERAL STOCK NO.	HARLEY-DAVIDSON NO.
	LOCK RING TOOL	41-T-3260	12052-32
	VALVE GUIDE REAMER	41-R-2309-65	12623-26
	STANDARD SIZE VALVE GUIDE PILOT FOR USE WITH CLEARANCE CUTTER (11890-29)	41-P-412	12621-26
	OVERSIZE VALVE GUIDE PILOT FOR USE WITH CLEARANCE CUTTER (11890-29)	41-P-410	12622-26
	CUTTER HOLDER WITH HANDLE AND NUT FOR 11890-29	41-H-2270	11898-X
	VALVE SEAT CLEARANCE CUTTER FOR USE WITH HOLDER 11898-X	41-C-2822-30	11890-29
	SPIRAL EXPANSION REAMER FOR PISTON PIN BUSHINGS		11915-X
	CONNECTING ROD CLAMPING FIXTURE FOR USE WITH 12057-X AND 11915-X	41-T-3091	12058-X
	PISTON PIN BUSHING HONE (WITH FINE ABRASIVES)	41-H-2382	11844-X
	EXTRA SETS OF FINE ABRASIVES FOR 11844-X (4 SETS PER BOX)	41-A-10	11845-X
	ECCENTRIC VALVE SEAT GRINDER (WITH DIAL GAUGE)	40-V-530	
	PISTON SQUARING PLATE	41-P-1550-25	12655-26

TOOL ILLUSTRATION	NAME OF TOOL	FEDERAL STOCK NO.	HARLEY-DAVIDSON NO.
	SET OF CARBURETOR CLEAN-UP TOOLS	41-T-3081-45	12012-38
	SPROCKET NUT WRENCH (ALSO FITS 45 CRANK PIN NUTS)		12731-29
	GEAR AND BEARING PULLER	41-P-2903	11849-X
	FLYWHEEL SHAFT NUT WRENCH	41-W-1410	12645-29
	PINION SHAFT BUSHING REAMER	41-R-2304	12135-37
	CONNECTING ROD LAPPING ARBOR	41-A-337-10	11944-X
	TAPPET GUIDE PULLER	41-P-2956	11960-38
	CAM GEAR BUSHING REMOVER	41-R-2372-20	11952-36
	CRANKCASE MAIN BEARING LAP	41-L-203	11954-40
	LAPPING ARBOR WRENCH FOR 11944-X AND 11954-40	41-W-475	11950-X
	CAM GEAR SHAFT AND TIMER DRIVE SHAFT BUSHING REAMER	41-R-2265	12133-37

TOOL ILLUSTRATION	NAME OF TOOL	FEDERAL STOCK NO.	HARLEY-DAVIDSON NO.
	OILER DRIVE SHAFT AND PINION SHAFT BUSHING REAMER	41-R-2303	12132-36
	FLYWHEEL TRUING DEVICE	41-S-4970	11962-X
	EXTRA STATIONARY CENTER FOR 11962-X	41-C-468-60	11963-X
	EXTRA MOVABLE CENTER FOR 11962-X	41-C-468-50	11964-X
	EXTRA SET OF INDICATORS FOR 11962-X	41-I-125	11969-X
	ENDPLAY GAUGE	41-G-198	11967-38
	CLUTCH WRENCH (1940 AND EARLIER)		12745-26
	INNER CLUTCH DISC NUT WRENCH (1941 AND LATER)		12745-41
	INNER CLUTCH DISC PULLER	41-P-2905-90	12022-41
	CLUTCH GEAR BUSHING REAMER (1940 AND EARLIER MODELS)	41-R-2268	12660-26B
	CLUTCH GEAR BUSHING REAMER (1941 AND LATER MODELS)		12132-42
	CLUTCH GEAR OIL SEAL TOOL	41-G-1255	12747-41

TOOL ILLUSTRATION	NAME OF TOOL	FEDERAL STOCK NO.	HARLEY-DAVIDSON NO.
	CLUTCH GEAR OIL SEAL REPLACEMENT TOOL		12735-42
	WHEEL TRUING STAND (INCLUDES WHEEL ARBORS)	41-S-4995	12028-X
	REAR WHEEL SPOKE NIPPLE WRENCH	41-W-3340	12033-39
	FRONT WHEEL SPOKE NIPPLE WRENCH		12032-X
	BATTERY HYDROMETER	18-H-1242	11831-X
	COMBINATION VOLT-AMMETER		11828-X
	2" TO 3" OUTSIDE MICROMETER	41-C-233-50	12063-X
	0" TO 1" OUTSIDE MICROMETER	41-C-225	12062-X
	2" TO 8" INSIDE MICROMETERS	41-C-304	12065-X
	WHEEL MOUNTING SOCKET SCREW WRENCH	41-W-3832	12025-35

TOOL ILLUSTRATION	NAME OF TOOL	FEDERAL STOCK NO.	HARLEY-DAVIDSON NO.
	CHAIN TOOL	41-T-3320	12039-X
	SET OF COPPER JAWS FOR VISE	41-J-325	11973-X
	HANDLEBAR END TAP	41-T-1026	12043-36
	RAWHIDE MALLET	41-M-486	12034-X
	COPPER HAMMER	41-H-265	11970-X
	OIL SIPHON AND TANK FLUSHER		12059-X
	REAR SPROCKET RIVETING SET	41-J-373	12067-42
	FRAME AND FORK STRAIGHTENING BAR	41-T-3205	12082-X
	EXTENSION HANDLE FOR 12082-X		12082-XA
			
	AIR OPERATED GREASE GUN	40-G-498-25	

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