The armored school

Motorcycle Department

Fort Knox, Ky.

Motorcycle mechanics handbook

1943

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Motorcycle Mechanics Handbook

This text has been prepared by the Motorcycle Department of the Armored School to assemble in printed form some of the information taught on the mechanics of the motorcycle, knowledge of which is required of every graduate of this Motorcycle Mechanics Course. Although both the Indian and the Harley Davidson motorcycles are used by the United States Army, the armored units use the Harley Davidson almost exclusively. This text, therefore, while dealing generally with all models, treats particularly and in detail the 1941 and 1942 WLA model Harley Davidson, as this is the motorcycle that armored units mechanics study at present (May, 1943). A chapter has been included to discuss briefly pertinent features of the new experimental Harley Davidson XA shaft drive motorcycle.

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Introduction

At the time of the formation of motorized and mechanized forces in our Army, the need arose for a light, fast motor vehicle which could perform certain duties beyond the capabilities of any other in the Army. A vehicle was required for the rapid transportation of messengers and agents on liaison missions; for traffic control and many other tasks, administrative as well as tactical. The motorcycle adequately meets these requirements.

To man the motorcycles in an armored division requires a large number of well trained riders and mechanics. The maneuvering ability of the motorcycle is limited only by deep mud, deep stream crossings, heavy snow banks and the ability of the Motorcyclist. This last is the most important. In an armored unit, properly trained riders and mechanics are invaluable.

Chapter I: General characteristics of the motorcycle

The Motorcycle Solo is a two wheeled rubber-tired vehicle, powered by a two cylinder, air-cooled gasoline engine operating on the standard four-stroke cycle principle.

The motorcycle has many steering and handling features similar to those of a bicycle. It utilizes steering forks, and its “body” consists of a frame made of a number of sections of brazed tubular steel.

The engine operation is characteristic of all air-cooled engines in that it runs extremely hot, relying upon the movement of air over the cylinder walls and head fins and the circulation of oil to dissipate the heat. Operating temperatures of 350 °F (177 °C) to 450 °F (232 °C) degrees are average for this engine.

The WLA motorcycle engine depends upon its lubricating oil to carry away at least

thirty-five percent (35%) of the heat created; hence, the oil circulating system of this engine has a very important part to play in cooling the engine as well as lubricating it. The bearings, piston rings, cylinder walls, bushings and gears are oiled by a combination force feed and splash system. Oil is circulated by a feed pump and a scavenger pump. The WLA motorcycle uses a “dry sump” engine in which the oil supply is maintained in a tank separate from the engine rather than in a pan in the crankcase, as in an automobile.

The compression ratio is low, being 5.00 to 1 (earlier models had lower compression ratios). Despite this low ratio, however, the engine develops a maximum of 23 horsepower at 4600 r.p.m. Top speeds obtainable are around 85 m.p.h., and the machine can run as low as 2 or 3 mp.h. in first gear. Bearing fittings are measured to ten thousandths of an inch, pistons are fitted at from one to two thousandths clearance and, in general, the engine is set up very precisely. It is an extremely fine piece of workmanship.

The power train consists of four sprockets, two drive chains, a clutch and transmission. The chain drive is satisfactory, but it has certain undesirable features which are always encountered when chains are used. A shaft driven motorcycle, the XA model is now: in the testing stage and if adopted will eliminate the problem of chain maintenance and sprocket wear.

The transmission is of the constant mesh, progressive type, with three forward speeds and a neutral position. High gear ratio for army solo motorcycles is 4.59 to 1. This can be changed, of course, by installing sprockets of other sizes, but this ratio is common for all solo army models. The motorcycle transmission has proven itself to be a very satisfactory unit in the power train, providing it is well lubricated. Oil from the engine does not lubricate the transmission; oil must be inserted through a goose neck filler hole in the right side of the transmission itself. This is a fact often overlooked by new riders and mechanics alike and must be emphasized.

The clutch is of the multiple-disc, dry type. It gives very little trouble providing the three adjustments are maintained. The plates, of course, must be kept dry, free from oil, and fairly rough to provide friction.

Brakes are located on both the front and rear wheels of the motorcycle. The front brake is controlled by a lever and cable from the left handlebar. The rear brake is controlled by a foot pedal and linkage from the right foot board. Both brakes are of the simple internal expanding, two-shoe, fixed pivot mechanical type.

Wire-wheels are used on the motorcycle. Rims are of drop center construction and are usually 18 inches in diameter. Tires are deeply treaded, 4 ply, and 4 inches in width. These smaller 4 inch tires are preferred for Army use, which usually involves considerable work in mud and loose gravel.

The motorcycle employs a circuit-breaker ignition system, utilizing a high voltage induction coil for spark. In the electrical system are such items as: Two-beam headlights, “Black-out” or tactical lights, tail lights, stoplights, and horn. The generator easily carries the electrical load besides charging the battery.

The WLA Harley Davidson Army model has several features not found on civilian machines. Some of those are: “Black-out” lights, oil bath air cleaner, a carburetor with a fixed high speed jet, skid plate, military type fenders, and lusterless paint. Improvements will be added to army motorcycles as they are developed. Further specifications of the H.D. Army Solo Motorcycle (WLA):

Armament	varies between .45 caliber sub-machine gun, .45 caliber pistol, and .30 caliber carbine
Climbing ability	minimum required, low gear, 55% slope
	minimum required, high gear, 15% slope
Cruising range	minimum 100 miles (160 km) — 3 1/8 (11.8 l) gallon tank, engine averages approximately 85 miles per gallon (36 km/l; 2.8 l/100km)
Fordability	18 inches (45 cm) of water
Payload	250 to 300 pounds (113 to 136 kg)
Road Clearance	4 inches (10 cm) (vehicle can safely negotiate obstacles much higher than 4 inches due to the excellent skid plate and with proper handling by rider)
Speed	maximum required, 65 m.p.h. (105 km/h)
	minimum required, 5 m.p.h. (8 km/h)
Weight	approximately 560 pounds (254 kg), without equipment
Wheel Base	57 1/2 inches (146 cm)

The following illustrations show three views of the WLA motorcycle in the order: Top View, Left Side View, and Right Side View. Note that these illustrations do not show the various items of extra equipment normally carried on an Army motorcycle when it is outfitted for field service. These additional items and their location on the motorcycle are as follows:

1. **Ammunition box** — Carried on a bracket running down beside the left steering forks, and supported by this bracket and by additional brackets to the front fender and to the rocker plate on the left side of the front wheel. Box designed to hold a maximum of 10 clips (300 rounds) and 1 drum (50 rounds) of .45 caliber sub-machine gun ammunition, but normally carries only 6 clips (180 rounds) in the field. (See Stowage List for Motorcycles, Chapter XIII, for more detailed information).
2. **Brackets for sub-machine gun scabbard** — Carried on a bracket running down beside the right steering forks, and supported by this bracket and by additional brackets to the front fender and to the rocker plate on the right side of the front wheel.
3. **Front windshield** — Placed in front of handlebars, between handlebars and horn. Windshield extends down to the top of the front fender only, and does not seriously impair engine cooling. Use of this item should be avoided in the field, however, as it is highly unnecessary.
4. **Leg guards** — Placed vertically in front of right and left foot boards. These guards are not recommended for general use. They seriously impair proper engine cooling by blocking oncoming air.
5. **Saddle bags** — Carried on either side of the luggage carrier at the rear wheel.

WLA top view description

(See Figure 1)

1. **Throttle control grip** — Turn inward to open throttle; turn outward to close throttle.
2. **Spark control grip** — Turn inward to advance, turn outward to retard spark. Under normal operation, carry spark full advance.
3. **Clutch footpedal** — Toe down to engage; heel down to disengage clutch.
4. **Gear shift lever** — Gear positions are indicated on tank shifter gate.
5. **Rear brake foot pedal** — Apply gradually to break the speed of the machine. Do not "slam" brake on and hold.
6. **Front wheel brake hand lever** — Use to hold motorcycle on a grade, etc. Do not apply front brake at high speeds or on sharp turns.
7. **Kickstarter** — Operate with a vigorous, full stroke. Gear shifter lever must be in neutral position with clutch engaged when operating kick starter.
8. **Carburetor choke lever** — Raise choke lever up to prime engine. Put choke lever all the way down for normal running position.
9. **Gasoline tank** — Capacity: 3 1/3 gallons. Gas tank cap is vented.
10. **Oil tank** — Capacity: 3 1/2 quarts. Leave about one inch of air space for expansion between top of oil level and top of tank. Oil tank cap is not vented and hence is not interchangeable with gasoline tank cap.
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 quarts, or the equivalent of approximately 15 to 20 miles of road mileage.
12. **Speedometer lamp switch**.
13. **Horn button**.
14. **Headlight dimmer switch**.
15. **Steering damper** — Turn counter-clockwise to apply damper; clockwise to relieve damping effect.
16. **Ignition and light switch** — Switch is off when in the straight ahead position. Switch turns only to the right - first position to the right turns ignition system on. Second position to the right leaves ignition on and brings in the blackout circuit (blackout headlamp, driving light, tail light and brake stop light). Third position to the right leaves ignition on and brings in the service light circuit (headlight, panel light, service tail light and service brake stop light).
17. **Instrument panel signal lights** — Right light is oil pressure indicator (red). Left light is generator charging indicator (green). When switch is on with engine not running, both lights should go on. However as soon as engine is started, oil light should go off and remain off. Generator light may flicker on and off at slow speeds up to about 5 m.p.h., but should remain off at any speed above this figure. If either light flashes on at speeds above 5 m.ph. turn engine off immediately and check for trouble in either the generator or engine oil feed circuits.
18. **Caution plate** — Contains manufacturer's oil and spark plug recommendations.

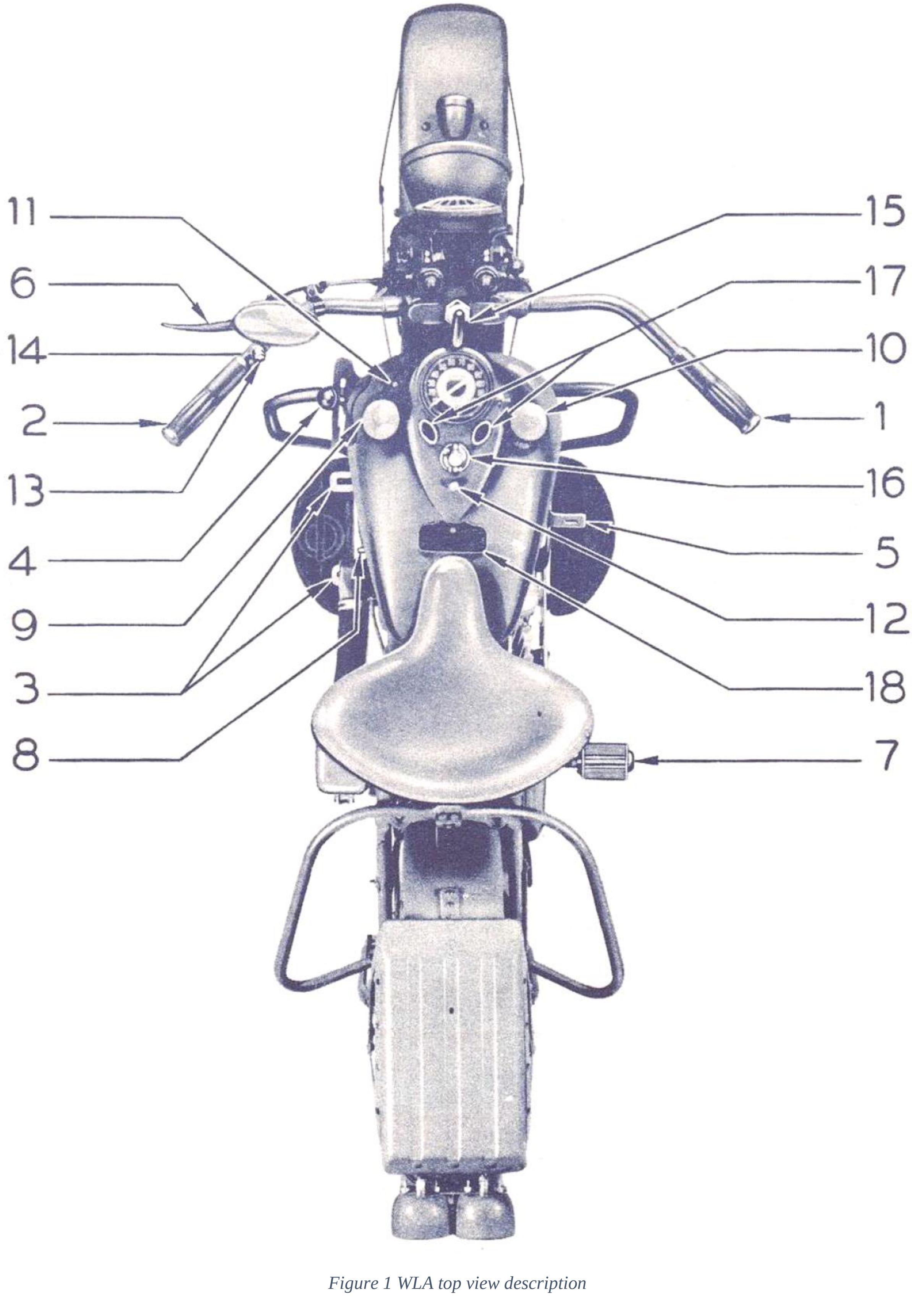


Figure 1 WLA top view description

WLA left side description

(See Figure 2)

19. **Balckout headlamp**.
20. **Horn**.
21. **Service headlight**.
22. **Rear vision mirror**.
23. **Oil bath air cleaner** — Requires daily service in dusty conditions.
24. **Blackout stop and tail light** (right side) — Top unit is blackout stop lamp; bottom unit is blackout tail lamp.
25. **Service and tail light** (left side) — Top unit is a double filament bulb which gives service stop and/or service tail light. Bottom unit is spare blackout tail lamp. In case regularly used (right side) blackout tail light fails, its socket plug can be transferred to this tail light socket.
26. **Front axle nut**.
27. **Front wheel brake control adjusting sleeve**.
28. **Front brake stabilizer**.
29. **Front brake shackle bolt**.
30. **Jiffy stand** — Always fold jiffy stand back before moving the motorcycle.
31. **Gear shifter rod**.
32. **Gasoline strainer**.
33. **Carburetor**.
34. **Timing inspection hole plug** — Provides access to ignition timing mark on flywheel.
35. **Engine serial number**.
36. **Front chain inspection hole cover**.
37. **Clutch cover inspection hole cover**.
38. **Rear wheel adjusting screw** (left side) — See rear wheel adjusting screw, right side - item 42.

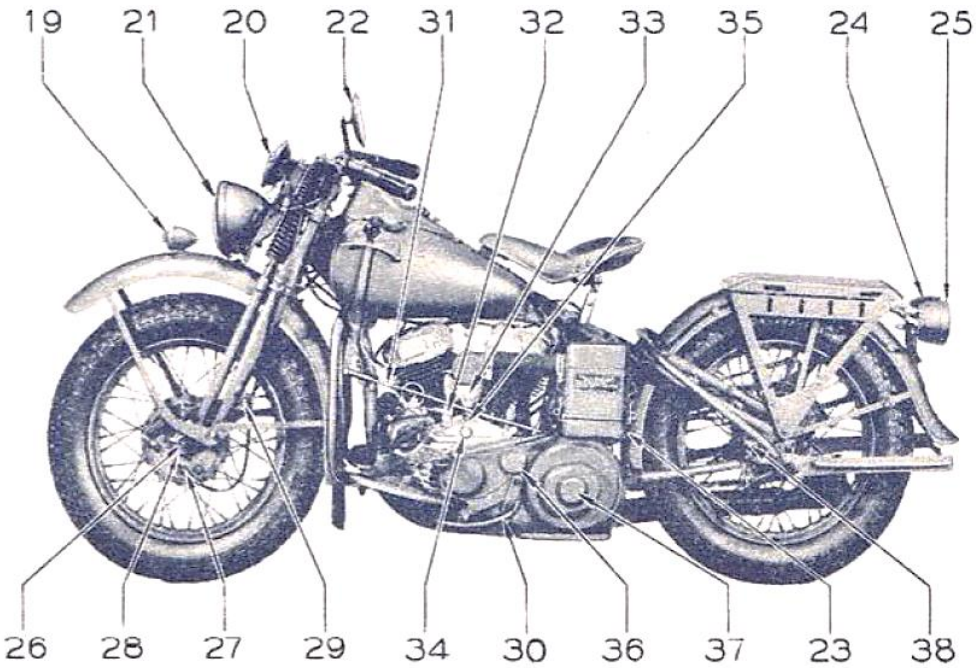


Figure 2 WLA left side description

WLA right side description

(See Figure 3)

39. **Rear brake rod lock**.
40. **Rear brake sleeve nut**.
41. **Rear axle nut**.
42. **Rear wheel adjusting screw** (right side) — See rear wheel adjusting screw, left side - item 88.
43. **Rear drive chain** — The chain should be adjusted to have 1/2 inch overall free movement, measured at a point midway between the sprockets. Move the rear wheel to adjust the chain as follows: Remove the rear axle nut and remove the rear axle and spacers. Replace the rear axle without spacers. Loosen the brake sleeve nut and move the rear wheel by means of the rear wheel adjusting screw on the right side until the chain acquires the proper tension. Tighten the brake sleeve nut, replace the axle spacers, tighten the rear axle nut, and bring the left side adjusting screw into contact with the axle.
44. **Clutch lever** — When clutch footpedal is in fully engaged position, lever should have 1/8 inch free travel back and forth along footpedal cable. When footpedal is in fully disengaged position, clutch lever should clear sprocket cover stud and nut by 1/16 inch. (See Chapter on Clutch).
45. **Transmission oil filler plug** — Engine oil does not lubricate the transmission. Lubricating oil for the transmission is put in by removing this filler plug. Transmission holds about 1/2 pint of oil, and uses same weight of oil as in the engine, according to the atmospheric temperature.
46. **Oil pressure switch**.
47. **Rear brake stoplight switch**.
48. **Oil feed pump**.
49. **Ignition circuit breaker**.
50. **Valve tappets and spring covers**.
51. **Generator relay**.
52. **Oil tank drain plug**.
53. **Rear brake rod adjustment**.
54. **Battery**.
55. **Oil tank vent pipe connection**.
56. **Feed pump oil pipe connection**.
57. **Scavenger pump oil pipe connection**.
58. **Spark plugs** — Use manufacturer's number 3 plug.

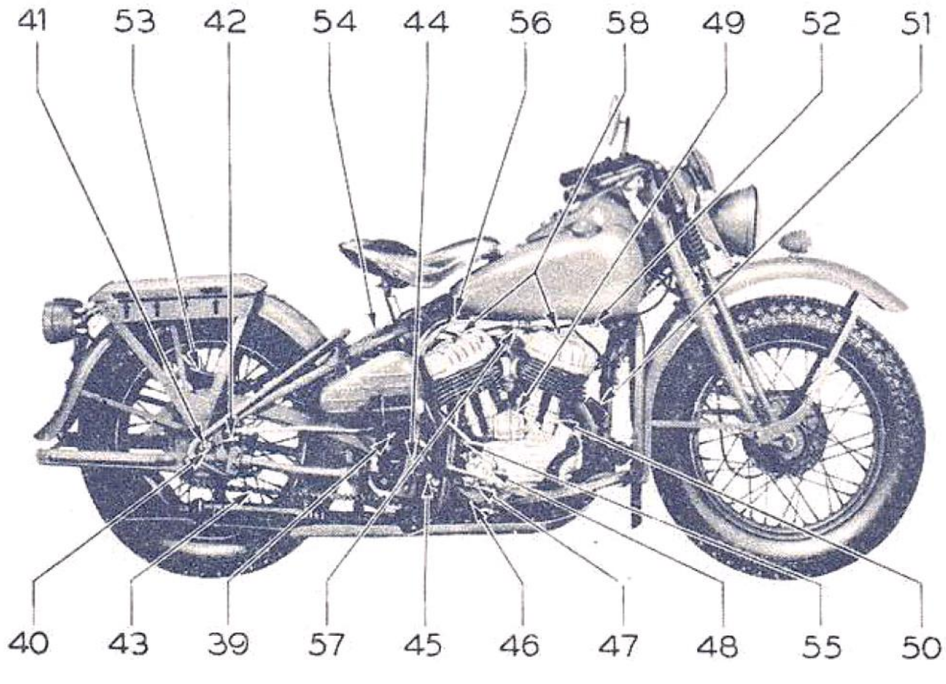


Figure 3 WLA right side description

Chapter II: The frame and forks

Barring accidents, the frame and forks require very little attention. If an accident distorts the frame, it is necessary to send the frame to the factory or to a unit that has a frame table. Straightening a frame by eye may sometimes be successful, and, in certain circumstances, may be necessary, but it is not advisable.

The frame consists of 9 castings and 8 pieces of S.A.E. 1045 steel tubing which vary in size and strength. The forgings are: the transmission base, seat post, frame head, engine brackets (two), foot board bracket, rear axle clips (two) and rear fender support and brace. The 8 steel tubings are: 1. Top cross bar from the seat post to frame head (1 1/4 inches in diameter). 2. Lower cross bar (1 1/8 inches in diameter). 3. Tubing from the seat post to transmission base (1 ¼ inches in diameter). 4 and 5. Two tubings from the seat post to the rear axle clips (7/8 inches in diameter). 6 and 7. Two tubings from the transmission base to the rear axle clips (7/8 inches in diameter). On the 45 the two tubings supporting the right rear wheel clip are reinforced internally with steel tubing and brazed due to added strain they absorb from the brake and the sprocket, which are on the right side. 8. The front tubing from the frame head to transmission base (1 3/8 inches in diameter), this tube is reinforced with an additional tube which is brazed inside, as it must absorb the engine torque. Each piece of tubing is shaped separately and then the knurled ends are press fitted into machined recesses in the forgings. The joints are then brazed.

When the whole frame has been assembled and brazed, it is heat treated. It is placed in an oven and heated from 1525 °F (830 °C) to 1540 °F (838 °F), quenched in water, and re-heated from 750 °F (400 °C) to 800 °F (427 °C) for two hours, allowed to cool and then trued. With this heat treatment, the frame becomes tough but not brittle. The steel in the frame is somewhat like spring steel. The actual hardness, measured by the Rockwell testing system, should be C 25 to C 30. The forks are brazed and heat treated in the same manner as the frame.

Motorcycle frames, although very strong, can be bent out of alignment by a terrific blow or other causes similar to those that would force a car or truck frame out of line. As with a car or truck frame a perfect job of straightening can be done only when the correct equipment is available. The motorcycle frame is straightened on what is termed a “frame table”. The top of this table is a heavy metal surface plate with threaded holes located 6 inches apart over the entire surface of the table top. These holes are for securing the necessary fixtures, clamps and equipment for straightening the various model frames (see Figure 4 on the next page).

The frame is supported on its side on this surface plate as shown in Figure 4, or if a frame table is not available, on some similar surface, and the center of all the tubings (with the exceptions of those supporting the rear wheel axle) should be equidistant from the table surface. When using a motorcycle frame table the center of each section of tubing (from the seat post forward) is located 8 inches from the table by measuring with a gauge that rests on the table surface and has different “steps” which make possible the checking of the different size tubings with only one gauge (this gauge is shown on the right of the frame table in the illustration).

For the first step in straightening the WLA frame, the transmission base casting is securely clamped in a special fixture, which is bolted to the table surface. This is the initial point and from it all other points on the frame can be accurately set.

The second point is the seat post which is bent until a fixture with a special plug gauge can fit into the seat post tubing.

Third, the upper tubing from the seat post to the frame head is checked, as this tube is 1 1/4 inches in diameter the 1 1/4 inch “step” on the gauge is used and the frame is bent until it just touches the gauge, the tube is then clamped securely in place by a clamp that is bolted to the table. Should it be necessary to bend any part, that part must be struck with a hammer to “set” it in the new position and then clamped in that position so that parts once straightened will remain that way while the rest of the frame is trued.

Fourth, the lower tubing from the seat post to the frame head is straightened, “set” and clamped. The 1 1/8 inch step on the gauge is used.

Fifth, the tube from the frame head to the engine base is trued. This is the largest and strongest tube in the frame and the 1 3/8 inch step on the gauge is used. It is straightened, “set” and clamped and all the points so far straightened should be re-checked.

Sixth, using a special gauge, the engine support brackets are squared, for the torque of the engine will tend to lower the front bracket, which can cause a cracked crankcase.

Seventh, the rear axle clips are set the correct distance apart (8 5/8 inches on the 1942 Models) and located in their correct relation to the rest of the frame by a gauge that rests on the table and has two “arms”.

Eighth, a small bar is placed in the axle clips to simulate the axle and using the same gauge as above, square the bar until it is exactly at right angles to the table. If it is not squared, the axle will not be horizontal to the ground when the motorcycle is assembled and the tire will wear on only one side. Quick “take offs” and stops tend to bend the axle clips out of line.

Ninth, the frame head must be checked. The forks fit into the frame head at a rake angle (similar to caster in automobile wheels) of 23 degrees, and they also have a 1/8 inch camber to the left to provide proper balance and steering characteristics. This camber is checked by using a 3 foot rod that fits flush into the frame head and a gauge designed to measure from the top of the rod to the table. The frame head, to be in proper alignment with the remainder of the frame, is bent so that at the frame head, the gauge is flush with the top of the check rod. At the lower end of the check rod, the gauge must be 1/8 inch above the top of the rod. The frame is never heated during the straightening process.

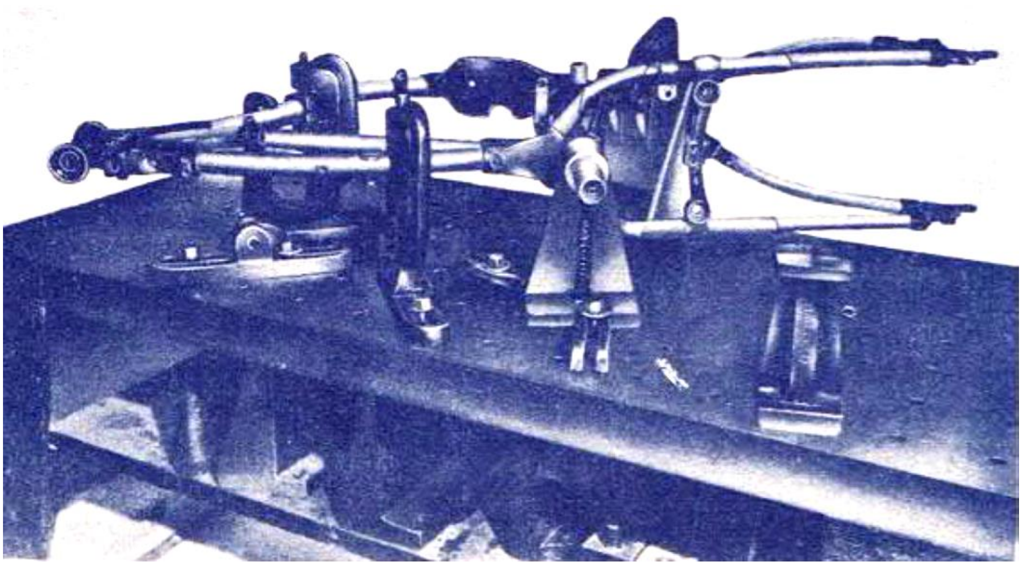


Figure 4 Motorcycle frame table

The motorcycle has two forks called the spring fork and the rigid fork. The spring fork consists of two spring fork side assemblies, the top parts of which are connected by a spring fork bracket. Equidistant from the center line of the forks, extending up from the spring fork bracket and bolted to it, are two spring rods.

The rigid fork consists of two rigid fork side assemblies joined at the proper distance at the top by the fork bracket. This bracket projects to the front of the fork. It is formed so as to provide a seat for the upper and lower coil springs which are used to spring the spring fork and also to provide a guide for the spring rods of the spring fork. The fork side assemblies are also held together by a bracket which is brazed to both the side assemblies. The bracket is called the crown plate reinforcement and supports the crown plate assembly. This assembly is a 7/8 inch steel rod extending up from the reinforcement along the centerline of the rigid fork. When the fork is assembled on the frame, this rod slides through a sleeve in the steering head assembly. The center section of the handlebars fits on the top of both fork side assemblies.

The crown plate assembly or rod projects through the center section of the handlebars far enough to allow a nut to be screwed on the threaded upper end. This construction permits the fork assembly to tum about the center line of the rigid fork, inasmuch as the crown plate assembly or rod turns in the head fitting on 26 ball bearings.

The spring fork assembly is supported on the rigid fork by coil springs which are placed concentrically around both spring rods. The bottom of the lower spring is seated on the bracket connecting the two side assemblies. Near the top of the rigid fork the upper end of the spring is seated on the bottom of a bracket, which projects from the spring fork. The top side of this spring is seated on a nut which is screwed on the top end of the threaded spring rod.

The fork is set in the steering head at an angle of 28 degrees to provide what is known as caster on an automobile but is called fork rake on a motorcycle. If this line of the rigid fork were extended to the ground it would be found to intersect the ground line in advance of the point of contact of the wheel with the ground; this distance is known as the "trail" of the wheel (see Figure 5). The steering geometry of the motorcycle, like that of most vehicles, is designed to enable the vehicle to be operated safely without weaving or shimmying.

The action of the spring fork in dampening road shock may be seen by referring to Figure 5. As the wheel is forced up by a bump in the road, spring "A" is compressed and absorbs the shock. The recoil is absorbed by spring "B'. This action continues until the vibration ceases. Inside springs "A" and "B" are stiff springs (not shown in Figure 5) which are shorter than the outer, and act only when extreme shock must be absorbed.

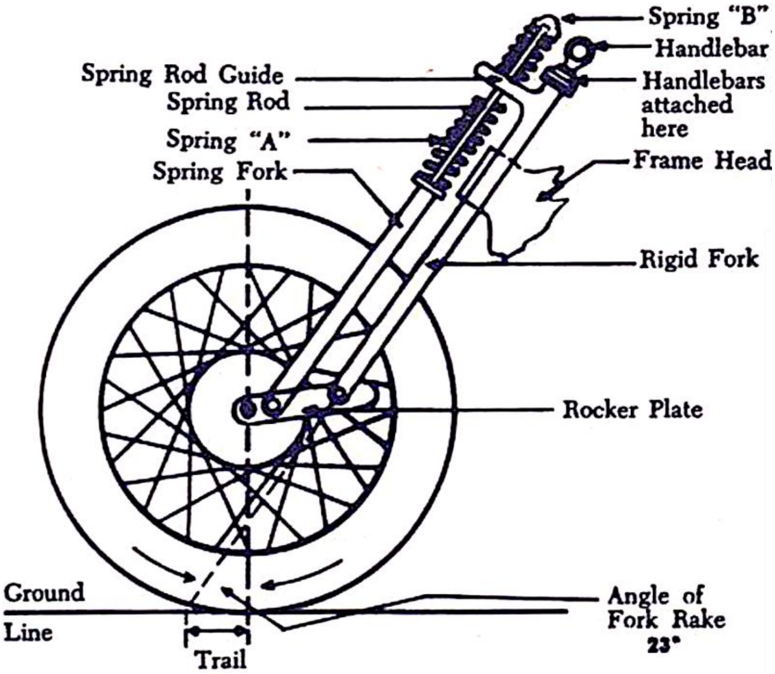


Figure 5 Illustrating fork rake and trail

Chapter III: The motorcycle engine

Section 1: Design, construction and operation of the motorcycle engine

The motorcycle engine is located in the frame between the two wheels and fastened by four bolts at the bottom and a bracket at the top. It is a high efficiency, high speed, air cooled engine, operating on the standard 4 stroke cycle. The Harley Davidson engine used in present WLA army solo models is a two cylinder, 45 degree, V-type, L-head (side valve), dry sump engine. It has a bore of 2 3/4 inches (69.85 mm), stroke of 8 13/16 inches (223.8375 mm), compression ratio of 5.00 to 1, and develops a maximum of 23 horse-power at 4600 r.p.m. The present (1942) retail price of the engine complete is $155.50.

The Armored Force at present uses only one size motorcycle; the 45 cubic inch solo model. The model number refers to the piston displacement of the engine in cubic inches. Piston displacement is the volume of gas displaced in one stroke of the pistons. The bore squared, multiplied by the factor .7854, multiplied by the stroke, equals the cubic inch displacement of a cylinder, which is approximately 22 1/2 cubic inches in the Army motorcycle solo. And since there are two cylinders, this gives the engine a total piston displacement of 45 cubic inches (737 ccm).

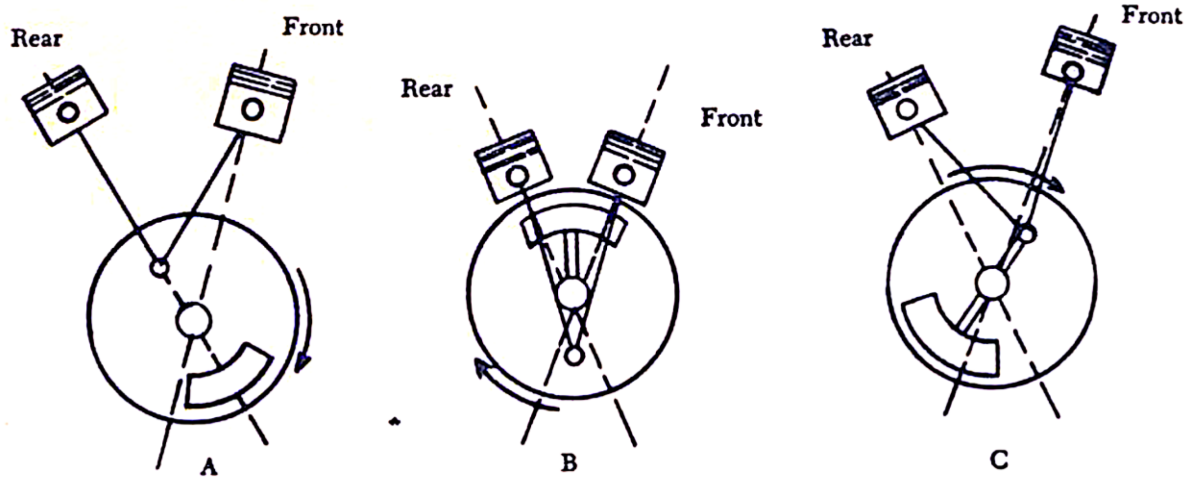
The crankshaft is entirely built up, the two halves of the flywheel combine the functions of crank throws, flywheels and counter weights, and are connected by a crank pin. Both connecting rods are attached to this crank pin. Both pistons, therefore, move in the same direction at the same time. The lower connecting rod bearings and the crankshaft main bearings are roller bearings.

The motorcycle engine has two cases, the crankcase, a completely enclosed unit containing the crankshaft (flywheel) assembly, and the timing gear case. The gear case is known as the “accessory case” on radial type air cooled engines. This case contains the 4 gear driven valve tappet cams, and from the gear case are driven the generator, circuit breaker, feed pump, scavenger pump and the crankcase breather (sleeve) valve. This latter is the only interconnection between these two separate cases and it provides a path for oil to leave the crankcase and enter the gear case.

The two cylinders are placed on the crankcase at an angle of 45 degrees to each other. It is impossible to obtain smooth operation from an engine of this type due to this angular relation of the cylinders.

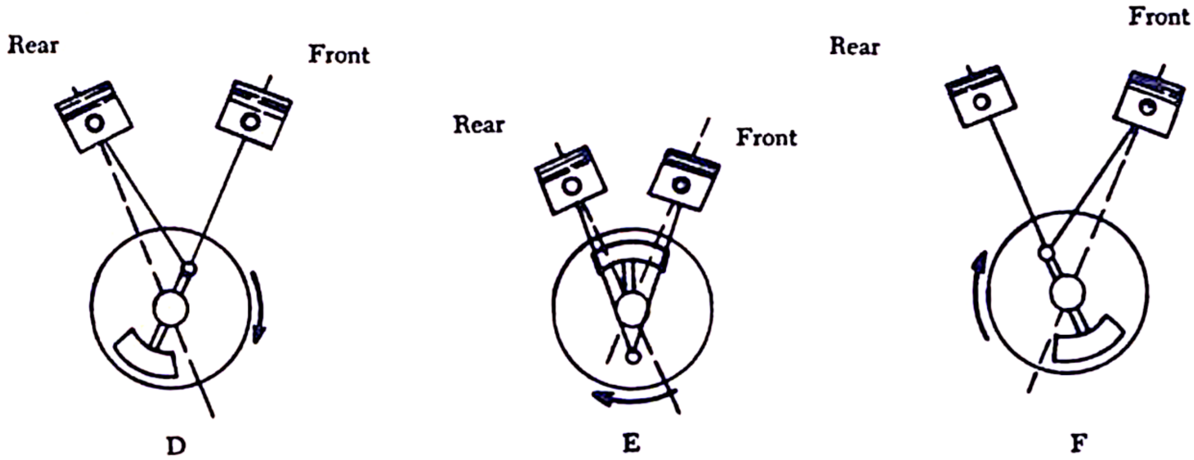
Referring to Figure 6, assume the rear cylinder in “A” has just fired and is on the power stroke; the front cylinder therefore is on the intake stroke. At “B” both pistons are near bottom dead center, the rear cylinder is beginning the exhaust stroke and the front is beginning the compression stroke. In order to reach top dead center in the front cylinder it is necessary for the flywheel to revolve the full 360 degrees to “X” and 45 degrees more to the front cylinder. This requires 405 degrees of flywheel rotation from power stroke of the rear cylinder to power of the front, as in “C”. When the front cylinder in “D” has just fired and is beginning the power stroke, the rear cylinder will be beginning the intake stroke. When they both reach “E”, the front cylinder will be rising on the exhaust stroke and the rear cylinder will be rising on compression stroke. At “F” the rear cylinder will be at top dead center and will fire, but the flywheel will not have rotated full 360 degrees to “Y’, but 360 degrees minus the 45 degrees angle between the cylinders. Thus, there will be only 315 degrees of flywheel rotation from power stroke of the front cylinder to power stroke of the rear cylinder.

With this type of engine, it is possible to have both spark plugs fire at the same time and yet have only one cylinder deliver a power stroke, because while one piston is rising on compression the other is always coming up on exhaust. Hence even though both plugs fire at the same time the only cylinder which would use the spark would be that one on compression. The spark would simply be wasted in the other cylinder which was on exhaust.



(Asterisk * Denotes Power Stroke In Each Case)

405° Flywheel Rotation Between Power Strokes from Rear to Front Cylinders



(Asterisk * Denotes Power Stroke In Each Case)

315° Flywheel Rotation Between Power Strokes from Front to Rear Cylinders

Figure 6 Flywheel rotation between power strokes

Section 2: Basic engine parts

A. The Flywheel Assembly

The crankshaft converts the reciprocating power it receives from the piston and connecting rod into rotary power and transmits it to the clutch and transmission. The conventional automobile engine uses a crankshaft with several cranks along its length, and a separate flywheel which is bolted to the shaft. The motorcycle engine has a “flywheel assembly” built up from eight principle parts: the two flywheels, the crank pin, the crankpin (lower connecting rod) roller bearings, the two connecting rods (one male and one female), and two shafts called the pinion shaft and the sprocket shaft. All these parts are accurately aligned and securely bolted together (see Figure 7).

The crank pin, sprocket shaft and pinion shaft are made of very hard carbonized steel. The threads are soft, however, and care should be taken not to damage them. The pinion shaft is tapered and keyed into the right flywheel and although the oil passages should automatically line up they should be tested by blowing air through them. The sprocket shaft fits into the left flywheel in a like manner, but care must be taken that the correct end of the shaft is inserted. The end with the short taper supports the engine sprocket. If the shaft ends are reversed it will be found to be impossible to tighten the sprocket, necessitating almost complete disassembly. Both these shafts are keyed into the flywheels and drawn up securely in the tapered holes by the shaft nuts. The nuts then are locked in place by lock washers which in turn are secured to the flywheels by screws.

The crank pin joins the two flywheels and completes the flywheel assembly (see Figure 7). The two connecting rods are attached to the crank pin and transmit the reciprocating action of the pistons to the crank pin and the flywheel assembly.

B. Connecting Rods and Crank Pin

Roller bearings like those between the shafts and the bearing races in the cases are used between the lower end of the connecting rods and the crank pin. The two connecting rods are of the yoke type and on all 45-inch models since the 1940 the forked or female rod goes in the rear cylinder. Each rod has forging marks on one side and is plain on the other, they are correctly assembled when the forging marks both face the same side. Single retainers, each containing twelve rollers, .270 inch long, are used in the forked end of the rear connecting rod and one double retainer of twelve rollers, .550 inch long, is used in the single-end connecting rod.

The connecting rods should be .0007 inch to .001 inch loose on the crank pin and this fit is achieved by using the proper size rollers between the lower rod bushing and the crank pin. The correct roller size is determined by the “plug fit” system described in Section 3, part A. The Crankcase. These rollers are available in 21 different sizes from .249 inch diameter to .251 inch diameter in graduations of .001 inch. If the bushings on the connecting rods are too small it will be necessary to lap them. When lapping, place both rods on the lap at the same time. It is difficult to press bushings accurately into the lower ends of the connecting rods and usually the rods are sent to the factory for new bushings.

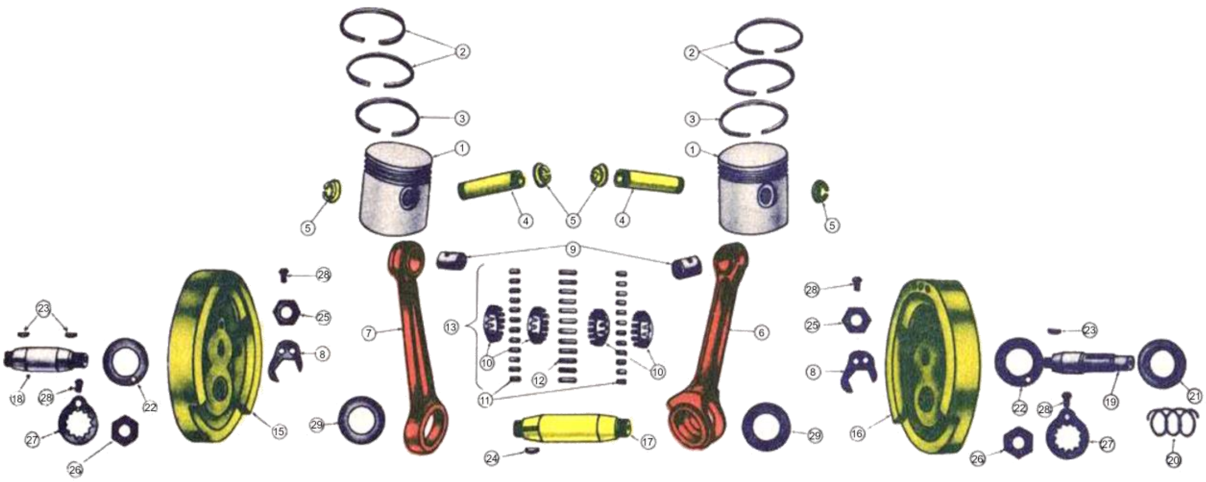
The upper end of each connecting rod contains a bronze bushing in which the piston pin operates. It is a simple operation to replace a worn piston pin bushing by pressing in a new one. The top of the rod and the top of the bushing each have an oil hole and great care must be taken that these holes line up when the bushing is in place. The piston pin bushing should be .001 inch larger than the piston pin. The bushing is enlarged to fit the pin by honing. A roughing stone can be used until it is just possible to force the pin into the bushing then a finishing stone should be used until the correct fit is obtained. A gauge can be used to determine bushing size, or the pin and bushing can be coated with OW 30 engine oil and fitted together. When turned sideways, the pin will slowly fall out of the bushing if the fit is correct. When honing, place the connecting rod on the hone in a clamp and at right angles to the hone, then expand the mandril and work along the entire length of the stones, taking care not to run the work off of the stones.

The crankpin, like the two shafts, is made of carbonized steel, and is tapered and threaded on both ends. The pin is keyed into the flywheel, and when assembling, it is fastened to this wheel first. Then the connecting rods with their roller bearings are installed on the pin and the other end of the pin is secured in the right flywheel. The overall width of the roller retainer assembly must be less than the width of the female rod end. The pin and flywheel tapers are assembled clean and dry and the pin is drawn up by the pin unts until the assembly is tight and the connecting rods have .006 inch to .010 inch side play between the flywheels. Side play is measured by inserting a feeler gauge between the side of the forked connecting rod and the flywheel and revolving the rods completely around to find the high point or the least clearance. Should the connecting rods have less than .006 inch side play on the pin it will be necessary to use another crankpin, and if the have more than 0.010 inch side play on the pin the crankpin nuts can be drawn down until 0.010 inch play is reached. In tightening down on the nuts, however, extreme care must be taken to apply tension gradually to prevent cracking the flywheels. Both the crankpin and the holes in the flywheels must be clean and free of any dirt or oil for this will also cause the flywheels to crack when the nuts are drawn down tight. The pin nuts are locked by washers similar to those used on the sprocket shaft and the pinion shaft. The nuts should never be loosened to fit the lock washers but always tightened.

C. Flywheel Alignment

This built-up flywheel assembly must be accurately aligned or it will vibrate and cause damage to the engine. One thousandth of an inch is the maximum that each shaft may be out of alignment with the other. When the shafts are absolutely true the two flywheels will then resolve as one unit.

The flywheels are roughly aligned with a copper mallet and a steel rule while tightening for rod side play. The holes in the ends of the shafts are then cleaned and the entire assembly is placed in a flywheel truing device and it is supported by the two hard steel points that clamp into the holes in the ends of the shafts. Two indicator needles are then set on the shafts near the flywheels. When the assembly is rotated, the exact amount that each shaft is out of line can be measured in thousandths of an inch by the movement of the needles on the scales. The exact point where a shaft is out of line can easily be determined and the wheels struck with a mallet at that point. Before striking the wheels to knock them into line, loosen the points that hold the shafts so the blow won't "set" the assembly together or break off the points.



1. Piston
2. Piston compression ring
3. Oil control ring
4. Piston pin
5. Piston lock ring
6. Rear connecting rod
7. Front connecting rod
8. Washer, shaft nut lock
9. Piston pin bushing
10. Crank pin roller retainer
11. Crank pin roller, short
12. Crank pin roller, long
13. Set of rollers & retainers
14. Flywheels, set with shafts
15. Flywheel, left
16. Flywheel, right
17. Pin, crank
18. Shaft, sprocket
19. Shaft, gear side
20. Spring, seal ring
21. Ring, bearing seal
22. Collars
23. Key, sprocket & gear shaft
24. Key, crank pin
25. Nut, sprocket & gear shaft
26. Nut, crank pin
27. Washer shaft nut lock
28. Screw, for lock washer
29. Washer flywheel

Figure 7 Connecting rods & flywheel assembly

If the flywheels "toe out", as in Figure 8, press in with the truing device and strike on the crank pin side or use a vise and pull the flywheels together opposite the crank pin. If they "toe in", as in Figure 9, drive a wedge lightly between the wheels opposite the crank pin and tap the flywheels on the crank pin side. The assembly can easily be loosened by removing the nut on the unkeyed (right) side of the crank pin and striking the flywheel at a point ninety degrees from the crank pin. When the flywheel assembly has been accurately aligned the crankcases are bolted around it as described in a later section of this chapter.

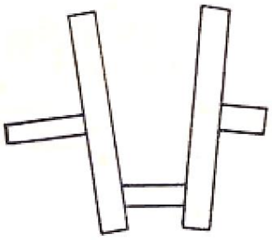


Figure 8 Flywheel "toe out"

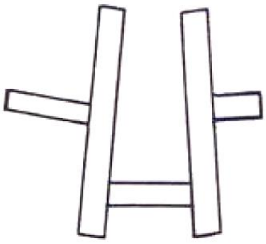


Figure 9 Flywheel "toe in"

D. Straightening Connecting Rods

The connecting rods being made of fine steel are very strong but occasionally they will become twisted or bent. Bent or twisted connecting rods will cause severe piston and cylinder wear. When assembling an engine it is always advisable to check for distortion.

To make this check, assemble the pistons on the rods and place a truing plate around the rod and on the cylinder studs on the top of the crankcase; the connecting rod is then pushing down through the truing plate until the piston touches the plate. The piston should touch the plate evenly all the way around the piston skirt whether the flywheel is revolved to the rear or to the front. If one side of the piston skirt does not touch the plate when the flywheel is turned forward and the same side does not touch when the flywheel is rotated backward, a bent rod is indicated.

To straighten, use a small bar inserted through the piston pin and bend the rod down so that the piston skirt will touch evenly. A recognized method of determining whether the skirt is touching evenly is to insert a thin piece of paper, such as cigarette paper, under each piston. Then while putting a slight pressure on top of the piston, attempt to withdraw the paper from under the piston skirt. It should be equally tight on both sides.

If one side of the piston skirt does not touch the plate when the flywheel is rotated forward and the other side of the skirt does not touch when the flywheel is rotated backward, a twisted rod is indicated. A twist is corrected by using a small bar placed in an old piston pin and twisting the high side of the skirt away from the direction in which the flywheel was rotated when bringing the piston down upon the plate. Never allow the connecting rods to strike the edge of the case as the soft aluminum will "burr" making it difficult to fit the cylinders into the recess in the case.

E. Pistons and Piston Pins

The motorcycle uses cam ground aluminum pistons which are tapered .003 inch to .004 inch toward the skirt. A cam ground piston is elliptical in shape instead of being perfectly round. Its diameter is greater from front to rear and less across the piston bosses.

This difference in the motorcycle piston is approximately .030 inch. The advantage of a cam ground piston is that it will fit tightly in the cylinder when cold and yet, it can expand sideways when hot by moving on the piston pin and damage neither piston nor cylinder. It is for this reason that the piston pin must be a hand press fit in the piston.

The pistons are fitted with three rings, (see Figure 10) the lower ring is an oil control ring with a channel in its face and is larger than the two upper compression rings. The rings should be fitted with .004 inch clearance in the groove and with .010 inch to .020 inch ring gap. Never use a ring that is any more than .005 inch larger than the cylinder bore. If a larger size ring is used and the ends are ground off to gain the correct ring gap the ring will assume an oval shape in the cylinder. To obtain proper ring groove side clearance (.004 inch) first secure an absolutely flat piece of steel. On the steel plate, place a piece of emery paper. Rub the ring evenly over the emery paper and remove the necessary amount of metal from the ring so that the desired side clearance can be obtained. Space the ring gaps about equidistant around the piston but never locate a ring gap near the exhaust valve port, as in this position ring ends may be overheated and burned.

Pistons are available in various sizes: standard, to fit the standard 2.746 inch bore, (actual piston size: 2.744 inches, with .002 inch clearance between piston and cylinder) and .005 inch, .010 inch, .020 inch, .030 inch and up to .070 inch oversize in graduations of .010 inch. The factory size of a piston can be determined by the number stamped on the top, but when measuring pistons the micrometer is placed at the bottom of the skirt and the piston is measured across the thrust (wide) sides.

Pistons from .030 inch oversize on up have T-slots to take care of over expansion due to excessive overheating. Both pistons should always be placed in the cylinder so that the T-slot is away from the thrust side, that is, facing the front of the engine, toward the direction of flywheel rotation.

The piston is fastened to the connecting rod by a hollow, full floating piston pin. A full floating piston pin is one which is free in both the piston and connecting rod bushings, as compared with one that is tight in either the piston or in the rod bushing. A full floating pin is necessary when using cam ground pistons.

The piston pin is held in the piston bosses by a lock ring which fits in a groove in the slotted end of the pin. Usually, both slotted ends face the same side. The lock rings can be used only once. Therefore, every time an engine is assembled a new piston pin lock ring must be used. Lock rings used a second time will, due to the fact that they have lost their tension, often allow the pin to slip out and score the sides of the cylinder. The lock rings are installed and removed by a special lock ring tool.

Pistons are easily bent and marred and should never be dropped. When they are assembled on the connecting rods never allow the piston skirts to strike the cylinder base studs for they can be permanently marred.

F. Cylinders

The cylinders are made of high grade cast iron with the fins for cooling. The Army solo motorcycle engine is of the L-head, or side valve, design and the valve seats and intake and exhaust ports are cast with the cylinder. The valves and valve seats are faced to an angle of 45 degrees. The exhaust valves, due to the high operating temperatures to which they are subjected, are made of higher grade steel than the intake valves. Exhaust valves can be identified by the letter “Ex” on the valve head and the intake valves by “In”. Valve and valve seat refacing stones are most efficient for accurate valve work. Valve grinding compounds, if used exclusively, will not produce a perfectly straight face but are likely to round off the corners thus giving a narrow area of contact between the valve and valve seat. Full surface contact aids in cooling the valve, contact can be tested by marking the face of the valve with a pencil and rotating it in the seat, and areas not in contact will not cause the pencil marks to rub off. If grinding a valve leaves the edge of the valve thin or sharp, discard it, as it will not seat normally, will burn easily and may crack or cause pre-ignition. Motorcycle valves are solid, and not of the hollow sodium filled type.

As valves and seats are refaced from time to time, the valve seats widen and the valves will seat in a lower position when fully closed. As a result, when the valve is fully open the passage around it will be restricted. To correct this, the metal above the cylinder valve seat must be cut away so that the top edge of the valve seat and the top edge of the valve match exactly (see illustration). The valve guides are pressed into the cylinder. The valve stems should be .0035 inch to .0055 inch loose in the guides. A new valve spring has a free length of 2.584 inches; when under 55 Ibs. pressure it is 2.196 inches (plus or minus 10%), and under 100 Ibs pressure it is 1.884 inches (plus or minus 10%). Valve springs should not be used if their overall free length is 2.459 inches or less.

Army pistons are usually fitted .002 inch loose in the cylinders and to get this fit it is necessary to hone the cylinders to fit the piston. For example, if it is necessary to use .020 inch oversize pistons it will be necessary to hone the cylinders .020 inch oversize or approximately 2.766 inches (2.744, standard piston, plus .020 inch oversize, plus .002 inch clearance equals 2.766 inches, refitted cylinder size). The piston is measured with an outside micrometer from front to back at the skirt and then the bore of the cylinder is measured with an inside micrometer. Inside and outside micrometers should always be checked against each other for accurate work. A cylinder is always measured on the thrust sides (front to rear) about one half inch down from the top where the greatest wear occurs, and it also should be checked at the bottom to determine the taper of the bore.

A power-driven hone is used to enlarge the bore and straighten the hole. The revolving hone should be run up and down in the cylinder bore with slow even strokes in order to make an absolutely straight hole. Care must be taken not to run the hone out of the bore as this will break the stones. The cylinder should be wiped clean and frequently measured for size and taper during the honing process.

There are three grades of honing stones, the roughing stone which is used for rough work up to the last .002 inch, the medium stone which is used up to the last .0005 inch and the polishing stone which polishes off the last .0005 inch. Roughing and finishing stones are used dry, but lard is used with the polishing stone. Each grade of stone uses a different hone guide and to prevent damage to the stone, the correct guide must always be used.

Another way to check piston clearance is, first, get a straight “hole” and enlarge it until the piston, together with a strip of .002 inch feeler stock, can be slipped into the cylinder.

When the pistons are correctly fitted, the cylinders can be assembled on the crankcase.

A paper gasket is fitted between the cylinders and the crankcase and the cylinders are slipped down over the pistons and onto the cylinder base studs. Next the intake manifold is attached to the intake ports and then the cylinder base nuts are tightened with a box end wrench, this wrench being the only type that can be used without involving the danger of denting the cylinder walls.

G. Cylinder Heads

Army motorcycles have aluminum cylinder heads which are fastened to the cylinders by eight bolts with heavy washers. The copper head gasket can be used repeatedly if it is not blackened more than one half inch across the gasket. Cement is not necessary but always use cylinder oil on the gasket so that it may “creep” when the head is tightened. A gasket cannot seal if its surface or that of the head or cylinder has been scratched or burred. A leaking gasket or a loose head bolt will permanently warp the cylinder head. The head bolts are 7/16 inch in diameter and opposite bolts should be drawn up with a torque wrench to approximately 60 foot pounds.

A special motorcycle spark plug should always be used, as it must operate under intense heat. Ordinary spark plug porcelains become loose when heated and create a leak along the side of the porcelain which will warp the cylinder head. Army motorcycles ordinarily use the manufacturer's No. 3 spark plug. Spark plugs fit into bronze inserts which are cast in the head. Spark plugs should never be removed when the head is hot as aluminum expands from the insert and allows it to come out with the spark plug. Frequently the usefulness of the cylinder head is destroyed as it is practically impossible to replace an insert.

The upper part of the engine is secured to the frame by the cylinder head bracket. Sufficient shims must be placed between the bracket and the frame so that when the bracket is bolted to the frame, the cylinders will be neither spread nor pulled together.

A “top overhaul” is the term applied to an overhaul consisting of the following operations: rebore cylinders, fit new pistons, piston pins and rings, grind valves and clean carbon. Top overhaul can be done easily without removing the engine from the frame.

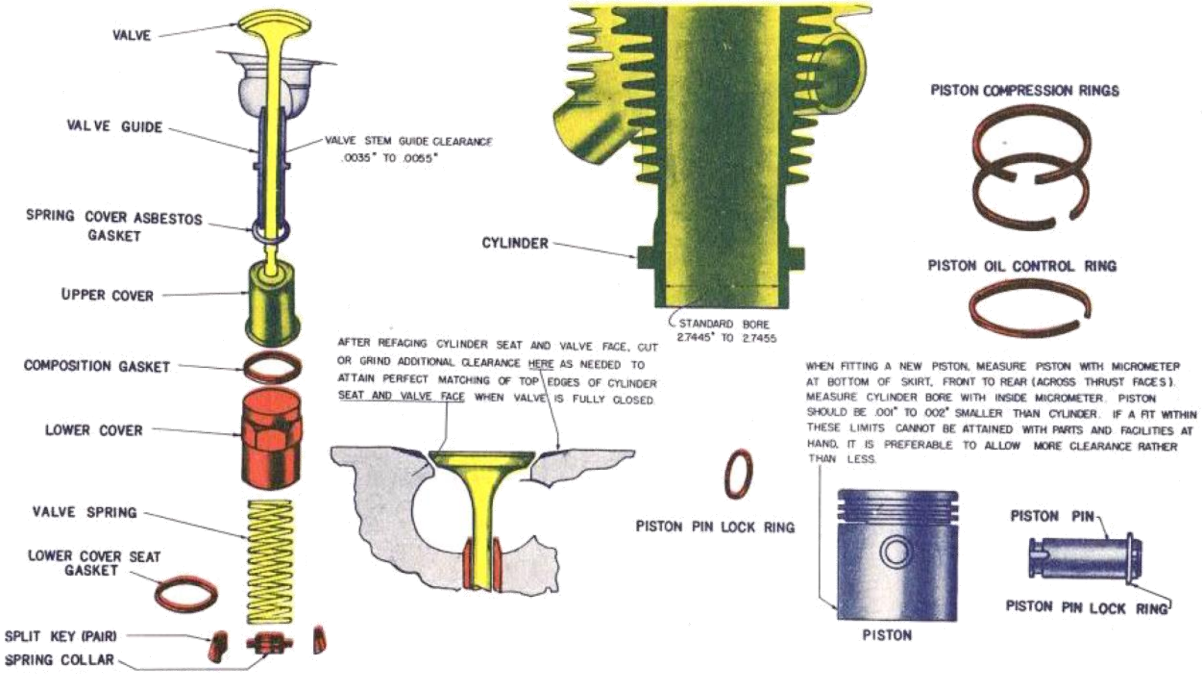
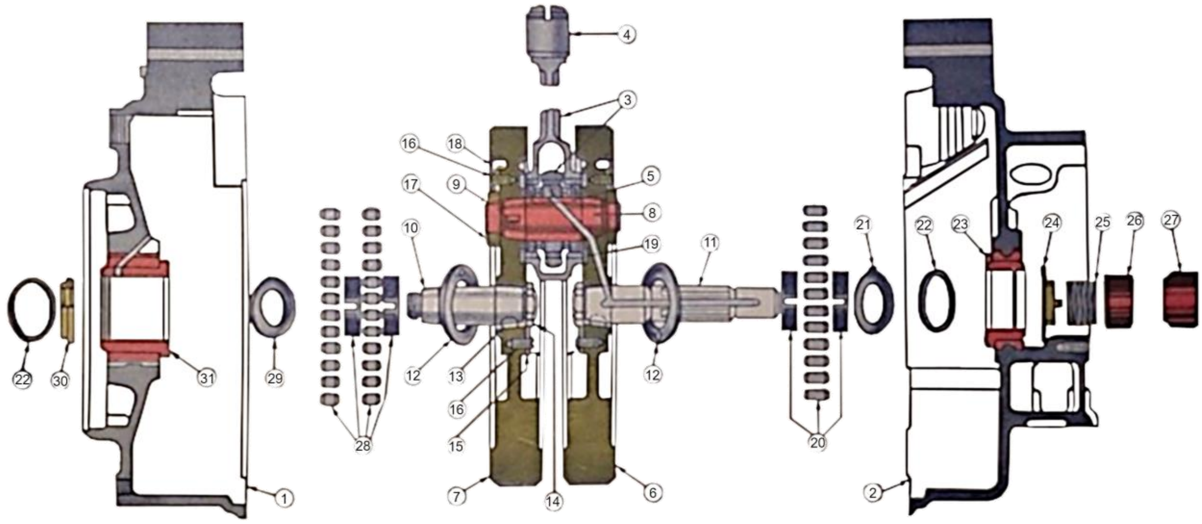


Figure 10 Upper end assembly

Section 3: Crankcase and timing gear case

The Harley Davidson WLA 45 cubic inch motorcycle uses a dry sump engine with two cases, the crankcase and the timing gear case. Both cases are of cast and machined aluminum for lightness and cooling.

The crankcase is a completely inclosed unit and contains the flywheel assembly. The timing gear case is on the right side of the crankcase, and its left (inner) wall is a part of the right wall of the crankcase. The timing gear case is connected to the crankcase by a timed, ported, sleeve valve (the crankcase breather valve) and it has a vent to the outside air (the relief pipe). From this case are driven the engine accessories and in it are located the four valve cam gears (two intake and two exhaust).



1&2. Set of crank cases
3. Set of connecting rods
4. Piston pin bushings
5. Crank pin roller bearing
6. Right flywheel
7. Left flywheel
8. Crank pin
9. Crank pin key
10. Spoket shaft
11. Gear shaft
12. Flywheel trust collar
13. Shaft key
14. Shaft nut
15. Lockwasher, sprocket & pinion shaft nuts
16. Lockwasher screw
17. Crank pin nut
18. Lockwasher, Crank pin nuts
19. Flywheel steel washer
20. Gear shaft roller bearing
21. Gear shaft bearing washer
22. Bearing spring ring
23. Right crank case roller bearing bushing
24. Gear shaft bearing oil seal ring
25. Bearing seal ring spring
26. Breather valve & scavenger pump drive gear
27. Pinion gear
28. Sprocket shaft roller bearing
29. Sprocket shaft bearing washer
30. Oil retaining Bushing
31. Left crank case roller bearing bushing

Figure 11 Engine base assembly

A. The Crankcase

Two aluminum castings accurately fitted together, aligned by means of a tongue-and-groove joint, and fastened by seven cadmium-plated steel screws and studs form the crankcase. No gasket is used between the castings. The stud at the top of the case and two at the bottom are machined to fit and act as a dowels to line up the halves accurately.

The sprocket shaft of the flywheel assembly protrudes through the left half of the case and the pinion gear shaft protrudes through the right half into the timing gear case, (see Figure 11). Each case housing has a soft steel bushing cast integrally with the aluminum and locked in place by splines and grooves. A hard steel race is pressed into each bushing and the sprocket and pinion gear shafts revolve on roller bearings which run in these races. The sprocket shaft runs on two sets of roller bearings in the left housing and the pinion gear shaft runs on one set of bearings in the right housing, as there is, less radial thrust on that side. (See Figure 11).

The standard bearings on both sides are .250 inch in diameter and are obtainable from .001 inch undersize (.249 inch) to .001 inch oversize (.251 inch), in graduations of .0001 inch. On the sprocket side are 24 rollers, 2 sets of 12 rollers each, .360 inch long, and on the right, pinion, side are 12 rollers .550 inch long.

When correctly fitted the sprocket shaft has clearance of .0005 inch in the roller bearings and the pinion gear shaft has .00075 inch to .00125 inch. The selection of a correct set of oversize or undersize rollers to obtain this fit is done by the following procedure:

Place the retainer and rollers, .0006 inch oversize (.2506 inch) for example, in the roller race and try to fit the shaft through the housing. Should the shaft slip through easily, try .0007 inch oversize rollers (all rollers the same size on each check) and try the shaft, if it is loose try .0008 inch oversize rollers.

Suppose this size roller results in a plug fit, that is a tight fit with NO clearance. It has now been established that an .0008 inch oversize (.2508 inch) roller fills completely the space around the shaft between the shaft and the housing.

To obtain the running fit see the manufacturer's specifications which in the case of the pinion gear shaft call for a clearance or fit of .00075 inch to .00125 inch. Then having decided the fit to use (in this case it could be a .001 inch running fit), take half of this figure .0005 inch, and subtract this from the .0008 inch oversize roller which gave the "plug fit" and the result, .0003 inch, will be the oversize roller to use in order to obtain the desired running fit. In this case a .0003 inch oversize roller bearing, .2503 inch in diameter, would be the correct size to use. The reason for using half of the desired running fit is that for every .0001 inch reduction in size from the "plug fit", .0002 inch clearance is gained, .0001 inch on each side of the shaft.

To fit roller bearings, ascertain the size bearing giving a plug fit, subtract from that size, one half of the running fit and the result will be the correct size to use. Make all checks with parts dry, as a film of oil will make calculations inaccurate.

Therefore, if:

- .0003 inch oversize rollers equal a plug fit,
- .0002 inch oversize rollers equal .0002 inch loose fit.
- .0001 inch oversize rollers equal .0004 inch loose fit.
- Standard rollers equal .0006 inch loose fit.
- .0001 inch undersize rollers equal .0008 inch loose fit.
- .0002 inch undersize rollers equal .001 inch loose fit.
- .0003 inch undersize rollers equal .0012 inch loose fit.

These rollers are checked for size with a snap gauge in the factory and as it is impossible to check their size with a shop micrometer, it is absolutely necessary that each size roller be kept in its own labeled container. Mixed rollers are useless.

The bearings on the sprocket shaft are lubricated by gravity through a drilled passage to the top of the outer bearings (see Figure 11). The vacuum created in the case on the up-stroke of the piston carries the oil over the inner race of rollers. The bearings on the pinion shaft side are lubricated by splash.

To assemble the crankcase, place the correct size bearings in each retainer, the necessary washers, etc., on the shafts (see Figure 11), the flywheel assembly in the case, and the housings together. Clean all oil and shellac from the edges of the two castings. Put in two screws at the top and two studs at the bottom. Tap the cases so the tongue and groove fits together and tighten them securely. If the halves of the case are not tapped together before tightening, the tongue and groove will shave the aluminum as the nuts are drawn down. At the top of the crankcase will be found two recesses approximately 3 inches in diameter and 45 degrees apart. In these recesses the two cylinders are seated by bolting them to eight studs.

When the two housings are drawn tightly together the flywheel assembly should have .012 inch to .014 inch end-play within the case. Should there be incorrect end-play, take the case apart and change thrust collars (see Figure 11). The thrust collars are obtainable from .066 inch to .102 inch in thickness in graduations of .004 inch.

In setting up the proper end play in the flywheel assembly, care must be taken to put in approximately the same size thrust collars on either side of the assembly so that the connecting rods will be centered in the cylinders. Connecting rods which are off center will cause extreme piston wear because they give the pistons an unbalanced stroke in the cylinders and do not allow them to wear evenly on both sides.

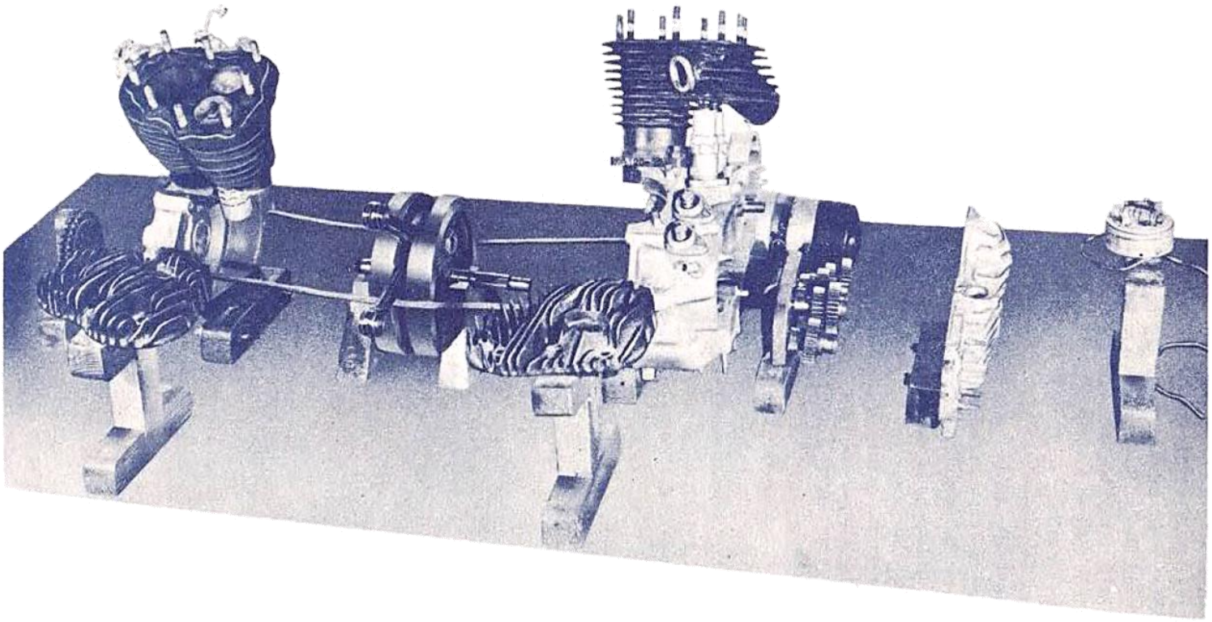


Figure 12 "Blown Up" WLA engine

As an example, assume the flywheel assembly has no endplay when there are thrust collars .082 inch thick on either side. To obtain the desired .012 inch to .014 inch end play and still center the connecting rods it would be necessary to remove say .004 inch from one side and .008 inch from the other side to set up the desired .012 inch end play. This could be done by inserting a collar .078 inch thick on one side (.082 minus .078 inch equals .004 inch) and a collar .074 inch thick on the other side (.082 inch minus .074 inch equals .008 inch). This will bring the rods within .004 inch of being on center, which is as close as can be expected.

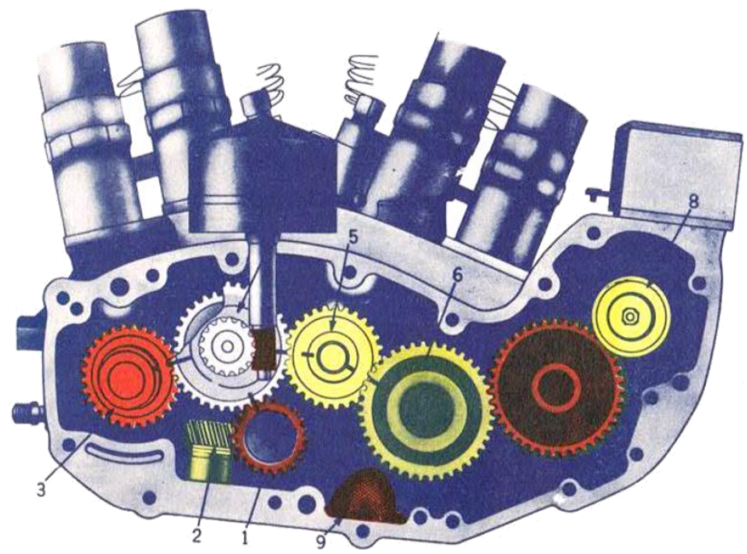
After the adjustments for end play and rod centering have been made, shellac the edges of the housings, tap them together, insert the bolts and screws and draw up opposite nuts a little at a time until tight. When the case is assembled, make a final check for end play (the shellac will change the end play adjustment only about .0005 inch).

B. The Timing Gear Case, Valve Operation and Tappet Adjustment

The timing gear case is on the right side of the engine and is usually referred to merely as the “gear case”. In it are ten gears, (see Figure 13), not including those in the scavenger pump. The principle units in this case are the four valve cam gears, two intake and two exhaust; two electrical accessory drives for the generator and the circuit breaker; and three oil accessory drives for the feed pump, the scavenger pump and the crankcase breather valve. The pinion gear shaft which extends into the gear case from the crankcase provides the power to drive all these units. On a radial engine the “gear case” is known as the “accessory case”.

One wall of the gear case is the right wall of the crankcase, the other is the gear case cover and within this compartment are housed the valve cam gears, and gear train. By removing the screws and tapping the case cover off with a brass drift, the gear train is exposed.

Each valve cam is on an individual shaft driven by a gear which meshes with the gear on the next shaft. These valve cams perform the function in a motorcycle engine that the cam shaft does in an automobile engine or the cam ring in radial aircraft engine. Each end of these shafts runs in bronze bushings. One bushing is in a boss in the gear case cover and the other is in a boss in the side of the crankcase. When the cover is on, each cam gear and shaft should have at least a “free running” fit and have not more than .005 inch end-play between the bushings. Due to the tolerance allowed in the machining of the cases, the bosses, the bushings and the gears, this clearance may vary with some engines. Spacing washers .006 inch thick are assembled on the shafts to take up end-play. The standard engine comes from the factory with six of these washers, one behind each of the gears and one in front of each of the two on the front cylinder. This may vary, however, and when disassembling a gear case it is important to notice the position of each washer and re-assemble them exactly as they were removed. After re-bushing a case, remove the valve tappet guides and check the end-play on each shaft with a feeler gauge. On the two front shafts place the washer on the side that will bring the roller more nearly in the center of the cam.



1. Pinion gear.
2. Crankcase breather sleeve gear, also drives scavenger pump.
3. Rear exhaust cam gear, also drives oil feed pump.
4. Rear intake cam gear, also drives ignition circuit breaker.
5. Front intake cam gear.
6. Front exhaust cam gear.
7. Intermediate or idler gear (not marked).
8. Generator drive gear with breather exhaust oil separator ring (not marked).
9. Oil screen.

Figure 13 Valve and ignition timing gears (showing gear marks in correct alignment)

The cylinders are placed at an angle of 45 degrees on the crankcase and the two valve tappets of each cylinder are in the top of the gear case. There are two cam gears for each cylinder, one for each tappet. The intake manifold is placed between the cylinders and therefore the intake valve cam gears are the two center gears. The exhaust manifolds are located on the front and back of the engine and the exhaust cam gears are the two outside cam gears. The valve tappets are of the roller type and are hollow (see Figure 14) to make them very light in weight so that they will not hammer the cam or valve stems. The tappets are fitted into guides which hold them in alignment. The four tappets are identical but the tappet guides are not. A front cylinder tappet guide used on the rear cylinder will place the tappet roller at right angles to the cam instead of in a position to revolve around it. When removing a tappet guide, always place the cam below it to protect the cam shaft bushing from damage.

Figure 14 Valve tappets

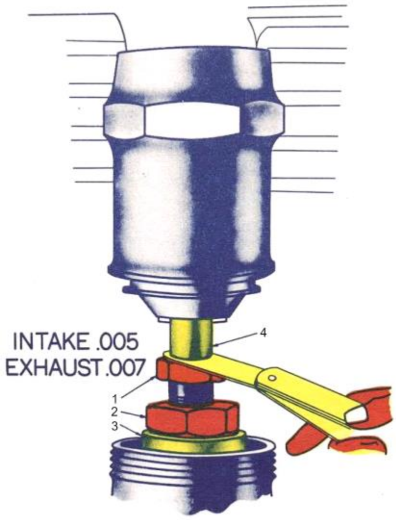
The WLA valve tappets are adjusted to give a clearance of .005 inch for both intake valves, and .007 inch for both exhaust vales. The factory specified clearance ranges are .004 inch to .005 inch for the intake tappets, respectively, and .006 inch to .007 inch for the exhaust tappets, respectively, but the larger clearance of .005 inch for intake and .007 inch for exhaust have proved very satisfactory.

Motorcycle valve tappets are always adjusted with the engine COLD. Since there is no temperature recording instrument on a motorcycle (such as a thermometer on a truck or automobile), there would be a wide difference of opinion as to just what was a “hot” engine-or one at even “normal operating temperatures”. Hence the tappet clearance is designed to be set with the engine cold, as this will provide a standard basis for the adjustment. An engine is said to be “cold” when the hands can be placed on the cylinders and heads without feeling any appreciable temperature. If the engine is at all too hot, it will not be possible to keep the bare hands on the cylinders.

To adjust the valve tappet clearance, (assuming the engine is COLD), first raise each threaded valve cover, then begin with any of the four tappets. Before adjusting clearance on any particular tappet, first turn the engine over with the kickstarter, and watch the rising and falling of the tappets to make sure the tappet which is about to be adjusted is fully closed. A further check on this is to watch the like tappet on the opposite cylinder - when the tappet being adjusted is fully closed, the like tappet on the other cylinder will be at its highest position (fully open).

Adjustment is made by simply loosening tappet adjusting screw lock nut and threading in or out on tappet adjusting screw until the proper clearance can be measured with a feeler gauge (see Figure 15).

After clearance is properly adjusted, tighten the tappet adjusting screw carefully, and prepare to turn down the valve cover. Before doing so however, inspect paper gasket between each cover and the tappet guide. If broken or damaged, fit a new gasket to prevent an oil leak.



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

Figure 15 Adjusting valve tappets

The cam gear shafts are lubricated by gravity through drilled passages on the cover side and by splash on the crankcase side. The rear intake cam gear meshes with the pinion gear on the pinion shaft and all other cam gears are driven from the rear intake. The pinion gear is timed to the pinion shaft by means of splines of different sizes which will prevent incorrect assembly. On the outer side of the pinion gear is a scribe mark which is aligned with a similar mark on the rear intake gear. The rear exhaust gear and front intake gear are meshed with the other marks on the rear intake gear. Although the rear intake gear has three marks, it is impossible to assemble the gear incorrectly if all three marks are accurately aligned with other marks. The front intake cam gear has two marks, one for the gear on either side. The front exhaust cam gear has only one scribe mark as it is not necessary to time the generator idler gear (see Figure 13).

When the cam gears are aligned, the cams are timed so the valves will open and close as follows:

Intake valves — open when the piston is 5/32 inch to 7/32 inch before top dead center — close when the piston is 37/64 inch to 45/64 inch after bottom dead center.

Exhaust valves — open when the piston is 37/64 inch to 45/64 inch before bottom dead center — close when the piston is 5/32 inch to 7/32 inch after top dead center.

The gear train is lapped in by sets so that when cold there is no backlash; but when the engine is warm and the aluminum case has expanded from .002 inch to .004 inch pitch clearance develops.

When it is necessary to re-bush a gear case, the old bushings are removed with pullers and new ones pressed in the bosses. After new bushings have been pressed in they must be dowel pinned to prevent them from turning and oil holes must be drilled in three of the cover bushings to match the holes in the bushing bosses. It is necessary to lineream the bushings with a special reamer made by the manufacturer for this operation. Bushings are reamed from the inside when the gear case cover is on, and as the cover bushings on the two rear cam gears differ, an adapter is used.

The pinion shaft bushing must be re-installed with the bushing oil hole placed in the boss so it is opposite from the drilled oil passage in the cover. Oil can still flow from the passage in the cover to the outlet of the bushing oil hole through an oil groove cut in the bushing itself, but in this position the oil hole in the pinion shaft will be aligned with the hole in the bushing when the pistons are near the top of their stroke. At this time the greatest vacuum exists in the crankcase which aids the flow of oil through the passage to the lower connecting rod bearings. The pinion shaft bushing is vented at the bottom to relieve oil pressure that would cause an end thrust on the pinion shaft. The rear intake bushing is similarly vented to keep oil from being forced up the circuit breaker shaft by the action of the circuit breaker drive gears.

Engine accessories

(See Figure 16)

1. The gear-driven generator is fitted on the front of the engine and is bolted to the gear case by two cover studs. The generator drive gear and the generator idler gear should be fitted with just the least amount of backlash, (.002 inch - .004 inch pitch clearance). The drive gear should slide on the idler gear freely without binding. This clearance can be regulated by fitting standard paper shims under the generator, with the oil hole on the shim always aligned with the oil hole on the generator. A cigarette paper used between the two gears to test the fit is not a good test as a burr on the gears may tear the paper and the fit may be still too loose. The outer side of the generator drive gear is a machined surface and runs in contact with a bronze oil separator seal on the passage leading to the relief pipe at the bottom of the gear case cover. The gear itself contains the oil “slinger” or “separator” and all air leaving the gear case is forced by the oil separator seal to pass through this “slinger”, which removes the liquid oil and allows the air to pass out the relief pipe.

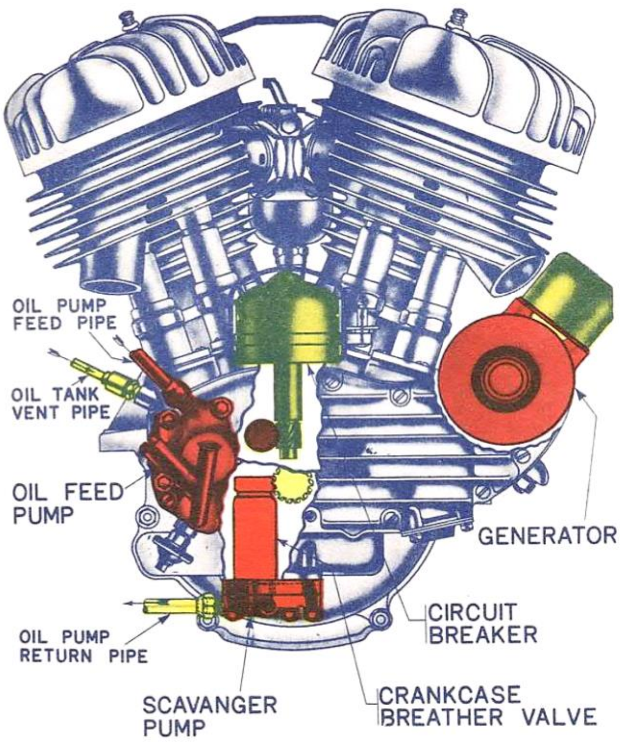


Figure 16 Engine accessories

2. The circuit breaker housing is fastened to the gear case cover by two screws. It contains the condenser, the breaker points, and the cam which is part of the circuit breaker shaft. On the lower end of the shaft is the drive gear which meshes with a similar gear on the rear intake cam shaft. The breaker cam revolves at half crankshaft speed, and by the design of the lobes on the breaker cam itself, the uneven ignition (315 degrees and 405 degrees) necessary on this V type engine is provided. The circuit breaker shaft should be meshed so the narrow lobe is correctly placed for timing the engine on the front cylinder.
3. The crankcase breather valve, which is between the crankcase and the gear case, provides a path for oil to be removed from the crankcase into the gear case. This sleeve valve must be timed accurately so that is opens when the pressure in the crankcase is at its maximum. Pressure is developed when the pistons descend in the cylinders and this pressure is utilized to blow crankcase oil into the gear case through the breather valve. The valve provides a positive method of removing oil from the crankcase. It is driven directly from the pinion gear shaft by the breather drive-gear, (a spiral gear) which is splined to the shaft, The valve has two parts, the housing with one window and the sleeve which has two windows and fits inside the housing. The sleeve turns at one half crankshaft speed.
4. The scavenger pump is below the oil screen in the bottom of the gear case and forces used engine oil back to the oil tank above the engine. It is a gear type pump and is powered from the crankcase breather valve by means of a short shaft, to which is keyed and locked the main driving gear of the scavenger pump (see Figure 19).

5. The vane-type oil feed pump, which is bolted to the outside of the gear case cover, is driven by direct connection with the rear exhaust cam gear shaft. This is the only shaft that extends through the cover. The two driving dogs on the end of the shaft engage with the rotor of the pump and revolve it at the same speed as the shaft. The pump contains the two check valves; which prevent the leakage of oil from the tank when the engine is not running, and the pressure relief valve which releases any pressure over 30 pounds which the pump may develop. It also contains a very important unit, the centrifugal valve, which varies, with the engine speed, the amount of oil pumped to the lower connecting rod bearings.

The gear case is assembled as follows: The units on the pinion shaft are assembled, the oil seal, the spring, the breather drive gear and pinion gear. Both gears are assembled with their scribe marks out.

Install the crankcase breather valve and time it as follows (see Figure 20):

1. Place the flywheel line in the center of the inspection hole.
2. With all parts assembled on the pinion shaft (oil seal, spring, breather drive gear, and pinion gear), the timing hole in the breather sleeve should register in the slot of the breather housing when the pinion gear is pushed in until its outside edge is exactly 5/16 inch from the edge of the case (normal running position).

If the hole does not line up with the slot, remesh gears until hole and slot do line up. This valve must be re-timed each time the case cover or the breather valve unit is removed.

Install the gear train, with the correct number of spacing washers on each shaft, in the following order:

1. Rear Exhaust
2. Front Intake
3. Rear Intake
4. Front Exhaust

Mesh all gears so the scribe marks meet.

5. Generator idler gear, mesh with teeth flush with the front exhaust gear.

Install the generator.

Install the gasket (if wrinkled, soak it in water).

Place the cover on the case and screw it on securely.

Install the circuit breaker assembly.

Time the circuit breaker as follows (See Chapter III, Section 6 for full explanation):

1. Set the breaker points at .022 inch.
2. Put the front cylinder on compression stroke by watching the front intake valve open and close.
3. Register the flywheel line in the center of the inspection hole thus locating the piston 9/32 inch before top dead center, at which time the spark should occur.
4. Check that the circuit breaker is correctly assembled so the narrow cam lobe of the timer shaft is aligned for timing the front cylinder.
5. By loosening the strap on the circuit breaker plate, move the points around the cam until the points just break when the spark hand control is at full advance.

Install the oil feed pump by meshing the rotor with the two driving dogs on the rear exhaust shaft. Never use a "home made" oil pump gasket. Secure the housing with three studs and one bolt.

Section 4: The Harley Davidson WLA engine oiling system

The capacity of the oil tank of the Harley Davidson WLA 45 motorcycle is 3 ½ quarts (3.3 l). The motorcycle uses regular army oil, engine lubricating. The viscosity for summer use (above 32° F (0° C)) is OE 50, for below 32° F and above 10° F (-12° C) OE 30, and for below 10° F OE 10. The oil is changed every one thousand miles during normal summer operation but should be changed more often (approximately every 500 miles) in cold weather or when operating over dusty terrain in any weather.

The motorcycle has a dry sump, air cooled engine with force oil feed to the lower connecting rod bearings - the hardest working bearings in the engine. A supply of oil is maintained in the 3 ½ quart tank above the engine and an oil line leads from the tank to the feed pump (see Figure 17).

The oil feed pump is of the vane type. It is driven by the exhaust valve cam shaft of the rear cylinder and is on the outside of the gear case cover. Oil flows by gravity from the tank to the feed pump, which then forces it under pressure in a line to the lower connecting rod bearings, the only bearings on this motorcycle lubricated under force. Oil leaves the pump, opens a ball check valve (which prevents oil seepage from the tank when the engine is not operating), and flows through passages to the right end of the pinion shaft. Here it enters a drilled passage in the shaft, flows through the right flywheel (which forms one side of the crank throw) and out of the crank pin onto the connecting rod roller bearings.

The oil pressure signal light on the instrument panel indicates whether pressure is being developed by the feed pump. When the pump is not working or the oil pressure is below 4 Ibs. per square inch (0.28 bar), the signal light burns red, but as soon as the engine starts and the pump begins to operate, pressure on the diaphragm inside the switch opens the contact points and holds them open as long as the pump is functioning.

It is not desirable that the entire output of the pump be delivered to the crank pin bearings at low speeds, as over-oiling and fouling of the spark plugs will result. However, at high speeds the bearings require a greatly increased amount of the pump output. Therefore at low speed most of the oil is by-passed to the gear case, but as the engine speed increases the by-pass valve in the feed pump gradually closes, thus cutting off oil to the gearcase and raising the pressure in the line to the connecting rod bearings. The unit of oil pressure by-passed is regulated by a centrifugal by-pass valve, whose operation is similar to that of a fly ball governor on a steam engine. The valve is placed in the same rapidly revolving rotor as the vanes (see Figure 18). At low speeds, when centrifugal force is least, the oil pressure holds the valve open but at high speeds centrifugal force throws the weight away from the center of rotation and the valve is gradually closed. When the valve is open, oil is permitted to by-pass through the valve seat, opening a ball check valve and flowing through a drilled passage to the gearcase. At high speeds, when the by-pass line is closing, oil pressure developed by the feed pump is forced to remain in the crank pin line. However, if this crank pin line pressure should build up to exceed 30 Ibs. Per square inch (2 bar), a condition of overoiling will again exist. Hence, another ball check valve, the pressure regulating valve, opens at 30 Ibs and allows the excess oil in the crank pin to be by-passed to the gearcase (see Figure 18).

Automatic front chain lubrication is provided by a small by-pass line running off the main passage from the feed pump to the gearcase. The oil flows past a metering needle valve and thence through a drilled passage to the chain. The needle valve, or metering pin, is adjusted by shims to allow a steady metered supply of oil to drip on the front chain at all times when the engine is running. The proper amount of oil on the chain is determined by running the finger back and forth along the chain. If there is inadequate lubrication the chain will feel dry —if there is too much oil the chain will be very wet.

The cylinder walls and piston pins are lubricated by a combination of splash and suction, and in the case of the rear cylinder this splash is augmented by the female, or forked connecting rod, placed in that cylinder. This forked rod acts as a scoop and serves to pick up additional oil to be thrown upwards into the rear cylinder.

The motorcycle engine, like an air cooled radial engine, has an air-tight crankcase and operates with a dry sump. Some means must be devised, therefore, to clear oil out of the crankcase. Due to the fact that both connecting rods are connected to the same crank pin, both pistons descend at the same time, and when they descend pressure is created in the lower sump. Crankcase oil collects in a passage (the scraper) at the base of the engine. The crankcase pressure (around 4 or 5 pounds per square inch (0.28 – 0.34 bar) is utilized to blow the oil out of the crankcase and into the gearcase through an opening in a timed sleeve valve known as the crankcase breather valve. This valve is timed so that it opens on the down stroke of the pistons, allowing the oil in the scraper to escape. It is closed on the up-stroke so that the oil may travel in one direction only.

As oil is blown into the gearcase through the breather valve, it naturally contains considerable air mixed in with it, and this air must be separated from the oil and relieved to the atmosphere in order to maintain the proper balance of pressure inside the gearcase. Air will also be brought into the gearcase through the pressure relief line from the engine oil tank to the gearcase (see Figure 17). This air, plus that which has entered through the breather, is mixed with the oil in a fine mist forms, and to separate the oil from the air an oil "slinger" is placed on the end of the generator armature protruding into the gearcase. This slinger is simply a perforated steel collar which revolves with the armature. It acts much as a cream separator, in that as the mist of air and oil strikes the slinger it begins to separate that oil which heretofore was suspended in the air in the form of a fine mist. As the mist strikes the revolving slinger, centrifugal force causes the relatively heavier oil particles to be thrown downward into the curved passage leading to the relief pipe in the gearcase cover. The air rushes on through the curved line, seeks the relief pipe, and vents to the atmosphere. But as the heavier oil mist rushes down the passage and meets the sharp bend at the relief pipe it is thrown downward and lies about the base of the pipe. Thus it does not escape to the outside.

To continue the circulation from this point, a small "flutter valve" is placed at the base of the relief pipe. The valve opens automatically on each upstroke of the pistons, and the vacuum created sucks the oil through a drilled passage from the gearcase cover to the crankcase, where it joins other oil from the crankpin bearings and continues to circulate. Each down stroke of the pistons forces the flutter valve closed.

Oil is removed from the gearcase and returned to the tank by a gear-type scavenger pump. At the scavenger pump a small amount of oil is allowed to flow off past a needle valve and through a tubing line to the rear chain. This needle valve is similar to the front chain oiling valve and its operation and adjustments are the same. To decrease the flow of oil to the chain, shims are removed from under the head of the valve, and to increase the flow, shims are added under the head. The contents of the oil tank circulates through the engine once in approximately 14 miles (22.5 km).

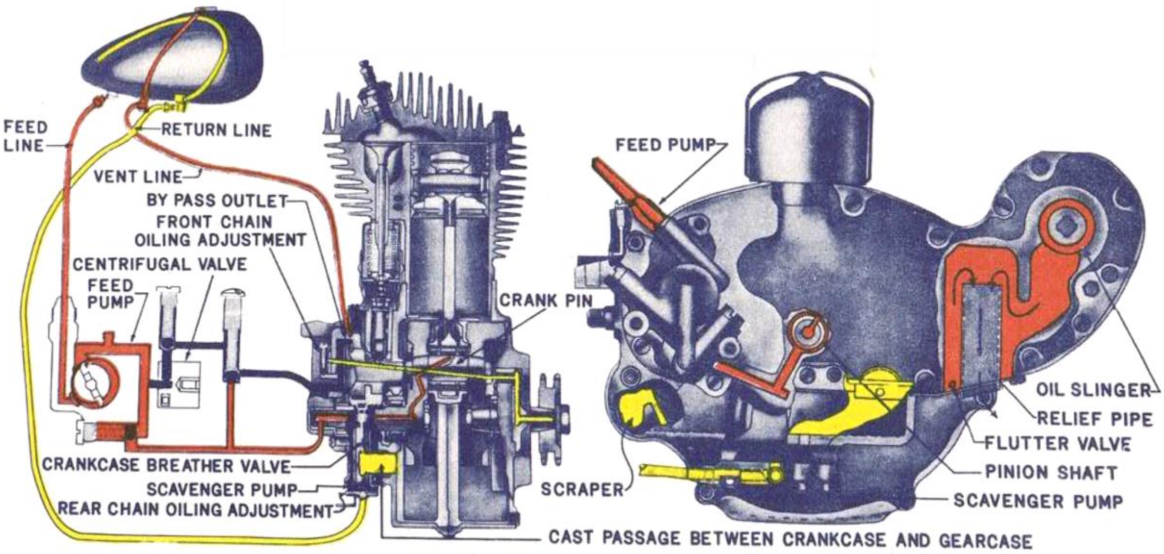


Figure 17 WLA engine lubrication system

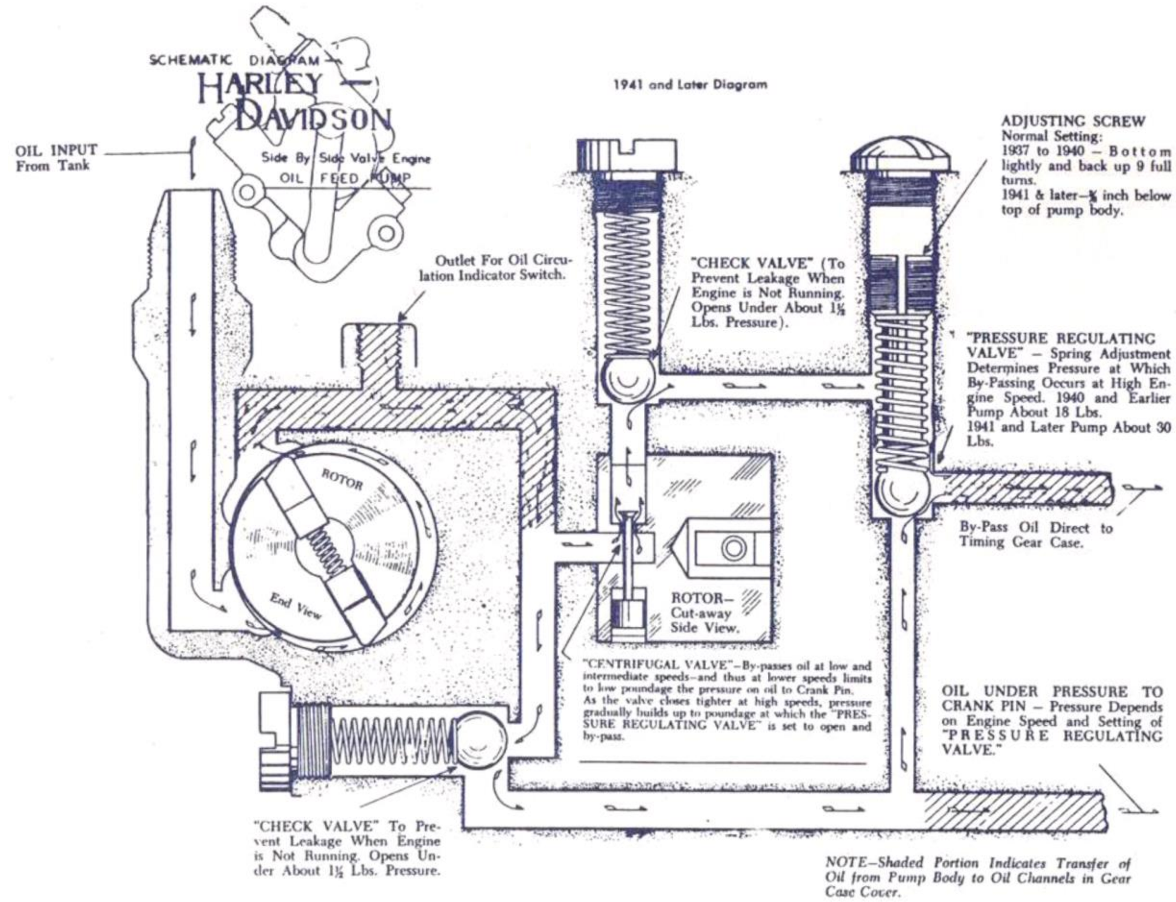
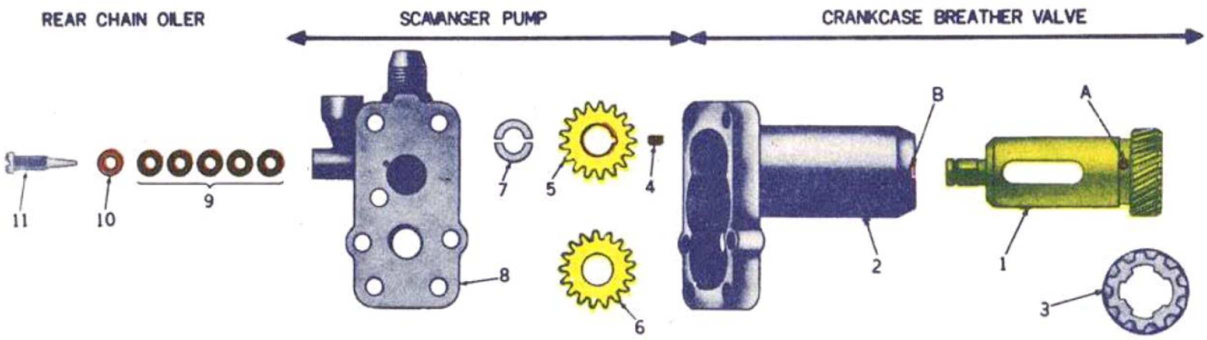


Figure 18 WLA engine lubrication valves



1. Breather valve sleeve
2. Breather valve housing
3. Breather valve drive gear
4. Key, oil feed gear
5. Scavenger pump gear
6. Scavenger pump idler gear
7. Washer, scavenger pump gear retainer
8. Cover, oil scavenger pump
9. Washer .002 adjusting screw
10. Washer
11. Screw, chain oiler adjusting

A. Timing hole
B. Timing slot

Figure 19 The crankcase breather valve

Timing the crankcase breather valve

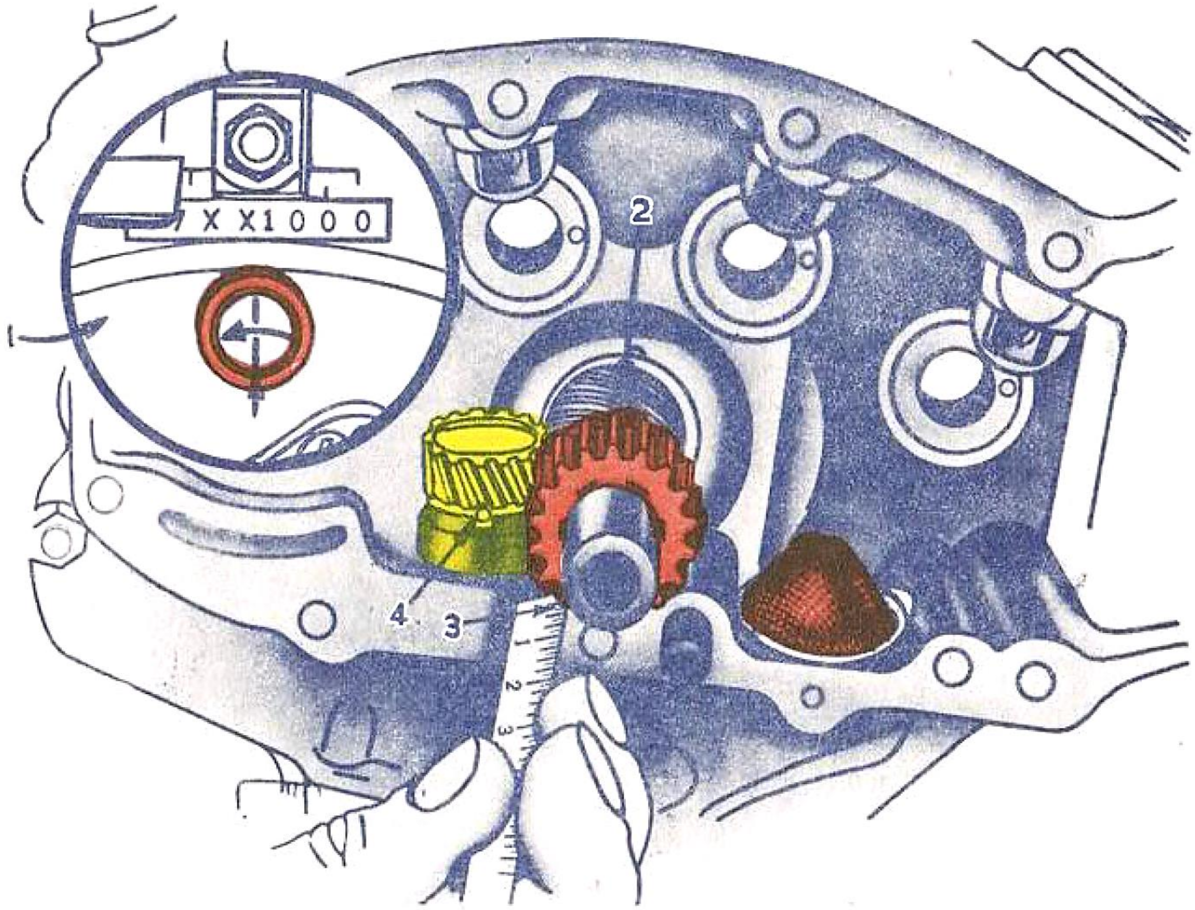
The breather valve is a control valve of the oil circulating system and it must be correctly timed. It is driven by a spiral gear on the pinion shaft and is placed in such a position that a slot or "window" in the housing of the valve sleeve is located at the gearcase end of a cast oil passage between the crankcase and the timing gearcase (see Figure 17 and Figure 19).

Oil in the crankcase is blown by the air caught beneath the descending pistons into the cast passage and thence through the open slot in the valve housing into the gearcase. Improper or inaccurate timing of the breather valve will cause it to open at a time when the pistons are not descending, and when no pressure is being developed in the crankcase. This would prevent the oil from leaving the crankcase and continuing its circulation to the gearcase, would cause oil to load up in the crankcase, and would eventually cause serious damage to the engine. Hence, it is vital that the crankcase breather valve be timed to open when the pistons are on their downstrokes. The proper timing procedure is as follows (see Figure 20):

1. Place the flywheel timing mark exactly in the center of the inspection hole in the left side of the crankcase; this locates the front piston exactly 9/32 inch before top dead-center.
2. With all parts assembled on the pinion shaft (oil seal, spring, breather drive gear, and pinion gear), the timing hole in the breather sleeve should register in the slot of the breather housing when the pinion gear is pushed in until its outside edge is exactly 5/16 inch from the edge of the case (normal running position).

If the hole does not line up with the slot, remesh gears until hole and slot do line up.

Removing the scavenger pump will always destroy breather timing and removing the gearcase cover frequently will destroy it. After either of these operations, always time the breather.



1. Flywheel timing mark
2. Breather pinion shaft gear (spiral gear)
3. Push pinion gear in until outer face is exactly 5/16” from gear case joint face.
4. Timing hole in breather sleeve registers in center of slot in breather bushing.

Figure 20 Timing crankcase breather valve

Section 5: Carburetor and air filter

A. The Carburetor

An internal combustion engine with spark ignition requires a fuel charge in the engine cylinders that is a mixture of air and vapor from a volatile liquid fuel. A carburetor mixes the fuel with the correct proportion of air and starts atomization and vaporization.

It is not generally appreciated that air has weight; this weight of air, known as atmospheric pressure, has an important bearing on carburetor design, construction, and adjustment. A cubic foot of air weighs 1 ¼ ounces (1.25 g/dm3), but a cubic foot of gasoline weighs 48 1/2 pounds, which is 776 ounces (776.9 g/dm3). One cubic foot of air must therefore be multiplied by 620 in order to equal the weight of a cubic foot of gasoline. The ratio of air to gasoline in the motorcycle at average engine speeds is approximately 13 parts of air to 1 part of gasoline by weight. Therefore, if 620 cubic feet of air weighs as much as one cubic foot of gasoline, in order to have a 15 to 1 mixture, it takes 9300 cubic feet of air to burn the one cubic foot of gasoline (9.3 m3 air/1 liter gasoline).

The motorcycle uses the gravity feed fuel system. The gasoline tank is on the left side and holds approximately 3 1/3 gallons. To turn on the gas the small control in front of the filler cap is unscrewed (this same control is lifted to cut in the reserve supply). Gasoline flows from the bottom of the tank through a feed line to a strainer, which is a fine wire mesh screen. This screen requires almost daily attention in the field, due to the fact that gasoline handled in the open often contains foreign matter. In winter operation, this screen may become clogged with ice and should therefore be inspected daily in freezing weather.

Gasoline flows from the strainer to the carburetor which is on the left side of the engine between cylinders. The motorcycle uses a side outlet plain tube carburetor. “Side outlet” carburetors draw air and vapor from the side, instead of from above or below. “Plain tube” refers to any carburetor using fixed venturis for metering air as contrasted to “air valve” carburetors which use expanding air valves. Although this carburetor is simpler than others in current use, it is able to make the motorcycle out-perform most other vehicles. There are two manually operated controls on the carburetor. The throttle is regulated from the right handlebar grip and is turned outward to cut off the gasoline supply. The choke is controlled by a lever on the carburetor itself and is raised when “choking”. A motorcycle carburetor must always be set a little rich, because a lean mixture (too little gasoline and too much air), due to its high oxygen content, will cause the machine to overheat dangerously. A lean mixture burns with an extremely hot flame and will overheat pistons until they “seize” in the cylinders. It is also relatively slow burning, which carries the heat of combustion farther down the cylinder.

When the piston descends in the cylinder a vacuum is created and air rushes in through the intake manifold and the carburetor to fill it. A metered quantity of fuel is drawn into this air, forming the proper air-fuel mixture in the combustion chamber.

The motorcycle carburetor falls naturally into four circuits:

1. The float circuit.
2. The low speed circuit.
3. The high speed circuit.
4. The choke circuit.

By treating each circuit separtely, the study and repair of the motorcycle carburetor is made easier (refer to Figure 21).

1. The Float Circuit

The float circuit automatically controls the height of the gasoline level in the bowl and also in the nozzle. A gasoline level too high or too low will cause trouble in both the high and low speed circuits and make the cause of faulty operation hard to locate. Most automobile carburetors are equipped with “offset” bowls which are part of, or are attached to the air metering passage. With this style the fuel metering occurs at a point off center to the nozzle, and naturally on steep grades and on other angles such carburetors have a tendency either to flood or to run lean due to the angular relation of the fuel level to the nozzle outlet. The motorcycle uses a “concentric” bowl and with this style the nozzle is in the center of the float mechanism. On steep grades or any other time the machine is on great angles, the fuel level remains more nearly constant with respect to the nozzle outlet, thus insuring a steady flow of fuel through the nozzle.

The float circuit consists of these major parts: The bowl, the needle valve and seat, and the float and lever assembly. The float is doughnut shaped and made of cork. Cork has proven satisfactory here because great buoyancy is needed in a very small space. The float bowl acts as a reservoir to hold the supply of gasoline throughout the entire range of performance of the engine. The level of the gasoline supply is controlled by a combination of the above parts. For float settings see “carburetor adjustments and maintenance”.

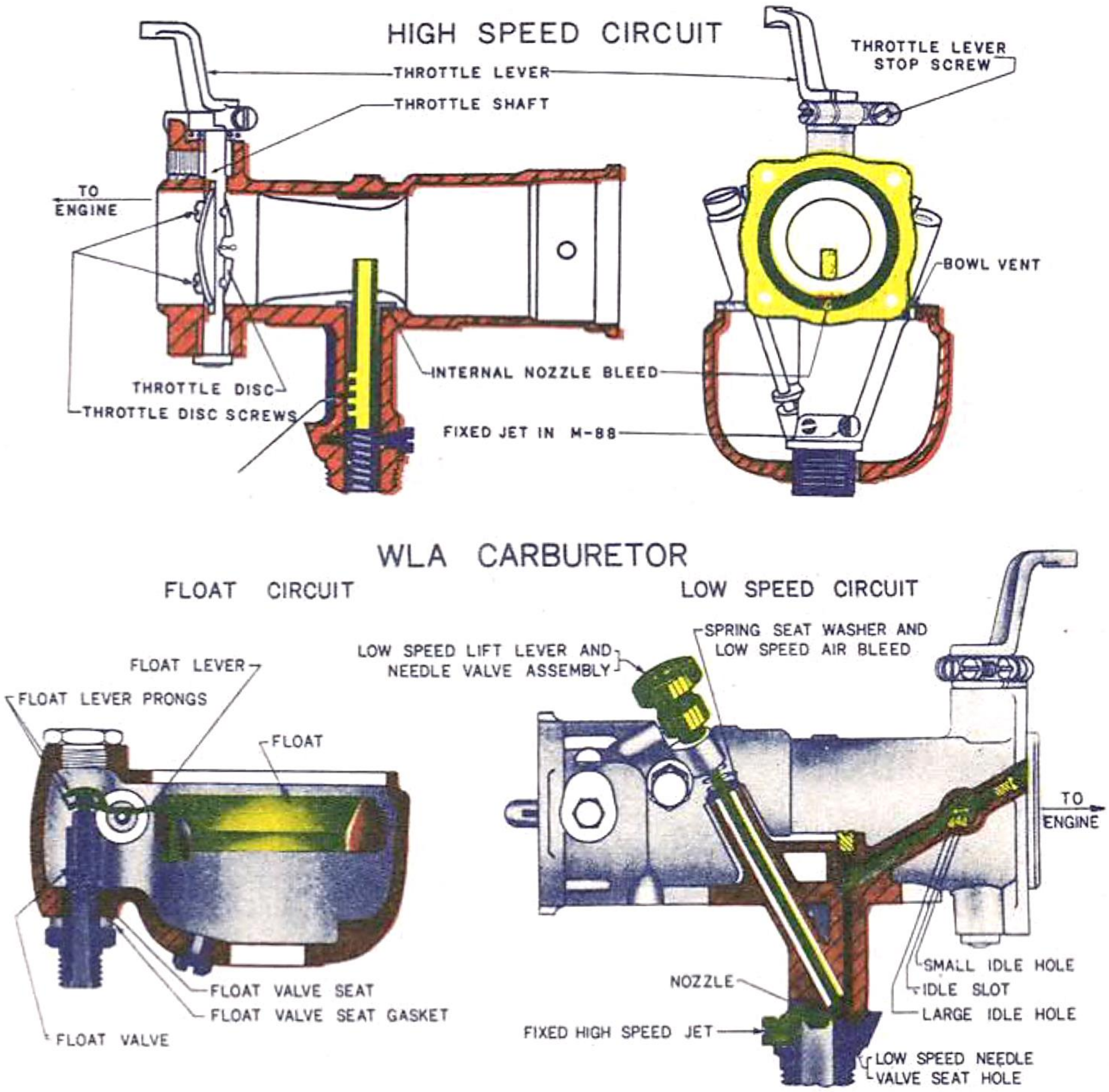


Figure 21 WLA carburetor

2. The Low Speed Circuit

The idle or low-speed circuit completely controls the supply of gasoline to the engine during idle and light load speeds up to approximately 35 m.p.h. (56 km/h). During this low speed operation, fuel is drawn into the engine solely by means of the intake manifold vacuum created by the downstroke of the pistons in the cylinders. Hence the vacuum or low pressure area is at the manifold side of the throttle valve and it is here that the low speed idle ports are located to release fuel to the engine (see Figure 21, “Low Speed Circuit”).

During operation of this circuit gasoline flows from the float bowl through the same metering jet as in the high speed circuit. From this point it is drawn off past the adjustable low speed needle valve and into the low speed channels which emit the fuel to the engine through the idle holes.

Air bleed is effected in this circuit from two sources. One inlet for air is down beside the low speed needle, which is held in place in its guide by a spring and spring seat washer. This permits air to vent down beside the needle and to begin mixing air with gasoline as the fuel is drawn past the seat of the low speed needle.

The second means of air bleed is accomplished by the large idle hole (see Figure 21) at certain instances during idle speed when the throttle valve is closed to such an extent that it is between the large and the small idle holes. At such times, air bleeds through the large hole and aids in breaking down the fuel which is about to emit through the small hole.

As fuel in the low speed circuit flows through the metering jet and thence to the channels, it also fills the high speed nozzle (see Figure 21) up to the level as determined by the float in the float bowl. It is well to keep this point in mind, as it will be found to play an important part in the operation of the high speed circuit, to be discussed later.

Fuel continues to be fed into the engine on the low speed circuit up to about 35 m.p.h., and the more the throttle is opened, the greater area of idle ports is exposed, resulting in a nearly constant ratio of air to fuel delivery. The principle parts of this circuit are the metering jet, idle needle and seat, channels and idle ports.

As the speed of the engine increases it is necessary to supply a greater volume of fuel than the low speed circuit can accommodate, hence another circuit - the high speed circuit - is utilized.

3. The High Speed Circuit

At speeds above 35 m.p.h. the relatively, low vacuum provided by the engine at the intake manifold is not great enough to cause a sufficiently large amount of fuel to rise up the high speed nozzle and operate the engine. Hence a venturi tube, or constriction is placed in the carburetor bore. As air flows through the venturi it causes a sharp drop in pressure at the narrowest constriction of the tube. This vacuum will be great enough to pull the necessary larger volume of fuel up the high speed nozzle to operate the engine. Hence the high speed nozzle is placed in such a position in the carburetor that its tip opens into the narrowest constriction of the venturi (see Figure 21) so as to make full use of the low pressure area afforded at that point.

In discussing the low speed circuit it was stated that fuel rises in the high speed nozzle to a level determined by the float. In Figure 21, “High Speed Circuit”, it will be seen that there are four small holes cut in the flat side of the lower end of the nozzle. The area of these holes is vented by an air bleed tube running from the center of the air stream at the choke side of the carburetor barrel, down to this point. As fuel fills the lower end of the nozzle during low speed operation it flows out through the four holes and remains lodged on the outside of the nozzle between the flat surface (which forms about one-fourth of the circumference of the nozzle), and the side of the well.

Hence as the throttle is opened more and more from low speed to high speed the low pressure area moves to the tip of the nozzle and fuel begins to rise up the nozzle and thus feeds the engine. The level of liquid fuel formerly held outside the nozzle now begins to drop exposing progressively the four holes in the side of the nozzle and “air bleed” is effected by passage of air from the air bleed tube, down the exterior of the nozzle, and through the four holes. It is important to note that because of the air bleed at the base of the nozzle, fuel is being delivered at the tip in the form of an emulsion, and not as a liquid.

In this manner the high speed circuit delivers all the fuel passing through the carburetor. This condition continues up to open throttle and to top speed, and under these circumstances a further air bleed is accomplished by an actual reversal of flow in the idle system, due to the fact that at top speeds the vacuum at the nozzle is greater than on the idle holes in the barrel. As long as a gradual increase in speed is experienced, the high speed circuit will function as described.

However, when it is necessary to accelerate rapidly from the low to the high speed circuit, there must be some additional means provided to supply the extra fuel required. In an ordinary truck or tank carburetor this is accomplished by means of an accelerating pump. There is no such device in the motorcycle carburetor, but instead it makes use of the four holes in the base of the nozzle. It will be recalled that during low-speed operation a reservoir of fuel was built up just outside the nozzle, to the level of the four holes. Therefore, when the throttle is snapped open quickly this reserve supply of fuel is fed rapidly into the nozzle and thence to the engine. This enables the engine to accelerate rapidly from low to high speeds and prevents “dead” or “flat” spots.

It must be emphasized that this reserve is used only when accelerating from low to high speed. As the fuel is discharged through the nozzle the air bleed holes come into play again, allowing air to pass through the holes as originally explained. Hence there is no further reserve supply of fuel built up outside the nozzle once the engine has accelerated to high speed. The fixed high speed jet is large enough to handle further acceleration within the high speed circuit.

The purpose of the four small holes in the high speed nozzle is then threefold. The first is to permit the bleeding of outside air into the nozzle to furnish an emulsion delivery at the nozzle tip. The second reason is to allow rapid delivery of the stored up fuel in and around the nozzle when accelerating from closed or nearly closed throttle position. The third reason for the holes is to properly proportion the mixture ratio from low to high speed.

The principle parts of the high speed circuit are the high speed metering jet, nozzle, venturi, and air bleed tube.

4. The Choke Circuit

This circuit is used only in starting a cold engine. At such times, the sole means available for vaporization is the heat of compression in the cylinders, which will vaporize only about ten per cent of the mixture under average conditions. The purpose of this circuit is to supply a rich mixture from which sufficient vapor to start the engine may be obtained. It consists of a choke valve to close off the air supply, and a shaft, lever and cam assembly. The cam allows the low speed needle to rise from its seat so that a richer mixture can reach the idle holes.

Carburetor adjustments and maintenance

There are only two running adjustments to be made on the present type of army motorcycle carburetor; both are in the low speed circuit.

1. The low speed mixture adjustment: The needle is screwed down until it touches bottom and then withdrawn about three turns. With this setting the engine will start and finer adjustments can be made from this point by turning the needle a few notches down until the engine idles smoothly with a slight “roll”. The carburetor should be set a little rich, for a lean setting will cause the engine to overheat.
2. The idle speed adjustment: Adjust the idle stop screw so the engine will idle at a reasonable speed. If the engine is set to idle too slowly, it will die out frequently during operation (i.e. whenever throttle is completely closed).

There are three settings in the float circuit:

1. The head of the float needle valve should have a good free fit between the float lever prongs (.003 inch). Excessive clearance develops lost motion between the float and needle, while insufficient clearance will cause the needle to bind.
2. The float level: With the bowl turned upside down, the top of the float should measure exactly 1/4 of an inch from the edge of the bowl. Make the measurement directly opposite from the float lever. Do not attempt to readjust the float when it is in the bowl, for doing so spreads the prongs (setting No. 1) between which the needle valve fits. Remove the float and lever assembly from the bowl and bend the lever as required to readjust.
3. When installing a new float on the lever, do so with all other parts of the float circuit completely assembled. Insert the float screw and pull the float away from the needle valve to the limit of the slot in the lever; then, looking down on the bowl, with the needle valve away, set the float about 1/16 inch to the left of center, to give the necessary carburetor body clearance. Tighten the float screw and cement the float to the lever with thick shellac. The bowl should always be assembled to the carburetor with the needle valve opposite the word “Power” that is cast on the body. This lines up the float of-set with the protrusion of the body.

By proper cleaning and replacing of worn parts the carburetor can be returned to its original condition and it will then deliver the correct mixtures as it did when new. Due to the design of the motorcycle engine and the arrangement of its valve timing, air flows through the carburetor in “surges”. This causes carbon formations in the barrel, around the throttle valve, and in the idle ports, particularly after the carburetor has been in service for some time. Usually excessive dirt and carbon crust result in a lean spot at speeds up to 30 miles an hour. To clean the carburetor barrel thoroughly, the throttle valve must be removed. However, it must be reassembled exactly as it came out. By scratching two heavy lines on the throttle disc, one each side of the throttle shaft, the position of the shaft on the disc is outlined to aid in re-assembling, Clean the barrel and the throttle disc with emery cloth. Care must be exercised not to round the beveled edge of the throttle disc. To clean the passages, remove all plugs from the low speed channels and clean them out with the proper standard drill sizes. Drill sizes for the M-88 carburetor as follows:

Linkert Carburetor M-88

Small idle port	No. 70 drill	0.71 mm
Idle slot	Use .009 inch blade	0.23 mm
Large idle port	No. 55 drill	1.32 mm
Vertical and diagonal idle channels	No. 42 drill	2.37 mm
Needle valve seat	No. 531 drill	

Do not drill to the bottom of the vertical channel as it will damage the low speed needle seat. A complete set of the carburetor drills is available in most third echelon shops.

B. The Air Filter

The oil bath type air filter now used on Army motorcycles was developed specially for this vehicle when it was found that the engine failures on motorcycles which were generally thought to have been due to “overheating” were actually directly traceable to the old type inefficient air filter. The old mesh pack cleaner was found entirely incapable of filtering from the air the quantities of dirt which the motorcycle stirred up on its cross country runs. This vehicle is extremely low and mobile and the air intake must of necessity be placed near the ground where the dust is thick. Formerly quantities of dirt reached the combustion chamber of the engine and came in contact with the pistons, piston rings and cylinders. The engine is high speed and operates at average temperatures of from 350 degrees F (177° C) to 450 degrees F. (232° C), therefore when the engine parts are operated in the presence of dirt, the cylinder walls and particularly the piston rings are subjected to terrific wear. This soon resulted in “blow-by”, that is, the hot combustion gases were no longer sealed in the combustion chamber by the piston rings but were allowed to pass the piston, heating it and also, the base of the cylinder where the fins are smaller. The direct result was a “burned-up” engine, the pistons became terrifically hot and melted or expanded until they “froze” in the cylinder. This so-called “overheating failure’ was directly the fault of the air filter and not due to overheating. There have been fewer engine failures since the advent of the oil bath air filter. The filter requires “DAILY” care in dusty operation and less frequent maintenance on paved roads.

The cleaner consists of three main elements, the case, the filter, and the oil cup. By loosening a clamp band the oil cup and baffle may be detached from the filter and intake element. Servicing the cleaner consists of removing the oil cup, cleaning it out, putting new engine oil in it, and replacing it. In the older type cleaners, the filter element cannot be removed from the cleaner case and the whole cleaner must be placed in kerosene to clean the filter elements. In the newer cleaners, the filter elements themselves may be removed for cleaning. The filter need be serviced only occasionally. After cleaning a filter element, a few squirts of engine oil should be applied before returning the filter to the case.

Referring to Figure 22, air (⟶) charged with heavy (●●➤) and light (●⟶) particles of dirt and dust enters under outer edge of weather cap and thence down central intake tube. The air hits the deflector and is directed upward to the filter elements. Velocity of the heavy particles carries them directly downward through the oil where they deposit in the sump. The air in passing around the lower edge of the central intake tube passes through oil, A large amount of the dust is washed out there and the rest is carried by the air into the filter elements along with a generous amount of oil picked up by the air. The dust is picked up by the filter and washed from the filter by the oil (⇨) that is draining back into the sump. The baffle in the oil cup prevents splashing and also prevents an excessive amount of oil from entering the filter element when the machine is operated over rough roads.

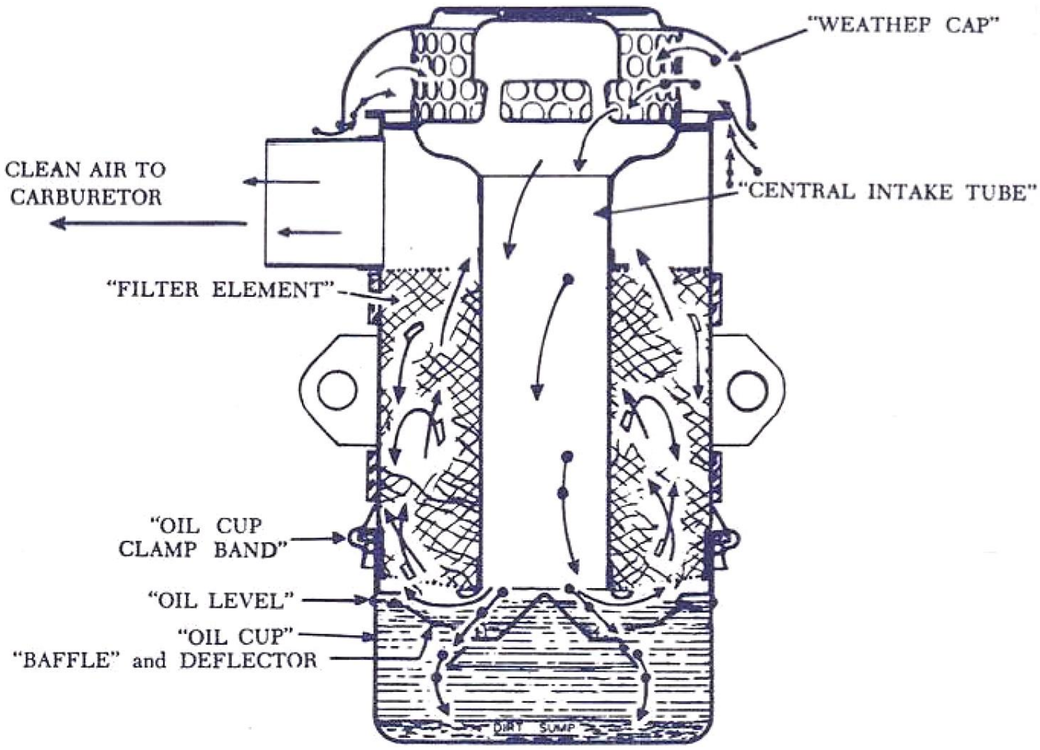


Figure 22 Oil bath air cleaner for army "V" engine motorcycles

Section 6: Ignition system and spark plugs

The Harley Davidson ignition system differs from that of the Indian motorcycle and from automotive ignition types in that it has no distributor. A circuit breaker alone is used. Instead of having the spark distributed from one cylinder to the other, both spark plugs fire at the same time, but as only one cylinder is on the compression stroke, (the other being on exhaust) only one cylinder develops a power stroke at any one instance. (See Chapter III, Sec. 1).

The ignition system has two circuits, the primary circuit and the secondary circuit. The primary circuit consists of the battery, switch, primary coil, breaker points, condenser, and necessary wiring. The secondary circuit consists of the secondary coil, the spark plugs, and necessary wiring.

The battery supplies the initial electricity for starting and will be taken up in more detail under the electrical system.

Both the primary coil and the secondary coil are found in the same container. The primary coil is wrapped around the secondary coil which is wrapped around a laminated soft iron core. The core is in the form of a rectangle with the coils wrapped around one leg of it. The primary coil is made of large wire and consists of 220 tums. The secondary coil is composed of 12'600 turns of fine wire. The coils are separated from one another by insulation and there is no physical contact between them, the only connection being by magnetic induction. The whole assembly is surrounded by tar in the metal container and is water tight. A mechanic does no work on the coil except to insert new spark plug leads. To insert new cables, warm the coil slightly to soften sealing compound. Either heat coil by flame or by running a current through it. Trim and round new cable ends so they will follow through holes left in sealing compound by old cables. Pull out the old cables when coil is warm, quickly transfer nut, steel washer, and rubber packing washer to new cable. Dip end of new cable in very light oil or gasoline and insert in coil and tighten seal nuts.

The breaker points are operated by a peculiarly shaped cam with a narrow and a wide lobe. Each lobe is equally high, but, as can be seen from Figure 23, one lobe holds the points open much longer. The two flat sides of the cam are of equal length, allowing the points to remain closed an equal length of time for each cylinder. This produces a spark of equal intensity in each cylinder. In Chapter III, Section 1, it was stated that the flywheel assembly revolves 405 degrees from power stroke of the rear cylinder to the power stroke of the front cylinder and that it revolves 315 degrees from power stroke of the front cylinder to the power stroke of the rear cylinder. The breaker cam revolves at one half crankshaft speed, therefore, the distance from the wide lobe to the narrow lobe is one half of 405 degrees or 202 1/2 degrees, and the distance from the narrow lobe to the wide lobe is one half of 315 degrees or 157 1/2 degrees. Therefore, the pointed lobe must fire the front cylinder and the wide lobe the rear cylinder. Both spark plugs fire at the same time but one spark is wasted in the exhaust stroke of one cylinder and the other spark fires the combustible gases in the other cylinder to produce a power stroke.

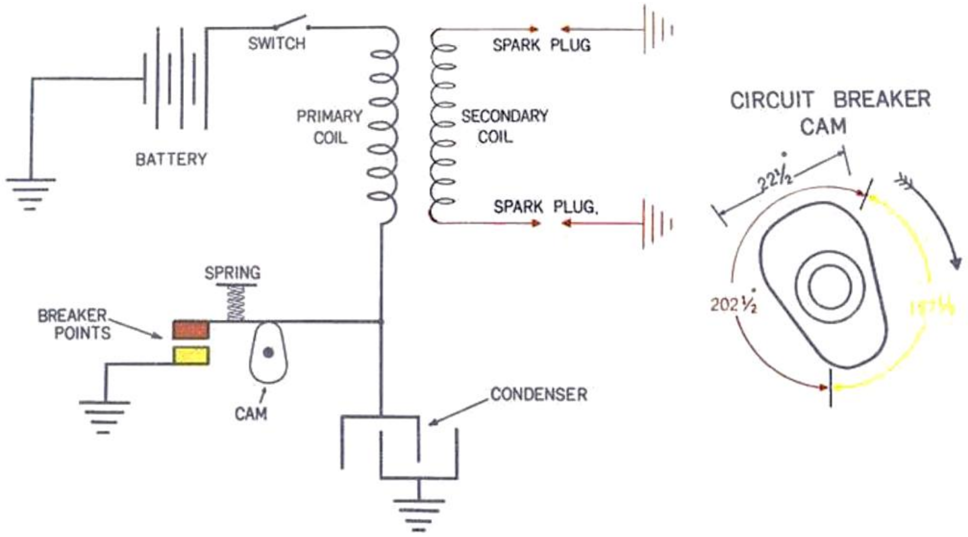


Figure 23 H-D ignition system

One of the circuit breaker points is insulated and actuated by a fibre rubbing block riding on the cam; the other is fixed

and grounded. The condenser is made of strips of tinfoil insulated from each other by wax paper, the even numbered sheets of tinfoil being connected in the line and the odd ones grounded.

In tracing the current through the ignition system, it is well to do so by tracing the circuits. Assume the motorcycle is standing still, the initial current comes from the battery. The current flows to the primary coil (while the points are closed) and activates it, making a magnetic field around the electromagnet. The points still being closed, the current flows through the points and into the ground thus completing the circuit. When the cam opens the points, the circuit is broken and the field around the primary coil begins to break down. As the primary field begins to break down, the lines of force slowly collapse to the core and cut the wires of the primary and secondary coils. The action is too slow to induce voltage sufficient to arc the spark plug gap, but on the now dead primary winding it induces a voltage of approximately 175 volts at 1/200 ampere which charges the condenser connected in parallel with the points. This cushions the kick voltage, thus preventing arcing of the points. One side of the condenser then is charged positively while the other side is charged negatively. The condenser immediately discharges in reverse direction through primary winding and battery in order to equalize potential on both sides of condenser.

As the points are open, there is no current flowing from the battery, so there is very little resistance to prevent the kick voltage from leaving the condenser, passing back through the primary coil to ground at the battery, and completing the circuit through the frame to the condenser ground. The condenser is grounded to complete the circuit itself. When the kick voltage passed through the primary coil coming from the condenser, it reversed the usual flow of current through the coil, thereby tending to reverse the magnetic poles of the coil, however, the current is not sufficient to reverse the poles but is sufficient to neutralize the magnet thereby breaking the field down very rapidly and in doing so causes the lines of force to cut the wires on the secondary very rapidly. The more lines of force that cut the wires on the secondary per second, the greater will be the induced voltage. With the speeding up effect given by the condenser, a potential of approximately 18’000 volts is induced in the secondary. This voltage will cause a spark to jump the air gap of the plugs. The flow of current, which occurs only when there is a spark, runs from one plug lead, down the center electrode of one plug, across its air gap to its grounded electrode. Then through the engine to the grounded electrode of the other plug, across its air gap to its center electrode, up this electrode, through the spark plug lead and back to the coil.

1. Flywheel timing mark in center of inspection hole in crankcase.
2. Adjustable contact point lock screws. Loosen these screws to readjust point gap.
3. Contact point gap.
4. Breaker cam.
5. Condenser.
6. Adjusting band screw.
7. Advance and retard lever.

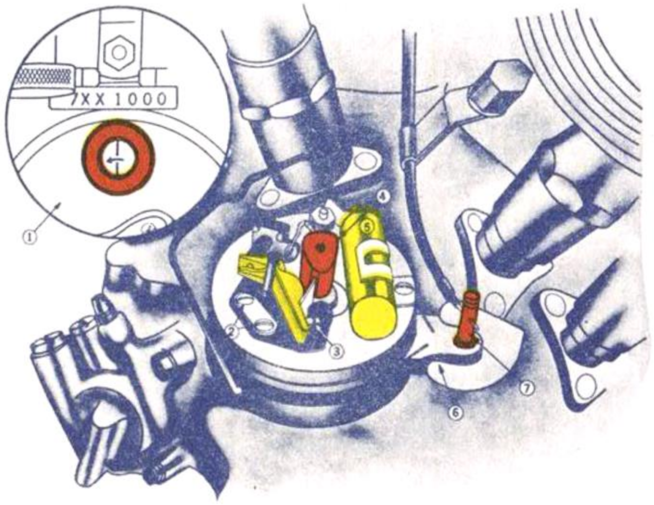


Figure 24 WLA ignition circuit breaker

The motorcycle ignition, as in every other ignition system, must be timed to fire at the proper point before top dead center on the compression stroke of the proper cylinder. The Harley Davidson motorcycle is timed on the front cylinder; the following are the steps in timing the motorcycle ignition (see Figure 24):

1. Set the breaker point gap at .022 inch on one of the two lobes of the cam.
2. Have the front piston on the compression stroke (this is done by lifting the valve cover over the front intake valve and noting its action as the engine is slowly turned over with the kick starter. When the valve opens, the piston is descending on the intake stroke and when it closes it indicates that the piston is ascending on the compression stroke).
3. Register the flywheel timing mark exactly in the center of the inspection hole on the left side of the engine.
4. Assemble the circuit breaker plate on the gear case cover so that the engine will be timed on the narrow lobe of the cam.
5. With the spark in the advanced position, loosen the strap on the breaker plate and rotate the plate around the cam until the points just break, then securely tighten the strap. For accurate timing turn the ignition on and connect a test light in parallel with the breaker points, the exact moment that the points break can then easily be ascertained, for the light will burn the moment that the points are separated and if the spark control is retarded slightly the light will immediately go out, as the points will then go together. The oil signal light may also be used as a test light for the purpose of timing, but in this case the oil light will be connected in series with the points and will remain on as long as the points remain together. At the instant the points separate, the oil light will go out.

For commercial purposes, spark plugs come in five degrees of “hot” or “cold” but the Army uses only the No. 3 motorcycle plug. The gap between the points should be set at .025 (0.635 mm) inch and the plugs should be cleaned periodically with a sandblast cleaner. After cleaning, the top of the grounded electrode and the bottom of the center should be dressed with a point file.

In trouble shooting the ignition system, it is well to start at the plugs to see if they are getting a spark, then to the breaker points, then back through the circuit.

A quick field test for ignition trouble: Hold a spark plug lead about a quarter of an inch from the cylinder head, turn on the ignition, break the points by hand and see if a “hot” or “blue” spark is obtained. If it is not it is an indication of a weak coil, dead broken or loose wires, etc. Arcing of the points and hard starting indicate a bad condenser. The battery may be tested by momentarily shorting it to see if a spark can be obtained, or if the shop, by using a hydrometer. A reading of from 1285 to 1300 indicates a charged battery and a reading of 1215 indicates a battery in need of charging.

Section 7: Causes and prevention of engine overheating

Normal operating temperatures: Motorcycle engines normally operate at the approximate temperatures as shown in Figure 25. These temperatures are for an “L-Head” engine, the type used by the Army. “Overhead” valve engines operate approximately 100 degrees F. (55° C) cooler. When higher temperatures are produced it is a sign of trouble. The normal overall operating temperature is considered to be between 350 degrees F. (177° C) and 450 degrees F. (232° C) (see Figure 25).

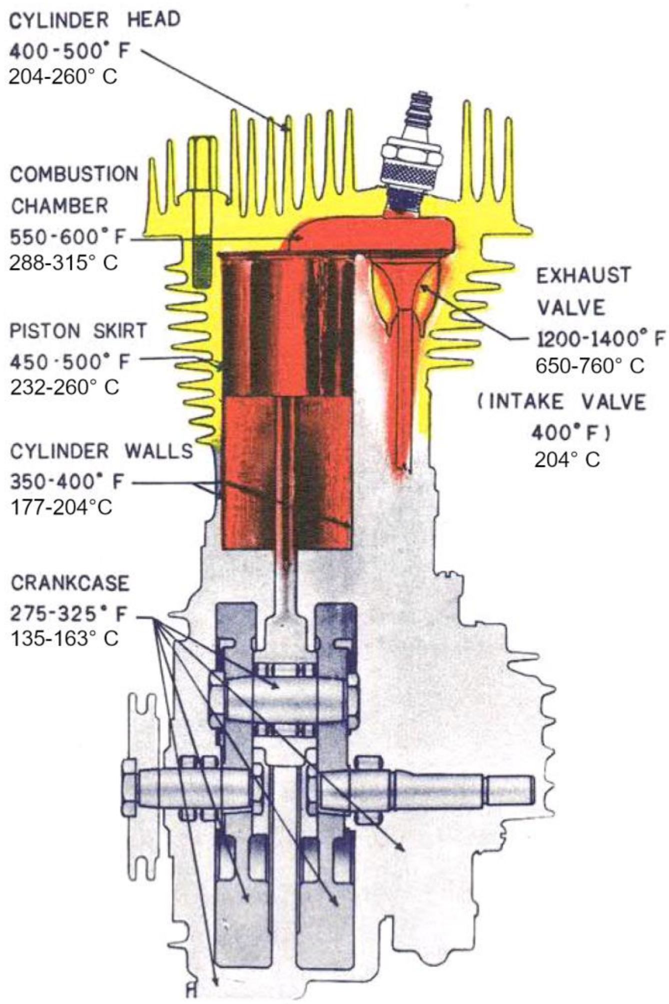


Figure 25 Representative temperatures (WLA engine)

How cooled: The motorcycle engine is cooled by the flow of air over the finned areas of the cylinder heads and cylinder barrels and by the circulating oil which absorbs heat developed at the cylinders, crankcase and pistons and dissipates it while traveling through the gearcase, tubing and in the tank.

Cause of overheating: Overheating can be attributed to the following factors:

a. Insufficient flow of air over the finned areas of the cylinder heads and cylinder barrels: This is the result of running the motorcycle for long periods of time in low and second gear and while running the engine when the motorcycle is not in motion. No motorcycle engine should run longer than one MINUTE when the machine is not in motion except when warming an engine on a cold day or when a fan is used to blow a stream of air over the finned areas. The fan should be placed on the valve side of the engine.
b. Improper carburetion: Rich as well as lean mixtures are slow burning and will cause excessive motor heat; a lean mixture in which an excessive amount of oxygen is present will seriously overheat the engine especially if operated at high speed.
c. Use of wrong type of fuel: Regular 80 octane ethyl gasoline should be used in the motorcycle engine.
d. Insulation of the inside and outside of the combustion chamber: Carbon formations inside the combustion chamber prevent proper conduction of the heat to the cylinder head. Dust, oil and dirt on the cylinder heads and barrels prevent the proper dissipation of the heat to the air. It is the, responsibility of the driver to keep

the finned area free of all dirt. Paint should not be used on the fins. Periodical maintenance service will take care of carbon formations.

e. Mechanical defects: Among the many mechanical defects causing overheating are: Blow-by, leaking head gaskets, leaking valves, leaking spark plugs, loose or leaking heads, use of the wrong type of spark plug, improper timing, retarded spark, and wear in the various parts. Most leaks provide new passages for escape of the hot gases which heat the surrounding metal through which they flow in much the same manner as the high temperatures produced by an acetylene torch.

f. Improper lubrication: The circulating, force-feed, dry-sump, oiling system carries away approximately 35% of the heat produced by the engine. Besides carrying away this heat it must also prevent the creation of more heat by friction. The use of an incorrect type of lubricant or the breakdown of any unit of the oiling system will result in improper lubrication causing overheating. Possible causes are: Not enough oil; key sheared in scavenger pump; bent oil line; impurities clogging passage; rotor spring of feed pump too weak; crankcase breather valve out of time; oil seal spring too weak; air vent line bent or clogged; gears in scavenger pump binding to the cover; water in the oil; crankcase dilution; sleeve binding in the crankcase breather valve housing; incorrect adjustment of the pressure regulating valve.

Results of overheating: Preignition is caused by overheating. Carbon formations and spark plugs become red hot, igniting the mixture before the spark is produced by the ignition system. High compression will also cause the mixture itself to pre-ignite.

Overheating will cause warping of valves, cylinder heads, and other parts of the engine.

Excessive gas and oil consumption results from overheating.

The metal of the pistons becomes plastic at 900° F (482° C) and the pistons will melt or seize (freeze) to the cylinder walls if greatly overheated. All overheating is preventable, repairs caused by overheating are expensive and time consuming.

Summary of engine specifications and clearances

Engine			WLA 1942
Bore and stroke			2 3/4 x 3 13/16
Piston displacement			45.12
Max. H.P. @ rpm			23 @ 4600
Compression ratio			5.0 to 1
Cylinder head material			Aluminum
Pistons	Material		Aluminum
	Piston cylinder head clearance		1/16 to 3/32 with piston at T.D.C.
	Features		Cam ground .030 to .040 across piston pin boss; tapered .002 to .003 top to bottom
	Size		2.744, standard, in oversizes of .005, .010, .020, .030, .040, .050, .060, .070
	Clearance-bottom		.001 to .002
	Pins		Diameter 0.7915 in oversize of .002 to .012 in steps of .002 clear. Light hand press in piston, .001 clear. In rod
Piston rings	Oil	No. used	1
		Side clearance	.004
		Gap	.010 to .020
	Comp.	No. used	2
		Side clearance	.004
		Gap	.010 to .020
Connecting rod	Features		Yoke - one piece - male & female
	Clearance		.001 in upper end
	End play		Forked rod - .006 to .010
	Bearings		Rollers - .250 standard, furnished in sizes from .249 to .251, in steps of .0001. Fit .0007 to .001 loose.

Engine			WLA 1942
Valves	Head diam.	Intake	1 5/8 Do not use in exhaust
		Exhaust	1 5/8
	Stem diam.		.339 to .340
	Angle of seat		45 degrees
	Tappet clearance	Intake	.004 to .005 Engine cold
		Exhaust	.006 to .007 Engine cold
	Intake opens		5/32 to 7/32 B. T. C.
	Operated by		Cam gears – one for each valve – fit .0005 to .001 loose on bushings; .005 end play with shims
	Timing		Scribe marks on gears
	Springs		2 19/32 free length; length 1 7/8 under 95 to 105 lbs. pressure
	Stem-guide clearance		.0035 to .0055
	Tappets	Rollers	.008 side play
		Guides	.0005 to .001 press fit
		Clearance	.0005 to .001
Flywheel assembly	Bearings		Rollers - .250 diam. furnished in sizes from .249 to .251, in steps of .0002. Fits: Gear shaft .0008 to .0012 loose; sprocket shaft .0005 to .0010 loose.
	Thrust collars		Thickness .066 to .102, in steps of .004
	Balanced		By flywheel truing device to .001 tolerance with connect. rods in place
	End play		.012 to .014 in crankcase by adjusting thrust collar size
Crankcase	Right	Main bearing bushing	.0025 press fit in case
		Cam gear bushings	Pressed into cover & case – oil hole 30 degreed ahead of vertical
	Left	Main bearing bushings	.0025 press fit in case

Chapter IV: Electrical system

Section 1: Operation of the system, battery, switch and instruments

The motorcycle electrical system is very simple and very effective, and, for the most part, is peculiar to the motorcycle although the principles are the same as for all electrical systems. The system may be divided into four circuits for the purposes of discussion. The battery–relay-generator circuit, the ignition circuit, the service light circuit and the blackout light circuit. Let us first discuss the battery-relay-generator circuit.

1. As the name implies, this circuit is composed of three main units; the battery, the relay, and the generator. Each one of these units will be discussed separately.

The motorcycle battery has three cells, 15 plates, and a 22 ampere hour capacity. Each cell consists of 8 negative plates and 2 positive plates. Between each positive and negative plate are two separators. On both sides of each positive plate are perforated bakelite separators which keep the active material from falling out of the positive grid. Between the bakelite separators and the adjoining negative plate are wood separators which keep the plates from coming together and forming an internal short circuit. The motorcycle battery is different from ordinary automobile batteries in that each cell group is burned to the cover to prevent vibration from shaking it loose. This construction renders work by mechanics on the inside of the motorcycle battery impractical.

The motorcycle battery should be inspected weekly. The level of the electrolyte should be kept 5/16 inch above the plates by adding distilled water when needed. In addition to checking the electrolyte level, the battery should be tested with a hydrometer. The specific gravity of the battery should be between 1285 and 1215. Whenever the gravity is 1215 or below, the battery should be charged. The battery should be charged at 3 amps until nearly charged and then at 1 1/2 amp until the electrolyte reaches and steadies at a specific gravity of 1285 or higher. Motorcycle batteries should not be "quick-charged" since the plates are not designed to withstand a high current, nor should they ever be charged on the same line with a truck or tank battery, for the high rate of current used in charging these large batteries would rapidly overheat the plates in the motorcycle battery, thus causing them to short-circuit and ruin the battery. If a battery's gravity cannot be brought up to 1285, the electrolyte probably needs replacing. To replace acid, first pour in distilled water, then add acid of 1345 gravity and let the mixture set for a while. When it has cooled, the specific gravity should be 1295. Always add acid to water and NEVER water to acid. In testing a battery with a hydrometer, always test before adding water, otherwise a false reading will result since acid and water will not have had time to mix. The small felt washer found on the terminals of batteries should be kept oiled as this keeps the terminals from corroding. If no felt washers are available, keep a light coat of grease on the terminals.

The relay (cutout) is simply an automatic magnetic switch for connecting and disconnecting the generator and the storage battery. If the battery were left connected to the generator when the latter runs very slowly or stops, an uneven current would flow from the storage battery back through the generator windings and would soon discharge the storage battery. The relay allows the current to flow only from generator to battery (see Figures 26 and 27).

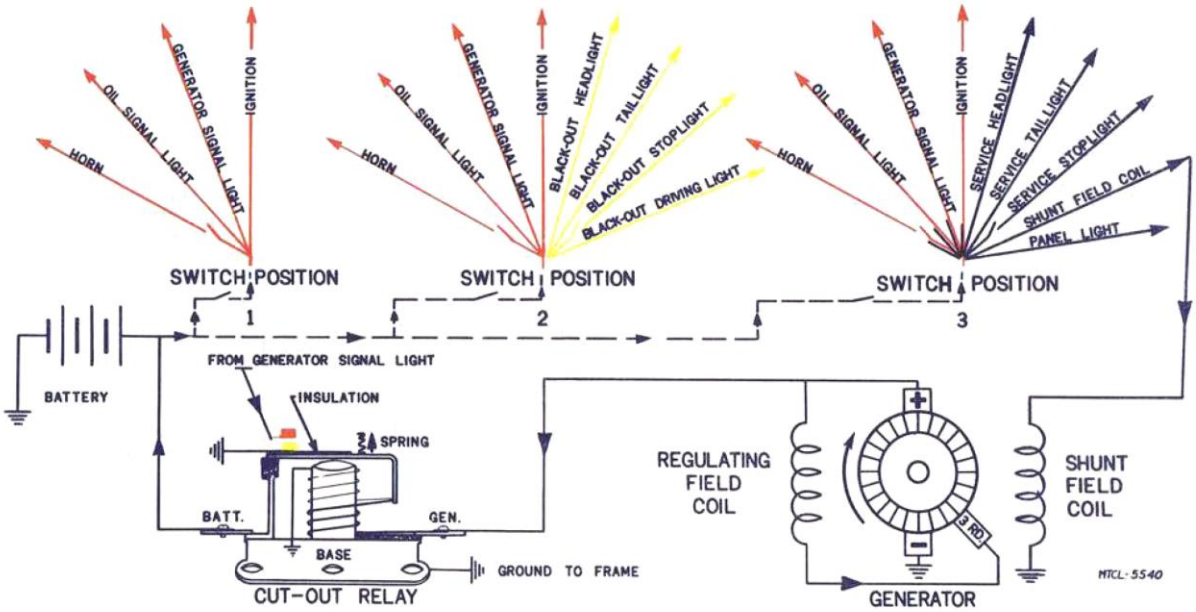


Figure 26 Harley-Davidson WLA wiring system

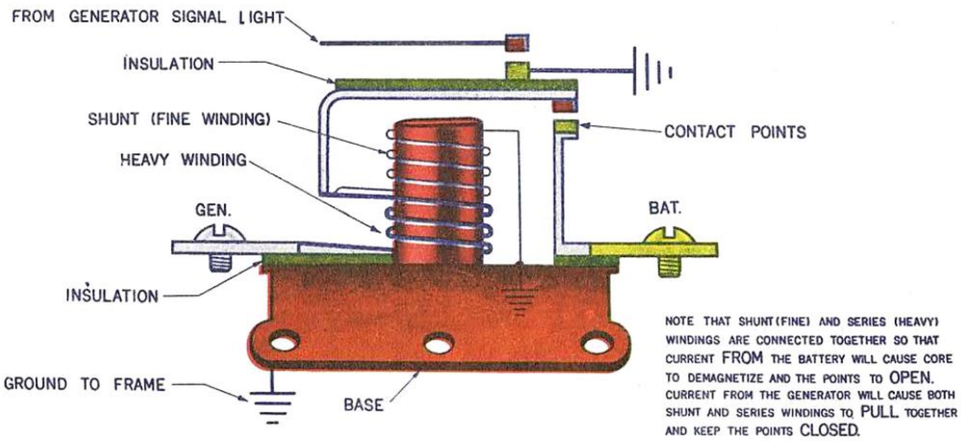


Figure 27 Cut-out relay

The relay has two windings, a shunt winding of many tums of fine wire and a series winding of a few turns of heavy wire, both wrapped around the same soft iron core. When the machine is stopped or just barely running, the generated voltage in the generator forces only a small current through the two windings to ground. When the generator voltage becomes greater than battery voltage (between 6.3 and 6.8 volts), the current through the coil causes the core to become a strong enough magnet to pull an arm down which is held up by a spring with a 5 oz. tension. When this arm is pulled down, it causes two contact points to close, thereby connecting the generator to the battery. When the generator voltage becomes less than battery voltage, the battery sends a current to the generator and in doing so the current passes through the series field of the relay coil in such a direction as to demagnetize the core. As soon as the core is demagnetized, the spring pulls the arm up and the points open and the generator is disconnected from the battery.

The relay requires very little maintenance. If the relay points are burned or pitted they should be replaced or should be dressed with a point file. With the points closed, the distance from the core to the arm (armature) should be .015 inch. With the points open, the point gap should be .020 inch. When mounting a relay, make sure the mounting screws are tight since correct operation of the relay depends upon the relay being thoroughly grounded.

The generator signal light (green light) is also operated by the cutout relay. An additional set of contact points is placed on the relay so that these points will be closed when the other points are open. Then when the generator voltage is greater than battery voltage, the signal light points are open (the other set necessarily being closed) and the green light is out. Whenever the generator voltage is less than that of the battery, the signal lamp points are closed, the other set of points being open, and the signal light is grounded and will light.

In operation, the motorcycle starts on battery current, which carries the ignition until the generator is turning over fast enough to close the relay points and allow current to flow from the generator to the battery and the rest of the electrical circuit. When the generator pressure, or voltage, is less than that of the battery, the relay points open and the battery carries the load of the electrical system while the current from the generator runs into the ground at the relay. The generator will be discussed later in Section 2 of this chapter.

2. The ignition circuit has been discussed in an earlier chapter.

3. The motorcycle has the conventional black-out lights with the clear light in front, the red light in the rear and amber stoplight. Number one post is the black-out post on the switch and when the switch is turned to the second position, current is shunted to this post from the number three hot post in the switch. The blackout stoplight works the same as the service stoplight. In addition, a black-out driving light is found on newer models. This light is mounted to the left of the horn and is operated by a switch on the top. The connection for this lamp is on the bakelite terminal board shown below the horn in Figure 28.

4. The fourth circuit of the electrical system is the service light circuit which brings in the shunt field coil of the generator to take care of the added load. The lights are connected to the number two post of the switch and are turned on by pushing the stop. lock button and moving the switch to the farthest position.

As in every modern vehicle, a one wire system is employed in which the frame acts as the other wire to ground and the current flows to the lights, then back through the ground to complete the circuit. There is 2 dimmer switch for the headlight. The stoplight is operated by a switch attached to the foot brake which, when the pedal is pushed down, completes the circuit from a hot wire at the primary coil to the stoplight.

The instrument panel on the motorcycle contains the generator charging indicator light, the oil pressure indicator light, and the speedometer. The generator charging indicator light, which is the green light on the left of the panel, operates on a wire from number 10 terminal in the switch housing to the top point in the relay. The operation of this light has been discussed previously. The red oil-pressure indicator light which is on the right of the panel, works on much the same principle. An oil pressure diaphragm is connected directly in the oil feed line at the bottom of the gear case. When the oil pressure is developed, the diaphragm rises, breaking the contact and causing the light to go out. However, if the oil pressure against the diaphragm drops, the diaphragm returns to the rest position grounding the oil wire and causing the light to burn. When starting the motorcycle, the instant the throttle is opened slightly, the oil and generator lights should go out. If the oil pressure light does not go out, the friction slip connection on the pressure switch should be checked as it might be loose. The horn is an electromagnet with a vibrator. The circuit is completed by pushing a button to ground the circuit.

All late model motorcycles are equipped with radio interference and suppression devices. These devices are pointed out in Figure 28 by the lettered stars. There are two general methods used to prevent automotive electrical systems from causing radio interference. These are shielding and suppression. Shielding consists of encasing the wires and parts in a metal shielding which is grounded out to the frame. Shielding is used on the motorcycle only on the wire leading from the coil to the circuit breaker (D in Figure 28). Suppression devices are devices which filter out unwanted electrical impulses. There are three types of suppression devices; bonds, condensers, and resistors. All three are used on the motorcycle. Condensers are used at the following points:

a. Coil-condenser case grounded by mounting bracket and end terminal connected to the low tension terminal of coil which is connected to post No. 10 (C in Figure 28).
b. Generator-condenser case grounded by mounting bracket on generator frame end and end terminal connected to “relay” terminal of generator (H in Figure 28).
c. Signal lamp terminal No. 10 – one terminal connected to signal lamp terminal No. 10 and the case is grounded to switch panel base (F in Figure 28).
   Note: This condenser will not be found on the latest models and if this condenser is found faulty, it need not be replaced.
d. Relay - one condenser connected to each relay front terminal. Both condensers are grounded to the relay base (G in Figure 28).
   Note: These condensers will not be found on the latest models and if these condensers are found faulty, they need not be replaced.

Resistors are used on the two spark plug terminals where they are attached to the ends of each spark plug high tension lead and secured to the spark plug terminals by snap connections (E in Figure 28).

Bonding is used to thoroughly ground the spark coil. A metal band is soldered directly to the coil case (A in Figure 28) and connected to this band is a flexible braid conductor (B in the Figure) which is grounded to saddle post frame tube at clutch control mounting bracket and also to the crankcase at rear upper crankcase bolt.

When it is found that a suppressed motorcycle is producing radio interference, there is no reason for believing immediately that something is wrong with the suppression system. Before checking the suppression devices, always check the rest of the electrical system for loose, corroded, or poor connections. The generator, if the commutator is dirty, or the brushes excessively worn, may cause interference.

If the trouble is then traced directly to the suppression system, replace any suspected faulty parts with new ones, one at a time and test for radio noise after each change. To maintain the suppression system and to keep it operating efficiently, all suppression devices should be kept **clean**, **dry**, and **tight**.

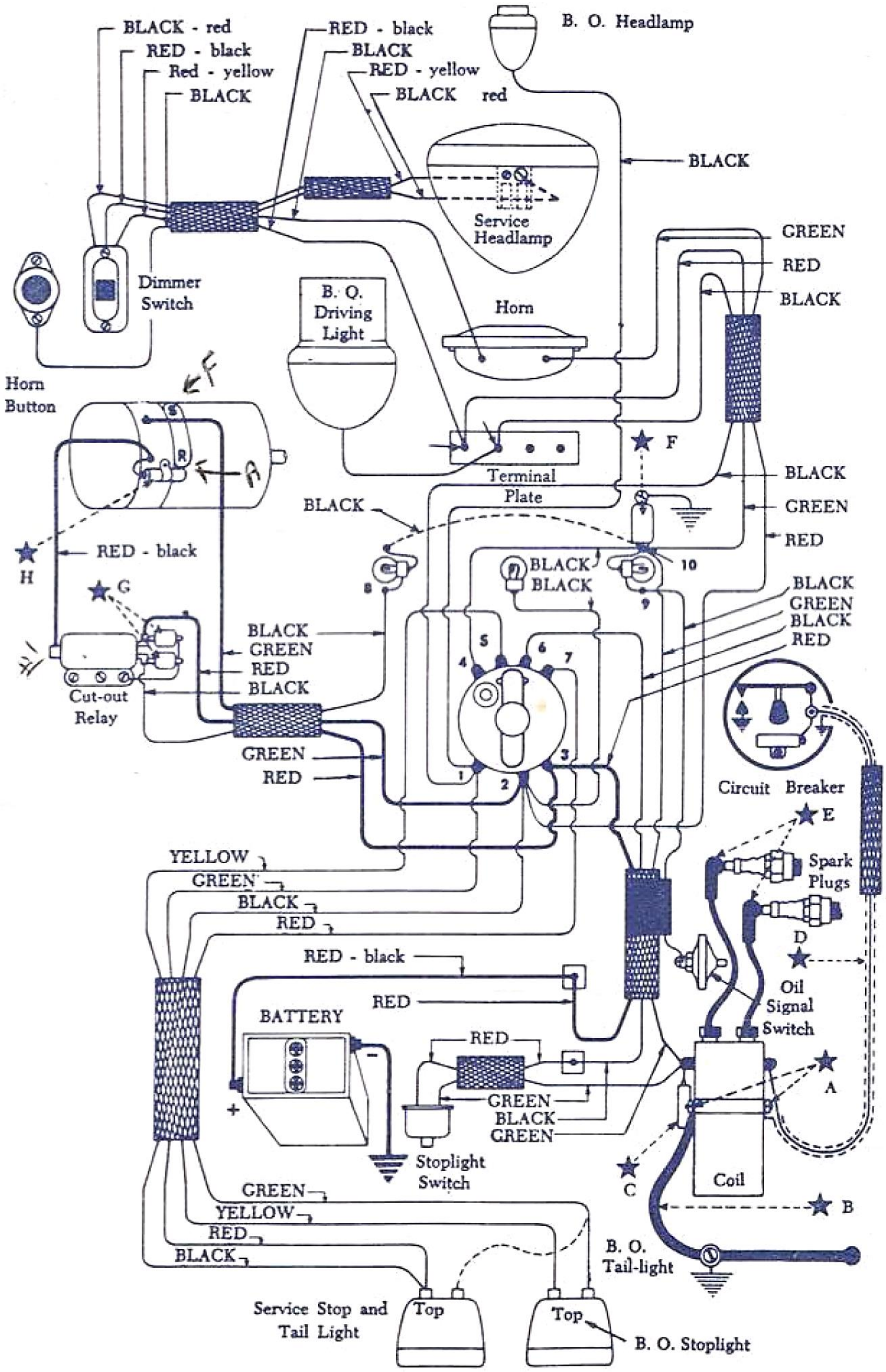


Figure 28 Standard WLA wiring system with radio interference suppression fittings added (indicated by stars)

The three switch positions are as follows: (See drawings for each position.)

Position No. 1 — Ignition.

The "hot" post from the battery, No. 3, is connected to post No. 4, (see Figures 29 and 32), No. 4 is connected by a wire to terminal No. 10 and from terminal No. 10 are wired four electrical units:

a. Ignition (primary) coil.
b. Horn.
c. Generator indicator light.
d. Oil pressure indicator light.

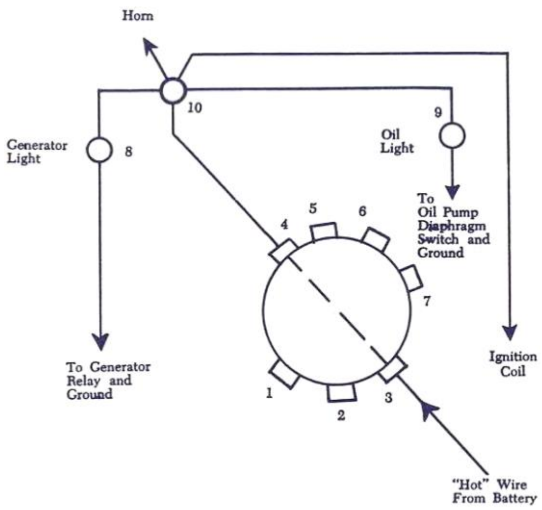


Figure 29 Switch position 1

Position No. 2 — Black-out lights.

Hot post No. 3 connected to No. 4 (see Figures 30 and 32). In addition No. 3 is connected to No. 1, (see Figures 30 and 32), from which wires run to the front black-out light and the rear black-out light. A wire runs from the ignition coil-to the brake stoplight switch and thence to post No. 6, and in this wire is placed the stoplight switch. Therefore, when the ignition is on and the switch is closed (brakes applied), post No. 6 is "hot". When the black-out lights are on, post No. 6 is connected to post No. 5 (see Figures 30 and 32) from which a wire runs to the black-out light (amber). The black-out lights and the black-out stop light have 3 c. p. filaments.

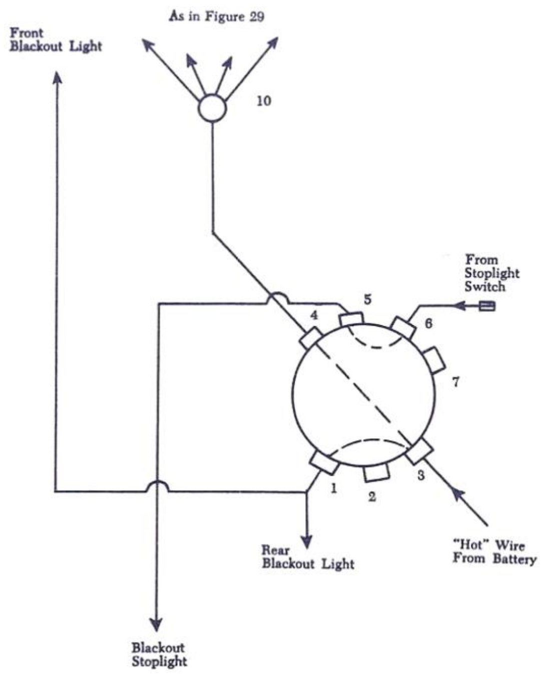


Figure 30 Switch position 2

Position No. 3 — Service lights.

Hot post No. 3 remains connected to No. 4, (see Figures 31 and 32). The stop light “hot” post (No. 6) is connected to the service stop light post No. 7, (see Figures 31 and 32), and in addition No. 8 is connected to No. 2 (see Figures 31 and 32), from No. 2, four units are wired:

a. Tail light.
b. Panel light switch, thence to panel light.
c. To shunt field coil of the generator (see Section 2 of this Chapter).
d. To the headlight dimmer switch which connects either the 32 c.p. upper filament or the 21 c.p. lower filament of the headlight. The service stop light has a 21 c.p. filament, the tail light, panel light and two panel indicator lights have 3 c.p. filaments.

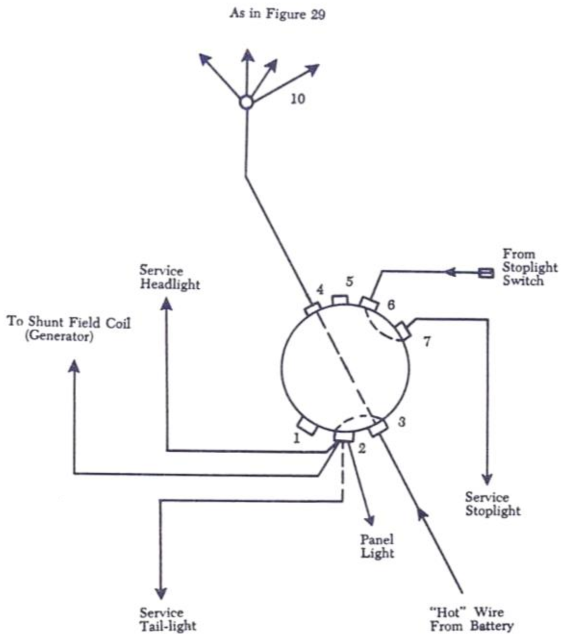


Figure 31 Switch position 3

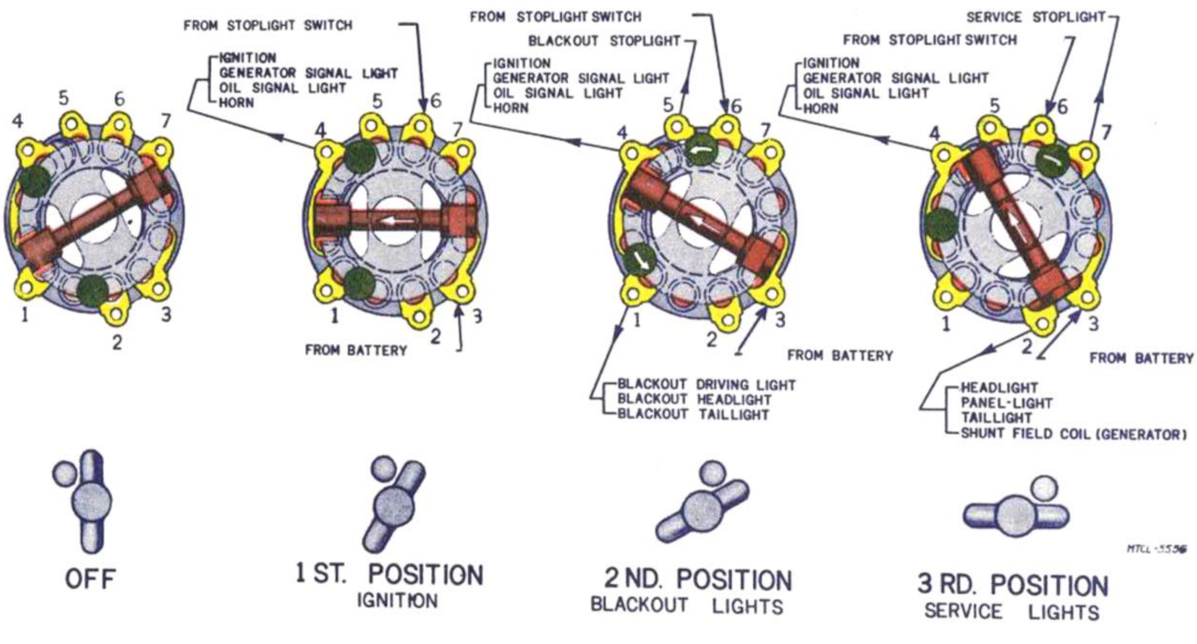


Figure 32 Harley Davidson switch

Section 2: The motorcycle generator

The generator is a device used to convert mechanical energy into electrical energy. The motorcycle uses a shunt wound generator which is regulated by a third brush.

Construction

The main parts in the generator are the frame, armature, and field coils. The frame is made of malleable cast iron and has the pole shoes which support the field coils attached to the inside. The commutator end of the frame has attached to it, by means of two long studs, a cast aluminum frame end. This frame end carries the brush holders and terminals. Both ends of the frame contain ball bearings to support the armature (see Figure 33).

The armature consists of a laminated iron frame on a steel shaft. The armature frame has twelve slots, each of which carries two coils. Thus the armature has a total of twenty-four coils of seven turns per coil. The armature is lap wound, one to six, two to seven, etc. and the ends of each coil are attached to adjacent commutator bars (see Figure 34).

There are two field coils, the regulating coil and the shunt coil. The regulating coil is connected with one end to the third or regulating brush and the other end to the positive brush. It consists of 300 turns of number 22 wire and is marked with an orange dot. The regulating field draws from 1.4 to 1.9 amperes when connected across a 6 volt battery.

The shunt coil is connected with one end to the “switch” terminal and the other end grounded at the negative brush. It consists of 432 turns of number 24 wire and is marked with a white dot. The shunt field draws from .6 to 1.0 amperes when connected across a 6 volt battery.

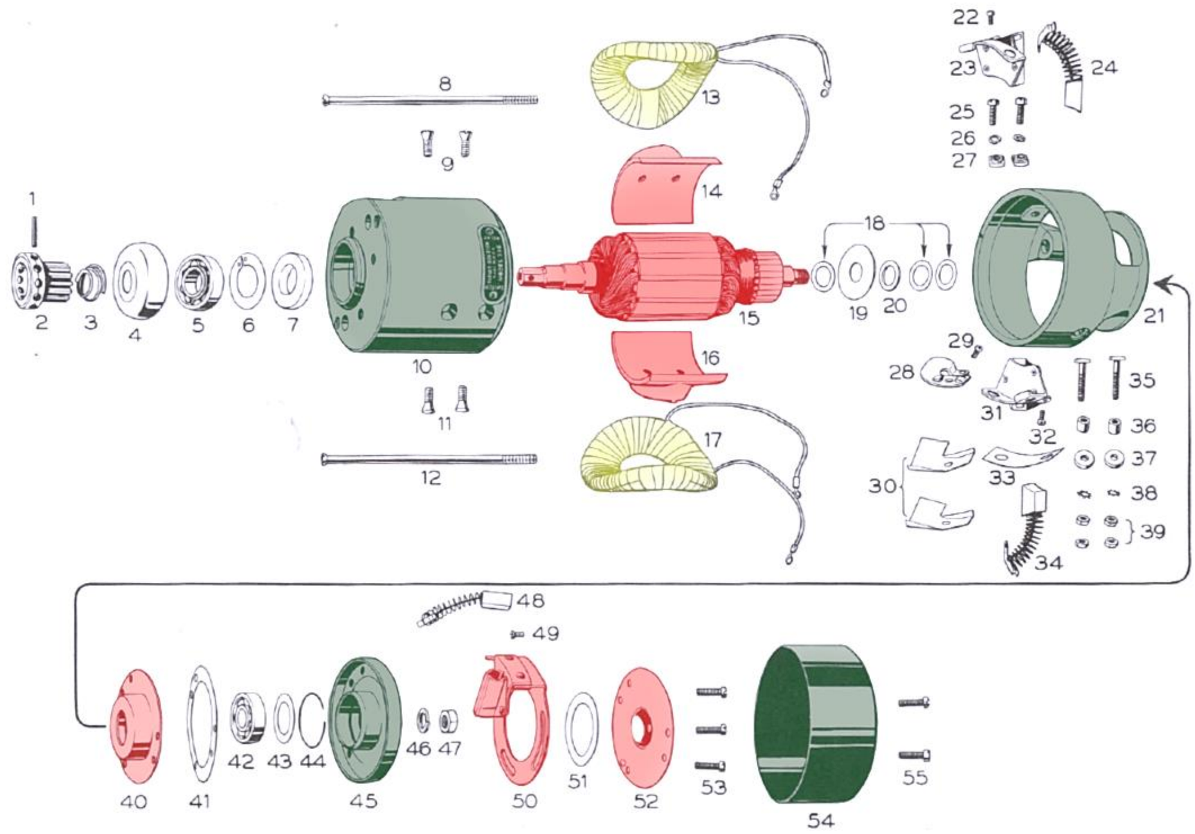


Figure 33 Generator assembly

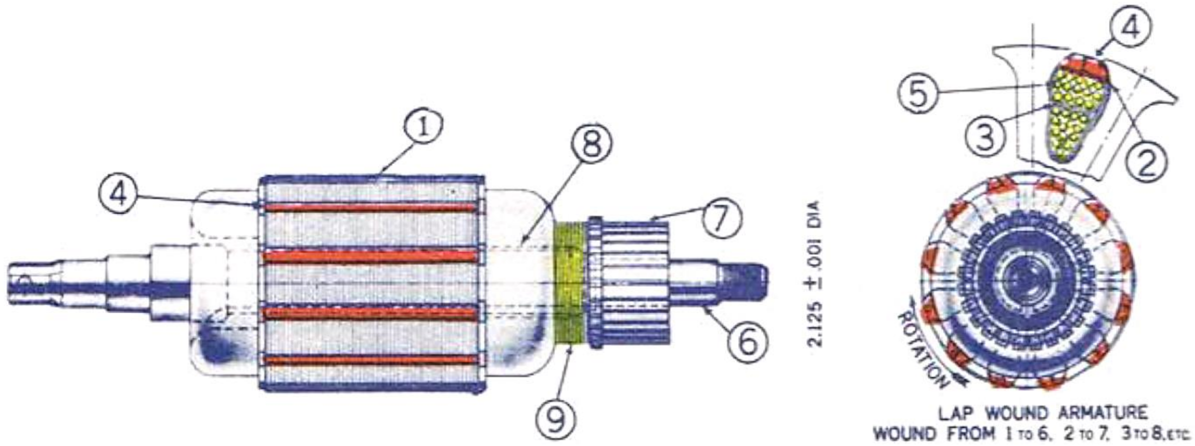
Item	Number used	Part number	Name	Item	Number used	Part number	Name
1	1	634-32	Drive Gear Pin	28	1	1663-32B	Shunt Field Coil Terminal
2	1	632-37	Drive Gear	29	(See Item 22)	-	—
3	1	1647-31B	Spring	30	2	1663-32A	Shunt Field Coil Terminal Insulation
4	1	1646-31	Oil Deflector				
5	1	1644-30	Drive End Bearing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

Operation

The generator is driven by a direct gear mesh with the idler gear in the gear train inside the gear case. It operates on the third brush regulating principle. (see Figure 35). The magnetic lines of force connecting the two pole shoes go straight across at low speeds. As the generator speed increases, the coils in the armature distort or twist the magnetic field until the lines become thin at the leading tip of the pole shoe and thick at the trailing tip. The regulating field is excited by the armature windings which are between the positive brush and the third brush. Thus as speed increases and the magnetic field is distorted, the current in the regulating field decreases, reducing the generator output. The motorcycle generator is designed to give maximum output at 80 miles per hour. Above this speed, the generator output drops. The third brush is adjusted for a generator output of 4 amperes at 50 miles per hour (see Figure 35).

The output with only the regulating field connected is sufficient to take care of the ignition and blackout light load of the vehicle. However, when the service lights are connected, an additional load of about 4 amperes is introduced and extra output from the generator is required to prevent discharging the battery. When the service lights are turned on, the shunt field is connected through the switch to the battery. Thus the shunt field is energized, the total magnetic field is approximately doubled, and the generator output is doubled.

The generator output can be changed by manually changing the position of the third or regulating brush. To increase the generator output, the third brush is moved in the direction of rotation of the armature. To decrease the output, the third brush is moved against the direction of rotation of the armature. The armature turns clockwise, looking at the generator from the commutator end.



1. Armature core
2. Slot insulation
3. Field coil cotton tape (10 ft.)
4. Armature slot closing strip
5. Armature coil assembly
6. Armature shaft
7. Commutator
8. 60# Green core gummed paper tape
9. Binding twine

Figure 34 Generator armature

Testing

When the generator signal light stays on it is an indication that the generator is not charging. The first thing to do is determine whether the trouble is in the relay, the wiring between the relay and generator, or in the generator itself. A logical trouble shooting procedure should be followed in testing the generator, and as many tests as possible should be made before disassembling the generator.

If the trouble is in the generator, check the brushes, brush holders and commutator before removing the generator from the motorcycle. If no trouble is found in these items, it is necessary to remove the generator.

Before disassembling the generator, the field coils, brush holders, and terminals should be checked. A test light should be used before using an ammeter, as a short circuit or ground may damage the ammeter.

Testing field coils

To test the regulating field coil, remove the three brushes from their holders and reconnect all leads. If no ground or short has been indicated by the test light, connect one terminal of a battery through an ammeter to the "Relay" terminal and the other battery terminal to the third brush holder. The ammeter should read between 1.4 and 1.9 amperes. If the test light showed a ground, the ground must be located and corrected before the ammeter is used. Connect one terminal from a battery through a test light to the "Relay" terminal, and ground the other battery terminal to the generator frame. If light burns, either the coil, third brush holder, positive brush holder or "Relay" terminal is grounded. Disconnect regulating coil lead from third brush. If current stops, third brush holder is grounded. If trouble persists, disconnect regulating coil lead from positive brush holder. Current still flowing indicates a grounded regulating coil. If current stops, the positive brush holder or "Relay" terminal is grounded.

Test the shunt field coil next by using a test light first, checking between the "Switch" terminal and the frame. If no ground is indicated, connect one terminal from a battery through an ammeter to the "Switch" terminal and ground the other battery terminal to the frame. The ammeter should read from .6 to 1.0 amperes.

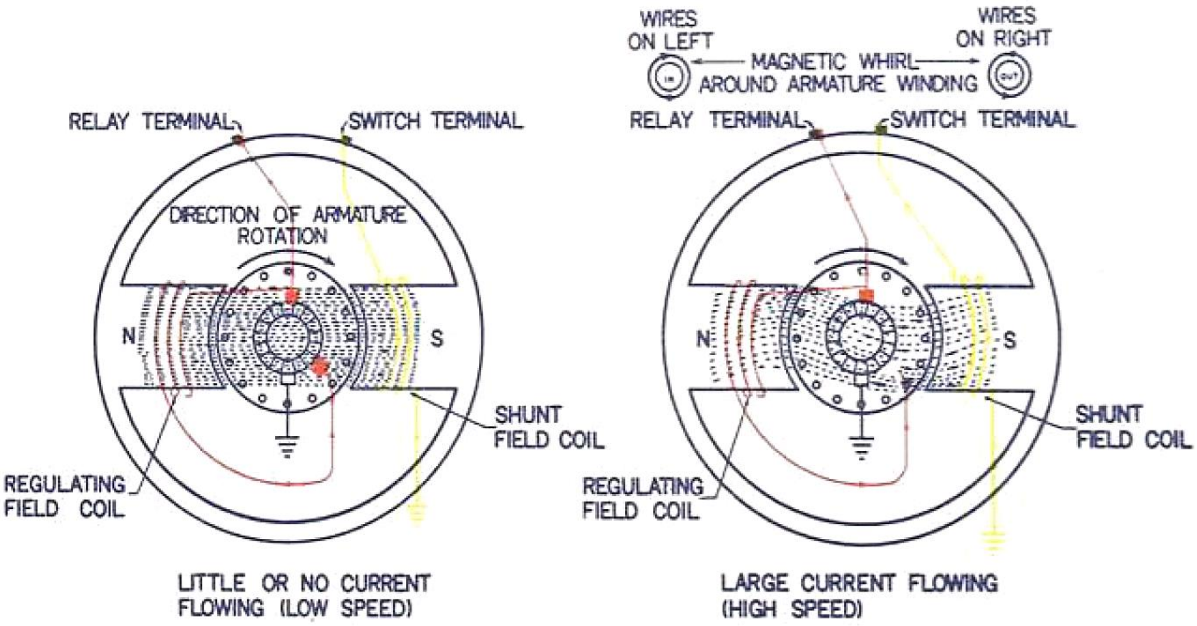


Figure 35 Third brush regulation

Testing the armature

In order to test the armature the generator must be disassembled. Three troubles may develop in the armature; a ground, an open, or a short. A special tester is available for the armature. It consists of an electromagnetic growler, an ammeter, and a test light.

To test for ground, turn test light switch "on". Place one test prong on the armature shaft or core and place other test prong on each commutator segment in turn. If light goes on, armature coil is grounded.

To test for short, place armature in growler and turn growler switch to "low". Hold a hacksaw blade lengthwise with flat side loosely in contact with armature core. Slowly rotate the armature with hacksaw blade held stationary. If a short exists, the blade will be attracted to the armature and will vibrate violently, producing a buzzing sound.

To test for open circuit, place armature in growler and turn switch to low. Place the double prongs on adjoining commutator segments which are nearest the point where armature and growler "V" make contact. Rotate armature and read ammeter as each set of commutator bars come into position. The ammeter should read between 12 and 13 amperes for each coil. No reading indicates an open circuit. High or low readings indicate a shorted coil.

The armature may also be tested for an open circuit by placing it in the growler and turning the switch to low. Insert tip of a hacksaw blade between the segments which are closest to point of contact between armature and growler "V". Make and break contact with the blade. A strong flash should be seen. No flash indicates an open circuit.

Chapter V: The power train

The power which causes the motorcycle to move is developed in the combustion chamber in the form of heat and is transformed into potential energy by expansion of the gases in the chamber. The expansion of these gases forces the piston downward on the power stroke. A connecting rod transmits the energy from the moving piston to the crankpin, causing the flywheel assembly to rotate. This rotation is transmitted directly by the sprocket shaft to the engine sprocket. When the engine sprocket turns, the power is transmitted by the double link primary chain to the clutch sprocket. The relation between the speeds of rotation of the two sprockets depends on their size. With the clutch engaged, the power is transmitted through the driving discs to the driven discs of the clutch, to the transmission and to the rear chain drive sprocket. A single link chain connects this sprocket with the rear wheel sprocket, transmitting the power to the rear wheel. Due to the difference in size between the engine sprocket and clutch sprocket, and also the difference between the rear chain drive sprocket and the rear wheel sprocket, the motorcycle engine turns over 4.59 times for each revolution of the rear wheel when the transmission is in high gear.

Thus, to summarize the flow of power in the WLA model, refer to Figure 36. Power is put out at the engine sprocket, is picked up by the primary drive chain and transmitted to the clutch sprocket and thence to the clutch. When the clutch is engaged and the transmission is in gear, power flows through the clutch, thence into and out of the transmission to the transmission sprocket keyed and locked to the transmission shaft. This sprocket puts power into the rear chain which finally delivers it to the rear wheel sprocket, thus causing the rear wheel to turn.

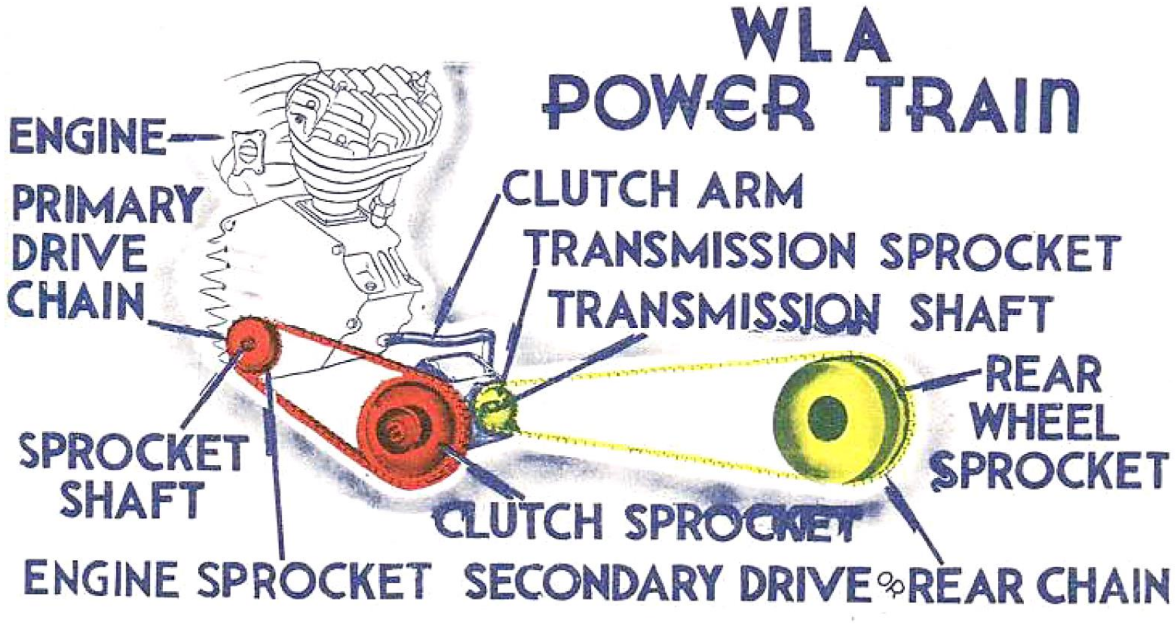


Figure 36 WLA power train

Chapter VI: The motorcycle clutch

The purpose of the motorcycle clutch is to disengage the engine from the rear or driving wheel for starting, stopping and shifting gears. The internal combustion engine develops torque with which to turn the wheels of a vehicle, only with speed. Consequently, the engine must be disengaged before it is started. With the engine crankshaft revovling and the driving wheel stationary, to transmit the torque of the revolving crankshaft of the engine to the stationary driving wheel to cause it to move, a flexible or slipping connection must be provided. The clutch provides this connection.

The Harley Davidson motorcycle clutch is a multiple disc dry clutch with steel plates and fibre lined plates set alternately in the clutch housing. One set of plates is connected to the engine and the other set to the transmission and through it, to the rear wheel. The plates driven by the engine are called driving discs, those connected to the transmission, the driven discs.

When the clutch is fully engaged, strong springs force the plates together and cause them to turn as a unit, with the result that the power is transmitted without appreciable loss to the rear wheel through the transmission. If the force that the springs exert is relieved somewhat, there is slippage. Lost motion in the clutch permits the engine to turn over normally while the rear wheel will move at a lower rate of speed because of slippage between the discs. If the force exerted by springs on the discs is completely relieved, the clutch is in the disengaged position. In this position the springs are compressed to permit the driven and driving plates to move independently of each other. The following illustration shows the disassembled clutch.

Figure 37 shows the order of assembly and disassembly of the clutch. The clutch sprocket housing (88) which houses the clutch discs, is free to turn on the hub assembly (72). The hub assembly is directly connected to the clutch shaft in the transmission. The lined friction disc (89) is the first part assembled in the clutch sprocket housing. The holes in the disc engage with the studs (86, 87); thus any power transmitted to the lined disc is transmitted to the hub assembly and to the transmission. The next part placed in the clutch sprocket housing is the steel friction disc (90). The steel discs are connected to the clutch housing by engaging the notch in the disc with the projection on the inside of the housing (88). It may be seen that when the discs are pressed tightly together the power goes from the clutch sprocket housing to the steel discs (90), thence to the lined friction discs (89), by means of friction between the two plates; then to the clutch hub by engagement of holes in the lined discs with studs on the clutch hub, and from the clutch hub to the transmission and thence to the rear wheel. Next to be assembled is another lined disc (89), then another steel disc (90). The steel discs have the word "out" stamped on one side. When assembling this side goes out. Then a sprung disc (91) lined on one side is put on. The holes in this sprung disc engage with the studs of the clutch hub.

As may be seen by referring to the illustration, curved slots are cut in the steel part of this disc (91). A portion of the disc between the curved slot and the edge of the disc is bent out. This portion of the metal projects out toward the releasing disc (92). When the clutch begins to engage, this will be the first portion to touch the releasing disc as it moves to compress the discs together. Due to the spring of the metal, the disc will not completely engage but will slip, allowing gradual transmission of power to the rear wheels, preventing any possibility of sudden grabbing. As more pressure is put on the disc, the bent portion will flatten to its original position and the discs will engage completely and turn as a unit.

The releasing disc which presses against the sprung disc has holes in it, allowing the studs of the clutch hub to project past the releasing disc. These projections provide a base for one end of springs (95), which are ten in number, arranged in a circle around the center of the disc. The other end of the springs is held in place by spring collar (96). Indentations on the collar line up with the projections of the studs past the releasing discs. Three of the studs are considerably longer than the others and are threaded on the ends. The spring compression collar has three holes in it through which the longer studs project. The collar is held in place by nuts (98), which screw on the threaded ends of the long studs. Lock washers (97) prevent the nuts from backing off with vibration. The nuts (98) not only hold the springs on but also adjust the spring tension. On the 1941 and 1942 Harley Davidson 45, this spring tension is adjusted by tightening the spring tension adjusting nuts (98) until the distance from the outside face of the releasing disc to the inner shoulder of the spring compression collar is 1 1/32 inches (26.2 mm).

In Figure 38 a small rod may be seen running through the center of the mainshaft and clutchshaft of the transmission and protruding into the clutch. This is the clutch push rod and is actuated by a clutch lever. This lever is attached to the clutch cable and the clutch pedal which may also be seen in Figure 38. Movement of the clutch pedal causes the clutch cable, the clutch lever and finally, the push rod to move. If the left end of the rod projects from the clutch hub far enough, it engages the end of the push rod adjusting screw in a manner similar to a ball and socket joint. Thus, when the clutch pedal is put in the disengaged position, (heel down) the movement is transmitted through the linkage to the push rod, causing it to move to a position where it projects farther from the clutch hub. In moving outward, the end of the rod engages the push rod adjusting screw in the releasing disc. The adjusting screw being part of the releasing disc, continued outward movement of the push rod will force the releasing disc outward toward the spring compression collar, la in Figure 38 compressing the spring between the collar and the releasing disc. The outward movement of the releasing disc relieves the spring pressure on the discs, and allows them to rotate loosely in the clutch housing and to turn with no relation to each other (see Figure 38, clutch “disengaged”).

When the clutch pedal is put in the engaged position (toe down), the movement is transmitted by the linkage and the push rod recedes into the clutch hub. Thus the pressure on the releasing disc, which compresses the springs, is relieved and the springs force the releasing disc inward, compressing the friction discs together, and causing discs to revolve as a unit. The power is then transmitted directly to the transmission and rear wheel (see Figure 38, clutch “engaged”).

The distance that the push rod projects out of the clutch hub and forces the releasing disc to compress the springs, determines how completely the clutch is disengaged and how well the discs are freed from each other. The distance this push rod projects out depends on how much free play there is between the clutch lever moving the push rod and the cable actuating the clutch lever. If the free play is too much, the push rod would not begin to move the releasing disc soon enough. The clutch pedal, and also the push rod, would reach the end of their travel before the springs between the releasing disc and spring collar were completely compressed. If the springs were not completely compressed, the discs would still be touching each other and there would be friction between them, causing a dragging clutch. To ward off such conditions an adjustment is made by turning the push rod adjusting screw (93) in Figure 37 clockwise and securing it by lock nut (94). This adjusting screw moves the ball joint in or out of the releasing disc and will adjust the free movement of the clutch lever on the cable. With the clutch pedal in the engaged position (toe down) the clutch lever should have about 1/8 inch (3.2 mm) free movement.

If there is too much free movement, the clutch will drag in the disengaged position. If there is not enough free play or none at all, the push rod will, in the engaged position, project out too far and will still compress the springs. This condition prevents the springs from forcing the discs together and the clutch slips.

With the proper linkage adjustment made, the setting of 1 1/32 inches for spring tension should be accomplished. If the clutch slips, after controls have been correctly readjusted, increase spring tension by tightening the three nuts (98) in Figure 37.

Tighten all three nuts, one-half turn at a time, until the clutch holds. Test after each half turn by cranking engine. Usually a clutch that holds without any noticeable slippage while the engine is being cranked also holds on the road.

Do not increase spring tension anymore than that actually required to make the clutch hold. On a new clutch, as originally assembled and adjusted, the distance from the inner edge of shoulder on spring collar (96) to the outer surface of the releasing disc (92) in Figure 37 is 1 1/32 inches. In any case, do not tighten nuts (98) to the point where the inner edge of shoulder on spring collar (96) is closer than 7/8 inch (22.2 mm) to the surface of the releasing disc (92). If compressed more, the clutch probably cannot be fully released.

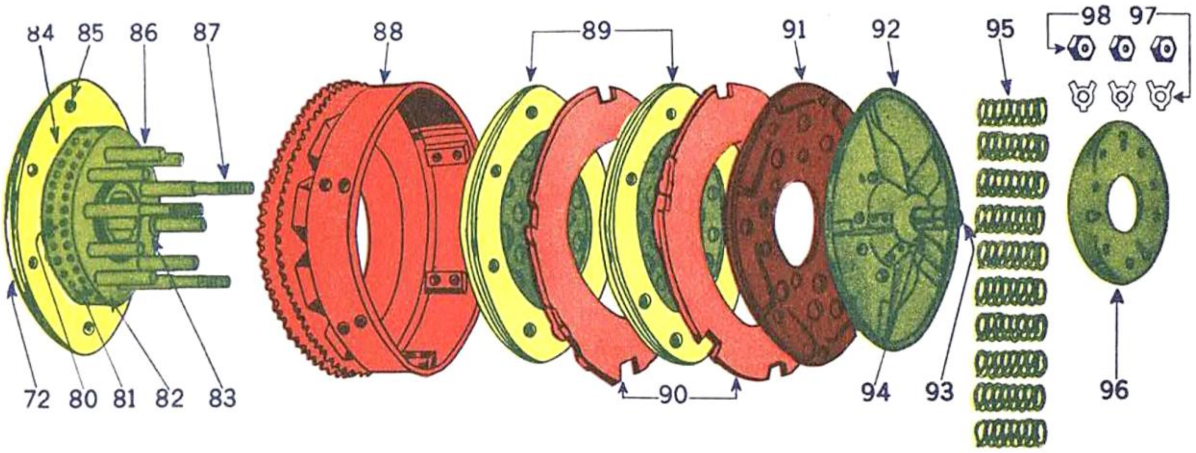
When the clutch is disengaged the clutch lever should clear the stud on the right side of the transmission by 1/16 of an inch (1.6 mm), this clearance is adjusted by lengthening or shortening the clutch cable.

Summary of clutch adjustments

The clutch adjustments should be made in the following order:

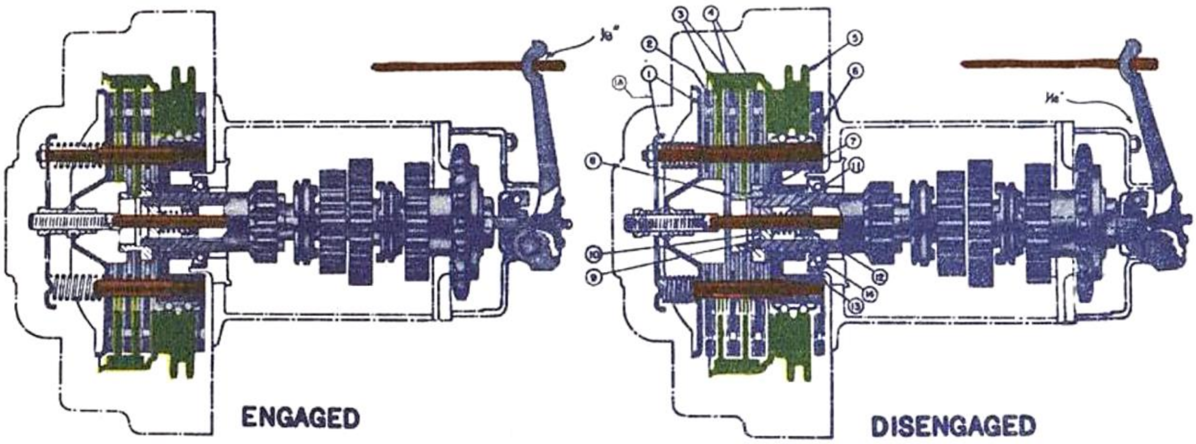
1. Adjust for 1/16 inch clearance between the clutch lever and the transmission with clutch disengaged by cable length adjustment.
2. Adjust for 1/8 inch free movement of clutch lever on the clutch cable with clutch engaged by push rod adjusting screw in the face of the releasing disc.
3. Adjust distance from spring collar to releasing disc with clutch engaged by the three (3) spring compression collar adjusting nuts.
   If the clutch does not hold after checking the control adjustments and spring tension, it will have to be taken apart for inspection of discs and springs. The fibre discs may be found worn, or oil-soaked and in

need of washing and drying. If the clutch has been overheated as a result of slippage, the springs may be found to be damaged and in need of replacement.



72. Clutch hub complete, with sprockets, bearings, studs, etc.
80. Ball bearing retainer
81. Ball – 7/32”
82. Bearing retaining plate
83. Retaining plate lock ring
84. Hub disc lining
85. Lining rivet
86. Pin
87. Stud
88. Sprocket complete with disc spline ring
89. Lined disc
90. Plain steel disc
91. Sprung steel disc with lining
92. Releasing disc
93. Push rod adjusting screw
94. Adjusting screw lock nut
95. Clutch spring
96. Spring compression collar
97. Stud nut lock washer
98. Stud nut

Figure 37 Clutch assembly



1. Releasing disc
2. Cushion plate
3. Clutch disc
4. Friction disc
5. Sprocket and key ring
6. Ball bearing and drive hub
7. Gear nut lock washer
8. Clutch gear nut
9. Push rod guide spring ring
10. Push rod guide
11. Push rod and mainshaft oil seal ring
12. Oil seal spring cup
13. Oil seal leather cup
14. Clutch gear oil seal

Figure 38 WLA clutch

Chapter VII: The motorcycle transmission

Section 1: Operation

The transmission is a device that permits the rider to vary the ratio of engine speed to the rear driving wheel speed in order to meet the varying conditions of operation. The motorcycle transmission is of the constant-mesh, progressive type. The term “constant-mesh” means simply that all the gears in the transmission are constantly in mesh with one another at all times. “Progressive” means that the transmission, being in low gear, cannot be shifted to high gear without going through neutral and second gear. Whereas in an automobile or truck one could shift from low to high gear by merely going across through neutral, no such selection is provided in the motorcycle transmission. The shifting must progress directly from either first gear through neutral to second and then to high gear, or vice versa — straight up or straight down. When the clutch is engaged, the power of the engine is carried through the transmission to the rear wheel. The transmission on the WLA model, by means of shifter clutches and different size gears, enables the rider to select one of three different gear ratios in order that he can gain the maximum performance from the engine.

The power from the clutch is transmitted into the transmission by the clutch shaft. As can be seen from Figure 39, the clutch gear meshes with, and drives the cluster gears. The low gear and the second gear can rotate freely on the main shaft and are meshed with, and driven from the cluster gears. Therefore, when the clutch gear revolves, all the gears in the transmission revolve; from this fact the transmission derives its name, a Constant Mesh Type Transmission.

The transmission mainshaft fits into a recess in the clutch shaft. This recess acts merely as a support for the mainshaft and does not connect it to the clutch shaft. Two sliding “shifter clutches” are splined to the mainshaft. These shifter clutches are free to move sideways on the mainshaft and are fashioned with “dogs” that engage with the dogs on the clutch shaft, and in recesses in the second gear or in the low gear, depending on the gear ratio desired. They transmit the speed and power of that particular gear to the mainshaft.

Assume a rider is starting his motorcycle from a stop. He should use “low” gear and to do so he disengages the clutch, stopping all gears in the transmission and moves the shifter lever forward into the low position. The linkage turns a cam that forces one of two shifter forks to move the low gear shifter clutch. When shifting into low the shifter clutch slides along the mainshaft until it engages in the recesses in the side of the low gear, which otherwise runs freely on the mainshaft. As can be seen from Figure 39, the power is then transmitted from the clutchshaft, to the cluster gears and to the large low gear. The power is transmitted from the low gear to the mainshaft by the shifter clutch. The sprocket is keyed to the mainshaft.

As the motorcycle accelerates, the engine increases its speed rapidly and it will become necessary to increase the vehicle speed but decrease the engine speed. This is done by disengaging the clutch and shifting the shifter lever into “second”. The linkage again turns the shifting cam and this time the two shifter forks move both of the shifter clutches. In the center picture in Figure 39 it can be seen that the low gear shifter clutch has been moved along the mainshaft and out of mesh with the low gear and the other shifter clutch has been moved into mesh with the smaller second gear. Power is then transmitted from the clutch gear to the cluster gears and to the second gear and through the shifter clutch to the mainshaft. As the relative gear sizes have been changed, the engine will run slower than when in low but the sprocket and rear wheel will revolve at the same speed as before.

When the motorcycle has attained sufficient speed the rider again disengages the clutch and shifts to “high”. The shifter fork then moves the shifter clutch out of mesh with the second gear and into mesh with the dogs of the clutchshaft. The power then travels directly from the clutchshaft dogs through the shifter clutch and to the transmission mainshaft. Then, each time the clutch shaft revolves once, the main shaft also revolves once resulting in a 1 to 1 ratio in the transmission. The low gear shifter clutch does not move when shifting to high. All the gears then, of course, are revolving but none are driving, the only power transmitted is from the dogs of the clutchshaft to the dogs of the shifter clutch and then to the mainshaft. The ratio of 4.59 to 1 in this gear is provided then not by the gears within the transmission, but by the difference in the number of teeth on the clutch sprocket and those on the transmission sprocket.

The transmission is designed to give the following ratios in 1st, 2nd and 3rd gears:

Gears	Engine revolutions	Rear wheel revolutions
1st	11.34	1
2nd	7.21	1
3rd	4.59	1

Section 2: Overhaul

Before any work can be performed on the interior of the motorcycle transmission, it must first be removed from the frame. To gain access to the transmission, however, the following additional items must first be removed from the motorcycle:

- Primary Chain Guard
- Complete Clutch
- Primary Chain
- Upper and Lower Inside Chain Guard
- Tool Box
- Battery Case
- Rear Chain
- Rear Chain Guard
- Gearshift Rod
- Rear Brake Rod
- Clutch Lever Rod
- Transmission Adjusting Screw

In the 1940 and earlier models of the WLA 45 cubic inch motorcycle the transmission is fastened to the frame by two studs. The 1941 and 1942 models have three such studs. After the nuts have been removed from these studs the transmission can be lifted from its base. Before starting any work on the transmission, remove the inspection hole cover, drain and thoroughly flush the interior of the transmission. In order to work on the transmission efficiently it should be held by the mounting studs in a copperjawed vise. If copper jaws are not available, two blocks of wood will serve the purpose. When the transmission is properly secured in the vise the inspections and adjustments should be carried out in the proper sequence as described below, beginning with the Shifter Fork Adjustment, and proceeding on to more complete disassembly and adjustments:

Shifter fork adjustment

To adjust the shifter forks or the shifting clutches, remove the sprocket cover, starter crank, and starter crank spring. When the inspection plate has been removed, it is possible to check with the gauges to determine what adjustments are to be made. These gauges can be made of wheel spokes.

The clearance allowed on the low gear shifter fork of the 1940 and earlier models is .248 inch (6.3 mm) to .253 inch (6.4 mm); on the 1941 and 1942 models it is .283 inch (7.19 mm) to .288 inch (7.32 mm). This measurement is taken between the side of low gear and the side of low gear shifter fork while the shifter cam is in the neutral position.

The clearance allowed on the second and high gear shifter fork for the 1940 and earlier models is .030 inch (0.76 mm) to .037 inch (0.94 mm); on the 1941 and 1942 models it is .053 inch (1.35 mm) to .057 inch (1.45 mm).

The clearance is measured between the highest points of the driving dogs on the shifter clutch and the dogs on the end of the clutch gear, while the shifter cam is in the neutral position.

To make an adjustment on the shifter forks, first remove the shifting cam shaft and shifting cam. A special drift is used to remove the shifting cam shaft. Insert the “L” end of the drift into the groove of the shaft and tap the drift with a small hammer.

Next remove the shifter fork shaft by drifting it out with a small punch. This shaft will come out through the gear box side cover.

With the shaft out, the shifter fork assemblies are free to be lifted out and adjusted. The shifter fork assemblies are not interchangeable, so before taking them apart for adjustment, the exact arrangement of parts in each assembly should be noted carefully so that they can be re-assembled correctly.

After the nut is removed from the shifter, adjusting shims may be taken off or more added. These shims are supplied in two sizes .007 inch (0.18 mm) and .014 inch (0.36 mm). From one to six are required for correct adjustment in a new transmission. To increase the clearance between the dogs of the clutch gear and the dogs on the second and high shifter clutch, remove shims. To decrease the clearance between these points, shims should be added. To increase the distance between the side of low gear and the low gear shifter fork, add shims. To decrease the distance between these points remove shims.

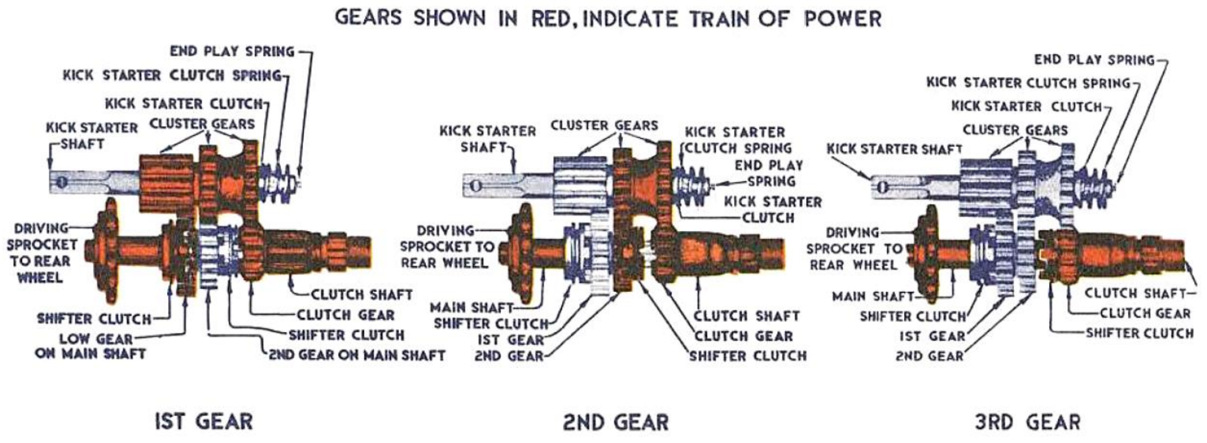


Figure 39 45 Transmission (1935 and including 1942)

Disassembly of transmission for complete inspection and renewal of parts

To disassemble completely the transmission for inspection, adjustment and renewal of parts, proceed as described in the foregoing for adjusting shifter forks. Then remove the sprocket from the right end of the mainshaft. It is held by two Woodruff keys and a large nut. To remove this nut turn it counter clock-wise with a 1 1/16 inch socket and handle. After the nut has been removed, tap the sprocket with a brass drift directly opposite the Woodruff keys; the sprocket will release itself from the tapered end of the mainshaft.

Remove the screws and nuts from the studs which hold the transmission side cover in position. All remaining internal parts may then be taken out through the side. On removing the transmission side cover from the gear box look for twenty-one needle bearings and a bearing thrust washer on the right end of the mainshaft.

1. To disassemble the mainshaft and all units from the mainshaft, remove the following from the right end in the order stated:
   a. The reverse gear spacer bushing (reverse gear spacing bushing is assembled with flanged side outward).
   b. Mainshaft thrust washer at the end of the raised splines.
   c. The low gear shifter clutch.

   From the left end of the mainshaft remove:

   a. The miainshaft adjusting spacer.
   b. The second and high shifter clutch.
   c. The second gear.
   d. The second and low gear adjusting spacer.
   e. The low gear.
   f. The low gear end thrust washer at the end of the raised splines.
2. Before removing the countershaft and countershaft gear from the-gear box, pull the countershaft out about one inch. Roll the countershaft gear forward and remove through the large opening in the side of the gear box.
   To disassemble units from the countershaft, first remove the small spring from the end of the countershaf take the kick starter clutch and spring from the left end of the countershaft. The countershaft can be pulled out through the left end of the countershaft (cluster) gear. There are nineteen needle bearings in the left side of the countershaft gear, in the 1941 and 1942 transmission. The standard size of these bearings is .152 inch (3.86 mm). They can be obtained from .001 inch undersize to .001 inch oversize in graduations of .0002

inch.
In the right end of the countershaft gear there are twenty-four needle bearings whose standard size is .114 inch (2.9 mm). They can be obtained in .0004 inch and .0008 inch oversize only .
There is a thrust washer on each side of the needle bearings on the right side and left side of the countershaft gear, a total of four thrust washers on the countershaft.
The clutch shaft may be removed through the right side of the gear box. There are forty needle bearings on the 1942 clutchshaft; the 1940 model has thirty-one. The 1942 standard size is .125 inch (3.18 mm), they can be obtained in standard .0004 inch and .0008 inch oversize only.
Assembled on the clutchshaft is a needle bearing thrust washer, and a thrust bearing retainer and balls (constructed as one unit).
The transmission, when entirely disassembled is ready for a thorough inspection of each part. The shifter fork shaft, shifting cam shaft, mainshaft and countershaft may be checked for alignment on a flywheel truing device. Inspect the shifter forks to determine whether bent or whether the sides of the shifter forks are under-cut. This condition may be due to improper shifter fork adjustment, to shifting with the clutch engaged, or to a dragging clutch.
Inspect the shifter clutches to see that they have a good free fit without binding on the splines of the mainshaft. Observe whether the engaging dogs on the shifting clutches and the dogs on the end of the clutch gear are in good condition without chipped corners.
Check the shoulders in the milled out portions of the low and second gears to see that they have not become rounded off. Assemble the low and second gears on the mainshaft and check for excessive play between the shaft and gear bushings. If these bushings are worn excessively install new bushings. The running clearance between the mainshaft and these bushings is .001 inch.
Inspect the clutchshaft, thrust bearing and clutchshaft needle bearings. Check the thrust bearing race on the clutchshaft and the thrust bearing race in the left side of the gear box for excessive wear.
Assemble the clutchshaft with the thrust bearing and race into its proper position in the gear box with the needle bearings in place around the clutchshaft. Check for excessive play between the needle bearings and the clutchshaft. The proper clearance between these parts is .001 inch. It may be necessary to replace these bearings with an oversize bearing to take up excessive clearance. Refer to Bearing Fitting for the Transmission.
Check the countershaft for alignment, check the countershaft gear for chipped or cracked teeth. Assemble the kick starter clutch on the splined end of the countershaft and be sure that it slides freely on the spline ways. Assemble the needle bearings into each end of the countershaft gear with the countershaft and bearing thrust washers in their proper position; check for any excessive clearance between the bearings and the countershaft. The clearance allowed is .001 inch.

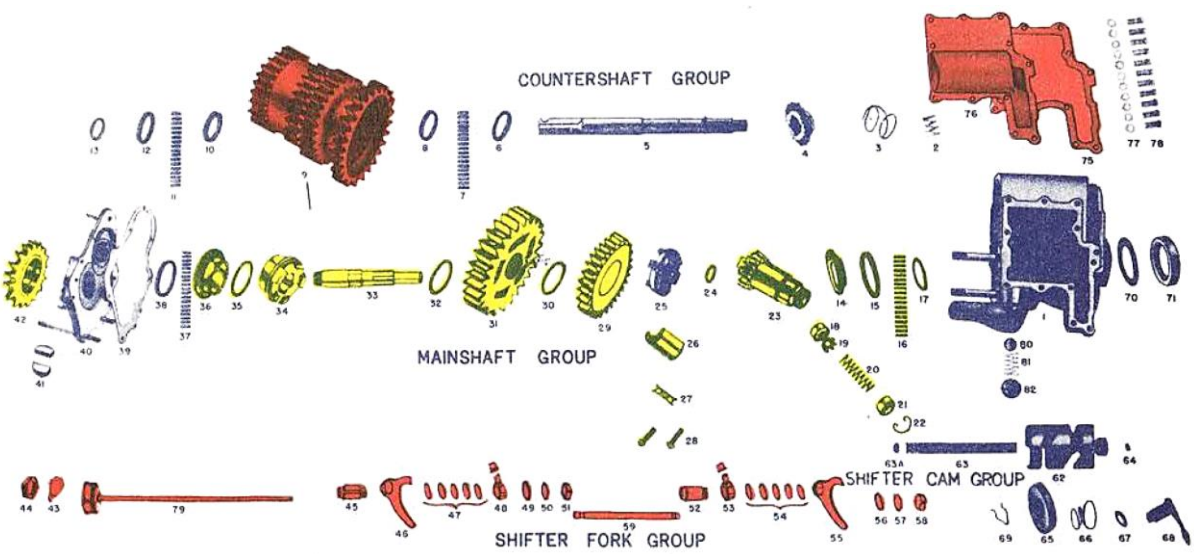


Figure 40 WLA transmission (1941 & later)

Mainshaft adjustments

There are clearances at various points in the transmission which must be made within the manufacturers specifications before the transmission will operate efficiently and give maximum service.

1. After the transmission has been disassembled, each part carefully inspected, and defective parts replaced, it is ready for assembly and adjustment. The first adjustment to be made is “mainshaft end play”. The end play of the mainshaft is from .003 inch (0.08 mm) to .005 inch (0.13 mm). Assemble the clutchshaft with the needle bearings around the clutchshaft, being sure that the clutchshaft thrust bearing and thrust race are on the clutchshaft in their proper positions. An easy method to assemble needle bearings on the clutchshaft is to apply a coating of grease to the clutchshaft and place the bearings around the bearing surface of the clutchshaft. After this is accomplished place the clutchshaft into the clutchshaft bearing race in the gear box.

   Assemble the following parts on the mainshaft: Mainshaft thrust washer on the right side of the raised splines; mainshaft bushing (be sure that the flanged side of this bushing is facing the tapered end of the mainshaft). Place the mainshaft into the bushing at the end of the clutch gear and assemble the gear box side cover and gasket with the twenty-one needle bearings in position in the side cover. Put the side cover on the gear box and tighten securely.
   At this time screw a “mainshaft end play gauge” on to the threaded end of the mainshaft; loosen the set-screw on the gauge and push the mainshaft into the gear box as far as possible being sure that the needle on the gauge is touching the side cover. Tighten the set screw down against the needle. Pull the mainshaft out toward the side cover and with a feeler gauge check the distance from the end of the needle to the side cover. If the clearance is less than .003 inch (0.08 mm) it will be necessary to remove the mainshaft and replace the mainshaft adjusting spacer with a thinner one. If the clearance is more than .005 inch (0.13 mm) a thicker adjusting spacer will be required. If the mainshaft end play is determined exactly, and also the thickness of the mainshaft adjusting spacer (measured with an outside micrometer), the thickness of the required adjusting spacer may be calculated easily.
2. The clearance between the second gear and the second gear retaining bracket must be adjusted. This bracket is located inside the gear box and is fastened to the case with two screws. Remove gear box side cover and take out the mainshaft. Be sure that the adjusting spacer with which correct end play was obtained, is not misplaced.
   Assemble the following parts on the mainshaft: Mainshaft thrust washers (2) one on each of the raised splines; the reverse gear spacer bushing on the right end of the mainshaft with the flange side toward the side cover; the low gear on the left end of the mainshaft with the milled outside of the gear towards the raised spline; the second and low gear adjusting spacer; the second gear with the milled side of the gear toward the left end of the mainshaft, and the mainshaft adjusting spacer. This assembly is then installed in gear box. Replace the side cover, with the twenty-one needle bearings in position, and tighten securely. By using a feeler gauge and checking the distance between the side of the second gear and the second gear retaining bracket, the exact amount of side play can be determined.
   The running clearance between the second gear and the second gear retaining bracket is .005 inch (0.13 mm) to .007 inch (0.18 mm). If the second and low gear adjusting spacer is too thick, the second gear will bind against the second gear retaining bracket. This also will cause the mainshaft to bind. If this trouble is experienced, replace the second gear adjusting spacer with one thin enough to allow side-play between second gear and the second gear retaining bracket. Determine the exact amount of this side-play with a feeler gauge. Remove the mainshaft and measure the thickness of the second and low gear adjusting spacer with a micrometer. By calculation, the thickness of the second and low gear adjusting spacer required to allow the specified clearance between the second gear and the second gear retaining bracket may be determined. Reassemble the mainshaft into the transmission with the correct spacer and check this clearance.
   The mainshaft low and second gear box adjustments being completed, remove the mainshaft from the gear box, leaving the clutchshaft in position. Assemble the bearings into each end of the countershaft gear, with the countershaft gear with the starter clutch, kick starter clutch spring and countershaft spring in their proper positions. Place the countershaft gear in its position in the gear box. Place the mainshaft and component parts in the transmission and fit the side cover with its gasket on the side of the case and tighten securely.

Assembly of shifter forks and shifting cam

To assemble the low, the second and high gear shifter forks to the shifting clutches, insert the shifter fork shaft through the hole in the gear box cover, then through the shifter finger bushings. Using a brass drift, tap the shaft into its full seated position. Assemble the shifter finger rollers to the fingers of the shifter forks with the flanged ends downward.

On the 1940 transmission, the wider shifter fork is assembled to the low gear shifting clutch. In the 1941 and 1942 transmission the shifter forks are interchangeable, in earlier models they are not. However it must be remembered that even though the shifter forks themselves are interchangeable, the shifter fork assemblies are not.

The shifting cam is the next unit to be assembled in the transmission. The gear on the end of this cam has a timing mark on one of the teeth made by grinding or beveling it on the end. On the shifter gear, note the number "3" stamped on the side between two teeth. Assemble the shifter cam into the transmission with these timing marks aligned; put the shifting cam shaft into position and then insert and tighten the shifting cam shaft lock-screw. The shifter cam requires up to .005 inch (0.13 mm) end-play to operate efficiently. If this end play is more than .005 inch it is necessary to insert shims on the shifter cam shaft between the end of the cam and the gear box. These shims may be made out of thin shim stock.

The shifter gear plunger ball must be seated with sufficient tension so that a fair amount of effort is required to move the cam from one position to another. This tension is adjusted by the cam plunger cap screw. To increase the tension turn the cap screw clock-wise; to decrease the tension tum the cap screw counter clock-wise. Place the inspection plate in its position with its gasket and tighten it with the six screws provided for the purpose.

Bearing fitting for the transmition

The 1940, 1941, and 1942 Harley Davidson transmission uses roller type bearings in four different places, as can be seen in Figure 41.

The fitting of roller bearings requires patience and care.

The first step is to get a "plug fit". The term "plug fit", means that there is no clearance between the bearings, the bearing race and the shaft.

It may be necessary to try several different sizes of bearings (always using all the same size bearings each time) before a plug fit can be obtained. For example, the standard size of the twenty-one bearings used on the mainshaft is .152 inch and other sizes can be obtained from .001 inch undersize (.151 inch) and to .001 inch oversize (.153 inch) in graduations of .0002 inch. There are, therefore, eleven different sizes used in the fitting of bearings on the mainshaft. The mechanic tries various sizes in the race, with the shaft in position, until a plug fit is obtained.

If a .0005 inch oversize bearing gives a plug fit, it is now necessary to figure exactly what size bearing will give the desired clearance or "running fit" of .001 inch.

The mechanic must take one-half the specified running fit and subtract it from the diameter of the roller which gives the plug fit. In the fore-going instance, a .0005 inch oversize (.1525 inch) roller resulted in a plug fit. By subtracting one-half of the correct running fit (.0005 inch) from .1525 inch, it is found that .152 inch is the correct size of the roller to be used for a running fit of .001 inch.

One-half of the running fit is used in figuring bearing size because each reduction of .0001 inch in the size of the roller results; in .0002 inch greater clearance; .0001 inch on each side of the shaft.

Summary of bearings, washers, clearances and adjustments – H. D. WLA transmission, 1941-1942

Roller bearings	**Where used**	**No. used**	**Size**			**Available**
Left bearing	Left side of counter shaft	19	.152” x 5/8”			a.
Right bearing	Right side of counter shaft	24	.114” x 3/4"			b.
Clutchshaft bearing	Clutch shaft	40	.125” x .615”			b.
Mainshaft bearing	Right side of main shaft	21	.152” x 5/8”			a.
Washers			**I.D.**	**O.D.**	**Thick.**	
End	Counter shaft gear – left side	1	13/16”	1 3/16”	.080”	1 size only
End	Counter shaft – left side	1	13/16”	1 5/64”	.092”	1 size only
End	Counter shaft – right side	2	13/16”	1”	.180”	1 size only
End	Main shaft – right side	1	29/32”	1 3/16”	.063”	1 size only
Spacing	Main shaft – end play	1	3/4"	15/16”	.078” to .113”	Steps of .005”
End play	Low and second gear	1	1 5/64”	1 7/16”	.040” to .075”	Steps of .005”
End thrust	Low gear – spline	1	15/16”	1 7/32”	.052”	1 size only
Thrust	Low gear shifter clutch	1	7/8”	1 7/64”	.052”	1 size only
End	Roller – main shaft	1	29/32”	1 3/16”	.063”	1 size only
Spacing shim	Shifter fork group	Varies	-	-	.014” to .007”	2 sizes
Spacing shim	Shifter fork group	2	-	-	5/64”	1 size only

a. .001 oversize to .001 under size in stops of 0002
b. Available in standard, .0004 and .0008 oversize

Figure 41 WLA Transmission 1941 - 1942 bearings and washers; sizes and locations

Part	**Fittings and adjustments, where measured**	**Range**	**Pref. clearance**	**How measured**
Roller bearings	All	.0006” to .001”	.0008”	Plug fit
Main shaft	In clutch gear bronze bushing	.0015” to .0025”	.002”	By feel
Counter shaft	In transmission case bronze bushing	.0015” to .0025”	.002”	By feel
Counter shaft	In transmission side cover bushing	.0005 to .0015”	.001”	By feel
Main shaft	End play	.003” to .005”	-	With dial or similar gauge
Low and 2nd gear	End play – between 2nd gear retaining braket and transmission case side cover (check between side of 2nd gear and retaining bracket in transmission case)	.005” to .007”	-	With feeler gauge
2nd and high gear shifter clutch	Side clearance – check with shifter cam in neutral position, and highest points on driving dogs overlapping about 1/8”	.053” to .058”	-	With feeler gauge
Low gear shifter clutch	Side clearance – Check between sides of shifter fork and low gear, with shifter cam in neutral position	.283” to .288”	-	With feeler gauge
Shifter cam	End play	Free to .005”	-	With feeler gauge
Cam plunger ball	Measured from outside of cap to case	3/16”	-	With steel rule

Figure 42 WLA transmission, 1941 - 1942; fittings, adjustments & clearances

Chapter VIII: Sprockets, chains, wheels, rims, tires, spokes

Sprockets

The motorcycle is equipped with four sprockets: engine sprocket, clutch sprocket, transmission sprocket, and the rear wheel sprocket. The engine and clutch sprockets have double sets of teeth to conform to the duplex construction of the front chain. The engine sprocket can be obtained in various sizes in order to increase or decrease the gear ratio. The standard sprocket has 31 teeth.

Sprocket pitch is the distance from the tip of one tooth to the tip of the next tooth. Chains are manufactured to conform to sprocket pitch.

Chains

The motorcycle has two chains: the primary or front chain and the secondary or rear chain.

The primary chain is of duplex construction but it does not use rollers as does the rear chain. It can be repaired with a master link. It is removed by taking off either the clutch or the engine sprocket, and is adjusted by moving the transmission forward or backward in the frame. It is lubricated from the engine lubrication system. An adjustable needle screw on the timing gear case cover controls the amount of oil distributed to the front chain. Adding shims under the head of the screw increases the flow and removing the shims decreases the flow of oil to the chain. The chain should be adjusted for an overall 1/2 inch (12.7 mm) up and down free play midway between the sprockets. When the transmission is moved to adjust the front chain, the clutch linkage, shifting linkage, rear chain and rear brake linkage should be checked and readjusted.

The rear chain is constructed with rollers riding on single links, has a master link, and is removed by taking off the master link. It is adjusted by moving the rear wheel forward or backward as the adjustment requires. The chain is adjusted for 1/2 inch overall up and down free play midway between the sprockets. When the rear chain is adjusted, the rear brake linkage should also be checked and readjusted. The rear chain wears on the inside between the rollers and the links as the rollers wedge themselves in the teeth of the sprocket. The links are fastened together by pins and as the bushings in the links wear larger and the diameter of the pins wear smaller, the chain stretches. Stretch is measured by laying the chain on a flat surface and compressing the chain working from the center out to the ends. When it is fully compressed a mark should be placed on the surface at one end. Then, while the opposite end is held stationary, the first end is pulled, and another mark made. The two marks should be compared and if there is more than 1 inch stretch, the chain should be discarded as it will not then conform to the sprocket pitch. When new, a commercial chain has about one eighth inch stretch.

The rear chain should be removed periodically and cleaned with kerosene, especially between the rollers and the links and inspected for stretch and wear. It should then be thoroughly soaked in warm engine oil or hot General Purpose Grease No. 2 and hung up to drain off surplus oil before reinstalling.

The slack side of the rear chain is lubricated directly from the scavenger pump of the engine lubrication system. The adjustment of the controlling needle screw is exactly like that of the front chain needle screw described above, except that the rear chain oiler screw is located in the scavenger pump.

Hubs

The Solo Motorcycle front wheel hub is constructed as follows (see Figure 43): The left side cone is pressed onto the axle. The right side of the axle is threaded and the second cone screws on. There are two sets of ball bearings, thirteen in each, that ride on the races of the cones and hub. The right side cone is held in place by a Jock washer and nut. To adjust the front wheel hub, remove the wheel from the motorcycle and clamp the left end of the axle in a vise. Free running play is obtained by turning the cone in until the wheel binds, then backing it off one quarter turn. It should be locked in place by the cone lock nut and washer.

The 45 rear hub is constructed as follows (see Figure 43): The thrust bearing cover assembly is held on the hub by five screws. After removing this assembly it can be disassembled into the following units: Outer thrust bearing cover, cork grease retainer, thrust bearing housing, adjusting shims (each .002 inch thick), thrust washer, thrust bearing sleeve, and another thrust washer. The small set of bearings, twelve, can then be removed. There are also fourteen roller bearings in a retainer on the opposite end. Radial play will result from worn bearings. End play can be adjusted by the shims in the thrust cover assembly. Check for end play with a dial gauge or in an emergency add shims until there is no end play of the inner sleeve; then remove two shims which will give clearance of approximately .004 inch. The proper end play is from .003 to .005 inch. All shims are .002 inch thick. Bearings are replaced by the plug fit system.

Rims

The front and rear wheel rims on the 45 are not the same because the front wheel brake drum is built directly into the hub. On the front wheel the holes drilled in the well for the nipples are at a greater angle on one side than on the other. This is because the distance from the brake drum to the rim is smaller than the distance from the hub to the rim. Therefore, preparatory to lacing the front rim, it is necessary to always select the holes with the greatest angle to go with the brake side. No such difference is encountered with the rear wheel rim, because here both flanges of the hub are of the same diameter. Hence it is not necessary that the hub and rim be matched as in the case of the front wheel. If the flanges of either rim become bent they can be straightened and the rims used again; but if the well, in which the 40 holes are drilled for the nipples, becomes bent, the rim should be discarded.

Spokes

There are 4 sets of 10 spokes on all motorcycle wheels. The spokes are attached to the rim by nipples, and to the hub by the enlargement on their heads. When lacing a wheel, the outside spokes go toward the front or in the direction of rotation. The inside spokes go toward the rear. The left side of the 45 inch front wheel is laced in the opposite direction from the above, however, because this has been found to give a stronger wheel. Each spoke crosses four other spokes, except that on the left side of the front wheel, each spoke crosses two other spokes.

Wheels

The front and rear wheels on the 45 WLA are not interchangeable, due to the fact that the front wheel is built with the brake drum as a part of the wheel, but the brake drum for the rear wheel is attached separately to the rear hub by means of lug nuts. Both wheels have wire spokes which absorb shock and both can be disassembled into the various parts: rim, spokes (40), nipples (40), and hub. In reassembling, the hub must be centered. This is accomplished by laying a straight edge across the end of the hub on the brake side and measuring the distance between the straight edge and the rim, tightening the spokes on the side of the straight edge if the clearance is too great and loosening if the clearance is too small. The clearances for the 45-inch wheels are as follows:

Model “45”

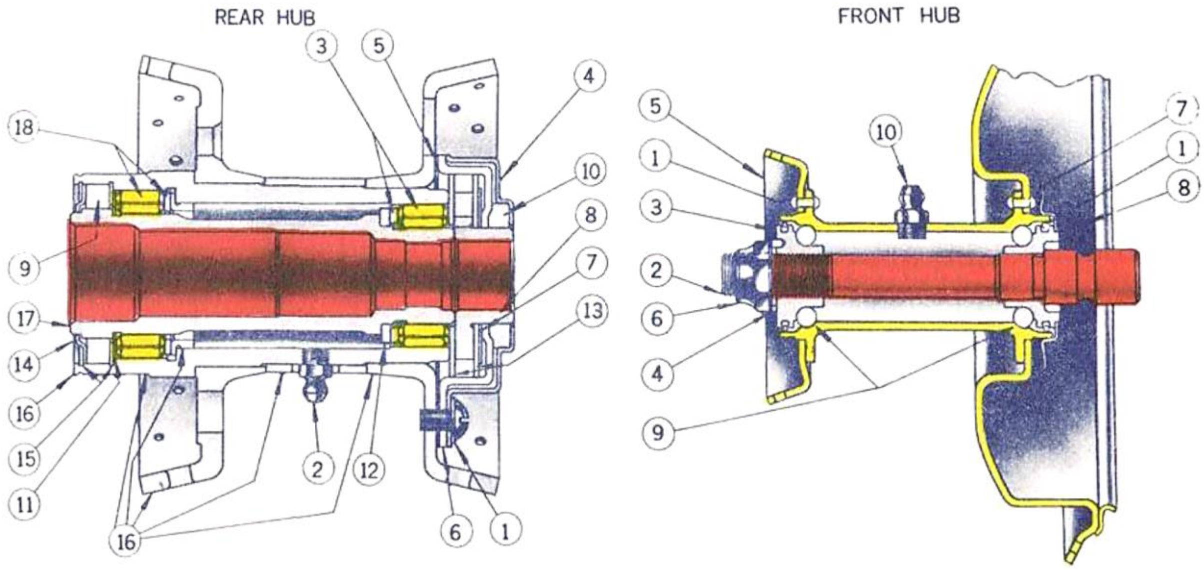
Rear wheel: 18 inch rim, 61/64 inch.

Front wheel: 18 inch rim, 1 7/64 inches.

After centering the hub, place the wheel on a truing stand and take out all side and bottom clearances. These should be worked out until there is no more than 1/32 inch variation on either the side or bottom. To take up side play, tighten the opposite side of the rim that is in contact with the feeler gauge of the truing stand. To take up bottom play, tighten all spokes near that part of the rim which is touching the feeler gauge of the truing stand.

Tires

Deep treaded four ply tires are standard equipment. The standard tire size for Army models is 4.00 x 18 — that is, they have a maximum side wall width of 4 inches, and fit an 18-inch rim. The front tire should be inflated to eighteen pounds (1.24 bar) and the rear tire to twenty pounds (1.38 bar).



No.	Name	No.	Name
1.	1/4” shake proof lock washer	11.	Hub bearing thrust washer
		12.	Hub sleeve thrust washer
2.	Alemite grease fitting	13.	Hub thrust washer
3.	Set of roller bearings	14.	Cork washer retainer
4.	Hub cork washer retainer	15.	Spring ring
5.	Hub thrust plate gasket	16.	Hub shell & flange assembly
6.	Hub thrust plate		
7.	Hub thrust bearing shims	17.	Hub sleeve
8.	Hub thrust bearing sleeve	18.	Set of roller bearings
9.	Cork washer		
10.	Cork washer		

No.	Name
1.	Spring rings
2.	Axle sleeve & cone assembly
3.	Cone assembly
4.	Lock washer
5.	Front hub shell assembly
6.	Axle bushing nut
7.	Left inner dirt guard
8.	Front axle sleeve
9.	5/16” steel ball bearings
10.	Alemite grease fitting

Figure 43 Wheel hub assemblies

Chapter IX: Brakes, linkages, and cables

Brakes

The motorcycle uses internal expanding, two shoe, fixed pivot, mechanical brakes on both the front and rear wheels (see Figure 44). The front brake is hand operated by a lever on the left handlebar; the rear brake is foot operated by a pedal placed just ahead of the right footboard. Besides being used in regular service, the front wheel brake can also be used as an emergency brake, for holding the machine on a grade, while the vehicle is stopped or while cranking the engine. Brakes should be kept properly adjusted and free from dirt and grease at all times. Caution must be exercised when lubricating the hubs, since over lubrication will cause the grease to work past the grease retainers onto the brake shoes and brake drums, resulting in slipping.

Either woven or moulded linings can be used but both shoes of a brake should have the same type lining. The shoes and brake linings for the front and rear wheel brakes are not interchangeable, for the front brake shoes are narrower. When relining brake shoes always start riveting at one end and work toward the other end for should the rivets be started at both ends and worked toward the center, the linings will not lie flat on the shoe. The ends of the linings must be ground thin to prevent self energizing action and locking of the brakes. There are two adjustments to be made on the brakes:

1. Centering the shoes in the drum: First, loosen the pivot stud nut on the outside of the backing plate, the pivot stud is then free to move. Next, set the brake tightly, this forces the two shoes out against drum. Should one shoe be closer to the drum than the other, the pivot stud will be moved, allowing both shoes to expand equally against the drum; while the brakes are applied, the pivot stud nut is tightened. This centers the shoes in the drum and provides a safe, positive braking action.
2. Linkage adjustment: The front brake hand lever and rear brake pedal should each move about one quarter of their full movement before the brakes engage. These adjustments are made by lengthening or shortening the linkages as described below.

Occasionally a brake becomes self energizing and its braking action severe. This is largely due to excessive clearance between the brake operating cam shaft and the bronze operating shaft bushing. The shaft should be .001 inch to .002 inch loose in the bushing. Brace operating cam shaft does not have replaceable bushing.

Linkage

Linkage is a system of levers, links or cables joined together. Although there are many places on the motorcycle in which linkages are used, only those requiring adjustment are referred to here. They are as follows:

Front chain

The front chain is adjusted so that it will have one-half inch overall up and down free play, midway between the engine and transmission sprockets. This adjustment is made by moving the transmission forward or back in the frame to loosen or tighten the chain, as the case may be. Moving the transmission moves the clutch and clutch sprocket with it, and this causes a corresponding adjustment in the free play of the front chain, which rides over the clutch sprocket. The transmission is moved by first loosening three lock nuts which hold it in the frame and then turning a stud which fits through the frame base and threads into the housing of the transmission. Turning the stud clockwise moves the transmission and clutch back in the frame and thus tightens the front chain. Turning the stud counterclockwise will move the transmission and clutch forward in the frame, and will cause the chain to loosen. After adjusting the front chain it is necessary to readjust or at least check the adjustment of four items: The gear shift lever, the clutch linkage, the rear chain, and the rear brake linkage. This is because movement of the transmission in the frame to any extent is liable to throw out the adjustments of those linkages mentioned above, since the proper operation of the parts which the various linkages control is directly dependent upon the distance from the transmission to the various parts and their controls. (i.e. clutch footpedal at left footboard, gear shift lever on gas tank, etc.) Moving the transmission to adjust the front chain will change this distance and so throw out the linkage adjustments.

Rear chain

The rear chain is adjusted so that the chain will have one-half inch up and down overall free play midway between the transmission and rear wheel sprockets. The rear chain is adjusted by moving the rear. wheel as follows: Remove the rear axle lock nut, remove the rear axle and spacers, and replace the rear axle without spacers. Loosen the brake sleeve nut and move the wheel by means of the rear wheel adjusting screw on the right side until the chain acquires the proper adjustment. Then tighten the brake sleeve nut, replace the axle spacers, tighten the rear axle nut and bring the left side adjusting screw in contact with the axle. After adjusting the rear chain it is necessary to check the adjustment of the rear brake linkage only.

Spark control cable

The spark control cable is adjusted by setting the spark in the fully advanced position and tightening the screw, wedging the wire, when the band arm is against the engine and the points are ready to break.

Throttle control cable

The throttle control cable is adjusted by setting the butterfly in the carburetor completely closed, and then tightening the screw, wedging the wire.

Clutch linkage

The correct adjustments of clutch linkage are: (1) have the clutch lever clear the sprocket cover stud by one sixteenth of an inch when the clutch is disengaged; (2) have the cable clear the clutch lever by one-eighth of an inch when the clutch is engaged. The first clearance is obtained by lengthening or shortening the cable as the adjustment requires and the second is made by adjusting the push rod adjusting screw (see Chapter on Clutch).

Shifter linkage

The shifter linkage is adjusted by the adjustable rod so that the shifter lever will fall into the slots of the shifter gate when the transmission is set for the gear corresponding to the number on the shifter gate.

Front brake linkage

The front brake is adjusted by lengthening or shortening the cable housing so that the hand lever will have one-fourth its total movement as free travel before the brake shoes start to engage. This adjustment is made by loosening the lock nut on the lower end of the cable housing and screwing the housing in or out of the threaded collar on the backing plate as the adjustment requires.

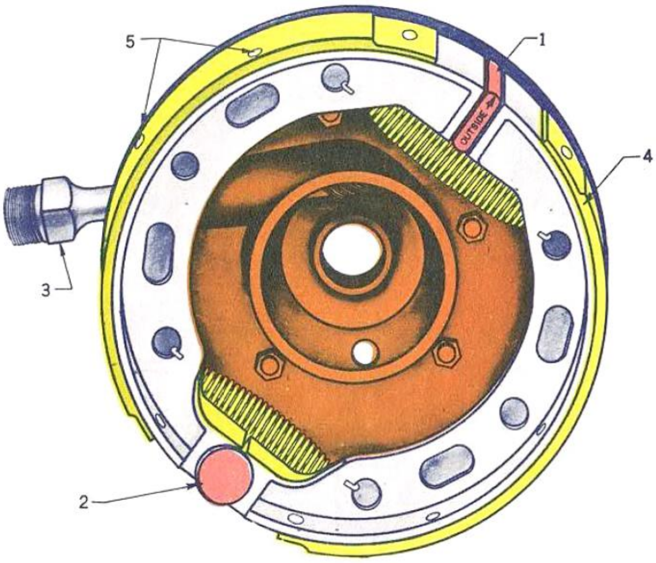
Rear brake linkage

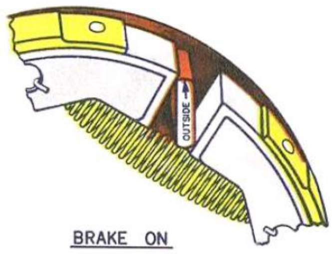
The rear brake is adjusted by the adjustable rod so that the brake pedal will have one inch free travel before the shoes start to engage.

Cables

Cables are frequently used in place of rods or other forms of linkages since they are more flexible. Cables are used as linkage on the motorcycle in the following places:

- Throttle control
- Spark control
- Harley Davidson clutch cable
- Speedometer
- Front brake





1. Operating cam. Shaft bronze bushing should be reamed for .001" to .002" shaft clearance
2. Adjustable pivot stud. After relining brake and reassembling in motorcycle, center shoe assembly in drum.
    a. Loosen pivot stud nut
    b. Apply brake hard
    c. Hold it applied and tighten nut
3. Speedometer drive
4. Brake liner
5. Liner rivets

Figure 44 Rear brake assembly

Chapter X: The XA motorcycle

Section 1: Characteristics and specifications

The Harley Davidson XA, or shaft drive motorcycle, though strictly in the experimental stage at the time this book was published, has created such widespread interest among Army motorcyclists that it was deemed necessary to include a short chapter on its basic characteristics and maintenance in this handbook.

There were originally 1000 XA motorcycles built and over 800 of these were distributed among units of the Armored Force for general test and experimental purposes. The Army — and particularly the Armored Force — had long wanted a shaft drive motorcycle, mainly because it would relieve the old and highly undesirable problem of chain maintenance — a factor of serious importance with the WLA model, and also because in the new shaft drive model there could be incorporated such desirable features for Army riding as a foot gear shift, hand clutch, opposed cylinder engine for better cooling, etc. The exact future of the XA model is unknown at present, but it is generally conceded that this machine possesses many outstanding improvements over the earlier chain drive types.

Some of the more important characteristics and specifications of the XA model are presented below:

1. Weight — 565 pounds.
2. Payload — 250-300 pounds.
3. Gasoline capacity — Slightly more than four gallons (each tank holds slightly more than two gallons).
4. Cruising radius — Approximately 150 miles (engine averages about 35 miles per gallon).
5. Hand clutch — Operated by hand lever on right handlebar. Pull lever into handlebar to disengage clutch; release lever gradually to engage clutch.
6. Foot gear shift — Operated with ball and toe of left foot. With clutch disengaged, mash down on foot shift lever to shift transmission into 1st gear. To shift up into 2nd, 3rd, or 4th gears, place toe of left foot under lever and raise up once for each desired shift (i. e. up once from 1st to 2nd gear, up once again from 2nd to 3rd gear, etc.) Locate neutral by placing foot shift lever approximately half way between the position it would occupy for 1st and 2nd gears, or use hand lever on right side of transmission (see "Additional Training for Riders of the XA Model", page 129, for a more detailed explanation of the above).
7. Kickstarter — Operated from left side of vehicle. To crank engine stand beside vehicle, facing into seat, with left hand grasping gas throttle grip and right hand braced on seat. Open throttle about 1/4 turn, turn switch on, and kick down vigorously in a plane perpendicular to the center line of the vehicle.
8. Automatic spark — The XA spark is advanced automatically when the engine starts by centrifugal weights in the ignition circuit breaker. Hence, there is no manual spark control, and the right handlebar grip is fixed.
9. Ignition system — "Waste spark" type, similar to the WLA system. Uses circuit breaker but no distributor. Spark advance automatic. Circuit breaker located in the front of the engine, and covered by large aluminum casing (see Figure 47). Ignition timing is covered in Section 2 of this Chapter.
10. Electrical system — Same as that used on the WLA model. Switch can be turned into three positions for ignition, blackout, or service light circuits. Battery has a larger capacity (44 amp. hr.) to handle radio equipment which may be installed at some future time.
11. Dual carburetors — The XA utilizes one carburetor for each cylinder, and hence the combined control of both carburetors from one handlebar gas throttle must be synchronized. This is accomplished by means of a cable running from the handlebar grip to the upper connection on the right carburetor throttle arm. From the lower connection on this same arm a crossover wire extends across the top of the engine and connects to the left carburetor throttle arm. Hence, when the main control cable is actuated from the handlebar grip the right and left carburetor throttle arms open and close simultaneously. The synchronizing and adjustment of these controls is a very delicate operation and should only be performed by an experienced mechanic. If unfamiliar with the XA carburetors it is advisable not to attempt adjustment. For proper procedure see Section 2 of this Chapter.

    The carburetors themselves are quite similar to the type used on the WLA model (see Figures 45 and 46). Both embody the same general features of the fixed high speed jet, concentric float bowl, etc. The adjustable low speed jet is provided with a novel clip which is screwed into the head of the low speed needle. When this clip is tight in position it prevents the turning of the needle more than about three-fourths of a full turn rich or lean. Hence, the inexperienced mechanic or rider is discouraged from attempting adjustment on either carburetor.

    This clip must be removed before adjustment can be made. To remove clip, first remove screw which holds clip in place in head of low speed needle. Always replace this screw before making needle adjustment.

12. Engine type and characteristics (see Figures 47 and 48) — Twin cylinder opposed, L-head valve arrangement, piston displacement: 45 cubic inches, stroke and bore: 3 1/16 inches, maximum H.P.: 23 at 4600 R.P.M.

    This engine departs radically from the standard "V" type design used on practically all military motorcycles in the past, in that the cylinders lie perfectly flat, at 180 degrees opposition to one another. This greatly improves engine cooling and results in the overall engine operating temperature being reduced to approximately 250-350 degrees F. (it will be recalled that the WLA engine operates at between 350 and 450 degrees F.). This better cooling also results in fewer maintenance difficulties and less engine failure, which is a factor of prime importance to Army motorcycles. It is not at all uncommon for XA models to run from 10,000 to 15,000 miles without requiring extensive engine overhaul. This is indeed remarkable and is due mainly to the more efficient cooling provided by the opposed cylinders.

    The opposed piston arrangement also makes for smoother engine operation, since it eliminates uneven firing between right and left cylinders. With the pistons opposed 180 degrees, it will be seen that each piston fires exactly 360 degrees from the opposite one, instead of the uneven 405 degrees rear to front or 315 degrees front to rear firing order encountered in the "V" type WLA engine. This even firing cuts down on engine noise and vibration to a great extent.

    The engine also differs widely in design and construction from that used on the standard "V" type model in that it uses such items as a double throw crankshaft instead of a flywheel assembly, split end connecting rods instead of the conventional yoke type, and a single camshaft with four cams cut along its length, instead of the four individual cam gears (see Figures 47 and 48).

    The lower connecting rod bearings are roller bearings, but the main support bearings for the crankshaft front and rear are caged ball bearings. The camshaft revolves in bronze bushings pressed into the front and rear of the crankcase.

    Valve timing is accomplished by the meshing of certain gears in the gear case in the front end of the engine (see Figure 48). The crankshaft is supplied with a pinion gear on the front end which meshes with a larger gear directly above it. This larger gear drives the camshaft, and when a single scribe mark on this gear is lined up with a corresponding scribe mark on the pinion gear, the camshaft is then timed to the crankshaft. The camshaft gear is exactly twice as large as the pinion gear, and thus is provided the necessary 2 to 1 ratio between crankshaft and camshaft speed.

    Other functions of the gear case are to operate the generator and the circuit breaker. The generator is driven from the generator idler gear which in turn is operated from the camshaft drive gear. The circuit breaker is driven by a gear mesh off the front end of the camshaft. The crankcase is vented by a breather valve located on the end of the camshaft drive gear. The breather is of elongated shape and has two vent holes, each of which line up with a single hole in the gear case cover once every revolution of the camshaft. The camshaft tums at 1/2 crankshaft speed and the breather mounted on the camshaft gear is so timed that it will open every time the pistons are on their inward stroke. All that is necessary in timing the breather is to assemble it so that the smallest notch in its back side fits into the stud protruding from the camshaft drive gear.

    The breather revolves in a cast and machined hole in the back side of the timing gear case cover. This machined hole is vented through a drilled passage running down through the face of the gear case cover and extending to the outside air on the lower right hand side of the engine.

    The engine lubrication system is of the wet sump, circulating splash type, quite similar to that used in automobile engines. Oil is carried in a reservoir or sump in the bottom of the crankcase, and is circulated by means of a gear type pump located in the base of the crankcase. The pump is driven off a worm gear on the rear end of the camshaft. From this worm drive a shaft is extended through a guide down to the driving gear of the pump in the base of the engine.

    The pump feeds oil up through a main drilled passage in the crankcase and then splits into four separate channels. Two of these channels lead to the main support bearings on either end of the crankshaft. The oil falling off of these bearings is caught in two oil slinging rings. By centrifugal force this oil is then thrown to the lower connecting rod bearings. The third channel conducts oil up to the crankshaft pinion gear which in turn slings it to the other gears in the gear case. The fourth channel takes the oil to the left cylinder walls. The XA crankshaft rotates clockwise (looking toward the front of the vehicle) and hence the right cylinder is adequately lubricated by splash oil from the crankcase. But due to this fact the left cylinder would not normally receive the proper amount of oil, and therefore it is necessary to provide the special oil feed channel running directly off the main line from the pump to that cylinder.

    After oil has lubricated the various areas noted above, it drains down into the sump at the bottom of the crankcase. The oil capacity of the engine is 2 quarts. Oil level is checked with a bayonet gauge which threads into the left side of the crankcase cover.

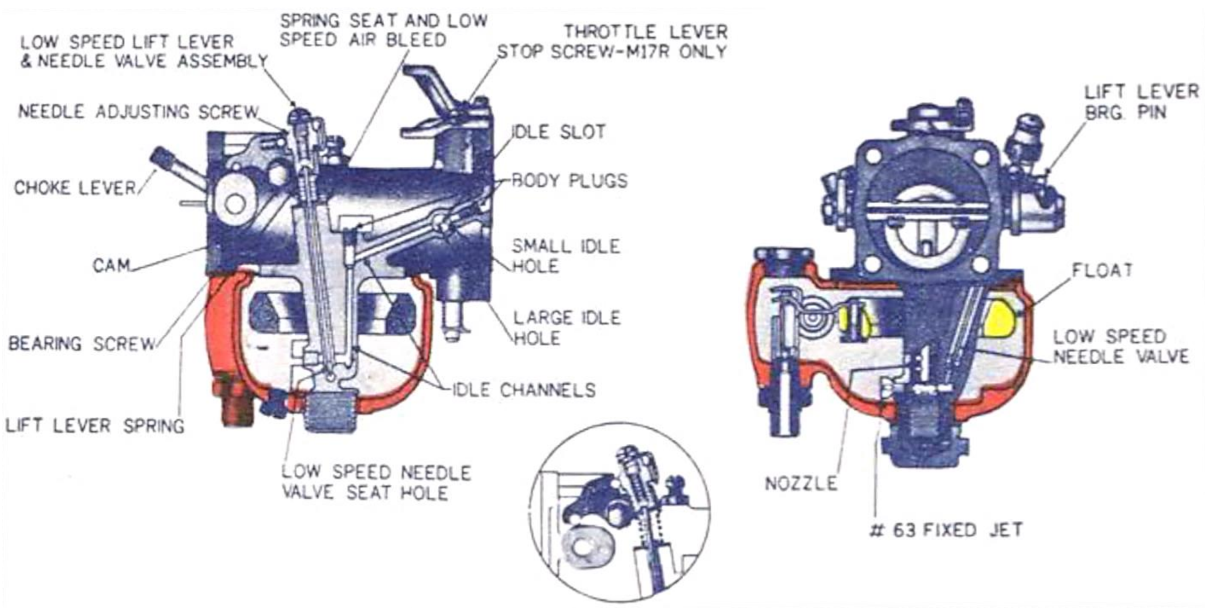


Figure 45 XA carburetor (low speed and choke circuits)

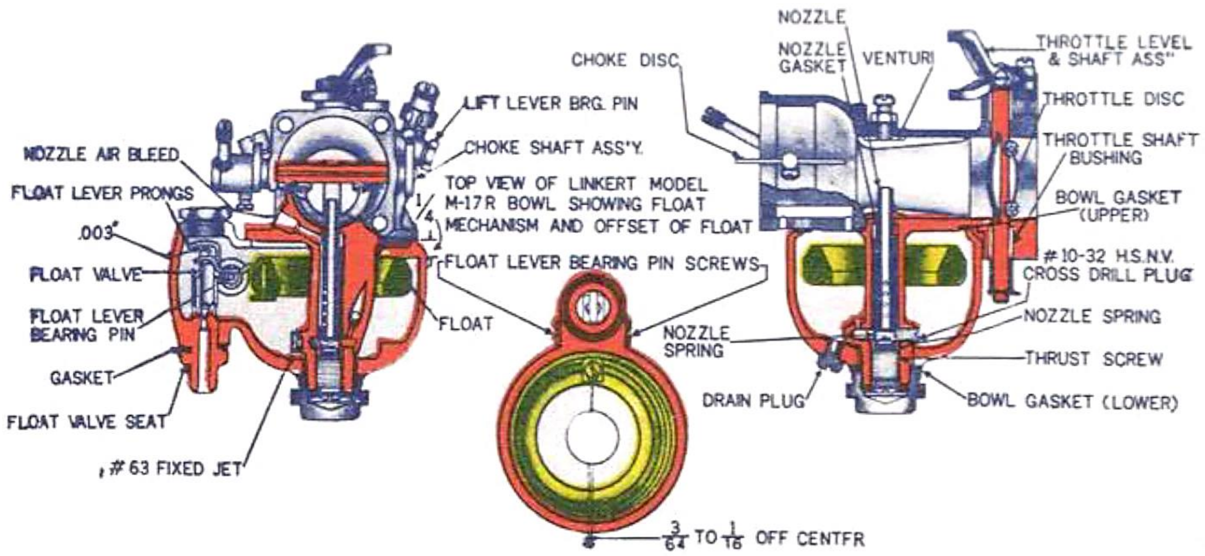
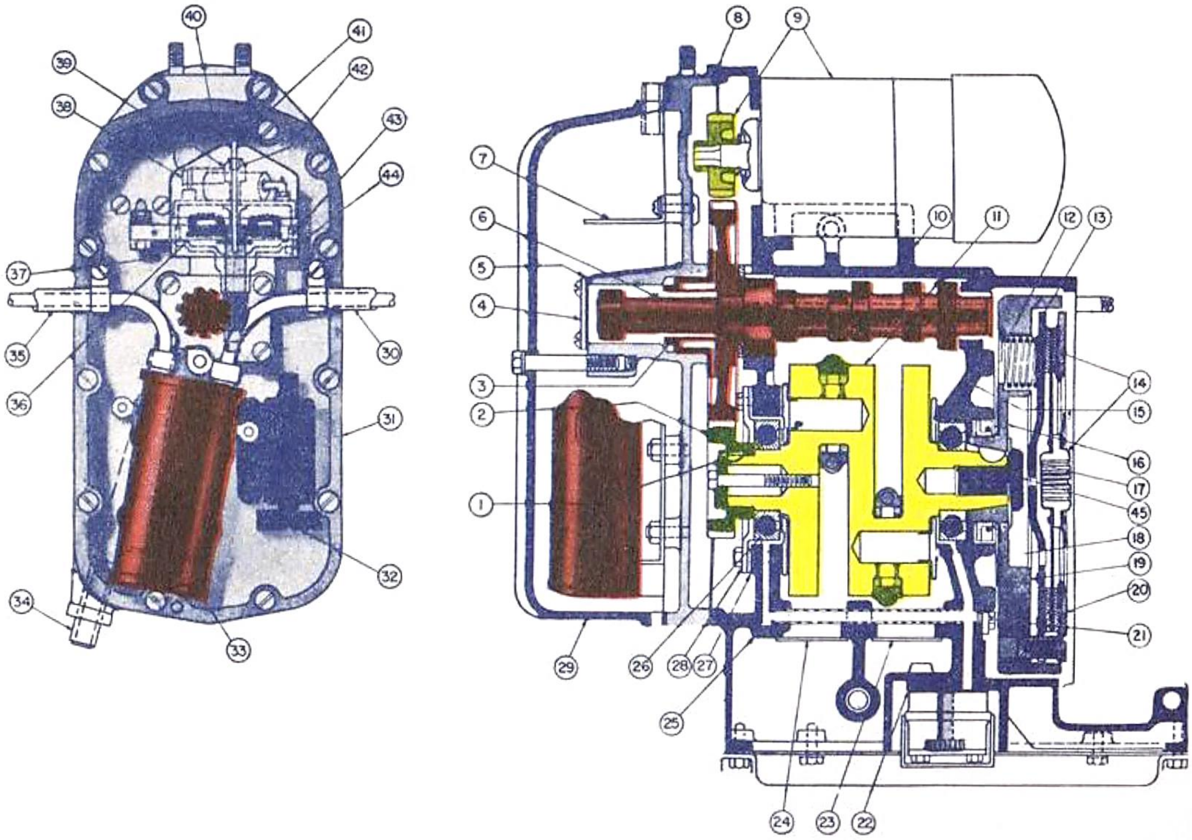
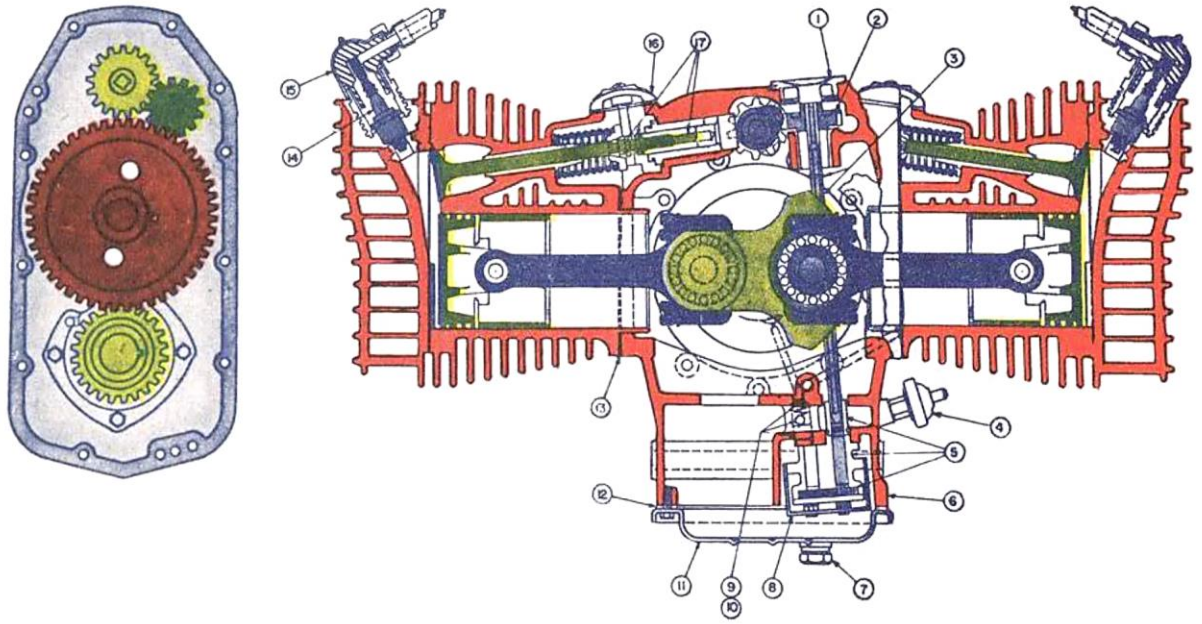


Figure 46 XA carburetor (high speed and float circuits)



1. Gear Key
2. Crankshaft gear
3. Breather valve
4. Timing gear cover plate
5. Cover plate gasket
6. Camshaft
7. Timer lever bracket
8. Cover gasket
9. Generator
10. Generator shim
11. Crankshaft
12. Clutch spring
13. Clutch releasing plate
14. Disc plate and hub
15. Rear main bearing plate
16. Main bearing housing seal
17. Flywheel key
18. Main bearing spring washer
19. Flywheel
20. Clutch back plate
21. Housing screw wire
22. Oil pump gasket
23. Oil screen (rear)
24. Oil screen (front)
25. Crankcase
26. Bearing
27. Front main bearing plate
28. Thrust plae
29. Crankcase timer cover
30. Spark plug cable housing left hand
31. Timing gear comp cover
32. Cut-out relay
33. Spark coil
34. Breather pipe
35. Spark plug cable housing right hand
36. Timer gov. weight
37. Timer lever and strap
38. Timer breaker plate
39. Timer cam
40. Timer breaker plate cover
41. Timer breaker plate cover catch
42. Timer cam oil pad
43. Ignition timer shaft and system
44. Breaker plate retainer
45. Flywheel fastening screw

Figure 47 XA engine (side view)



1. Gear cap
2. Oil pump drive gear
3. Gear shaft & pin assembly
4. Oil pressure switch assembly
5. Oil pump assembly
6. Crankcase assembly
7. Plug
8. Oil screen assembly
9. Oil feed line valve seat
10. Oil feed line ball spring
11. Crankcase pan
12. Pan gasket
13. Cylinder base gasket
14. Spark plug
15. Shield & insulator
16. Tappet inspection cover
17. Tappet & guide

Figure 48 XA engine (front view)

13. Power train — The XA power train is unique among Army motorcycles in that it uses a drive shaft and rear drive unit for power take off instead of drive chains and sprockets. This method of power transmission has proven extremely desirable because it is much more rugged than the old type drive chains and highly dependable. From Figure 49, it will be seen that power developed by the engine crankshaft is transmitted first to the clutch. The clutch is of the single-disc, dry type. Its operation is controlled by the clutch push rod, which in turn is actuated by the hand lever on the right handlebar (see Figure 49). When the lever is pulled in to the handlebar the push rod moves to the left in the illustration and forces the steel driving disc to separate from the fibre driven disc. Het the clutch becomes disengaged. When this push rod force is released at the hand lever, strong springs (which heretofore were compressed by the movement of the steel disc), expand outward and force the steel disc up against the fibre disc, and the clutch becomes engaged. The steel disc fits over studs extending out of the face of the engine flywheel, and hence receives its driving power from them. The fibre plate is splined to the input shaft of the transmission.

    The transmission is of the constant mesh, progressive type, and is practically identical to the type used on the WLA. It has four forward speéds and a neutral position. Gears are splined to the mainshaft and are shifted internally by shifter clutches similar to the WLA transmission. First, second, and third gears are of the straight spur tooth type, but fourth gear is cut with helical teeth for quiet running. The operation of the foot shift lever and the hand neutral locator lever have been discussed earlier in this Section. Overhaul of the XA transmission is greatly simplified because all parts are designed to give the proper clearances and fittings when installed. Thus no extra fitting is required. Provided that new parts are properly installed, no additional clearances need be set up.

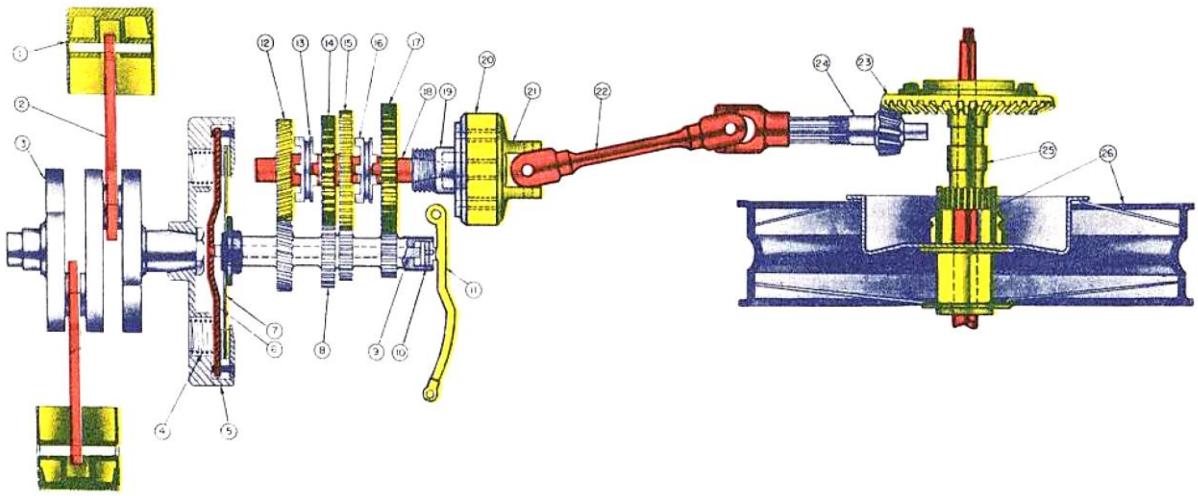
    After leaving the transmission, power flows through a flexible rubber coupling disc and thence to the first of the two universal joints. The rubber coupling is inserted to absorb excess shock which might snap off or otherwise damage the transmission output shaft. The universal joints are of the needle roller bearing type and are placed one at either end of the drive shaft.

    After power passes through the universal joints and drive shaft, it is delivered finally to the pinion gear meshing with the ring gear inside the rear drive housing (refer to Figure 49). The ring and pinion gears are of the spiral bevel type. The ring gear is bolted to the rear wheel spline hub which meshes in a mating splineway inside the rear wheel hub. Thus when the ring gear turns it also turns the spline which accomplishes the final driving of the rear wheel.

    A slip joint is provided between the rear universal joint and the pinion gear to absorb the shock of bumps, ruts, etc. which are introduced into the power train from the rear wheel. The extension shaft from the rear universal joint is fashioned with splines which fit into mating splineways in the pinion gear. Thus a slippage distance is provided along the extension shaft, and the pinion gear can slide back and forth without damage to the ring gear or universal joints.

Section 2: Clearances and adjustments

1. Circuit breaker points — .022 inch, set on either lobe. Check point gap every 500 miles.
2. Spark plugs — .025 inch gap. Check every 500 miles.
3. Exhaust valve — .014 inch tappet clearance, with engine cold.
4. Intake valve — .005 inch tappet clearance, with engine cold.
5. Low speed needle valve — Three turns up from bottom.
6. Carburetor float — 1/4 inch from edge of bowl.
7. Clutch — Adjusted to slight free movement of clutch lever (with clutch engaged) by means of threaded clevis on clutch lever cable.
8. Front brake — Lever should move 1 inch or 1/4 of its travel before brake takes hold.
9. Rear brake — Pedal should move 1 inch before brake takes hold.
10. Tire pressures — Front, 18 pounds; Rear, 20 pounds.
11. Carburetor adjustments (1) Loosen control wires at right carburetor and back off idling screw on right carburetor, make sure both throttle valves are completely closed and tighten cables. (2) Remove mixture needle lock, turn low speed needle valves down until seated and back each needle out three full turns from the bottom. (3) Start engine and adjust each carburetor separately until either low speed needle is 8 to 10 notches rich (out) from leanest running position (to adjust each carburetor separately, depress the low speed needle valve of the opposite carburetor and hold down with finger, thus cutting out one cylinder and permitting adjustment of the one carburetor without noise interference from the other cylinder). Never remove and ground spark plug leads to cut out alternate cylinders. (4) Adjust with micrometer adjustment so that left cylinder is running at same speed as the right one (cut out alternate cylinders as in 3 above). (5) Adjust idle screw for correct idling speed.
12. Ignition timing — (1) Set points at .022 inch (on either lobe). (2) Locate flywheel line in center of crankcase hole (just in rear of right cylinder). (3) Loosen strap, rotate plate until points just break (light goes on) and tighten strap.



1. Piston with rings and pin
2. Connecting rod
3. Crankshaft
4. Spring, clutch
5. Flywheel
6. Plate, releasing
7. Friction disc plate
8. Gear, mainshaft
9. Rod, clutch push
10. Thrust bearing, clutch push rod
11. Release lever, clutch push rod
12. Gear, countershaft, high
13. Clutch, third & high shifter
14. Gear, countershaft, third
15. Gear, countershaft, second
16. Clutch, low and second shifter
17. Gear, countershaft, low
18. Countershaft, transmission
19. Connection, rear end
20. Cushion, rubber
21. Connection, transmission end
22. Rear wheel drive shaft
23. Bevel gear
24. Pinion gear
25. Drive spline, rear wheel
26. Rear wheel and hub

Figure 49 XA power train

Section 3: Lubrication and maintenance

The complete schedule of XA lubrication and mechanical maintenance is included with that for the WLA model in Chapter XII, “Motorcycle Maintenance”. Refer to that Chapter for further information.

Chapter XI: Motorcycle trouble shooting

The term "trouble shooting" may be defined as any engine or vehicular failure that necessitates repair, replacement, or adjustment. It is a systematic search for trouble which involves eliminating possibilities by groups rather than by a hit or miss procedure. The motorcycle mechanic must be thoroughly familiar with the correct trouble shooting procedure, for the accurate diagnosis of such trouble forms the basis for his repairs and adjustments.

All motorcycle troubles, either WLA or XA, break down into the approximate proportions: 70% mechanical, 15% electrical, and 15% air fuel system. Most mechanical troubles are such as a slipping clutch, worn sprockets, broken rings, etc. However, troubles in the other two brackets, electrical and air fuel systems, are so similar in their reactions on the engine that there must be a clearly defined trouble shooting point from which to start. Whether the engine starts and misses or will not start at all makes no difference in the procedure. The proper approach is to localize the trouble in one of the three groups, following the sequence listed below (always perform this first step first):

1. **Test for spark at the plugs**: If no spark is present the trouble lies in the electrical system and this system should be checked. In checking, the mechanic proceeds from one point to another along both the primary and secondary circuits of the electrical system, omitting no part of either circuit. If there is a spark at the plugs it follows that the trouble must be of mechanical or air fuel nature, and the second step is employed.
2. **Test the engine for compression**: If there is a lack of compression the trouble can usually be accounted to worn rings, pistons, or cylinder walls. However in this event the clutch should also be checked for slippage and the chains and sprockets checked for wear and breakage. This will indicate to the mechanic whether or not the force he applies to the kickstarter is actually being transmitted to spin the engine. If the engine has good compression the trouble can then be logically placed in the air fuel system. This system is first checked for flow of fuel to the carburetor and also for air leaks at the manifolds. Then and only then is the carburetor itself disassembled, adjusted, and checked. In general, troubles in the air fuel system are not due to faulty carburetor adjustment, and the mechanic should not be too anxious to readjust the low speed needle valve setting.

Trouble	**Probable causes:**		
	Mechanical	**Electrical**	**Air fuel**
Won't start	Worn rings, slipping clutch, worn kickstarter, broken chains, improper valve tappet adjustment.	Plugs, points, dead battery, loose wires, bad condenser, shorted coil.	Out of gas, no fuel feed to carburetor, air leaks, vapor lock, improper carburetor adjustments.
Misses at low speeds	-	Plugs, points, coil	Air leaks, too rich or lean.
Lopes at low speed	Front chain excessively loose.	-	Too rich.
Misses at high speed	-	Condenser, points.	No fuel supply, air leaks
Misses at all speeds	Valve timing, tappet adjustment.	Plugs, loose connections, switch, condenser.	Too rich, toll lean.
Coughs	Valve tappet adjustment.	Point adjustment, timing.	Too lean.
No power	Valve tappet adjustment, overheated	Timing.	Too rich, too lean.
Labors at all speeds	-	Timing.	Too rich, too lean.
Runs OK and then stops	Vapor lock.	Loose connections.	Oil level in air cleaner too high, no fuel supply.
Sudden stop	Vapor lock, "frozen" piston.	Ignition, wiring, points, condenser.	Out of gas.
Stops slowly with misfire	-	Plugs, loose connections.	Fuel line clogged.

Chapter XII: Motorcycle maintenance

Section 1: Maintenance general – lubrication and mechanical maintenance schedules

The life and usefulness of a motorcycle depends more on its maintenance and preventative maintenance inspections than does that of any other vehicle in the Army. This is due primarily to the basic differences in design between a motorcycle and other vehicles.

The motorcycle is a light machine of small payload (250 to 300 Ibs.) intended primarily for the transportation of individuals. It is capable of high and low speeds and of rapid acceleration and deceleration. It is the most versatile and flexible means of transportation in the Army today.

Its very size and weight make fine adjustments and close clearances necessary. This two wheeled vehicle is powered by a light, 2-cylinder, high speed engine, which, by means of air cooling, the use of aluminum, and small perfectly machined parts, has the power and flexibility to make the motorcycle invaluable to the Army. Its ruggedness and strength when properly maintained have been proved by commercial fleet and police operators. The WLA engine construction is such that its operation is necessarily rough. For example, the flywheel revolves 405 degrees between the power strokes of the rear piston and the front piston, while it revolves only 315 degrees from the power stroke of the front to the power stroke of the rear piston. This constant vibration under high operating temperatures, together with the fact that the engine operates close to the ground, exposed to dust, brush, and weather, makes necessary careful and constant lubrication, maintenance, and adjustments to insure maximum efficiency.

The bearings on the frame, forks and chassis are small, yet they are sturdy enough to carry a motorcycle over the same terrain negotiated by tanks and scout cars. These small, exposed bearings must be lubricated more frequently than those on larger vehicles. The setting of clearances and adjustments must also be made more carefully.

Preventative maintenance of the motorcycle is based on four principles:

1. The training of competent motorcycle mechanics:
   The motorcycle is unique among vehicles. Practices generally followed on other wheeled vehicles have little, if any application here. The motorcycle mechanics must be trained thoroughly in every phase of this vehicle.
2. Application of the mechanic's knowledge:
   On returning to his unit, a soldier who has successfully completed a course of instruction in motorcycle mechanics should be required to maintain the motorcycles of this organization. He has been given special training and is fully qualified for his job.
3. Thorough training of riders:
   The skill of the rider is the principle limitation of the maneuverability of the motorcycle. Each motorcyclist should be able to ride well and be competent in the care, simple adjustment and first echelon maintenance of his machine. His first thought should be of his “cycle”. Preventative maintenance is of critical importance in the successful employment of these vehicles and it is only through the efforts of capable, conscientious riders that major repairs may be checked while they are still adjustments.
   In picking men from organizations to become motorcycle riders, give considerable attention to the fact that during most of the time, the rider is completely on his own. Many times there will not be another man nor a non-commissioned officer to help him out of trouble. He must survive and be able to accomplish his assigned mission. A good motorcyclist should possess at least the five following qualifications:
   a. Voluntarily show interest in work with motorcycles.
   b. Be alert and quick thinking, and have above average mentality.
   c. Have initiative.
   d. Have courage.
   e. Have the physical strength and ability to handle his machine under all conditions.
4. The policy of assigning one rider to a vehicle:
   By assigning a motorcycle to one rider and his understudy, responsibility, pride and ownership are generated in these men; they strive to keep their mount tuned up and in condition for any task. This policy also prevents many of the abuses to which the motorcycle is continually subjected by irresponsible riders.
   Proper care of the motorcycle, beginning at the time it is received from the factory and continuing throughout its use in the Army, will be amply repaid by trouble-free operation. Also, any failure of brakes, steering, power train or engine may easily cause a serious accident resulting in the death or the permanent injury of the rider.

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 of the vehicle. Experience has proved that it is usually the direct result of the rider's knowledge of correct operation, his diligence in applying this knowledge and the application and completeness of periodic preventative maintenance, inspections and lubrication schedule by competent mechanics and their superiors.

On the following pages will be found the complete Lubrication and Mechanical Maintenance schedules for the Harley Davidson WLA and XA motorcycles, presented in the following order:

1. An outline for the procedure for breaking in a motorcycle.
2. Most commonly referred to motorcycle adjustments and clearances.
3. Motorcycle Rider's daily and weekly inspections.
4. Motorcycle lubrication schedules.
5. Motorcycle 1000 mile mechanical maintenance inspection sheet.
6. Motorcycle Command Inspections.

1. Breaking in of new motorcycles

The "breaking in" of a new vehicle is a very important period in the life of a motorcycle. All new vehicles are stiff and require "limbering up and seasoning" for proper, economical and trouble free operation.

To insure proper breaking in of a new motorcycle the following restrictions apply:

1. Only experienced riders should operate motorcycles for the first 1000 miles.
2. During the first 500 miles of operation, new motorcycles should be operated in convoys under the direct supervision of an officer. During this period the vehicles will be run fast enough to avoid overheating and within speed limits recommended by the manufacturers. These speeds are shown on stickers pasted on the speedometer and are repeated herewith:
    - Not over 30 M.P.H. for the first 100 miles.
    - Not over 35 M.P.H. for the next 200 miles.
    - Speeds in excess of 40 M.P.H. are prohibited for the first 500 miles.

    Note: 4th gear on the XA model should never be used for speeds less than 25 M.P.H.

3. For the first 500 miles, when breaking in new motorcycles, this convoy should stop about every 10 miles and allow the engines to cool until the bare hand can be placed on the heads. Then run the machine for approximately another 10 miles and again allow to cool. This process should be repeated throughout the entire first 500 miles, to properly "season" cylinders and pistons.
4. During this first 500 mile period when running the machines within the speed limits specified, the throttle should be smartly closed once every half mile or so and the machine allowed to coast about 50 feet, this will create a vacuum in the combustion chamber, which will suck oil up the cylinder walls.
5. New motorcycles that have traveled less than 1000 miles should not be used for training new riders.
6. Vehicles should be broken in by running on level highways. Steep hills, slow driving, stop and go operation, and low and second gear work will be held to the minimum during the break in period.
7. Parts may work loose or come out of adjustment during the break in period. Consult the Manufacturer's Maintenance Manual for specific instructions on adjustments. All adjustments should be made under the supervision of a qualified mechanic.
8. On the WLA after the first 250 miles and again after the first 500 miles, check the front and rear chains for adjustment and make sure the chains are receiving the proper amount of oil. If necessary readjust the chain and chain oilers.
9. The 1000 Mile Maintenance Inspection should be given each machine when it reaches 500 miles and again at 1000 miles. Engine oil should be changed at the completion of the first 500 miles and again at the end of the first 1000 miles.
10. The 45 cubic inch solo motorcycle should never be forced to carry two persons except in an emergency.
11. Only qualified mechanics should repair or adjust motorcycles.
12. On the XA, the carburetor should never be adjusted by anyone but a trained mechanic. This shaft drive motorcycle has dual carburetors and the adjustment is very sensitive.
13. Use 80 octane gasoline. 92 octane fuel can be used.

2. Harley Davidson, WLA & XA adjustments & clearances

Adjustments:	**WLA**	**XA**
Breaker points	.022 inch.	.022 inch.
Spark plugs	.025 inch.	.025 inch.
Exhaust valve	.007 inch (set cold).	.014 inch (set cold).
Intake valve	.005 (set cold).	.005 (set cold).
Low speed needle valve	3 turns up.	3 turns up.
Carburetor float	1/4 inch from bowl edge.	1/4 inch from bowl edge.
Front chain Rear chain	1/2 inch up and down overall free movement at a point 1/2 way between sprockets.	-
Clutch	About 1/8 inch free movement of clutch arm along foot pedal cable when engaged. Clutch arm should not strike sprocket cover when engaged.	Slight free movement of clutch lever.
Front brake	Lever should move 1 inch or 1/4 of its travel before brake takes hold.	Lever should move 1 inch or 1/4 of its travel before brake takes hold.
Rear brake	Pedal should move 1 inch before brake takes hold.	Pedal should move 1 inch before brake takes hold.
Tire pressure 45 inch solo	Front, 18 pounds Rear, 20 pounds.	Front, 18 pounds Rear, 20 pounds.
Carburetor adjustment	1. Turn low speed needle all the way down. 2. Turn needle out 3 turns. 3. Start engine and turn needle down until engine misses, then turn needle out 5 to 10 clicks. 4. Adjust idling speed and recheck low speed needle. Note: A carburetor once properly adjusted will require little, if any, adjustment.	1. Loosen control wires at right carburetor and back off idling screw on right carburetor, make sure both throttle valves are completely closed and tighten cables. 2. Remove mixture needle lock, turn low speed needle valves until seated and back each needle out three full turns from the bottom. 3. Start engine and adjust each carburetor separately until either low speed needle is 8 to 10 notches rich (out) from leanest running position (to adjust each carbuetor separately, depress the low speed needle valve of the opposite carburetor and hold down with finger, thus cutting out one cylinder and permitting adjustments of the one carburetor without noise interference from the other cylinder. (Never remove and ground spark plug leads to cut out alternate cylinders)). 4. Adjust with micrometer adjustment so that left cylinder is running at same speed as the right one. (Cut out alternate cylinders as in 3. above). 5. Adjust idle screw for correct idling speed.
Ignition timing	1. Set point gap at .022 inch (on either lobe) 2. Have front piston on compression stroke (watch intake valve). 3. Locate front piston 9/32 inch before T.D.C. (by flywheel mark). 4. Check and make certain the narrow cam lobe is about to break the points. 5. Set spark control at full advance, loosen strap, rotate plate until points just break (light goes on) and tighten strap.	1. Set points at .022 inch (on either lobe). 2. Locate flywheel mark in center of hole. 3. Loosen strap, rotate plate until points just break (light goes on) and tighten strap.

3. Rider's inspections: Daily and Weekly

<u>A. Rider's daily inspections:</u>

1. *Check gas & oil level, check tires for inflation and wear.
2. *Clean gasoline strainer, clean and refill oil bath air filter pan.
3. *Check for oil and gasoline leaks, loose nuts, bolts, parts, broken springs, bent front chain guard.
4. *Clean engine cooling surfaces.
5. *Check steering forks for looseness.
6. *Check brakes, clutch and all controls for proper operation.
7. *'Clean rear chain with a brush and kerosene, dry, re-oil and check adjustments.
8. Check lights, horn, instruments, etc.
9. Check wheel alignment, loose spokes or damaged rims.

<u>B. Riders weekly inspections:</u>

1. *Perform rider's daily inspections.
2. *'Check adjustment of rear chain; if necessary, remove, clean, dry, examine for wear and breakage, lubricate, drain, reinstall & readjust it.
   # Check rear drive for proper lubricant level.
3. *Check transmission for proper oil level.
4. *Check battery for proper charge and water level.
5. *Lubricate machine if necessary.
6. Check wiring for loose connections or burned insulation.
7. 'Check front chain adjustment and lubrication.
   #Clean drive shaft with brush, etc.

The rider makes the above inspection every day and every week. If any items demand attention, only those marked * can be repaired by the rider; all others he must turn over to a qualified Motorcycle Mechanic who will make the repairs or readjustments. Rider or First Echelon Maintenance items are listed below and these are the only repairs or adjustments a rider will make:

1. *Remove wheel and tire, repair inner tube, keep tires correctly inflated.
2. *Check battery condition and add water; clean and tighten terminals.
3. *Clean and refill oil bath air filter pan, clean gasoline strainer, drain carburetor bowl.
4. *Completely lubricate, re-fuel machine and wash machine, clean engine cooling surfaces.
5. *'Check adjustment rear chain; if necessary remove, clean, dry, examine for wear and breakage, lubricate, reinstall and readjust.
6. Tighten and replace loose or missing bolts, nuts and parts.

'WLA model only.

#XA model only.

4. WLA and XA lubrication schedules

<u>A. For Harley Davidson WLA Model only.</u>

Check daily

- Oil bath air filter
- Engine oil supply

Oil after washing (use engine oil)

- Clutch linkage (except friction disc)
- Gear shifter linkage
- Front brake control cable and lever
- Rear brake linkage
- Ends of spark and throttle control wires
- Rear drive chain

Check once a week

- Check transmission oil level (just visible in goose neck when vehicle upright; use same viscosity oil as in engine).

Every 500 miles (use grease, general purpose; grade number 1 or 0. The numbers in parentheses show number of grease fittings)

- Right front spring fork rod bearings (1)

- Left front spring fork rod bearing (1)
- Right front fork rocker plate bearings (2)
- Left front fork rocker plate bearings (2)
- Front brake shackle bearings (2)
- Front brake operating shaft (1) (don't over lubricate)
- Front brake cover bearing (1) (don't over lubricate)
- Saddle bar bearing (1)
- Seat post (1)
- Rear brake pedal bearing (1)
- Rear brake rod intermediate shaft (1)
- Clutch push rod bearing, in starter cover (1)
- Rear brake operating shaft (1) (don't over lubricate)
- Remove, clean, inspect and lubricate rear chain.

Every 1000 miles

- Drain and refill oil tank, flush tank with light engine oil. Change oil more often under dusty conditions; change oil every 500 miles in freezing weather.
- Drain, flush, and refill transmission with same viscosity oil as engine.

Every 1500 miles (use grease, general purpose, grade No, 2).

- Front wheel hub (1) (don't over lubricate)
- Rear wheel hub (1) (don't over lubricate)
- Remove handle bar grip spirals and grease, grease control cables.
- Remove and grease front brake cable.

Other items

- Repack generator bearings (commutator end) (3000 miles)
- Clean and repack wheel hubs and bearings (3000 miles)
- Repack upper and lower head cone bearings (15000 miles)

B. For Harley Davidson XA model only

Check daily

- Engine oil (vehicle upright)
- Oil bath air cleaner

Oil after washing

- Clutch cable and pin in hand lever
- Front brake cable and lever
- Throttle control wires
- Rear brake linkage

Check once a week

- Check transmission oil (oil level up to filler hole when motorcycle upright). (Use same viscosity oil as in engine).
- Check rear drive housing (oil level up to filler holes, vehicle upright). (Use same viscosity oil as in engine).

Every 500 miles (use grease, general purpose, number 1 or 0, the numbers in parenthesis show number of grease fittings).

- Front brake operating shaft (1) (don't over lubricate)
- Front brake cover bearing (1) (don't over lubricate)
- Left front rocker plate (2)
- Front brake shackle bearings (2)
- Right front rocker plate bearings (2)

- Right front spring fork rod bearing (1)
- Left front spring fork rod bearing (1)
- Foot lever shifter (1)
- Saddle bar bearing (1)
- Right rear axle cushion spring (1)
- Left rear axle cushion spring (1)
- Rear brake pedal bearing (1)
- Clutch push rod bearing (1)

Every 1000 miles

- Drain and refill engine crankcase, flush with light engine oil. Change oil more often under dusty conditions; change oil every 500 miles in freezing weather.

Every 1500 miles (use grease, general purpose, grade No. 2).

- Front wheel hub (1) (don't over lubricate)
- Rear wheel hub (1) (Don't over lubricate)

Every 5000 miles

- Drain, flush and refill transmission with same viscosity oil as engine.
- Drain and refill rear drive housing; use same viscosity oil as engine.

Other items

- Repack generator bearings (commutator end) (3000 miles)
- Repack wheel hubs and bearings (3000 miles)
- Repack universal joint bearings (15000 miles)
- Repack upper and lower head cone bearings (15000 miles)

C. The following are approved grades and viscosities of lubricants for the XA and WLA models:

Part	Engine and transmission			Rear drive (XA)			Chassis fittings, universal joints		Wheel bearings
Lubricant	Oil, engine, all purpose Grade (OE) No.			Oil, engine, all purpose Grade (OE) No.			Grease, general purpose Grade No.		Grease, general purpose Grade No.
Temperature	below +10°F	+10°F… +32°F	above +32°F	below +10°F	+10°F… +32°F	above +32°F	below +32°F	above +32°F	all temperatures
WLA XA	10 10	30 30	50 50	- 10	- 30	- 50	0 0	1 1	2 2

Other items:

- Oil Bath Air Cleaner same as engine
- Motorcycle Chains same as engine
- Linkages same as engine
- Speedometer Drive Cable grease, general purpose NO. 0 or 1

D. The following are approved intervals of lubrication and oil changes for the WLA and XA:

Part	Engine	Transmission	U-Joints	Rear chains drive		Chassis
WLA	1000*	1000	-	-	500	500@
XA	1000	5000	15000	5000	500	500@

Part	Wheel bearings	Air cleaner	Linkages etc.	Headcones	Generator bearing
WLA	1500	Daily’	500	15000	3000
XA	1500	Daily’	500	15000	3000

* More often under severe conditions.

‘ Under dusty conditions.

@ 18 fittings. 2 hubs lubricated each 1500 miles, 16 other fittings lubricated each 500 miles. On the XA model the clutch throw out bearing should be lubricated more frequently.

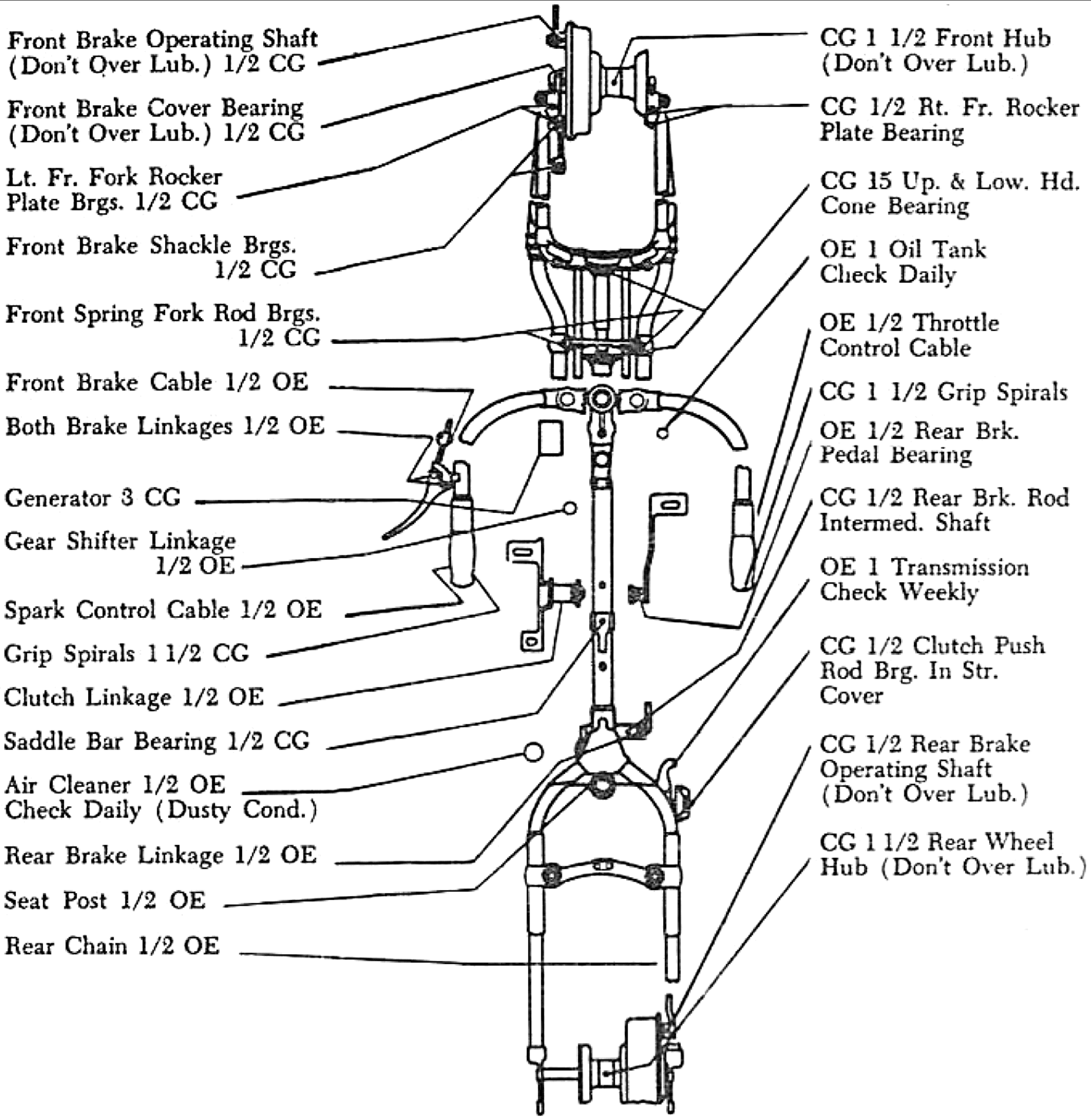
E. The following Are capacities of units on the WLA and XA models:

Part	Transmission	Engine oil	Rear drive	Air cleaner	Gasoline
WLA	1/2 pt. (240 ml)	3 1/2 qts. (3.3 l)	-	1/2 pt. * (240 ml)	3 1/2 gal. (13.2 l)
XA	2 qts. (1.9 l)	2 qts. # (1.9 l)	1/4 pt. (120 ml)	1/2 pt. (240 ml)	4 gal. (15.1 l)

* 1941 cleaner, 1 pt. #in crankcase

F. War department lubrication guide. Motorcycle, Solo, 45 cubic inch, WLA:

Units	Capacity	Predominating temperatures		
		Above +32°F (0°C)	+32°F…+10°F (0°C…-12°C)	Below +10°F (-12°C)
Oil tank	3 1/2 qts.	OE50	OE30	OE10
Transmission	1/2 pt.	OE50	OE30	OE10



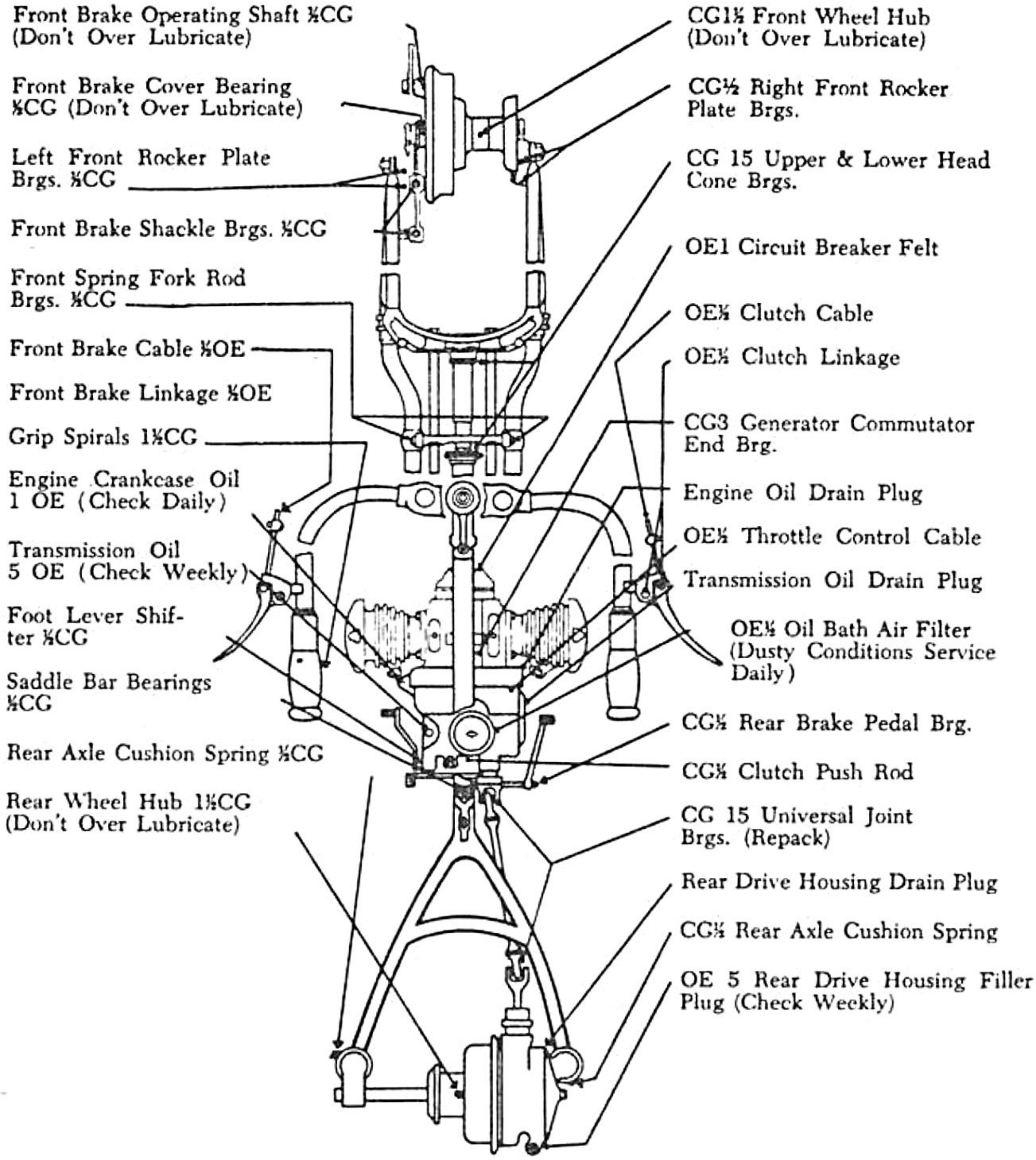
Lubricants	Interval
OE-oil, engine all purpose	1/2- 500 Mi.
CG-grease, general purpose	1- 1000 Mi.
	1 1/2- 1500 Mi.
	3- 3000 Mi.
	15- 15000 Mi.

Check weekly	Check Daily
Chains	Air cleaner
Transmission	Gas strainer
Battery	Oil tank
	Cooling fins

1. Air cleaner — Check level & refill oil cup to bead level daily with OE.
2. Oil tank — Drain only when engine is hot. Flush tank with kerosene & drain, re-fill. Oil should be changed more frequently (each 500 Miles) when operating at high speeds, in dust, or in cold weather.
3. Fittings — Clean before applying lubrication. Do not over lubricate fittings on brakes & hubs.
4. Always lubricate chassis Lubrication points after washing vehicle.

G. War department lubrication guide. Motorcycle, solo, 45 cubic inch, XA:

Capacity		Predominating temperatures		
		Above +32°F (0°C)	+32°F…+10°F (0°C…-12°C)	Below +10°F (-12°C)
Crankcase	2 qts.	OE50	OE30	OE10
Transmission	2 qts.	OE50	OE30	OE10
Rear drive housing	4 ½ ozs.			



Lubricants	Interval		Check weekly	Check Daily
OE-oil, engine all purpose	1/2-	500 Mi.	Transmission	Engine oil
CG-grease, general purpose	1-	1000 Mi.	Rear drive housing	Air cleaner
	1 1/2-	1500 Mi.	Battery	Gas strainer
	3-	3000 Mi.		Cooling fins
	5-	5000 Mi.		
	15-	15000 Mi.		

(5) 1000 mile mechanical maintenance inspection sheet

Motorcycle – H.D. solo WLA and XA models

(To be prepared monthly, or after every 1000 miles of operation)

If correct, mark V ; if defective, mark X ; if replacement required, mark XX .

After defect is corrected, mark (X); after replacement is made, mark (XX).

________________ Co., ____________ armored Regt. Or Bn. ________ 194 ________

USA No. W ________ Type ________________ Mileage ________________

Date of last maintenance check ________________ Mileage ________________

Running Check

No.	Mark	Item	Detail
		Preliminary inspection (inspector will operate vehicle before starting inspection. Hang on test sign).	
1.	____	Ease of starting	
2.	____	Knocks, unusual sounds	
	____		Clutch
	____		Rear drive
	____		Engine
	____		Transmission
3.	____	Oil signal light	
	____	Generator light	
4.	____	Controls	Throttle, etc.
5.	____	Clutch	Adjustment
	____		Operation
6.	____	Transmission	Linkage adjustment
	____		Operation
7.	____	Brakes	Adjustment
	____		Operation front
	____		Operation rear
8.	____	Speedometer	Proper operation
	____		Odometer
9.	____	Steering	
	____		Balance
	____		Shimming
10.	____	Engie	Power
	____		Acceleration
	____		Temperature (overheat)
11.	____	Carburetor	Adjustment
	____		Operation
12.	____	Wheels	Adjustment
	____		Bearings
13.	____	Equipment	Siren
14.	____	Inspect vehicle, loose parts, cracks, etc.	
15.	____	Wash vehicle	

Electrical units

No.	Mark	Item	Detail
16.	____	Battery	Terminals
	____		Oil felts
	____		Cables
	____		Battery box cover bolts
	____		Rubber pads (top & bottom)
17.	____	Battery	Electrolyte level
	____		Filler caps
	____		Hydrometer readings (1.215 or better)
18.	____	Generator changing rate	
19.	____	Cut-out (relay) operation	
20.	____	Switch	
21.	____	Head lights (service and black-out)	
	____	Tail lights (service and black-out)	
	____	Stop lights (service and black-out)	
	____	Panel	
22.	____	Head lamp and bracket (beam adjustment)	
23.	____	Horn	Operation
	____		Button

Engine

No.	Mark	Item	Detail
24.	____	Wiring (insulation, loose connections, breaks)	
25.	____	Drain, flush & refill engine oil (bayonet gauge, motorcycle upright)	

Engine (continued)

No.	Mark	Item	Detail
26.	____	Valve tappet clearance (engine cold)	
	____	Valve operation	
27.	____	Breaker points (clean & gap)	
28.	____	Ignition timing	
	____	Fiber block (lubricate)	
29.	____	Spark plugs (clean & gap)	
30.	____	Condenser & coil connections	
	____	Ignition shielding #	
31.	____	Compression (cranking)	
32.	____	Engine cooling fins, clean	
33.	____	Engine support bolts	
	____		Upper bracket & bolts
	____		Head bolts
	____		Filler plug
	____		Drain plug #
	____		Cylinder base nuts
	____		Crank case bolts
	____		Generator screws
34.	____	Generator band	
35.	____	Exhaust manifolds	
	____		Right muffler
	____		Left muffler #
36.	____	Engine sprocket	Condition
	____		Sprocket tight
37.	____	Kick starter	

Fuel system, oil system

No.	Mark	Item	Detail
38.	____	Gas tank leaks	
	____	Gas line	
39.	____	Oil tank leaks	
	____	Oil line	
40.	____	Filler caps	Gas
	____		Oil
41.	____	Shut off valve	
	____	Reserve valve	
42.	____	Carburetor tightness	
	____	Manifold bolts & nuts	
	____	Linkage	
43.	____	Sediment strainer, clean	
	____	Carburetor bowl, drain	
44.	____	Oil bath air filter, service	
	____	Hose connections	

Power train

No.	Mark	Item	Detail
45.	____	Transmission oil level (level of inspection hole, motorcycle upright). Drain, flush & refil WLA transmission each 1000 miles. XA each 5000 miles.	
46.	____	Gear shift lever & linkage, condition	
47.	____	Clutch controls, condition	
48.	____	Transmission support bolts	
	____	Filler plug	
	____	Drain plug #	
49.	____	Transmission housing leaks	
	____	Gasket & oil seal leaks	
50.	____	Sprocket	Transmission
	____		Clutch
51.	____	Front chain	Condition
	____		Adjustment
	____		Lubrication

Power train (continued)

52. ________ Rear chain — Condition
________ Adjustment
________ Lubrication
________ Stretch

53. ________ Drive shaft #
________ Universal joints #
________ Dirt protector #

54. ________ Rear wheel sprocket

55. ________ Rear drive oil level # (level of inspection hole, motorcycle upright), change each 5000 miles.

56. ________ Rear drive — Filler plug #
________ Drain plug #
________ Leaks #

Frame, forks wheels & chassis

57. ______ ● Frame; broken tubing, etc., alignment; forks.

58. ________ Frame head bearing

59. ________ Handle bar — Grip spirals, operation
________ Grips
________ Alignment, tightness

60. ________ Springs (8) — Condition
________ Tightness

61. ________ Fork rocker plates, bolts & locks

62. ________ Front brake shackle, nuts & locks

63. ________ Front brake — Adjustment
________ Shoes dragging, centralized

64. ________ Front brake lever, 1” free movement

65. ________ Clutch hand lever #, condition

66. ________ Front wheel bearing — Adjustment
________ Condition

67. ________ Front wheel alignment (turn wheel)

68. ________ Front wheel spokes, broken, loose
________ Damaged rim

69. ________ Tire pressure, 18 lbs. front; 20 lbs. rear

70. ________ Foot boards
________ Foot rests

71. ________ Rear wheel adjusting screws

72. ________ Rear wheel spring suspension #

73. ________ Rear axle nuts

Frame, forks wheels & chassis (continued)

74. ________ Rear wheel mounting screws

75. ________ Rear wheel bearings — Adjustment
________ Condition
________ Side play
________ Damaged rim

76. ________ Rear wheel alignment (turn wheel)

77. ________ Rear brake — Adjustment
________ Shoes dragging
________ Linkage

78. ________ Rear brake pedal, 1” free movement

79. ________ Rear brake arm anchor stud, tight

80. ________ Fenders & braces

81. ________ Stands — Rear
________ Jiffy

82. ________ Luggage rack, saddle bags

83. ________ Chain guard — Rear
________ Front

84. ________ Bracket — Machine gun
________ Ammunition box

85. ________ Crash bar — Front
________ Rear

86. ________ Seat
________ Saddle bar
________ Post operation

87. ________ Loose bolts & nuts, entire machine

88. ________ Paint

89. ________ Fire extinguisher
________ Pump

90. ________ Windshield
________ Leg shields (guards)

91. ________ Tools, condition & completeness
________ Mirror

92. ________ Grease fittings — Lubricate (18 fittings, don’t over lubricate hub & brake)
________ Missing
________ Defective

Road test vehicle

________ (Hang on a “test sign)

Remarks

____

____

____

____

Drivers’s name ____________________ Motor vehicle operator permit no. ____________________

Date assigned ____________________ Maintenance ability ____________________

Certificate

The above inspection and check was:

Performed by ______________________________ Mechanic(s), M/Sgt., M/Officer

Supervised by ______________________________ Maintenance Sergeant, M/Officer

Directed by ______________________________ Maintenance officer

● Explain under “remarks” using item number

XA modle only

6. Motorcycle command inspections

Command Maintenance Inspections of necessity must be a “Spot Check” type due to the ground to be covered in a short time. The purpose of these inspections is to become familiar with the maintenance conditions and serviceability of vehicles in general, to inform the Commanding Officer of the condition of maintenance and to improve maintenance discipline within the Organization. These are not technical inspections.

No one person can really cover the vehicles of a unit even in a “spot check”. Suggestion: Prior to making the inspection the Commander should select a staff of commissioned and enlisted personnel to accompany him on the inspection and assign to each specific items from the attached list. While the Commander looks at the general conditions of maintenance, the assistants can cover these specific items for each vehicle. Do not attempt to cover all unless personnel and time will permit. At the next inspection select a different set of items to be inspected. An inspection made in this way will be far less monotonous and yet much more effective and efficient. Specific items to be checked should not be announced. The object of these inspections should be constructive and to learn just how well the rider cares for his vehicle. Announced inspections for which all men are “primed” do not give a true picture and should be avoided as a general practice. Deficiencies may be found for which the rider cannot be held responsible. However, if deficiencies are found, the last trip ticket should be checked to be certain the defect was properly reported. If the deficiency was reported to the Company Maintenance Crew, the Maintenance Officer should be required to explain why repairs had not been made.

The motorcycles to be inspected are to be in orderly formation with tools and equipment displayed. The following is a guide for a Command Inspection of motorcycles.

1. Guide for Command Inspection (brief).

1. ______ General appearance; cleanliness, paint, dents, loose parts, etc.
2. ______ Leaks; oil, gasoline.
3. ______ Tires; inflation, condition; valve caps; spokes tight.
4. ______ Tools; completeness, condition.
   ______ Accident report.
5. ______ Lubrication; check grease fittings, check brakes for evidence of over lubrication.
6. ______ Oil bath air cleaner; oil level; oil free from water and dirt.
7. ______ Engine oil level; check with bayonet gauge; when motorcycle upright; use OE 50, 30, 10; check oil condition.
8. ______ Transmission oil level, check oil condition; use same oil as in engine, oil should be at level of filler hole, when motorcycle upright.
9. ______ Rear Drive oil level (XA only), oil condition, use same oil as engine, oil should be at level of filler hole.
10. ______ Rear chain (WLA only), condition; lubrication (chain should not be covered with lubricant); adjustment (1/4 inch up and 1/4 inch down free movement, 1/2 inch over all).
11. ______ Battery; electrolyte level; terminals clean.
12. ______ Engine fins clean; paint, mud or brush will prevent cooling.
13. ______ Front brake; operation; adjustment (1 inch lever free movement before brake engages).
14. ______ Rear brake; operation; adjustment (1 inch pedal free movement before brake engages).
15. ______ Throttle control; operation (not stiff).
16. ______ Horn; operation, tight.
17. ______ Lights; operation and condition of; service, blackout, stop lights; dimmer switch,
18. ______ Kick starter; kick for engine compression.
19. ______ Clutch; linkage adjustment.
20. ______ Saddle bags, tool box; clean, secure.
21. ______ Mufflers; present and in operating condition.

2. Additional guide for more detailed inspection:

22. _____ Engine starting, ease of.
23. _____ Engine idling (tuned-up?).
_____ Throttle control adjustment.
_____ Spark control adjustment.
24. _____ Engine noises.
25. _____ Instrument lights operate; red and green light should be on when engine not running, when engine running, red light (oil pressure) and green light (generator output) should go off.
26. _____ Spark plugs; clean, not cracked.
27. _____ Generator; tight, wires tight.
28. _____ Gasoline strainer; clean.
29. _____ Front chain (WLA only) condition; lubrication; adjustment (1/4 inch up and 1/4 inch down free movement, 1/2 inch overall).
_____ Chain guard not bent.
30. _____ Clutch; operation (test); adjustment; (WLA friction-should be tight so that pedal will not move into engaged position when foot removed) (XA-lever should have slight free movement before clutch
starts to disengage).
31. _____ Steering; free; steering damper operates correctly.
_____ Headcones adjusted.
32. _____ Gear shifter lever; operation; adjustment (WLA-should go into same gear as indicated on shifter gate) (XA- foot shifter should shift completely into correct gear).
33. _____ Wiring, not frayed, cracked, loose etc.
34. _____ Seat; condition, tight.
35. _____ Fenders; tight, straight.
36. _____ Forks; rocker plates tight, straight,
37. _____ Springs; tight, not broken.
38. _____ Skid plate; present, secure.
39. _____ Crash bars, luggage carrier, ammunition box, gun rack and scabbard; secure, appearance.
40. _____ Frame and handle bars; straight.
41. _____ Wheels; alignment; spokes tight; bearing adjustment correct.
42. _____ Loose nuts, bolts, and parts.
43. _____ Gasoline and oil lines; tight, not bent or crimped.
44. _____ Brakes; operation (test).
45. _____ Valves; adjustment (WLA – intake .005 inch Cold, exhaust .007 inch Cold) (XA intake .005 inch Cold,
exhaust .014 inch Cold).
46. _____ Ignition; check timing.
47. _____ Question rider for knowledge of proper method of operating and servicing his motorcycle.

Section 2: List of tools

The following is a list of tools and equipment supplied by the manufacturer with the WLA and XA model Army Motorcycle.

		WLA			XA
1	ea.	pliers	1	ea.	pliers
1	ea.	screwdriver 2 inch	1	ea.	screwdriver 2 inch
1	ea.	wrench 1/2 inch x 9/16 inch	1	ea.	wrench 1/2 inch x 9/16 inch couple end wrench handle
1	ea.	tool assembly, chain			
1	ea.	Wrench end handle and chain tool holder	1	ea.	wrench socket, spark plug, oil filler and drain plug
1	ea.	wrench, rear axle nut and transmission case			
1	ea.	wrench, valve cover	1	ea.	wrench, carburetor and tappet.
1	ea.	wrench, wheel mounting screw	1	ea.	wrench, 5/16 inch x 3/8 inch double end
1	ea.	wrench, spark plug	1	ea.	tube repair kit
1	ea.	holder, spark plug wrench	1	ea.	tire tools
1	ea.	chain link, master	1	ea.	tool rool
1	ea.	tool roll	1	ea.	grease gun
1	ea.	grease gun	1	ea.	pump, tire
1	ea.	pump, tire	1	ea.	Operation & Maintenance Manual, TM 10-1293
1	ea.	spare parts list, TM 10-1483			
1	ea.	Operation & Maintenance Manual, TM 10-1175	1	ea.	spare parts list, TM 10-1292

Section 3: Shop bench

Following is a drawing of a shop bench for the motorcycle. One mechanic, by using this bench, may raise a motorcycle sufficiently high so that it may be worked on with ease.

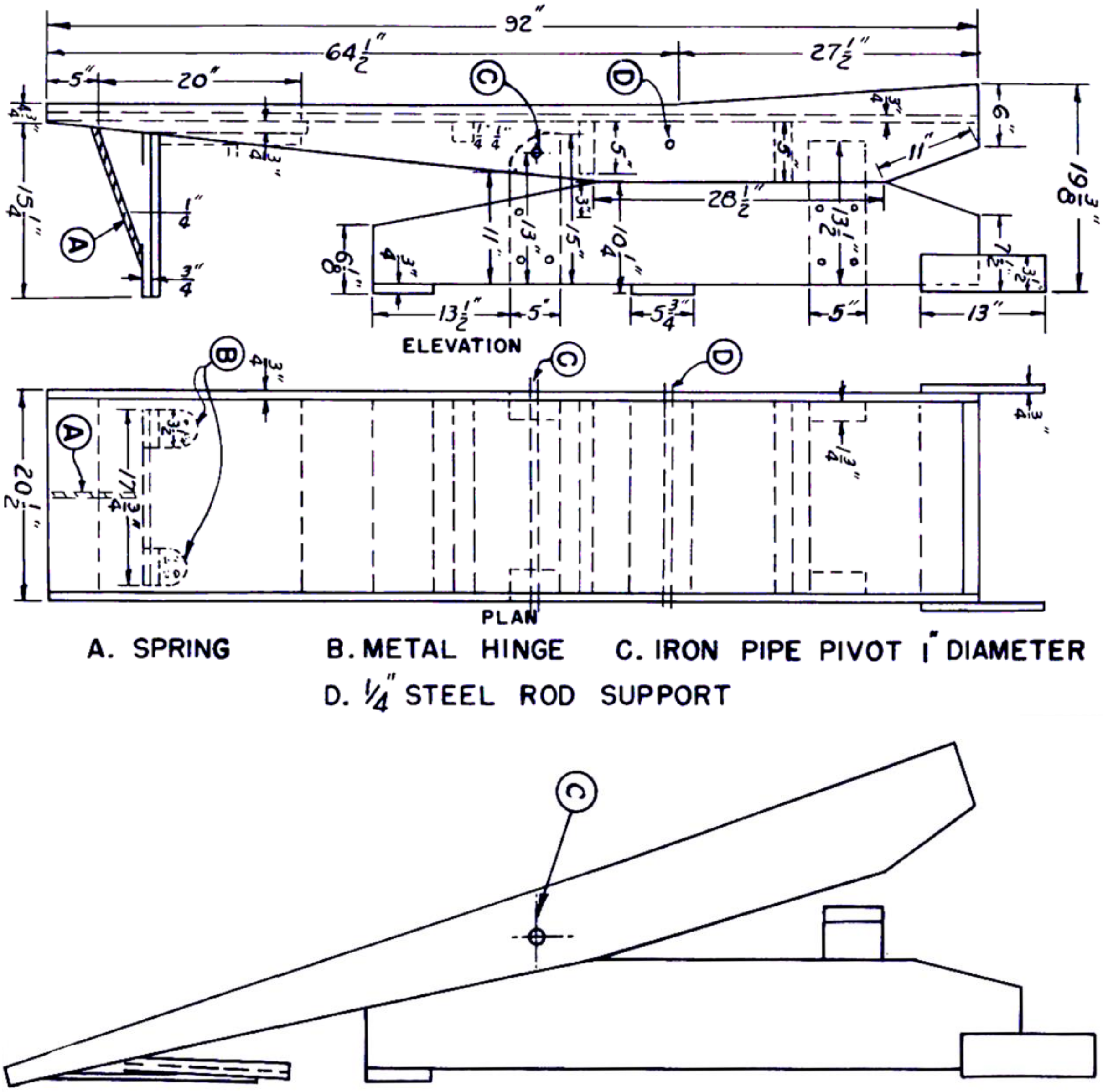


Figure 50 Drawing of motorcycle work bench

Chapter XIII: Stowage list for army motorcycles

The following is a breakdown of the approved stowage list for the Harley-Davidson WLA and XA motorcycles, including individual equipment carried by the rider. The items listed are authorized for issue under Armored Force T/BA No. 17.

1. Individual Equipment (carried by WLA or XA riders and stowed in the same positions on either model, as indicated).

Item of equipment	Stowage position on motorcycle
A. Armament (the rider may be armed with either of the following, with accompanying spare parts and accessories):	
1. Pistol, .45 Caliber In belt holster	In belt holster
(a) Spare parts carried — None	
(b) Accessories carried — None	
2. Gun, submachine, Caliber .45 Thompson (M1928A1)	In submachine gun scabbard, M1940, in brackets on right steering forks
(a) Spare parts for submachine gun, carried in spare parts case, (M1918) (15-18-98):	In right saddle bag
1 Disconnector (B147671)	
1 Ejector (M1928A1 only) (B147672)	
1 Ejector, assy. (M1 only) (C113654)	
1 Pin, firing (B147678)	
1 Rocker, (B147682)	
1 Spring, disconnector (A153018)	
1 Spring, firing pin (A153019)	
1 Spring, magazine catch (A153021)	
1 Spring, recoil (A153024)	
1 Spring, sear (A153025)	
1 Extractor (64370)	
(b) Accessories for submachine gun:	
1 Brush, chamber cleaning, M6 (B108828)	In right saddle bag
1 Brush, cleaning, Caliber .45 M5 (C4036), carried in fabric envelope (15-18-102) in spare parts case.	In right saddle bag
1 Oiler, TSMG (B257624)	In butt stock of gun
1 Rod, cleaning (64183)	In right saddle bag
1 Sling, gun M1923 (webbing) (C7791)	On gun
1 Thong, carried in spare parts case	In right saddle bag
3. Cal. 30 Carbine	In leather carbine scabbard in brackets on right steering forks
(a) Spare parts carried — None	
(b) Accessories for Cal. .30 carbine:	
2 Brush, cleaning Cal. 30 M2 (C4035)	In right saddle bag
1 Brush and thong complete with 1 thong (69175) and 1 Brush, thong, Cal. .30 (C64174), carried in Pouch, web (39847)	In right saddle bag
1 Oiler, carbine, Cal. 80 M1 (C64364) carried in Pouch	In right saddle bag

Item of equipment	Stowage position on motorcycle
B. Ammunition (depending upon whether the rider is armed with the Cal. .45 Pistol, the Cal. .45 submachine gun, or the Cal. .30 carbine):	
1. 21 Rds. Cal. .45 (Pistol)	On individual
2. 75 Rds. Cal. .30 (Carbine)	In ammunition box on left steering forks
3. 180 Rds. Cal. .45 (TSMG), carried in 6 Magazines (TSMG) (D35506) (Capacity, 30 rds. per forks magazine)	In ammunition box on left steering
4. 4 Grenades: hand	In left saddle bag
2 Offensive Mk III w/fuze	
2 Smoke, WP M15	
C. Communication:	
1 Flag Set, M238:	Strapped to scabbard TSMG, M1940 w/4 footman loops & 2 straps
1 Flag MC-278 (red)	
1 Flag MC-274 (orange)	
1 Flag MC-275 (green)	
1 Flagstaff MC-270	
1 Case CS-90	
D. Miscellaneous:	
1 Bag, canvas, field OD M1936	In right saddle bag
1 Flashlight (TL-122-A)	In right saddle bag
Rations, type “C” (1 man for 2 days, 12 cans) or rations type “K”, 6 pkgs	In left saddle bag
Rations, type “D” (1 man for 1 day, 3 bars)	In left saddle bag
1 Roll, blanket	Strapped to bracket on top of rear fender
1 Template, Map, M1	Issued to Agent Messenger — stowed in right saddle bag

2. Vehicular Equipment — these are to be furnished with the vehicle and constitute the "must" list.

Item of equipment	Stowage position on motorcycle
A. WLA Model:	
1. Tools — carried in tool roll (with the exception of the grease gun, as noted below):	In tool box located near center of frame on right side
1 Chain, link master	
1 Holder, spark plug	
1 Pliers	
1 Screwdriver, 2 inch	
1 Tool Assy Chain	
1 Wrench, 1/2 x 9/16 inch	
1 Wrench & handle & chain tool holder	
1 Wrench, rear axle nut transmission case	
1 Wrench, spark plug	
1 Wrench, valve cover	
1 Wrench, wheel mounting	
1 Grease gun	In right saddle bag
2. Accessories:	
1 Pump, tire	In rear of seat bracketed to frame
2 Bags, saddle	One on each side of rear fender, on brackets
1 Gauge, tire pressure, general service type	In right saddle bag
3. Miscellaneous:	
1 Operation & Maintenance Manual, TM 10-1175	In right saddle bag
1 Spare Parts List, TM 10-1483	In right saddle bag
B. XA Model:	
1. Tools—carried in tool roll (with the exception of the grease gun and the tire tool set, as noted below:	In tool box located near center of frame on right side
1 Pliers	
1 Screwdriver, 2 inch	
1 Wrench, 1/2 inch x 9/16 inch couple	
1 Wrench, 5/16 inch x 3/8 double	
1 Wrench, carburetor & tappet	
1 Wrench, adjustable	
1 Wrench, socket, spark plug, oil filler and drain plug	
1 Grease gun	In right saddle bag
1 Tire tool set	In right saddle bag
2. Accessories:	
1 Pump, tire	In rear of seat, bracketed to frame
1 Tube repair kit	In right saddle bag
2 Bags, saddle	One on each side of rear fender, on brackets
1 Gauge, tire-pressure, general service type	In right saddle bag
3. Miscellaneous:	
1 Operation & Maintenance Manual, TM 10-1293	In right saddle bag
1 Spare Parts List, TM 10-1292	In right saddle bag

Chapter XIV: Motorcycle training programs

Section 1: A suggested outline of a course in motorcycle mechanics

This Course Combines Approximately 90% Instruction on the WLA Model, and Approximately 10% Instruction on the XA Model.

Duration of Course — 8 Weeks

NOTE:

C	—	Conference
D	—	Demonstration
PW	—	Practical Work
GT	—	Graded Test
WLA	—	Harley Davidson chain drive motorcycle
XA	—	Harley Davidson shaft drive motorcycle

Subjets	Hours C	Hours D	Hours PW	Hours GT	Total hours
1st Phase - Orientation					
Opening Exercises, Outline of Course	2				2
Receive Equipment			1 ½		1 ½
Hand Tools		½			½
Read Micrometer			1		1
Familiarization with Motorcycle	½	1	1		
Totals	2 ½	1 ½	3 ½		
Total Hours - 1st Phase					7 ½
2nd Phase - Motorcycle Engine					
Internal Combustion Engine	1	1			2
Characteristics of Motorcycle Engine	½	1	½		2
Disassemble and Assemble Engine		8	10		18
Engine Lubrication System	1	½	1 ½		3
Time and Adjust Valves	½	1	1 ½		3
Written Exam				1	1
Performance Test				1	1
Totals	3	11 ½	13 ½	2	
Total Hours - 2nd Phase					30
3rd Phase - Carburetor Air-fuel System					
Fuels and Carburetion	1				1
Disassemble, assemble and adjust Carburetor		2	5		7
Motorcycle Air-fuel System	½	½	1		2
Trouble Shoot Air-fuel System			7		7
Performance Test				1	1
Totals	1 ½	2 ½	13	1	
Total Hours - 3rd Phase					18

Subjets	Hours C	Hours D	Hours PW	Hours GT	Total hours
4th Phase - Electrical System					
Electricity and Magnetism	1	1			2
Batteries and Hydrometers		½	1 ½		2
Principles of Generator	1				1
Disassemble, Assemble & test Generator		2	6		8
Cutout Relay	½	½	1		2
Ignition System (Induction Coil, Spark Plugs, Condenser	1 ½	½	5		7
Lights, Horn, Instruments		½	2 ½		3
Wiring System	½	1	4 ½		6
Trouble Shoot Electrical System			9		9
Written Exam				1	1
Performance Test				1	1
Totals	4 ½	6	29 ½	2	
Total Hours - 4th Phase					42
5th Phase - Power Train Units and Frame					
Motorcycle Power Train, Chains & Sprockets	½	½	2		3
Clutch Operation	½	½			1
Disassemble and Assemble Clutch		2	5		7
Transmission Operation	1				1
Disassemble and Assemble Transmission		6	7		13
Wheel & Hubs	½		2		2 ½
Wheel Alignment & Spokes	½		2		2 ½
Tires and Tubes		1	1		2
Brakes	½	1	3 ½		5
Frame and Forks	½	2 ½			3
Handlebars, Spirals & Controls			2		2
Written Exam				1	1
Performance Test				1	1
Totals	4	13 ½	24 ½	2	
Total Hours - 5th Phase					44
6th Phase - General Overhaul					
Hone Cylinders		½	½		1
Fit Bearings		1			1
Paint Motorcycle		1			1
Parts Book & Parts Ordering	½				½
G.O.H.			72		72
Written Exam				1	1
Performance Test				1	1
Totals	½	2 ½	72 ½	2	
Total Hours - 6th Phase					77 ½

Subjets	Hours C	Hours D	Hours PW	Hours GT	Total hours
7th Phase - Shaft Drive Model (XA)					
Operation & Characteristics	1	3			4
Engine, Air-fuel System	1	3	5		9
Ignition			2		2
Power Train	1		3		4
Tune-up Engine			6		6
Maintenance & Inspections		2	3		5
Written Exam				1	1
Totals	3	8	19	1	
Total Hours - 7th Phase					31
8th Phase - Ride and Maintain Motorcycles					
Select and Instruct Riders	2				2
Ride and Maintain Motorcycles		2	48		50
Convoy, Traffic control, Reconnaissance and Messenger Duties	1				1
Operation of Motor Parks, Records and Reports	½				½
Maps and Map Reading	6				6
Echelon System of Maintenance	½				½
Mtcl. 1st Echelon Maintenance		½	4		4 ½
1000 Mile Maintenance Inspections			5		5
Lubrication, Types of Lubricants	1				1
Lubricate Chassis			2		2
Field Maintenance & Field Expedients	1				1
Trouble Shoot Motorcycle			10		10
Written Exam				1	1
Performance Test				1	1
Graduation Exercise	½				½
Totals	12 ½	2 ½	69	2	
Total Hours - 8th Phase					86
Total Hours - All Subjects	31 ½	48	244 ½	12	336

% Conference	--------	9.4
% Demonstration	--------	14.3
% Practical Work	--------	72.8
% Graded Test	--------	3.5

Section 2: A suggested outline of a two weeks course in motorcycle riding instruction (WLA model)

The motorcycle rider, particularly in the Armored Force, must be intelligent and have split-second coordination. This must be remembered in choosing men for riders. The prospective riders preferably should be young men. Simple tests may be run, such as having men ride a bicycle or perform balance tests. It must be taken into consideration that some men are temperamentally unfit to be motorcycle riders and during the early training periods, close watch must be kept to weed out men who are unfit to be riders or who are afraid of the motorcycle.

Training expert riders demands a well balanced schedule, including maintenance as well as riding. The best training period is approximately two weeks in duration with a daily schedule as follows:

First Week

<u>First Day</u>

It should be devoted entirely to familiarization with the motorcycle, dry runs and maintenance. No riding should be done. Nomenclature should be explained in detail and, in addition, the operation of the following controls and instruments pertaining to Harley Davidson WLA motorcycles should be discussed. Differences from the Indian motorcycles may be explained by instructor.

a. The throttle is on the right handlebar and is opened by turning the handlebar grip in (toward the rider) and closed by turning the handlebar grip out (away from the rider).
b. The spark control is on the left handlebar and is fully advanced when the handlebar grip is turned in (toward the rider) and retarded by turning the grip out (away from the rider). The spark control is very rarely used except in timing the motorcycle engine.
c. The horn button is on the left handlebar.
d. The headlight dimmer is on the left handlebar. It is used to. select either the bright or dim filament of the headlight.
e. The handbrake is on the left handlebar. It controls the brake on the front wheel. The handbrake is ordinarily not used in conjunction with the rear brake except, in an emergency, for holding the motorcycle on a hill or when the right foot must be on the ground.
f. The gear shift lever moves in a bracket, attached to the left side of the gas tank. The motorcycle has a constant mesh non-selective transmission, shifting from low or first gear to third entails shifting the lever through neutral and second.
g. The clutch is above the left foot board and has a toe and heel rest, which swing as a unit on a pivot. The clutch is engaged with the toe down, disengaged with the heel down.
h. The foot brake pedal above the right foot board controls the brake on the rear wheel.
i. The switch is on the top center of the gas and oil tanks. The ignition is turned on by turning the switch one click to the right. The blackout lights are turned on by moving the switch two clicks to the right. The headlights are lighted by pressing the lock button and turning the switch three clicks to the right.
j. Panel instruments: The speedometer is conventional. The green light on the left when lighted indicates that the generator is not charging. The red light on the right, when lighted, indicates that the oil pressure is down. When the engine is run above idling speeds, the green and red lights should go out. If they do not, shut off the engine and have the machine checked by a mechanic. The motorcycle may be run in an emergency on the battery with the generator not charging but should not be run without oil pressure.
k. The carburetor choke on the air intake end of the carburetor is located between the cylinders on the left side of the engine. The choke is closed when the lever is pulled up vertically and open when the lever is horizontal. The choke is used only in and in starting a cold engine. To prime the engine, close the choke, leave the ignition off, and kick the engine over with the starter pedal several times. Then open the choke, turn the ignition on and start the engine. For cold starting, after priming, leave the choke one-third open to start and open it completely after the engine is warm.
l. The kick starter is on the right side of the transmission, It should be explained that nearly one-half of its swing is free play so that it is necessary to use a full vigorous kick. On the 45-inch model it is not necessary to retard the spark to start.
m. The gasoline tank holds 3 1/3 gallons. The valve in front of the gas cap controls the flow of gasoline from the tank. The valve, fully seated, cuts off the gasoline supply. The supply is turned on by unscrewing it just clear of the threads. Pulling the valve up from the tank brings in a reserve supply sufficient for ten to twenty miles of operation. The oil tank holds approximately 3 ½ quarts, CAUTION: Leave about 1 1/2 inches of air space

at the top of oil tank, as oil foams when hot and may leak from the cap on to the rider. The gas cap is vented, the oil cap is not. They are not interchangeable.

Starting and dry runs

The starting position and the position in which the motorcycle should always be left, is with the gear shift lever in neutral and clutch engaged.

A cold engine is started as follows:

1. Put the gear shift lever in neutral.
2. Engage the clutch.
3. With the ignition off, choke closed and the throttle slightly open, kick the engine over once or twice to prime.
4. Turn the ignition on, open the choke, open the throttle about one-sixth and kick the starter pedal vigorously. The engine should start. If it doesn't start, repeat the process.

It is not necessary to choke a hot engine. Have student riders practice the starting exercise first on the rear stand and, when mastered, on the jiffy stand. Dry runs should be practiced with the motorcycle on the rear stand. The student rider starts it and shifts gears up to 3rd and back and simulates actual riding conditions; facing such situations as sudden stops, etc.

On other pages in this book, maintenances sheets are shown and the student rider shall be given rider's maintenance, daily and weekly inspections and as much additional information as time allows. The rider should be taught the rider's daily inspections on the first day, and on succeeding days maintenance should be worked in as suggested by the rider's maintenance inspection sheet. The first day every man should learn about the power train.

Second Day

The students are ready to begin learning to ride. First the controls are reviewed, and he practices the use of them on dry runs. It is recommended for group instruction that the following points be observed:

1. There should be at least one instructor for every six men.
2. During the first three days while the motorcycles are being run slowly in the lower gears, there should be two motorcycles for each group. Run one and allow one to cool, alternating them at approximately half-hour periods. Motorcycle engines depend on the movement of the machine through the air for cooling and will overheat when operated slowly. In cold weather this is not so necessary.
3. The throttle should be set back by means of the screw holding the throttle wire on the throttle wire control connection. During the first three riding days the throttle should be set so that 25 to 30 miles per hour in high gear is the maximum possible speed.
4. A truck or other vehicle should be on hand to transport any injured students to the hospital and also to bring in motorcycles that are damaged, or have flat tires, etc.

The instruction site for the first day of riding should be a large flat field or any such site where supervision is possible. The motorcycle should be ridden to the field by the instructors, having a truck relay the instructors in order to bring out all the machines. A truck should also transport students to the field. The course should be laid out in straight parallel lines or in large ovals circling to the left. The students should be instructed to ride short distances in low gear riding only fast enough to maintain smooth operation and be instructed to stop immediately upon signal from the instructor. A check should be made to determine which men have had motorcycle riding experience and these should be watched carefully for "cowboy" riding. At the first sign of this type of riding they should be disciplined, perhaps by grounding them for the day. Do not ridicule a student for his riding or reprimand him unless he commits an infraction of orders. However, do not pamper riders.

Points to emphasize:

1. A vigorous kick on the starter pedal using a full swing of right leg and hips, should be practiced.
2. Lean the machine to the right when starting, so the student will not edge his clutch foot off the pedal to keep his balance.
3. Practice smooth starting — throttle and clutch coordination.
4. Caution students against grasping the throttle control too far toward the outside, for doing so will prevent him from shutting the throttle rapidly, should the need arise.

5. Any man who does not have normal balance should be pushed with the engine off or given a bicycle to ride. If this balance and coordination do not improve by the end of the third day, he should be dropped from the class.

Third Day

Place — same

Course — same

Instructions — For the first half of the day ride as on the second day, practicing smooth starts and stops. During the second half, allow students to shift into second gear. Work in maintenance instructions.

Points to watch for:

1. Too rapid take-off; killing the engine by not using enough throttle in starting.
2. Looking down while shifting gears. Do not tolerate this, or tolerate students looking elsewhere than the direction in which motorcycle is traveling.
3. Same points as first day of riding.

Fourth Day

Place — Ovals on slightly bumpy terrain — small obstacles.

Instructions — Shift through all three gears up and down with the throttle still cut.

Points to watch:

1. Same points as previously. Work in maintenance inspections.

Fifth Day

Place — Slightly rougher terrain, however, do not attempt cross country work. Shift in all three gears. Throttles are not cut.

1. Caution students against “cracking” of the throttle while the clutch is disengaged.
2. Avoid hitting bumps too fast head-on. Teach angling over ditches to prevent hitting skid plate.
3. Teach students to keep both feet on foot boards at all times except when stopping.
4. Same points as previously. Work in maintenance inspections.

Sixth Day

Place — If possible mud or mud holes. It is well for the student to take a spill in low gear. In this way he gains confidence and experience and gets the feel of the motorcycle.

Instructions — Walk the motorcycles through the mud with the clutch partially disengaged to prevent engine from choking out. The throttle should be even and not raced suddenly as this spins the rear wheel causing spills. Teach students to keep their legs out from under machine if it spills and immediately cut the ignition and right the motorcycle.

Points to watch:

1. Opening the throttle in mud.
2. Not walking the motorcycle through the mud.
3. Using jiffy stand in starting engine.
4. Motorcycle should be left at the finish in neutral with the clutch engaged.
5. Same points as previously. Work in maintenance.

Second week

First Day

Place — On the road in convoy at speeds not in excess of 30 miles per hour. Assistant instructors act as road blockers and keep the convoy in formation. Cyclists should ride in single file with 45 to 50 feet distance between motorcycles. Columns should stop every five or six miles to allow stragglers to catch up and for corrections of riding. Mistakes must be pointed out by an instructor. Upon stopping, the column should be pulled well off to the side of the road in single file. No civilian property should be entered without permission. When starting the column again, the traffic from the rear should be blocked and the oncoming traffic slowed down. Never allow a speeding vehicle to pass the column of students; flag it down!

All during the week of road work, have a truck follow at the rear of the column and make it stay behind the last motorcycle. It should stop every time a motorcycle stops, is damaged, or has a flat tire. Men block roads should hold their block until the truck has passed. Motorcycles which cannot be repaired should be loaded on the truck and the rider should sit in the cargo space with his machine to keep it from falling over. In the truck at all times should be carried a spare battery, a box of tools, and several master links for the rear chain.

During the road riding, the officer or noncommissioned officer in charge of instruction should ride at the head of the column, setting the pace and directing his command. For convenience in handling the riders, cavalry signals to increase or decrease the gait, forward, mount, dismount, and assemble, may be taught the students.

Instructions — The rider's inspection should be performed before the machines leave for instruction. Upon return, each rider should clean his machine thoroughly and report any mechanical faults to the officer in charge. Copies of rider's daily and weekly inspections should be provided each student.

Ride in single file with 50 feet between machines. Eyes should be kept to the front with straight riding. No swinging should be allowed. Machines should be closed up to ten feet when stopped. The assistant instructor's technique in road blocking shall be observed carefully by the students.

Points to watch:

1. Symptoms of "cowboy" riding. Deal harshly with anyone riding in this manner.
2. Upon starting, if riders kill their engines, they should be instructed to halt in place, then join the tail of the column.
3. Elbows should be kept in to the sides, throttle hand on the inside of the grip in a position to close the throttle if necessary.

Second Day

On the road same as first day. Identical instructions apply.

Place — Rutty dirt roads and loose gravel roads.

Instructions — Students shall ride the ridges and not the ruts of dirt roads. On a gravel road, do not angle back and forth over the gravel ridges as it causes spilling. Student riders should assist in road blocking. A good technique is to motion to the student rider behind the officer or N.C.O. in charge of the column and then to the road ahead directing him to ride ahead and block it. See the diagrams for road blocking technique.

Points to watch:

1. Mistakes in road blocking.
2. Same as previously.

Third Day

On the road same as second day. Identical instructions apply.

Fourth Day

On the road same as third day. Identical instructions apply.

Fifth Day

Place — Pick out a highway and ride at speeds up to 40 miles per hour. Take riders through the traffic of a small city, if possible, to accustom them to cars and traffic control.

Instructions — Keep a distance of 25 to 30 yards when increasing speed to 40 miles per hour. Upon approaching a city, slow down and close up the column. Cooperate with city police. Block all major intersections until the last vehicle has passed them. Speed should not exceed 15 miles per hour through cities or congested areas.

Points to watch:

1. Leaving a road block before the last vehicle has passed.
2. "Cowboy" riding and inattention to the road while passing through traffic.
3. Looking down while shifting gear.
4. Same as previously.

Sixth Day

Place — Rough cross country and climbing and descending fairly steep slopes. Watch riders to see if they qualify for motorcycle operator's license. In issuing operator's licenses don't hesitate to withhold a license from an operator who is not qualified to hold one or demonstrates dangerous riding practices.

Instructions — At first, riders should descend banks one at a time, motorcycle in low gear with clutch fully engaged. The hand brake should not be used. Foot brake should be used lightly but not enough to slide the rear wheel. Ascending the slope should be done in low gear with the rider getting a good start with plenty of gas. Throttle should be cut off at the brink of the bank so the machine will not shoot over the top. If the machine stalls and must be laid down, lay it on the left side so the foot brake may be used in descending.

Points to watch:

1. Sliding rear wheel in descending by using too much foot brake.
2. Insufficient throttle to ascend slope.
3. Rider too rigid in seat and failing to lean forward as he climbs slope.
4. Too much throttle at top of slope causing machine to leap.
5. Same as previously.

Maintenance shall be given continuously through second week. Riders will always inspect their machines before taking them out. Upon returning, riders will clean their machines and perform first echelon maintenance.

Additional training for riders of the XA model

Although the basic principles of motorcycle rider training as outlined for the WLA course will enable the student to readily "graduate" to the XA motorcycle, this new model combines certain features the operation of which need be stressed to beginners.

These are:

1. Gas throttle on left handlebar — tum in to open throttle, out to close throttle.
2. Hand clutch on right handlebar — pull in to handlebar to disengage clutch, release gradually from handlebar to engage clutch.
3. Foot gear shift — operate with ball and toe of left foot — depress pedal all the way down for 1st gear (with clutch disengaged), slip toe under tip of lever and pull up once from 1st to 2nd, up once again to shift from 2nd to 3rd, and finally up once more to shift from 3rd to high gear (4th). To shift down, disengage clutch and mash down on lever once for each desired drop in gear range (i.e., once from 4th to 3rd, once again from 3rd to 2nd, etc.). Always slow machine down with footbrake to 20 m.p.h. or less before attempting to shift down into any gear below 3rd.
   The XA model, like the WLA, must be left with its transmission in neutral and its clutch engaged in order to crank the engine.
   Neutral lies between 1st and 2nd gears and may be located in two ways. One method is to use the foot shift lever and "feel" for neutral between 1st and 2nd. This involves bringing the vehicle to a stop, disengaging the clutch, and kicking all the way down on the foot shift to place the transmission in 1st gear. Then, holding the clutch lever in the disengaged position, slip the toe under the shift lever and raise up with a slight pressure (about half of that required to shift up from 1st to 2nd gear) of the foot. This will place the transmission in

neutral. A check should be made by slowly releasing the hand clutch to the engaged position. If the transmission is still in gear the machine will begin to move forward. If this condition exists, disengage clutch completely, kick down again to 1st gear, and repeat the procedure described above.
Beginners may find this method of locating neutral slightly difficult, hence an auxiliary means is provided. A hand lever is placed on the right side of the transmission, extending vertically upward from the side cover. It will be noted that as the transmission is shifted with the foot shift on the left side, the hand lever jumps forward or back into various notches, or positions, When the transmission is shifted into 1st gear the lever moves as far to the rear as it will go. Neutral, then, is simply the first notch ahead of the 1st gear position. Two notches ahead is the 2nd gear position, etc. To place the transmission in neutral the rider stops his machine, disengages the clutch, and kicks down on the foot shift to put the transmission in 1st gear. He then transfers the disengaged clutch lever from his right to his left hand, reaches over with his right hand and moves the lever one notch forward from the 1st gear position. This places the transmission in neutral. Check by slowly releasing the hand clutch and repeat the above procedure if necessary.
It should be emphasized that the hand lever is simply an auxiliary means of locating neutral position. It is not a "hand shift", and the rider should never attempt to use this lever to replace the use of the foot shift for ordinary shifting. It is practically impossible to shift the transmission with the hand lever when the motorcycle is moving, and this practice will most certainly lead to overturning the vehicle.

4. Brakes — the XA model is equipped with two brakes, one for the front wheel and one for the rear wheel. The front wheel brake is controlled by a hand lever on the left handlebar, and the rear wheel brake is operated by a foot lever placed slightly in rear of the right cylinder, near the right foot rest. Action of these brakes is the same as for the WLA front and rear wheel brakes.
5. Kickstarter — operated from left side of vehicle. To crank engine stand beside vehicle, facing into seat, with left hand grasping gas throttle grip and right hand braced on seat. Open throttle 1/4 turn, turn switch on, and kick down vigorously in a plane perpendicular to the center line of the vehicle.

Road blocking technique

The motorcycle has three main uses in the Armored Force, or for that matter, in any Army unit, and these are (1) for messenger service, (2) for scouting, patrolling, and reconnaissance, and (3) for convoy traffic control and road blocking. The latter constitutes probably the most important use of this vehicle in the Army and particularly in mechanized outfits. It is as well, if not better adapted to this use than any other vehicle in the Army today, because of its light weight, great pickup, and high maneuverability and flexibility. For these reasons, the basic principles of road blocking technique are discussed below.

A motorcyclist on road block duty should stop only the traffic interfering with his convoy. He should hold the block until every vehicle in the unit for which he is blocking has passed. He should leave his motorcycle pointing in the direction the convoy is traveling, and he should always turn his engine off to prevent overheating. On large convoys, the blocker should always leave his motorcycle on the left side of the road so he will not have to cut through the following serial to rejoin his unit. At railroad crossings, the rider should stand on the near side to warn the convoy of an approaching train. Should a train approach, he should stop the convoy. At a narrow one-lane bridge, or a sharp turn, the rider should stop oncoming traffic at least one hundred yards beyond the hazard.

Figure 51 shows some of the various traffic hazards blocked by convoy riders, and the proper technique to be used in each case.

Reading from left to right across the top of the figure, note the following situations:

1. Single intersection — rider parks his machine on the right of the intersection for small convoys, but preferably on the left of the road for larger convoys, and waits until the first vehicle of his column comes into view. At this point he walks out into the intersecting street, holds one hand up to block oncoming traffic, and with the other hand waves the convoy on. In this manner he has a "solid block" — that is, he is holding all traffic, but at the same time he has notified the driver of the first vehicle that the intersection is clear.
2. Double intersection — all cross traffic is stopped and no oncoming traffic is permitted to turn left. In the case illustrated there was only one motorcyclist available to block this double intersection. Hence the rider uses his motorcycle to block one side of the intersection and he himself will block the other side.
3. Railroad crossing — motorcycle on the right in this view, but preferably on the left for larger convoys. Rider will stop the convoy should a train approach.

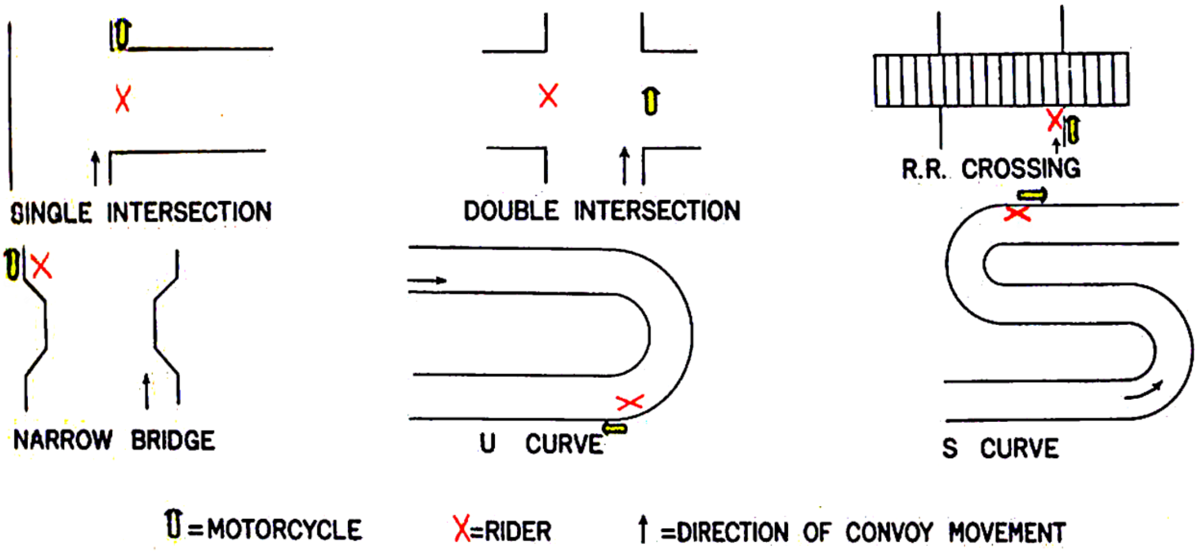


Figure 51 Varois traffic hazards blocked by convoy riders

Reading from left to right across the bottom of the figure, note the following:

4. Narrow bridge — oncoming traffic is halted 100 yards beyond the bridge and held until all vehicles in the column have crossed.
5. U curve — rider stops oncoming traffic at least 100 yards beyond the curve outlet.
6. S curve — same principles apply as for the U curve. Rider must continually make sure that the curve is kept clear of jams from civilian traffic which may slip into the curve from his rear.