CONSTRUCTION AND MAINTENANCE *of* INDIAN MOTOCYCLES

1917 and 1918 Military Models

FIFTH EDITION

HENDEE MANUFACTURING COMPANY
SPRINGFIELD, MASS., U. S. A.

To Start the Indian Motocycle

1—Disengage the clutch by pressing down the left hand or clutch pedal as far as it will go. This withdraws the safety lock and disengages the clutch and permits the gears to be shifted. **The clutch must always be disengaged before any attempt is made to shift the gears.** Pull up on the gear shift lever at the right of the machine until it goes into the upper step on the quadrant (low speed). Open the throttle slightly and at the same time raise the left foot gradually, when the motocycle will move on the road.

2—When the motocycle is running at about 10 miles per hour, close the throttle and depress the clutch pedal; then move the gear shift lever to the third step (intermediate speed) on the quadrant. As soon as the lever has reached that position, engage the clutch and open the throttle. To shift to high gear, proceed as above, except that the gear shift lever is to be moved to the lowest step on the quadrant.

3—The throttle must always be closed by the left hand grip before any gear shift is made. Always start on low gear, as it imposes the least strain on the driving mechanism.

4—To stop the machine, disengage the clutch by either the clutch pedal or clutch hand lever (at the right) and apply the brake with the right foot. Shift the gears to neutral position every time a stop is made, unless a restart is to be made immediately.

5—To stop the motor, lift the valves by turning the right hand grip outward as far as it will go or pull back, according to model of the machine, the exhaust valve relief hand lever.

CONSTRUCTION AND MAINTENANCE OF INDIAN MOTOCYCLES

1917 and 1918 Military Models

1–This book is divided in two parts. Part 1 treats of the construction of these models of motocycle and gives the adjustments and methods of repair by means of which they may be kept in the highest state of efficiency for first class service.

2–The location of troubles and the procedure in correcting the same is facilitated by a series of tables in chapter 3.

3–Part 2 is an amplification of Part 1 and includes valuable suggestions regarding the upkeep of the machines for military organizations.

Part 1

Chapter 1, Definitions.

MOTOR–The mechanism or engine in which the burning of an explosive mixture of gasoline and air is transformed into power for propelling the motocycle.

It consists of the following:

(1)–**Cylinder:** A cylindrical cast iron member in which the piston moves up and down. It is fitted with thin ribs or flanges for cooling, flanges being horizontal on the body of the cylinder and vertical on the cylinder head. The cylinder is accurately bored and ground throughout its length.

a)–**Cylinder head**–The upper part of the cylinder forming the combustion chamber and valve chamber.

b)–**Combustion chamber**–The space between the piston at its uppermost position and the upper interior part of the cylinder head. In this chamber the burning or combustion of the explosive mixture of gas and air takes place.

c)–**Valve chamber**–A pocket formed by a projection of the cylinder head in which the valves operate.

d)–**Valve seat**–That portion of the lower surface of the valve chamber on which the valve rests when in the closed position.

e)–**Bore**–The internal diameter of the cylinder.

f)–**Stroke**–The distance that any point on the piston has travelled from its uppermost position in the cylinder to its lowermost. The extreme upper and lower positions of the piston are known as "dead centres."

(2)–**Piston:** A cylindrical member with closed upper end which moves up and down in the cylinder. It is so fitted in the cylinder that the force of the explosion acts on its closed end and transforms this force into up and down or "reciprocating" motion of the piston.

a)–**Piston ring**–A split ring preventing the escape of gas past the piston. It is made of cast iron, the same size as the bore of the cylinder and is cylindrical in form. When in place its outer surface bears on the interior surface or "walls" of the cylinder and forms a gas-tight seal between the cylinder and the piston. Three rings are used on each piston.

b)–**Piston groove**–A channel cut in the outer surface of the piston to keep the ring in place. There are three grooves in each piston, one for each ring.

c)–**Wrist pin. Also called Piston pin**–The steel pin which attaches the piston

to the connecting rod. It fits in bosses in the piston and on it works the bronze bearing in the end of the connecting rod.

(3)-**Connecting rod:** The rod connecting the piston and crank shaft. It is a steel drop-forging of I-beam section and is attached to the piston by the wrist pin and its bearing and to the crank shaft by means of a roller bearing.

a)-**Crank shaft bearing**-The means of reducing friction between and coupling the crank shaft and connecting rod. The crank shaft carries a series of rollers and the connecting rod a sleeve, the two forming a bearing in which friction is greatly reduced.

b)-**Wrist pin Bearing-Also called Piston pin bearing:** The means of reducing friction between and coupling the wrist pin and connecting rod. This bearing is a bronze bushing fitted into the upper end of the rod and having its bearing surface on the wrist pin.

(4)-**Flywheel:** A heavy-rimmed wheel to secure even running of the motor. There are two flywheels to each motor, each being of steel or cast iron and both running on short main shafts. The crank shaft couples the two flywheels. The inertia from the flywheels stores up energy during the explosion or power stroke and gives it off during the other strokes. Both flywheels are inside the motor base.

(5)-**Crank Shaft:** The shaft which converts the up and down motion of the piston into rotating motion of the main shaft.

(6)-**Main shaft or Driving shaft:** The shaft which transmits the power of the motor to the transmission. It fits into the centre of the left flywheel and is carried in bearings in the motor base. On its end outside the motor base is the sprocket for the front drive chain.

(7)-**Pinion shaft:** The shaft which drives the timing gears. It fits into the centre of the right flywheel and has a bearing in the motor base. It carries a gear on its outer end which drives the other timing gears.

(8)-**Motor base. Also called Crank case:** The casing or chamber in which the flywheels rotate. It serves as a holder for the lubricating oil and has lugs to bolt it to the anchor plates.

a)-**Centre bearings**-The bearings for the main and pinion shafts. The main shaft is carried in a bronze bushing, while the pinion shaft is carried by a roller bearing.

b)-**Compression release valve bushing**-The bearing carrying the special compression release device. Described later.

c)-**Oil gauge**-A window in the lower portion of the motor base for observing the level of the oil within.

(9)-**Cam:** A metal piece of irregular form for opening the valves and allowing them to close. There is one cam for operating the intake valves and another for operating the exhaust valves.

(10)-**Valve lift or Rocker:** A rocking piece acted upon by a cam to operate a valve.

(11)-**Lift lever:** A lever pivoted at one end and acted upon near its centre by the valve lift or rocker. The toe or end of the lift lever operates the tappet or lifter rod.

(12)-**Tappet or Lifter rod:** A short rod acting on the end of a valve stem and operated by a lift lever. It works in a bushing in the timing gear casing.

(13)-**Valve:** A mushroom-shaped metal piece controlling the flow of gas in or out of the valve chamber and cylinder. It consists of a head having a smoothed surface known as the "face" which rests on the valve seat when closed, and a "stem" or shank by means of which the valve is operated by the tappet.

a)-**Intake valve**-The valve admitting the explosive mixture to the cylinder.

b)-**Exhaust valve**-The valve releasing the exhaust gases from the cylinder.

c)-**Valve guide**-The long bearing in which the valve stem moves in opening and closing the valve. It guides the movement of the valve.

d)-**Valve spring**-The coiled spring which closes the valve when the cam ceases to act on the lifter, etc., and keeps it closed until the cam again comes into action.

e)-**Valve spring collar**-A small circular metal piece holding the valve spring in place and exerting its force on the valve stem.

f)-**Valve key**-A semi-circular piece fitting in a groove in the valve stem for retaining the valve spring collar in place. Two keys are used for each valve stem.

g)-**Adjusting nuts**-Small nuts on the end of the lifter rod for regulating the distance between the end of the valve stem and the end of the rod.

(14)-**Timing gears:** The train of five meshed gears operating the valves and driving the magneto. Also called "Valve gears."

a)-**Pinion shaft pinion**-The first gear or pinion in the timing gear train. It fits on the pinion shaft.

b)-**Intake and exhaust cam gear**-The gear or pinion on which the intake and exhaust cams are formed in one piece. The second pinion in the train.

c)-**Release valve gear**-The gear whose shaft is pierced to release any compression in the motor base. The third pinion in the train.

d)-**Idler gear**-The fourth gear in the train. It connects the release valve gear with the magneto pinion.

e)-**Magneto pinion**-The gear or pinion on the armature shaft of the magneto. The fifth gear of the train.

(15)-**Magneto:** An electrical instrument for generating the current used in exploding the charge of air and gas in the cylinder.

a)-**Armature**-A shaft carrying soft iron discs in thin layers on which are sometimes wound insulated copper wires. When rotated it generates current for the ignition.

b)-**Poles**-Curved metal pieces fitted to the ends of the magnets. The armature rotates between them.

c)-**Magnets**-Horseshoe-shaped iron pieces which have been magnetized and which with the poles form a magnetic field. The rotation of the armature in this field generates the current.

d)-**Contact breaker**-The mechanical device for interrupting the primary or low tension current. It is worked by cams on the armature shaft.

e)-**Contact breaker casing**-The casing in which the contact breaker operates.

f)-**Condenser**-A device for preventing sparking or arcing between the contact points of the contact breaker when the points separate. It increases the strength of the secondary or high tension current.

g)-**Brush**-A carbon piece for collecting current for transmission from the secondary portion of the armature to the spark plugs. It is in contact with the collector ring.

h)-**Collector ring**-A ring or collar having a metal portion from which secondary current is drawn by a brush. It takes current from the secondary winding of the armature.

(16)-**Mechanical oiler:** The pump whose plunger moves to and fro and sends oil from the oil tank to the motor base via the front cylinder. It is driven by worm gear from the pinion shaft.

(17)-**Carburetor:** The device for mixing air and gasoline gas in the proper proportions to give an explosive mixture.

a)-**Spray nozzle or Jet**-The opening through which the gasoline emerges into the mixing chamber.

b)-**Mixing chamber**-The chamber surrounding the spray nozzle in which air flows and draws gasoline from the spray nozzle. This forms an explosive mixture, hence the name—mixing chamber.

c)–**Needle valve**–The needle or spindle regulating the flow of gasoline from the spray nozzle.

d)–**Float chamber**–The chamber or reservoir holding sufficient gasoline to give a constant flow from the spray nozzle.

e)–**Float**–A cork or hollow metal body regulating the height and quantity of gasoline in the float chamber.

f)–**Float valve**–A valve of needle form attached to the float by a lever and admitting gasoline or cutting off its flow into the float chamber.

g)–**Air intake**–The port or opening admitting air to the mixing chamber.

h)–**Auxiliary air valve**–The valve operated by the suction of the motor against the action of a spring. It keeps the proportions of gasoline and air constant.

i)–**Throttle**–The device regulating the quantity of explosive mixture passing from the carburetor. It is in the form of a butterfly or disc pivoted along its vertical diameter.

(18)–**Manifold:** The tube leading from the carburetor outlet to the intake valve chamber. It conducts the explosive mixture to the chamber.

(19)–**Spark plug:** The device used for igniting the charge of explosive mixture in the cylinder.

a)–**Shell**–The metal case which screws into the spark plug aperture in the valve cap of each cylinder. There is a metal point or electrode on the threaded end of the shell.

b)–**Insulation**–Porcelain or mica surrounding the centre electrode and preventing leakage of current or short circuits.

c)–**Centre electrode**–The wire passing through the insulation whose long end is a short distance away from the shell electrode and whose other end has the spark plug cable attached.

d)–**Terminal**–The device for attaching the spark plug cable to the centre electrode.

e)–**Gap**–The distance between the electrodes over which the igniting spark passes.

(20)–**Air relief tube:** The tube leading from the gear casing to the outer air for relieving air pressure within the motor base. It acts in conjunction with the compression release valve. (Part N322).

(21)–**Exhaust tube:** The pipe leading the exhaust gases from the cylinder to the muffler.

(22)–**Muffler:** The chamber for silencing the noise of the exhaust.

a)–**Tail pipe**–The pipe conveying the exhaust gases from the muffler to the outer air at the rear of the motorcycle.

(23)–**Chains:** The connecting elements between the motor, three-speed gear and rear wheel. The chains have rollers for reducing the friction caused in their passage over the sprockets. The rollers run freely on rivets which act as couplers for the side plates of the chain.

a)–**Short chain**–The chain leading from the sprocket on the motor main shaft to the sprocket on the clutch body. It forms the primary drive of the transmission. Also called Front chain.

b)–**Long chain**–The chain leading from the inside countershaft sprocket to the sprocket on the rear wheel hub. It forms the final drive of the transmission. Also called Rear chain.

(24)–**Transmission:** All members collectively which transmit or convey the power of the motor to the rear wheel. Thus, the transmission consists of the short chain, clutch, three-speed gear and long chain. The term is often but erroneously applied to the three-speed gear.

(25)–**Clutch:** The friction device which enables the motorcycle to be stopped without stopping the motor and by means of which the power is applied to the rear wheel to start the motorcycle in motion.

a)–**Sprocket ring**–The cup-shaped member of the clutch carrying a sprocket for the short chain.

b)–**Clutch discs**–Metal plates forming the members of the clutch.

c)–**Clutch lining**–A ring of special friction-fabric attached to alternate discs of the clutch. Lined and unlined discs are alternated within the clutch body and are forced into contact by springs.

d)–**Clutch springs**–Small coiled springs which force the discs into contact with each other.

e)–**Release plunger rod**–The rod which forces the discs apart against the action of the springs or allows the discs to contact with each other.

(26)–**Kick starter:** The combination of lever and gearing which rotates the motor when operated by the foot. The starter crank has a geared segment attached to it which meshes with a pinion on the clutch. When the crank is kicked downward the main shaft of the motor is rotated through the primary drive.

(27)–**Three-speed gear:** The device for varying the ratio of motor revolutions to rear wheel revolutions. There are three definite ratios or "gears", the movement from one to the other being made by a "gear shift lever" operated by the rider. Also called Gearset.

a)–**Main shaft**–The shaft carrying the clutch at its outer end and having splines or ribs within the gear case on which the driving dog slides.

b)–**Countershaft**–The secondary shaft carrying three integral pinions meshing with gears on the main shaft.

c)–**Sprocket driver**–The sleeve carrying the inside countershaft sprocket outside the gear case and a pinion inside the gear case. This pinion meshes with a gear on the countershaft.

d)–**Driving dog. Also called Sliding gear**–The sliding member incorporating two integral pinions and a dog-clutch, which is moved along the splined main shaft to mesh the pinions with others on the countershaft.

e)–**Shifter fork**–The forked part for moving the driving dog along the splined main shaft.

f)–**Inside countershaft sprocket**–The sprocket carried by the sprocket driver and in its turn carrying the final drive chain.

g)–**Gear case**–The box or case housing the three-speed gear.

h)–**Gear case cover**–The end plate for the gear case.

i)–**Safety lock**–The device for preventing shifting of the gears unless the clutch is disengaged.

j)–**Gear**–A toothed wheel transmitting power or motion. When the gear has a small number of teeth it is generally called a "pinion."

(28)–**Brake:** The device for retarding or stopping the motion of a motorcycle.

a)–**Brake drum**–The cup-shaped member attached to the rear hub on which the brake bands operate.

b)–**Brake band**–The metal strap faced with friction-fabric which acts on the brake drum.

c)–**Brake lining**–Friction-fabric used to face or line a brake band.

d)–**Brake operating lever**–The straight or bell crank lever operating the brake band.

e)–**Brake arm**–The arm forming part of the side plate of the brake and

anchoring it to the frame of the motocycle. It overcomes the tendency of the plate to turn when the brake is applied.

f)–**Internal expanding brake**–The brake whose band is expanded inside the brake drum when in action. This brake is worked by the brake pedal on the right side of the machine.

g)–**External brake**–The brake whose band is contracted around the outside of the drum when in action. It is worked by a hand lever or by the forward movement of the clutch lever as the case may be.

(29)–**Frame:** The tubular structure supported by the wheels and carrying the motor, transmission, etc.

a)–**Top tube**–The upper horizontal tube extending from the steering head to the saddle post cluster.

b)–**Lower tube**–The lower horizontal tube extending from the steering head to the saddle post cluster and forming the lower seat for the gasoline tanks.

c)–**Loop tube**–The curved tube extending from the steering head and forming a loop at its lower part. In this loop is carried the motor. At its rear end is a forging or bracket for the gearset.

d)–**Upright tube**–The tube extending from the saddle post cluster to the bracket carrying the gearset.

e)–**Steering head**–The forging in which the front fork stem turns on its ball-bearings.

f)–**Head Cup**–A cup-shaped part fitted inside the steering head and forming part of a ball-bearing which supports the fork stem.

(30)–**Cradle spring frame:** The combination of springs and forked members which flexibly supports the rear wheel on an Indian motorcycle.

a)–**Rear springs**–The group of spring leaves fastened at their butts to the saddle post cluster and attaching at the other end to the vertical connecting link. There is a group of rear springs on each side of the rear wheel, each with six leaves.

b)–**Rear forks**–The forked member carrying the rear wheel at the outer end and hinged to the three-speed gear bracket at the front.

c)–**Connecting link**–The vertical member coupling the rear fork end to the rear spring group.

d)–**Yoke**–The curved tube which couples the upper ends of the connecting links.

(31)–**Front fork:** The tubular construction carrying the front wheel. In combination with the wheel and handle bars it forms the steering mechanism of the motorcycle.

a)–**Fork stem**–The tubular portion of the front fork carried in bearings in the steering head. Its lower end is brazed to the fork crown, while its upper end has a straddling bracket for attaching the handlebars.

b)–**Fork crown**–The forged pieces connecting the stem to the fork sides. On the lower side is carried a seat for the front spring.

c)–**Fork side**–The main member of the fork. One is brazed on each side of the fork crown. The tip or end carries the bell crank or rocker.

d)–**Truss tube**–The tubular member bracing the front fork on each side. It forms part of the fork construction.

e)–**Bell crank or Rocker**–The small lever pivoted to the fork end and attaching to the front axle. It is also coupled to the connecting link. The rocker allows the front spring to function in the forks.

f)–**Fork connecting link**–The member coupling the bell crank to the front spring.

g)–**Front spring**–The group of spring leaves attached by their butts to the fork crown on the lower side and to the fork connecting links at the front. The front spring

absorbs road shocks at the front of the motorcycle while the Cradle Spring frame performs the same function at the rear of the machine.

h)–**Head cone**–The conical part fitted to the fork stem and forming part of a ball-bearing supporting the fork stem. The lower cone is at the lower end of the stem and moves with it. The upper cone or head adjusting cone is screwed on the end of the fork stem.

(32)–**Front wheel:** The guiding wheel of the motorcycle. It is carried by the bell cranks in the front fork.

a)–**Front hub**–The tubular member of the front wheel, in which are carried the wheel bearings. The rim is coupled to it by means of spokes laced into flanges on the hub.

b)–**Front axle**–The steel pin passing through the axis of the front hub and supporting the wheel in the bell cranks.

c)–**Spokes**–Wire members coupling the rim to the hub and keeping the rim concentric to the hub.

d)–**Rim**–The circular steel band carrying the tire. The edges are curved inwards to grip the clinches of the tire.

e)–**Front mudguard**–The curved steel member around the front wheel for protecting mechanism and rider from dirt and wet. It is attached at the rear by braces to the fork ends and to the crown.

f)–**Mudguard extension**–The forward extension of the front mudguard. It is attached to the fork connecting link by braces and eyes at the rear.

(33)–**Rear wheel:** The driving wheel of the motorcycle. It is carried by the Cradle Spring frame.

a)–**Rear hub**–The tubular member of the rear wheel carrying the wheel bearings within and the brake drum and rear wheel sprocket on its ends. The rim is coupled to it by spokes laced into flanges on the hub.

b)–**Rear wheel sprocket**–The sprocket for driving the rear wheel. It is attached to the end of the rear hub. It forms the final member of the transmission.

c)–**Rear mudguard**–The curved steel member around the rear wheel for protecting mechanism and rider from splash and dirt. It is attached at the front to the frame and to the connecting links and other points by braces.

(34)–**Tanks:** The reservoirs for gasoline and oil.

a)–**Gasoline tank**–Made in two sections or halves and fitted between the top and lower tubes of the frame. Each section is a complete tank.

b)–**Oil tank**–Attached to the upright tube directly in rear of the motor. It has the hand oil pump fitted to its left side.

(35)–**Controls:** The means by which the throttle, spark, valve lifter, etc., are operated.

a)–**Grip control**–The combination of grip, flexible shaft, rods and rockers for operating the spark, throttle and valve lifter. The spark and valve lifter (exhaust valve relief) are operated by the right grip control, while the throttle is operated by the left grip control.

b)–**Clutch pedal**–The pedal or foot lever at the left side operating the clutch.

c)–**Clutch hand lever**–The lever at the right side for operating the clutch.

d)–**Gear shift lever**–The vertically-moving lever at the right side of the motorcycle for shifting the gears in the gearset.

e)–**Brake pedal**–The pedal or foot lever at the right side for operating the internal expanding brake.

f)–**Hand brake lever**–The lever on the left handlebar operating the external brake. On some machines, this is not used, the external brake being set by a forward motion of the clutch hand lever.

(36)–**Footboard:** The metal platform supporting the foot of the rider. It is attached

by means of brackets to the motorcycle frame and is hinged to fold up. There is one footboard on each side of the machine.

(37)–**Stand:** The support for the rear wheel of a motorcycle when this wheel is raised from the ground. When lowered the stand keeps the machine upright. In the traveling position, the stand is latched to the rear mudguard.

FURTHER DEFINITIONS

This supplementary list includes terms very frequently met with in motorcycle work and which should be known by all riders.

Advanced spark: The term used to describe a spark igniting an explosive mixture before the piston has reached the dead centre on the compression stroke.

Air lock: A stoppage of the flow of a liquid due to a bubble of air in the pipe. It generally occurs at a bend in the pipe. A tube or pipe so stopped is said to be "air bound."

Annular bearing: A bearing formed like a ring. The term refers particularly to ball-bearings in which the load comes radially.

Arc (1): The path described by any point of a lever moving around its pivot. The arc is a portion of the circumference of a circle and is generally less than 90 degrees. When a lever works over a quadrant, the latter is formed in an arc to correspond to the motion of the lever.

Arc (2): An electrical discharge or continuous stream of sparks between the points of a spark plug or contact breaker. It is so called because it takes the form of a curve or arc.

Atmospheric pressure: The pressure of the air at sea level and at normal temperature. It is taken as 14.7 pounds per square inch with a temperature of 60 degrees Fahrenheit.

Babbitt: An alloy of copper, tin and antimony used to line bearings.

Baffle plate: A partition in a fuel or other tank to prevent the contents surging when the motocycle is in motion. Also, a plate put at the base of a cylinder to limit the amount of oil entering it from the motor base.

Ball-bearing: A device to reduce friction of a shaft by rolling contact. It consists of an inner race, outer race and balls.

Ball cage: A device for holding the balls in a ball-bearing in their proper position.

Ball race: A hardened steel ring or disc against which the balls in a ball-bearing travel. The race fitted to the shaft is termed the inner race, while that fitted to the part carrying the shaft is termed the outer race.

Bearing: A support for a shaft or other member which keeps it in its proper relation to other parts and permits its rotation therein. Bearings are also designed to reduce friction as much as possible.

Boss: An enlarged portion or bulge on a part on which a rocker is carried or through which a bolt passes, etc.

Breather: The air relief pipe from the motor base. It equalizes the air pressure within the motor base and acts as an overflow pipe when there is too much oil in the motor base.

Bushing: A bronze bearing, usually in one piece.

Castle nut or castellated nut: A nut with slots cut in its outer part so it may be locked from turning by a cotter pin.

Clearance: The distance between two objects. Examples: the distance between the end of a valve stem and the lifter rod. The distance between the road surface and the lowest part of the motorcycle frame.

Clevis: The forked end of a rod for connecting it to a lever or bell crank.

Compression cock: A cock for relieving compression in a cylinder. Also used for priming. Generally called "priming cock."

Compression stroke: The upward stroke of a motor when both valves are closed and the explosive mixture is being compressed into the combustion chamber.

Contact points: Metal points or electrodes in an electrical circuit serving to make and break the flow of current. They are generally made of platinum.

Cotter pin: A split pin for preventing a nut loosening on its bolt. It passes through a hole in the bolt and has the ends spread apart to keep it in place. It is also used as a fastening.

Cut-out: A valve or opening to allow exhaust gases to pass freely to the outer air. The term also refers to a short-circuiting device in an electric circuit.

Cycle: A series of actions or events in regular sequence during a definite period of time.

Dead centre: The upper and lower limit of motion of a piston.

Distribution gears: The timing gears.

Drain plug: A screw plug fitted near the lowest part of the motor base for draining off the oil.

Dowel: A pin or metal piece holding two parts together. The dowel generally passes through both parts.

Electrode: A contact point, as on a spark plug or contact breaker.

Exhaust gases: The burnt gases passing out of the cylinder after producing power therein.

Exhaust stroke: The fourth stroke in the four-stroke-cycle, during which the exhaust gases are released through the open exhaust valve.

Flanges (1): Ribs or projections for attaching one part to another. Example: the flanges on a hub to which the spokes are laced.

Flanges (2): The cooling ribs on a cylinder.

Flooding: The dripping of fuel from a carburetor due to too high a level within or to over-priming.

Four-stroke: The term describing the strokes of a four-stroke-cycle motor. In such a motor there is an intake, a compression, a power and an exhaust stroke in each cylinder during two revolutions. Generally used to describe a motor operating on this cycle, as "Four-stroke motor."

Four-cycle: An incorrect term designating a four-stroke-cycle.

Gasket: A packing device used between two parts to prevent leakage. Usually a ring of paper, soft metal or fibre.

Gear ratio: The relation of the number of revolutions of the motor to one revolution of the rear wheel.

High gear: The position of the gears in a gear set which gives the least reduction between the motor and the rear wheel. The main shaft of the gearset is locked to the sprocket driver in this position and the drive is direct.

High tension: Current of high voltage or pressure.

Ignition: The firing of the compressed explosive mixture in the combustion chamber of a motor.

Inlet valve: An intake valve.

Insulation: Non-conducting covering for a wire or cable to prevent leakage of the current which it carries.

Intake stroke: The first stroke of the piston in a four-stroke-cycle motor. The explosive mixture is admitted to the open intake valve during this stroke. Also called "admission stroke."

Jump spark: The arc or shower of sparks between the electrodes of a spark plug when the current passes.

Key: A metal piece fitting into a slot in the shaft and also in a slot in a gear or sprocket hub to lock the two together.

Keyway: The slot in a shaft or hub to receive a key.

Labor: Said of a motor which runs irregularly because of too great a load.

Lead (1): The advancing of the spark so that it passes at the plug before the piston is at upper dead centre.

Lead (2): A wire carrying current. Example: the lead from the magneto to a spark plug.

Lift: The distance through which a valve moves from its closed to its fully open position.

Liner: A thin strip of metal inserted between two parts to provide means of adjustment by altering the distance between them.

Low gear: The position of the gears in a gearset giving the greatest reduction between the motor and the rear wheel.

Low tension: Current of low voltage or pressure. Developed in the primary winding of a magneto or obtained from a storage battery.

Misfiring, or Missing: The skipping of an explosion in the cylinder of a motor.

Neutral: The position of a gear shift lever when no gears are engaged. It is located between the low and intermediate gear positions.

Piston displacement: The volume of the cylinder of a motor swept by the piston. It is given in cubic inches. Piston displacement does not include the volume of the combustion chamber.

Port: An opening allowing gases to pass in or out of a cylinder. Example: the intake and exhaust ports.

Pre-ignition: The ignition of the explosive mixture in a cylinder before the piston has reached dead centre.

Primary drive: The forward drive of a transmission. The front chain and its sprockets.

Primary winding: The turns of wire on the armature of a magneto which compose the primary or low tension circuit.

Quadrant: The curved metal piece over which a lever moves. Example: the gear shift quadrant and the clutch hand lever quadrant.

Reciprocating parts: Those parts of a motor which move to and fro. Example: the piston and connecting rod which move up and down in the cylinder.

Retarded spark: A spark occurring after the piston has passed the upper dead centre.

Secondary winding: The turns of wire on a magneto armature which compose the secondary or high tension circuit. This wire is wound over the primary winding and furnishes current for ignition.

Shim: A liner.

Short circuit: The passing of an electric current in a path different from that ordinarily traversed by it

Sliding gear: A gear sliding on a shaft to bring it in or out of mesh with another gear.

Spark plug aperture: The threaded hole in which the spark plug is screwed. This aperture is in the intake valve cap.

Sprocket: A toothed wheel carrying a chain.

Stud: A headless bolt for connecting two pieces or for supporting one piece upon another. The stud may be threaded at both ends in which case one end screws into the one piece and the second piece is attached by means of a nut on the other end of the stud.

Suction stroke: The intake stroke.

Switch: A device for opening and closing an electric circuit.

Tap: A tool used for cutting threads inside a part. Such threads are called "female threads."

Taper pin: A pin smaller at one end than at the other. Used for fitting parts together. The friction of the pin in the hole tends to keep it in place.

Terminal: A metal piece attaching the end of a wire to a spark plug, magneto, etc.

Thrust: An endwise pressure on a shaft.

Timing: Regulation of the opening and closing of the valves so they will operate at the proper periods. The term also refers to the regulation of the magneto with relation to the strokes of the motor.

Torque: The tendency for a shaft, axle or rod to turn and twist under load.

Total displacement: The sum of the piston displacement and the volume of the combustion chamber of a cylinder.

Vaporization: The conversion of gasoline into fine gaseous particles by means of a current of air. It takes place around the spray nozzle in the mixing chamber of a carburetor.

Venturi tube: A tube used in the mixing chamber of a carburetor resembling an hour glass in form. Its shape is stated to give the best vaporizing action possible.

Wheelbase: The distance between the centres of the rear and front wheels of a motorcycle, measured on the ground.

Woodruff key: A semi-circular key for attaching gears or sprockets to a shaft. The wider portion fits into the gear keyway, while the curved portion fits in a curved keyway in the shaft.

Chapter 2. Motor Design and Construction

1–The motor fitted to all military models of the Indian motorcycle is of the two-cylinder, V-type, 61 cubic inches piston displacement and operating on the four-stroke-cycle. The cylinders have their axes at an angle of 42 degrees with each other. The whole motor has the general form of the letter V, hence the name "V-type".

2–The intake and exhaust valves in each cylinder are arranged side by side in a common valve chamber. On the front cylinder, the exhaust valve is in the right portion of the valve chamber, looking at the cylinder from the valve side, while the intake valve is in the left portion. On the rear cylinder, the exhaust valve is at the left, while the intake valve is at the right. This arrangement brings both intake valves in the most convenient position for attaching the intake manifold and getting an even supply of explosive mixture from the carburetor.

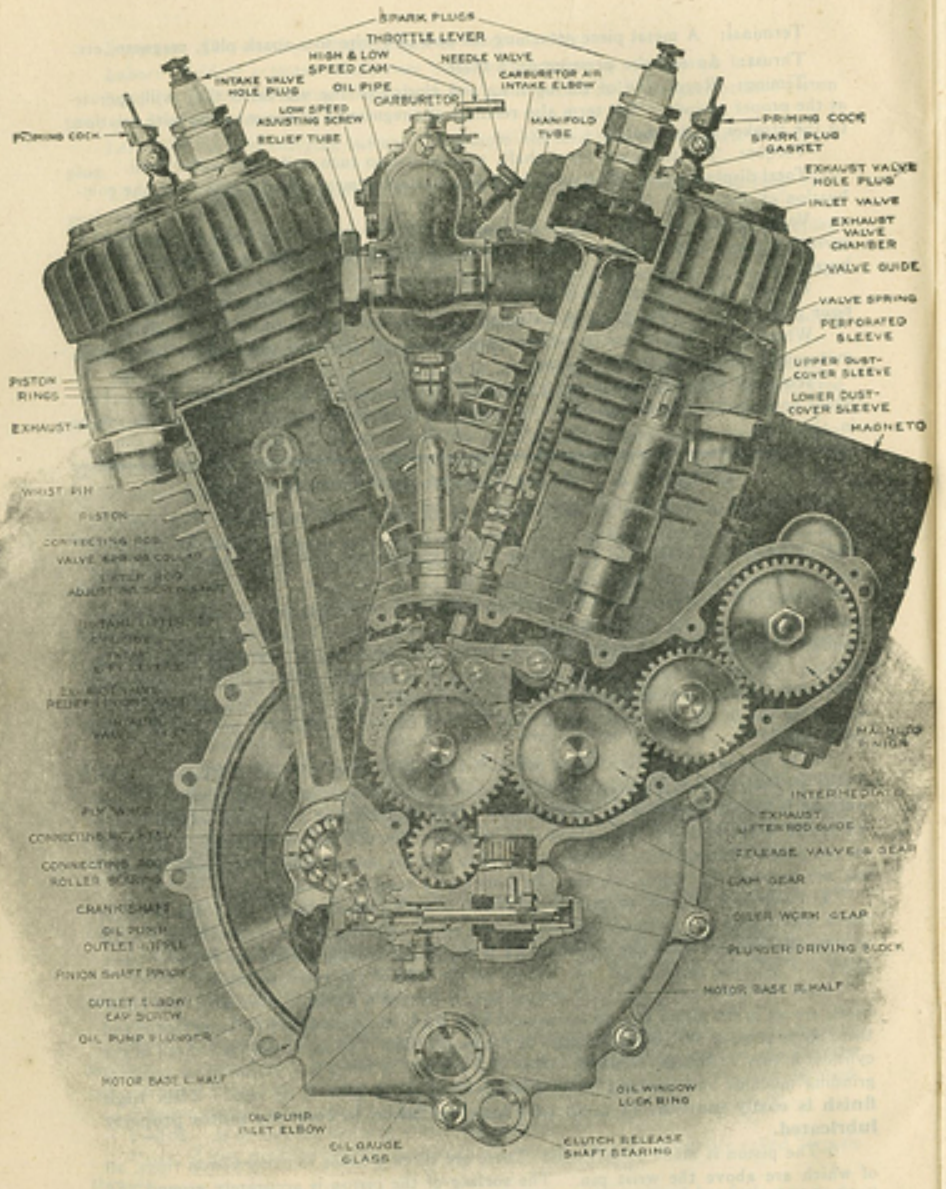
3–On the outer surface of each cylinder are cast a series of cooling flanges or ribs. These are cast in such a manner as to maintain as thin a cross-section as possible. Their purpose is to cool the cylinder by radiation. It is evident that the motor will be cooled efficiently only when the motorcycle is in motion. For this reason emphasis is put later on one point: Never allow any rider or driver to race his motor while the machine is standing nor to have the motor running idle over half a minute at one time.

4–A hole is bored and tapped in the centre of each cylinder head. This hole is either fitted with a plug or a priming cock, and serves as an excellent place for inserting a scale to time the motor. When the priming cock is not fitted into the hole in the cylinder head, there is a priming valve fitted into a boss on the side of the cylinder head.

5–At the lower part or base of the cylinder is formed a flange, drilled with four holes. Studs are set in the motor base to correspond with the holes in the heavy cylinder flange and these studs serve to secure the cylinder to the motor base. The inner surface or wall of the cylinder is very accurately finished. After each cylinder is bored it is placed in an accurate grinding machine and the bore finished to one-thousandth part of an inch. **This high finish is easily marred, so great care must be taken to keep the motor properly lubricated.**

6–The piston is made of cast iron. There are three grooves to carry piston rings, all of which are above the wrist pin. The surface of the piston is accurately ground and finished. It has bosses on the inside through which are drilled holes for the wrist pin.

7–The wrist pin is a press fit into the piston, being held in place by a dowel. The sur-



Sectional View of 1917 and 1918 Indian Motor

face of the wrist pin is ground to give a proper bearing surface for the bushing in the upper end of the connecting rod.

8–The connecting rods are of I-beam cross-section. The wrist pin bearing is a bronze bushing pressed into the upper end of the rod. The lower end of the connecting rod carries a sleeve, forming part of a roller bearing, the rollers being carried on the crank shaft.

9–One of the connecting rods has its lower end forked. A boss on its lower side prevents the forked ends from spreading. The other rod fits into the forked member. Both are thus independent, yet remain in their proper positions on the crank shaft. The connecting rod with forked end has a roller bearing sleeve on each of its ends, while the other rod has a sleeve for two sets of rollers. There are thus four sets of rollers on the crank shaft. The sleeves are of high grade steel, hardened and ground to size. The rollers are likewise hardened and ground, as is the crank shaft.

10–The four rows of rollers are fitted with retainers to keep them in their proper relation to each other. If this bearing develops play it is possible to take this up by inserting oversize rollers which the manufacturers supply.

11–The crank shaft, in addition to acting as a bearing surface for the lower connecting rod bearings, serves to connect the two flywheels. It is tapered on both ends, each taper surface being accurately ground and registering with similarly tapered holes in the flywheels. A special nut and locking device prevents the crank shaft working loose in the flywheels.

12–There are two flywheels in this type of motor. They are housed in the motor base. The flywheels are generally drop-forgings, but in some cases may be iron castings. Each flywheel has the necessary counter weights formed integral with it. At the centre of each wheel is formed an accurately finished taper hole. The main shaft and pinion shaft (also called "centre shaft") have tapered ends which fit their respective flywheels. These shafts are keyed in place in addition to the friction of the taper.

13–The main shaft fits in the flywheel at one end. It has a bearing in the motor base left half. Its projecting end is tapered and on it is carried the sprocket for the short drive chain. This sprocket is keyed on in addition to the taper and a nut and lock washer further assists in securing it in place.

14–The pinion shaft fits in the flywheel at one end. It has a roller bearing in the motor base right half. On its projecting end is keyed the pinion forming the first gear in the timing train.

15–The motor base bearing for the main shaft is a bronze bushing, while that for the pinion shaft is a roller bearing.

16–The motor base is of cast aluminum. It is divided into two halves vertically; that is, along the axis of the motor. When the halves are bolted together they form an oil-tight reservoir. The flywheels revolving in the motor base splash oil upon the other working parts.

17–Drilled lugs on the circumference of each motor base half permit the halves to be bolted together. Anchor plates attach the motor base securely to the frame of the motorcycle. The upper part of each half is accurately machined and has four studs inserted. The cylinders fasten to the motor base by means of these studs and in such a position that their axes form an angle of 42 degrees. When prolonged, the axes will pass through the centre line of the main and pinion shafts at the lower end. A chamber or casing is cast on one side of the motor base right half for housing the timing gears.

18–The bronze bushings in which the timing gears rotate are pressed into the walls of the chamber. The bushings for the lift levers, rockers and exhaust valve relief device are also pressed into the walls. The compression release valve bushing is pressed into a seat in a deep lug integral with the walls. The air relief tube has an opening into this chamber at the top. An extension of the timing gear casing at the lower part carries the mechanical oiler.

19–The intake and exhaust cams are formed integral with a gear driven directly by

the pinion on the pinion shaft. This set of cams operates the valves of both cylinders. The gear on the pinion shaft and the gear having the cams in one piece with it are both marked so that when removed from the motor they may be replaced in their proper positions.

20–The intake and exhaust cams operate the valves once every two revolutions of the flywheels. The pinion shaft or centre shaft makes one revolution for every revolution of the flywheels; hence, it is necessary to use a gear which shall revolve at one-half the speed of the pinion shaft pinion for the cams. To do this we employ one with twice the number of teeth as are on the pinion shaft pinion, and it will take two revolutions of the flywheels to give one revolution of the cam gear.

21–In the upper part of the timing gear casing work the rockers and lift levers. These parts have short shafts which fit the bushings in the timing gear casing and cover. The cams operate the rockers directly and these in turn move the lift levers. The toes of the lift levers operate the tappets in their turn.

22–The valve tappets are small hardened steel pins. On the upper end of each tappet are fitted adjusting nuts for regulating the "clearance" between the end of the tappet and the end of the valve stem. This clearance is necessary by reason of the expansion due to heat which might prevent a valve from seating properly unless a certain space is left between the parts mentioned. Therefore, the adjusting nuts are provided.

23–The valves work vertically in guides in a common valve chamber, intake and exhaust valves being side by side in each cylinder. To remove them, a hole is provided above each, in the upper part of the chamber. Each hole is threaded and in it is screwed a valve cap or valve hole plug. The plug or cap over the intake valve has the spark plug aperture formed in it. On top of the exhaust valve plug are cooling flanges to aid in cooling the exhaust valve.

24–The valve springs are of the spiral type. They bear against a sleeve at their upper end and against the valve spring collar at their lower end. This collar is held in place by two semi-circular keys which fit in a groove in the valve stem. The valve spring thus tends to keep the valve closed at all times. The action of the cam, rocker, lift rod and tappet opens the valve against the force of this spring.

25–The valves are of the mushroom type, with 45 degree seats. Both intake and exhaust valves are the same size. The stem, spring, tappet and adjusting nuts are protected from premature wear due to road grit by means of dust cover sleeves. These are telescopic to give access to the valves. When screwed in place they cover the exposed parts entirely.

26–In addition to the valve operating parts, the timing gear case houses other parts that perform important functions.

27–Between the two intake valve rockers is a short shaft having a toothed segment near one end. This segment meshes with teeth cut on the circumference of a cam plate, known as the exhaust valve relief cam. On the surface of the plate are formed cams which lift the exhaust valves through the rockers, lift levers and tappets when the plate is moved to a certain position. The end of the shaft projects through the cover of the timing gear casing and is squared to take a short lever operated from the grip control. This device enables the rider to lift the exhaust valves on the compression stroke of the motor, thus making it easier to start.

28–As mentioned above, the flywheels are contained in the motor base. They are of such size as to displace most of the air within it. The pistons in descending tend to compress the air in the motor base. If this pressure was not relieved efficient operation and lubrication of the motor could not be obtained.

29–This pressure is relieved by the compression release valve. This valve consists of a shaft which is bored nearly through its length and has two rectangular slots on opposite sides of the shaft. The slots communicate with the hole in the shaft. The compression release valve shaft works in a bushed lug formed in the timing gear casing and is so placed

in this lug that the hole opens into the motor base. The lug and its bushing have a slot to correspond with one of the slots in the valve at certain positions of the valve. The valve has a gear formed on its shaft which is driven by the cam gear. These two gears are so meshed as to open communication between the motor base and the timing gear casing when the pistons are descending in their cylinders. The release valve gear is so marked that if removed from the motor it may be readily replaced in its proper position.

30–The pressure from the motor base is relieved from the timing gear case by means of the air relief tube. This tube conducts the superfluous air and oil away from the case, across the top of the motor base between the two cylinders and ejects it on the front drive chain. The oil from this pipe lubricates the chain.

31–The mechanical oiler is carried in the lower extension of the timing gear casing. This is a plunger pump which draws oil from the oil tank and sends it to the rear wall of the front cylinder. It lubricates this cylinder and the oil drops to the motor base where it is splashed to the rear cylinder and to the working parts.

32–The mechanical oiler is driven by a worm gear and driving block from a worm on the pinion shaft. The shaft of the worm gear has an eccentric pin for moving the driving block, this giving the block a to and fro motion. The driving block has the pump plunger screwed in it, so that the plunger moves back and forth with it.

33–The end of the plunger opposite to that where it attaches to the driving block does the pumping. This end of the plunger moves in a cylindrical pump chamber provided with an intake port in its side near one end. Oil from the oil feed pipe can enter this port through an elbow connection at the lower side of the oiler body. At the end of the pump chamber is an outlet elbow in which there are two ball check valves for preventing the return of the oil to the pump.

34–The motion of the plunger to the right uncovers the intake port and draws in oil, while the motion to the left forces the oil out of the pump chamber, opening the outlet valves on its way and sends the oil to the front cylinder. The position of the plunger can be regulated by screwing it to right or left in the driving block. The alteration of the position of the plunger with relation to the intake port governs the amount of oil drawn from the oil feed line and sent to the motor.

35–On the front of the motor base is formed a bracket to which the magneto is bolted. The magneto is so mounted that the tapered end of its armature shaft extends into the timing gear case. When in place, a pinion, the last in the timing train, is keyed on to this taper and a nut fitted to the end of the shaft further secures it. In order to have the spark pass at the spark plug at the proper instant the magneto armature must be revolved in time with the motor. This will be described in chapter 5.

36–The magneto pinion is marked to register with the mark on the idler or intermediate gear. This gear has marks to register with the magneto pinion and the release valve gear. When the marks on all five gears in the timing train are in register, both valves and magneto are properly timed.

37–A cover is provided for the timing gear casing. It is readily removable for inspection and adjustment of the parts within. This cover should not be removed for any reason except by an experienced motorcycle mechanic. If this warning is disregarded, serious trouble will result.

38–Midway between the cylinders and at the top of the motor is fitted the carburetor. It is bolted to a flange on the manifold. The carburetor and its method of adjustment is described in chapter 4.

39–The curved manifold is clamped on the end of a manifold tube to each cylinder. Nuts hold the ends of these tubes to nipples in the valve ports, making air-tight joints. Great care is necessary in fitting these parts as air leaks at any of the joints will result in uneven running of the motor.

Chapter 3. Motor Troubles and Their Remedies

1–Having covered the design of the motor and the functions of its various parts, its care and operation will next be taken up. Upon the efficient operation of the powerplant depends the correct and economical operation of the motorcycle, and its high value as a superior means of motor transportation.

2–Most of the operations described in this chapter should be performed in a well-equipped repair shop and under the supervision of men experienced in motorcycle repair work.

3–Motor troubles may be divided under the following heads:

(A)–Motor will not run.
(B)–Motor misfires.
(C)–Motor difficult to start.
(D)–Motor stops shortly after starting.
(E)–Motor knocks.
(F)–Motor stops suddenly.
(G)–Hot crankcase and Loss of power.
(H)–Muffler Explosions.

4–A series of tables is here given, outlining the various motor conditions which it may be necessary to meet. The trouble is shown in the table in each case and the remedy is given under the corresponding head in the text.

5–The following troubles are listed in Trouble Table No. 1, on the opposite page.

6–**MOTOR WILL NOT RUN:** If no spark passes at the spark plug and it is not possible to feel a distinct electric shock when the hand is held on the plug and the motor is rotated, the trouble lies in the cables or the magneto. **Try out the cables before commencing on the magneto.** All magneto repairs should be made by experienced mechanics only and not attempted by the rider. If the following adjustments fail to rectify the trouble, the magneto should go to the magneto shop for repair:

a)–**Faulty cables**–Bruised or burnt insulation on a cable allows the current to leak and cause an occasional misfire. This can be detected by running the machine in a dark room and by observing the spark jump to some part of the frame. Tape wound on the cable gives a temporary repair, but a new cable should be put in place as soon as possible.

b)–**Contact breaker points out of adjustment**–The proper distance between the platinum points or electrodes when fully separated should be 0.020 inch, (1/50-inch). A gauge of the proper thickness is provided on the special magneto wrench for measuring this adjustment. If the distance is more or less then this, correct the adjustment and try to start the motor. Prove by trial that the adjustment is correct for both cylinders.

c)–**Contact breaker points pitted**–The platinum points should be kept clean and properly adjusted. Should the points become pitted they can be smoothed with a fine Swiss or jeweller's file, to have them come into perfect contact when closed. Be sure the filed surfaces are parallel and readjust them after filing.

d)–**Contact breaker points badly worn**–If the platinum points are so badly worn that filing will not correct the trouble, they must be replaced by new points.

e)–**Brushes oil soaked**–Remove the screws from the brush holders and remove the brushes. Care must be taken not to damage the gasket. Clean the brush and holder with gasoline and remove all oil from the collector spool.

f)–**Collector spool oil soaked**–Remove the brush holders, dip a piece of cloth in gasoline, wrap it round a lead pencil and insert it in the brush hole. Rotate the magneto by turning the motor over slowly and carefully a few times to ensure proper cleansing. **Be careful not to injure the collector spool as it is very delicate.** Grease and dirt may be removed by forcing gasoline from a priming syringe through the spool housing opening. Blow out the gasoline with a tire pump before restarting.

Trouble Table No. 1

MOTOR WILL NOT RUN

- No Spark
  - Magneto
    - Cables Faulty.
    - Contact Breaker Points out of Adjustment.
    - Contact Breaker Points Pitted.
    - Contact Breaker Points Badly Worn.
    - Brushes Oil Soaked.
    - Brushes Worn.
    - Magneto Water Soaked.
    - Magneto at Fault.
  - Spark plug
    - Cracked Insulation.
    - Points Set Wrong.
    - Points Dirty.
    - Plug is Oil Soaked.
  - Timing is Wrong
    - No Key in Pinion.
    - No Key in Magneto Gear.
    - Gear Removed.
  - Carburetor Trouble
    - No Gasoline.
    - Water in Gasoline.
    - Gasoline Pipe Clogged.
    - Sediment in Carburetor.
    - Carburetor Out of Adjustment.
    - Carburetor Disabled
    - Vent in Float Chamber Plugged.
- Good Spark
  - No Compression
    - Valves Do Not Seat
      - Poor Tappet Adjustment.
      - Valve Stem Bent.
      - Valve Head Bent.
      - Valve Face Pitted.
      - Valve Key Sheared Off.
      - Valve Seat Broken.
      - Valve Spring Broken.
      - Tappet Sticking.
    - Valves Do Not Lift
      - Rocker or Lift Lever Loose.
      - Rocker Broken.
      - Pinion Shaft Gear Loose.
      - Gears Stripped.
      - Worn Lift Lever
    - Valves Timed Wrong
      - Gear Removed.
      - No Key in Pinion.
      - Were New Gears Fitted?
    - Valve Seats O. K.
      - Motor Worn in Service.
      - Cylinders Scored.
      - Piston Rings Worn.
      - Piston Rings Burnt.
      - Blow Hole in Piston.

g)–**Brush holder cracked**–Examine both holders closely for cracks. Sometimes these cracks are difficult to find. Any cracks will let the electric current escape. Smelling the brush holder after running the motor on one good cylinder will often lead to detecting a crack. There will be an odor of burned rubber. Defective holders must be replaced by new ones.

h)–**Brushes worn**–The carbon brushes must be free to move and must project one-quarter inch from the end of the brush holder. If worn, they must be replaced.

i)–**Magneto water soaked**–The only remedy is to dismantle the instrument, thoroughly dry the windings and coils and reassemble it. This work is to be done in the shop, only.

j)–**Magneto at fault**–If the magneto does not generate current and none of the foregoing troubles are located, the magneto must be sent to the magneto shop for repair.

7–**Defective spark plug:** The causes of defects in spark plugs are:

a)–**Cracked insulation or Core**–Replace with new one.

b)–**Points set wrong**–The space between the points should be about 0.020 inch.

c)–**Points dirty**–Clean with gasoline and emery cloth. If plug will not then spark, replace with new one.

d)–**Plug is oil-soaked**–Take the plug apart, clean with gasoline and scrape the core. Clean the insulation with gasoline and allow it to dry thoroughly. Be sure to assemble the plug tight to avoid compression leaks.

8–**Good spark:** If the spark is good at the plugs and the plugs are in good condition, the trouble may be:

a)–**Motor timing is wrong.**

b)–**Carburetor trouble.**

c)–**No compression.**

9–**Motor timing is wrong:**

a)–**No key in pinion**–The key on the pinion shaft may be sheared. Put in a new one.

b)–**No key in magneto gear**–The key may be sheared. Put in a new one and see that all timing marks on the five gears register. Be sure also that the contact breaker is properly timed with the motor. To time the magneto, see opposite page.

c)–**Gear removed**–Put in the proper gear and see that the motor is properly timed.

10–**Carburetor trouble:** First examine the tanks and fuel pipe.

a)–**No gasoline**–Examine the gasoline tanks to see that they have gasoline in them and that the shut-off valves are open.

b)–**Water in gasoline**–This condition causes the motor to run irregularly and misfire at intervals. To remedy it, dismantle the carburetor and gasoline pipe and drain the tanks.

c)–**Gasoline pipe clogged**–If dirt or sediment in considerable quantity has collected in the tank it will find its way into the gasoline pipe and clog it. Disconnect the pipe and blow through it, from the carburetor end to the tank end. Wash out the tanks with clean gasoline, after opening the shut-off valves wide. If necessary, remove the tanks and wash out, draining the gasoline through the filler openings.

d)–**Sediment in carburetor**–Remove the carburetor float chamber and wash it out with clean gasoline. Blow out any deposit in the spray nozzle before reassembling.

e)–**Carburetor out of adjustment**–Follow the instructions in the chapter on Carburetor.

f)–**Carburetor is disabled**–This is generally due to breakage of some part and is of infrequent occurrence. It should be dismantled and the broken parts replaced, if time permits, otherwise a new carburetor should be put on.

TO TIME THE MAGNETO. Unscrew the priming cock in the rear of No. 1 cylinder. Open the priming cock on the front cylinder. Turn the main shaft of the motor **in the direction of rotation of the motor** until the piston of No. 1 (the **REAR**) cylinder is on compression dead centre. All valves will then be closed. Insert a stout piece of wire in the hole left by the removal of the priming cock and mark it to correspond with the dead centre. Remove the wire and make a mark 9/32 inch above the dead centre mark.

Next turn the main shaft **backwards** until the piston is about 1¼ inches below the dead centre. Reinsert the marked wire, making sure that it touches the piston and moves with it. Turn the main shaft **forward** carefully until the 9/32 inch mark on the wire shows that the piston is that distance below compression dead centre. These backward and forward movements serve to take the backlash out of the gears. Next, advance the spark fully.

On the back plate of the magneto just in rear of the timing gear casing will be seen the figures "42°." Below these is an arrow pointing to the right; this indicates that the rotation of the magneto armature shaft is from **left to right** or clockwise. Standing on the right side of the machine, turn the armature shaft in a clockwise direction until the fibre bumper commences to ride up on cam No. 1. The intermediate gear should now be put in without disturbing the setting, and the timing is complete. With one cylinder correctly timed, the other is automatically timed correctly.

Magnetos for the Indian motocycle, military models, are 42°, clockwise rotation, marked "M-2" or "H" on the side plate. Magnetos of other degree angle or different rotation will not work with the Indian motor.

---

g)–**Vent in float chamber plugged**–The vent or hole is located in the lid of the float chamber close to the low speed adjusting screw. If clogged the gasoline will not flow from the float chamber and the motor will not run. Clear the hole by blowing or scraping.

11)–**No compression, valves do not seat:**

a)–**Poor tappet adjustment**–Raise the dust cover sleeves and see that the clearance between the end of the valve stem and the upper adjusting nut is not less than 0.006 nor more than 0.012 inch when the motor is cold. If there is less than this, trouble may be caused by the valve stem expanding when the motor gets hot. If greater than this, the accuracy of the timing is destroyed and the amount of valve opening decreased. Care should be taken that the cam is in such a position that the valve is fully closed before making any adjustment.

b)–**Valve stem bent**–This causes the valve to stick in the guide. Remove it carefully and replace by a new valve. Stems are often bent in removing valve springs. A new valve must be ground in before starting the motor.

c)–**Valve head bent**–The valve will not seat properly. Remove it and put in a new one.

d)–**Valve face pitted**–If a valve is pitted and there is loss of compression the valve should be reground. If the pits are deep and numerous the valve should be replaced and the seat should be reformed. Pitting is caused by poor fitting of the valve face on the valve seat, and is often due to incorrect tappet adjustment.

Excessive grinding is not necessary to remove the pits. If such grinding is resorted to, the valve being harder than the valve seat will wear the latter, thus allowing the valve to seat deeper in the valve chamber. This reduces the clearance between the valve and the chamber when the valve is open. The motor will not be properly cleared of exhaust gases and some will remain in the cylinder, reducing the power of the motor. Excessive grinding also reduces the width of the valve face and allows of only a narrow seat.

e)–**Valve key sheared off**–When the valve dust cover sleeves are raised, this trouble can be seen directly. Remove the valve cap and insert a tool to hold the valve on its seat. Raise the spring and collar and insert new keys in the groove in the stem.

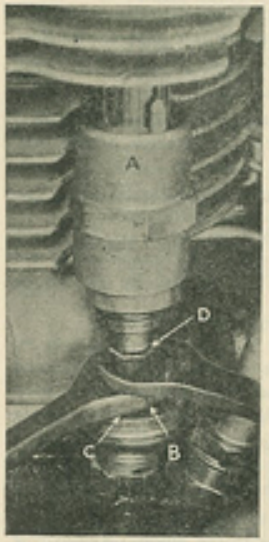
f)–**Valve seat broken or cracked**–A new cylinder is needed.

g)–**Valve spring broken**–Remove valve cap. Unscrew lower dust sleeve and raise it. Push up valve and remove broken spring. Replace with new spring and refit dust cover sleeve.

h)–**Tappet sticking**–Raising the lower dust cover sleeve will show if the tappet and valve are operating. Tappets occasionally stick in the guides owing to gummy oil. Clean with gasoline. If tappet is bent, remove and replace with new one.

12–**No compression, valves do not lift:**

a)–**Rocker or Lift lever loose**–Take off timing gear casing cover and examine the parts therein. Looseness is generally due to worn bushings, which must be replaced. If cam gear is removed it should be replaced so that the marks on it register with those on the pinion shaft pinion and release valve gear. This trouble is infrequent.



Adjusting Tappet Clearance. After raising dust cover sleeve A, loosen lock nut B with special wrench in tool kit. Hold nut D with wrench and turn C to right or left until proper clearance is obtained.

b)–**Rocker broken**–Take off timing gear casing cover and remove cam gear. Replace any broken parts. On replacing cam gear, see that marks register as mentioned above.

c)–**Worn lift lever**–The wearing of a spot where the lift lever contacts with the tappet end will give a poor opening of the valve and the power of the motor will be reduced. A new lift lever is needed.

d)–**Pinion shaft gear loose**–The key is probably sheared. Put in new key and retime motor.

e)–**Gears stripped**–Replace them and retime the motor.

13–**No compression, valves timed wrong:**

a)–**Gear removed**–Replace gear and retime motor.

b)–**No key in pinion**–Remove pinion, put in key and retime motor.

c)–**Were new gears fitted?**–See that the gears mesh properly and retime the motor. If gears do not work properly, replace them.

14–Attention is called to the fact that under all headings of "Valves Timed Wrong" the motor must be retimed as to the opening and closing of the valves. Timing may be expressed in degrees on the stroke and by the position of the piston measured in inches.

15–In the "four-stroke-cycle" all operations in the cycle are completed in two revolutions of the flywheel for each cylinder of the motor. A stroke is equal to one-half a revolution, or the motion of the piston from dead centre to dead centre. Since the cycle is completed in two revolutions of the flywheel, it will be completed in four strokes; hence the term "four-stroke-cycle."

16–The names of the strokes in the "four-stroke-cycle" are: Intake, Compression, Explosion and Exhaust. Piston positions are determined for either the lower or upper dead centre, in inches, by inserting a small graduated scale in the opening in the centre of the cylinder head.

Trouble Table No. 2

MOTOR MISFIRES

- **Plugs Spark Regularly**
  - Carburetor Faulty
    - Readjust Carburetor.
    - Water in Gasoline.
    - Poor Gasoline.
    - Gasoline Pipe Clogged.
    - Float Lever Sticking.
    - Auxiliary Air Valve Loose on Bushing.
    - Auxiliary Air Valve Spring Weak.
  - Poor Compression
    - Valves Do Not Seat.
    - Poor Tappet Adjustment.
  - Air Leaks—Test with Gasoline while Motor Runs
    - Around Manifold Nipples and Nuts.
    - Around Spark Plugs.
    - Around Priming Cocks.
    - Around Valve Caps.
- **At all Speeds**
  - Faulty Spark Plugs.
  - Poor Gasoline or Pipe Clogged.
  - Carburetor Out of Adjustment.
  - Poor Compression.
  - Valves Stick.
  - Valve Key Sheared Off.
- **At Low Speed**
  - Readjust Carburetor.
  - Faulty Spark Plugs.
  - Poor Compression
    - Poor Tappet Adjustment.
    - Valves Do Not Seat.
    - Leaks Past Piston Rings.
    - Blow Hole in Piston or Cylinder.
  - Air Leaks—Test with Gasoline while Motor Runs.
    - Around Manifold Nipples and Nuts.
    - Around Spark Plugs.
    - Around Priming Cocks.
    - Around Valve Caps.
- **At High Speed**
  - Faulty Spark Plugs.
  - Poor Gasoline or Pipe Clogged.
  - Readjust Carburetor.
  - Valve Springs Weak.
  - Tappets Stick.
  - Valves Stick.
  - Contact Breaker Lever Sticks.
- **Plugs Spark Irregularly**
  - Magneto
    - Faulty Spark Plugs.
    - Contact Breaker Lever Sticks.
    - Brushes Oil Soaked.
    - Collector Spool Oil Soaked.
    - Oil on Contact Breaker Points.
    - Contact Breaker Points Pitted.
    - Contact Breaker Points Need Adjusting.
    - Faulty Cables.

17–Before commencing to time the motor, all tappet adjustments must be accurately made. For the Indian motor, there should be the following clearances:

Intake valve.....0.006 inch to 0.012 inch
Exhaust valve.....0.006 inch to 0.012 inch

These measurements are taken when the motor is cold.

18–In order to get the explosive mixture into the cylinder at all speeds with the least delay and greatest ease, the intake valve opens on upper dead centre; just when the piston is ready to go down in the cylinder on the intake stroke. The piston remains open during the full intake stroke and then closes 19/32 inches after the lower dead centre is passed.

19–It will be noted that the intake valve is closed when the piston ascends 19/32 inch on the compression stroke. The piston continues to rise and compress the explosive mixture in the cylinder. The piston reaches the upper or compression dead centre and the mixture is fired by the spark at the spark plug. The compressed gases explode and furnish power to drive the piston downward. This is the explosion stroke.

20–When the piston reaches a point ¾ inch before reaching the lower dead centre the exhaust valve opens and the exhaust gases commence passing out of the cylinder. The piston passes the lower dead centre and continues upward, completing the exhaust stroke. The exhaust valve stays open during the entire exhaust stroke and closes only when the piston again has descended (on the intake stroke) 5/16 inch. There is thus an overlap of 5/16 inch; that is, the exhaust valve and intake valve are both open while the piston is moving that distance on the intake stroke.

21–The above is the valve timing expressed in inches. Expressed in degrees it is: Intake valve opens O degrees (dead centre); intake valve closes 52 degrees after lower dead centre; exhaust valve opens 58½ degrees ahead of lower dead centre; exhaust valve closes 29½ degrees after upper dead centre.

22–Since the intake and exhaust cams are in one-piece with the cam gear, they do not require independent timing. The object of compressing the explosive mixture is to hasten its burning when fired by the spark at the spark plug and to make the explosion more powerful. If it were not compressed, the explosion would be feeble and the motor would run slowly and sluggishly. The need of proper seating of the valves will be obvious.

23–After the explosive mixture is properly compressed it is ignited or fired. On the Indian twin cylinder motor, the spark should occur 9/32 inch before upper dead centre on the compression stroke, with the circuit breaker casing in the fully advance position. In theory, the spark should occur at the upper dead centre on the compression stroke, when the explosive mixture is compressed as much as possible. However, there is a slight lag between the instant of the passing of the spark between the plug points and the explosion. For this reason, the spark is timed in advance and it actually occurs on dead centre.

24–When the spark occurs, it first ignites the mixture around the plug points. The flame from this part of the ignited mixture shoots through the rest of the mixture, exerting great pressure and forcing the piston downward. The time between the occurrence of the spark and the complete explosion of the mixture is very short; but it will be easily understood that as the speed of the motor increases the spark should be advanced. For this reason, the spark position is made adjustable by the right grip control.

25–If the motor runs with the spark retarded, the spark occurs when the piston has passed the upper dead centre. Much energy is lost, then, by reason of the lag or lapse of time between the occurrence of the spark and the explosion. Again, running the motor at slow speed with the spark fully advanced results in complete combustion of the mixture before the piston has reached the upper dead centre. The ascending piston will

Trouble Table No. 3

MOTOR HARD TO START	Good Spark	Carburetor Out of Adjustment. Water in Gasoline. Poor Gasoline. Poor Compression.
	Poor Spark	Plug Points Set Wrong. Faulty Spark Plugs. Contact Breaker Points Pitted. Contact Breaker Points Need Adjusting. Collector Spool Dirty. Brushes Dirty. Contact Breaker Lever Sticks. Magneto at Fault.

tend to be stopped or forced downward, giving rise to a "knock" or to injury to the working parts, depending on the speed of the motor.

26–To get the full effect of the explosion the spark must occur slightly before upper dead centre is reached by the piston. To time the magneto on the Indian motor see page 19.

27–There is a rotary valve in the shaft of the release valve gear in the timing train. This valve is to relieve compression in the motor base. The slot in the shaft carrying this gear should register with that in the boss in which it rotates when the piston has moved down 5/16 inch on the firing stroke. The motor base is then in communication with the timing gear chamber and pressure is relieved through the air relief tube.

28–If the motor still has its original timing gears, these will be found to be marked. By bringing these marks to register, both valves and ignition will be timed.

29–**No compression, valves seat O. K.:**

a)–**Motor worn in service**–The motor is to be disassembled, inspected and all worn parts replaced. It should then be reassembled and tested. This work is to be done in the shop by experienced mechanics only.

b)–**Cylinder scored**–Such a cylinder must be replaced with a new one, or the cylinder sent to the manufacturer to be reground.

c)–**Piston rings worn**–If the ring is worn in its groove in the piston or at its ends, it must be replaced. When the new ring is fitted it should fit snugly in its groove, yet be capable of being "walked" or revolved around the circumference of the piston without binding at any point. If it binds, it can be eased down by rubbing the ring on a piece of emery cloth fastened to a flat board. The distance between the ends of a ring when in place in the cylinder should be 0.020 inch, measured at right angles to the cut. The rings should be fitted into the cylinder free of the piston to determine the fit of the ends.

d)–**Piston rings burnt**–Such rings have no life or spring. They must be replaced.

e)–**Piston rings too loose**–This is due to bad fitting. Replace them.

f)–**Blow hole in piston**–Met with only in new motors. A casting flaw which shows up in service, and is very rare on Indian motors. The remedy is replacement with

a new piston. A blow hole in a cylinder, very rarely met with, can be detected by gas coming out. A new cylinder should be used.

30–The above cover all cases under the heading of "Motor Will Not Run." Under the next heading will come those cases when the motor misfires.

31–**MOTOR MISFIRING:** There are five conditions under which trouble should be sought for:

a)–**Plugs spark regularly.**
b)–**Motor misfires at all speeds.**
c)–**Motor misfires at low speed.**
d)–**Motor misfires at high speed.**
e)–**Plugs spark irregularly.**

32–**Motor misfiring, plugs spark regularly:** Look for

a)–**Carburetor Faulty.**
(1)–Readjust carburetor. See instructions in Chapter 4.
(2)–Water in Gasoline. See previous instructions.
(3)–Poor Gasoline. Sometimes gasoline of very poor quality is obtained. It will not vaporize easily in a cold motor. Drain it off and fill tanks with good gasoline.
(4)–Gasoline Line Clogged. See previous instructions.
(5)–Float Lever Sticking. See instructions in chapter on the Carburetor.
(6)–Auxiliary Air Valve loose on Bushing. This allows extra air to leak into carburetor, giving lean mixture and irregular running. Put in new valve.
(7)–Auxiliary air valve spring weak. Replace with new spring.

b)–**Poor compression:**
(1)–Valves do not seat. See previous instructions.
(2)–Poor tappet adjustment. See previous instructions.

c)–**Air leaks:** These may occur at the places indicated below. They weaken the mixture by letting in extra air and the motor runs unevenly.
(1)–Around manifold nipples and nuts.
(2)–Around spark plugs.
(3)–Around priming cocks and cylinder head plugs.
(4)–Around valve caps.

To test for these troubles, take a priming syringe filled with gasoline and squirt some gasoline on the joints of the parts suspected. The gasoline can be seen to enter where there is a leakage. The motor will either stop or run better. When the defective joint is located, the part should be tightened. Retest all parts until convinced all joints are tight.

33–**Motor misfires at all speeds:** The correction for the causes given has been printed above.

a)–**Faulty spark plugs.**
b)–**Poor gasoline or Pipe clogged.**
c)–**Carburetor out of adjustment.**
d)–**Poor compression.**
e)–**Valves sticking.**
f)–**Valve key sheared off.**
g)–**Overlubrication**–Indicated by heavy smoke from the exhaust. Correct by removing the drain plug in the front of the motor base and draining out the oil; then replacing the plug and putting in oil with the hand pump until the gauge glass shows proper height (1/3 up the glass).

Trouble Table No. 4

MOTOR KNOCKS	Spark Too Far Advanced.
	Carbon in Motor.
	Overheating.
	Lack of Oil.
	Poor Oil.
	Poor Carburetor Adjustment.
	Overloading.
	Loose Bearings.
	Loose Pistons.
	Defective Spark Plugs.
	Foreign Matter in Cylinder.
	Bent Connecting Rod.
	Pistons Out of Round.

See previous instructions on all these troubles.

34–**Motor misfires at low speed:**
a)–**Readjust carburetor.**
b)–**Faulty spark plugs.** See previous instructions.
c)–**Poor compression:**
(1)–Poor tappet adjustment. See previous instructions.
(2)–Valves do not seat. See previous instructions.
(3)–Leaks past piston rings. The rings may be worn or broken or the slots may be in line. To ascertain which is causing the trouble, remove the cylinder. See instructions below.
(4)–Blow hole in piston or cylinder. See previous instructions.
d)–**Air leaks.** See Section 32, c).
e)–**Overlubrication**–See above.

35–**Motor misfires at high speed:**
a)–**Faulty spark plugs**–See previous instructions.
b)–**Poor gasoline or Pipe clogged**–See previous instructions.
c)–**Readjust carburetor**–See chapter on carburetor.
d)–**Valve springs weak**–If suspected, lower the dust cover sleeve and speed up the motor. Exert additional pressure by inserting a screwdriver in the valve spring and pressing downward. This should correct the misfiring. If it does, replace the defective spring with a new one.
e)–**Tappets or Valves stick**–See previous instructions.
f)–**Contact breaker lever sticks**–This is due to lack of lubrication as a general thing. The contact breaker lever should be lubricated with a few drops of magneto or 3-in-1 oil every 500 miles. Motor bil should never be used for the magneto. See chapter on ignition.

36–**Motor misfires, plugs spark irregularly:** The trouble lies in the plugs, cables or magneto. The correction of all these has been given previously:
a)–**Faulty spark plugs.**
b)–**Contact breaker lever sticks**–See Section 35, f).
c)–**Brushes oil soaked**–See Section 6, e).
d)–**Collector spool oil soaked**–See Section 6, f).
e)–**Dirt on contact breaker points**–The points are located in an extension of the contact breaker casing on top, and access to them is had through a hinged cover. Draw clean paper between the points to remove the dirt. Use gasoline if this will not remove it.

f)–**Contact breaker points pitted**–See Section 6, c).
g)–**Contact breaker points need adjusting**–See Section 6, b).
h)–**Faulty cables**–See Section 6, a).

37–**MOTOR HARD TO START:** See Trouble Table No. 3.

38–**MOTOR RUNS FOR A SHORT TIME AND THEN STOPS:** Following are conditions which may cause this:

a)–**No gasoline**–Examine tanks.

b)–**Gasoline shut off**–See that shut-off valve in tanks are open. Prime the carburetor to assure yourself of the flow of gasoline from the tank and that the pipe is not clogged. For clogged gasoline pipe see previous instructions.

c)–**Carburetor out of adjustment**–See chapter on carburetor.

d)–**Carburetor parts broken**–Replace with new carburetor.

e)–**Float set too low**–This gives too low a gasoline level in the float chamber and in the spray nozzle. Dismount the carburetor and bend the float lever gently until the float valve is in a higher position before it shuts off the gasoline. A very little will be found to be sufficient. Reassemble the carburetor and test it. See chapter on Carburetor.

f)–**Motor hard to turn over**–It runs tight due to lack of oil, bearings out of alignment or broken parts inside. The motor should be removed from the frame and disassembled. This work should only be done by an experienced mechanic.

39–**MOTOR KNOCKS:** Following are the causes:

a)–**Spark too far advanced**–Retard it when under heavy load. See also Section 9, b).

b)–**Carbon in motor**–Carbon deposits are caused by burnt oil. The best method of removing the deposit is by scraping. For scraping, the cylinder is to be removed, the carbon scraped out and the valves reground. UNDER NO CIRCUMSTANCES SHOULD AN OXY-ACETYLENE OR OXY-GAS FLAME BE USED FOR BURNING OUT CARBON, OR THE MOTOR WILL BE RUINED.

c)–**Overheating**–Due to over-rich mixture, lack of oil, poor oil or running too long on low or intermediate gear. See below.

d)–**Lack of oil**–The mechanical oiler may be air-bound, or may not be feeding enough for the speed at which the machine is running. First force oil into the motor base with the hand oil pump. In most cases this will effect a cure. If it does not,—stop the motor; remove the short screw above the oil pump inlet elbow and note if oil drips from it. If not, run the motor a little and see that the oil runs out of the hole. When it runs out regularly and freely, replace the screw, making sure that it is tight. Be sure the washer is on it.

e)–**Poor oil**–Drain off and replace with the proper oil. See chapter on lubrication.

f)–**Poor carburetor adjustment**–Generally the mixture is too rich. Readjust the carburetor. Too lean a mixture will also cause a knock.

g)–**Overloading**–Putting too much load on a motor for the high gear. Change down; assist by pushing, if necessary.

h)–**Loose bearings**–Motor should be overhauled.

i)–**Loose pistons**–Motor should be overhauled.

j)–**Defective spark plugs**–Some plugs get their points incandescent, and ignition occurs prematurely (the same as too much advance of the spark). Put in new ones.

k)–**Foreign matter in cylinder**–Occasionally small metal pieces or carbon will give a knock very similar to that of too much spark advance. Remove valve cap and flush cylinder with kerosene thus washing out the matter. Then replace the cap.

l)–**Bent connecting rod**–Caused by some heavy backfire or sticking through lack of lubricant. A knock from this cause makes itself most evident when motor is under load. The motor should be disassembled, the damaged part removed and the fault corrected.

m)–**Pistons out of round**–Remove the cylinders and true up the pistons. This work is to be done only by experienced motorcycle mechanics.

40–**MOTOR STOPS SUDDENLY:** Generally, the motor will give some sort of notice in the form of misfiring or slacking up before coming to a quick stop. If such is the case, look in tank to see that gasoline has not run out.

a)–**Water in gasoline**–Drain carburetor and tank. See previous instructions.

b)–**Water in magneto**–This is only experienced after going through a water splash or mud-wallow. Generally, the trouble is temporary, and the water confines itself to the contact breaker casing. It can be removed by wiping and by injecting gasoline. All parts must be dry before motor is again used.

c)–**Water on spark plugs**–This is due to a splash of mud or water, which temporarily short circuits the plugs. Wipe the plugs clean and when dry the motor will again start.

d)–**Breakage inside motor**–This will result in a quick stop of motor and machine. The motor will not start, and should be sent to the shop for overhaul.

e)–**Vent in tank filler plugged**–This vent is in the filler cap and if clogged will prevent the flow of gasoline to the carburetor. Remove the cap or priming syringe and free the hole by clearing out. In cases where the motor stops and there is gasoline in the tank, examine the vent in the filler cap first.

41–**HOT CRANKCASE WITH LOSS OF POWER:** This trouble indicates a leakage of gas from the combustion chamber into the motor base. It may be due to:

a)–**Piston rings loose or with Ends broken.**
b)–**Piston rings stuck in grooves.**
c)–**Cracked piston.**

All these troubles are to be corrected in the shop and require disassembling of the motor. Trouble b) may be corrected in emergencies by taking off the cylinder and loosening the gummy oil which sticks the rings in their grooves with gasoline.

42–**MUFFLER EXPLOSIONS:** These can easily be traced to either carburetor or electric sources.

a)–**Faulty spark plug**–See previous instructions.

b)–**Spark retarded too much**–Advance it.

c)–**Weak mixture in carburetor**–Readjust it.

d)–**Weak auxiliary air valve spring**–If turning of knurled button will not remedy matters, replace carburetor with new one or have carburetor overhauled at the shop