B. W. Benedict

CONFIDENTIAL:
The contents of this handbook may be disclosed only to officers of the service and to enlisted men whose duties require them to be familiar therewith.

No. 1995

HANDBOOK OF THE

SIX-TON SPECIAL TRACTOR MODEL 1917

(*NINETY-FIVE - PLATES*)

JULY 15, 1918

533-3

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JULY 15, 1918

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ORDNANCE,
WASHINGTON, July 15, 1918.

This manual is published for the information and government of the Regular Army, National Guard, and National Army of the United States.

By order of the Secretary of War:

C. C. WILLIAMS
Maj. Gen., Chief of Ordnance, U. S. A.

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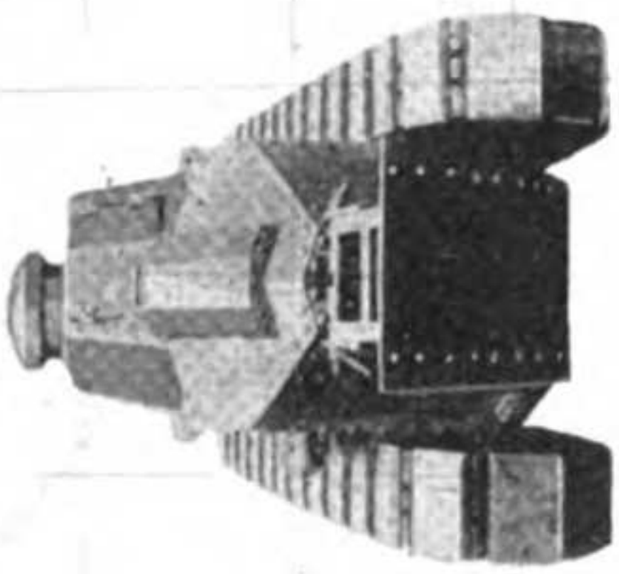

FRONTISPIECE—COMPLETE SIDE VIEW OF 6-TON SPECIAL TRACTOR MODEL 1917 WITH 37 m. m. GUN MASK IN POSITION. UPPER LEFT—FRONT VIEW. UPPER RIGHT—REAR VIEW.

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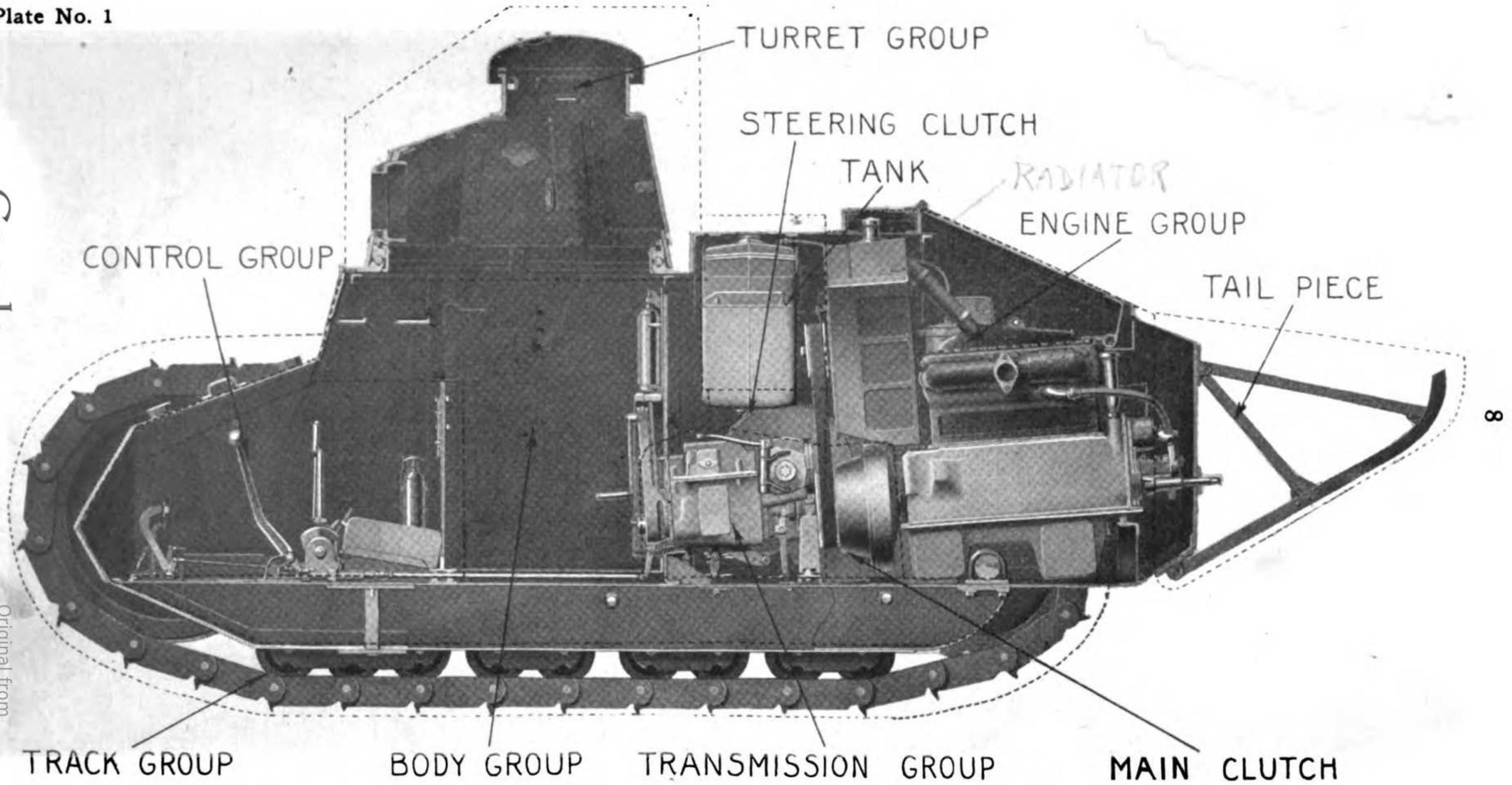


SECTION THROUGH 6-TON SPECIAL TRACTOR MODEL 1917 SHOWING RELATIVE LOCATION OF PRINCIPAL PARTS AND THE MAIN GROUP ASSEMBLIES

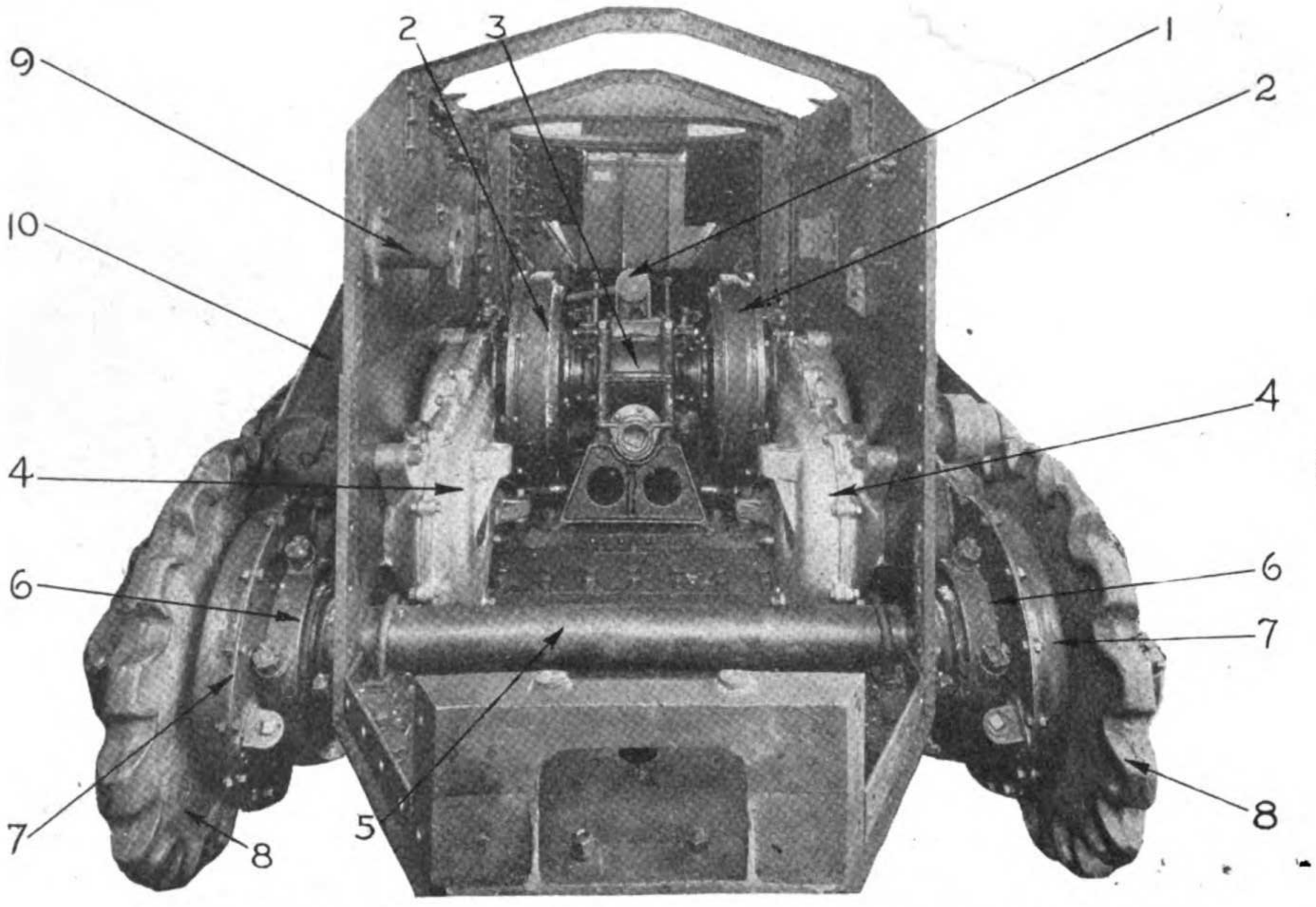
HANDBOOK OF THE SIX-TON SPECIAL TRACTOR, MODEL 1917

CHAPTER I

GENERAL DESCRIPTION AND INSTRUCTIONS

GENERAL WEIGHTS AND SPECIFICATIONS

Weight	6 tons
Length overall	15 ft. 7 in.
Height overall	7 ft. 6.5 in.
Width overall	5 ft. 9 in.
Type of drive	Track-laying or crawler
Type of engine	L-head gasoline type
Number of cylinders	Four
Bore	4¼ in.
Stroke	5½ in.
Main clutch	Inverted cone
Transmission gearset	Four forward speeds, one reverse, selective
Reduction gears	Spur train
Armament	One 37 mm. gun or Marlin machine gun
Personnel	Two, driver and gunner
Turning diameter	14 ft.
Width of single track shoe	13½ in.
Road clearance under body	16 3/16 in.
Height of towing hooks from ground	22 in.
Radiator	Tubular type mounted in front of engine in body
Ignition	Eisemann high tension variable spark magneto type G 4/2 driven by timing gear
Carbureter	Wheeler-Schebler Model A.
Gasoline feed	Vacuum system, 30 gal. tank hung in front of radiator
Governor	Flyball type mounted on magneto drive gear controlling throttle
Steering	By track control through inverted cone steering clutches
Control	Steering through steering clutch levers on either side of driver's seat. Left clutch pedal, right brake pedal, spark and throttle levers, accelerator pedal, gear-shift lever



1. Inside starter sprocket.
2. Brake on exterior of steering clutch.
3. Transmission housing.
4. Spur gear reduction case.
5. Rear axle.
6. Cap on extension of track frame.
7. Final reduction casing.
8. Track drive sprocket.
9. Exhaust extension.
10. Muffler.

This view shows the general layout of many of the assemblies.

SIX-TON SPECIAL TRACTOR MODEL 1917 WITH POWER PLANT AND SEVERAL OTHER BODY PARTS REMOVED

Equipment.....Speedometer, Pyrene fire extinguisher, electric lantern, oil pressure gauge, kick switch, long handled shovel, short handled shovel, oil and kerosene cans, towing cable and hook, tools, including bolt clippers, 4 cleansing brushes, cope chisel, cold chisel, cotter pin extractor, drifts, 2 funnels, 3 files and handle, grease gun and extension, gasoline measuring stick, machinists' hammer, hoisting chain, jack, 2 oilers, punch, pliers, pick, 3 scrapers, 2 screw drivers, gasoline strainer, 24 wrenches, and valve lifter.

GENERAL DESCRIPTION

The 6-ton special Tractor Model 1917, is an armored two-man type equipped with a turrent and either a Marlin machine gun or a 37-mm. gun. It is driven by a four-cylinder gasoline engine which imparts the drive through a transmission gearset and reduction gearing to a track-laying or crawler traction mechanism.

The power plant is located in the rear and the operator is at the forward end in a compartment inside the main body of the tractor. The gunner's compartment is in the center and this is surmounted by the turret which is mounted on a ball race on which it is capable of rotation. The entire tractor is enclosed in armor plate capable of withstanding machine gun or rifle fire.

The engine delivers its drive through an inverted cone clutch housed behind the fly-wheel. From this point the drive is taken through a universal joint to a four speed selective sliding gearset and thence through bevel gears to a transverse shaft which carries the drive outboard to a set of spur reduction gears which operate the track. Interposed between the transmission gear and the spur gear reduction is a clutch on either side of the tractor. These clutches serve to free the track on either side desired thus acting as a means for steering.

Operation of the track is effected by a large driving sprocket actuated by the spur reduction train from within the body of the tractor. This driving sprocket is at the rear end and at the forward end there is a large idler blank sprocket which serves to maintain the tension on the track chain. The tractor has a nominal forward speed of between 6 and 7 miles an hour and due to its great gear reduction and the peculiarities of its track laying propulsion it is capable of obtaining traction up to any tractive angle and over ground of unusual difficulty such as would be encountered in territory marked by shell craters.

Structurally the tractor consists of a main armored body which is hung between two track-carrying frames. Surmounted on the body is the revolving turret supported on a ball-bearing raceway. The track structure includes the traveling track chain and consists of a built-up inverted U-beam, in which is carried the track roller mechanism. The track structure is bracketed to the armored body which forms the backbone of the structure.

INSTRUCTIONS CAREFULLY FOLLOWED

It is of the highest importance that the instructions in this manual be carefully followed if the tractor is to be maintained at its highest efficiency. Inspection in accordance with these rules should be made a matter of routine.

OPERATING INSTRUCTIONS

PREPARATORY TO RUNNING

Thoroughly clean entire machine with kerosene, removing grease or slush coat applied for protection in shipment.

Fill radiator with clean water.

Pour 4 gallons of cylinder oil into engine crank case through filler. (See page 19.)

Fill gasoline tank.

Lubricate entire tractor in accordance with chart and instructions. (See pages 20 and 21.)

Unpack and place all tools in proper locations.

TO START ENGINE

Put gear lever in neutral. (See page 105.)

Open throttle one third. (See page 107.)

Retard spark half way. (See page 108.)

Turn on ignition switch.

Pull air choke on carbureter.

Crank engine rapidly either with outside crank or inside starter. (See page 108.)

Prime engine through priming cups if starting is difficult.

AFTER ENGINE IS STARTED

Advance spark.

Retard throttle lever allowing engine to idle slowly.

TO START TRACTOR

Release brake, if it is engaged.

Depress left pedal releasing main clutch.

Increase engine speed slightly by depressing accelerator pedal.
Engage first speed. (See page 107.)
Slowly allow clutch to engage.

GEAR CHANGES

As tractor gains momentum depress main clutch pedal; close throttle, shift to second speed, release clutch and open throttle. Repeat operation to reach third and fourth speeds, after which speed can be controlled by foot throttle or hand gas lever.

GEAR CHANGES TO LOWER SPEEDS

In changing to lower speed, disengage main clutch, do not retard throttle, instantly shift to lower gear and open throttle to gain speed.

TO REVERSE TRACTOR

Reduce engine speed, release main clutch, apply foot brake.
When truck has stopped engage reverse gear, release brake and engage clutch.
Never engage reverse gear when tractor is moving forward.

TO STOP TRACTOR

Reduce engine speed, release main clutch, apply brake, place gear shift lever in neutral.

TO STOP ENGINE

Turn off ignition switch.
While engine still rotates, advance gas lever slightly to supply initial charge to assist starting.

GENERAL DRIVING INSTRUCTIONS

The spark control lever should be maintained in as advanced a position as possible without causing the engine to knock. It must be retarded under loads severe enough to cause a knock.

Since both the hand throttle control lever on the steering column and the foot accelerator on the floor plate control the throttle opening of the carbureter, either may be used, the choice being largely a matter of preference, although it is good practice to set the hand lever at the desired position when the tractor encounters a long hard pull, and to use the foot acclerator when roads or tractive conditions are such as to make necessary a more flexible means of control.

If the engine should be excessively stiff investigate before attempting to crank it to ascertain whether the pump has been frozen through failure to drain. Should it have frozen it will be necessary to thaw out the cooling system before attempting to start the engine.

Shift gears when necessary to prevent needless laboring of the engine. If the spark control lever has been retarded during the climbing of a hill, be sure to advance it after the hill has been negotiated, for to run with a retarded spark will cause the engine to overheat.

When steep depressions or ridges are encountered allow the tractor to enter them slowly, momentarily slipping the main clutch. As the track itself will climb the ridges it is not necessary to rush the hole. With very severe depressions it is best to enter low gear beforehand.

The same instructions as before given for climbing hills are applicable when the tractor must negotiate soft roads, mud, sand, or snow. Under these conditions shift to the lower gears before the engine begins to labor else the engine may overheat or stall.

Should there be great resistance when starting such as that due to an excessive grade or exceptionally soft ground, speed the engine by depressing the accelerator pedal just as the clutch is engaged, thus allowing the engine to utilize its fully energy to start the tractor.

TO NEGOTIATE STEEP GRADES

This tractor will readily negotiate either downward or upward grades, which are practically up to the limit of traction. For descending steep grades, put the tractor into low gear and let it take its own way over the edge of the shell crater or other hole, and it will readily manage itself in this manner. For negotiating a very steep grade, a little experience will teach the operator a great many valuable lessons, as to manipulation at the top of the grade. If the top comes up very steeply, the tractor will point vertically upward, and is apt to drop forward with a severe pitch if the operator is not skillful in manipulating it. After experience the operator will be able to slip the steering clutches slightly, letting the tractor resume a horizontal position easily instead of with a severe jolt. Care must be taken in slipping the steering clutches not to apply the brakes, as this would stall the engine and would allow the tractor to roll backwards down the hill, if the operator were not watchful.

CROSSING STEEP TRENCHES

Trenches too wide to be spanned and too steep to be descended can be negotiated by towing train formation. The tractors are connected by towing cable, the second tractor lowering the first over the edge gradually until it is able to secure traction on the bottom of the hole. The third tractor assists the second in the same way until the last tractor reaches the edge. The last will have to drop from the line allowing the

others to go on, unless by that time the ground on the edge of the trench is worn to such a degree that it is able to go over the edge.

TRANSPORTING TRAILER

For transportation of the tractor from point of operations to another there is a 10-ton trailer which is briefly described on pages 129 to 131. For complete details see Ordnance Hand Book on 10-ton trailer.

LUBRICATION INSTRUCTIONS

Careful attention to the lubrication of the tractor is highly essential.

ENGINE LUBRICATION

For the engine, use the general specifications for engine oils and greases as specified by the Signal Corps and the Ordnance Corps. This oil will be specified as the medium grade and an allowance of 5 gallons is made for use in running in and testing the engines on 6-ton tractors. Any manufacturer's oil meeting these specifications will be accepted.

LUBRICANT SPECIFICATIONS

General

1. The oils for the lubrication of the gasoline engines of engine equipped vehicles must consist of refined and filtered mineral oils or mixtures of same and must be suitable in every way for satisfactory use in internal combustion engines.

Use

2. The medium oil shall generally be for use in winter and upon the engines of new tractors at other times. The heavy oil shall be for use in summer and for old engines.

Viscosity of Engine Oil

3. The viscosity in seconds on the Saybolt Universal Viscosimeter at 100 degrees F. shall come within the following limits:

Engine oil, medium	270 to 330 Sec.
Engine oil, heavy	470 to 530 Sec.
Engine oil, extra heavy	730 to 780 Sec.

Test

4. The engine oil medium must not congeal in a 4-oz. bottle at a temperature of 25 degrees F.

The engine oil heavy must not congeal in a 4-oz. bottle at a temperature of 35 degrees F.

The engine oil extra heavy must not congeal in a 4-oz. bottle at a temperature of 45 degrees F.

Carbon Content of Oil

5. The carbon residue test by the Conradson Method must be less than 0.4 per cent for the medium oil, 0.6 per cent for the heavy oil, and 0.8 per cent for the extra heavy oil.

6. The following characteristics of oil bid upon must be stated in proposal: Viscosity tests on the Saybolt Universal Viscosimeter at temperatures of 70 degrees F., 100 degrees F., 130 degrees F., 212 degrees F, and 300 degrees F., Gravity, Beaume at 60 degrees F.

TRANSMISSION LUBRICANT

For transmission and reduction gears will be governed by the specifications for non-fluid transmission lubricant as approved by the Signal Corps and Quartermaster's Department, also Medical Corps and U. S. Navy. Sixty-five pounds of this lubricant will be specified for the testing and running in of each 6-ton tractor and to remain in the transmission and reduction gear cases of this 6-ton tractor when shipped.

TRANSMISSION LUBRICANT SPECIFICATIONS

General

1. This lubricant shall be a well manufactured product composed of calcium soap and mineral oil, and must be suitable in every way for the lubrication of the axles and transmissions of engine equipment.

Consistency of Transmission Lubricant

2. The lubricant shall be equal in consistency to a standard sample of No. 00 non-fluid lubricant.

Moisture Content

3. The lubricant shall be of a boiled grease, containing not less than 1 per cent nor more than 1.5 per cent of moisture when finished.

Mineral Oil Base

4. The mineral oil used in reducing the soaps shall be at least 180 seconds viscosity at 100 degrees F. on a Saybolt Universal Viscosimeter.

Saponifiable Fat Base

5. Not over 10 per cent of either pure tallow oil, Neats Foot oil, lard oil or horse oil, singly or in combination, to be used as a fat base.

Acidity

6. When applied to polished copper, there shall be no reaction after a period of 48 hours.

Heat Test

7. When 2 oz. of the grease are heated to 212 degrees F. or until the entire mass becomes liquid and then allowed to cool, there shall be no separation of the soaps from the oil.

Fillers

8. The grease shall not contain fillers of any kind, such as resin, resinous oils, soap stone, wax, talc, powdered mica, lamp black, sulphur, clay, asbestos or any other artificial thickening.

CUP GREASES

Specifications for medium cup greases, as specified and approved by the Signal Corps, Ordnance Department, Quartermaster's Corps and U. S. Navy, are endorsed for use on this 6-ton tractor, 10 pounds of this grease herewith specified for use on 6-ton tractor. This grease will be left in cups and oiling devices when shipment is made.

CUP GREASE SPECIFICATIONS

General

1. This grease shall be a well manufactured product, composed of calcium soap and mineral oil and must be suitable in every way for the lubrication of such parts of engine equipment and other machinery as are lubricated by means of compression cups.

Consistency

2. The grease shall be a medium cup grease similar in consistency to a standard sample of No. 3 grease.

Moisture

3. The grease shall be a boiled grease, containing not less than 1 per cent nor more than 3 per cent of moisture when finished.

Saponifiable Fat Base

4. From 15 per cent to 20 per cent of either pure tallow oil, Neat's Foot oil, lard oil, or horse oil, singly or in combination, to be used as a fat base.

Mineral Oil Base

5. The mineral oil used in reducing the soaps shall be at least 180 seconds viscosity at 100 degrees F. on a Saybolt Universal Viscosimeter.

Acidity

6. When applied to polished copper, there shall be no reaction after a period of 48 hours.

Heat Test

7. When 2 ounces of the grease are heated to 212 degrees F. or until the entire mass becomes liquid and then allow to cool, there shall be no separation of the soaps from the oil.

Fillers

8. The grease shall not contain fillers of any kind such as resin, resinous oils, soapstone, wax, talc, powdered mica, lamp black, sulphur, clay, asbestos or any other artificial thickening.

TRACK

The following specifications on oils to be used on oiling track rollers, track links and track pins on the 6-ton tractor will be governed by the specifications for gear chain and wire rope lubricant as specified and approved by the Signal Corps and Quartermaster's Department. Six gallons of this lubricant are hereby specified for running in.

SPECIFICATIONS OF TRACK LUBRICANT

General

1. This lubricant must be a very adhesive, heavy bodied, straight mineral oil, suitable in every way for lubrication and protection.

Character

2. The oil must be a hydro-carbon product only, without the mixture of vegetable or animal oils, products or residues or fats of any kind, and entirely free from fillers such as talc, resin, tar or materials of similar or other nature not related to the original product.

Viscosity

3. The viscosity in seconds on the Saybolt Universal Viscosimeter at 212 degrees F. shall come within the following limits: 900 seconds to 1100 seconds.

Quality

4. The quality shall be similar to that of a standard sample of crater compound No. 1.

Adhesiveness

5. As this is one of the most necessary qualifications for this oil and there is no laboratory method for suitably indicating the value of this characteristic, the adhesiveness will be determined by applying the lubricant to a track operating under practical conditions, the effect produced by the lubricant as compared to the effect produced by the standard sample of Texaco crater compound to be taken as a basis of comparison.

Corrosion Test

6. When the lubricant is applied to a plate of polished steel, the steel is to be protected for a period of 30 days from vapors from chemicals and from the action of salt or fresh water and of solutions of water containing from 10 to 25 grains of sulphuric acid per unit, the water and solutions to be at 60 degrees F.

LUBRICATION INSTRUCTIONS

Every point indicated on the lubrication chart should be attended to with the frequency indicated in the following instructions.

After each part mentioned on the lubricating instructions and indicated on lubrication chart will be found a figure, which indicates the kind of oil or grease best suited to the lubricating needs of each part. The meaning of the various letters is as follows:

2—Gasoline engine oil, Specification 3502.
5—Non-fluid transmission lubricant, Specification 3505.
4—Transmission lubricant, Specification 3504
6—Medium cup grease, Specification 3506.

ENGINE

CAPACITY FOUR GALLONS—NO. 2, DAILY ATTENTION

The oil supply is carried in the crankcase which has a capacity of 4 gallons. The oil is poured in the combination breather and filler opening. There is a rod gauge on the right side of the engine which is pulled out by the handle, wiped off and re-inserted after which it is again pulled out to determine the oil level. There is an indicating mark for full, and another for empty. When full the crankcase contains 4 gallons. When the empty mark is indicated there are 1½ gallons in the crankcase.

In filling the crankcase open the upper try cock on the priming sump of the crank case and pour in oil until it starts to flow from this cock. Then shut cock and replace cap on filler opening.

Too much oil should be guarded against as well as too little. Too much will foul the cylinders and dirty the plugs causing misfiring and carbon formation in the combustion chamber.

Once a month the drain plug on the bottom of each of the two crank case sumps should be removed and all the oil allowed to drain out. Before refilling with fresh oil it is desirable that the crank case be flushed with kerosene. To do this, close drain plugs, pour in 3 gallons of kerosene through filler, run engine slowly for 15 seconds, *but not longer*, then drain crank case again and put in 4 gallons fresh oil.

MAIN CLUTCH

CAPACITY FOUR OUNCES—NO. 2 WEEKLY

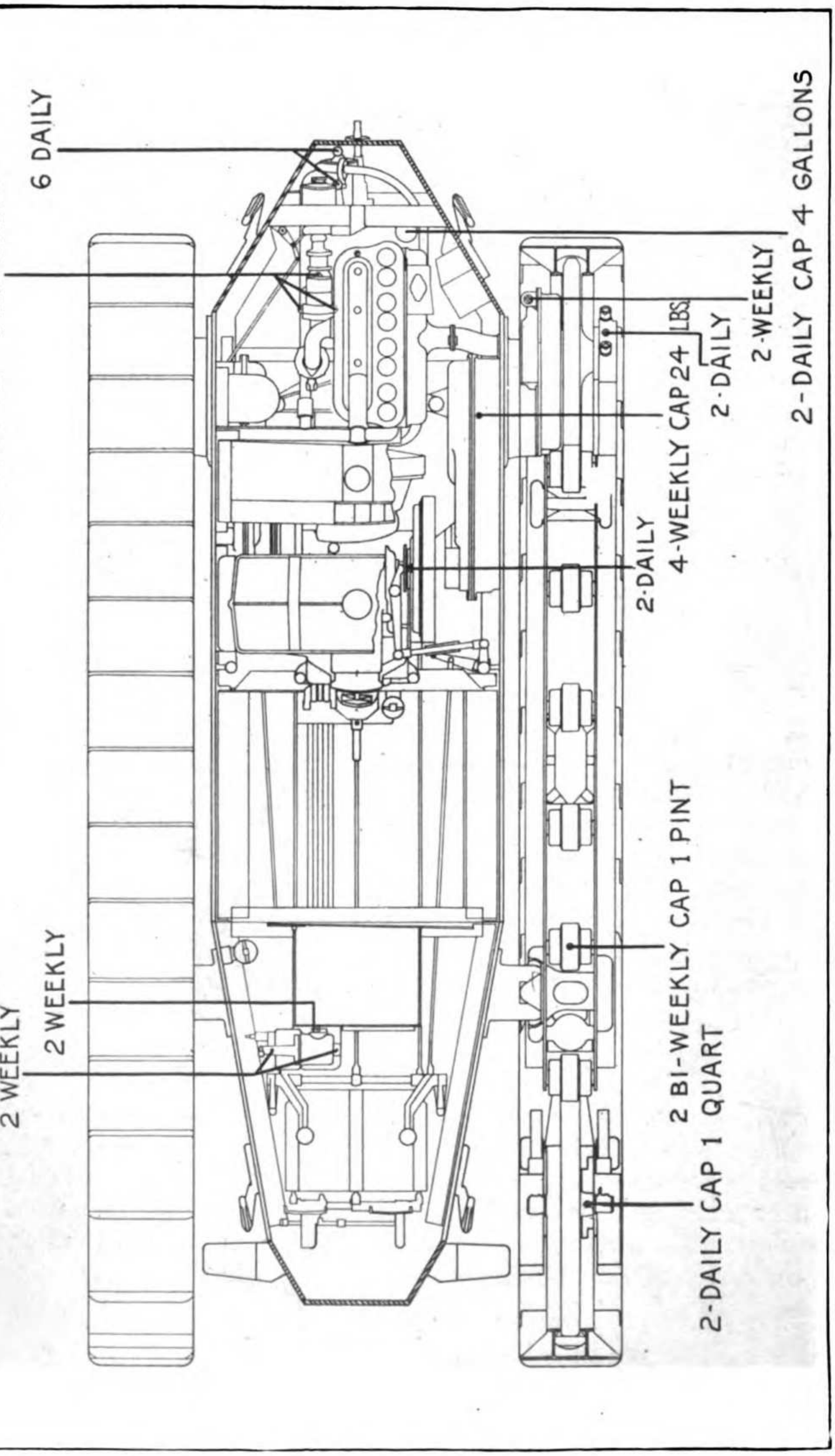
The main clutch has an oil opening in the housing or face which supplies a wick feed to the ball thrust bearing at the forward end. This should be kept supplied as this bearing takes the thrust load of the clutch spring. A thin wire inserted in the hole will aid in the injection of the oil. The driving member also rotates on this bearing in relation to the driven member when the clutch is slipped.

MAIN CLUTCH THROWOUT

PACK WITH NO. 6—MONTHLY

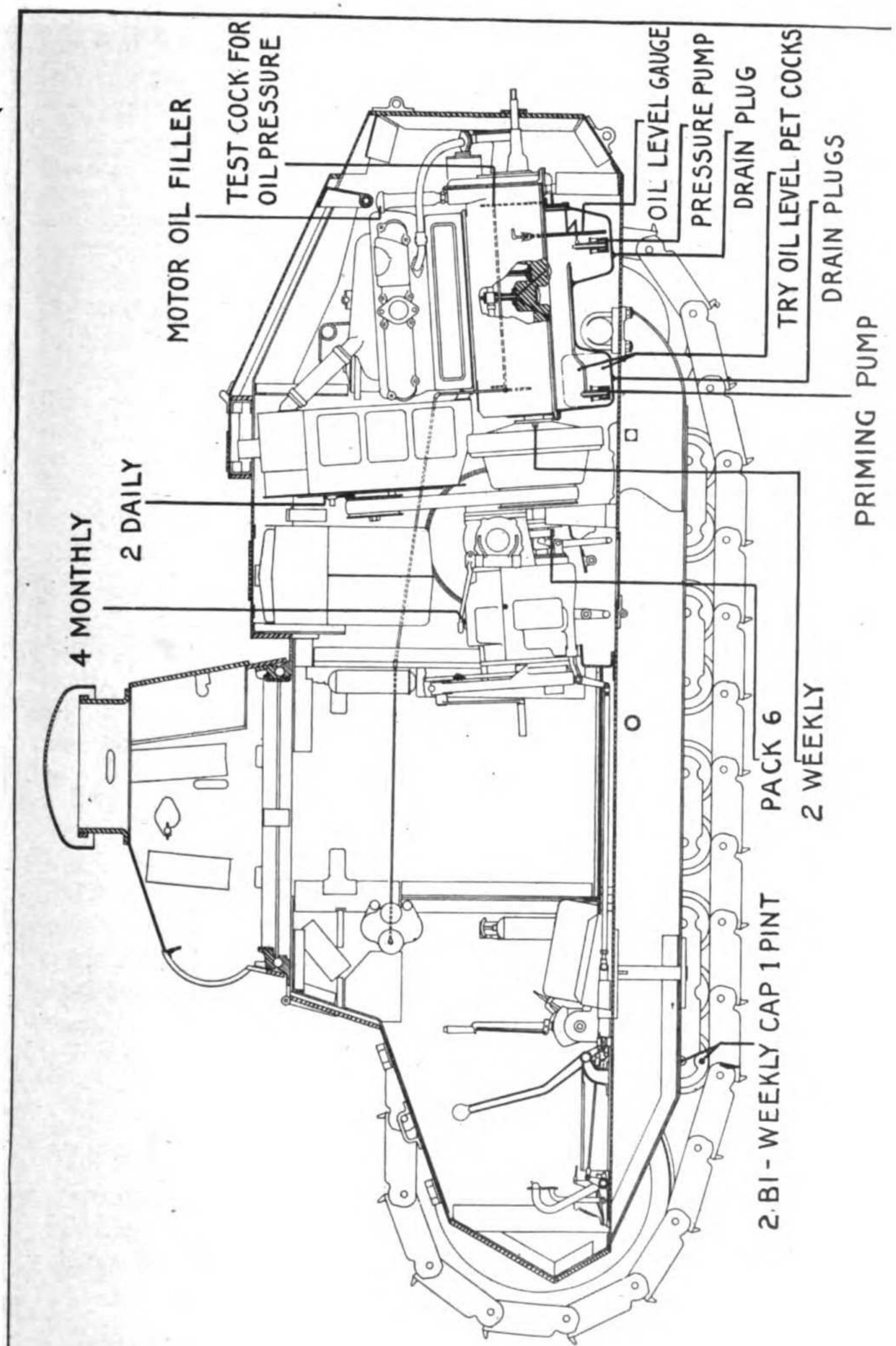
The clutch throwout should be kept packed in grease. It is located just behind the main clutch assembly and must take the load when the

Plate No. 3



OILING DIAGRAM, PLAN VIEW, SHOWING SPECIFICATION OF LUBRICANT TO BE USED AND FREQUENCY
FOR ADDITIONAL POINTS SEE ELEVATION

Plate No. 4



clutch is slipped. There is a ball thrust against which the throwout bears. To repack remove bolts holding universal in place and separate parts far enough to introduce grease with gun.

MAIN CLUTCH ALIGNMENT JOINT

This joint is located between the clutch and transmission. Its forward end is lubricated by the oil placed in the clutch lubricator which flows through the hollow shaft of the clutch and thence to the joint. The rear end is oiled by the lubricant which works its way from the forward end; hence a plentiful supply of oil applied in the clutch oilers will take care of these parts.

TRANSMISSION

NO. 4 MONTHLY

The gearset runs on ball bearings throughout which are lubricated along with the gears themselves by the distributing action of the rotating gears in the lubricant. The case is supplied by removing the plug in the cover plate. Fill to level of lower or main shaft.

If too much lubricant is used it will heat from the friction of churning and the oil will become thin and work out the ends of the bearings. Every month the lubricant should be drained out, the drain plug replaced, kerosene put in and the transmission run for five minutes in neutral to thoroughly wash it out, then drain and refill with fresh lubricant.

STEERING CLUTCHES

NO. 2 DAILY

The steering clutches are similar to the main clutch, being inverted cones and are lubricated in the same manner by means of oilers placed in the housing. The transverse shaft carrying the driving member of the clutch runs on ball bearings. The connection to the driving member is through a splined shaft. The oiler takes care of the entire unit.

SPUR GEAR REDUCTION

NO. 2 WEEKLY

Two oil holes are provided on the spur gear reduction which carries the drive from the steering clutches outboard to the track. The reduction gears operate in a case inside the armor plate and another outside and the oil holes take care of each of these cases.

TRACK SPROCKET

NO. 2 DAILY

An oil hole closed by a plug is provided on each track drive sprocket. The oil level should be kept just below the shaft which drives the track

and which carries the sprocket. The oil takes care of the plain bearing upon which the sprocket is mounted and also the engaging faces of the sprocket wheel.

TRACK ROLLERS

NO. 2 BI-WEEKLY ATTENTION

A point for lubrication is provided on each track roller, at the center axis of the roller. These oil holes take care of the bearing about which the roller revolves.

Distribution on the roller is secured by a hole drilled to the center through the middle of the track gudgeon. A hole is then bored diametrically in the middle of the roller to meet the other hole. This provides ample lubrication and must be taken care of regularly because the entire weight of the tractor is distributed over these bearings.

TRACK RAIL

OIL BATH DAILY

No provision is made on the track itself for lubrication between the roller and the rail. At a base where a number of the tractors are permanently stationed or at an assembly base an oil pond makes a quick and advantageous method of handling the work efficiently.

TRACK OIL POND

The pond should be thirty feet in length and at least 7 feet wide and 8 inches deep. The tractors can be run through this in succession, thus cleansing and oiling in one operation. Where the pond plan is not possible swabbing will have to be relied upon. The specifications for track lubrication have been outlined on page 18.

TRACK IDLER

NO. 2 DAILY

Oil plugs are provided on the hubs of the front idler or blank sprocket. These are on the outside of the idler hubs and supply a reservoir surrounding the axle, providing a lubrication for the bearing which carries the wheel.

CONTROL UNITS

NO. 2 WEEKLY

Three oil holes are provided in the control set to the right of the driver's seat. These lubricate the shifter mechanism.

ENGINE ACCESSORIES

FAN

NO. 2 DAILY

The fan is oiled through a tube just above the upper fan pulley.

MAGNETO

2 DROPS, NO. 2 MONTHLY

Two drops only of a light, clean oil, injected into the oil wells every month or so will be sufficient. One of these oil wells is located on the distributor housing, oiling the armatus ball bearing, the distributor plain bearing and oil well in the timing lever body. The other oil well is located on the extension of the end plate near the driving shaft and lubricates the ball bearing on the end of the magneto.

WATER PUMP

NO. 6 DAILY

There is a grease cup located on each side of the water pump. These should be given two turns daily and refilled when necessary.

MAINTENANCE ROUTINE

It is essential for the proper care and maintenance of the 6-ton tractor that the following maintenance routine schedule be rigidly adhered to. Preparedness for emergencies can only be obtained by keeping these tractors in excellent condition and this necessitates a regular maintenance routine.

The following items refer only to inspection and adjustments. Repairs or replacements detected as necessary should be made at the earliest opportunity.

DAILY MAINTENANCE ROUTINE

ENGINE

Examine all wiring terminals for tightness.

Clean magneto externally.

Note tension of fan belt.

Inspect oil pump for performing its function, by means of pump pressure cock.

Inspect radiator water supply.

Inspect gasoline tank for proper fuel supply.

Inspect pipe line and all connections for leaks.

GENERAL

Inspect and thoroughly clean all track parts and exterior. See that tools are in place.

CONTROLS

Inspect controls for proper functioning.

WEEKLY MAINTENANCE ROUTINE

ENGINE

Inspect all wires for proper support and freedom from damage.

Thoroughly clean engine externally.

Inspect for oil leaks.

Try oil pressure cock for pump action.

Inspect control connections.

Try goverr.or for accurate functioning.

Inspect all water connections for leaks.

Keep engine free from carbon, inject a tablespoonful of kerosene into each cylinder through the spark plug holes. This should be inserted when the motor is hot and left standing over night.

Remove, clean and adjust all spark plugs.

Remove magneto distributor cover and clean with gasoline.

Operate engine at low speed and with one wire at a time separate it from spark plug, inspect the spark given for length and apparent hotness.

Drain water and dirt from water trap in gasoline line.

Inspect carbureter control connections and connections with governor.

Do not attempt to alter adjustment of carbureter or governor unless this is shown to be necessary when tractor is in service.

Inspect motor oil drain cocks and drain plugs for loss of oil.

BRAKES

Inspect and thoroughly clean all brake connections.

CLUTCH

Inspect main and steering clutches for wear and proper operation and adjustment.

MONTHLY MAINTENANCE ROUTINE

MAIN CLUTCH

Thoroughly clean and inspect all pedal connections.

TRANSMISSION

Clean externally and inspect for leaks, particularly in bearing covers at the front and rear ends in order to ascertain if undue leakage is occurring around shafts.

STEERING

Thoroughly clean and inspect all steering clutch linkage.
Try action to ascertain damage if any.

TRACK

Check over all track parts for tightness. See that rollers revolve freely and that the dirt is removed from shoes. Examine for pin wear.

GENERAL

Inspect speedometer drive for reliability, also gauges.

IGNITION

Clean magneto collector ring, drain and adjust breaker points.
Inspect cam spark lever for correct advance.

ENGINE

Inspect cylinders for carbon.
Inspect valves and grind if necessary.
If engine has had unusual amount of use, remove and inspect engine bearing.
Clean oil pump screens.
Drain carbureter and clean screen.

TURRET

See that turret rotates freely.
Inspect turret brake for wear.

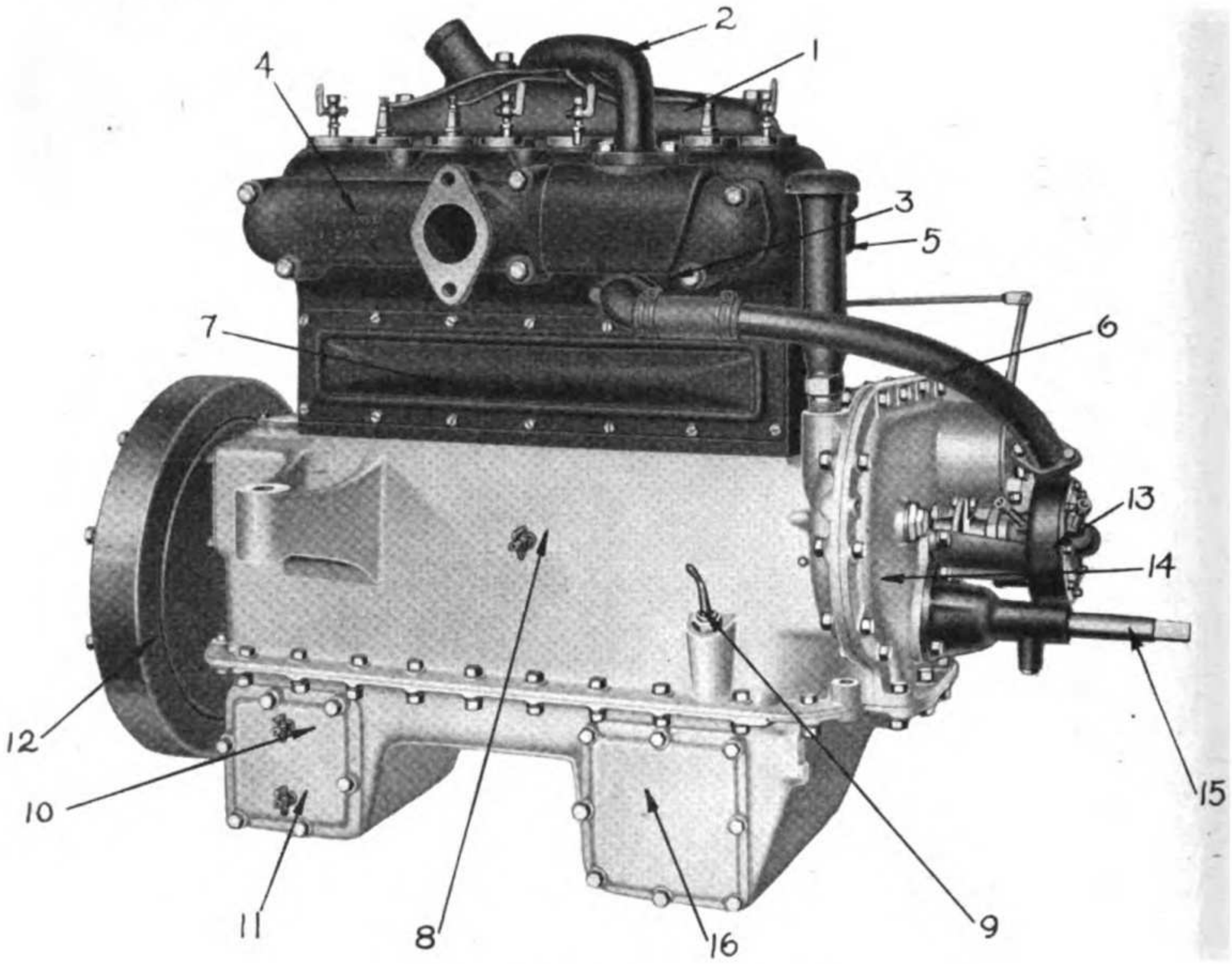
CHAPTER II

ENGINE GROUP

GENERAL SPECIFICATIONS

Engine type	Four cycle
Number of cylinders	Four
Cylinder shape	L-head
Bore	4¼ inches
Stroke	5½ inches
Piston displacement	312 cubic inches
Brake horsepower	40 at 1300 r. p. m.
Cylinders cast	In block
Cylinder material	Grey iron
Piston material	Grey iron
Piston length	5⅜ inches
Piston clearance at top land	.02 inch
Piston clearance second land	.012 inch
Piston clearance at skirt	.004 inch
Spare pistons	.04 inch over size
Number of piston rings	Three per piston
Type of ring	Eccentric
Piston pin	Steel tube
Piston pin diameter	1⅛ inch
Piston pin length	4.3 inch
Connecting rod	I-beam forging
Connecting rod length	12¼ inch
Upper rod bearing	1⅛ inch diameter x 2⅛ inch length
Lower rod bearing	2⅛ inch diameter x 2½ inch length
Camshaft	Drop forging
Number of camshaft bearings	Three
Front camshaft bearing	2½ inch diameter x 2 1/16 inch long
Center camshaft bearing	2.379 inch diameter x 1.5 inch long
Rear camshaft bearing	1.878 inch diameter x 1.5 inch long
Crankshaft bearings	Three
Front crankshaft bearing	2⅛ inch diameter x 3⅛ inch long
Center crankshaft bearing	2¼ inch diameter x 2¾ inch long
Rear crankshaft bearing	2⅜ inch diameter x 4 inch long
Valve material	Tungsten steel
Valve type	Poppet

Plate No. 5



EXHAUST SIDE OF ENGINE

1. Water outlet.
2. Hot air pipe.
3. Water inlet from pump.
4. Exhaust manifold.
5. Oil filler and breather.
6. Water inlet pipe.
7. Valve action cover plate.
8. Oil pressure cock.
9. Oil level gauge.
10. Oil level test cock, high.
11. Oil level test cock, low.
12. Flywheel.
13. Water pump.
14. Timing gear case.
15. Starting crankshaft.
16. Oil sump cover plate.

ENGINE GROUP

GENERAL SPECIFICATIONS—Continued

Valve diameter	1 27/32 inch
Valve stems	7/16 inch diameter x 7 27/32 inch length
Oiling system	Pressure feed
Water circulation	Centrifugal pump
Gasoline feed	Vacuum
Radiator	Tubular type
Ignition	High tension magneto
Magneto type	Eiseman G4-2

ENGINE GROUP—GENERAL DESCRIPTION

ENGINE.

The engine is mounted longitudinally within the tractor body at the rear end. It is a specially designed four-cycle, four-cylinder type with block cast L-head cylinders having a bore of 4¼ and a stroke of 5½ inches. The brake horsepower is approximately 52 at 1900 r. p. m. The piston displacement is 312 cubic inches.

The cylinder block, water header, crankcase and oil pan are all separate, the latter two being aluminum. The cylinders and water header are cast from grey iron. The engine assembly includes a governor, water pump and Eisemann Magneto, all driven from the timing gears, and a Wheeler-Schebler Carbureter.

PRINCIPLE OF FOUR-STROKE CYCLE.

The engine is of the four-cycle type. The four strokes of the cycle are popularly termed as follows: suction stroke, compression stroke, expansion or working stroke, and scavenging stroke.

1. The intake stroke is the downward motion of the piston which sucks the explosive charge into the cylinder through the intake valve.
2. The compression stroke is the upward stroke of the piston which compresses the charge in the upper part of the cylinder.
3. Ignition is caused by the spark at the spark plug igniting, the compressed charge in the upper part of the cylinder known as the combustion chamber. The expansion of the exploded gases forces the piston down to the bottom center, this being the power stroke.
4. Near the bottom center on the exhaust stroke, the exhaust valve opens, and as the piston moves upward it forces out the burned gases, clearing the cylinder in preparation for a repetition of the cycle.

CYLINDERS.

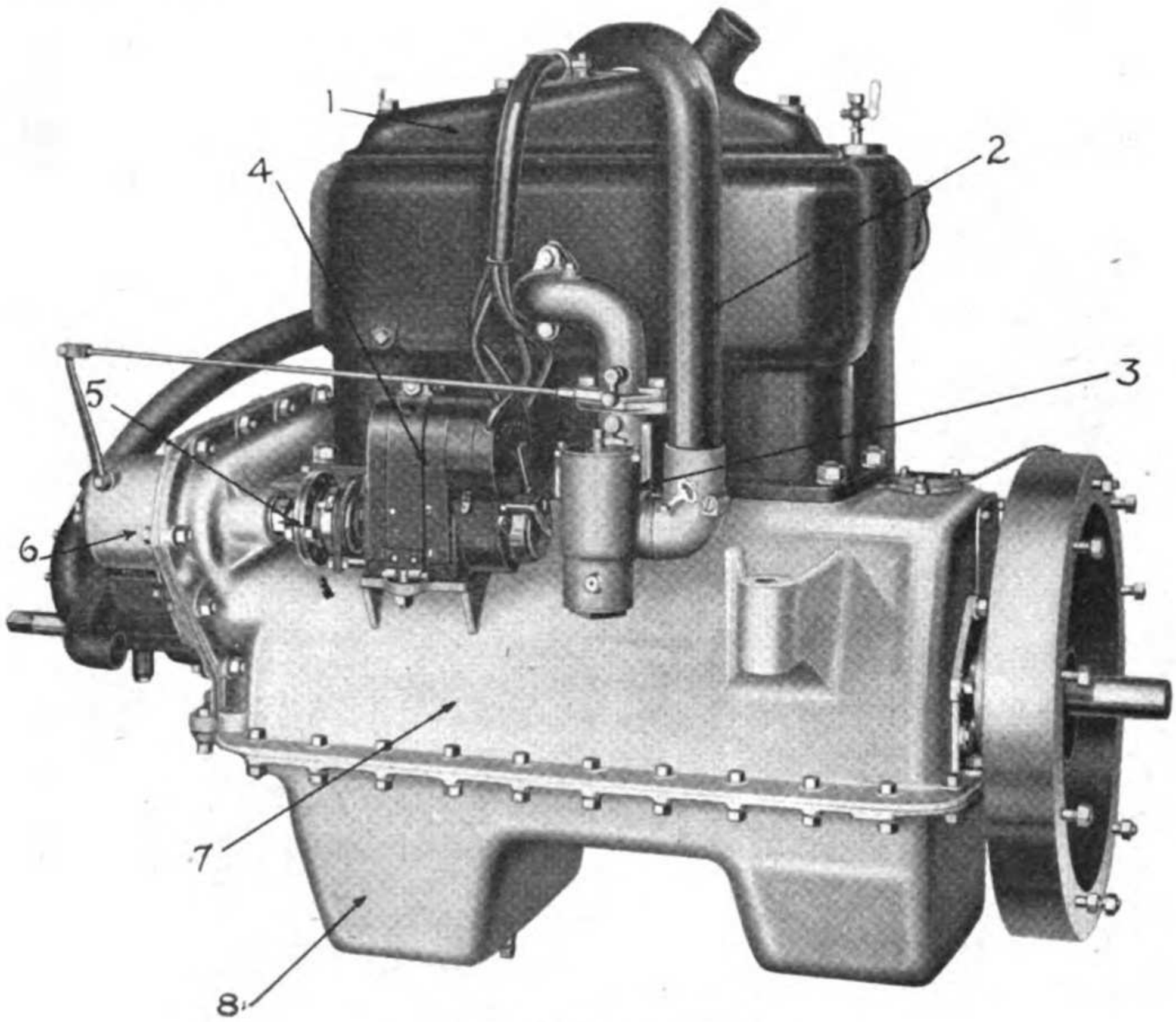
The cylinders are cast in block, and are of grey iron. They are provided with water jackets cast integral with them.

PISTONS.

The pistons, of which there are four, are of cast iron, and are each 4¼ inches in diameter at the bottom and 5⅜ inches long. The piston head is smaller in diameter than the piston skirt, because all the heat to which the piston is subjected is applied to the piston head, thus causing it to expand to a greater degree than the skirt.

The proper clearance between cylinder and piston at the top land is .02 inch at the second land .012 and at the skirt .004. The spare part pistons are .04 inch oversize.

Plate No. 6



ENGINE INTAKE SIDE

1. Water header.
2. Hot air pipe.
3. Carbureter.
4. Magneto.
5. Magneto drive coupling.
6. Governor case.
7. Crankcase.
8. Oil pan.

TO REMOVE PISTON

The pistons at the rear can be removed from the bottom through the engine crank case after taking off the oil pan by removing the flange bolts at the flywheel end; the front pistons can not be removed without first taking out the crankshaft. See page 46.

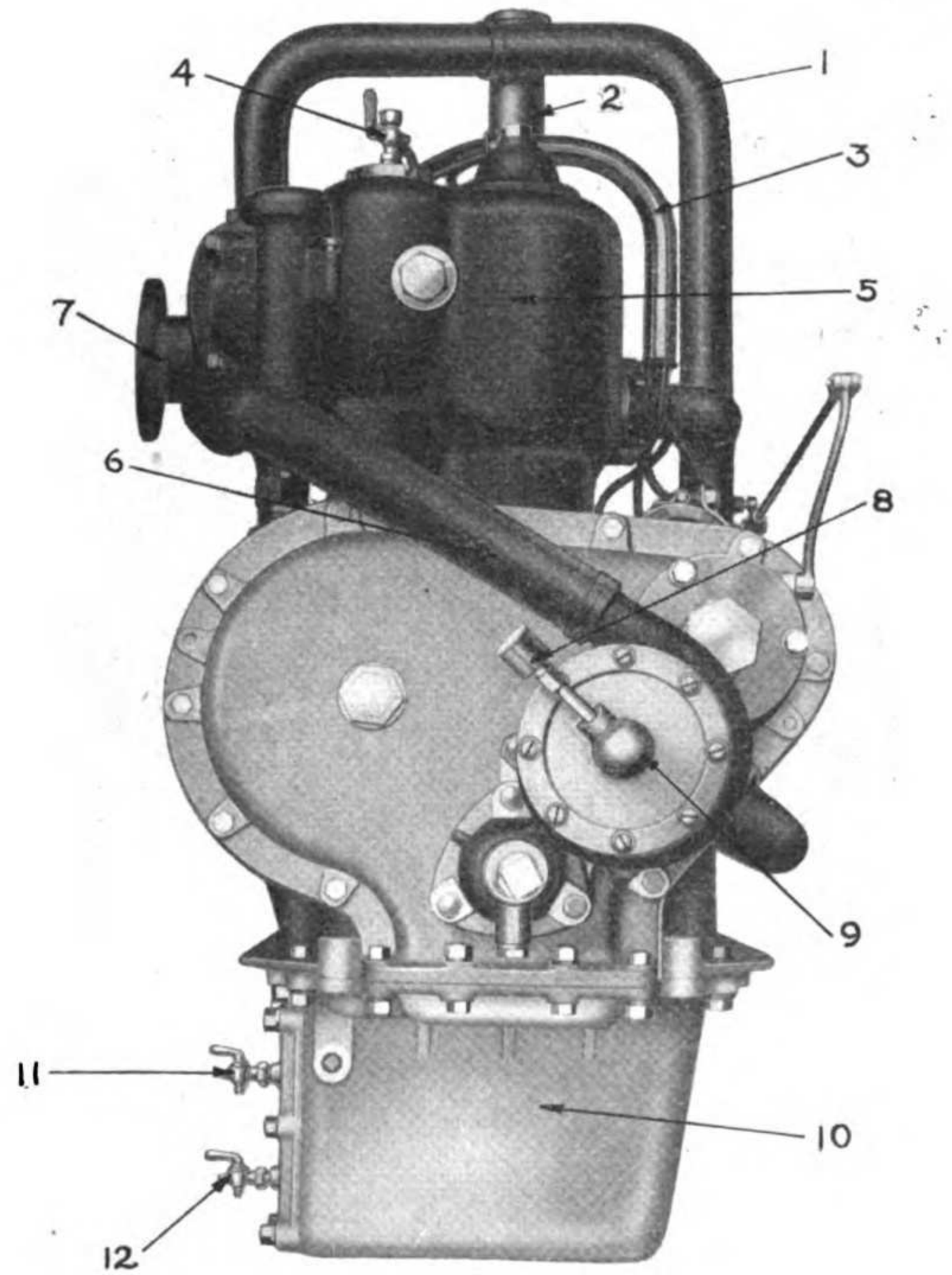
PISTON RINGS

To each piston there are three piston rings. These are of cast iron .249 inches wide, and are eccentrically machined. They are .1875 inches and .125 inches thick. They are split at an angle of 45 degrees.

The piston rings pack the piston, preventing the gases under pressure from leaking down into the crank case, between the cylinder and piston. They also prevent the lubricating oil from working up into the combustion chamber.

The proper gap between the ends of the top piston ring is .009 inch.

Plate No. 7



TIMING GEAR END OF ENGINE

1. Hot air pipe.
2. Water outlet pipe.
3. Wire conduit.
4. Petcock and priming cup.
5. Cylinder casting.
6. Water inlet pipe.
7. Exhaust pipe.
8. Water pump grease cup.
9. Water pump.
10. Oil pan.
11. Oil level cock, high.
12. Oil level cock, low.

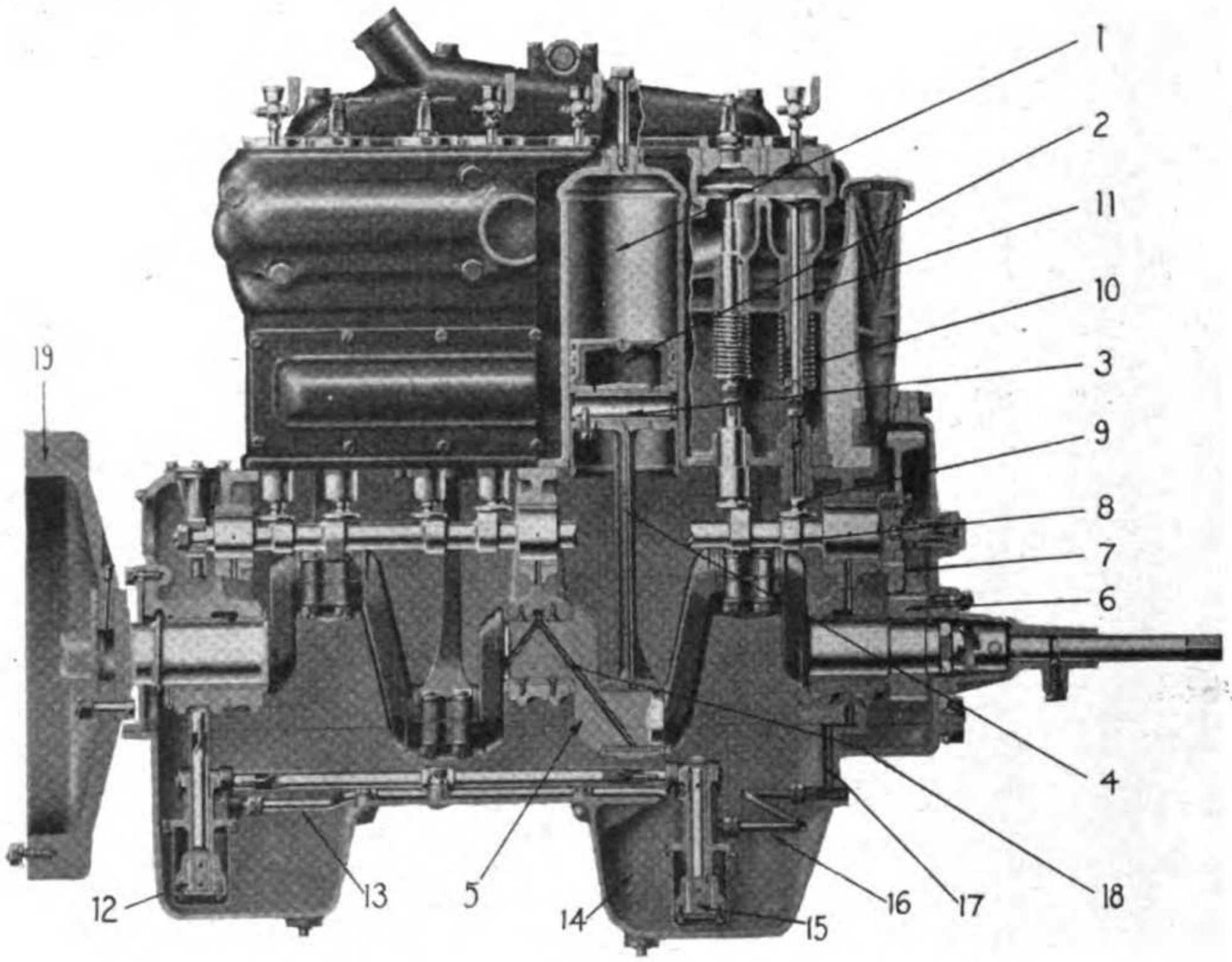
INSTALLATION OF PISTON RINGS

The piston rings should be placed up into the cylinder before they are applied to the piston, and fitted (filed) if necessary, to secure the proper gap between the ends of the ring.

Before the rings are installed on the piston they should be rotated around the piston in the piston ring groove to insure a proper clearance up and down which is about .001 of an inch.

The rings should be placed in grooves over skids made of three or four pieces of tin or very thin light gauge sheet iron about 2 inches long

Plate No. 8



PARTIAL LONGITUDINAL SECTION THROUGH ENGINE

1. Cylinder.
2. Piston.
3. Piston pin.
4. Connecting rod.
5. Crankshaft.
6. Timing gear (crankshaft).
7. Timing gear (camshaft).
8. Camshaft with cams integral.
9. Valve push rod.
10. Valve spring.
11. Valve stem.
12. Oil priming pump.
13. Oil priming lead.
14. Oil delivery sump.
15. Oil delivery pump.
16. Oil delivery pipe.
17. Oil delivery lead.
18. Oil lead through crankshaft.
19. Flywheel.

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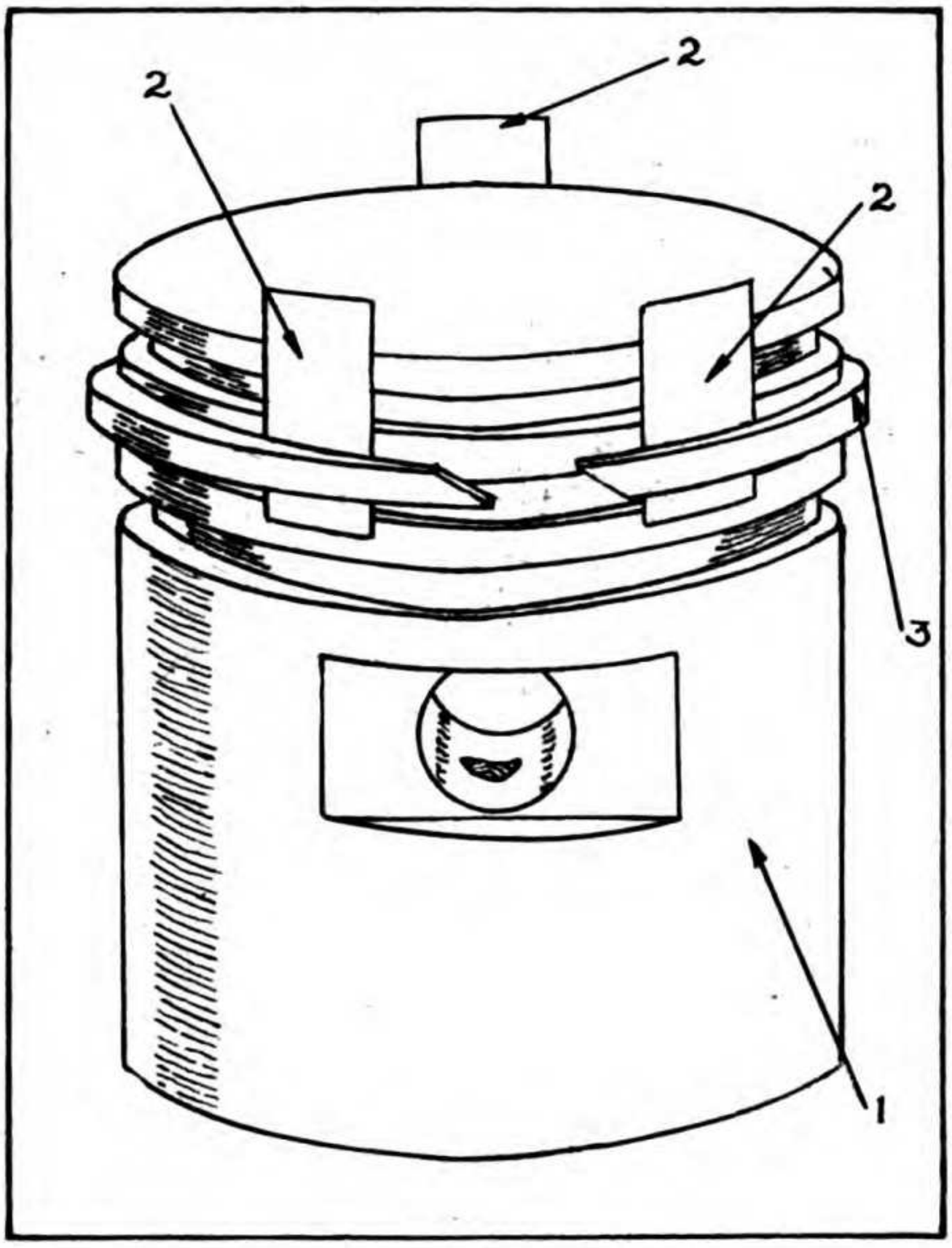
by 3/8 inches wide, the rings being pushed down evenly all around to prevent any twisting of the rings which might result in distortion and uneven bearing on the cylinder wall.

PISTON RING TROUBLES

In fitting the piston into the cylinder, caution should be exercised not to push up the piston too high into the cylinder, for if this is done, the top ring will expand out into the combustion chamber, and the piston cannot be pulled down again.

If this happens, both valve caps should be removed and the piston ring compressed as much as possible with the aid of screw drivers or similar tools until the piston can be pulled down. In case it is

Plate No. 9



METHOD OF REMOVING AND REPLACING PISTON RINGS

1. Piston. 2. Metal Strips. 3. Piston ring.
Strips are inserted beneath ring to enable ring to be slipped off readily.

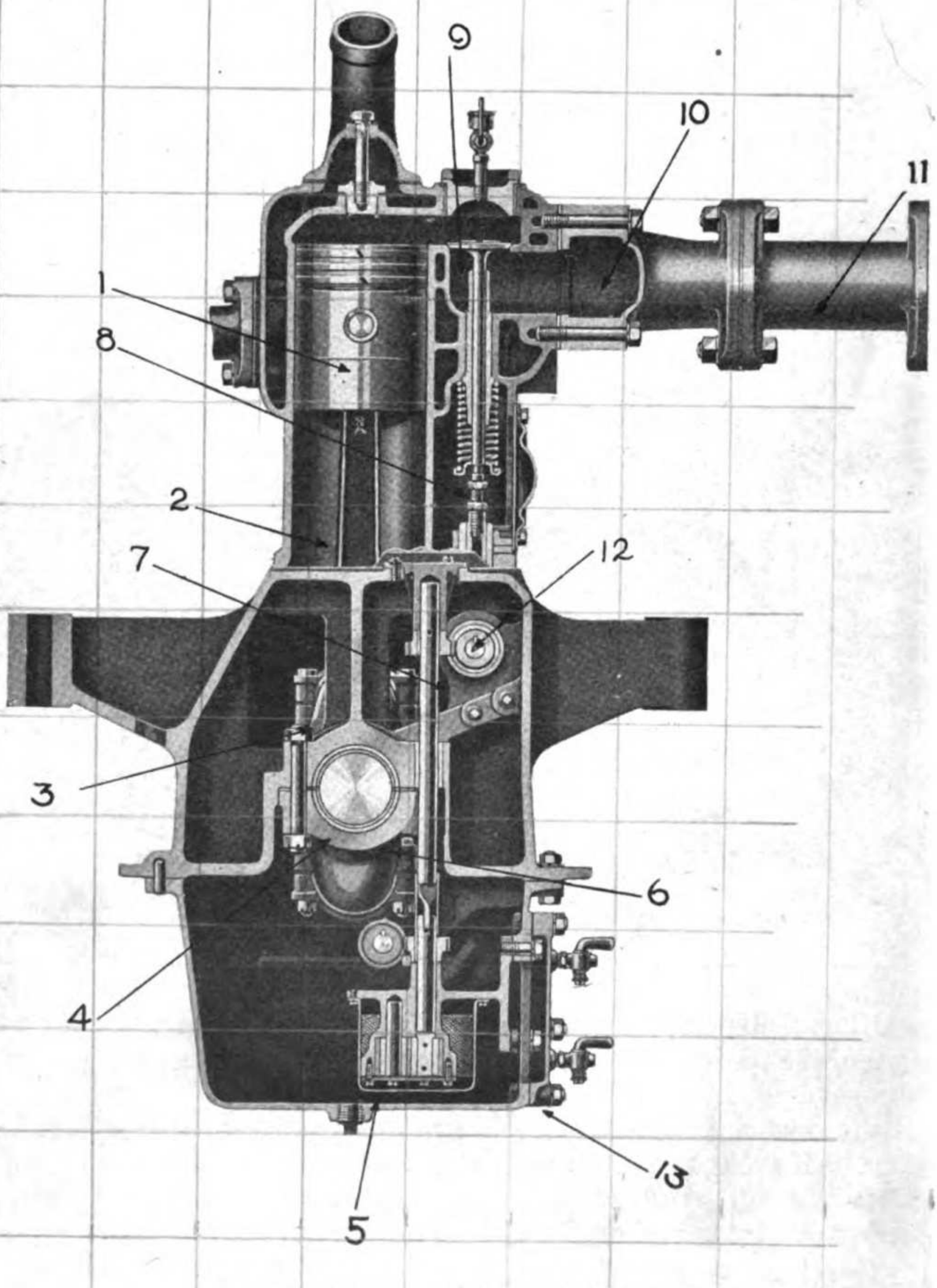
found impossible to compress the ring sufficiently to permit the removal of the piston down to its proper place again, the piston ring may be broken and the pieces removed.

If the rings are not stiff enough, or have insufficient wall pressure, the oil will work up past them into the combustion chamber. The bottom edge of the piston ring must in all cases be very sharp and square to scrape the oil off the cylinder wall as the piston comes down.

PISTON PIN

The piston pins are of steel tubing 1.125 inches in diameter and 4.3 inches long. In each piston boss there is 5/16 inch set screw which holds the piston pin about which oscillates the upper connecting rod bearing.

Plate No. 10



TRANSVERSE SECTION THROUGH ENGINE

1. Piston.
2. Connecting rod.
3. Connecting rod cap bolt.
4. Connecting rod cap.
5. Oil pan.
6. Crankshaft.
7. Oil pump driveshaft.
8. Valve adjustment point.
9. Exhaust valve and port.
10. Exhaust header.
11. Exhaust extension.
12. Camshaft.
13. Oil pump cover plate.

TO LOCATE WEAR IN THE PISTON PIN BEARING

If the piston is in place in the engine and the lower crank case is down, remove a valve cap, turn engine over so that piston is on top dead center in such a position that a screw driver may be inserted in the valve cap pocket, then pry down on top of the piston, while with a bar the piston may be pushed upward from under the side of case, then by alternately moving piston up and down, any play may be detected.

In case the piston and rod have been removed from the engine, place the connecting rod in a vise and hold the piston in the same position in which it has always worked on the pin, then by trying to rock the piston in the direction of the length of the pin, wear may be detected.

PISTON PIN BEARING

The upper end of the connecting rod contains a bronze bushing in which the piston pin fits. This acts as the bearing surface. The bushing is driven in the upper end of the rod.

TO ALIGN PISTON AT RIGHT ANGLES TO CRANKSHAFT

With the cylinder removed and the connecting rod and piston in position a level may be used to ascertain parallelism between the top of the piston and the top of the crankcase, which is parallel to the center lines of the crankshaft. Or a pair of calipers may be used to determine uniformity of distance between the top of the crankcase and the under side of a piston ring on all sides of the piston. Or with a straight edge laid across the top of the piston lengthwise of the engine, the distance to the crankcase may be measured at its ends.

CONNECTING ROD

The connecting rod through which the force of the explosion is transmitted to the crankshaft is an I-shaped steel forging, 12¼ inches long from center to center of the bearings. The upper bearing contains the piston pin as described. It has a diameter of 1⅛ inches and length of 2⅛ inches.

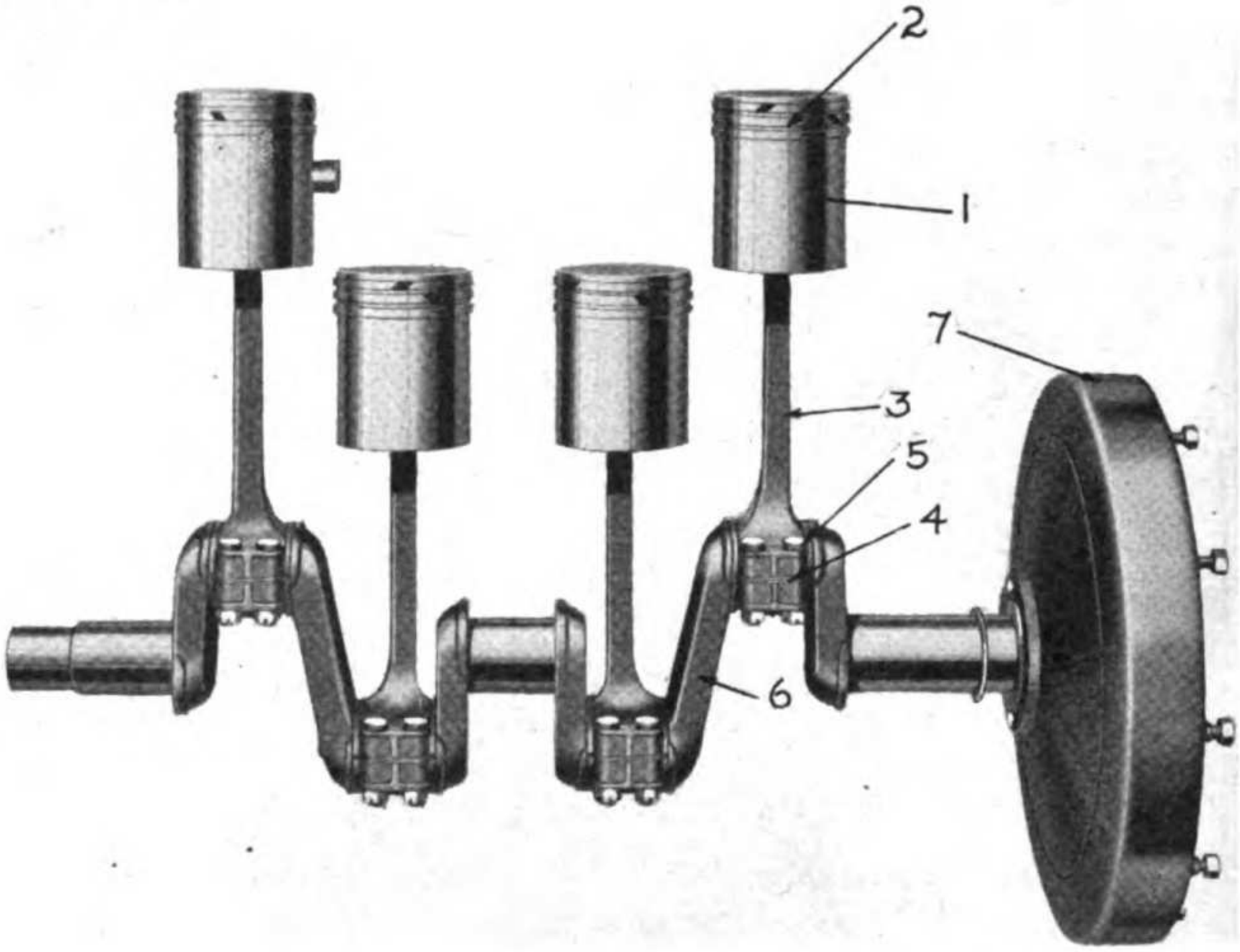
The lower bearing is 2⅛ inches in diameter and 2½ inches long, and is lined with a babbitt metal bushing. The cap of the bearing is held in place by four bolts each 7/16 inches in diameter.

TO ADJUST CONNECTING ROD BEARINGS

In replacing connecting rod bearings (if the crankshaft is out of the crankcase) it is best to place the crankshaft in a vise and adjust the bearings to the shaft while in this position, as the work can be done more readily.

The ends and round corners of the connecting rod bearings may be sized before they are placed in the rod or cap. In case an end flange

Plate No. 11



PISTON CONNECTING-ROD AND CRANKSHAFT ASSEMBLY

1. Piston.
2. Piston rings.
3. Connecting rod.
4. Connecting rod bearing shim.
5. Connecting rod cap bolts.
6. Crankshaft.

---

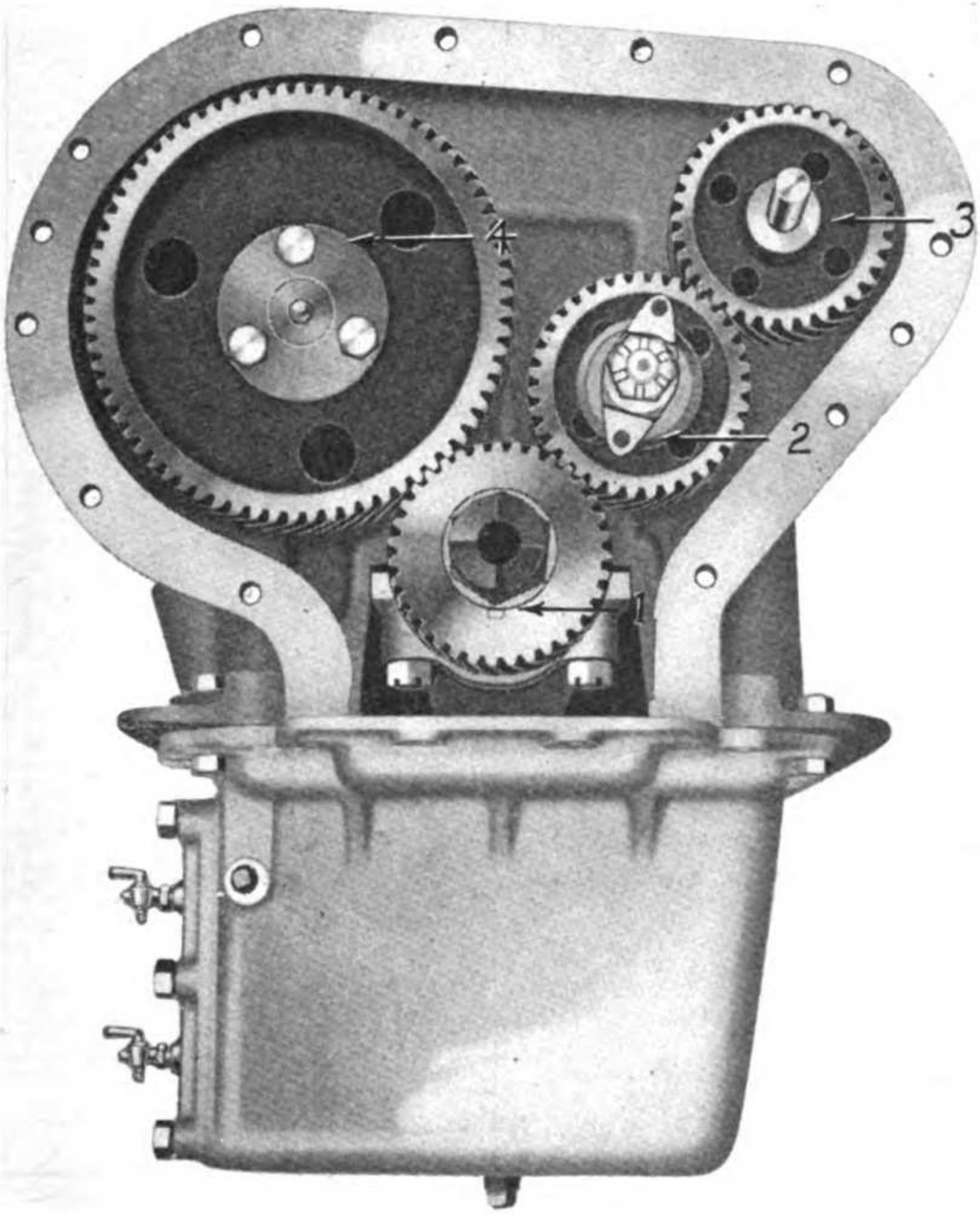
should be broken off the bearing liner, it may be soldered on with half and half solder, care being taken to prevent melting the bearing with the soldering iron.

The sides of the bearing liner next to the shaft should be filed or scraped down for a distance of about ¼ inch to ⅜ inch to prevent contact with crankshaft and prevent side pressure also to aid lubrication.

After the connecting rod has been fitted, the piston should be lined up with the top of crankcase. When the bearing has been scraped in and bears well all over, it should be adjusted just so tight that the piston and rod, when same are at an angle of 45 degrees to the vertical, will just maintain their position and slight pressure down will cause them to fall.

The tightness of the bearings is controlled by the thickness of the shims against which the caps are drawn up snug after a bearing has been properly scraped in and every nut must be tightened by drawing the caps against the shims solidly, but never strained. The shims are illustrated on page 41. If a castellated nut is tight when in such a position that cotter pin hole does not line up, the nut should be re-

Plate No. 12



TIMING GEAR SET

1. Crankshaft gear.
2. Water pump gear.
3. Magneto and governor drive gear.
4. Camshaft or half time gear.

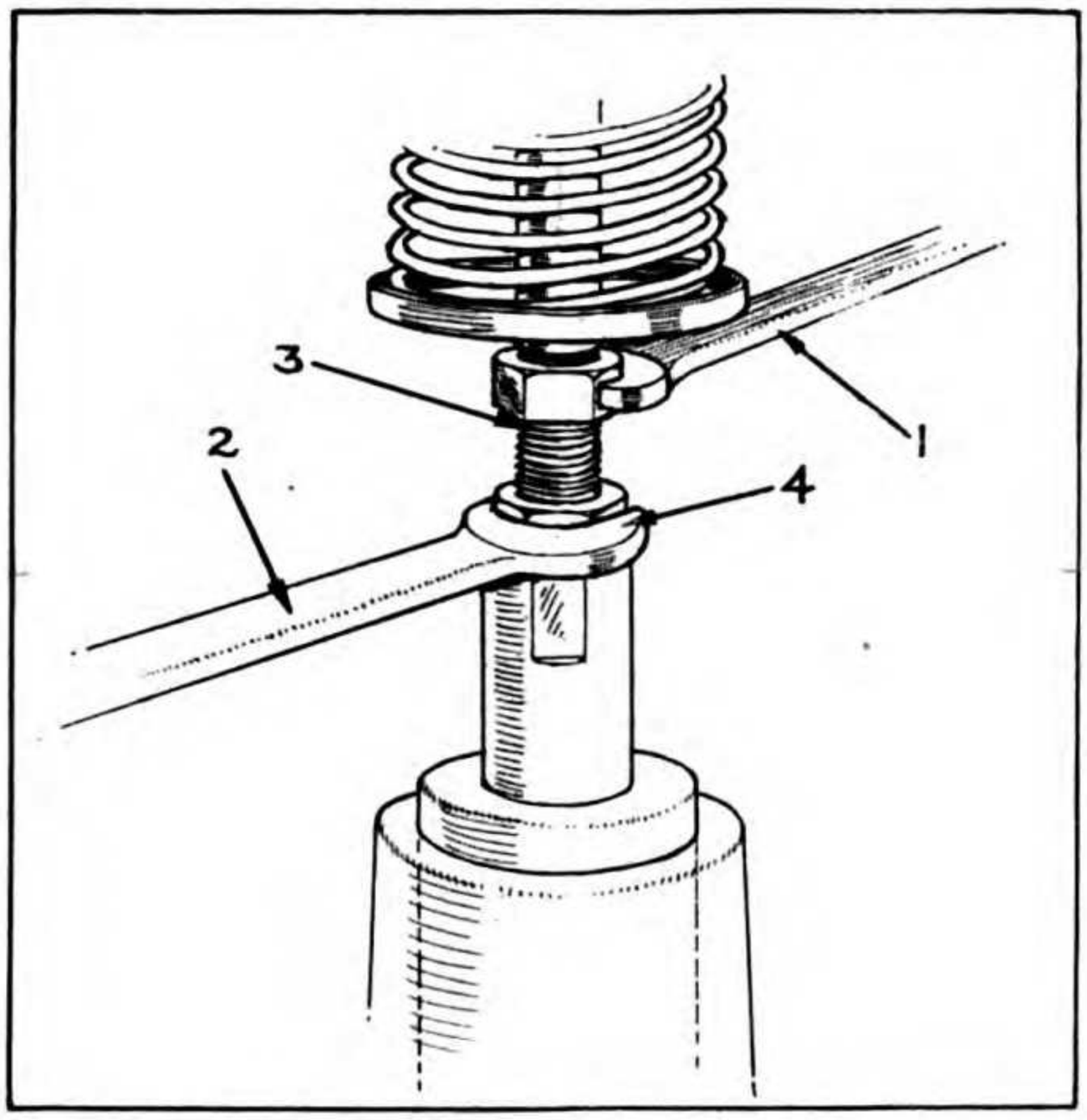
moved and light cut taken off face of nut with a file permitting its being turned to a proper position so that the cotter pin can be inserted when tight.

CAMSHAFT

There is one camshaft actuating all intake and exhaust valves. The camshaft is driven by means of helical gears from the crankshaft, and is of forged steel, heat treated, hardened and ground, with the cams made integral with the shafts.

The front bearing is 2½ inches in diameter by 2 1/16 inches long. The center bearing is 2.0312 inches in diameter and 1.5 inches long, while the rear bearing is 1.878 inches in diameter and 1.5 inches long.

Plate No. 13



METHOD OF VALVE ADJUSTMENT

1. Adjusting nut wrench.
2. Lock nut wrench.
3. Threaded adjustment.
4. Lock nut to hold adjustment.

CAMSHAFT BEARING WEAR

As a result of lack of support of the camshafts by center bearing, due to wear, there would be a tendency for the camshafts to spring down, as the high part of the cams passed under the tappet rollers because of the valve spring pressure. The valves would open a sufficient distance to permit of proper intake and exhaust. The bending of the shaft would cramp them at the end bearings, also wear and possibly cramp the teeth of the timing gears, on account of the misalignment.

TO REMOVE CAMSHAFT

It is first necessary to remove engine from the tractor, then remove the crankcase front cover, remove valve spring assemblies which relieves spring pressure on cams, then remove camshaft which is designed to come out of front end of engine as each bearing is smaller than the next allowing the shaft to come through.

VALVES

There are two valves of the poppet type in each cylinder, an intake valve and an exhaust valve, with functions as indicated by their names.

The valves are of tungsten steel, 1 27/32 inches in diameter.

The valve stems are of machine steel electrically welded on to the heads. They are 7/16 inches in diameter, and 7 27/32 inches long overall. The stems move in cast iron guides. The guides are forced into place in the cylinder block in a manner that permits of their being knocked out when it becomes necessary to renew them.

TO GRIND AND FACE VALVES

In grinding valves, the valve tappet should always be screwed down, insuring sufficient clearance. To prevent the end of valve stem riding on any carbon or dirt on top of valve tappet, and to allow for the amount ground away. The valves should never be rotated around a complete revolution, being turned back and forth about a quarter turn, occasionally being raised up and dropped down in another position for the purpose of quickening the action.

If no valve grinding compound is at hand, emery or carborundum may be mixed with heavy oil, or very light cup grease, and a thin coat applied, it being better to put three or four coats of valve grinding compound on than to use an excess at the start.

A high spot on the valve seat will permit the valve head being ground bright all around, though the seat may yet be in improper condition, and vice versa. Therefore, both seat and valve must be examined to see that both have been ground bright. After the valves have been ground all grinding compound should be washed away with gasoline.

In case the valves are very badly pitted, and grinding until the pits were removed would grind the valve seats down too deeply, the valves should be faced off. They should also be faced in case a groove has been worn in the valve face by constant operation.

In case the valves are so hard that facing with a tool is impossible, they may be adjusted by use of a fine tooth file wetted with water, or, preferably, with turpentine. They must not be filed down beyond the groove, it serving as a guide.

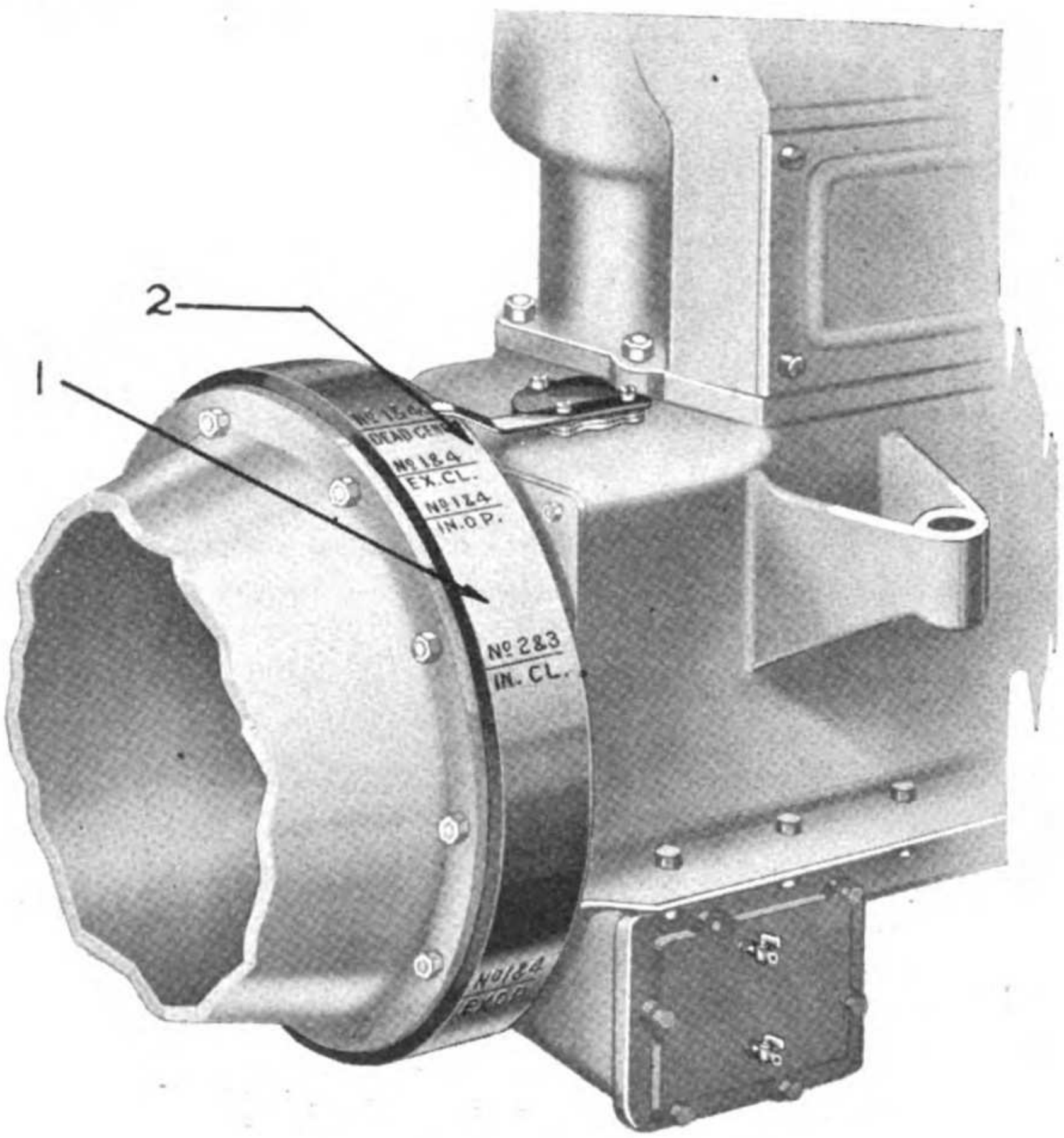
Unscrew the valve cap and with the valve lifted, raise the valve spring without raising the valve by holding the valve down from the top.

The valve spring seat is locked to the valve stem with a key held in place by the cupped spring seat which fits over it. After removing this the valves may be lifted out through the valve cap opening by looping a string under the valve head.

VALVE SPRINGS

On each valve there is a 60 pound coil spring 5 inches long when free and 1⅜ inches outside diameter, made of 12 coils of wire. These springs are slipped over the valve stems, the lower end being held against the valve spring cup, the other end against the cylinder casting.

Plate No. 14



TIMING MARKINGS ON FLYWHEEL

1. Flywheel. 2. Indicator.

VALVE TAPPETS

Each valve is actuated by a tappet. These are adjustable as to length, with a flat circular face under their bottom ends, which rides on the cams. Their outside diameter is $\frac{5}{8}$ inches at the shank and 1 15/32 inches on the circular face. Each valve tappet is supported by a bronze bearing.

VALVE TAPPET CLEARANCE

The proper clearance between valve stems and the tappet is .005 inches, for the intake valve, and .007 inches for the exhaust valve tappet. For practical purposes the clearance should be the thickness of two sheets of paper, the same as that used in this book.

It is important that the valve clearance be ample. An insufficient amount of clearance would prevent them closing freely and cause loss of compression.

VALVE TIMING

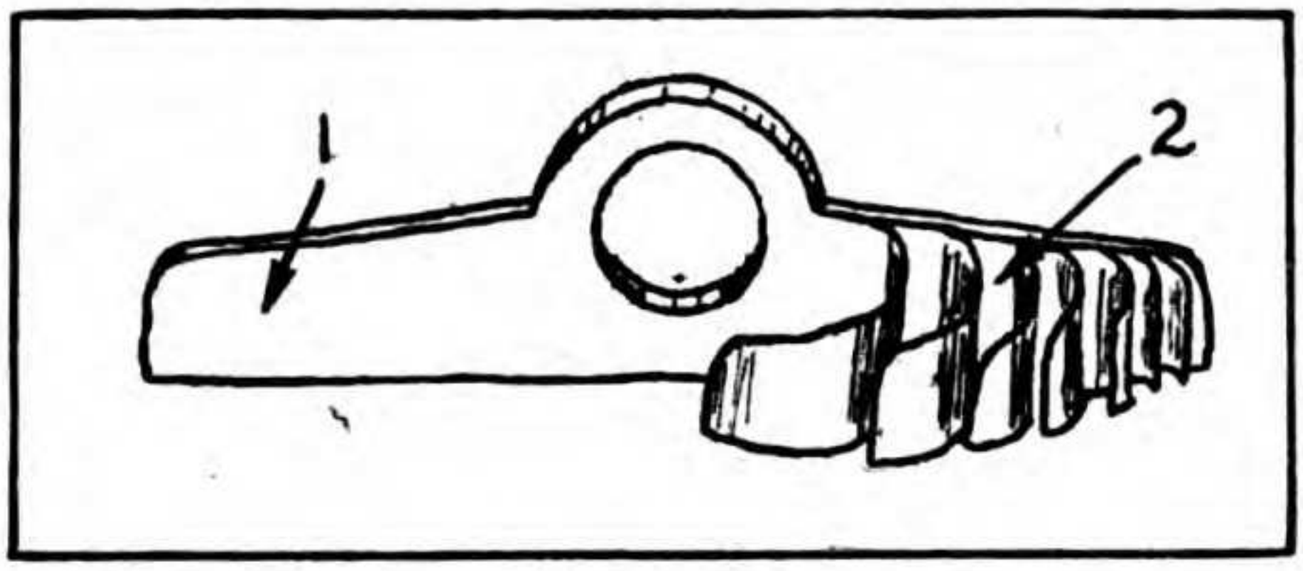
The proper operation of the engine demands that the valves open and close with reference to the location of the piston in its cycle of movement with considerable accuracy.

The rotation of the camshaft is timed with reference to the rotation of the crankshaft by means of a proper meshing of the gears which interconnect between the two. The inlet opens 15 degrees after top center and closes 40 degrees after lower center. Exhaust opens 45 degrees before lower center and closes 10 degrees after top center.

Timing the valves is accomplished, and also checked, by means of markings stamped into the periphery of the flywheel. When any one of these markings is put in alignment with the pointer which overhangs the top of the flywheel, a definite valve position as indicated by the following table should obtain:

"EX. OP 1 and 4" (Exhaust valve of cylinder 1 or 4 begins to open.)
"IN. CL 1 and 4" (Inlet valve of cylinder 1 or 4 finishes closing.)
"EX. CL 1 and 4" (Exhaust valve of cylinder 1 or 4 finishes closing.)
"IN. OP 1 and 4" (Inlet valve of cylinder 1 or 4 begins to open.)

Plate No. 15



ENGINE BEARING SHIM. THIS ILLUSTRATION SHOWS THE LAMINATED SHIM SYSTEM USED FOR ROD BEARINGS

1. Shim when solid. 2. Laminations to be peeled off for required thickness.

In case the camshaft gears are for any reason unmeshed from the idler gear, and crankshaft gear, the procedure of timing the camshafts is as follows:

Turn flywheel so that the marking "IN. OP 1 and 4" is in line with the flywheel pointer; then with the gear case cover of the engine and the idler gear removed, turn the intake camshaft in the direction it operates, until No. 1 intake valve is just beginning to open. This is determined by adjusting No. 1 intake valve tappet to just admit three thicknesses of paper loosely between it and the end of the valve, when the tappet is clear down, and then with but one piece of paper in place, turning camshaft until the paper is slightly gripped by the upward movement of the tappet. Replace idler gear, revolving the camshaft

either to the right or the left (whichever direction will admit of least turning) until it is possible to replace idler gear in mesh with both the camshaft gear and the crankshaft gear.

The proper location on the flywheel of the 1 and 4 "center marking" is indicated by the pointer when 1 and 4 pistons are at the tops of their stroke. The dead center is offset on the flywheel due to the location of the timing marker as shown on page 40. This can be accurately obtained as follows:

With No. 1 intake or exhaust valve cap removed, insert some light tool such as a screw driver until same contacts with the top of the piston, and by oscillating the flywheel slightly to the right or left, a flywheel position can be ascertained, at which the piston is at the top of its stroke and motionless during a small movement of the flywheel. Bisecting the length of this movement determines the proper location of this center marking.

PROPER CLEARANCE BETWEEN TIMING GEAR TEETH

Just enough clearance shall exist between timing gear teeth to prevent humming when new and properly oiled; never more than about .001 inches. If too much clearance exists timing is rendered inaccurate; whereas, if the clearance is insufficient, a steady humming noise, rapid wear, and deformation of the teeth will result. Ends of meshing gear teeth should not bottom.

NOTE—The contact between the gear teeth is a rolling one.

The most frequent causes for noise indicating trouble in timing gears are: front crankshaft bearing lining broken out, which causes improper meshing of teeth, chips or dirt on teeth, meshing too deeply, wear of teeth giving excessive clearances, gears loose on camshaft.

FLYWHEEL

The flywheel is 17.5 inches in diameter. The width of its face is 2.5 inches. It is fastened to a flange on the crankshaft by six ½ inch bolts. In the face of the flywheel are the two oil holes for the clutch. If the oil will not enter readily, thrust in a thin wire and let it run down.

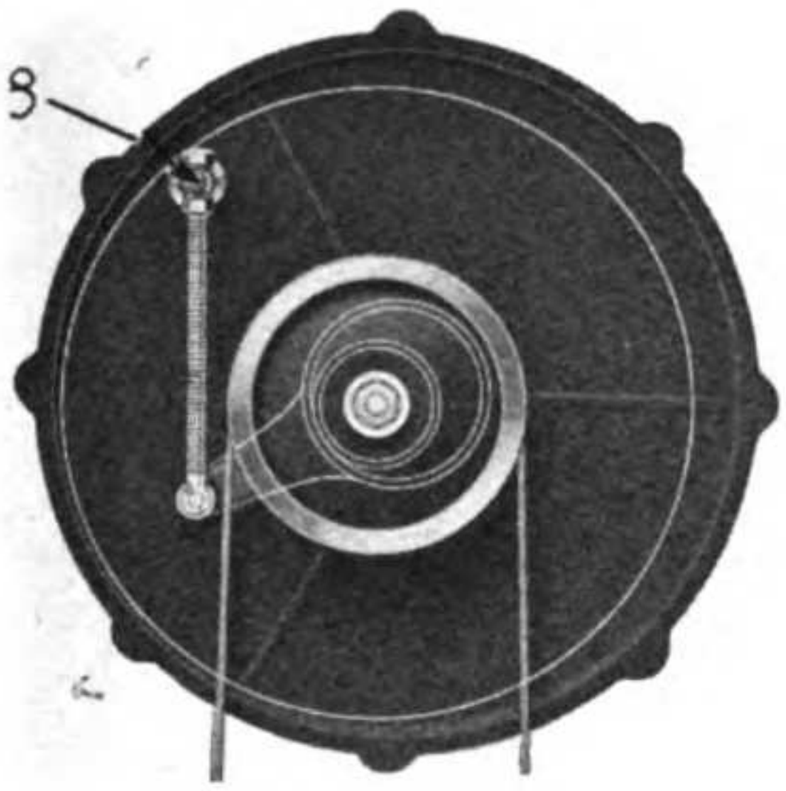
TO REMOVE ENGINE

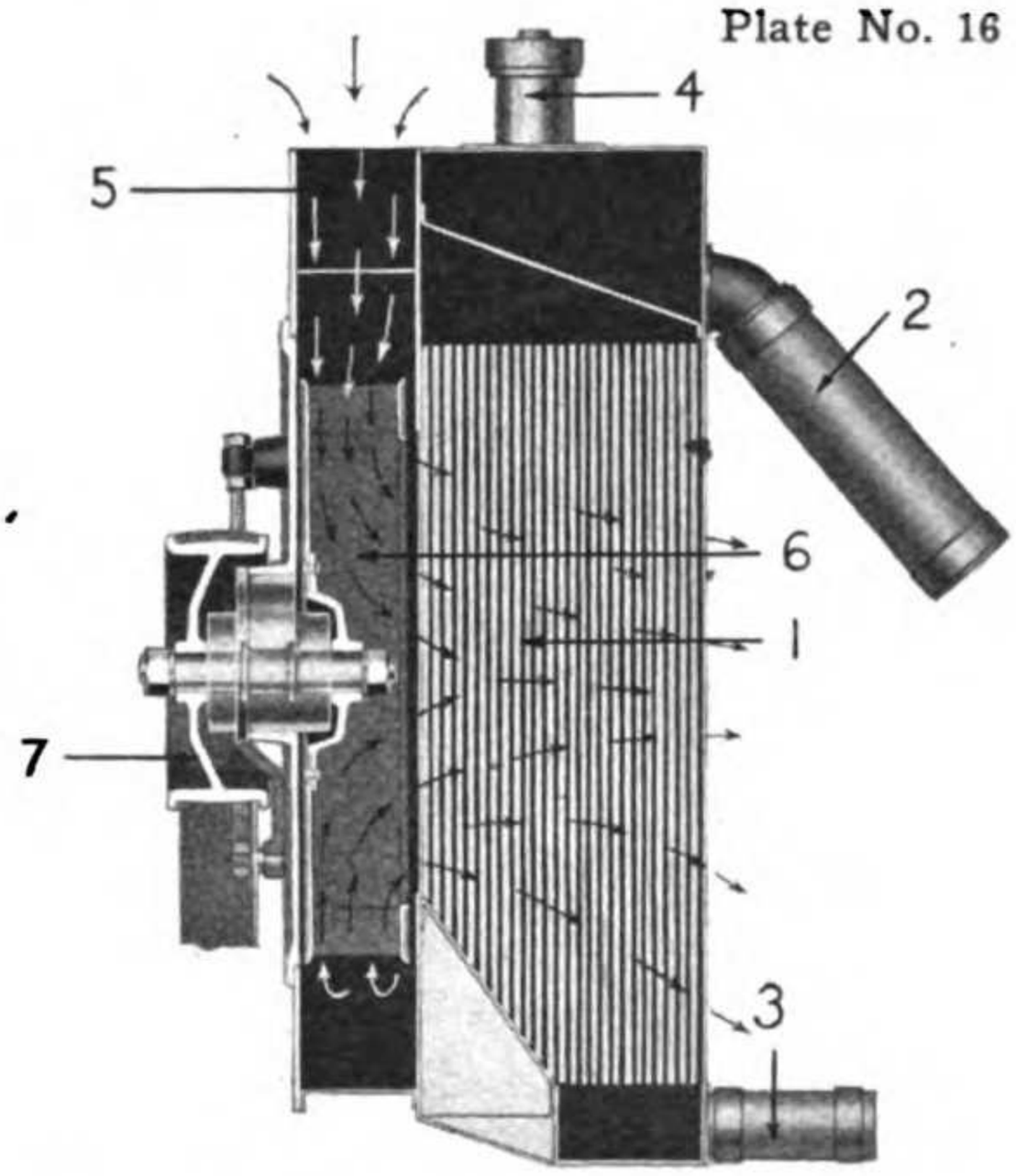
Take off the top armor plate, remove radiator and gasoline tank, unscrew the base bolts in the back and front of the engine, disconnect hose connections, control rods, etc., disconnect clutch and lift engine out.

FAN

The fan is of the 24 blade blower type. Each blade is of pressed steel. The outside dimension of the fan is 16 inches. It is driven by

Plate No. 16





RADIATOR AND COOLING SYSTEM

1. Radiator.
2. Radiator inlet.
3. Radiator outlet.
4. Radiator filler cap.
5. Fan housing.
6. Blower fan.
7. Fan pulley.
8. Fan pulley adjustment nut for taking up eccentric.

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a flat leather belt 69 9/16 inches long and 2 inches wide by ¼ inch thick. It is driven off a 10 inch pulley, forming part of the main clutch housing. The fan or driven pulley is 7 inches in diameter.

ADJUSTING FAN

Adjustment of the fan is provided by an eccentric held in place by a threaded rod and nuts. The lock nut is loosened as shown above. The play in the belt is taken up on the adjusting nut and the lock nut is then tightened.

TO LACE FAN BELT

A fan belt can be laced by punching three small holes in each end of the belt (directly opposite each other) and lacing with a rawhide lace or a shoestring if necessary.

The joints should be laced double in case a single row of lacing will not hold.

REASONS WHY FAN BELT JUMPS OFF PULLEY

The fan belt may jump off a pulley if it is too loose, if two pulleys are not parallel with each other, or if the ends of the belt are not cut squarely, thus causing the belt to be curved.

TO DETECT IF FAN IS RUNNING AT PROPER SPEED

A fan will not run at proper speed if the belt is oiled or greasy, if the belt is too loose, or if the fan shaft is too tight in the bearing.

CRANKSHAFT

The crankshaft is of alloy steel. It is mounted on three bearings, the front one of which is 2.125 inches diameter and 3.125 inches long, the center 2.25 inches diameter by 2.75 inches long, while the rear bearing has a diameter of 2.375 inches and length of 4 inches.

The caps for the main bearings of the crankshaft are held in place by four 7/16 inch studs.

Both bearings and caps are provided with bronze backed bushings of babbitt metal. This arrangement affords an easy means of renewing the bearings when they become worn.

The bushings are held in place by pins fitting in holes in the main bearings. The bearings at the lower end of the connecting rods are oiled by pressure through the drilled crankshaft. A copper tube up the side of the rod carries the oil to the wrist pin.

Crankshaft end play is taken up on the center bearing and all end play fitted from that point. An end play of .004 to .006 inch should be allowed. About 1/32 inch clearance is allowed on the front and rear bearings to take care of expansion in the crankshaft.

KNOCKS IN BEARINGS

The center bearing is that most likely to develop looseness, because of the fact that it carries a greater load than the two other bearings. The bearing next most likely to show signs of wear is the front one, while the rear bearing shows longest life in service.

Should the crank bearings knock, usually the removal of metal shims placed between the bearing and the bearing cap returns them to proper adjustment. In removing the shims it is necessary that an equal number be taken from each side of the bearing cap.

If the shims are laminated one or more layers should be removed. If that be too much substitute a thin shim of paper for one of the metal layers removed. If the shims are solid, file them to necessary reduced thickness.

If the above is not successful it will be necessary to replace the bushing and scrape to a perfect bearing. A perfect bearing surface is important.

TO SCRAPE CRANKSHAFT BEARINGS

In scraping the bearings, the first consideration is the proper meshing of the timing gears, the front bearing controls the position of the crankshaft and its gear, consequently, it should be fitted and scraped

first, the other end bearing being lined up with it at the same time. Then the middle bearing fitted in line.

In scraping the crankshaft or connecting rod bearings, the area of contact of bearing surface is the important factor. If the shaft does not bear well, all over, the high spots are scraped and the cap will have to be tightened, but if the shaft bears well and evenly, the bearing need not clamp so tightly. One bearing should be adjusted at a time, then loosened and another bearing adjusted. In this way, any chance of one bearing being too tight and another too loose is avoided. Always relieve the bearings at the upper part at the sides to prevent binding. If a bearing must be raised up, thin shim stock or paper should be used. Bearing blue, in oil, should be rubbed on the shaft to mark its contact with the bearings while being scraped in. When the three main crankshaft bearings have been adjusted and tightened, one should be able to revolve the shaft by grasping firmly the flywheel.

CRANKSHAFT BEARING ADJUSTMENT

Because of the weight of the shaft, flywheel, and their inaccessibility it is not advisable to attempt to adjust crankshaft bearings from under the engine.

When the crankshaft bears evenly in its bearings, and a bearing cap becomes loose, the shaft will spring down and away under the impulse of the explosion, and on the return of the piston to the top dead center the shaft will spring back, hammering away or upsetting the bearing. The result of this is not only a wearing down or hammering out of the top bearing, but the wearing away and the hammering out of the bearing in the crankcase as well. This condition can only be remedied by the removal of the engine from the chassis. The shaft should be removed from the engine, the journals blued, scraped in and readjusted. Should it be found that a bearing is out of line, being high or low, shims may be removed or added under the bushings. The shaft should not be sprung when it is finally fixed in its bearings.

SHIMS MUST BE EVEN

If an equal thickness of shims is not always maintained on each side of the bearing cap, on refitting or readjusting, the shaft will not bear on the same place on which it bore before the adjustment. When the bolts are tightened the caps may be sprung and pinch the shaft.

CRANKCASE

The crankcase is of a cast aluminum and is made in two parts. The cylinders are bolted to the upper half which has four arms cast integral, providing means for fastening the engine to the frame. To the lower half there is bolted the oil base and oil pump.

PRIMING CUPS

A set of priming cups are placed on the engine, located above the cylinders, and used for priming the engine with gasoline.

They may be used to determine the compression stroke of the different cylinders to ascertain how the cylinder is firing.

REMOVING CRANKSHAFT

The crankshaft can be removed through the bottom of the case by dropping the pan and removing the starting crank bracket, which is bolted to the front of the timing gear case. Drop the oil pan, remove flywheel by taking out clutch, as described on Page 81, take out the six bolts which hold the flywheel and the crankshaft flange, remove the oil retainer plate at the flywheel end of the crank case, take off main connecting rod bearing caps and withdraw the crankshaft.

TIMING GEARS

Timing gears are contained in a case on the front end of the engine. There are four gears in the set—the driving gear being that which is attached to the crankshaft, which in turn drives the pump gear and finally the magneto gear. The camshaft gear is driven directly off the crankshaft gear.

All the timing gears are 10 pitch 20 degree pressure angle, involute teeth. Crankshaft gear is .20—.30 open hearth carbon steel. Water pump gear is cast iron. Magneto gear .20—.30 open hearth steel, and the camshaft gear cast iron.

The crankshaft gear has 35 teeth; camshaft gear 70 teeth; magneto gear 35 teeth, and the water pump gear 35 teeth.

LUBRICATION TIMING GEARS

The timing gears are lubricated by the internal lubricating system of the engine, a lead carrying the oil direct to the gears. The oil put in the filler pipe also flows over the gears on the way to the crank case.

REMOVAL OF GEARS

The crankshaft gear is keyed to the crankshaft. It can be removed by taking off the retaining nut and withdrawing key.

The pump gear comes off by removing the nut on the end of the stud which holds it in place. The magneto gear is keyed to the magneto drive shaft and carries the governor on the outside or forward end. To remove this gear it is necessary to take off the governor end plate, removing the entire governor assemblies, and then slipping the gear off the key. The camshaft gear is bolted to a flange on the end of the

camshaft by three bolts, and can be removed by taking out these three bolts, as the spring thrust which bears against the gear comes off with the timing gear cover plate.

CAUSES OF KNOCKS

The following are the most common causes of knocks:

(a) Carbon
(b) Broken rings
(c) Loose piston pins
(d) Loose connecting rod
(e) Loose crankshaft bearings
(f) Loose flywheel
(g) Early spark
(h) Overheated engine
(k) Excessive valve tappet clearance
(l) Chipped or cam roller
(m) Burr or chip in gear teeth
(n) Crankshaft end play
(o) Camshaft end play

IDENTIFICATION OF ENGINE KNOCKS

(a) The carbon knock cannot be noticed when the engine is cold as it is entirely the result of carbon in the cylinders becoming heated to a temperature which will ignite the compressed charge prior to the occurrence of the ignition spark.

Carbon can be removed by speeding up the engine and pouring about one gallon of water into the air valve of the carbureter, a small quantity at a time, care being taken that the engine does not stop. After this is done it is a good plan to remove the spark plugs and see that they are clean, or the carbon can be scraped out through the valve plug holes.

(b) Broken piston rings will result in a lack of compression and permit oil to work up into combustion chamber. A light click at closed position of throttle may be noticed.

(c) The knock produced by loose piston pins is lighter than that of a crankshaft or connecting rod knock, and like a connecting rod knock is most noticeable when the engine is idling with a nearly closed throttle. This knock is not as indicative of danger as loose connecting rod or crankshaft bearing knocks. There is very little danger of bearings being rendered unserviceable by reasonable further use. Replacement of pin is necessary.

(d) The knock produced by a loose connecting rod, a rather heavy pound, is most noticeable at low engine speed with a closed throttle, but if the play is excessive this knock can be noticed at all speeds and

loads. It is the most common and the easiest to identify. It should be remedied immediately.

(e) A loose crankshaft bearing will knock most noticeably when the engine is working under a heavy load. If the front crankshaft bearing is very loose it may be detected by the excessive noise in the timing gear case due to improper meshing of timing gears.

(f) If the engine is speeded up suddenly and the throttle closed quickly, a knock resulting at the instant the throttle is closed will usually indicate a loose flywheel.

(g) The spark knock is a result of too early ignition, the spark being timed or advanced too far. It can be corrected by retarding the spark. It sounds like a carbon knock.

(h) Pre-ignition caused by overheated engine cylinders will result in lack of power, a heavy knock and excessive vibration.

(k) A knock produced by excessive valve tappet clearance is very light, being more of a click than a knock.

(l) A chipped cam or tappet roller may be detected by placing one's finger on the valve tappet while the engine is running, to determine if the tappet movement is smooth.

(m) After the front end flanges of the crankshaft bearings have been worn by the thrust of the clutch being released, the crankshaft will move lengthwise through the bearings, producing a knock as the limit of travel is reached. This knock may be located by pushing down clutch pedal, thereby pulling shaft back and holding it against the front flanges of bearings.

(n) A camshaft moving endwise will produce a knock somewhat similar to a light connecting rod knock. As the engine speed is increased, the camshaft is held in one position by the additional power required to drive it and the knock usually ceases. The camshaft gear plate may be removed and pressure exerted on the end of the shaft holding it back against the front flange of camshaft bearing, thereby determining if end play is producing the knock.

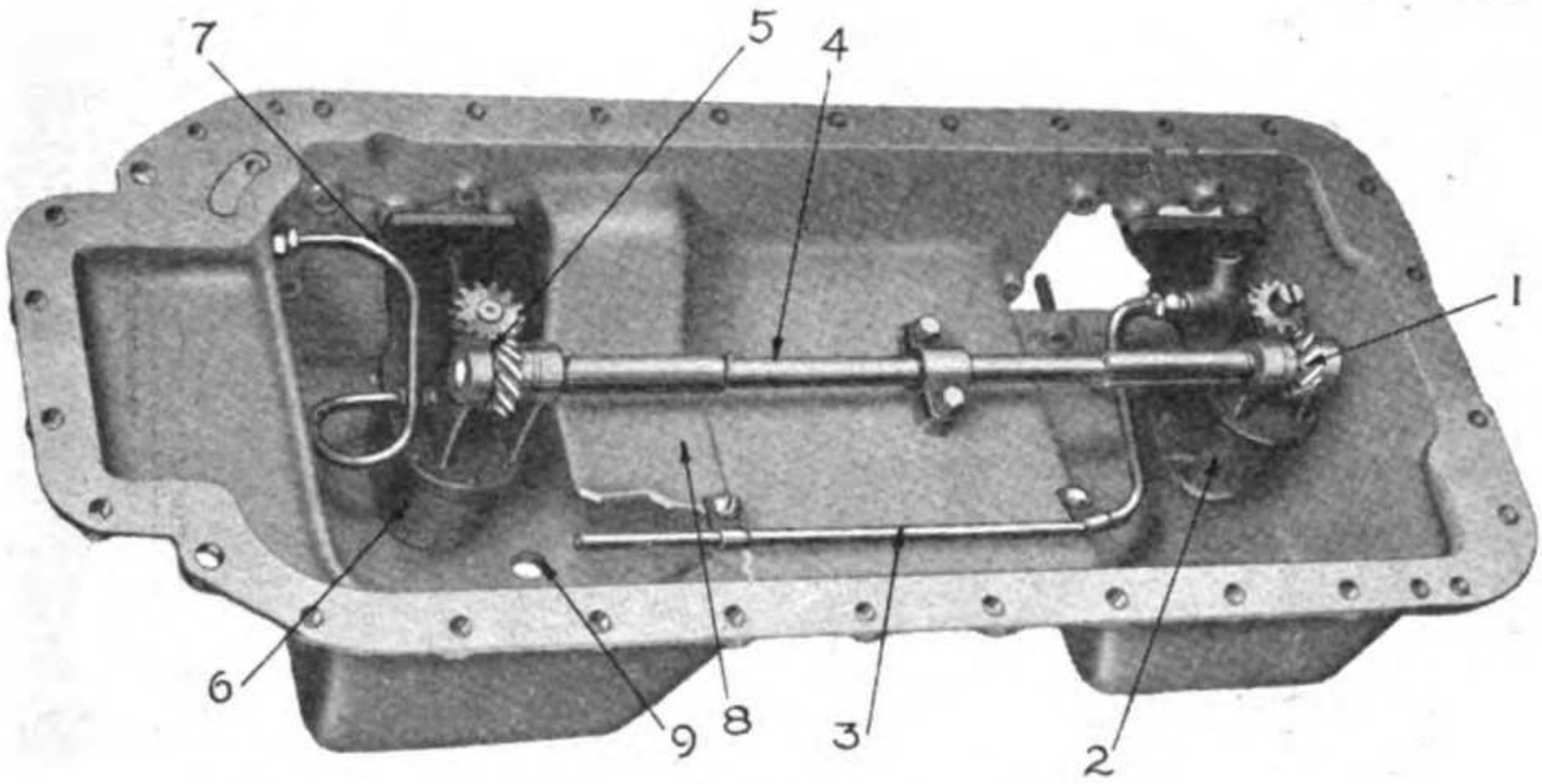
NOTE: The camshaft is driven by a helical gear.

(o) A burr or chip in the gear teeth will give a periodic knock.

OIL PUMPS

There are two gear oil pumps, one in each sump of the oil pan. The front pump is for priming and the forward pump delivers the feed to the pressure oiling system. The front pump is driven off the camshaft by a 45-degree spiral gear, 12-tooth, 12-pitch, through a vertical shaft. The drive for the rear pump is taken off this vertical shaft by a horizontal shaft through a set of spiral gears.

Plate No. 17



OIL PAN AND PUMPS

1. Drive gears for oil priming pump.
2. Screen for oil priming pump.
3. Oil priming pipe.
4. Oil delivery pump driveshaft.
5. Oil delivery pump drive gears.
6. Oil delivery pump screen.
7. Oil delivery lead.
8. Oil retaining wall in delivery sump.
9. Oil delivery sump drain hole.

ACTION OF OIL PUMPS

The oil pump in the sump at the flywheel end of the engine delivers the oil through a feed pipe to the rear sump which it keeps supplied. This second sump has a horizontal shelf which keeps oil in it in spite of a severe tilt of the tractor. This pump forces the oil through a main lead to the rear end main bearing, where it enters the bearing, and also the crankshaft, which is drilled to receive it. The oil is forced through the crankshaft to each main bearing and then through the drilled cranks to each lower rod bearing. Up the side of the rod is a tube which carries the oil to the piston pins. The camshafts are lubricated by separate leads at each bearing. The pistons and cylinder walls are lubricated by the spray from the ends of the connecting rods.

TO CLEAN OILING SYSTEM

To properly clean the oiling system, the lower half of the crankcase must be removed as the dirty oil and sediment in the troughs beneath each of the four connecting rods cannot be properly cleaned otherwise. Before removing the lower half of the crankcase, the two plugs in the base of the case should be removed and the oil allowed to drain out. Then replace the two plugs and pour two gallons of kerosene oil into the crankcase through the oil filler (at the left front end of engine), start the engine and run it slowly for only twenty seconds, thereby flushing the oil ducts, pipes, bearing oil grooves, and entire interior of case, pistons, rods, etc. Drain off and discard this kerosene and refill with 4 gallons of new cylinder oil.

Plate No. 18

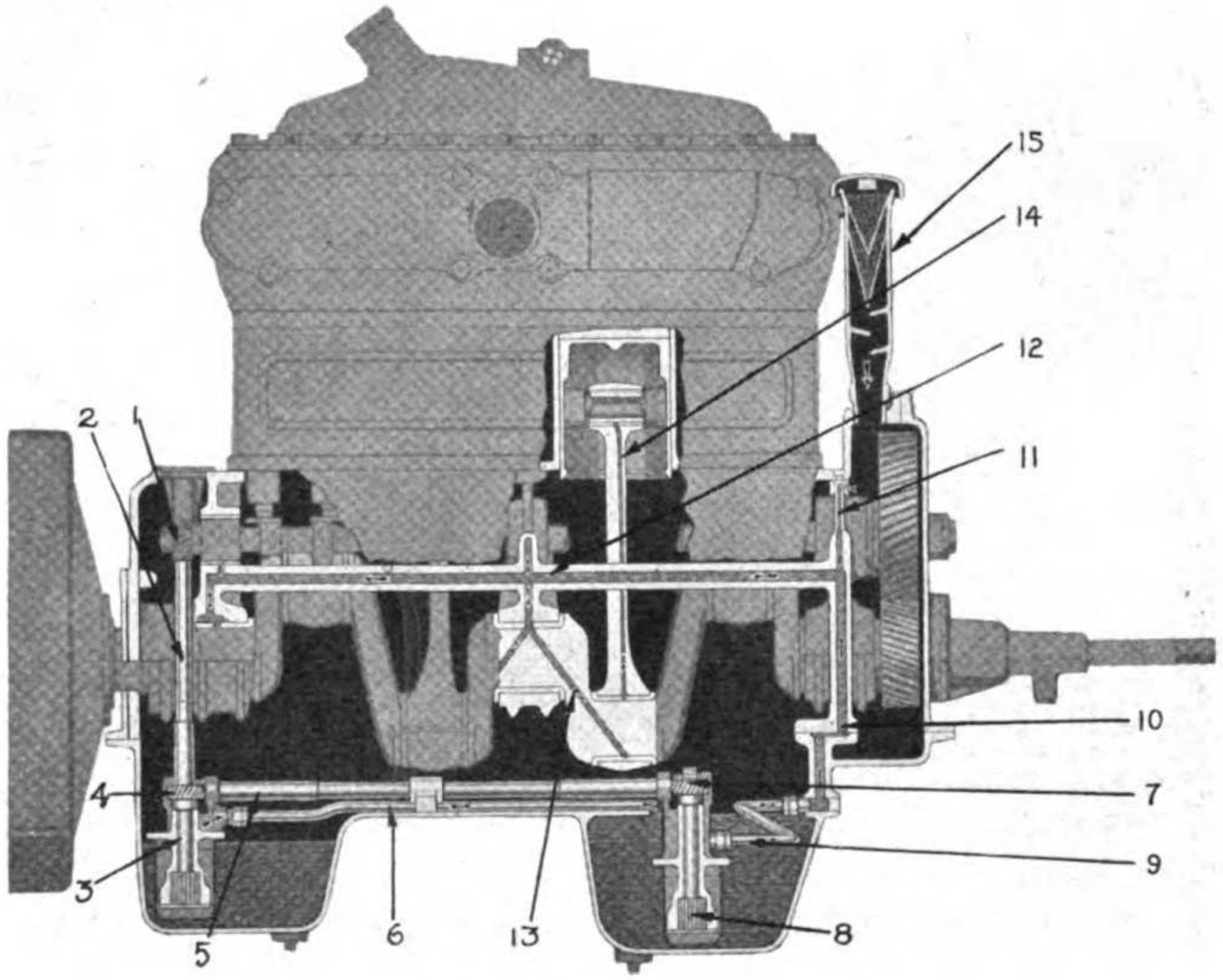


DIAGRAM OF OIL PASSAGE

1. Priming pump drive gear on camshaft.
2. Priming pump drive shaft.
3. Oil priming pump.
4. Oil delivery pump drive gear.
5. Oil delivery pump driveshaft.
6. Oil priming lead.
7. Oil delivery pump drive gear.
8. Oil delivery pump.
9. Oil delivery pipe.
10. Oil delivery lead.
11. Oil lead to timing gears.
12. Oil lead to main bearings.
13. Oil lead to lower rod bearings.
14. Oil lead to upper rod bearings.
15. Oil filler pipe.

If more extensive cleaning is advisable remove the base and oil pump intake screen, clean thoroughly, but before replacing same, examine all bearings, nuts, bolts and cotters. The oiling system should never be cleaned or flushed with gasoline, as it will destroy the glaze on the surface of the bearing and the shafts, causing friction and damage.

OIL LEVEL GAUGE

The oil level gauge permits the driver to conveniently ascertain the quantity of oil held in the oil base of the engine.

It is fastened to the crankcase between the cylinders on the exhaust side of the engine. It is a rod which can be pulled out. It is marked for full and empty levels. It shows full when there are 4 gallons in the case and empty when there are 1½ gallons.