No. 2003

HANDBOOK OF THE TEN-TON ARTILLERY TRACTOR MODEL 1917

(EIGHTY-TWO PLATES)

JULY 19, 1918

REVISED NOVEMBER 26, 1918

No. 2003

HANDBOOK OF THE

TEN-TON ARTILLERY TRACTOR MODEL 1917

(EIGHTY-TWO PLATES)

JULY 19, 1918

REVISED NOVEMBER 26, 1918

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ORDNANCE,
WASHINGTON, Nov. 26, 1918.

This manual is published for the information and government of the United States Army.

By order of the Secretary of War:

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

TABLE OF CONTENTS.

CHAPTER I.

GENERAL INFORMATION.

CHAPTER II.

THE ENGINE GROUP.

CHAPTER III.

MASTER CLUTCH.

CHAPTER IV.

TRANSMISSION GROUP.

CHAPTER V.

DRIVE SPROCKET AND GEAR.

CHAPTER VI.

SUPPORTING ASSEMBLIES.

CHAPTER VII.

TRACK GROUP.

CHAPTER VIII.

CONTROLS.

CHAPTER IX.

PINTLES.

CHAPTER X.

SUPERSTRUCTURE.

CHAPTER XI.

ARMOR.

CHAPTER XII.

CAPSTAN.

CHAPTER XIII.

EQUIPMENT.

CHAPTER XIV.

NOMENCLATURE.

LIST OF PLATES.

CHAPTER I.

CHAPTER II.

CHAPTER III.

CHAPTER IV.

HANDBOOK OF THE TEN-TON ARTILLERY TRACTOR MODEL 1917

CHAPTER I.

GENERAL INFORMATION.

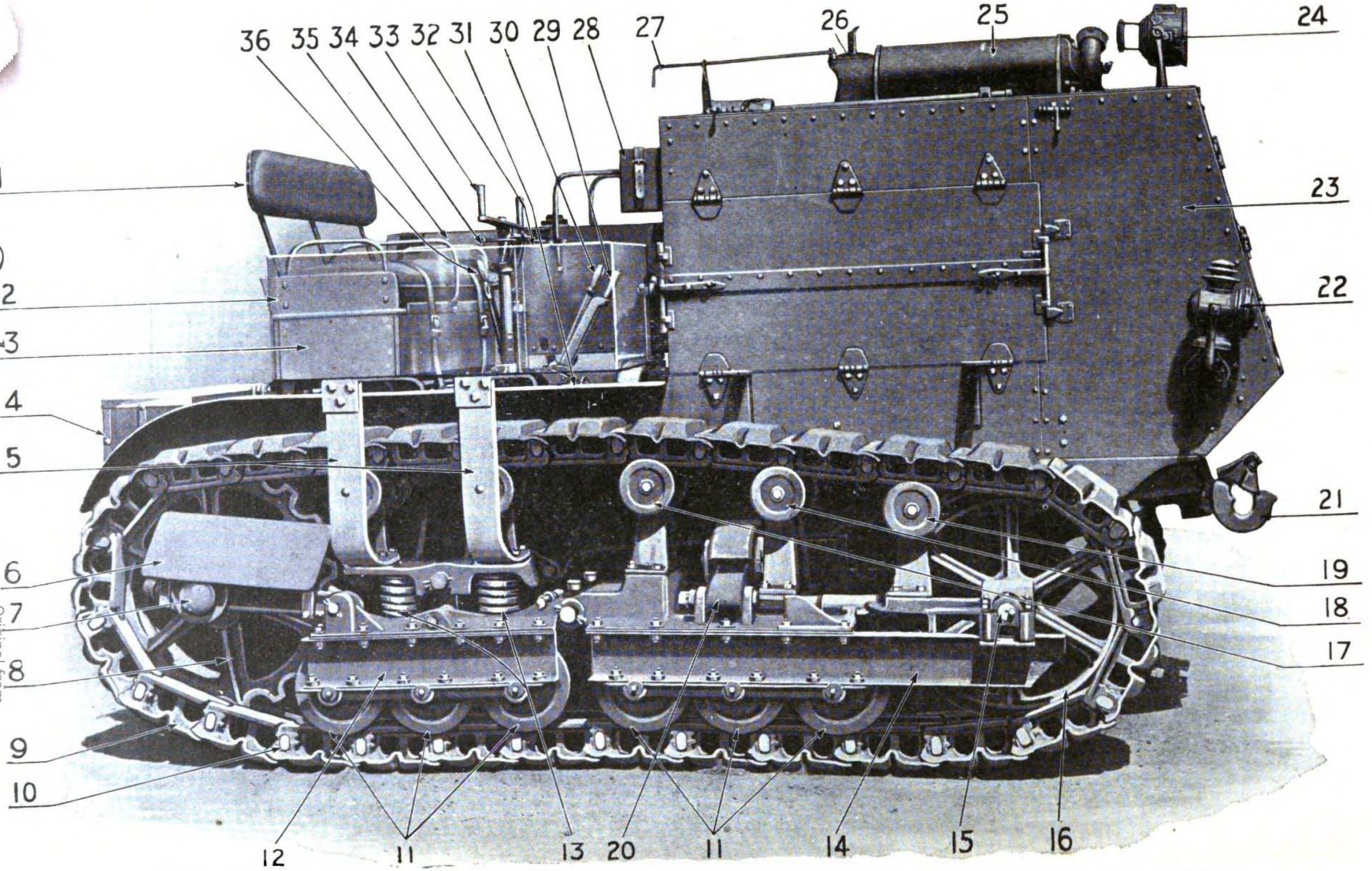
WEIGHTS AND DIMENSIONS.

Overall length	inches	162
Overall width	inches	84
Height (to top of muffler)	inches	96
Length of ground contact	inches	96
Ground clearance (under equalizer bar)	inches	12
Weight (complete with full equipment)	pounds	21,500
Ground pressure, per square inch	pounds	7.46
Weight of each track	pounds	1,725
Weight of each track shoe complete with grouser	pounds	59.5
Width of track shoes	inches	15
Tread of tracks (center to center)	inches	61
Diameter of turning circle	inches	85

Road Speed—

Low speed at 600, 700, 800 R. P. M.	miles per hour—	1.47	1.71 1.96
Direct speed at 600, 700, 800 R. P. M.	miles per hour.	2.71	3.16 3.61
High speed at 600, 700, 800 R. P. M.	miles per hour.	4.19	4.89 5.59
Reverse speed at 600, 700, 800 R. P. M.	miles per hour.	1.09	1.27 1.45

Capacity of gasoline tank	gallons	46
Capacity of auxiliary tank	gallons	10
Capacity of oil tank-engine	gallons	6
Capacity of track oiler tank	gallons	5.5
Brake horse power (600 R. P. M.)		55
Brake horse power (1,000 R. P. M.)		75
Drawbar horse power (average)		35 to 45
Drawbar pull (on direct—second speed)	pounds	5,200
Drawbar pull (on low—first speed)	pounds	8,000



RIGHT SIDE OF 10-TON ARTILLERY TRACTOR COMPLETE, SHOWING GROUSER BOX IN PHANTOM.

OUTLINE SPECIFICATIONS.

ENGINE.

Four-cylinder, four-stroke cycle, valve-in-head type. Bore 6.5 inches. Stroke 7 inches. Cylinders cast separately. H. P. 55 at 600 R. P. M.

RADIATOR.

Tubular type. Separate brass headers.

IGNITION.

K. W. Model R. K. or H. K. high-tension magneto with impulse starter.

CARBURETOR.

Two-inch Model E 4 Kingston carburetor with Stewart vacuum feed system.

GOVERNOR.

Centrifugal flyball type, drives from camshaft.

MASTER CLUTCH.

Dry-plate multiple-disk.

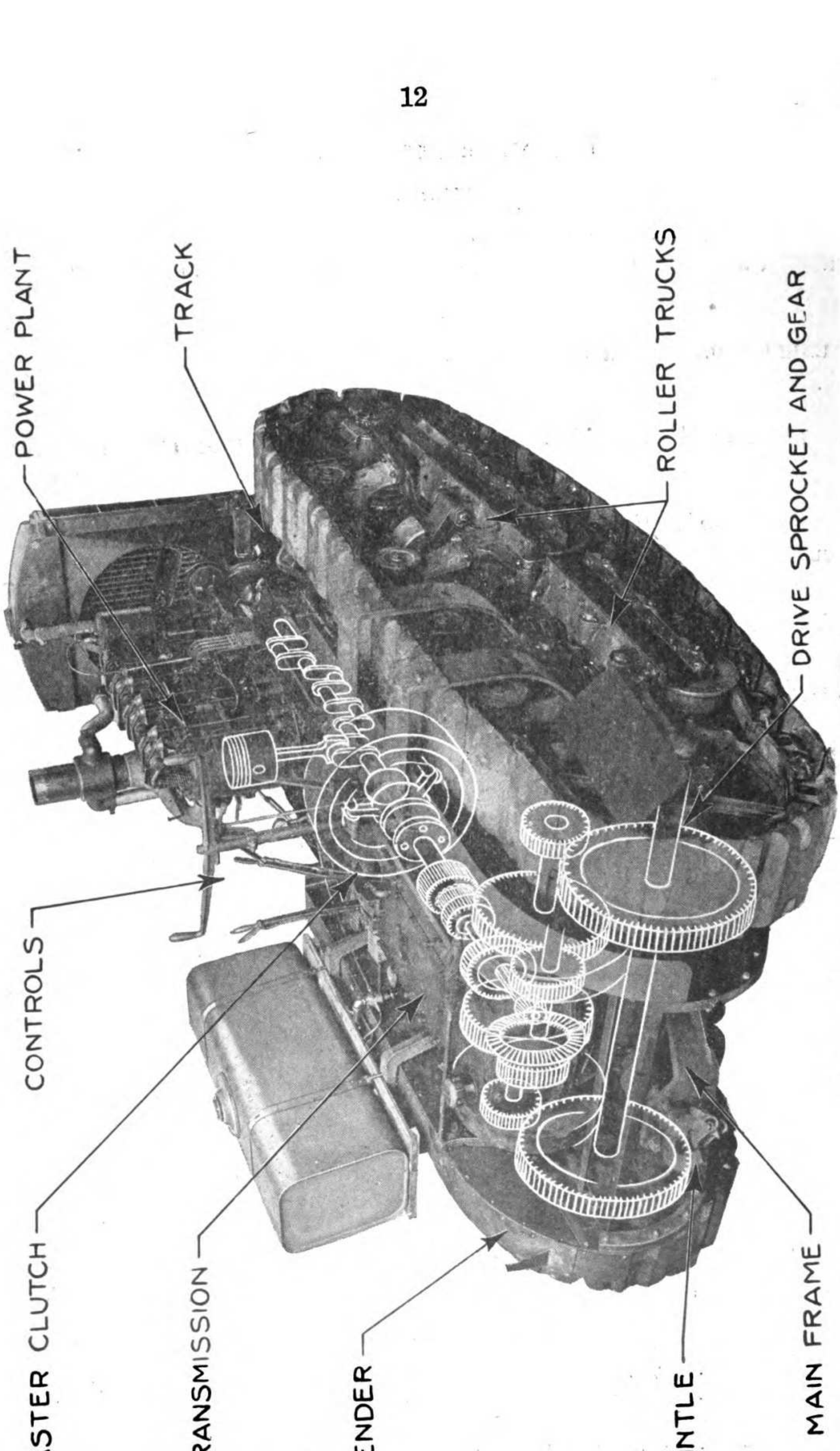
TRANSMISSION.

Selective sliding-gear type. Three speeds forward, one reverse. Direct drive on second.

SIDE VIEW OF COMPLETE TRACTOR.

Ref. No.	Part No.	Name of Part.
1	9870	Seat assembly.
2		Seat side.
3	10204	Grouser box.
4		Tool box.
5	10315	Front upper bracket.
	10314	Rear upper bracket.
6	7101	Guard over rear thrust rod.
7		Drive sprocket cap.
8	6958	Drive sprocket.
9	8324	Track link.
10	3247	Track pin.
11	6377	Roller frame truck wheel.
12	7043	Roller frame channel, outer right, rear.
13	1899	Roller frame spring, outer.
14	7037	Roller frame channel, outer right, front.
15	6368	Roller frame blank sprocket gudgeon.
16	6333	Roller frame blank sprocket.
17		Track supporting roller.
18	10283	Track supporting roller.
19		Front track supporting roller.
20	7003	Equalizer bar spring support.
21	7198	Pintle, front.
22		Lamp—Order No. MC10A, class 15, division 21.
23		Armor assembly—class 31, division 22.
24		Searchlight—Order No. MC11A, class 15, division 21.
25	9121	Muffler assembly.
26		Muffler cut-out.
27		Muffler cut-out control rod.
28		Lamp socket.
29	7268	Hand brake lever.
30	7269	Master clutch lever.
31	7581	Fender.
32	7234	Throttle control lever.
33	6909	Steering clutch hand lever.
34	7232	Spark advance lever.
35	7109	Fuel tank assembly.
36	7270	Gear shifting lever.

Plate No. 2.



GENERAL ASSEMBLIES OF TRACTOR.

DRIVE.

Through steering clutch shaft to spur pinions, which mesh with spur gears on drive sprocket shaft to drive sprockets.

STEERING CLUTCHES.

(2) Dry-plate multiple-disk.

STEERING.

By means of separate friction clutches which provide independent drive to either track.

CONTROL.

Right-hand steer. Master clutch release lever, and gear shift lever left of steering column. Hand brake in front of steering column. Spark and throttle lever operates on sector clamped to steering column in front. Steering clutch pedals right and left at bottom of and in front of steering column.

BRAKES.

One set. External contracting. Raybestos lined. Operate on steering clutch housings.

GASOLINE TANK.

Galvanized steel tank, 46-gallon capacity. Auxiliary galvanized steel tank, 10 gallon capacity on new tractors.

MAIN FRAME.

Cast in one piece—open hearth steel.

ROLLER FRAME.

Four pieces steel channel, sides, cast steel tops, joined by roller frame shaft. Two pieces right and left front. Two pieces right and left rear.

TRUCK WHEELS.

Six on each side tractor, fitted with Hyatt roller bearings, turning on steel gudgeons, and flanged to fit on track rail.

TRACK.

Made up of track shoes with track links cast integral, fitted with block spacers and 1.25 (1¼) inch track pins.

TRACK DRIVE SPROCKETS.

Two. Teeth mesh with block spacers in joints of tracks.

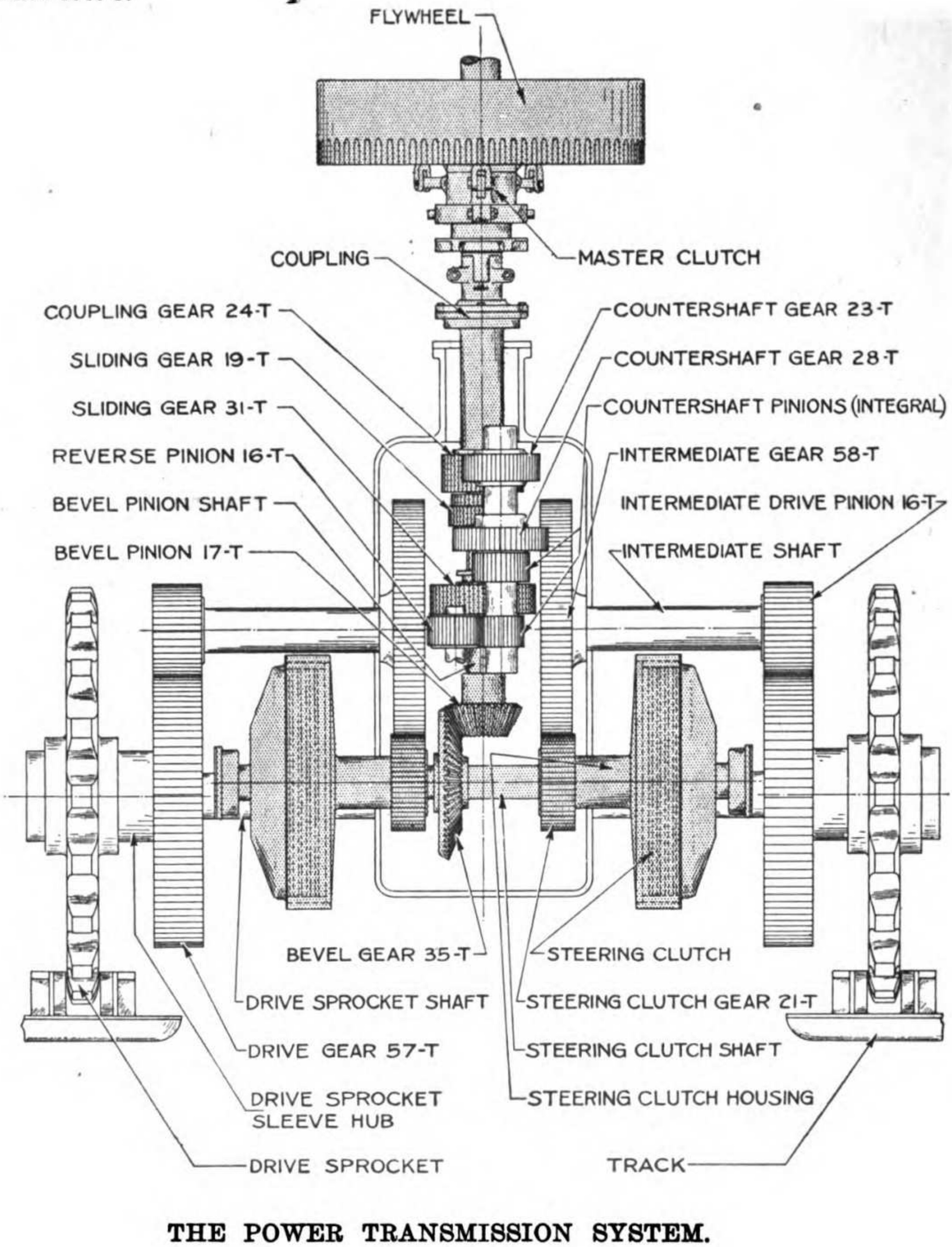
BLANK SPROCKETS.

Two. Fitted with roller bearings, turn on steel gudgeons.

TRACK (CARRIERS) SUPPORTING ROLLERS.

Five on each side of tractor mounted on brackets on front and rear roller frame channels, and on spring bracket bolted to main frame.

Plate No. 3.



THE POWER TRANSMISSION SYSTEM.

SPRINGS.

Four double-coil springs, two on each side bolted on rear roller frame sections

EQUALIZER BAR.

Spring-supported on front roller frame sections.

DESCRIPTION OF 10-TON ARTILLERY TRACTOR MODEL OF 1917.

The 10-ton Artillery Tractor Model of 1917 is a self-propelled road vehicle of the track-laying type; that is, the power is transmitted to the ground through a flexible, endless chain or track (composed of steel links and shoes, cast integral, and connected by hardened steel pins) instead of through the rear wheels as in the usual type of truck construction. The advantage of this type of tractor for military purposes lies in its ability, due to very low unit ground pressure, to negotiate soft or uneven surfaces.

The general design and construction of the 10-ton tractor does not differ materially from that of the modern motor truck except for the above-mentioned method of power transmission and that it is not designed to carry a load but as a power vehicle to be employed in the motorization of ordnance equipment.

MAIN GROUPS OF THE TRACTOR.

The various units or groups composing the 10-ton tractor are assembled on the main frame, a unit steel casting, rigidly reinforced, which not only supports the units or groups but holds them in the proper relation to each other. The main frame with its assembled units is supported on the track by means of a roller frame assembly on which it rests through the medium of an equalizing bar in front and springs in the rear. See Plate 1.

The power is developed by means of a power plant which consists of an internal combustion engine, using gasoline for fuel, suspended in the forward end of the main frame, a fuel supply and carburetion system, an ignition system, lubrication system and a cooling system.

The power developed in the power plant is transmitted to the track drive sprocket, which drives the track through the medium of a power system, consisting, in order, of a master clutch controlling the application of power between the engine and the transmission unit; transmission unit containing the gears by which the speed of the tractor is varied; the steering clutches controlling the application of power to either track; and the track drive sprocket and gears, which transmit the power from the steering clutches to the track. See Plate 2.

The track is an endless chain consisting of steel links and shoes cast integral and connected by hardened steel track pins. The track shoes are so designed that when assembled the links form a continuous double steel rail on which the truck wheels ride, the shoes providing a wide bearing surface which rests on the ground and supports the weight of the tractor.

Ordnance pintles are supplied at either end of the 10-ton tractor, the front pintle being secured to the main frame, and the rear to a bracket bolted to the main frame.

A clevis is bolted to the main frame below the rear pintle.

POWER TRANSMISSION SYSTEM.

It is in the transmission case that the design of the tractor begins its radical difference in principle from conventional motor mobile units. As in most conventional types the power of the engine is transmitted through a clutch, here known as the master clutch, thence through a universal to the change-speed gearset—ordinarily a unit in itself. In this application, however, the change-speed gearset comprises only a part of the mechanism within the transmission case.

The scheme of applying power from the engine to the track is shown in Plate 3.

The main transmission shaft of the gearset, called the pinion shaft, carries a bevel pinion which meshes with a bevel gear of larger diameter mounted on a transverse shaft known as the steering clutch shaft, either end of which extends outside of the transmission case and carries the driving members of a steering clutch.

From this point, the power transmission is the same on both right and left sides of the tractor. The driven plates of the steering clutch are normally engaged with the driving plates, but may be held out of contact with the driving plates on either side by the operation of the steering clutch lever, which corresponds to the steering wheel. The driven plates are attached to a sleeve known as the steering clutch housing within which the steering clutch shaft is free to rotate when the clutch is not engaged. Upon the steering clutch housing is mounted the steering clutch spur gear which is within the transmission case. This pinion meshes with a larger gear known as the intermediate spur gear.

By means of a shaft carried on two roller bearings the intermediate spur gear is connected permanently to a pinion called the drive spur pinion. This pinion meshes with a large gear called the drive gear which is secured by means of a key to a sleeve known as the track sprocket sleeve hub. This sleeve rotates on a dead shaft passing through the frame and is known as the track drive sprocket shaft.

To the outer end of the track sprocket sleeve hub is keyed the track drive sprocket whose teeth engage the block spacers in the chain links of the track and thus cause the track to be drawn around as with any chain and sprocket.

The drive sprocket is at the rear of the track and the front end is guided and kept in tension by means of a similar wheel without teeth known as the blank sprocket. The distance between the centers of the drive sprocket and blank sprocket is adjustable by means of a thrust rod which can be lengthened the length of one link of the chain by a double-threaded nut. This permits the tension to be relieved for replacement of links and also permits the blank sprocket to be moved forward to keep the tracks tight.

OPERATING INSTRUCTIONS.

PLACING THE TRACTOR IN SERVICE.

INSPECTION.

Regardless of the condition under which the tractor is received, the *first* duty of anyone charged with its care and operation is to give it a systematic and detailed inspection.

The initial inspection must cover all possible shortages of easily removable parts, including accessories and tools, such defects as loose parts and any damage that may have been caused in shipment, or at the hands of the previous operator, and any other conditions that would affect its proper operation.

REPAIRS AND REPLACEMENTS.

Such repairs and replacements as are necessary to the proper operation of the tractor must be given attention immediately. If permanent repairs cannot be made at once, temporary repairs should be made and advantage taken of the first opportunity to make this permanent.

GENERAL LUBRICATION.

How long a tractor will give first-class service depends more upon proper lubrication than any other feature of its care. This is particularly true of a new tractor and no precaution should be overlooked to make certain that every lubricated part has a full supply of lubricant. As a precautionary measure tractors are shipped by the manufacturers fully lubricated with the exception of the track oiler and engine. However, when placing the tractor in service this fact should be completely ignored and every lubricated part given careful attention, as indicated in the section on "Lubrication Instructions," Page 25.

FILLING THE COOLING SYSTEM.

Fill the radiator and water circulating system with clean, soft water. Water containing lime and other impurities should not be used. Rain water is ideal for the purpose. If the temperature is below freezing (32 degrees F.) proceed as outlined under Cooling System, Chapter II.

TO FILL THE FUEL TANKS.

These tanks, two in number, are located one at the left of the operator's seat and one in the upper part of the engine armor. Where possible, it is recommended that the gasoline be strained through chamois skin to remove any water that may be in it.

TO PREPARE THE LAMPS FOR SERVICE.

Fill the side lamps (two) and the tail lamp (one) with kerosene. Light and trim the wicks so that immediate service can be depended on.

TO START ENGINE.

It is assumed that the tractor is in condition to operate, that is, that the instructions outlined in the preceding paragraphs on "Placing the Trac-

tor in Service'' have been complied with, and that all adjustments are correct or nearly so.

PRELIMINARY STEPS.

Start the engine with the tractor in this condition, and before starting the engine it is essential to see that the master clutch is disengaged, that the gears are in neutral position and that all tools and materials which might become entangled in moving parts have been removed from the tractor.

ESTABLISHING OIL FILM IN CYLINDERS.

If an engine has been inoperative for more than three days, especially after undergoing the conditions to which it would be subjected in shipment, it is necessary to remove the spark plugs and with aid of an oil can inject about ¼ pint of oil in each of the four cylinders. Revolving the flywheel by hand will distribute the oil between piston rings and cylinder walls and re-establish compression.

TURN ON THE FUEL.

Move the lever of the three-way gasoline valve at the carburetor to "Aux." This permits the flow of gasoline from the auxiliary tank under the armor to the carburetor. This facilitates starting, as in order to start on the main tank, it may be necessay to prime the vacuum tank. In old-model tractors not provided with reserve tanks, the vacuum tanks must be partially filled when the engine is to be started on a wholly new supply of gasoline.

PRIMING A COLD ENGINE.

If the engine is cold, or if it has been inoperative for some time, its starting will be greatly facilitated by priming the cylinders. Open the priming cups by pulling priming cup gang lever towards driver's position, and with squirt can, put three or four squirts of gasoline in each priming cup. Close priming cups.

(NOTE: Overpriming is very detrimental and must not be permitted. Only a small amount of liquid gasoline is necessary to furnish the proper explosive mixture and no more should be used. Overpriming will destroy the lubricant film between the piston rings and the cylinder walls, and, in turn, the compression in the cylinders. It also increases the deposit of carbon under the upper piston ring, which in time will cause cylinder scoring, due to the lack of motion of the piston ring in its slot.)

RETARD THE SPARK.

Move the spark control lever from full retard position to a position about one-eighth of the range of the quadrant.

ADVANCE HAND THROTTLE LEVER.

Advance to a position about one-fourth of the full quadrant.

TRIP IMPULSE STARTER.

Do this by pressing down on back end of the ratchet catch lock, releasing ratchet catch and bringing impulse starter into operating position.

Open compression release cocks.

CRANK ENGINE.

Use the hand starter. To get the best results from the hand starter turn the crank until the starter gear meshes with the teeth on the rim of the flywheel. Turn slowly until on compression and then give the flywheel a quick flip or pull past center.

(NOTE: There should be no occasion for continued cranking of an engine. An engine that has been idle for a long period of time or a cold engine necessitates a certain number of revolutions before the various related units such as the oiling system, carbureter, etc., will function properly, but after this no difficulty should be experienced. If the engine does not start readily after a reasonable number of turns of the starting crank, look for the reason and correct the difficulty instead of attempting to make the engine start by continued cranking.)

IF THE ENGINE FAILS TO START.

Failure of an engine to start can generally be traced to three reasons, namely, ignition, carburetion or lubrication. A short systematic search will reveal which system is at fault and, as a rule, the remedies are simple. Two essentials are necessary before an engine will run, or even start, *fuel* and *ignition*. If fuel reaches the cylinders in the form of a vapor mixed with a certain proportion of air, although not the correct proportion to produce power, and a spark occurs, some result would be noticeable even though it be but a single weak explosion. If no explosion occurs, even after priming, which insures an explosive mixture in the cylinders, it can be reasonably assumed that the ignition is at fault. This trouble can generally be traced to the following causes:

1. Magneto excessively retarded, causing arm on circuit breaker-box to short circuit primary circuit.
2. Breaker points out of adjustment.
3. Breaker or distributor over-lubricated.
4. Open circuit, broken or disconnected wires.
5. Spark plug points too far apart. The spark plug gap should be about 0.0156 inch. In extremely cold weather wet with gasoline the end of the spark plug after cleaning and before inserting in the cylinder head.

If one or more explosions occur and then the engine stops, it proves that the ignition system is functioning and that the fuel is either not reaching the cylinders or has not the proper proportion of air. (The explosions were due to the fuel supplied in priming.)

1. Lack of fuel.

See that needle valve is turned on from one to one and one-quarter turns, and that the shut-off cock in the fuel line is turned on. The screen in the vacuum tank may be clogged. The reservoir in the vacuum tank may be empty. The screen under the fuel tank may be clogged.

2. Carburetion out of adjustment.
3. Water in gasoline.
4. Over-primed engine.

Do not overprime engine with gasoline. Overpriming will wash the lubricating film off the piston and cylinder, thus causing loss of compression. If an engine has been repeatedly primed and compression lost, remove the spark plugs and pour one-quarter cup of cylinder oil in each cylinder and revolve the engine several times by hand to re-establish compression. Prime the cylinders with a small quantity of gasoline. Prime carburetor heavily.

5. Air leaks above carburetor.

Air leaks above the carburetor may make starting difficult. The butterfly shaft should not leak air. The intake manifold gaskets should not leak air. The intake valve-stem guides should not leak air.

LACK OF PROPER LUBRICATION.

This will not necessarily make an engine difficult to start as long as the required lubrication film has been established between the piston rings and the cylinder walls. This film makes the necessary compression possible.

WHAT TO DO WHEN THE ENGINE STARTS.

CLOSE THE RELEASE COCKS as soon as possible after the engine starts.

ADVANCE THE SPARK FULLY. This is the correct position for all ordinary driving.

ADJUST THE ENGINE SPEED.—Place the hand throttle lever in such a position that the engine will idle at a low speed. In cold weather the engine should be allowed to run at a rather high rate of speed until warm.

EXAMINE WATER CIRCULATION.—See that the water is circulating freely. Fill the cooling system to overflowing.

EXAMINE FAN BELT.—See that the fan belt has the proper tension and is not slipping.

IF THE ENGINE RUNS IRREGULARLY (MISSES).—Such a condition must not be neglected. The difficulty should be located and remedied immediately. The trouble can as a rule be traced to a comparatively few causes easily determined and remedied, as indicated later.

IF THE ENGINE STARTS BUT STOPS AFTER A FEW EXPLOSIONS.—It is obvious that the ignition is not at fault and that the difficulty is due to either lack of fuel or failure of the fuel supply system to furnish the proper kind of mixture.

To find out if the vacuum system is working, open the pet cock on the bottom of vacuum tank. If the tank is dry, remove the filler plug, Plate 25, in top and refill.

When the auxiliary gasoline tank, Plate 28, is furnished, turn the lever of the three-way gasoline valve at the carburetor to "Aux" or auxiliary. After the engine has been running for not less than five minutes, turn the lever to "Main."

By this time the suction caused by the running engine has filled the

vacuum tank, making it possible for the fuel from the rear tanks to reach the carburetor.

GEARS.—Select the gear to be used, low, direct or high, and through the medium of the gear shifting lever engage the gear selected. Starting and running is done without a change of gears, in fact the gears cannot be changed when the tractor is in motion. See Plate 4.

CLUTCH.—Move the master clutch hand lever gently forward until the load is taken up and the tractor is in motion, then push it forward firmly and without jerking.

DRIVING THE TRACTOR.

POSITION OF AN OPERATOR.

It is the duty of an operator to remain in his seat at all times when the tractor is in motion. The tendency to jump off momentarily for any reason whatsoever must not be tolerated.

STEERING.

Steering is accomplished from the operator's seat through the medium of a steering clutch hand lever operating the steering clutches located on either side of the transmission unit. These steering clutches control the power transmitted to either track through the track drive sprocket and gears. If it is desired to turn in a certain direction the steering clutch hand lever is turned in the direction it is desired to go, which releases the steering clutch on that side, and in turn releases one track from driving. The released track becomes a pivot while the driving track on the other side will cause the tractor to change direction. The degree of turning can be governed by applying the foot-brake on the released steering clutch as desired. If a short turn is desired, release steering clutch and apply steering clutch housing brake firmly on the released clutch. A brake is located on each steering clutch housing and is controlled by a foot brake pedal for each side located at the base of the steering column. A hand brake lever and ratchet are provided to lock both brakes simultaneously.

With a load, the effect of disengaging a steering clutch is more pronounced, and except for sharp right-angle turns the use of the brakes is not necessary.

CHANGING THE GEARS.

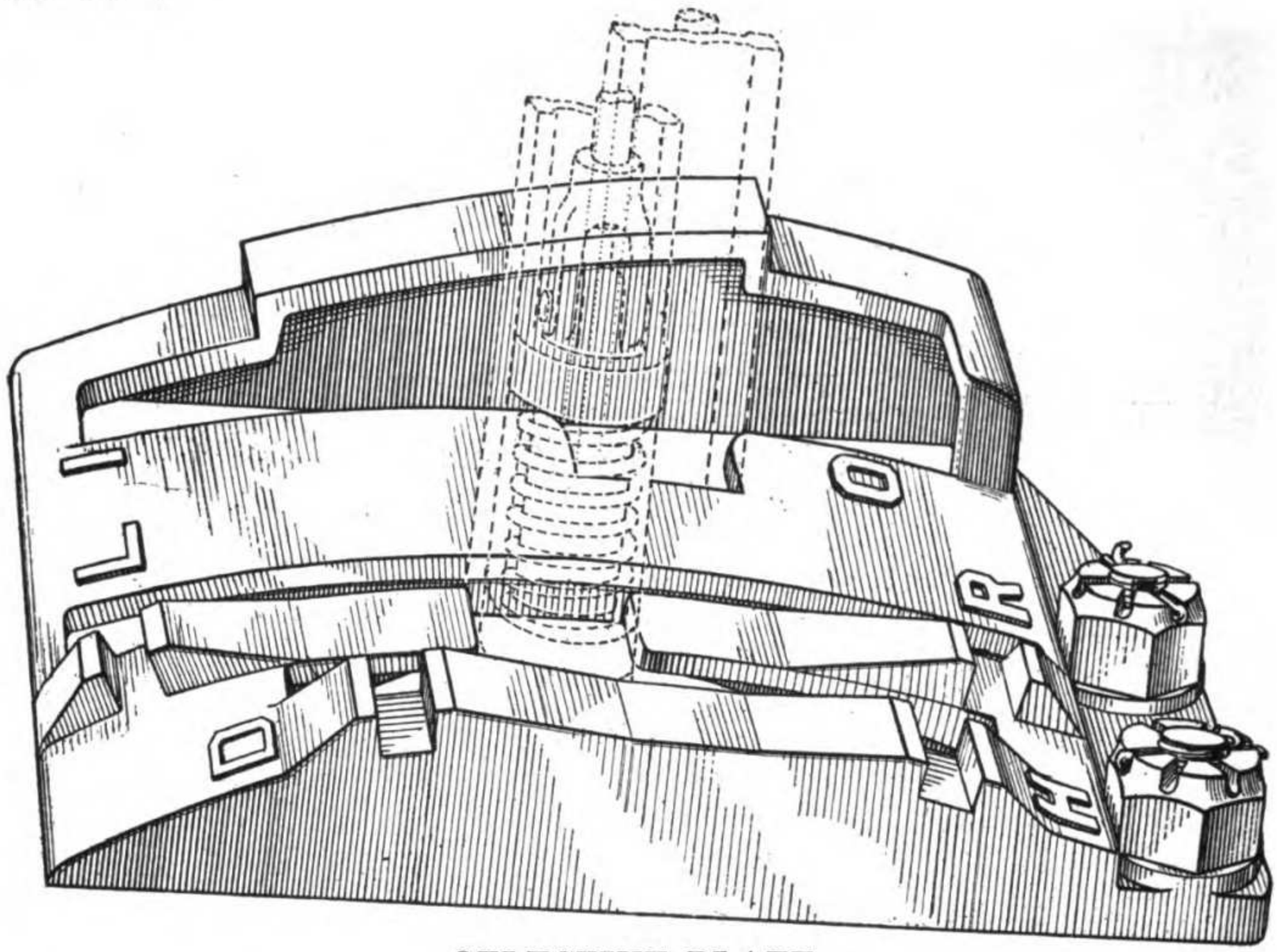
It is not intended that the gears of the 10-ton tractor be changed while the tractor is in motion. Due to the limited coasting abilities of the tractor, the weight of the master clutch and the size and type of gears used, changing of gears while the tractor is in motion is not to be attempted.

TO CHANGE THE GEARS.

See Plate 4.

Stop the tractor by disengaging the master clutch. Engage the gear desired by placing the gear shifter lever in the slot designating the speed. If for any reason the gears do not mesh easily, it is not advisable to force them, but engage the master clutch slightly for a moment and try again.

Plate No. 4.



SELECTIVE PLATE.

LUBRICATION OF TRACKS.

The tracks can be lubricated only while the tractor is in motion. Open the two valves under the front of the driver's seat for 10 minutes each hour while tractor is running. Care must be taken to cut off the flow of lubricant immediately on stopping the tractor. The method of lubrication is indicated under "Lubrication of Track."

BRAKES.

The brake bands operating on the steering clutch housing are used not only to facilitate steering but to retard the motion of the tractor or hold it in position. To facilitate steering, these brakes may be applied independently with the pedals. If it is desired to retard the motion of the tractor or to hold it in position both pedals or the brake lever may be used. The brake hand lever is equipped with a ratchet which holds both pedals.

DRIVING SUGGESTIONS.

While driving, a constant watch must be kept on the oil pressure, oil level and water temperature. A full supply of cylinder oil should be kept in the reservoir at all times and any reduction in oil pressure should be given immediate attention.

Any unusual noise in the operation of the tractor should be immediately investigated. A great amount of trouble can be avoided by giving attention to any symptoms as soon as they become evident, as the remedy at that time is generally simple.

TO STOP TRACTOR TEMPORARILY.

TURN OFF THE TRACK OIL.—Track oil should be used only when the tractor is in motion.

DISENGAGE THE MASTER CLUTCH by pulling the master clutch lever as far to the rear as possible.

REDUCE ENGINE SPEED by moving the hand throttle lever toward "Retard" until the engine runs at a slow even speed.

TO STOP THE ENGINE move the spark lever to full retard position. This short circuits the magneto and stops the engine.

DISENGAGE THE GEARS in mesh by moving the gear shifter lever to the neutral position.

STOPPING AT END OF RUN.

TO STOP THE TRACTOR.—Proceed as outlined in the preceding paragraph.

INSPECTION.—At the end of each run the tractor must be given a general inspection covering all loose or damaged parts, any defects that interfere with the proper operation of the tractor, any shortages of parts or materials, and any conditions which might interfere with the proper functioning of any part.

CLEANING.—Such facilities as may be available to clean the tractor should be taken advantage of. No opportunity should be overlooked to keep the working parts free from any accumulation of dirt and grit.

FUEL AND LUBRICANT.—The supply of fuel and lubricant in all containers should be replenished and the tractor otherwise made ready for immediate service. After the tractor is ready for further service it should be covered with the tarpaulin from the driver's seat as a protection against the elements.

CONCISE OPERATING INSTRUCTIONS.

PRELIMINARY TO STARTING.

Put gear lever in neutral.
See that master clutch is disengaged.
Trip ratchet catch lock on magneto to put impulse starter in motion.
Advance spark lever about one-eighth of total range forward.
Advance gasoline throttle one-fourth to one-half its travel.
Prime engine.
Open release cocks.
Rotate hand cranking device.

AFTER ENGINE IS STARTED.

Close release cocks.
See that the water pump is delivering water to radiator.
Advance the spark.

See that the fan is running properly.
Determine if any slippage is occurring on pulley that drives the fan.
See that the gauge on the force feed oiling system is working.
Never allow the engine to operate on one or more misfiring cylinders.

TO START TRACTOR.

Engage proper speed gear. See Plate 4.
Advance gas throttle.
Engage master clutch at first slowly, then firmly.

GEAR CHANGES.

Stop tractor by disengaging master clutch.
Engage gear desired by placing the gear shifter lever in the slot designating the speed wanted.

TO REVERSE TRACTOR.

Reduce engine speed, release master clutch, when tractor has stopped, engage reverse gear and engage master clutch.
Never engage reverse gear when tractor is moving forward.

TO STOP ENGINE TEMPORARILY.

Close the throttle.
Disengage the master clutch.
Retard the spark to full back position.
Close the valve controlling track oilers.
Inspect oilers, bearings, and cooling system.

TO STOP AT THE END OF A RUN.

Close the throttle.
Disengage the master clutch.
Retard the spark to full back position.
Close valves controlling track oilers.
Close valve on fuel supply line.
Make careful inspection of whole tractor.
In cold weather drain radiator, cylinders and pump.

LUBRICATING INSTRUCTIONS.

After each part mentioned in the lubricating instructions there will be found a figure. The key to the various figures is as follows:

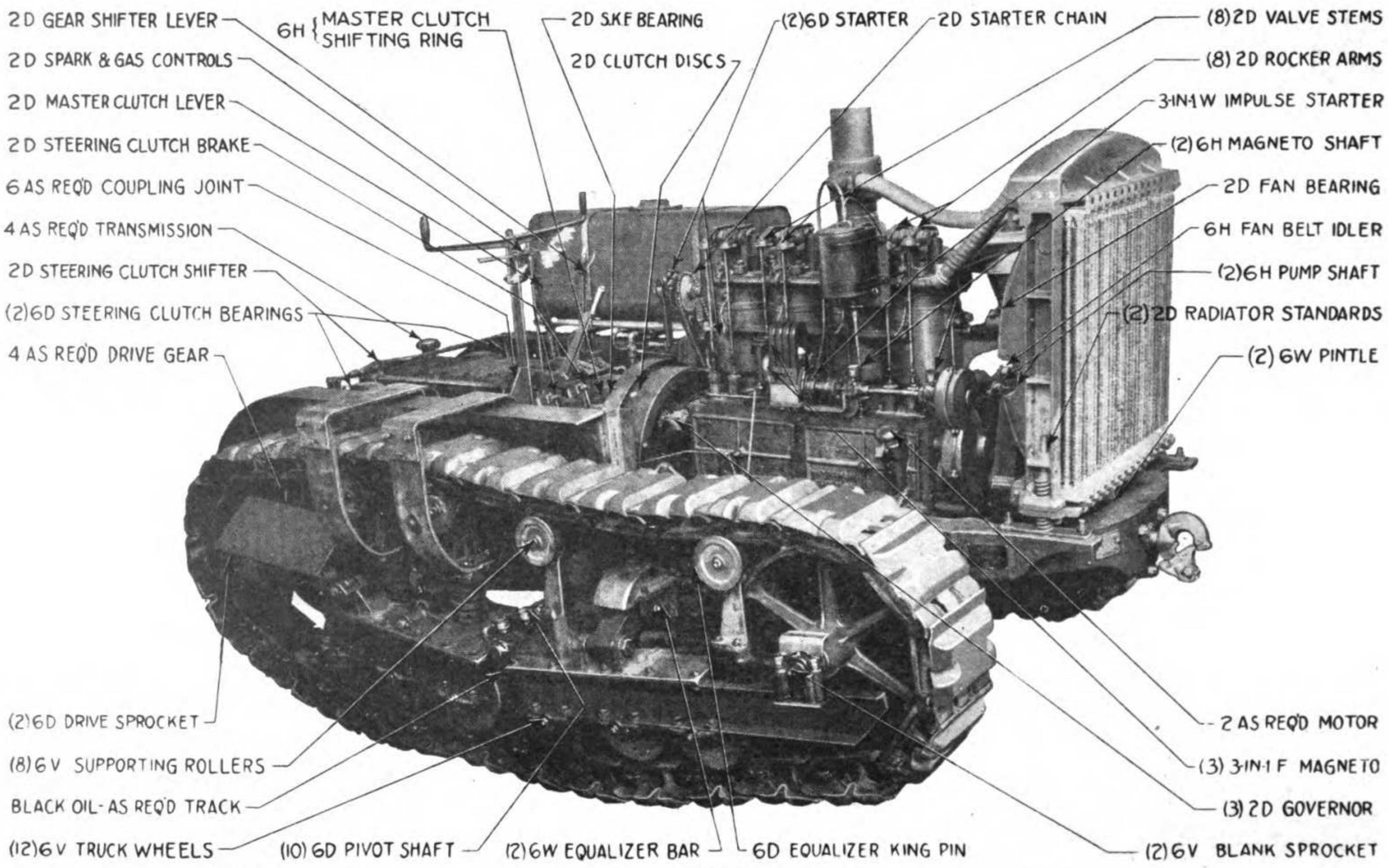
2, No. 3502 cylinder oil furnished in light, heavy and medium.
4, No. 3504 fluid transmission oil.
6, No. 3506 medium cup grease.

Each place on the 10-ton tractor where lubricant must be applied, must be given attention regularly. These places are pointed out on Plate 5, with the lubricant to be used and the frequency. The method of application is:

LUBRICATING CHART.

(BASED ON A 10-HOUR DAY) AT AVERAGE SPEED OF 3 MILES PER HOUR.

Part	*Lubricant*	*How Applied*	*How Often*
Hyatt roller bearing in fan	No. 2 medium	Oil can	Every 6 miles or 4 times daily
Magneto shaft	No. 6	Two grease cups	Two turns per hour
Valve stems	½ No. 2 med. ½ kerosene	Oil can	Every 6 miles or 4 times daily
Rocker arms	No. 2 medium	Oil can	Twice daily
Butterfly valve shaft	No. 2 medium	Oil can	Twice daily
S. K. F. bearing at flywheel end of master clutch.	No. 2 medium	Through pipe carried by clutch	Two times daily
Master clutch discs	No. 2 medium	Between discs	Once daily
Master clutch shifting ring	No. 6	One grease cup	One turn per hour
Gurney 200% ball bearing for shifting steering clutches	No. 6	One grease cup and pipes (2)	Four turns four times daily
Track drive sprocket sleeves	No. 6	Remove pipe plug rear end thrust rods and use grease gun (2)	Fill every day
Track supporting roller	No. 6	Grease cup (10) (new design	Turn down fully twice daily
		Grease gun (old design)	Fill till grease forces out—twice week or every 50 miles
Truck rollers	No. 6	Remove pipe plug (10) in end of gudgeon and use grease gun (2)	Every 50 miles or twice week
Equalizer (king pin)	No. 6	Grease cup	Two turns twice daily
Pintle hook (front and rear)	No. 6	Remove pipe plug (2) and use grease gun	Fill twice a week or every 50 miles
Roller frame pivot shaft	No. 6	Ten grease cups	Two turns one time daily
Fan belt idler	No. 6	One grease cup	Two turns per hour
Pump shaft bearing	No. 6	Two grease cups	Two turns per hour
Mechanical starter	No. 6	Two grease cups, chain-cylinder oil	Two turns daily; once per day
Track	Black oil or refuse oil from crankcase (not crude oil)	Gravity feed (2) through pipe lines from tank regulated by valve for each track	Open valves often enough while running to keep track pins and space blocks oiled
External spur gear (in dust guard)	No. 4	Fill oil tight dust guard by removing plug and filling 1 inch below level of hole (2)	Sufficient to maintain proper level
Transmission	Heavy body fluid No. 4 *mineral* oil	Fill case to level of pipe plug at rear right-hand corner of case, or up over one-third of gears; 6 gals. Fill through vent in upper trans. case	Sufficient to maintain proper level
Engine (timing gears, crankshaft and cylinders)	No. 2 medium	In crankcase	As required
Magneto	3-in-1 or other household oil, no cylinder or other mineral oil	By *drops* with wire oiler (3)	One drop—15 days, main bearings One drop—15 days, circuit breaker roller One drop—15 days, circuit breaker pin bearing
Impulse starter	3-in-1	Ball check oiler, using wire oiler or toothpick	Four drops per week
Governor	No. 2 medium	Squirt can, Hess-Bright bearing, ball pins, levers	Once per day
Spark and gas control connections	No. 2 medium	Squirt can	Once per day
Master clutch lever joints	No. 2 medium	Squirt can	Once per day
Gear shifter lever joints	No. 2 medium	Squirt can	Once per day
Steering clutch shifter joints	No. 2 medium	Squirt can (2)	Once per day
Steering clutch brake joints	No. 2 medium	Squirt can (2)	Once per day
Internal-external universal joint	No. 6	Pack housing	Whenever required
Equalizer bar rocker joints	No. 6	One cup each side (2)	Fill cup once per day
Radiator standards	No. 2 medium	Squirt can (2)	Once each side per day



LEGEND

2 = CYLINDER OIL — SPEC 3502	H = HOURLY V = SEMI-WEEKLY
4 = TRANSMISSION OIL SPEC 3504	D = DAILY W = WEEKLY
6 = CUP GREASE — SPEC 3506	F = SEMI-MONTHLY

LUBRICATING DIAGRAM (FOR FURTHER INSTRUCTIONS SEE PRECEDING PAGE).

MAINTENANCE ROUTINE.

It is essential for the proper care and maintenance of the 10-ton artil lery tractor model 1917 that the following maintenance routine schedule be rigidly adhered to. Preparedness for emergencies can only be obtained by keeping the tractor in excellent condition, and this necessitates that adjustment be kept proper at all times.

Inspections must be systematic and detailed, and made at regular intervals, daily, weekly and monthly.

Daily inspections must cover a general search for loose nuts and connections, all shortages of parts, all defects or conditions that would interfere with the proper operation of the tractor.

Weekly inspection must cover an examination of the compression, valve adjustment, condition of ignition system, clutch adjustments, and any other adjustments that are necessary, due to ordinary wear and tear.

Monthly inspections must be detailed in their nature and assuming that daily, semi-weekly and weekly inspections have been conscientiously made must cover an examination of all bearings, wear and tear on working parts and deterioration.

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

DAILY MAINTENANCE ROUTINE.

ENGINE.

Examine all wiring terminals for tightness.
Clean magneto externally.
Inspect all wires for proper support and freedom from damage.
Thoroughly clean engine externally.
Note tension of fan belt.
Inspect oil pump for performing its function.
Inspect radiator water supply.
Inspect gasoline tanks for proper fuel supply.
Inspect pipe line and all connections for leaks.
Inspect action of transmission oil pump by opening test cock on top of transmission case, when transmission gears are revolving.

STEERING, CLUTCH BRAKES, GENERAL.

Inspect for undue wear or looseness.
Inspect for proper operation.
Inspect and thoroughly clean all lamps.

SEMI-WEEKLY MAINTENANCE ROUTINE.

Inspect main bearings and all connecting rod bearings in engine.
Inspect transmission for proper oil level.

WEEKLY MAINTENANCE ROUTINE.

ENGINE.

Inspect for oil leaks.
Inspect control connections.
Inspect all water connections for leaks.
Drain water and dirt from water trap in gasoline line.
Inspect carburetor control connections.
Do not attempt to alter adjustments of carburetor unless this is shown to be necessary when tractor is in service.
Inspect engine oil drain cocks and drain plugs for loss of oil.

STEERING CLUTCH BRAKES.

Inspect thoroughly, cleaning all brake connections.

SPRINGS.

Inspect springs.

TRACKS.

Inspect tracks, truck wheels, carriers, drive sprocket, blank sprocket, equalizer bar for wear, breakage or proper adjustment.

MASTER CLUTCH.

Inspect clutch, clean externally.

TRANSMISSION.

Clean and inspect all control connections.

STEERING CLUTCHES.

Inspect clutches for proper action, and inspect clutch brakes for proper action and adjustment.

GENERAL.

Inspect armor bolts, fasteners and all similar bolts for apparent tightness.
Inspect tool equipment for completeness.

MONTHLY MAINTENANCE ROUTINE.

MASTER CLUTCH.

Thoroughly clean and inspect all lever connections.

TRANSMISSION.

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

GENERAL.

Inspect speedometer drive.

GENERAL MAINTENANCE INSTRUCTIONS.

EVERY TWO WEEKS.

Renew oil in crankcase and clean it out, washing with kerosene. Use no waste or rags which will leave lint in case as this will clog oiling system.

EVERY NINETY DAYS.

Renew oil in transmission, washing out case with kerosene (not gasoline, because it destroys oil film on bearing surfaces).

KEEPING THE TRACTOR CLEAN.

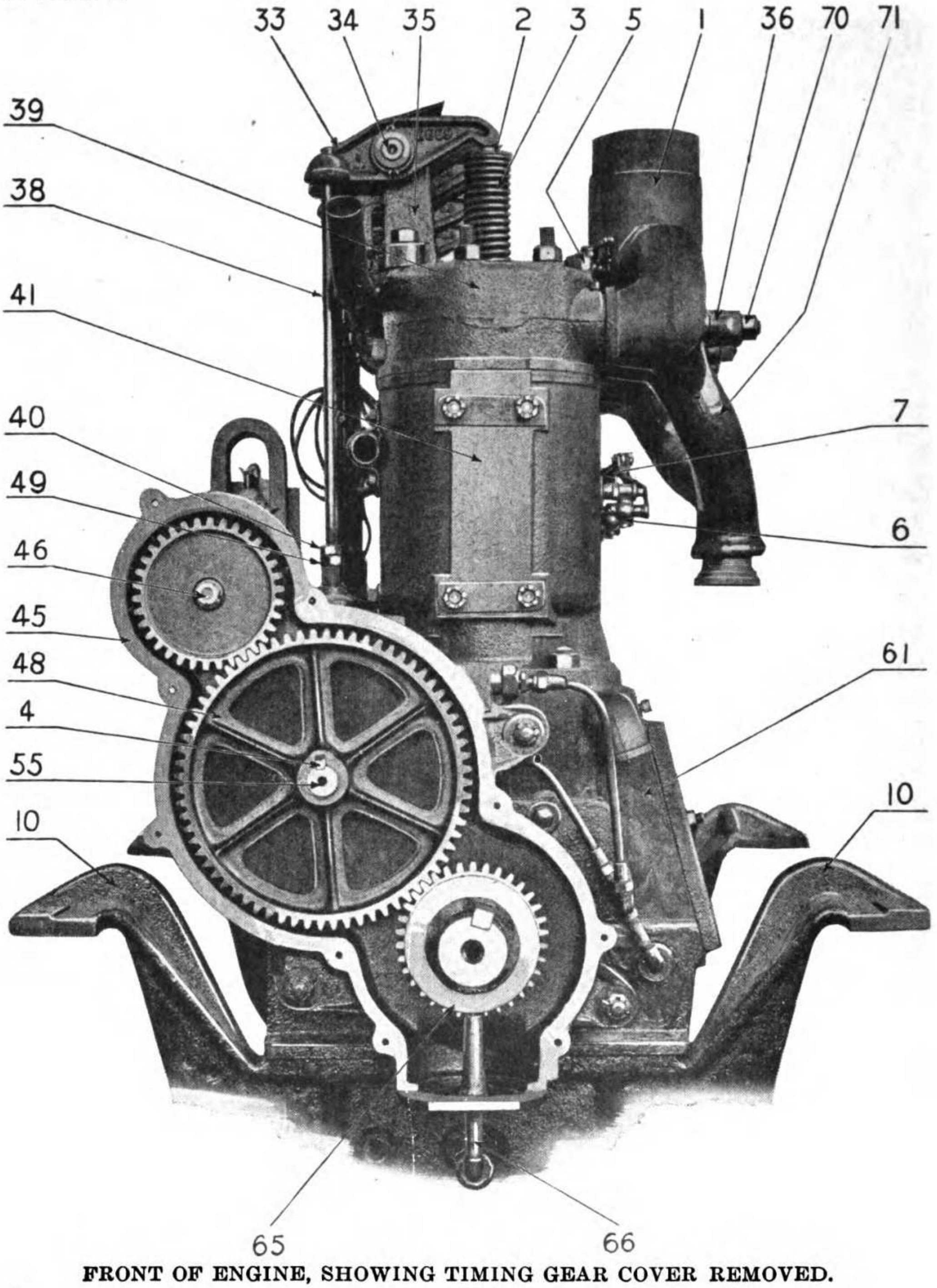
Grit, dirt and mud are the sources of greatest wear to an artillery tractor. All such deposits must be removed as well as facilities permit immediately after every run. If deposits of dirt and grit are allowed to accumulate, particles will soon find their way into bearing surfaces, causing unnecessary wear, and if the condition is not remedied it will soon cause serious difficulty.

When removing crankcase doors, or any other part in making repairs and replacements, or for the purpose of inspection where working joints or bearing surfaces are to be exposed, all dirt and grit that might find its way to the exposed surfaces must be carefully removed. The tools must be clean, and care must always be taken to eliminate the possibility of brushing dirt or grit into the openings with the sleeve.

To cut oil-soaked dirt and grit, hardened grit or road oil, use crude oil or kerosene applied with a waste rag.

The 10-ton artillery tractor is so designed that the possibility of interfering with its proper operation by careless application of cleaning water is very small. However, care should be taken that water in large quantities does not get under the armor as it might interfere with proper ignition and carburetion. Water should not be allowed to stand on exposed metal parts as it will cause rust. Such exposed parts should be painted as soon as conditions permit.

Plate No. 6.



65 66

FRONT OF ENGINE, SHOWING TIMING GEAR COVER REMOVED.

Ref. No.	Part No.	Part Name.	Ref. No.	Part No.	Part Name.
1	ZH17	Manifold, exhaust	39	Z649	Cylinder head
2	M11442	Cylinder head valve spring collar	40	102283	Valve tappet rod and lock nut
3	M10278	Cylinder head valve spring	41	100184	Cylinder, front
4	M11527	Gib key	45	100138	Timing gear case
5	AM1522	Priming cup	46	M1421	Magneto shaft
6	AM1656	Compression release cock	48	102293	Camshaft gear
7	M1427	Compression release cock lever	49	102195	Valve tappet rod adjusting nut
10	Z712	Engine hanger bracket	55	M10664 or M11183	Camshaft
33	M11453	Valve rocker arm	61	Z667	Crankcase
34	M2503	Valve rocker arm pin	65	M11497	Crankshaft gear
35	Z670	Valve rocker arm bracket	66		Oil pipe
36	ZH28	Exhaust and inlet manifold clamp	70	M1945	Exhaust and inlet manifold stud nut
38	AM1632	Valve tappet rod	71	Z650	Inlet manifold

CHAPTER II.

THE ENGINE GROUP.

The engine group consists of the engine proper and its cooling, fuel supply, carburetion, exhaust and ignition systems together with the hand engine starter.

ENGINE.

The engine is a four-cylinder, four-stroke cycle type and is mounted longitudinally on the main frame, being suspended at four points. The cylinders are cast separately, are of the valve-in-the-head type, and have a bore of 6.5 (6½) inches and a stroke of 7, developing 55 horsepower at 600 revolutions per minute. The firing order is 1-2-4-3.

The crankcase is a one-piece construction, is of cast iron and to its lower part is bolted the oil base or sump.

The single camshaft is gear-driven from the crankshaft and the high-tension magneto is driven by a gear in mesh with the camshaft gear. The governor is mounted on the camshaft at the flywheel end of the engine.

Ignition is by a K-W high-tension magneto and there are but four cables or wires, the conventional grounding wire and switch being replaced by a finger or grounding member on the circuit breaker of the magneto.

The fuel supply is by a main and auxiliary tank to a vacuum tank, thence to a Kingston carburetor. Three-way valves at main fuel tank and carburetor control the fuel supply.

The lubrication system is a combined force feed and splash, the oil being circulated by a gear-driven pump located in the oil base or sump.

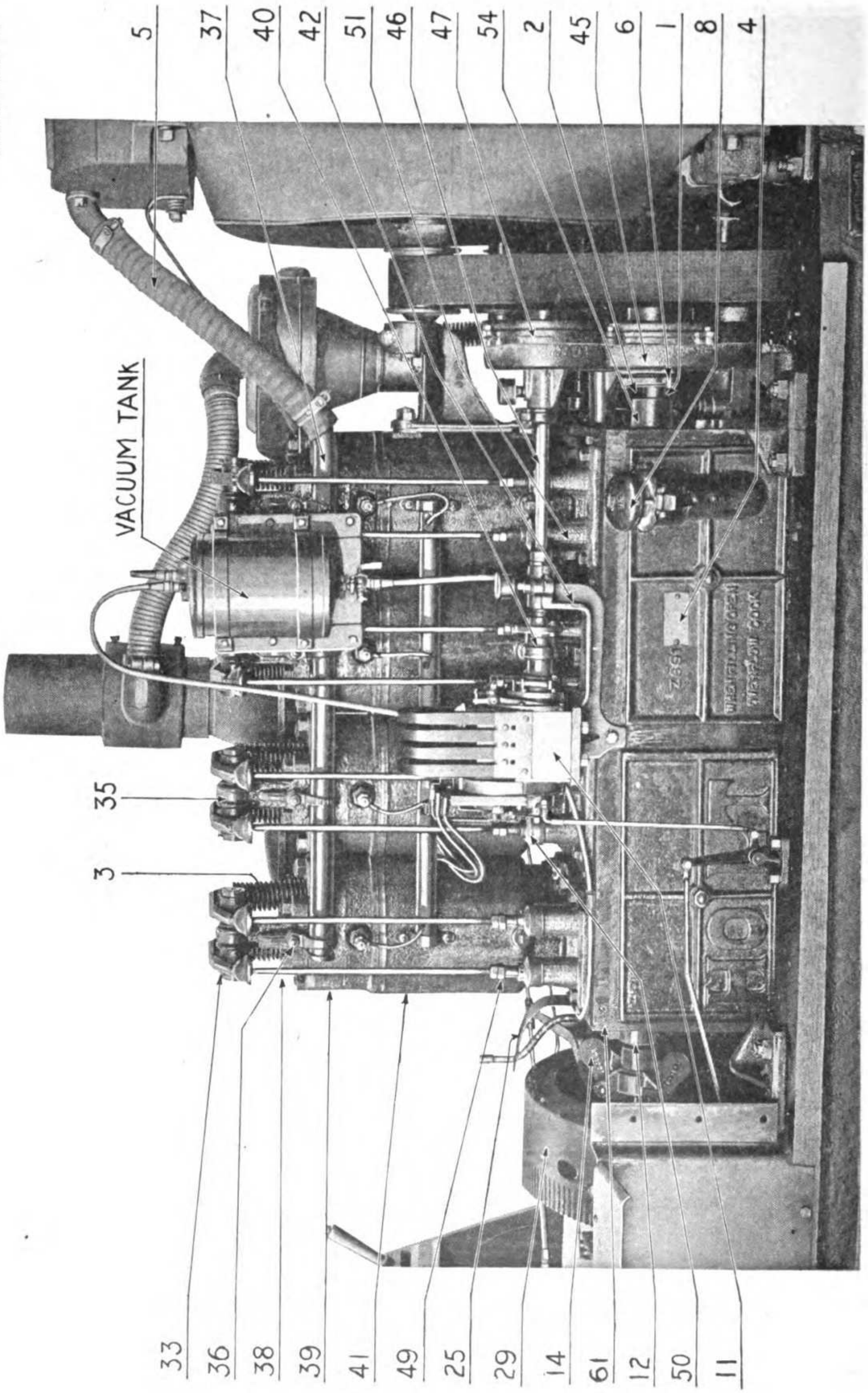
Cooling is by a pump driven by the belt driving the fan, the pump pulley being mounted on a bracket carrying a yoke which has a spring-tensioned idler.

CYCLE OF OPERATION.

The engine operates on the four-stroke cycle which is the same as that of passenger car and truck engines. There are four distinct strokes of the piston necessary for the completion of a cycle, these four strokes being called: Intake, compression, firing (or working stroke) and exhaust.

Upon being cranked by hand, a piston descends while its intake valve is open, and draws a charge of gas into the cylinder through the carburetor and the intake pipe. When the piston is just past the bottom of its stroke, and again returning upwards, the intake valve closes, and as the exhaust valve is at this time also closed, the gas is trapped within the cylinder and

Plate No. 7.



RIGHT SIDE OF ENGINE, SHOWING FITTINGS INSTALLED.

compressed by the piston's upward motion.

When the piston nearly reaches the top of its stroke, the spark occurs and explodes the mixture which, due to its increase in pressure, drives down the piston with considerable force, thus storing up energy in the flywheel for the succeeding stroke.

When the piston nears the bottom of the next stroke the exhaust valve opens, allowing the expanded and now useless gases to escape, and stays open during the following upward movement of the piston, allowing ejection of the remaining burned gases.

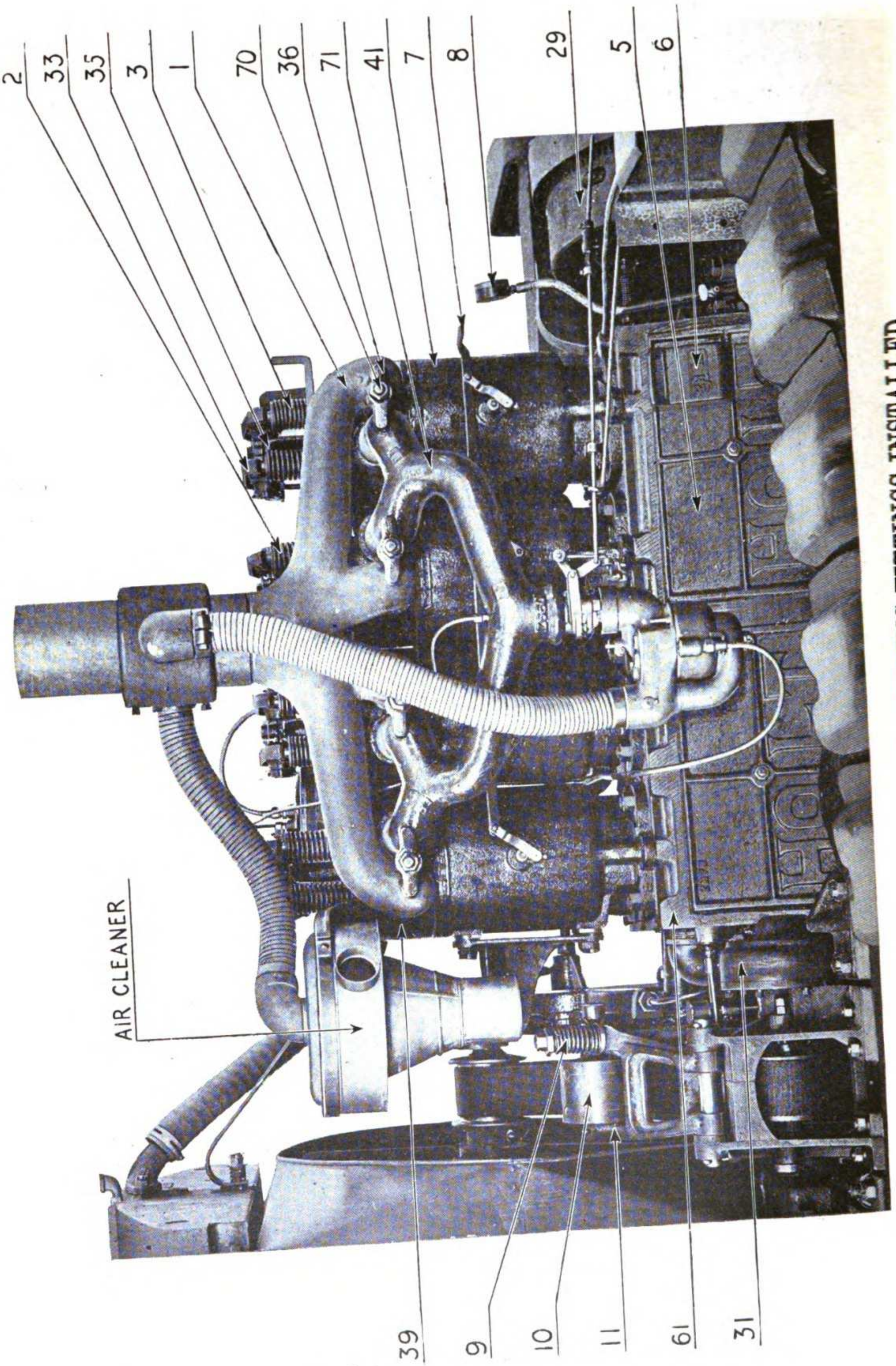
CYLINDERS.

The cylinders (41), Plates 7, 8, 9 and 10, are cast separately, with detachable heads. The material is a close-grained grey iron. The top and bottom ends are machined, after which the cylinders are reamed and the bore ground with a plus or minus tolerance of .001 (one thousandth) inch. The cylinders are attached to the crankcase by four studs and nuts. Both the removable head and the cylinder are water-jacketed.

RIGHT SIDE OF ENGINE, SHOWING FITTINGS INSTALLED.

Ref. No.	Part No.	Name of Part.
1	M10664	Camshaft.
2	160173	Camshaft bearing assembly, timing gear end.
3	M10278	Cylinder head valve spring.
4	AM1408	Crankcase door.
5	7644	Hose.
6	Z717	Camshaft felt retainer ring.
8	Z689	Oil filler cap.
11	AM101	Magneto.
12	160174	Camshaft bearing assembly, flywheel end.
14	100125	Governor weight.
25	M11892	Flywheel pointer.
29	Z683	Flywheel.
33	M11453	Valve rocker arm.
35	Z670	Valve rocker arm bracket.
36	Z731	Water manifold clamp.
37	AM1362	Water manifold assembly.
38	160883	Valve tappet rod.
39	Z649	Cylinder head.
40	AM140	Magneto, Oldham coupling assembly.
41	ZH92	Cylinder, rear.
42	101703	Magneto bracket.
45	100138	Timing gear case.
46	M1421	Magneto shaft.
47	101691	Timing gearcase cover.
49	102195	Valve tappet rod adjusting nut.
50	102197	Valve tappet rod dust cap.
51	Z672	Valve tappet guide.
54	100422	Camshaft bearing assembly, timing gear end.
61	Z667	Crankcase.

Plate No. 8.



LEFT SIDE OF ENGINE, SHOWING FITTINGS INSTALLED.

PISTONS.

The four pistons (6), Plate 9 and Plate 11, are of grey iron and have three rings (7), Plates 8 and 10, above the wristpin (10). They are 6.496 inches in diameter at the bottom, 6.477 at the top and are 6 inches long. The bottom has a 0.0625 ($\frac{1}{16}$)-inch chamfer.

PISTON CLEARANCE.

The piston itself cannot be made an absolute fit in the cylinder because provision has to be made for expansion under the high operating temperature to which it is subjected. The expansion of the piston is taken care of in two ways:

First, the piston is tapered from the bottom of the third piston ring slot to the top of the piston.

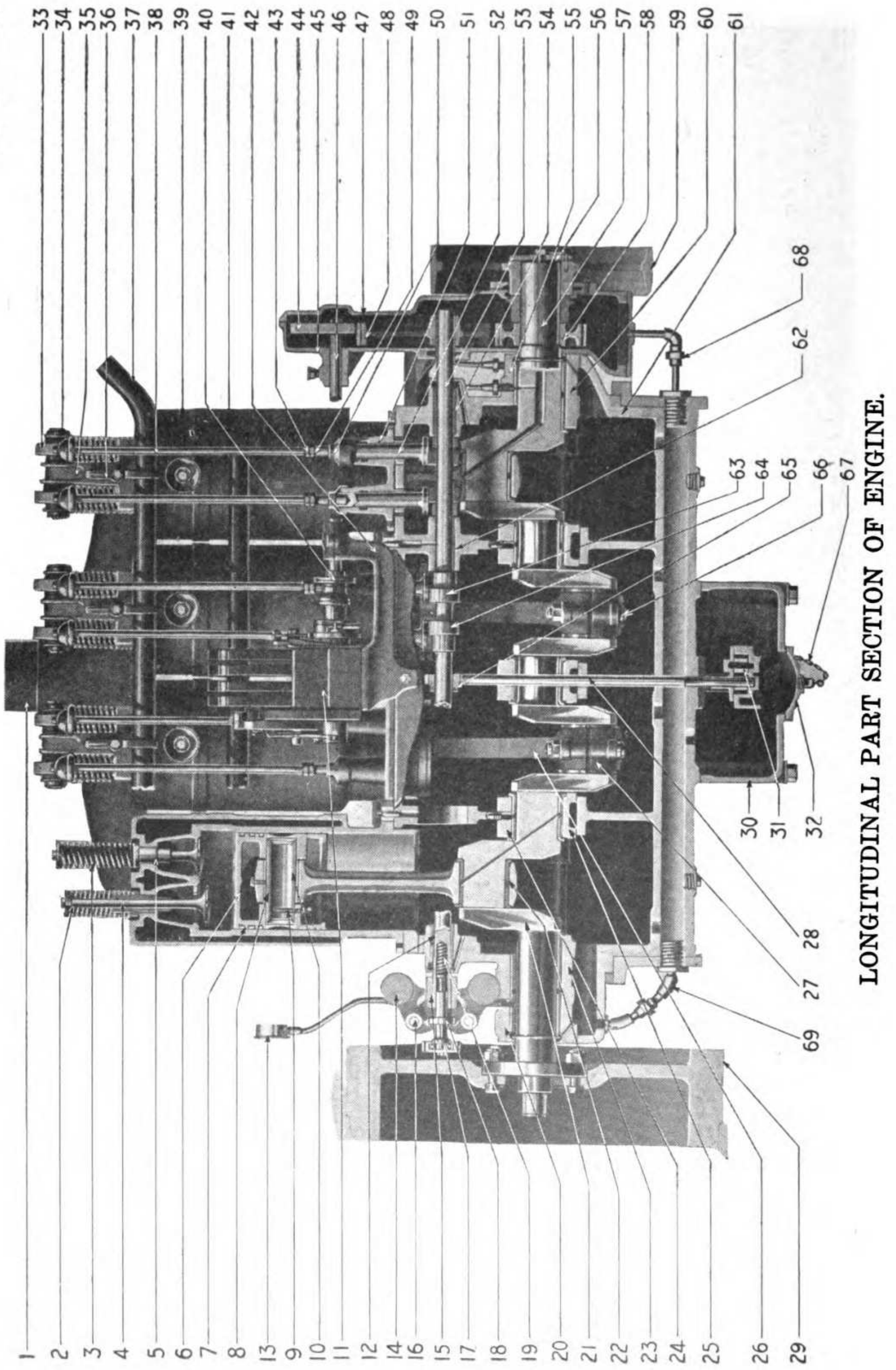
Second, the body of the piston or "skirt" is made a certain amount smaller than the cylinder it works in. The piston clearance is 0.001 (one

---

LEFT SIDE OF ENGINE, SHOWING FITTINGS INSTALLED.

Ref. No.	Part No.	Name of Part.
1	ZH17	Manifold, exhaust.
2	M11442	Cylinder head valve spring collar.
3	M10278	Cylinder head valve spring.
5	Z725	Crankcase door.
6		Breather.
7	M1427	Compression release cock lever.
8	10533	Oil gauge.
9	2151	Idler tension spring.
10	10297	Idler pulley.
11	8912	Idler pulley yoke.
29	Z683	Flywheel.
31	8911	Water pump casing.
33	M11453	Valve rocker arm.
35	Z670	Valve rocker arm bracket.
36	ZH28	Exhaust and inlet manifold clamp.
39	Z649	Cylinder head.
41	ZH92	Cylinder, rear.
61	Z667	Crankcase.
70	M1945	Exhaust and inlet manifold stud nut.
71	Z650	Inlet manifold.

Plate No. 9.

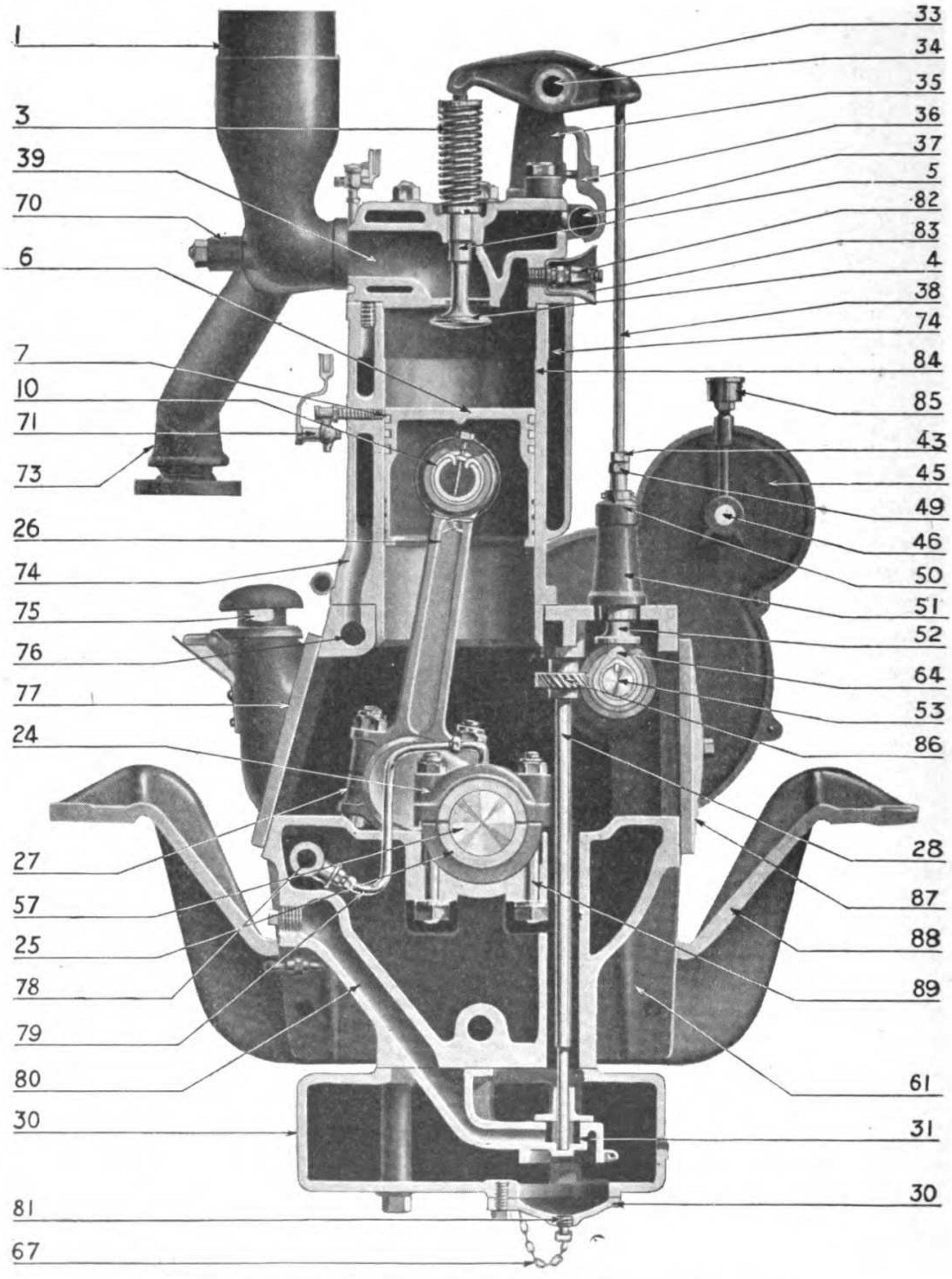


LONGITUDINAL PART SECTION OF ENGINE.

LONGITUDINAL SECTION THROUGH ENGINE.

Ref. No.	Part No.	Name of Part.
1	ZH-17	Manifold, exhaust.
2	M-11442	Cylinder head valve spring collar.
3	M-10278	Cylinder head valve spring.
4	M-11381	Cylinder head valve.
5	Z-714	Cylinder head valve guide.
6	Z-676	Piston.
7	M-2292	Piston ring.
8	B-359	Connecting rod piston-pin end bushing.
9	M-11849	Set screw ($\frac{1}{2}$ x $2\frac{3}{16}$").
10	M-11850	Piston pin.
11	AM-101	Magneto.
12	160174	Camshaft bearing assembly, flywheel end.
13	10533	Oiler gauge.
14	100125	Governor weight.
15	ACDH-4	Governor body.
16	M-1036	Governor weight pin.
17	AM-1403	Governor plunger bearing.
18	100462	Governor plunger.
19	100463	Governor plunger spring.
20	Z-730	Crankshaft bearing cap, flywheel end.
21	M-11101	Crankshaft, flywheel end.
22	B-355	Connecting rod die-cast bushing.
23	Z-659	Crankshaft bearing, flywheel end.
24	Z-660	Crankshaft bearing cap, center.
25	Z-655	Crankshaft bearing, center.
26	100379	Connecting rod.
27	100258	Connecting rod cap.
28	M-1062	Oil pump shaft.
29	Z-683	Flywheel.
30	Z-690	Crankcase oil reservoir.
31	AM-1480	Oil pump assembly.
32	Z-692	Crankcase oil reservoir hand hole cover.
33	M-11453	Valve rocker arm.
34	M-2503	Valve rocker arm pin.
35	Z-670	Valve rocker arm bracket.
36	Z-731	Water manifold clamp.
37	AM-1362	Water manifold assembly.
38	160883	Valve tappet rod.
39	Z-649	Cylinder head.
40	AM-140	Magneto Oldham coupling assembly.
41	100184	Cylinder, front.
42	101703	Magneto bracket.
43	102283	Valve tappet rod lock nut.
44	ZH-20	Magneto shaft gear.
45	100138	Timing gear case.
46	M-1421	Magneto shaft.
47	101691	Timing gear case cover.
48	102293	Camshaft gear.
49	102195	Valve tappet rod adjusting nut.
50	102197	Valve tappet rod dust cap.
51	Z-672	Valve tappet guide.
52	ZH-31	Valve tappet.
53	M-10664 or M-11183	Camshaft.
54	100422	Camshaft bearing assembly, timing gear end.
55	Z-656	Crankshaft bearing cap, gear end.
56	M-11465	Crankshaft end washer.
57	M-11101	Crankshaft, timing gear end.
58	M-11497	Crankshaft timing gear.
59	Z-715	Crankshaft fan pulley.
60	Z-658	Crankshaft bearing, gear end.
61	Z-667	Crankcase.
62	160175	Camshaft bearing assembly.
63	Z-647	Camshaft cam, inlet.
64	Z-648	Camshaft cam, exhaust.
65	M-10630	Camshaft spiral gear.
66	M-11927	Connecting rod bolt.
67	M-11189	Chain for oil reservoir drain plug.
68		Oil pipe.
69		Oil pipe.

Plate No. 10.

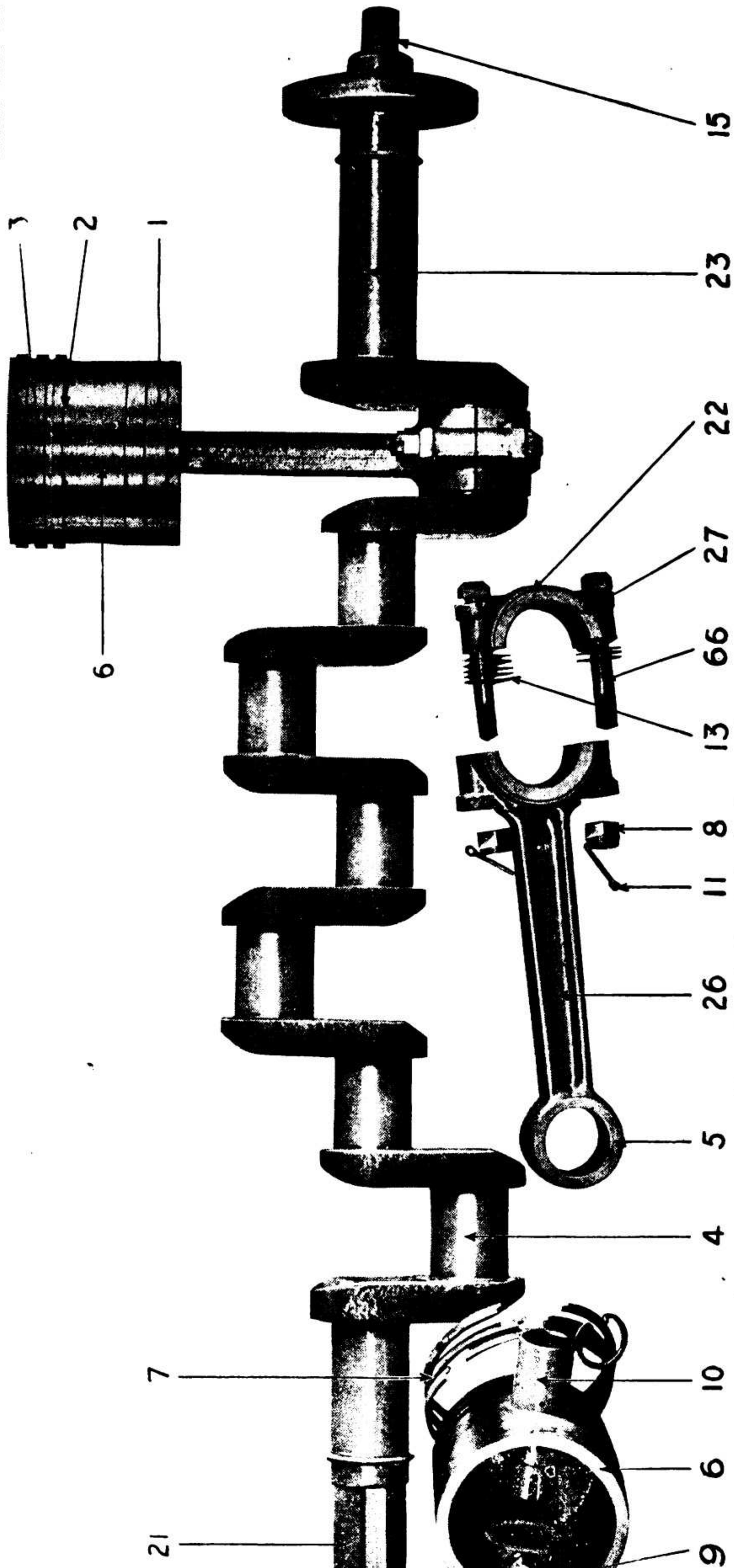


TRANSVERSE SECTION THROUGH ENGINE.

TRANSVERSE SECTION THROUGH ENGINE.

Ref. No.	Part No.	Name of Part.
1	ZH17	Manifold, exhaust.
3	M10278	Cylinder head valve spring.
4	M11381	Cylinder head valve.
5	Z714	Cylinder head valve guide.
6	Z676	Piston.
7	M2292	Piston ring.
10	M11850	Piston pin.
24	Z660	Crankshaft bearing cap (center).
25	Z655	Crankshaft bearing (center).
26	100379	Connecting rod.
27	100258	Connecting rod cap, crank pin end.
28	M1062	Oil pump shaft.
30	Z692	Oil reservoir hand hole cover.
31	AM1480	Oil pump assembly.
33	M11453	Valve rocker arm.
34	M2503	Valve rocker arm pin.
35	Z670	Rocker arm bracket.
36	Z731	Water manifold clamp.
37	AM1362	Water manifold.
38	160883	Valve tappet rod.
39	Z649	Cylinder head.
43	102283	Valve tappet rod lock nut.
45	100138	Timing gear case.
46	M1421	Magneto shaft.
49	102195	Valve tappet rod adjusting nut.
50	102197	Valve tappet rod dust cap.
51	Z672	Valve tappet guide.
52	Z431	Valve tappet.
53	M10664 or M11183	Camshaft.
57	M11101	Crankshaft.
61	Z667	Crankcase.
64	Z648	Camshaft exhaust cam.
67	M11189	Oil reservoir drain plug chain.
70	ZH28	Exhaust and inlet manifold clamp.
71	AM1656	Compression release cock.
73	Z650	Inlet manifold.
74		Water jacket.
75	Z689	Crankcase door oil filler cap.
76		Water jacket inlet.
77	AM1408	Crankcase door with oil filler.
78	M10662	Tee-oil piping assembly.
79	M10658	Copper tubing.
80		Pump outflow.
81	M11150	Crankcase oil reservoir hand hole cover plug.
82	7840	Spark plug.
83	100124	Spark plug protector.
84	ZH92	Cylinder, rear.
85	160516	Grease cup.
86	Z674	Oil pump shaft spiral gear.
87	ZH78	Crankcase door.
88	Z712	Motor hanger bracket.
89	M12039	Crankshaft bearing stud.

Plate No. 11.



CRANKSHAFT, CONNECTING RODS, PISTONS, ETC., PARTIALLY DISASSEMBLED.

thousandth) of an inch for every inch of bore plus 0.0015 (one and one-half thousandth) inch for overall.

The sides of the piston body or "skirt" are parallel. When the working temperatures expand a piston it finally fits the cylinder with a sliding fit. The film of lubricating oil occupies the final clearance between piston ring and cylinder walls, and is the final seal to retain compression.

Three oil grooves (1), Plate 11, are cut on the bottom of the piston skirt to carry the lubricating oil to the cylinder wall and piston rings. The third or lower ring groove (2) is drilled with 0.15625 ($\frac{5}{32}$)-inch holes at a tangent for the purpose of draining excess oil back into the crankcase. These oil grooves and holes must be kept free from carbon and foreign matter.

PISTON RINGS.

The three piston rings (7), Plate 11, are of grey iron, machined and ground. They are of the step type and are located above the wristpin (10). The function of the piston rings is to seal the space between the

---

PISTON CONNECTING ROD AND CRANKSHAFT.

Ref. No.	Part No.	Name of Part.
1		Oil grooves.
2		Piston oil drain holes.
3	M2292	Piston ring.
4		Crank pin.
5		Connecting rod, piston pin end.
6	Z676	Piston.
7	M2292	Piston rings.
8	M2023	Castle nut.
9	M11849	Piston pin set screw.
10	M11850	Piston pin.
11	M1590	Cotter pin.
13	M11448 }	Shims.
	M11449 }	
15	M11101	Crankshaft.
21	M11101	Crankshaft.
22	100258	Connecting rod cap.
23		Crankshaft main bearing surface.
26	100379	Connecting rod.
27		Connecting rod crank pin bushing (babbitt).
66	M11927	Connecting rod bolts.

cylinder walls and piston, preventing the escape of the gases under pressure. The rings also prevent excess lubricant from working into the combustion chamber of the cylinder.

PISTON PIN.

The piston pin (10), Plates 9 and 11, is of the fixed type; that is, the small end of the connecting rod (8), Plate 9, and (5), Plate 11, rotates on it. The piston pin is of hollow tube steel, ground to size and case hardened and is 1.9375 ($1\frac{15}{16}$) inch in diameter.

The piston pin hole is bored at right angles to the axis of the piston through two bosses. The hole in the boss that carries the wrist pin set screw is reamed to 1.875 ($1\frac{7}{8}$) inch, while the hole in the other boss is reamed to 1.9375 ($1\frac{15}{16}$) inch.

PISTON PIN RETENTION.

The piston pin is held in position by a pin set screw. This allows the expansion of the case-hardened steel piston pin to occur without carrying the piston out of round, as but one end is anchored. The set screw should be accurately inserted in the place provided on the inside of the pin and should be kept tight and accurate in its position.

CONNECTING ROD.

The connecting rod (26), Plates 10 and 11, so-called because it connects the piston pin (10), Plate 10, of the piston (6), and crankpin. (4) of the crankshaft (21), is a drop forging of H section, and is 13.5 ($13\frac{1}{2}$) inches long from center to center of piston pin and crankpin. The material is carbon steel.

CONNECTING ROD BEARINGS.

The small end of the connecting rod (5), Plate 11, carries a phospohr-bronze bushing (8), Plate 9, which is retained by means of a set screw, which prevents turning of the bushing when the rod oscillates on the piston pin.

The large end of the connecting rod, which is of the split type; is clamped about the crankpin. The bearing is 2.8125 ($2\frac{13}{16}$) inches in diameter, and 3.25 ($3\frac{1}{4}$) inches long. The bearing material is babbitt, in a die-cast bushing (22). The bearing cap (27), Plates 9 and 11, is retained by two connecting rod bolts (66), Plates 9 and 11, which are locked by a nut (8), Plate 11, and cotter pins (11). Shims (13) are provided between the bearing cap and connecting rod proper for the purpose of compensating for wear of the bearing.

CRANKSHAFT.

The crankshaft (21), Plates 9 and 11, is a chrome nickel steel forging, heat-treated and all bearings are ground with a tolerance of plus or minus 0.0005 (one-half thousandth) inch. The flywheel flange is integral with the crankshaft and the flywheel (29), Plate 9, is bolted to the flange. The extreme flywheel end of the shaft (15), Plate 11, is turned down to take a self-aligning S. K. F. ball bearing which supports the weight of the master clutch.

CRANKSHAFT BEARINGS.

The crankshaft is supported by five main bearings, one at the flywheel end (20), Plate 9, one at the timing gear end (60), and by three center bearings (24). The bearing dimensions are: Flywheel end, 7.5625 inches; center, 3.5 inches; timing gear end, 5.1875 inches. For convenience, the main bearings are numbered 1, 2, 3, 4, 5, the timing gear end bearing being known as the No. 1. The main bearings proper of the crankshaft are of the divided type, and the bearing material is babbitt. The bearings are retained by bolts and nuts, cotter pinned.

The cap for the flywheel and gearcase end bearings, in addition, have a plate cast on to completely cover the area of the crankcase required to insert the crankshaft through, consequently these two are called flywheel cap and end plate, and gear case end cap and end plate.

CRANKCASE.

The crankcase (61), Plates 7, 8 and 9, is a one-piece construction of cast iron and bolted to it at either end are the engine hanger brackets (88), Plate 10. These brackets are bolted to the main frame. Two doors on either side of the crankcase afford access to the bearings, etc., and these crankcase doors are secured by a stud and nut. The left rear crankcase door (5), Plate 8, carries the breather (6). The right forward crankcase door (4), Plate 7, includes the oil filler member and cap (8). Gaskets are utilized between the doors and crankcase to avoid the possibility of oil leaking.

CAMSHAFT.

The camshaft (53), Plates 9 and 10, which is supported in the crankcase by cylindrical cast iron bearings, bronze bushed, carries the intake or inlet cams (63), Plate 9, and the exhaust cams (64), the function of which is to open the valves, admitting the mixture into the cylinder and permitting egress of the burned gases or exhaust. The 10-ton tractors have one of two types of cams, those forged integral with the shaft and the built-up, the latter being pinned and keyed to the shaft.

TIMING GEARS.

The camshaft is rotated by the camshaft gear (48), Plate 6, which has sixty-eight teeth. The gear rotates at half crankshaft speed as the crankshaft gear has thirty-four teeth. The timing gear also drives the magneto gear, which has thirty-four teeth. The camshaft rotates in bronze bushings.

VALVE ASSEMBLY.

There are two valves to each cylinder, an intake and an exhaust, and each valve (4), Plate 9, is opened or moved from its seat or the pressure of the valve spring (3), Plate 9, overcome by the valve tappet rod (38), Plates 7 and 9, which is actuated by the valve tappet (52), Plate 9. The valve tappet moves in the valve tappet guide (51), and entrance of dust or other foreign elements to the tappet guide assembly is prevented by the tappet dust cap (50). The valve tappet is lifted by a cam (64), Plate 10.

VALVES.

The valves are of the poppet type, are 2.75 (2¾) inches in diameter and have a 45-degree bevel seat. The inside diameter of the seat is 2.5 (2½) inches and the lift is 0.4137 inch. The valve head is of cast iron electrically welded to a mild steel case-hardened stem. The tappet guide material is cast iron.

The valves are located in the detachable cylinder head (39), Plate 9, and the cylinder head valve spring (3), Plates 7 and 8, is retained by a cylinder head valve spring collar (2) and split lock washer. The valves are opened by compressing the valve springs by a valve rocker arm (33) pivotally mounted on an arm bracket (35). The cylinder head valve guide (5), Plate 9, is of the removable type.

VALVE STEM GUIDE LUBRICATION.

The valve stem guides should be lubricated four times a day with a mixture one-half cylinder oil and one-half kerosene. This penetrates better than straight cylinder oil. The lubrication of valve stems and guides must never be neglected.

FLYWHEEL.

The flywheel (29), Plates 8 and 9, is 25 inches in diameter and is secured to the flanged end of the crankshaft by six bolts. One hole is staggered so that a new marked flywheel can always be inserted in the field. The periphery of the flywheel has 148 teeth with which the gear of the hand engine starter meshes.

ENGINE MANIFOLDS.

There are two manifolds, the exhaust and the intake. The intake manifold (71), Plate 8, conveys the mixture to the cylinders. The exhaust manifold conveys the exhaust gases and, like the intake, has four branches with openings registering with ports in the cylinders. Attached to the exhaust manifold proper is a pipe or exhaust manifold (1), Plate 9. The manifolds are secured to the cylinders by manifold clamps (36), Plate 8, which are tightened on manifold studs (70), Plate 8, by nuts. Copper asbestos gaskets are utilized between the manifolds and cylinder to obtain a tight connection. The conventional gasket between the carburetor and intake manifold is eliminated, the part carrying the throttle operating mechanism being threaded into the carburetor and manifold.

LUBRICATION SYSTEM.

Lubrication of the engine is by a combined force feed and splash system, a rotary pump (31), Plates 9 and 10, located in the bottom of the crankcase oil reservoir (30), pumping the lubricant under pressure to a pipe extending the length of the crankcase. Leads or pipes from the main pipe convey the oil to the main bearings of the crankshaft which is drilled diagonally so that the oil is carried through the crank from the main bearings to the connecting rod bearings.

The oil which overflows at the ends of the connecting rod bearings is splashed by the ends of the connecting rods to the cylinders, piston pins and camshaft bearings. The timing gears are lubricated by the oil from the pump by a check valve with a by-pass into the timing gear housing, the overflow from a standpipe, in the last named returning through a duct, to the crankcase, thence to the oil reservoir. The function of the check valve is to maintain the pressure which is from 3 to 4 pounds.

PRESSURE GAUGE.

A pressure gauge (13), Plate 9, and (8), Plate 8, is mounted at the rear of the engine and in plain view of the driver. It should show a steady pressure at all times. If the gauge or indicating member fluctuates it indicates that the system is clogged at some point and the trouble must be immediately located and the fault corrected.

OIL PUMP.

The oil pump is of the rotary gear type, is driven by a spiral gear (86), Plate 10, on a vertical shaft and the first-named gear meshes with a similar gear (65), Plate 9, on the camshaft.

OIL PUMP SCREEN.

The oil pump screen which is placed over the bottom of the oil pump body (31), Plate 9, may become clogged by foreign matter collecting at this point. In order to clean this screen, the reservoir does not have to be removed, but by draining off the oil in reservoir (30) and taking off hand plate (32) on bottom of oil reservoir, the screen can be readily removed and cleaned. Loss of plate is prevented by a chain (67).

The most common agent in clogging the screen will be particles of waste or lint from rags used in cleaning the crankcase. Waste or rags giving off lint should never be used in the crankcase as the disengaged particles will clog the oiling system and pump screen and damage will result.

If the oil is not drained from the engine, or the crankcase washed at regular intervals, foreign matter may accumulate in the bottom of the reservoir that will clog or impede the circulation of the oil. The correct method of washing the crankcase is described under the section dealing with the crankcase.

RENEWING OIL SUPPLY.

The engine must have the correct supply of clean cylinder oil, Spec. Medium No. 3502, at all times. The oil must always be inserted through the cap and strainer (8), Plate 7. The oil runs under the forward cylinder and thence through a tunnel on the bottom of the crankcase to oil reservoir. A pet cock is provided in the bottom of the crankcase on the right hand forward side of the engine. This pet cock should be opened when putting oil in through strainer and filling continued till oil comes out of pet cock. A pet cock located in the right side of the oil reservoir gives "low" oil level.

FIELD REPAIRS TO ENGINE.

FITTING CYLINDER GASKETS.

The cylinders proper are bolted to the crankcase and it is important that the joint be oil-tight, else the lubricant will escape from the crankcase. If oil escapes, remove the cylinder and clean thoroughly the bottom of the cylinder and the crankcase, taking care to displace all dirt and oil. Make a gasket of heavy wrapping paper, taking care not to cover the water passage to the cylinders. This passage utilizes a cylindrical rubber gasket which is approximately 0.03125 (1/32) inch thick. It is important that this gasket seal the opening between the cylinder and

crankcase and it may be necessary to add paper gaskets to obtain the desired seal. After making the paper gasket, cover it on both sides with shellac and allow the shellac to almost dry before placing it on the crankcase. Replace cylinder and bolt down. The correct size of a gasket may be determined by placing the paper or other material over the part and with a light ball pein hammer lightly tap the material to outline the part.

FITTING CYLINDER HEAD GASKETS.

The joint between the cylinder and cylinder head is made watertight by using a copper-asbestos gasket. If the cylinder head has not been bolted down evenly and tightly into place the cylinder head gasket may leak water into the cylinder, or the water may leak on the outside of the engine. To determine if gasket is leaking due to cylinder head being improperly bolted down, proceed as follows: Slack off the nuts on the cylinder head studs a few turns, seat cylinder head on cylinder head gasket by using a large hammer on the cylinder head and a block of wood to cushion the blows, then commence to bring cylinder head into place with the nuts on the cylinder head studs by giving each nut in rotation around cylinder head an equal number of turns until firmly bolted down. If the gasket still leaks, remove the gasket and replace with a new one. If a new gasket is not at hand an emergency repair can be made by drying the cylinder head and cylinder surface and gasket, shellacking the gasket and allowing it to dry until very tacky. This practice is not to be recommended, but can be used in case of an emergency.

REMOVING PISTON.

When it is desired to remove the pistons for the purpose of fitting new rings or cleaning the piston ring grooves, the pistons can be removed through the crankcase doors on the side opposite the camshaft. Plates 12 and 13 show the method.

(a) Remove the spark plugs so that compression will be released and not interfere with handling the piston.

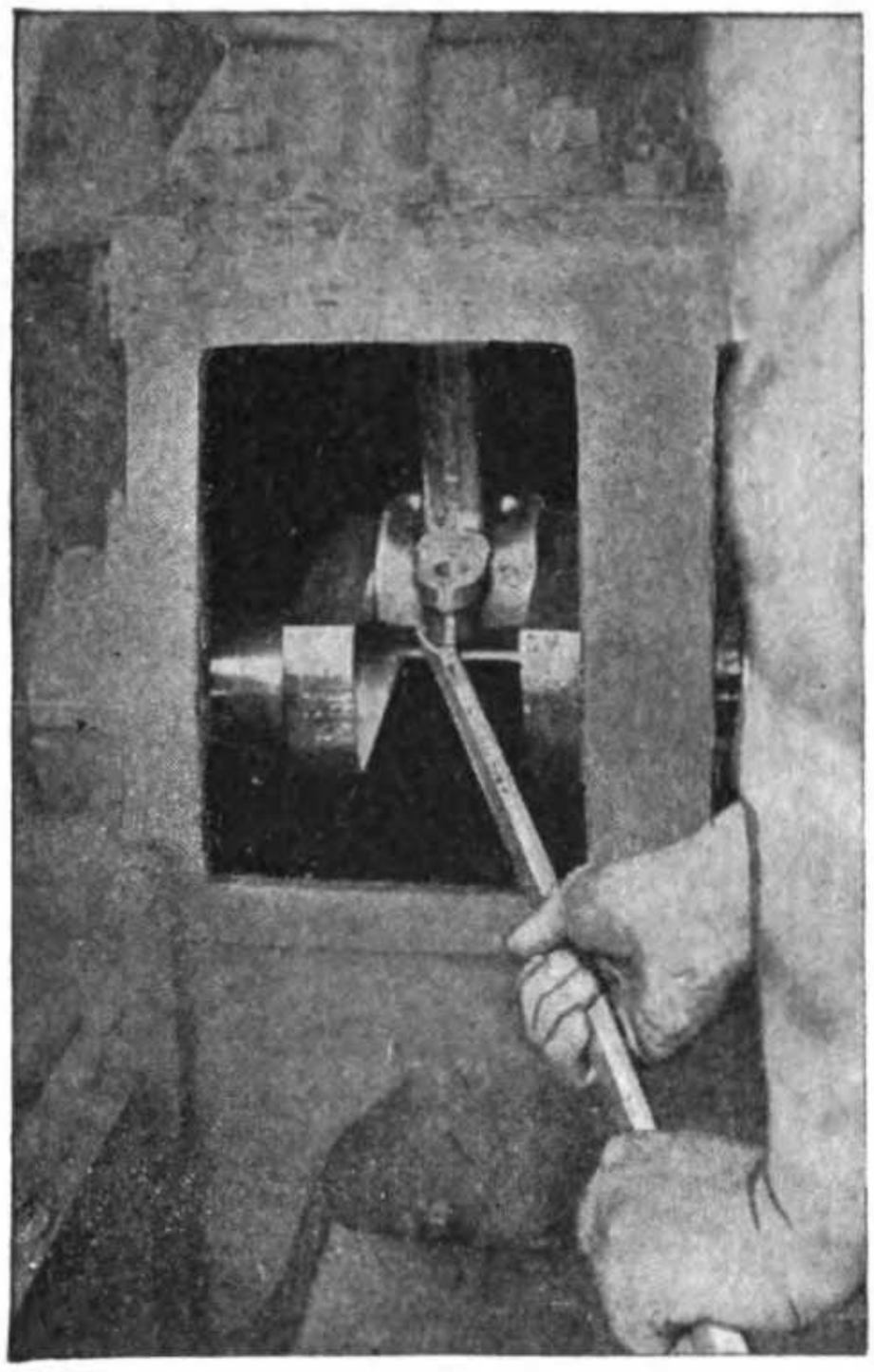
(b) By means of the flywheel revolve the crankshaft until the lower connecting rod bearing of the piston desired is accessible.

(c) Remove the lower half of the connecting rod bearing.

(d) Rotate the flywheel (with the upper half of the connecting rod bearing still on the crank-pin) until the bearing is almost on the opposite side of the crankcase.

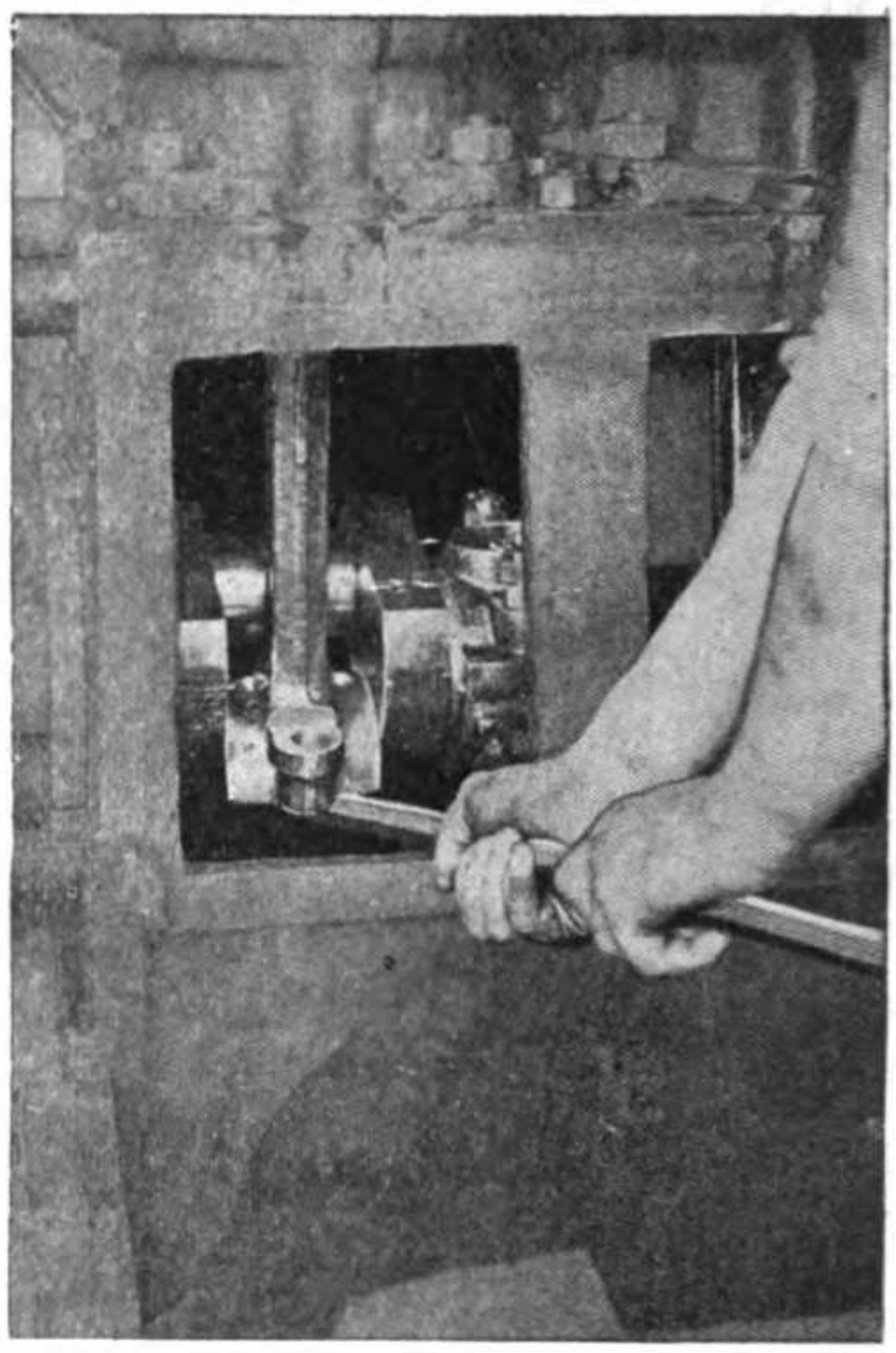
(e) With a light bar unseat the upper half of the connecting rod bearing from the crank-pin and with one hand on the connecting rod lower it with the bar until the upper part of the bottom bearing spans the oil tunnel in

Plate No. 12.



POSITION 1.

After removal of bolts and connecting rod cap, place small bar carefully under rod, taking care not to damage babbitt metal.



POSITION 2.

Lower until connecting rod spans the oil tunnel in the base and piston rests on sides of crank webs.

Plate No. 13.

POSITION 3.

Pull piston forward. Don't let it fall out. It will not bind if crank is in right position.

POSITION 4.

Grasp the piston in the manner shown and lift out of the base.

METHOD OF REMOVING PISTONS.

the base of the crankcase. At this point it may be necessary to rock the crankshaft one way or the other to obtain the necessary angle to allow the piston to clear the top of the door.

REPLACING PISTON.

Replacing the piston after cleaning or repairing is accomplished in the reverse direction given above, except that a light bar must be used under the piston with a light purchase on camshaft to slip it into the cylinder. The bottom edge of the cylinder is beveled to aid in compressing the piston rings and to make the insertion of the pistons an easy matter. Never insert a piston through the top of the cylinder as the necessary bevel is not provided to compress the rings and the piston rings may be damaged on one edge. After the piston has been inserted in the cylinder and the lower half of the connecting rod bearing placed on the connecting rod be sure that all cotter keys are placed in the connecting rod bolts.

FITTING PISTON RINGS.

Fitting piston rings to a piston requires care and accuracy in the work. There are three factors to be considered:

First, the fit of the piston ring in the cylinder to get proper ring "break."

Second, the fit of the piston ring in the slot on the outside of the piston.

Third, the fit of the piston ring when placed on the piston.

One should be able to get a perfect adjustment on new piston rings if the following precautions are observed:

Fit the piston ring in the cylinder first. With a fine file remove any wire edge or burrs from the top or bottom outside edge of ring. There are two methods of placing the ring square in the cylinder in order to get the proper ring "break."

First, if the cylinder heads are removed, one of the pistons can be left in the cylinder and the piston ring placed squarely against the head of the piston and then the piston dropped away for an inch or so, to afford an examination of the "break."

Second, in case that it is not desired to remove the cylinder heads, the piston can be removed through the crankcase, piston ring inserted squarely in the bottom of the cylinder by taking accurate measurement from the bottom edge of cylinder. When the piston ring is fitted in the bottom of the cylinder, using a small hand mirror will facilitate examination of the "break."

Allowance must be made for the piston ring's expansion lengthwise so that when the piston and cylinder are heated to operating temperature the free ends of the piston ring will not meet and cause binding of the ends of the piston ring. The top piston ring should have a "break" of 0.024 inch, as this ring is close to the hottest part of the piston, and the

second and third piston rings should have 0.012 of an inch "break." A steel shim out of the connecting rod bearing is 0.012 of an inch thick and can be used as a gauge in determining the correct piston ring "break."

When material has to be removed from the ends of the piston ring to provide the necessary "break" for expansion, clamp a fine mill file in a vise, open the piston ring and clamp the ends of the ring squarely over it and remove material. Be careful never to damage the piston ring split surfaces where they come together horizontally.

CLEANING PISTONS.

The piston ring slot (3), Plate 11, should be scraped clean of all carbon deposits and washed with kerosene. It is useless to fit a piston ring unless the slots are clean, because deposits will interfere with accurate fitting. Scrape the piston ring slot clean with a flat metal scraper. If it is not possible to remove all of the carbon, use No. 000 sand paper under a flat stick, bearing on it lightly while cleaning the slot. *Never use a file or emery cloth for cleaning piston ring slots.* Rinse the slots with kerosene, and wipe dry with a cloth.

After the piston ring has been fitted in the cylinder it should be fitted to the piston slot by revolving the piston ring on the outside of the piston and inside the slot. The vertical expansion of the piston ring in the slot has to be provided for. The top ring should have a clearance of 0.004 inch and the bottom two rings should have a clearance of 0.003 inch. If the ring does not have free movement in the slot some of the material will have to be removed from the top or bottom edge of the ring. Obtain a flat board over which spread a quantity of fine carborundum powder and cup grease mixed into a paste, or use a reliable valve grinding compound; lay the ring flat in this mixture and rotate until the sufficient quantity of material has been removed to secure the necessary clearance. Wash the piston ring with kerosene and wipe clean before trying it in the slot.

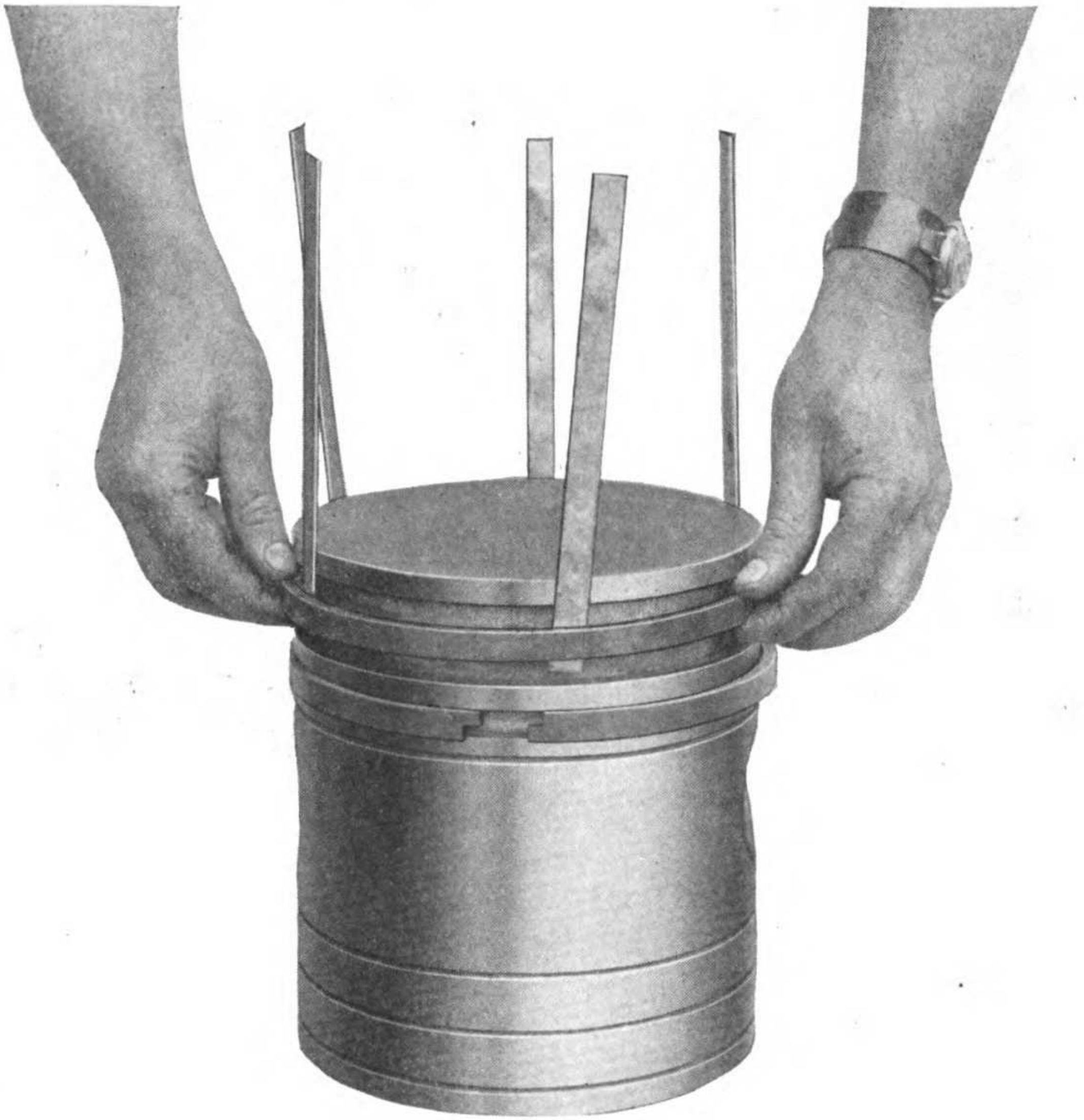
REMOVING RING TOOL.

One of the most convenient tools to have is a piston ring remover, as by its use the piston ring will not be sprung out of round by careless handling or forcing. If removers are not available, three metal guides 0.25 (¼) inch wide, 0.015625 (1/64) inch thick, and about six inches long should be provided. In taking off or replacing piston rings these guides should be placed equally around the piston and underneath the piston ring. In removing rings take off the top first, then the second and third.

In replacing, reverse the order and be careful not to mix the rings, but replace each in the same slot it was taken from.

Place the piston ring in the piston slot to test for freedom of movement horizontally and the correct clearance in the vertical direction.

Plate No. 14.



PUTTING ON PISTON RINGS.

One of the easiest and quickest ways of installing piston rings is here illustrated. Five or six strips of sheet steel, tin or any thin metal is used. Place the ring on the top of the piston ready to slide over the head. Have a helper slip the strips of metal under the ring evenly spaced, as shown. Adjust the metal strips so that their ends are even with the groove into which the particular ring is to be inserted. Then slip the ring down over the strips and it will drop into the groove.

In replacing, be careful not to mix the rings, but replace each in the same slot it was taken from.

Place the piston ring in the piston slot to test for freedom of movement horizontally and the correct clearance in the vertical direction.

Piston rings should be handled carefully and when opened to put on the piston should not be sprung sideways. The piston ring can be easily

sprung so that it will produce a rocking motion when laid on a flat board or bench. It is impossible to fit a rocking or warped piston ring. Piston rings should not be carried indiscriminately with other tools in the tool box. Make provision to carry piston rings separately and stack one on top of the other.

REPLACING PISTON PIN.

The end of the piston pin that carries the hole for the set screw is smaller than the blank end and must be inserted through the hole in the piston opposite the boss carrying the set screw. Piston pins should fit in the piston with a light tapping fit. Always use a bronze or babbitt plug between piston pin and hammer when putting pins into place. In fitting new pistons to piston pins there is always a chance that the operator in the field may get the piston badly out of round by forcing the pin in the piston. Never force a piston pin into piston.

The piston pin bearing (8), Plate 9, is a phosphor-bronze bushing pressed in. This bearing is located at upper end of connecting rod. Two methods can be used for determining looseness in the bearing.

TO DETERMINE LOOSE PISTON PIN BEARING.

First, revolve the crankshaft by the flywheel until the desired piston is at its greatest down position. With a light bar get a "purchase" on the camshaft under the piston, and with one hand on the connecting rod and the thumb extending to the piston. Any movement in the bearing can be felt by the hand. Use pry carefully, observing great care not to injure the bottom edge of the piston.

The best way, however, to determine looseness in the bearing is to remove the pistons and connecting rods from the cylinders, wash the under side of the piston with kerosene, set piston on head and rock the connecting rod sideways. The piston pin bearing can "float" about 0.1875 ($\frac{3}{16}$) inch endwise on the piston pin.

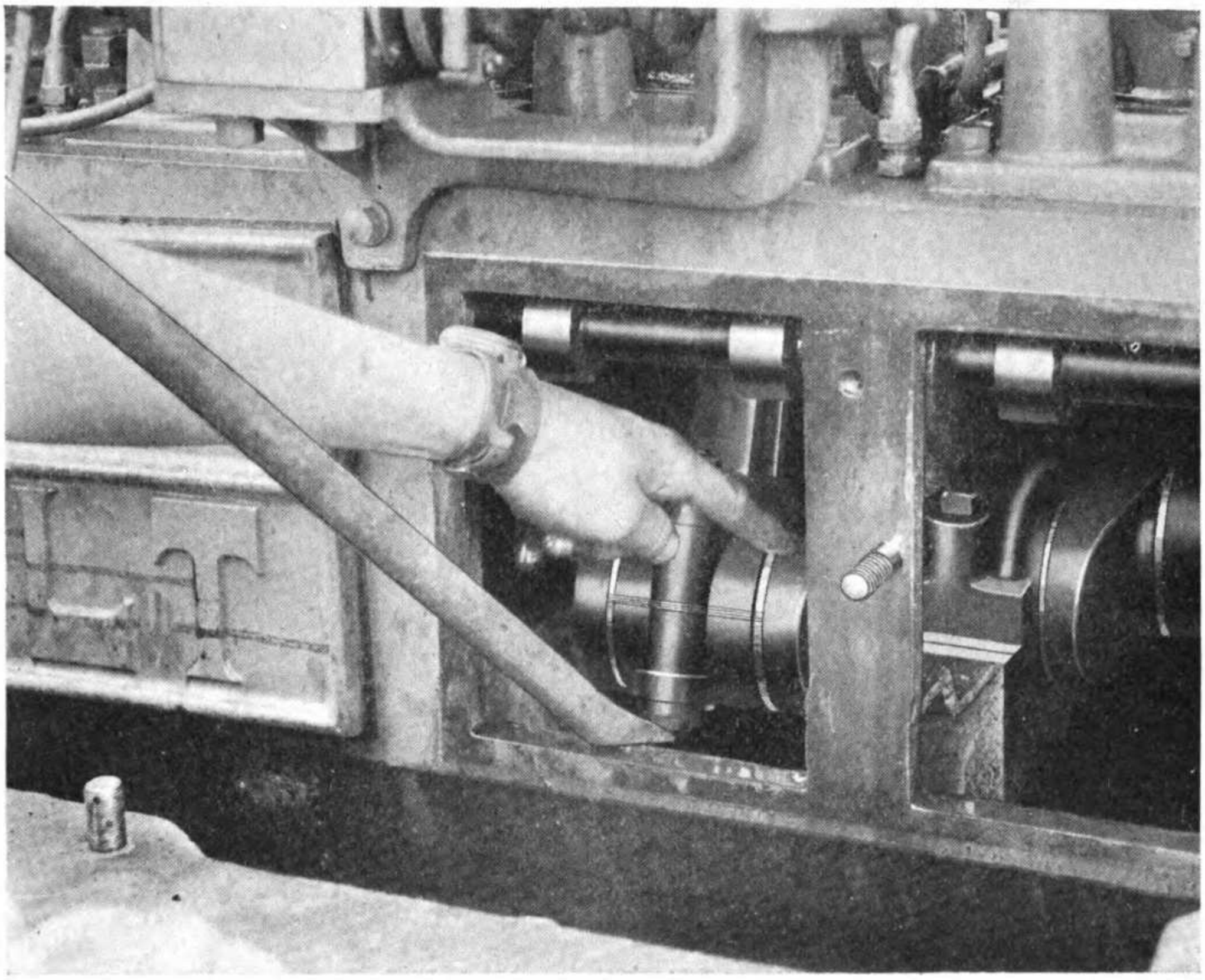
WHEN TO TEST BEARINGS.

The bearings of an engine should be tested when the engine is warm. The operating temperature has then expanded the various parts and the oil film is thinned to the condition under which it has to work. A bearing tested when the engine is cold can have a good deal of play taken up by the thickened oil film, and an accurate determination of loose bearings cannot be made. The bearings of an engine using the force feed system must be maintainel tighter than an engine using the splash feed system. A loose bearing will allow undue escape of oil which will cause the pressure on the rest of the bearings to fall and possibly cause lubrication failure at some point.

TESTING CONNECTING ROD BEARING.

The crankpin bearing is commonly called the connecting rod bearing. This bearing is located in the lower end of the connecting rod. The method of testing is shown in Plate 15. There must be absolutely no vertical movement. The bearing fit, however, must be such that the

Plate No. 15.



TESTING CONNECTING ROD BEARINGS.

Remove the crankcase door and turn the flywheel until the bearing to be tested is at a point nearest the door. Place a bar under the connected rod bearing, using the bottom of the crankcase door as a fulcrum and with a finger placed partly on the top of the bearing and partly on the web of the crankshaft, as shown, move the bar up and down. If the bearing has any looseness, it will readily be felt by this method.

bearing can be moved sideways the thickness of a crankpin bearing shim, or 0.012 of an inch.

FITTING CONNECTING ROD BEARINGS.

Remove the spark plugs to release compression, blue the crankpin with a thin film of color, insert piston in the cylinder and mount the upper

half of the connecting rod bearing on the crankpin and revolve crankshaft slowly. Remove connecting rod and piston, scrape all high spots and continue blueing and scraping until a majority of the bearing shows solid blue. Give relief to edges of bearings about 0.375 (3/8) of an inch down where the two halves of the bearing meet. When the upper half of bearing has been accurately spotted and scraped, place an equal number of shims on each side of the bearing and bring the lower half of the bearing into place by tightening on the connecting rod nuts, and fit cap by spotting and scraping as above outlined. The fit on both the connecting rod bearings and the main bearings must be very close in order that undue escape of oil at one bearing, which will cause a drop of pressure throughout entire system, may be avoided.

One side of each connecting rod and cap contains the same figure on the upper and lower half as 1/1, 2/2, 3/3, 4/4. Always have these numbers on the same side, as the lower part of the bearing will match in the way that it was sawed from the original drop forging, and the connecting rod bolt holes will always line up. When one connecting rod bearing has been satisfactorily scraped in and bolted to the final fit, slack off on the connecting rod bolts and proceed to the next connecting rod. It is not possible to scrape a connecting rod bearing properly without having the piston in the cylinder, as the bearing must be blued and scraped so that the piston will be squared in the cylinder.

TESTING CRANKSHAFT BEARINGS.

To test the crankshaft bearings insert a heavy pinch bar under the crankshaft close to the bearing to be tried, and using the crankcase as a fulcrum try to move the crankshaft vertically in its bearings by prying. One hand should be partly on the bearing and partly on the crankcase web to detect motion, while using the other hand to operate the bar. The least movement in the bearing can be felt. See Plate 15.

SCRAPING IN MAIN BEARINGS.

Bedding or scraping in the crankshaft may be divided into two operations:

First, bedding the main bearings, in crankcase cradles.

Second, bedding the crankshaft in the main bearings.

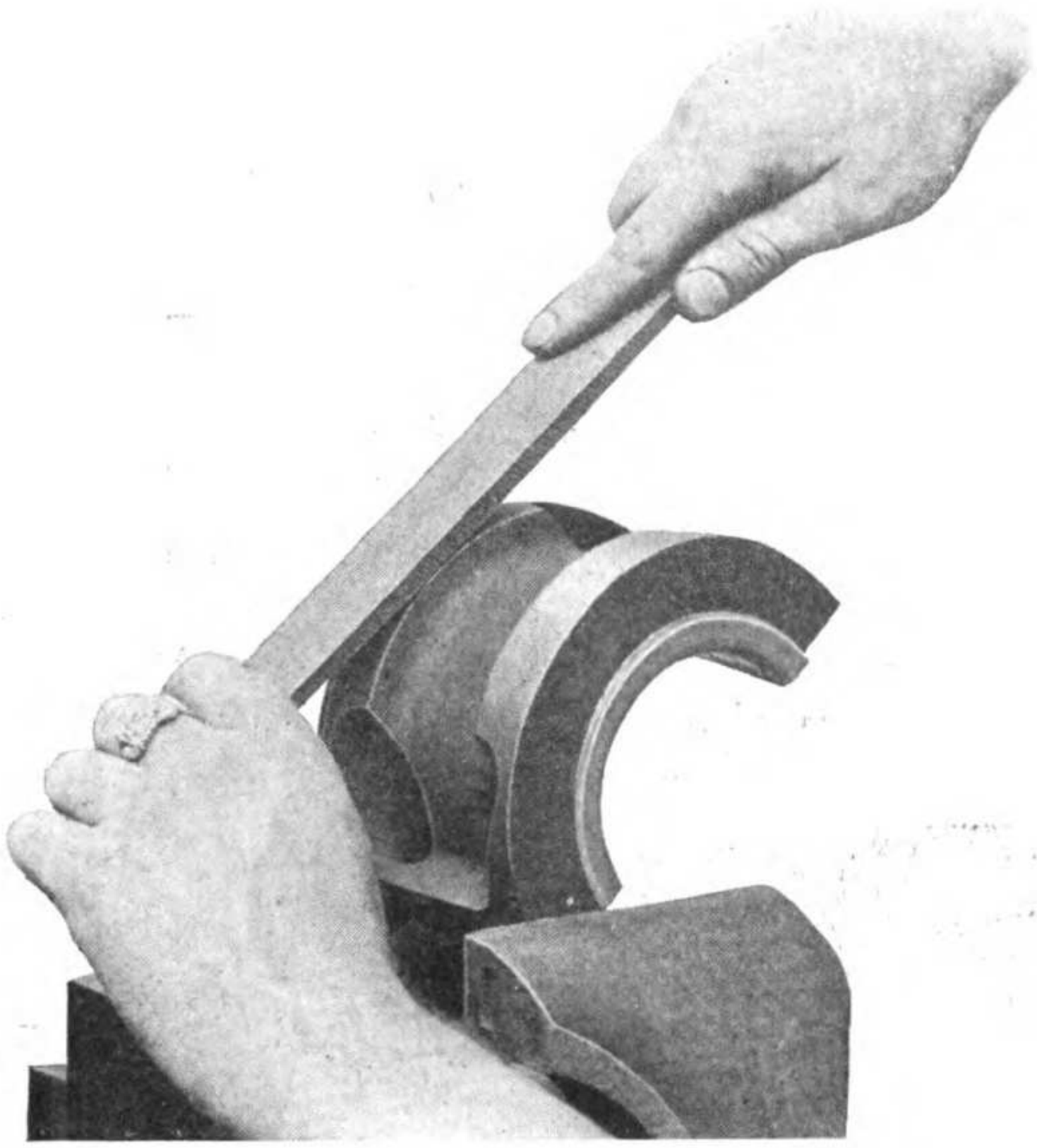
Assuming that crankshaft has not been placed in engine.

(*a*) Blue one end of crankshaft bearing and rotate the babbitted parts of all the lower halves on the crankshaft and scrape to remove high spots. This fitting is not final, but is the starting point for fitting the lower halves.

(*b*) Clean crankcase cradle thoroughly, then blue entire crankcase cradle surface.

(*c*) Put bottom half of main bearing that is to work in that particular

Plate No. 16.



FITTING CAST-IRON BACK OF BEARING.

cradle in place, rock back and forth a few times, then remove lower half from cradle and examine cast iron back of bearing for high spots.

(*d*) Remove any high spots with a fine mill file and continue fitting on back until a perfect seat is secured. *This is important.* See Plate 16.

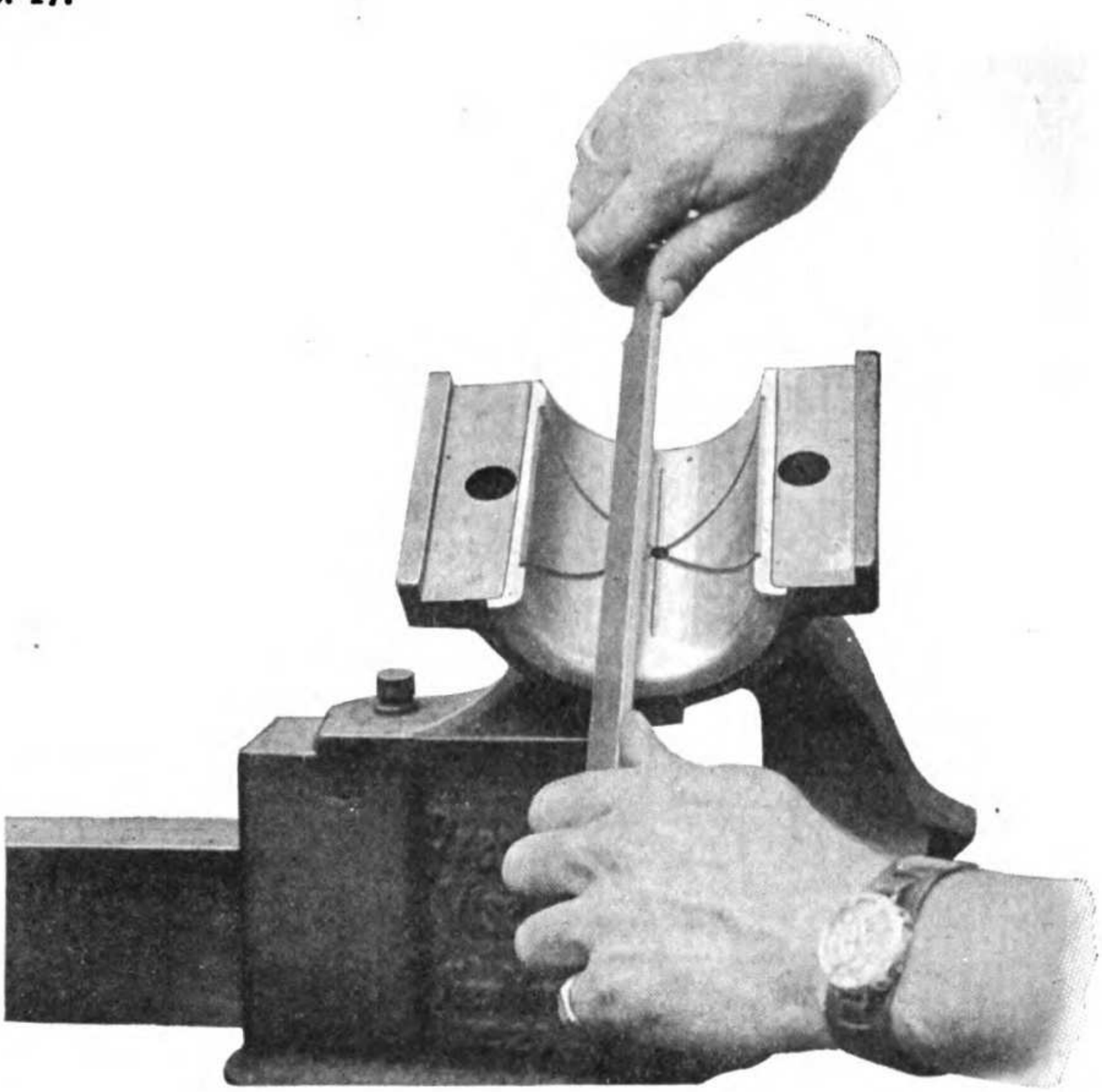
(*e*) After all backs of main bearings have been fitted to crankcase cradles, insert crankshaft which had previously been blued on every main bearing and revolve crankshaft on bottom halves.

(*f*) Either lift up and block crankshaft or remove bottom half bearing by rotating around crankshaft, and scrape all high bearings until they are on line. Never shim up under a low bearing but scrape all high bearings down to a level.

(*g*) Give relief to ends of babbitt in bearing so that the crankshaft can float endwise the thickness of a shim out of the connecting rod bearing 0.012 (twelve thousandths) of an inch. Use a curved babbitt scraper to fit inside edge of fillet of crankshaft. Use a flat babbitt scraper to work on inside of bearing. See Plates 17 and 18.

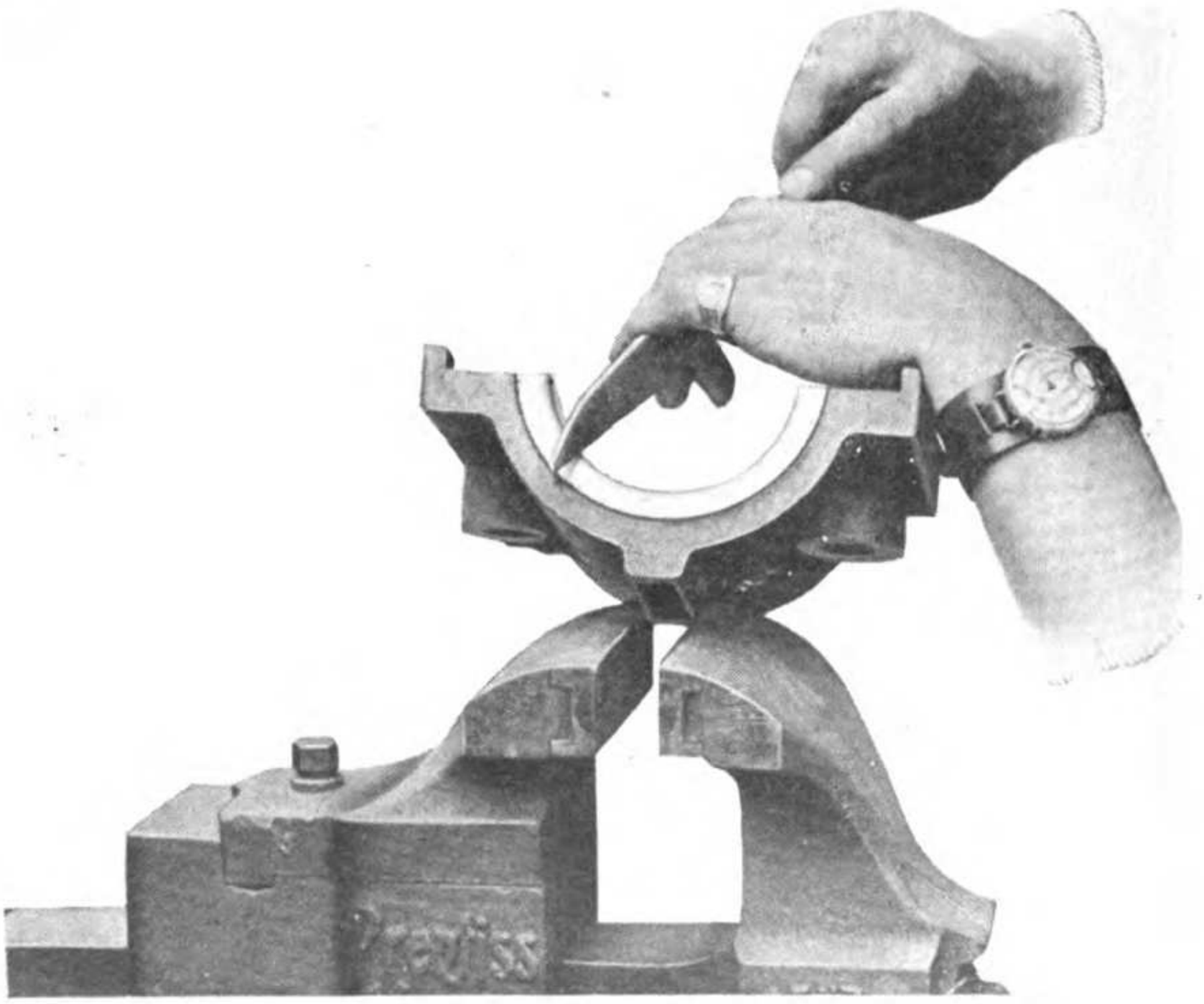
Use a file, applying it level on top of the bottom half of the bearing to bring babbitt down to the level of the cast-iron back of bearing. Give the upper edge of bearing 0.375 (3/8) inch of babbitted surface relief, so that

Plate No. 17.



USING FLAT SCRAPER.

Plate No. 18.



SCRAPING BEARING FILLET.

when pressure is applied to shims the pressure will not be transferred to the babbitt and pinch the crankshaft at the point where the two halves of the bearing meet.

The crankshaft bedding operation has to be accurately done as all the strains are transmitted to the bottom bearing and if one bearing is lower than the others there will be a weave and strain on the crankshaft that will start crystallization and ultimately result in a broken crankshaft.

SHIMMING BEARINGS.

After the bottom bearings have been fitted:

(*a*) Put the bearing bolts into place.

(*b*) Blue the crankshaft.

(*c*) Insert an equal number of shims on each side of the bearing—usually, seven to nine.

(*d*) Bolt down cap lightly, revolve crankshaft.

(*e*) Remove and scrape the cap as before outlined until the bearing surface throughout shows a good seat.

(*f*) Slack off the bearing cap when fitted and proceed to next cap.

(*g*) Slack off the caps as they are fitted so that determination of fit can be made by revolving the crankshaft for the bearing cap that is being worked on.

If the fit is too snug when the bearing caps are all fitted, the final fit is then a matter of inserting shims, always being sure to have an equal number of shims on each side of the bearing.

SHIM DIMENSIONS.

The standard thickness of a shim or liner in the connecting rod and main bearings is 0.012 (twelve thousandths) of an inch. When a bearing is loose and requires the removal of shims to take up the wear, do not remove one shim from one side of the bearing only, but a shim from each side of the bearing. If a shim is removed from each side of a bearing the adjustment of the wearing surfaces of the bearing and the shaft is not altered.

In taking play out of a bearing, removal of a single shim 0.012 (twelve thousandths) of an inch thick may prove too much and the bearing will be too tight. Usually every bearing contains a brass liner 0.005 (five thousandths) of an inch thick which should be carefully preserved when removed from the bearing and used in making close adjustments. If no other means are at hand to get close adjustment a shim cut to shape out of a piece of good tough writing paper can be used. A good grade of writing paper will usually be between 0.003 (three thousandths) and 0.004 (four thousandths) of an inch thick.

CAUSE OF EXCESSIVE WEAR.

If the lower connecting rod or crankpin bearing, and the crankshaft bearings require frequent adjustment it indicates that some cutting compound is at work and a lack of correct care of the crankcase oil supply. Always wipe the crankcase doors clean before removing. Rinse all tools with gasoline before using in crankcase, and have sleeves rolled up. Keeping the crankcase oil supply scrupulously clean means a minimum of bearing trouble and adjustment.

BEARING SCRAPERS.

The best babbitt scraper for crankshaft and connecting rod bearings can be made out of a large mill file which has been hollow ground on one side, one edge brought to a straight edge and a small hollow grinding placed on the thin edge to make a rapid cutting tool. A file is made of very hard material and the grinding is a little difficult.

In using the babbitt scraper on the bearing, take a light firm cut from one edge of the bearing to the other.

REMOVING CRANKSHAFT.

To remove the crankshaft from the engine it will be necessary to:

(*a*) Drain the water from the cooling system.

(*b*) Disconnect the hose (5), Plate 7, between the radiator and water manifold of cylinders and,

(*c*) Remove the radiator.

(*d*) Next displace the fan and

(*e*) Water pump drive pulley,

(*f*) The timing gears and gear housing,

(*g*) Master clutch and

(*h*) Flywheel.

The pistons, connecting rods (see Plate 13), main bearing caps and bolts and oil pump will have to be removed before taking out the crankshaft. In reassembling reverse the order.

REMOVING CAMSHAFT.

The camshaft (53), Plate 9, camshaft bearing assembly timing gear end (54), camshaft bearing assembly flywheel end (12), are removed as a unit. This is accomplished by displacing the radiator, fan, valve tappet assembly, removing the key of timing gear and gear, loosening the three cap screws locked by wire on the triangular plate on the timing gear case or housing, and screws retaining bearings.

This triangular member carries a felt washer.

Remove crankshaft timing gear, magneto gear and timing gear case.

Next displace the governor as a unit and drive out camshaft bearing assemblies (54) and (12), Plate 9, from the inside.

The camshaft assembly can now be moved out through the front end of the crankcase. The camshaft bearing assemblies within the crankcase can be readily loosened after the end camshaft assemblies have been driven out.

WASHING CRANKCASE.

The crankcase of the engine should be washed at regular intervals, usually not less than once every two weeks. Drain all oil from the oil reservoir, remove side plates on one side of engine, and with a squirt gun or dipper wash sides of crankcase allowing kerosene to drain into oil reservoir. With a piece of clean soft canvas or other cloth that does not give off lint, wipe out kerosene on each side of the tunnel in bottom of crankcase. Do not wipe sides of crankcase, thus minimizing chances of getting lint in oil. Wipe out bottom of oil reservoir, replace hand plate cover and fill system with new oil.

VALVE GRINDING.

To grind the valves:

(*a*) Remove the cylinder head and

(*b*) Compress each spring sufficiently to remove the clip that holds it on to the valve stem.

(*c*) Make note of order of removing valves and springs so that they may be reassembled in their proper position or order.

An effective valve grinding tool can be made by forging a bit to fit the slot in the valve head and work in the socket of a brace. This method is much to be preferred over using a screw driver.

A valve grinding tool that can be quickly improvised is a small cut washer inserted in the socket of a brace.

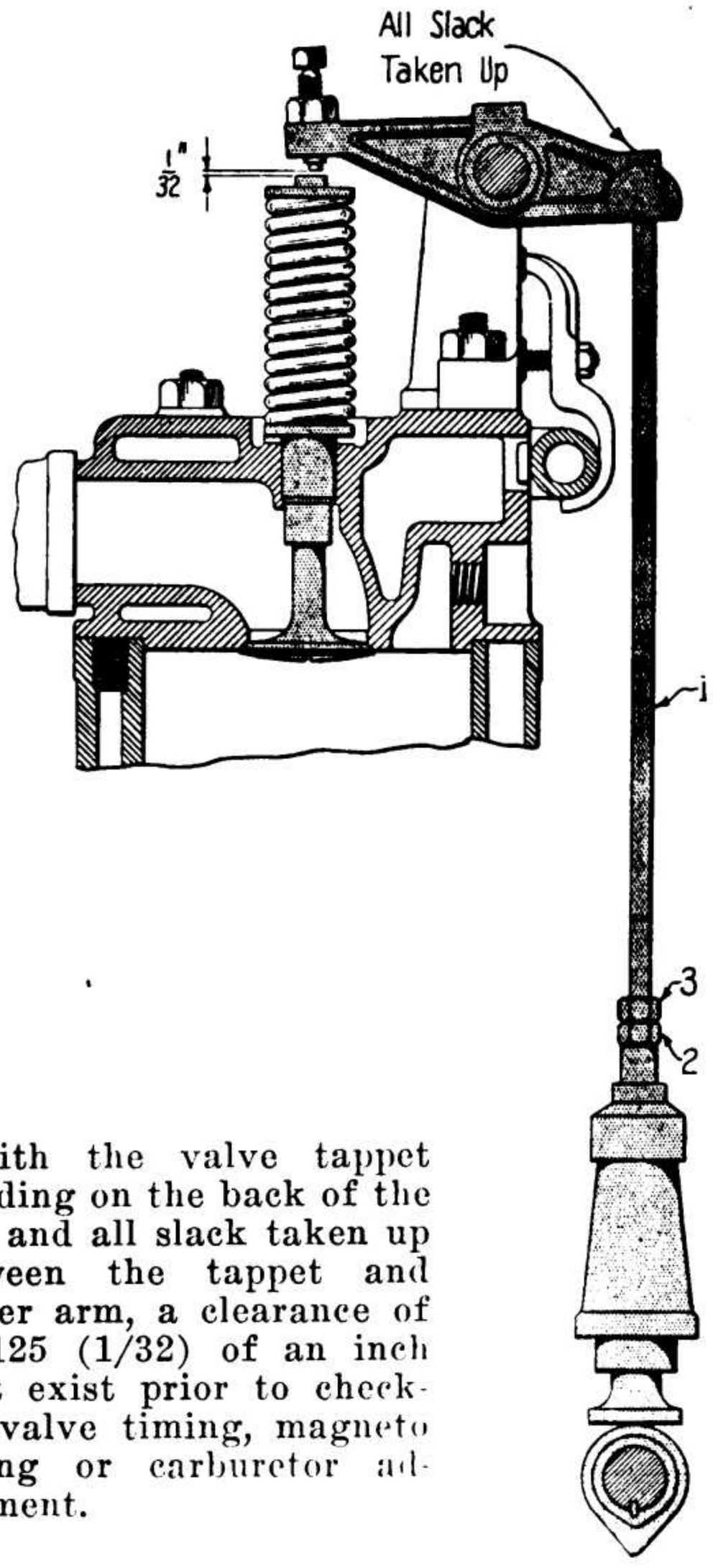
(*d*) Use carborundum powder mixed into a paste with cup grease, or use a reliable valve grinding compound. If the valve or valve seat is pitted badly use a coarse compound first, finishing with a fine compound. In grinding valves do not use a circular motion. Grind valves with a back and forth motion, turning about one-quarter of the way around, then lift the valve off its seat and bring it about one-quarter of a turn toward the right, seat valve and grind as before. Continue this stepping the valve around, so that all the high spots will come in contact with each other, until the valve is ground to an even seat. To watch the progress of the work wash the valve and valve seat with kerosene.

(*e*) When the grinding is finished flush the valve stem, valve stem guide, valve seat and cylinder head thoroughly with kerosene to remove all traces of grinding compound. Never allow the least trace of any grinding compound to get into the cylinders.

TESTING VALVE SEAT.

With a soft lead pencil make six or eight marks at regular intervals around the valve seat, drawing the pencil from the inner edge of the valve seat to the outer edge in a straight line. Place valve on seat and rotate in a circular direction several times. If the valve and seat are evenly ground all the lead pencil marks will be removed. If part of the lines remain it indicates that the valve seat and valve are still uneven and grinding must be continued until the lead pencil marks are removed.

Plate No. 19.



With the valve tappet standing on the back of the cam and all slack taken up between the tappet and rocker arm, a clearance of 0.03125 (1/32) of an inch must exist prior to checking valve timing, magneto timing or carburetor adjustment.

VALVE ADJUSTMENT.

Provision is made for compensating of the wear of the valve stem and rocker arm. The valve rod, Plate 19 (1), is threaded to take an adjustable hexagonal nut (2), which is prevented from turning by a lock nut (3). Loosening the lock nut permits of screwing the adjusting

nut up or down decreasing or increasing the length of the valve rod and consequently the space between the rocker arm and valve stem.

REPLACING VALVE STEM GUIDE.

The valve stem guide, which is the part subjected to wear, can be readily removed by driving it out of the cylinder head and a new one can then be inserted. A worn intake valve stem guide can admit air to the mixture after it has passed the carburetor and give trouble by producing an over-lean mixture.

TIMING THE VALVES.

(*a*) Before starting to time the valves be sure that a clearance of 0.03125 (1/32) of an inch exists between the rocker arm and the valve stem with the valve tappet standing on the back of the cam.

(*b*) Place piston in cylinder next to the radiator on top center.

(*c*) Rotate camshaft by means of governor in the direction opposite to the rotation of the flywheel so that the exhaust cam operates the exhaust valve.

(*d*) Continue turning the camshaft until exhaust valve has been entirely opened and until almost closed, having but slight compression on the exhaust valve tappet.

(*e*) Line up keyway in camshaft and camshaft gear.

(*f*) Mesh camshaft timing gear and insert key.

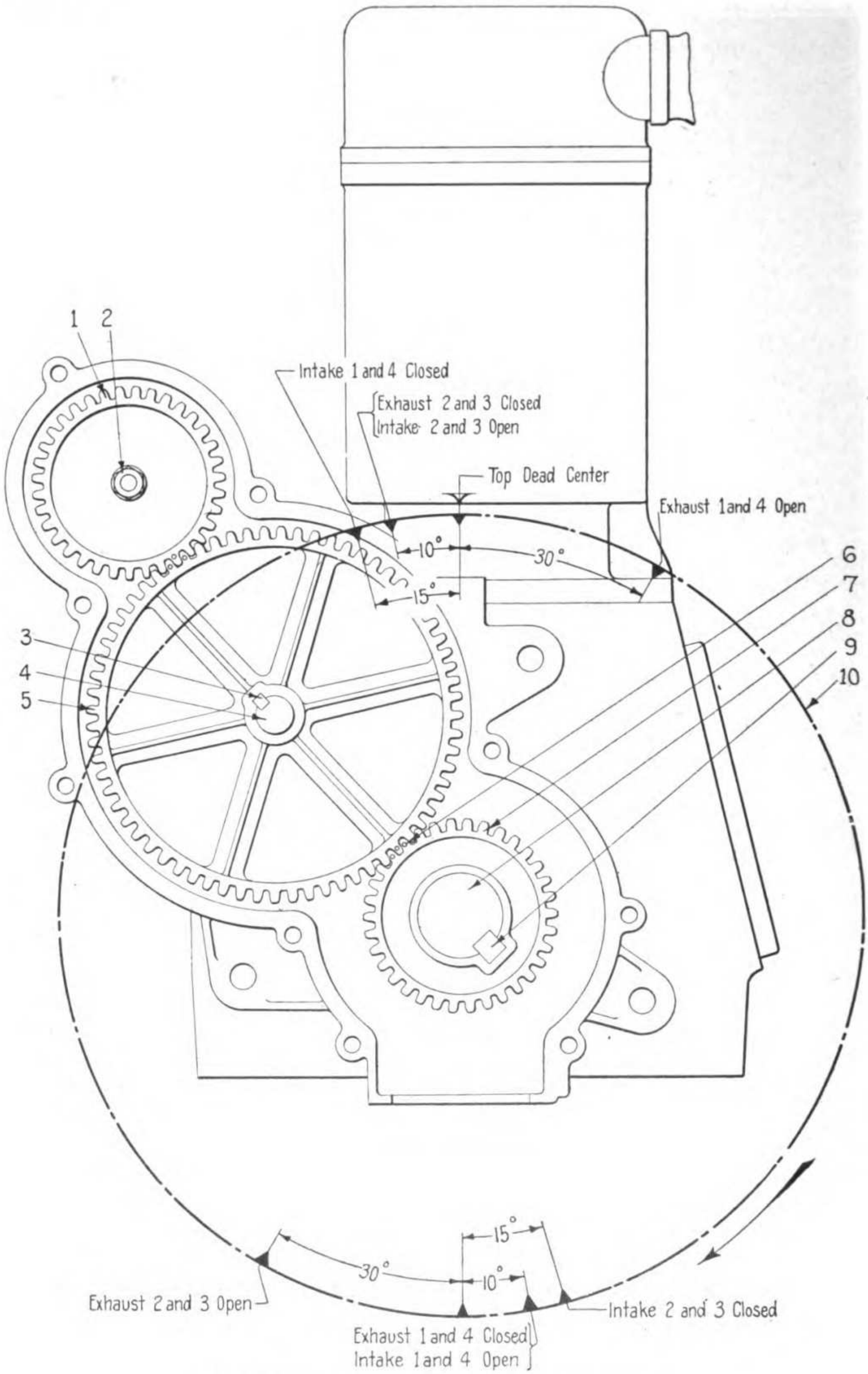
In replacing the camshaft with its gear it is a simple matter to retime the valves if the crankshaft gear and camshaft gear be marked. A tooth of either the camshaft or camshaft gear will be prick punched and this tooth should be meshed between two similarly marked teeth on the other gear.

(*g*) Rotating the crankshaft five degrees past top center should give the rocker arm its full 0.03125 ($\frac{1}{32}$) inch clearance over the exhaust valve stem. The operation of entirely opening and closing exhaust valve insures tappet resting on correct side of cam when gears are meshed. No attention is paid to inlet valve in timing engine except to have rocker arm clearances correct.

The crankshaft gear has 34 teeth, is of steel, is 6 inches in diameter and has a 1.5 (1½) inch face. The keyway is 0.75 by 0.375 (¾ by ⅜) inch.

The camshaft gear has sixty-eight teeth, is 11.66 inches overall diameter, has a 1.5 (1½) inch face and a keyway 0.375 by 0.1875 (⅜ by $\frac{3}{16}$) inch. This gear makes one complete revolution to two of the crankshaft or driving gear.

Plate No. 20.



TIMING GEARS AND FLYWHEEL.

The valves may be timed by observing the flywheel marks, these consisting of letters and figures. For example: the opening of the intake valve is indicated by "IN 1 & 4 OP," meaning that either the No. 1 or No. 4 intake valve should begin to open when the mark corresponds with the indicator or pointer (25), Plate 7, attached to the crankcase: marks "IN 1 & 4 CL" indicate the time of closing of the intake valves. Similarly, "EX 1 & 4 CL" indicates the closing point of the exhaust valves of the No. 1 and No. 4 cylinders. The openings of all valves, intake and exhaust, can be checked by the flywheel marks, as shown by Plate 20.

REMOVING OIL PUMP.

To remove oil pump:

(*a*) Drain oil from reservoir and crankcase.

(*b*) Remove oil reservoir, Plate 9 (30), from bottom of crankcase by taking out four machine bolts.

(*c*) Drive out two taper pins holding spiral gear and collar at upper end of pump shaft inside crankcase.

(*d*) Remove the two 0.5 (½) inch cap screws holding pump body to bottom of crankcase and pump and shaft complete can be removed by dropping down.

(*e*) The oil pump can be completely disassembled for cleaning and inspection.

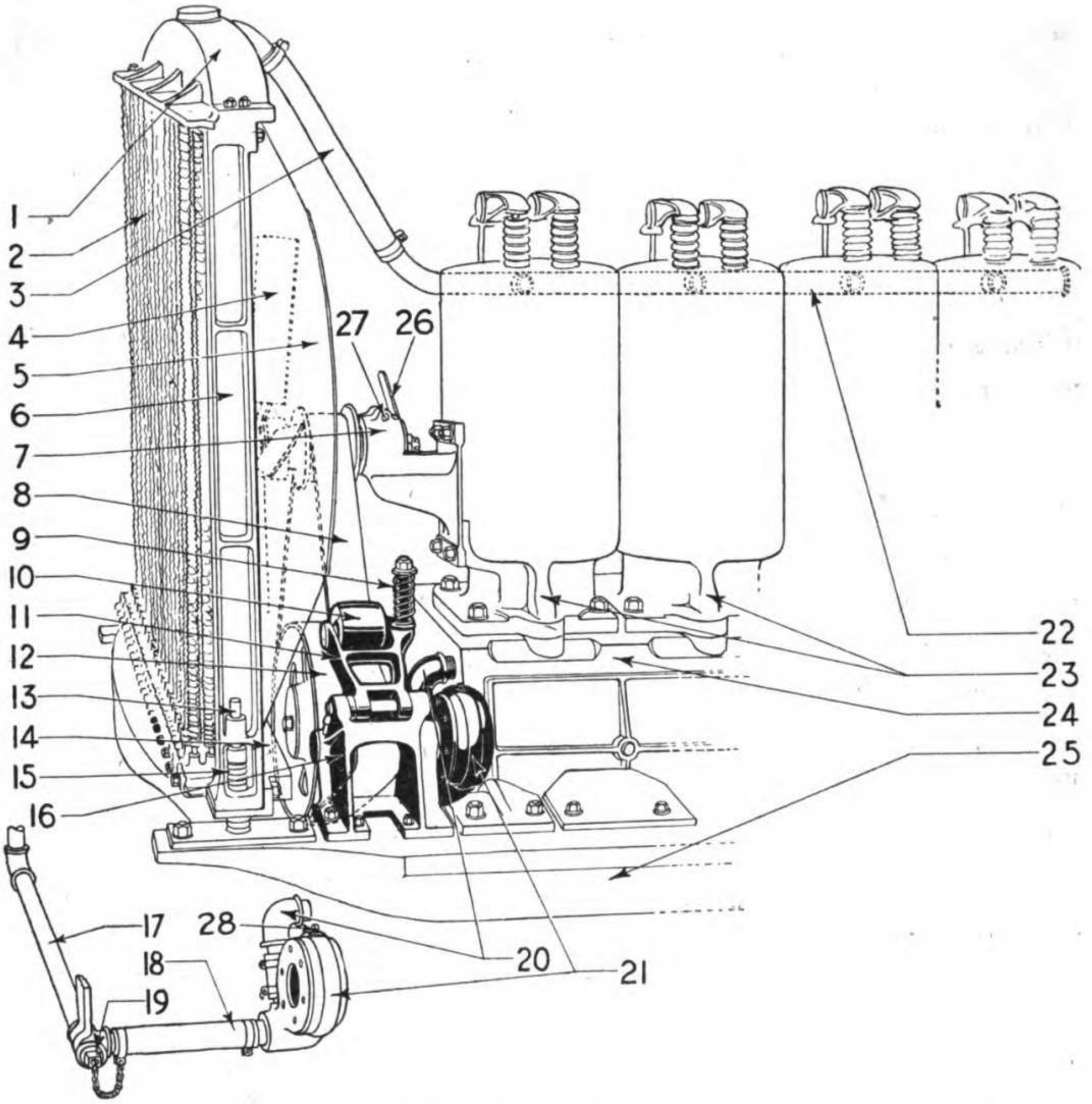
REPLACING OIL PUMP.

In replacing oil pump body, insert pump shaft far enough up in crankcase to put on spiral gear and collar, bring spiral gear into position on shaft so that the holes in the gear and shaft correspond, drive in taper pin, fit holes in collar in like manner and then insert upper end of pump shaft into socket, mesh spiral gear with camshaft gear and replace the 0.5 (½) inch cap screws in pump.

TIMING GEARS.

Ref. No.	Part No.	Name of Part.
1	ZH20	Magneto gear.
2	M2018	Magneto shaft nut.
3	M11527	Camshaft gib key.
4	M10664	Camshaft (built up type).
5	102293	Camshaft gear.
6		Timing gear punch marks.
7	M11497	Timing gear.
8	M11101	Crankshaft.
9	M11443	Crankshaft gear taper key.
10	Z683	Flywheel.

Plate No. 21.



COOLING SYSTEM.

Ref. No.	Part No.	Name of Part.	Ref. No.	Part No.	Name of Part.
1	6979	Upper header.	15	4505	Supporting spring.
2	6827	Tube.	16	8947	Water pump bracket.
3	7644	Hose.	17	9981	Pipe.
4	7032	Fan.	18	7645	Hose.
5	6991	Fan housing.	19	3142	Pipe plug.
6	6826	Column.	20	54301	Elbow (inlet).
7	6983	Fan bracket.	21	8911	Waterpump casing.
8	8968	Fan belt.	22	AM1362	Water manifold (outlet).
9	2151	Idler spring.	23		Water passage.
10	10297	Idler pulley.	24		Crankcase.
11	8912	Idler pulley yoke.	25	6992 or 9844	Main frame.
12	Z715	Crankshaft pulley.	26	6988	Fan hub eccentric handle
13	6823	Radiator foot.	27	6980	Eccentric clamping screw.
14	5551	Lower header.	28	56421	Plug pipe.

COOLING SYSTEM.

WATER CIRCULATION.

The engine is cooled by water assisted by a fan (4), Plate 21, and the water is circulated by means of a centrifugal pump (21), which is driven by the belt (8) driving the fan. The water is drawn from the bottom of the radiator by the pump and forced through a water passage (24) cast integral in the upper half of the crankcase, thence through water passages (23) in the cylinders and water jackets to the outlet water manifold (22) which is connected to the radiator by rubber hose (3).

FAN.

The fan (4) is of the four-blade type and is driven by 3-inch flat belt (8) the tension of which is maintained and regulated by an idler puller spring (9), on the idler pulley yoke (11), which carries the leather-covered idler pulley (10). The belt runs over an upper and lower pulley and the lower pulley (12) is the driving pulley, as it is mounted on an extension of the crankshaft.

CENTRIFUGAL WATER PUMP.

The centrifugal water pump (21) is located on the left side of the engine and is driven by the fan belt (8), an idler pulley being mounted on the pump shaft in the bracket (16) which is bolted to the frame (25). The pump is cast iron and a brass gland is utilized. The pump has a 1.375 (1⅜) inch outlet and inlet. Connection with the water passages (23) is by a 1.5 (1½) inch hose and elbow (20) and nipple.

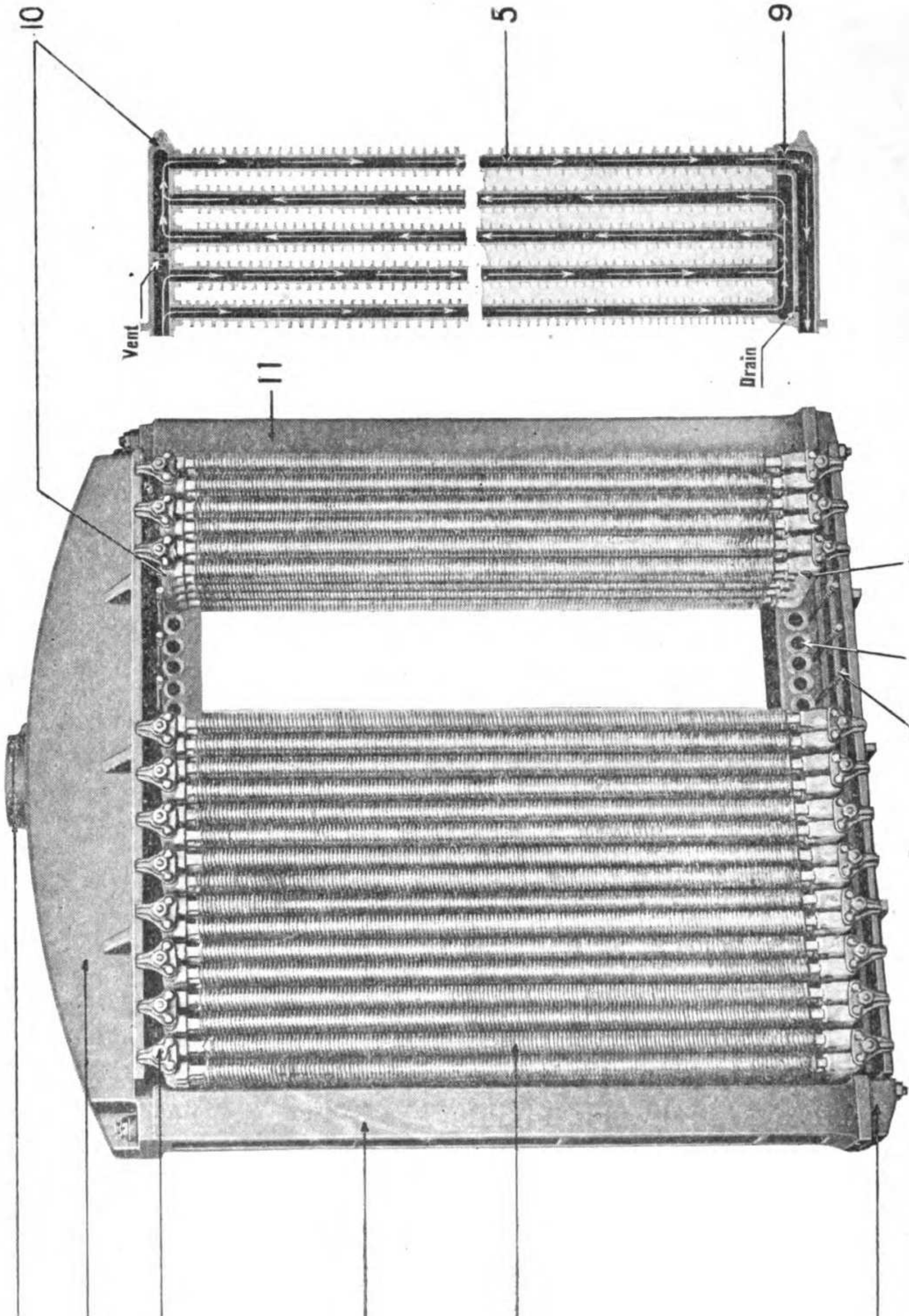
RADIATOR.

The radiator comprises twenty-eight sections, each section containing five tubes or a radiator section assembly (10), Plate 22. The radiator sections are mounted on upper (2) and lower (6) headers and the joints are made water-tight by gaskets (8). The radiator tubes (5) are retained in pairs in the upper and lower headers by section header clamps (3) on studs, and the clamps are secured by nuts. In case of damage to any tube an entire section may be replaced as described under "Assembling Radiator."

RADIATOR SUSPENSION.

The upper and lower headers are supported and the correct distance and alignment preserved by right (4) and left (11) columns each having a foot or extension, also a foot stud (13), Plate 21, on which is mounted two supporting springs (15), Plate 21. These springs compensate for upward and downward thrust of the columns as well as absorb shocks.

Plate No. 22.



RADIATOR, SHOWING SECTIONAL CONSTRUCTION.

RADIATOR WATER CIRCULATION.

The water supply is introduced by displacing the filler cap, Plate 22 (1). The water flows from the upper header (2) down the first two tubes, up the next two and down the last tube, passing out of the radiator through a 1.25 (1¼) inch pipe (17), Plate 21, and 1.5 (1½) inch hose (18) to the pump, to the water jackets and thence back to the top of the radiator.

DRAINING RADIATOR.

A baffle is located between the second and third tubes where the section header joins the radiator header. This causes the water to flow down. A small vent hole is drilled in each baffle affording admission of air to the top of the tubes, preventing vacuum and insuring complete drainage. A small hole is drilled at right angles in the baffle dividing the section header (9), Plate 22, in half lengthwise permitting of completely draining the tube.

The water can be drained from the cooling system by removing the plug (19), Plate 21, from the drain pipe hanger. In order that the pump be thoroughly drained it is important that the plug (28) in the pump housing (21) be removed else a vacuum is likely to retain a portion of the water in the pump. The engine should be cranked several times after draining to make sure all water is displaced from the pump.

LUBRICATION OF WATER PUMP.

Lubrication of the water circulating water pump shaft is by two grease cups supplying lubricant to the bushings in which the pump shaft rotates.

RADIATOR.

Ref. No.	Part No.	Name of Part.
1	7028	Radiator filler cap.
2	6979	Radiator header, upper.
3	1342	Radiator section header
4	6825	Radiator column, right.
5	6827	Radiator section tube.
6	5551	Radiator header, lower.
7	3817	Radiator section header
8		Radiator section header
9		Radiator section header,
10	3813	Radiator section header,
11	6826	Radiator column, left.

REPACKING WATER PUMP.

The water pump brass gland (or stuffing box) should be packed with round, graphited packing which should be wound in the direction the pump shaft rotates to avoid the possibility of unwinding. If the standard packing be not available, loose twisted asbestos packing can be utilized or candle wicking braided. It is important that the material be thoroughly saturated with oil and covered with graphite. If only square packing of too large a size be available, cut off a piece of the desired length, place it between the jaws of a bench vise, squeeze out flat, and then cut off a strip of the desired length and width.

THAWING FROZEN PUMP.

During cold weather, after an engine has been stopped for a sufficient period to permit any water in the cooling system to freeze, the engine should not be cranked until it is ascertained that no water has collected in the water pump, and frozen the pump rotor to the pump housing. The pump may be warmed with a gasoline blow torch, hot water or cloths soaked with gasoline may be applied to the pump and lighted to thaw the ice. The use of an open fire is not recommended as it is dangerous and is suggested only as an emergency measure.

TO AVOID FREEZING COOLING WATER.

To avoid freezing in winter, drain when not in use or use an anti-freezing solution, also cover the radiator with canvas curtain provided. There is a square hole in curtain to admit some air.

ADJUSTMENT OF FAN BELT.

The fan will not be driven at a proper rate of speed if the belt tension be insufficient or if the belt be oily or greasy. The tension of the belt (8), Plate 21, may be adjusted by means of an eccentric mounted in the bracket (7). The eccentric is operated by a handle (26) and the eccentric is locked by a cap screw (27) in the bracket (7). The fan hub or upper pulley bearing is lubricated by means of a ball check oiler. The idler yoke pulley (10) is lubricated by a grease cup.

Note.—Moisture causes a belt to shrink with a consequent increase in the tension of the belt. The increase in the tension of the belt is largely responsible for breakage of fan belts or tearing out of lacing. When the tractor is exposed to the weather the belt should be loosened at the end of a run and tightened up again when the tractor is placed in operation. This will eliminate the majority of fan belt troubles.

REPAIRS TO FAN BELT.

If fan belt will not run true on center of pulleys, the trouble may be

due to two causes: the fan belt may not be cut square on the ends where laced together or either the fan pulley or water pump pulley may not be properly aligned with the crankshaft pulley.

If the fan felt is not laced squarely the belt must be cut square on each end and relaced.

If fan pulley is out of line, the bracket which holds fan assembly on the front cylinder of engine may be loosened up and shims inserted under one end or the other until proper alignment is secured.

The water pump pulley may be lined up in same manner by placing shims between water pump bracket and main frame of tractor.

FIELD REPAIRS TO RADIATOR.

ASSEMBLING RADIATOR.

In replacing radiator sections on the upper and lower header, care must be taken to use new gaskets or ones in good condition. If the gasket is not punched, lay a strip of the gasket material over the header and outline the holes by tapping with a ball pein hammer, being careful not to cut the gasket material in two, and allow part to enter the header. Remove material and complete cutting of openings with a knife.

In replacing radiator tubes, which are clamped in pairs to the upper and lower headers by header clamps (3), Plate 22, and after the nuts on the studs running through the clamps have been tightened, it is advisable to hit the clamps a light blow with a hammer over each section header. This will seat the header firmly and tighten the clamp.

SOLDERING TUBES.

The upper and lower section header where the tubes fit in are "tinned" as are the end of the tubes. In replacing a damaged tube with a new one care must be taken to maintain the proper distance between the upper and lower section headers. After inserting tube, heat one side of the section header and bottom of tube wtih the flame of a blow torch, until the solder begins to run, making a "sweat" joint. Repeat the operation on the other side of the header and tube. Care must be taken not to so heat the parts first soldered that the solder will be melted. Next give the parts a coating of acid and with the torch melt solder, preferably wire solder, sufficiently to fill completely the area between the tube and the header. Do not use a soldering iron.

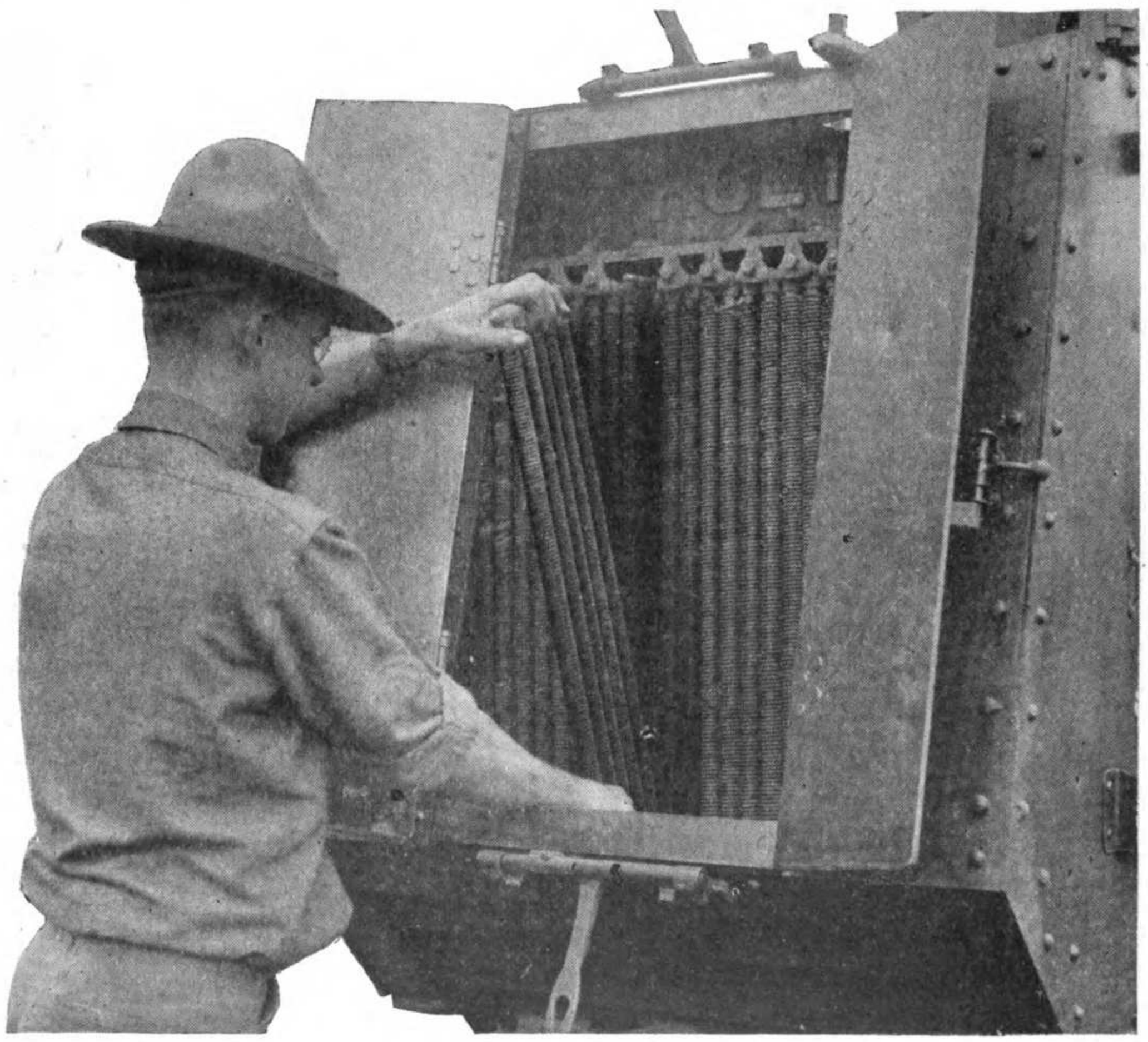
If the header and tube have not been "tinned" prepare a solution of commercial muriatic acid and zinc, adding shavings or small pieces of the latter to the acid until it ceases to give off bubbles. Dip the parts in the solution, then into melted solder, allowing them to remain until all old solder is melted and the part is covered with a bright coating. Wipe all excess solder away with cloth and leave a bright even surface, otherwise the tube will not fit the header.

The upper and lower section headers where the tube fits should be tinned by dipping the header with the holes down about 0.5 (½) inch in the melted solder.

EMERGENCY REPAIRS TO RADIATOR.

In case the radiator develops a leak in one or two sections, and no means are at hand for properly repairing, the sections may be plugged temporarily.

Plate No. 23.



REMOVING RADIATOR SECTION.

To make emergency repair to a damaged radiator section—

First: Drain the radiator.

Second: Remove the damaged section by taking off the clamp at the top and bottom which holds the section in the radiator assembly.

The illustration shows a damaged section being pulled out.

Plate 23 shows a leaking radiator section being removed.

Plate 24 shows the method employed in repairing the damage.

When a repair of this kind is made, it must be born in mind that the repair is only temporary and a permanent repair must be made at the first opportunity.

Plate No. 24.

PLUGGING DAMAGED RADIATOR SECTION.

By plugging a damaged section at both ends and reinserting the section in the radiator, the section is cut out completely from the water circulation. In the view, a plug which has been whittled out of a stick of wood is being driven into the bottom of the radiator section. The plug in the soldier's hand at the top of the view is being fitted before cutting off and driving in. These plugs must be a snug fit in order to exclude the water. Cut the plugs off flush with the hole before putting the section back into the radiator.

CLEANING RADIATOR.

If scale is present in the circulation system it should be treated with common washing soda as follows: Dissolve 6 pounds of common washing soda in 5 gallons boiling water. Fill the radiator and let the solution circulate under load for one full day, and then the entire system should be drained and flushed with clean water. Particles of scale may be disengaged and not completely dissolved and it is advisable to flush the system out.

If convenient to a pressure system, the hose connections on both the bottom and top of the engine and drain plug on bottom radiator frame header should be removed and clean water under pressure should be flushed through the water inlet manifold of the engine as well as through the radiator. The radiator can be readily disassembled if it is necessary to clean out disengaged scale.

THE FUEL SYSTEM.

The gasoline or fuel supply system consists of a main supply tank (20), Plate 25, mounted on brackets (21), bolted to the main frame on the left side of the operator's seat. The fuel is supplied to a vacuum tank (14) through a brass pipe (13). The flow from the vacuum tank to the carburetor is by gravity by the pipe (11).

THE MAIN FUEL TANK.

The main tank is of galvanized steel, of 46 gallons capacity, and is secured by straps (17), having a threaded end and passing through the brackets (21). Nuts and lock washers (30), (32), secure the straps which hold the tank in firm contact with a board (33) interposed between the tank and brackets.

The interior of the tank is provided with two baffle plates to prevent undue movement of the fuel and its collecting at one end when ascending or descending grades, and there is also a partition (19) which provides two compartments known as the main and reserve supply, the last named being about 10 gallons capacity. The main supply is through a brass pipe (23) to a reducing elbow (24), thence to the three-way valve (25), which includes a filter or sediment bulb with a drain cock (26).

RESERVE FUEL SUPPLY.

The reserve supply is connected by a small brass pipe (31) to the three-way valve. This valve has a lever which when moved to a horizontal position permits flow of the fuel to the vacuum tank. Moving the lever to the left or right connects the main and auxiliary tanks, respectively. When occupying a vertical position the fuel supply to the

vacuum tank is shut off. The filler plug (18) of the tank has a hole or vent and this should be kept clear to avoid the possibility of vacuum forming.

AUXILIARY FUEL TANK.

Note—Provision is made in later models of tractors for an auxiliary fuel supply with gravity feed to the carburetor from a small tank under the engine armor. This is illustrated in Plate 28.

VACUUM SYSTEM.

The vacuum system makes use of a small tank (14), Plate 25, which is connected by tubing (11), (12), (13), to the intake manifold of the engine; also to the main fuel supply tank and to the carburetor. The partial vacuum occurring in the intake manifold is transmitted to the vacuum tank and the vacuum is utilized for lifting the fuel from the main tank to the upper chamber of the vacuum tank, Plate 26, which consists of two chambers, an upper or filling, and a lower or emptying. Between the two chambers is a partition attached to and below which is a flapper valve (19).

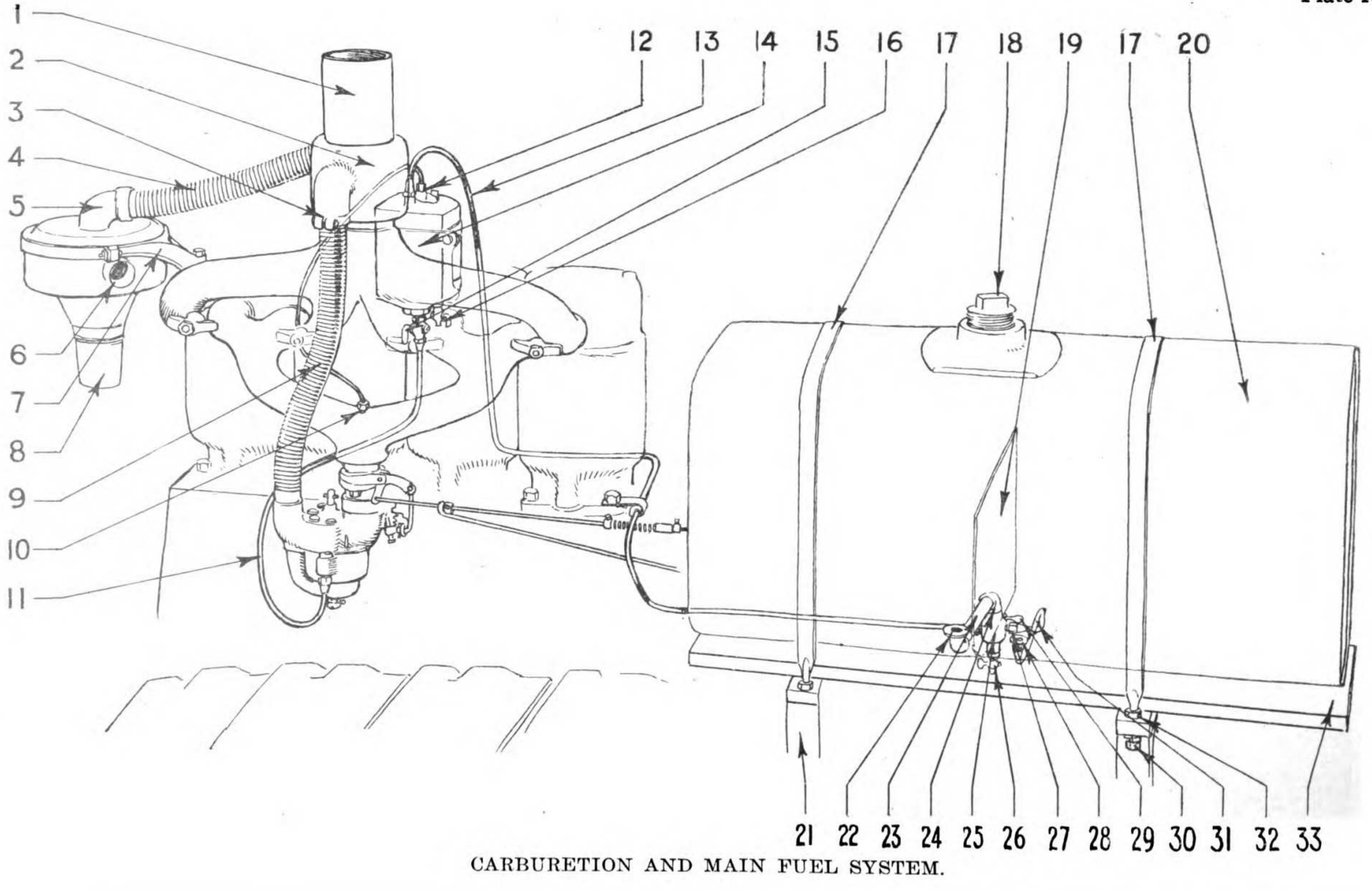
The partial vacuum in the intake manifold on the intake stroke of the piston of the engine creates a vacuum in the upper chamber of the vacuum tank and this vacuum closes the flapper valve (19), also sucks or pumps fuel from the main supply tank into this chamber. The fuel in entering the upper chamber raises the float (14). When this float rises to a predetermined point it actuates the float lever (2), which shuts off the suction and at the same time opens an atmospheric valve (11).

The entrance of the outside air releases the vacuum suction, causing the valve leading into the lower chamber to open and the fuel flows through this valve to the lower or emptying chamber, which is always open to the outside air, so that fuel is supplied to the carburetor by gravity.

A screen or strainer is combined with the outlet member (16) and is located inside the lower tank and attached to it is a petcock (17) for draining water and other foreign elements. The strainer should be maintained in a clean condition and should be first examined when fuel does not flow to the carburetor.

CARBURETION SYSTEM.

The carburetor is a Kingston Model E-4 threaded to the intake manifold of the engine. Its function is to vaporize the fuel and mix the vapor with air, forming a mixture that is burned in the cylinder. The quantity of mixture admitted is regulated by a valve manually controlled by the operator.



CARBURETION AND MAIN FUEL SYSTEM.

Heat is utilized to assist in vaporizing the fuel, a stove or jacket surrounding the exhaust pipe and the heat is conveyed to carburetor by a flexible pipe.

The fuel supply is through a vacuum tank from a main supply tank and auxiliary supply tank. Connection between the vacuum tank and carburetor is by a copper pipe.

CARBURETOR.

All air utilized in the mixture passes through the carburetor, Plate 27, which has a fixed air intake around the needle valve (10), but when the throttle (3) lever is opened to a certain point and when more air is required by the fuel supply, auxiliary air enters above the spray nozzle (17), the bronze balls (14) lifting from their seat and supplying air in volume according to requirements. There is but one adjustment, that of the fuel supply which is regulated by the needle valve (10).

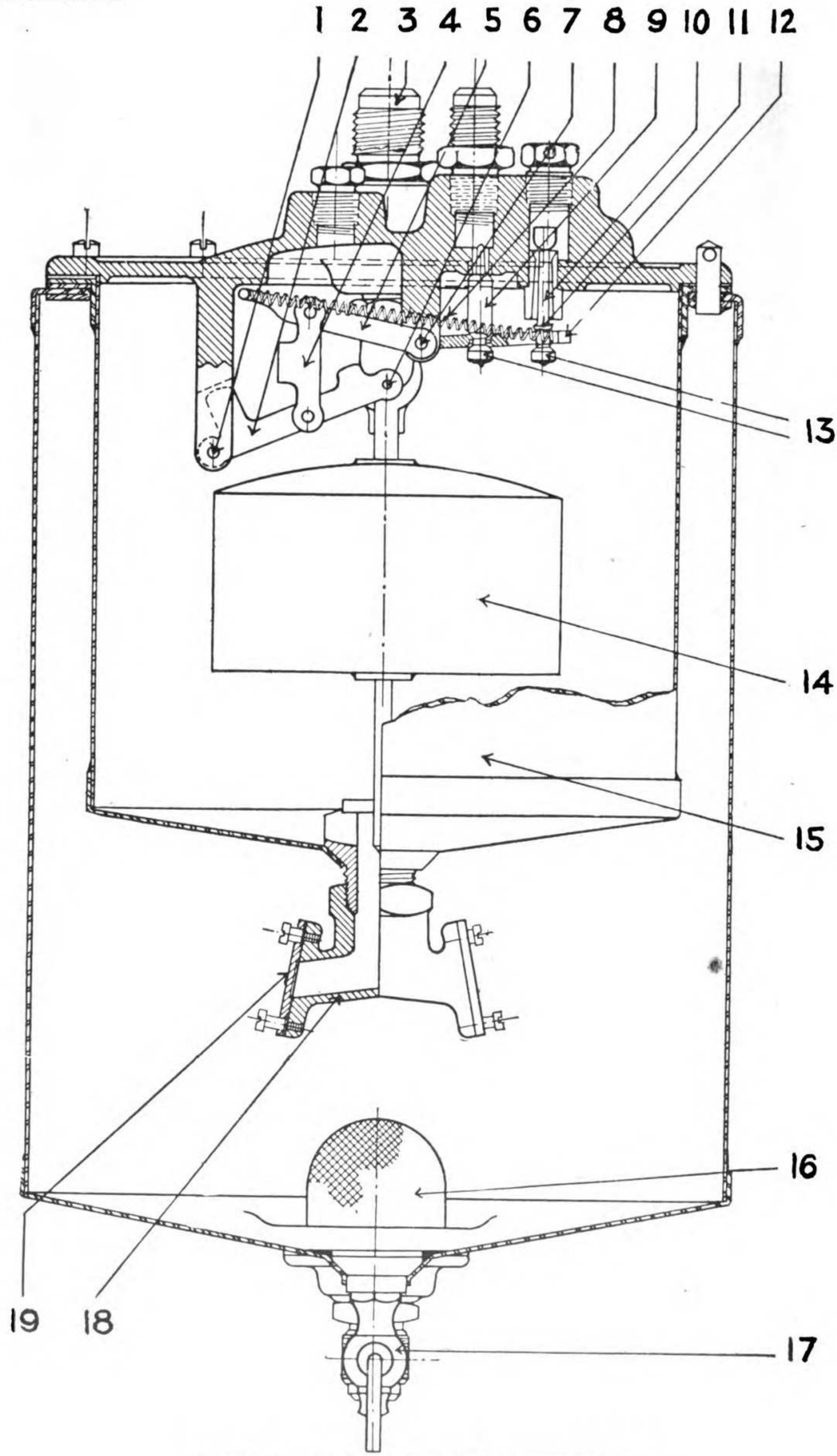
The function of the carburetor is to change the liquid fuel into a fuel vapor mixed with such proportions of air that an explosion of instantaneous burning mixture is obtained. If more air or less air is supplied than is required to make a proper mixture, the fuel vapor mass will be a slow burning mixture.

Specific directions cannot be given for adjusting the carburetor. When adjusting the carburetor on any engine it is necessary to check the rocker arm clearance so that 0.03125 inch clearance will exist between the rocker arm and the valve stem when the valve tappet is standing on the back of the cam and all slack taken up between the rocker arm and valve

CARBURETOR AND MAIN FUEL SYSTEM.

Ref. No.	Part No.	Name of Part.
1		Exhaust manifold.
2	10439	Air heater.
3	7726	Air heater sleeve.
4	7731	Flexible tube.
5		Air cleaner outlet.
6		Air cleaner inlet.
7	9595	Air cleaner bracket.
8		Air cleaner dirt receptacle.
9	7732	Flexible tube.
10	54939} 54925}	Union nut and half union.
11	9738	Tubing.
12	54937	Union nut.
13	9740	Tubing.
14	9741	Stewart vacuum tank.
15	8902	Gasoline shut off cock.
16	8443	Pet cock.
17	7589	Fuel tank strap.
18	5242	Filler plug.
19	7584	Reserve partition.
20	8565	Fuel tank body.
21	8560	Fuel tank outer bracket.
22	7583	Pipe fitting (rear).
23	8321	Pipe from fuel tank to sediment trap.
24	8322	Ell-reducing.
25	7842	Sediment trap.
26		Drain cock.
27		Union nut.
28	7582	Pipe fitting (front).
29		Sediment trap three way valve.
30	53153	Fuel tank strap nut.
31	8320	Tubing-tank to sediment trap.
32	53153	Fuel tank strap adjusting nut.
33	7588	Board.

Plate No. 26.



STEWART VACUUM FUEL FEED TANK.

tappet. The magneto should be checked for correct timing so that when the piston is on top center of the compression stroke and the circuit breaker is put into full retard position, the circuit breaker points will just commence to separate.

The adjustment of the carburetor depends upon the condition under which the engine is operated, atmospheric conditions, elevation, quality of fuel used and load pull. The best adjustment is one just lean enough to enable the engine to develop the required power and still not overheat.

CARBURETOR ADJUSTMENT.

Varying temperatures and altitudes will require changing the supply of fuel. Turning the needle valve (10), Plate 27, to the right decreases the fuel supply and in the opposite direction increases it. The needle valve is prevented from turning by a lock screw (11). Lock the needle valve by tightening the screw (11).

In adjusting the carburetor, decrease the fuel supply by turning needle valve towards the right till there is a tendency for "pop-back," then turn needle valve towards the left till the engine runs smoothly, has the requisite power under load and does not overheat.

AIR LEAKS THAT INTERFERE WITH ADJUSTMENT.

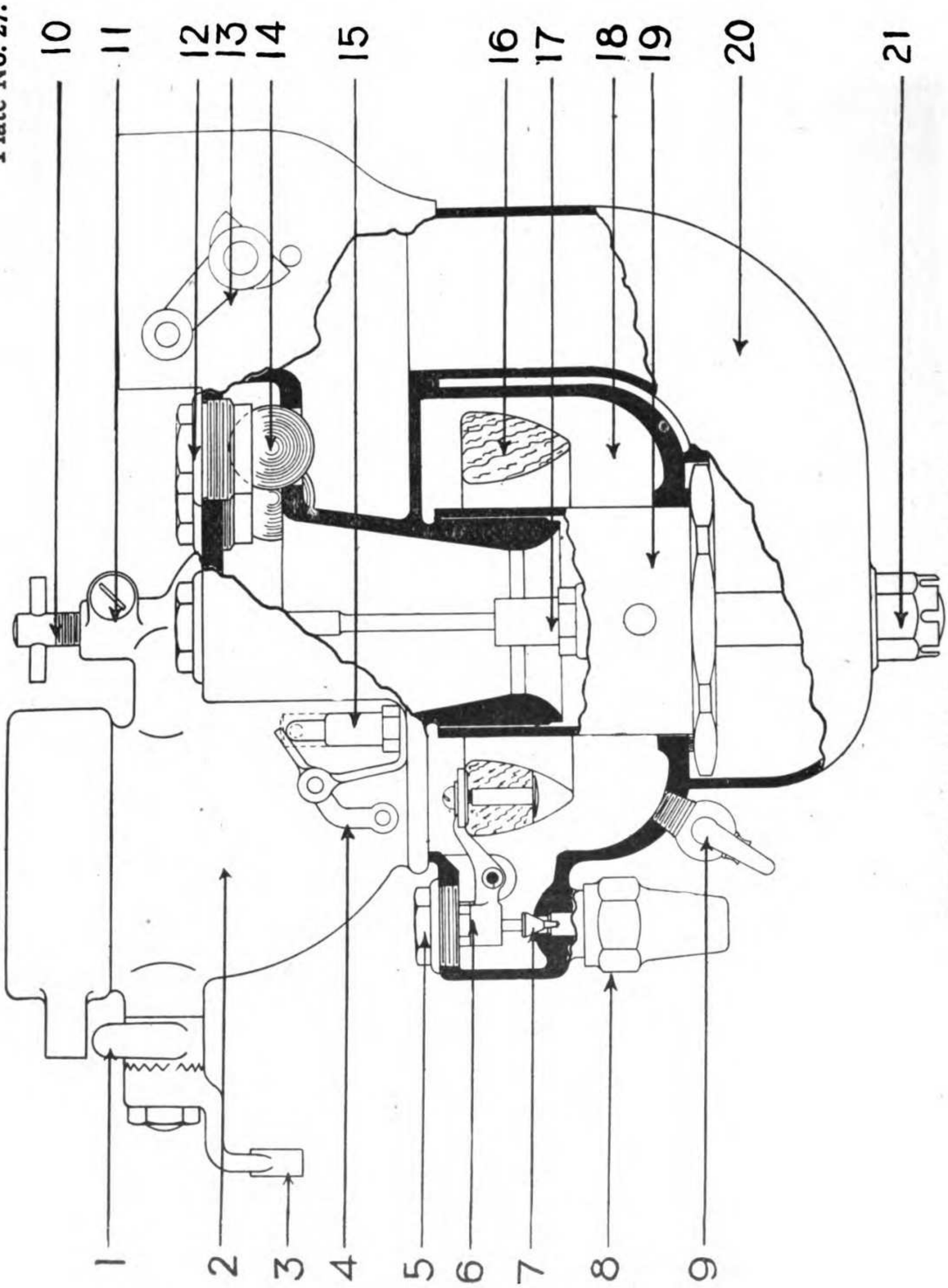
There are five places where air can enter the cylinder besides through the carburetor proper:

1. Throttle shaft or bearing being worn.
2. Intake manifold leaking.

STEWART VACUUM TANK.

Ref. No.	Part No.	Name of Part.
1	9852	Float lever pin.
2	9851	Float lever.
3	8459	Tube fitting.
4	9855	Lever connection link.
5	9853	Spring lever.
6		Float lever pin.
7	9860	Valve stem lever pin.
8	7559	Valve tension springs.
9	9857	Vacuum lever stem.
10	8445	Atmospheric valve stem.
11	8446	Valve stem sleeves.
12	9854	Valve stem lever.
13	8447	Stem washer and float assembled.
14	9858	Valve stem collars.
15	8449	Inner shell assembly.
16	8444	Strainer and outlet assembly.
17	8443	Pet cock.
18	8450	Flapper valve.
19	8453	Flappers.

Plate No. 27.



INTERIOR OF KINGSTON CARBURETOR.

3. Intake manifold gaskets leaking.
4. Worn intake valve stem guides.
5. Poorly fitting piston rings or worn pistons and cylinders.

An accurate carburetor adjustment cannot be secured until all air is excluded from gaining admission through the above mentioned places. Air gaining admission through any of these places dilutes the mixture that has passed through the carburetor thus producing an over-lean mixture and can cause rapid overheating of the engine and consequent loss of power.

LEAN MIXTURE.

Decreasing the fuel supply by means of the needle valve (10) until there is too little fuel in proportion to the air obtains what is termed a lean mixture, a mixture that is slow burning as well as not easily ignited by the spark. A lean mixture is generally indicated by a back-fire or "popping" in the carburetor, due to the flame being present in the combustion chamber, and which ignites the incoming mixture on the intake stroke. A too lean mixture heats the engine.

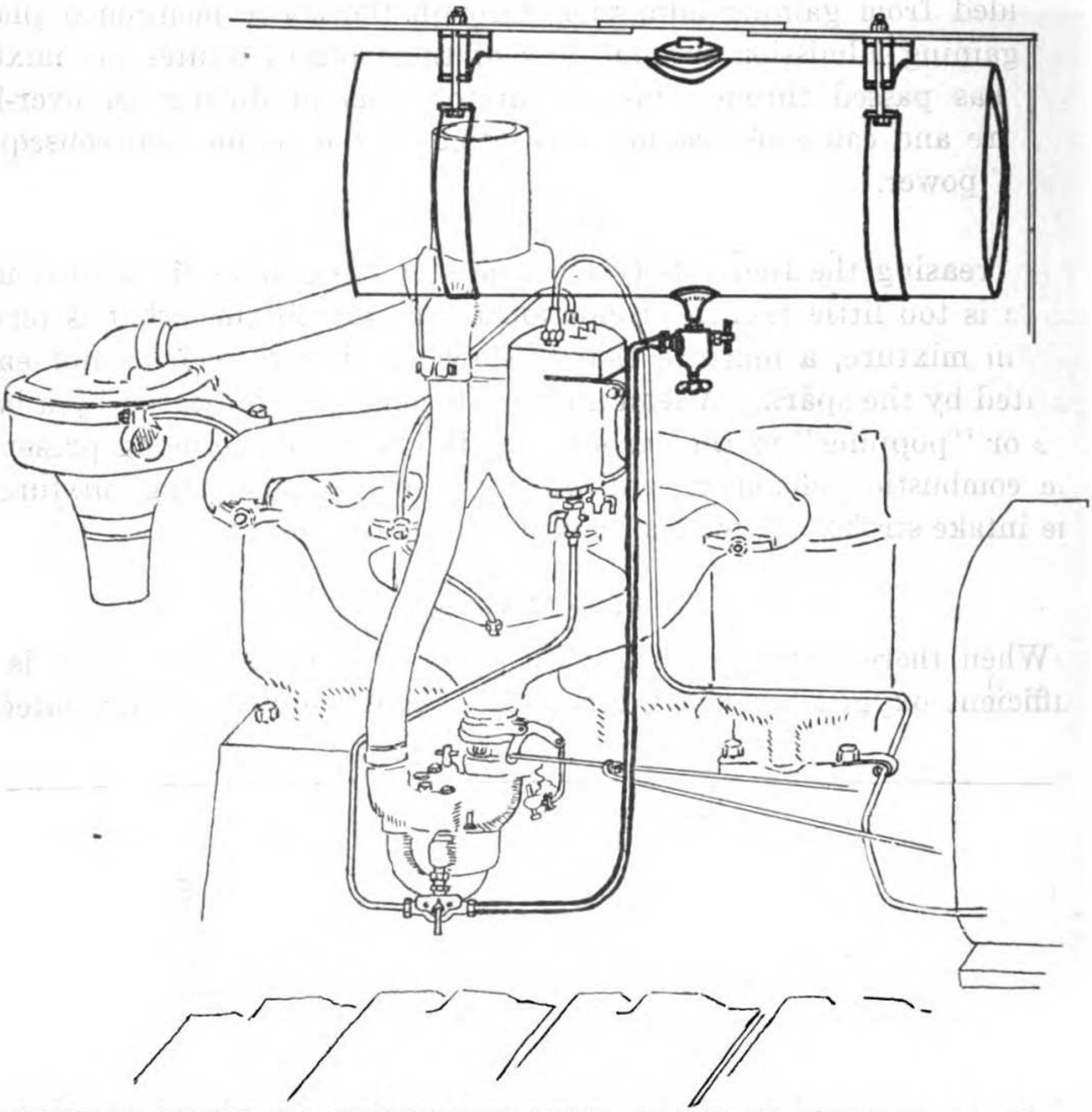
RICH MIXTURE.

When there is too much fuel in proportion to the air, there is not sufficient oxygen to burn the mixture. This condition is indicated by

CARBURETOR.

Ref. No.	Part No.	Name of Part.
1	9374	Carburetor throttle gate stem and screws.
2	9368	Carburetor fuel mixing chamber.
3	9373	Carburetor throttle lever.
4	9379	Carburetor primer lever.
5	7462	Carburetor float valve cap.
6	7459	Carburetor float valve lever.
7	7461	Carburetor float valve.
8		Gasoline feed pipe.
9	7464	Carburetor drain cock.
10	7457	Carburetor needle valve.
11	7517	Carburetor needle valve lock screw.
12	7520	Carburetor bronze retaining cap.
13		Carburetor chock valve lever.
14	7521	Carburetor bronze ball.
15	9378	Carburetor primer.
16	7458	Carburetor float.
17	7463	Carburetor spray nozzle.
18	9367	Carburetor float chamber.
19	9369	Carburetor center member.
20	9375	Carburetor constant air supply connection.
21	7516	Carburetor constant air supply connection lock nut.

Plate No. 28.



INSTALLATION OF AUXILIARY FUEL TANK IN ENGINE ARMOR.

a black smoke in the exhaust, by the color of the exhaust flame and by the odor given off. When too rich the odor is pungent or acrid. A rich mixture deposits soot and carbon forms on the piston heads, valves, combustion chamber, etc. Too rich a mixture is apt to deposit particles of fuel on the cylinder walls and the gasoline may find its way to the crankcase, thinning the lubricant.

FLOAT CHAMBER VENT.

To prevent a vacuum forming in the float chamber there is a small hole or vent drilled in its top. This permits of the entrance of air and the hole should be kept clear.