NO. 1996

HANDBOOK OF THE

5-TON ARTILLERY TRACTOR

MODEL 1917

WITH INSTRUCTIONS FOR ITS CARE,
OPERATION AND MAINTENANCE

(ONE HUNDRED THIRTY-THREE PLATES)

JULY 15, 1918

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

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

By order of the Secretary of War:

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

TABLE OF CONTENTS

CHAPTER I

SPECIFICATIONS, OPERATION AND CARE

CHAPTER II

ENGINE GROUP

CHAPTER III

MASTER CLUTCH

TABLE OF CONTENTS—Continued

CHAPTER IV

TRANSMISSION SYSTEM

CHAPTER V

SUPPORTING ASSEMBLIES

CHAPTER VI

TRACK ASSEMBLIES

CHAPTER VII

CONTROLLING SYSTEM

CHAPTER VIII

PINTLE ASSEMBLIES

CHAPTER IX

SUPERSTRUCTURE

CHAPTER X

EQUIPMENT

CHAPTER XI

NOMENCLATURE

INDEX

LIST OF PLATES

CHAPTER I

CHAPTER II

CHAPTER III

LIST OF PLATES—Continued

CHAPTER IV

CHAPTER V

CHAPTER VI

CHAPTER VII

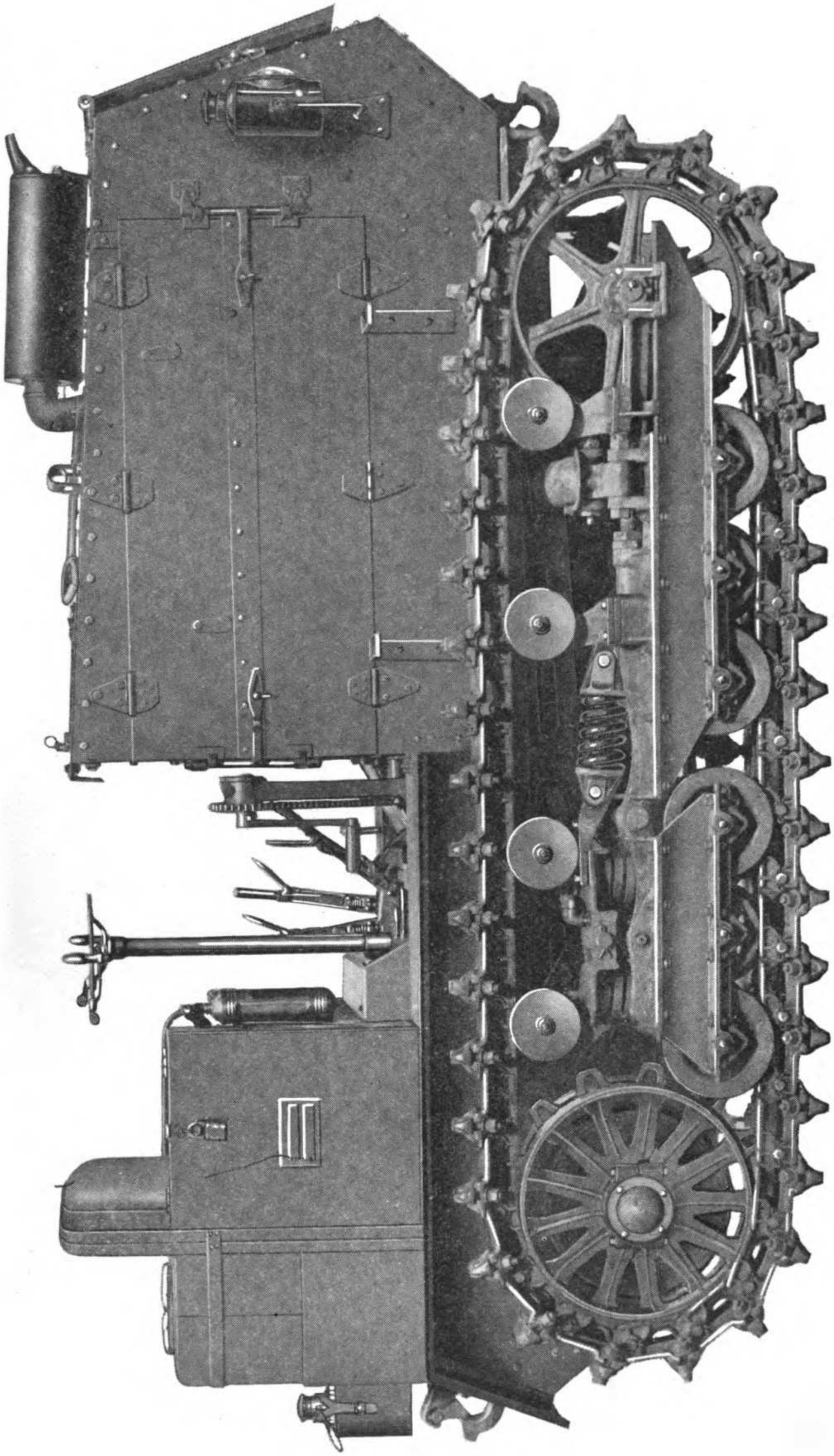
CHAPTER VIII

CHAPTER IX

CHAPTER X

LIST OF PLATES—Continued

PLATE 1



5-TON ARTILLERY TRACTOR—MODEL 1917

HANDBOOK OF ARTILLERY TRACTOR 5-TON MODEL 1917

CHAPTER I

TABLE OF WEIGHTS, DIMENSIONS, OUTLINE SPECIFICATIONS, ETC.

Overall Length (armored)	inches	133.5 (133½)
Overall Width	do.	63
Height (armored, to top of muffler)	do.	72.5 (72½)
Length of Ground Contact	do.	91
Ground Clearance	do.	11
Weight (complete, with full equipment)	pounds	9200
Ground Pressure (9 and 11 inch treads)	pounds per inch	5.6—4.5
Weight of Each Track	pounds	545
Weight of Each Track Shoe (9 inch)	do.	12
Width of Track Shoes	inches	9—11
Tread of Tracks (center to center of tracks)	do.	48.875 (48⅞)
Diameter of Turning Circle (overall clearance)	do.	176
Engine, Number of Cylinders		4
Bore	do.	4.75 (4¾)
Stroke	do.	6
Horsepower at 1200 Revolutions per Minute		56
Oil Reservoir Capacity	U. S. Gallons	3.25 (3¼)

Road Speed. Gear Used.	Miles per Hour
Low Speed at 1200 Revolutions per minute of engine	1.94
Direct Speed at 1200 do. do.	3.92
High Speed at 1200 do. do.	7.37
Rev. Speed at 1200 do. do.	1.41

Capacity of Main Gasoline Tanks (two) Combined	U. S. gallons	24
Capacity of Auxiliary Tank under Armor	do.	10
Capacity of Transmission Case	do.	3
Capacity of Track Oiler Tank	do.	2.5 (2½)

BRIEF DESCRIPTION OF THE 5-TON ARTILLERY TRACTOR MODEL 1917

The 5-Ton Artillery Tractor Model 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 which acts as a track and is composed of steel links and shoes cast integral and connected by hardened steel pins. The advantage of this type of tractor as compared with the usual type of wheel tractor or truck, is its ability, due to very low unit ground pressure, to negotiate very soft and uneven

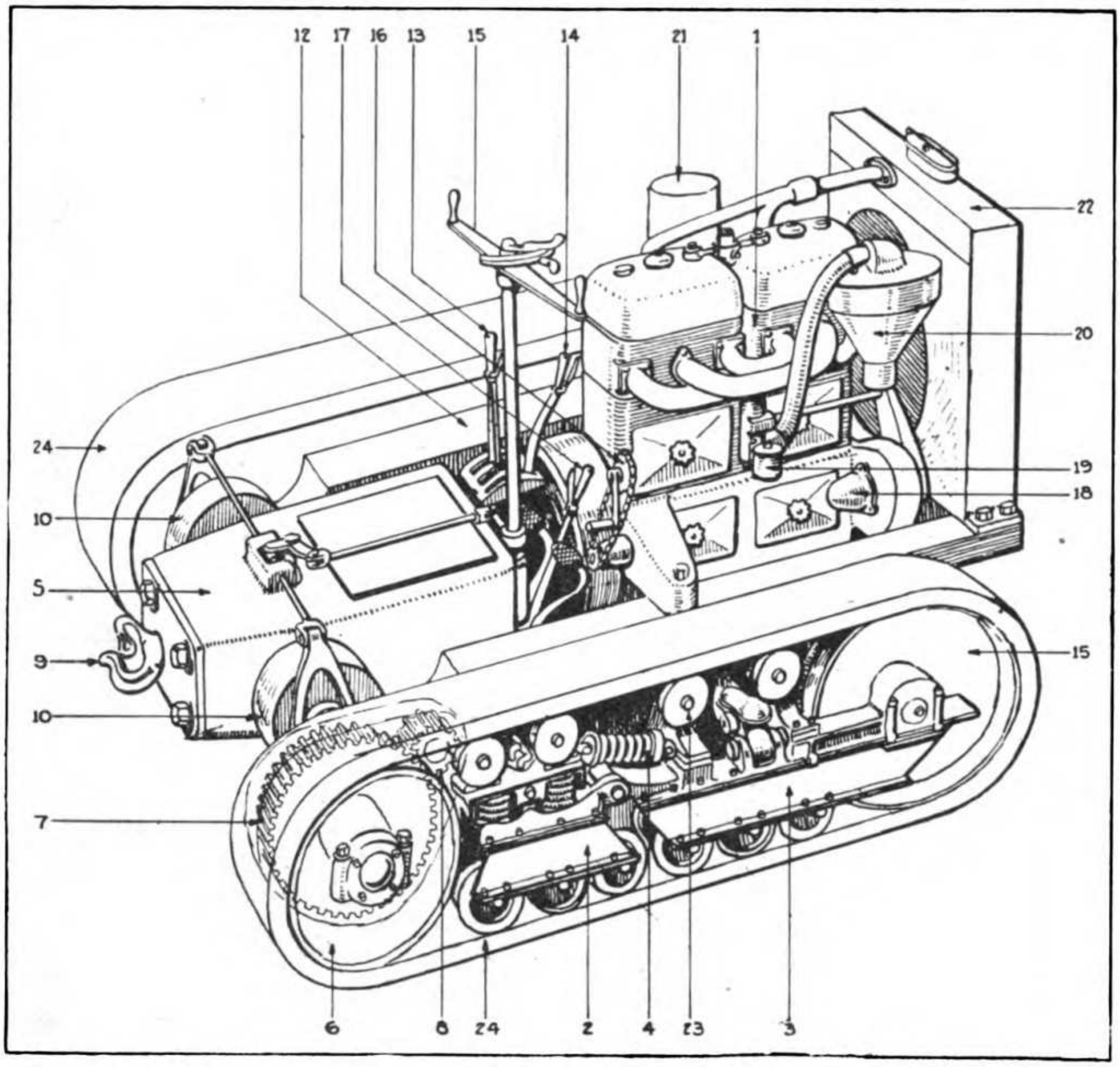


PLATE 2—DIAGRAM OF TRACTOR MAJOR ASSEMBLIES

Ref. No.	Name
1	Engine.
2	Rear roller frame.
3	Front roller frame.
4	Spring radius rod.
5	Transmission unit.
6	Track drive sprocket.
7	Drive sprocket gear (encased).
8	Intermediate shaft drive pinion.
9	Rear pintle.
10–10	Steering clutches and brakes.
12	Main frame.
13	Change gear lever.
14	Clutch lever.
15	Steering handles.
16	Hand starter.
17	Brake lever.
18	Governor housing.
19	Carbureter.
20	Air cleaner.
21	Vacuum tank.
22	Radiator.
23	Track supporting roller.
24–24	Tracks.

surfaces, impassable to the usual type of self-propelled vehicle except under the most extreme difficulties.

The general design and construction of the 5-Ton Tractor does not differ materially from that of the modern truck except in the method of transmitting the power from the transmission unit to the ground. It is used entirely as a power vehicle to be employed in the motorization of Guns and other Ordnance equipment heretofore drawn by other means.

ENGINE—Four cylinder, four cycle, valve-in-the-head type. Bore 4.75 (4¾) inches. Stroke 6 inches. Cylinders cast in pairs. Horse Power 56 at 1200 Revolutions per minute.

RADIATOR—Honeycomb-Tubular type. Eight separate headers.

IGNITION—Eisemann Model G-4 high tension Magneto with Automatic Impulse Starter.

CARBURETER—Model A Schebler carbureter with Stewart Vacuum Feed System. 1.5 (1½) inch.

GOVERNOR—Centrifugal flyball type mounted on special shaft and driven off Camshaft Gear.

MASTER CLUTCH—Dry Plate Multiple Disc Type.

TRANSMISSION—Selective sliding gear type. Three speeds forward, one reverse. Direct drive on second. Stepped up on high.

DRIVE—From Transmission through Bevel Gears to Steering Clutch Shaft through Steering Clutches to spur pinions, which mesh with intermediate spur gears, thence through outside gears, encased, to Sprocket Drive Sleeve and Drive Sprockets.

STEERING CLUTCHES—Two used of Dry Plate Multiple Disc type.

STEERING—By means of Steering Clutches operated from hand Steering Device and brake bands operated by foot pedals, which act on outside of Steering Clutch Drums.

CONTROL—Steering Gear located on right hand side. Change gear, Master Clutch Operating Lever, and Brake Lever, left of Steering Gear, left to right respectively. Spark and Throttle Levers operate on sector clamped to steering column. Steering Clutch Pedals right and left at bottom of, and in front of Steering Column.

BRAKES—One set. External contracting type. Raybestos or equal lined. Operate on steering clutch housings.

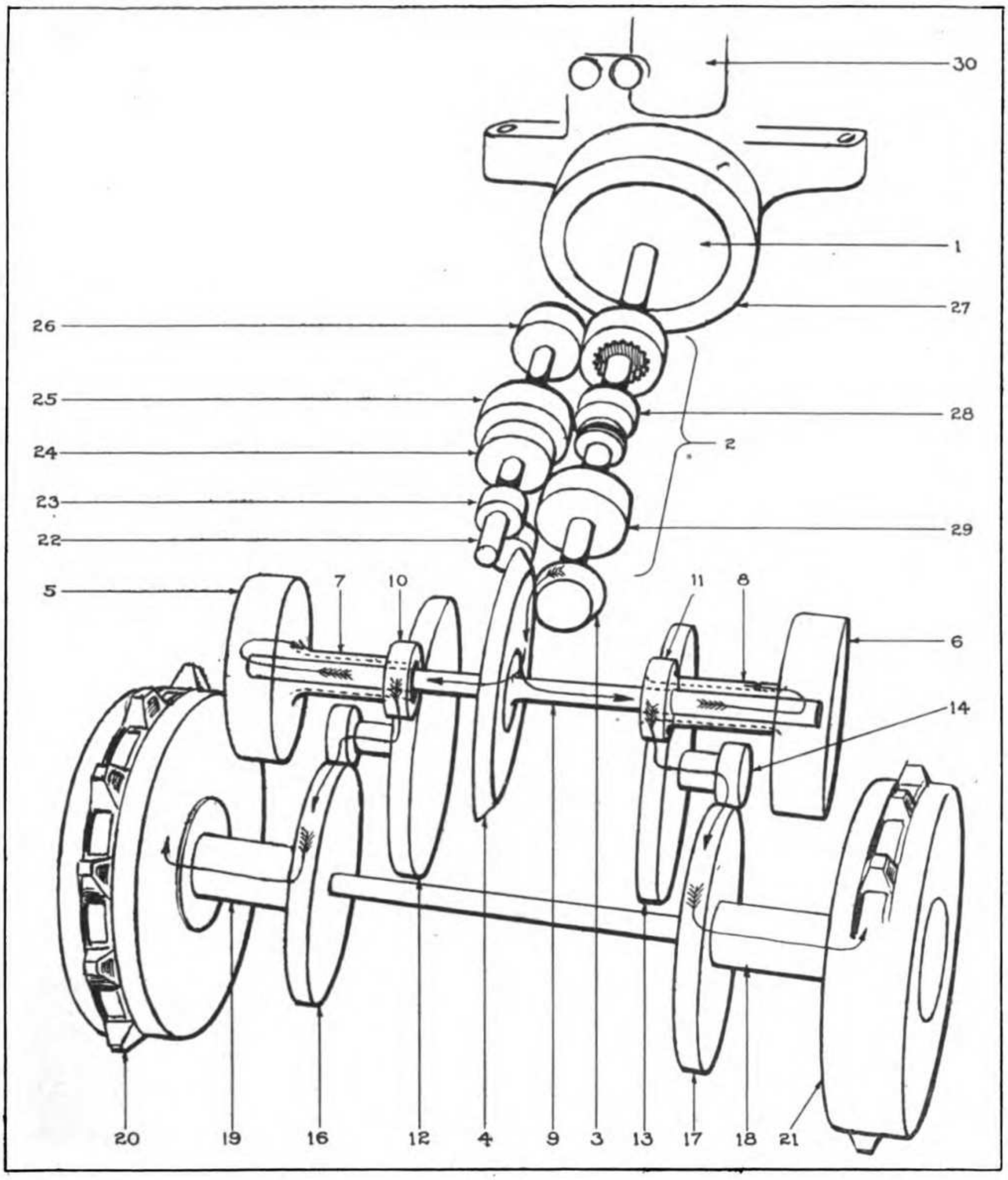


PLATE 3—DIAGRAM OF POWER TRANSMISSION SYSTEM

Ref. No.	Name	Ref. No.	Name
1	Master clutch in engine flywheel.	20–21	Track sprocket.
2	Transmission, gear shift.	22	Transmission countershaft.
3	Transmission, bevel pinion.	23	Reverse drive gear.
4	Steering clutch shaft bevel gear.	24	Low speed driving gear.
5– 6	Steering clutches.	25	High speed driving gear.
7– 8	Steering clutch housing (sleeve).	26	Countershaft driving gear.
9	Steering clutch shaft.	Unnumbered gear meshing with 26	Main drive pinion.
10–11	Intermediate (gear drive) pinion.	27	Engine flywheel.
12–13	Intermediate gears.	28	High speed driving.
14–15	Intermediate shaft drive pinions.	29	Pinion shaft gear.
16–17	Track drive sprocket gears.	30	Engine cylinders.
18–19	Track sprocket sleeve.		

TRANSMISSION SYSTEM.—From Engine (30) through Flywheel (27) to Master Clutch (1) to Transmission Gear Shift (2) through 3 and 4 to Steering Clutch Shaft (9), then in two similar paths, one of which is, 6–8–11–13–14–17–18–21 to Track Links.

GASOLINE TANK—Terne plate Tanks. Two independent duplicate tanks each of 12-gallon capacity. Auxiliary terne plate tank under Armor, 10-gallon capacity.

MAIN FRAME—Cast in one piece—open hearth steel.

ROLLER FRAMES—Four frames steel channel, joined by oscillating shaft. Two frames right and left front. Two frames right and left rear.

TRUCK ROLLERS—Six on each side tractor, fitted with roller bearings, turning on steel Gudgeons, flanged to follow Track Rail.

TRACK—Made up of malleable iron Track Shoes with Track Links integral, fitted with space blocks, and 1.25 (1¼) inch pins.

TRACK DRIVE SPROCKETS—Two. Teeth mesh with opening in tracks.

BLANK SPROCKETS—Two. Fitted with roller bearings which turn on steel gudgeons. Used to adjust Track tension.

TRACK SUPPORTING ROLLERS—Four on each side of tractor, two mounted on brackets attached to Front Roller Frame channel, and two in the rear mounted on spring bracket which is bolted to Main Frame.

SPRINGS—Four double coil springs at rear, two on each side between Rear Roller Frame and Bracket on Main Frame and, four—two on each side of Equalizing bar at front.

EQUALIZING BAR—Spring supported on front roller frame sections.

OPERATING INSTRUCTIONS

PLACING 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.

This initial inspection should 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.

Refer to Chapter X for itemized list of Equipment.

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 these permanent.

General Lubrication—Just 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 of a new Tractor has a full supply of lubricant. As a precautionary measure 5-Ton Tractors are shipped by the manufacturer 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.

Turn to the lubrication charts on pages 24, 25, and make certain that every point indicated on these charts has been supplied with lubricant specified for the particular point before the tractor is put in operation. The lubricant specifications will also be found there.

SPECIAL INSTRUCTION WHEN FIRST RECEIVING TRACTOR

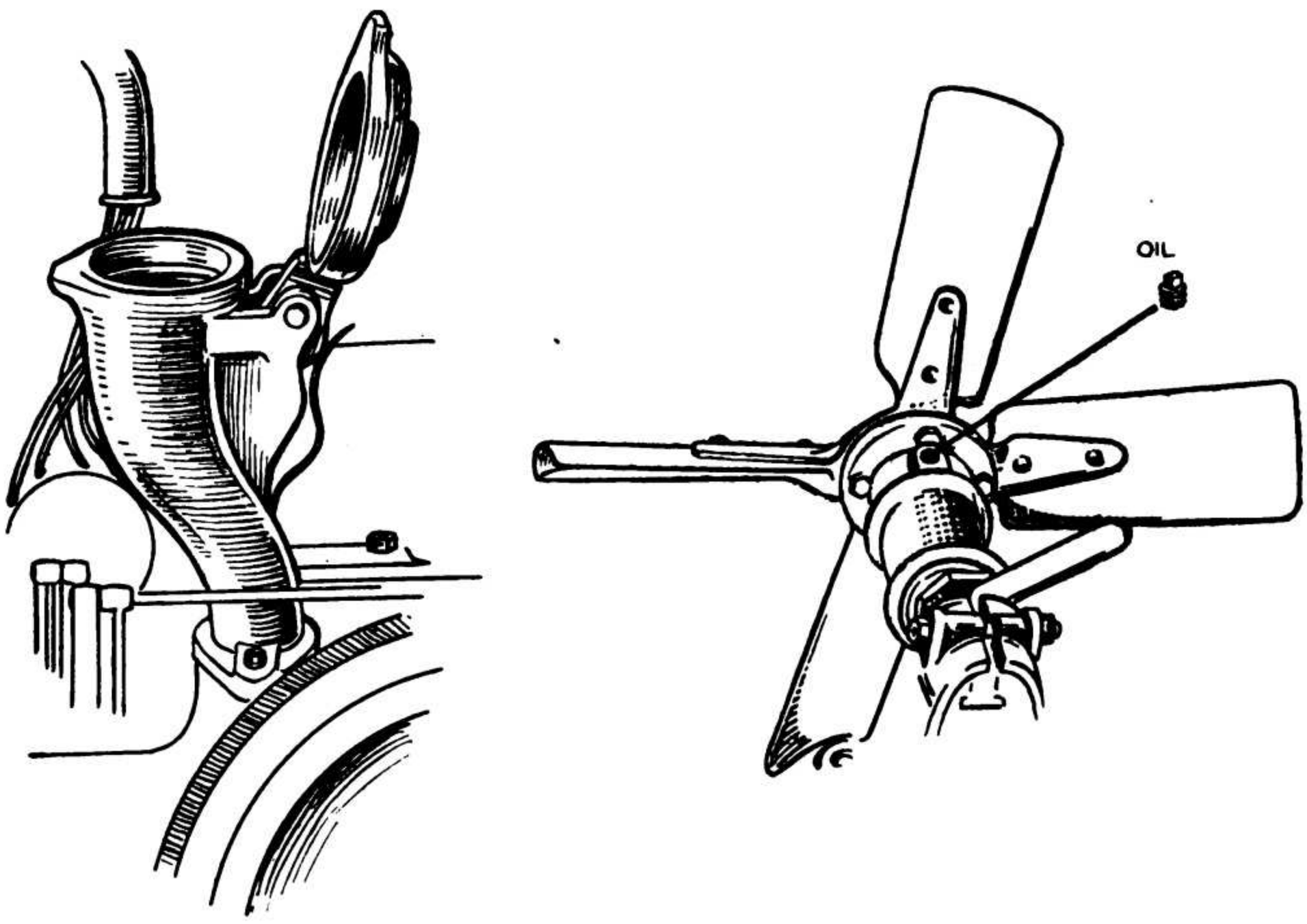


PLATE 4—OIL BREATHER AND FILLER—COOLING FAN

Engine—To prevent corrosion during shipment, in some cases the cylinder oil in the Crank Case of the Engine may have been drained and the Cylinder Walls, Connecting Rods and other exposed metallic surfaces covered with a heavy "slush." Before lubricating the Engine remove the Hand Hole Covers and carefully clean all surfaces covered with this "slush" if it has been used.

Kerosene applied with a cloth or brush will facilitate the complete removal of this protective covering.

Lubricate the Engine with cylinder oil, Ref. No. 2 Medium applied through the Breather located on the Crank Case to the left and rear of number 4 Cylinder. The capacity of the Oil Pan or Reservoir is 3.25 (3¼) U.S. gallons, the level of a full supply reaching the 4/4 mark on the Oil Gauge, a removable graduated rod projecting through the left rear motor supporting arm.

Fan Bearings—Lubricate the Fan Bearings with cup grease, Ref. No. 6. The lubricant is applied by removing the Pipe Plug protecting the hole in the Fan Hub just to the rear of the Blades. The hub should be well packed with grease.

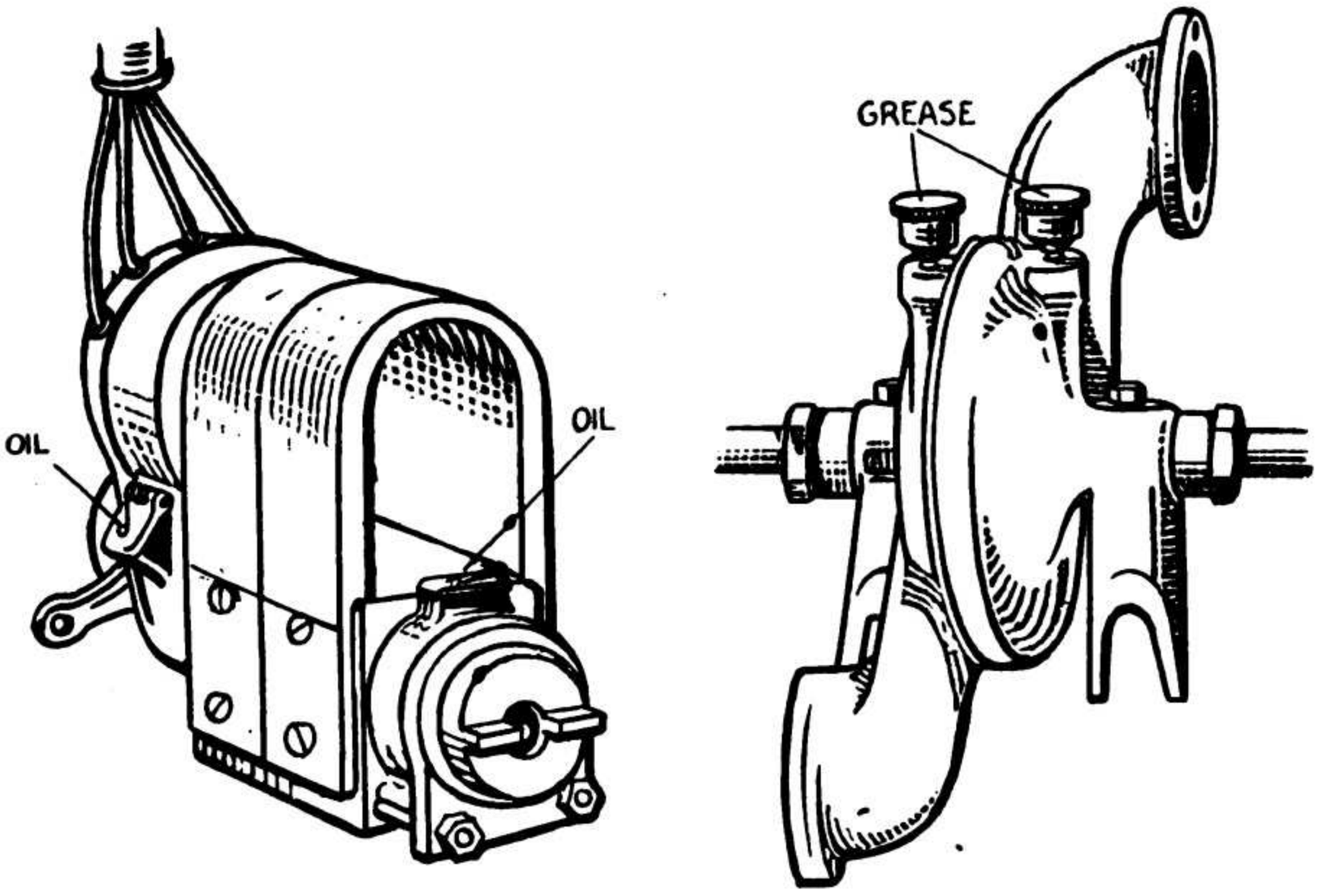


PLATE 5—MAGNETO AND WATER PUMP

Magneto—Lubricate the Magneto with "3 in 1" oil or when not available with cylinder oil, Ref. No. 2 Light, placing *one or two drops*, not more, in each of the two wells.

Water Pump—Fill the grease cups with cup grease, Ref. No. 6, and give two complete turns every four hours.

Hand Starter—Lubricate the Hand Starter with cylinder oil—Ref. No. 2 Medium. Two oil holes are supplied for the lower bearing surfaces of the Starter but the upper bearing surfaces must be lubricated at the intersections of the various parts with an oil can.

Radial Bearings in Master Clutch—Lubricate the Radial Bearing supporting the Master Clutch Inner Disc Hub on the Crank Shaft with cylinder oil, Ref. No. 2 Medium. The lubricant is applied through an oil hole drilled in the shoulder of the Master Clutch Inner Disc Hub, and normally closed with a plug.

Master Clutch Shifter Yoke—Lubricate the Master Clutch Shifter Yoke with grease Ref. No. 6, by giving the Grease Cup two complete turns daily.

Transmission—Inspect the level of the lubricant in the Transmission Unit by removing the Pipe Cap from the Stand Pipe located just to the

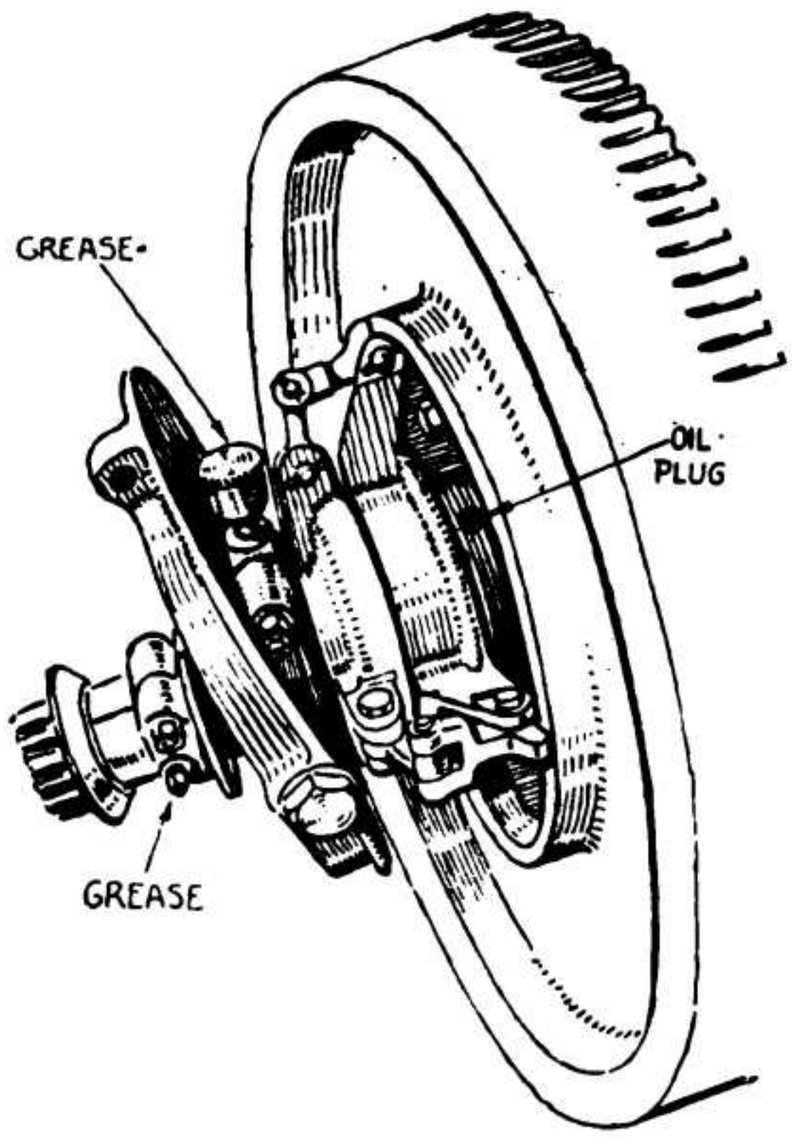


PLATE 6—MASTER CLUTCH AND SHIFTER YOKE

rear of the Track Drive Sprocket Shaft. If the level is below the top of the Stand Pipe, add more lubricant through the Oil Filler located on the Upper Half of the Transmission Unit (Transmission Grease Ref. No. 4 is specified for this unit but if not available any good grade of

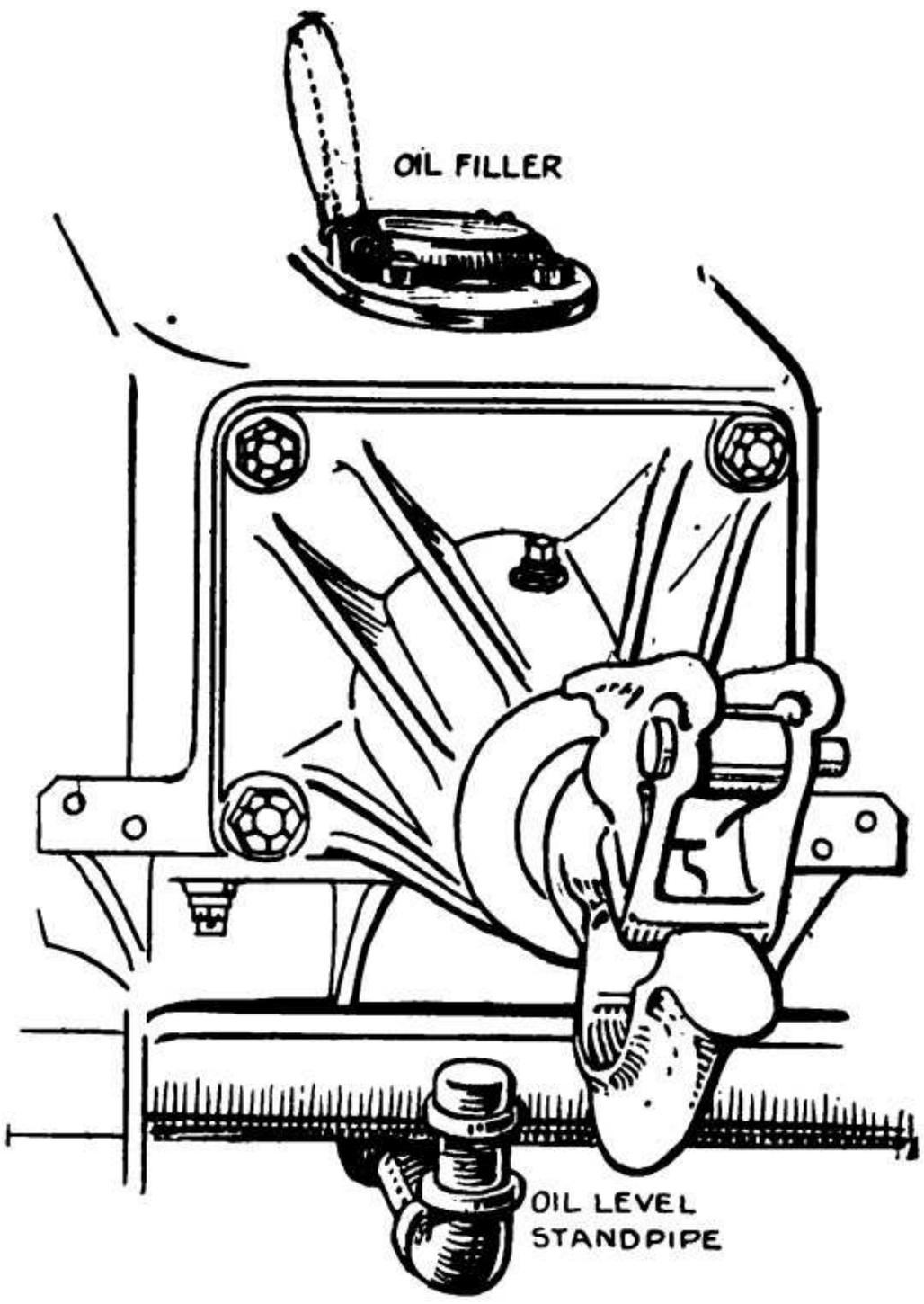


PLATE 7—TRANSMISSION LUBRICATION

Transmission Lubricant, such as Ref. No. 9, i. e. 600-W, may be substituted, but no grease should be used).

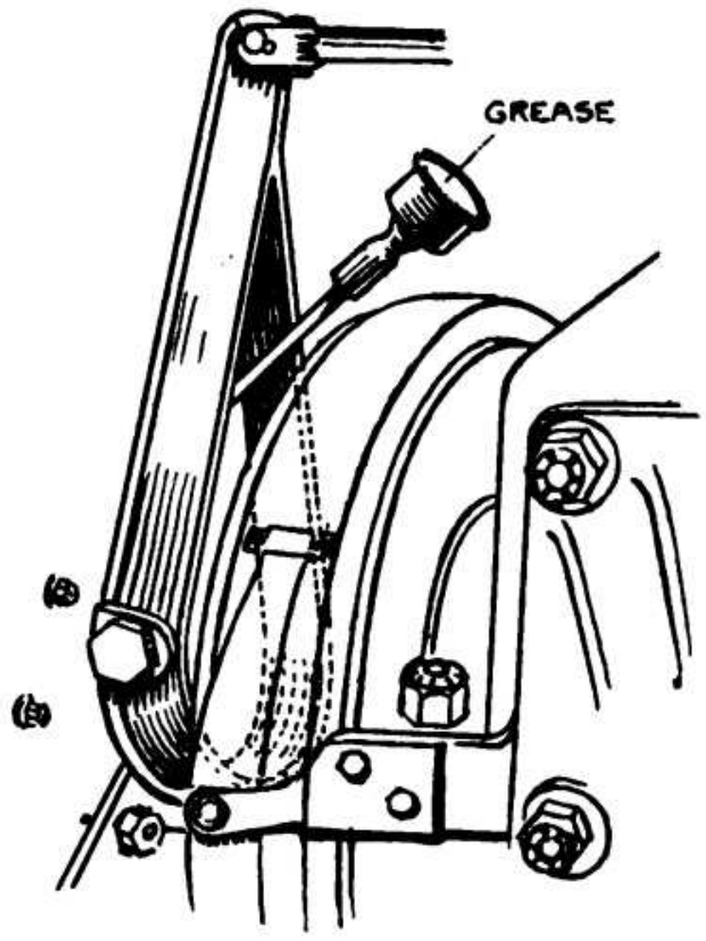


PLATE 8—STEERING CLUTCH YOKE

Steering Clutch Shifter Rings—Give grease cups, filled with grease Ref. No. 6, on Steering Clutch Shifter Rings two complete turns daily.

Track Drive Sprocket Gear—Inspect the level of the lubricant in the Track Drive Sprocket Gear Case by removing the Filler Plug in the side of this case. Use lubricant Ref. No. 8 for this when possible or Refs. No. 9 or No. 4 as alternatives when necessary.

Drive Sprocket Hub—Remove the ¼-inch Pipe Plug at the rear end of the Thrust Rod and with a Grease Gun, fill the chamber with Cup Grease, Ref. No. 6.

Blank Sprocket Shaft and Bearings—Lubricate with cup grease Ref. No. 6 by removing ⅜-inch Pipe Plug from hole in the end of shaft and inject with grease gun.

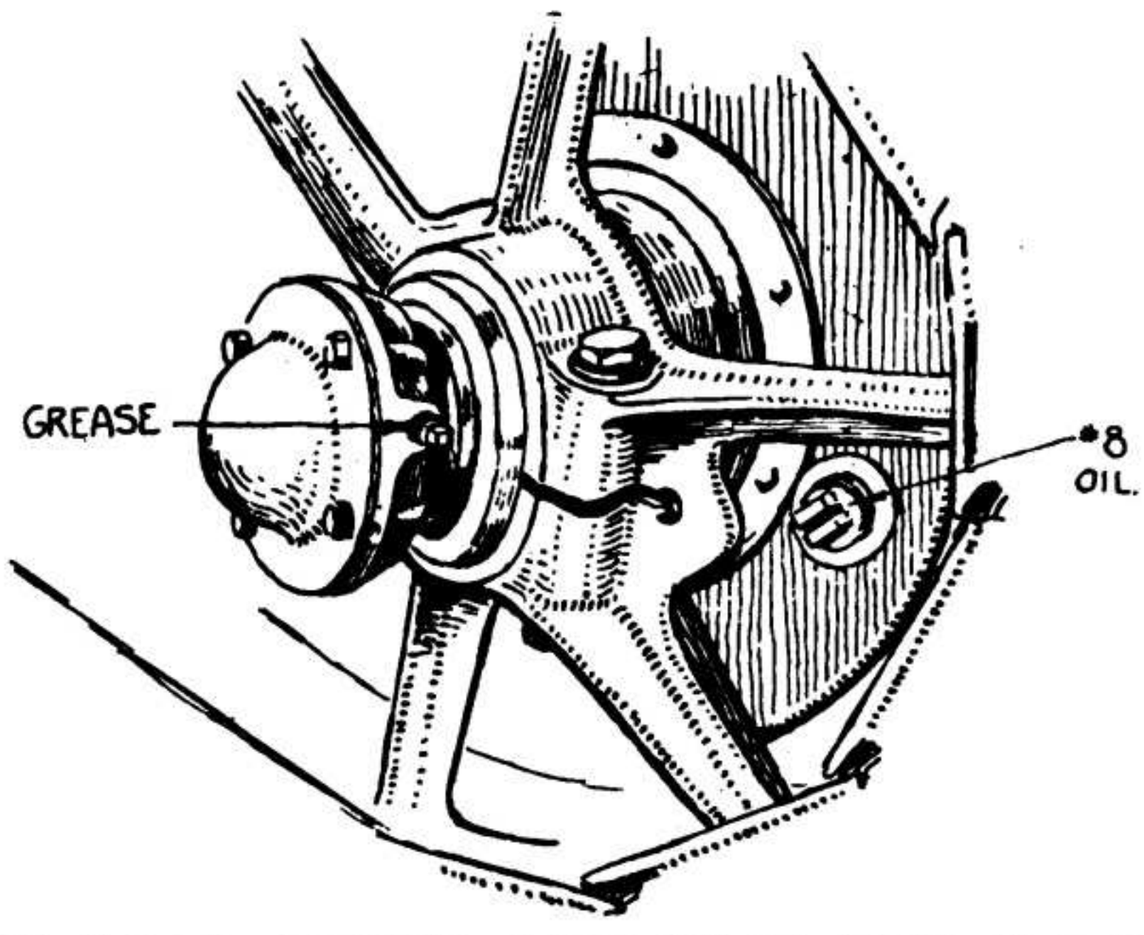


PLATE 9—DRIVE SPROCKET AND GEAR

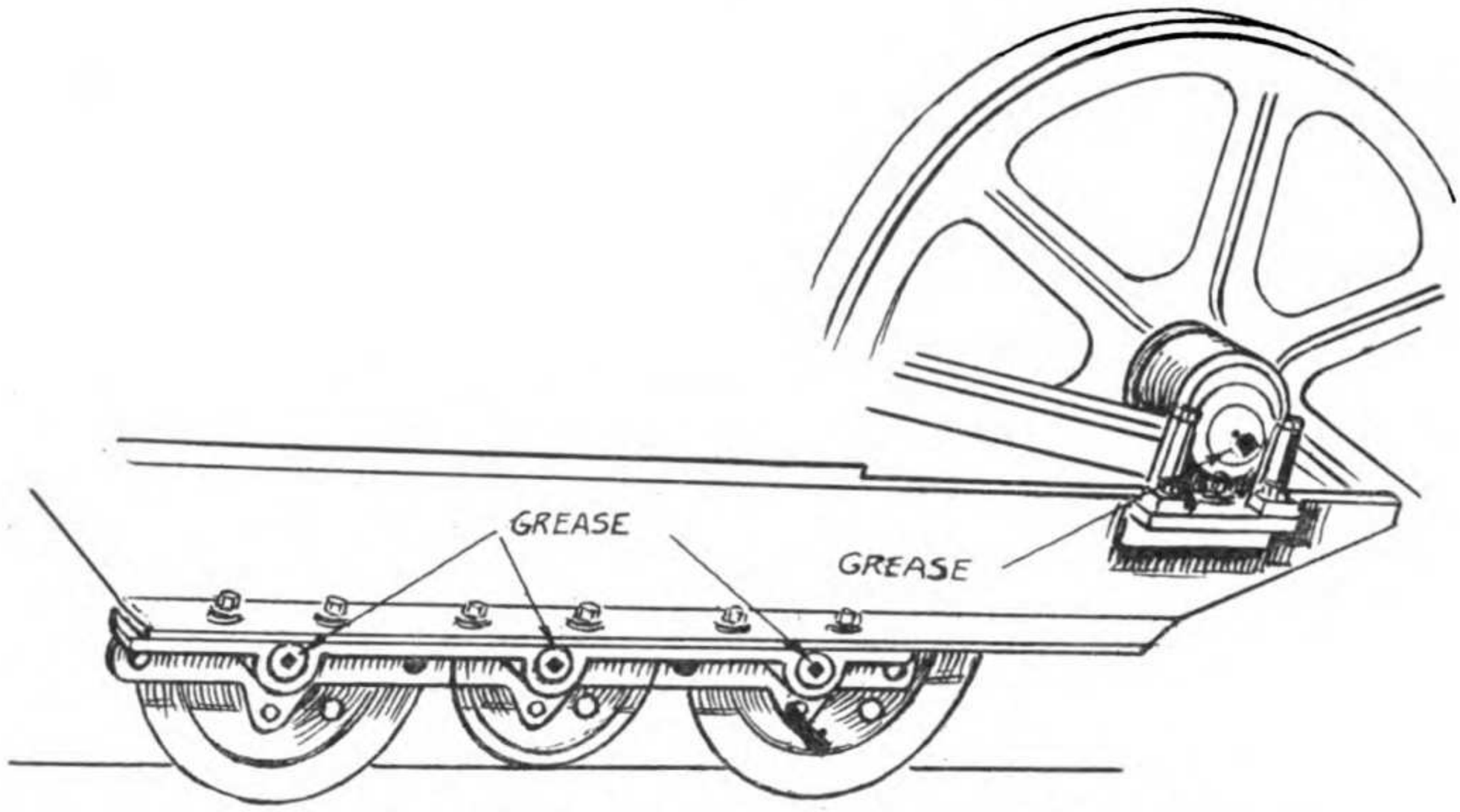


PLATE 10—TRUCK ROLLERS AND SPROCKET

Track Supporting Rollers—Lubricate with cup grease, Ref. No. 6, by removing ¼-inch Pipe Plug from end of Track Supporting Roller Shaft and inject lubricant with a grease gun.

Truck Wheels—Lubricate with cup grease, Ref. No. 6, by removing ⅜-inch Pipe Plug from end of Gudgeons and inject with a grease gun.

Fill 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 in Chapter II under Cooling System.

Fill the Fuel Tanks—These Tanks, three in number, are located at the right and left rear corners of the Operator's Seat and in the upper left rear corner of the Armor, respectively. To open, turn the handle of the Angle Valve under each rear Fuel Tank to the left until it stops.

Prepare the Lamps for Service—Fill the two side Lamps and the Tail Lamp with kerosene. Light and trim the wicks so that immediate service can be depended on.

TO START ENGINE

Condition of 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 Tractor in Service" have been complied with, and that all adjustments are correct or nearly so.

Establishing Lubricant 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 the aid of an oil can, lubricate the

cylinder walls. Turning the Engine over by hand a few times distributes this lubricant, establishing a film between the Piston Rings and the Cylinder Walls, and compression becomes effective.

Turn on the Fuel—Move the lever of the Three-Way Gasoline Valve and Strainer, located on the right side of the Reserve tank, to "Reserve." This permits the flow of gasoline from the Reserve Tank under the Armor to the Carbureter. It also facilitates starting, for in order to start on the Main tanks, it would be necessary to prime the Vacuum Tank.

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. See that the priming cocks are closed, before filling them full of Gasoline. Then open them allowing the gasoline to run into the Cylinders. Close the Priming Cups as soon as they are empty. (Note: Overpriming is very detrimental to an Engine and should not be permitted. Only a priming cup full of liquid gasoline is necessary to furnish the proper explosive mixture and no more should be used. Over-priming will destroy the lubricant film between the Piston Rings and the Cylinder Walls, causing loss of compression and the possibility of scoring the Cylinders.)

Disengage the Master Clutch—The Master Clutch is disengaged when Master Clutch Hand Lever is in a position farthest to the rear.

Retard the Spark—Move the Spark Control Lever "S" toward "Retard" to a position about 1 inch from the rear end of the Quadrant.

Advance Hand Throttle Lever—Advance Throttle Lever to a position about one-quarter of the full advance on Quadrant.

Switch on the Ignition—Move the Ignition Switch on the Instrument Board to the "Mag." position. (Note: The Impulse Starter on the 5-ton Tractor is automatic in its operation so needs no setting.)

Choke the Carbureter—Pull the Carbureter Choke Ring located on the rear of the Armor, as far back as possible. The Carbureter

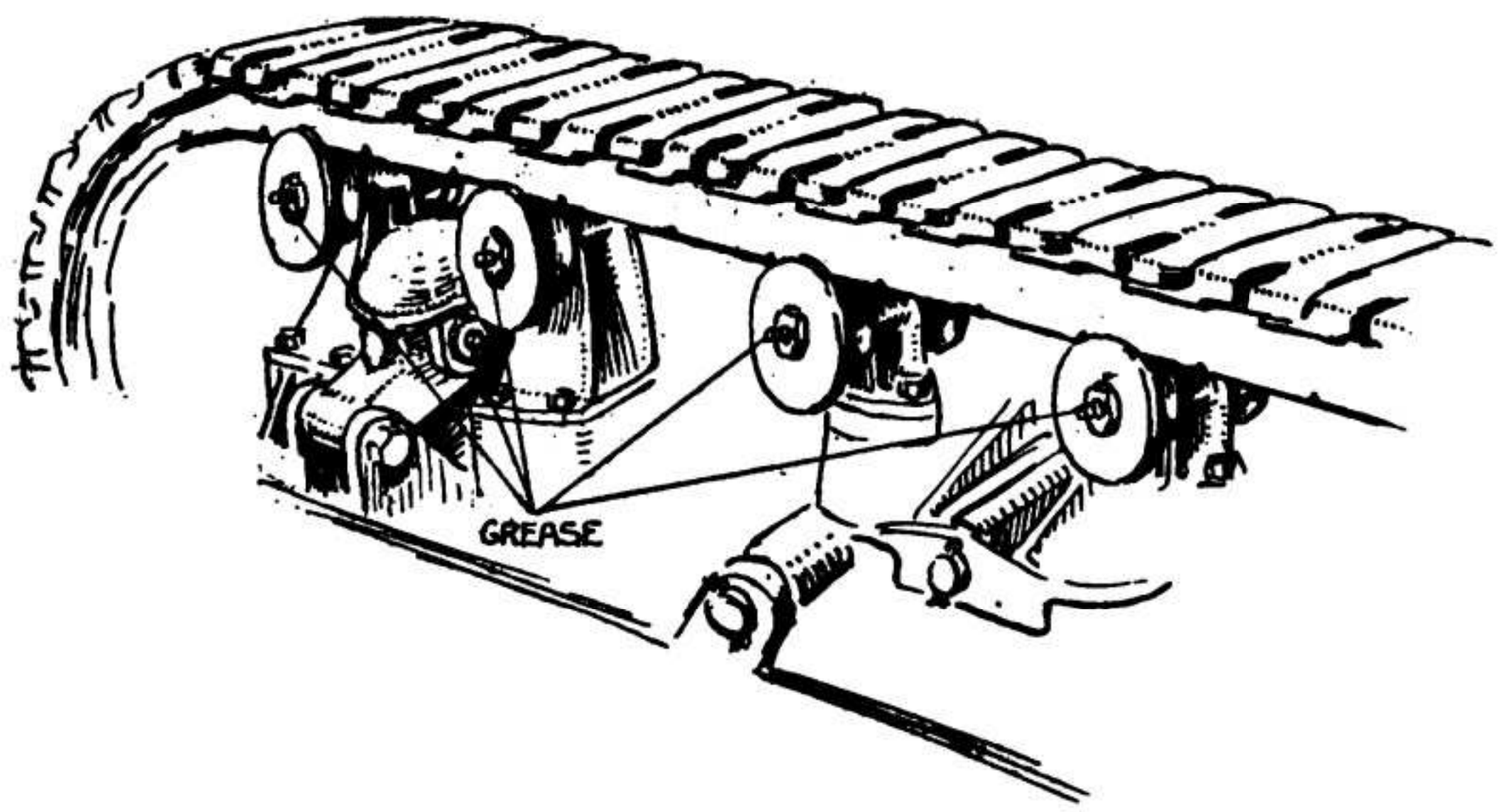


PLATE 11—TRACK SUPPORTING ROLLERS

should not be choked for more than two or three complete revolutions of the Flywheel.

Crank the 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 a compression stroke and then give the Flywheel a quick flip or pull past center and over compression.

(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.) See page 31.

WHAT TO DO WHEN ENGINE STARTS

Advance the Spark—Advance the Spark Lever "S" to a position about half way up on the Quadrant. This is the correct position for all ordinary driving.

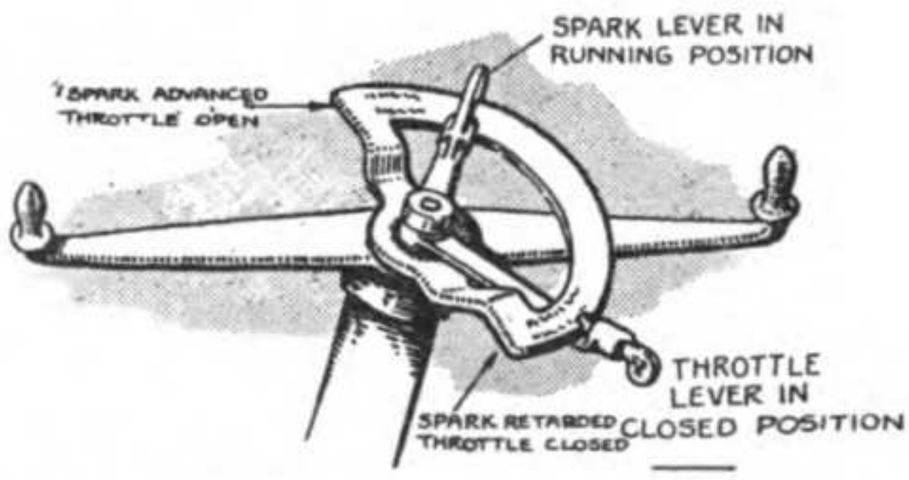


PLATE 12—SPARK AND THROTTLE CONTROLS

Adjust the Engine Speed—Place the Hand Throttle Lever in such a position that the Engine will idle at low speed. In cold weather the Engine should be allowed to run at a rather high rate of speed until warm.

Examine Oil Circulation—Examine the Oil Pressure shown on the Pressure Gauge, the dial of which is on the instrument board. If the pressure is below 25 lbs. at the governed motor speed, 1200 Revolutions Per Minute, after warming up for ten minutes, the reason should be investigated. Lack of oil, old thin oil or loose bearings may be the cause.

Examine Water Circulation—See that the Water is circulating freely. Fill the Cooling System to overflowing.

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. See page 31.

After Starting Engine—After the Engine has been running not less than five minutes, turn the lever of the Three-way Gasoline Valve and Strainer to "Sup" or Supply. By this time the suction caused by

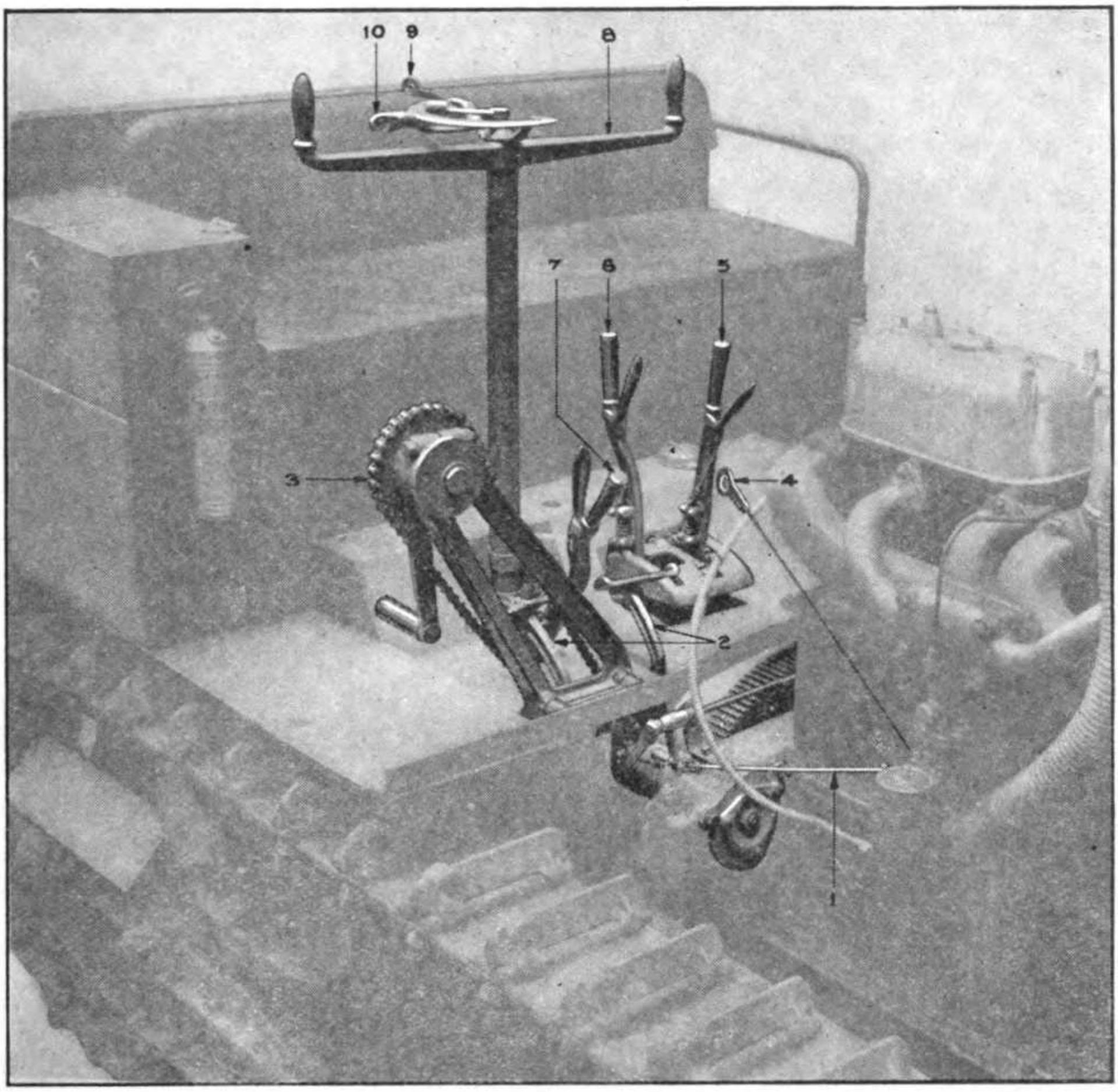


PLATE 13—5-TON ARTILLERY TRACTOR CONTROLS

Ref. No.	Ord. No.	Name
1	403F	Carbureter control rod, front.
2	67B	Brake foot pedals, right.
	67A	Brake foot pedals, left.
3	184F	Hand starter.
4	409E	Carbureter choke handle.
5	63A	Gear shift hand lever.
6	62C	Master clutch hand lever.
7	62A	Brake hand lever.
8	70A	Steering clutch hand lever.
9	70C	Spark control hand lever.
10	70B	Throttle control hand lever.

running Engine will have filled the Vacuum Tank, making it possible for the fuel from the rear Tanks to reach the Carbureter.

Gears—Select the Gear to be used, Low, Reverse, Direct or High, and through the medium of the Gear Shifting Lever engage the one selected. Starting and running is done without a change of Gears; gears must not be changed when the Tractor is in motion.

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 TRACTOR

Position of Operator—It is the duty of an Operator to remain in his seat at all times when the Tractor is in motion.

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 the Tractor will turn gradually in the direction toward the released Steering Clutch.

To Turn Quickly—If a shorter turn is desired, it is necessary to increase the resistance of the Track on the side toward the objective.

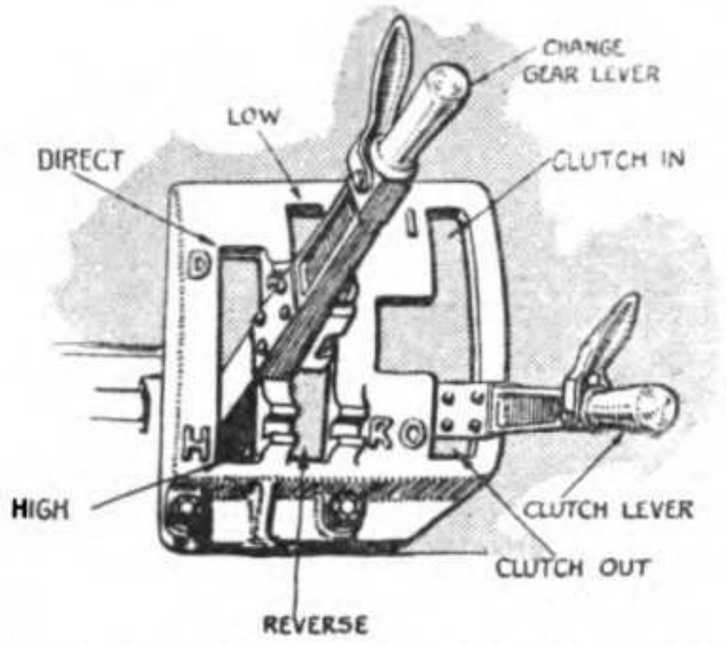


PLATE 14—POSITIONS OF GEAR SHIFT LEVER

This is accomplished through the medium of a brake operating on the drum of each Steering Clutch and controlled by two Foot Brake Pedals located on either side of the base of the Steering Column. The radius of a turning circle decreases in accordance with the amount of resistance thrown into the released Track. If the motion of the Track is stopped, it acts as a pivot on which the Tractor turns.

Turning with Load—With a load the effect of disengaging a Steering Clutch is more pronounced. Except for sharp right angle turns the use of the Brakes is not necessary, and should be used with discretion as the Tractor is liable to turn so quickly that it may foul the draw bar.

Changing the Gears—The Gears of the 5-Ton Tractor must not be changed while the Tractor is in motion.

To Change the Gears—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 do not force them but engage the Master Clucth slightly and try again.

Lubrication of Tracks—The Tracks should be lubricated only while the Tractor is in motion. Cut off the flow of lubricant immediately on stopping the tractor.

Lubricant to Use—Any grade of lubricant of such consistency as will flow through the Track Oiling System is satisfactory for Track lubrication. Waste Engine Oil is ideal for this purpose. Crude Oil or Fuel Oil should never be used as they have practically no lubricating value and when used there is a greater tendency for the working joints of the Track to clog and prevent the entrance of lubricant to the Space Blocks and Track Pins than with other oils of higher lubricating value. Higher grades of oil give longer lubrication, a smaller amount is necessary and the wear and tear of the Track is reduced to a minimum.

Time to Lubricate—Driving conditions vary so greatly that it is impossible to specify just when the Tracks should be lubricated and an Operator will have to use his own judgment in the majority of cases. Tracks should be well lubricated when the Tractor is put into service and about once every two hours thereafter if the running is continuous. TRACK LUBRICANT MUST NOT BE USED IN SAND, heavy dust or loose dirt, as such a large amount of dirt and grit will become mixed with the lubricant that its action will be that of a grinding compound rather than of a lubricant.

Brakes—The Brake Bands operating on the Steering Clutch Drums 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 Foot Pedals. If it is desired to retard the motion of the Tractor or to hold it in position, both Foot Pedals or the Brake Hand Lever may be used. The Brake Hand Lever is equipped with a ratchet to hold the brakes on when required.

Driving Suggestions—While driving a constant watch must be kept on the Oil Pressure, and also of any tendency to overheat which would be indicated by steam from radiator. A full supply of lubricant must be kept in the Oil Reservoir at all times and any reduction in Oil Pressure below twenty-five (25) pounds 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 unusual noises or performances as soon as they become evident, as the remedy at that time is generally simpler.

TO STOP TRACTOR TEMPORARILY

Disengage the Master Clutch—Pull the Master Clutch Control Lever as far to the rear as possible.

Engine Speed—Reduce the speed of the engine by moving the Hand Throttle Lever toward "Retard" until the engine runs at slowest speed.

Disengage the Gears—Disengage the Gears in mesh by moving the Gear Shifter Lever to the neutral position.

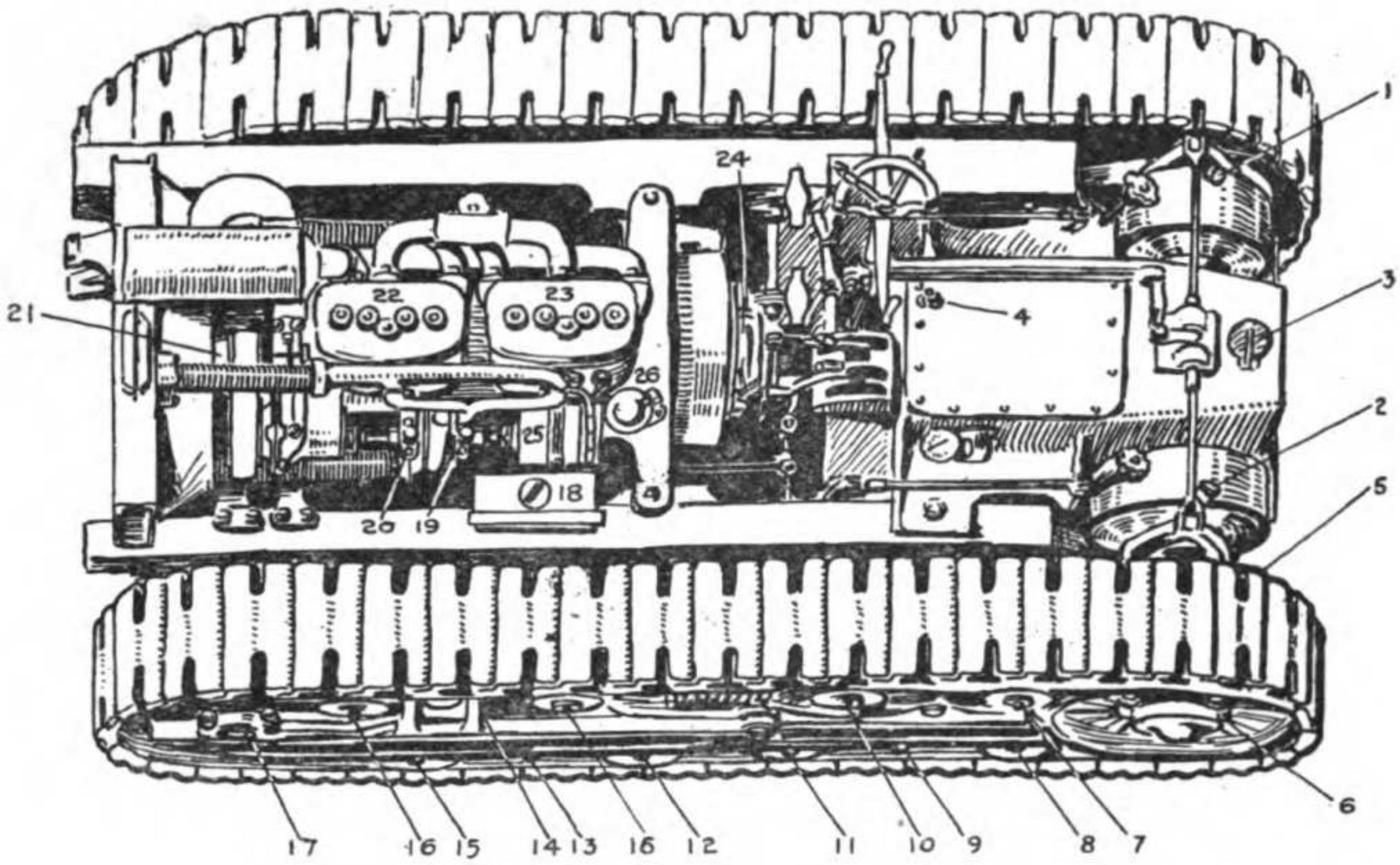


PLATE 15—LUBRICATING CHART

Ref. No.	Name	Lubricant
1-2	Steering clutch yoke	Grease No. 6.
3	Transmission unit	Trans. lubricant No. 4.
4	Pet cock to indicate oil circulation in transmission.	
5	Drive sprocket gears in housing	Heavy oil No. 8.
6	Drive sprocket shaft bearing	Grease No. 6.
7-10-16-16	Track supporting roller gudgeon pins	Grease No. 6.
8-9-11-12-13-15	Truck roller gudgeon pins	Grease No. 6.
14	Equalizing bar trunnions	Grease No. 6.
Not shown	Equalizing bar center pin	Grease No. 6.
17	Blank sprocket bearing	Grease No. 6.
18	Track oil tank	Black or waste Engine oil.
19-20	Water pump bearings	Grease No. 6.
21	Fan bearing	Grease No. 6.
22-23	Oil cups on top of engine (initial production only)	Cylinder oil No. 2 medium.
24	Clutch (see instructions, p. 27).	Grease No. 6. Oil No. 2 medium.
25	Magneto	"3 in 1"
26	Crank case breather	Cylinder oil No. 2 medium.

STOPPING THE TRACTOR AT THE END OF A RUN

To Stop the Tractor—Proceed as outlined in the preceding paragraphs.

To Stop the Engine—Move the Magneto Kick Switch to the "Off" position.

Inspection—At the end of each run the Tractor should be given a general inspection covering all loose or damaged parts, any defects that

LUBRICATING INSTRUCTIONS

After each assembly mentioned in the lubricating instructions herein will be found a number. The key to the various Reference Numbers is as follows:

Ref. No. E. M. Specification No.	Type of Lubricant
2 No. 3502	Cylinder oil furnished in light, medium and heavy.
4 No. 3504	Fluid transmission oil.
6 No. 3506	Medium cup grease.
8 No. 3508	Gear lubricant and slushing oil.
9 No. 3509	Usually known as 600-W.

NOTE: Use light oil only in freezing weather, or colder. Use medium oil regularly. Use heavy only on old, worn motors or in very hot weather.

PART	LUBRICANT REF. NO.	HOW APPLIED	HOW OFTEN
Fan Shaft	6	Grease gun	Weekly
Magneto	"3 in 1" or 2 Light	Dropper	See Magneto instructions
Engine Crank Case (See note under specifications, above)	2 Medium	Thru Breather	When required. Test by oil level indicator rod
Ball Bearings in Master Clutch	2 Heavy or Medium	Oil gun	Daily
Master Clutch Yoke	6	1 Grease cup	2 turns daily
Transmission	4	Through oil filler cap on top	As required to maintain level. Test at standpipe in rear of transmission case
Steering Clutch Shifter Ring	6	2 Grease cups	2 turns daily
External Sprocket Drive Gear, Dust Case	8	Grease gun	Sufficient to keep gears dipping. Fill up to plug hole
Drive Sprocket Hub	6	Through 2 plug holes	Daily
Track	Black oil—2 heavy, or 9; preferred in order named	Reservoir	Sufficient to keep space block and pin lubricated
Truck Wheels	6	With grease gun through 12 plugs	Daily
Track Supporting Rollers	6	Through 8 plugs with grease gun	Daily
Roller Frame Shaft	2 Medium	Oil can	Daily
Blank Sprocket Shaft	6	Through 2 plugs with grease gun	Daily
Water Pump Shaft	6	2 Grease cups	2 turns every 4 hours
Starting Crank Assembly	2 Medium	Oil can	Daily
Equalizing Bar	6	3 plugs	Daily

NOTE—All foot and hand brake rod clevises, change speed, steering gear and foot pedal connections, engine control rods and connections and all other working joints not provided with oil or grease cups should be lubricated with an oil can using cylinder oil No. 2 light or medium.

interfere with the proper operation of the Tractor, any shortages of parts or materials, and any conditions that might interfere with the proper functioning of any part.

Fuel and Lubricant—The supply of fuel and lubricant in all containers should be replenished and the Tractor otherwise made ready for immediate service.

Tractor Protection—After the Tractor is prepared for further service it should be covered with the Paulin carried under the Driver's seat, as a protection against the elements.

CLEANING OIL PUMP SCREENS

The oil pump screens which are placed at the bottom of the oil pans may become clogged by foreign matter collecting at this point. In order to clean these strainer screens, the whole oil reservoir or underpan does not have to be removed. Drain off the oil in both the front and rear oil reservoirs and take off the plates at the bottom of these oil reservoirs. The screens will be found on them and readily cleaned. This should be done every month, although every two weeks is more desirable. At the same time the lower Oil Pan should be removed and the screen in the top of this cleaned also.

The crank case of the engine should be washed at regular intervals. To do this first drain all oil from the oil reservoir by removing the bottom plates. Remove the hand hole plates on one side of the engine and with an oil gun or dipper wash the sides of the crank case with kerosene, allowing it to drain into the oil reservoirs. Then with a piece of clean soft canvas or other cloth that does not give off lint, wipe out kerosene on the bottom half of the crank case. Do not wipe the sides of the crank case. Wipe out the bottom of the oil reservoir, replace the hand plate cover and fill system with new oil through oil filler caps. BE SURE NO KEROSENE REMAINS IN RESERVOIRS. The proper oil level will be reached when the oil shows 4/4 on the oil gauging rod on the left hand rear arm of the crank case. DO NOT USE OLD OIL UNLESS NO OTHER IS AVAILABLE. Use old crank case oil for Track Oiling.

Every main and connecting rod bearing should be examined for looseness frequently. The main and connecting rod bearings of an engine that has a force feed lubrication must be kept up tighter than those of a splash lubricated one. If one bearing becomes looser than the rest, the oil will escape unduly, and cause the pressure throughout the entire system to drop, with the possibility of failure of lubrication at some point.

Before entering the crank case to examine the bearings for tightness, wipe the crank case side plates clean with a rag, or piece of waste saturated with gasoline or kerosene. Indeed, so essential is it that no dirt of any kind be admitted to the crank case that the operator's sleeves should be rolled up before he works on inside of the engine. All

wrenches and bars used in the crank case of the engine must be rinsed with gasoline before insertion, thus minimizing the possibility of putting dirt in the crank case. Keep the oil in the crank case scrupulously clean, for any dirt is sure to clog the oiling system and pump screen, and will result in damage.

If the oil is not drained from the engine or the crank case washed at regular intervals, foreign matter resulting from the breaking down of the oil may accumulate in the bottom of the reservoir so that circulation of oil will be clogged and engine ruined.

OIL PUMP

To Remove—First drain the oil from the rear reservoir in the crank case. Remove the rear oil reservoir from the bottom of the crank case by taking out the cap screws that hold it in place. The pump and rear oil reservoir will drop off together. Undo the cap screws holding the top of the pump onto the oil reservoir and remove pump assembly. The oil pump can then be completely disassembled for cleaning and inspection.

To Replace—Take off rear hand hole plate on crank case. Reach through this opening to guide pump drive shaft into place when replacing the rear oil reservoir on which the pump is mounted. Fasten oil pan in place, being careful to keep gasket unbroken. Close hand hole and fill system with Ref. No. 2 medium oil.

CARE OF MASTER CLUTCH

With the master clutch thrown to out position, put a couple of squirts of cylinder oil with an oil can on the friction surfaces on the bronze and cast iron friction ring thrust members twice a day. Use Ref. No. 2 medium oil. *Be careful not to over lubricate.*

It is advisable at frequent intervals to flush the Master Clutch Friction plates with gasoline to cut any gummy residue that may be left by the oil; keep the Shifting Ring oiled thoroughly, giving the grease cup thereon two turns per day.

On the Master Clutch there is located an oil plug through which oil is fed directly to the ball bearing which supports the master clutch on the crankshaft. Fill this with Ref. No. 2 medium or heavy oil. Oil the friction dog pins with Ref. No. 9 cylinder oil or Ref No. 2 medium or heavy oil, as also the bronze throw-out collar.

LUBRICATION OF TRANSMISSION

All parts of the transmission are lubricated by the transmission oil pump located within the gear case. The two bearings of the steering clutch assembly on the transmission are lubricated by the action of

the transmission oil pump. To test whether the pump is functioning open the pet cock at the top of the transmission case.

LUBRICATION OF TRACK DRIVE SPROCKET

Cup grease is applied through grease plugs on the end of the drive shaft, and through an oil hole for lubrication of the floating bushing. Holes are provided in both the oil tight dust guards, bolted to ends of the sprocket shaft through which Ref. No. 8 oil should be injected to lubricate the Track Sprocket Drive Gears.

LUBRICATION OF TRUCK WHEELS

Truck wheels are lubricated with Ref. No. 6 cup grease supplied through grease plugs by using a grease gun. These plugs are located on the ends of each roller gudgeon. Grease should be injected into each plug with a grease gun.

LUBRICATION OF TRACK

The tracks are lubricated while the tractor is in motion. They should be flooded with a black oil. Oil that has been drained from engine can be used. As long as the track pins and the space blocks have a film of oil additional lubrication will not be required. The track oil is carried in a reservoir under the driver's seat and is distributed to the tracks by pipe connections. Two valves under the foot boards govern the flow of oil.

MAGNETO LUBRICATION AND ADJUSTMENT

The lubrication of the circuit breaker is essential but over lubrication must be avoided. All parts of the magneto must be lubricated with a light oil like Three-in-One, or a household lubricant, or machine spindle oil. Since only a small quantity of oil is needed for magneto lubrication, an oil can ought never to be used. Use a tooth pick or a piece of wire with a notch filed in it near the end so that it resembles a crochet hook. The lubrication of the Eisemann Magneto, with which the tractor is provided, and particularly the circuit breaker, must be limited to one drop of oil at one place. Keep the circuit breaker scrupulously clean of excess oil and the breaker points adjusted to break 1-64 of an inch. Supply oil to each bearing once every two weeks.

MAINTENANCE ROUTINE

It is essential for the proper care and maintenance of the 5-Ton Artillery 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 proper adjustment at regular intervals of time.

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

DAILY MAINTENANCE ROUTINE

Engine

Examine all wiring terminals for tightness.
Clean magneto externally.
Note tension of fan belt.
Inspect oil pump for performing its function.
Inspect oil supply in engine crank case.
Inspect radiator water supply.
Inspect gasoline tanks for proper fuel supply.
Inspect pipe line and all connections for leaks.

Steering Clutch Brakes

Inspect for undue wear or looseness.
Inspect for proper operation.

General

Inspect and thoroughly clean all lamps.

MAINTENANCE ROUTINE WEEKLY

Engine

Inspect all wires for proper support and freedom from damage.
Thoroughly clean engine externally.
Inspect for oil leaks.
Inspect control connections for looseness.
Inspect all water connections for leaks.
Drain water and dirt from water trap in gasoline line.
Inspect carbureter control connections.

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

Inspect oil lines and drain plugs for loss of oil.
Test main and connecting rod bearings for looseness.

Master Clutch

Inspect clutch for oil leaks, clean externally.

Brakes

Examine thoroughly. Clean all brake connections and adjust.

Steering Clutches

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

Springs

Inspect springs for breakage, both under frame bracket and on equalizing bar.

Tracks

Inspect tracks, rollers, carriers, drive sprocket, blank sprocket, equalizing bar for wear, breakage and proper adjustment.

Transmission

Clean and inspect all control connections.

Inspect action of transmission oil pump by opening test cock on top of transmission case.

General

Inspect armor bolts, fasteners, and all similar bolts for tightness.

Inspect tool equipment for completeness.

MAINTENANCE ROUTINE MONTHLY

Master Clutch

Thoroughly clean and inspect all lever connections.

Transmission

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

General

Inspect speedometer drive.

COMMON TROUBLES

IMPORTANT ADVICE

Do not touch any adjustments or tamper with any parts until you know what causes the trouble. Otherwise you may get everything out of adjustment.

ENGINE FAILS TO START

Lack of Gasoline—See that fuel tanks are full and shut-off cocks are open. If fuel line is free, gasoline will run out of drain cock on the bottom of the carbureter.

Lack of Ignition Current—This may be due to neglect in throwing on the switch or to a broken or disconnected wire. May also be caused by "grounding" on some part of Engine or frame of wire from magneto to ignition switch.

Dirty Spark Plugs—These are due to an excessive amount of oil in the Engine and too long service without attention, whereby the points become coated with carbon. Dirty spark plugs should be removed and cleaned with Gasoline.

Spark Plugs—Points are improperly set. (See under "Engine Misses".

ENGINE STOPS

Lack of gasoline.

Disconnected switch or wires, or "grounded" magneto switch wire.

Lack of oil or water.

Carbureter flooding.

ENGINE MISSES

Broken or Disconnected Wiring—If the Engine misses, short circuit the spark plugs one after another, by touching a hammer or screw

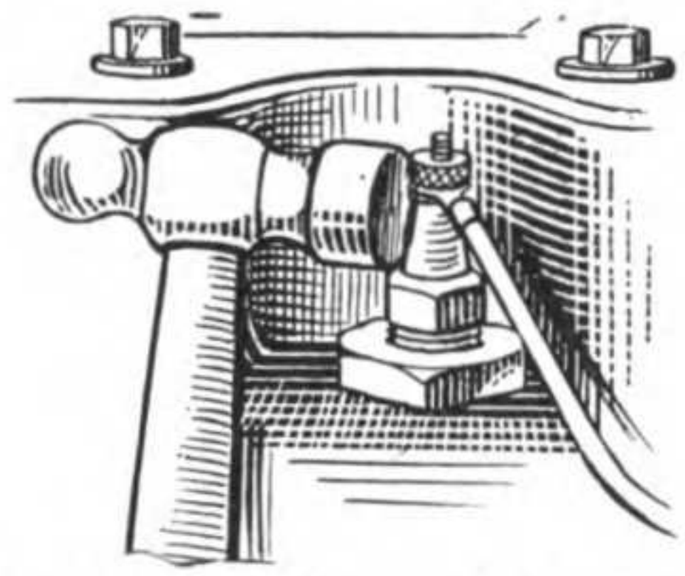


PLATE 16—TESTING SPARK PLUGS

driver from the metal of the cylinders to the terminals of the spark plugs. When one is reached which makes no difference in the running of the Engine, this is probably the plug at fault. Opening of the pet cocks will also show which cylinders are firing as the flame will show.

Dirty or Broken Spark Plugs—Remove and clean. Be sure porcelain insulator is not cracked.

Points of Spark Plugs Improperly Set—If these points are too close together or too far apart, missing may result. Spark plug points should be set approximately .025-inch apart—about the thickness of a dime.

Defective Carbureter Adjustment.

Loss of Compression in any Cylinder—Valve may be stuck or there may be dirt under it. Examine the valve tappet to see whether the valve seats properly. To locate cylinder that is weak on compression, turn over the engine by hand, testing each cylinder in turn.

Water in Gasoline—Indicated by engine running and stopping and running again by fits and starts.

Overheating—Engine runs with some pounding and slowly. Close throttle completely. See "Engine Overheats."

LOSS OF POWER

The engine will run but will not pull the tractor under a heavy load.

May be due to:

Loss of compression.

Too rich a mixture through carbureter flooding.

Valves not seating properly and not holding compression.

Weak ignition.

Lack of oil or water.

Lack of gasoline. If this is due to the stoppage of the gasoline pipe, the engine will spit back through the carbureter when the throttle is opened.

LACK OF GOOD COMPRESSION

This is generally due to leaky valves. These should be adjusted or their seats reground. Scored cylinders are a very common cause and are the result of insufficient lubrication.

POPPING BACK THROUGH CARBURETER

This usually indicates too weak a mixture and may be caused by:

Dirt in gasoline passage or nozzle—Try pet cock on carbureter.

Air leak in the intake passage or vacuum tank and connections.

Inlet valves holding open.

Water in gasoline.

ENGINE OVERHEATS

Lack of Proper Lubrication.

Defective Water Circulation—Inspect all water passages, making sure that the gaskets (washers) at flange joints have not swollen in such a way as to cut down the opening.

Slipping Fan Belt—Belt should be tightened.

Too Much Gasoline—Too rich a mixture is indicated by black smoke at the exhaust. The engine will sometimes continue to fire after the switch has been turned off, even though the water is not hot enough to indicate overheating. This firing is caused by a carbon deposit in the cylinders, which becomes incandescent.

Too Little Gasoline—Too lean a mixture is indicated by lack of acceleration, popping in the carbureter or back-firing when the throttle is suddenly thrown open.

ENGINE KNOCKS

Connecting Rod Bearings too Loose or Burned Out—Loose bearings give a light knock at high speed. Burned out bearings knock whether running under load or idling and low pressure is shown on Oil Gauge.

Lack of Proper Lubrication of Engine.

Faulty Carbureter Adjustment.

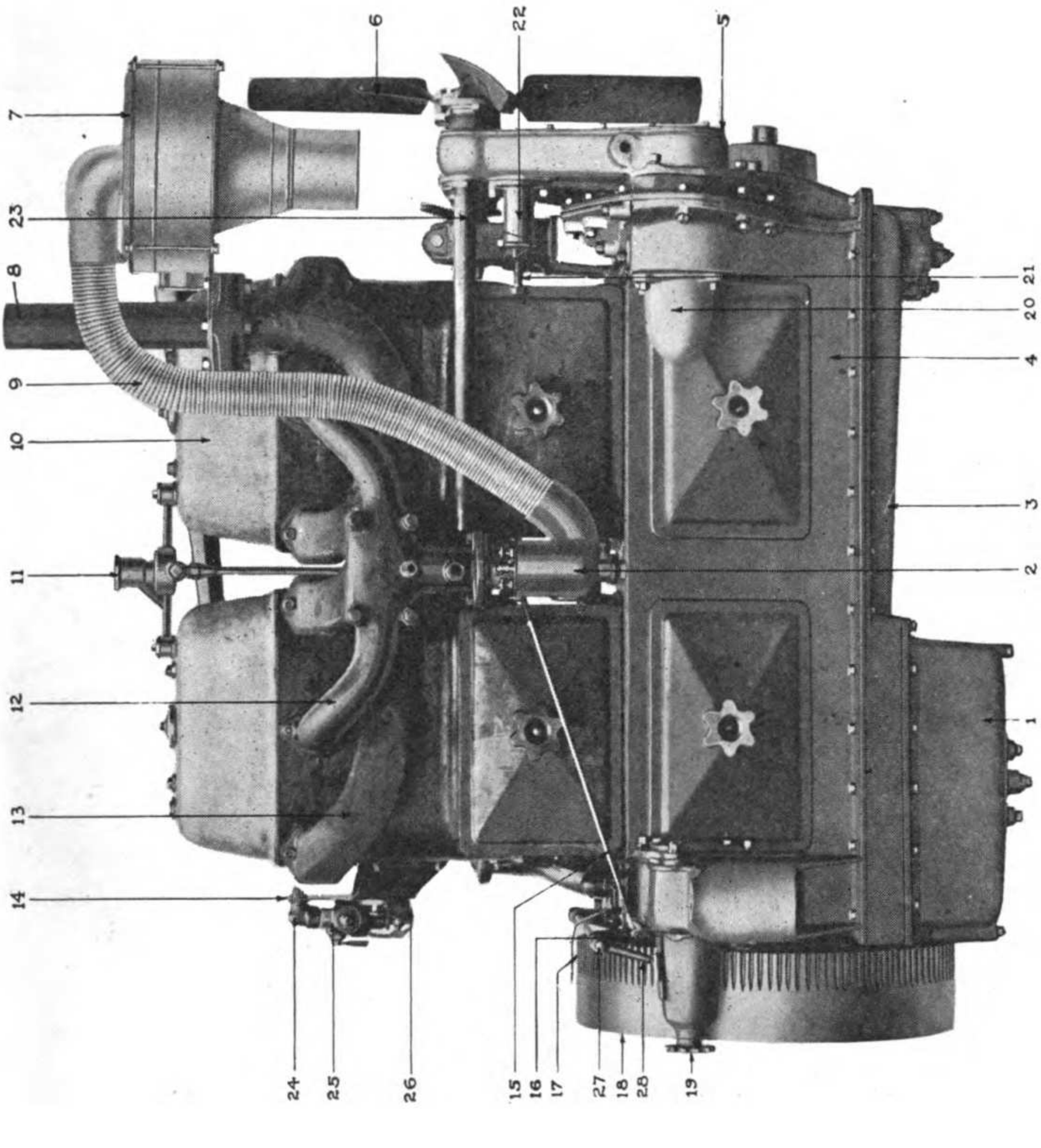
A Loose Piston in One of the Cylinders—Knocks only under full load at low speeds.

Carbon in Cylinders—This carbon becomes heated and may cause premature ignition. Remove cylinder heads and clean cylinders.

Crankshaft Bearing Loose—Heavy pound at slow engine speed under heavy load. The adjustment of this bearing should by all means be made as soon as possible.

Overheating Due to Lack of Water.

PLATE 17



RIGHT HAND SIDE OF ENGINE

PLATE 17—RIGHT HAND SIDE OF ENGINE

Ref. No.	Ord. No.	Name
1	340A	Lower oil pan.
2	407A	Carbureter assembly.
3	341A	Upper oil pan.
4	322A	Crank case—upper.
5	309A	Governor lever housing.
6	281A	Fan.
7	408A	Air cleaner.
8	241C	Exhaust pipe.
9	407B	Air cleaner flexible
10	304A	Cylinder head cover
11	429A	Valve cover oil reli
12	394A	Intake manifold.
13	393A	Exhaust manifold.
14	415A	Instrument bracket
15	403F	Carbureter control
16	403A	Carbureter control
17	331B	Flywheel pointer.
18	261A	Flywheel.
19	181A	Eclipse-Bendix sta
20	310A	Generator shaft co
21	313C	Governor adjusting
22	313E	Governor adjusting
23	311E	Governor rod tube.
24	416D	3-way gasoline valv
25	416C	3-way gasoline valv
26	416B	Magneto switch.
27	401E	Spark control shaft
28	401D	Spark and carburet

CHAPTER II

ENGINE GROUP

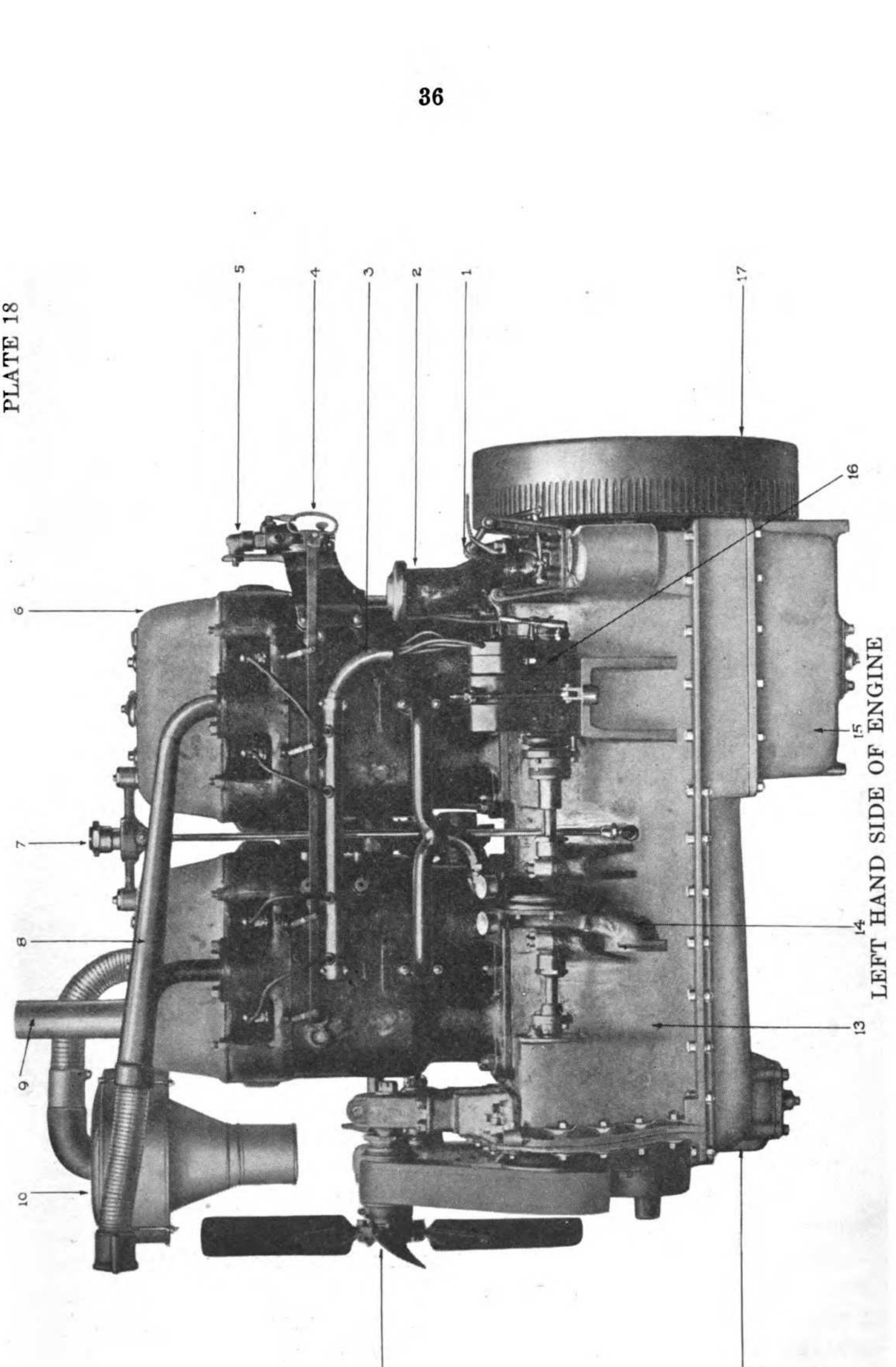
ENGINE

CHAPTER CONTENTS

BRIEF DESCRIPTION

The Engine Group consists of the parts which together develop the power to propel the Tractor. It includes the Engine Complete, the Fuel Supply System, the Ignition System, the Cooling System and the Starting Units. The engine is of the four-cylinder type with the Cylinders cast in pairs and mounted upon a two-piece Crankcase of cast aluminum. The latter is mounted in the Main Frame on a three point suspension, two of the points being on either side of the Flywheel and the third at the front end of the motor on the Timing Gear Cover Plate. The Cylinders have detachable heads in which the Intake and Exhaust Valves are located. The Ignition is obtained with a Magneto which has an Impulse Starter for ease in starting the engine. Carburetion is obtained with a Schebler Carbureter. A "hot spot" Manifold is provided to insure the vaporization of even poorer grades of fuel. The

PLATE 18



LEFT HAND SIDE OF ENGINE

PLATE 18—LEFT HAND SIDE OF ENGINE

Ref. No.	Name
1	Spark and throttle control.
2	Oil filler and breather.
3	Ignition cable tube.
4	Gang hand lever.
5	Instrument assembly.
6	Rocker arm covers.
7	Oil pressure relief valve.
8	Water outlet pipe.
9	Exhaust pipe.
10	Air cleaner.
11	Cooling fan.
12	Upper oil pan.
13	Crank case, upper.
14	Water pump.
15	Lower oil pan.
16	Magneto.
17	Flywheel.

speed of the Engine is regulated by means of a flyball Governor located in the Timing Gear Case and operating a butterfly throttle above the Carbureter. Cooling is accomplished by means of a flat tube type of Radiator in conjunction with a centrifugal Water Pump and a belt-driven four-bladed Fan. The Lubricating System is unique in that it has been designed to deliver a uniform quantity of oil to the bearings at all times whether the tractor is going up or down a 100 per cent grade. This is accomplished by the use of three oil pumps, pressure feed, and a dry crankcase.

ENGINE OPERATION.

The engine operates on the four-stroke cycle which is conventional on all truck and passenger car engines made in the United States. There are four distinct strokes of the pistons 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 into the Cylinder through the Carbureter and the intake manifold, a charge of gas. 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 also closed at this time, the gas is trapped within the Cylinder and compressed by the Piston's upward motion.

When Piston reaches top of its stroke, the spark occurs and explodes the mixture which, due to its increase in pressure, drives down the

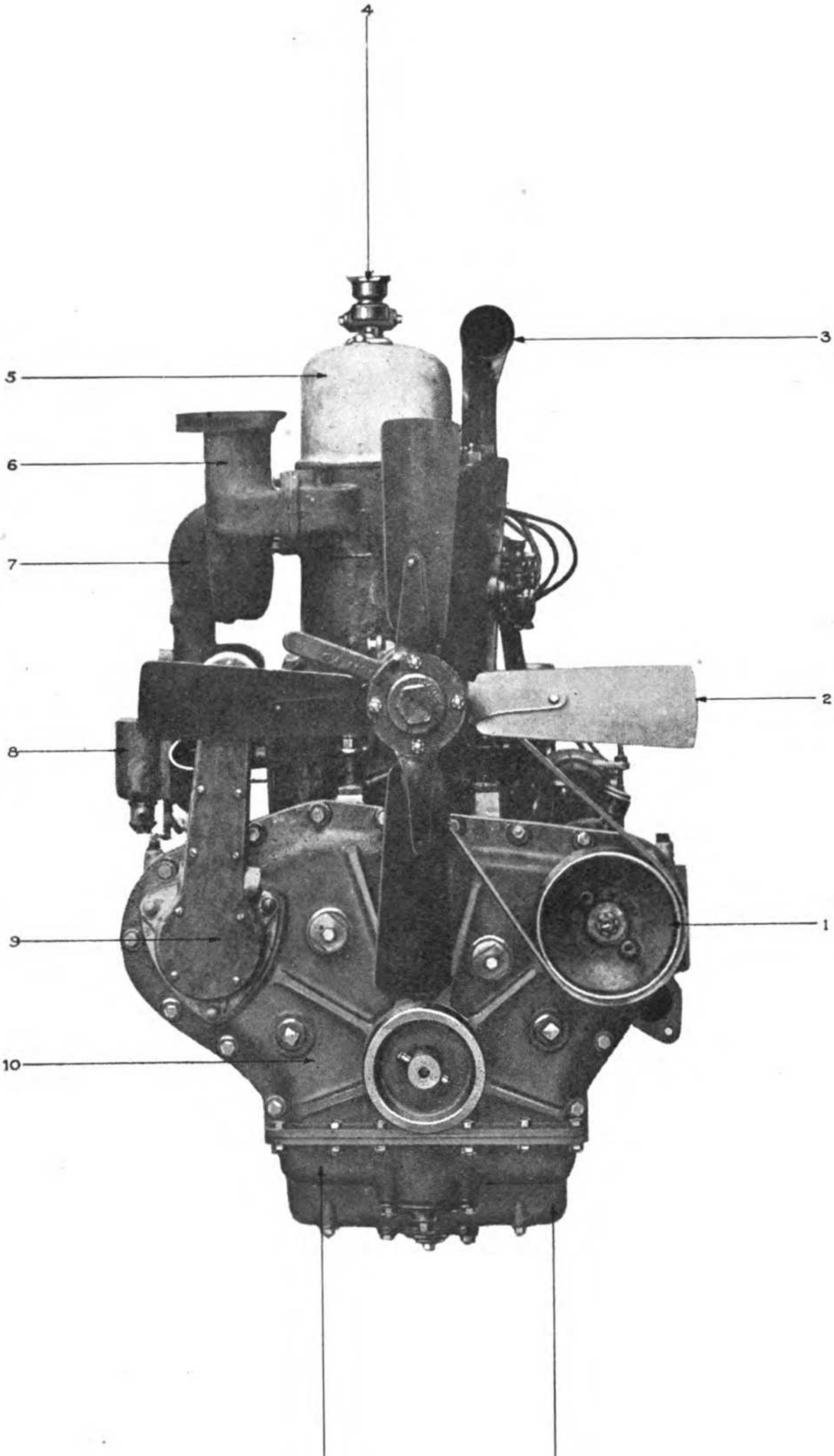


PLATE 19—FRONT VIEW OF ENGINE

PLATE 19—FRONT VIEW OF ENGINE.

Ref. No.	Name
1	Fan drive pulley.
2	Cooling fan.
3	Water outlet manifold.
4	Oil pressure relief valve.
5	Rocker arm covers.
6	Exhaust manifold.
7	Intake manifold.
8	Carbureter.
9	Governor lever housing.
10	Timing gear cover plate.
11	Upper oil pan.
12	Lower oil pan.

Piston with considerable force, thus storing up energy inthe Flywheel for the succeeding stroke.

When the Piston nears the bottom of its 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 the ejection of the remaining burned gases.

ENGINE GROUP

The Engine used in the Five-ton Artillery Tractor has four Cylinders with a bore of 4.75 ($4\frac{3}{4}$) inches and stroke of 6 inches, giving a Piston Displacement of 425.3 cubic inches. The Cylinders are cast in pairs and mounted upon an aluminum Crankcase, which is supported by the Main Frame at three points. The Cylinder Head is detachable and carries all of the valves which are located in the top of the Cylinder Head. The Engine Assembly comprises the following sub assemblies, namely: Cylinder, Rocker Arm Cover, Piston and Connecting Rod, Crankshaft, Crankcase, Oiling System, Governor, Fan, Water Pump, Manifolds and Muffler.

CYLINDER ASSEMBLY

The Cylinder Assembly consists not only of the two Cylinders, which are cast integrally together, but also the Cylinder Head with its Valves, Rocker Arms and Valve Springs, Valve Push Rods, and Valve Tappets and Guides.

CYLINDER

The Cylinders are cast in pairs without the Cylinder Heads and have a bore 4.75 ($4\frac{3}{4}$) inches and total over all length for piston travel of 11.625 ($11\frac{5}{8}$) inches. The cylinder walls are 0.312 ($\frac{5}{16}$) inch thick. The Cylinders are surrounded by water jackets the walls of which are 0.187 ($\frac{3}{16}$) inch thick. The Cylinders are cast from gray iron. They

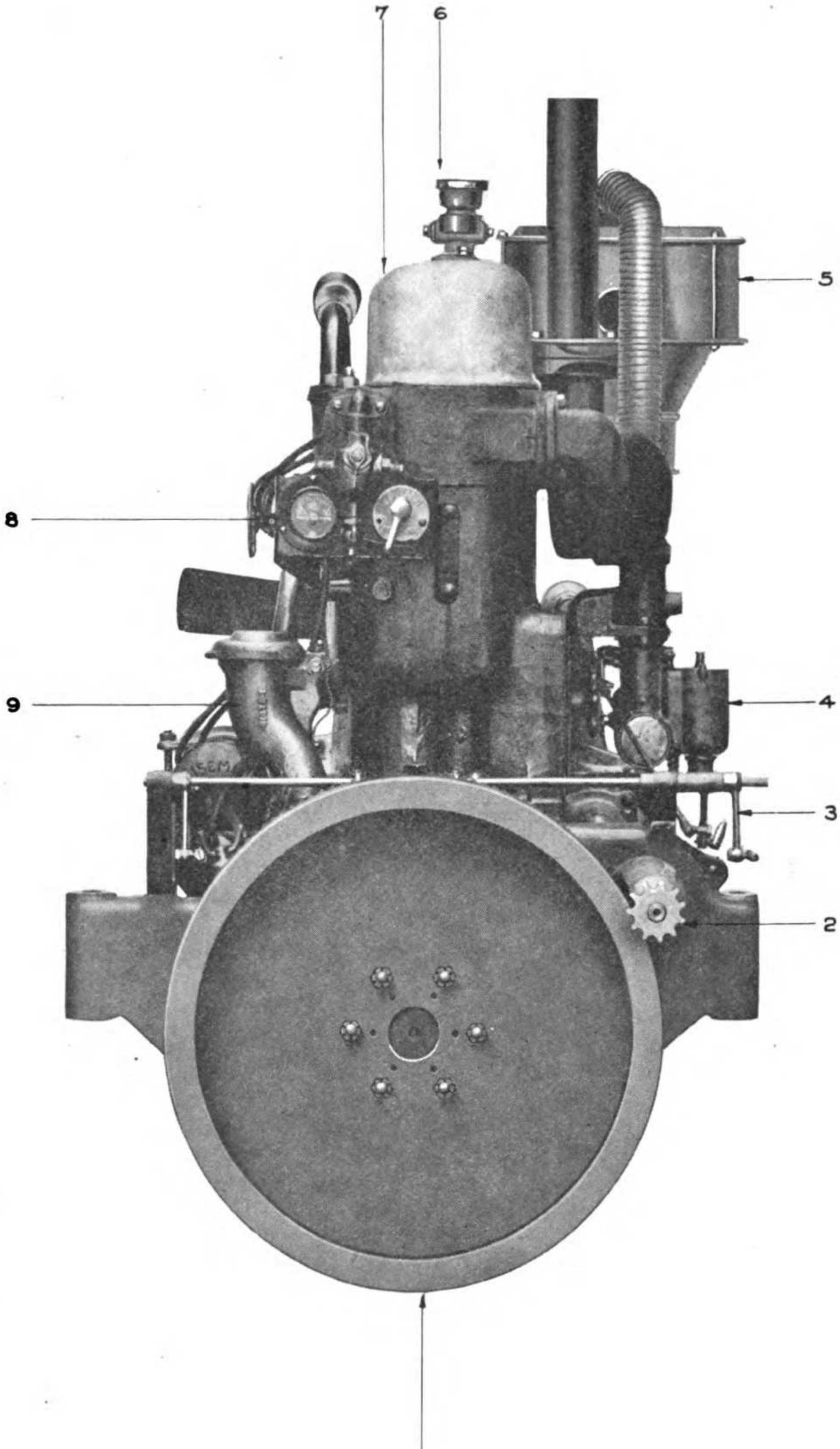


PLATE 20—REAR VIEW OF ENGINE

PLATE 20—REAR VIEW OF ENGINE

Ref. No.	Ord. No.	Name
1	261A	Flywheel.
2	181A	Bendix starting drive.
3	401D	Spark control lever.
4	407A	Carbureter.
5	408A	Air cleaner.
6	301F	Sight feed oil cup.
7	303A 304A	Cylinder head cover.
8	415A	Instrument bracket.
9	274A	Breather.

are held in place upon the Crankcase by seven 0.625 (5/8) inch steel studs. Two of the nuts on these Studs which hold the cylinder casting in place are inside of the Valve Cover Plate. In the head of the Cylinder there are eleven 0.5 (1/2) inch steel Studs which hold down the Cylinder Head. In the side of the Cylinder are two 0.125 (1/8) inch Street Elbows, one for each Cylinder, into which are screwed the priming cups. The four priming cups on the assembled engine are connected together by means of a Gang Hand Lever which extends backward and through the armor plate which forms the dashboard of the Tractor. The Gang Lever Handle is within easy reach of the driver at this point. The Gang Lever was eliminated after first production.

On the opposite side of the Cylinder Block there is a Valve Cover Plate of pressed steel which keeps the dirt and dust from working into the Push Rod Guides and Valve Tappets. In order to make this oil tight a Valve Cover Plate Gasket of cork is inserted between the Cylinder body and the Valve Cover Plate. A 0.375 (3/8) inch standard Stud provides anchorage for the Valve Cover Nut used to hold the Valve Cover Plate in place. A small wire ring is placed on the inside end of the Valve Cover Plate Nut to prevent its loss when the Valve Cover Plate is removed.

CYLINDER SCORED

Cylinders may become scored because of engine operation for long periods when overheated, lack of lubrication, tight pistons, loose or broken wrist pin, piston out of round, connecting rod out of alignment.

CYLINDER HEAD

The Cylinder Head carries all of the overhead valve gear, which comprises the four Valves; the eight Valve Springs, the four Valve Spring Seats and Locks, the four Rocker Arms and the two Rocker Arm Brackets and in addition the two Spark Plugs.

The Cylinder Head, like the Cylinder Body, is cast from gray iron and is made up so as to form the head for a pair of Cylinders, hence each Engine requires two Cylinder Heads. There are two Valves for each Cylinder, one an exhaust and one an inlet. Hence the Cylinder

Head carries four Valves, the two outside Valves being for the exhaust and having separate outlet passages, while two located at the center of the Head and having a common inlet passage are for the intake. The Valves have a clear opening 2.125 (2⅛) inches. The Cylinder Head is held in place by eleven 0.5 (½) inch Studs. The nuts which hold down the Cylinder Head have brass washers beneath them, which prevent injury to the Cylinder Head casting, compensate for expansion

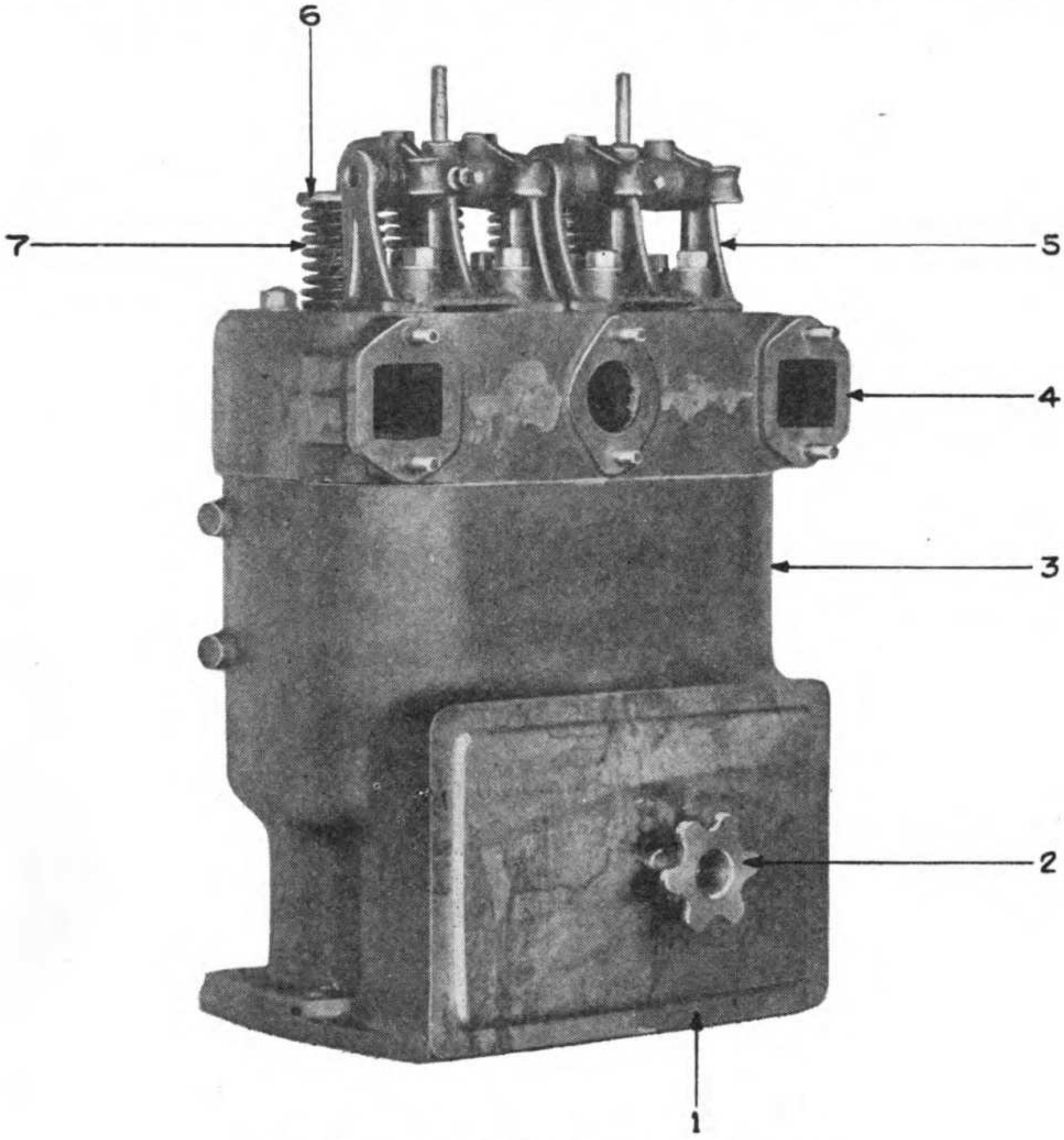


PLATE 21—CYLINDER ASSEMBLY

Ref. No.	Ord. No.	Name
1	299A	Valve cover plate.
2	297F	Valve cover nut.
3	291A	Cylinder.
4	292A	Cylinder head.
5	298D	Rocker arm bracket.
6	296B	Valve spring seat.
7	300A	Main valve spring.

and act as packing when tightening down the Cylinder Head nuts. Pockets are cast in the left side of the Cylinder Head in which the Spark Plugs are located. These are tapped out for 0.875 (⅞) inch S. A. E. Spark Plugs. This is the standard size of S. A. E. Spark Plug and

should be distinguished from the 0.5 (½) inch or Metric Plug, which is common on European and Aviation Engines.

Between the bottom of the Cylinder Head and the top of the Cylinder Block is pressed an 0.093 ($\frac{3}{32}$) inch thick copper-asbestos gasket. Whenever there are any indications of lost compression or leakage of water into the Cylinder bore, the condition of the Cylinder Head Gasket should be immediately investigated. This can readily be done by removing the Cylinder Head.

CYLINDER HEAD GASKETS MUST NOT LEAK WATER

The joint between the cylinder and cylinder head is made water tight by using a copper-asbestos cylinder head 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 the cylinder head one turn, until firmly bolted down. If the cylinder head gasket still leaks, remove the gaskets and replace with a new one. If a new cylinder head gasket is not at hand, an emergency repair may be made by drying the cylinder head and cylinder surface and gasket, shellac the gasket allowing to dry until very tacky and bolt into place. This practice is not to be recommended but can be used in case of an emergency repair.

VALVE GEAR

The Valve Gear consists of the following parts between the Cam on the Cam Shaft, located in the Crankcase, and the Valve, located in the Cylinder Head; the Valve with the Rocker Arm, the Push Rod, the Valve Tappet and Roller. The Valves have an outside diameter of 2.375 (2⅜) inches with forty-five degree beveled seats 0.125 (⅛) inch in width. The Valve Head is 0.325 ($\frac{5}{16}$) inch thick and is made of cast iron electrically welded onto the steel stem which is 7.312 (7 $\frac{5}{16}$) inches long and 0.434 ($\frac{7}{16}$) inch in diameter. The upper end of the Valve Stem, against which the Valve Tappet Rocker Arm acts, is hardened in Cyanide.

The Valve is guided in the Cylinder Head by a cast iron Valve Stem Guide 4.5 (4½) inches long and held against its seat by means of two Valve Springs and a Pressed Steel Spring Seat which is attached to the top of the Valve by means of a Valve Spring Seat Lock. The Valve Spring Seat Lock is tapered 3 inches per foot so that when the Valve

Spring Seat is crowded up against it by the Valve Springs it will tend to clamp tighter and thereby prevent any wear. There should be no difficulty in assembling the Valve Spring Seat and Valve Spring Seat Lock if one observes the directions of the taper on the Valve Spring Seat Lock, which should have the small end down or towards the Valve or Cylinder Head.

The Valves are held in place by two Springs, the Main Valve Spring being the larger and outside, and the Auxiliary Valve Spring the smaller or inside one. The Main Valve Spring is 2 inches outside diameter and when compressed to its normal length, 2.468 (2 15/32) inches, should have a tension of about seventy to seventy-three pounds, and when free a height of approximately 4.25 (4 1/4) inches. The Auxiliary Valve Spring is lighter and measures 1.0625 (1 1/16) inches inside diameter. When this spring is compressed to its normal length, 2.343 (2 11/32) inches, it should show a tension of thirty-two to thirty-four pounds and when free should be approximately 4.125 (4 1/8) inches in length.

VALVE GRINDING

To grind the valves of the 5-ton Artillery Tractor Engine, remove the cylinder head and place it in a vise so that a good hold may be obtained in grinding. Compress each valve spring enough to remove the clip that holds it onto the valve stem. Note the order of removing valves and springs so that they may be reassembled in their original position.

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. Placing a light spring under the valve head—just enough to raise it off its seat—will facilitate grinding.

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 1/4 of the way around, then lift the valve off its seat and bring it about 1/4 of a turn toward the right, then seat valve and grind as before. This is where the spring under the valve head helps. 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.

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 GRINDING

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.

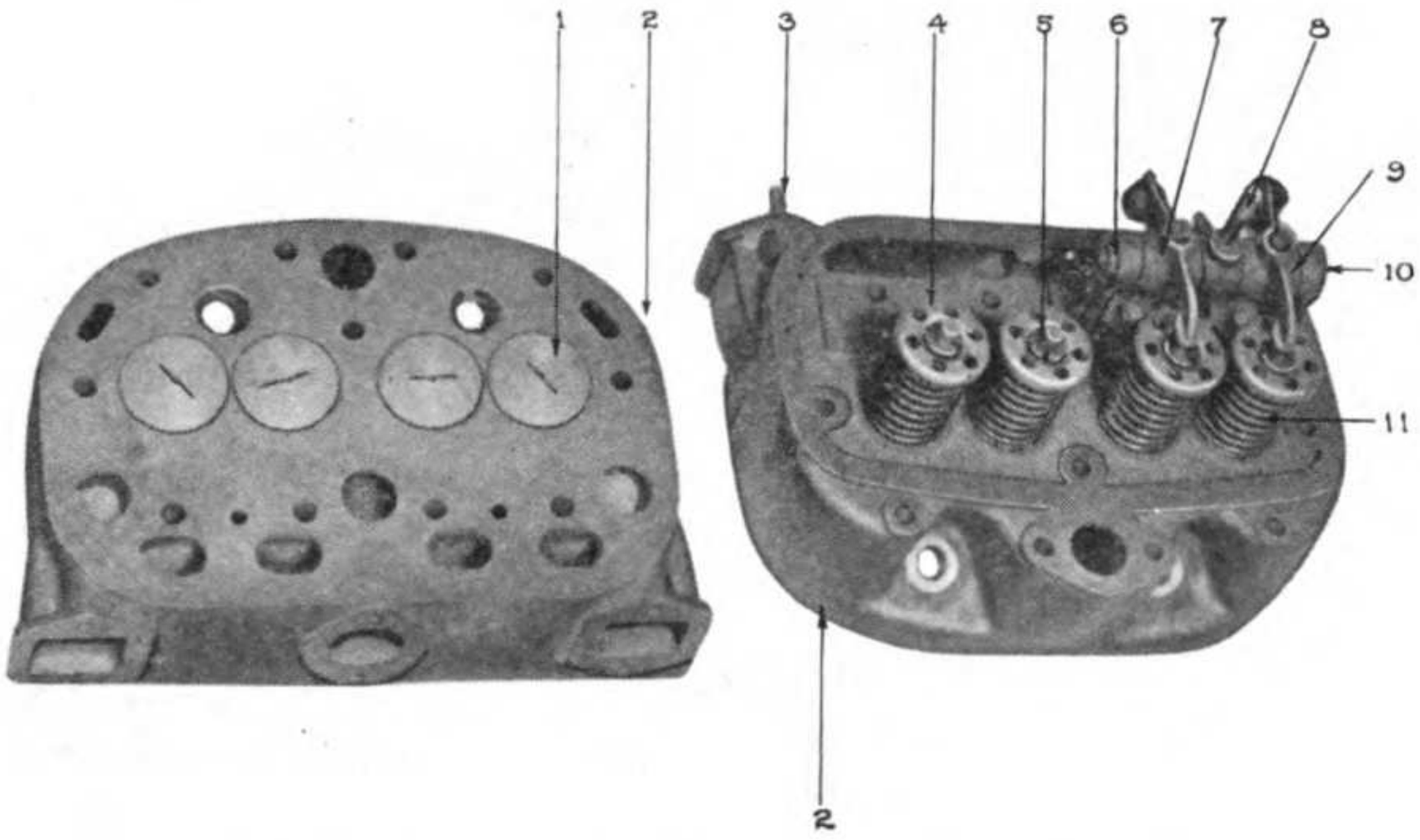


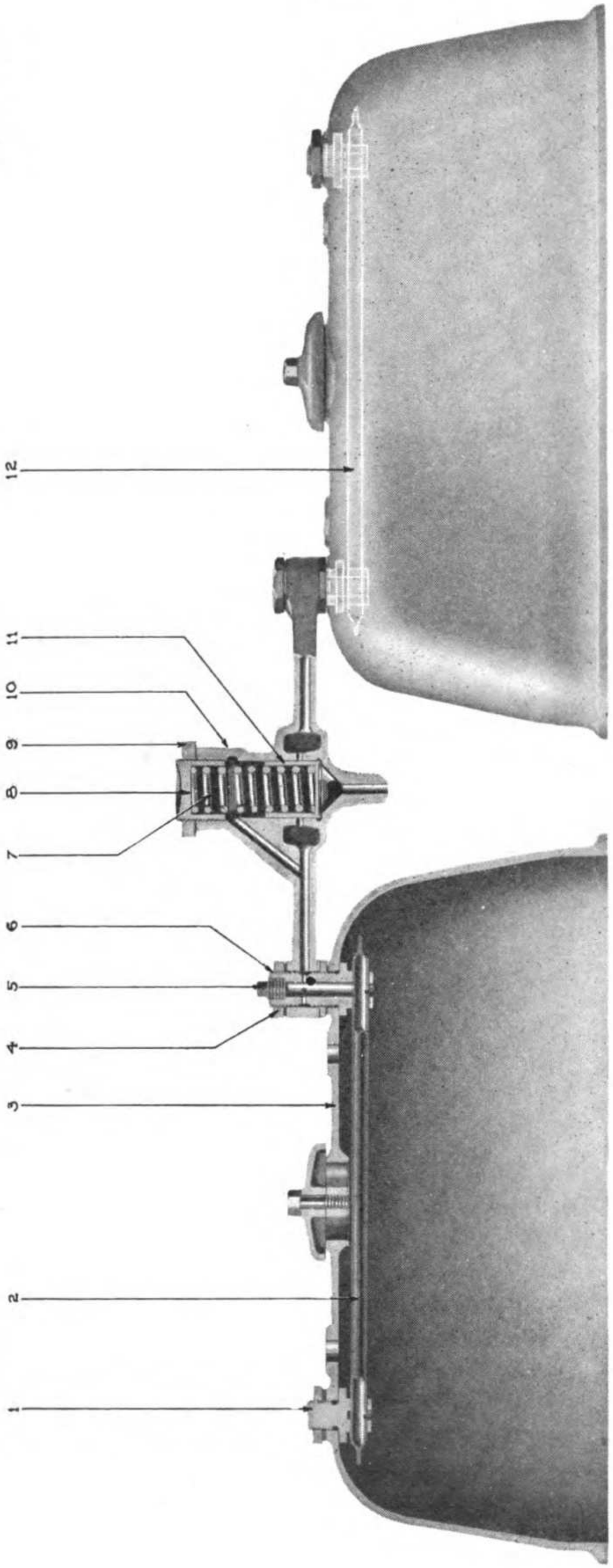
PLATE 22—CYLINDER HEAD AND PARTS

Ref. No.	Ord. No.	Name
1	296A	Valve.
2	292A	Cylinder head.
3	302D	Manifold stud.
4	296B	Valve spring seat.
5	297A	Valve spring seat lock.
6	296F	Rocker arm shaft.
7	298C	Rocker arm, straight.
8	302H	Cylinder head cover stud.
9	298B	Rocker arm, left.
	298A	Rocker arm, right.
10	298D	Rocker arm bracket.
11	300A	Main valve spring.
	300B	Auxiliary valve spring (inside).

CORRECT VALVE OPERATION

To keep valves in perfect condition, maintain compression and secure a perfect carbureter adjustment, the valves must seat uniformly and open and close correctly. Before proceeding with a carbureter adjustment, it is absolutely necessary to be sure that when the tappet is standing on the heel of the cam and all slack taken up from the rocker arm down a clearance of .008 of an inch exists between the rocker arm and valve stem.

PLATE 23



ROCKER ARM COVERS AND OILING SYSTEM

PLATE 23—ROCKER ARM COVERS AND OILING SYSTEM

Ref. No.	Ord. No.	Name
1	430D	Pipe support stud.
2	430A	Valve cover feed pipe, right.
3	304A	Cylinder head cover.
4	430E	Oil pipe stud lock nut.
5	176F	Pipe plug.
6	430C	Oil pipe stud.
7	429B	Oil relief spring.
8	429C	Oil relief adjustment plug.
9	431C	Adjusting lock nut.
10	429A	Valve cover oil relief body.
11	429D	Oil relief plunger.
12	430B	Valve cover feed pipe, left.

ROCKER ARM COVER ASSEMBLY

The Rocker Arms on the Cylinder Head are assembled in groups of two Rocker Arms each, mounted upon a Rocker Arm Bracket, which is attached to the Cylinder Head by two small cap screws when the Cylinder Head is not in place, but when in place by two of the Cylinder Head Holding Nuts in addition. These Rocker Arm Brackets are made from cast steel. The Rocker Arm Shaft is held stationary in the Rocker Arm Bracket by means of a 0.25 (¼) inch dog point set screw which is prevented from rotating by a 0.25 (¼) inch lock nut. The Rocker Arm Shaft is made from steel tubing, case hardened and ground. Its inside diameter is 0.437 ($\frac{7}{16}$) inch and its outside diameter 0.7485 (¾) inch with an overall length of 5.375 (5⅜) inches.

The Rocker Arms are not interchangeable, there being three types, the Rocker Arm, Straight; the Rocker Arm, Left and the Rocker Arm, Right. The Rocker Arm, Straight, is used on the intake valves only; the Rocker Arm, Right, is always used on the front Exhaust Valve of each Cylinder Head, while the Rocker Arm, Left, is used on the rear Exhaust Valve of each Cylinder Head. The Rocker Arms are not symmetrical about the fulcrum or center of the Rocker Arm Shaft. The distance from the center of the Rocker Arm Shaft to the center of the Valve Stem is 2.156 ($2\frac{5}{32}$) inches, while the distance from the center of the Push Rod to the center of the Rocker Arm Shaft is 1.843 ($1\frac{47}{32}$) inches, giving a ratio of 1.171 to 1. The bent Rocker Arms have a 0.5 (½) inch offset. The Rocker Arms are all bushed with a bronze Rocker Arm Bushing, 1.496 (1½) inches long with an inside diameter 0.75 (¾) inch and outside diameter 1.0325 ($1\frac{1}{32}$) inch.

The Rocker Arms are operated by Push Rods, which are located inside of the Valve Cover Plates and enclosing cored passages provided for this purpose in both the Cylinder Head and the Cylinder Block. These Push Rods are made from 0.562 ($\frac{9}{16}$) inch seamless steel tubing with 0.093 ($\frac{3}{32}$) inch walls. Into the ends of these tubes are inserted and welded the Valve Push Rod Balls, which are case hardened and have 0.562 ($\frac{9}{16}$) inch diameter. The overall length of the complete Push Rod from center to center of the balls is 18.9325 ($18\frac{13}{16}$) inches. The upper end of the Push Rod fits into a socket in the Rocker Arm, which is oiled by means of a groove cut in the top of the Rocker Arm. The Rocker Arm Bushing is drilled and there is a 0.625 ($\frac{5}{8}$) inch opening in the top of the Rocker Arm immediately above it which acts as an oil reservoir.

ROCKER ARM OILING SYSTEM

The Rocker Arm Oiling System requires separate explanation because the first of the Five-ton Artillery Tractors were not equipped with it in the form which is now regularly used. The first Tractors of the Model 1917 were equipped with separate Oil Cups, eight in number, each of which served to lubricate the one Rocker Arm on each Rocker Arm Bracket. These cups had to be filled daily and the operator had to turn them on before starting the Engine. Now they have been replaced by the Rocker Arm Oiling System, which is an integral part of the Pressure Feed Oil System of the Engine.

The Rocker Arm Oiling System is located in the Cylinder Head Covers and not only includes the Valve Cover Feed Pipes, through which the oil is fed to the Rocker Arms, but also the Oil Relief Valve for the Main Oil Supply.

MAIN OIL RELIEF VALVE

The Main Oil Relief Valve is now located in the Valve Cover Oil Relief Body, which is mounted on top of the Cylinder Head Covers at the center of the Engine and from which oil is distributed into both Front and Rear Valve Cover Feed Pipes. The Oil Relief Valve is kept closed by the Oil Relief Spring, but is opened when the pressure reaches 25 pounds or more, and the surplus oil escaping at this point is conveyed to each of the Valve Cover Feed Pipes. This oil runs down over the Rocker Arms, lubricates the Rocker Arm Shafts and then drains down over the side of the Cylinder Head to the Crankcase, thoroughly lubricating on its way the Valve Tappets and Push Rods.

CONSTRUCTION OF OIL RELIEF VALVE

The Oil Relief Valve is made up of the Valve Cover Oil Relief Body, the Oil Relief Adjusting Plug, the Oil Relief Spring and the Oil Relief Plunger.

The latter fits into the bottom of the Valve Cover Oil Relief Head and is 1.122 (1⅛) inches in diameter and 1.062 (1$\frac{1}{16}$) inches in height. When it is raised by the oil pressure 0.5625 ($\frac{9}{16}$) inch, it uncovers a groove in the wall of the Valve Cover Oil Relief Body 0.125 (⅛) inch wide which communicates with the Valve Cover Feed Pipes. This Plunger is held in place by a 0.875 (⅞) inch outside diameter spring that has a free length of 2.375 (2⅜) inches, but when compressed to 30 pounds, has a length of 1.687 (1$\frac{11}{16}$) inches. The Oil Relief Adjusting Plug is very accessibly located in the top of the Valve Cover Oil Relief Body and when properly adjusted is locked by a check nut provided for this purpose.

VALVE COVER FEED PIPES

The Valve Cover Feed Pipes are held in the Cylinder Head by an Oil Pipe Stud and a Pipe Support Stud. The first of these is hollow and conveys the oil from the Valve Cover Oil Relief to the Valve Cover Feed Pipes. The latter only serves as a support for the other end of the Feed Pipe. There are two Valve Cover Feed Pipes, one for the Rear and one for the Front Cylinder Head Cover. This is made necessary because the Valve Cover Feed Pipe is not symmetrical. The Valve Cover Head Pipe is made from 0.312 ($\frac{5}{16}$) inch copper pipe with 0.031 inch number 20 B. & S. gage wall, the ends of which are pinched together and soldered.

VALVE TAPPETS

The Valve Tappets are of the roller type and are mounted in the Valve Tappet Guides, which are clamped in the upper half of the Crankcase. The Valve Tappet Guides are made from cast iron and are held in the Crankcase by means of a Valve Tappet Guide Crab. The latter is in the form of a yoke which holds the two adjacent Valve Tappet Guides in place. Since the Roller Tappets are used, it is essential that these Guides be prevented from turning, which is accomplished by means of a keyway, 0.156 ($\frac{5}{32}$) inch wide, cut in one side of the Valve Tappet Guides and engaging with a pin in the Crankcase. The Valve Tappet carries an 0.9355 ($\frac{15}{16}$) inch diameter roller with 0.437 ($\frac{7}{16}$) inch face. This roller is mounted on a Valve Tappet Roller Pin, 0.5 (½) inch diameter, the ends of which are flattened off so as to engage 0.25 (¼) inch slots in the sides of the Valve Tappet Guide, which prevents the Roller Pin from rotating.

In the upper end of the Valve Tappet are inserted the two pieces which provide for the Valve adjustment. One of these is the Valve Tappet Adjusting Screw; the other is the 0.875 (⅞) inch 18 U. S. Standard Thread Nut which locks the adjusting screw in place. The Valve Tappet Adjusting Screw is made from case hardened steel with the upper end of it cupped out to receive the Roller Ball on the end of the Valve Push Rod.

VALVE TIMING

The Intake and Exhaust Valves both have the same lift, namely: 0.396 ($\frac{13}{32}$) inch. When the Valves are properly timed, there should be 0.006 inch clearance between the Valve Stem and the end of the Rocker Arm. The Timing Gears at the front of the Engine are marked so that there should be no difficulty in replacing them and putting the Engine in proper time if it has been disassembled. However, in case some difficulty in the timing is encountered, the following information will be invaluable. The Valve timing in degrees is as follows: The Intake Valve is open over a period, measured on the Crankshaft circle, of 200 degrees. In the same way the period of opening of the Exhaust Valve is 230 degrees. The Exhaust Valve closes 5 degrees past the Upper Dead Center and opens 45 degrees ahead of the Bottom Center. The Intake Valve opens 15 degrees past the Upper Dead Center and closes 35 degrees past the Lower Dead Center.

FLYWHEEL TIMING MEASUREMENTS

To facilitate in timing the Engine, the degrees mentioned in above paragraph are here given in inches measured on the circumference of the Flywheel. According to this, the Exhaust Valve closes 0.867 ($\frac{7}{8}$) inch past the Upper Dead Center and the Intake Valve opens 2.601 ($2\frac{39}{64}$) inches past the Upper Dead Center. In timing the Engine, it is necessary that there be this difference in the timing between the closing of the Exhaust Valve and the Opening of the Intake. If this is observed and checked, for one Cylinder, the rest of the Valves will be timed properly. Due to a slight variation in the workmanship and adjustment, an allowance of $\frac{3}{4}$ inch is made in the adjustment of the Exhaust Valve closing and the Intake Valve opening. In other words, the Exhaust Valve may close $\frac{3}{8}$ inch earlier or $\frac{3}{8}$ inch later when measured on the Flywheel circumference than the 0.867 ($\frac{7}{8}$) inch dimention given above.

For further checking the following figures are given: The Exhaust Valve should open 45 degrees or 7.803 ($7\frac{13}{16}$) inches before the Lower Dead Center and the Intake Valve close 35 degrees or 6.069 ($6\frac{1}{16}$) inches past the Lower Dead Center.

FIRING ORDER

The Cylinders of the Engine are numbered from the Radiator back, calling the first one, or one nearest the Radiator, Number 1, the second one Number 2, and so on. Having this order of cylinder location in mind, the Firing Order of the Engine is 1-3-4-2.

PISTON AND CONNECTING ROD ASSEMBLY

The Piston and Connecting Rod Assembly consists of the Piston proper, the Piston Rings, the Piston Pin and Piston Pin Locking Screw, the Connecting Rod and Connecting Rod Cap, the Piston Pin Bushing and Connecting Rod or Crank Pin Bushings. Four of these assemblies are required per Engine.

CONNECTING ROD

The Connecting Rod is a steel drop forging of "I" beam section, S.A.E. Specification Number 1035, with heat treatment "D." The Connecting Rod length from the center of the Piston Pin to the center of the Crank Pin is 13.25 (13¼) inches. The "I" section of the Connecting Rod tapers slightly, but just above the big end is 0.75 (¾) x 1.625 (1⅝) inches and 0.125 (⅛) inch thick. The Connecting Rod Caps are held in place by four special nickel steel bolts 0.498 (½) inch in diameter. Between the Connecting Rod and the Connecting Rod Cap are inserted the Connecting Rod Shims. Two sets of Shims are used on each Connecting Rod, one set of Laminated Shims composed of eight Shims 0.003 inches thick and one pair of sheet brass Shims Number 18 B. & S. gauge, 0.050 (1/16) inch thick. The latter Shims are interchangeable with part Number 1067-V on the Class A and B trucks.

TO REMOVE CONNECTING ROD

To remove connecting rod and piston, drain off oil, and remove oil pan, turn engine over by hand until lower end of connecting rod to be removed is half way down on side of engine towards camshaft; remove connecting rod bearing nuts, take off cap and lower rod and piston down and out.

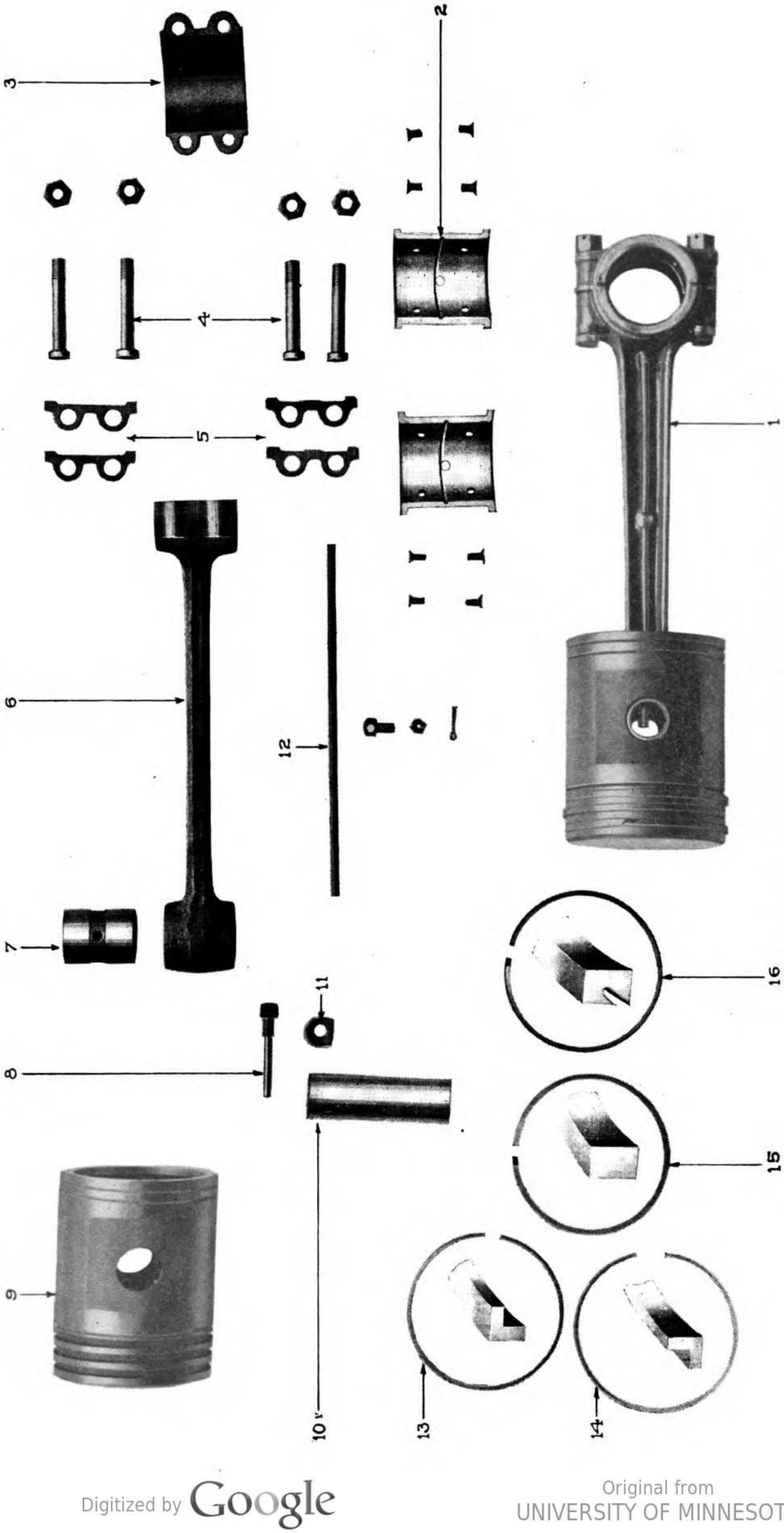
TO REPLACE CONNECTING ROD BUSHING

To replace a connecting rod bushing, remove oil pan, disconnect connecting rod bearing and pull out piston; take out bushings by removing countersunk screws which hold bushings in place in connecting rod and cap; insert new bushings and fit to shaft, leaving enough end play, but no looseness up and down.

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

The ends and round corners of the connecting bushings may be sized before they are placed in the rod or cap. In case an end flange should be broken off the bearing liner, it may be soldered on with half and half solder, care being taken to prevent melting the bushing with the soldering iron.

PLATE 24



PISTON AND CONNECTING ROD ASSEMBLY

PLATE 24.

PISTON AND CONNECTING ROD ASSEMBLY

Ref. No.	Ord. No.	Name
1	384A	Connecting rod.
2	330B	Crank shaft bushing.
	330C	Crank shaft bushing.
3	384B	Connecting rod cap.
4	383C	Connecting rod bolt.
5	383A, 383B	Connecting rod shim.
6	384A	Connecting rod.
7	382B	Piston pin bushing.
8	382C	Piston pin lock screw.
9	385A	Piston.
10	382A	Piston pin.
11	382D	Piston pin lock.
12	384C	Connecting rod oil tube.
13	386B	Piston ring, leak proof, upper half.
14	386B	Piston ring, leak proof, lower half.
15	386A	Piston ring, plain.
16	386C	Piston ring, oil.

The sides of the bushing (liner or bronze back) next to shaft should be filed or scraped down to prevent contact with crankshaft and prevent side pressure, also to aid lubrication.

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

CONNECTING ROD BEARING SHIMS

The tightness of the bearings is controlled by the thickness of the shims against which the caps are drawn up snug after a bushing has been properly scraped in and every nut must be tightened up, drawing the caps against the shims solidly, but never strained. If a castellated nut is tight when in such a position that cotter pin hole does not line up, the nut should be removed and light cut taken off face of nut (with a file), permitting its being turned to a proper position, so that the cotter pin can be inserted when tight.

PISTON PIN BUSHING

At the upper end of the Connecting Rod there is a bronze Piston Pin Bushing with the following dimensions: Inside diameter 1.375 (1⅜) inches, outside diameter 1.628 (1⅝) inches and length 2.125 (2⅛) inches. There are three 0.25 (¼) inch equally spaced holes drilled through this Bushing at its center to permit lubricating oil

working to the center of the Bushing from the Oil Supply Tube attached to the side of the Connecting Rod. The metal specifications of this bronze Bushing are S. A. E. Number 26. The part is interchangeable with part Number 1070-V on Class A and B trucks.

TO LOCATE WEAR OF PISTON PIN BUSHING

If the Piston is in place in the Engine and the lower half of the crankcase is down, remove the Cylinder Head, turn the Engine Flywheel until the Piston to be tested is on the top dead center. Then with the fingers or a rod press down upon the top of the Piston and upward from the underside of the case with a rod or some similar device so that by alternately moving the Piston up and down any play may be detected.

In case the Piston and Connecting Rod have been removed from the Engine, place the Connecting Rod in a vice and then try to rock the Piston on the Piston Pin. Rocking the Piston must not be confused with sliding it endwise on the Piston Pin, as there is a clearance between the Piston Pin Bushing and the Piston Bosses.

FITTING PISTON PINS

The end of the Piston Pin that carries the hole for the Piston Pin Set Screw is smaller than the blank end and must be inserted through the hole in the Piston opposite the boss carrying the Piston Pin 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 Piston 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 Piston Pin into the Piston. *Never force a Piston Pin into the Piston.* The Piston Pin is held in position by one Piston Pin Set Screw, this allows the expansion of the case-hardened steel Piston Pin to occur without forcing the Piston out of round, as only one end is anchored. The Piston Pin Set Screw should be accurately inserted in the place provided on the inside of the Piston Pin and should be kept tight and accurate in its position.

PISTONS

The Pistons are cast from gray iron and are carefully annealed and should weigh within plus or minus of 0.5 (½) ounce of one another. The Piston carries three packing rings, all located at the top, one oil groove immediately below the three packing rings and two oil grooves at the bottom of the Piston skirt. The three Oil Grooves mentioned are 0.125 (⅛) inch wide and 0.031 ($\frac{1}{32}$) inch deep.

Provision is made for fastening the Piston Pin into one of the Piston Bosses. The other end of the Piston Pin is not fastened so that it may

float as it expands and contracts with the changes of temperature. The Piston is ground straight and parallel from the upper edge of the Piston Ring Land between the Middle and Bottom Packing Rings to the bottom of the Piston. The clearance of the Piston is 0.005 inch over this portion of the skirt. The Piston Ring Land between the Top and the Middle Packing Rings has more clearance, 0.012 inch, while the top of the Piston has 0.020 inch clearance. This difference is provided in order to allow for the greater expansion of the head end of the Piston. The outside diameter of the finished Piston is 4.745 (4¾) inches with the clearances located and of the amounts as mentioned above, and 6.125 (6⅛) inches long. The Piston has an eccentric relief located over that portion of the Piston wall to which the Piston bosses are cast. This relief is 0.015 ($\frac{1}{64}$) inch deep on the center line of the Piston Pin Hole and is 2.75 (2¾) inches in width, measuring 1.25 (1¼) inches above the center line of Piston Pin and 1.5 (1½) inches below.

PISTON TROUBLES

The piston moving up and down in the cylinder must constantly be protected by a film of oil otherwise both it and the cylinder wall will be scored. If run long enough without oil the piston will seize in the cylinder. The usual piston trouble encountered is due to excessive piston wear which causes oil leakage into the combustion chamber and gas leakage downward into the crankcase. Also piston pin wear is not unusual. This latter causes knocking. Both are brought about by lack of or insufficient lubrication. Piston and rod may be removed through the crankcase.

PISTON RINGS

Three different kinds of Piston Rings are used upon each Piston. The top ring, which is used to arrest the immediate explosion pressure is of the compound type, made up of an inner and an outer piece. The MaQuay-Norris Ring or a similar type is used at this point. The Center or Intermediate Ring is a plain concentric ring with a 45 degree slot 0.010 inch wide. The third or bottom ring is similarly a concentric ring with a 45 degree slot 0.010 inch wide, but has in addition an oil scraping groove which distinguishes it from the Intermediate Ring. All the rings are the same diameter, 4.75 (4¾) inches, when compressed, and the same width, 0.249 (¼) inch. The Piston Pin is made from steel tubing 4.437 ($4\frac{7}{16}$) inches long and is 1.374 (1⅜) inches outside diameter with 0.1875 ($\frac{3}{16}$) inch wall. It is case hardened and ground, and is interchangeable with part Number 1075 on the Class A and B trucks.

PISTON RING PRECAUTIONS

Great care should be exercised so that loose piston rings are not allowed to wear the square faces of the piston ring slot to a bevel. If

these square edges are worn to a bevel it will be impossible to prevent the passage of gases above, behind and below the piston ring and the edges of the slot. Compression will be lost and carbon will form behind the rings.

FITTING PISTON RINGS

Accuracy and care should be used in fitting Piston Rings to a Piston. Four factors have to be taken into consideration:

1st. *The fit of the Piston Ring in the Cylinder to get proper ring "break."*

2d. *To get the proper ring.*

3d. *The fit of the Piston Ring in the slot on the outside of the Piston.*

4th. *The fit of the Piston Ring when placed on the Piston.*

The average engineer should be able to get perfect adjustment on new Piston Rings if the following precautions are observed.:

INSTALLATION OF PISTON RINGS

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 piston ring. There are two methods of placing the piston ring square in the cylinder in order to get the proper ring "break."

1st. 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."

2d. In case that it is not desired to remove the cylinder heads, the piston can be removed through the crank case 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 make examination of the "break" an easy matter.

Allowance has to be made for the piston ring's expansion lengthwise so that when the piston and cylinder are up to operating temperature the free ends of the piston ring will not meet and cause binding of the ends of the piston ring and in turn the piston ring against the cylinder wall. The top piston ring should have a "break" of .024 (twenty-four thousandths) of an inch, as this ring is close to the hottest part of the piston, and the second and third piston rings should have .012 (twelve thousandths) of an inch "break." A steel shim out of the connecting rod bearing is .012 (twelve thousandths) of an inch thick and can be used as a gauge in obtaining piston ring "break."

When material has to be removed from the end of the piston ring, split to provide the necessary "break" for expansion, clamp a fine mill file in a vice, open the piston ring and clamp the ends of the piston

ring squarely over it and remove material. Be careful never to damage the piston ring split surfaces where they come together horizontally.

USE CARE IN HANDLING PISTON RINGS

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.

TO ALIGN PISTON AT RIGHT ANGLES TO CRANKSHAFT

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

FITTING RINGS TO PISTON SLOTS

The piston ring slot should be scraped absolutely clean of all carbon deposits and washed off with kerosene. It is useless to fit a piston ring unless this condition exists, because the deposits will produce a bind, interfering 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, 000 sand paper used under a flat stick should be used bearing on it lightly while cleaning the slot. Never use a file in the piston ring slot. Never use emery cloth for cleaning piston ring slots. Rinse the slots when finished, cleaning 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 .004 (four thousandths) of an inch and the bottom two rings should have a clearance of .003 (three thousandths) of an inch. If the piston 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 the piston ring in the slot.

MOUNTING RINGS ON PISTON

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 or four metal guides 0.25 (¼) to 0.5 (½) inch wide, 0.0325 (1/32) inch or less thick, and about 6 inches long should be provided. Hack saw blades ground

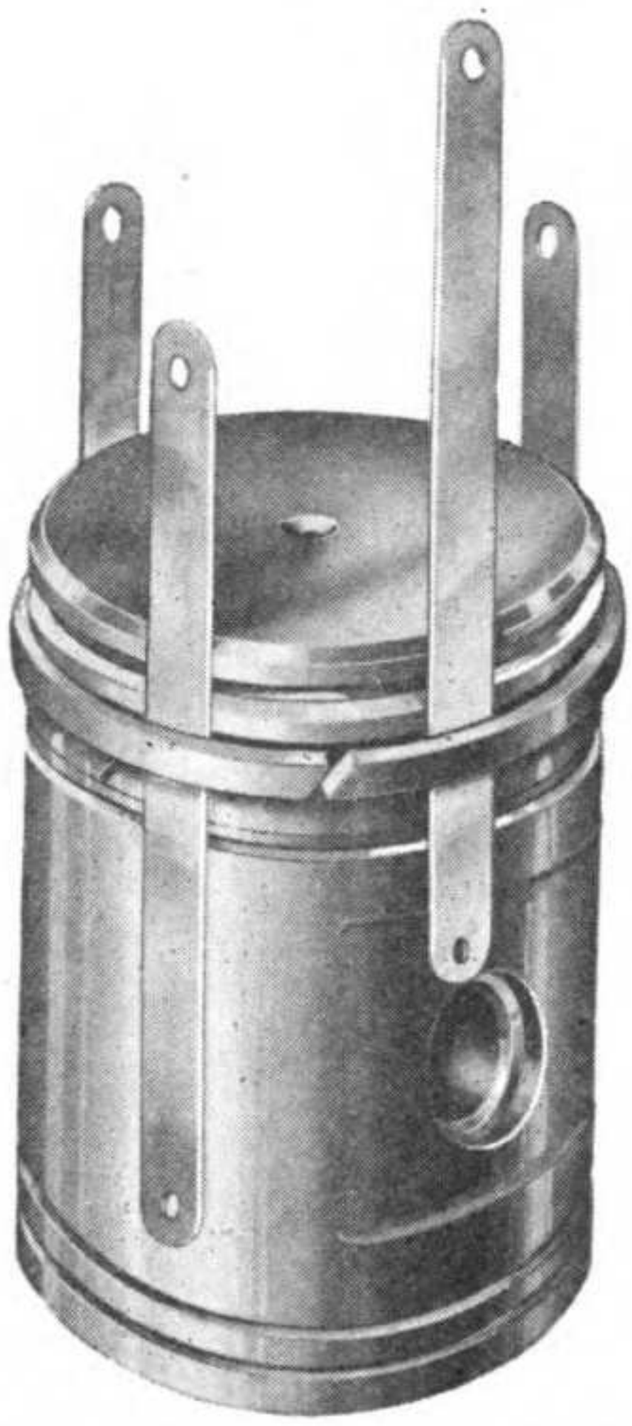


PLATE 25—REPLACING PISTON RINGS ON PISTON

off smooth are ideal for this purpose. In taking off or replacing piston rings, these guides should be spaced equally around the piston and underneath the piston ring.

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

INSERTING PISTON

Inserting 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 cam shaft to slip it into the cylinder. The bottom edge of the cylinder is beveled to aid in compressing the piston rings and 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 can be damaged on one edge. After piston has been inserted in the cylinder and the lower half of the connecting rod replaced on the connecting rod be sure that all cotter keys are placed on the connecting rod bolts.

CRANKSHAFT ASSEMBLY

The Crankshaft Assembly is composed of the Crankshaft, the Flywheel, the Crankshaft Gear and Crankshaft Oil Sling.

CRANKSHAFT

The Crankshaft is a steel drop forging of S. A. E. specifications number 1045 with heat treatment E. The Crankshaft is interchangeable with that on the Class A and B trucks where part number 1043-Y has been assigned.

The Crankshaft is drilled with four Oilways 0.25 (1/4) to 0.375(3/8) inch in diameter. These Oilways are from the Front Bearing to the number 1 Crank Pin, from the Middle Bearing in both directions, so as to reach both number 2 and number 3 Crank Pins, and from the Rear Bearing to number 4 Crank Pin. At the rear end of the Crankshaft a Flange 6.127 (6 1/8) inches in diameter and 0.687 (11/16) inch thick is provided to carry the Flywheel.

At the front end a Keyway for a number 18 Whitney Key is cut for a key which drives the Crankshaft Gear. At the very front end of the Shaft there is inserted a pin 0.5 (1/2) inch in diameter and 2.375 (2 3/8) inches long for the Starting Crank. This pin is held in place by means of the Starting Pin Lock Screw, which is a 0.312 (5/16) inch diameter, 24 thread set screw.

The dimensions of the Bearings of the Crankshaft are as follows: The front main bearing is 2.375 (2 3/8) inches in diameter and 3.062 (3 1/16) inches long; the center bearing and the rear main bearings are 2.5 (2 1/2) inches in diameter and 4.062 (4 1/16) inches and 4.002 (4) inches in length respectively. The Connecting Rod or Crank Pin Bearings are 2.375 (2 3/8) inches in diameter and 2.999 (3) inches in length.

KNOCKS IN BEARINGS

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

PLATE 26

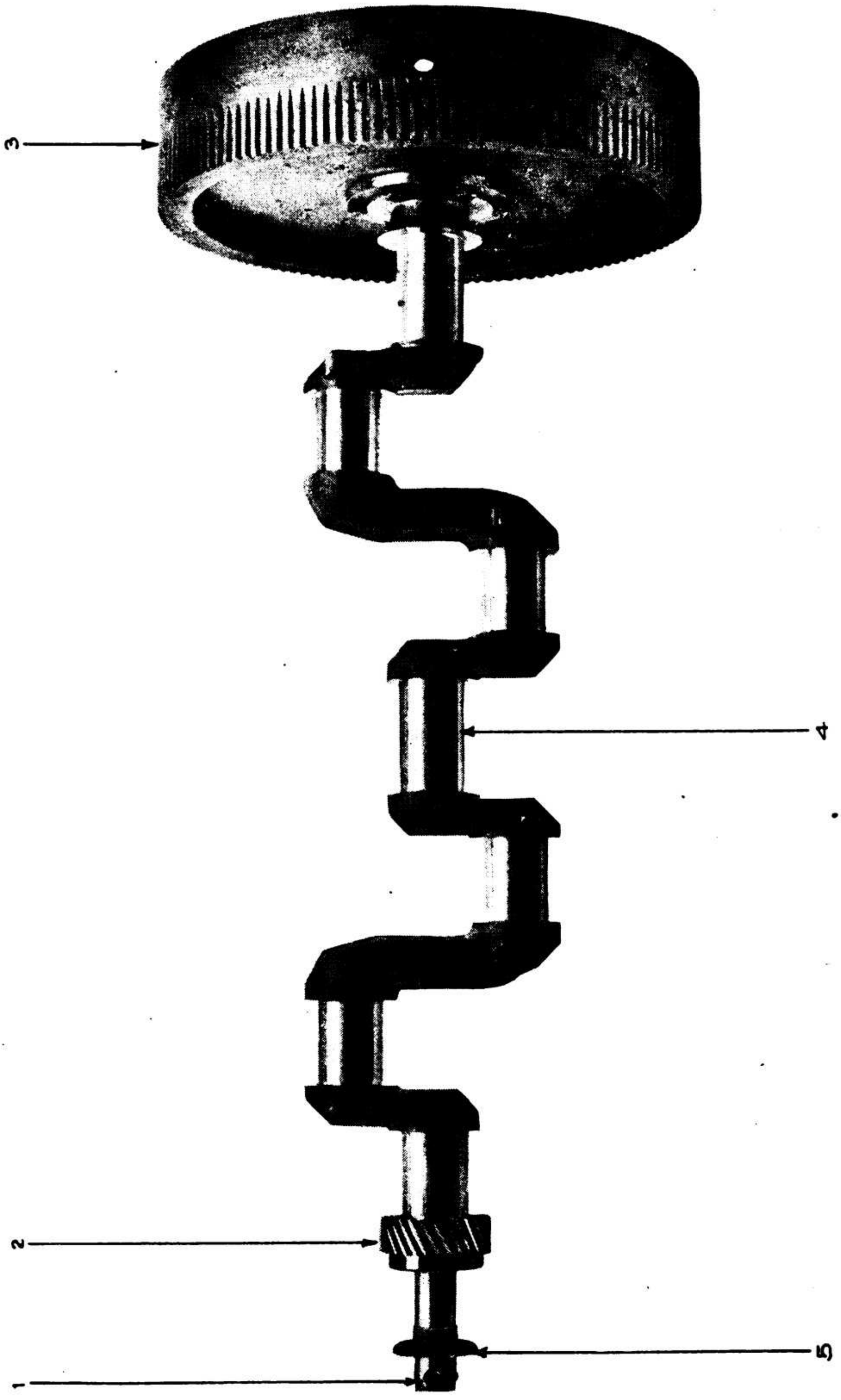


PLATE 26—CRANKSHAFT ASSEMBLY

Ref. No.	Ord. No.	Name
1	262D	Starting crank pin.
2	262A	Crankshaft gear.
3	261A	Flywheel.
4	260A	Crankshaft.
5	262B	Crankshaft oil sling.

TO DETERMINE A LOOSE CRANK PIN BEARING

The crank pin bearing is commonly called the connecting rod bearing. This bearing is located in the lower end of the connecting rod. To determine any looseness in the crank pin bearings turn the engine over with the flywheel until the crank pins of No. 1 and No. 4 connecting rods are close to the crank case door. Place the bar under the bearing, using the crank case as a fulcrum, with one hand partly on the web of the crankshaft and partly on the crank pin bearing, pry up on bar. There should be absolutely no vertical movement. Repeat for No. 2 and No. 3. Connecting rod bearings, however, should be able to move sideways the thickness of a crank pin bearing shim, .012 (twelve thousandths) of an inch.

TO ADJUST CONNECTING ROD BEARINGS

Remove the spark plugs to release compression, blue the crank pin with a thin film of color, insert piston in the cylinder and mount the upper half of the connecting rod bearing on the crank pin and revolve crank shaft slowly. Remove connecting rod and piston, scrape all high spots and continue blueing and scraping until a majority of the bushing shows solid blue. Give relief to edges of bushings about 3/8 of an inch down where the two halves of bushing meet. When the upper half of bushing has been accurately spotted and scraped place an equal number of shims on each side of the bushing and bring the lower half of the bushing 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 bushing 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.

NOTE—One side of each connecting rod and cap contains the same figure on the upper and lower half as 1, 2, 3, 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 bushing 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 bushing properly without having the piston in the cylinder, as the bushing

must be blued and scraped so that the piston will be square in the cylinder.

TIGHTENING CRANKSHAFT BEARINGS

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

If one or more layers are removed and that is found to be too much, substitute a thin shim of paper for one of the metal layers removed.

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

BEDDING THE CRANKSHAFT

Bedding the crankshaft may be divided into two operations:

1st. Bedding the main bearings, in crank case cradles.

2d. 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 crank case cradle thoroughly, then blue entire crank case cradle surface. (c) Put bottom half of main bearing that is to work in that particular cradle in place, rock back and forth a few times then remove lower half from cradle and examine aluminum back of bushing for high spots. (d) Remove any high spots with a fine mill file and continue filing on back until a perfect seat is secured. This is important. (e) After all backs of main bushings have been fitted to crank case cradles, insert crankshaft which had previously been blued on every main bearing and revolve crankshaft in upper 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 .012 (twelve thousandths) of an inch. Use a curved babbitt scraper to fit inside edge to fillet of crankshaft. Use a flat babbitt scraper to work on inside of bearing. Use a file, applying it level on top of bottom half of bearing to bring babbitt down to level of aluminum back of bearing. Give the upper edge of bushing $\frac{3}{8}''$ of babbitted surface relief, so that 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 bushing meet.

The crankshaft bedding operation has to be accurately done as all

the strains are transmitted to the bottom bushing 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.

FLYWHEEL

The Flywheel is made of cast iron and is bolted onto the Crankshaft with six ½ inch steel bolts located on a 5.25 (5¼) inch bolt circle and equally spaced. On the outside, or periphery, of the Flywheel is cut the Starting Gear. This gear has 1.25 (1¼) inch face, an outside diameter of 19.911(19 29/32) inches, a pitch diameter 19.694 (19 45/64) inches, 138 teeth of 20 degree Fellows Stub Tooth Form. The outside diameter of the Flywheel Rim is 19.875 (19⅞) inches, the inside of the Flywheel Rim, into which the Master Clutch fits, is 17.25 (17¼) inches in diameter and the depth of the recess for the Clutch is 2.875 (2⅞) inches. Four 0.75 (¾) inch holes are provided in the Rim of the Flywheel for the Clutch Driving Keys. These holes are drilled in radially, are equally spaced and their center is 1.875 (1⅞) inches from the rear face of the Flywheel.

On the outside, or periphery, of the Flywheel Rim are the Valve Timing Marks, which give the following information for each Cylinder: Dead Center, Inlet Opens, Exhaust Opens, Dead Center, and Inlet Closes.

CRANKSHAFT GEAR

The Crankshaft Gear is made from a steel forging S. A. E. specification number 1035 with heat treatment H. This gear has an outside diameter of 3.971 (3 31/32) inches, pitch diameter 3.75 (3¾) inches, 30 teeth, with a left hand helical angle of 27 degrees 15 minutes. It is interchangeable with the same part on Class A and B trucks, part number 1126-W. It is driven by a number 18 Whitney Key, which is 0.25 (¼) inch thick and the gear is held in place on the end of the Crankshaft by means of a Crankshaft Gear Pin, 0.25 (¼) inch diameter and 3.375 (3⅜) inches in length.

UPPER CRANK CASE ASSEMBLY

The Upper Crank Case Assembly consists of the cast aluminum Crank Case proper on which are mounted the Magneto, Water Pump and Fan Assemblies, the Governor Assembly and the Cylinder Blocks. Provision is also made in the right rear engine arm for the Bendix Starter. On the right hand side of the Crank Case there are two hand holes 11.125 (11⅛) inches wide and 6.75 (6¾) inches high. These openings are closed by Crank Case Hand Hole Covers which are interchangeable with the Valve Cover Plates used on the side of the Cylinder Block. The same Valve Cover Nut used on the Cylinder block is also used here, but instead of a stud screwed into the Cylinder

Block being used to hold it in place, a yoke called the Crank Case Hand Hole Clamp is employed.

CRANK CASE—UPPER

The Crank Case, Upper Assembly, includes the Gear Case Cover, which is bolted onto the front end, the fourteen Cylinder Block Holding Studs and Nuts, and the three Main Bearing Caps with bushings.

Each of the Main Bearing Caps is held in place by four 0.5 (½) inch bolts. They are set into a milled slot in the upper part of the Crank Case so that there is no chance of their twisting into disalignment with the Crankshaft.

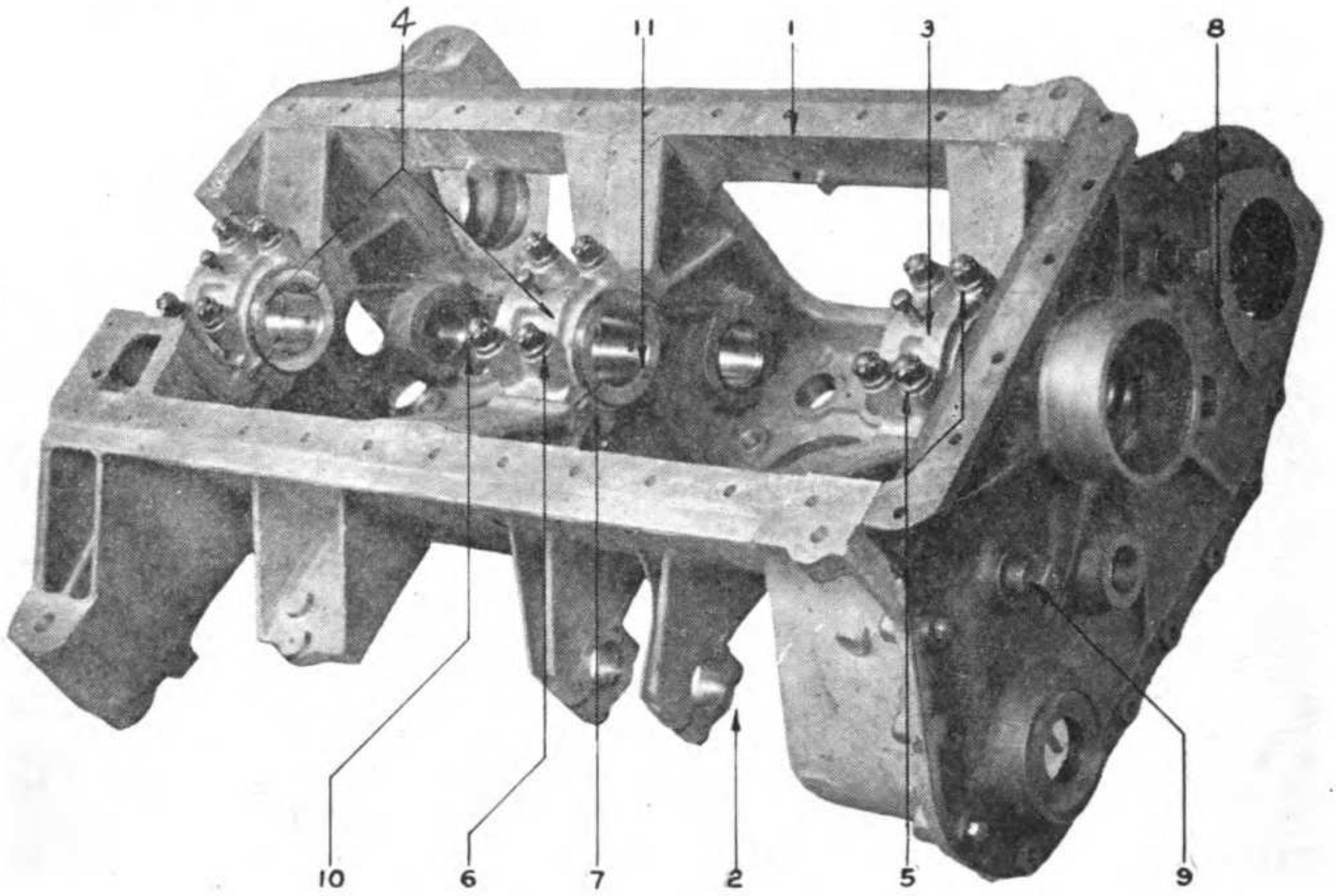


PLATE 27—CRANK CASE ASSEMBLY, UPPER

Ref. No.	Ord. No.	Name
1	322A	Crank case, upper half.
2	333C	Water pump bracket cap.
3	330A	Front bearing cap.
4	329A	Center and rear bearing caps.
5	330E	Front main bearing stud.
6	229E	Main bearing bolt.
7	229D	Bearing shim, center.
8	226A	Gear case cover.
9	113E	Pipe plug.
10	328E	Cam shaft bushing, rear.
11	329C	Crankshaft bushing, center, upper half.

At the front end of the Upper Crank Case there is located a Timing Gear Oil Tray, which is a trough located immediately below the Crank Shaft Timing Gear and into which the teeth of this gear dip. Its purpose is to throw oil onto the Governor Gear located on the right hand side of the Engine and insure an adequate supply of oil to the Governor

parts and Governor Bearing. If this part should be left out accidentally in assembling the Engine, there is danger of the Governor Bearing seizing when in operation.

CAMSHAFT BUSHINGS

Three bushings are provided to carry the Camshaft. The front one is also provided with a flange so as to take the Camshaft Gear thrust while the other two are plain bushings. The inside diameter of the Front Bushing is 2.25 (2¼) inches, outside diameter 2.625 (2⅝) inches, and length 2.55 (2½) inches. The outside diameter of the thrust flange is 3 inches. The intermediate or middle Camshaft Bushing has 2.125 (2⅛) inches inside diameter and 2.5 (2½) inches outside diameter and 2.25 (2¼) inches length. The rear Camshaft Bushing has 2 inches inside diameter, 2.375 (2⅜) inches outside diameter and 1.468 (1$\frac{15}{32}$) inches length.

All of these bushings are bronze backed babbitt lined. The babbitt is 0.05 ($\frac{1}{16}$) inch thick. The bronze specification is S. A. E. Number 27, while the babbitt is S. A. E. specification Number 24. It should be noted at this time, also, that the Front, Intermediate and Rear Camshaft Bushings are respectively parts number 1042-V, 1042-V and 1044-V of Class "A" and "B" trucks.

MAIN BEARING BUSHINGS

There are three Split Bushings upon which the Crankshaft runs. Of these the Center and Rear Bushings are interchangeable. The Front Bushing is shorter so is not interchangeable with the other Crankshaft Bushings but is interchangeable with the Connecting Rod Bushings. From this it will be seen that there are only two sizes of Split Bushings required for the Main and Connecting Rod Bearings.

The Center and Rear Main Bearing Bushings have the following dimensions: Inside diameter 2.502 (2½) inches, outside diameter 3 inches and overall length 4 inches. They are of bronze, lined with babbit 0.0625 ($\frac{1}{16}$) inch thick. The dimensions of the Front and Connecting Rod Bushings are as follows: Inside diameter 2.376 (2⅜) inches, outside diameter 2.875 (2⅞) inches and overall length 2.998 (3) inches. These Bushings are likewise bronze with babbitt facing 0.0625 ($\frac{1}{16}$) inch thick. The specifications of the bronze and babbitt are respectively S. A. E. number 24 and S. A. E. Number 27. These Bushings are interchangeable with the similarly used bushings in the Class "A" and "B" trucks. The large Bushing used in the Center and Rear Main Bearings has truck part number 1034-W, while the smaller bushing has truck part number 1033-W.

MAIN OIL DISTRIBUTING LINE

The Main Oil Distributing Line is cast integral with the aluminum Crank Case, Upper, and is made from 0.375 (3/8) inch steel tubing with Number 20 B and S Gage (0.031 inch) wall. The tubing is welded together prior to inserting in the mold and the aluminum cast around it. With this construction there is no chance of oil leakage through porosity in the aluminum casting.

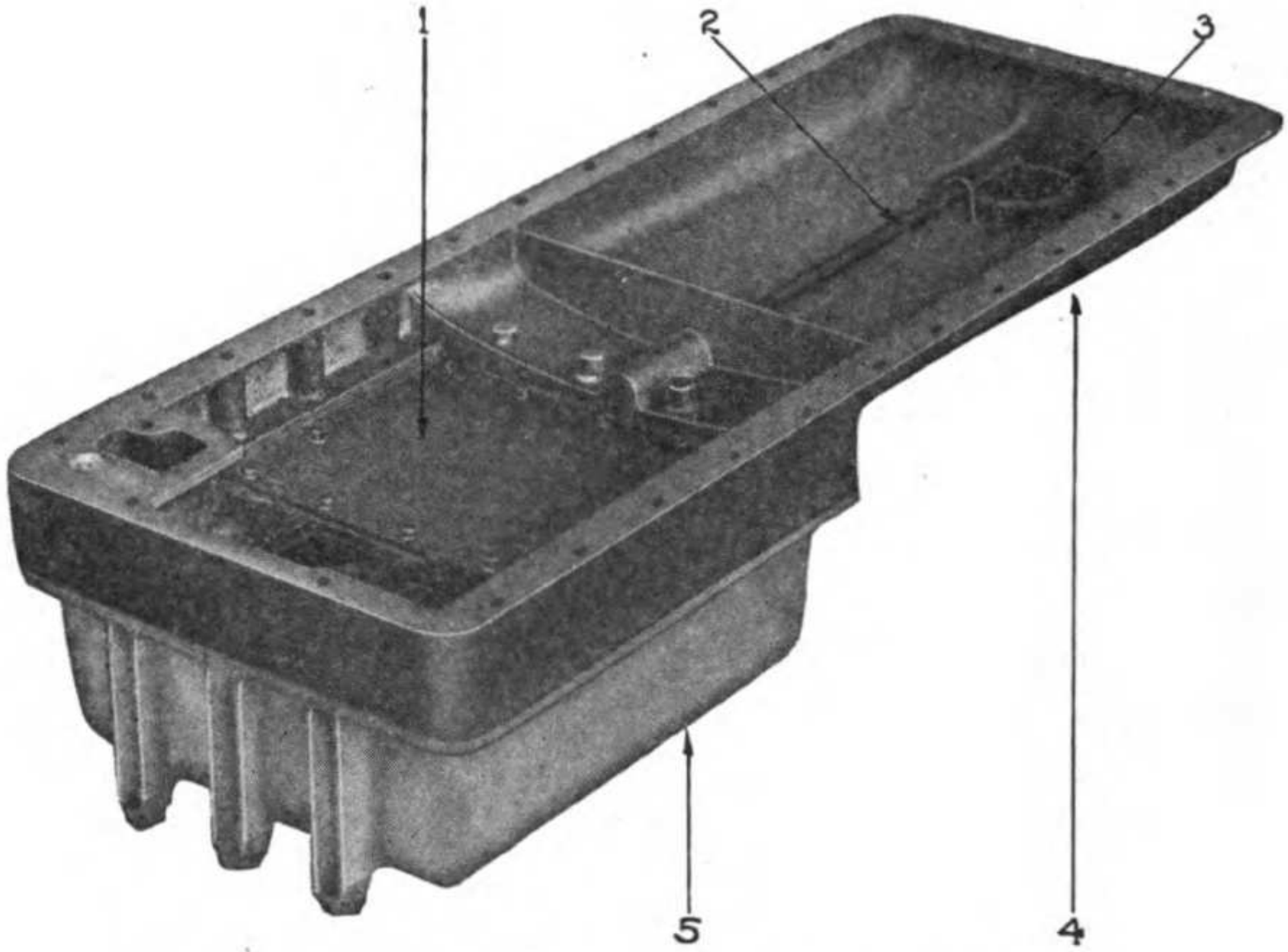


PLATE 28—CRANKCASE ASSEMBLY OIL PANS

Ref. No.	Ord. No.	Name
1	346B	Oil partition plate.
2	345A	Upper oil pan pipe.
3	342A	Oil screen body.
4	341A	Upper oil pan.
5	340A	Lower oil pan.

LOWER CRANK CASE ASSEMBLY

The Lower Crank Case Assembly consists of two parts, the Upper Oil Pan and the Lower Oil Pan, both of which are made from cast aluminum.

LOWER OIL PAN

The Lower Oil Pan covers an opening in the rear half of the Upper Oil Pan. The reason for this rather complicated construction is that the Equalizing Bar of the Tractor passes under the center of the Engine and, were it not for this subdivision of the lower portion of the Crankcase, it would be impossible to remove the Oil Pan without first lifting the entire Engine. As it now is, the Lower Oil Pan may be dropped off

first and then the Upper Oil Pan withdrawn over the Equalizing Bar. thus giving access to the inside of the Crankcase and permitting the removal of the Crankshaft, Pistons and Connecting Rods.

UPPER OIL PAN

The Upper Oil Pan is divided into two compartments by means of a dam or rib cast integral with it and running transversely at the center of the Crankcase. The Upper Oil Pan serves only as an oil catcher and does not carry the oil supply. The Lower Oil Pan forms the oil sump or oil reservoir for the Lubricating System. At the front end of the Upper Oil Pan is located an Oil Pump Screen mounted upon an Oil Screen Body, which is a brass casting held to the body of the Upper Oil Pan by four 0.375 (3/8) inch cap screws. The purpose of this screen, which is number 30 mesh brass wire, is to prevent any dirt or sediment from being drawn out of the Oil Pan and into the Lubricating System.

LOWER OIL PAN CONSTRUCTION

The Lower Oil Pan closes an opening through the bottom of the rear half of the Upper Oil Pan. In the upper portion of the Lower Oil Pan there is cast a small cup, over which is placed an oil filtering screen. This serves the same purpose at the rear end of the Crankcase as does the Oil Screen at the forward end of the Upper Oil Pan. It, however, has no connection whatever with the oil reservoir located immediately below it.

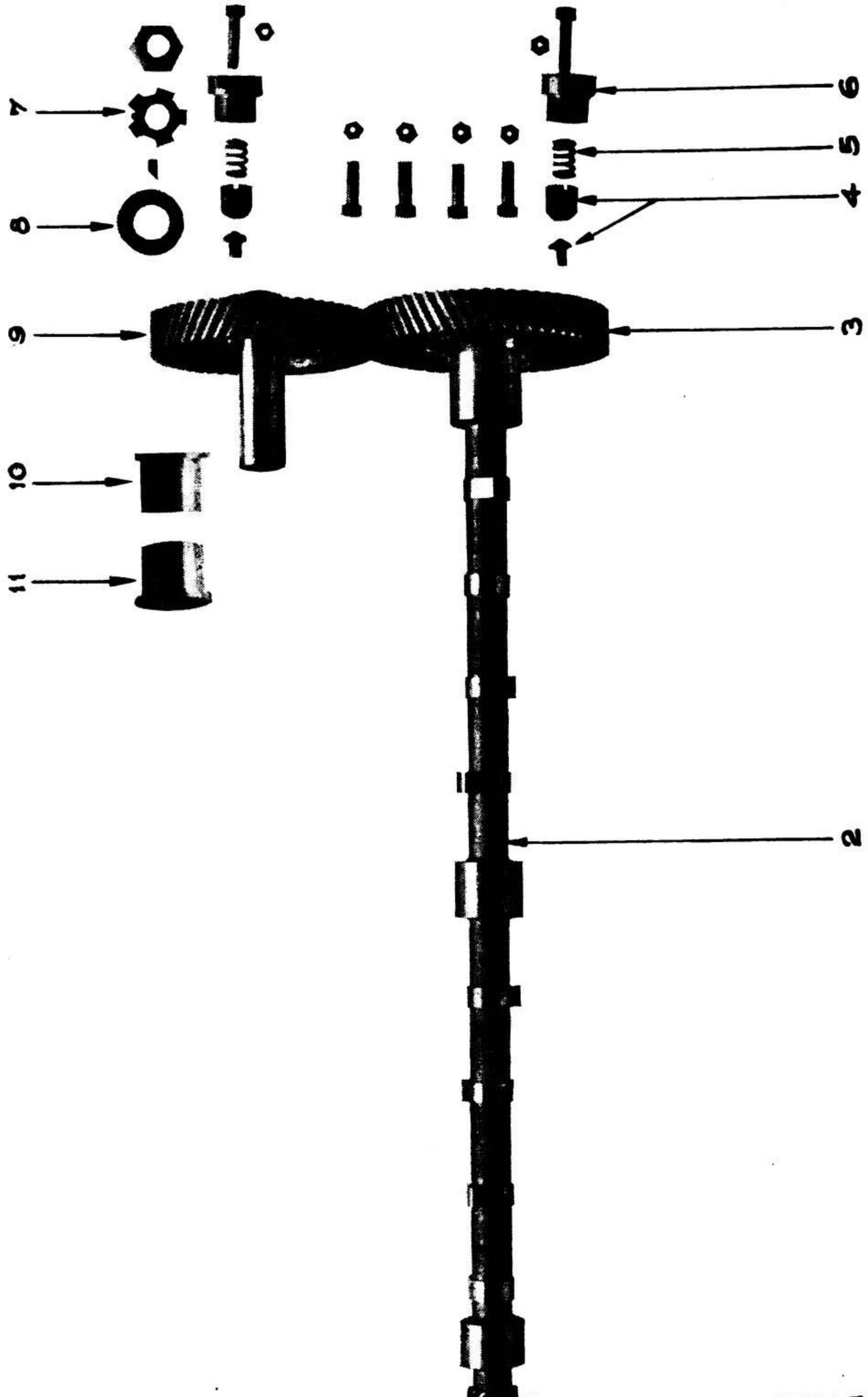
An opening is provided in the top of the Lower Oil Pan through which the oil reservoir may be inspected and cleaned. This, however, is closed by a sheet steel Oil Partition Plate so that there is no direct connection between the Upper Oil Pan and the oil reservoir in the Lower Oil Pan. Through another opening in the upper portion of the Lower Oil Pan the Oil Pump is inserted, and in service the Oil Pump will usually be found as part of this assembly, but for the sake of clearness it is not included in this assembly.

CAMSHAFT ASSEMBLY

The Camshaft Assembly consists of the Camshaft, the Camshaft Gear, the Idler Gear, the Pump Drive Gear and the Idler Shaft and Bushings.

The Camshaft is a steel drop forging with case hardened cams and bearings, which are forged integral with the Shaft and ground. The Front Camshaft Bearing is 2.25 (2 1/4) inches long and 2.249 (2 1/4) inches in diameter. The Center Camshaft Bearing is 1.75 (1 3/4) inches long and 2.124 (2 1/8) inches in diameter. The Rear Camshaft Bearing is 1.375 (1 3/8) inches long and 1.999 (2) inches in diameter. At the rear

PLATE 29



CAMSHAFT AND IDLER ASSEMBLY

PLATE 29—CAMSHAFT AND IDLER ASSEMBLY

Ref. No.	Ord. No.	Name
1	268E	Oil pump drive gear.
2	266A	Camshaft.
3	268A	Camshaft gear.
4	269C	Thrust plunger.
5	269B	Thrust plunger spring.
6	269A	Thrust plunger housing.
7	267C	Idler shaft nut lock washer.
8	267E	Idler gear thrust washer.
9	267A	Idler gear.
10	268B	Inner idler bushing.
11	268C	Outer idler bushing.

end of the Camshaft the Oil Pump Drive Gear is keyed and pinned. This is a steel gear with twelve helically cut teeth of twelve pitch and 45 degree right hand helical angle. It has a 0.5 (½) inch face. The Camshaft diameter between the Cams is 1.25 (1¼) inches in diameter. The Cams are 0.625 (⅝) inch wide. Both the intake and exhaust have a base circle diameter 1.375 (1⅜) inches. Both the intake and exhaust Tappets have a lift of 0.3385 ($\frac{21}{64}$) inch.

To the front end of the Camshaft is bolted the Camshaft Gear, which is made from cast iron, has a 1.25 (1¼) inch face, 7.72 (7¾) inches outside diameter, 7.5 (7½) inches pitch diameter, 9 diametral pitch, 27 degree 15 minutes left hand helical angle. The Gear is held in place with four 0.375 (⅜) inch bolts.

The Idler Gear, which meshes with it, is made from semi-steel, has 1.25 (1¼) inch face, 6.97 ($6\frac{31}{32}$) inches outside diameter, 6.75 (6¾) inches inside diameter, fifty-four teeth, 9 diametral pitch and right hand helical angle of 27 degrees and 15 minutes. The Idler Gear is mounted on a separate shaft, the bearing length of which is 4.062 ($4\frac{1}{16}$) inches long and diameter 1.499 (1½) inches. This runs on two babbitt lined bushings 1.5 (1½) inches inside diameter, 1.877 (1⅞) inches outside diameter and 1.812 ($1\frac{13}{16}$) inches overall length. These are interchangeable with the Rear Governor and Pump Bushings used on the Tractor Engine and part Number 1045-V, on Class A and B truck Engine.

In order to hold the Camshaft and Idler Gear accurately in place and prevent any axial movement, a thrust device is used at the front end of each of these Shafts. The thrust device is carried in the Timing

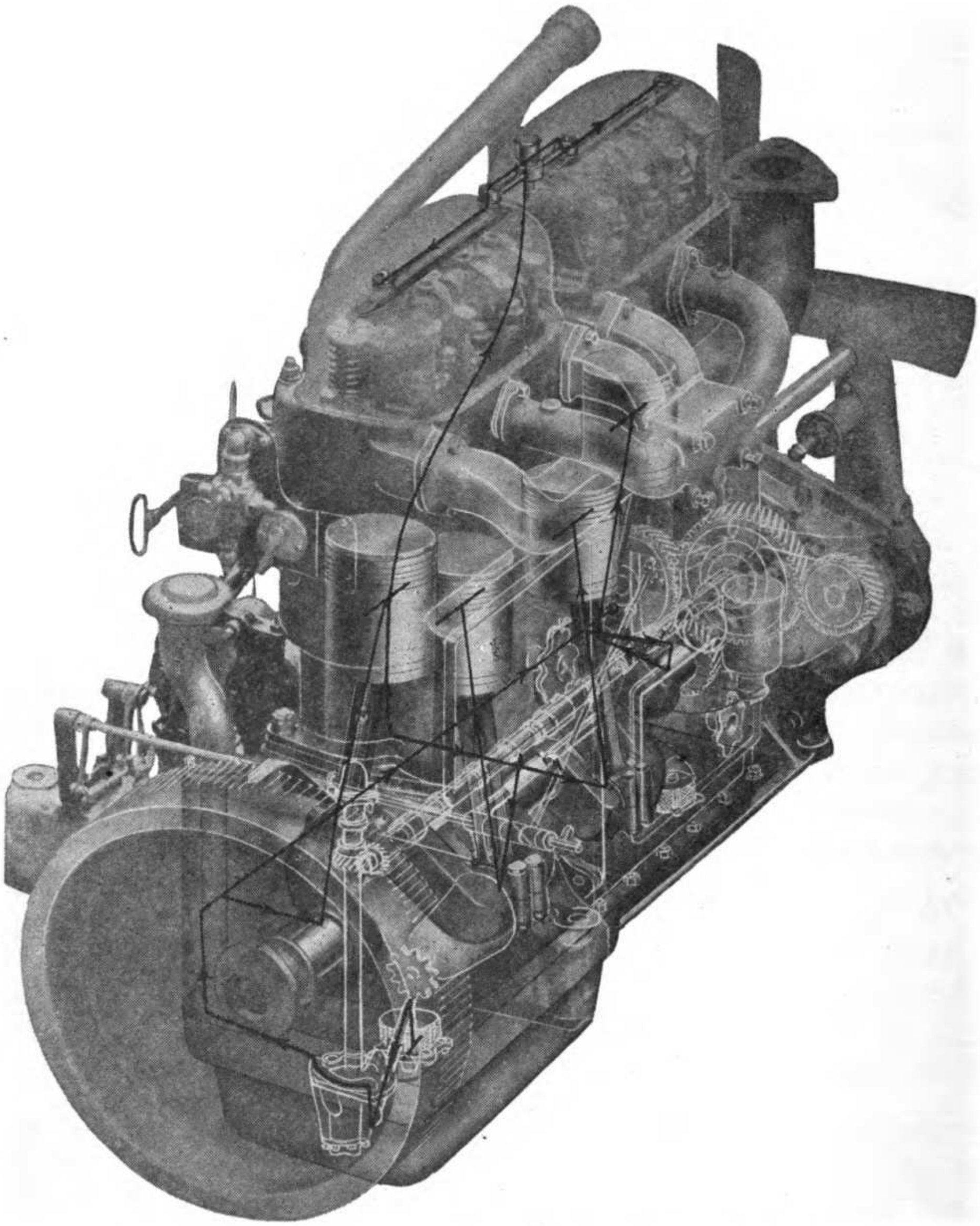


PLATE 30—PHANTOM DRAWING OF ENGINE OILING SYSTEM

Gear Cover and is composed of the following parts: The Thrust Plunger Housing, the Thrust Plunger, the Thrust Plunger Spring, and the Thrust Plug which bears against the Thrust Plunger and is pressed into the ends of both the Camshaft, and the Idler Shaft.

TO REMOVE CAMSHAFT

In order to remove the Camshaft it is necessary to take off the Timing Gear Cover Plate on the front end of the Engine and also to take out the Valve Tappets which would interfere with the removal of the shaft. The Timing Gear Cover Plate cannot be removed until the Front Engine Support is removed. This may be removed if the weight of the Engine is first taken off it by placing a jack under the Engine. When it is removed it is not necessary to keep the jack under the Engine because two arms are provided on either side of the Engine to hold it in place. If a jack is not available wooden wedges may be driven in between the Engine and the arms provided on the side of the Main Frame. This will hold the front end of the Engine while the Front Engine Support is removed. After this is off it is not difficult to remove the Timing Gear Cover Plate. A pry bar will pull the timing gear out of the case and free the Camshaft so that it can readily be removed. In removing the Radiator prior to getting into the Timing Gear Case follow the instructions under Removing Radiator, under Cooling System.

LUBRICATING SYSTEM

The Lubricating System used on the Five-ton Artillery Tractor appears at first hand to be decidedly complicated, but when carefully analyzed will be found quite simple.

It is distinctive from that used in most automotive engines because it is not affected by the position of the engine, no matter how steep the grade which the Tractor is ascending or descending. This is because it is of the Dry Crank Case Type. The Dry Crank Case is maintained so that all the superfluous oil which flies off of the Crankshaft and Gears and drains from the Cylinder Walls is not left in the Oil Pan to be splashed about by the Connecting Rods, but is immediately pumped out of the Oil Pan and delivered into the Oil Reservoir. From the Oil Reservoir it is re-circulated through the Engine Bearings under pressure.

OIL CIRCULATING SYSTEM

The oil is drawn from the Oil Reservoir, in the Lower Oil Pan, by a Gear Pump and delivered to the Main Oil Line, which is cast integral with the Upper Crankcase. This Oil Line delivers the supply from the Pump to each of the three Main Bearings, to the Rocker Arm Oil System, to the Oil Pump Drive Shaft Bracket and to the Timing Gears. From the Main Bearings it is delivered through drilled passages in the Crankshaft to each of the Connecting Rods, runs up a tube provided on the side of the Connecting Rod to the Piston Pins and thence to the Cylinder Walls. At the front end of the Engine this oil is delivered to the inside of the Idler Gear, which has a groove machined on the inside of the rim for this purpose and holes through the rim by means of which

the oil is distributed over the Camshaft Gear Face, the Water Pump and Magneto Gear and the Crankshaft Gear. The Oil Line which goes from the Main Line in the Crankcase to the Rocker Arm Oil System at the top of the Engine terminates in the Oil Relief Valve.

THE OIL RELIEF VALVE

The Oil Relief Valve is a piston held in place by means of the Oil Relief Valve Spring, and provision is made for the adjustment of the spring tension so that the oil pressure in the Lubricating Oil System may be regulated at this point. The Oil Relief Valve Body is conveniently located between the two Rocker Arm Covers at the top of the Engine and should be adjusted so that, after the Engine has been running ten minutes, the Oil Pressure Gage, located in the Instrument Bracket at the rear of the Engine, shows 25 pounds pressure.

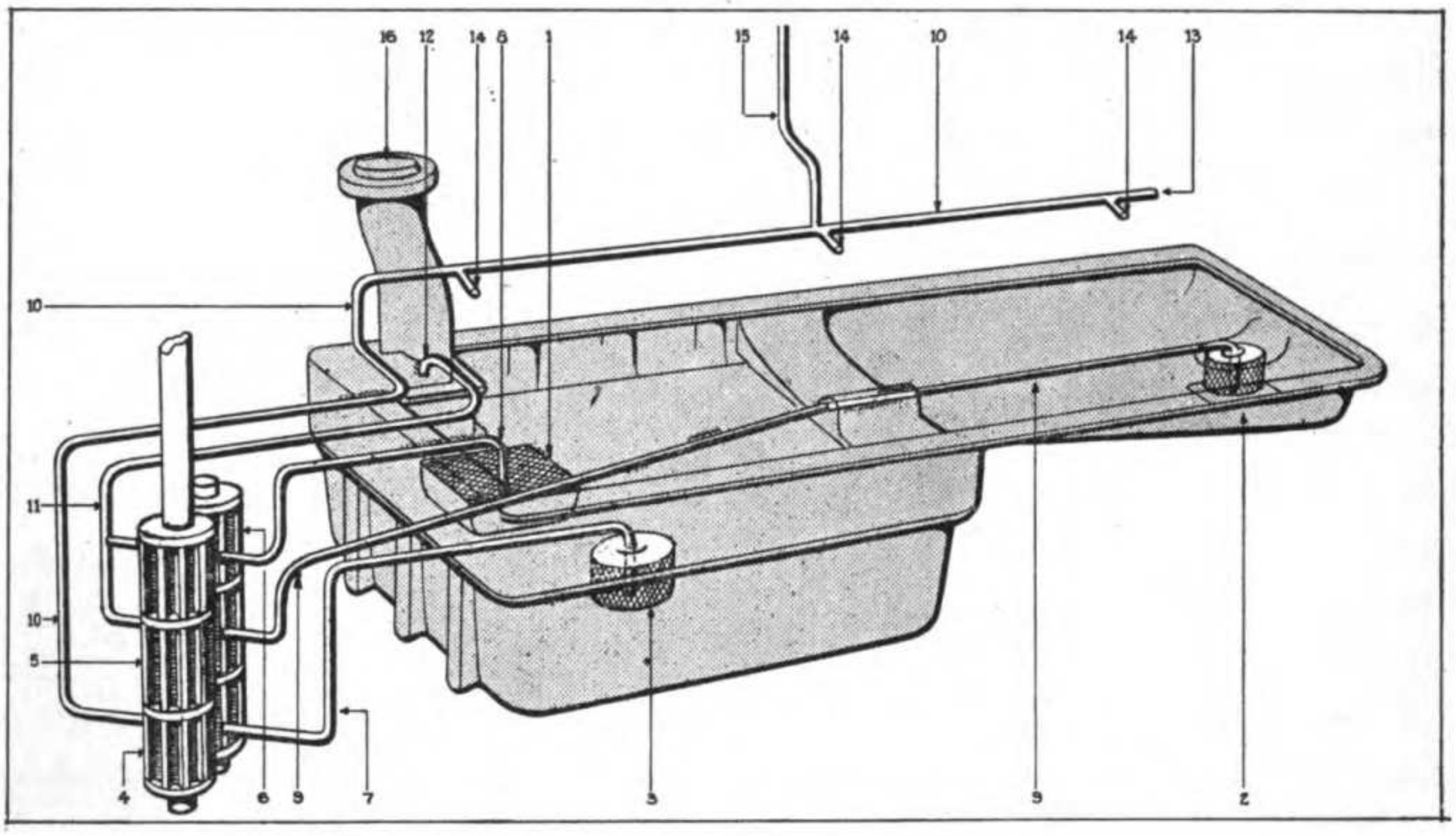


PLATE 31—DIAGRAM OF OILING SYSTEM

Ref. No.	Name
1	Rear upper oil pan oil screen.
2	Front upper oil pan oil screen.
3	Main oil line screen in oil reservoir.
4	Main oil pump.
5	Oil pump draining front upper oil pan.
6	Oil pump draining rear upper oil pan.
7	Suction line from oil reservoir to main oil pump.
8	Suction line from rear upper oil pan.
9	Suction line from front upper oil pan.
10	Delivery line from main oil pump to bearings.
11	Delivery line from suction pumps, 5 and 6, to oil reservoir.
12	Outlet of line 11 into main oil reservoir.
13	Outlets from main oil line to lubricate gears.
14	Outlets from main oil line to lubricate main crankshaft bearing.
15	Main oil line to rocker arm cover oiling system.
16	Breather and oil reservoir filler opening.

OIL PUMP ASSEMBLY

The Oil Pump is a triplex pump, that is, in one pump body there are three independent Gear Pumps. The Bottom or Lowest Pump delivers oil from the Oil Reservoir to the Main Oil Line in the Crankcase; the Intermediate Pump draws oil from the front end of the Upper Oil Pan and delivers it into the Oil Reservoir in the Lower Oil Pan; the Top Gear Pump draws oil from the rear end of the Upper Oil Pan and also delivers it into the Oil Reservoir in the Lower Oil Pan. These two Upper Pumps, therefore, do not serve to lubricate the Engine but to drain the Upper Oil Pan as fast as the oil accumulates in either end of it.

OIL PUMP BODY

The Oil Pump Body is made from cast iron and not only houses the three Gear Pumps but also carries most of the oil distribution passages. The remaining oil distribution passages are in the Oil Pump, Upper Cover, which is clamped down upon the Lower Oil Pan. The Oil Pump, Lower Cover, merely serves to close the bottom end of the Pump and support the Oil Pump Idler Shaft and Oil Pump Drive Shaft. The Oil Pump Gears have 1.25 (1¼) inches face, 1 inch pitch diameter and twelve 12-pitch teeth. The three Driving Gears are steel and the three Driven Gears are bronze. Between the Bronze Gears there are two Steel Spacing Washers, while between the three steel gears there are two Bronze Washers. This combination of washers and gears should be carefully noted when assembling the Pump. The Oil Pump is driven by a small helical gear located on the rear end of the Camshaft.

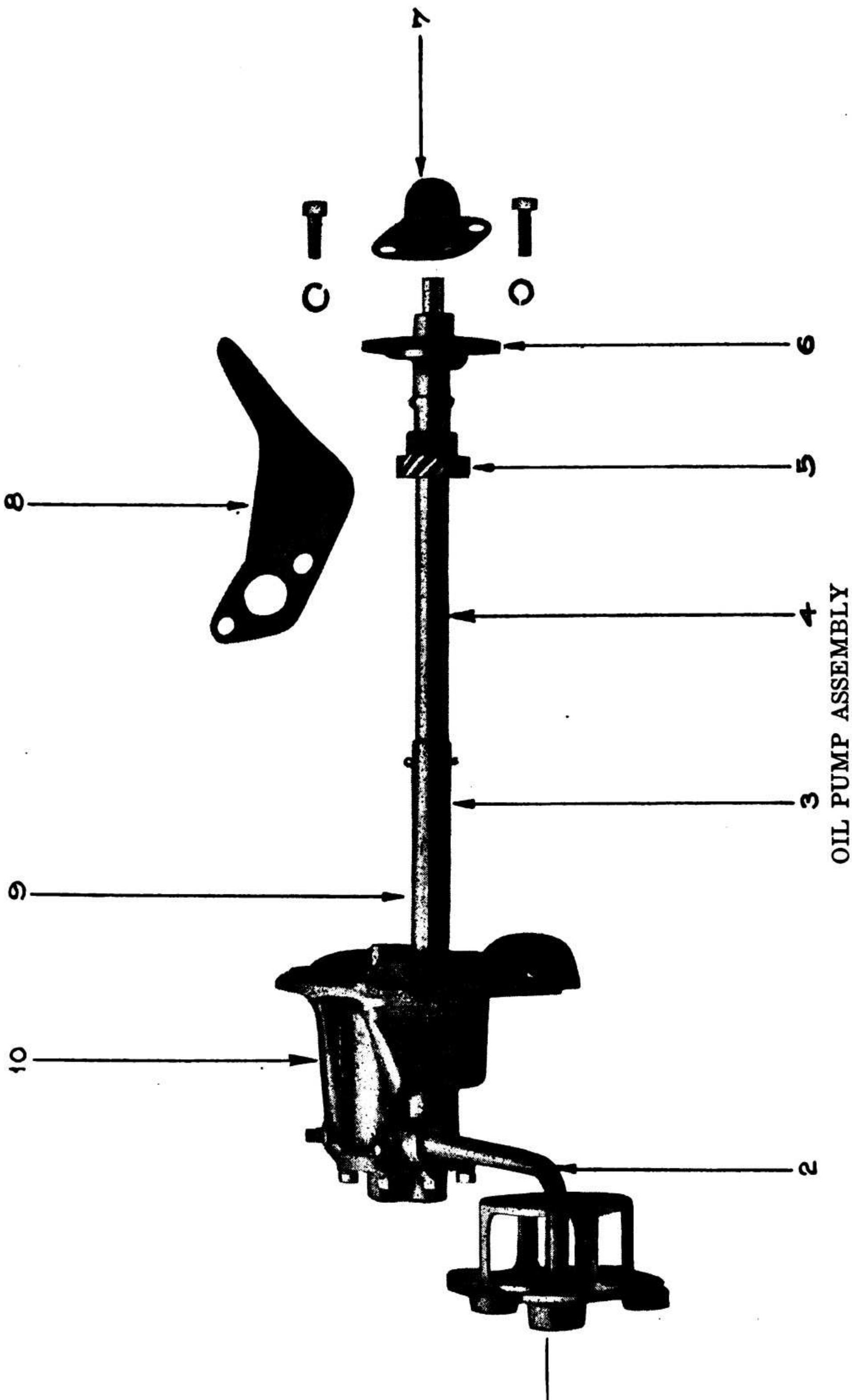
OIL PUMP DRIVE

The Gear on the Camshaft and the Gear on the Upper Oil Pump Drive Shaft are interchangeable. The Upper Oil Pump Drive Shaft is supported by a collar at the top of the Oil Pump Drive Shaft Bracket. It is also guided by a bushing located in the Crankcase above the Oil Pump Shaft and designated the Drive Shaft Bushing, Lower. The Oil Pump Coupling Shaft forms a sort of Oldham coupling between the Oil Pump and the Oil Pump Drive Shaft, Upper. The Oil Pump Coupling Shaft is attached to the Oil Pump Drive Shaft, Upper, by means of a 0.125 (⅛) inch split pin. When removing the Lower Oil Pan or when replacing it, it is only necessary to guide the Oil Pump Coupling Shaft into the Oil Pump Shaft Collar as the Lower Oil Pan is lifted into position. This can be done readily by removing the rear Crankcase Hand Hole Cover Plate and reaching into the Crankcase.

CLEANING OIL PUMP

The 5-ton artillery tractor has three oil filtering screens, which may become clogged by foreign matter collecting upon them. For this

PLATE 32



OIL PUMP ASSEMBLY

PLATE 32—OIL PUMP ASSEMBLY

Ref. No.	Ord. No.	Name
1	342A	Oil screen body.
2	374G	Oil pump suction pipe.
3	373G	Oil pump coupling shaft.
4	377D	Oil pump drive shaft, upper.
5	268E	Oil pump drive gear driven.
6	377F	Oil pump drive shaft bracket.
7	377B	Drive shaft cover.
8	331B	Flywheel pointer.
9	377G	Oil pump shaft collar.
10	372A	Oil pump body.

reason it is desirable to clean them at least once each month. The most common agent in clogging the screen is the particles of waste or lint from rags that are used for cleaning the Crankcase.

The three screens are located as follows: The main oil supply screen is mounted upon the oil screen body, a brass casting that is inserted in the bottom of the lower oil pan and held in place with four cap screws; the front oil pump screen is held in a similar brass oil pump screen body casting fastened to the bottom of the upper oil pan toward the front end. Each of these screens may be readily cleaned by removing the oil pump screen body after the oil reservoir and the upper oil pan have been drained of oil. The screen which protects the pump for the rear portion of the upper oil pan is located in the cover of the lower oil pan so that, in order to clean it, the lower oil pan must be removed.

REMOVING OIL PUMP.

To remove the Oil Pump:

1st. Drain the oil reservoir and the upper oil pan.
2nd. Remove the lower oil pan from the bottom of the crankcase.
3rd. Take out cap screws holding pump body on lower oil pan.
4th. Oil pump can then be disassembled for cleaning and inspection.

REPLACING OIL PUMP.

In replacing oil pump body,

1st. Insert pump in lower oil pan, being careful not to damage the gaskets.
2nd. Remove rear crankcase hand hole cover.
3rd. Reach through hand hole in crankcase and guide oil pump coupling shaft into upper oil pump drive shaft after the lower oil pan is replaced on the bottom of the engine.

GOVERNOR ASSEMBLY

The Governor Assembly is located on the right hand side of the Motor and carries not only the Governor mechanism, the Governor Lever and Governor Spring, Governor Rod and Tube, but also the

Governor and Generator Drive Shaft and that portion of the Shaft provided to drive an electric generator when this is necessary. The Governor Lever Housing is bolted onto the front of the Timing Gear Cover and is independent of the rest of the Governor Assembly, as the

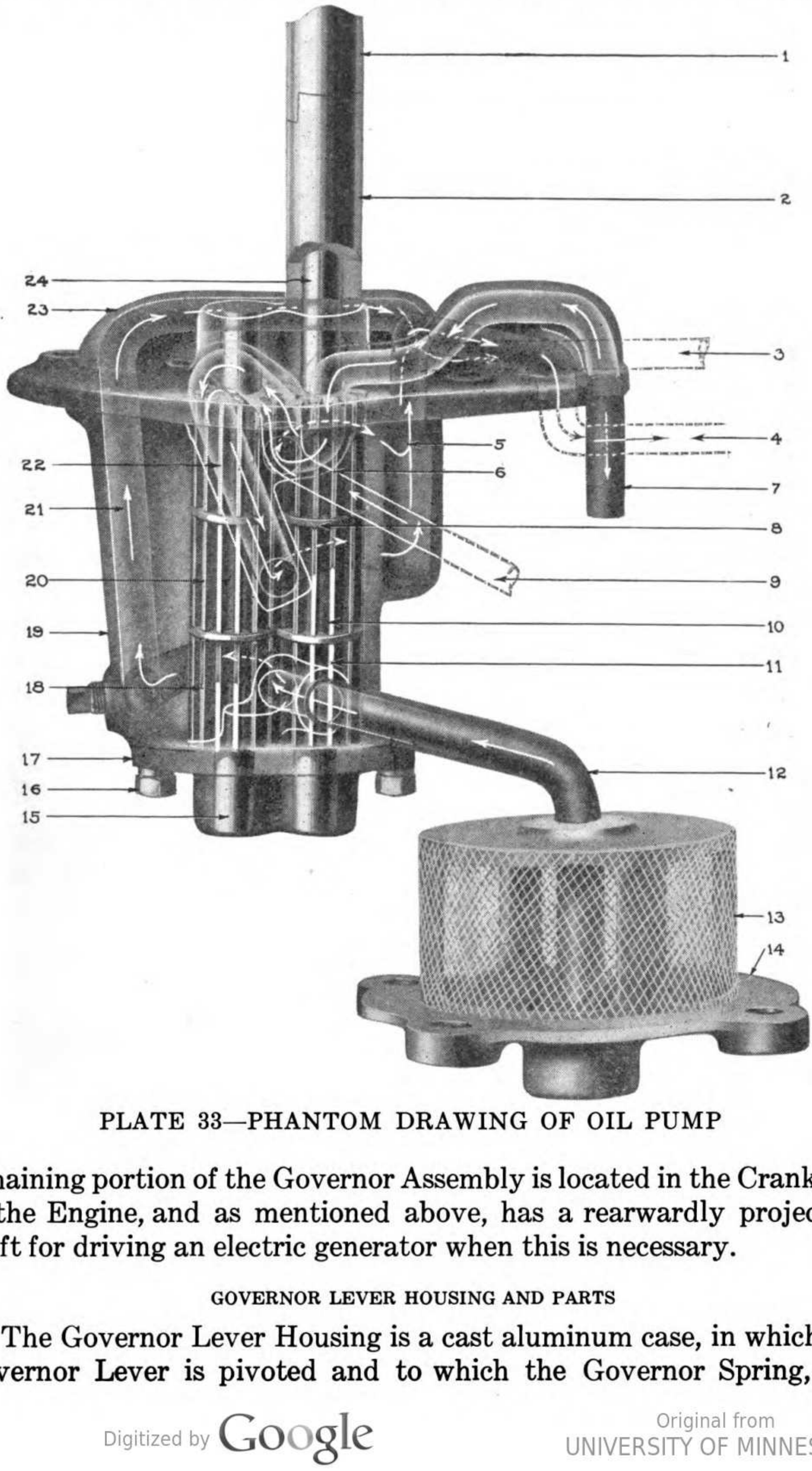


PLATE 33—PHANTOM DRAWING OF OIL PUMP

remaining portion of the Governor Assembly is located in the Crankcase of the Engine, and as mentioned above, has a rearwardly projecting shaft for driving an electric generator when this is necessary.

GOVERNOR LEVER HOUSING AND PARTS

The Governor Lever Housing is a cast aluminum case, in which the Governor Lever is pivoted and to which the Governor Spring, the

PLATE 33—PHANTOM DRAWING OF OIL PUMP

Ref. No.	Ord. No.	Name
1	373G	Oil pump coupling shaft.
2	377G	Oil pump shaft collar.
3	. . .	Main oil delivery tube to bearings.
4	. . .	Return oil tube from pumps to oil reservoir.
5	. . .	Discharge passage connecting two upper pumps with tube 4.
6	373C	Oil pump gear driver.
7	375D	Oil pump upper cover nipple, suction line from rear upper oil pan.
8	375B	Oil pump spacing collar.
9	. . .	Suction oil line from front upper oil pan.
10	373C	Oil pump gear driver.
11	373C	Oil pump gear driver.
12	374G	Oil pump suction pipe from oil reservoir to main oil pump.
13	342C	Main oil pump screen.
14	342A	Oil screen body.
15	373E	Oil pump idler shaft.
16	376C	Cap screw.
17	373A	Oil pump cover, lower.
18	373D	Oil pump gear, driven.
19	372A	Oil pump body.
20	373D	Oil pump gear, driven.
21	. . .	Discharge passage from main oil pump connecting pump 11-18 with discharge tube 3.
22	373D	Oil pump gear, driven.
23	372B	Oil pump upper cover.
24	373B	Oil pump drive shaft, lower.

Oil Circuits:

A—Main lubricating system: Suction 12; through pump 11-18; through passage 21 to delivery line 3.

B—Front oil pan draining system: Suction 9; through pump 10-20; through passage 5 to return tube 4 leading to main oil reservoir.

C—Rear oil pan draining system: Suction 7; through pump 6-22; through passage 5 to return tube 4 leading to main oil reservoir.

Governor Adjusting Spring Gage, the Governor Adjusting Screw and the Governor Adjusting Screw Lock Nut are applied.

In order to protect the Governor Rod, which extends from the Governor Lever to the Throttle Valve located in the Intake Manifold, a Governor Rod Tube has been provided. This slips into a hole provided in the Intake Manifold, but is screwed into the Governor Lever Housing and held in place by the Governor Tube Lock Nut. There is a sheet steel Governor Lever Housing Cover which incloses the forward side of the Governor Lever Housing. It is kept oil tight by means of a manila paper gasket, 0.010-inch thick and is held in place by eleven 0.25 (¼) inch A. S. M. E. Machine Screws.

GOVERNOR ADJUSTMENT

The tension of the Governor Spring is varied by means of the Governor Adjusting Screw. A Governor Adjusting Screw Lock Nut is provided with eight 0.125 (⅛) inch holes equally spaced so that a wire may be slipped through it, and a similar diameter hole in the Governor

Adjusting Spring Gage and then sealed so that the Engine speed can not be varied or the Governor readjusted without the knowledge of the Commanding Officer.

The Governor and Generator Drive Shaft runs upon two bronze bushings, babbitt lined, that are interchangeable with similarly placed bushings used on the Water Pump and Magneto Drive Shaft. On page 83 their dimensions will be found in detail. The end of this

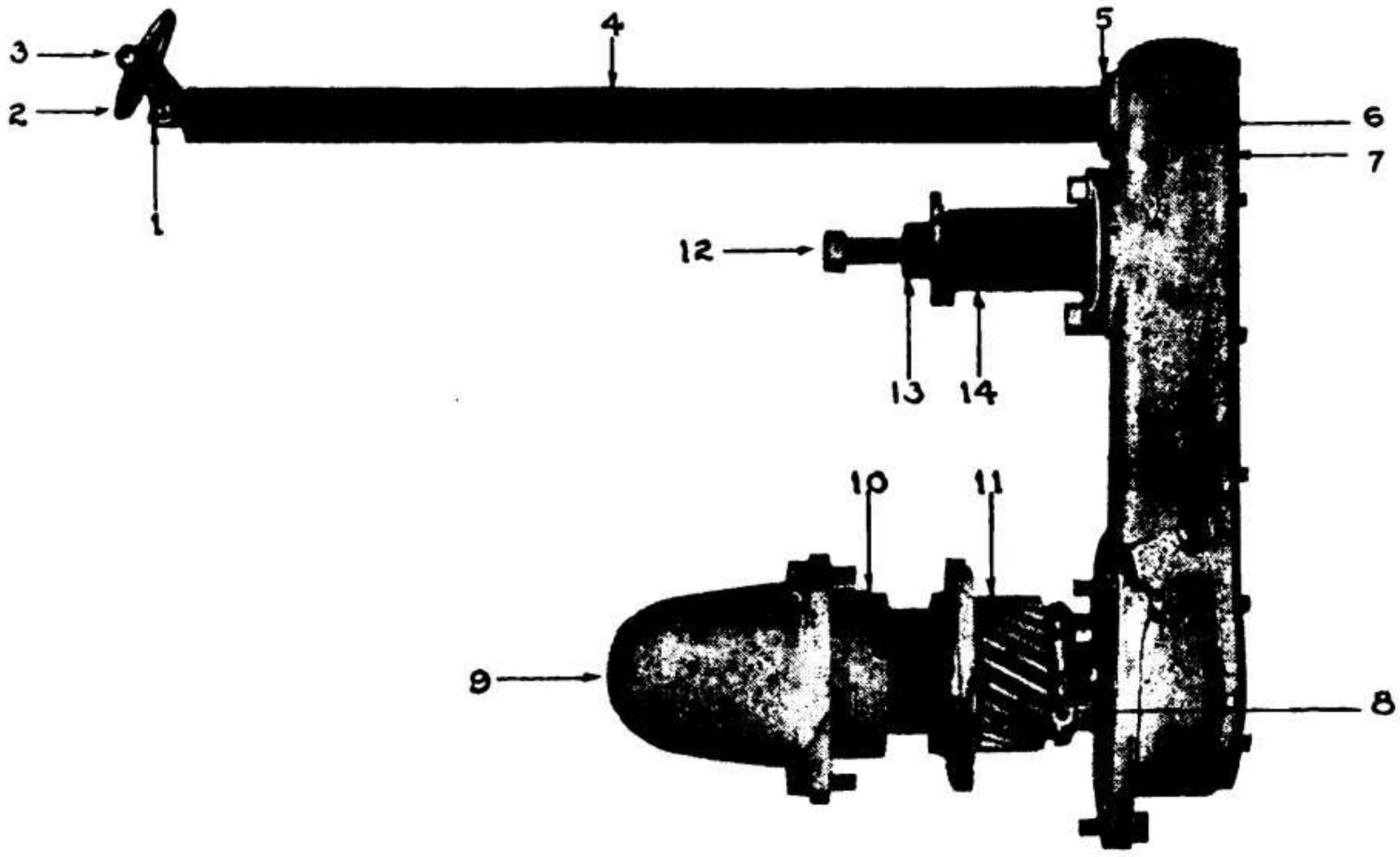


PLATE 34—GOVERNOR ASSEMBLY

Ref. No.	Ord. No.	Name
1	312D	Throttle lever.
2	312E	Governor throttle valve.
3	312H	Throttle spindle.
4	311E	Governor rod tube.
5	311F	Governor tube lock nut.
6	309A	Governor lever housing.
7	309C	Governor lever housing cover.
8	311C	Governor weight.
9	310A	Generator shaft cover.
10	310D	Shaft bearing cage.
11	314C	Generator gear.
12	313C	Governor adjusting screw.
13	313D	Adjusting screw lock nut.
14	313E	Governor adjusting spring case.

Shaft is covered by the Generator Shaft Cover that takes the place of the electric Generator, which is not used on the five-ton Artillery Tractor. The Generator, or Governor Gear, is steel, of S. A. E. specification number 1035 with heat treatment H. It has a face of 1.25 (1¼) inches, an outside diameter of 2.97 (2 31/32) inches, a pitch diameter of 2.75 (2¾) inches, 22 teeth, 9 diametral pitch with right hand helical angle of 27 degrees 15 minutes. On the front end of this are four 0.25 (¼) inch holes tapped 0.5 (½) inch deep. These holes are for the Cap Screws which hold the Governor Spider in place on the Gear.

The Governor Spider is a drop forging with provisions for carrying the four drop forged Governor Weights, which are 1 inch wide and 0.625 (5/8) inch in diameter. They are forged integral with a small bell crank, the Long Arm of which is 1.687 (1 11/16) inches and the Short Arm 0.562 (9/16) inch long. Between the Governor Shifting Collar and the Short Arm of the governor bell crank is imposed a governor Ball Thrust Bearing.

FAN ASSEMBLY

The Fan Assembly consists of the Fan Bracket, Fan Shaft, Fan Bearings, Fan Hub, Fan Blade Assembly, and Fan Belt. The Fan is 24 inches in diameter and has a projected area of 2.25 (2¼) inches; i. e. the thickness from front to rear of the Fan Blade Path. The Fan Belt Assembly is bolted to the front of the Fan Hub by means of four 0.375 (3/8) inch bolts. The Fan has four stamped steel blades made from 0.062 (1/16) inch sheet steel stock.

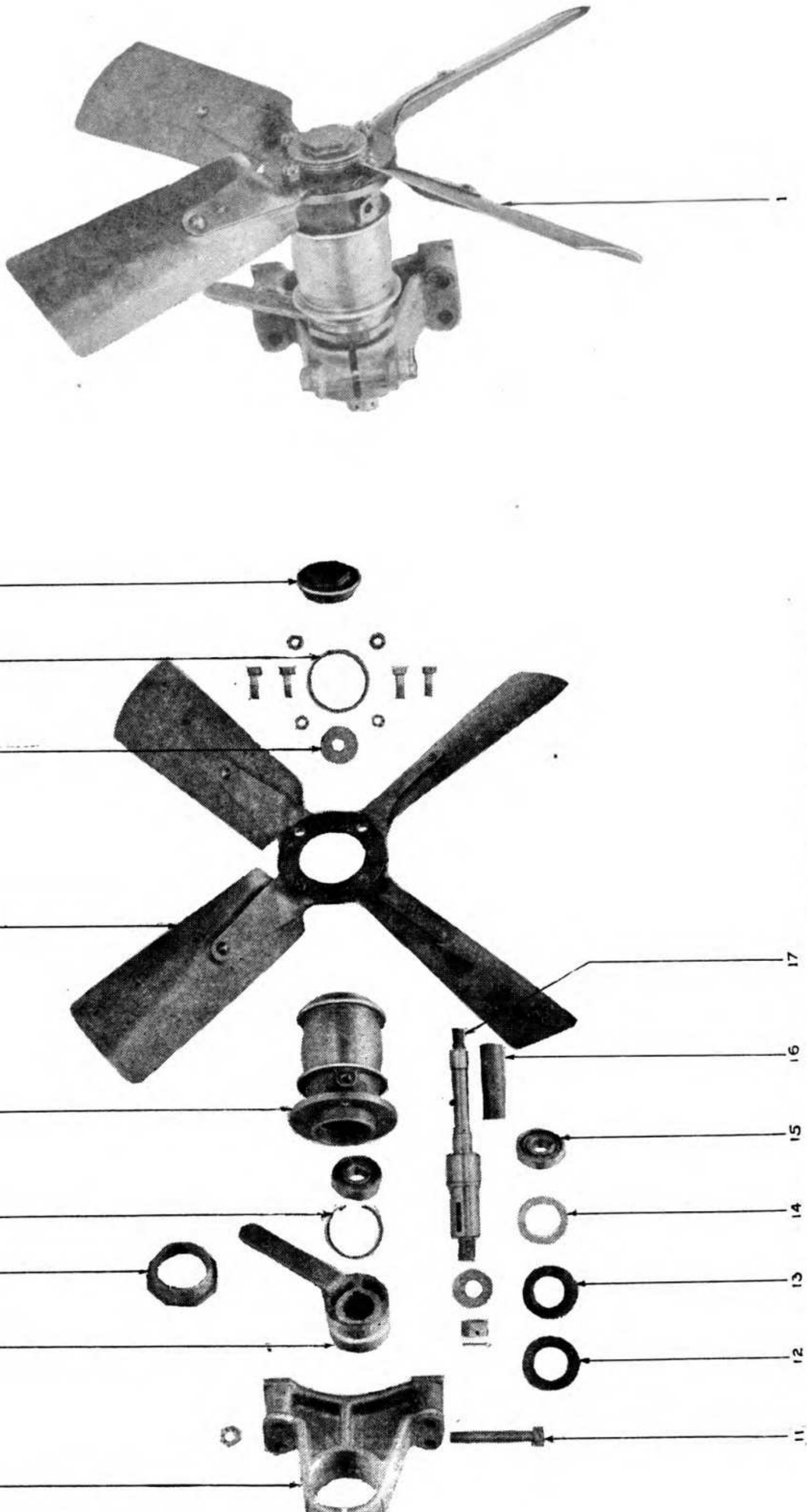
FAN HUB

The Fan Hub is made from cast iron and acts both as the Drive Pulley and the Fan Blade Carrier. Inside of it are the two annular ball bearings, upon which the Fan rotates. A ¼-inch pipe plug in the side of the Fan Hub is provided through which the Fan Hub may be filled with Ref. No. 6 cup grease for the purpose of lubricating the bearings. The front end of the Fan Hub is closed by a Fan Hub Cap, which is made oil tight by means of the Fan Cap Gasket. At the rear end of the Fan Hub there is a Fan Hub Washer of felt, which serves to retain the lubricant inside of the Fan Hub at this point. The Fan Hub is located in place upon the Fan Shaft by clamping the Back Fan Bearing between the Back Fan Bearing Retainer and the Fan Hub Packing Nut. The Front Fan Bearing merely floats and serves to support the Fan Hub but not to retain it in position. Both ball bearings used in the Fan are of the same size, namely: number 304 standard annular type bearings. The bearings are held in place upon the Fanshaft by means of a Fanshaft Washer and a 0.5 (½) inch S. A. E. castellated nut with a tubular steel Fan Hub Bearing Spacer, 3.125 (3⅛) inches long, 1 inch in outside diameter and with 0.095 (3/32) inch gauge walls.

FAN BRACKET

The Fanshaft is not fastened directly into the Fan Bracket but to the Fan Belt Adjusting Eccentric. The eccentric is provided with a 6-inch handle, which makes it convenient to operate and is clamped in place by splitting one side of the Fan Bracket Hole into which the eccentric fits and clamping with a 0.5 (½) inch bolt. By means of this eccentric, a 1-inch adjustment or variation between the fan belt

PLATE 35



COOLING FAN AND PARTS

PLATE 35

COOLING FAN AND PARTS

Ref. No.	Ord. No.	Name
1	.....	Fan and bracket assembled.
2	283B	Fan hub cap.
3	285A	Fan cap gasket.
4	284F	Fan shaft washer.
5	281A	Fan.
6	283A	Fan hub.
7	283C	Fan hub retaining ring.
8	283D	Fan hub packing nut.
9	282B	Fan belt adjusting eccentric.
10	282A	Fan bracket.
11	285G	S. A. E. bolt.
12	285B	Fan hub washer.
13	285C	Fan hub washer.
14	285D	Fan bearing washer.
15	285F	Fan bearing.
16	284D	Fan hub bearing spacer.
17	284A	Fan shaft.

pulley centers is obtained. Both the Fan Belt Adjusting Eccentric and the Fan Bracket are cast from malleable iron. The Fan Bracket is attached to the upper Crankcase by four 0.5 (½) inch bolts.

FAN BELT

The Fan Belt is made of 2.5 (2½) inches wide two-ply chrome tan leather. The developed length of the belt, not including the splice, is 41.125 (41⅛) inches. The splice should have a lap of 5 inches and the belt should be stitched ¼-inch in from either edge with 8 stitches per inch. The minimum center to center distance of the Fan Belt Pulleys is 12.625 (12⅝) inches. The radius of the Fan Hub Pulley is 1.625 (1⅝) inches and that of the Driving Pulley is 3.187 (3 3/16) inches.

REASONS FOR FAN BELT SLIPPAGE.

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

WATER PUMP AND FAN DRIVE ASSEMBLY

The Water Pump and Fan Drive Assembly consists of the following important parts: Centrifugal Water Pump with shaft and coupling, the Main Drive Shaft which is located inside of the Crankcase, the Bushings for this Drive Shaft, the Pump and Magneto Drive Gear and the Fan Drive Pulley.

WATER PUMP

The Water Pump consists of three important parts: the Water Pump Body, the Water Pump Cover and the Water Pump Rotor. The Water Pump Body and Cover are held together by means of eight 0.25 (¼) x 0.625 (⅝) inch Round Fillister Head Screws. The Water Pump Body and Cover when assembled are held in place on the Engine

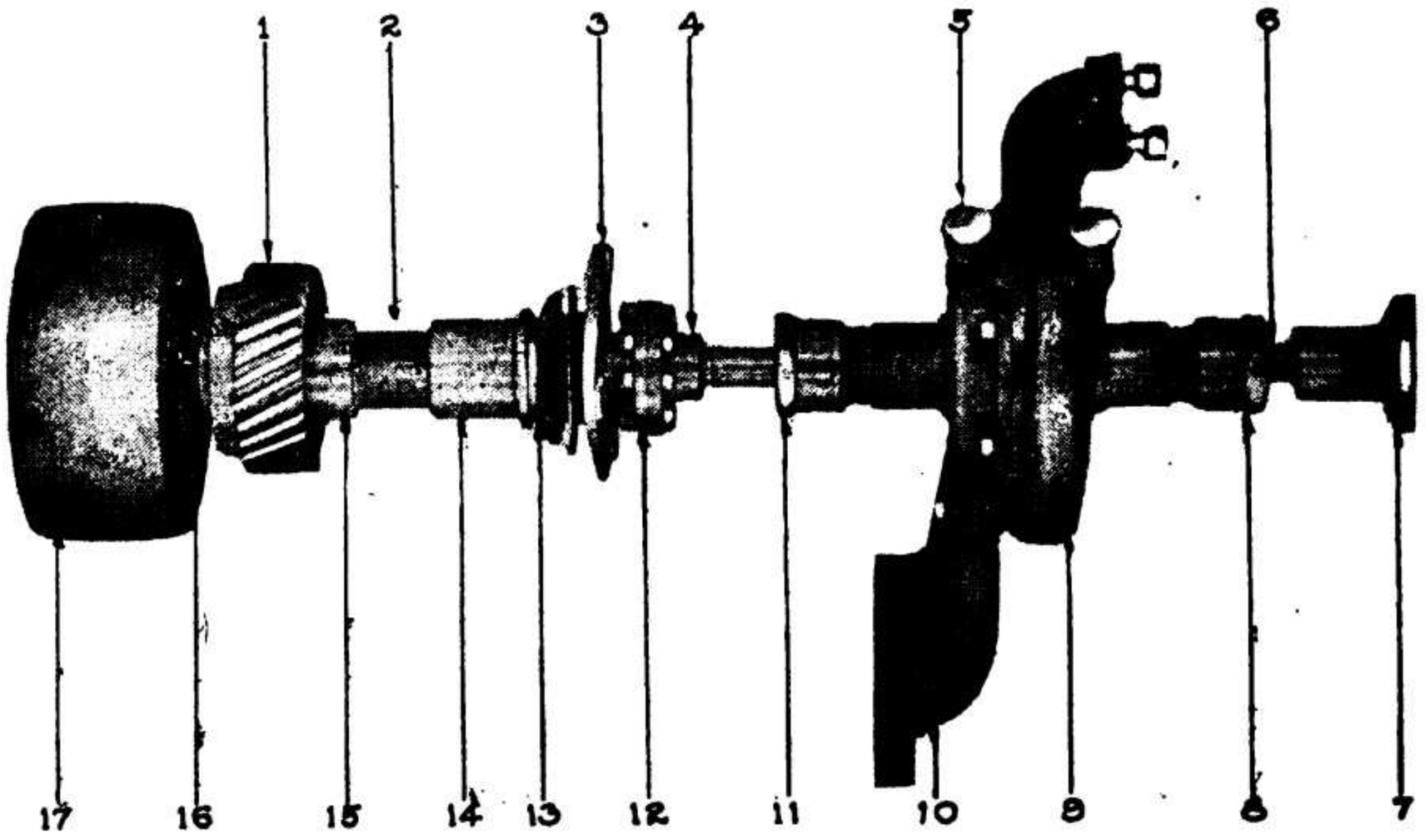


PLATE 36—WATER PUMP ASSEMBLY.

Ref. No.	Ord. No.	Name
1	364B	Pump and magneto gear.
2	362A	Water pump drive shaft.
3	363A	Pump shaft housing cover.
4	363C	Pump coupling flange—8 hole.
5	362E	Grease cup.
6	362B	Water pump shaft.
7	361A	Water pump rotor.
8	361F	Water pump packing nut, L. H.
9	360B	Water pump body.
10	360A	Water pump cover.
11	361E	Water pump packing nut, R. H.
12	363D	Pump coupling flange—10 hole.
13	365A	Drive shaft gland.
14	268C	Bushing, outer.
15	362F	Shaft bushing, outer.
16	364D	Drive shaft oil sling.
17	364A	Fan drive pulley.

Crankcase by two bearing-like supports. The Rotor is mounted upon a 0.749 (¾) inch bronze shaft, 14.125 (14⅛) inches long, the specification for which is S. A. E. Number 26. This is interchangeable with part number 1105-V on the Class "A" and "B" trucks.

The Rotor of the Water Pump is also of bronze and of the same specification. It is held in place by a Number 1 taper pin, 0.183 x 1.5 (1½) inches. The Water Pump Shaft is carried upon two cast iron Bushings, 0.75 (¾) inch inside diameter, 1.063 ($1\frac{1}{16}$) inch outside diameter and 1.5 (1½) inches long. Care must be taken, should these

Bushings be replaced, to see that the holes drilled through them to allow grease to be forced into the bearings register with the corresponding Grease Cup holes in the Water Pump Body and Cover. Two Grease Cups are provided for the purpose of lubricating these bearings and are conveniently placed on the top of the Water Pump Body and Cover.

To prevent water leakage around the Pump Shaft, Water Pump Packing is inserted in glands at either end of the Pump Assembly.

Water Pump Packing Nuts are required to keep the packing in the glands tight. The nuts are made from bronze and are not interchangeable; the one toward the rear end of the engine has a left hand thread, while the one at the front end of the Engine has a right hand thread.

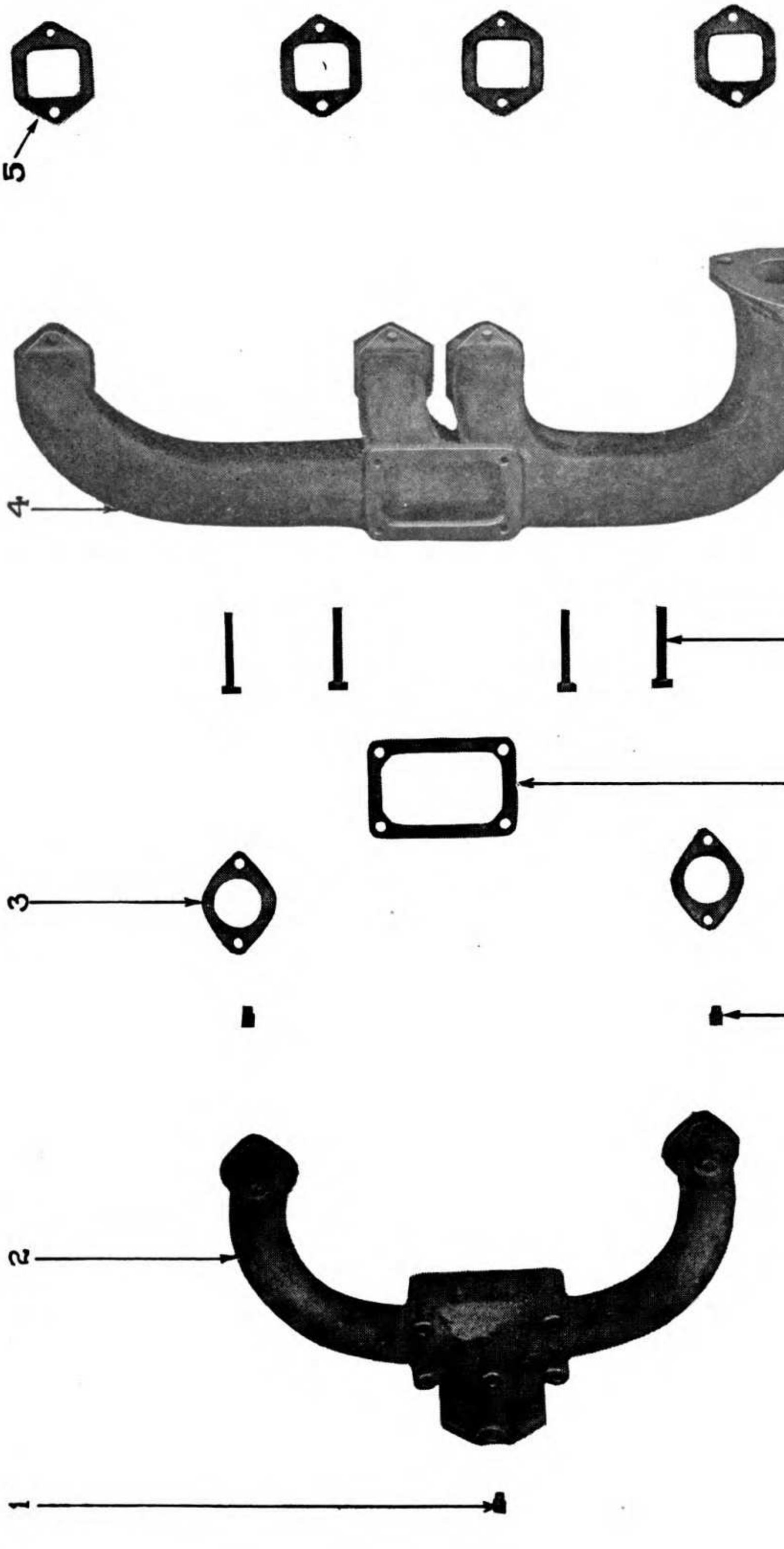
WATER PUMP COUPLING

A Flange Coupling is placed between the Water Pump Drive Shaft located in the Engine Crankcase and the Water Pump Shaft located outside of it. This Coupling is to facilitate the removal of the Water Pump when this is necessary, and to provide convenient means for timing the Magneto. This Coupling is made up in two parts, both the same size but having a different number of holes drilled in them. The Rear Pump Coupling Flange has eight 0.265 ($\frac{17}{64}$) inch drilled holes located on 2-inch diameter circle and equally spaced. The Front Pump Coupling Flange has ten holes of the same diameter and on the same diameter bolt circle. It is possible by the use of this coupling with the holes so spaced to readily adjust the timing of the Magneto, which is driven off of the rear end of the Water Pump Shaft. Two S. A. E. bolts 0.25 ($\frac{1}{4}$) inch and 0.875 ($\frac{7}{8}$) inch are used to transmit the drive.

WATER PUMP DRIVE SHAFT

The Water Pump Drive Shaft is carried upon two Bushings, located in the Crankcase, both of which are bronze, babbitt lined. The Bushing located at the front end of the Water Pump Drive Shaft is not interchangeable with the one located at the rear but is interchangeable with a similarly located Bushing used on the Governor Shaft found on the opposite side of the Engine. This Front Bushing is provided with a Thrust Flange 2.312 ($2\frac{5}{16}$) inches in diameter. The Front Bushing measures 1.5 ($1\frac{1}{2}$) inches inside diameter and 1.877 ($1\frac{7}{8}$) inches outside diameter and 1.812 ($1\frac{13}{16}$) inches overall length. The specifications of the bronze back and babbitt lining of these Bushings are respectively S. A. E. Number 27 and S. A. E. Number 24. The Rear Bushing for the Water Pump Drive Shaft is of slightly different size and is interchangeable with the Idler Bushings and a

PLATE 37



INTAKE AND EXHAUST MANIFOLDS

PLATE 37—INTAKE AND EXHAUST MANIFOLDS

Ref. No.	Ord. No.	Name
1	176F	Pipe plug.
2	394A	Intake manifold.
3	391E	Intake port gasket.
4	393A	Exhaust manifold.
5	391C	Exhaust port gasket.
6	13E	Pipe plug.
7	391A	Intake heater gasket.
8	394B	Bolt.

similarly placed bushing on the Governor Shaft. Its dimensions are as follows: Outside diameter of Flange 2.322 ($2\frac{5}{16}$) inches, inside diameter of Bushing 1.5 ($1\frac{1}{2}$) inches, outside diameter 1.877 ($1\frac{7}{8}$) inches and overall length of 1.812 ($1\frac{13}{16}$) inches. It differs from the Front Bushing on this Shaft in that the babbitt lining is not carried over the face of the Thrust Flange.

The Water Pump Drive Shaft is driven by means of a Pump and Magneto Gear located inside of the Timing Gear Housing.

This Gear is made from steel, has a 1.25 ($1\frac{1}{4}$) inch face, 3.971 ($3\frac{31}{32}$) inches outside diameter, 3.75 ($3\frac{3}{4}$) inches pitch diameter, 30 teeth, 9 diametral pitch and left hand helical angle of 27 degrees 15 minutes.

On an extension of the Water Pump Drive Shaft is keyed the Fan Drive Pulley. This Pulley is made from cast iron and is 6.375 ($6\frac{3}{8}$) inches in diameter and has a crowned face of 9 inches radius and 2.75 ($2\frac{3}{4}$) inches width. To facilitate its removal two 0.375 ($\frac{3}{8}$) inch tapped holes are provided in the Pulley into which puller screws may be inserted. A large Felt Pulley Washer 3.375 ($3\frac{3}{8}$) inches in diameter and 0.25 ($\frac{1}{4}$) inch thick is provided to keep oil from working out of the Timing Gear Cover through the Hole provided for the Fan Drive Pulley Shaft.

TO PACK WATER PUMP GLANDS

The water pump glands (packing boxes of the shaft) should be packed with a good grade of waterproof asbestos, or compounded packing. If asbestos loose twisted rope packing is available, untwist one strand, soak it thoroughly with cylinder oil, and cover with as much fine graphite as it will retain.

Always coil the packing around the shaft in the direction of rotation of the packing nut, so it will not tend to unwind when the packing nut is screwed on.

If only square or round braided packing of too large a size is available, cut off a piece of about the desired length, place it between the jaws of a bench vise, squeeze it out flat, and then cut off a strip of the desired width with a pair of thin snips or heavy scissors. The gland nuts should not be tightened any more than necessary to prevent leakage of water.

PLATE 38

MUFFLER ASSEMBLY AND PARTS

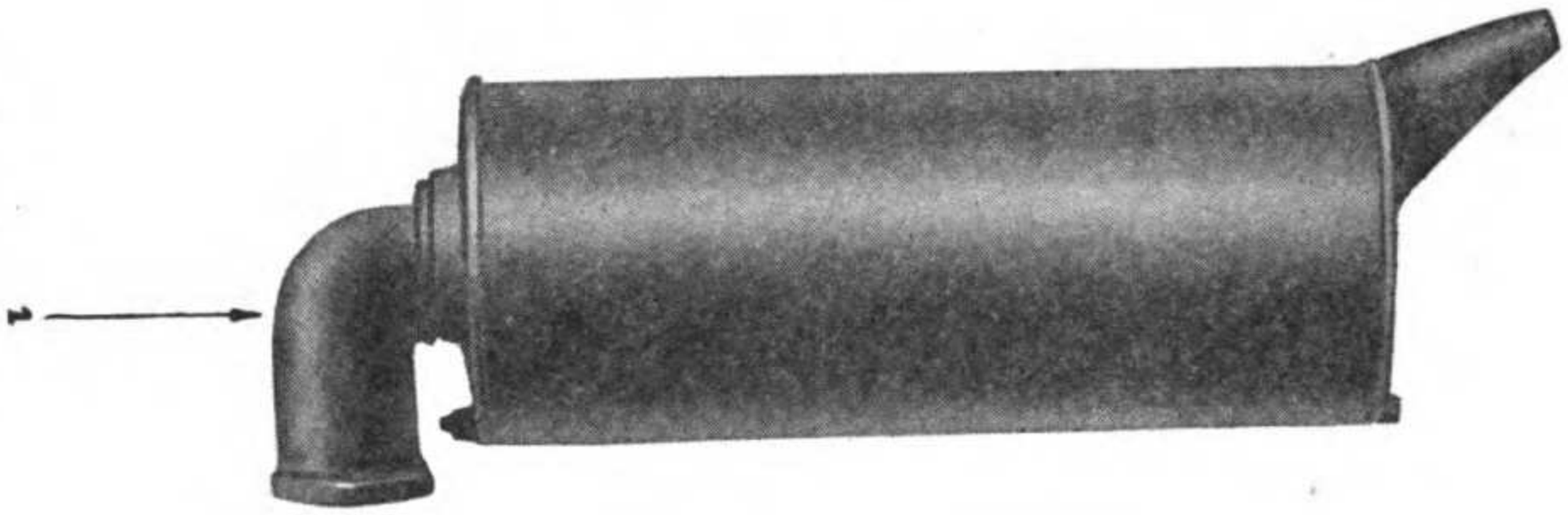


PLATE 38—MUFFLER AND PARTS.

Ref. No.	Ord. No.	Name
1	241A	Muffler assembled.
2		Flange.
3		Head piece.
4	241C	Exhaust pipe.
5		Tail piece.
6		Tee rods.
7		Tee rod nuts.
8		Inner sleeve.
9		Center sleeve.
10		Outer sleeve.

TO TEMPORARILY REMEDY DEFECTIVE WATER PUMP

In case of a damaged or inoperative pump the water pump rotor should be removed from the pump to prevent its obstructing the passage. The cooling system must be full to insure circulation (by thermo-syphon) under these conditions, which are produced by the water boiling. Necessarily this is a temporary arrangement, as water is lost rapidly.

TO THAW FROZEN PUMP

During cold weather, after an engine has been stopped for a sufficient time to permit any water in the cooling system to freeze, the engine should not be turned over with a crank 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.

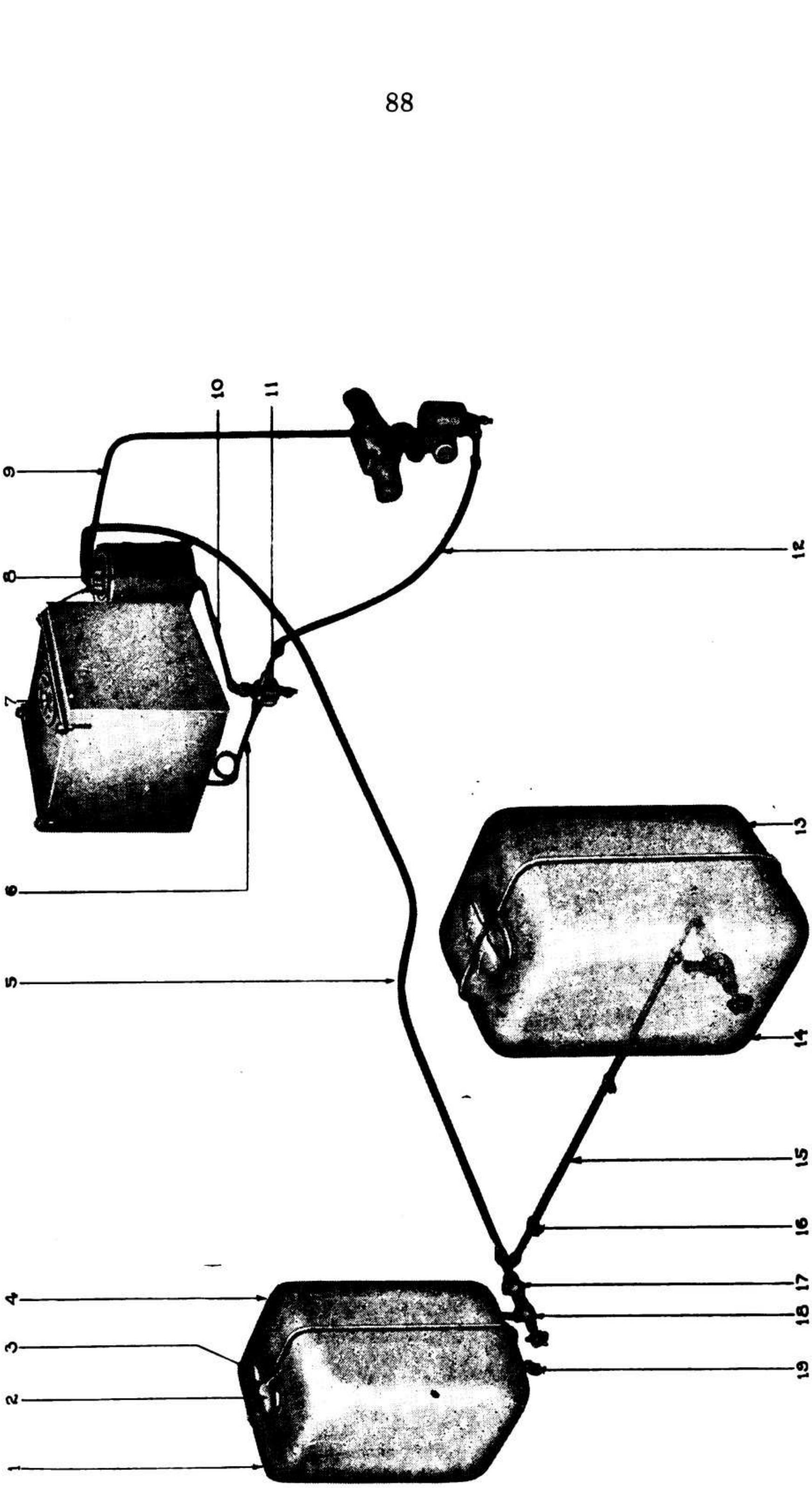
To avoid freezing in winter cover the lower portion of the radiator with cardboard to obstruct air flow. The lower portion is always colder than the top because the water, when it gets to the bottom, already has been cooled. The water, as it enters the top of the radiator is hot, having just come from around the cylinders.

MANIFOLD ASSEMBLY

There are four Manifold Assemblies on the Engine: the Water Outlet Manifold which is attached to the top of the Cylinders and the Water Inlet Manifold which is attached to the lower side of the Cylinder Water Jackets. In addition there are the two Manifolds, one for the Intake and one for the Exhaust, which are bolted together immediately above the Carbureter. The common point at which the intake and exhaust manifolds are bolted together serves as the "Hot Spot" in the Fuel Supply System and insures better vaporization and fuel economy.

The water outlet manifold and the flexible metallic Radiator Inlet Hose are sweated together and form a single assembly.

PLATE 39



FUEL SUPPLY SYSTEM

PLATE 39—FUEL SUPPLY SYSTEM.

Ref. No.	Ord. No.	Name
1	200B	Gasoline tank—right half.
2	201A	Filler cap.
3	202D	Filler cap bail.
4	200A	Gasoline tank—left half.
5	202F	Gas pipe hose outlet.
6	207E	Reserve supply pipe.
7	206F	Filler cap.
8	209A	Vacuum gasoline tank.
9	211A	Vacuum pipe.
10	202E	Gas pipe hose.
11	416C	3-way gasoline valve and strainer.
12	202G	Carbureter and gas pipe hose.
13	200B	Gasoline tank—right half.
14	200A	Gasoline tank—left half.
15	202G	Carbureter and gas pipe hose.
16	211D	Gasoline line clip.
17	204D	Horizontal check valve.
18	204B	Needle angle valve.
19	204G	Drip cock.

MUFFLER ASSEMBLY

The Muffler is mounted on the top of the armor and connected to the Exhaust Manifold by a 12-inch piece of 2.5 (2½) inch seamless steel tubing. The Muffler is very simple in construction, as the photograph of the part shows. It is held in place upon the armor by means of a heavy pressed steel bracket at the front end, and by a cast iron connecting piece at the rear.

FUEL SUPPLY SYSTEM

The Fuel Supply System may be divided into what might be called two independent sources of fuel, the Main Fuel System, which consists of two 12 U. S. gallon tanks located on each side of the Superstructure back of the driver's seat, from which fuel is drawn and delivered to the Carbureter by means of a Vacuum Tank, located under the armor and mounted between the two Cylinder Blocks. The other source of fuel supply is the Reserve or Auxiliary Tank, suspended from the armor plate which forms the cover of the Engine and which carries a supply of 10 U. S. gallons of gasoline.

MAIN FUEL TANKS

The Main Fuel Tanks are made up from two terne plate pressings with rolled flanges, soldered together, making each tank 19 inches high, 12.5 (12½) inches wide and 13 inches thick. A Filler Opening is provided in the top of each tank approximately 6 inches long and 2 inches wide. This is provided with a hinged cap that is held in place

by a Filler Cap Bail. A Filler strainer to prevent dirt being introduced into the Fuel System is provided and each Tank also has an independent Drip Cock by means of which it can be drained. In addition each tank is provided with a check valve between the Needle Angle Valve, which is used to shut it off, and the Main Feed Line from the Supply Tanks to the Vacuum Tank. The purpose of the Check Valve is obvious. If one of the other Fuel tanks were punctured accidentally or by bullets or the like, all of the fuel in both tanks would be lost.

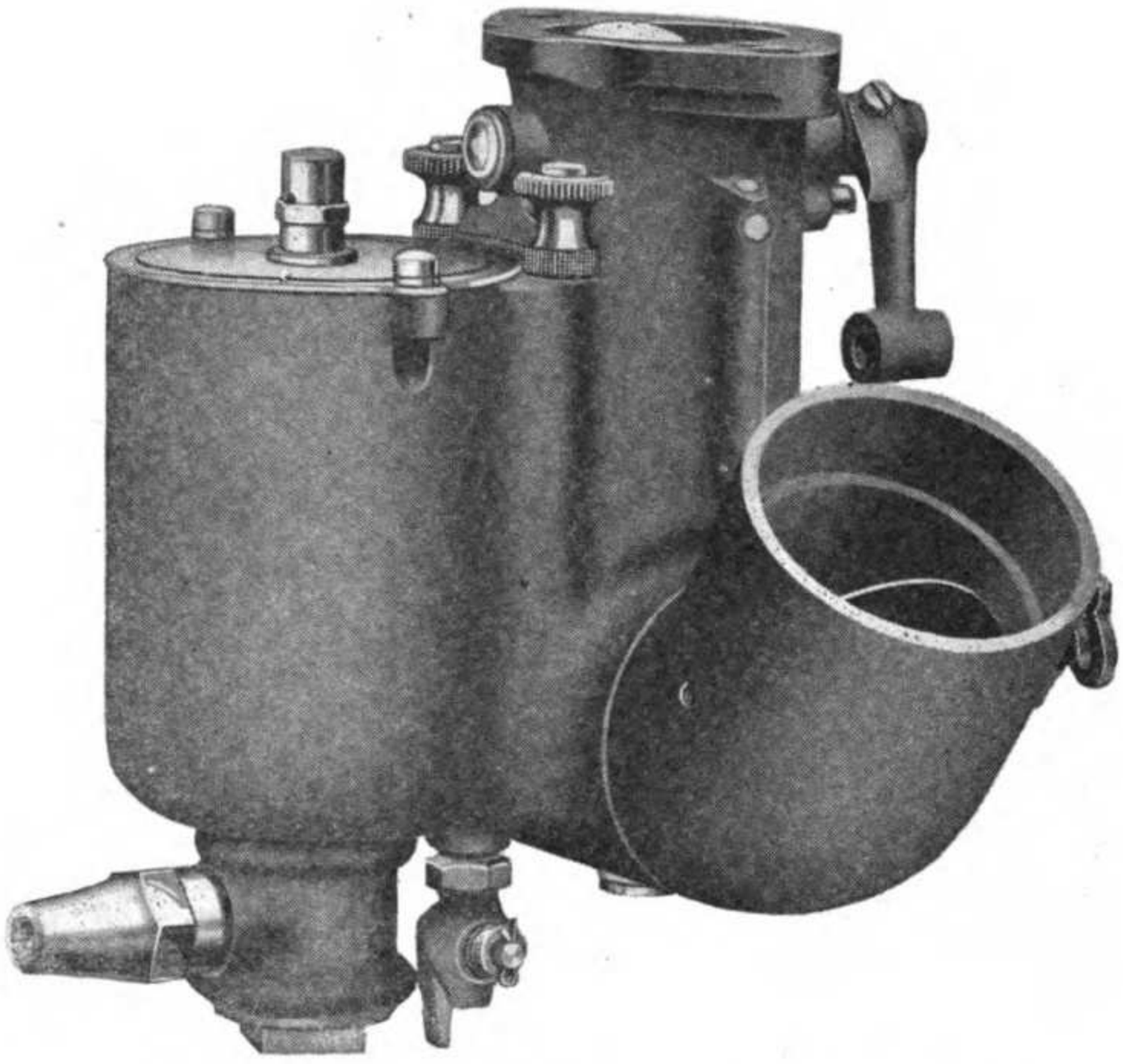


PLATE 40—SCHEBLER CARBURETER

By the introduction of the Check Valve only the fuel in the tank which is leaking will be lost. A line is used connecting the two rear tanks to a single pipe from a tee located under the Left Main Fuel Tank and goes from that point to the Vacuum Tank.

The Vacuum System draws the fuel from the Main Fuel Tanks at the rear into the Vacuum Gasoline Tank and from thence feeds it by gravity to the Carbureter.

CARBURETER

The Carburetion System is the means of supplying the Engine with an explosive mixture of gasoline and air. The System consists of a Carbureter, which receives gasoline from a Supply Tank and mixes it with air in the proper proportion, and a system of passages from the Carbureter to the Inlet Valves which direct the mixture into the Cylinders.

The Tractor is equipped with a Schebler Carbureter, Model A Special. The Carbureter is bolted to a flange on the lower end of the Intake Manifold.

The Carbureter converts the gasoline into vapor and mixes it with the proper amount of air to produce a gas that will explode rapidly in the Cylinders. This Carbureter is of the plain tube type, that is, all the air through the Carbureter passes the fuel nozzle, which is located in the center of a simple pipe or tube and no parts of the Carbureter are of automatic operation or move except the Float mechanism.

Referring to Plate 41, the action of the Carbureter is as follows:

All air enters the Carbureter at (1) and passes up through the Venturi Tube or Mixing Chamber, past the nozzle and Throttle Valve to the Intake Manifold. Fuel enters the Carbureter at (12), passes through the strainer (11) into the Float Bowl, where it is held at a constant level by means of a metal float (15), which actuates the Needle Valve (13) through the Float Arms.

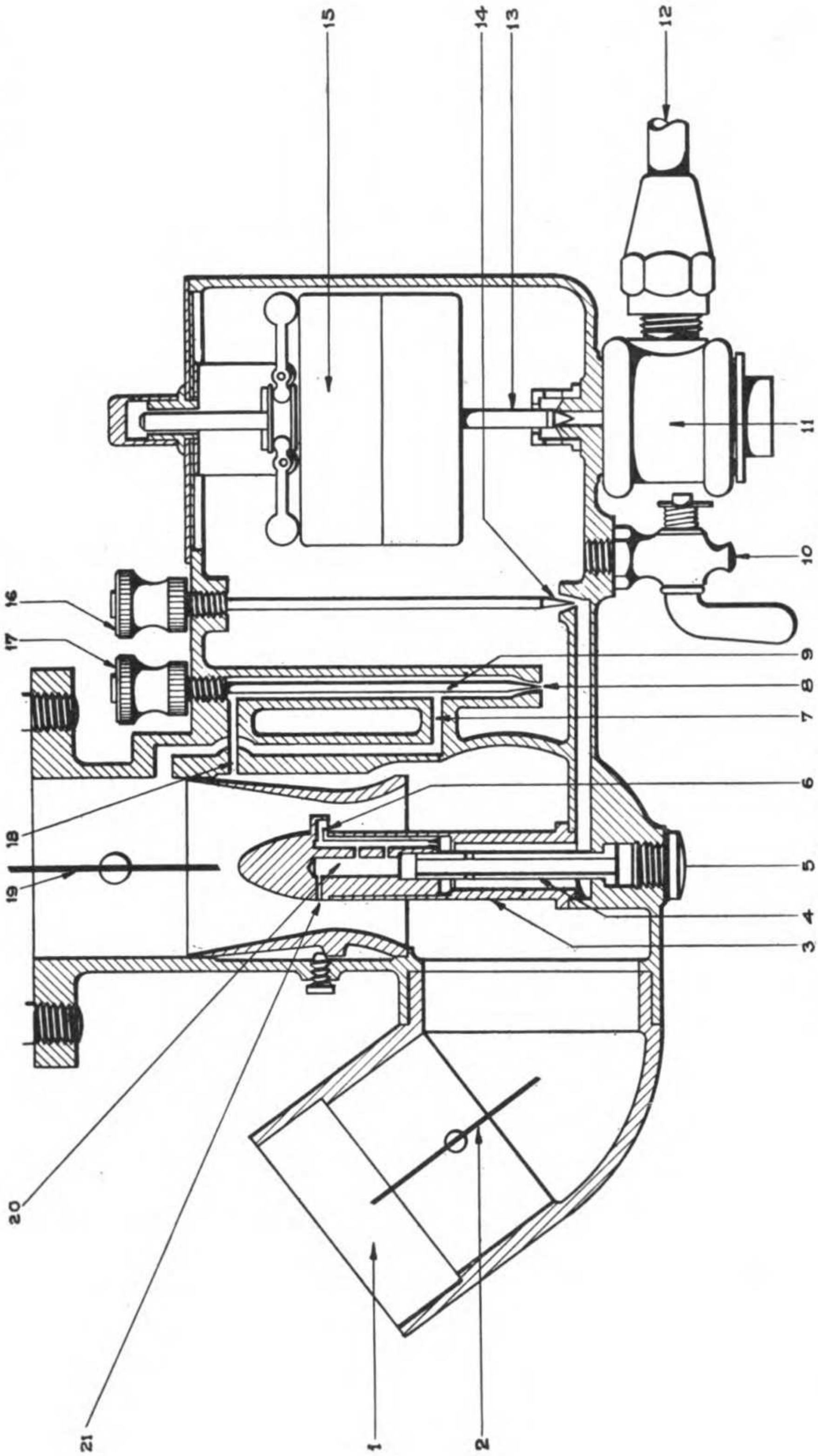
From the Float Bowl the fuel passes the Idling or Low Speed Adjusting Needle Valve (8) into the passages (7) and (9) until it reaches the same level as the fuel in the Float Chamber. It also runs through the Main Fuel Adjusting Needle Valve into the Main Nozzle (4) until the same level is reached.

The Engine is started with the Throttle Valve (19) nearly closed. The air at the Inlet (1) should be choked by means of the Valve (2) if the weather is cold enough to make this necessary. Fuel is drawn through the passage (7) together with some air from the small hole (18) and delivered to the edge of the Throttle Valve (19) where it is atomized and drawn into the manifold. (See diagram on Plate 42 showing Carbureter at choked position.)

As the Throttle is opened, more air is drawn past the Nozzle Housing (3) and tends to draw or suck fuel from the three holes (21), (only one of which is shown on diagram), while it drives into the holes (6) which face the incoming air. The air that drives into the holes (6) mixes with the fuel in the Main Nozzle and is drawn out the holes (21) together with the fuel. This atomized fuel is picked up by the inrushing air and is drawn through the Main Venturi Tube, past the Throttle Valve and into the Intake Manifold. This action of the air driving into the Nozzle controls the reserve of fuel stored there for acceleration purposes, as well as the fuel flow through the valve (14) thus maintaining the proper proportion of fuel to air constantly without the use of moving parts. (See Diagram on Plate 42 of Carbureter running under partial and full loads.)

The only care necessary to insure the proper operation of the Carbureter is to make certain that all connections are tight and that the choke valve is free to return to its normal open position after use.

PLATE 41



SECTIONAL DRAWING OF CARBURETER

PLATE 41
SCHEBLER CARBURETER, MODEL A

Ref. No.	Name
1	Air inlet.
2	Choke valve.
3	Main fuel nozzle housing.
4	Main fuel nozzle.
5	Main fuel nozzle drain plug.
6	Pitot tube vents (3)
7	Auxiliary fuel passage.
8	Idle adjusting needle valve.
9	Auxiliary fuel passage.
10	Carbureter drain cock.
11	Strainer.
12	Fuel supply pipe.
13	Float feed needle valve.
14	Main fuel adjusting needle valve.
15	Float.
16	Main needle valve adjusting head.
17	Idle needle valve adjusting head.
18	Auxiliary air passage.
19	Throttle valve.
20	Main fuel jet mixing chamber.
21	Main fuel jets (3).

Occasionally remove and clean the Strainer and drain the Float Bowl by means of the pet cock on the bottom to remove any water or sediment which may have collected in the bottom of the bowl.

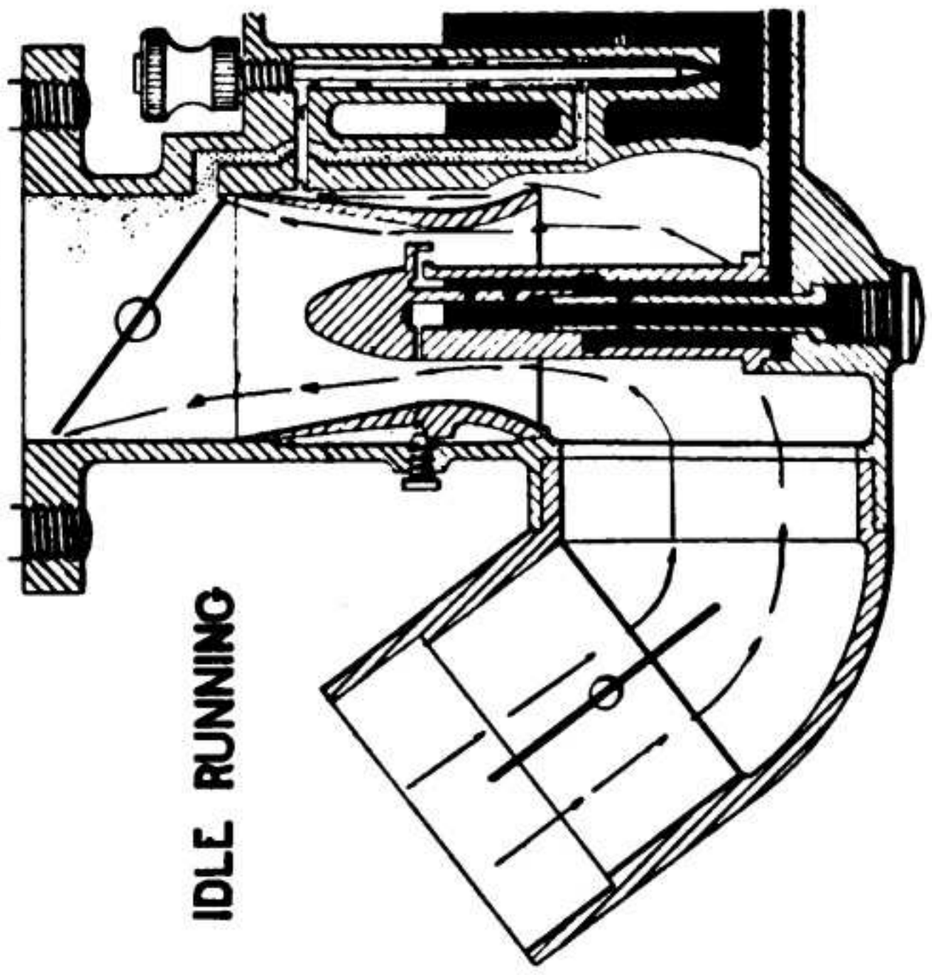
CARBURETER ADJUSTMENT

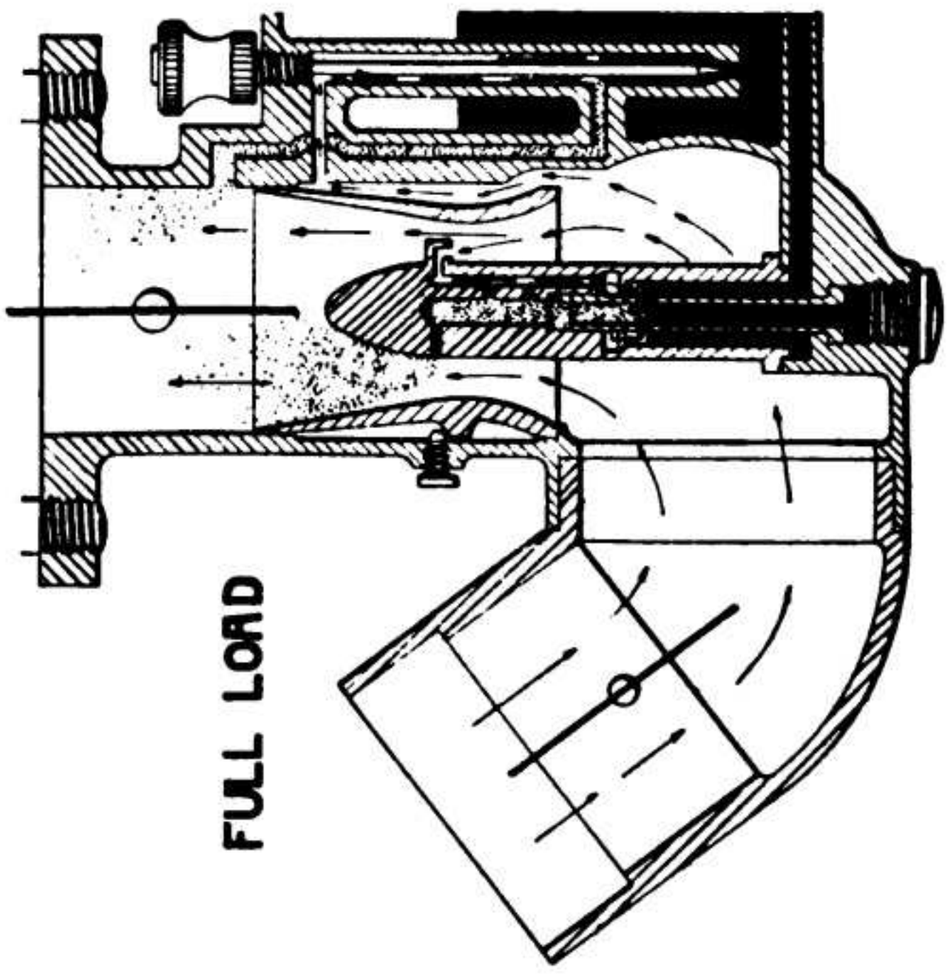
There are two adjustments on the Model "A" Special Carbureter, one is for the idling or slow speed and one for the main jet, and they are so marked on the dial on the tops of the Adjusting Heads. If these adjustments are once set, they should require no further attention except in extreme changes of temperature or when the Engine Valves require re-grinding. In the latter case, a slight enrichment of the Idle Adjusting Head should suffice.

Adjustments are made as follows:

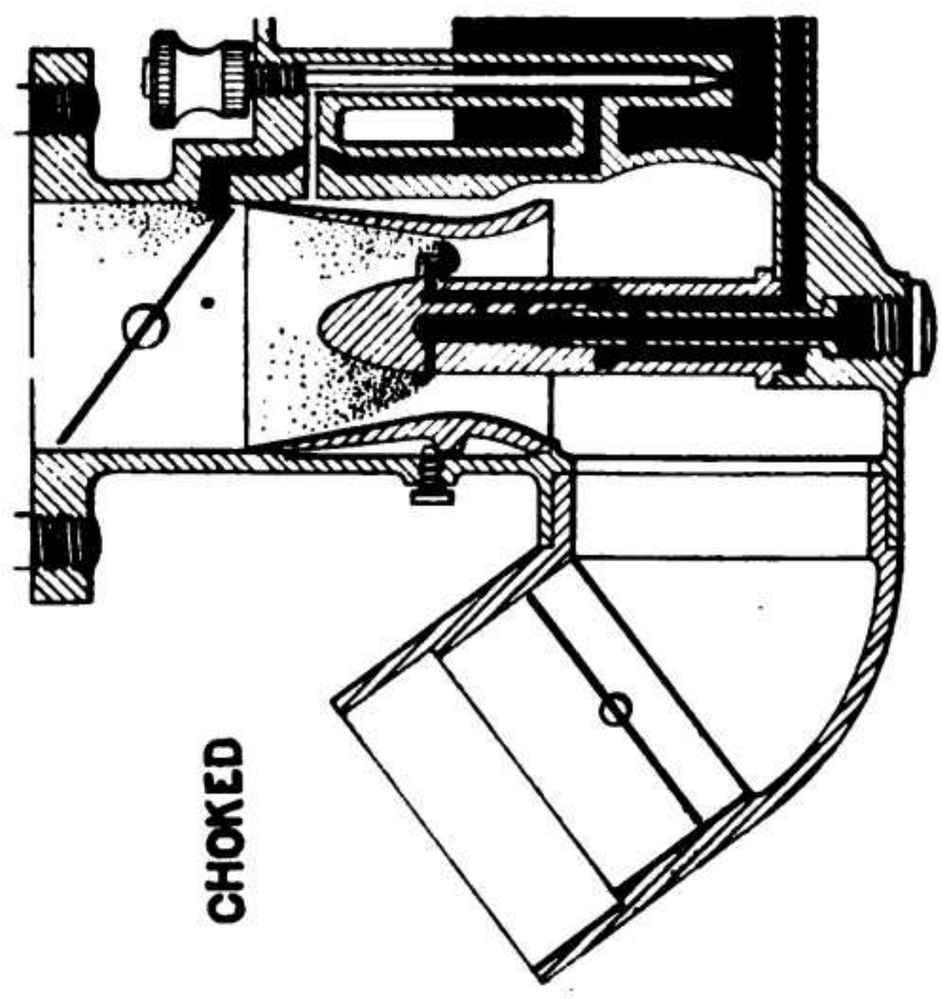
Screw out both Adjusting Needles several turns. Start the Engine with the Throttle slightly open. Slowly turn the Idle Adjusting Head (17) to the right or towards the "less gas" position as indicated by the dial until the Engine fires evenly. Adjust the Engine speed for running idle by means of the Throttle Lever Stop Screw on the Throttle Lever. Open the Throttle wide, allowing the Governor to regulate the Engine speed and with a retarded spark, turn the Main Gas Adjusting Head (16) toward the "less gas" direction until the Engine begins to back-fire. Turn the Adjusting Head in the "more gas" direction just sufficient to stop the Engine back-firing. These adjustments should produce a good clean powerful mixture.

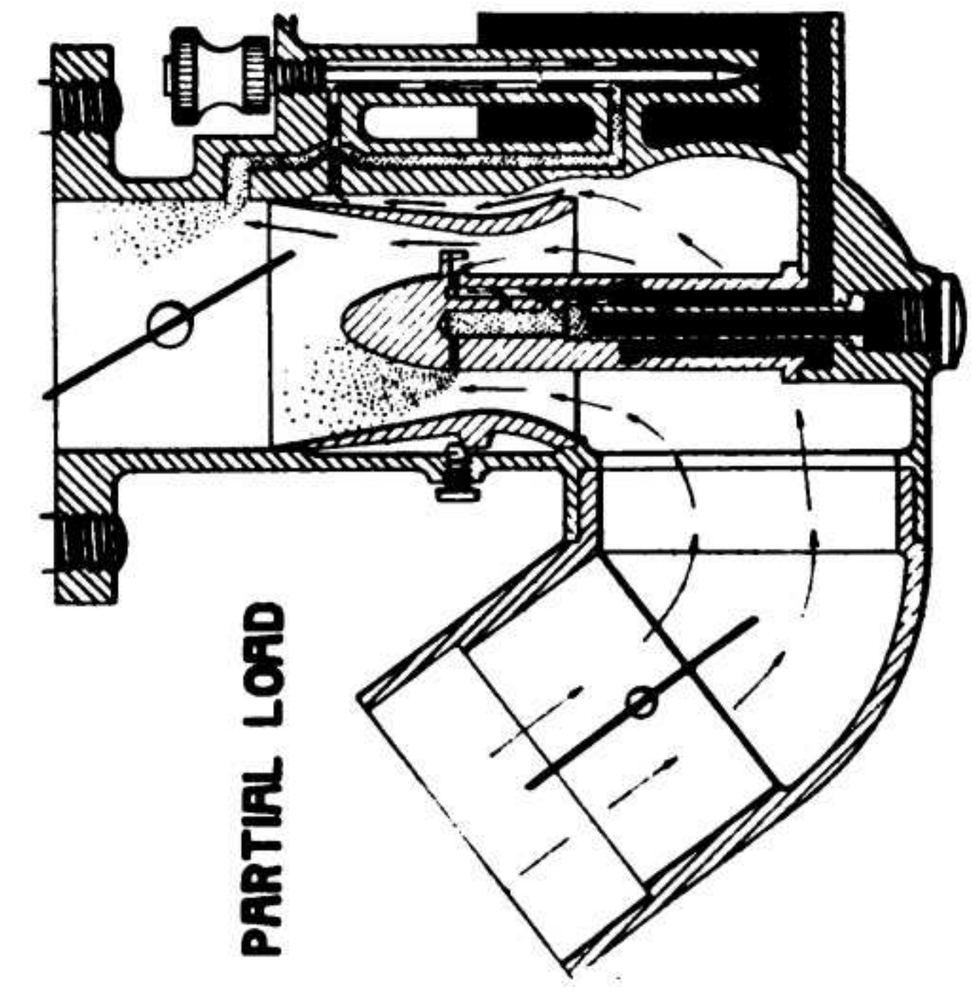
PLATE 42





CARBURETER OPERATING DIAGRAMS





For starting or warming up with the present day fuel, it is almost always necessary to use the air choke until proper operating temperature is obtained. The Engine will start readily with the choke closed one-half to three-quarters of the way. Under some conditions, as when the weather is very cold, it may be necessary to close the choke entirely, but this should be done only for an instant, as it cuts off all the air and delivers practically raw gasoline.

INTAKE MANIFOLD LEAKS

It is imperative that the Intake Manifold be air tight and care should be taken that there is no possibility of leakage around the gaskets where it is bolted to the Cylinders, or between the Carbureter and the manifold. Oil put on parts where leakage is suspicioned will be sucked in if there is a leak, and repairs should be made at once.

TO PREVENT WATER IN CARBURETER

The Drain Cock in the bottom of the Carbureter should be opened occasionally and the Carbureter drained so that any water or sediment will be cleaned out.

PREVENTION OF GASOLINE WASTE

If it becomes necessary to leave the Tractor standing on a steep grade for any length of time, shut off the gasoline at the Three-Way Valve on the Instrument Board, as the Carbureter Float may bind, due to the angle of the Tractor, and hold the Needle Valve open instead of allowing it to close as under ordinary circumstances. Under some conditions, this would allow gasoline to leak from the Carbureter unless turned off at the tank.

AUXILIARY OR RESERVE FUEL SYSTEM

The Reserve Gasoline Tank is made from terne plate, is 12 x 15.5 (15½) inches and 12 inches high. It is filled through a 4-inch opening located on top of and reached through a door in the armor plate. Like the Main Fuel Tanks, it is provided with an adequate gasoline strainer to prevent the introduction of dirt. Gasoline is fed from this tank directly to the Carbureter by gravity.

THREE-WAY VALVE

A Three-way Valve, already mentioned in connection with the Instrument Assembly, is located upon the Instrument Bracket at the rear end of the Engine. It controls the supply of fuel from the Main and Reserve Fuel Tanks. When turned in one direction, it feeds fuel from the Vacuum Gasoline Tank to the Carbureter. When in the opposite position, it feeds fuel from the Reserve Tank to the Carbureter. There is an intermediate position at which it shuts off fuel from both tanks.

FUEL PIPING

All of the Fuel Piping used on the Tractor is 0.375 (3/8) inch seamless copper tubing with 0.035 inch number 19 B. & S. gauge walls. In addition, all of the piping is covered by .075 (3/4) inch outside diameter and 0.375 (3/8) inch inside diameter rubber gas pipe hose. Adjacent to each union on the pipe lines the hose is cut off and a Hose Clamp applied. This makes it impossible for the Tractor to be held up, due to the breakage of a gas piping between the unions. This is put upon the pipes for emergencies and, in case a pipe breaks, the rubber tube should not be depended upon any longer than is necessary because the fuel will tend to rot out the hose at the point of breakage.

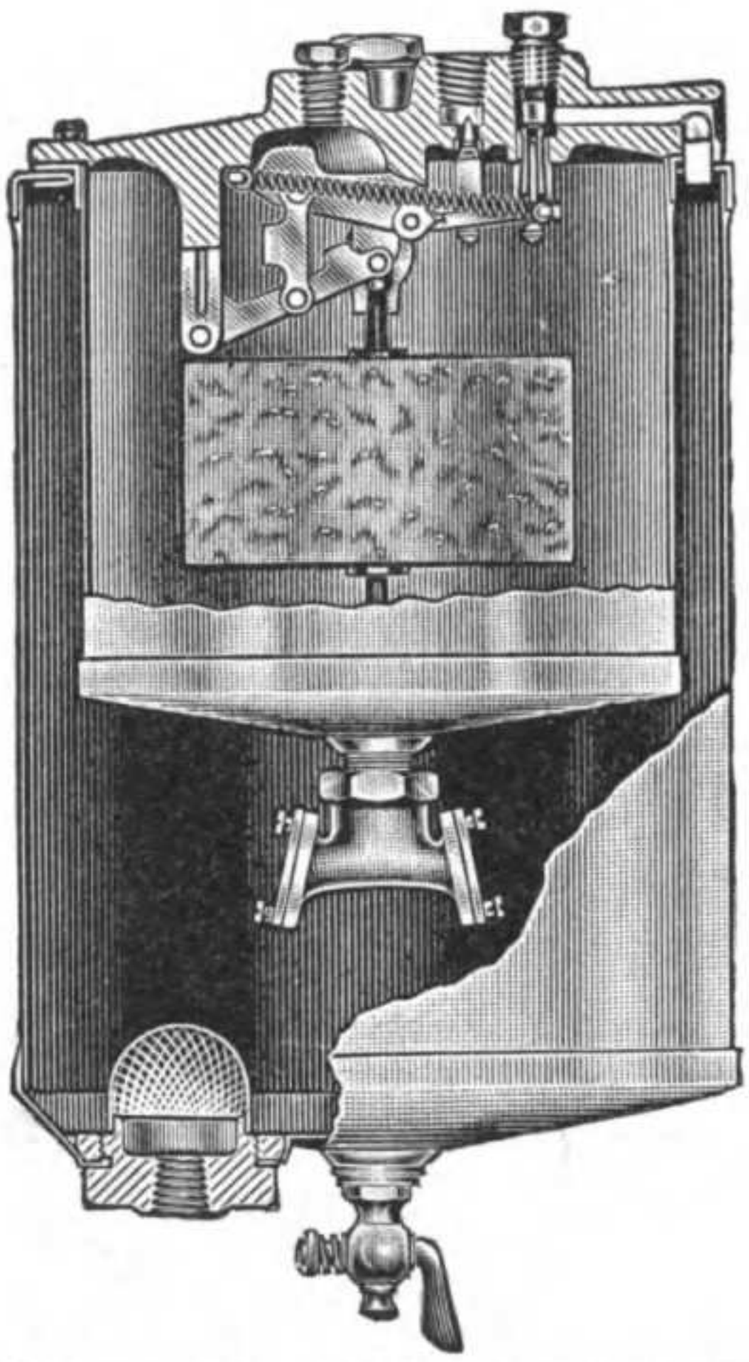


PLATE 43—VACUUM TANK

SOME DETAILS OF VACUUM TANK

The Stewart Model 146-A Vacuum Tank is built heavier and of greater capacity than the former models. It is designed especially for tractor work. The model used on the 5-Ton Artillery Tractor has 3.75 (3¾) pints capacity. It has a Venturi type air vent which insures rapid emptying of the inner chamber. The latter has a double flapper valve which also allows the inner chamber to empty twice as fast as when only one was used. The float is made of cork and carefully coated to prevent it absorbing gasoline. A strainer is provided in the bottom to stop and catch any sediment that may accumulate in the lower chamber. A pet cock in the bottom of the vacuum tank permits this sediment to

be withdrawn when necessary and also drains any water which may have been separated out in the lower chamber of the tank. It should be cleaned out every week at the same time that the carbureter is drained and its strainer cleaned.

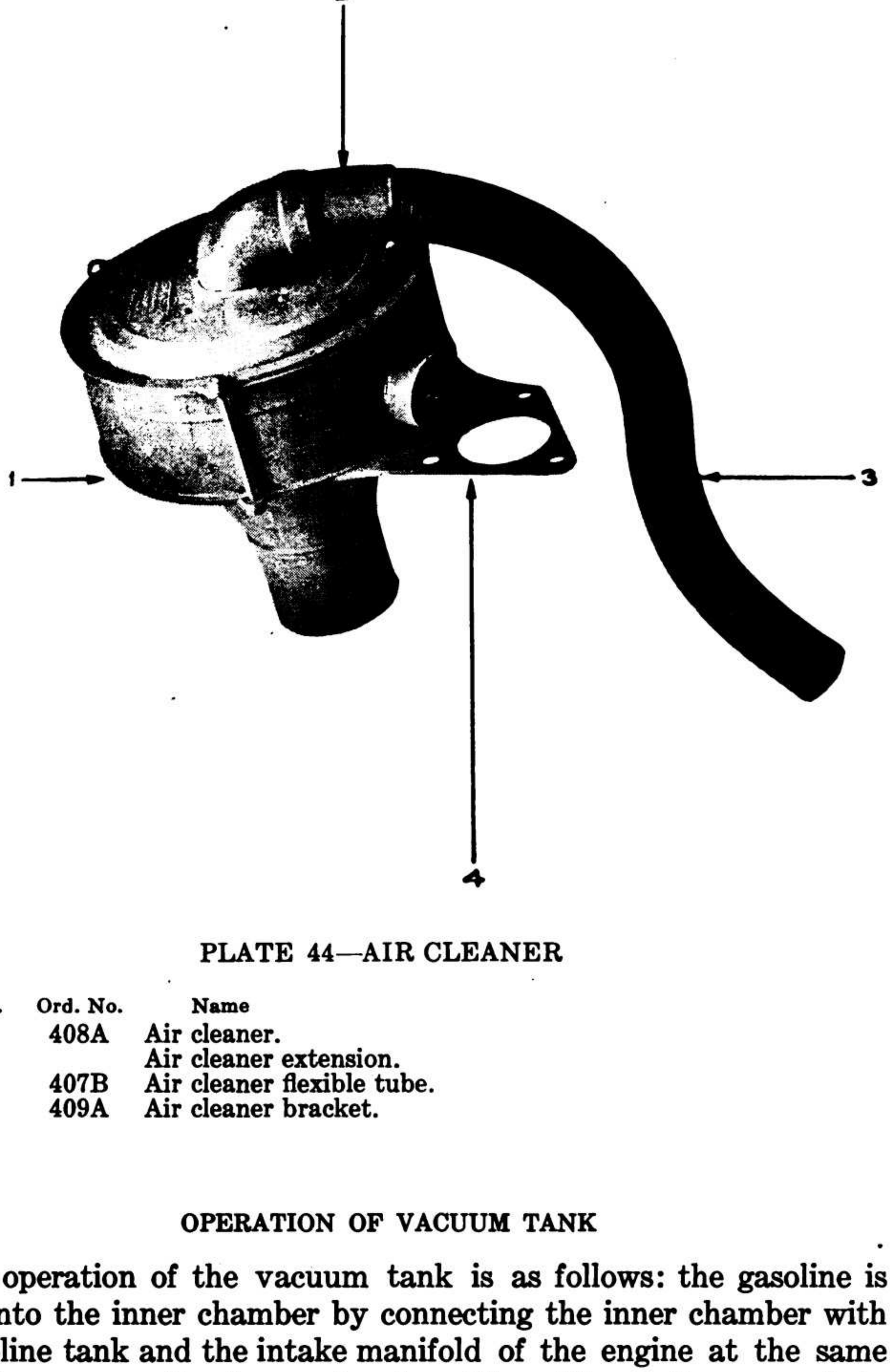


PLATE 44—AIR CLEANER

Ref. No.	Ord. No.	Name
1	408A	Air cleaner.
2		Air cleaner extension.
3	407B	Air cleaner flexible tube.
4	409A	Air cleaner bracket.

OPERATION OF VACUUM TANK

The operation of the vacuum tank is as follows: the gasoline is drawn into the inner chamber by connecting the inner chamber with the gasoline tank and the intake manifold of the engine at the same time. As soon as the inner chamber fills with gasoline enough to

raise the float, which is carried inside of it, it trips a valve connecting the inner chamber with the intake manifold and at the same time opens one which connects with the atmosphere. This allows the gasoline in the inner chamber to empty into the lower chamber and from there flow to the carbureter by gravity. A valve located between the lower chamber and the inner chamber prevents gasoline from being sucked up when it is being drawn into the inner chamber from the Main Fuel Tank.

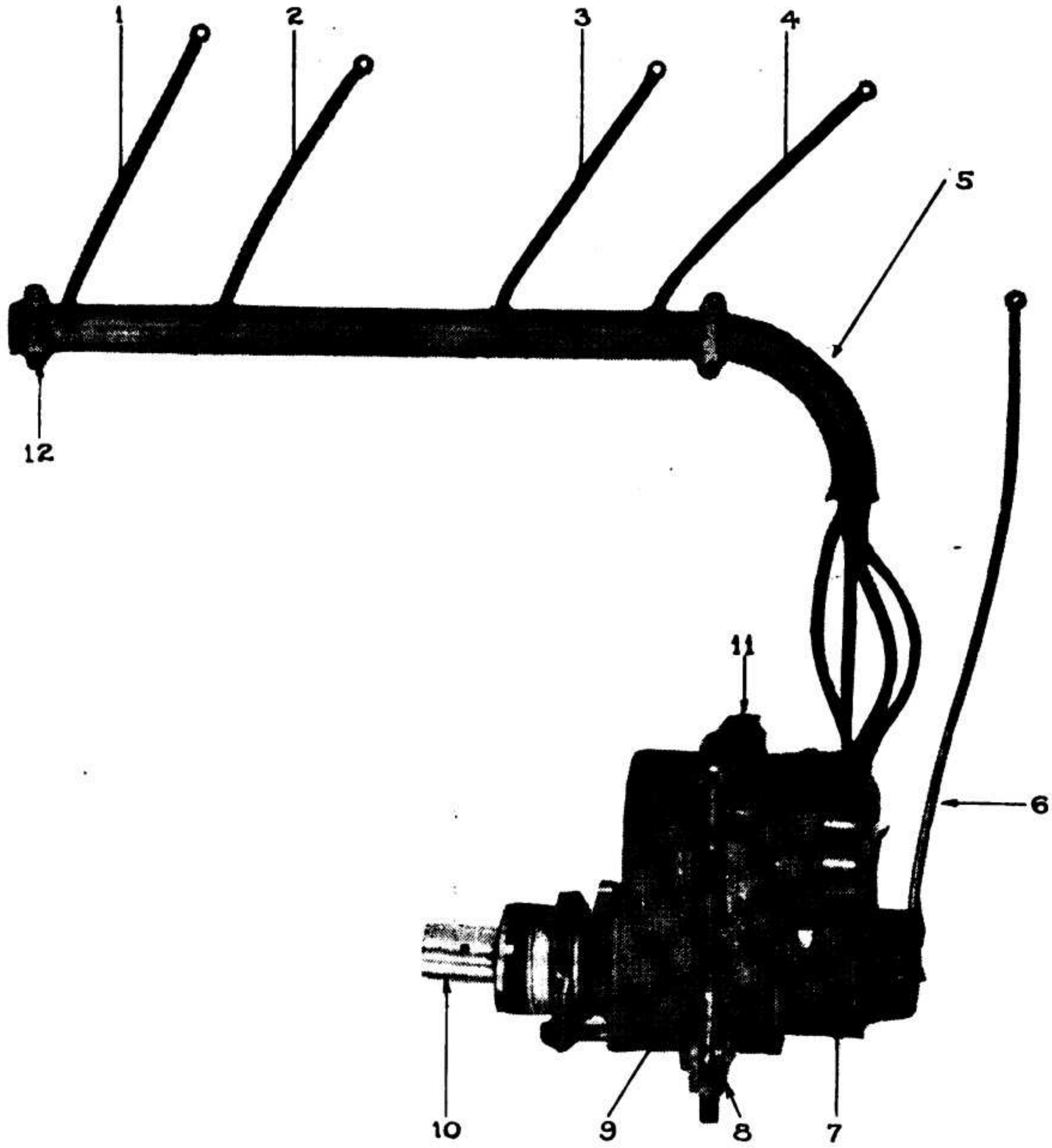


PLATE 45—MAGNETO AND CONNECTIONS

Ref. No.	Ord. No.	Name
1	354B	Ignition cable tube.
2	354C	Ignition cable tube.
3	354D	Ignition cable tube.
4	354E	Ignition cable tube.
5	354A	Ignition cable tube.
6	353A	Magneto ground wire.
7	423A	Magneto.
8	424C	Magneto strap yoke stud.
9	424E	Magneto strap tie bolt.
10	424A	Magneto coupling.
11	424B	Magneto strap clamp.
12	353B	Cable tube bracket, upper.
	353C	Cable tube bracket, lower.

IGNITION SYSTEM

The Ignition System used on the Five-ton Artillery Tractor is extremely simple, consisting of the G 4 II type Eisemann Magneto, the Ignition Switch, located on the Instrument Bracket, the High Tension Wires from the Magneto to the Spark Plugs, a tube in which these cables are carried, and the Spark Plugs.

MAGNETO

BRIEF DESCRIPTION OF OPERATION

A magneto is an alternating current generator which supplies current to cause a spark at the spark plug terminals, which spark fires the explosive mixture at the proper time.

The Magneto is mounted upon the left hand side of the Engine upon a bracket cast integral with the Crankcase. It is driven by the rear end of the Water Pump Shaft. A coupling of the Oldham type is enclosed between the end of the Water Pump Shaft and the Magneto so as to take care of any disalignment between the two assemblies.

The magneto used in this truck is an Eisemann straight high-tension magneto, that is, one which does not employ an outside coil for stepping up the voltage. Both primary and secondary windings are on the armature shaft and both windings have a grounded end. The armature shaft revolving in the magnetic field existing between the permanent magnets, causes a low voltage current to be produced in the primary winding. This winding is connected with the breaker or interrupter, so that the current flow of the primary may be broken or interrupted in order to induce a secondary current of high-voltage in the secondary winding. At the instant of interruption of the primary the secondary is induced and this is the current which flows to the distributor and thence through cables to the spark plugs.

When you throw the switch to "on" position no current passes through the switch. The primary current path after generation is through the primary winding, through the interrupter, and to ground, thus returning to its source of generation, which every current does if there is a path for it.

The secondary winding also is grounded at one end. The induced high-voltage current flows through the secondary winding to the distributor to the spark plugs in order, thence to ground, and the secondary winding being grounded the circuit is completed through the metal parts of the engine.

MAGNETO TIMING

As the spark occurs when the primary circuit is broken by the opening of the platinum contacts on the breaker mechanism, it is necessary that the magneto will be so timed that at full retard position of the timing

lever body the platinum contacts will open when the respective piston of the motor has reached its highest point on the compression stroke. Turn motor by hand until piston of No. 1 cylinder is on dead center (firing point), remove the distributor plate from the magneto and turn the armature shaft until the setting mark on the distributor disc is in line with the setting screw. With the armature in this position, the platinum contacts are just opening and the metal insert of the distributor disc is in connection with carbon for No. 1 cylinder. The driving medium must now be fixed to the armature shaft without disturbing the position of the latter, and the cables connected to the spark plugs.

MAGNETO MAINTENANCE

Aside from lubrication, as mentioned on page 000, there is little attention required. Eisemann Type G-4- II Edition should receive 20 drops of 3-in-1 or similar oil every two weeks, distributed as follows: One drop in the oil hole, one most convenient (on side of breaker box), 5 drops in the covered holes on each side of the distributor and 14 drops in the large covered hole at the driving end of the magneto.

MAGNETO MOUNTING

The Magneto is held in place upon the Magneto Bracket by means of a Magneto Strap Clamp, a light steel forging that goes over the top of the Magneto and is held down by two 0.375 (3/8) inch Magneto Strap Tie Bolts. The base of the Magneto is accurately located on its bracket by two steel 0.375 (3/8) inch Dowel Pins that are screwed onto the base of the Magneto.

TO CLEAN BREAKER POINTS

The platinum contacts of the breaker mechanism should be occasionally cleaned with gasoline, and for obvious reasons, thoroughly dried before starting the engine. The distributor disc and collect or ring should likewise be cleaned once or twice in four months with a cloth moistened with gasoline.

WHEN TO REPLACE IGNITION CABLES

In order to obtain the best results, the cables should be at once replaced if they show signs of cracking or wearing. After a year of normal service, it is advisable to carry in reserve a few carbons for the distributor plate, as well as a contact spring and an adjustable contact screw.

IMPULSE STARTER

This device, mounted on the armature shaft outside of the magneto proper, is simply a means of giving the armature a quick, fast turn. The