

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



En 629.2
R8-4

**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.***

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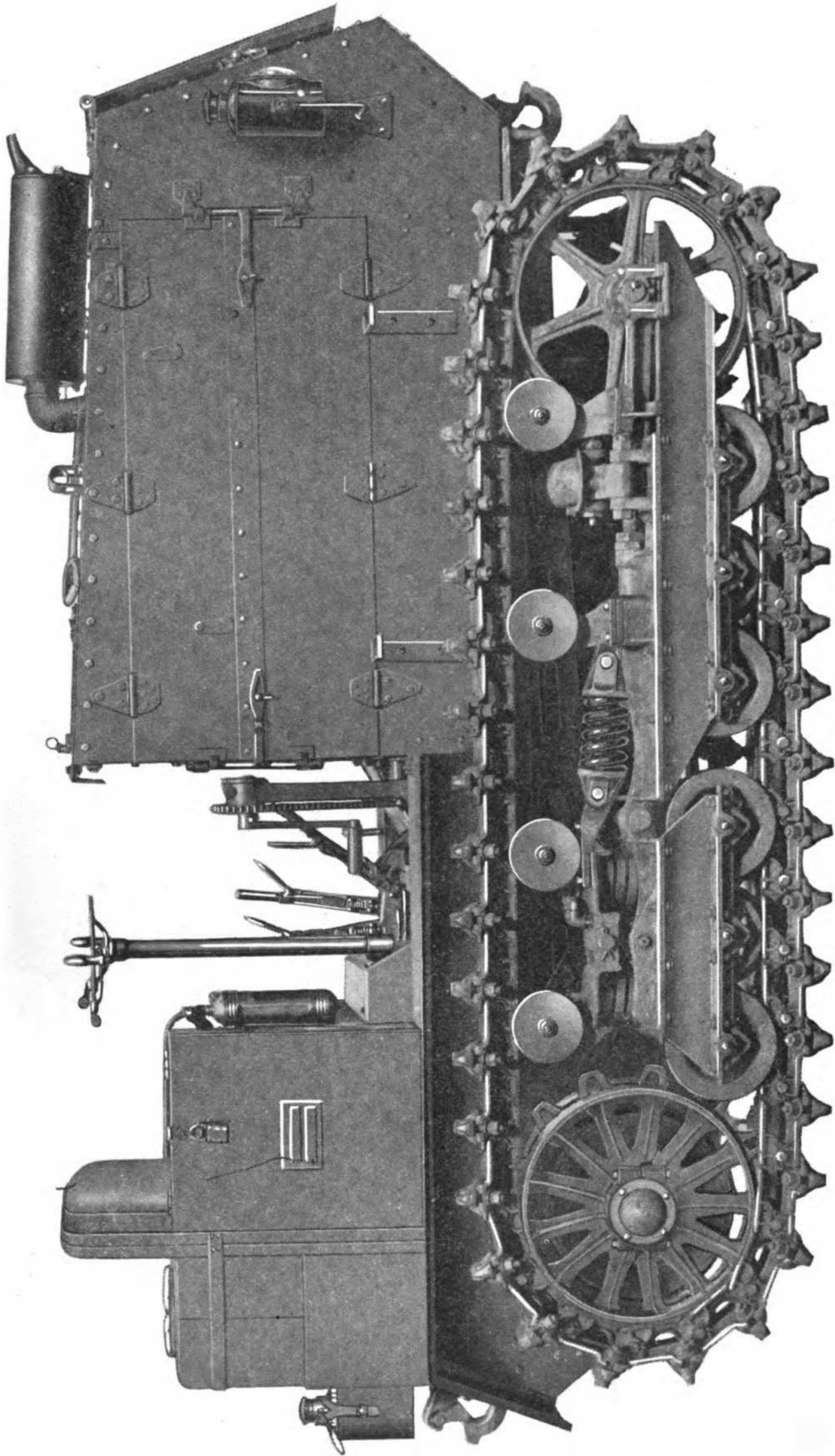
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5-TON ARTILLERY TRACTOR—MODEL 1917

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

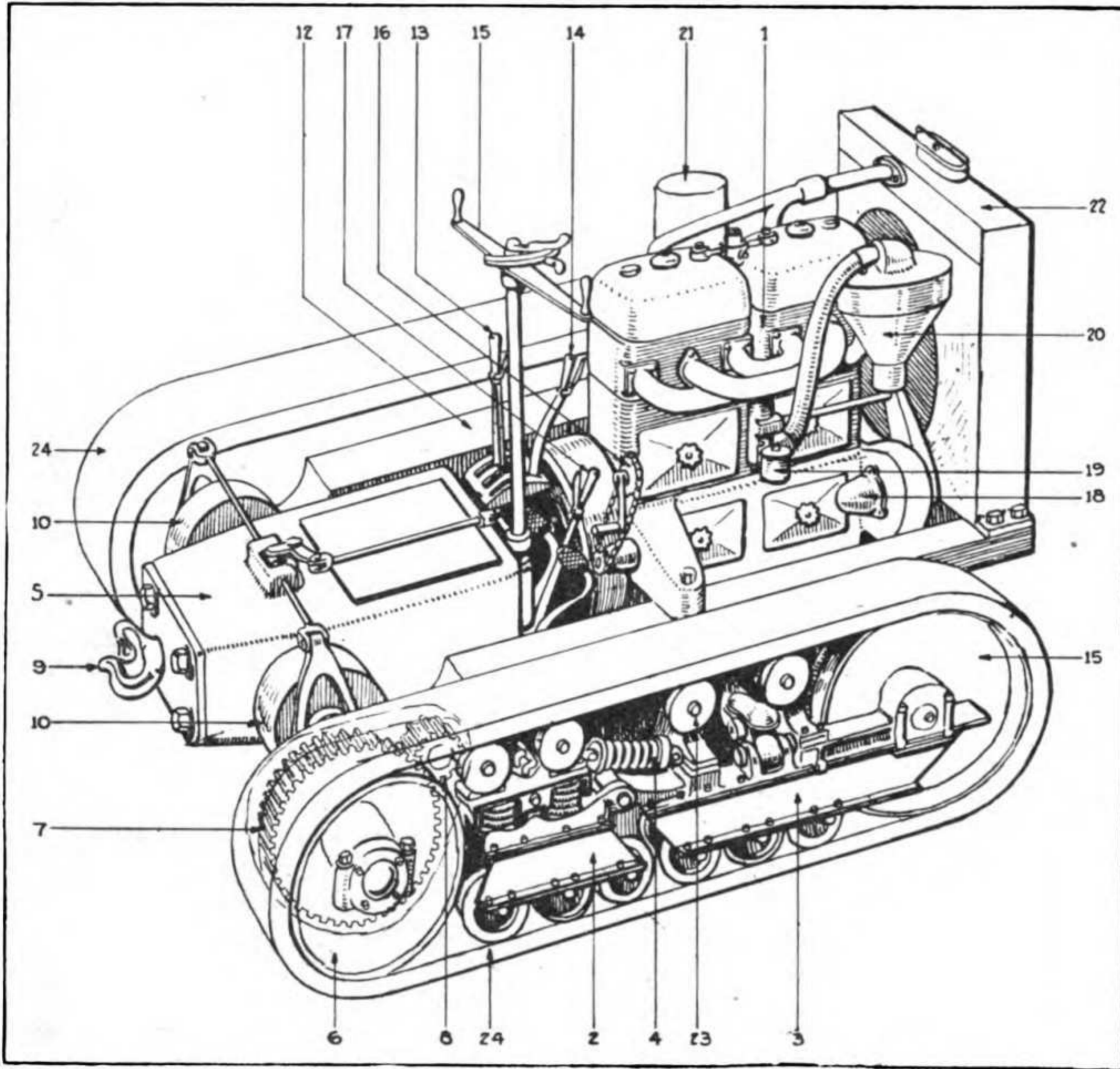


PLATE 2—DIAGRAM OF TRACTOR MAJOR ASSEMBLIES

Ref. No.	Name
1	Engine.
2	Rear roller frame.
3	Front roller frame.
4	Spring radius rod.
5	Transmission u.it.
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 ($4\frac{3}{4}$) 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 ($1\frac{1}{2}$) 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.

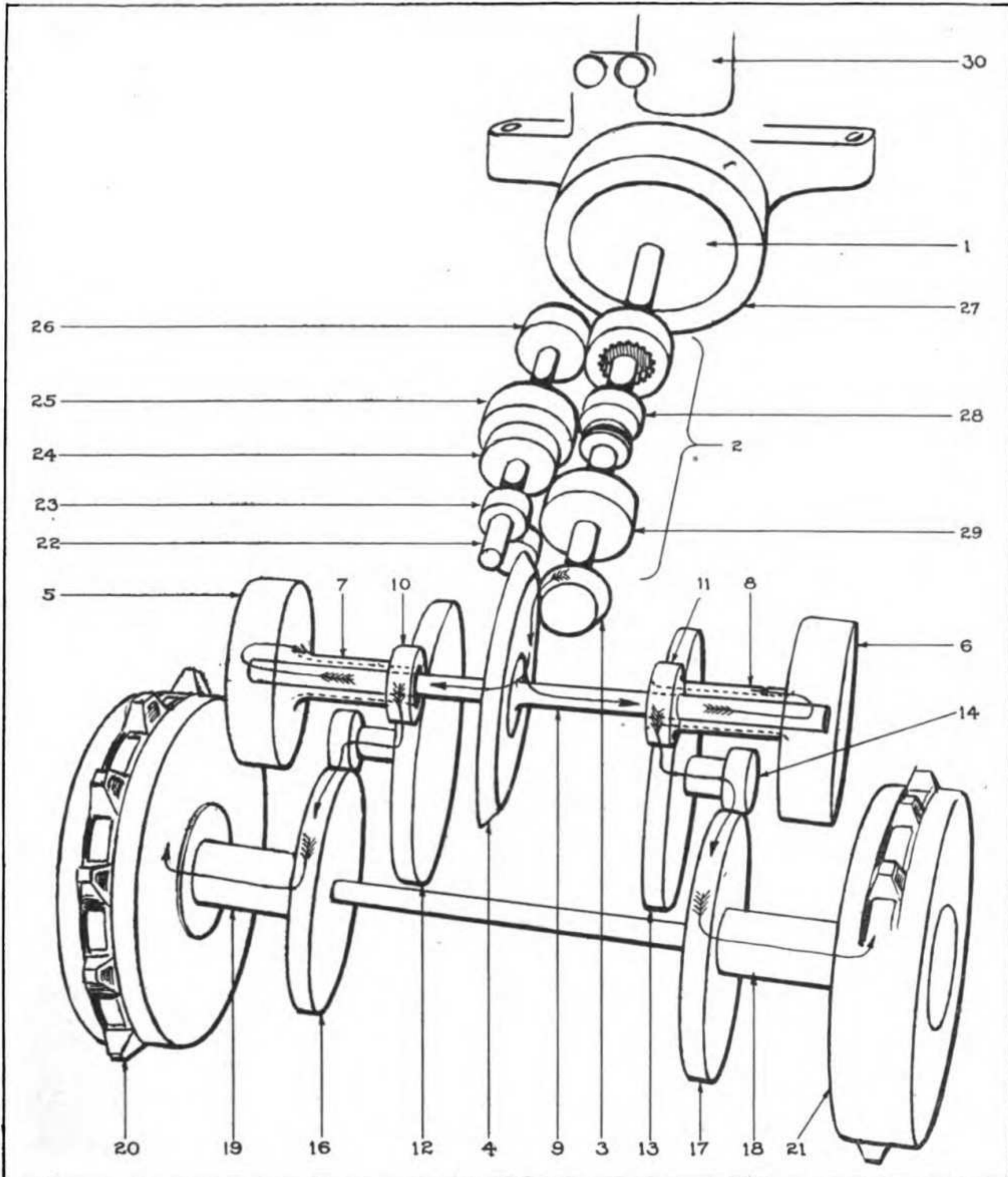


PLATE 3—DIAGRAM OF POWER TRANSMISSION SYSTEM

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

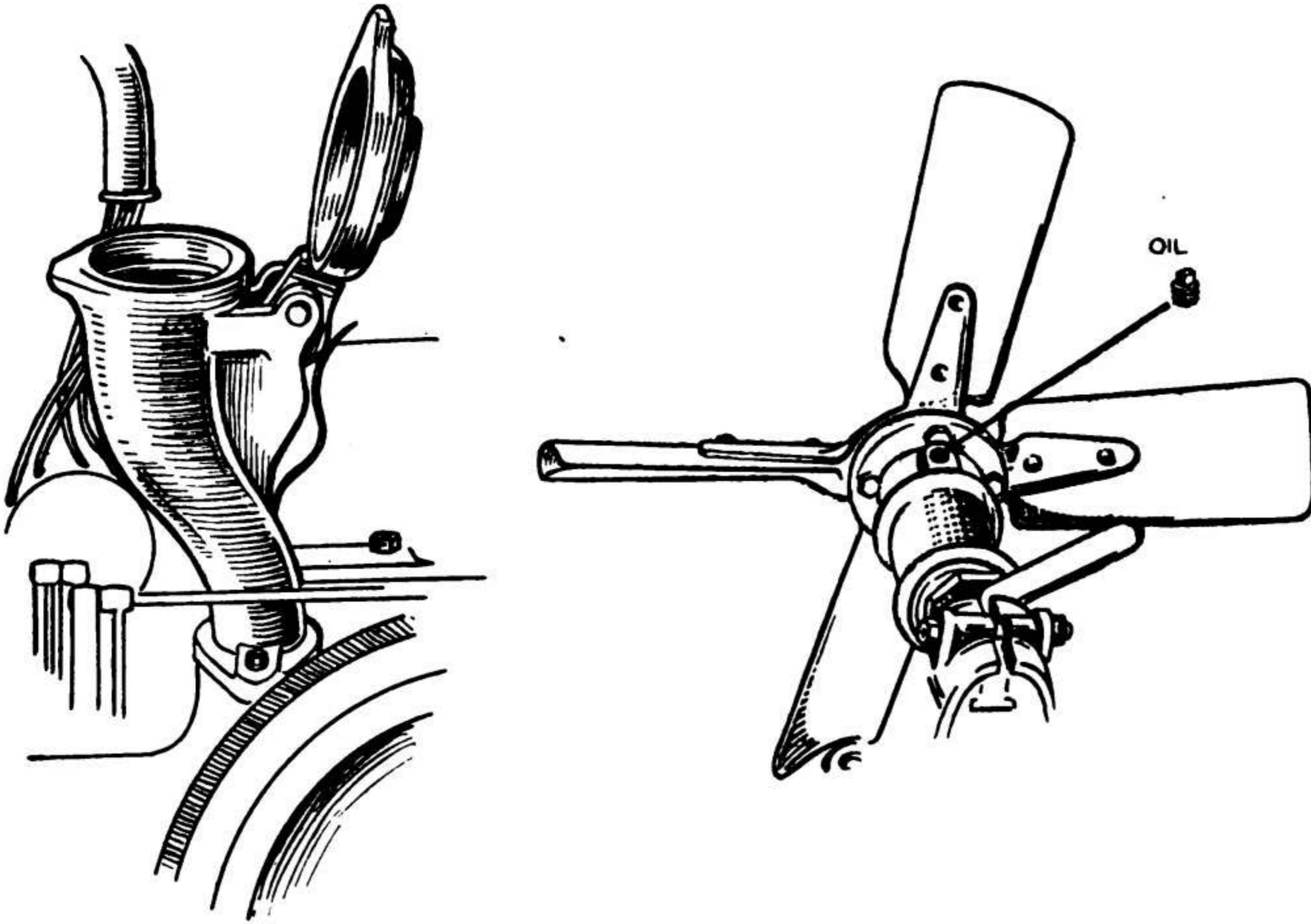


PLATE 4—OIL BREATHER AND FILLER—COOLING FAN

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.

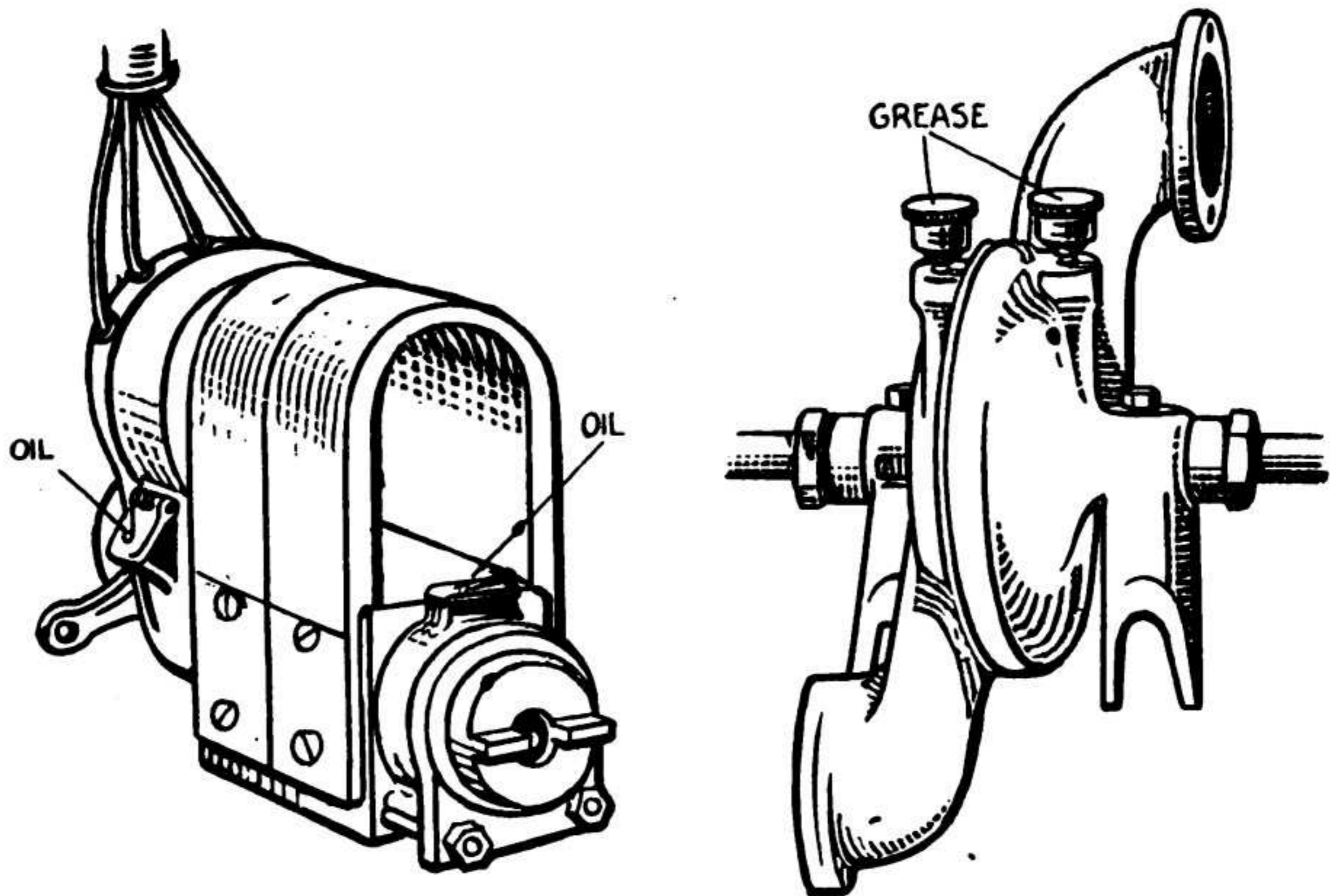


PLATE 5—MAGNETO AND WATER PUMP

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

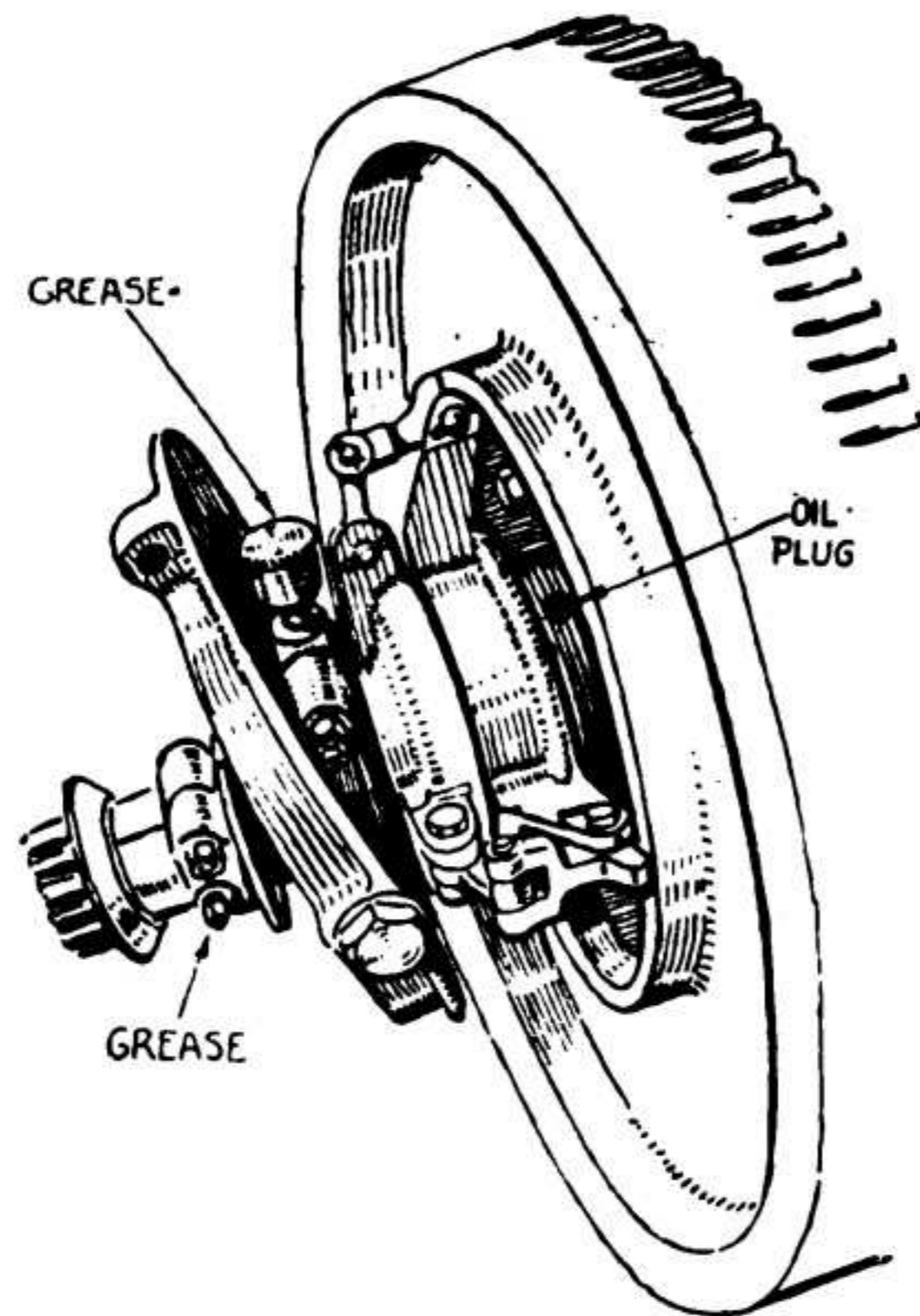


PLATE 6—MASTER CLUTCH AND SHIFTER YOKE

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

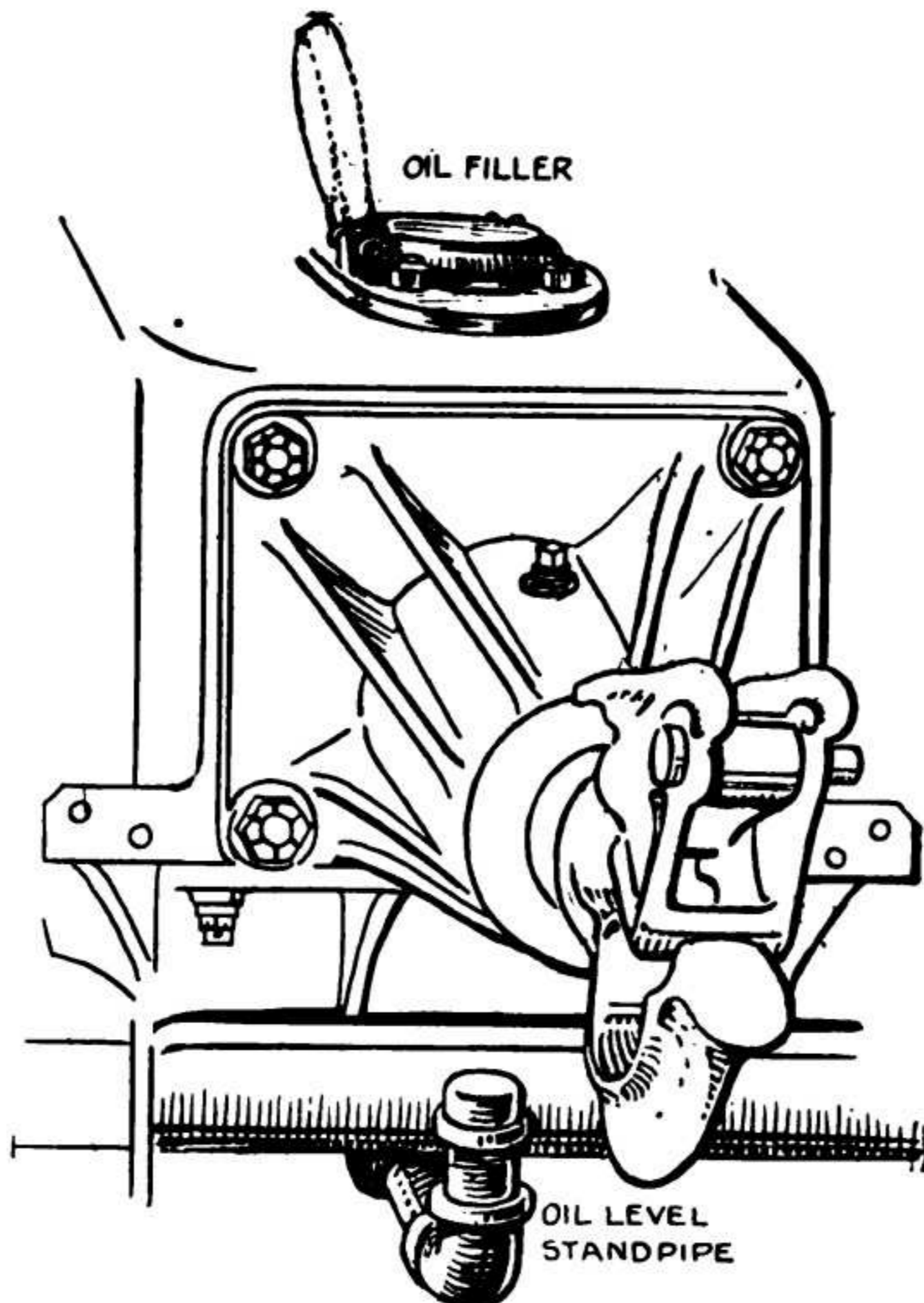


PLATE 7—TRANSMISSION LUBRICATION

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

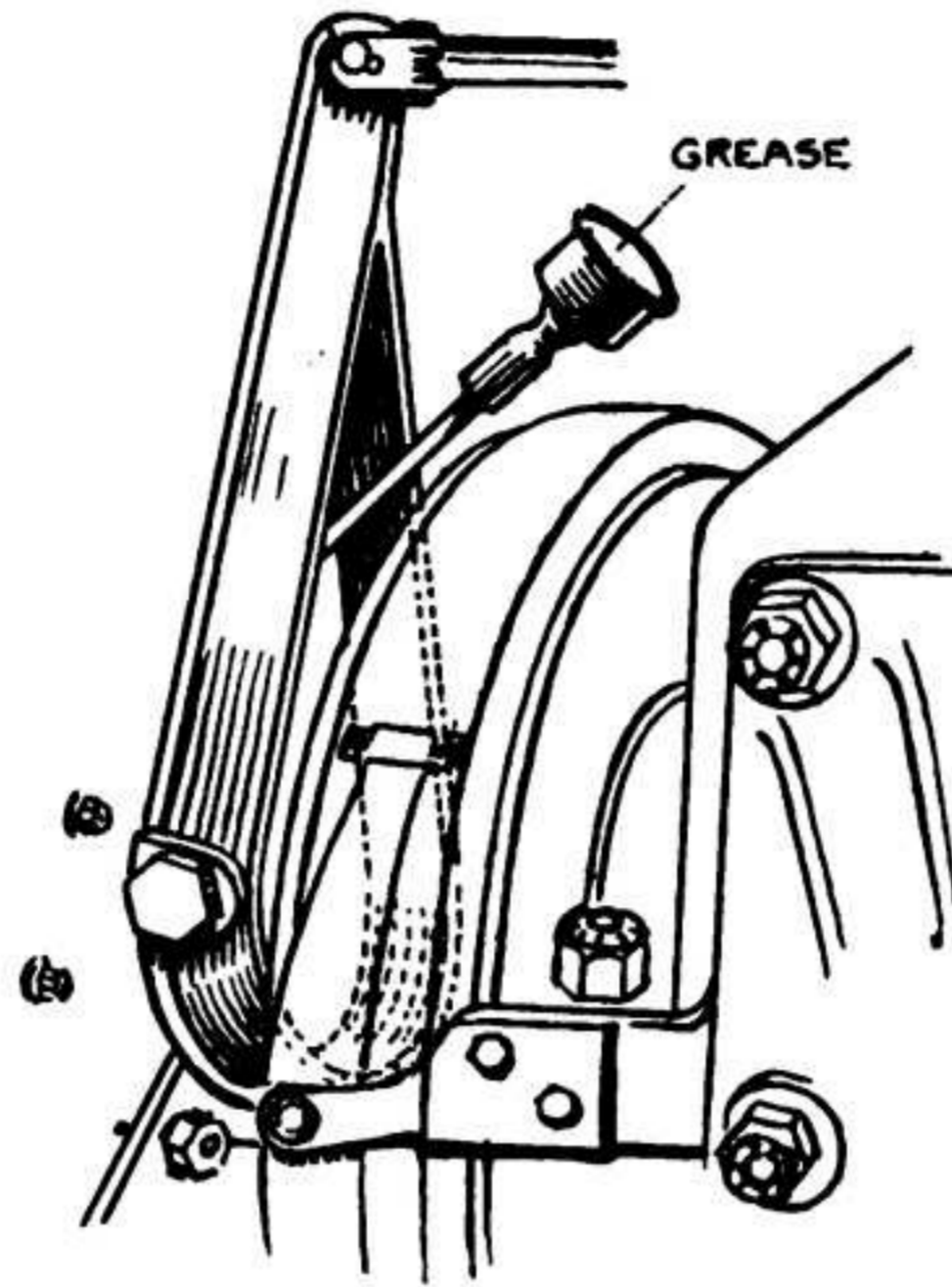


PLATE 8—STEERING CLUTCH YOKE

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 $\frac{1}{4}$ -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 $\frac{3}{8}$ -inch Pipe Plug from hole in the end of shaft and inject with grease gun.

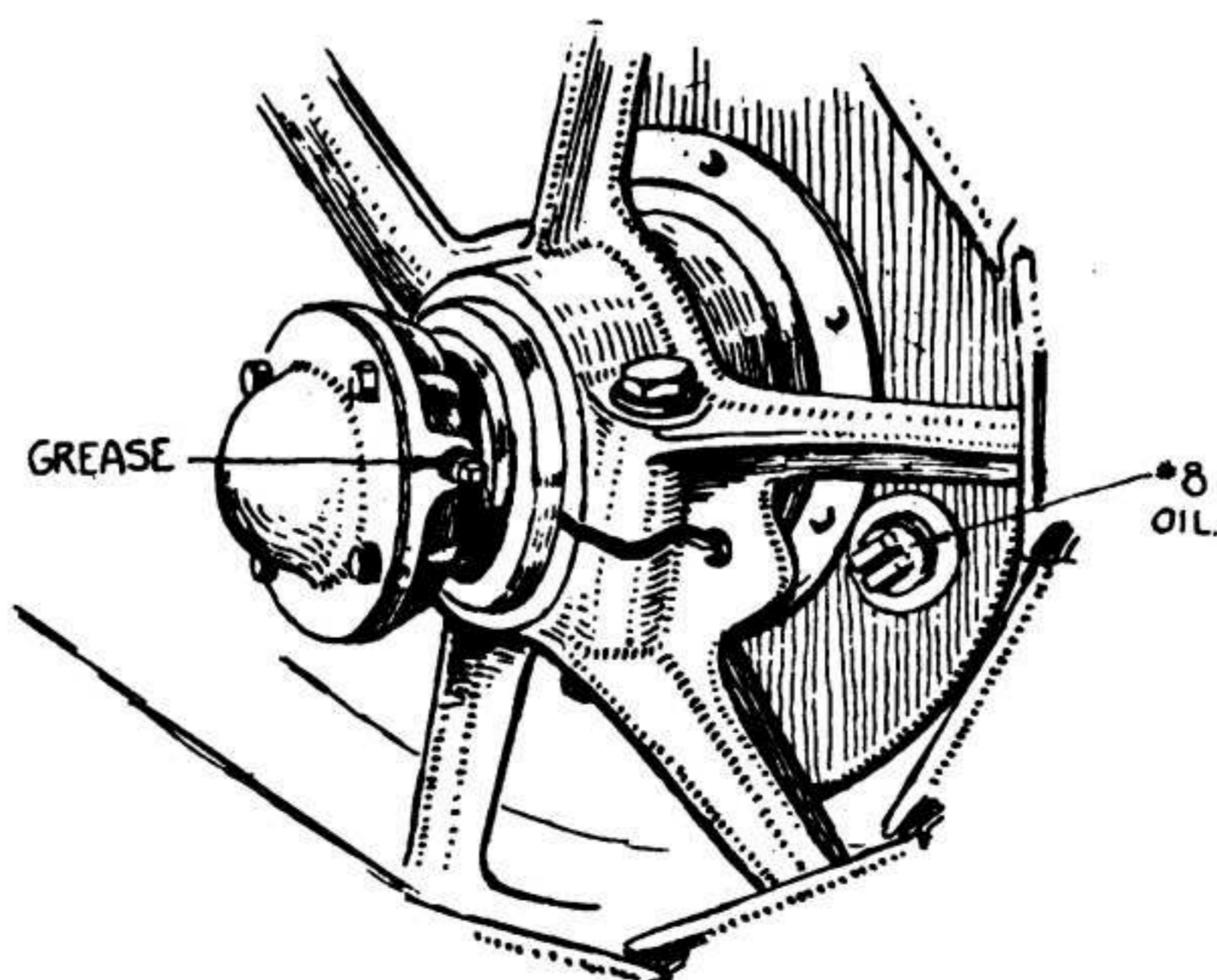


PLATE 9—DRIVE SPROCKET AND GEAR

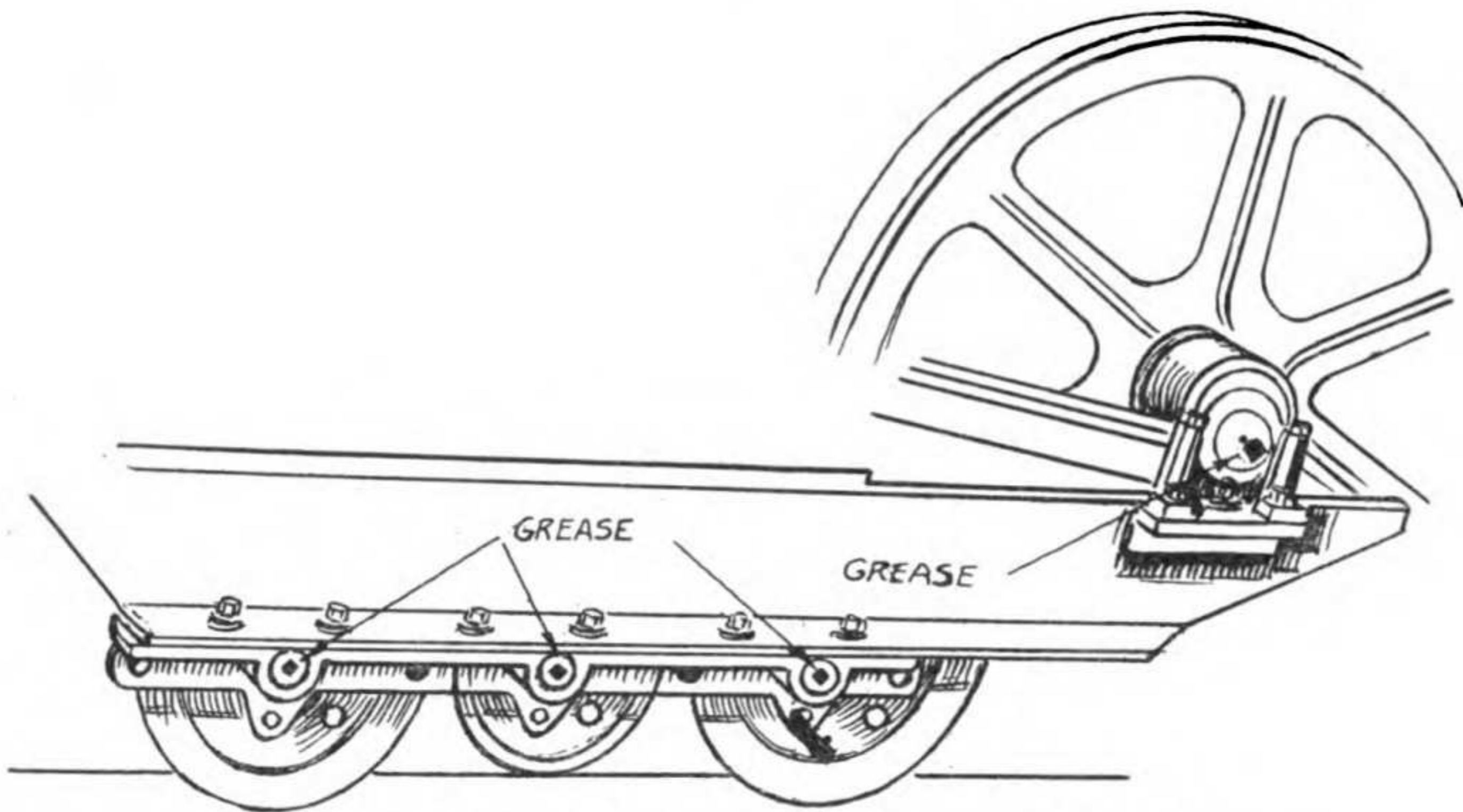


PLATE 10—TRUCK ROLLERS AND SPROCKET

Track Supporting Rollers—Lubricate with cup grease, Ref. No. 6, by removing $\frac{1}{4}$ -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 $\frac{3}{8}$ -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

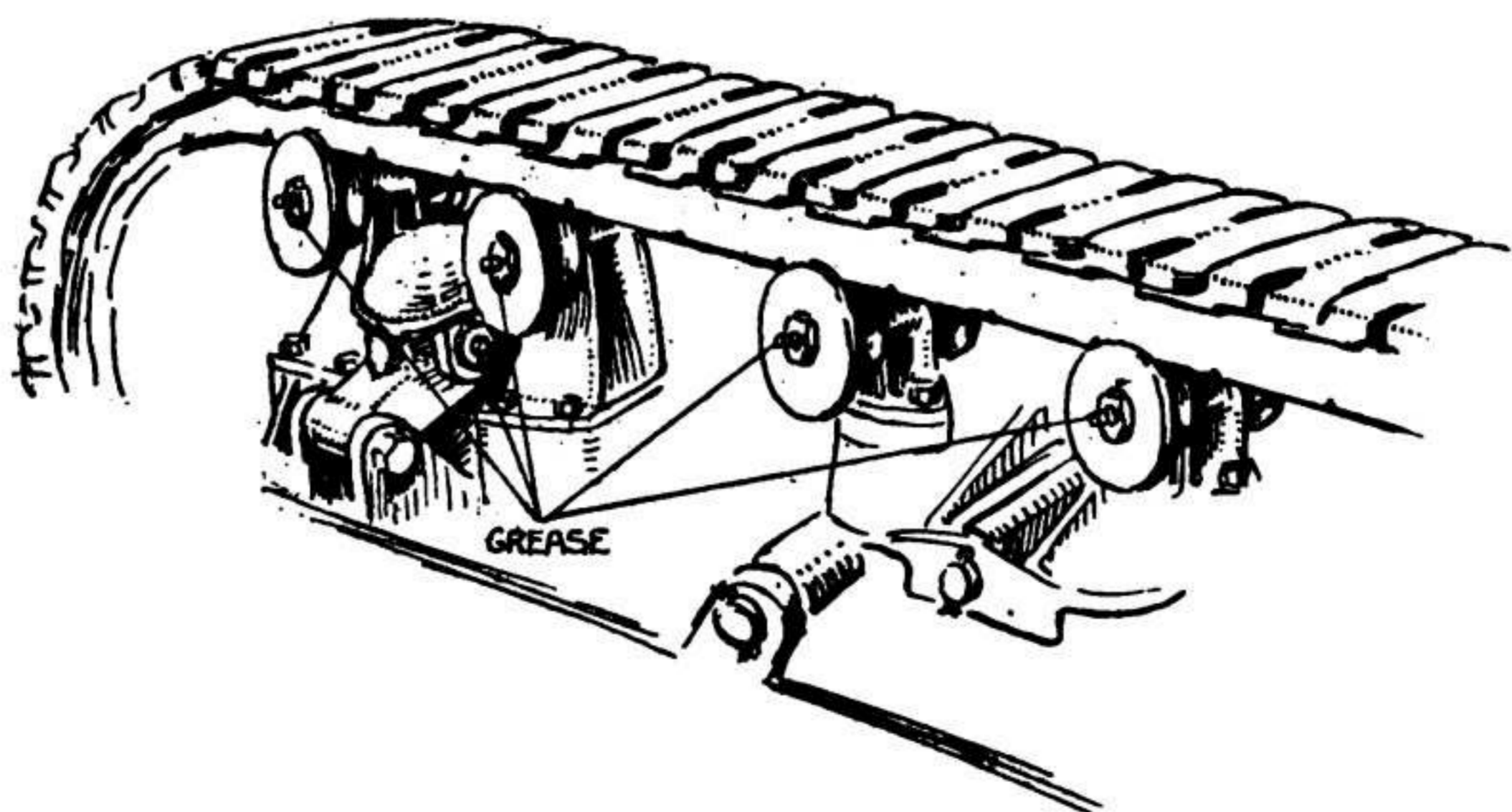


PLATE 11—TRACK SUPPORTING ROLLERS

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.

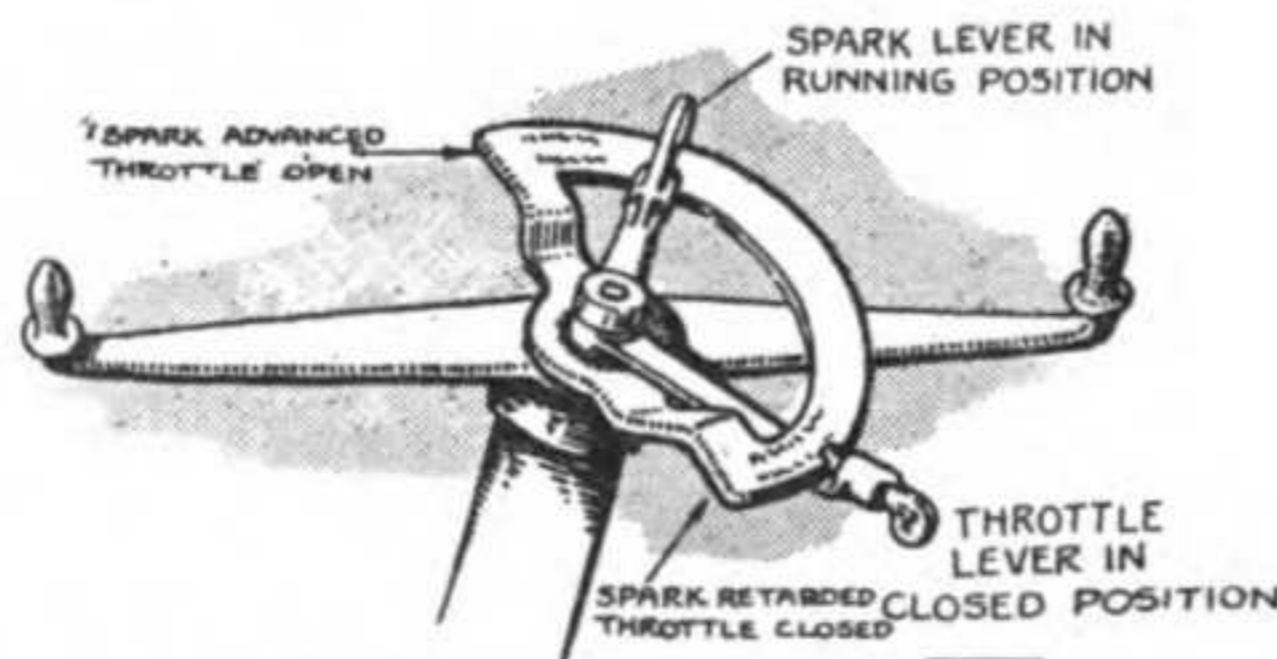


PLATE 12—SPARK AND THROTTLE CONTROLS

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

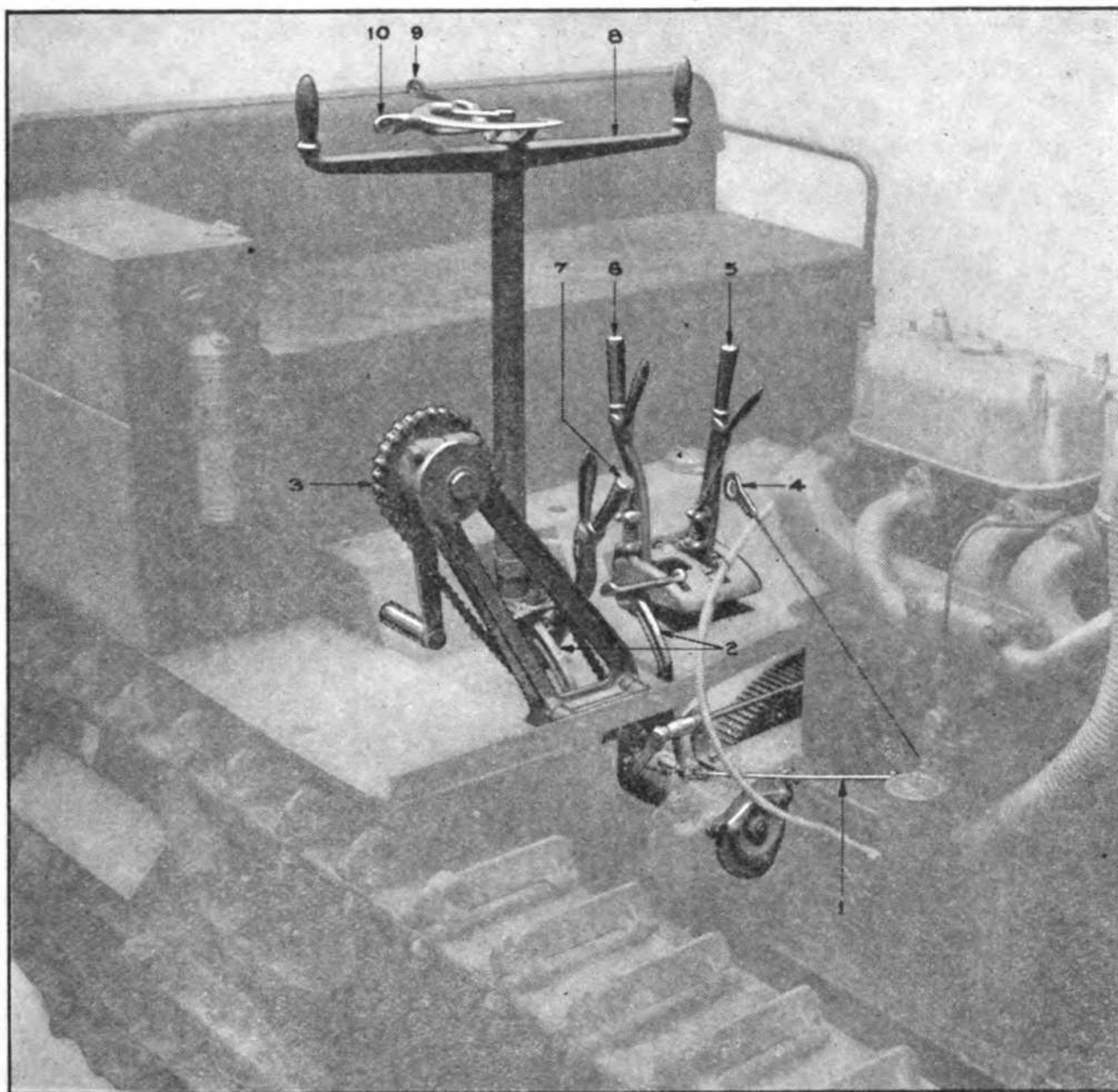


PLATE 13—5-TON ARTILLERY TRACTOR CONTROLS

Ref. No.	Ord. No.	Name
1	403F	Carburetor control rod, front.
2	{ 67B	Brake foot pedals, right.
	{ 67A	Brake foot pedals, left.
3	184F	Hand starter.
4	409E	Carburetor 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 Carburetor.

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.

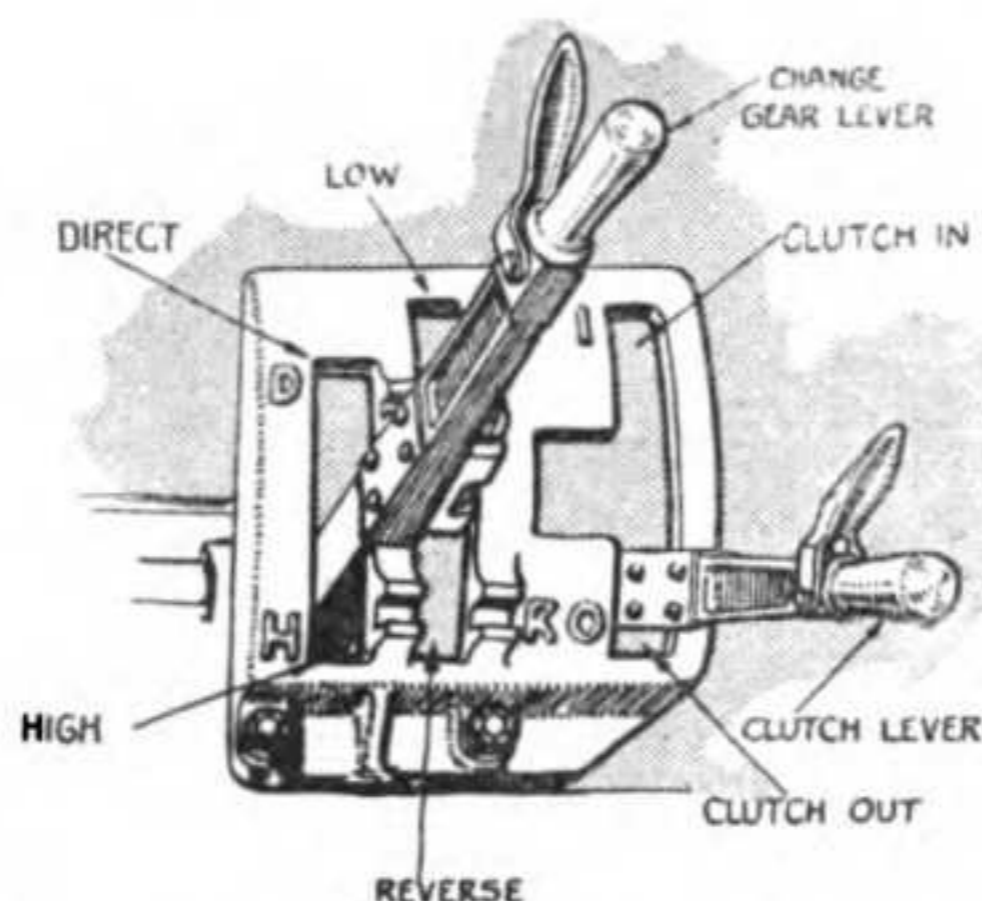


PLATE 14—POSITIONS OF GEAR SHIFT LEVER

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 Clutch 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.

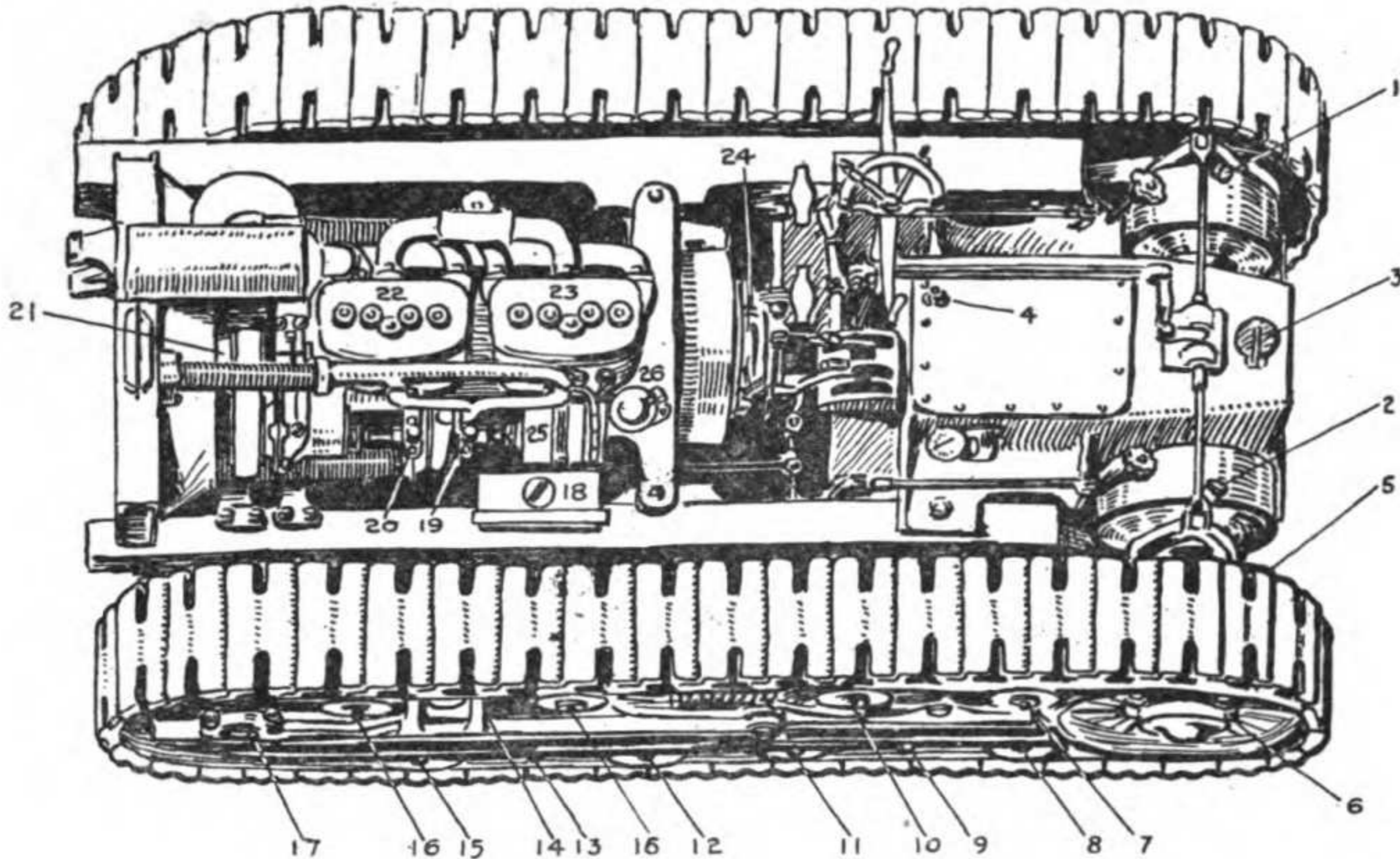


PLATE 15—LUBRICATING CHART

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	Track 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	Cil 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

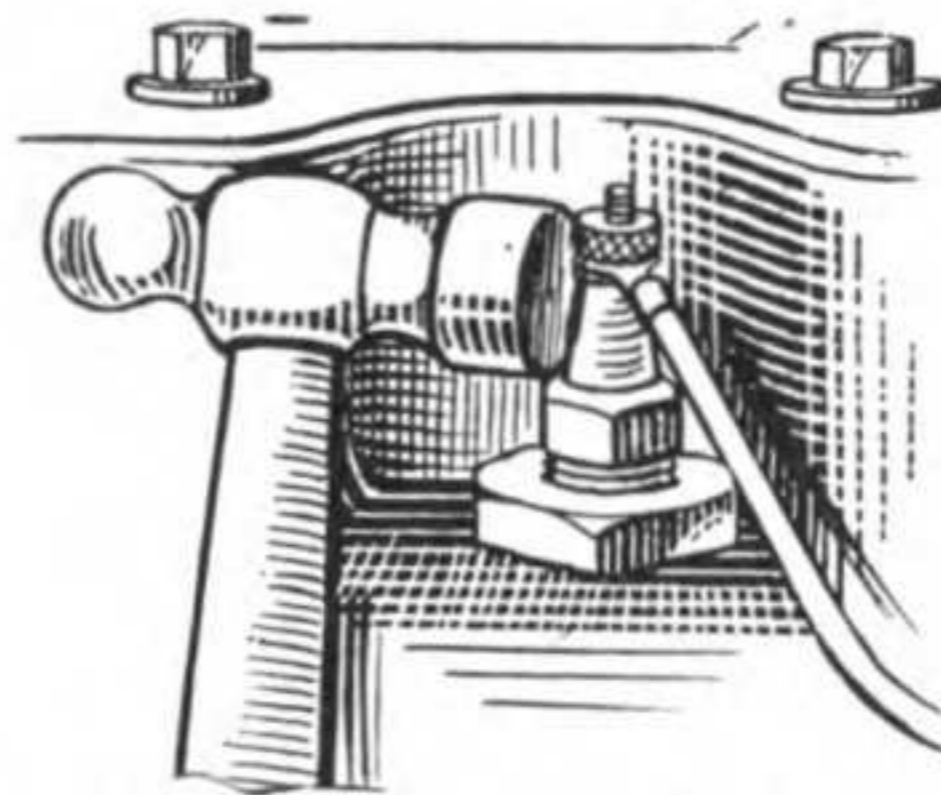


PLATE 16—TESTING SPARK PLUGS

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.

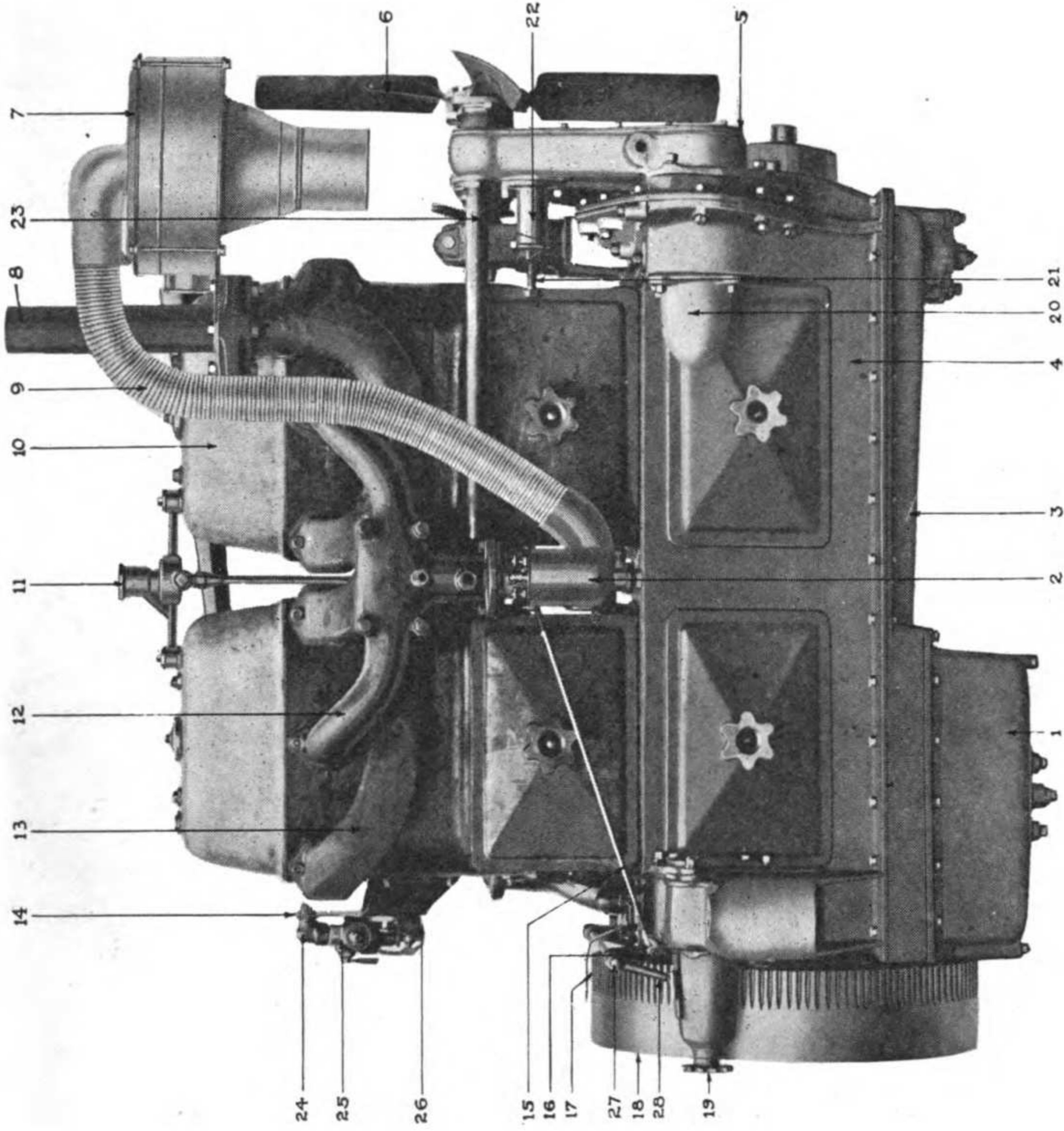
Faulty Carbureter Adjustment.

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.



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 tube.
10	304A	Cylinder head cover.
11	429A	Valve cover oil relief body.
12	394A	Intake manifold.
13	393A	Exhaust manifold.
14	415A	Instrument bracket.
15	403F	Carbureter control rod, front.
16	403A	Carbureter control lever.
17	331B	Flywheel pointer.
18	261A	Flywheel.
19	181A	Eclipse-Bendix starting drive.
20	310A	Generator shaft cover.
21	313C	Governor adjusting screw.
22	313E	Governor adjusting spring cage.
23	311E	Governor rod tube.
24	416D	3-way gasoline valve elbow.
25	416C	3-way gasoline valve and strainer.
26	416B	Magneto switch.
27	401E	Spark control shaft.
28	401D	Spark and carbureter control lever.

CHAPTER II

ENGINE GROUP

ENGINE

CHAPTER CONTENTS

ENGINE

FUEL SUPPLY SYSTEM

IGNITION SYSTEM

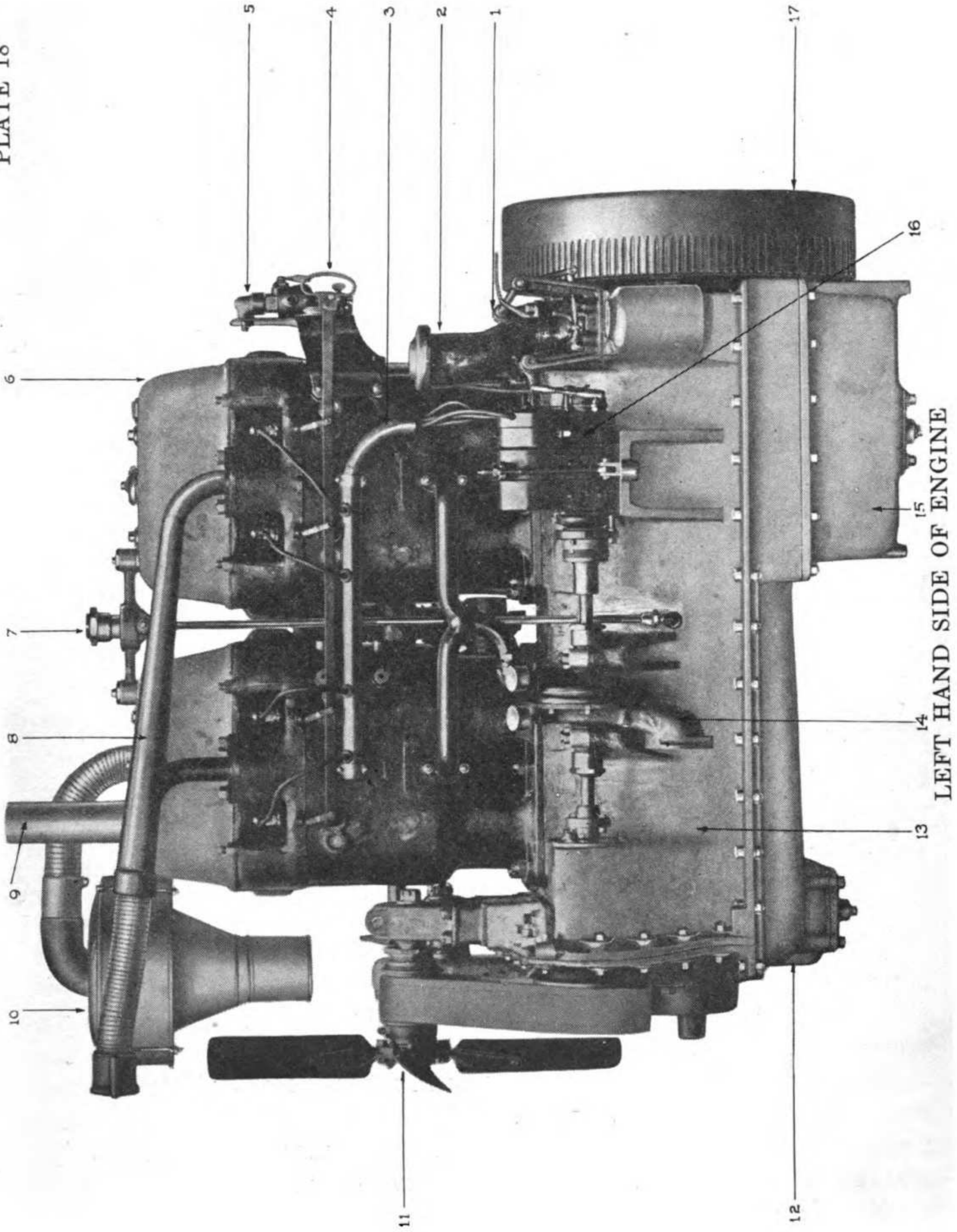
COOLING SYSTEM

STARTING DEVICES

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

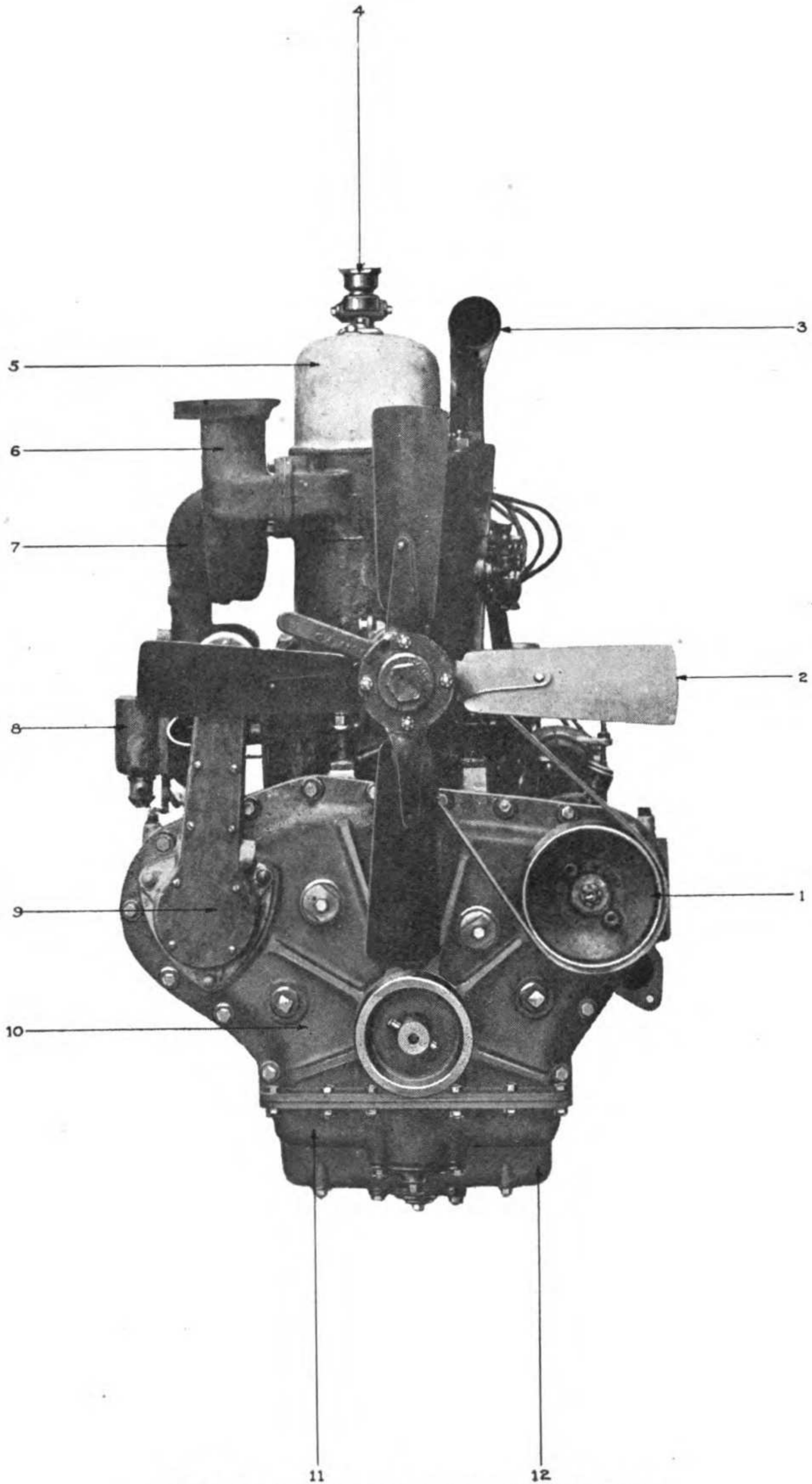


PLATE 19—FRONT VIEW OF ENGINE

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 in the 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

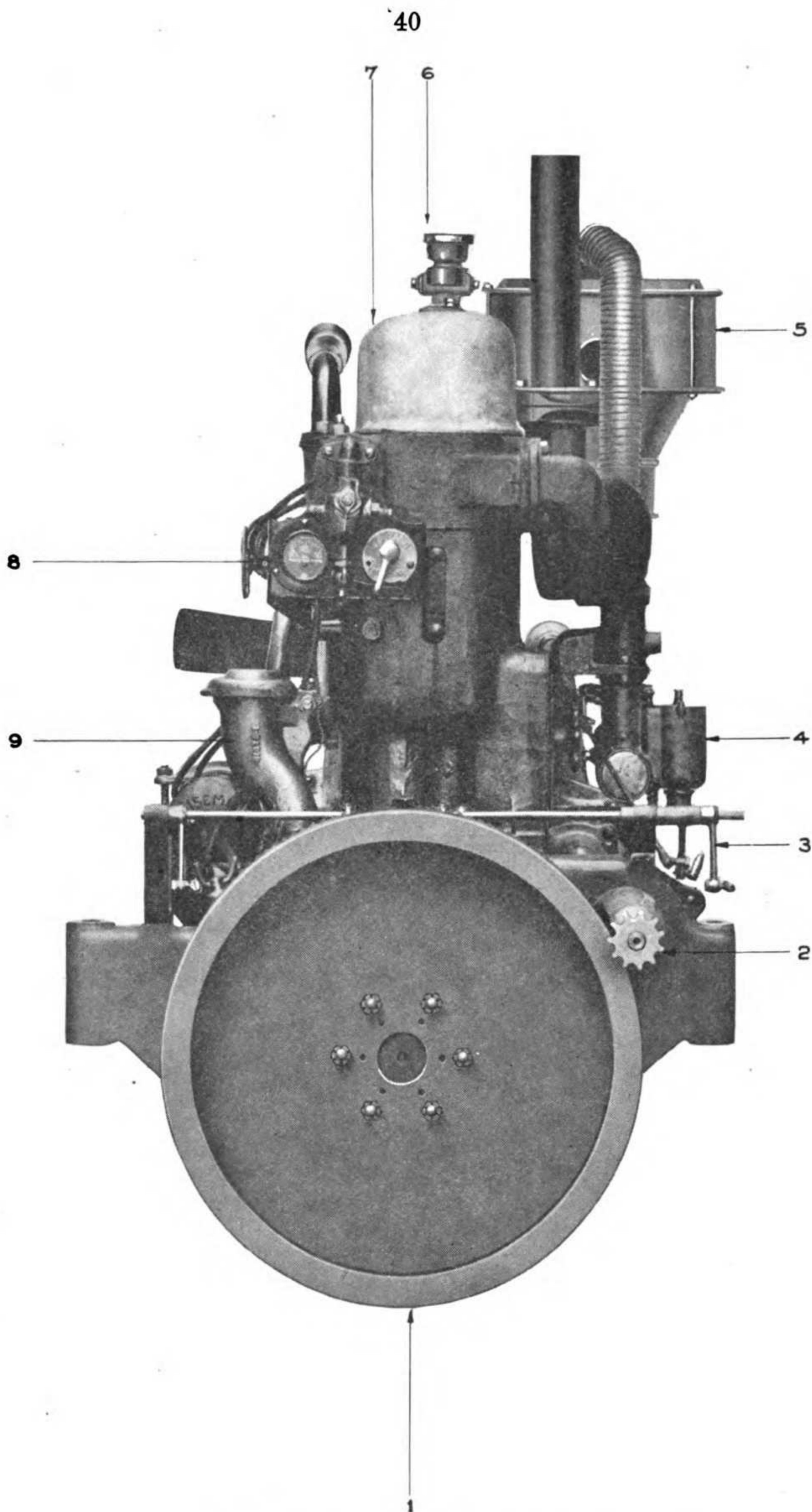


PLATE 20—REAR VIEW OF ENGINE

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 ($\frac{5}{8}$) 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 ($\frac{1}{2}$) inch steel Studs which hold down the Cylinder Head. In the side of the Cylinder are two 0.125 ($\frac{1}{8}$) 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 ($\frac{3}{8}$) 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 ($2\frac{1}{8}$) inches. The Cylinder Head is held in place by eleven 0.5 ($\frac{1}{2}$) inch Stud. The nuts which hold down the Cylinder Head have brass washers beneath them, which prevent injury to the Cylinder Head casting, compensate for expansion

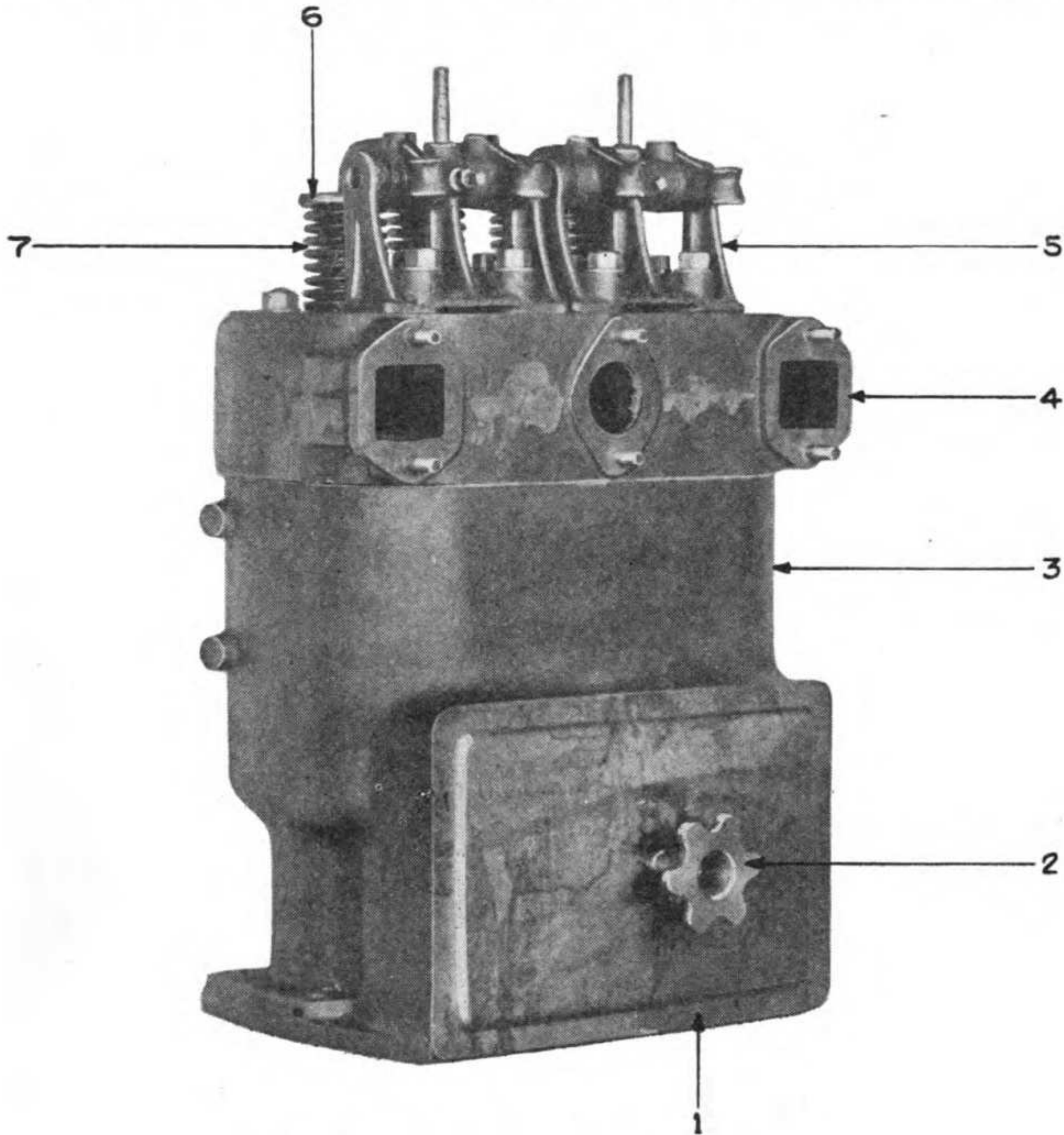


PLATE 21—CYLINDER ASSEMBLY

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 ($\frac{7}{8}$) 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 ($\frac{1}{2}$) 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 ($2\frac{3}{8}$) inches with forty-five degree beveled seats 0.125 ($\frac{1}{8}$) 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 ($4\frac{1}{2}$) 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 ($2\frac{1}{2}$) inches, should have a tension of about seventy to seventy-three pounds, and when free a height of approximately 4.25 ($4\frac{1}{4}$) inches. The Auxiliary Valve Spring is lighter and measures 1.0625 ($1\frac{1}{8}$) inches inside diameter. When this spring is compressed to its normal length, 2.343 ($2\frac{1}{2}$) inches, it should show a tension of thirty-two to thirty-four pounds and when free should be approximately 4.125 ($4\frac{1}{8}$) 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 $\frac{1}{4}$ of the way around, then lift the valve off its seat and bring it about $\frac{1}{4}$ 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.

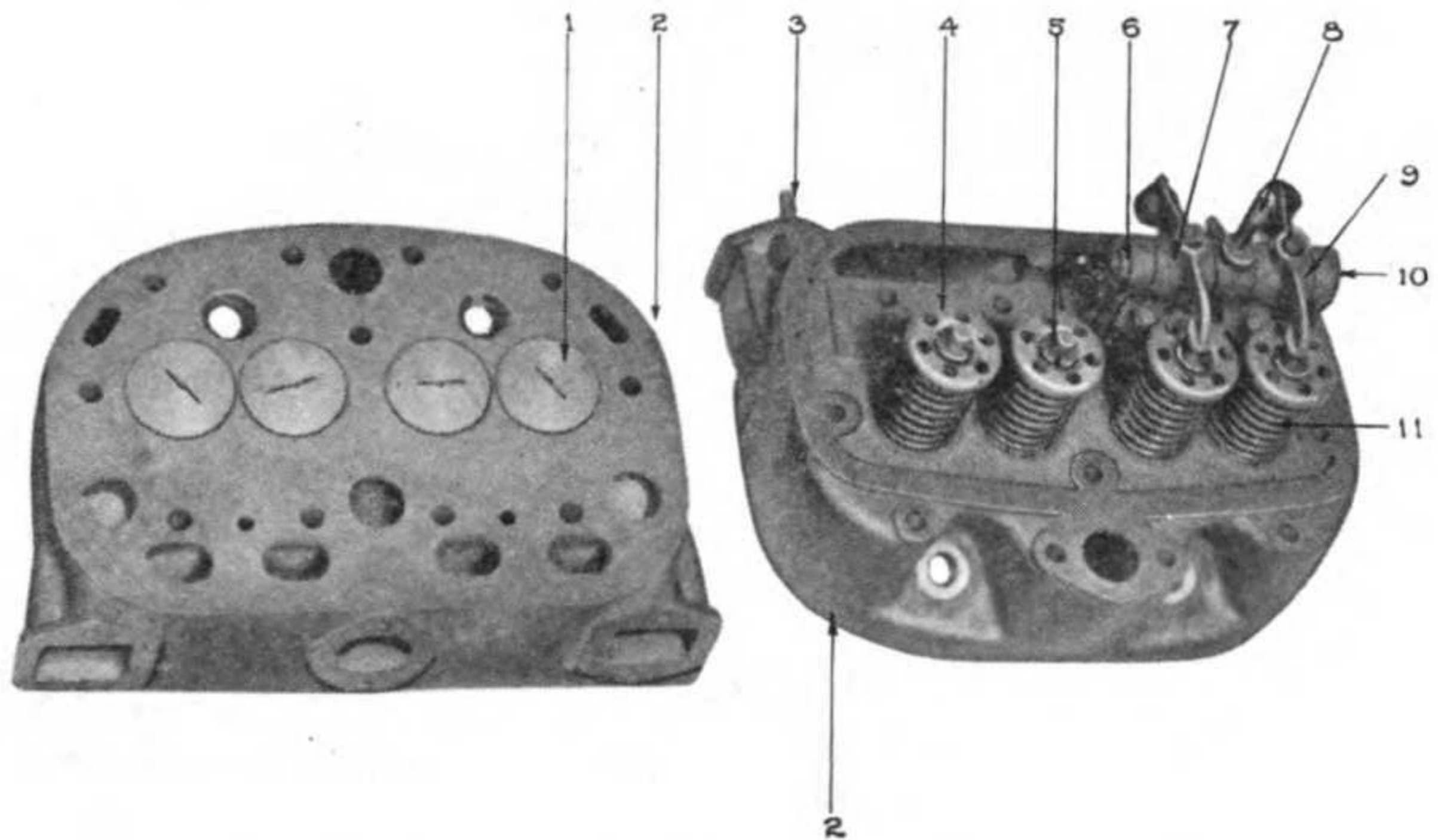
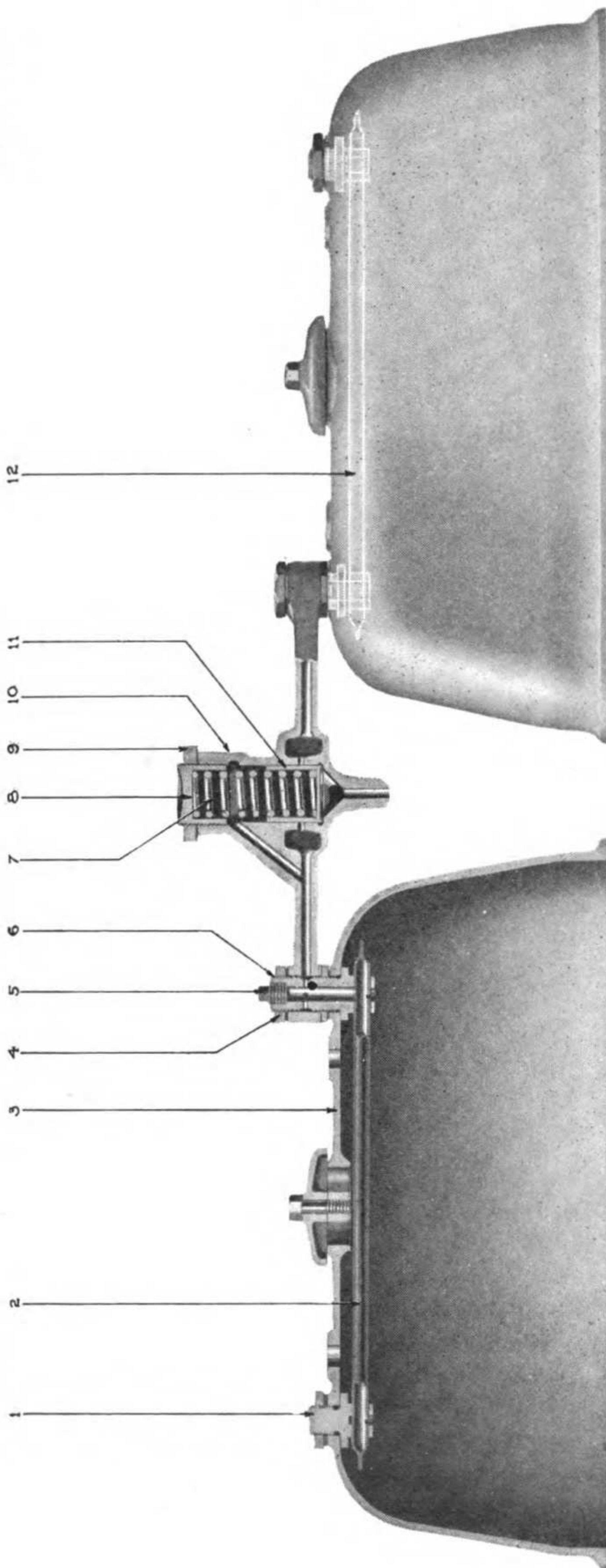


PLATE 22—CYLINDER HEAD AND PARTS

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.



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 ($\frac{1}{4}$) inch dog point set screw which is prevented from rotating by a 0.25 ($\frac{1}{4}$) 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 ($\frac{3}{4}$) inch with an overall length of 5.375 ($5\frac{3}{8}$) 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 ($2\frac{1}{8}$) inches, while the distance from the center of the Push Rod to the center of the Rocker Arm Shaft is 1.843 ($1\frac{7}{16}$) inches, giving a ratio of 1.171 to 1. The bent Rocker Arms have a 0.5 ($\frac{1}{2}$) inch offset. The Rocker Arms are all bushed with a bronze Rocker Arm Bushing, 1.496 ($1\frac{1}{2}$) inches long with an inside diameter 0.75 ($\frac{3}{4}$) inch and outside diameter 1.0325 ($1\frac{1}{16}$) 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 ($18\frac{11}{16}$) 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 ($1\frac{1}{8}$) 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 ($\frac{1}{8}$) inch wide which communicates with the Valve Cover Feed Pipes. This Plunger is held in place by a 0.875 ($\frac{7}{8}$) inch outside diameter spring that has a free length of 2.375 ($2\frac{3}{8}$) 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 ($1\frac{1}{8}$) inch diameter roller with 0.437 ($\frac{7}{16}$) inch face. This roller is mounted on a Valve Tappet Roller Pin, 0.5 ($\frac{1}{2}$) inch diameter, the ends of which are flattened off so as to engage 0.25 ($\frac{1}{4}$) 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 ($\frac{7}{8}$) 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 dimension 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 (13 $\frac{1}{4}$) inches. The "I" section of the Connecting Rod tapers slightly, but just above the big end is 0.75 ($\frac{3}{4}$) x 1.625 ($1\frac{5}{8}$) inches and 0.125 ($\frac{1}{8}$) inch thick. The Connecting Rod Caps are held in place by four special nickel steel bolts 0.498 ($\frac{1}{2}$) 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 ($\frac{1}{16}$) inch thick. The latter Shims are interchangeable with part Number 1067-V on the Class A and B trucks.

TO REMOVE CONNECTING ROD

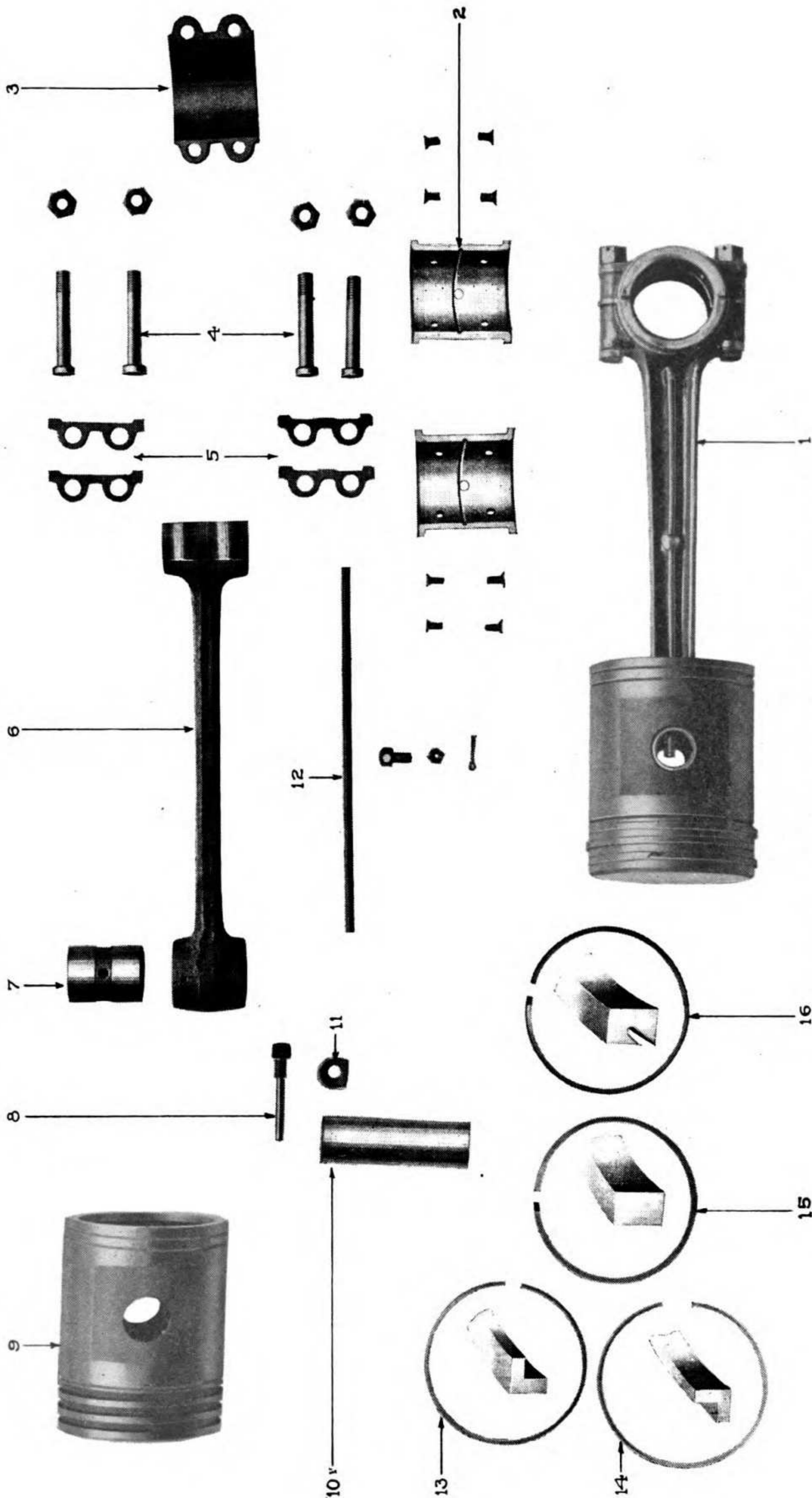
To remove connecting rod and piston, drain off oil, and remove oil pan, turn engine over by hand until lower end of connecting rod to be removed is half way down on side of engine towards camshaft; remove connecting rod bearing nuts, take off cap and lower rod and piston down and out.

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.



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	Connecting rod shim.
	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 ($1\frac{3}{8}$) inches, outside diameter 1.628 ($1\frac{5}{8}$) inches and length 2.125 ($2\frac{1}{8}$) inches. There are three 0.25 ($\frac{1}{4}$) 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 crank-case 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 ($\frac{1}{2}$) 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 ($\frac{1}{8}$) 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 ($4\frac{3}{4}$) inches with the clearances located and of the amounts as mentioned above, and 6.125 ($6\frac{1}{8}$) 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 ($\frac{1}{16}$) inch deep on the center line of the Piston Pin Hole and is 2.75 ($2\frac{3}{4}$) inches in width, measuring 1.25 ($1\frac{1}{4}$) inches above the center line of Piston Pin and 1.5 ($1\frac{1}{2}$) 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 ($4\frac{3}{4}$) inches, when compressed, and the same width, 0.249 ($\frac{1}{4}$) inch. The Piston Pin is made from steel tubing 4.437 ($4\frac{7}{16}$) inches long and is 1.374 ($1\frac{3}{8}$) 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