



INSTRUCTIONS TO ENGINEERS

ON

GAS-ELECTRIC RAIL MOTOR CARS

**75-FT. STEEL GAS-ELECTRIC
COACH-BAGGAGE RAIL CAR**

400 HP. DOUBLE END, REMOTE CONTROL

CAR Nos. SP 3, SP 4, SP 5 and SP 6

Dated Nov. 1, 1930.

PREFACE

These pages are written particularly for the benefit of those who operate gas-electric cars. They describe generally the operation of the various units, explain briefly their function and call attention to the points which require special care.

CAUTION:- The voltage employed by the generator, traction motor and motor circuits is approximately 600 volts maximum, which is sufficiently high to give a very severe shock or burn.

The electrical circuits which lead to the devices whereby the operator controls the car carry only low battery voltage.

Due caution should be exercised not to come in contact with the generator terminals, or any part of the main circuits, while the engine is in operation.

Observation of the following simple precautions may prevent serious shocks or burns.

Never open the high voltage cabinet while the power plant is in operation.

Do not attempt to make adjustments on the generators or exciters while the power plant is in operation.

Do not replace the fuses in the fan switches or compound switch above operator's seat while the engine is running. The switch box doors should not be opened until after engine is stopped.

Do not operate the traction motor contacts or reverser by hand while the power plant is in operation. In general, the switch cabinet doors SHOULD NOT be opened when the power plants are in operation.

The term motor used in the following pages has reference only to the truck traction motors and not to the internal combustion engine in the engine room. When the internal combustion engine is referred to the term engine is used.

The power plant in these gas-electric cars consists of the following equipment: A Model 148 Winton, 8 cylinder gasoline-distillate internal combustion engine, 8-1/2" diameter cylinder by 10" stroke, 400 H.P. at 900 R.P.M., and is equipped with the distillate burning carburetors of the Electro-Motive Company's manufacture. All the electric equipment used in the power plant is manufactured by the General Electric Company. The main generator is an eight pole series wound generator, Type DT-513-A having a continuous rating of 505 volts, 540 amperes at 900 R.P.M. The exciter or auxiliary generator is Type TE-513-A having a continuous rating of 150 volts, 65 amperes at 900 R.P.M. The total capacity of the main generator and exciter is 280 KW. The front truck is equipped with two series wound traction motors, Type GE-297-A-51, having a continuous rating of 455 volts, 280 amperes at 900 R.P.M. The cooling system is provided with two series wound blower motors Type CY-99-C, 7-1/2 H.P. each, and has a continuous rating of 470 volts, 14 amperes at 1800 R.P.M. The air compressor is Type CP-130-A-6, 50 cubic feet per minute capacity, equipped with a series wound motor having a continuous rating of 500 volts, 10 amperes at 2200 R.P.M.

The four views shown on the four following pages are of the Winton Model 148 Engine. This is an eight cylinder engine, of the valve-in-head type, and is known as a four stroke cycle engine. These strokes are defined as follows:

The first stroke is what is known as the suction stroke; this stroke is from top dead center to bottom dead center and during this stroke the intake valve opens at the top and closes at the bottom, thereby admitting a charge of fuel vaporized by the speed by which it was "sucked" in.

The second stroke is known as the compression stroke and is from the bottom dead center to top dead center; during this stroke all valves to the cylinder are closed and the charge which was admitted during the suction stroke is compressed. Just before the stroke reaches the top dead center, the charge is fired by an electric spark of high voltage arcing across two points of a spark plug; there are four spark plugs in this engine per cylinder. This firing increases the compression a number of times, due to expansion of the heat generated in firing the compressed charge.

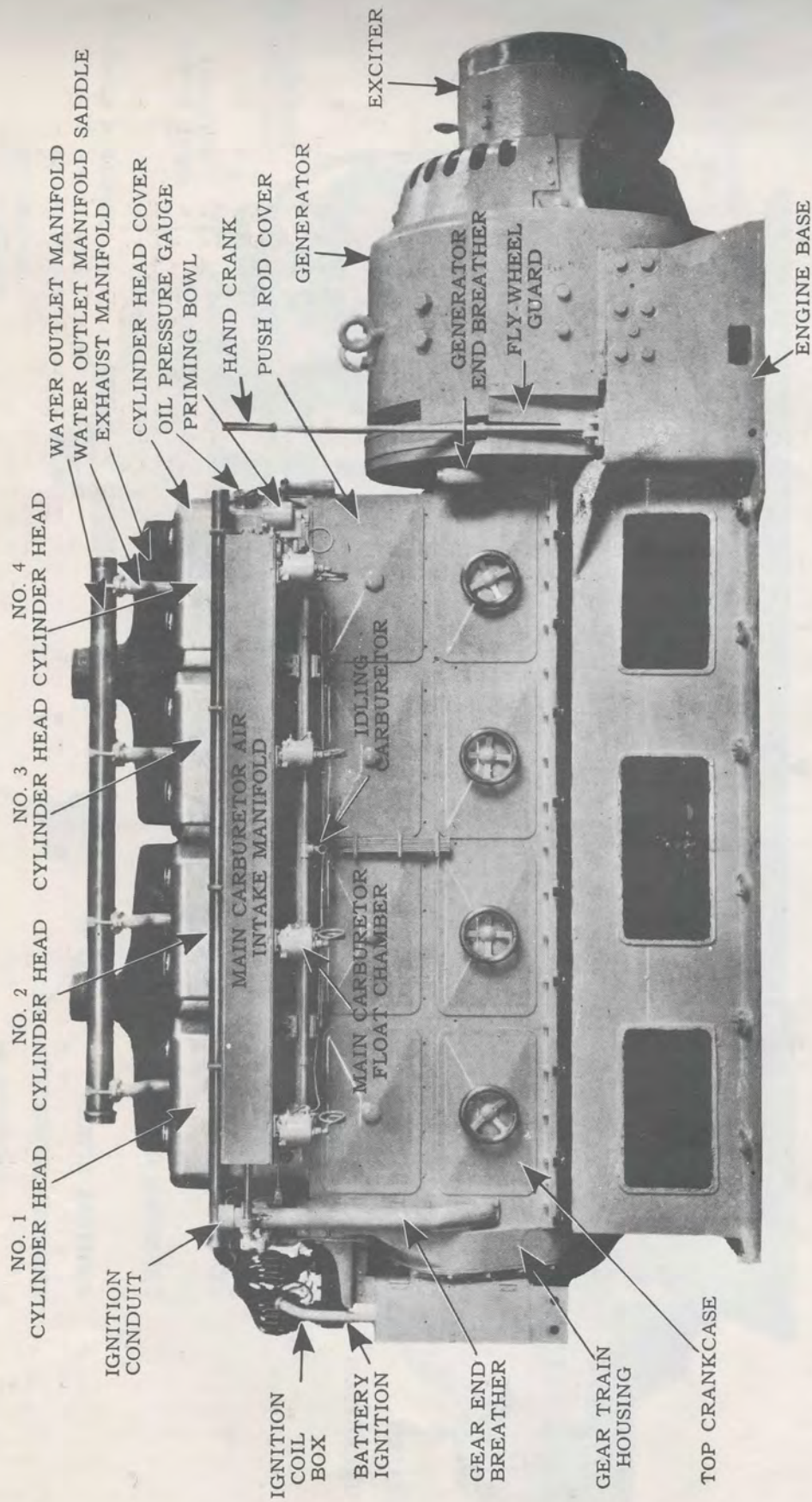
The third stroke is the power stroke, caused by the expansion of the fired charge, and is from top dead center to bottom dead center. Just before the stroke reaches the extreme bottom dead center, the exhaust valve is opened and releases the fired charge.

The fourth stroke is the discharge of exhaust stroke and is from bottom dead center to top dead center; during this stroke all the burned gases are forced out through the exhaust valve which remains open until just before the top dead center is reached. The next stroke is the first stroke of the cycle again. Thus you will see it takes four cycles, or two complete revolutions of the crank shaft to complete a power cycle, hence the name "Four Cycle."

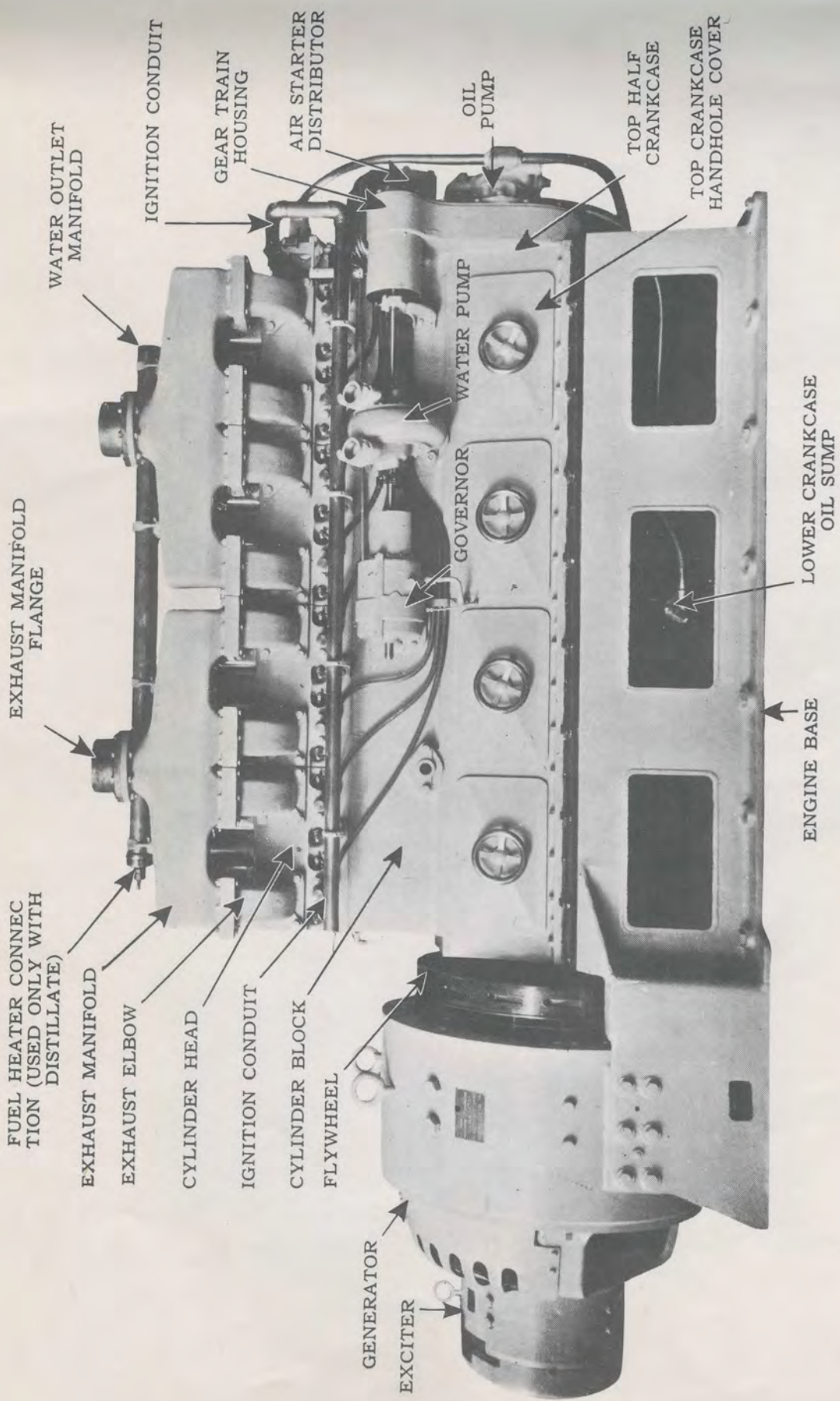
The Intake and Exhaust Valves are timed to open at the proper time by a cam on a shaft, which is driven by a train of gears from the crank shaft, reducing the revolutions of the cam shaft to one half of that of the crank shaft. The ignition or firing of the spark plugs is timed to once every two revolutions of the crank shaft and the ignition system is usually driven through a train of gears off the cam shaft.

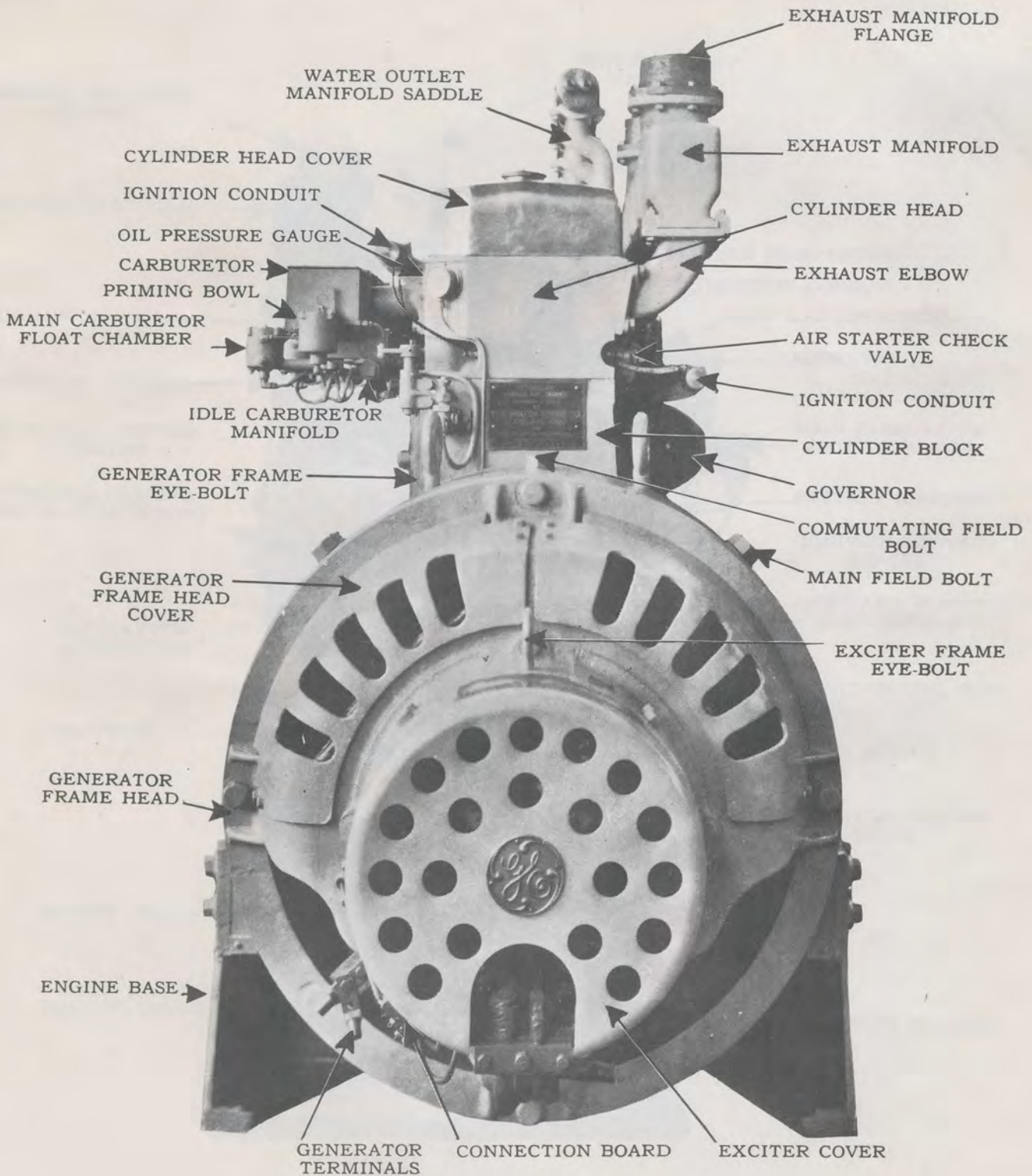
The speed of the engine is determined by the timing of the valves and ignition, and the amount of fuel and air mixture admitted into the cylinders.

The grade of fuel used and its characteristic burning qualities as well as the design of the engine, effect the maximum speed to some extent. In order that the engine speed may not exceed a predetermined value, some form of a mechanical governor is usually supplied. This ordinarily controls the amount of mixed fuel to be admitted into the cylinder. The mixed fuel is admitted into the cylinder by a manually controlled throttle to obtain the speed up to that at which the governor is set.

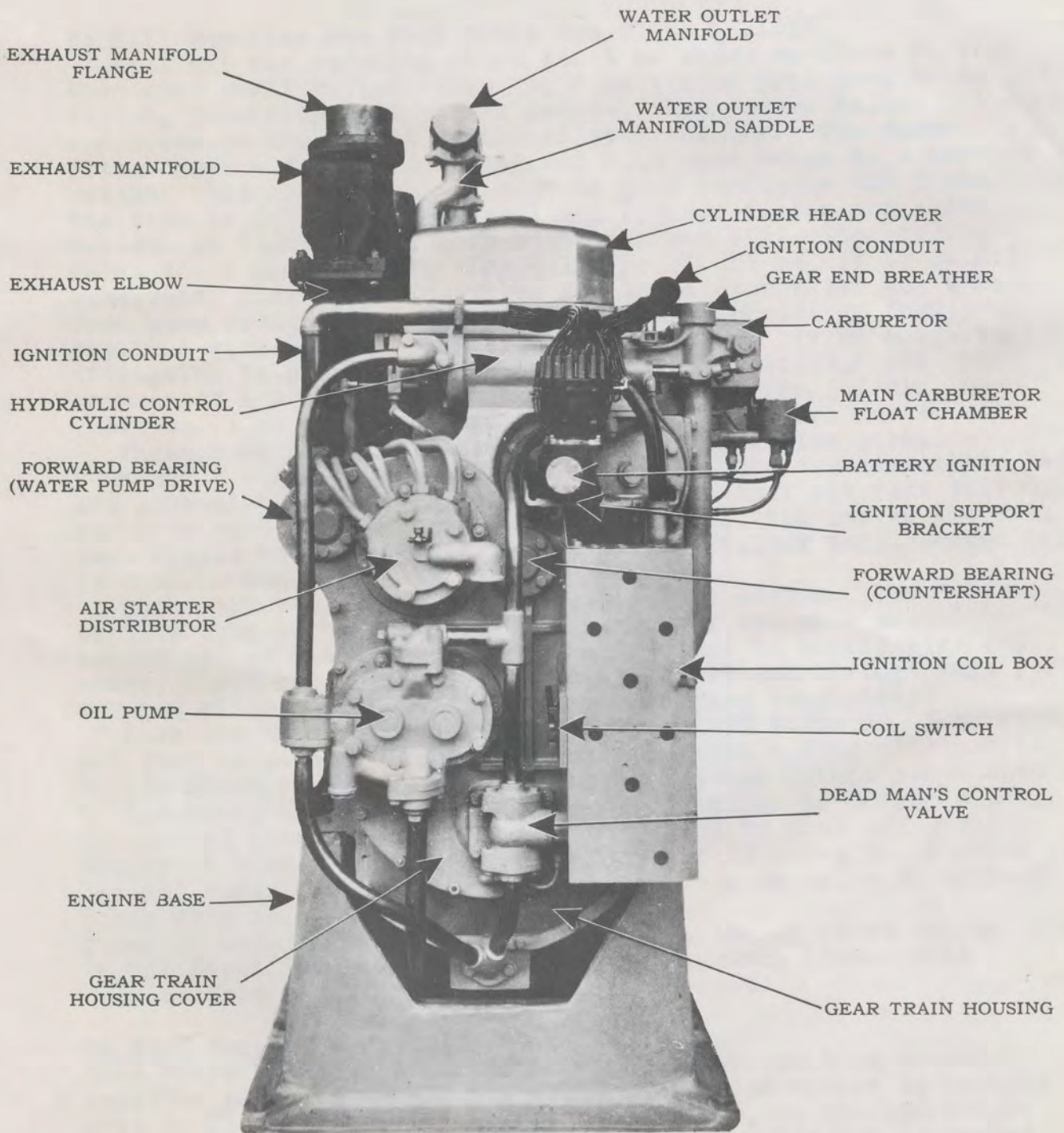


Carburetor Side of Engine





Generator End of Engine



Timing Gear End of Engine

PRELIMINARY PREPARATIONS AND
OPERATING INSTRUCTIONS.

To Fill Gasoline and Fuel Tanks see Plate No. 1512.

Shut off air reducing valve No. 1 as shown on Plate No. 1512 then open small relief valve No. 2 on top of fuel tank to be filled, permitting all air to escape, then remove Filler Cap No. 3, and screw in the funnel furnished with the car. The funnel is fitted with a fine mesh screen and will shed water to a certain extent; this screen must be kept in good condition and clean. When the tank is full, remove funnel and replace filler cap being careful to tighten. If main reservoir has air, close relief Valve No. 2 and open reducing Valve No. 1. If no air is in main reservoir, close reducing valve No. 1 and open Valve No. 4 near foot pump connection close to floor, then connect up foot pump supplied with car and pump up about 3 lbs. of air on gauge before attempting to start engine. After engine is started and air compressor has had a chance to pump up to 10 lbs. of air, open Valve No. 1 on pressure regulator, and close Valve No. 4.

These cars use distillate and have a 100 gallon gasoline tank and 2 - 250 gallon distillate tanks. The two distillate tanks are connected together and it is important that air vent Valves No. 2 on each tank be opened, and when full, the one on the full tank should be closed, and then continue filling until second tank is full. Then close all vents.

Each tank has a sump with a plug in the bottom. The purpose of this sump is to catch all sediment, and the plug should be backed out at least once a week, sufficient to permit dirt and water, which may have accumulated, to drain out through vent port in plug which is provided. (Never remove plug completely)

Each car is equipped with a safety cutoff Valve No. 5 to shut off fuel in case of fire. A wire cable with a ring attached is placed close to the operator's seat No. 6 and within reach when in his seat, and one on each side of car close to filler pipes; in case of fire this ring should be pulled to shut off gasoline supply at tank. To reset this safety cutoff Valve No. 5 which is located under car close to tank, raise stem on valve so trigger holds stem up.

Note: On these distillate cars there are two of these valves, one on the distillate tank and one on the gasoline line. Both operate from one ring and both must be reset.

To Fill Cooling System See Plate No. 510.

Open Valve B, close Drain Valve F, open Valve No. 1 on secondary overflow pipe, then fill with clean soft water either by holding hose on Filler Pipe Fitting No. 2 under car, or through Filler Pipe No. 3 on top of car, until it overflows through secondary overflow; after water has ceased to flow out of this overflow, close Valve No. 1.

Note A: During summer weather, overflow Valve No. 1 need not be opened and water can be filled to regular Overflow No. 4, but it is important that this valve be opened and water be filled to that level each night when tying up car during freezing weather

and it must always be closed when engine is running.

Note B: Valve B for cutting heating system into cooling system must be closed at all times when engine is running.

LUBRICATION (see Plate No.1002)

The oil tank should be filled about 1/2 gauge glass full 25 to 27 gallons. If car or power plant has been standing for several days, the valve cover should be removed and about a pint of oil should be poured over the rocker arms of each cylinder head, also squirt distillate on valve stem guides. Water pump and generator bearing should be greased with a good grade of Alemite grease. The pilot bearing in the fly-wheel should also be greased with the Alemite gun (to do this, turn the engine over and watch for the Alemite fitting, which is in the center of the fly-wheel rim; through the slot in fly-wheel cover or guard provided for barring engine over). The fan motor should be greased with the Alemite gun which is furnished with the car. (Care should be taken to avoid over-filling). A drop of good oil should be applied to each oil hole on the magneto or battery ignition distributor each day.

LUBRICATION-GENERAL.

Just how long and how satisfactorily a car will operate depends more upon proper lubrication than upon any other feature of its care.

Excellence of quality of oil is not sufficient. Bearing surfaces or assemblies which, when properly lubricated, will give years of perfect service, may be completely ruined by a few hours of neglect.

Even slight neglect not serious enough to destroy immediately, will have its damaging effect upon mechanism and service, causing loss of time, excessive maintenance and operating costs, and a performance in general below that which should be obtained.

The lubricating oil tank should be kept filled to the proper height at all times. Oil strainers ZW & 14, See Plate No.1002, should be kept clean. When engine is stopped, the oil can seep through oil pump into engine base, therefore, bear in mind that when engine is not running, the entire oil supply may be in the engine base and not in the tank. This oil in the engine base is all returned to the tank in a very few minutes after starting the engine. Consequently, if oil is put into tank when engine is stopped, the tank will overflow when engine is started, because it cannot accomodate the oil in the engine base in addition to the fresh supply which has just been added. When it is necessary to add oil, always do so when the engine is running, which will insure putting in enough fresh oil to bring the oil in the tank to the proper level.

The grease fittings are filled by means of an Alemite gun or injector supplied with the equipment. The grease injector has a capacity of about 3/4 lb. of grease, one filling of same being sufficient to fill all fittings.

To operate the grease lubricating gun, attach its bayonet lock to the fitting on the part to be lubricated and turn handle several turns. If the grease does not flow into the bearing without

using too much force, it is probable that the oil channels are plugged, in which case they should be examined and cleaned.

Although small, the grease cups and fittings must not be despised and neglected. The directions herewith must be followed with completeness and regularity.

Special care and pains should be exercised when operating the first 5000 miles with a new car. Through lubrication during this period, while bearing surfaces and adjustments are new, will contribute largely to a full measure of future usefulness.

The discovery that any part has been running without sufficient lubrication should be followed by a careful examination and correction before further operation, in order to avoid the possibility of additional damage.

Only kerosene or distillate should be used in cleaning the different oil compartments such as sump in engine base, oil tank, oil radiator and oil lines, and care must be taken that all residue or sediment is removed.

Caution: Waste must not be used in cleaning any part of the power plant; good clean rags only must be used.

All kerosene or distillate must be removed before applying new oil, to avoid damaging the new oil. The crankcase and oil tank should be thoroughly cleaned each time the oil is changed but not necessarily with kerosene or distillate each time. It is very important to see that the containers where lubricating oil is stored are tight so that no dirt or foreign substance will eventually get into the moving parts or bearings of the power plant and ruin them.

Kerosene or distillate should be applied to all engine intake and exhaust valve stems daily with a small squirt can to remove any gum or carbon which may accumulate on them.

GENERAL INSTRUCTIONS

The generator is equipped with a special series winding so that it may be used as a series motor to turn and start the engine. When used as a starting motor, the generator is connected to the batteries by contactors "G" and "G1".

Before starting the engine, operator should look over the power plant and make sure that no tools, bolts, nuts or other miscellaneous material is lying around the engine or generator, where they could possibly get caught or fall into any of the working mechanism. This applies particularly to material lying on the generators and above all make sure that no one has left a bar sticking in a flywheel.

To start the engine the following should be followed:

(a) See that pressure regulator shows at least 3 lbs. of air on the fuel tanks.

(b) Open valve No. 7, see Fuel Plate No. 1512, to strainer; watch needle valve in float chamber and see that it drops on seat and that carburetor float chamber does not flood.

(c) Open the Low Voltage Control Cabinet door and close the Main Battery Switch No. 7 on panel board. This cabinet is located in the right rear corner of the engine room and is shown on Plate No. 2018.

(d) Close the exciter field switch No. 3 in the gang switch cabinet over the operator's window shown on Plate 2002.

(e) Close the ignition switch No. 2 in the gang switch cabinet over the operator's window shown on Plate 2002.

(f) Move the handle on the three-way fuel valve at the center of the engine towards the right side of the car which allows gasoline to fill up the fuel chambers.

(g) Make sure the throttle is in the "Idling" position which is the first stop on the throttle quadrant shown on Plate No. 2505. If throttle handle is pulled out too far, the throttle switch will snap over and prevent operation of electric starter. If this happens, return throttle handle to "off" position, and again open carefully to a point where throttle toggle switch remains closed.

(h) Controller must be in the "off" position.

(i) The engine is now ready to be started. Pull priming choke or primer to carburetor and press on starter Switch No. 1 in gang switch cabinet over the operator's window shown on Plate 2002, which will cause switches "G" and "G1" to close circuit to series winding in generator. Hold starting button on steady and use primer until engine starts to fire, which should occur after a few revolutions, if it does not, flood the carburetor by raising the needle valve in the float bowl until gas comes out of top and try again, pulling choke.

(j) After the engine starts, let go of primer button.

Oil pressure gauge should indicate pressure as soon as engine is started; carefully note that this occurs. Pressure on starting will probably go up to approximately 50 pounds but will generally drop to about 45 lbs. as the engine and oil warms up, with the engine idling. See that oil pressure comes up to at least 40 lbs; also see that compressor switch is in the "on" position; see that all drain valves are closed on air brake air reservoir. The engine should not be run faster than 500 R.P.M., or run under any load until they have warmed up to 115 - 125 degrees, after which pull out throttle, bring the engine speed up to about 700 R.P.M. or until throttle switch on top of throttle is open (this switch is open when throttle is away, allowing plunger to come out.

Do not increase engine speed above this speed or equipment will be damaged. Compressor should now be running and air pressure starts to show on gauges; if not, see that compressor is running by opening door at brush end of motor. If it is not running, check Fuse No. 1, Plate No. 2003; try the fan; if the fan runs, put a new fuse in compressor switch-30 amp. for 25-ft. compressor, 60 amp. for 50-ft. compressor. After air is pumped to 110 lbs. pressure on main reservoir, use air starter to start engine until air falls below 80 lbs. If the engine does not turn over when pushing starter switch, see that throttle is not out too far and throttle switch is open; see that Fuses Nos. 1 & 3, Plate No. 2002 in circuit with exciter field switch and starter switch overhead in gange switch are good.

After starting engine, ordinarily, it is to be expected that the air system is to be charged immediately. However, this cannot be accomplished until engine has been warmed up and the compressor switch placed in the "on" position. The controller handle must be left in the "neutral" position. With the controller in this position and the 'Reverser' lever in "off" position, the main

out and you hear exciter field contact come in when FS switch is made.

(k) If engine fails to start, tests should be made in the order named below:

See that there is sufficient fuel.

See that there is at least 3 lbs. air pressure.

See that safety cutoff Valve No. 5, Plate No. 1512, under car is open.

See that Supply Valve No. 7, Plate No. 1512, at strainer is open.

See that strainer is clear.

See that you have fuel in carburetor float bowl.

See that ignition switch is properly placed.

See that spark plugs are good, also clean and properly adjusted.

Remove wire from spark plug and hold 1/8" from engine and turn engine with starter to see if there is spark.

Be sure that throttle is just cracked and not too wide open.

Check spark advance which should be 25° B.T.C.

Check firing order which should be 1-7-4-6-8-2-5-3.

Check intake manifolds for air leaks.

See that Fuses Nos. 2 & 3, Plate No. 2002, in ignition and exciter field circuits are good.

See that braker points are set properly.

See that lamps in circuit are good and make proper contact.

Test condensers in breaker heads.

On engines with 64 volt starting, see that all fuses are good and test on board by pushing Buttons Nos. 17A or 17B as shown on Plate No. 2018.

Check Fuse No. 1, Plate No. 2002, starter button in gang switch.

See that controller is in "off" position.

The length of time required to charge air system varies according to the engine speed which ordinarily should be reasonably constant (approximately 700 R.P.M.); the number of cars to be charged, also affects the length of time. An operator can readily detect failure of compressors to operate by watching gauge, or to check more closely, get out and listen to compressor. If not running the indication would be that the air compressor fuse may be burned out, or the switch not in the "on" position.

Compressor governor is set to "cut in" when air pressure in system drops below 115 pounds and "cut out" when pressure reaches 130 pounds.

The correct engine temperature to maintain during car operation is from 180 to 190 degrees Fahrenheit. The temperature of each engine is indicated by thermometers on instrument board at operator's position at each end of the motor car. Be sure to watch engine temperature very closely.

Operating at a lower temperature will result in improper lubrication of the frictional surfaces in the engine, while the unvaporized fuel will work down past the pistons, diluting the oil

in lower crankcase.

Should the thermometer of the engine show above 190 degrees, it would indicate something was not right. The engine should be stopped and the cause of this excessive heating remedied. Continued operation above 200 degrees will cause the systems to empty themselves, break down the film of lubricant on the cylinder walls, and serious damage to the engine will result.

A water pump on the engine circulates the cooling water around cylinders through passages in heads, then up through piping to the radiator core tubes, where the cooling takes place. The water then runs by gravity to the expansion tank and then through the air cooler to the pump.

Fans driven by electric motors, draw air between the radiator tubes to hasten the cooling; the rate of cooling being governed by speed at which the fans are operated.

The radiators on the roof are connected to cool the water.

The fan motors should be operated, when necessary, and at a speed that will hold the engine cooling water at an efficient operating temperature - 180 to 190 degrees Fahrenheit, when using distillate.

The fans are controlled by a switch above operator's head. Never shut off fan switch until the throttle is brought to the "Idling" position.

It can be assumed that when a motor car is delivered to or released at a terminal for service as a certain train; that it must be in satisfactory condition to give uninterrupted service. However, operator should satisfy himself that his air brake and signal equipment are safe and suitable for service; that the devices for regulating all pressures are properly performing their functions; that the air brake valve works properly in all positions; that conductor's valve functions properly and that the water has been drained from the air brake system.

Regardless of the completeness of the system of maintenance and inspection existing on the car, the following items must personally be checked by the engineer:

Check water level in the cooling system expansion tanks; do this before starting engine, if you know engine has been operated since cooling system was filled. Otherwise, allow engine to run for a few minutes; then shut off and check water level; as oftentimes in filling system, air pockets will form, which are deceiving in determining the water level.

With engine shut down check the oil level in reservoir of engine; it is preferable that this be in sight in the oil glass.

Start engine, watching the oil pressure gauges. Unless pressure immediately starts to register, shut engines down. On a warm engine, idling pressure should be from 10 to 30 pounds and on opening throttle should rise approximately to 50 pounds, depending on the load put on the engine. For locating cause of low or no oil pressure, see Questions 117, 118, 119, Page 38.

Observe whether battery charging ammeter is functioning properly.
Be sure the fan motors are in working order.
See that sanders operate properly and sand boxes have an adequate supply of dry sand.
See that the fuel tanks have an adequate supply.
Investigate any excessive oil and water leaks around engines.
Note if air compressor, compressor governor and feed valves are working properly.

The Car is Now Ready to Start.

Main reservoir air pressure should be 110 pounds. Throttle should be brought back to idle position and throttle switch should be closed; (that is, plunger in). The controller has two handles, one controller lever moving to a neutral and three running positions, and one smaller removable reverse lever for forward and backward movement of the car. Place reverse lever in position on controller, then move it to forward position to move car ahead. Now move controller handle to first notch to the left of "off" position or series position. Now open throttle slowly and car should move. If not, try fans and compressor. If fan runs, trouble is between controller and traction motors. If fan does not run, see that exciter contact snapped in; if the contact has not snapped in, see if Main Switch No. 7, Plate No. 2018 is closed; test Fuses Nos. 3 in exciter circuit in gang Switch Plate No. 2002 over engineer's window.

See next following page for other troubles.

Caution: Throttle should always be opened slowly to give the engine a chance to pick up.

Series position is ordinarily used only in starting or when severe grades or road conditions demand slow operation.

After car has reached a speed of 14 miles per hour, move controller to second position or parallel, just relieving throttle before going over from series to parallel. When a speed of 29 miles per hour is reached, move controller handle to third or shunt position. This car has a 56 tooth large gear and a 20 tooth small gear, and the correct speeds for shifting are:

Series to Parallel-14 miles per hour
Parallel to Shunt -29 miles per hour
Maximum car speed when being towed -65 miles per hour.

Never attempt to move controller handle from forward to reverse position, or vice versa, while car is in motion. Car must be brought to a complete stop before reversing direction or the result may prove serious. Car should always be allowed to drift down grades or into stations with closed throttle to conserve fuel and keep spark plugs clean. Engine should be shut down and idling avoided as much as possible. When a sudden stop must be made, close throttle and make emergency brake application (and in extraordinary emergency to save life throw controller in reverse position).

In regular service, the controller handle should be used as little as possible and car speed regulated largely by throttle.

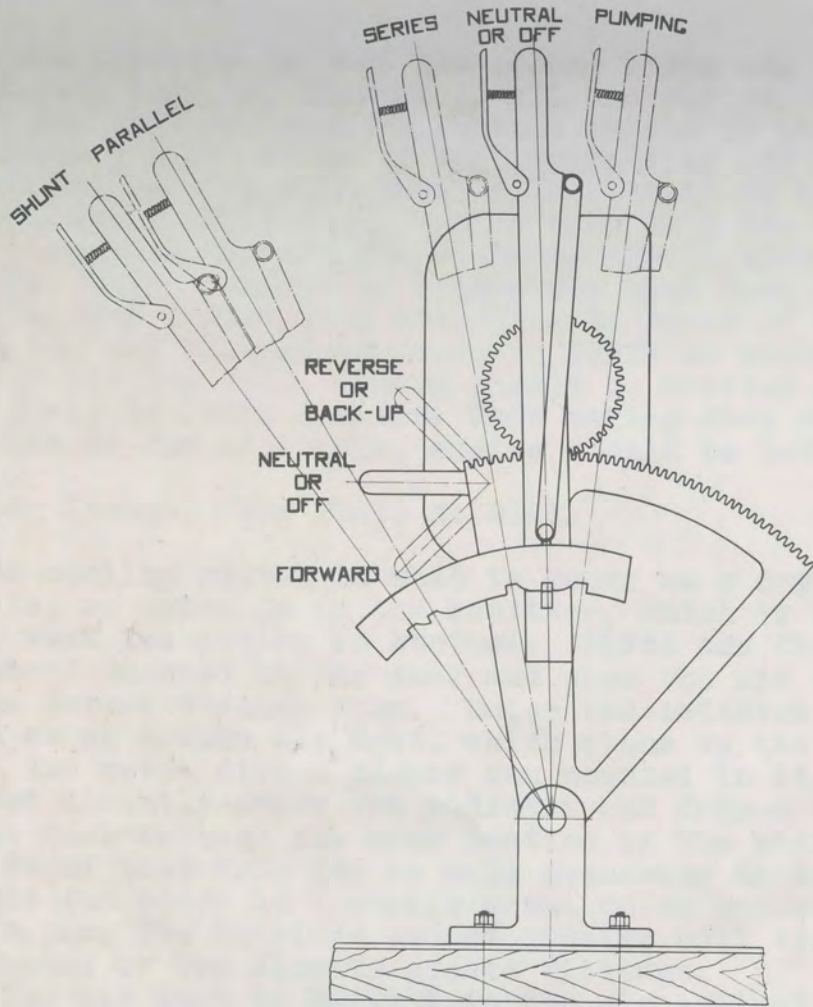
Car should be run with extreme care and reduced tonnage during the first 1,000 miles, when new, or after general overhauling, to give all wearing parts a gradual running in; this will contribute largely to future performance of the power plant.

Should car fail to move and engine is running, check the following in the order named:

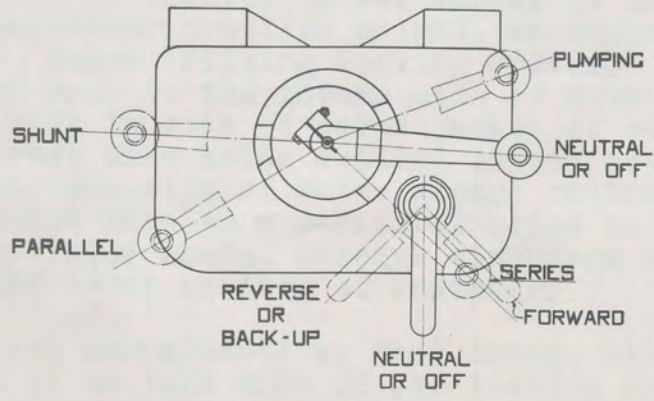
- See if brakes are off.
- See if Main Switch No. 7 is in on panel, Plate No. 2018.
- See if main Fuses Nos. 8A and 8B are good, Plate No. 2018.
- See if Fuse No. 3 in exciter circuit is good, plate No. 2002.
- See if exciter field contactor snaps in when throttle switch is all the way out.
- See that controller is in series position.

Try fan and compressor; if running properly cut out the No. 1 traction motor by closing Nos. 2 and 3 Valves as shown on Plate No. 2005. Move controller handle to parallel position, (be sure to do this as the car will not move with controller in Series Position with one traction motor) and try to move the car. If the car still does not move, open Valve No. 3 and close Valves Nos. 1 and 2, as shown on Plate No. 2005; again put controller handle in the parallel position and try to move the car. The above procedure should be followed for cutting out one traction motor due to a hot armature bearing.

Caution: - When one motor is cut out on one of these gas-electric cars, never use shunt position and never crowd the car.



VIEW SHOWING LAID DOWN
CONTROLLER INSTALLATION



VIEW SHOWING UPRIGHT
CONTROLLER INSTALLATION

Fig. 104. Various Controller Handle and Reverse Lever Positions

To Stop The Car:

Close throttle so that the engine stops and throttle switch is closed; that is, plunger is all the way in, and switch snaps and cuts off exciter contact switch on panel board. Make usual heavy application of air, graduating off so as to come to a complete stop with about 5 lbs. still in brake cylinder. In most cases, full stops can be made with one application. This conserves air and the operator should strive to do this always. Engine should be completely shut down at least 500 to 1000 feet before stop according to speed of car when making stop, and car allowed to coast or drift as much as possible. At each station stop, engine should be started by air starter when ready to leave station. When making flag stop of short duration or for crossings, engine should be left running idle.

Cooling System, (See Plate No. 510).

The cooling system is what is known as a dry radiator type; that is, no water is in the radiator, which is mounted on the roof, when the engine is stopped. There are three Fin type radiators mounted on the roof and when the air is moving, the air is forced through them. Under the radiator is what is known as an intake air duct, which opens to the front and which has a fan motor with a blower fan mounted in it. This is located directly under the radiator and forces the air from the intake duct through the rear section of the radiator. It has been found that this fan is only necessary in hot weather.

The fan motor is a series wound motor and should run 1800 to 2000 r.p.m. The bearings are of annular ball type and are lubricated by two Alemite grease fittings.

The air duct is built into the car against the roof and has a screen in front of car to prevent birds and other large objects from getting caught in the fan.

The radiator is known as a Single Pass type and is provided with an intake on one side and a discharge on the opposite side.

Operation of Cooling System-See Plate No. 510.

Tank XY which is located in car should be filled with clean soft water to secondary overflow height, as explained in these instructions under "Filling Cooling System." Water is taken out of bottom of tank to the intake side of water pump, forced through a duct cast in side of water jacket of engine, which has a series of correct size holes drilled at correct intervals to insure proper distribution of water around cylinder sleeves out of water jacket through a series of holes to cylinder heads out of top of cylinder heads, through discharge casting into header, then into front section of radiator.

The radiators are mounted so that intake side of No. 1 and No. 3 Radiators is on left side of car looking forward, and intake side of No. 2 Radiator is on the right side.

The cooling system should be drained and flushed out at least once a month while in service. The system is drained

through drain Valve "F" on floor of car.

Provision is made to cut the heating system of this car into the cooling system of the engine when standing at night, or for a lay-over period during the run, by operating Valve "B" and filling cooling system to secondary overflow.

Where hard or only treated water is obtainable, distilled water should be used and the monthly flushing of radiator may be omitted.

Hydraulic Control Cylinder-See Plate No.2501:

This engine is equipped with a hydraulic control cylinder whereby the throttle of engine is controlled by oil pressure. It serves the purpose of magnifying the force necessary to open the carburetor throttle without much strain on the hand throttle and it also serves as a safety feature on the lubrication system, preventing the opening of throttle above idling position without oil pressure. Therefore, if at any time this hydraulic control cylinder fails to operate, shut down the engine at once and check oil pump, or examine oil tank to see if you have sufficient oil. The oil from the service pump is passed through this control cylinder and causes it to function.

The hand throttle and also the mechanical governor throttling mechanism are connected through the hydraulic control. The speed of the engine is controlled up to the governed speed by this hand throttle, at which time the mechanical governor comes into play, preventing over speeds at all loads.

The hydraulic control cylinder in itself consists of a cylinder body, No. 2, bolted onto engine; it has a front or outlet cover, No.4, and a rear or inlet cover, No. 3. The rear cover No. 3, has the oil inlet connection and the front cover, No.4, has the oil outlet connection. Inside of this cylinder there is a piston, No. 27, fitted with two regular piston rings, No.24; this piston operates against a heavy coil spring, No. 12, which is almost the same diameter as the cylinder bore. The piston, No. 27, is mounted on a shaft, No. 1, which has a hole, A, drilled in one end to a point past the piston location, and the other end extends through the oil inlet cover, No. 3. This end has a clevis fastened on it to connect to throttle arm No.17, by link, No.15, on the front side of the piston. This shaft has three sets of holes, B, C and D drilled to connect to the hole A, in shaft No. 1. In the front of the piston are mounted two brass sleeves, 19-A and 19-B, which slide on Shaft No. 1 freely. Sleeve 19-A is connected to hand throttle mechanism by rods No. 10 and No. 6 and controls the movement of the piston by hand covering hole B. Sleeve 19-B is connected to the mechanical governor through rod No.11. In the front outlet cover, No.4, and rear inlet cover, No.3, is cast an oil pocket which collects any oil which might leak by shaft No.1 or rods Nos.10 and 11. The oil is collected in this pocket and is drained to crankcase through copper tubing connected to fitting at No.22 and No.7.

Operation of Hydraulic Control Cylinder:

Oil is delivered under pressure directly from oil pump on engine to the inlet connection on cover, No. 3, to rear side of piston. It then passes through holes D, to center of shaft No. 1, and out of holes, B (as holes, C, are covered at closed throttle) to front side of piston and through outlet connection No. 4, to the oil header at bottom of crankcase. When hand throttle is opened, it pulls out Rod, No. 10, which moves Sleeve No. 19-A, which in turn covers the holes, B, causing the oil pressure to build up against back of piston, No. 27, moving it forward until holes, B, are opened in front of sleeve No. 19-A, and allowing oil to flow to bearings; as throttle is pulled out, piston will follow as the oil pressure will always push piston so that holes, B, will be open (unless there is no oil pressure, in which case the throttle will not open, indicating that something is wrong with the oil pump, or that there is no oil), until the speed of the engine reaches the governed speed, at which the mechanical governor is set. The travel of the piston, No. 27, is controlled entirely by hand throttle, but when speed of the engine reaches the governed speed, the mechanical governor moves Rod 11 (which is connected to sleeve No. 19-B) in which this sleeve uncovers the holes, C, which relieves the pressure on back side of piston and allows it to go back until the proper speed is reached, and the moving back of shaft, No. 1, closes the holes, C, by sliding into Sleeve 19-B. The hydraulic control cylinder is operated by balancing the pressure of oil on each side of the piston, No. 27, so that when the engine is riding on the governor, both holes, B and C are partly open so at the least movement of any rod the piston will follow.

Adjustment.

The adjustments of the hydraulic control cylinder care simple if followed carefully and should not require any further attention after once adjusted correctly. First, disconnect link, No. 15, from clevis on end of shaft, No. 1; disconnect hand throttle by removing nut on rod, No. 6, so that rod No. 10 can be moved freely by hand, then disconnect governor from rod No. 11, now push both rods No. 10 and No. 11 all the way in; make a pencil mark on rod, No. 10, at face of cylinder cover, move this rod out so this mark is exactly 2" from face of outlet cover, No. 4; start the engine and fasten throttle so that engine will idle about 300 or 400 r.p.m. Hold rod No. 10 in position so mark is 2" from face of outlet cover; now pull rod No. 11 out slowly, until shaft No. 1 just begins to move; mark rod, No. 11, at face of outlet cover, No. 4, at this point; now connect rod No. 11 to mechanical governor so that this mark on Rod 11 is exactly 2" from face of outlet cover No. 4 with engine stopped.

Caution: This setting must be correctly made and never changed.

Next disconnect rod from mechanical governor to bell crank that connects rod No. 11 at governor arm and see if all parts are free and there is no binding. The entire mechanism from the governor arm to and including sleeve 19-B, should work very freely, requiring not more than a pound of effort to move full

travel either way. This must be free before any further adjustments can be made. After this works free, connect mechanical governor to rod No. 11 so that the mark is exactly 2" from face of cover No. 4 (any further adjustments to correct the speed of the engine must be made in the mechanical governor.)

Now start the engine and idle at about 300 or 400 r.p.m. with carburetor arm, No. 17, and rod No. 10 still disconnected. Push rod No. 10 in as far as it will go, then move out slowly until shaft No. 1 begins to move. Mark at face of No. 4 cover and stop engine; now connect hand throttle. First place hand throttle in extreme off position and connect to rod No. 10 so that mark is inside cover $3/8$ ". This means that hand throttle will have to be opened so that rod No. 10 will come out $3/8$ " before shaft No. 1 moves. Place hand throttle in extreme off position again and set idle carburetor so that butterfly valve is all the way closed, so that when throttle is shut off all the way, engine will stop. This is necessary so that first $3/8$ " travel opens idle carburetor, permitting engine to be started as hydraulic control cylinder will not work unless engine is running. When the hand throttle is wide open the mark which was made on rod No. 10 when shaft No. 1 began to move, must be 2" from face of cover No. 4. This means that rod No. 10 will have $2-3/8$ " movement by hand throttle from off to wide open position. These settings are very important and must be followed if full power is expected out of the engine with the most economy and once set correctly should not need further attention until changed account of loose pins or overhauling. Should governor act sluggish see that all parts are free and well oiled; be sure that rods No. 10 and No. 11 do not become bent or injured by rough handling.

Operation of the Engine.

Too much emphasis cannot be placed on the proper lubrication of an internal combustion engine. Before starting the engine it is very necessary that all parts to be lubricated must be thoroughly gone over, also be sure that sufficient lubricating oil is in the oil tank. Immediately upon starting the engine the operator must first observe that the correct oil pressure is being pumped up. This should be 40 pounds or more, and if the gauge does not show any indication of pressure the engine should be stopped immediately, and the cause determined before attempting to start the engine again. An internal combustion engine can be rendered useless in a very short time by operating it without sufficient lubricating oil of proper grade.

Before starting the engine, inspection should be made to be sure that sufficient cooling water is in the cooling system. Any leaks in the pipes, joints, gaskets and hose connections should be taken up immediately. For the best operation of the engine, the temperature should be maintained between 180°F . and 190°F . For ordinary operation the temperature should always be maintained above 185°F . and when a temperature of 200°F has been reached, the engine should be operated with extreme care and precaution. Use all the available facilities to prevent the temperature from going any higher, and make an examination for the

THE ABOVE LIST OF CAUSES OF OVERHEATING IS NOT EXHAUSTIVE
AND SHOULD BE KEPT IN MIND AT ALL TIMES. THE ENGINE IS
DESIGNED TO OPERATE AT A NORMAL TEMPERATURE OF 180° F.
AND SHOULD NOT BE KEPT AT A HIGHER TEMPERATURE FOR
ANY LENGTH OF TIME.

conditions listed below as causing the engine to overheat.

In filling the cooling system, only clean, soft water should be used; dirty water will cause considerable sediment to collect in the engine and cooling system, quite frequently mud and scale from hard water will collect on the small cooling passages in the radiator almost closing them. If possible, use soft water and above all, use clean water. Water that has oil in it is very objectionable. Should the engine temperature go below 180°F. due to low or insufficient water, the engine should be allowed to idle very slowly to keep the water circulating and hot water, if possible, should be added. If it is necessary to add cold water due to lack of hot water, the cold water should be added very slowly while engine is running slowly. The introduction of cold water around the cylinder walls and cylinder heads of the hot engine is very likely to cause cracks to occur in the cylinder head due to the rapid reduction in temperature of the cast iron. This should be kept in mind at all times when the engine has exceeded the maximum allowable temperature of 200°F.

It is not absolutely necessary that the engine be perfectly clean to operate, but it is recommended that the engine, electrical equipment and the entire engine room be kept as clean as possible; for then, when it is necessary to do work in an emergency, conditions will be most favorable for quick and easy repairs. By carefully cleaning the equipment occasionally, quite frequently loose connections and defects can be detected and repairs made before they become serious. It is strongly recommended that wiping rags be used altogether in connection with the operation of this equipment as the use of waste is likely to deposit considerable lint. Quite often small pieces of the waste will drop off; should some of this get in the lubricating system of the engine it would prove disastrous.

Caution: Do not wipe engine, electrical equipment or any parts while they are running.

Should any oil be spilled or leak on the engine room floor or on the engine it should be carefully wiped up and the oily rags burned or washed. Do not allow old oily rags to accumulate in the corners of the motor car as this greatly increases the fire hazard.

The battery ignition should receive sufficient lubrication but must not be flushed with oil and it is very important that they always be kept clean. It is very important that all carburetor connections be kept tight, and as soon as a leak develops in any part of the fuel system it should be repaired at once as this greatly increases the fire hazard.

Careful attention must frequently be given to the valve clearance adjustments. This should be .015" intake .030" exhaust (cold). If they are adjusted with too much clearance the valves will be noisy and if insufficient clearance is given the valves are very likely to burn or warp, which will necessitate regrinding them and in severe cases the valve must be replaced, also

causing deterioration of valve seats and cracking of cylinder heads. It is recommended that at all times when operating the engine with light or no load, the speed be kept below 700 r.p.m. When it is necessary to adjust the governor for no load speed then short periods of operation at full speed are permitted, but never should the engine be operated over 900 r.p.m. under full load.

Engine Over-heating:

If engine becomes overheated feel the pipe leading from expansion tank to the pump and the pipe leading out of top of engine. If the top pipe is considerably hotter than the bottom pipe, it would indicate the cooling water is not circulating.

Look for:

- (a) Insufficient water in that system.
- (b) Water pump impellor not rotating.
- (c) Obstructed radiator core tubes or obstructed water passages through piping or in engine.

However, if both the top and bottom pipes of that engine are about the same temperature, the water is circulating and something less serious is probably wrong. Look for:

- (a) Fan motor not running.
- (b) Inadequate oil supply reaching cylinder walls.
- (c) Engine overloaded.
- (d) Dragging resistance - brakes.
- (e) Radiator cores may be covered or obstructed so air cannot circulate.
- (f) If on first trip after engine has undergone repairs, have ignition timing checked.

Poor cooling water circulation. Examine all hose connections. Be sure that the flange rubber gaskets do not have fins projecting into the passage of the cooling water, obstructing same. Be sure that sufficient water is in the cooling system and that the fan is operating satisfactorily. If any of the radiator shutters are in place they should be removed. If hard or dirty water has been used, probably the radiator and cooling system should be thoroughly cleaned. Make certain all valves are set properly and all radiators cut in. (See Pages 16 & 17, "Operation of Cooling System.")

The lubricating oil should be examined. If the heating is localized the lubrication of the hottest parts should be thoroughly investigated before operating the engine further. If the oil has just been changed, inquiry should be made to determine if this is the correct grade of oil. If the oil has been used a considerable length of time, investigation should be made to determine if it is time for changing the oil.

If any mechanical adjustments of bearings have been made recently, perhaps these parts have been fitted too closely and are causing localized heating. Correct adjustment should be made at once.

Too rich or too lean a fuel mixture or an inferior grade

of fuel will cause the engine to overheat. Leaky intake manifolds will also cause the engine to overheat.

Ignition timing should be examined to determine if the spark is occurring at the proper time. When magnetos are used both should be functioning. All spark plugs should be examined to determine if they are in working order.

Large deposits of carbon and improperly adjusted valves may cause the engine to overheat.

If the engine is heavily overloaded it may be expected that the temperature will increase proportionately. Also, if engine speed under full load is low, water circulation will be reduced and overheating of engine will result.

When operating in an extremely cold temperature have butterfly valve open to increase temperature.

A 3/4" shut-off cock is located on engine room floor to drain circulating system.

Engine Knocking:

Knocking or pounding in an engine is not always a result of worn or improperly fitted bearings; however, it is very necessary that the bearing clearances be kept within the limits specified in these instructions.

An inferior and too light a grade of lubricating oil is very likely to cause the engine to pound or knock more than usual. More especially after this oil has been heated to the extent that it is too thin to form the proper lubricating film. Carefully investigate the lubricating system and the lubricant. Oil having a viscosity of less than 55 seconds Saybolt at 210°F. should not be used at any time.

The adjustment of the ignition timing, when set too early, will cause the engine to knock or ping considerably, more especially when under heavy load. This should be adjusted for the proper setting. One or more spark plugs failing will cause engine to knock.

Large carbon deposits in the combustion space will cause the engine to knock. If considerable carbon is deposited on the piston head, this condition will be somewhat aggravated.

An inferior grade of fuel will cause the engine to ping considerably under heavy load, more so when the engine is hot. This can be remedied by using a lighter throttle and changing the grade of fuel soon as convenient. A lean mixture will also cause ping.

Heavy overloads or low engine speed will cause the engine to labor and knock. Unless some of the electrical adjustments have been tampered with, it is not very probable that this will occur.

Engine Losing Power.

The ignition breakers should be checked for satisfactory operation, the spark plugs examined and cleaned and the spark advance examined for the correct firing position.

The carburetor should be thoroughly examined. The choke butterfly valve should remain in the full open position, the jets should be open and the fuel flow freely to the carburetor.

A poor grade of lubricating oil will not form the correct piston seal, causing loss of compression, as well as increasing the wear of all moving parts of the engine.

Poorly seated and leaking valves are quite frequently the cause of loss of power. Obviously, this causes poor compression.

System of Lubrication. (Study Oiling Diagram-Plate Nos. 1002, 1006.)

The lubricating system used on these engines is of the force feed dry sump type. There are two oil pumps. The outside or service pump of the dual pump draws the oil from the external oil reservoir or tank through the 1-1/4" suction line and strainer, forcing it under pressure to the back or inlet end (this is the carburetor side of the engine) of hydraulic control cylinder, and through the control cylinder to outlet side, thence to oil header. (Between oil control cylinder outlet and main header is a connector to oil pump which connects to the bypass No. 10, Plate 1002 or regulator. This regulates the pressure to main header and is adjustable. To increase pressure, remove cap at bolt on No. 10, Plate 1002 and place washers under spring; to decrease, remove washers or grind off spring to shorten. Pressure should be 50 lbs. with cold new oil. On cars equipped with Deadman's Control brake system, a throttle shut-off in the form of a bypass Valve No. 11 Plate 1002 is installed in the inlet line from hydraulic control cylinder and main pump, which bypasses all the oil in this line direct to the main header and causes spring in control cylinder to close the throttle when brake goes into application by Deadman's Control.

From the main oil manifold or header oil is forced through branch lines "C" to the crankshaft main bearings, which are grooved to provide a continuous oil flow to the passage in the crankwebs through which oil is delivered to the connecting rod bearings.

The oil escaping from the connecting rod and main bearings is mechanically atomized, or fanned into a mist, by the pressure of the service pump and by the centrifugal force of the rapidly revolving crankshaft. This atomized oil is thrown to the cylinder walls and all other internal bearing surfaces not supplied directly by the pump. The wrist pin bearings are lubricated by this spray through oil holes "M"

of the oil scraped from cylinder walls and passed to the bushings through oil holes, "L". The surplus oil then falls to the bottom of the crankcase, from whence it is drawn by the outer unit, or scavenger pump, of the dual oil pump assembly and forced to the oil cooling radiator through the line "A" Plate 1006 and to the top strainer; in line "B" Plate 1006 there is provided a spring loaded bypass set at 30 lbs. and is connected to line "B" Plate 1006 to provide a passage for the oil when radiator is clogged with heavy oil in cold weather, which drains into the oil tank, from where it is again circulated through the system.

A globe valve No.1 Plate 1006 is also provided in this line so that oil cooling radiator can be cut out and drained at night. This globe Valve No.1 Plate 1006 should be left open in extreme cold weather and oil allowed to bypass directly into tank until it has become warm enough to circulate through oil cooling radiator.

The suction for this scavenging pump is through a fine strainer located in the depression in the crank case called the oil sump. The strainer is screwed into the sump and can be easily removed (by the use of a large barrel or socket wrench) for the purpose of thoroughly cleaning the sump and the strainer. This strainer should be thoroughly cleaned every time the oil is changed. The suction strainer and top strainer should have the same attention.

Oil is fed under pump pressure through branch leads from the oil manifold to the cam-shaft and to the overhead valve mechanism through line No.12 Plate 1002 and branch line No. 13 Plate 1002 the valve roller and cam mechanism being enclosed, operates in a bath of oil, the surplus oil returning to the crankcase. The rocker levers are drilled for supplying oil to the valve stems and push rod sockets.

The train of gears on the end of the engine are sprayed by nozzles located above the uppermost gears, the oil being supplied by oil line. The idling gear shaft is hollow and oil from the manifold is forced through its center out two oil holes to the bushings on each side of gear. The ignition and water pump drive shafts are supported by bearings carrying bushings, these are lubricated by oil which is splashed into oil pockets in the bearings draining into holes drilled through to the bushings. The air starter distributing valve disc shaft is lubricated likewise. The oil pumps lubricate themselves. The governor is lubricated by a connection to the main oil header. The oil collects in the governor housing and is constantly being splashed over all moving parts, and any surplus is passed back into the crankcase. Where the shaft passes through the housing, lubrication is supplied as in the ignition drive shafts. To prevent oil from leaking out around the shafts thus lubricated, an annular groove is provided at the end of the bushing, with a hole drilled back into the inside of the case to allow the oil collected there to drain back into the housing.

The water pump shaft bearings and packing glands are lubricated by cup grease from Alemite fittings. The generator bearing and shaft pilot bushing are also provided with Alemite fittings, the latter is in the flywheel.

The oil pressure is controlled by a spring actuated oil by-pass valve located within the oil pump assembly. As the pump is designed to deliver more oil than can pass through the bearings when normal clearances are maintained, the surplus raises the valve from its seat in the by-pass No.10-Plate 1002 and flows back into the suction space of the same pump. A spring holds this valve on its seat until the predetermined oil pressure has been exceeded. The indicating pressure gauges are connected to the pressure side of this by-pass port.

Oil Pressure Regulation.

In the use of engines having force feed lubricating systems, the operator has often been led to believe that if his oil pressure is not high, the system is not functioning properly.

Pressure alone is not a measure of the quantity of oil flowing through the bearings at a given engine speed-the body of the oil and fit of the bearings are also factors that determine this.

When the oil is chilled it tends to thicken, consequently, it takes more pressure to force it through the various passages than when heated. Result: Cold oil-high pressure; warm oil, low pressure.

With warm oil in circulation and the bearings properly fitted, a gauge reading of 35 pounds or more at 900 r.p.m. is sufficient.

Caution: Should the gauge fail to register any pressure, STOP AT ONCE-do not, under any consideration, continue to run the engine until the trouble is corrected.

If the engine receives no oil, damage will result that will necessitate EXPENSIVE REPAIRS.

Do not change the by-pass valve setting without first carefully checking the following factors:

No pressure may be due to the following causes:

1. No oil in tank.
2. Use of unsuitable oil or oil of too light body.
3. Oil excessively diluted with fuel. Follow instructions for draining crankcase and oil reservoir.
4. Loose bearings due to wear or improper adjustment or poorly fitted shims. Refit bearings.
5. A leaky or broken oil line. Tighten connections or repair line.

7. Bearings improperly fitted.

Draining the Oil.

To reduce wear and maintain the efficiency of the engine, the lubricant must be kept in serviceable condition. This can only be done by draining the external oil tank at regular intervals and filling with fresh oil.

A good grade of oil does not break down to any extent or undergo any permanent thinning when it is heated. When diluted with a certain amount of fuel, however, its body may be so reduced that it will not properly separate the friction surfaces. A poor grade of oil or an oil not suitable for this service may have one or more of a multitude of serious objections; will not hold up in body; causes excessive carbon; sticky valve stems; deposits tarry substance, et cetera.

Particles of worn metal or carbon which flakes off the under side of the piston heads also contribute to this contamination. The accumulation of worn metal particles is greatest in a new engine, while the friction surfaces are being worked in to a permanent finish.

The oil tank is provided with a level gauge. While operating the engine, oil should always be visible in this level gauge. Do not add oil to tank unless the engine has been run to get all the oil out of the crankcase.

In line "J" Plate No. 1006 a globe valve is installed; to the opposite side of this globe valve there is a drain pipe. This globe valve must be closed at all times while operating the engine.

Method Of Draining Oil Tank and Cleaning Strainers.

1. Arrange suitable container for catching the drained oil. Open globe valve in the drain pipe and allow oil contained in the tank oil line "J" and the line from the pump to drain.

2. When the oil has been drained the strainers "W" and "Z" should be thoroughly cleaned with kerosene or distillate and blow off with compressed air. Remove the crankcase inspection plates and wash out the sump with a small amount of kerosene or distillate, using good clean rags, which are not likely to deposit lint, nap or strands of thread in the crankcase, which might possibly interfere with the correct lubrication at some time thereafter.

Waste should not be used under any circumstances. The oil drain channel on both sides of the sump, as well as oil sump "Y" should be thoroughly cleaned of all gummy deposits. The oil tank should also be cleaned in this same manner. The suction strainer No. 14, shown on Plate No. 1002, in the bottom of the tank should be removed and cleaned.

Filling the Oil Tank.

(a) Before refilling the oil tank be sure that the globe valve on the drain pipe is closed tightly.

(b) Be sure that the strainer "Z" has been replaced in the oil sump "Y" and the gasket making the joint against the sump casting is in good order.

(c) Open the vent valve "V" on top of the suction line to the service pump when provided.

(d) The oil may now be poured into the oil tank. (Note- Be sure strainer No. 14-Plate 1002 is in place.) Fill the tank until the oil level shows in the visible gauge at least one-half of a gauge.

(e) Replace the oil tank cover and the crank case inspection hand hole plates.

(f) The engine should now be operated for a few minutes on air pressure and the oil pressure gauge observed to note if the service pump is functioning.

Caution: At this time the engine should be started before the party changing the oil leaves the engine and everyone concerned should be sure that the oil is circulating properly.

It will be found advantageous to change the oil immediately after service operation, as the oil is then warm and will drain out much faster.

How to Avoid Crankcase Oil Dilution.

A good engine oil does not "break down" in service nor does it become permanently thinner after it has been subjected to heat. When mixed or diluted with a sufficient quantity of fuel, however, its body is proportionately reduced. This is what takes place in the crankcase of the engine under certain conditions. To keep the oil in its normal condition so that it will properly protect the engine, excessive dilution must be avoided. It can be controlled by careful attention to the following points:

1. Engine temperature is the greatest factor influencing dilution. If the cylinders are too cold, the heavy ends of the fuel do not vaporize and are not burned. The liquid fuel mixes with the oil on the cylinder walls or is blown past the piston into crankcase where it mixes with the oil supply. If, on the other hand, the engine is kept sufficiently warm, at least 120°F., preferably 160°F., the fuel will vaporize and part of the "diluent" already collected in the oil will be distilled off.

Distillate is a non-volatile fuel which is not evaporated either in the intake passage or later out of the lubricating oil in the crankcase. This fuel is atomized in the carburetor and then burned before it has a chance to collect on the cylinder

walls. High cylinder wall temperatures and regular firing of the engine are the only means of preventing oil dilution when burning distillate and special attention to ignition and carburetor is necessary. Care must be taken to avoid chilling of the cooling water in service or to allow missing when idling or during acceleration.

2. Renew the oil regularly. The oil tank should be drained regularly-at the required intervals.

3. Excessive choking is often responsible for dilution. When the carburetor is choked for starting, an excess of raw fuel is drawn into the cylinders. This is necessary because only the lighter fractions of the fuel will vaporize in the cold engine. The part that does not vaporize goes by pistons and tends to dilute the oil. An over-rich carburetor adjustment also promotes dilution for the same reason.

4. The mechanical condition of the engine is an influencing factor. If the ignition system is out of order and a cylinder fails to fire, the fuel which should have been burned goes to dilute the oil.

5. Idling for long periods or at too slow speeds promotes dilution both from the fact that the mixture is rich and that the engine loses its cylinder temperature.

Oil Cooler or Radiator.

An air cooled oil radiator is provided on the car for the purpose of cooling the lubricating oil.

The oil cooler is installed in the return line "A"-Plate No.1006. In order that the oil, when cold, may not be passed through the cooler, a spring-loaded by-pass valve is connected between the discharge pipe from the scavenging pump and the pipe returning to the oil tank from the cooler. When the oil is so cold that 30 pounds pressure is required to force it through the cooler it opens this by-pass valve automatically and goes directly to the oil tank.

Engine Data.

The firing order of the engine is 1-7-4-6-8-2-5-3

Valve clearance should be intake .015", exhaust .030" cold.

Minimum oil pressure should be 25 pounds per square inch.

The engine speed should not be over 980 R.P.M., at no load and the governor should hold a speed under full load at about 900 R.P.M.

The ignition should be set to fire as follows:

Model 148 Engine; 25° advance before top dead center.

QUESTIONS AND ANSWERS

ENGINE

1. Q. What is an engine?
A. A machine designed to convert the forces and products of nature into useful work.
2. Q. What is a gasoline or distillate engine?
A. An engine which takes the gasoline or distillate and air mixture into its cylinders and there is burned, producing power. This is a form of internal combustion engine.
3. Q. How many cylinders are there in this engine?
A. Eight.
4. Q. How are they numbered?
A. From one to eight. Number one being at timing gear or oil pump end, number eight is next to flywheel and generator.
5. Q. What is meant by a four cycle engine?
A. It takes four strokes of the piston to complete a unit of its work.
6. Q. What does each stroke of the piston do?
A. First stroke downward, Suction Stroke, draws mixture of fuel and air into cylinders (intake valves open).
Second stroke is upward, Compression Stroke, compresses the mixture (intake and exhaust valves closed).
Third stroke is downward, Power Stroke, piston being driven by force of the burning and expanding of the mixture (intake and exhaust valves closed).
Fourth stroke is upward, Exhaust Stroke, piston forcing out burned gases (exhaust valves open).
7. Q. How are the valves operated?
A. The valves are operated by the cam-shaft which is driven through gears by the crankshaft. Actual opening and closing of the valves is accomplished between camshaft and valves by the push rods and rocker arms.
8. Q. Where are the intake valves located in Model 148 engines?
A. The two inside valves on each cylinder head block.
9. Q. Where are the exhaust valves located in Model 148 engines?
A. The two outside valves on each cylinder head block.
10. Q. Are these valves liable to give trouble?
A. Yes.
11. Q. What trouble might these valves give?
A. Valves might be adjusted too tight, which will not allow valves to seat, others too loose, which will cause the tappets to pound.

12. Q. Should the engine be operated with valves improperly adjusted? Why?
- A. No. If adjusted too close, valves will not seat. This causes loss of power, burning and warping of valves and if continued may completely ruin the valves and cylinder heads. If adjusted too loose, valve mechanism will be noisy, in extreme cases causes loss of power.
13. Q. How should valves be set?
- A. Engine should be cranked over, by hand, until the cylinder's intake valve opens and closes, engine should then be given an additional one-half revolution. Both valves can be checked, then proceed likewise to the next cylinder.
14. Q. What duties do the valves perform?
- A. The intake valves open and admit fuel vapor to the combustion chamber; all valves close while the vapor is compressed and remain closed while fuel is ignited and piston moves down on its power stroke; the exhaust valves then open and allow piston to force the burned gases out into the exhaust manifolds.
15. Q. How do the valves affect the operation of car?
- A. The valves must open the full amount, in proper relation to piston travel, and be air tight when seated. If they do not, compression and power will be lost, valves will burn, and power pressure can leak into manifolds.
16. Q. What trouble might these valves give?
- A. Valve adjusting screws might be set too tight which will not allow valves to seat, or if too loose, will not properly provide ample opening and will cause the rocker arms to be noisy.
17. Q. What else is there on the valves that should be watched?
- A. The springs, which may break.
18. Q. If springs on valve break, what would be the result?
- A. The valves would not seat properly, or it would not seat fast enough and engine would miss and back fire.
19. Q. If valves do not seat, what will happen?
- A. If allowed to operate with valves not seating properly, valves and seats will carbon up, making regrinding necessary.
20. Q. If operation is continued and engine worked hard, is any further damage to be expected?
- A. Yes, it will burn valve seat, and cause head to break off and drop on piston, causing serious damage to engine.
21. Q. If valve spring breaks on run, what should be done?
- A. Disconnect all wires leading to spark plugs on that cylinder. Take out the push rod roller plug, and spark plugs, block or tie up the valves and come in on remaining cylinders which are functioning. If tools and spare springs are on the car, replace the springs. If only one of the two springs break, come into terminal without repairs.

22. Q. How are the rocker arm shafts oiled?
A. Forced feed; as oil pipe leading to rocker arm, which is hollow, allows the oil to flow around the rocker arm at shaft.
23. Q. Should these valves be oiled with any oil/^{other} than gas-engine oil?
A. No.
24. Q. What are two of the most essential functions of a gas-engine to make it run?
A. The right mixture of fuel and air and the proper ignition spark.
25. Q. How many carburetors on this Model 148 engine?
A. Four.
26. Q. What causes back-firing in the carburetor?
A. Poor mixture caused from jets being dirty. Strainer in fuel line, which is close to carburetor, being closed up. Sticking valves or valves not properly adjusted. Not enough fuel supplied carburetor. Leaking intake manifold gaskets and joints.
27. Q. If there are loud explosions in exhaust, what would you look for?
A. Sticking valves, valves not properly adjusted, spring broken on valve, ~~ignition~~ not properly timed will do this, but ~~ignition~~ cannot get out of correct timing unless tampered with. Fuel mixture too rich.
28. Q. How is the right level of fuel held in the carburetor?
A. By a float in fuel bowl which regulates needle valve pressure on its seat.
29. Q. What is the result if this float becomes punctured and fills up with fuel and sinks to bottom of carburetor fuel bowl?
A. Fuel will not have any regulation and will fill carburetor, flooding engine.
30. Q. How could you tell if this float leaked?
A. Fuel would flood out of air chamber; this must not be confused with dirt getting under needle valve, which also will make carburetor flood.
31. Q. What could be done to get in off run in this condition?
A. Take float out and wipe clean and see where fuel comes out; then make a large hole and let all fuel drain out of float; plug hole with gum or a stick; come in and report.
32. Q. How can ample fuel supply to carburetors be determined?
A. By raising needle valve allowing bowl to flood.
33. Q. How is dirt kept out of fuel systems?
A. First by a strainer mounted on side of engine; one for gasoline and one for distillate. Second, by a sediment trap

in bottom of each fuel tank.

34. Q. Which of these requires the most attention?
A. Those mounted on engine.
35. Q. How is gasoline and distillate forced up to carburetors?
A. By air pressure taken from main reservoir controlled through a reducing valve located in right rear side of cab.
36. Q. How are these controlled?
A. The gasoline and distillate are changed from one to the other by a three-way control valve located on the generator end of the engine.
37. Q. Is there any shut-off valve on this line?
A. Yes, in left hand corner of engine room.
38. Q. How many pounds pressure should be kept on this air line leading to fuel tank?
A. Four pounds.
39. Q. What troubles may be expected from the carburetors?
A. Lack of fuel supply; obstruction in lines or on strainer screens; clogged carburetor jets or bad intake manifold gaskets.
40. Q. What is the function of the carburetor?
A. To mix fuel and air in proper proportions to make a volatile or explosive mixture.
41. Q. What is the correct carburetor adjustment?
A. The carburetor jets are fixed in size and not adjustable. Do not tamper with or attempt to make any adjustments.
42. Q. What causes back firing or coughing back through the carburetors or if loud explosions occur in the exhaust system, what should you look for?
A. Engine cold, throttle open too suddenly, a valve sticking or adjusted too tight or valve spring broken, insufficient fuel supply to the carburetor bowls, incorrect ignition which may be caused by the ignition not being properly timed. However, this system will not do this unless it has been taken off and on replacing was timed incorrectly, or possibly the driving coupling has been loosened either manually or from wear.
43. Q. How do you know how many pounds pressure is on this line?
A. By the air gauge located on the regulating valve.
44. Q. What is ignition?
A. Ignition is that spark which fires the fuel mixture in the cylinders.
45. Q. How is this ignition made?
A. By the storage batteries.

46. Q. What are spark plugs for?
A. To conduct the electricity into the cylinders and there make a spark for burning the fuel-air mixture.
47. Q. How many spark plugs are there on Model 148 engines?
A. Tirty two.
48. Q. Where are they located in each cylinder?
A. On each side of each cylinder.
49. Q. What can happen to spark plugs?
A. The porcelains can be broken, allowing current to leak to a ground, the inside of plug can become carboned so that current will ground and not arc across points. Plug electrodes or points may warp to excessive gap clearance or even burn off.
50. Q. How can you detect a fouled spark plug?
A. By testing the spark plug with a spark plug tester.
51. Q. What gap should spark plugs have? How often should they be inspected?
A. .020". Once a week.
52. Q. How does the spark get into the cylinders?
A. Breaker points located in the interrupter housing of each system are opened and closed at a predetermined moment, by cams mounted on the distributor shaft. The high tension electricity induced by this make and break in each coil is led to a distributor rotary where in turn it is directed to the desired spark plug wire. Travelling along this wire it reaches the spark plug where jumping or arcing across the narrow gap between the points of the plug, ignites the charge in the combustion chamber.
53. Q. What would cause failure of the ignition system?
A. The most frequent cause is from over-oiling. This will result in breaker points becoming shorted or the point contact surfaces dirty or corroded or covered with carbon or oxide so that the contacts may become insulated from each other and current cannot pass between them.
54. Q. Should oil be used on this ignition system? How often?
A. Yes, fill oil holes at each end of distributor every twenty-four hundred (2400) miles. Avoid overoiling. This system to be oiled only by the maintenance force.
55. Q. If one ignition system does not function properly, what should be done?
A. Switch over to other ignition system.

56. Q. Name three important requirements to insure a smooth running gas engine?
A. Correct functioning of the carburetor, ignition system properly functioning and good compression in all cylinders.
57. Q. When operating on distillate what additional precaution must be taken?
A. Maintain water temperature of 185°- 190°.
58. Q. Where is No. 1 cylinder?
A. No. 1 cylinder is at the timing gear end of engine. No. 6 or No. 8 cylinder, as the case may be, is at the generator end of engine.
59. Q. How do you start engine when you have no air?
A. Close the main battery switch. Close air valve in left hand corner of engine room; turn on fuel valve at carburetor; place hand air pump on small tire valve at front of engine near base; pump by hand until air gauge in left hand corner of engine room shows 3 pounds; lift needle valve which protrudes from top of carburetor bowl until fuel flows out of air intake pipe. Open engine throttle about one inch; hold choke rod out; press down starter button and engine will go.
60. Q. Where is the starter on Model 148 engines?
A. The main generator acts as a starter by the use of special field coils, constituting a starting motor.
61. Q. If starter refuses to work, what would you look for?
A. See if large switch is in. Try another fuse, the largest one of all, which is located near the large switch. See if starter button makes a contact. Follow wiring and see if any wires are broken leading from battery or from starter button.
62. Q. What would you do if starter still refuses to work?
A. Try to get air in tank from outside source.
63. Q. If you could not get air, what then?
✓ A. Take a wire and run it from each end of the batteries to the two leads going into the starter.
64. Q. What else could you look for?
A. Try batteries, see if hydrometer shows them charged. Examine all leads going from one battery to another.
65. Q. After engine starts, what is to be done?
A. Open air valve in left hand corner of engine room which allows the air to go to fuel tank.
66. Q. What else do you do?
A. Make sure exciter switch is in.

67. Q. What comes next?
A. Be sure air pump switch is in.
68. Q. Why do you have to have exciter switch in?
A. This switch controls exciter field contactor and allows the battery current to pass through the exciter fields, which makes the generator work.
69. Q. Why do you put in air compressor switch?
A. This switch controls the flow of electricity to air compressor and allows the compressor to pump up air.
70. Q. Is there any other switch or fuse which runs on this air compressor line?
A. Yes, the fan motor switch.
71. Q. Is fuse in exciter switch was blown, what would happen?
A. Car would not move. Air pump would not work.
72. Q. If large main fuse was blown, what would happen?
A. Starter would not work.
73. Q. If small battery line fuse was blown, what would happen?
A. Car would not move; lights would not burn. Ammeter would show zero. Compressor would not work. Generator would not pick up.
74. Q. After engine is running and all valves have been taken care of, what should be the next thing to do?
A. Throttle should be brought out far enough to allow throttle relay switch to close; as it does, the ammeter should show a discharge when engine is idling and a charge when engine is up to speed.
75. Q. What else should you watch when pulling out throttle?
A. Water exciter field switch on panel board and see if it snaps in.
76. Q. Suppose it does snap in and ammeter does not show a discharge?
A. See that copper contacts on this switch are clean.
77. Q. If all this is done and still ammeter does not show charge, what then?
A. Look for loose wire to exciter. Loose connections.
78. Q. Where are the main fuses which are in the fan and air compressor line?
A. In a box located in a position above controller which enables engineer to see from his seat in cab.
79. Q. If ammeter shows charge and compressor does not function, what is to be done?
A. Put fan in; if fan operates; main fuses are O.K.

80. Q. Will fan or compressor operate if engine is idling?
A. No. Engine has to be turning 400 or 500 R.P.M.
81. Q. If fan operates, what then?
A. Take fuse out of air compressor switch and renew.
82. Q. What else can happen to make air compressor fail?
A. The governor switch of air compressor motor can be dirty or burned so switch will not make proper contact.
83. Q. Could valves in compressor stop the functioning of pump?
A. Yes to a certain extent, but this would show a little at a time; when compressor does not keep up air. Then take out valves and clean and oil them.
84. Q. What should be taken care of in the controller?
A. Fingers should be examined every week and the controller handle should not stick going from one position to another. File fingers if burned.
85. Q. What is meant by series or first positions?
A. The electricity comes from generator to controller to No.1 motor, back to controller; back to No. 2 motor and then back to controller and generator.
86. Q. What is meant by parallel or second position?
A. Both motors No. 1 and No. 2 get the electricity at the same time.
87. Q. What is meant by shunt or third position?
A. The field in motors is reduced and the motors run faster.
88. Q. When should you use series?
A. When starting the car.
89. Q. When should you use parallel?
A. When car is up to the series critical speed.
90. Q. When should you use shunt?
A. When car is exceeding the parallel critical speed.
91. Q. What does critical speed mean?
A. Critical speed is the speed at which position of controller can be changed without losing power at the wheels.
92. Q. Would there be any need of using shunt position if you can make your time in parallel position?
A. Yes; if speed is constantly above the critical speed, it saves fuel.
93. Q. Would you use shunt position on grade of any consequence when handling a trailer?
A. Yes, if over the parallel critical speed.

94. Q. Explain the flow of electricity from the batteries to the starting of the car.
A. When throttle is open, the contact switch at throttle comes out. This allows the electricity to go to first switch on panel board, which snaps in; from there it goes to the exciter field and ammeter will show discharge until engine is up to speed, when second and third switch on panel board will snap in and ammeter will show charge.
95. Q. What should batteries show on hydrometer test?
A. 1.250 to 1.275 and 1.230 to 1.250 for iron-clad batteries.
96. Q. If they keep on running higher, what would you do?
A. Adjust charging resistor or burn lights more.
97. Q. How high should water show over battery plates?
A. About one inch over plates, up to filling nipple.
98. Q. What is the permissible maximum temperature for operating batteries?
A. 110°F.
99. Q. What kind of water should be placed in these batteries?
A. Only clean distilled water that has been kept in a glass jar.
100. Q. How is engine started when you have air?
A. By allowing throttle to take hold of air valve at off throttle position; air enters through distributor valves which distribute air to the cylinders.
101. Q. When does this air go in each cylinder?
A. At 5° past top dead center on working stroke.
102. Q. How can you tell when one of the air valves stick?
A. The pipe leading to that cylinder will become hot.
103. Q. What would you do if this happened on the road?
A. Try to make it seat, if possible. Use a blind gasket in pipe coupling or remove valve body and plug hole.
104. Q. How is oil supplied to friction surfaces in engine?
A. By a positive driven pump, which is attached to front of engine on timing gear end.
105. Q. How many oil pumps on these engines?
A. Two.
106. Q. What does the service pump do?
A. Takes the oil out of oil tank and then distributes same to manifold in bottom of crankcase.
107. Q. What does the scavenger pump do?
A. Pumps the oil from sump in bottom of engine crankcase back to oil tank through strainer in top.
108. Q. How are the main bearings lubricated?
A. Through an oil passage drilled from manifold to each main bearing-not less than 25 pounds pressure.

109. Q. How are the connecting rods lubricated?
A. Through drilled holes in the crank shaft; these holes run from each main bearing to each connecting rod bearing.
110. Q. How are the cylinder walls lubricated?
A. Some of the oil will come out from the sides of the connecting rod bearings and be thrown on the walls.
111. Q. How are the rocker arms and shaft lubricated?
A. Oil is taken from main channel under engine bed to center of hollow shaft under pressure.
112. Q. How is the cam shaft lubricated?
A. The cam shafts have each bearing lubricated by a separate oil line from the main header.
113. Q. How are push rods oiled?
A. Oil channels are drilled in rocker arms, permitting oil to drill down on these parts.
114. Q. Where does the surplus oil go?
A. It flows into sump under the No. 3 piston inside of crankcase, from there it is picked up by scavenger pump and pumped back into oil tank.
115. Q. What is the correct oil pressure at idling speed?
A. With oil warm, 20 to 30 pounds in normal; 10 pounds minimum.
116. Q. What is correct pressure at full operating load?
A. At 900 R.P.M. with oil in good condition and warm, 40 to 60 pounds, 60 pounds normal.
117. Q. Can oil pressure be regulated?
A. It cannot. Pressure is set.
118. Q. If oil pressure gauge fails to show pressure where would you look for trouble?
A. First check level of oil in reservoir. Second, examine bypass and pressure adjusting valve for dirt on seat. Third. Oil line air bound.
119. Q. If unable to build up proper oil pressure, what should you do?
A. If pressure is obtained, but below normal, proceed slowly to next telephone and report for instructions. If no oil pressure shows, engine will be seriously damaged, even by careful operation.
120. Q. What is the hydraulic control cylinder?
A. The hydraulic cylinder is a cylinder operated by pressure of the engine oil pump and actuating the carburetor throttle.

121. Q. Where is the hydraulic control cylinder located?
A. On the engine cylinder block at the timing gear end of the engine.
122. Q. What is the purpose of the hydraulic control cylinder?
A. To prevent burning out engine bearings, by shutting down engine throttle in case of oil pressure failure. Also to magnify the force required to operate the carburetor throttle.
123. Q. Describe the flow of oil in engines not equipped with hydraulic control cylinder.
A. Comes from oil tank to service pump, which is the outer pump, out the other side of service pump to main channel. From main channel it goes to main bearings, connecting rod bearings, cam shaft, rocker arms, and cylinder; from there to crankcase, then to sump, then to return pump, which takes it back to tank from whence it came.
124. Q. Describe the flow of oil in engines equipped with hydraulic control cylinder.
A. Comes from oil tank to service pump which is the outer pump, out the other side of service pump to hydraulic control cylinder, thence to main channel. From main channel it goes to main bearings, connecting rod bearings, cam shaft, rocker arms, and cylinders; from there to crankcase, then to sump, then to return pump, which takes it back to tank from whence it came.
125. Q. Can you regulate pressure of the oil?
A. Yes, but it should not be tampered with.
126. Q. Where does the oil which is allowed to go through the by-pass go to?
A. Back to the suction side of the service pump.
127. Q. How high should you carry oil in glass at tank?
A. Half to full glass while engine is running.
128. Q. Where are oil strainers?
A. One in sump, one in oil tank at top, one in tank on 1" suction pipe.
129. Q. What should be done if in extreme cold weather cars stand outside all night?
A. Be sure oil is sufficiently warm in the morning before starting on the schedule.
130. Q. How often should you change oil?
A. Every 700-800 miles average.
131. Q. When you change oil, what care should be taken?
A. All strainers and bottom of oil tank should be cleaned. Never use waste to clean oil tank.

132. Q. What is liable to happen which would congeal oil and make it hard for pump to pick it up.
A. At the bottom of each piston sleeve there is a round rubber gasket which may develop a leak, allowing water to drop into crankcase and then into sump.
133. Q. If rubber gasket should leak, what is to be done?
A. Remove sleeve and renew gasket.
134. Q. Could you run if this was leaking?
A. Yes; come into the first terminal and make repairs.
135. Q. What is the purpose of the oil cooling radiator?
A. To keep the viscosity of the oil from getting too low and to maintain the body of the oil.
136. Q. What is the purpose of the by-pass valve as used in the oil line in connection with oil cooling radiators?
A. To prevent oil from going to the oil cooling radiators when the oil is so cold as to require 30 pounds pressure to force it through the cooler.
137. Q. Where is the trigger operated check valve located?
A. In the fuel line near the fuel tank.
138. Q. How is the trigger valve operated?
A. By pulling cable attached to trigger from any one of three control stations about the car.
139. Q. What is the purpose of the trigger operated check valve?
A. In case of fire and destruction of fuel line, to prevent spraying fuel and feeding the fire.
140. Q. Is the "dead man's by-pass valve" used only in conjunction with the hydraulic control cylinder?
A. Yes.
141. Q. Is the "dead man's by-pass valve" used with all hydraulic control cylinders?
A. No. Only on those cars whose air brakes have "dead man's control" feature.
142. Q. What does the "the dead man's by-pass valve" do?
A. Upon "dead man" application of air from brake system, it by-passes oil around the hydraulic control cylinder, which in turn shuts down engine throttle.
143. Q. What is the purpose of the engine governor?
A. To prevent overspeeds of engine and maintain a practically constant speed of the generator for its various loads.

Engineers and All Concerned: Watch carefully the lubrication as it is even of greater importance that oil be constantly supplied to an internal combustion engine than to a steam engine, as the walls of an internal combustion cylinder are exposed to the actual flame. The lubrication of cylinders and practically all bearings are constantly indicated by the oil gauge in front of engineer, also the gauge on the No. 6 or No. 8 cylinder.

Do not allow dirt or oil to accumulate around engine room and report all parts that do not function properly.

ELECTRICAL.

144. Q. What is the general method of operation of this car?
A. The mechanical power developed by the engine is converted into electrical energy by the main generator, which in turn is transmitted through the control apparatus to the electric driven motors mounted on the drive trucks.
145. Q. When does the main generator start to produce current?
A. As soon as engine is started and throttle is opened.
146. Q. How is current from the generator conducted to drive motors?
A. Through reverser and line switches.
147. Q. Where are car driving motors located?
A. On both axles of drive truck.
148. Q. What is the purpose of reverser and where is it located?
A. To change direction of current flow to the drive motors so that car can be operated forward or backward. This is located at bottom of high voltage cabinet.
149. Q. What is the purpose of the motor cutout cocks and where are they located?
A. To close the control circuit to the line switches. These are small cutout cocks located in air line feeding to "Series" and "Parallel" contactors.
150. Q. What is the purpose of the power contactors and where are they located?
A. There are three of these all located in High Voltage Cabinet.
151. Q. How are the line switches brought into contact?
A. They are operated by electro-pneumatic valve units, one under each set of main contacts. The valves are operated by electric control from the Master Controller.
152. Q. What may cause an electro-pneumatic valve to leak air?
A. Small particles of dirt or scale may accumulate on valve seat.
153. Q. How may this dirt ordinarily be removed?
A. By operating the valve manually a number of times, causing dirt to blow through. This will generally clean the valves either on the reverser, line switches; if a valve continues to leak or "blow", remove, disassemble and clean valve seat.
154. Q. What would prevent the line switches from making contact?
A. Battery switch not closed; air system not charged, or feed valve not regulating required 70 pounds pressure.

155. Q. What else would prevent these line switches from making contact?
A. Interlock fingers on the line switches and the small fingers on end of reverser drums. Check for loose and dirty connections and bent fingers.
156. Q. What is the purpose of the 80-0-80 scale ammeter on instrument panel?
A. To indicate charge or discharge of batteries.
157. Q. Where are the accessory switches located?
A. Air compressor switch is located over operator's side window at No. 1 end of car.
2. Headlight switches are in push button gang switch box mounted on side wall above operator's window. Headlight bright switch is operated by button at extreme right; headlight dim is operated by the next button to the left.
 3. Battery switch is located at the lower left hand side of control panel.
 4. Engine ignition switch located at second button from front of car. Field switches should also be turned to the "Off" position when engine is stopped.
 5. Fan switch is located over operator's side window.
 6. Numeral light and cab light switches are incorporated in the gang switch box and are stenciled for identification.
 7. Engine starting buttons are mounted in throttle control lever bracket and a starting button is also mounted on each engine. Engine starter buttons are first buttons toward front of car in gang switch.
158. Q. How can the charging of batteries be checked?
A. Battery ammeter should show "Charge" with engine running above 700 R.P.M. and also at fast car speed.

159. Q. What is the purpose of the '0-750' scale voltmeter on instrument panel?
A. These indicate the amount of electric current flowing into the traction motors, and enable the operator to judge proper car speed at which to shift the 'Series-Parallel' lever.

CAR OPERATION

160. Q. What precautions should be taken before attempting to start engines?
A. See that cooling system tanks are filled. Check fuel and oil supply. See that main battery switch and battery load switches are closed. See that exposed rotating parts are free from obstructions, particularly note that bar has not been left in flywheel or crank on end of crank shaft.
161. Q. How is engine rotated for starting?
A. A starting winding is incorporated in the generator. When electrical current is passed through this winding, the generator acts as a motor, turning the engine for starting.

162. Q. How do you start the engine?
A. 1. Close the battery switch in the low voltage control cabinet and control switch over operator's seat.
2. Move controller handle to "FF" position.
3. Set "Throttle" lever in idling position.
4. Turn ignition switch on.
5. Move the three-way fuel selector valve handle towards the right side of car.
6. Push the engine start button, mounted on engine instrument bracket and engine will start to rotate. Hold until engine starts firing; also use primer.
Note: Never attempt to start engines on distillate if the water temperature is below 170°F.
163. Q. If generator does not turn engine, what should be looked for?
A. See that control switch and battery switch are closed and controller is in 'OFF' position. For starting engine, see that "G" and "G1" contactors close when starting button is pressed.
164. Q. What else would you look for?
A. Check battery connections. See if battery load switches are in, and if correct, test battery with hydrometer. Specific gravity should normally be about 1.240 and never less than 1.110.
165. Q. If generator rotates engine, but engine does not start to fire?
A. See that supply of gasoline in fuel bowls is correct and that three-way fuel selector valve handle is properly set. Disconnect spark plug wire and hold its terminal about 1/16" away from cylinder head casting and rotate engine. If no spark appears the ignition is at fault.
166. Q. If ignition sparks at plugs and carburetor fuel bowls are filled to the desired level, but engine still not start firing, what should be checked?
A. Spark plugs may be fouled. Take all spark plugs out and clean, or put in new ones.
167. Q. If it is desired to run engine at faster than idling speed without moving car, what precaution must be taken?
A. Controller handle should be in the "Off" position and throttle lever can then be opened to give the desired engine speed.
Note: Do not run engine faster than 500 R.P.M. until engine has warmed up.
168. Q. How should engine be operated after starting cold?
A. Engine should be allowed to idle with "Throttle" lever in idling position, until it is warmed up, as indicated by thermometer. Check the oil pressure as indicated on the gauge.
169. Q. How long will this ordinarily take?
10 to 15 minutes, depending upon atmospheric temperature.

170. Q. Is it permissible to run engines with blower fans not operating?
A. Yes, if atmospheric conditions and engine water temperature permit; otherwise fans should be operated at speed necessary to maintain the proper engine operating temperature.
171. Q. How is car speed increased?
A. By increasing speed of engines.
172. Q. How is car speed decreased?
A. By decreasing speed of engines.
173. Q. How is speed of engine regulated?
A. By movement of throttle handle or lever. Safe maximum speed is maintained by engine governor.
174. Q. How is car started?
A. With throttle lever in idling position, move the controller handle to 'Series' position. Throttle can then be opened and car will move off.
175. Q. When should controller handle be shifted from (1) 'Series' to 'Parallel'; (2) 'Parallel' to 'Shunt'; (3) 'Shunt' back to 'Parallel'; (4) 'Parallel' back to 'Series'?
A. (1) When car speed has increased to 14 m.p.h.
(2) When car speed has increased to 29 m.p.h.
(3) When car speed has decreased to 29 m.p.h.
(4) When car speed has decreased to 14 m.p.h.
176. Q. If after starting engine, putting controller handle in 'Series' position, releasing brakes and car does not move as throttle lever is opened, what control units should be checked for failure of operation, and how should each of these be investigated?
A. Never attempt to move car until it is assured air compressor is operating satisfactorily and air gauge registers approximately 90 pounds. Seventy (70) pounds air pressure is necessary to cause the line switches to operate. If this is correct check both the throttle toggle switch and field switch for making contact and make sure the motor cutout valves in the power cabinet are in the proper position.
177. Q. What should the maximum speed of engine be, as indicated on the tachometer?
A. 900 R.P.M. under full load. 975 R.P.M. maximum without load.
178. Q. What might be indicated by speed lower than this when under load?
A. Throttle not fully open, ignition trouble, or engine not properly loaded electrically.

179. Q. What is the proper operating temperature for gasoline operation?

A. Water temperature should be 150 to 180 degrees; 160 degrees is preferable. For distillate operation the water temperature should be 180 to 190 degrees. The transfer from gasoline to distillate should be made after the engine cooling water has reached a temperature of 170 degrees or higher and if the engine cooling water temperature decreases below 170 degrees, the engine should be transferred from distillate back on gasoline. The engine should never be run over 500 R.P.M. until the water has at least reached a temperature of 140 degrees F. Engine should neither be run on gasoline or distillate if the temperature has reached over 200 degrees. If engine temperature exceeds 200 degrees instructions given on page 12 should be followed.

180. Q. How is this controlled?

A. By the regulation of the fan or blower motor speed and the butterfly valve in water circulating system. In extreme cold climates, section of radiators can be blocked off.

181. Q. What is the length of time car can be run with a maximum amount of current flowing as indicated at the power circuit ammeter?

A.

CURRENT LIMITS

<u>Time</u>	<u>297-A-51 Motors</u>	<u>Operating Position</u>	<u>Limiting Equipment</u>
Continuous	Amps.	Parallel or Shunt	Generator
Hourly	Amps.	Parallel or Shunt	Generator
Continuous	Amps.	Series	Motors
Hourly	Amps.	Series	Motors

182. Q. How is control operated at No. 2 or rear end operating position on double end control cars?

A. Same as control in engine room end, with exception of compressor switch.

183. Q. How is engine temperature checked at rear operating position?

A. By fan switch and thermometer reading.

184. Q. How may engine be stopped in an emergency from rear end of car when operating double end control car?

A. By releasing brake valve handle or foot pedal at any time the brakes are not applied.

185. Q. Should the throttle lever be moved to the 'Off' position before stopping from rear of car?

A. Yes, move throttle lever to 'Off' position before stopping engine except in the case of an emergency.

186. Q. In what position should handle in Master Controller be when operating from opposite end of double end control cars?

A. Off. Reverse lever should be removed.

187. Q. On double end control cars what would happen if operator should provide himself with an extra reverse lever so as to have one set for front controller and other for rear controller?
- A. CAUTION: Do not use more than one set of handles or levers as furnished per car. Serious damage to equipment and erroneous car movement can result. When changing ends, take reverse lever out of controller at its 'Off' position and carry it with the brake handle and throttle lever to the other end of the car.

AIR BRAKES.

188. Q. What power is used to operate the brakes on these Gas-Electric Motor Cars?
- A. Compressed air normally and by hand if air brakes are inoperative.
189. Q. How is the air compressed?
- A. By a motor driven two cylinder air compressor.
190. Q. Explain the operation of the compressor?
- A. Power is transmitted from motor shaft to crank shaft by a pinion and gear. Assuming the left position to be on its backward stroke, a suction is created in the air cylinder, which opens the inlet valve and draws air through the inlet pipe and suction strainer into the cylinder. On the return stroke of the piston the inlet valve closes and the air in the cylinder is compressed lifting the discharge valve and passing through ports into the discharge pipe and thence into the main reservoir. The same operation takes place in the right cylinder except that it is compressing air while the left cylinder is drawing air in. In this manner the main reservoirs and equipment are charged up.
191. Q. What is the voltage of these motors?
- A. These motors operate normally at 400 volts. This is obtained from the main generator.
192. Q. How is air compressor governor adjusted?
- A. Governor adjusting screws are marked High and Low. Make one quarter turn on each of the two adjusting screws at same time to prevent getting out of balance. Screwing down raises and screwing up lowers governed air pressure.
193. Q. What designation or name has been given the air brake equipment on these Gas Electric Motor Cars?
- A. The Westinghouse A.M.L. combined automatic and straight air brake equipment with safety control features.
194. Q. Name the principal parts of this equipment.
- A. Motor driven air compressor, main reservoirs, safety valves, equalizing reservoir, "L" triple valve, auxiliary reservoir, double check valve, brake application valve, brake cylinder, slack adjuster, check valves, cut-out cocks, foot-valve, diaphragm cut off valve, brake valve, pilot valve and oil by-pass control valve.

195. Q. What pipe connections are made to the brake valve?
A. Control pipe, straight air by-pass, straight air pipe, brake pipe, equalizing reservoir pipe and exhaust pipe.
196. Q. What pipe connections are made to the pilot valve?
A. Feed valve pipe leading to outer pilot valve chamber and safety control pipe leading from chamber in pilot valve body.
197. Q. How many positions of the brake valve are there?
A. Seven.
198. Q. What are these positions called?
A. Release, straight air lap, straight air application, automatic lap, automatic service, handle off and emergency positions.
199. Q. Trace the flow of air from main reservoir thru system with brake valve in release position.
A. Air flows from the main reservoir through the feed valve where it is reduced by proper pressure. Air at feed valve pressure flows through pilot valves to safety control pipe through the foot valve and through pilot cut off valve to brake application valve charging brake application valve cylinder, on the same side of the piston as is the return spring. At the same time air at feed valve pressure flows through pipe connected to opposite end of brake application valve charging the slide valve chamber. Then the air flows from the slide valve chamber to control pipe, to brake valve, through passage in brake valve to the top of rotary valve and through port in rotary valve to brake pipe, equalizing reservoir, and top and bottom chambers of equalizing pistons. The brake pipe air flows to the triple valve charging the system. A pipe from the low pressure side of feed valve supplies air direct to the triple valve by-pass valve.
200. Q. Trace the flow of air from the brake valve in straight air application position.
A. Air on top of brake valve rotary flows through port in rotary to straight air pipe through double check to brake cylinder forcing piston out and operating the levers, rods, etc.
201. Q. Trace the flow of air in straight air release position.
A. When the brake valve is placed in release position exhaust port in rotary valve is opened and the air from brake cylinder is thus released to the atmosphere through the double check valve and straight air pipe.
202. Q. Trace the flow of air in automatic service application position.
A. When the brake valve is placed in automatic service position all the air supply to the brake pipe and equalizing reservoir is cut off and the preliminary exhaust port in

brake valve is connected to the atmosphere which permits air to escape from above the equalizing piston. This allows equalizing piston to raise, opening the brake pipe exhaust valve to the atmosphere, and allowing brake pipe pressure to exhaust. In this manner brake pipe reductions are made producing brake application. When brake valve is placed in lap position ports are closed by equalization and brake pipe exhaust is closed causing brake to remain set until brake valve is placed in release position.

203. Q. In case of danger requiring quickest possible stop, what position of brake valve is used?
A. The brake valve should be placed in emergency position leaving it there until car stops. With the brake valve in emergency position the brake pipe is opened direct to the atmosphere through large ports in the brake valve, causing a sudden drop in brake pipe pressure.
204. Q. Does the brake application valve operate when automatic brake applications are properly made?
A. No.
205. Q. When does the brake application valve operate?
A. Whenever both the foot valve and brake valve handle are released at the same time, with brake valve in any position, except when there is more than 35 lbs. pressure in the brake cylinder.
206. Q. What precaution should be taken with this type of equipment?
A. Brake valve handle or foot pedal must be held down, at all times, when car is in operation.
207. Q. Explain the operation of the brake application valve.
A. When both the foot valve and brake valve handle are released at the same time air pressure on one side of the piston is exhausted to the atmosphere. When the spring raises the brake valve handle, after the hand is removed, it also closes the outer pilot valve, cutting off feed valve pressure from the safety control pipe and opens the inner pilot valve allowing the pressure in the safety control pipe and in the chamber on one side of the application valve piston to exhaust through the cut off valve and inner pilot valve to the atmosphere. The feed valve pressure in the slide valve chamber on the other side of the piston will force the piston and slide valve to emergency position. The port in the slide valve seat leading to the brake pipe is now connected through the slide to the passage leading to the application valve exhaust, allowing the brake pipe air to rapidly exhaust to the atmosphere and produce emergency application of the brakes. At the same time the pressure supplied to the automatic oil by-pass control valve by a safety control brake application causes the piston to move and open the oil by-pass valve which causes the engine lubricating oil to pass around the hydraulic throttle control cylinder, automatically reducing the engine to idling speed. The

all to be made from above the 300 lb. pressure
equal to the 100 lb. pressure in the atmosphere which is 14.7

engine speed cannot again be increased until the application valve piston moves back to release position which permits the air pressure to exhaust from the automatic oil by-pass control valve. This closes oil by-pass valve allowing hydraulic control cylinder to function and again respond to movements of throttle. If, however, a brake application is made, resulting in more than 35 lbs. brake cylinder pressure, the diaphragm pilot cut off valve will operate, holding pressure on the return spring side of the application valve piston and thus preventing it from moving to safety control position.

- 208. Q. Explain the release of the brakes after a safety control application.
A. The brakes cannot be released until the brake valve handle is held down, in release position, with foot removed from pedal of foot valve, so that feed valve pressure can flow through pilot valve and cut off valve to application valve. As soon as the pressures are equalized on each side of the application valve piston, the spring returns the piston and slide valve to release position. The feed valve port in the seat is uncovered by the slide valve and feed valve pressure flows through the control pipe to the brake valve and thence to the brake pipe and triple valve recharging the auxiliary reservoir, releasing the brakes.
- 209. Q. Does car operate on straight or automatic air?
A. Either.
- 210. Q. How should car be operated?
A. Straight air for single car train and automatic air for trailer operation.
- 211. Q. What is necessary to change from straight to automatic operation?
A. By opening or closing valve in straight air pipe beneath Engineer's valve. Valve handle to be parallel with pipe for automatic air operation.
- 212. Q. How is main reservoir pressure controlled?
A. By air pressure to a governor which operates electrical contacts that open and close electrical circuits between the main generator and compressor motor.
- 213. Q. What is standard brake pipe pressure on gas-electric cars?
A. 90 lbs.
- 214. Q. What is standard main reservoir pressure?
A. From 110 to 130 lbs. which range allows pressure governor control.
- 215. Q. What regulates the brake pipe pressure?
A. A type M-3 feed valve.

216. Q. How should feed valve be adjusted?
A. Remove cap and turn nut 'In' to raise pressure and 'Out' to reduce pressure.
217. Q. What kind of a triple valve is used?
A. A type L-3 triple valve.
218. Q. If trailers with FM equipment are operated behind a motor car with LN equipment, is it best to make graduated or direct release?
A. Direct release.
219. Q. Normally, how should a motor train be stopped?
A. Make two applications when stopping from high rate of speed and one application when stopping from a low rate of speed using direct or graduated release depending upon type of trailer brake equipment. Do not make more than a 15 lb. automatic application and use split reductions according to speed.
220. Q. Why should not a heavy application be made at low rate of speed?
A. Too heavy an application may result in wheels sliding and rough handling.
221. Q. When should sand be used?
A. Only in making a stop where rail conditions may cause the wheels to slide. Sand should be used only when actually needed to diminish the possibility of same getting into traction motors and causing damage.
222. Q. What is correct piston travel for air brake cylinders?
A. 4-1/2" standing, or 5" running piston travel.
223. Q. How is piston travel maintained?
A. By Westinghouse Type K Slack Adjuster on end of brake cylinder.
224. Q. How may slack adjuster be returned to original position?
A. By backing off adjusting screw on slack adjuster and adjusting truck lever spreader rods.
225. Q. How can brake handle and foot pedal be released?
A. By making a 15 pound reduction, or having a 35 pound brake cylinder pressure.
226. Q. What care do the air storage tanks require?
A. Never let water or oil accumulate in the tanks. Cocks are provided at each tank for draining daily.
227. Q. What should be done if feed valve sticks and brake pipe pressure goes up to reservoir pressure?
A. Take cap off feed valve and throw brakes on emergency which will remove all air from brake pipe. Then turn nut in feed valve all the way out and start over again and build up to 90 pounds.

228. Q. What precautions should be taken when operating with trailer?
A. Open all shut-off cocks except 1/2" cock in straight air pipes.
229. Q. In case of leakage through brake valve, where would you look for trouble?
A. Either in No. 4 double check valve at center of car, or in rotary of brake valve. Valves should be taken out and cleaned thoroughly.
230. Q. What should be done if motor car is moved in train (dead) or handled by locomotive?
A. Brake valve handle should be removed, and brake pipe cut-out cock under brake valve should be closed. The three cut-out cocks in the safety control piping, which are connected together and operated by a common lever underneath the car, should be locked and the cut-out cock in the pipe connecting the safety valve to the brake cylinder should be open.
231. Q. Why should this safety valve cock be open when handling in a train or by a locomotive?
A. To limit the pressure obtainable in the brake cylinder to 30 lbs. and prevent the sliding of wheels which might occur if brake pipe were overcharged.
232. Q. What should be done if brake pipe on motor car should break at a place that repairs could not be made?
A. Broken pipe should be plugged and motor car handled with straight air.
233. Q. If safety control feature should become defective or give trouble and repairs could not be made, can this feature be cut out?
A. Yes, by plugging safety control pipe (or brake application valve) shutting down compressor and bleeding all main reservoir pressure. The heavy spring on one side of the application valve piston would then return slide valve and piston to release position. Then start air compressor and charge up equipment. Automatic brake could then be used but the safety control feature would be inoperative.
234. Q. What could be done if equalizing reservoir pipe should break?
A. If repairs cannot be made, brake pipe exhaust should be plugged and brake valve handled very slowly towards emergency position to make a gradual brake pipe reduction being careful to prevent an emergency application.
235. Q. How should brake pipes be tested for leakage and how often?
A. What amount of brake pipe leakage is allowed?
A. Before leaving roundhouse each trip a 15 lb. reduction should be made, brake valve lapped and brake pipe hand gauge watched. The leakage should not exceed 5 lbs. per minute. This test should be repeated before leaving initial station when car inspectors test out train.

236. Q. How should main reservoir and pipe connections leakage be tested and how much leakage is allowed?
A. Air pressure in main reservoir should be pumped up to 100 lbs. air compressor shut down, a 10 lb. reduction made and brake valve lapped. The drop in pressure will be shown by the main reservoir hand on air gage. This should not exceed 3 lbs. per minute.
237. Q. What is the last thing that Engineman or operator should do before leaving motor car?
A. Apply hand brake using outside brake wheel at rear end of motor car and see that hand brake in engine room is fully released. Also see that air brake valves are left in proper position for handling motor car with a locomotive.

MISCELLANEOUS

238. Q. Where is bell valve located?
A. In front of operator's seat alongside brake valve.
239. Q. Where is whistle valve located?
A. At front of operating compartment, near roof, and has cord attached.
240. Q. What is the purpose of tachometer mounted on engine?
A. To indicate engine crankshaft speed.
241. Q. Where are the sander valves located and what is method of operation?
A. These are Graham-White sanders and are operated the same as the sanders on a steam locomotive.

TROUBLES, CAUSE AND REMEDY.

242. Q. What damage may result from filling a hot engine with cold water?
A. If the water has fallen below the level of the cylinder heads, castings of the engine will very likely be cracked, due to the sudden chilling when being refilled after being hot.
243. Q. How can you determine whether water is circulating?
A. By comparing temperature of water pipes immediately below and above the pump. If water is circulating, these pipes should be the same temperature, otherwise outlet pipe will be hot and the intake pipe will be cold. If water is circulating, level in gauge on expansion tank will drop quickly as engine is accelerated.
244. Q. What level do you want in cooling system of engine?
A. On roof radiation cars, fill system (with engine shut down) until expansion tank is full. Never operate car when some water cannot be seen in gauge glass.

245. Q. What would you do if operating temperature of engine suddenly becomes excessive, as indicated by water boiling?
- A. 1. See that radiator faces are not obstructed.
 2. See that radiator fans are operating.
 3. See that oiling system is full and functioning properly.
 4. See that cooling system is full of water.
 5. See that water is actually circulating.
246. Q. If car runs and engine is operating smoothly and quietly, but car does not appear to have enough power?
- A. 1. See that engine is free.
 2. Determine whether is firing on all eight cylinders.
 3. Examine brakes for dragging resistance.
 4. See that electrical loading of generator has not been tampered with.
247. Q. Under what conditions, if any, should car operator attempt to change loading of generator?
- A. Operator should never change any adjustments. This is a duty solely for the maintenance department and overloading of engine should be reported to them.
248. Q. When should the maintenance department attempt to make a change in the loading of a generator?
- A. Only after it has been ascertained that engine is functioning properly otherwise.
249. Q. 1. What trouble may occur with contacts in controller?
 2. Under what condition if any should car operator make repairs to this unit?
 3. What care should be given the controller by the maintenance department?
- A. 1. Contacts may become dry, causing the drum to work hard, when being moved. Fingers might become loose or bent.
 2. Operator should report this trouble, or if car is tied up on road, finger may be tightened or contacts lubricated, using vaseline or cup grease sparingly with a rag.
 3. The fingers should be checked for clean contacts, and occasionally lubricated with a small amount of vaseline, applied with a cloth. Periodic inspection should be made also for loose or bent fingers.

WHAT CONDITIONS WOULD CAUSE THE FOLLOWING:

250. Q. If engine will not turn when 'Engine Starting Button' is pressed?
- A. 1. See that controller handle is moved to 'OFF' position.
 2. Make sure that throttle lever is placed in idling position.
 3. See that throttle is not out too far.
 4. See that battery switch is closed.
 5. See that battery load switches are pushed in.
 6. Observe whether contactors "G" and "G1" close when power plant starting button is pressed. If these contactors do not operate, check the fingers on the controller, throttle switch contacts.

251. Q. If engine cannot be started, although it can be turned over in the regular way by starting arrangement?
- A. 1. Check to see that fuel is gasoline, see that three way fuel selector valve is on gasoline.
2. See that ignition switch is on. Choke when starting.
3. Check level of gasoline in main tank and see that strainers are clean.
Note:-If engine should stop while running, always check fuel supply.
252. Q. If engine is not firing on all cylinders?
- A. 1. Locate lame cylinder by trying first one set of plugs with a spark plug tester.
2. Remove 'dead' spark plug, replace with a new one, or clean and replace. Adjust gap to .020".
3. If no spark appears as a plug is being 'shorted', trace its lead to ignition system.
253. Q. If engine appears lame or continues to run with continuous backfiring through air inlet of carburetor and after fuel supply has been checked, this is indicating that a valve is sticking open or that a valve adjusting screw is too tight (has not specified clearance of .015" for the intake valve and .030" for the exhaust valve.)
- A. Remove valve mechanism covers and check each rocker arm for freedom of valve stems when engine is turned by hand and for clearance between screws and valves when piston is on firing position of each particular cylinder. If all have clearance, idle engine and note again whether a valve seems to stick, that is, not return to seat promptly. If this is found, work a small amount of kerosene, alcohol or penetrating oil in around valve stem and at the same time, work valve down and up with a small bar or screw driver until free. If unable to free up, pry valve closed, remove spark plug wires leading to this particular cylinder, remove all four rocker arms and exhaust side spark plug for defective cylinder and come in on seven cylinders.
In case of stuck exhaust valve and it is impossible to free up, or pry it closed, it is not advisable to operate engine unless in case of extreme necessity, as serious damage may result, such as a scored piston and cylinder sleeve.
254. Q. If oil pressure drops around 30 pounds on open throttle?
- A. 1. Check supply and condition of oil in crankcase.
2. Examine pressure by by-pass valve on oil pump for dirt on seat.
3. See that oil pump drive is correct.
4. Look for obstructed or broken oil pipes inside and outside of engine.

255. Q. If oil pressure appears to fluctuate when throttle position and engine speed are held constant?
- A. 1. Check oil level in reservoir; if too low; air enters pump.
2. If fluctuation is slow, pressure adjusting valve may have dirt in seat.
3. If fluctuation is rapid, causing pressure gauge to tremble violently, look for a broken or partially obstructed oil pipes and leaking connections or gaskets.
4. Pressure gauge may be bad, or oil pressure pipe connection may be attached to crankcase near the oil passage to a bearing, which has started to burn out or wear to excessive clearance.
256. Q. If car will not move with engines running?
- A. 1. See if exciter switch over operator's seat is pushed up or check control fuse in the switch box and small fuse in control cabinet.
2. Check contacts on throttle switch and Field Switch.
3. If line switches "S1", "P1", "P3", fail to close, check the control pressure; this must be 70 pounds.
4. Check the interlock fingers on these line switches.
5. See that motor cutout switches are closed.
6. See that the field switches close.
257. Q. If line switches cannot be made to operate?
- A. Block "P1", "P3" line switches with pieces of wood to make contact. Run with controller handle in "Parallel" position only. This practice recommended only to get car to a siding or to a terminal, providing there are no stops during the remainder of the run.
258. Q. If a pneumatic valve operating any of the electro-pneumatic switches sticks?
- A. Work valve operating pin a number of times, which will probably loosen the valve.
259. Q. If one traction motor is damaged; i.e., burned out, short-circuited or ground?
- A. This will be evidenced by car not moving in series. By examining the motors, if one is damaged, it will be much warmer than the other traction motor. Continue trip on the remaining motor with controller handle in 'Parallel' position. Do not run over half speed in parallel position with one motor.
260. Q. How is a traction motor cut out?
- A. 1. If No. 1 traction motor is to be cut out close No. 2 and No. 3 power contactor valves.
2. If No. 2 traction motor is to be cut out close No. 1 and No. 2 power contactor valves.

261. Q. If a traction motor armature bearing runs excessively hot?
A. 1. Tanke all waste out, clean off the charred part and repack bearing. Put in oil until level measure three and one-half inches (3-1/2) in oil well.
2. If bearing continues to run hot, or burns out; take all waste out, repack bearing and put in plenty of oil. Then cut this motor out by closing the contactor valves.
Note: -Place controller handle in 'Parallel' position and watch voltmeter carefully. Do not exceed 15 M.P.H. with one motor.
262. Q. If traction motor axle bearings run excessively hot?
1. Take out all waste and remove the charred parts, saturate the remaining good portion with oil; then repack bearings. Add oil until level measures three and one-half (3-1/2) inches in the oil well.
2. If bearing continues to run hot, repack using plenty of oil, loosen the four bearing cap bolts, and continue to run with motor cut out, as explained under No. 260.
263. Q. If compressor motor will not operate (pump air)?
A. See that compressor switch is closed.
Check for blown fuse.
Check governor for poor contact, a broken wire, or possibility of being stuck.
Note: Defective fuses are the most frequent cause of compressor motor failing to operate.
264. Q. If blower motor will not run (does not start)?
A. 1. See that switches above front operator's seat is closed and set properly. Also see that contact is made properly.
2. See that fuses are not blown.
265. Q. If generator will not build up voltage?
A. 1. Check control fuses.
2. Check operation of field relay "F1" in low voltage cabinet. This may be sticking or not making contact, or field switches on ignition panel not being in the 'On' position.
266. Q. If engine will not come up to governor speed on normal load?
1. Make sure carburetor throttle opens fully.
2. Check ignition and timing.
3. Make sure engine is firing evenly, etc.
4. Engine may be overloaded, due to some changes of adjustment on exciter field resistance tube. Raise the band on this tube to unload the engine.

INSTRUCTIONS FOR OPERATING STEAM HEATING SYSTEM

The following controls are used for the operation of the Peter Smith, Steam Heating System, as shown on Plate No.100S:

Main line switch (#1) is located on bulkhead in heater room.

The intermediate gauge cock (#2) located on boiler is used to indicate the height of water in boiler. There is also a high and a low test gauge (no number) located above and below #2 cock respectively.

Water gauge glass (#3) shows the height of water in boiler.

Valve (#5) is used to let air out of boiler.

Metering valve (#7) is used to control the flow of oil into the burner.

Switch (#8) controls the oil burner motor.

Switch (#11) is an automatic switch which controls the fire, when the pressure reaches a pre-determined pressure setting.

Key valve (#12) is used to regulate the low fire setting, so as to maintain sufficient fire to avoid the fire going out.

Switch (#13) is an automatic switch which starts and stops the boiler feed pump, thereby maintaining the water level in the boiler.

Switch #14 is an automatic switch, which controls the burner motor and trouble lights at low water level.

Switch (#15) controls either boiler feed pump.

Valve (#16) is a blow off valve.

Valve(#17) controls the air strainer.

Before attempting to start the heater, make sure that there is an ample supply of oil and water in the tanks. The water tank can be filled from underneath the car, on either side, and holds 2250 pounds of water; the oil tank must be filled from the roof and holds 700 pounds of oil.

It is assumed that there is no water in the boiler and that the train line heating valves are closed, the continue as follows:

1. Close main line switch (#1) to put electric current in the 'On' or 'Operating' position, which should immediately start up boiler feed pump. Globe valve on pump not working should not be closed. Sufficient time should elapse to permit water level to reach gauge cock #2. Gauge cock should be opened to prove water level in the water gauge glass(#3).

2. When water level has reached gauge (#2) push up gently on button (#4) which is a manually operated release lock on the low water cutout switch. This permits electric current to pass through to the oil burner controls and trouble lights should light in operators' cabs when oil burner is running.

3. Open up pet cock (#5) to let the air out of the boiler, this pet cock to remain open until it shows a discharge of steam.

4. Open up inspection door #6 and illuminate inside of firebox by means of a flash light or other means to see that oil has not flooded into firebox. Due to curiosity, someone may have opened oil system. If oil shows in firebox, light a piece of paper and allow oil to burn off by natural draft.

5. Now ready to start oil burner.

Put a substantial wad of paper, equal to a double sheet of newspaper or larger, thorough inspection door. Then light end of paper and push lighted paper over and in front of oil burner. As soon as paper has become well lighted, open metering valve #7 by turning one three quarter turn to the left and immediately throw oil burner motor switch #8 in the 'On' position. This starts oil burner motor. Oil fire should start at once.

6. After fire has been started, close inspection door #6 and close off metering valve #7 slightly to the right, so that fire will not be too paid until steam shows at pet cock #5.

7. After steam shows at #5 pet cock, it should be closed and metering valve #7 can now be opened and regulated by opening air control #9 and blast gate #10 to burn a clean fire which can be determined by the clearness of glass shown in inspection report #6.

8. When boiler pressure reaches predetermind pressure setting of switch #11, oil burner will go on low fire and one half blower speed. Key valve #12 should not be regulated to maintain sufficient fire to avoid burner going out on low fire. This setting of valve can be left at this proper low fire setting even when boiler is not in operation.

9. Train line heating valves may now be opened-valves must be opened gradually.

10. To discontinue operation of boiler entirely, close metering valve #7 by turning to the right and open main line switch #1 also oil burner motor switch #8.

Note:- If at any time, trouble light goes out, follow the above instructions.

Blow off valves under controls #13 and #14 and Blow off valve #16 should be opened once a day for a few seconds when boiler is under pressure.

Boiler should be washed out once a week when first put in service to remove dirt and scale that accumulates from new piping, etc. After first month, boiler should be washed out once a month or to suit water conditions.

Oil burner and pump motors should be oiled sparingly once every 300 miles, based on a continuous operation.

The boiler feed pump that is being used, should have the grease grease cups turned up slightly, once every period equal to thirty six hours continuous pump service. Open up pet cock and screw up to right one half turn, then close pet cock.

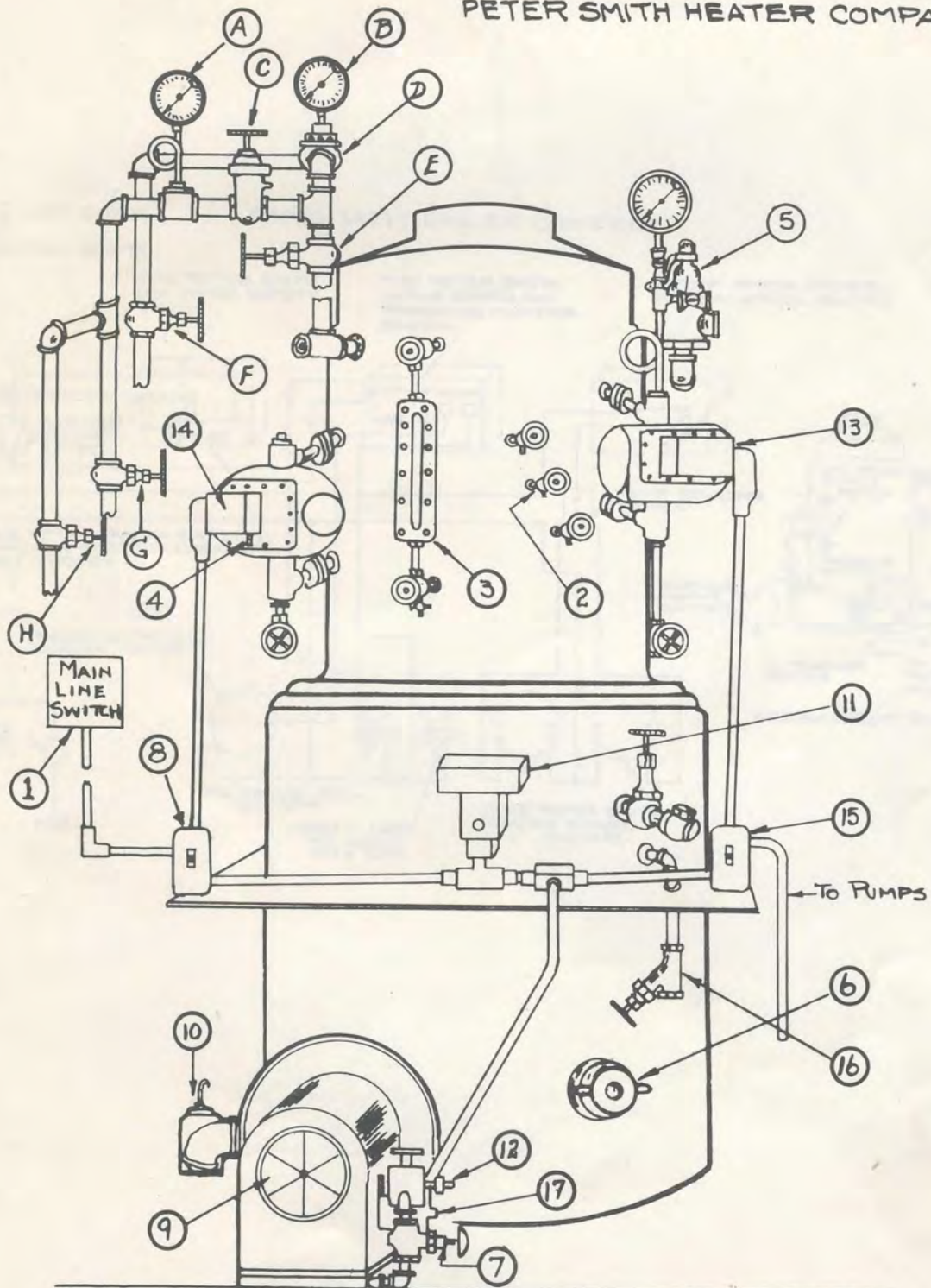
Use Kasson Water-Proof grease on pumps as most any other grease will affect the boiler.

If flow of oil and water becomes interrupted, remove strainer from oil valve #17, also remove strainers from water and radiation line and clean.

Note:- See Plate No. 101S for wiring diagram of the "Automatic Boiler Control."

See Plate No. 102S for "Plan of Heater Compartment."

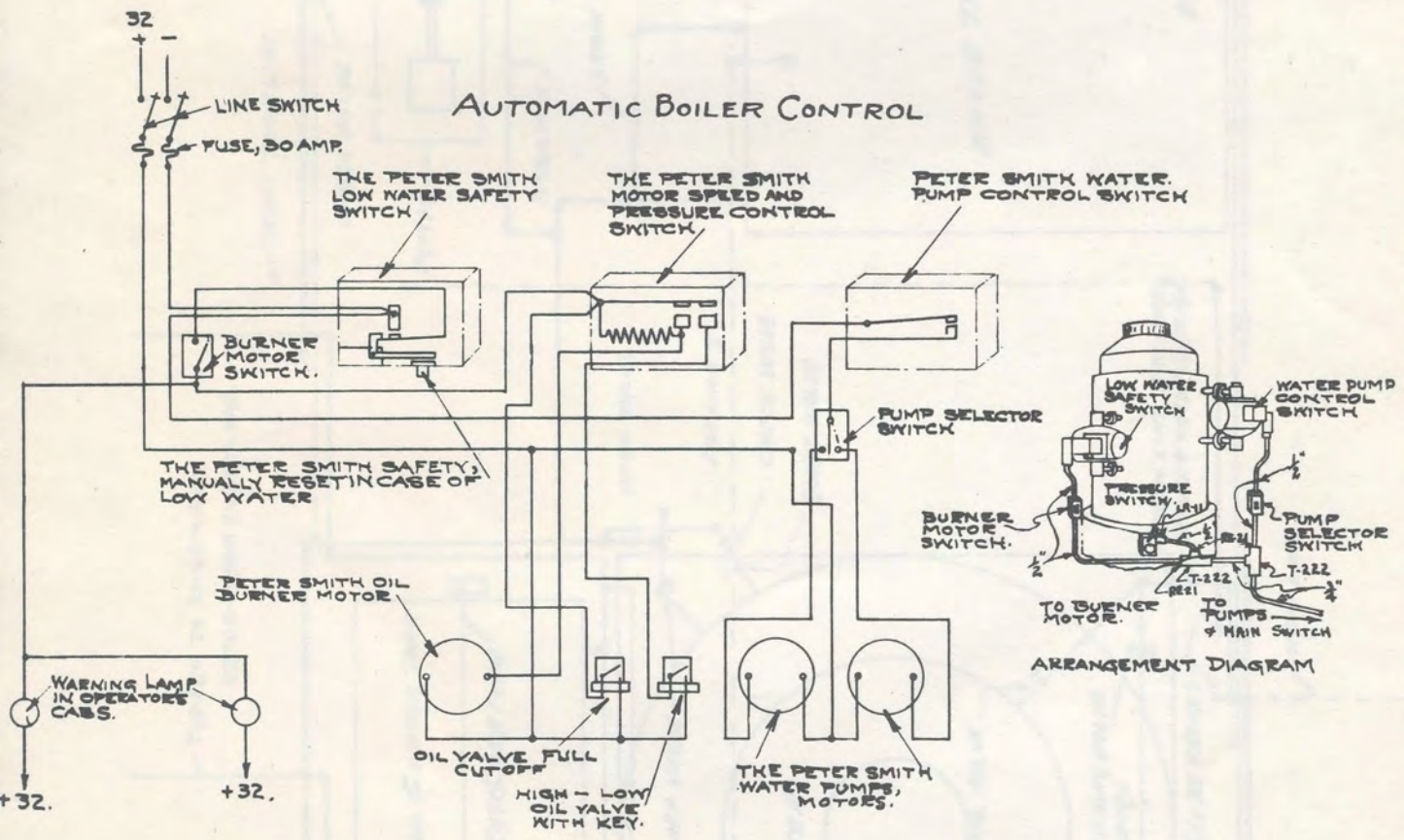
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 BUILT BY
 PETER SMITH HEATER COMPANY

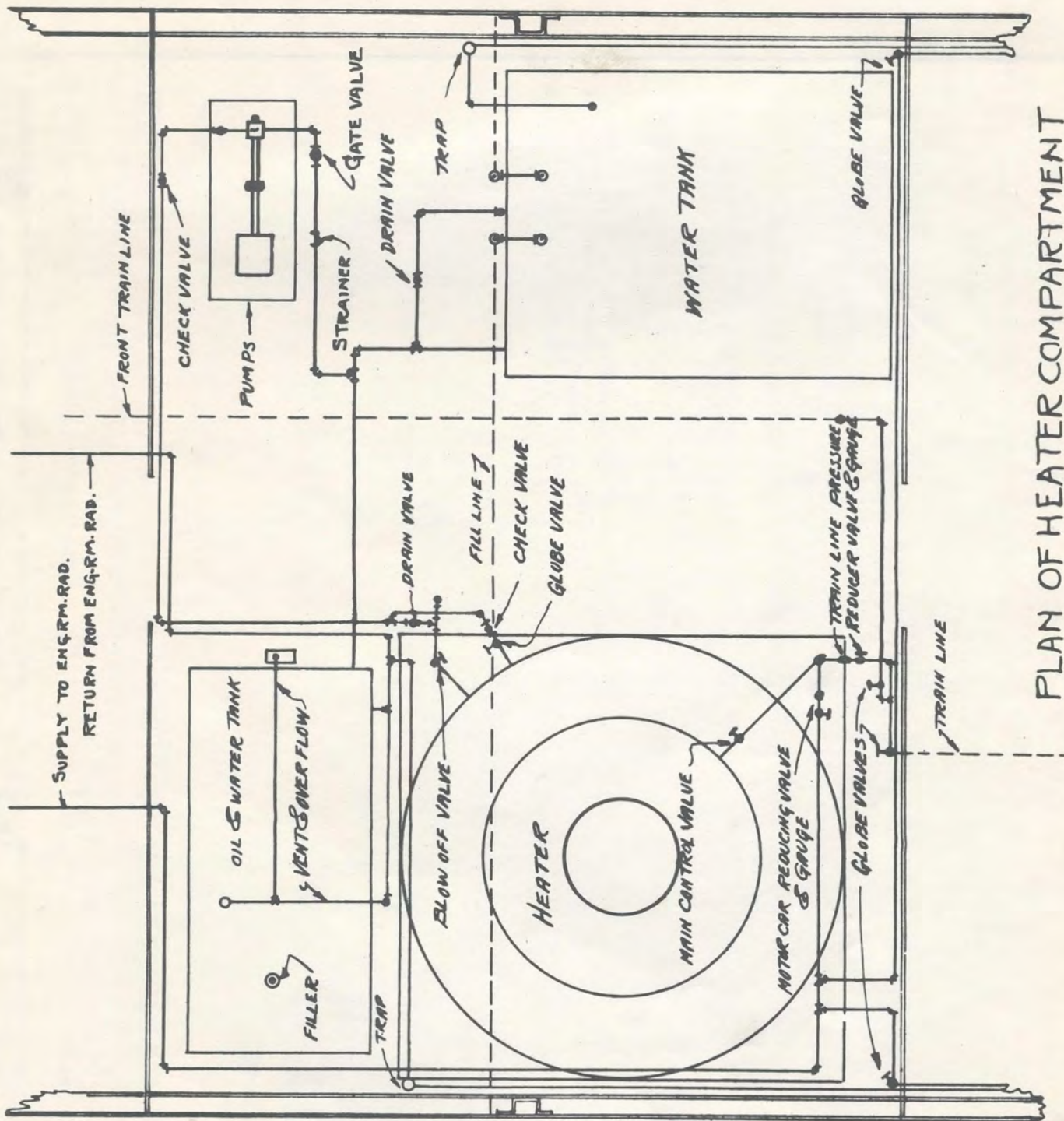


- | | |
|-------------------------------|--------------------------|
| A-TRAIN LINE PRESSURE GAUGE | E-MAIN SHUT OFF VALVE |
| B-MOTOR CAR PRESSURE GAUGE | F-MOTOR CAR SUPPLY VALVE |
| C-TRAIN LINE PRESSURE REDUCER | G-REAR TRAIN LINE VALVE |
| D-MOTOR CAR PRESSURE REDUCER | H-FRONT TRAIN LINE VALVE |

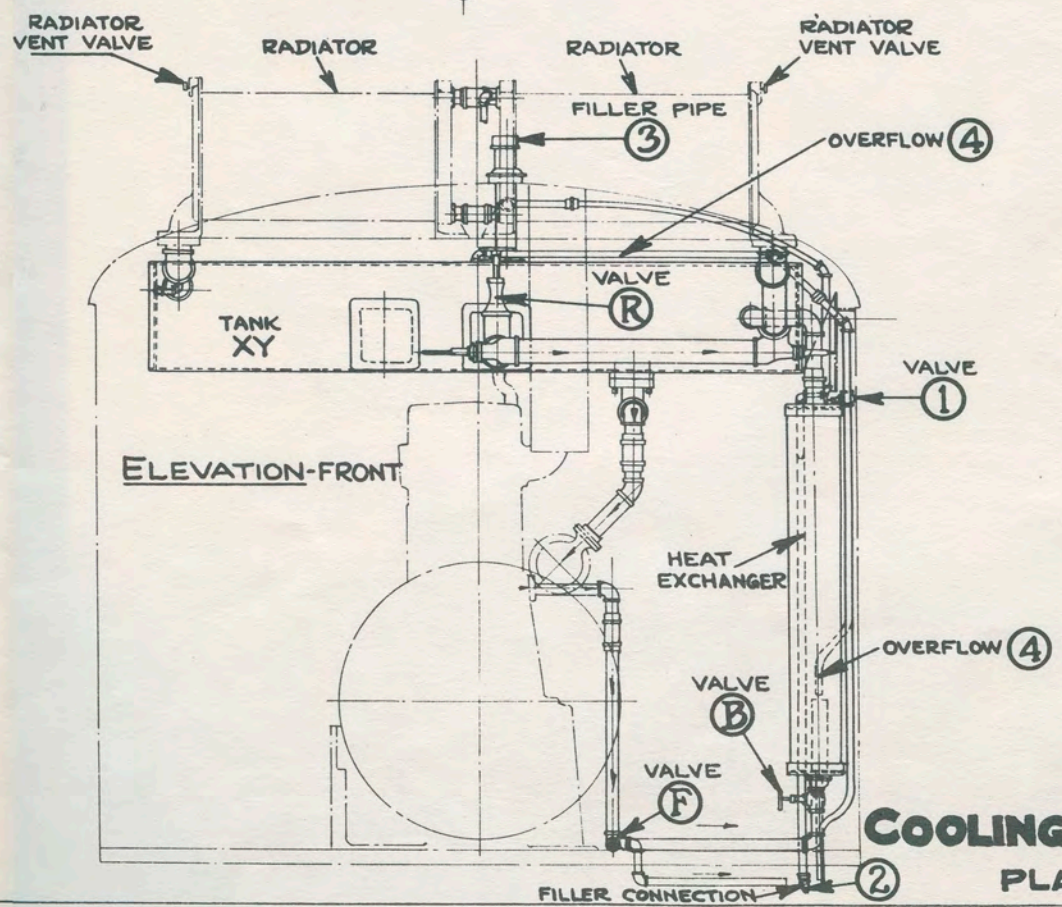
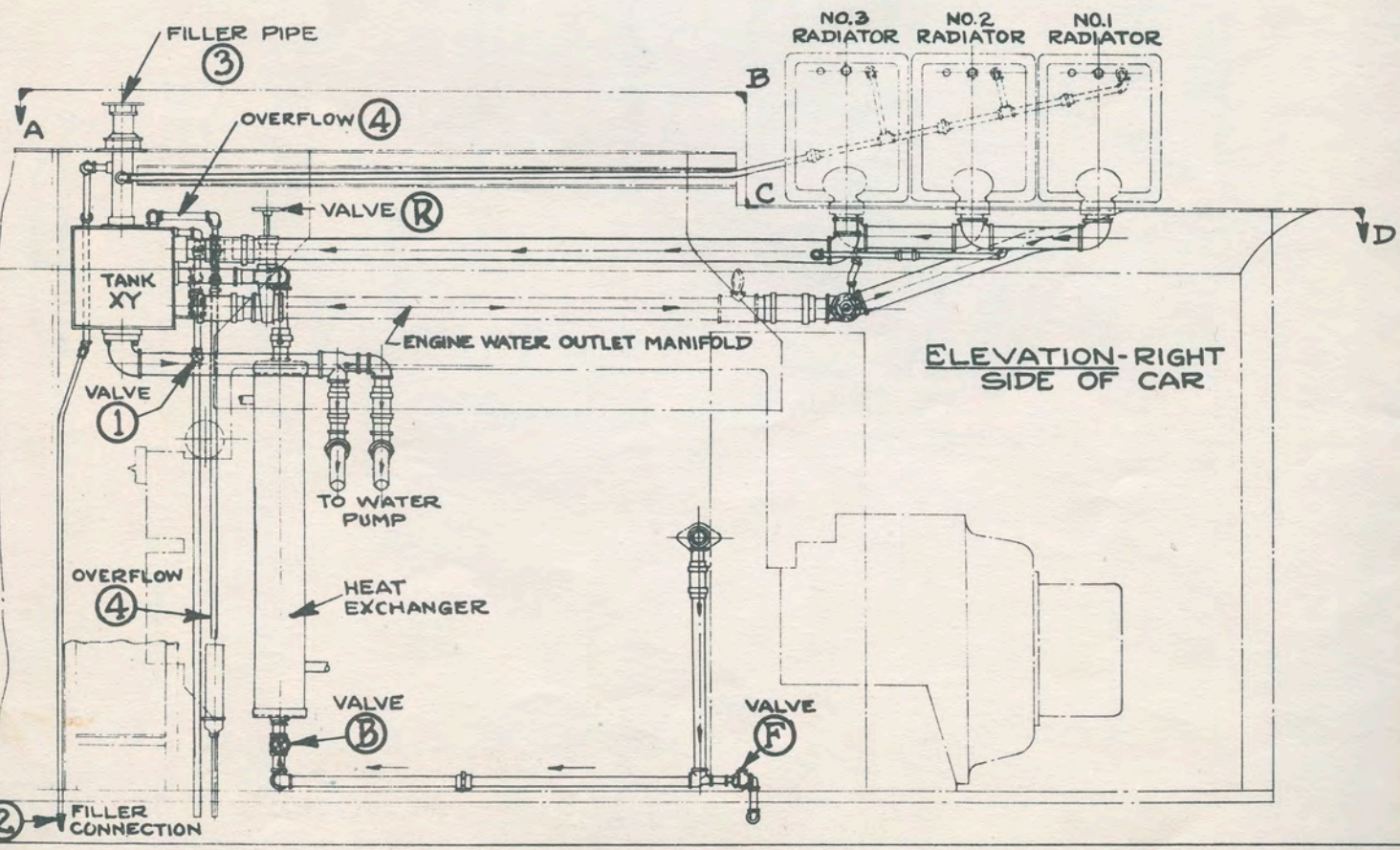
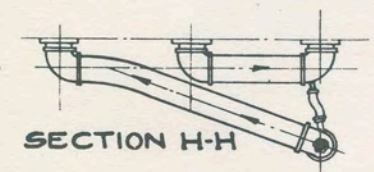
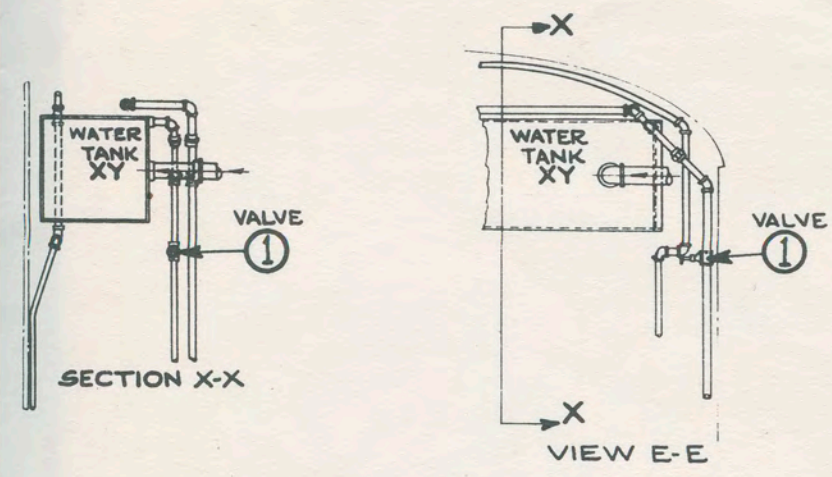
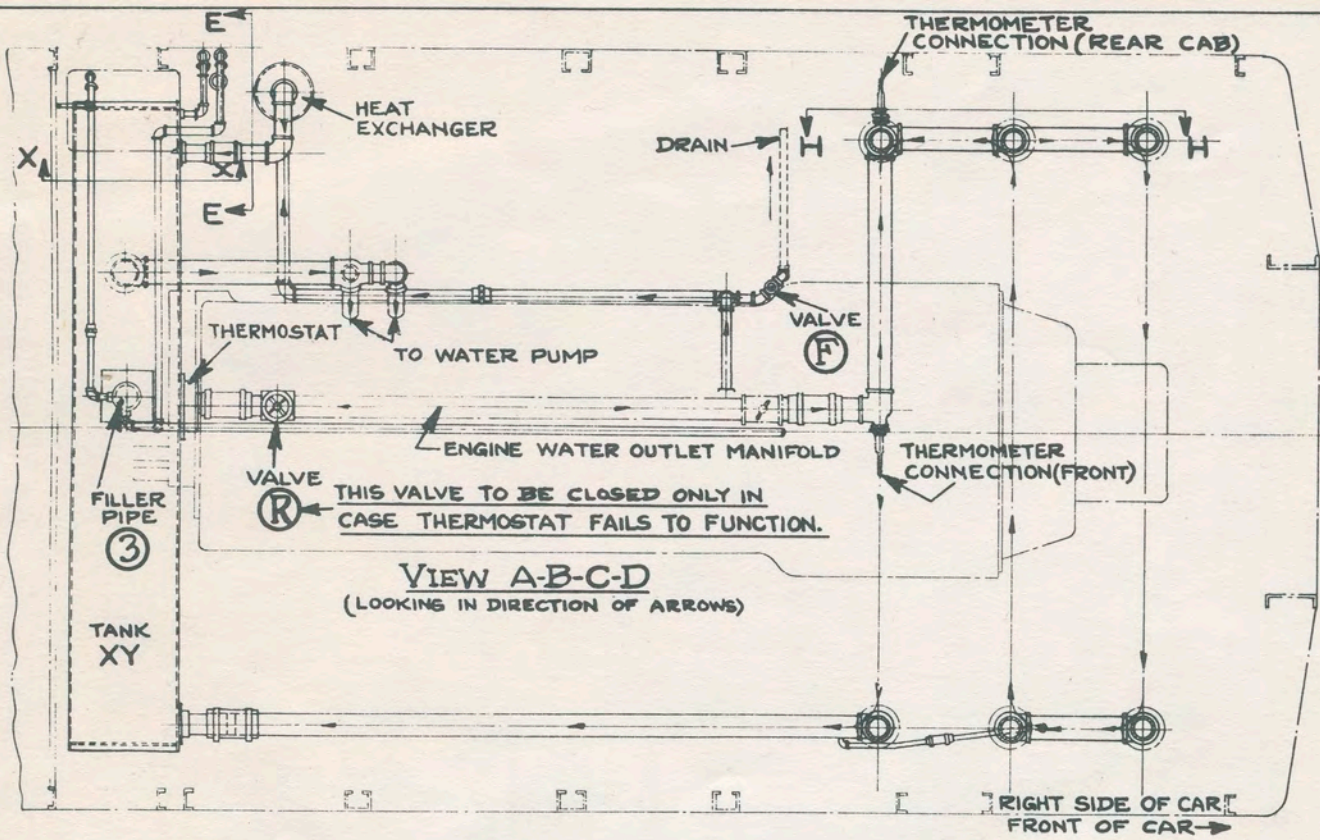
PLAN OF WATER COMPARTMENT

AUTOMATIC BOILER CONTROL





PLAN OF HEATER COMPARTMENT



**OILING DIAGRAM
ENGINE AND GENERATOR**

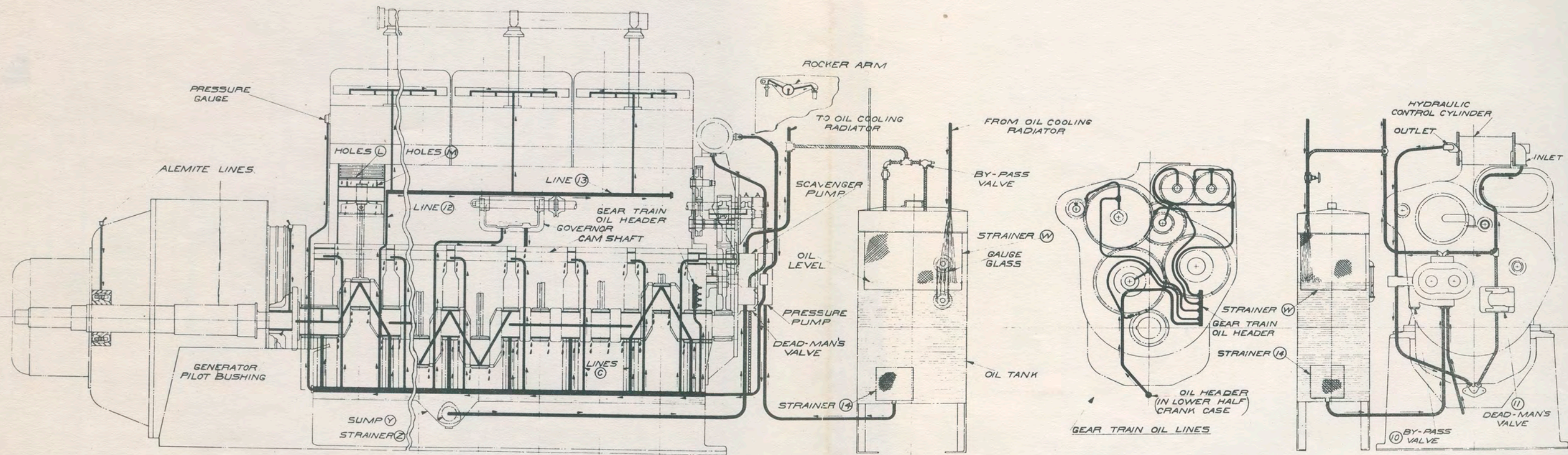
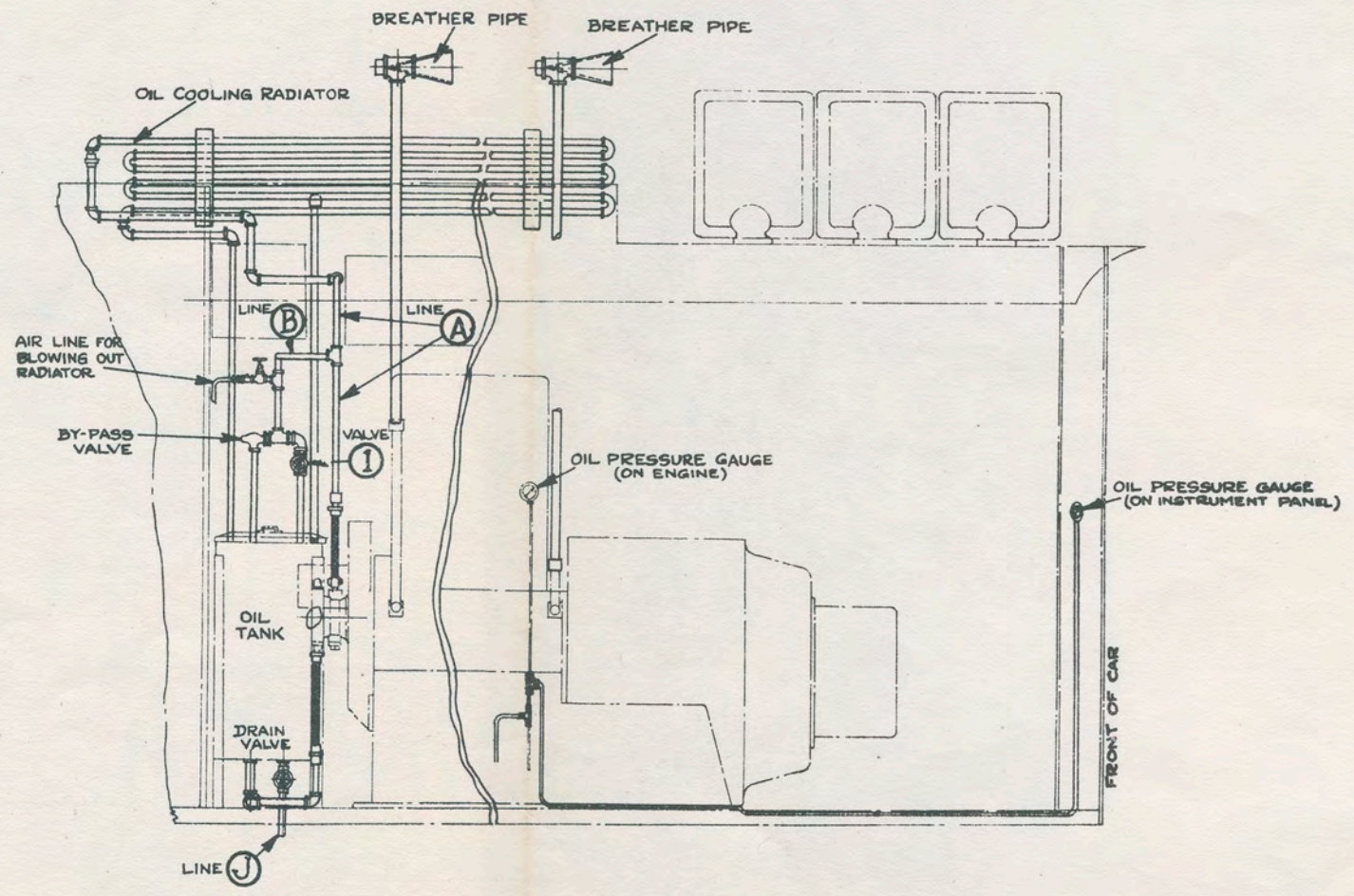
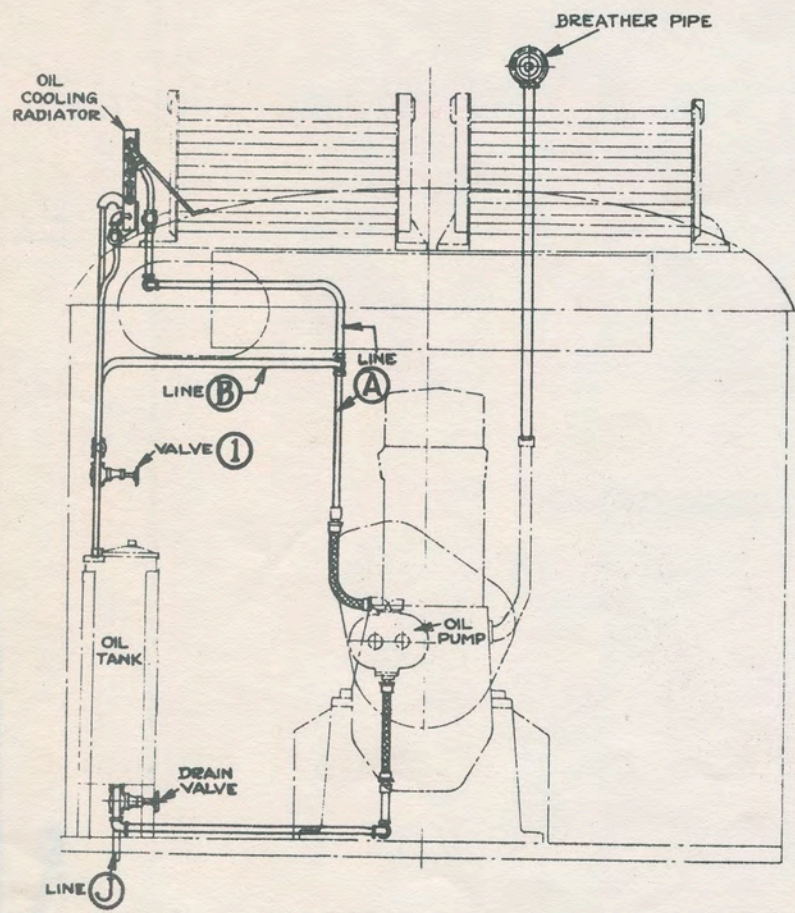
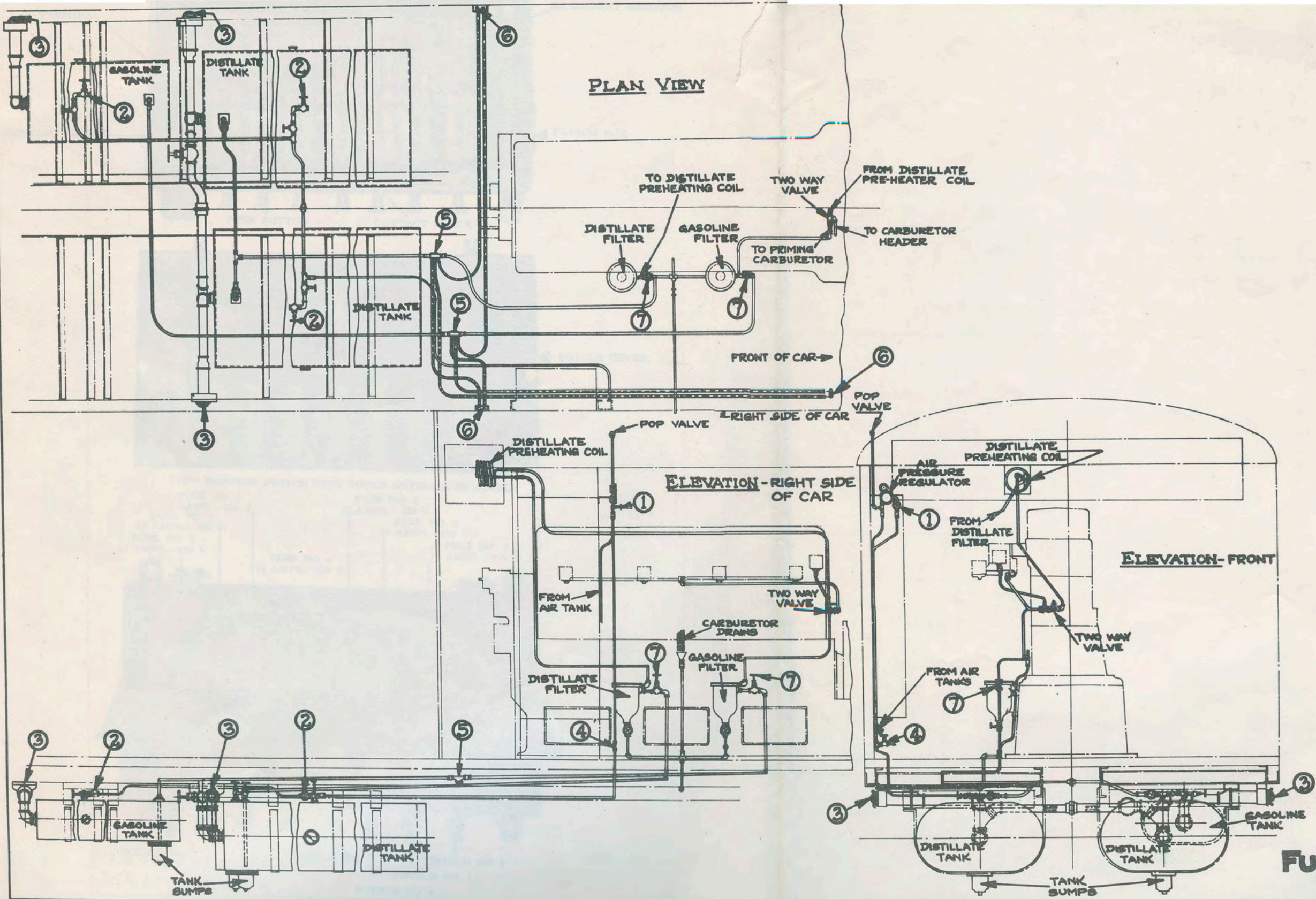


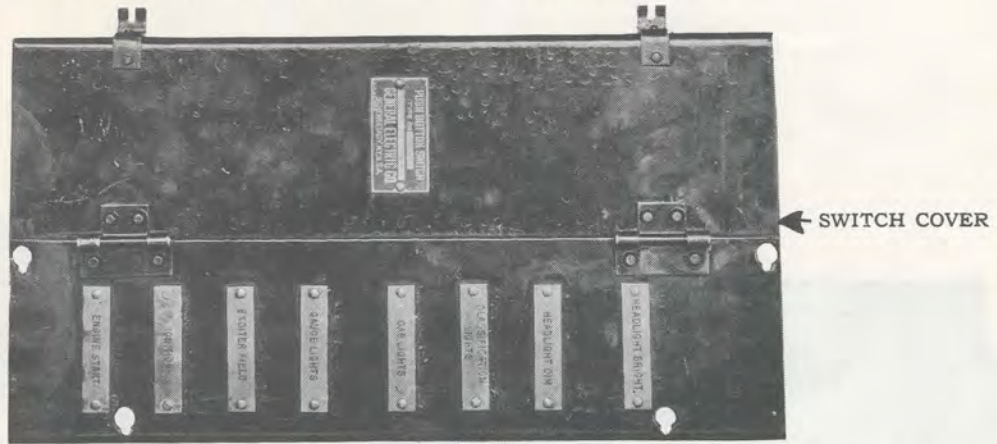
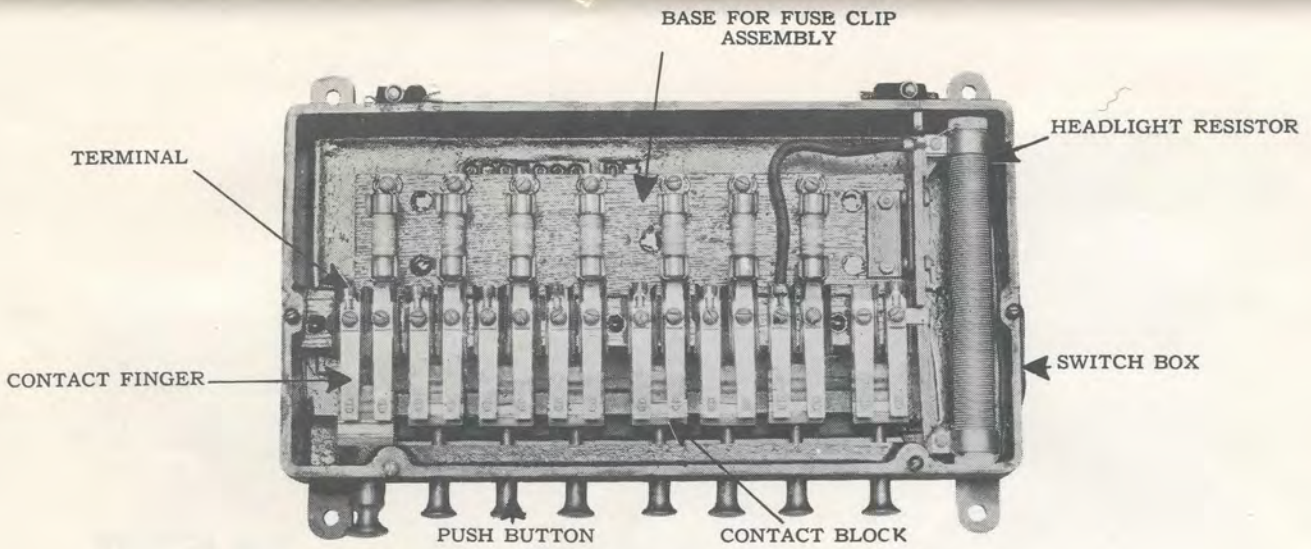
PLATE No. 1002 Oiling System of Engine and Generator



OILING SYSTEM
PLATE NO. 1006

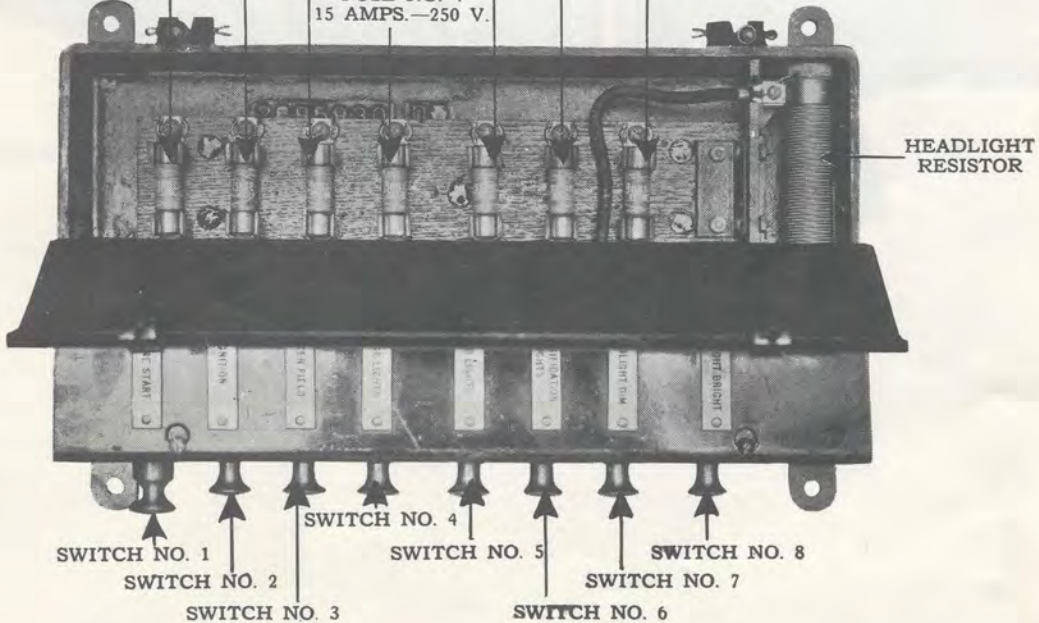


FUEL SYSTEM
PLATE NO. 1512



VIEW SHOWING SWITCH WITH COVER ENTIRELY REMOVED

FUSE NO. 3 15 AMPS.—250 V.	FUSE NO. 5 15 AMPS.—250 V.
FUSE NO. 2 15 AMPS.—250 V.	FUSE NO. 6 15 AMPS.—250 V.
FUSE NO. 1 15 AMPS.—250 V.	FUSE NO. 7 15 AMPS.—250 V.
FUSE NO. 4 15 AMPS.—250 V.	



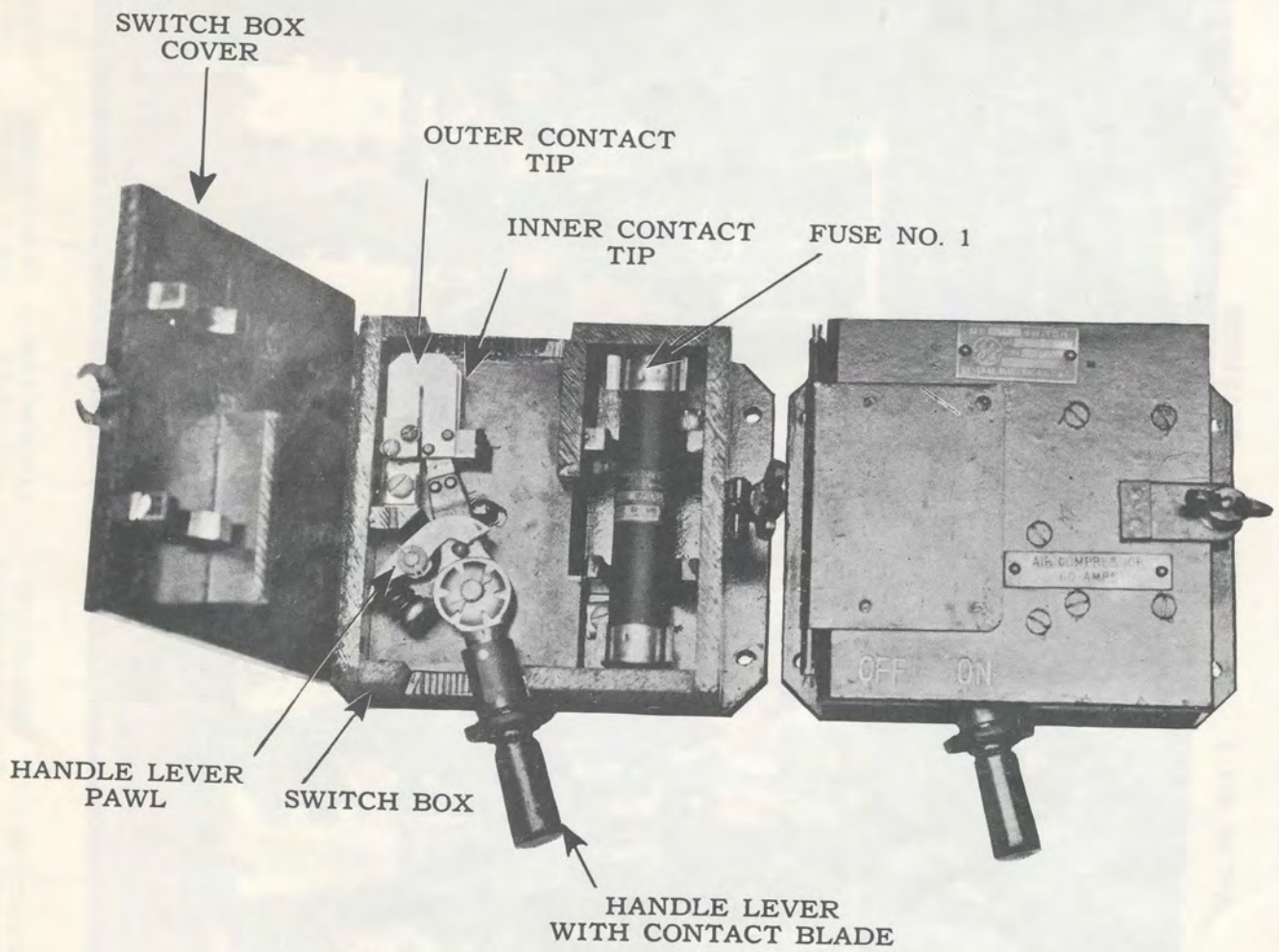
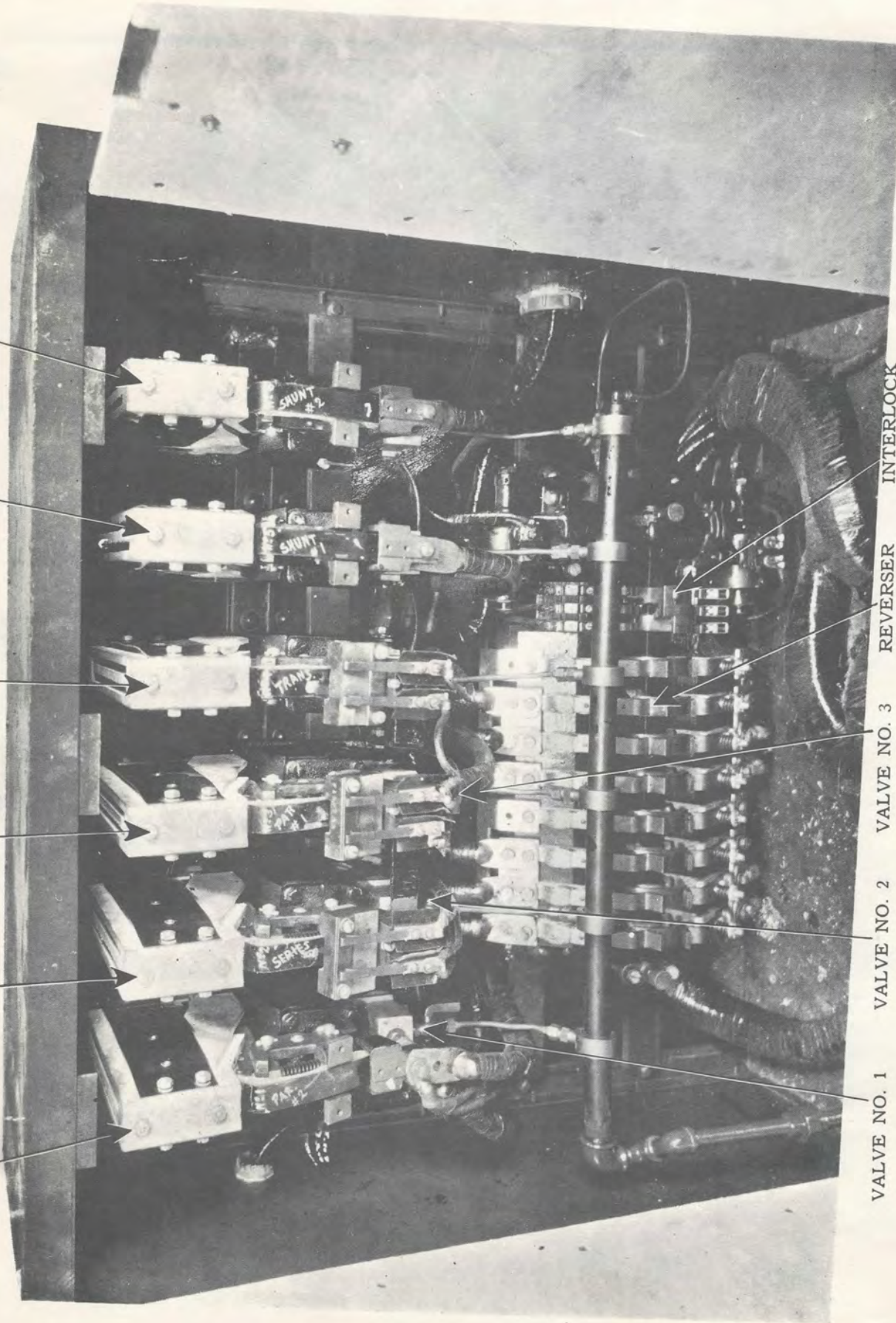


PLATE No. 2003

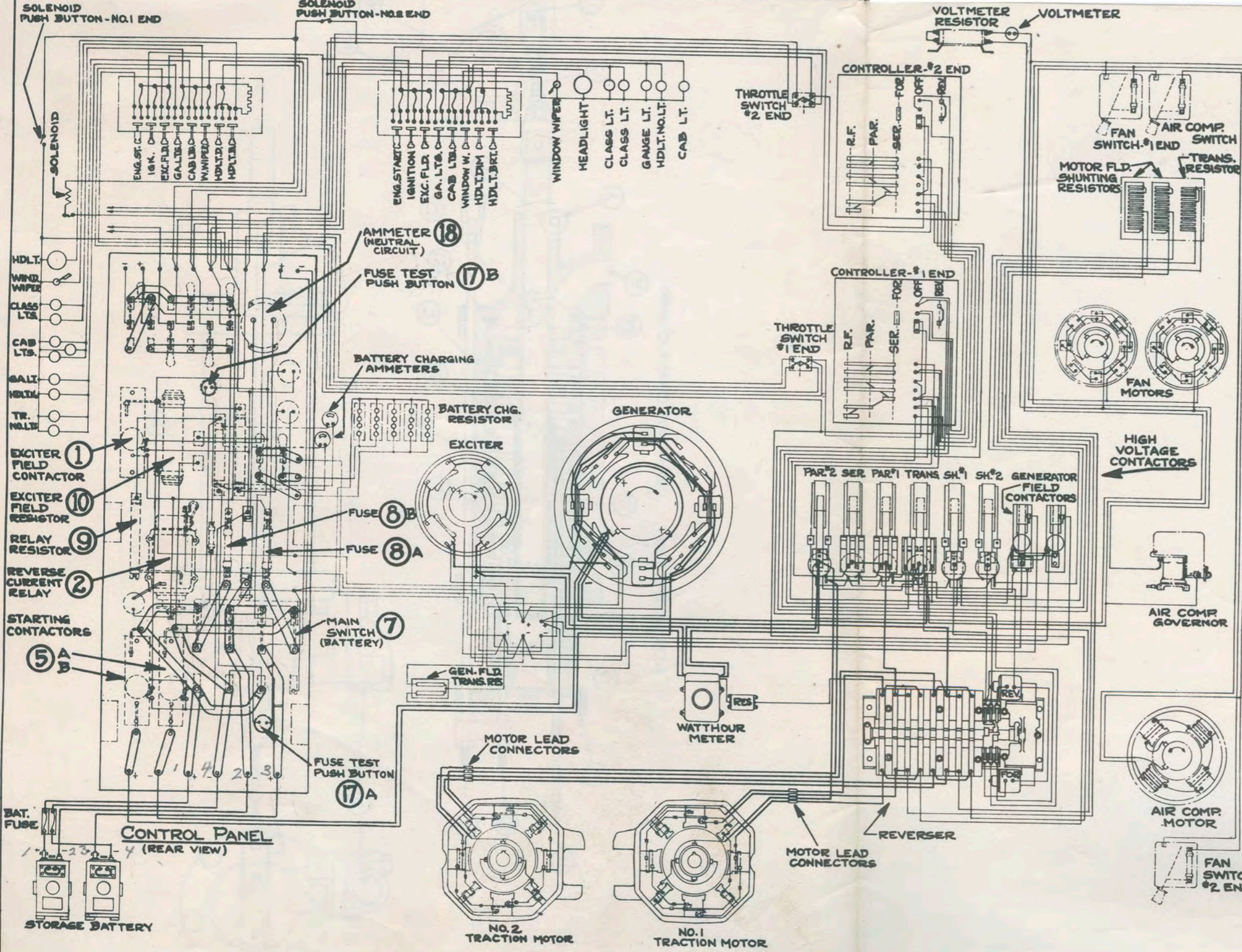
Air Compressor and Fan Switches

NO. 2 PARALLEL CONTACTOR
SERIES CONTACTOR
NO. 1 PARALLEL CONTACTOR
TRANSFER CONTACTOR
NO. 1 SHUNT CONTACTOR
NO. 2 SHUNT CONTACTOR



VALVE NO. 1
VALVE NO. 2
VALVE NO. 3
REVERSER
INTERLOCK

PLATE No. 2005 Remote Control High Voltage Cabinet



1st pt 2-7-8
 2 " 1-3-4-78
 3 " 1-3-4-5-6-7-8
 neutral 7-8

WIRING DIAGRAM
PLATE NO. 2018

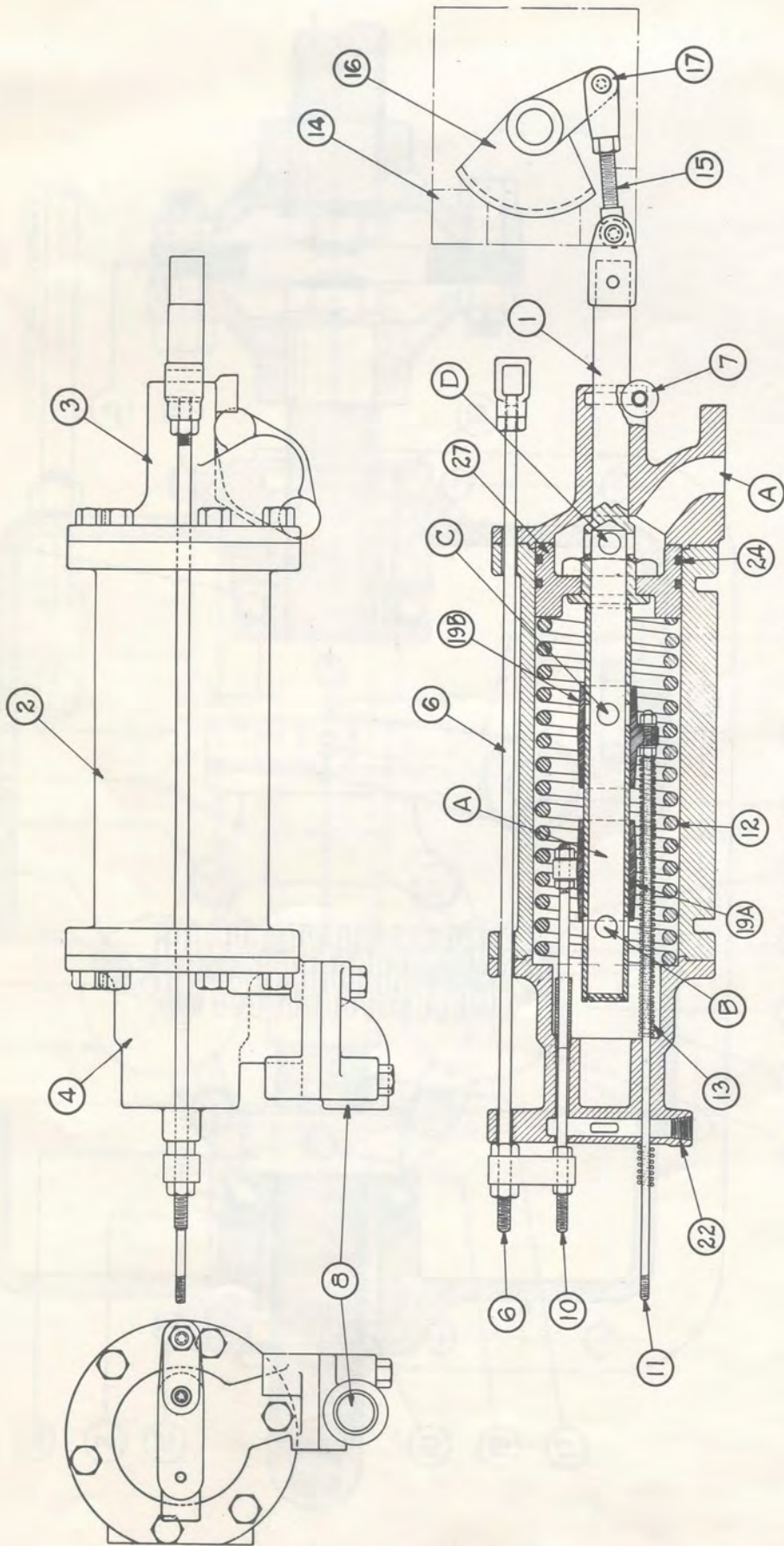


PLATE No. 2501 Hydraulic Control Cylinder

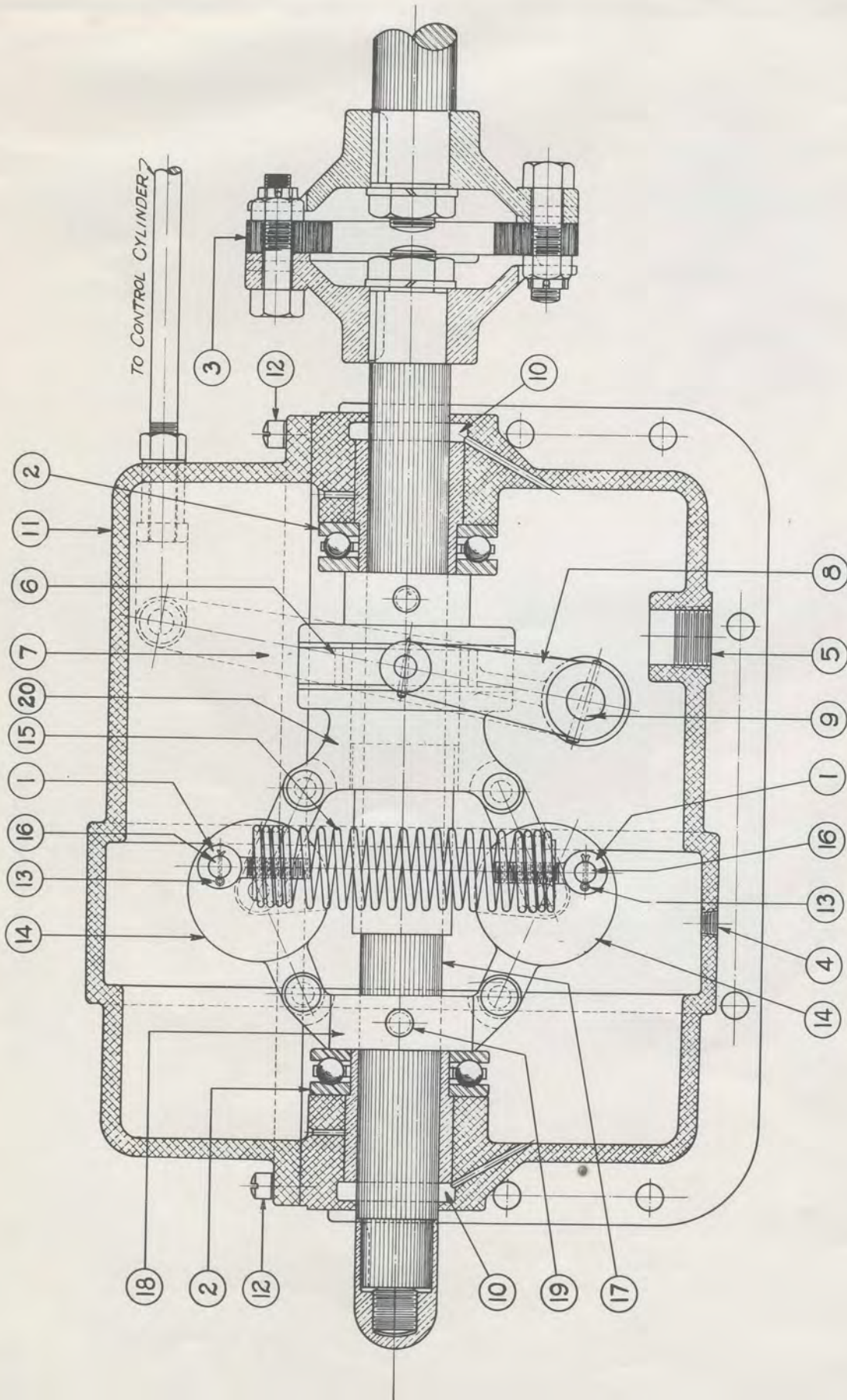
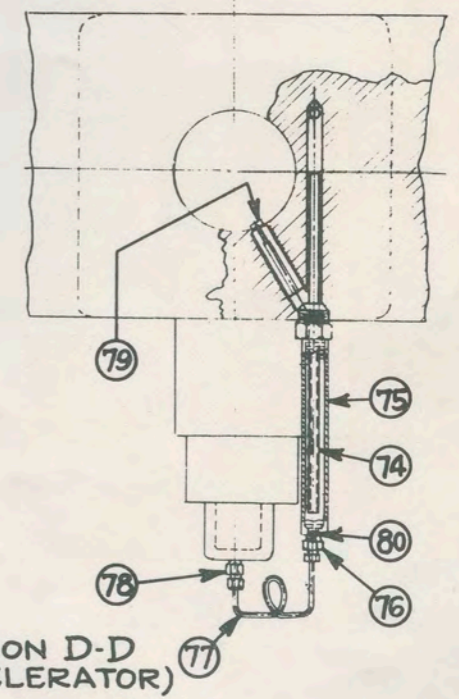
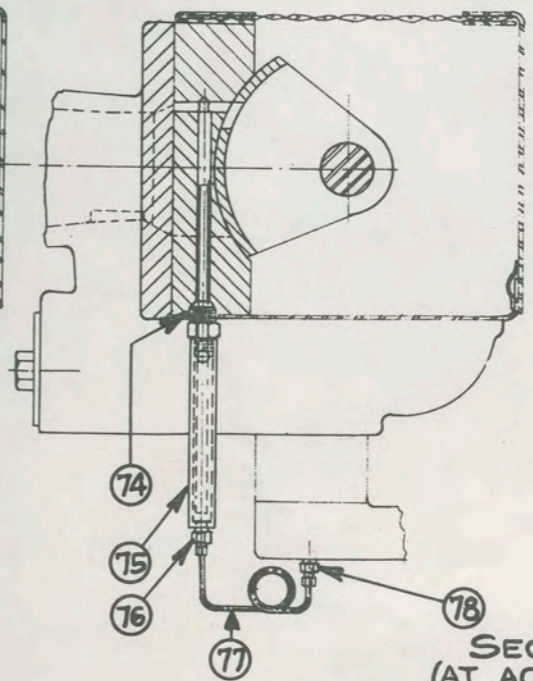
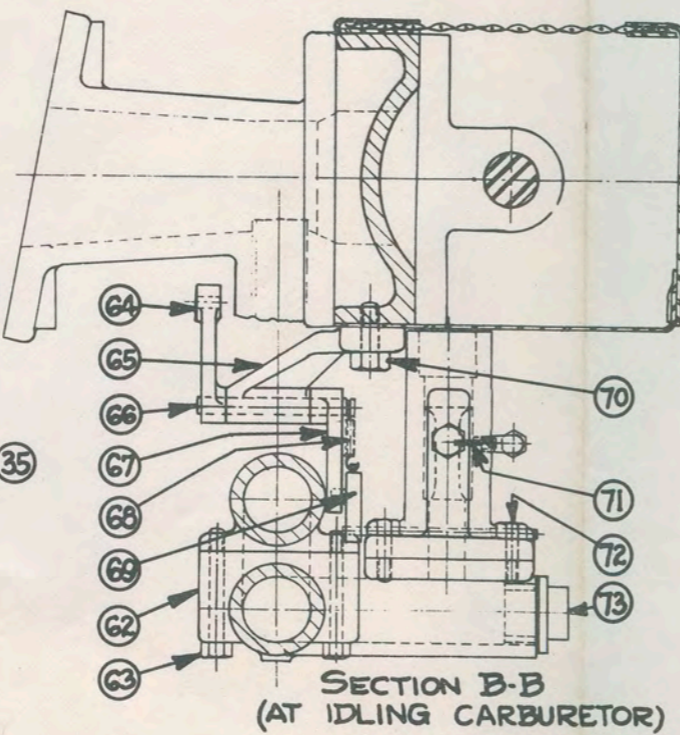
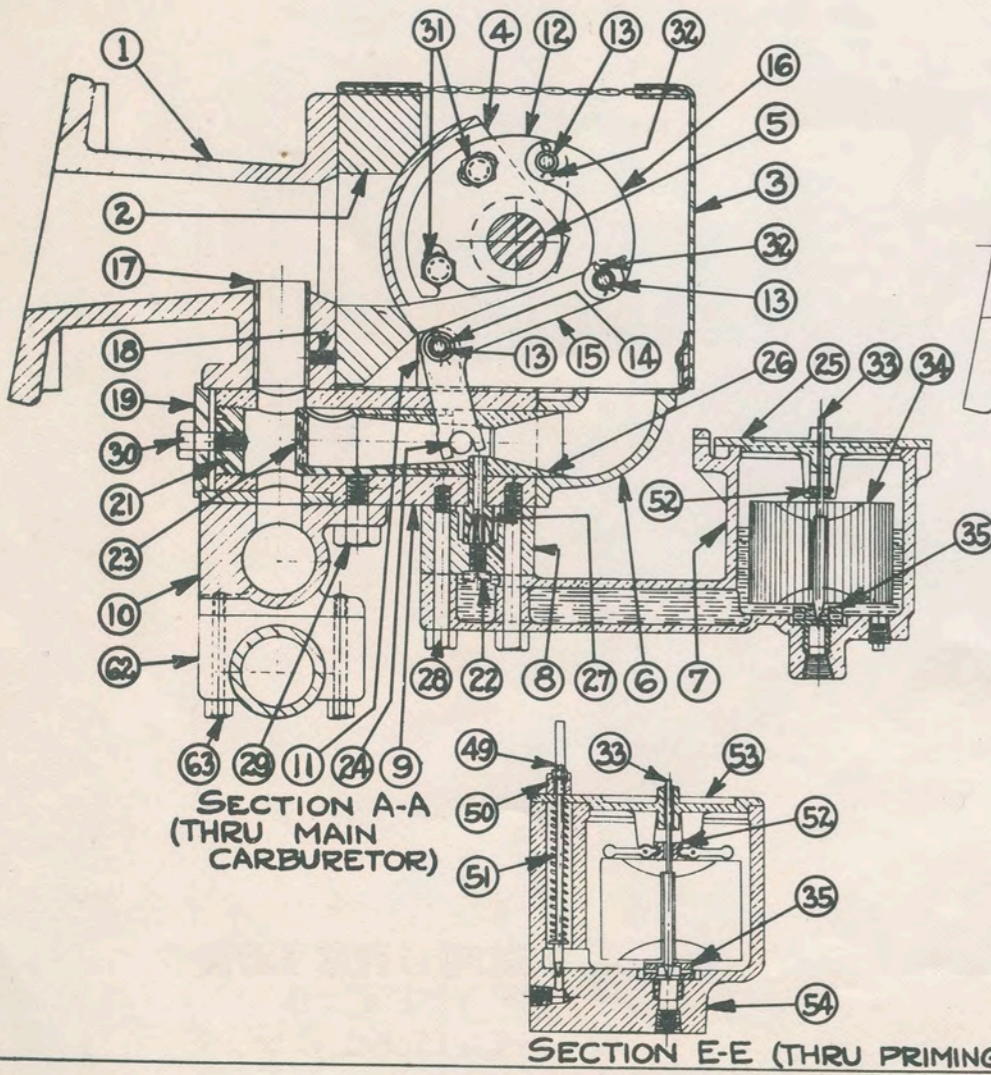
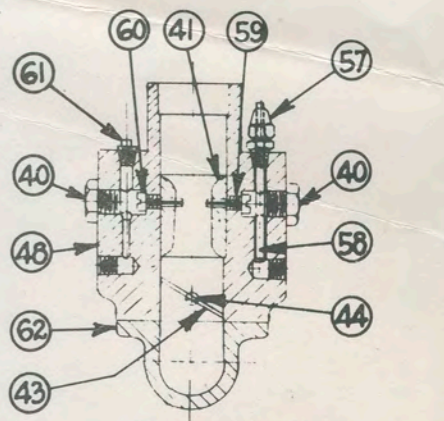
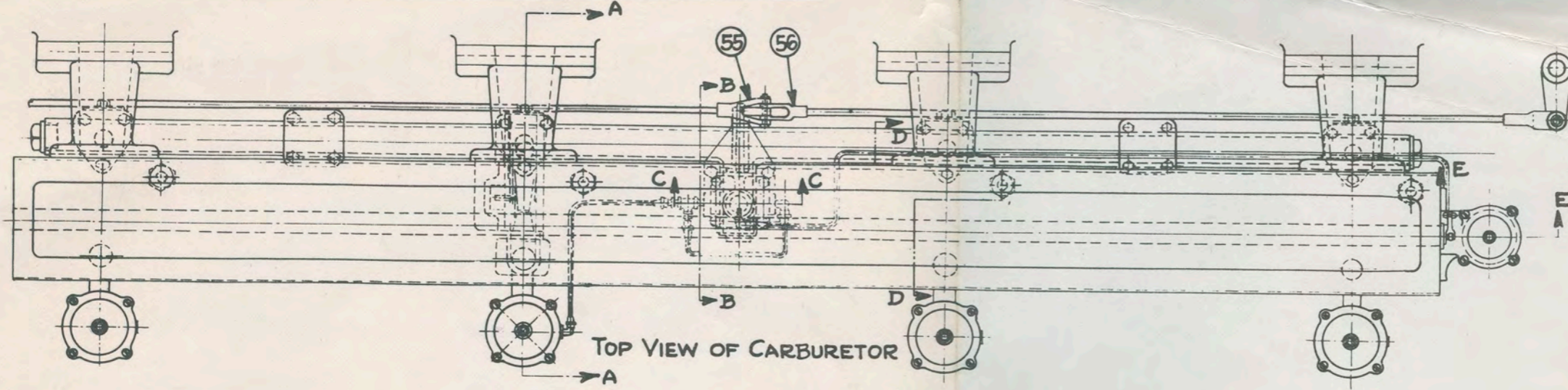


PLATE No. 2502 Engine Governor



CARBURETOR
TYPE 5
PLATE NO. 2504

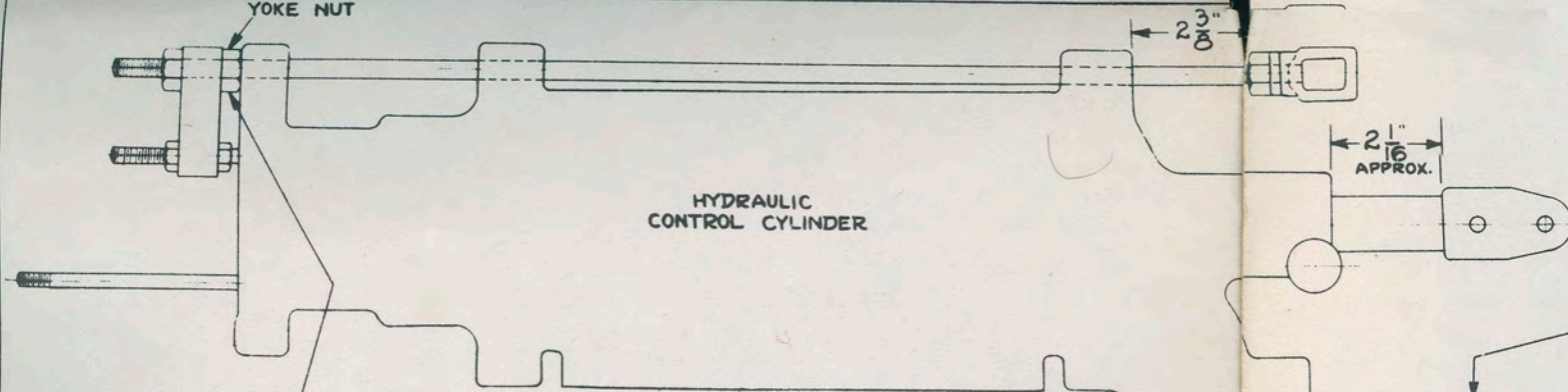


FIG.1-OFF POSITION-
SET THROTTLE LEVER AT 30° AND HYDRAULIC CONTROL CYLINDER YOKE NUT AGAINST FACE OF CYLINDER AS SHOWN. EXCITER FIELD SWITCH OPEN. STARTING CONTACTOR SWITCH CLOSED.

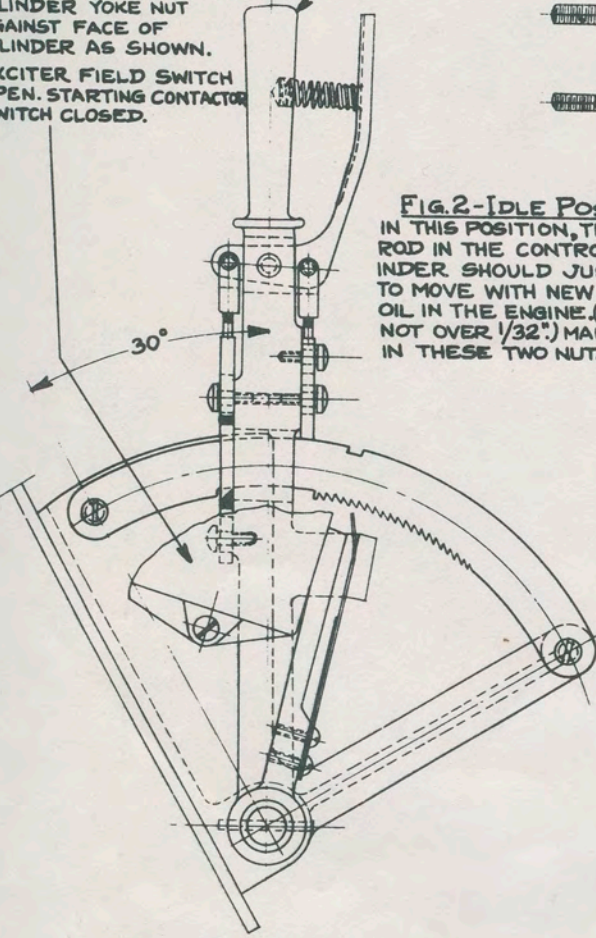


FIG.1

FIG.2-IDLE POSITION-
MOVE THROTTLE LEVER UNTIL HYDRAULIC CONTROL CYLINDER YOKE NUT IS 3/8" FROM FACE OF CYLINDER.

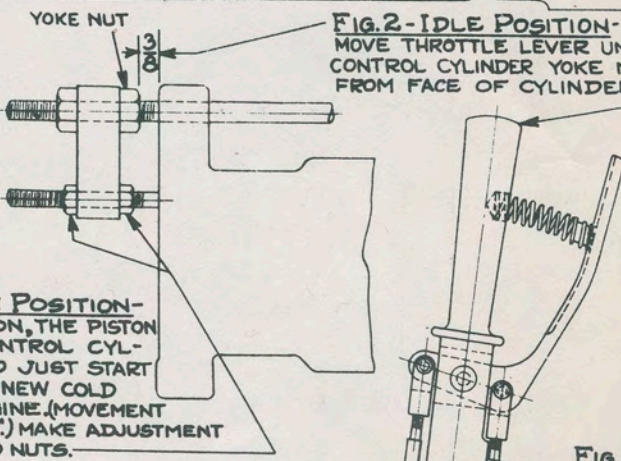


FIG.2-IDLE POSITION-
IN THIS POSITION, THE PISTON ROD IN THE CONTROL CYLINDER SHOULD JUST START TO MOVE WITH NEW COLD OIL IN THE ENGINE. (MOVEMENT NOT OVER 1/32") MAKE ADJUSTMENT IN THESE TWO NUTS.

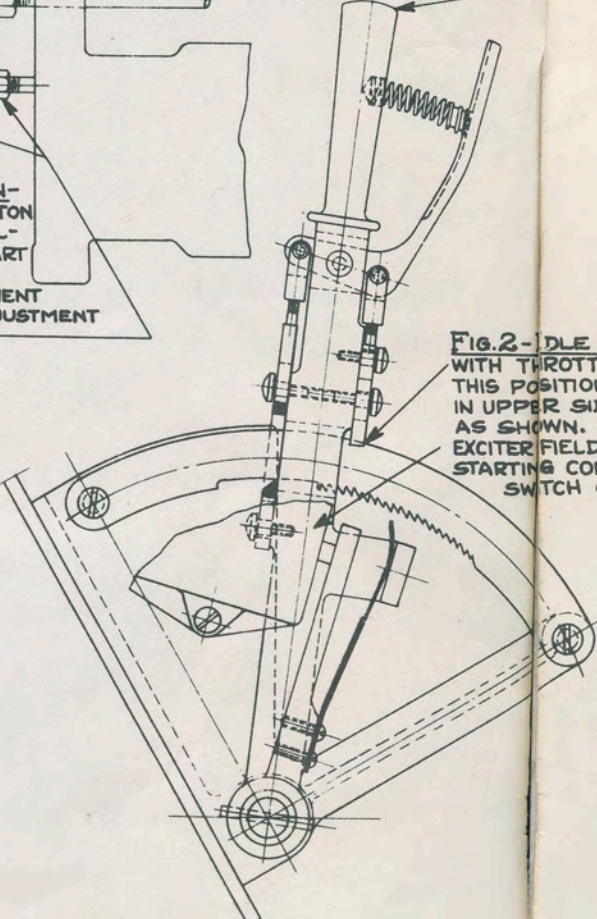


FIG.2

FIG.2-IDLE POSITION
WITH THROTTLE LEVER IN THIS POSITION, CUT NOTCH IN UPPER SIDE OF QUADRANT AS SHOWN. EXCITER FIELD SWITCH OPEN. STARTING CONTACTOR SWITCH CLOSED.

FIG.3-STARTING POSITION-
MOVE THROTTLE LEVER UNTIL HYDRAULIC CONTROL CYLINDER YOKE NUT IS 3/4" FROM FACE OF CYLINDER.

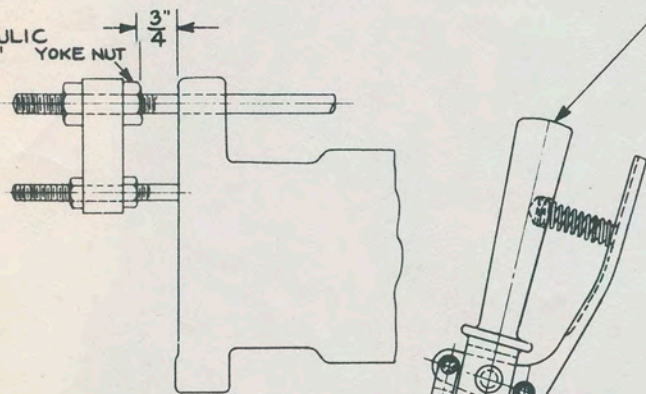


FIG.3-STARTING POSITION
CUT AWAY TEETH INSIDE OF QUADRANT SO THAT THROTTLE LEVER WILL STOP IN THIS POSITION. EXCITER FIELD SWITCH OPEN. STARTING CONTACTOR SWITCH CLOSED. ANY FURTHER MOVEMENT TOWARD WIDE OPEN SHOULD CLOSE EXCITER FIELD SWITCH AND OPEN STARTING CONTACTOR SWITCH.

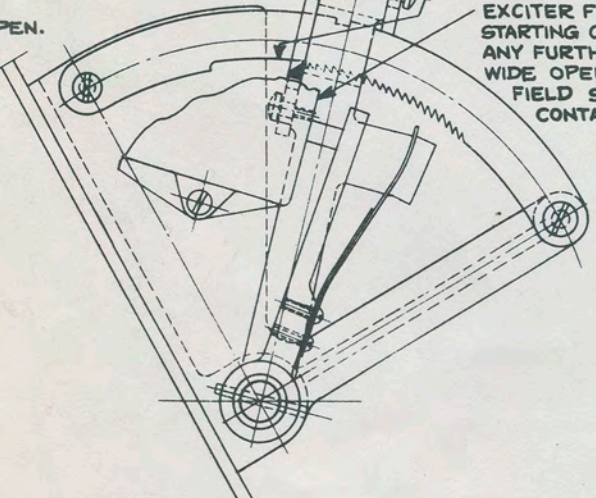


FIG.3