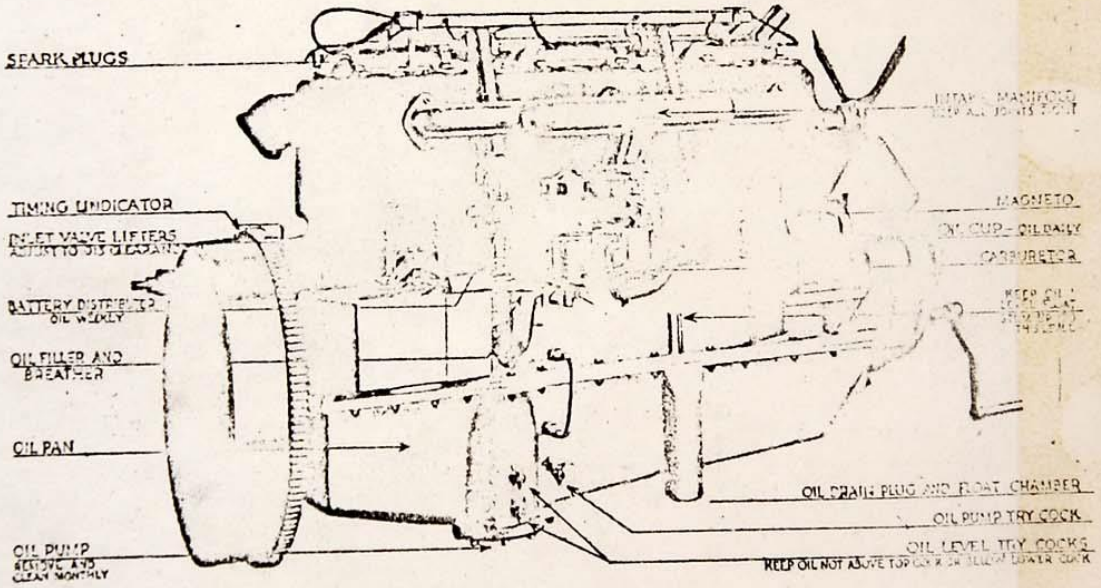
MATERIAL AND CONSTRUCTION

All units used in the construction of American-La France fire trucks represent exclusive designs which are the result of our eighty years' experience in the manufacture of fire fighting apparatus.

In the design, dimensions and fit, they often vary materially from customary automotive practice due to the entirely dissimilar requirements, and in the matter of adjustment in particular, the mechanic or operator should closely follow the proper instructions laid down in this manual.

Regardless of its cost, nothing but the very best and most suitable material is used in the construction of each and every part, and with the exception of the electrical equipment, instruments, carburetor and tires, everything is built entirely within our factory.

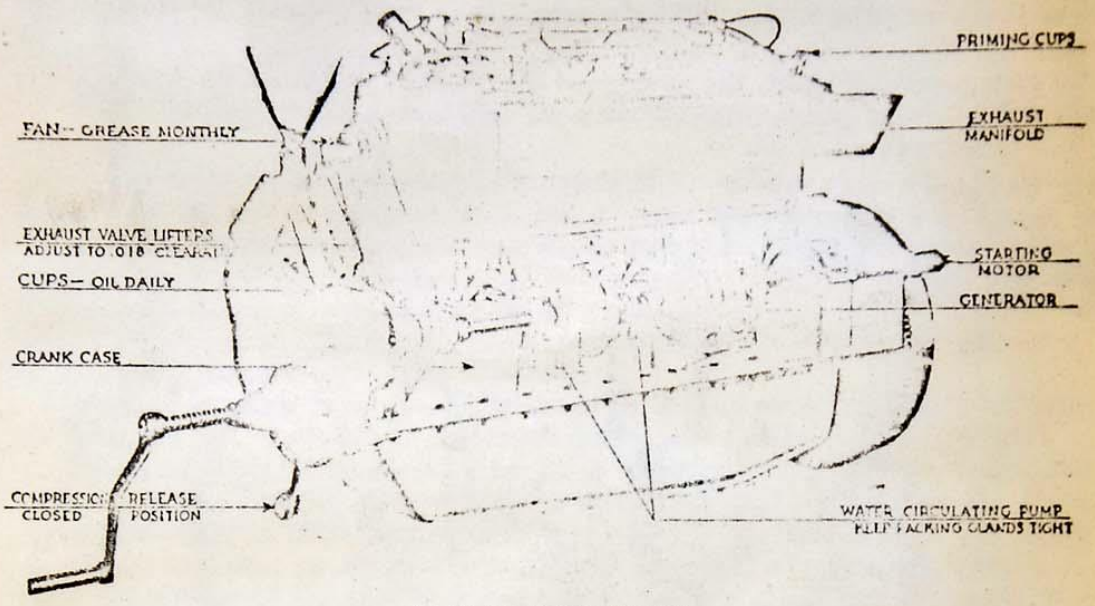
In the inspection and test, as with manufacture, the same degree of exacting requirements and standards have to be carried out—all of which results in American-La France apparatus establishing the Standard of the World.



RIGHT SIDE OF MOTOR

Power Specifications of Standard Types of Motors

Type	Number of Cylinders	Bore	Stroke	S. A. E. Rating	Actual Horse-Power
10	4	5½"	6"	48.40	85
38	6	4½"	6"	48.60	85
75	6	5½"	6"	72.60	115
12	6	5½"	6"	72.60	130



LEFT SIDE OF MOTOR

DESCRIPTION OF UNITS

Cylinders—All cylinders are of the "T" head type, cast in pairs with inlet and exhaust valves on opposite sides. The water passages through the jackets are unusually large, free from pockets and obstructions, and completely surround the valves and stems.

In replacing cylinders, use every precaution to get them back into position without damaging the piston rings, as a broken ring means a scored cylinder. Make certain all manifolds and connections are tight, and all bolts and nuts properly secured by lock-washers or cotter pins.

Pistons—Are slightly tapered toward the top to allow for expansion. Each is fitted with three rings, and oil holes perforate the walls. When removing pistons from the motor, it is well to mark them in such manner as to insure their being replaced in the proper cylinders.

Carbon will gradually collect in the cylinders due to too much or a poor quality of lubricating oil, or to running with too rich a mixture of gas. If care is exercised to see that oil in the reservoir is not filled above the "high level cock," and the carburetor choke control lever on the steering column is lowered as far as possible at all times to give smooth running, the formation of carbon will be greatly reduced.

When carbon accumulates to an extent where it interferes with or prevents smooth running, it should be scraped from the interior of the combustion chamber and cylinder heads. Garages are equipped with tools for this purpose.

The indication of carbon in the cylinders is a "knock" when the spark is fully "retarded," a tendency to fire after the spark is cut off, overheating, and failure to develop full power.

Piston Rings—There are three to each piston, their purpose being to create a leak-tight joint or packing between the piston and cylinder wall, thus holding the gas charge under compression. In fitting rings to the piston, first test them by rolling the new ring around in the piston ring groove. Do not use force—hold the piston in a horizontal position against the body; stand a ring up in the groove so that the lower portion rests in the groove and one side

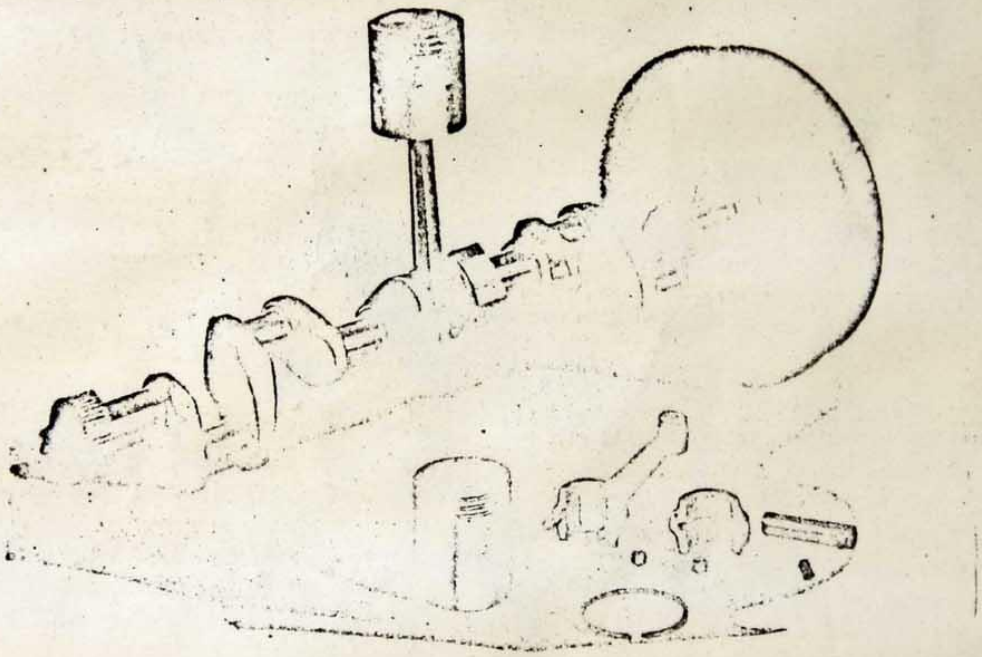
against the body, then gently turn the piston and watch how the ring fits into the groove. If of proper fit, the ring will roll smoothly without sticking.

Should the ring be too tight, the best way to treat it is first to tack a square of fine emery cloth to a flat, smooth board; then lay the ring flat on this surface and scrub till a proper fit is secured.

Next, slide the ring into the cylinder (only a slight distance) ar straighten it up by slipping in the piston. Remove the piston and measu the gap at the joint ends with a "feeler gauge." The right gap will be about .018.

If the gap is not sufficient, the expansion due to heat will score the cylinder walls, while if the gap is too wide, the gas will leak by the ring and the motor will lack power.

Stuck or broken rings may often be detected by the hissing sound which may be heard by holding the ear close to the oil filler spout as the motor is turned over slowly by hand. Do not touch the compression release lever during this operation.



SIX CYLINDER CRANK SHAFT ASSEMBLY

Piston Pins—Are of hollow steel, rigidly held in position by means of locking bolt and snap rings at the end. When making replacements, do not be misled by an apparent looseness of fit; a piston pin should slide into the piston almost of its own weight. It should never be pressed or hammered into position; this will only cause distortion in the piston.

Piston Pin Bearings—Consist of bronze bushings pressed into the head or upper end of the connecting rod. When it is necessary to make a replacement, remove the cylinder.

Connecting Rods—Are drop forged, special heat treated steel, "I" beam section. The crankshaft ends are fitted with babbitt-lined, bronze bushings, held in position by means of a cap and two nickel-steel bolts. The bearing cap is provided with a dipper to scoop oil from the crankcase troughs.

Crankshaft—Is a chrome nickel steel forging, heat-treated, and bearing surfaces accurately ground to size and balance. If it is necessary to remove

the crankshaft for any purpose, the best plan is to remove the entire motor from the car, as bearings and other parts can not be properly replaced with the motor in the chassis.

To undertake such work, proceed as follows—remove radiator, fan assembly, timing gear cover, intake and exhaust manifolds. Disconnect wiring, being very careful to mark and tag all terminals so as to indicate just where wires belong and thus avoid trouble when again replacing them.

To avoid possibility of damage, remove magneto, and by marking its connection, time will be saved the inexperienced man. Take off steering column (this can be removed without taking off dash); disconnect oil tube leading to indicator on dash. Take off clutch pedal assembly, disconnect universal joints and remove clutch from flywheel.

A crane or chain hoist should be used to lift the motor out of the frame. If these are not available, a makeshift block and tackle can be arranged.

Drain oil from the crank-case, and if it is desired to reduce the weight the cylinder blocks can be removed before removing motor from chassis. Care should be taken in attaching sling to crank-case to see that it does not injure any part, and that point at which sling is attached is sufficiently strong so that the weight of the case will not spring the metal. When these matters have been attended to, remove the bolts holding the motor to frame and the motor can then be lifted out and placed on rigid supports.

Crankshaft and Connecting Rod Crank Bearings—These are all bronze boxes with babbitt linings. A looseness of these bearings is generally indicated by a thumping sound regularly occurring with the rotation of the crankshaft. This is particularly noticeable on a hill or under a heavy pull. Bearings may be inspected by removing the bolts holding the lower half of the crank-case and dropping same.

Loose bearings require immediate attention, but adjustments, and particularly replacements, should only be undertaken by an experienced mechanic.

A convenient method to determine if there is a loose bearing, is to place a jack under the flywheel or center crankshaft arms; if there is any play in the bearings, it may be felt on moving the jack handle up and down. Any looseness should be taken up by removing the bearing cap and taking out one or more of the metal shims, then replacing the cap.

The liners or shims are of varying thickness, and if a thin liner is removed it should be preserved, as it may be necessary to replace it at some future time. Always remove the same thickness of shims from both sides of the bearing cap. Right here it should be understood that it requires considerable time and trouble to obtain satisfactory results, and that even under the most favorable conditions it is difficult to obtain perfect bearing surfaces, unless the job be undertaken by one familiar with such work.

Scraping in Bearings—As stated before, this operation of scraping and fitting bearings represents work which should be performed by an experienced man; however, there may arise at some time, conditions which will necessitate the work being undertaken by some one more or less unfamiliar with it, and the following directions are given with the hope that at least a passable job may be turned out. It would be well to have such work gone over by an experienced man at the first opportunity.

First—Before motor is removed from frame, remove cylinder blocks, piston and connecting rod assembly, and then remove motor and place case bottom side up on supports so that it will rest evenly and in such a position that there

is no danger of the case slipping off the supports. Crankshaft bearing caps should then be removed, and if necessary new bearings installed. Bearings should be fastened in the case and cap with screws, and edge of bearings dressed off until the edge of the bearing is just flush with the side of case and cap. The crankshaft main bearing surfaces can then be painted with a thin solution of Prussian blue dissolved in oil, shaft placed in the bearings in the case and revolved, then removed and high points of bearings scraped off. These high points will appear as blue spots on the bearings, as the Prussian blue will be rubbed off the shaft by the points of contact. This operation should be repeated until the bearings in the case show that the shaft hits evenly on the four bearings and the high points are fairly well scattered over the surface of the bearing.

The crankshaft should then be placed in the case and bearing caps drawn out with a sufficient number of shims between the cap and the case so that the caps just touch the crank lightly. The crank should then be revolved, caps removed and high points on caps scraped off. It will also be necessary to remove the crank from the case and spot in bearings in the case at the same time, in order to insure perfect bearing. This operation should be repeated until bearings in both the cap and the case show points of contact which are very close together. It is never practical to fit up main bearings without removing motor from frame.

After bearings are scraped in sufficiently, shims should be used between the bearing caps and the case so that clearance is about .003. Clearance can be estimated very closely by putting on one bearing cap at a time, putting sufficient shims in the bearing so that it is just possible to turn the crank with the flywheel. By adding one more thin shim of about .002 clearance will be about right. Allow .0006 clearance for crankshaft end play at number 3 locating bearing. After scraping in the bearings on the motor, it should never be necessary to tow the car to start the motor. The bearing should be free enough so that the car will crank without difficulty when the job is completed.

Connecting Rod Bearings—What has been said in the foregoing concerning the main engine bearings also holds good for the connecting rod.

Play in the connecting rod bearings may be located by moving the rod up and down by hand; the removal of the lower half of the crank-case is of course necessary before the connecting rods can be reached.

Guard against adjusting the bearings too tight. The bearing is properly adjusted when it has no play and the crankshaft turns free. When replacing the bearing caps be sure to lock the nuts securely with cotter pins. If the cotter pin hole in the bolt or stud does not line up with the slot in the castle nut when the nut is drawn up tight, remove the nut and take a slight cut off its face with a flat file. If a bearing is burned out or so badly worn that replacement is necessary, the new bearing must be fitted to the crankshaft very carefully. The fitting is accomplished by scraping, as outlined in the foregoing pages, and while it is a simple matter for the experienced mechanic who has the proper tools, the average man will find it very difficult, and if the bearing is not properly fitted it will give continuous trouble; it is advisable to leave the scraping of new bearings to someone experienced in the work.

Where an entire set of new bearings has been installed, it is well to allow the motor to run at moderate speeds for five or six hours; if the car be a pumper, let it operate at about half capacity and about one hundred pounds pressure.

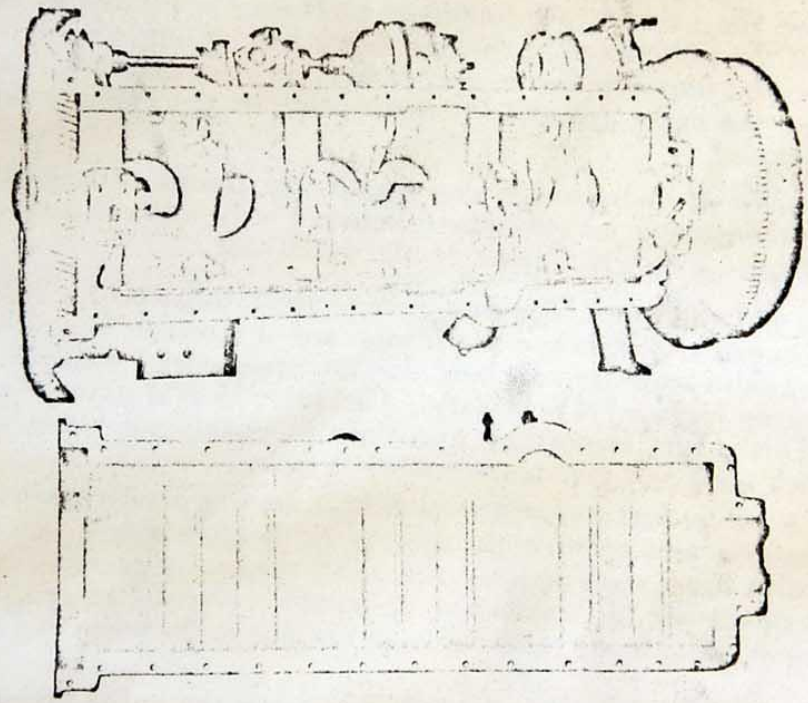
In the case of a combination chemical or ladder truck, drive over level roads for about four hours, but not at a speed exceeding fifteen miles per hour. Under no circumstances should a motor with new bearings be used at full power or speed till certain the bearings are right and not too tight.

Make sure, when replacing bearing caps, that all nuts are tight and securely locked by cotter pins.

Use nothing but the starting crank to start the motor after adjusting the bearings.

In making final adjustment of bearings and crankshaft, be sure the timing gears are properly meshed as indicated by the markings on their face.

Camshaft—Camshafts are machined from a solid bar with integral cams hardened and ground. Special babbitt bushings of large size support the shafts; these are not adjustable and when worn must be replaced. The intake camshaft on the right side carries a spiral gear for driving the oil pump and in pumping cars, the distributor and timer for the double ignition system.



UPPER AND LOWER SECTION OF SIX CYLINDER CRANK-CASE

The exhaust camshaft on the left side has its cams machined in a little different manner than those on the intake, so that by moving the compression release lever (see illustration on page 45) in front of the motor, away from the starting crank, the exhaust valves on compression strokes are lifted slightly, relieving compression and enabling the operator to turn motor more easily.

Both camshafts are removed from the front of the motor by taking off the timing gear cover.

Crank-case—Is made in two sections from aluminum alloy and heavily reinforced. The upper half carries the bearings and shafts, while the lower constitutes an oil reservoir.

In front there is a compartment for the timing gears inclosed by a cover plate. When replacing the lower half of the crank-case, make sure the heavy

paper gasket is intact, otherwise carefully scrape off the old one and replace with new. The new gasket should only be attached to the lower section by shellac; if necessary, the upper gasket surface may lightly be smeared with grease to make a tight joint. These directions also apply to gaskets for the timing gear cover. (See page 107, relative to "Cleaning.")

Compression—Proper development of power largely depends upon the compression of the gas in the combustion chamber or head of the cylinder. As previously explained, the upward stroke of the piston following that of the "intake," compresses the gas into a very small space, and from that of atmospheric pressure to one of from 65 to 75 pounds per square inch.

The exploding or burning of the gas under such condition, exerts tremendous force, much of which would be lost if any leak existed. It is therefore important that piston rings, valves, port plugs and spark plug gaskets be regularly inspected and maintained in proper condition, for one or all of these points represent a possible source of compression loss.

Weak compression, besides being evidenced through lack of power, is also responsible for uneven running at low speeds and difficulty in starting.

Test the compression at frequent intervals with the spark shut off, by cranking or rather, rocking the starting crank against the compression stroke in each cylinder. If one or more of the cylinders does not offer considerable springy resistance, the cylinder or cylinders at fault may be located by opening in turn, all of the pet-cocks but the one under test. Compression being relieved on three, if a four cylinder motor, or five, on a six cylinder, enables you to determine the exact amount of compression in the cylinder whose priming cock is closed.

Weakness or loss of compression can usually be traced to improperly seated valves, either insufficient clearance between valves stems and valve lifters or more likely, a carbon deposit on the valve seat.

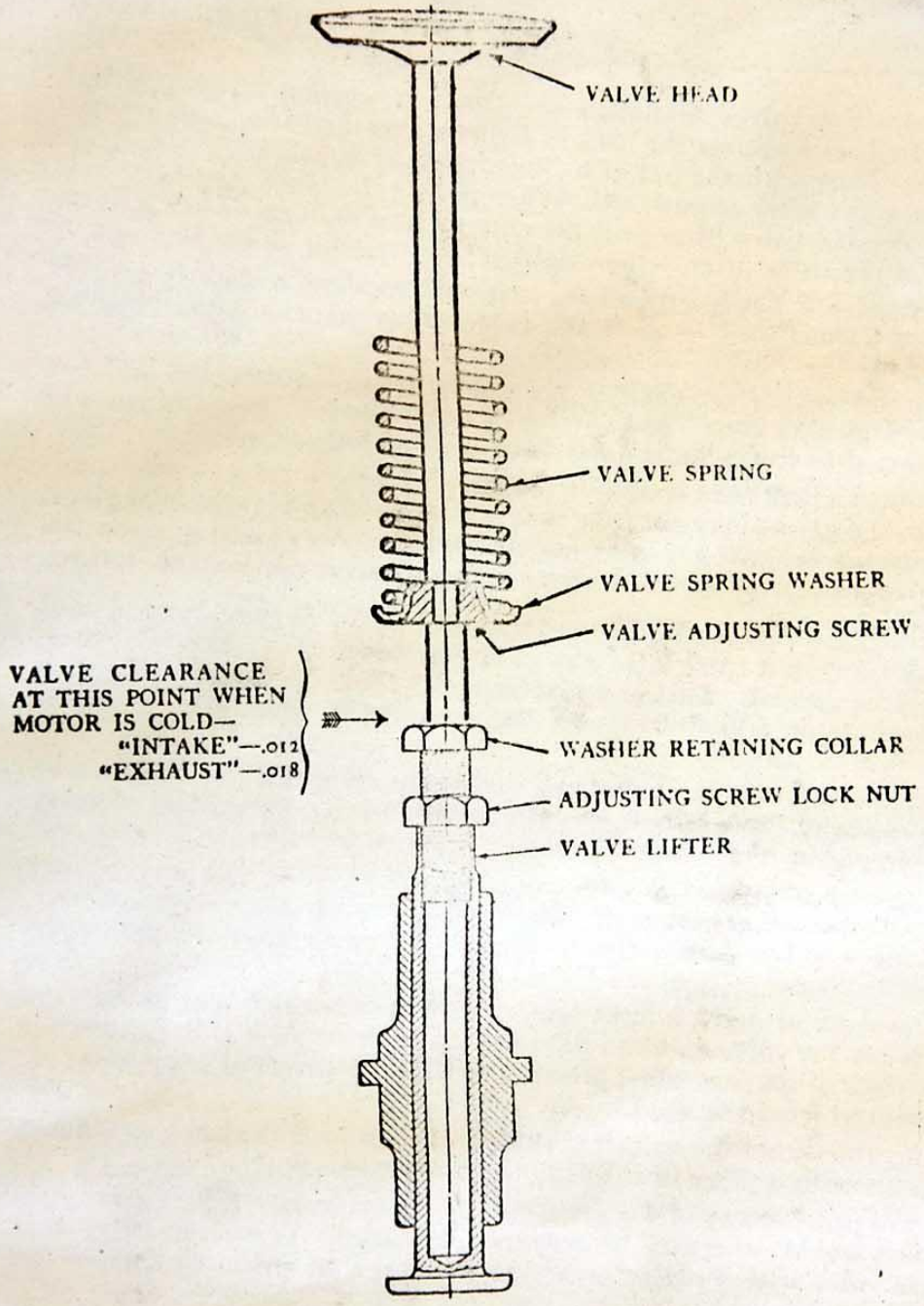
Valves—Valves and stems are from one piece of steel, those on the exhaust side being of Tungsten steel, while the intake are of Chrome Nickel steel. The valve stem guides are extremely long, and are pressed into the cylinders. They may be easily replaced if necessary. The valve should have a free fit in the guide. This is very important, as a tight fit at this point may cause the valve to stick open and give considerable trouble.

To remove a valve, first make sure that it is resting firmly against th seat. Next unscrew and remove the port plug directly above it. Hold down on the valve head and compress the valve spring by pressing on the spring retainer or washer till a sufficient clearance is secured to enable the small split retainer collar being removed from the slot in the lower end of the valve stem.

This operation can be greatly simplified by using the valve lifting tool which is furnished with each apparatus. After removing the retainer collar, press up on the valve stem and remove the valves through the top cylinder port. Remove the spring.

In replacing the valves, reverse the above operation—first place the spring washer on the lower end of the spring and place same in position under the valve guide. Next replace the valve and then apply the valve lifting tool and compress the spring enough to allow of the replacement of the spring retainer collar. When a valve is replaced care should be taken to make proper clearance as outlined in next paragraph.

Valve Clearance and Adjusting Valves – In order that the valve may properly and positively seat, it is necessary that there be a slight separation



or "clearance" between the lower end of the valve stem and top of the valve lifter. This clearance should be adjusted by the aid of thin steel gauges, termed "feelers." When the motor is "cold," the proper clearance for **intake** valves is .012" and .018" on **exhaust** valves.

When adjusting valves, first make sure that compression release is closed, the valve lifted rests against the back of the cam and the valve itself is properly seated. Then with the aid of a "feeler gauge" regulate the adjusting screw of the valve lifter or push rod. When porper clearance is secured, it is well to revolve the valve lifter to make sure there is no high or low spot on either end of the valve lifter,—then tighten the adjusting screw lock nut.

When a valve is newly ground in, it is well to allow a slightly greater clearance for a short time to allow the valve to become thoroughly bedded and worked in.

If valve clearance is too great, there will be considerable noise, and due to the valves opening "late" and closing "early," the full charge of gas will not be admitted to the cylinders and burned gases fully expelled.

Too close an adjustment is equally undesirable, as due to heat and expansion some of the valves may not fully seat and a loss of power will take place. Also the burning exhaust gas has a greater opportunity of acting upon the exhaust valve seats, with the result that they soon become pitted and burned.

Valve Grinding—Valves and their seats should be maintained in good condition at all times, but there is no way of laying down a rule as to how often they should be ground. This is a matter dependent upon many things,—use, oil, carburetor adjustment and the manner in which the motor is operated.

Inspect and test valves regularly as well as the compression. In grinding in a valve and seat, procure from any accessory store a good quality of valve grinding compound, two grades if possible—coarse and fine.

Next remove and grind in one valve at a time. This will prevent any possibility of the valves becoming mixed and applied to the wrong cylinder. In removing a valve, follow the instruction given on page 50 under the heading of "valves."

Next procure or make a light tension coil spring which will fit into the opening below the valve seat and have sufficient strength or stiffness to raise the valve clear of the seat when pressure of the screwdriver or valve grinding tool is removed from the head.

Clean carbon from the valve chamber and then pack the opening leading to the piston with a piece of cloth; never use waste.

This will prevent any of the grinding compound from reaching the cylinders, which would otherwise be seriously damaged. Wash the valve seat and entire valve with gasoline or kerosene, scrape off any carbon from the valve head.

Lightly apply a very light coating of the coarse grinding compound to the beveled surface of the valve head, wipe off stem and drop the valve into place. Next insert the end of a heavy screwdriver into the slot in the valve head and then rotate the handle between the palm of the hands. This gives the necessary constant reversing motion to the grinding action which alone will produce a perfect seat. No pressure other than to hold the valve down against the seat is necessary.

Constantly inspect the valve and seat; at such times it is well to use gasoline to thoroughly wipe the surface. When the seat and valve face have been well ground, then finish the operation with the fine quality of grinding compound. While there are a number of valve grinding tools on the market, nothing equal to the heavy screwdriver held between the hands has been found for doing the best kind of work.

When finished, thoroughly remove every trace or particle of the grinding compound as well as the cloth used to plug the cylinder opening. Replace the valve and adjust for proper clearance.

Valve Timing—This is a term applied to the adjustment of pistons and valves so that the opening and closing of the latter take place in proper relationship to the movement of the former. The exact position of the crankshaft and pistons at which the different valve actions take place, is determined by markings on the outer flywheel surface.

Four Cylinder Motor—Type 10

Firing Order	No. 1 Cylinder	No. 2 Cylinder	No. 3 Cylinder	No. 4 Cylinder
1-2-4-3	Working	Compression	Exhaust	Suction

Six Cylinder Motors—Types 12, 75, 38

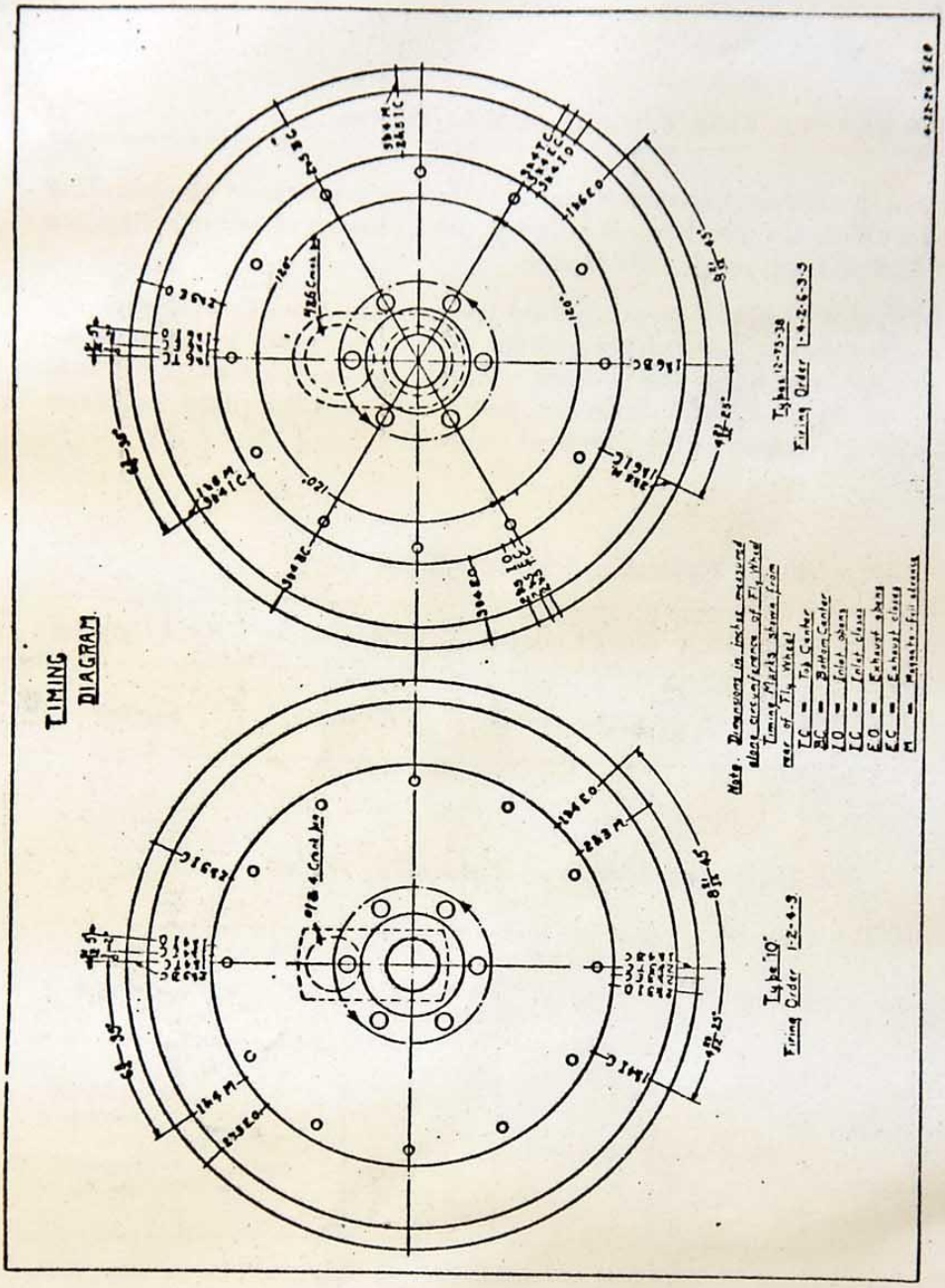
Firing Order	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
1-4-2-6-3-5	Start to work	Suction	Exhaust	Compression	Working Ex. about to open.	Exhaust closed. Suction starts.

All valves are properly timed at the factory and there will be no necessity for retiming them as long as the timing gears are not removed. However, if such an operation be necessary, see to it that the marked surfaces of the timing gears are properly meshed so that all valves will open and close at the right moment.

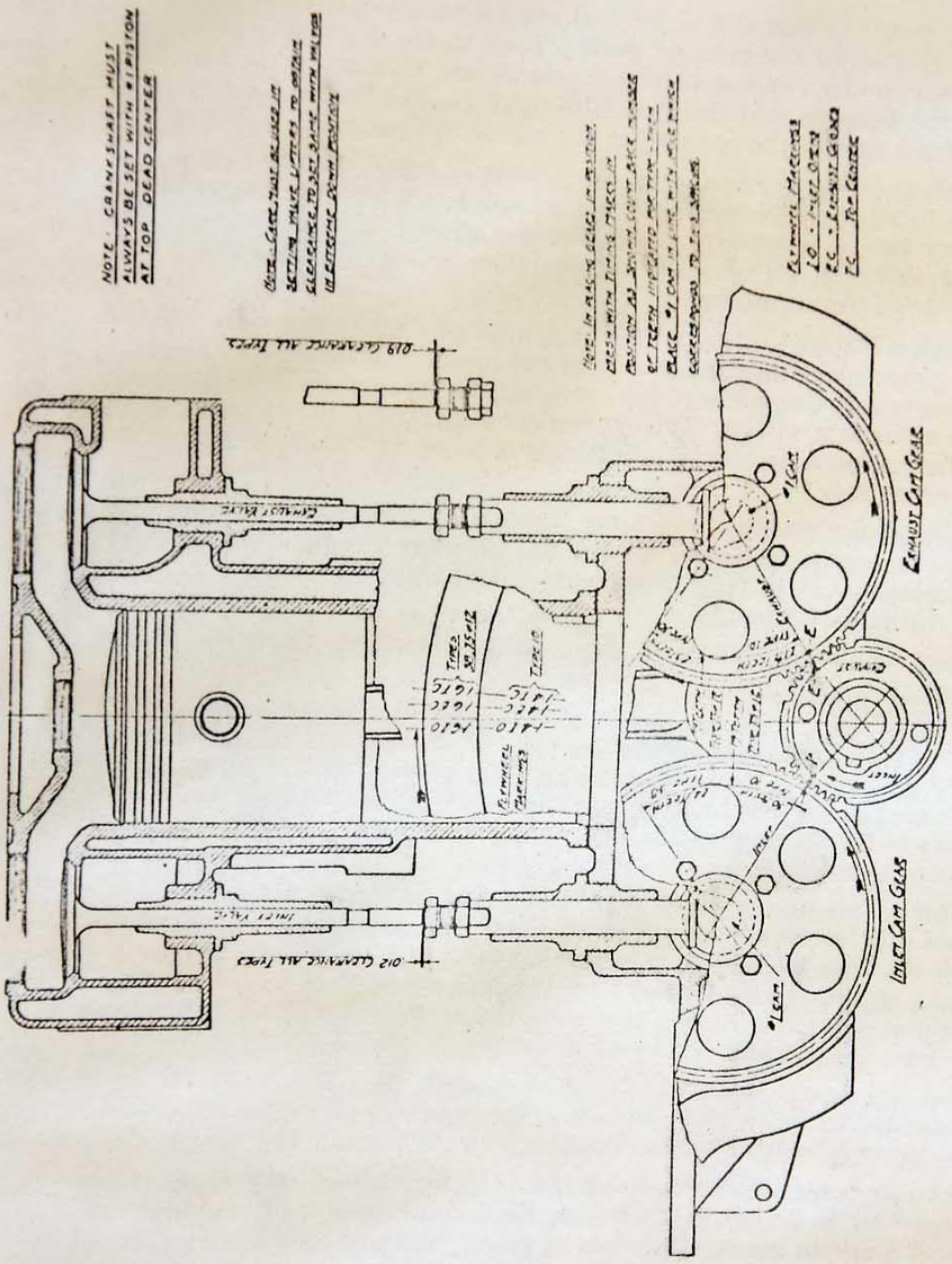
The marks on diagram on page 54 are those that appear on the flywheel and when brought opposite the indicator extending over the top of it, show the opening and closing moments of the valves of each cylinder. All cylinders are numbered from the one nearest to the radiator, which is number one.

Should it become necessary as the result of an accident, to install a new crankshaft or flywheel, it will be necessary to mark the latter and the following procedure will assure you of obtaining the accurate top center of No. 1 piston. After this has been established the other marks can be laid out on the flywheel by measurement.

First—Turn the flywheel in the direction of rotation until No. 1 piston has reached the limit of its upward travel; continue turning flywheel **very slowly until the first perceptible downward movement of the piston is noticed.**



Determine this point very accurately, then place a light mark on the flywheel under the indicator pointer. Now turn the flywheel **very** slowly in the opposite direction from its natural rotation, and **again very carefully determine** the point where No. 1 piston just commences its first perceptible downward movement. Again lightly mark the flywheel at this point under the indicator pointer. You now have two light marks on the flywheel about 3½ inches apart, and the exact top dead center of No. 1 piston is **exactly half way between these two marks,** at which point the heavy permanent line should be scribed and marked 1 and 4 T. C. (Top Center) if a 4-cylinder motor, or 1 and 6 T. C. (Top Center) if a 6-cylinder motor.



CAM SHAFT GEAR SPACING AND VALVE

Lifter Clearance Diagram – Types 10, 38, 75 and 12 Motors

All cams are integral on the shafts, and therefore there is no possibility of their shifting their position. The timing of the valves of any one cylinder will suffice for the others. As an example, turn the flywheel until the mark and pointer indicate that the inlet valve in No. 1 cylinder just starts to open, then insert the camshaft and mesh the gears so that the least movement in the flywheel, in the direction which the motor runs, will cause the valve to

rise. If a valve opens within three-quarters of an inch on the flywheel of the correct marked position, the valve may be considered as properly timed.

The amount of clearance in the valve adjustment greatly affects the timing mark on the flywheel, hence the importance of making correct adjustment.

Having properly seated and meshed the inlet camshaft timing gear, c likewise with that of the exhaust shaft. Turn to the mark indicating tha number one cylinder exhaust valve has just closed, then insert the camshaft and mesh the gears so that the least turning of the flywheel in the opposite direction from that of the running of the motor will cause the valve to rise.

The valve setting will not approximate that of the above illustration and the valves in all of the remaining cylinders will follow in their proper order. While valve timing is not such a difficult operation, it nevertheless requires great care and fine adjustment. It therefore represents something best left to the experienced mechanic.

Compression Release—Is operated by a lever projecting from the front of the timing gear cover on the left side of the motor. When about to engage the starting crank, throw the compression release lever away from the starting crank as far as it will go. This movement slightly lifts the exhaust valves so that the compression in the cylinders is reduced and turning over of the motor is made easy.

As soon as the motor starts firing, move the compression release lever back to its disengaged position. Do not use the lever when testing the cylinders for compression; in fact, this device should never be used except when starting the motor by hand.

Oil Pump—Full description of this will be found on page 107, under "Lubrication."

Fan—This member is mounted on a shaft equipped with two ball bearings. The entire unit is attached to the front of the forward pair of cylinders by means of an adjusting cam. The fan belt should be kept just tight enough to drive the fan without binding; adjustment is made by means of the cam mounting of the fan assembly. Unless the fan operates properly, the motor will probably overheat.

Radiator—This unit consists of top and bottom tanks and tubular core mounted in a framework or casing. The cooling system is filled with water through the large filler opening in the top tank; it then trickles through t small passages in the tubular cooling core into the bottom tank from whic it is drawn through a rubber hose into the water pump mounted on and driven from the left side of the motor.

From the pump, the water is forced through the passages of the water jackets of the cylinder walls, then into the manifold on top of the cylinder blocks, through another rubber hose back to the top radiator tank.

The water supply in the radiator should be maintained at all times, otherwise there will be no means of carrying the excess heat away from the motor. This will result in overheating, loss of power, and sometimes the seizure of the pistons.

Stoppage of the circulation system also results in the above troubles; for that reason the radiator should be flushed out and cleaned occasionally. **Open the drain plug on the under side of the bottom tank and the pet cock**

the elbow below circulating water pump. This will completely drain the entire system.

The radiator may now be flushed by directing a stream of water from a hose into the filler opening. If it is desired to further clean the radiator, replace the radiator drain plug and close pet cock in elbow under circulating pump. Then dissolve a handful of soda in a pail of hot water and pour the solution into the radiator and allow to stand for a few minutes. After this, the system should be drained and well rinsed out with clean, fresh water.

Surplus water and steam are carried from the radiator by means of an overflow pipe leading from the top tank to the lower left-hand corner. On pumping cars the overflow is connected into the exhaust pipe; see to it that the vent does not become clogged. The rubber lining of the connecting hose sometimes deteriorates and scales off. For that reason the connections should be inspected and cleaned out.

Should leaks develop in the radiator, it should be removed at once from the car and given to an experienced radiator repair man to solder. Do not use an anti-leak compound, bran, corn meal and other makeshift remedies. All of these only clog the circulation system.

A steaming radiator indicates the water is low, exhausted or stopped up; in cold weather it may be frozen. In the latter case, place the car in a warm building and cover the radiator with a blanket and allow the radiator to thaw out gradually. Open drain plug in the bottom tank and the cock below the pump. This permits the water to run off as it melts.

Be very careful about removing the filler cap when the radiator is steaming, as boiling water is liable to rush out. Never pour cold water into a radiator when the motor is hot. This might cause a cracked cylinder.

Tighten all water connections, gaskets, etc., whenever the slightest leak develops. When using alcohol in the circulation system during the winter season, it is particularly important to constantly inspect the circulation system for leaks.

The caps at either end of the water pump may require tightening or new packing from time to time; ordinary wick packing or graphite packing can be used for these stuffing boxes. Do not try to remove the small packing glands (against which the screw caps rest) by force. By allowing the motor to turn over slowly and holding the edge of a screwdriver against the flange of the gland, the latter will easily slide out of the pump housing, due to the motion of the shaft. Remove all the old packing, replace with the new, and screw up the caps; hand tight should be sufficient to stop leakage. The necessity of using a spanner to produce a leak-tight joint indicates that new packing is required; be sure to replace the spring-locking device after the caps have been replaced.

After the cooling system has been completely drained and replenished with water, it is well to start the motor and run it a minute or two to drive out any air there may be in the pipes or water jackets; generally after a moment's running, it will be found that more water may be added to the radiator.

Auxiliary Cooling System on Pumping Cars—Pumping cars are fitted with an auxiliary cooling system to properly control the temperature while the car is at rest and working under the load of the pump. From the large fire pump, a pipe leads forward and connects with the motor circulating system at a point directly above the motor water pump. The overflow pipe of the radiator is much larger on these machines and is carried back and into

the exhaust pipe. Since the latter always contains more or less carbon, it is necessary every little while, to disconnect the overflow pipe where it joins the exhaust and clean out any carbon deposit that might interfere with the free passage of water.

On pumping cars, practically any volume of water may be thrown in the circulating system from the fire pump and for that reason there is constant liability of over cooling the motor. To produce maximum efficiency the motor should be neither too cool not too hot. A very good way to constantly watch and safeguard the temperature, is to occasionally place the hand on the water jacket cover; to be about right, it should be possible to hold the hand on the cover a few seconds without burning. Constant attention should be given temperature as shown by motometer.

After pumping, make sure the proper valves are closed to prevent water being drained from the radiator and water jackets. (See instructions, page 137.)

Cold Weather Precautions—See page 172.

Capacity of Cooling System:

Type 10	7½ gallons
Type 75	10½ gallons
Type 12	10½ gallons
Type 14—6 Cyl.	10½ gallons
Type 14—4 Cyl.	7½ gallons
Type 31—6 Cyl.	11½ gallons
Type 31—4 Cyl.	9 gallons

Gas Tank—This is mounted back of the seat and is fitted with a large filler opening at the top, and at the bottom, with a large wash out port and shut-off and drain cock.

Water is often present in gasoline, and particularly in cold weather, may cause trouble through settling in the bottom of the tank or carburetor bowl, freezing and clogging the passages. It is well to open the drain cock once in a while during cold weather and drain off a small quantity of the gasoline.

The small air vent hole in the top filler cap should be kept open and f[illegible] from dirt, so that a vacuum will not be created within the tank.

Too much care not be taken to prevent dirt or other foreign matter entering the tank, and to that end a very fine copper mesh strainer should be used when filling the tank; best of all however, for this purpose, is a chamois skin placed inside the funnel.

Carburetor—The Schebler carburetor as adjusted and set at the factory will require but little additional manipulation, as any variation in the mixture or temperature are cared for by the choke lever on the steering column.

Intake Manifold from Carburetor—This is cast from aluminum, and due to the metal being comparatively soft, inspection should be made to see that it is at all times firmly seated and bolted to the cylinders. Any looseness or air leaks between the carburetor and the cylinders will greatly affect the character of the mixture and in turn the running and power of the motor.

arburetor Control—Complete control of the carburetor is virtually confined to two levers,—the throttle, which is the lower one of two levers directly under the steering wheel, and the choker mounted further down on the steering column.

The throttle regulates the supply or volume of fuel entering the cylinders. When pulled back toward the driver, it is closed; pushing forward, opens the throttle and by allowing more gas to enter the cylinders, increases both the power and speed of the motor.

The choker lever governs only the quality of the gas mixture produced by the carburetor.

Attached to the floor boards and located near the foot brake pedal, is a small foot lever known as the "accelerator." This connects with the carburetor and performs the same duties or functions as the throttle; it differs from the latter however, as it automatically closes as soon as the pressure is removed from it.

In driving, it is generally found easier to keep both hands on the steering wheel and operate the accelerator pedal with the foot, than to continually move the throttle. It is a good plan to set the throttle lever at a point where the motor will idle and rely upon the accelerator for all increase in power.

Choker—This control lever is fitted to the steering column and moves on a quadrant marked with six graduation points and the words "Gas" at the top and "Air" at the bottom limits of movement.

The choker controls the tension of the carburetor auxiliary air valve spring; moving the lever up toward the word "Gas" tightens the spring, causing greater quantities of gasoline to enter the mixing chamber of the carburetor and results in what is termed a "rich mixture." Moving the lever down toward the word "air" releases the spring tension, thereby causing less gasoline and more air to be drawn in, producing a "lean mixture."

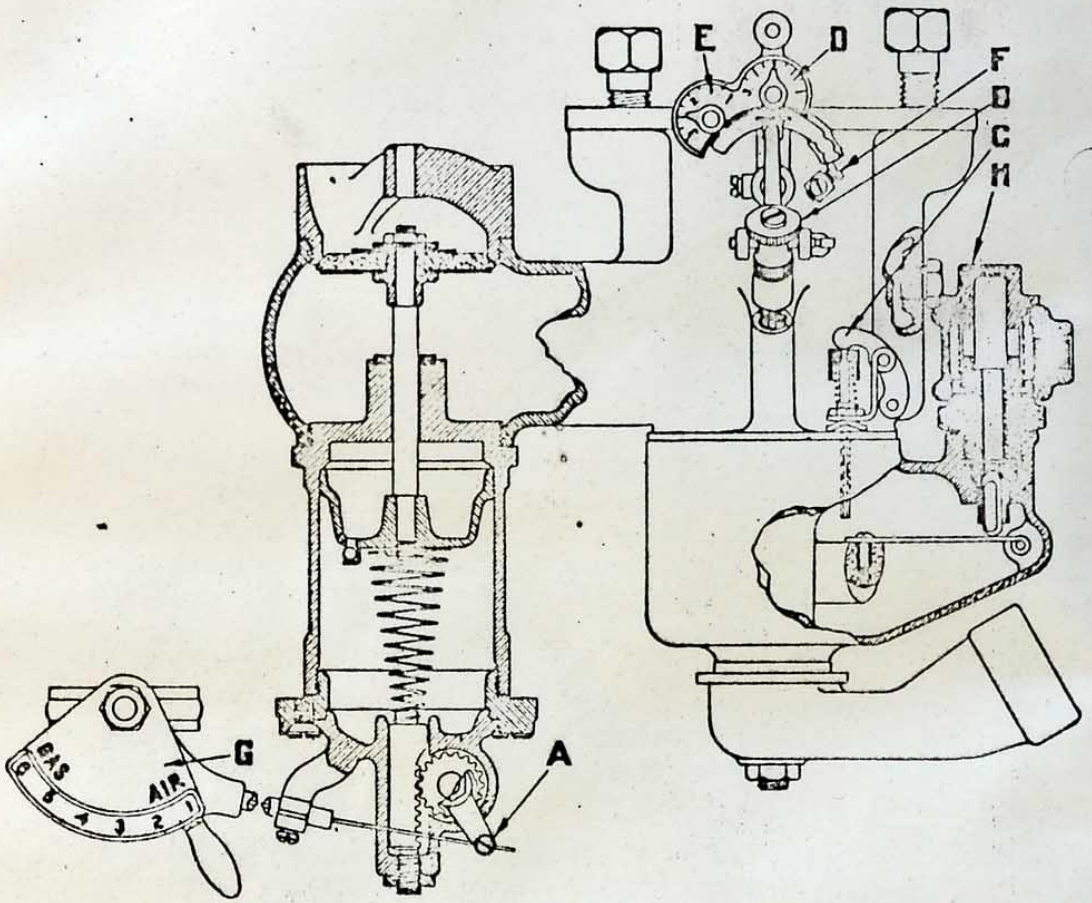
When the motor is cold, it is hard to start on the lean mixture ordinarily delivered by the carburetor; for that reason, the choke lever should be moved ıp to a point half way or more toward the word "gas." Such a rich mixture ıgnites easily but after the motor starts firing, the choke should be moved back to "air" as far as possible, consistent with even running.

A rich mixture, besides wasting the fuel, causes carbon deposits, pitted valves, fouled spark plugs and diluted lubricating oil, overheating and loss of power. All these things represent considerable extra work of the operator or mechanic and may largely be avoided by proper handling of the choker.

Always run with as lean a mixture as possible and with the choke lever moved to the lowest point consistent with even running.

Stove or Air Heater—In order that the low grades of gasoline now furnished may be more readily vaporized, warm air from around the exhaust manifold is taken into the carburetor by means of a flexible metal tube. During the summer months, this connection may be dispensed with, but in winter or cold weather, it is particularly important, as the motor runs far better and with less liability of there being much liquid gasoline running down past the pistons and diluting the lubricating oil in the pan. The stove may also be disconnected during extended pumping operations.

Carburetor Adjustments—Such work should be only undertaken by a really experienced man. Much trouble is caused by unnecessary "tinkering"



with the carburetor and trying out of "pet" theories regarding adjustments, —some men never will leave the instrument alone.

Before undertaking any work, make sure the valves and ignition are properly timed, that there is a good hot spark at each plug, that all valves are properly seated, port plugs and carburetor connections without air leaks.

Next, warm up the motor, as no proper adjustments can be made while it is cold. With this accomplished, move the choker down full distance to "air" as shown by letters "A" and "G" in the cut.

Next make sure that auxiliary air valve seats firmly (the auxiliary ai valve spring tension can be adjusted by means of the screw in the bottom of the casting) and then close needle valve by turning adjustment screw "B" to the right until it stops. Do not use pressure in closing this valve—the instant it meets with resistance, stop. Now turn it to the left from four to five complete turns.

Open the throttle lever about one-third, start the motor and then close throttle slightly. Retard the spark and by means of a screw driver, adjust throttle lever screw "F" and needle valve "B" so that the motor idles at slow speed, and hits on all cylinders.

Having secured the slow speed adjustment, do not again touch the needle valve. Now make intermediate and high speed corrections on the dials "D" and "E." On dial "D" move the pointer to about opposite figure 2 and then advance the spark and open throttle so that the small roller on the track below the carburetor dials is in line with the first one.

Should the motor backfire with the spark and throttle levers as set, the mixture is too "lean," and the pointer on dial "D" should be turned slightly more toward figure 3 to make the mixture richer. If, however, with the above adjustment, the mixture is too rich, the motor will be sluggish in picking up and the pointer should then be moved to figure 1. This is the adjustment for intermediate speeds.

Now advance spark fully and open throttle till roller is under dial "E," then make adjustment with dial pointer as before; this represents the high speed setting.

In making the carburetor adjustments, it is well to use the accelerator lever, pressing the hand upon it long enough to note the motor action and releasing it in time to prevent racing, which is very unnecessary and detrimental to the motor.

Very often when first starting a motor, it shows a tendency to backfire, this does not necessarily mean the carburetor is out of adjustment, but rather that the motor is cold. After warming up, the adjustment will be found correct; many drivers however, immediately start making changes in the carburetor setting, with the result that soon after, the work has to or should be done all over again.

We find a tendency to give too rich a mixture and recommend that when adjusting the instrument at low, intermediate and high speeds, the gas be cut down until the motor starts to backfire, and then increase the fuel supply a notch at a time for slow speed, till it hits evenly on all cylinders.

Do not increase the gasoline supply by turning the needle-valve screw more than a notch at a time for low speed adjustment and leave it alone after the motor runs easily and evenly;—this we repeat, as it seems difficult to make operators appreciate the necessity of following instructions.

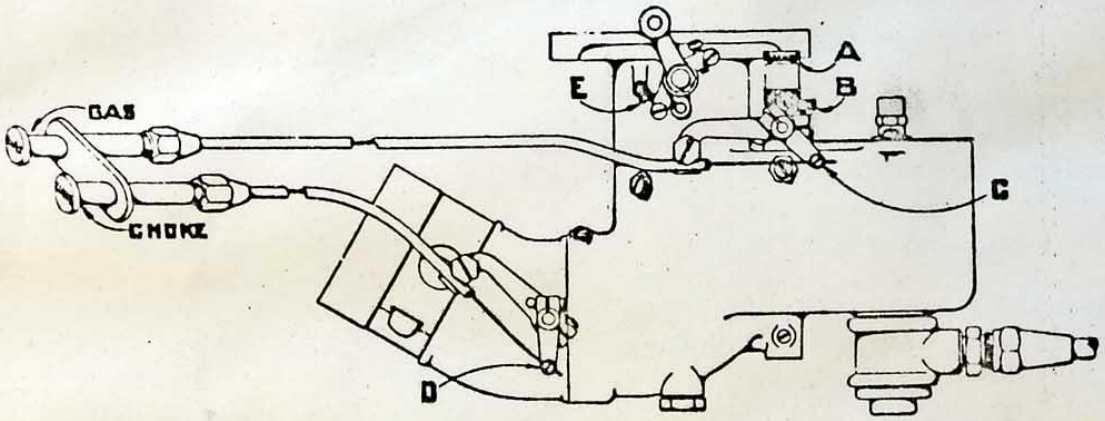
When adjusting the intermediate and high speed dials, do not turn the pointers more than half way at a time between the graduated divisions or marks on the dials. Carburetor adjustment should always be tested for easy starting with motor cold.

Dirt, sediment and water are responsible for much of the so-called carburetor trouble, therefore it is well to frequently remove and clean the strainer "H."

Leaking Carburetor—Leaking of the Carburetor may generally be attributed to two causes: opening wide the throttle when bringing the car to a stop, with the idea of throwing a rich charge of gas into the cylinders to facilitate easy starting, or to the presence of dirt under the needle or float valve, Sticking of the float will also cause the bowl to overflow and a constant dropping of gasoline will take place.

INSTRUCTIONS FOR ADJUSTING THE 2½" MODEL "A" SCHEBLER CARBURETOR

The dual type control is required. The hook-up is as follows: The wire attached to the plunger marked "Gas" is fastened in the binding post on lever "C" that controls the high speed needle "A." When the plunger is pushed entirely in the lever should be against the stop. The wire attached to the plunger marked "Choke" is fastened in the binding post on lever "D" that operates the butterfly choke, so that when the plunger is entirely in the choker is wide open.



Preliminary Adjustments—Turn both needle adjustment knurls "A" and "B" to the right until they are seated, but be careful not to use any force. Then turn both knurls to the left about four complete turns. See that the throttle stop screw "E" is screwed in far enough to hold the throttle disc open slightly. Pull the "Gas" plunger out, set the throttle about one-eighth open. Use the "Choke" plunger only when the motor is cold. And then only for a few turns of the motor. After the motor is started let it run until it is thoroughly warmed, and then push "Gas" plunger in.

Low Speed Adjustment—Close the throttle. Screw the knurl (B) down (to the right) until the motor starts missing. Then turn the knurl (B) to the left until the motor runs smoothly. Adjust the throttle stop screw (E) until the desired low speed is obtained. In doing this it may be necessary to readjust the knurl (B) a few notches in either direction to complete the low speed adjustment.

NOTE:—It is better that this adjustment be slightly too rich than too lean.

High Speed Adjustment—Open the throttle about one-fourth way with the spark retarded. Turn the needle valve knurl (A) to the right until the motor starts to slow down, then turn the knurl to the left until the motor hits evenly on all cylinders.

If, in trying out the motor, it is inclined to back-fire when the throttle is opened suddenly, turn the knurl (A) to the left until this condition is eliminated.

ELECTRICAL SYSTEMS

On all American-La France apparatus, three electrical systems are employed for as many distinctive purposes. These cover—Ignition, Starting and Lighting. Each system and unit is dealt with in detail in the following pages and in the order given.

Ignition System—The ignition system as explained elsewhere in this manual, is responsible for the setting fire of the compressed gas in each cylinder of the motor, thereby creating the power or impulse stroke of the piston.

In all motors but those used on pumping cars, what is known as the dual system is employed; on pumpers, the "double" system is used. The "dual" system comprises a magneto and battery, but has but one timer and distributor and only one set of spark plugs. On most pumping cars, two independent sources of electric current supply separate sets of plugs through distinctive timers and distributors.

Either source of current may be used at will by the driver, by simply turning the key of the switch attached to the dash to the point marked Battery or Magneto. Certain types of pumping cars, such as Type 75 and Type 12, have three-way switches. This makes it possible to synchronize both battery and magneto systems for use at same time. Consequently there is no danger of the car going dead through the failure of one system of ignition.

Electricity is often more or less of a mystery to many people, and as the electrical systems on the car are highly important, we have endeavored in the following pages, to so explain their principles as to enable the operator to understand and intelligently look after their upkeep.

Electrical Terms—In this connection, it is desirable that a clear understanding be had of the common electrical terms in general use:

Ampere—The ampere is the unit of current strength; it expresses the rate of current flow. It is not correct to speak of it as measuring quantity. An ampere is the current which results from a pressure of one volt acting in a closed circuit on a resistance of one ohm.

Ohm—The ohm is the electrical unit of resistance. Resistance is a property possessed by all materials, but in varying degrees. It always varies inversely as the cross-section of the material; that is, the larger the wire the less will be the resistance and the smaller the wire the greater will be its resistance. The resistance of all materials increases with length. It is the resistance in the filament of a lamp that gives light when current is forced through it, but it is also the resistance which causes the loss in voltage or pressure which makes it so difficult to transmit currents of magnitude over wide areas. Resistance tends to diminish current flow and when great enough, prevents it entirely. As an illustration of a more practical nature, 2 3/10 feet of No. 36 B. & S. gauge wire has a resistance of one ohm; 380 feet of No. 14 wire a resistance of one ohm and 1,000 feet of No. 10 wire a resistance of one ohm.

Volt—The volt is the unit of force, or electrical pressure. It is this pressure which is the immediate cause of current flow and we speak of it as so many volts, just as we speak of steam pressure as of so many pounds. The volt is defined as the electromotive force which will force a current of one ampere through a resistance of one ohm.

Watt—The watt is the unit of power. Just as the ampere expresses the rate of current flow, without telling anything about the actual quantity delivered, so the watt measures the rate of doing work, or rate of energy consumption in the circuit. The watts in any circuit are equal to the volts multiplied by the amperes. 746 watts equal one horsepower.

Conductor—Anything which readily carries the electric current such as wire, carbon brushes, lamp filaments and the frame of the apparatus.

Ground—When a wire leading to the negative battery terminal accidentally comes in contact with any part of the car frame to which the positive terminal of the battery is connected, a "ground" results. In a single wire system, a "ground" is also a short-circuit.

Grounded—The positive battery terminal and one from all other units are electrically connected with the apparatus frame; they are thereby grounded.

Insulator—Material that does not conduct electric current, such as rubber, mica, wood, etc.

Insulated—Separating one conductor of electrical current from another by means of some non-conducting material, is insulating them. In the car, the negative terminal of the battery is insulated from the frame.

Live—The parts connected to the negative or insulated terminal of the battery are referred to as "live."

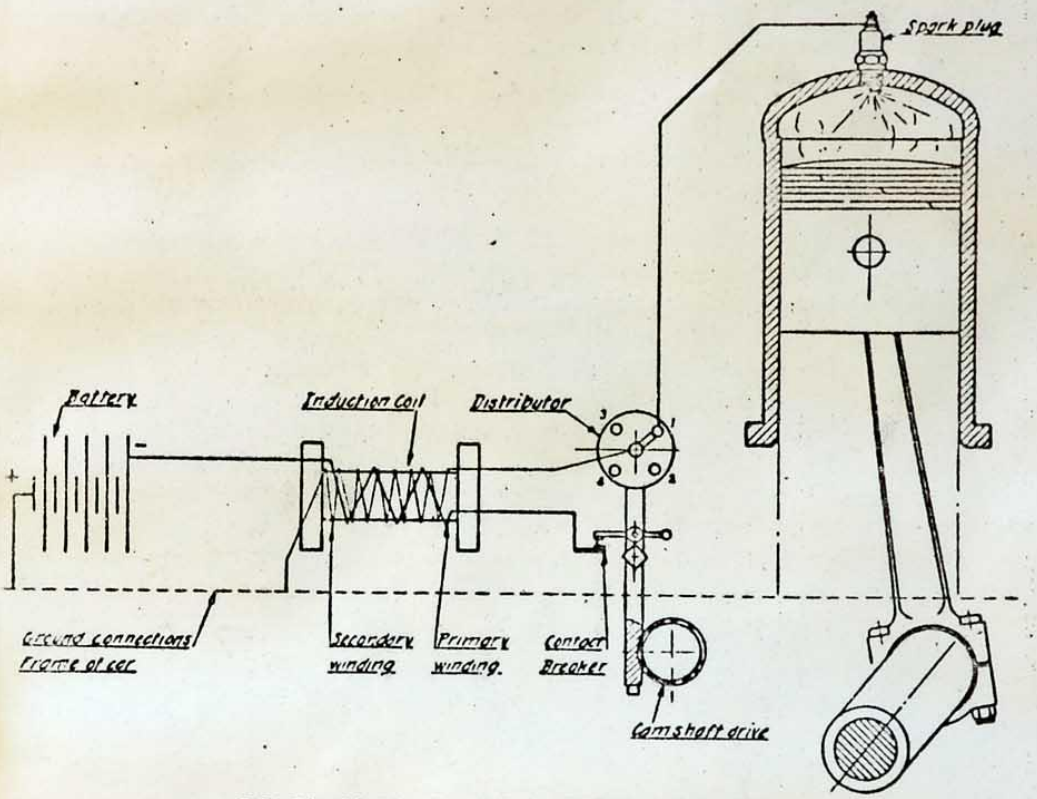


DIAGRAM OF SIMPLE ELECTRIC SYSTEM

Open Circuit—Where a conductor is broken or becomes loose from its connection, the circuit is open and the current can not pass.

Short Circuit—A direct connection between or leading to the two terminals of the battery. A short circuit is destructive to the electrical equipment and should be guarded against.

We will first deal with the simple battery ignition system and then take up that of the magneto, the former leading to and furnishing a clearer idea of the latter instrument. To reach a clearer understanding of electric current and its passage through wires, it might be well for the student to liken it in his mind, to a current of water passing through pipes of different sizes with valves which control its flow.

The storage battery is one of the sources of supply of the electric current which, at the proper moment is made to jump the small gap or separation between the two metal points at the lower end of the spark plug and in doing so creates an arc or spark which sets fire to the compressed gas in the cylinders.

The electric current as furnished by the battery is not however, of sufficient force or "voltage" to jump this gap, consequently a means must be employed to step up or increase this "voltage" to the required point. What

primary current is broken by the breaker points, the natural tendency of the current would be to follow across these open points; this would cause them to become pitted and burnt. To prevent the formation of this electric arc, the wire to the breaker points is connected to a condenser.

This condenser is built of numerous layers of tinfoil separated or insulated from one another by paraffin paper. Half of these layers of tinfoil are connected to the wire leading to the breaker points; the other half of the layers are grounded. When the breaker points are separated, instead of the current trying to follow across the gap in an arc, it follows the path of least resistance and goes into the condenser, thus preventing the arc and stopping the flow of current instantly.

In order to effect a proper contact between battery and coil, a switch is placed on the dash within reach of the driver. This switch has three positions,—"off," when all contacts in the electric ignition system are broken. "Bat," meaning the closing of the circuit between the battery and coil; and in which position, the motor can be run on battery ignition only. "Mag," meaning the circuit connecting up to the magento, which alone will furnish the current for the spark.

If the switch to the battery should be turned after stopping the motor, the battery would soon be drained of all its current through the coil. To prevent this, a resistance coil is placed in the primary wiring between the ' and coil. This resistance coil becomes hot when the current flows h it while the motor is not in operation to use the electricity. After il reaches a certain temperature less current will flow through it; the being in the nature of an automatic shut-off, so that the battery will e drained so quickly.

ıould you remove one of the spark plug wires while the motor is running ıold the terminal free of any connection, the surge of high voltage ıgh this wire would have no outlet, and as its tendency is to go to ground, ı as water seeks its own level, the current would force its way through ınsulation of the secondary wiring of the coil and so ruin it.

To prevent this, a "safety gap" is incorporated in the secondary wiring; side of this safety gap is grounded and when a spark wire is removed, the rent flows along the lines of least resistance and goes to the ground ough the safety gap without injury to the coil.

ıttery—The storage battery furnished with American-La France appara- s is the product of the Willard Storage Battery Co., of Cleveland, Ohio. represents the heart of the electric system of the car and is a reservoir into hich the electric energy made by the generator of the machine or from out- de sources, is stored for Ignition, Lighting and Starting purposes.

A storage battery is an electro-chemical apparatus entirely different from he mechanical parts of the machine. Its life is dependent upon the care which it receives and the kind of service demanded of it.

When a new piece of apparatus is purchased, the Chief or Master Mechanic should go to the nearest Willard Service Station immediately and have the battery registered in order to take advantage of the Willard 90-day insurance policy. Also ask for a Service Card on which the registration day will be written. If you buy a Willard battery to replace the one you now have, it will be registered when sold.

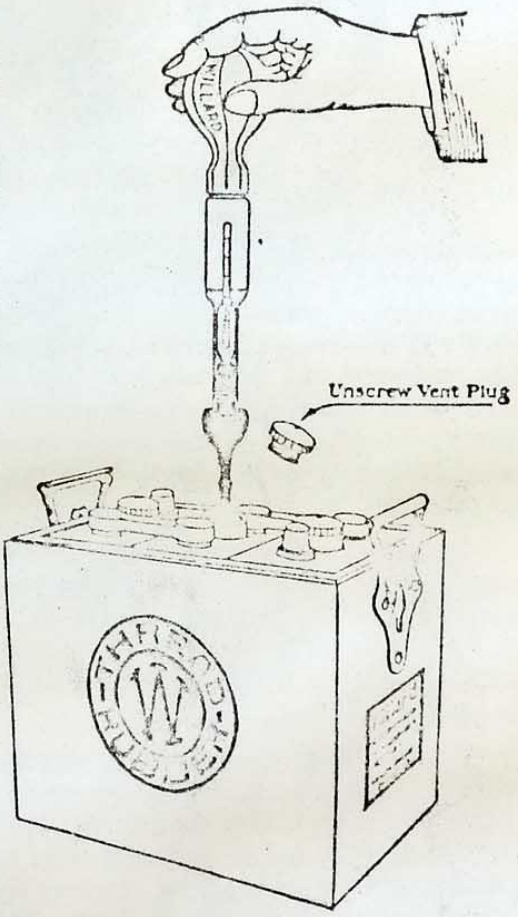
Motor apparatus in many cities is not given sufficient use to keep bat-

teries charged as they should be, for successful operation. **It is imperative that some means be taken to keep the battery properly charged.** One plan is to have an extra battery which may be charged while the other is in service. Recharging should be done at the fire house, with proper apparatus, or some local garage or electrical company.

This is expensive in first cost of extra battery. However, this plan has been satisfactorily followed in departments having several cars and where batteries were changed in rotation. There is recommended as the simplest and most efficient means, the purchase of a rectifier for use with alternating current, or a lamp resistance for direct current. Local electricians can advise nature of current available in your city.

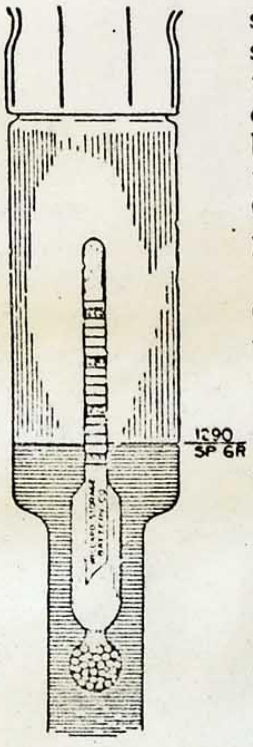
The rectifiers can be purchased through any supply house, or the American-La France Fire Engine Co. and should be arranged with snap-on connectors for attachment to the battery. If the current is direct, the local electric supply house can furnish the proper lamp resistance, and that should be arranged with snap-on connectors to the battery.

The rate of charging should not be above rates noted on plates attached to the battery.



Another method, and one necessary where electricity from city system or private source is not available, is by running the motor idle in the house. Do not race the motor while engaged in this work, run it as slowly as possible to give charging rate; it may be necessary to run about five hours if battery is nearly exhausted, but we recommend motor be run for this purpose each day, as time required will be comparatively short and this daily running will keep motor in condition for quick starting. However, we recommend the method using the rectifier or resistance wherever possible as being less troublesome and much cleaner, because the exhaust from continuous running is objectionable in close quarters.

To find condition of the battery (that is, charged or discharged) it is necessary to use a hydrometer. This may be purchased from battery makers or



Reading for fully charged battery should be between 1280 & 1300

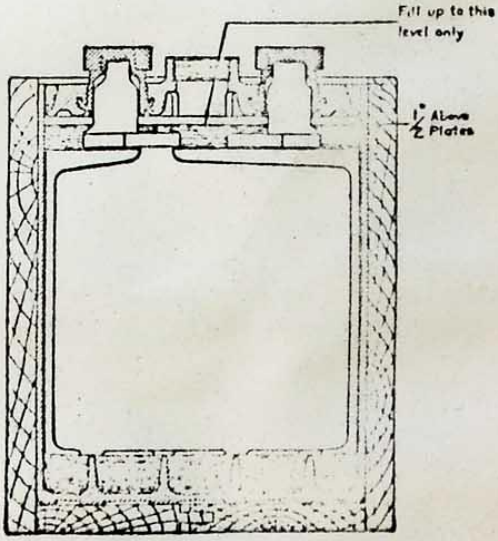
supply stores. The hydrometer is intended to show specific gravity of solution of sulphuric acid in battery. Great care should be taken to keep the level of liquid up to point indicated in these instructions, by adding distilled water every week or two. Particularly when charging, the battery must be full. Continue charging battery at finish rate until sample drawn from liquid through vent hole shows 1.280 hydrometer reading.

Care of the Battery, Testing Cells—Test all cells with a hydrometer on the first and fifteenth of every month. Fully charged cells should read between 1.280 and 1.300. If any cells are below 1.275 on two successive testing dates, take the battery to the nearest Willard Service Station and have it fully charged. In taking these readings, care should be exercised to return the electrolyte from the hydrometer syringe to the same battery cell from which it was taken.

Keep all cells filled with distilled water to a level ½" above the top of the plates; NEVER FILL ABOVE THIS LEVEL.

Keep the battery and the battery compartments clean and dry. Keep the terminals clean, tight and well covered with vaseline to prevent corrosion.

Never allow the battery to become heated in service above 100 degrees Fahrenheit. Watch the battery for heating once or more each day during warm weather. If the top connectors feel more than blood warm to the touch, take the temperature with a dairy thermometer. If the temperature registers over 100 degrees Fahrenheit, burn all the lamps until you can consult a Willard Service Station which will prescribe what is necessary. If the temperature reaches 120 degrees, the battery may be ruined.



In order to prevent freezing in cold weather, test your battery frequently and see that the gravity is kept up to at least 1.275. A discharged battery will freeze at a little below the freezing point.

When filling, if one cell takes considerably more water than the others, this indicates a leaky jar and the battery should be taken out and sent to a Willard Service Station. Unless repaired immediately, the battery may be ruined.

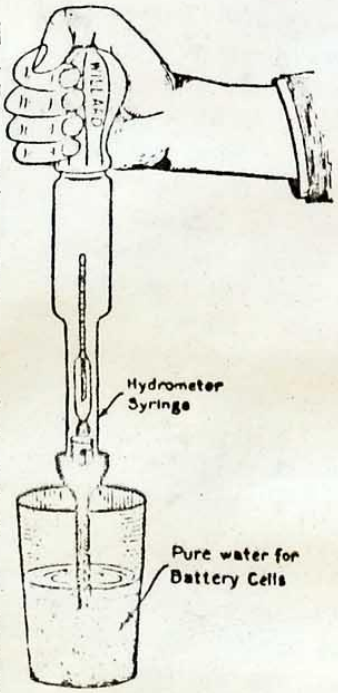
A battery will slowly discharge when standing idle. Serious injury will result if it is not kept charged.

Never short-circuit the battary

te nals as the battery is shipped in fully charged c ion. To be certain that the contacts at battery terminals are tight, turn up solid so they will not work loose.

If the battery tends to run down, the car should be operated a larger portion of the time without or with fewer lights, until the charge is increased.

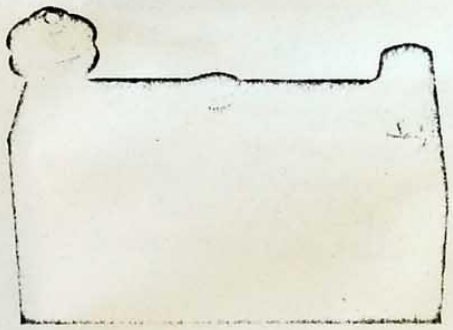
With the motor not running, there is no charge entering the battery and any lights used at such times simply drain the current.



Indications of Discharged Battery—If the voltage drops to 5 or 5½ volts with the headlights burning and the motor not in operation, the indications are that the battery is practically discharged. Where the specific gravity of the electrolyte drops to 1.100 or 1.150 it also indicates the battery is discharged.

Willard consulting service is provided for all owners of Willard batteries. This covers expert advice any time, and testing and filling the battery twice each month without charge. Cards entitling the holder to this service are issued upon application to the Willard Service Station in the town where the car is located.

Coil ("Transformer" or Induction Coil)—Two types are used; on all but pumping cars, the coil is mounted as one part with the switch and attached to the dash,—on pumpers. It is a separate unit from the switch and mounted independently.



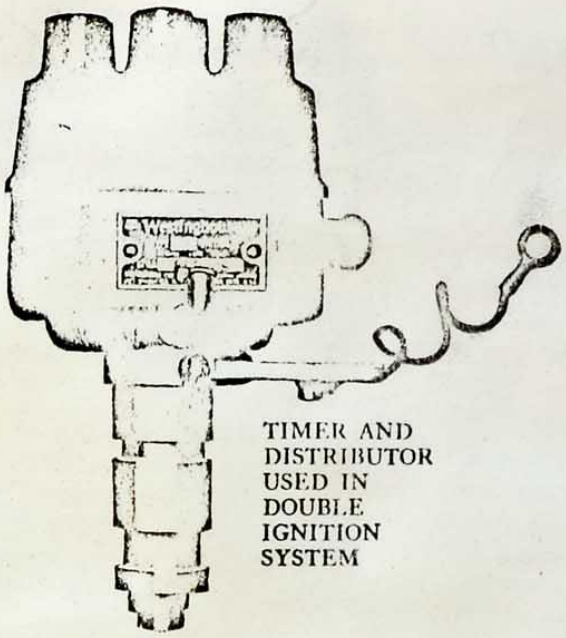
WESTINGHOUSE COIL

The transformer coil is small and compact so that it can be mounted conveniently close to the motor, thus eliminating long and unsightly wiring and adding materially to its appearance. All parts of the transformer coil are held in place by mechanical means, being securely anchored to the base plate. The resistance coil limits the amount of current drawn from the battery and a safety gap protects the high tension wiring.

Timer and Distributor—On American-La France apparatus of the pumping type, which alone use a timer and distributor separate from that incorporated in the magneto itself, the parts are combined in one instrument driven from the inlet camshaft on the right side of the motor and are mounted directly above the pump.

The parts are few and simple; the construction is substantial. All parts have been carefully proportioned with the result that it will produce a hot spark equally well at high or low motor speeds. The breaker mechanism is carried in a movable case and consists of an insulated bracket having an adjustable contact. A pivoted breaker arm also carries a contact at one end,—the two contacts being normally held together by the action of a spring.

The movement of a fibre cam, mounted on the timer shaft, striking the breaker arm, causes the two contacts to separate and break the primary circuit at the proper time. A high tension current is carried from the transformer coil to the distributor housing and, by means of a stationary brush, to a rotating finger mounted on top of the camshaft,—the blade of the finger being wide enough to allow for the variation in advance and retard.



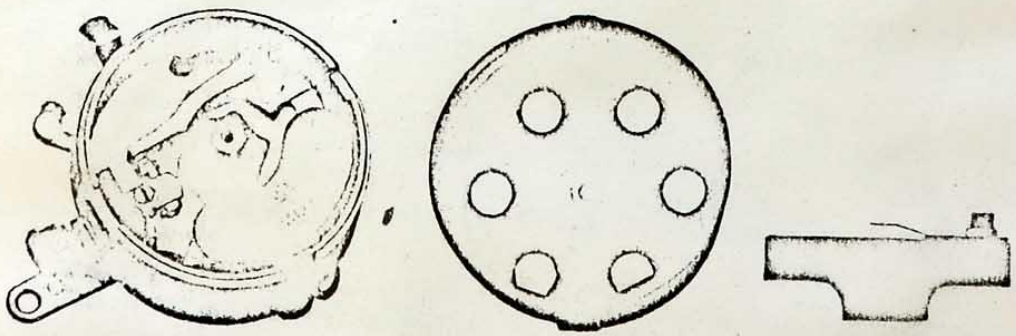
TIMER AND DISTRIBUTOR USED IN DOUBLE IGNITION SYSTEM

The rotating finger distributes the high tension current to the proper spark plug lead, through a carbon brush contact

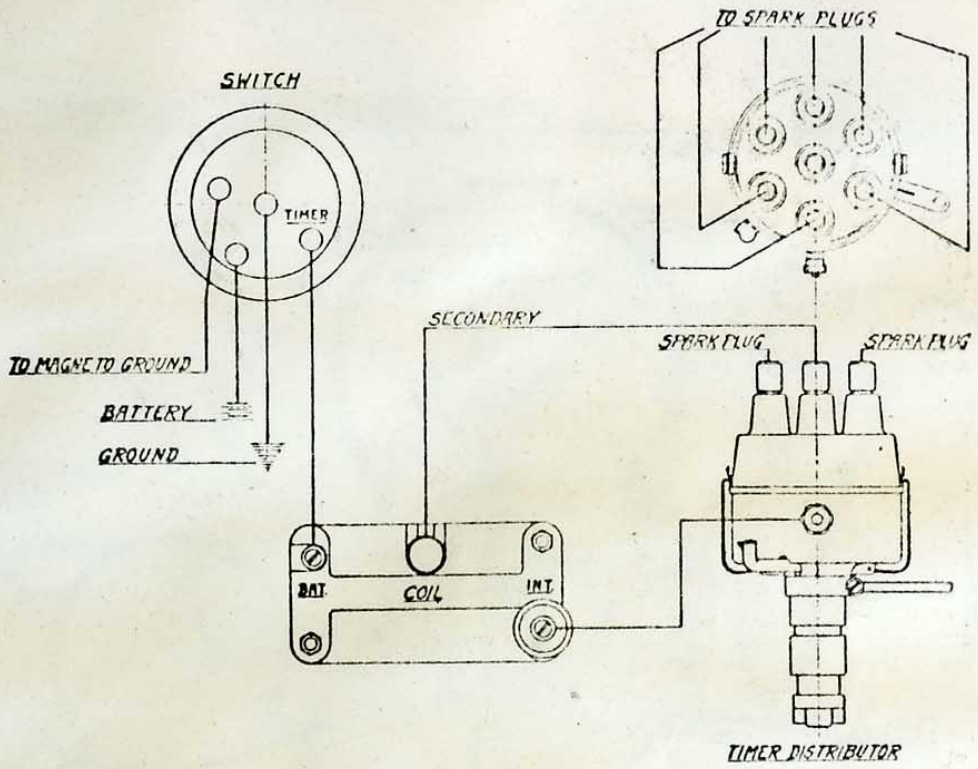
Twenty-five degrees of advance and retard are obtained by means of a lever extending from the timer case. As the timer-distributor operates at one-half motor speed, this permits fifty degrees advance and retard of the motor.

Care and Adjustment—For lubrication, see page 109. The contact points should be separated .015 of an inch when the breaker lever is raised to the highest point of travel by the action of the cam.

To set timer, loosen the screw holding the lever arm to timer case until it is free to turn; rotate the crankshaft of the motor until number one piston is at the end of the compression stroke and indicator over flywheel wheel points to top dead center of No. 1 cylinder. With the spark lever in the full retard position, turn the timer case opposite the direction in which the distributor brush will be driven until the breaker points are about to separate; tighten the screw to hold the lever arm in position, exercising care that the position of the case is not altered. After adjustments are tightened the carbon brush in distributor arm should be making contact with wire leading to No. 1 cylinder.



BREAKER MECHANISM OF DISTRIBUTOR

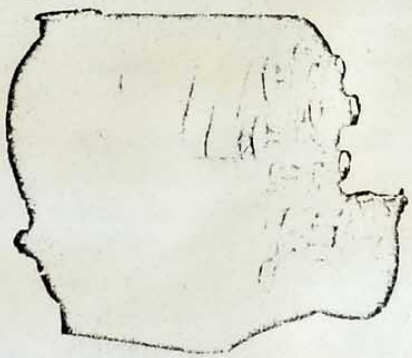


WIRING PLAN OF WESTINGHOUSE TIMER DISTRIBUTOR

WIRING PLAN OF WESTINGHOUSE TIMER-DISTRIBUTOR

Magneto—To better understand this instrument, let us refer back to the fundamental principles and description of battery ignition.

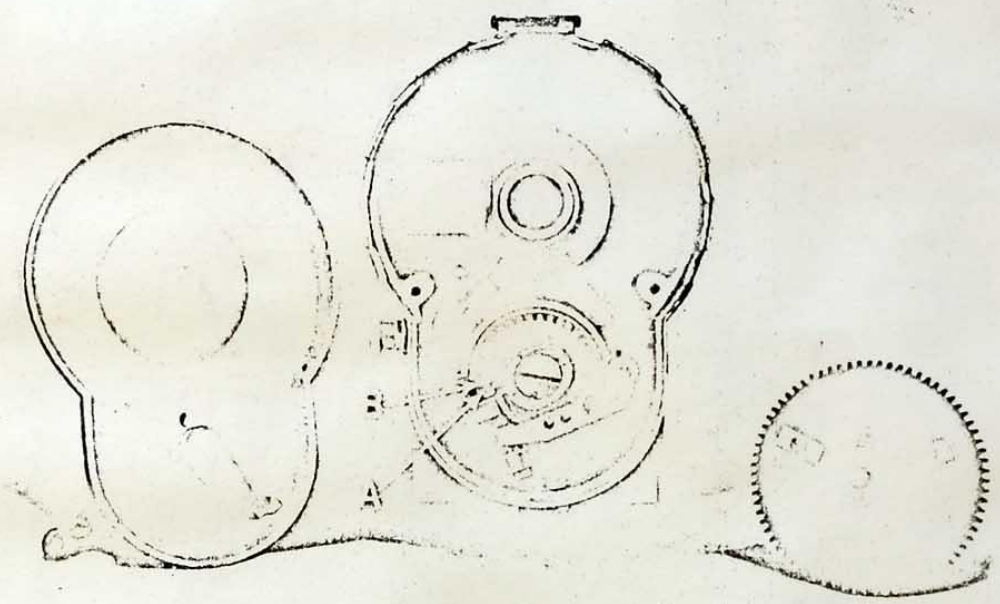
Suppose we change the shape of the soft iron core of the transformer or induction coil so that instead of being entirely covered with the primary and secondary windings, part of this core will be exposed on two sides for its entire length. We now extend the length of this core at each end beyond the windings so that bearings may be mounted and a rotative motion given to it. Next we place a couple of horseshoe magnets over this coil and in close contact with it, but without actually touching the exposed parts of the core. The original induction or transformer coil now loses its former name and is termed an armature; and when rotated, a distinct pull is felt, due to the tendency of the magnets to hold the armature stationary.



EISEMANN MAGNETO

By rapidly turning the armature, an electrical current is generated in the primary winding; this is caused by the rapid interruption of the flow of magnetism from one side of the horseshoe magnets to the other.

On the forward end of the extended shaft of the armature are placed the conventional contact breaker or breaker points as previously described and used in the battery ignition. When one of these breaker points comes in contact with a cam built into the housing or cover around these points, they will separate.



BREAKER AND DISTRIBUTOR MECHANISM IN SPLITDORF MAGNETO

This breaks the primary current just the same as before and causes a secondary or high tension current to be generated in the secondary winding.

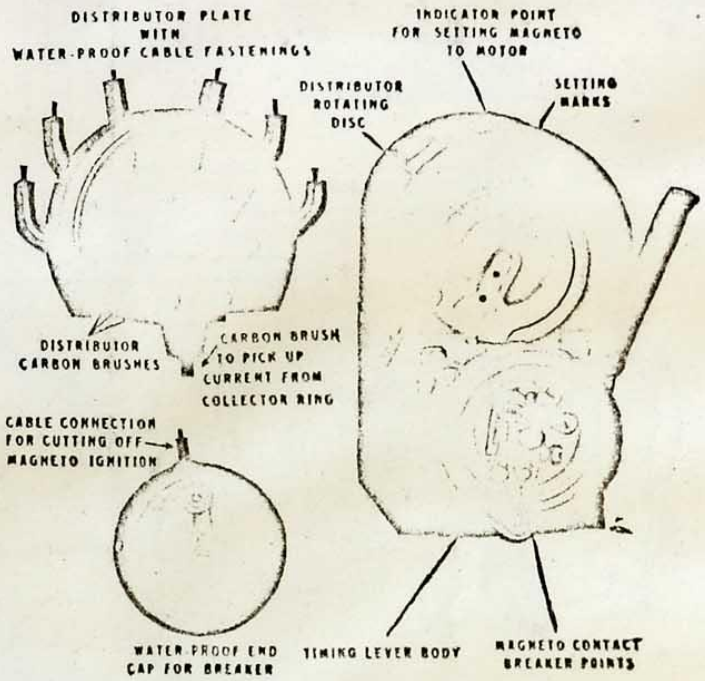
The end of the secondary winding is attached to a collector ring fastened around the armature shaft and the current is picked up from there by the collector brush, and by means of another brush, carried to the distributor rotating disc. This disc is driven by a gear attached to the armature shaft and when the magneto is properly timed with the motor, this disc comes in contact with distributor brushes fitted in the cover and from which wires lead to the spark plugs.

In place of having a number of scattered parts as in the case of the battery ignition, all are brought together in one unit which is termed the "magneto." Within the instrument are also incorporated the condenser and safety gap. The resistance coil, however, is not necessary as there is no flow of current when the magneto stops.

Magneto Timing--As two sparks occur in each revolution of the armature, the magneto is rotated at one and one-half times motor speed in six cylinder cars and at the same speed as that of the motor in four cylinder machines.

Turn the motor over slowly until the intake valve on No. 1 cylinder has closed and continue turning until the mark 1 and 6 M or 1 and 4 M on the flywheel is directly under the indicator. Now set the spark lever to the full advance position and see that there is no lost motion in the spark lever connections and the timing lever body. Remove the distributor plate from the magneto and turn the armature in the same direction that the motor turns until the setting mark "R" on the distributor disc is in line with the setting screw.

With the armature in this position the platinum contacts are just opening, and the metal insert of the distributor disc is in contact with the carbon brush of No. 1 cylinder. The driving coupling from the motor to the armature must now be fixed rigidly in place without disturbing the setting of the armature.



TIMING DIAGRAM OF MAGNETO USED ON "DOUBLE" IGNITION SYSTEM OF PUMPING CARS

Magneto Wires—The attaching of the cables to the spark plugs must be made in accordance with the firing order of the motor, which is 1-4-2-6-3-5 in the six cylinder, and 1-2-4-3 in the four cylinder. For connection between magneto and switch, see illustration. The proper fastening of the cables is of great importance in order to prevent short circuiting between the connections.

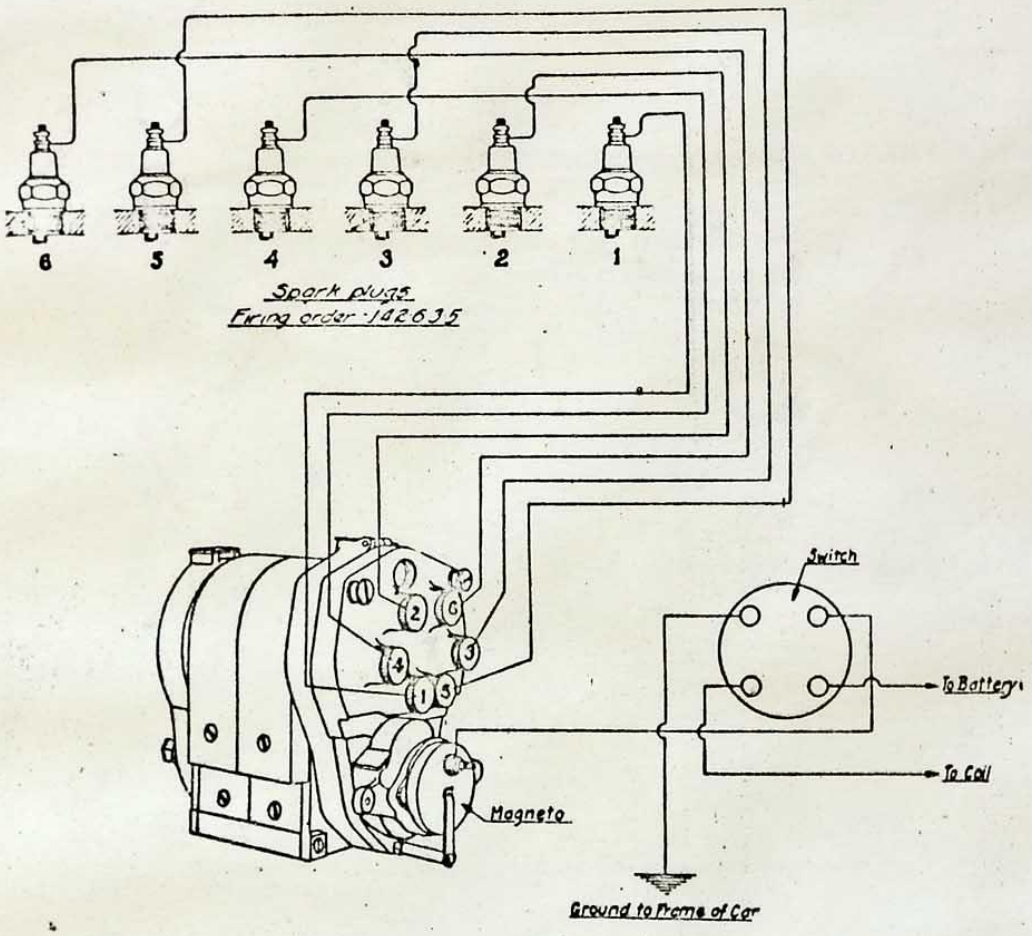
The binding nuts must be securely tightened, but no attempt made to use pliers for this purpose on account of the danger of cracking the insulation.

Loose or broken terminals should be promptly replaced. In case it should become necessary to make a temporary connection by means of the stranded wire of the cable without the use of a regular terminal, care must be taken that none of the tiny strands are left sticking out where they may cause a short-circuit or a burnt distributor plate.

Cleaning and Oiling Magneto—The contact points of the breaker mechanism and, in fact, the entire breaker itself, should be thoroughly cleaned with gasoline as often as they accumulate even a trace of oil or dirt. The distributor rotating disc, carbon brushes, and collector ring should likewise be cleaned occasionally with a soft cloth moistened with gasoline. Owing to the possibility of setting fire to the magneto through the presence of sparks at the various brushes, all parts of the magneto should be allowed to thoroughly dry after cleaning with gasoline.

Contact Points—The contact points should be regularly inspected, cleaned and kept flat. The maximum gap between the points is between 0.012″ and 0.014″. A special magneto wrench supplied with the instrument carries a "feeler" gauge to guide in their adjustment.

Dual Ignition System—The two distinctive ignition systems just described are used only on pumping cars. On all others, what is termed the "Dual" system is employed, the difference between the two systems being the elimination of separate timers and distributors.



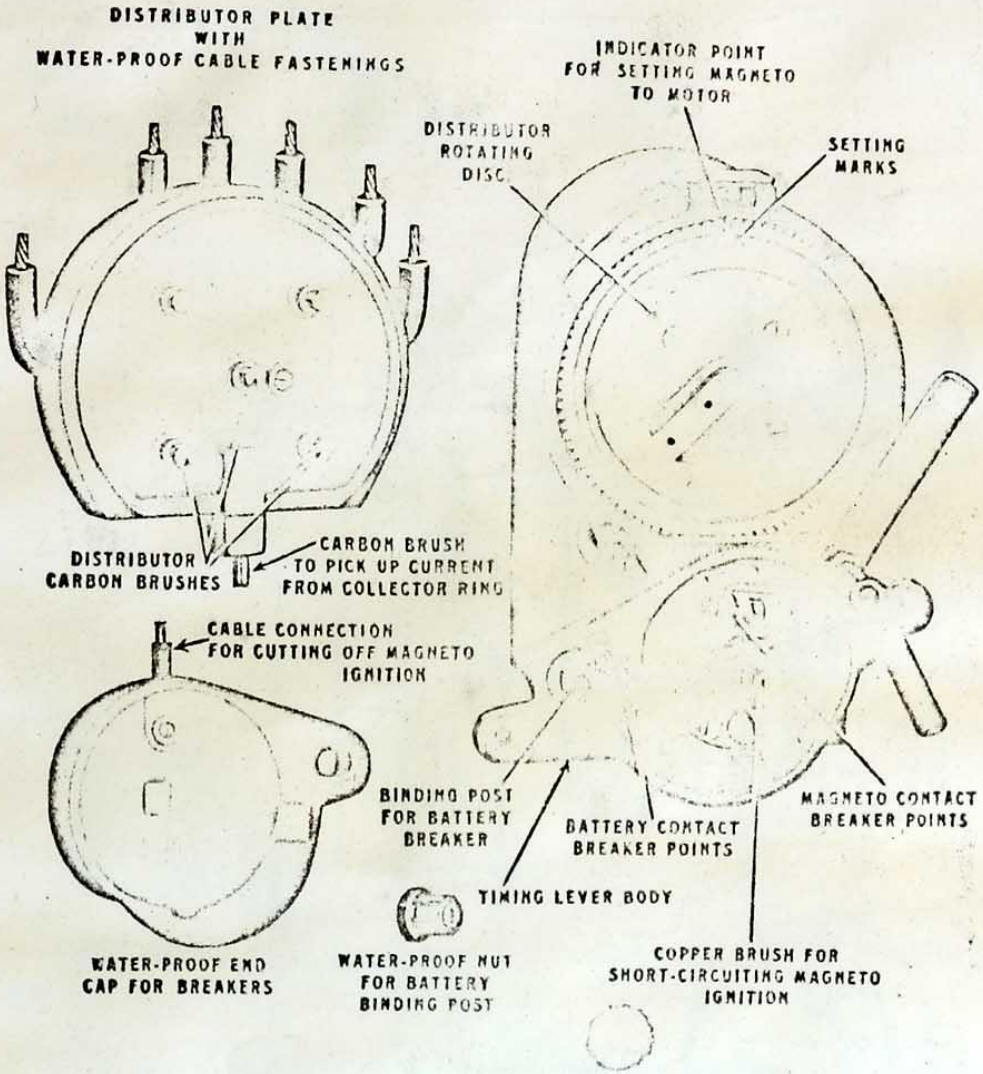
DOUBLE IGNITION
Magneto Wiring System—Six Cylinder Motors

In the magneto used in the "Dual" system, an extra set of contact breaker points is installed and the transformer coil is incorporated and mounted with the switch at the dash. When the switch key is turned to the Battery position, the primary current is drawn from the storage battery and connected to the battery breaker points in the magneto.

The secondary or high tension current generated in the transformer coil leads to the distributor on the magneto and from there to the plugs. When operated in this manner, the magneto primary current is grounded so that no current is generated by the magneto itself. When operating on the magneto, the current from the battery to the coil is shut off and the magneto operates independently.

Care and Maintenance of Magneto—Water should not be allowed to get on the magneto, neither should oil or dirt. It is important to refer to illustration of cable connections within the distributor plate, as the connection screw with round head used on the inside of the plate must not be changed with the headless screw on the inside of the cap; the large head will not clear the revolving breaker mechanism.

After a time, it is advisable to carry a few extra carbon distributor plate brushes and contact points.



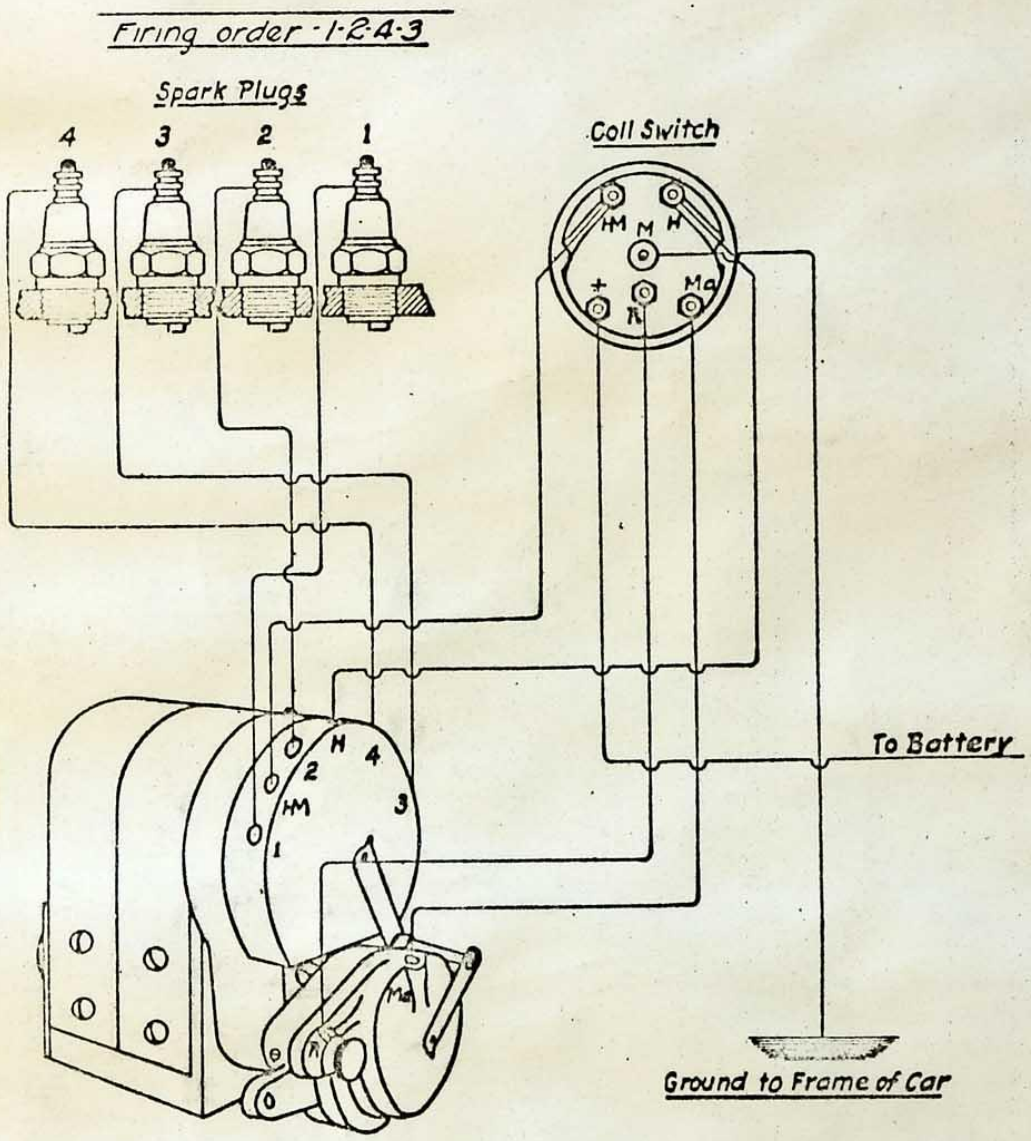
TIMING DIAGRAM OF MAGNETO
Used in "Duai" Ignition System on all but Pumping Cars

The contact points should be cleaned with gasoline until the surface appears quite white; if pitted, use a very fine file carefully so that the surfaces remain square to each other. For this purpose, a special file may be procured from any accessory store or the magneto manufacturers at small cost. The correct gap of the contact points is 0.012", and as these wear away in time, they should be regulated by giving the adjustable screw a forward turn, after which the lock nut should be securely tightened.

This work can be done without removing the timing lever or breaker mechanism, by means of the combination wrench which is furnished with each magneto.

When the contact riveted to the rocker-arm, or that of the adjustable screw wears down, it is necessary to renew both, and in doing so, make sure that the lock nut on the screw is thoroughly seated and tight.

Testing Magneto—Remove the distributor plate and rest a screwdriver on the gear casing, holding same about $\frac{1}{8}$ inch from the collector ring. If upon

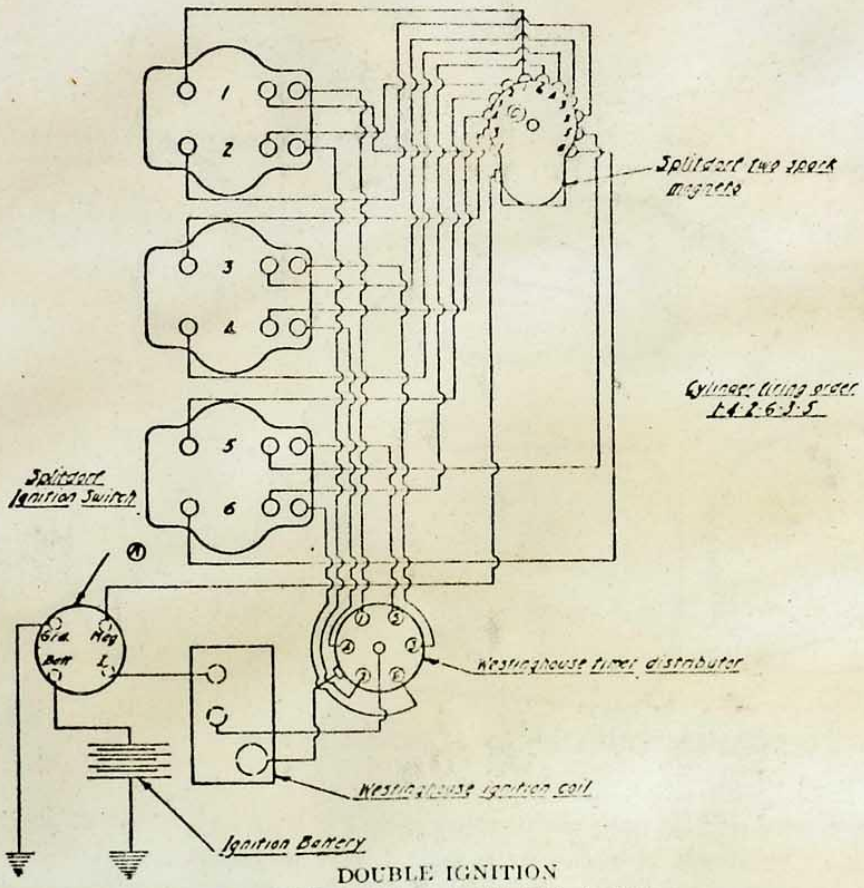


DUAL IGNITION
Wiring System—Four Cylinder Motors

rotating the armature, a spark does not jump across the gap, it indicates something is wrong and the instrument should be sent to the nearest manufacturer's service station.

Spark Plugs—Plugs should frequently be removed and examined, as they may be short-circuited through collection of oil or carbon. Sometimes the insulation may be cracked. Clean thoroughly with gasoline, scrape off the carbon and measure the gap between the electrodes; this should be between $\frac{1}{64}$ and $\frac{1}{32}$ of an inch. In replacing the plug, make sure the gasket is in good condition and there is no leak after screwing the plug into position.

Westinghouse Self-Starting System—This consists of an electric starting motor mounted on left side of the crank-case forward of the flywheel.



DOUBLE IGNITION
Two Spark Splitdorf Magneto—Six Cylinder Motor

All cables should be pushed in as far as possible. It is also very advisable to consolidate the stranded ends with solder.

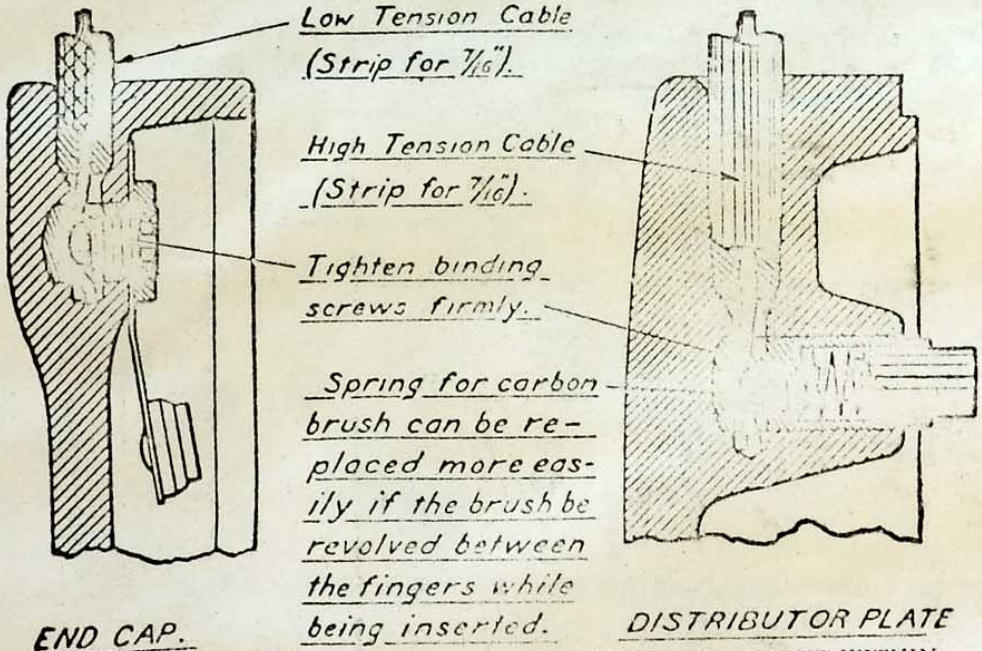
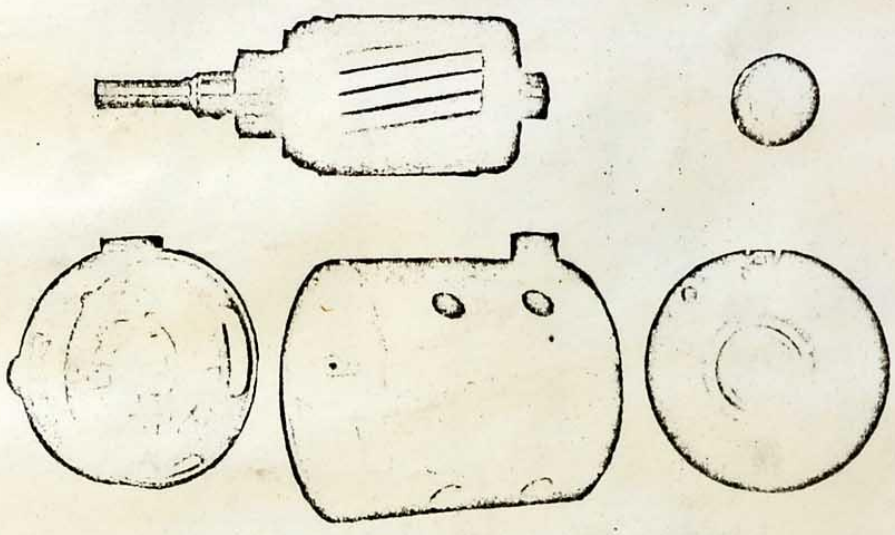


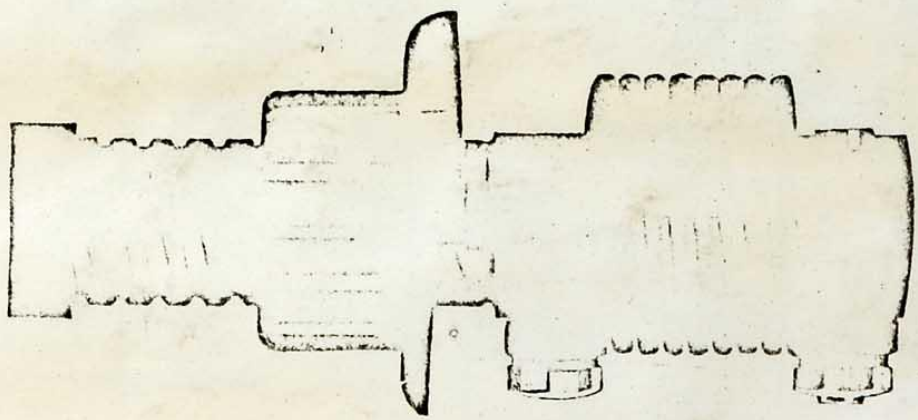
ILLUSTRATION OF PROPER METHOD OF ATTACHING CABLES WITHIN DISTRIBUTOR PLATE



DISASSEMBLED VIEW OF STARTING MOTOR

To the forward end of the electric starting motor is fitted a "Bendix" worm drive which may be made to mesh with gear teeth on the external surface of the flywheel. Power to drive the motor is furnished by the battery and controlled by a large push button switch on the dash.

When the starting switch is pressed down, the Bendix drive of the starting motor automatically engages with the flywheel and rapidly turns the motor over; as soon as the latter starts firing, its speed being so much greater than that of the electric power, the Bendix drive is forced out toward the end of its shaft, thus disengaging.



BENDIX DRIVE ATTACHED TO REAR END OF STARTING MOTOR

The connections from the starting battery to the electric motor are of the simplest, but one wire being used. The positive terminal of the battery is grounded to the frame while the starting motor is grounded through its supports, forming one permanent connection. The negative wire of the battery leads to the starter switch while another one leads from there to the starting motor. These connections should, like all others, be kept tight and free from grease and dirt.

Should the Bendix drive revolve without engaging with the flywheel, remove the foot from the switch, wait a moment and then try again; this sticking occasionally of the drive is due to the gumming action of grease, oil or dirt, which prevent the Bendix drive from properly and freely traveling along its worm shaft. Remedy—thoroughly clean the worm and lubricate with a few drops of kerosene.

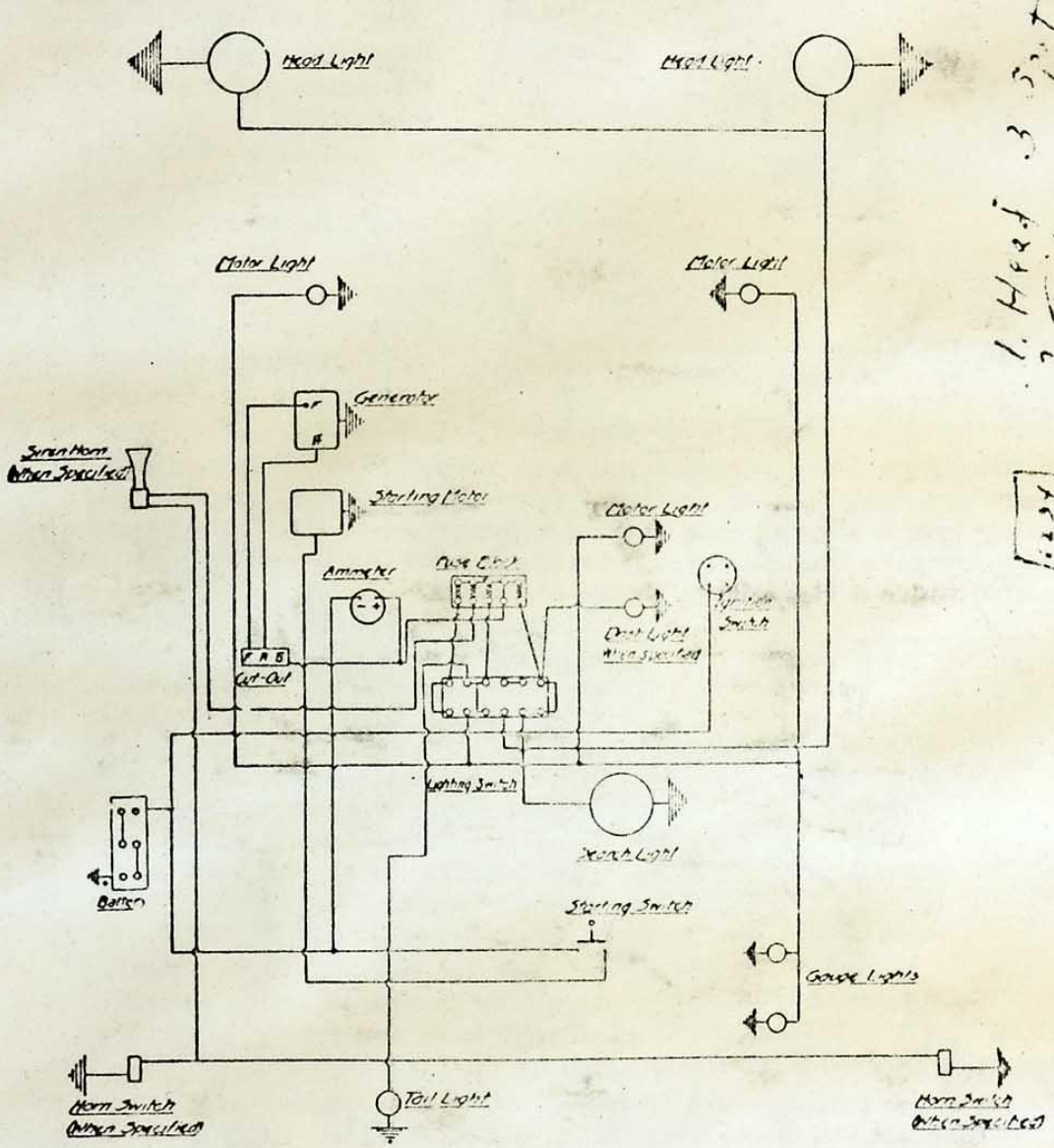
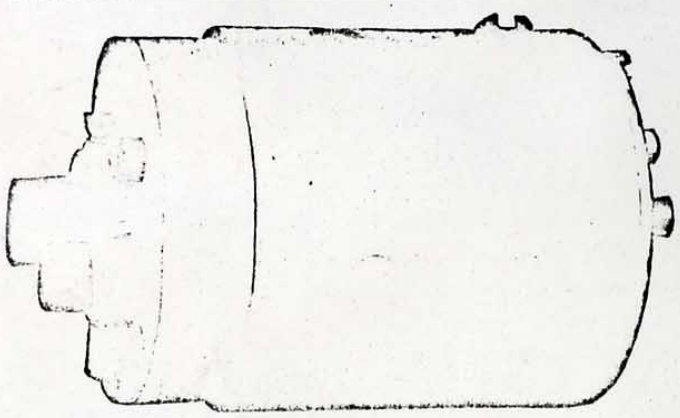


DIAGRAM OF LIGHT WIRING SYSTEM

Be sure and remove the foot from the starting switch as soon as the motor starts firing.

Lighting System—Besides the storage battery described in detail elsewhere, the lighting system includes a generator, lighting switch, ammeter, fuse and coupling boxes, lights and wiring.

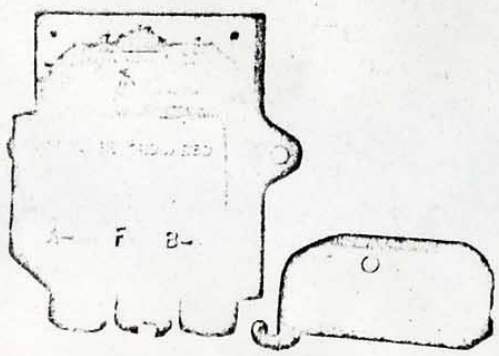
Owing to its extreme simplicity, the single-wire (ground return) system is used on all apparatus. In this system, the negative wire terminal of the



WESTINGHOUSE GENERATOR

battery is connected to the electrical units and lamps through switches, while the positive terminal of the battery is connected or grounded with the metal frame of the machine which serves as one conductor. The positive terminal of each unit and lamp is also coupled to the metal frame either through connections or wires; the circuit is therefore complete when the switch key is turned.

The Generator—The generator is a type of small dynamo, mounted, in the case of the six cylinder motors, on the left side of the crank-case forward of the self-starter and is driven from the water pump shaft. On four cylinder machines, the generator is located between the road transmission and drive shaft, from which it is driven by means of a chain.

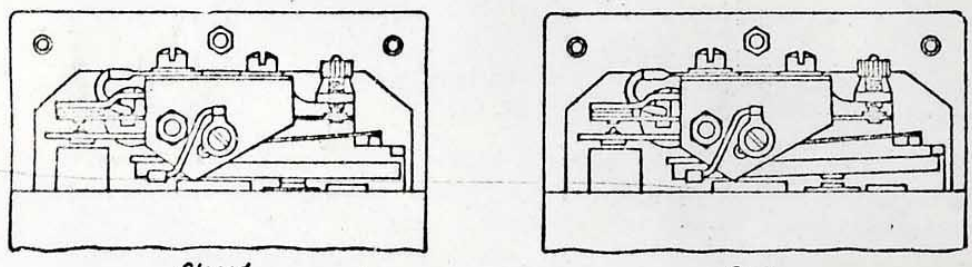


VOLTAGE REGULATOR

The generators are of the automatic type with a voltage regulator mounted separately on the inside of the dash. When the motor is running slowly or not at all, the light circuit is supplied entirely by the battery; at a predetermined motor speed, the generator cuts in on the battery circuit and supplies some of the current used by the lights or begins charging the battery if the lights are not turned on.

A further increase of motor speed naturally causes a greater output of current from the generator and this is automatically cared for and controlled by the "regulator."

The regulator performs two functions:—that of a cut-out which automatically connects and disconnects the generator from the battery when the



CUT-OUT SWITCH OF VOLTAGE REGULATOR

generator is driven respectively above or below a predetermined speed, and that of an automatic voltage regulator which, after the cut-out has connected the generator circuit to the battery, automatically keeps the generator voltage at a predetermined value.

Cut-Out—When the generator is being operated at a speed below the predetermined "cut-in-speed," the contacts of the cut-out armature are open, the voltage of the generator being below that of the battery. When the generator speed reaches the "cut-in-speed," these contacts are closed, connecting the generator circuit to that of the battery. The "cut-in-speed" varies from five to ten miles per hour on high gear, depending upon the gear ratio of the rear wheels of the apparatus.

The "cut-in-speed" of the generator can be observed by running the apparatus, allowing it to increase in speed slowly, and observing on the speedometer the speed at which the apparatus is running when the cut-out contacts close; this will be indicated by a slight movement of the meter needle.

The regulator is so constructed that the cut-out operates so as to disconnect the generator from the battery circuit at a speed slightly below the "cut-in-speed." This enables the regulator to keep the circuit closed, and not constantly open and close it when the car is being run at speeds close to the "cut-in-speed."

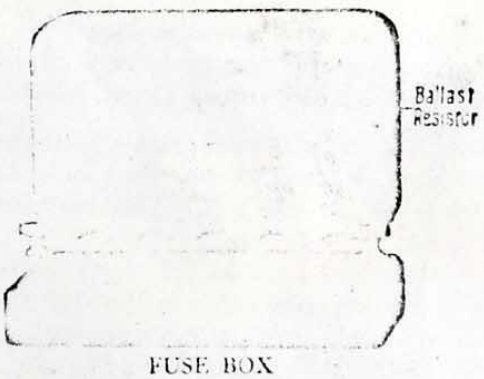
LIGHTING SWITCH

This disconnection of the generator from the battery circuit when the generator voltage is below that of the battery, insures the battery not being discharged through the generator.

Lighting Switch—The connection of the various lights to the circuit is accomplished through the use of the lighting switch mounted on the dash. As shown in the diagram of connections, the lighting switch and fuse box are so arranged that the tail-light circuit is connected when either or both the headlight or side-light switch is closed. This can readily be changed so that the tail-light can only be operated at the lamp, this being required by law in some states.

Generator Brushes—In general the wear on the brushes is so slight that they will outlast the apparatus. They should not be disturbed except in case of trouble. These are accessible by removing the hand hole cover when the brush may be readily inspected. In removing each brush, it should be noticed which side was turned up and each brush should be replaced in its original holder with the proper side up, taking care to see that the brush is resting against the commutator.

The adjustment of the spring should be such that there is at least 1¼ inch compression on it when resting on the brush. In putting in new brushes care should be taken to see that they have a good bearing fit over their entire surface on the commutator, grinding them in until this fit is obtained. To obtain satisfactory operation always use brushes furnished by the manufacturer.



FUSE BOX

Fuses—Two or three sets of fuses of each size should be carried at all times. If a fuse is blown it should not be replaced until the cause is located. This may be due to a ground or short-circuit in the wiring or socket of that circuit. Never use a piece of wire in place of a fuse.

Capacity of Fuses—The capacity of fuses in each circuit should be as follows:—Side-lights, 3 to 5 amperes; headlights, 15 amperes; tail-light when as separate circuit, 3 amperes.

Leece-Neville System

Voltage Regulation—Voltage regulation greatly improves the electrical generating system because it brings this source of electrical energy into close relation to the service required. Correct charging of the storage battery to increase its useful life is a result of voltage regulation. Lamps and other electrical equipment are not subjected to excessive voltage, therefore they last well in use. Adequate service is maintained because the Leece-Neville voltage regulated electrical generating system is adapted to the duty to be performed.

The current output of a voltage regulated generating system will taper down to a low value as the battery becomes charged but a current controlled system will allow the current to remain about the same for all conditions of the battery. Therefore do not attempt to set the voltage regulator for high current output.

Correct charging of a storage battery requires a high ampere rate when discharged and a low rate when charged. That is, the ampere rate may be 20 to 25 for a discharged battery but is less than 5 when the battery is fully charged. Between the high and low points the ampere rate tapers according to the state of charge of the battery. The ammeter will indicate different readings as the battery receives its charge, because the combination of the Leece-Neville generator and voltage regulator permits a tapering ampere rate from high to low. This lowering ampere rate protects the battery from rapid evaporation of the electrolyte and buckeling of its plates, because of the absence of overheating. This balancing of charging rate with the state of charge of the battery, and the addition of distilled water when needed, assures good battery services and longer life.

Lamps and other electrical equipment are operated under practical service conditions, at the proper voltage, resulting in economy and long life. A sudden increase in engine speed will not cause the voltage to rise above the limit. If the battery should become disconnected the voltage will not rise above the limit.

Adequate and uninterrupted service is maintained when the battery is kept properly charged, and "burn-outs" in the electrical system are minimized by the use of Leece-Neville voltage regulation.

Installation Instructions—Mount the regulator so that the free ends of armatures A hang down, that is, with the two box mounting lugs M, Fig. 11, Page 87, at the top. The two load terminals B+ and B− will be on the right.

A three wire cable WC inclosed in flexible conduit and fitted with the proper connectors is furnished by the manufacturer to apply between the generator and three post connector on the regulator. From the two post connector marked B+ and B−, Fig. 11, use No. 10 B & S gauge wire or larger depending upon the length.

Protect the regulator from rain or wash water.

Regulators adjusted and marked for a certain type number of generator must not be used on other types. For instance, a type 553-R regulator is for a type 553-G generator and not for a 557-G generator. The type number is also marked on the bakelite sub panel X, Fig. 1, so that the regulator can be

ntified if the name plate
st.

The voltage is also stamped on the upper face of the regulator element armature. All adjustments have been made by the manufacturer, however, it is sometimes advisable to adjust the regulator element to meet specific conditions. That is it may be advisable

service,
the usual
frequent stop schedules. Careful judgment is necessary
adjustments.

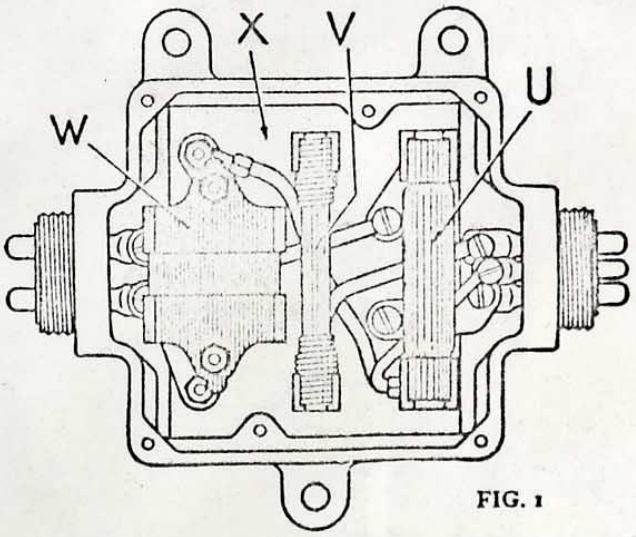
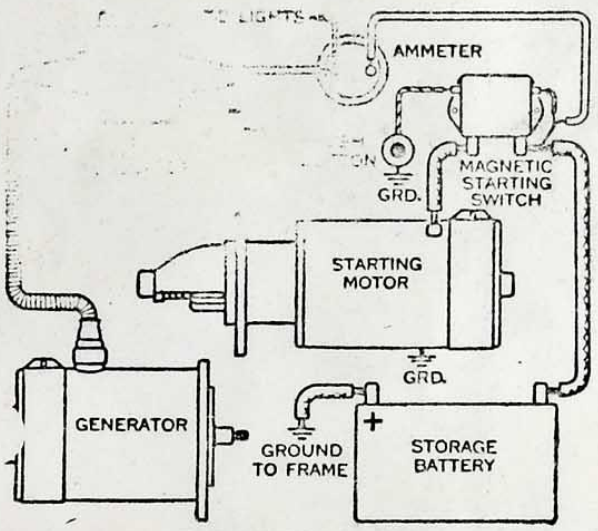


FIG. 1



WIRING DIAGRAM

The resistance U, heat compensation element V, and condenser W on the under side side of bakelite sub panel X, Fig. 1, will not require attention. These elements are soldered to their clips and must be unsoldered in order to be removed easily by hand. Do not pry out these elements with a tool.

All instruments of this class appear to be the same, but differ in their characteristics, therefore always refer to type number and voltage before applying to the circuit.

Circuit Breaker Adjustment—For correct performance, the circuit breaker has three possible adjustments, as follows:

1. Adjustment for magnetic air gaps by means of the armature spring hinge. These air gaps rarely need changing and then only in case of replacements or 2 and 3 have failed.
2. Adjustment for contact points gap by means of the armature stop. This gap does not need to be changed unless the contacts wear or have been filed or adjustment 3 has failed.
3. Adjustment for circuit breaker performance by means of the tension spring. In most cases this is the only adjustment required and should be tried before disturbing either No. 1 or 2.

When it is necessary to make all adjustments, do so in the order 1-2-3.

Do not change position of generator brushes. They were correctly set by the manufacturer during a test run, therefore any change will alter the rated performance of the generator and voltage regulator.

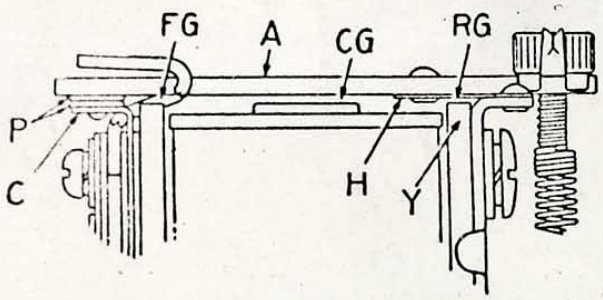


FIG. 2

Adjustment No. 1—Fig. 2 shows front air gap FG, rear gap RG and core gap CG. Gap RG refers to the space from steel yoke pole face Y to bronze armature hinge H.

Air gap RG should be .006—.016 of an inch by feeler gauge with armature A held down, closing contact points P. Fig. 3 (old method) shows an enlarged screw hole E in armature hinge AH to permit adjustment of armature A up or down to obtain gap RG. Fig. 4 (new method) shows an elongated hole E in armature hinge carrier HC to permit the same adjustment.

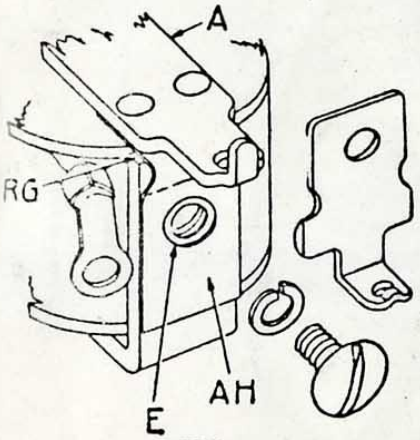


FIG. 3

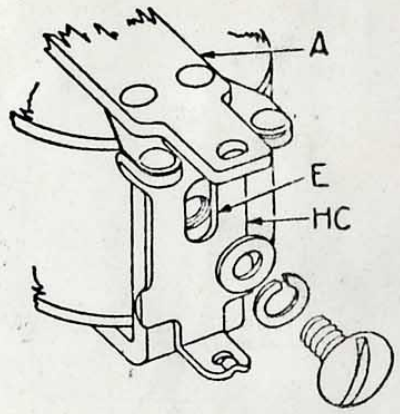


FIG. 4

Air gap CG should be .017—.027 of an inch by feeler gauge with armature A held down closing contact points P. If contact carrier C has been removed or replaced use care in reassembling this part so as to maintain the .017—.027 of an inch gap CG.

Air gap FG will be correct if gaps RG and CG are correct.

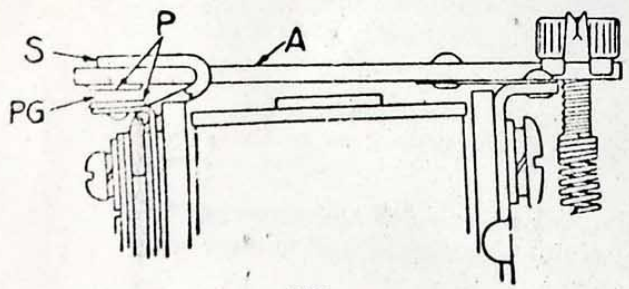


FIG. 5

Adjustment No. 2—Fig. 5 shows contact point gap PG which must be .027—.032 of an inch by feeler gauge with armature A against stop S. This gap is obtained by bending stop S up or down as required.

The silver contact points P will not require frequent attention, but if they become corroded or roughened, clean or smoothe with a fine file, removing only enough metal to correct the fault.

The faces of the points must fit squarely together to give maximum contact area for wear and current carrying capacity. Blow out dust or filings and reset for point gap PG.

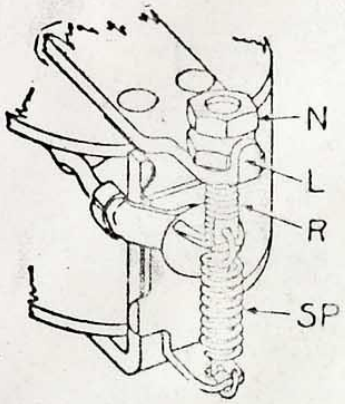


FIG. 6

Adjustment No. 3—Fig. 6 illustrates the old form of adjusting nut, screw and spring. Pull nut N straight up until it clears lip L before turning to increase or decrease the tension of spring SP. The lip L prevents nut N from turning after making adjustment. Spring SP hooks into a hole in screw R for attachment.

Fig. 7 illustrates the new form of adjusting nut, screw and spring. Turn nut KN for adjusting, and spring clip K ratchets in the notches of nut KN preventing the same from vibrating loose in service. Spring KS screws on to KR for attachment. There is a flat F on the screw KR and a flat sided hole in armature A to prevent screw KR from turning.

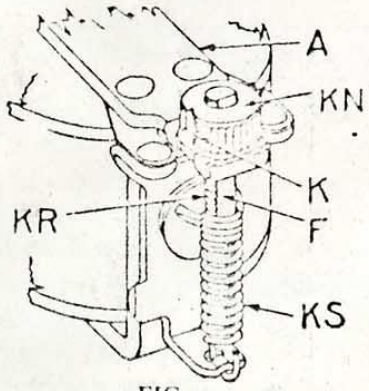


FIG. 7

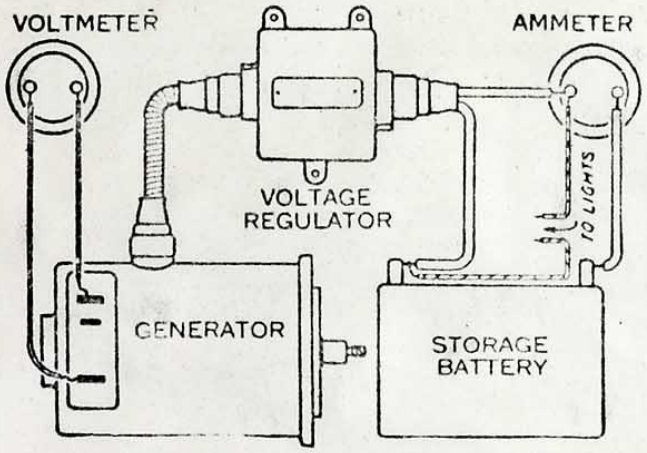


FIG. 8

In making adjustment No. 3 the voltmeter should be connected across the generator brushes as shown in Fig. 8, for the meter needle will swing slowly when the voltage changes and the reading will be easy. If the voltmeter is connected on the battery side of the circuit breaker box, the needle will likely overswing and prevent accurate reading when the circuit breaker contacts close.

As the generator speed is increased, the armature should act to close the contact points firmly at 11.5—11.7 volts when cold, that is, before running 10 minutes. As the generator is stopped the armature should open quickly on a reverse or discharged current of not to exceed 4 amperes from the battery.

If the closing voltage is lower than 11.5—11.7 volts turn adjusting nut right handed or clockwise to raise to 11.5—11.7.

If the closing voltage is higher than 11.5—11.7 volts turn adjusting nut left handed or counterclockwise to lower to 11.5—11.7.

In other words, increasing the spring tension means higher closing voltage with lower opening reverse current. And decreasing the spring tension means lower closing voltage with higher opening reverse current.

Always try No. 3 before disturbing other adjusting means.

CIRCUIT BREAKER SETTINGS
Figures 2 and 5

Rear Gap RG	Core Gap CG	Point Gap PG	Cut in Voltage cold	Cut Out Amperes
.006"—.016"	.017"—.027"	.027"—.032"	11.5—11.7	Not exceeding 4

Voltage Regulator Adjustment—To satisfy specific service requirements, the voltage regulator has three possible adjustments, as follows:

1. Adjustment for magnetic air gaps by means of the spring hinge. These air gaps rarely need changing and then only in case of replacement or adjustments 2 and 3 have failed.
2. Adjustment for contact point gap by means of the stationary contact point support. This gap does not need to be changed unless the contacts wear or have been filed or adjustment 3 has failed.
3. Adjustment for proper voltage by means of the tension spring. In most cases this is the only adjustment required and should be tried before disturbing either No. 1 or 2.

When it is necessary to make all adjustments, do so in the order 1-2-3.

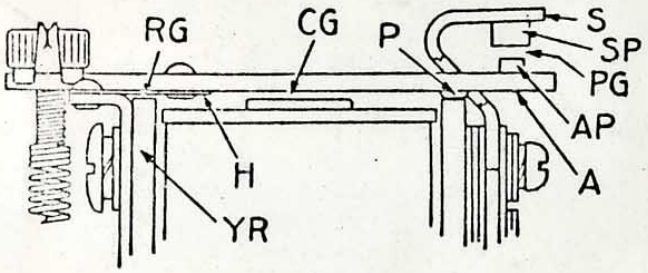


FIG. 9

Adjustment No. 1 for new method assembly. Fig. 9 shows core gap CG between core and armature A. Rear gap RG is between yoke pole YR and armature hinge H. Stop pin P prevents armature A from sticking.

Gap RG should be .010—.015 of an inch by feeler gauge when armature A is held down against stop pin P. Fig. 4 shows an elongated hole E in armature hinge carrier HC to permit this adjustment, the construction here being the same for both the circuit breaker and the voltage regulator elements.

Gap CG will be correct when gap RG is correct.

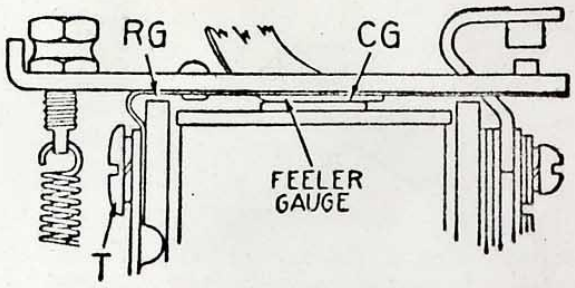


FIG. 10

Adjustment No. 1 for old method assembly. Fig. 10 shows gaps RG and CG. Gap CG should be .004—.007 of an inch and is obtained by holding armature A flat against a feeler gauge .004—.007 of an inch thick which is laid flat on the core face at CG, and tightening screw T which was previously loosened to make the adjustment. By this operation gap RG also becomes correct. Fig. 3 shows an enlarged hole E in armature hinge H to permit this adjustment, the construction here being the same for both the circuit breaker and voltage regulator elements.

Adjustment No. 2 for old and new method assembly. Fig 9 shows contact point gap PG which must be .020—.025 of an inch by feeler gauge when armature A is held against stop pin P, or hinge extension (old method).

This gap is obtained by bending stationary contact point support S up or down as required.

The contact points P will not require frequent attention, but if they become roughened, clean or smooth with a fine file, removing only enough metal to correct the fault. The faces of the points must fit squarely together to give maximum contact area for wear and current carrying capacity. Blow out dust or filings and reset for point gap PG.

If PG is more than .020—.025 the voltage will be higher because armature A will vibrate in a weaker magnetic field, and the effect is similar to increasing the tension of adjusting spring SP. If PG is less than .020—.025 the voltage will be lower because armature A will vibrate in a stronger magnetic field, and the effort is similar to decreasing the tension of adjusting spring SP.

The contact point AP riveted to armature A is a special alloy. The stationary point SP on the support S is pure silver. This combination of points is the result of exhaustive tests and from the standpoint of service is correct.

Caution—If support S is too far away gap PG will be too wide and armature A will not vibrate because the weak magnetic field will not draw armature A to the core at CG. When armature A does not vibrate the contact points remain closed, therefore no voltage regulation will occur.

The generator will only be current controlled by the influence of the third brush, and the voltage will increase as the speed increases.

Adjustment No. 3 for old and new method assembly. Fig. 6 illustrates the old form of adjusting nut, screw and spring. Pull nut N straight up to clear lip L before turning to increase or decrease the tension of spring SP Lip L prevents nut N from turning after making adjustment. Spring S hooks into a hole in screw R for attachment.

Fig. 7 illustrates the new form of adjusting nut, screw and spring. Turn nut KN for adjusting, and spring clip K ratchets in the notches of nut KN preventing it from vibrating loose in service. Spring KS screws on to R for attachment. There is a flat F on the screw KR and a flat sided hole in armature A to prevent screw KR from turning, the construction here being the same for both the circuit breaker and voltage regulator elements.

Turn nut KN right handed to raise the voltage. This increases the spring pull and holds the contact point closed for longer periods of time.

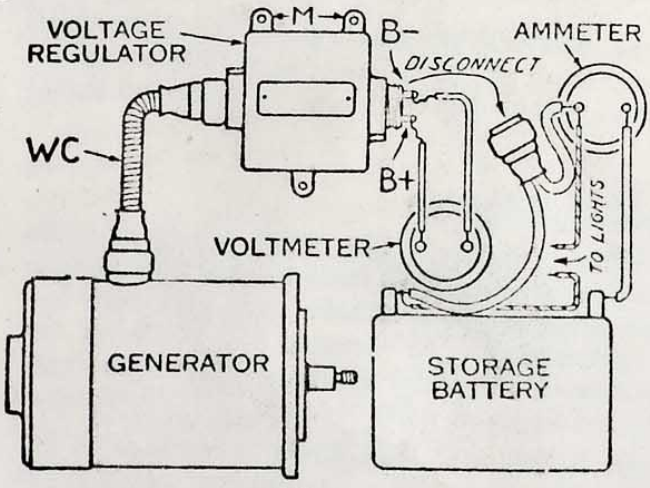


FIG. 11

Turn nut KN left handed to lower the voltage. This decreases the spring pull and allows the contact points to be open for longer periods of time. To adjust for proper voltage, disconnect the battery and load from voltage regulator terminals B+ and B– and connect an accurate voltmeter in place as shown in Fig. 11. Run the generator at about 1500 R. P. M. for 15 minutes to stabilize the heat compensation element, then with the gener-

ator still running at 1500 R.P.M. adjust nut KN until the voltmeter reads 14.4—14.6 volts. This is known as the hot open circuit setting. An adjustment of .2 volt higher in winter and .2 volt lower in summer is permissible.

When the generator is mounted on a vehicle it may be difficult to determine the exact speed, in which case it will be necessary to depend upon judgment. But after making the adjustment, and increased engine speed does not substantially increase the voltage, then the proper setting has been made.

Always try No. 3 before disturbing other adjusting means.

VOLTAGE REGULATOR SETTING
Figures 9 and 10

NEW METHOD ASSEMBLY

Rear Gap RG	Core Gap CG	Point Gap PG	Open Circuit Voltage At 1500 R.P.M. After 15 Minutes
.010"—.015"	See Text	.020"—.025"	14.4—14.6

OLD METHOD ASSEMBLY

See Text	.004"—.007"	.020"—.025"	14.4—14.6

General Instructions—If trouble developes in the electrical system, do not disturb the regulator until every effort has been made to discover the fault in some other part of the circuit. For instance, the ammeter needle might swing wide and rapid due to an external loose connection instead of incorrect regulator performance.

If no faults can be found in the electrical system and the regulator does not respond to the adjustments stated in the foregoing, return the complete unit to the manufacturer for investigation. Refer to unit by type and serial number in correspondence.

Locating Trouble

When trouble arises it is desirable to locate it as quickly as possible. To assist in doing so we furnish below practically all the troubles that could occur with the lighting system, and the possible cause of each, although very few of these troubles will ever be experienced. In locating the cause of the trouble, check up the various points in the order given, as the most likely cause and the one most easily tested is given first.

Lamps In One Circuit Do Not Burn—(a) The lamp is burnt out; try another lamp in the same socket. (b) Blown fuse in that circuit; try the same fuse in another circuit. If the fuse is blown, do not replace it immediately but look over the wiring for an accidental ground or short-circuit. In looking for "grounds," an abrasion of the insulation on the wire or a mechanical contact between the ends of cables or current-carrying parts of the wiring devices and the metal of the car; sockets, shells, etc., should be especially looked for. When the trouble has been located and corrected, replace the blown fuse with another of the same capacity. If the trouble can not be located immediately, turn off the switch on the damaged circuit until

e trouble has been located. If the trouble is in a particular lamp socket, disconnect the attachment plug from this socket until the trouble can be remedied and see that the attachment plug does not touch the car frame in such a way as to make a short-circuit. (c) An open circuit, or broken or loose connection in the wiring. Examine the place where the connections are made on that particular circuit.

None of the Lamps Will Burn—If the ammeter hand goes all the way over on the discharge side with motor stopped, this may be due to—(a) Terminals of the battery are disconnected or corroded so that they do not make good contact. (b) Ground wire from the battery to the chassis is detached or broken.

If the voltmeter reading is all right, the trouble may be due to:—(a-1) The lamps are burned out. (c-1) Battery is run down.

Lamps Go Out for an Instant Only—If the lamps in one circuit act this way, there is probably a loose connection on the circuit so affected. If all the lamps go out for an instant there is probably a loose connection at one end of the wire from the battery to the fuse box.

Lamps Become Dim When Motor Stops—This indicates a discharged battery. If possible have the battery charged at once from an outside source. If this cannot be done, endeavor to run with fewer lamps than normal turned on for a few days, or until the battery voltage picks up again.

The Battery Does Not Stay Charged—This may be due to any of the following causes:

(a) The car is not run enough without lights or at high enough speed for the generator to charge the battery and replace the current that is taken from it when the lamps are burning with the motor idle or running at very low speed.

(b) A ground in the car wiring. With the motor idle and all switches "off," disconnect the battery wire and touch it lightly on the battery terminal a few times. If there is a spark produced, there is a ground in the wiring between the battery, the generator, and the switch, or the magnetic switch in the regulator is not open.

(c) Regulator cut-out switch is not operating properly. Examine the switch and see that it is properly connecting and disconnecting the generator circuit. The switch should be in the open position when the engine is not running or should stay in the closed position when the motor is running above "cut-in-speed." If the switch does not close, there may be oil on the brushes or commutator, or one of the brushes may be worn too short.

(d) Automatic voltage regulator may be out of adjustment. If this seems to be the trouble, some authorized agent of the electrical unit manufacturer should be consulted if possible. If such is not convenient, proceed as follows: (d-1) With ignition switch "off," turn over the engine by the starting motor for a few seconds. (d-2) Then turn on ignition and speed the motor. With the motor speeding, the ammeter should indicate fifteen to twenty amperes.

If the generator does not give this output: (d-3) Remove the cover from the regulator and clean the regulator contacts by drawing a thin piece of soft paper between them. Test again as in paragraph (d-2). If the generator does not give the correct output, (d-4), adjust the voltage-regulating screws until the output of the generator is as noted in (d-2).

Be sure to replace the cover of the regulator after making adjustments.

If the battery is fully charged, care should be taken not to "race" the motor for too long a time while observing the reading, as the output of the generator naturally falls off when the battery is fully charged. Under these conditions the motor should be turned over again as in paragraph (d-1), to obtain a partly discharged condition of the battery.

Lamps—For the best operation of this system, lamps of the highest quality should be used. Westinghouse Mazda automobile lamps have been especially designed for the service and we recommend their use.

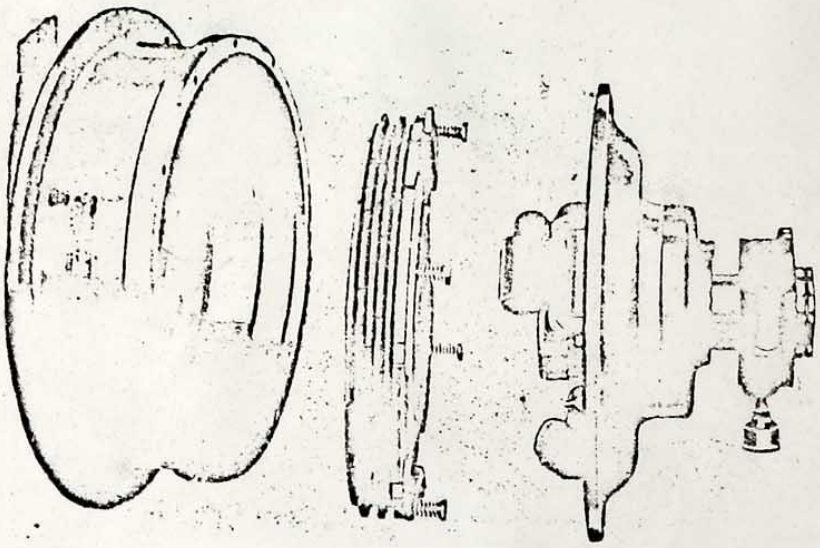
Fire apparatus motors are not operated as much as those of passenger cars and you can not expect the generator to keep your battery fully charged at all times. It requires approximately an hour or two hours of motor operation to replace the charge in a battery used to start the motor once. Always crank the motor by hand for warming up purposes in the house; use the starter only in the event of an alarm.

Test your battery for charge frequently as already outlined and if necessary remove from car and have charged at a service station. Never operate the motor when the battery is removed from the car unless you uncouple the generator from the drive shaft, or turn on all your light switches.

This either renders your generator inoperative if uncoupled, or by turning on the light switches, the current generated is taken care of by burning the lights. To run the motor when the battery is removed and above precautions not taken, will result in burning out the generator regulator or possibly the generator itself.

Every fire department should provide itself with a spare battery which should be kept fully charged, or rent a battery from the service station when it is necessary to charge.

Clutch—This member is of the dry plate type consisting of a large housing bolted to the flywheel and a series of five discs or plates, three of which are polished steel, and two of which have "Raybestos" covered surfaces. With the compression plate, which is lined on one side, all are mounted on a core



DISASSEMBLED VIEW OF CLUTCH

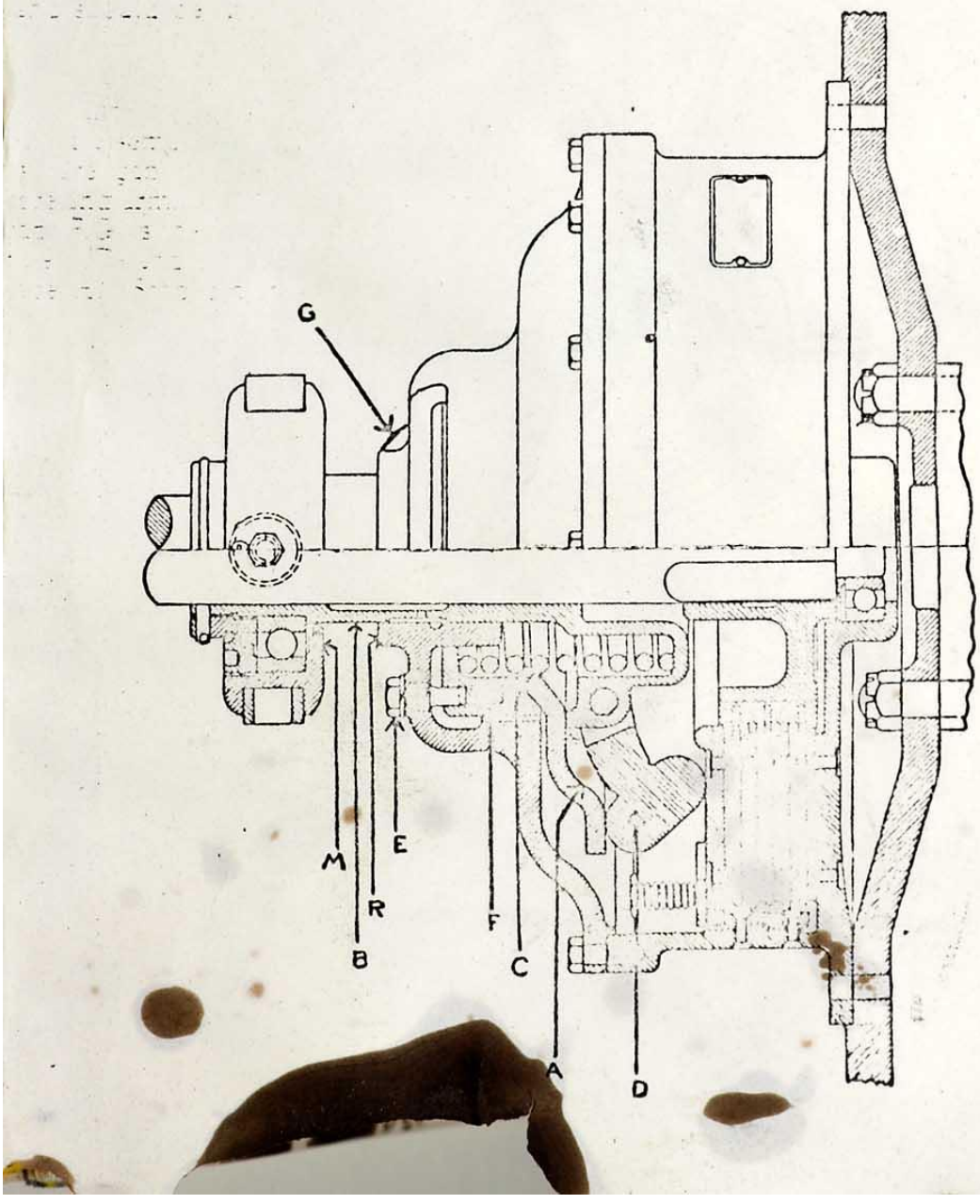
which fits on squared end of driving shaft. The plates are so arranged that every other one engages with a series of metal strips or "lugs" attached to the

.ıner surface of the housing and revolves with it, while the intervening plates engage with the clutch core on driving shaft and rotate free of the housing.

Back of the plates there is a housing cover, carrying a stiff spring and a cam action which either compresses or releases the plates; this is controlled by the clutch pedal. When the clutch pedal is released, the spring acts upon the cams and causes them to securely press and hold all of the plates together so that they rotate as one unit, thus locking the housing attached to the flywheel to the clutch shaft leading to the transmission.

By depressing the clutch pedal, the pressure of the spring is released, the cams unlock, and the plates separate one from another so that a space exists between each; the three which mesh with the clutch housing then revolve independent of the other three attached to the clutch shaft which becomes stationary.

A study of the line cut will give a clear idea of the working principle of the clutch. The clutch shaft at its forward end is fitted with a ball bearing retained within the front of the housing; another ball bearing is located in the



"actuating ring" ("M") or throw-out collar. Sleeve "B" through which passes the clutch shaft, and upon which it slides, carries all the compressing and releasing mechanism of the clutch.

Cams "D," upon release of spring "C" straighten out and exert great pressure upon the clutch plates thus making the clutch shaft revolve with the housing and flywheel. In operating the clutch, the driver should alway engage it easily yet quickly. After the clutch is engaged, **remove the foo from the pedal.** Probably ninety per cent of drivers "ride the clutch" as it is termed, yet nothing is so detrimental to any clutch as this practice.

Place the foot on the pedal when you wish to engage or throw off the motor power,—otherwise keep the foot off. Always disengage the clutch fully, when shifting gears or applying the brakes. Never follow the practice of "slipping the clutch" when turning corners, etc.

Do not allow oil or grease to enter the clutch housing; it requires none and it will only destroy the efficiency of this important part of the car. At least once a week, sleeve "B" should be wiped clean and dirt or rust accumulations next to the housing removed. Due to small clearance between the sleeve and housing, a slight rim of dirt may prevent the full engagement of the plates.

REAR VIEW OF CLUTCH HOUSING

Clutch Lubrication—Regarding such parts as require oil or grease, see page 116 ("Lubrication").

Clutch Adjustment—The clutch is extremely efficient and is not likely

either "slip" or "grab"; provision has been made for adjustment and the ing up of wear.

1—Disengage clutch and keep in released position while adjusting.

2—Remove lock bolt "E."

3—Place spanner wrench in hole "F" and turn to right one or as many notches as are necessary to take up frictional wear and have a free release. Keep a reserve of travel for sleeve "B" of from ¼ to ½ inch between points "R" and "M"; ¼ inch should be minimum and ½ inch maximum, when clutch is fully engaged.

Caution:—Never allow actuating ring "M" to come in contact with cover "R" as the spring pressure can not then act on the friction plates and damage to them will result.

Important—Keep clutch foot pedal adjusted so that it has one inch clearance under foot boards when clutch is engaged. On pumping cars, where the pump shift lever also operates the clutch, said lever should have one inch free lift before it acts on the clutch foot pedal.

Dismantling Clutch—

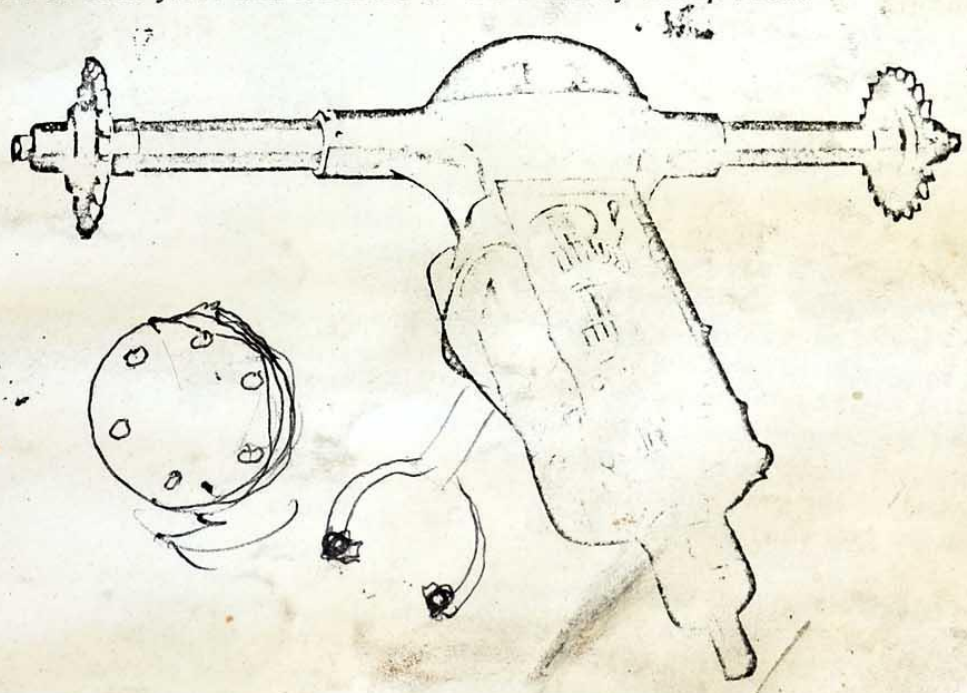
1—Release clutch and place wooden block between "R" and "M" to release spring pressure and keep in this position until clutch is reassembled.

2—Disconnect drive shaft.

3—Remove cover assembly.

4—Remove pack by lifting out clutch core.

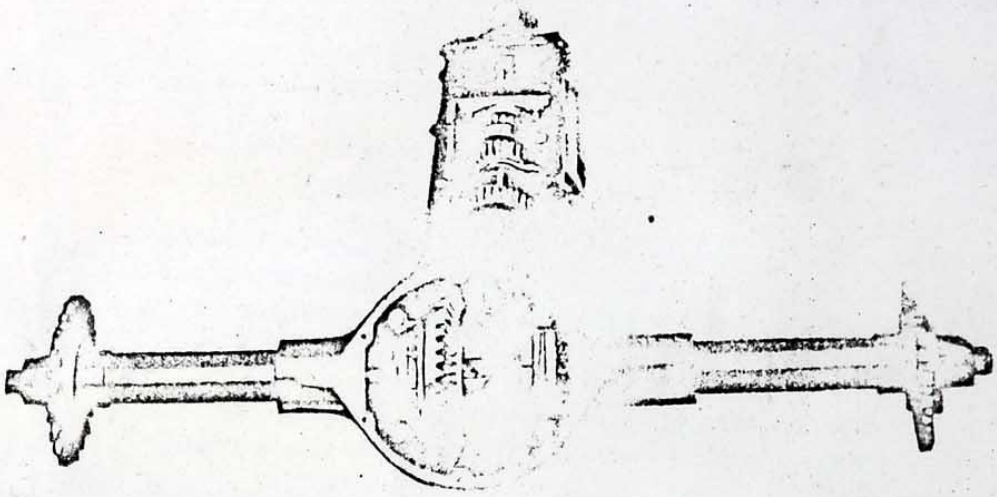
Universal Joints—Between the clutch and transmission gear set is a drive shaft fitted with two universal joints to take care of frame distortion or any misalignment. The joints are connected by a short shaft having squared ends which fit similar holes in the universals. On the shaft are two collars, one next to each joint and fastened to the shaft by clamp bolts.



FRONT END OF GEAR SET

These collars should be separated from the joints by not more than $\frac{1}{32}$ inch, which is quite sufficient for end play. The universals are much like

pinions sli[illegible]to internal gears with th[illegible]pt that
th[illegible]ixed position and cann[illegible]There is
[illegible]ecessity for atte[illegible]



REAR [illegible]ON
SHOWI[illegible]

Transmission—The transm[illegible] the power of the motor to the rear whe[illegible] makes provision for reversing the direct[illegible] the motor.

When the motor is running slowly, [illegible] increases with the [illegible]ed until at [illegible] per minute, the [illegible]

When starting the car, it would not [illegible]apply this great power directly to the wheels as the terrific strain s[illegible] through quickly imparting motion to the resting vehicle would soon rack the entire machine.

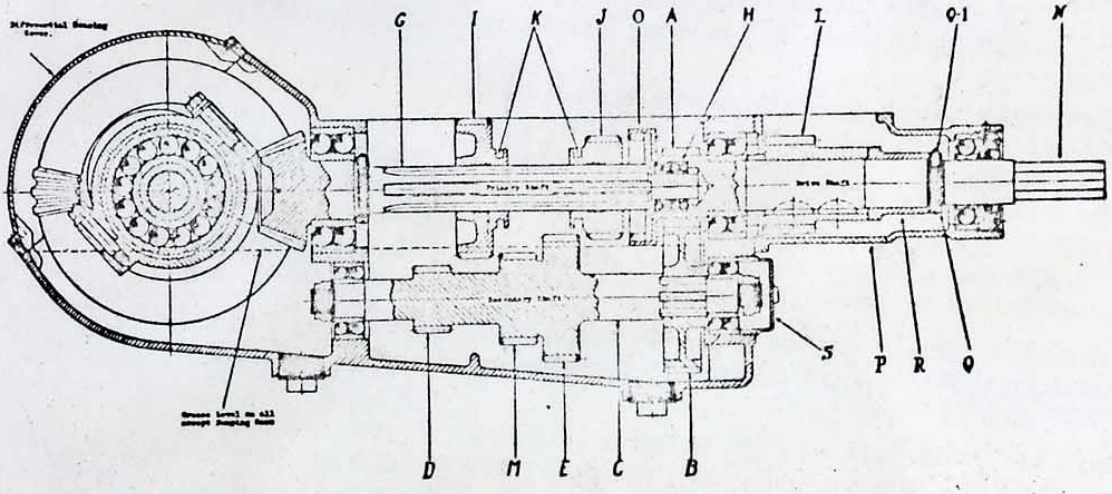
When the roads are very heavy or on grades, the resistance offered to the progress of the machine is tremendous, hence it is necessary to greatly increase the power output of the motor by some mechanical means.

The various speed or gear ratios accomplish this purpose; the lower the gear ratio, the greater is the power of the motor multiplied at the rear wheels, so that no matter what condition be met, the driver will be able to overcome it by the proper selection of gears in the transmission set.

The shifting and engaging or "meshing" of any combination of gears is effected by means of the gear shift lever which travels through a series of marked slots in the gear shift quadrant or "H" plate. (See illustration, page 126).

Within the transmission gear case there are two shifter rods which change the position of the gears. These are fitted with little plunger locks which positively prevent the gears from slipping out of mesh. The design and mechanism of the shifter levers is such as to prevent the engagement of two series of gears at the same time.

Starting at the forward end of the transmission gear set, the power enters the case through the driving shaft "N" which is coupled to the rear end of the shaft connecting with the clutch.

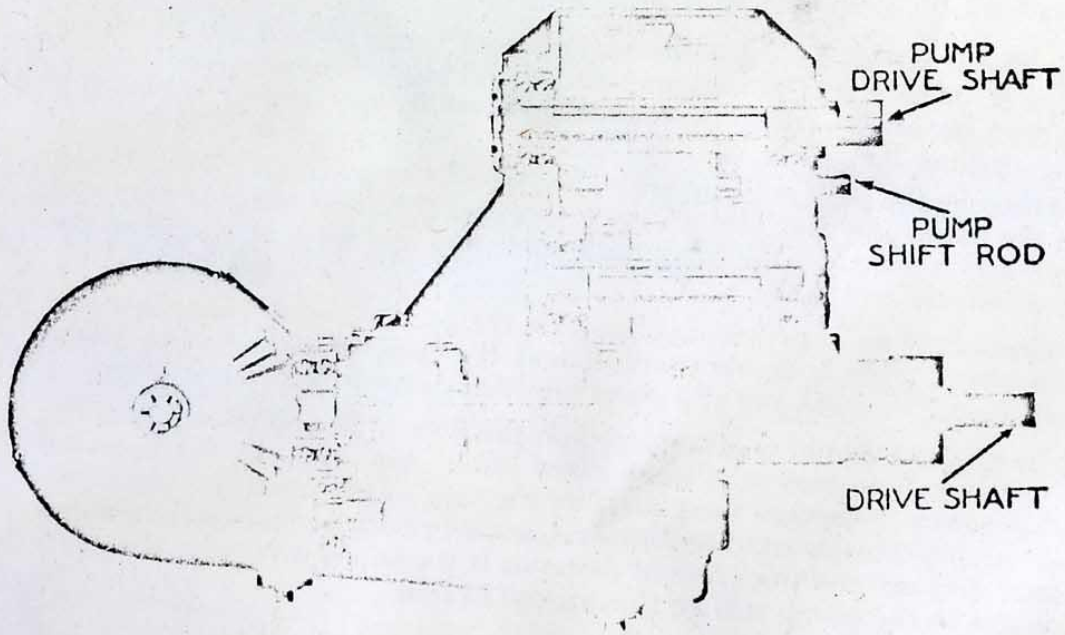


TRANSMISSION

At the rear end of this shaft are two gears, the first of these ("A") is in constant mesh with gear "B" on the forward end of the secondary or lay shaft; both of these shafts are therefore revolving when the clutch is engaged. All gears on the secondary shaft are fixed regardless of gear shifts, their position remains unchanged.

Directly back of the driving shaft which also acts as a forward support for it, is the primary or main transmission shaft, which leads back to and drives the differential gears.

The two gears are mounted on the main shaft slide, and it is due to the shifting of their position and engagement with gears on the secondary shaft, that different gear ratios are effected.



SECTIONAL VIEW OF [illegible] TRANSMISSION

Returning again to the driving shaft "N"; the first gear "A," drives the secondary shaft, the other gear "O" at the extreme end is fitted with internal teeth, and when the second speed sliding gear "J" is moved all the way forward, it meshes with this internal gear "O" and securely locks the driv shaft "N" and primary shaft "G" making a straight line drive from clute differential.

This represents high gear, the revolutions of this series of shafts being the same as the motor. When second speed sliding gear "J" is shifted or moved back so as to engage with the second speed gear "E" on the lay shaft, the power from driving shaft "N" and gear "A" is carried first to gear "B" and then to second speed gear "E" on the lay shaft, through second speed sliding gear "J" and the primary shaft to the differential. This combination represents second or intermediate speed.

First or low speed represents the same travel of power except that from the secondary shaft, it is transferred to the primary shaft through low speed gears "M" and "I."

It will be noted that on high speed or direct drive, the drive "N" and primary shaft "G" are virtually one, revolving at the same speed while the secondary shaft is "idling" at a lower speed. In second or low speed, the drive shaft "N" rotates at motor speed, the lay shaft (now transmitting power) at a slightly lower speed, while the primary shaft "G" has still another speed dependent upon the gear ratios of "E" and "J" (second) and "M" and "I" (1st or low).

In all of the above combinations, the primary shaft rotates in the same direction with the motor and causes the truck to move forward. In order to back up or reverse it is necessary to change the direction of rotation of the primary shaft, consequently an extra short shaft and gear are placed in the case and this gear is in constant mesh with gear "D" of the lay shaft.

To shift into reverse, gear "I" is moved back into mesh with the reverse idler which is being driven from the lay shaft.

The two shifter rods of the case which control the movements of sliding gears "I" and "J" by means of forks fitting into the slots marked "K," connect with the gear shift lever by means of rods.

Pump Transmission—With the exception of types 38 and 39, all transmissions for rotary gear pumps and centrifugal pumps are mounted on t of the road transmission gear cases and are driven by special gear "L" on t driving shaft of such cars.

To remove the pump transmission, disconnect the universal joint between it and the pump and then remove the hold-down bolts and nuts. It may also be necessary to remove the body bolts and raise the front end clear of the frame about six inches.

By means of an improvised sling, raise the pump transmission clear and place a short, wide board between it and the road transmission to guard against damage should any slip occur while taking out the transmission.

A long board should also be placed on the floor of the body on which the pump transmission may rest when lifted out of the way. In this removal operation, do not damage the gasket on the base of the pump transmission. In case it should become cut or torn, care must be exercised in selecting a new one to make sure the thickness of material is the same, otherwise the gears and shafts to the pump will be thrown out of line.

Lubrication—See page 117, "Lubrication" (Pump Transmission); see page 116, regarding road transmission.

Taking Down Transmission—The work of overhauling the transmission gear set, replacing gears, shafts or bearings as well as adjusting, should be performed by an experienced mechanic, and the following is for their guidance. With the exception of front drive apparatus or pumping cars, it is unnecessary to remove the transmission gear set in order to replace any part.

First take off the driving chains and then pull the sprockets; these are keyed or splined to the jack shaft ends. Holding the bearing is a retaining ring, the latter being secured by a small wire locking device; remove this and the retainer may then be taken off with a spanner wrench.

Note that the threads on both ends of the jackshaft at this point are right hand. Next pull out the jackshafts (the bearings come with them). This can be simplified by slipping the sprockets and nuts back on the shafts without keys and then the differential housing cover should be removed; the latter operation will require the removal of the floor boards in the body.

Before undertaking other work on the gear set, it is necessary to take off the top cover plates; in the case of pumping cars, the pump transmission as well. (See pump transmissions.)

Removing Primary Shaft—After the differential gear assembly is lifted out, it is only a matter of sliding back the primary shaft with its rear bearing to free it from the case. The sliding gears can then be removed through the top of the case by simply tilting up the shifter forks.

Removing Secondary Shaft—When it becomes necessary to remove the secondary and driving shafts, while not essential to do so, the work can more easily be performed if the entire transmission gear set is taken out of the car. To do so, first disconnect the drive shaft coupling back of the clutch, the front transmission hanger swivel bolt, and lastly, the jackshaft supports to the frame.

Next proceed to take out the bolts holding the drive shaft housing (P) to the front end of the case and then slip this off the end of the shaft; the front bearing comes off with the case. If the machine is not a pumping car, the next part to remove is the drive shaft bearing collar locking ring, then the lock collar, after which the driving shaft may be forced out through the rear end of the transmission housing.

In the case of pumping cars where the forward section of the driving shaft is fitted with a gear driving the pump transmission, after the removal of the housing inclosing the driving shaft, locking spring (Q-1) must be taken off, then locking collar (Q) followed by driving pinion spacer (R).

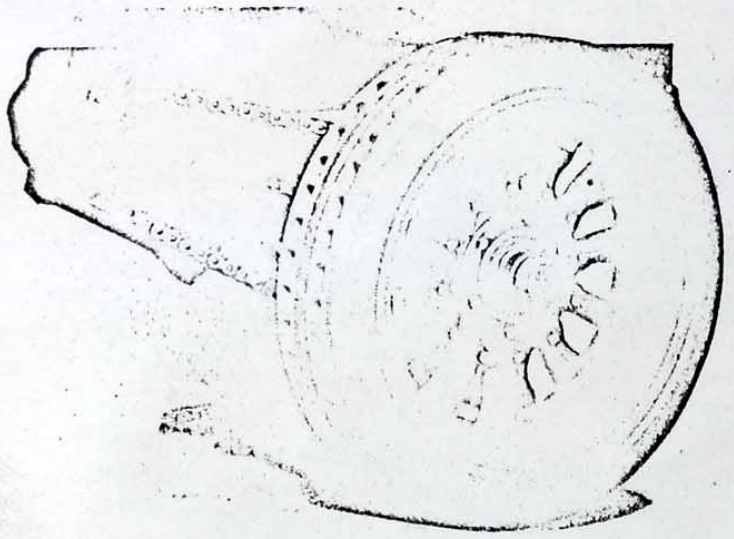
Next gently tap the forward end of the driving shaft, using a lead hammer or a block of hard wood held next to the shaft end where a regular hammer is used. The driving pinion (L) is held in position by two Woodruff keys and often a little pressure is necessary to force the driving shaft through to the rear where it can be removed. In replacing this shaft, do not fail to replace small spacer between the bearing and driving pinion.

With both primary and driving shafts removed, the work of taking out the secondary shaft may be undertaken. First remove cap screw (holding cap "S"), next the cap, then the shaft nut lock and nut from each end of the secondary shaft. Drive out the shaft to the rear with a soft hammer till front end is clear of the bearing, then remove rear bearing and lift shaft out of the case.

In replacing all shafts, directly the reverse of all above instructions should be followed and bearing adjustments correctly made before locking the nuts and fastening devices are inserted.

Be sure that the jackshaft sprocket nuts have been thoroughly tightened. After one or two days' operating, tighten these nuts again by means of a long handled wrench.

Reverse Shaft—First remove bolt block and then cover bolt from the forward support of the reverse shaft. Then screw cover bolt into front end of reverse shaft, which will provide means for pulling this shaft out of its supports. This reverse shaft is faced or has a flat surface on one side so that it can pass the secondary shaft gear easily.

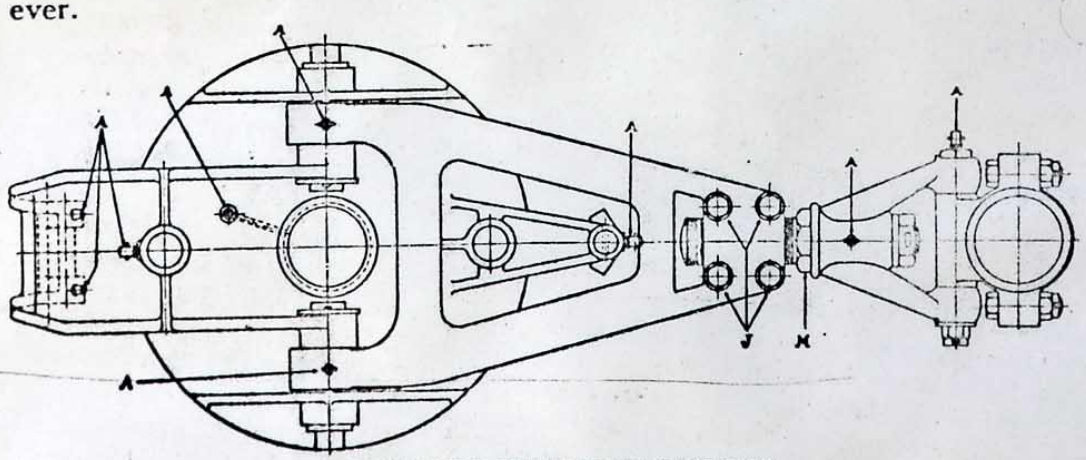


DRIVE CHAIN ADJUSTMENT

Drive Chains—The radius rods connecting the jackshaft and rear axle should be carefully inspected and kept in adjustment so that the driving chains are at the proper tension, and the distance between the axle and jackshaft centers are uniform on both sides of the car.

Chain Tension—Too slack a chain may run off a sprocket and cause considerable damage. Remember that the chain pitch, that is, the distance from center of one link to center of the next, increases with wear so that the chains will not fit properly over the teeth of the sprockets. Chains too tight will wear and climb the sprockets, causing unnecessary loss of power, wear on the teeth of the sprockets and bearings.

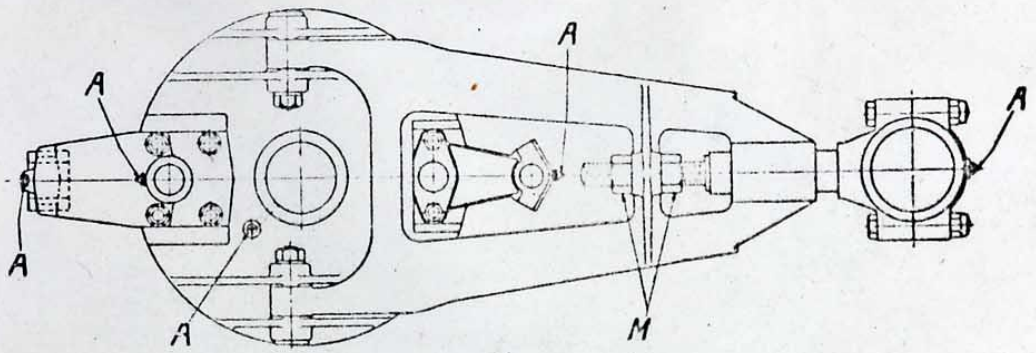
When changing the adjustment of the radius rods, it is also necessary to alter that of the brakes, as any lengthening of the radius rod will tend to set the brakes, while shortening the rod will prevent any gripping action whatever.



A STANDARD TYPE OF RADIUS ROD
Letter "A" Indicates Lubrication Points; "M" and "J" Those of Adjustment

Adjust Radius Rods—The first operation in making adjustments is to loosen the two clamp bolts "J." Turning adjustment nut "M" shifts the position of the radius rod bushing and alters the distance between axle centers.

Adjust radius rods so that drive chains are neither too loose nor too tight; a proper tension would be one where, with the chains tight at the top, there would be a slight sag below of from ¾ to 1¼ inches from a tight tension.



A STANDARD TYPE OF RADIUS ROD
Letter "A" Indicates Lubrication Points; "M" Those of Adjustment

After having adjusted one side and properly tightened the adjusting and locking bolts, then repeat the operation on the opposite rod, taking care, as before instructed, to maintain the same distance between rear axle and jackshaft.

Having finished with the radius rods, the brakes will next have to receive attention. After the drive chains have been in use for some time, it may be necessary to remove a link or two when making an adjustment to the radius rods.

Aerial Type Radius Rod—To make adjustment, first loosen the two lock-nuts at either end of the turnbuckle. Turn the latter in the direction to lengthen or shorten the distance as required and when adjustment is secured. Tighten the locking nuts at both ends of the turnbuckle.

Service (Foot Brake) as Used on all Types Except Aerial—These consist of external bands which contract upon rear wheel brake drums. Slipping of the brake bands or shoes does not always necessarily indicate that brakes require tightening; very often the brake lining becomes covered with grease or oil, thus overcoming the gripping action.

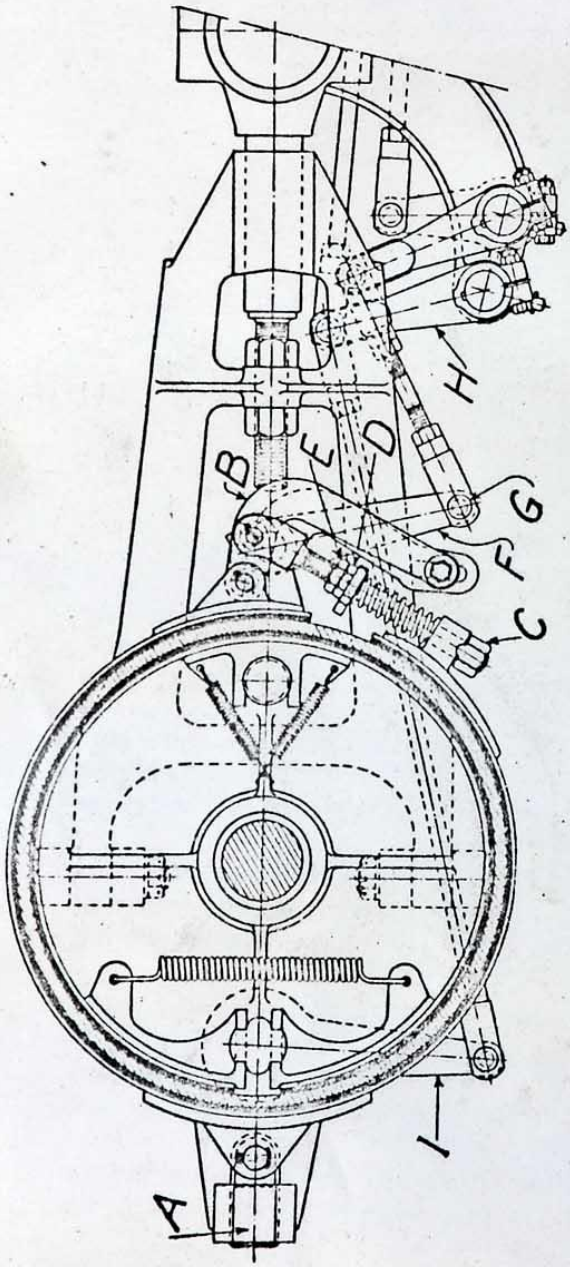
It is, therefore, well to carefully examine the condition of the lining before undertaking other work. If oil or grease are present, clean with gasoline or kerosene and then test the holding qualities.

Before undertaking any work on the brake system, the rear wheel bearings should be checked up and if found not in proper adjustment, attention should be given this matter before turning to the brakes. The first move is to jack up the rear wheels clear of the ground and then fully release both service and emergency sets; make sure that lever "B" is back against toggle mechanism.

Next see to it that the pivot pin "A" works freely in its support and that toggle mechanism and other moving parts are free from any binding action. The upper half of the brake band may now be adjusted by loosening lock nut "E" and then turning adjusting nut "D" up or down the yoke bolt stem until

all parts of the upper portion of the band have a clearance of about $\frac{1}{64}$ of an inch over the drum.

Locking nut "E" may then be screwed tight against the adjusting nut. The lower portion of the brake band is next adjusted by turning the adjusting nut "C" to the right or left till the lever "B" is brought into position close t the yoke bolt and a clearance of about $\frac{1}{64}$ of an inch exists between the ban and drum. As there is no equalizing device in the braking system, it is necessary that the brake on each side of the axle be adjusted so that they will apply equally. It is very important that the adjustments be so made, that when the service brake is fully applied, the lever "B" will stand about as shown in the line cut.



Should difficulty be experienced in fully releasing brakes so that lever "B" is back against the yoke rod, then removed pin "G" from the end of the rod "F." When adjustment has been effected, the above pin may be returned to position after the connecting rod has been properly lengthened or shortened so as to permit of the engagement of the yoke end with lever "F."

Emergency Brakes—This consists of a large band which is expanded by means of a cam against the inner surface of the brake drum on the rear wheels. In making any adjustment, be sure and do not alter anything but the length of the rod connecting levers "H" and "I."

The correct positions of all levers and lengths of pull have carefully been determined at the factory; do not alter their position with the exception of the one above mentioned. Disconnect brake cam lever "I" from yoke on long rod; then push forward on this lever till the brake band just clears the drum, permitting the wheel to turn freely and then connect with pull rod to lever "H."

Service Brake on Aerial and Water Tower—(See line cut on next page). These powerful brakes are located on the outboard ends of the jackshaft close to the frame and are the contracting band type. In order to make an adjustment, first loosen locking nut "B" and then turn the adjusting nut below it to the right to loosen, or the left to tighten the brake. Only a slight change in position of the nut is generally necessary.

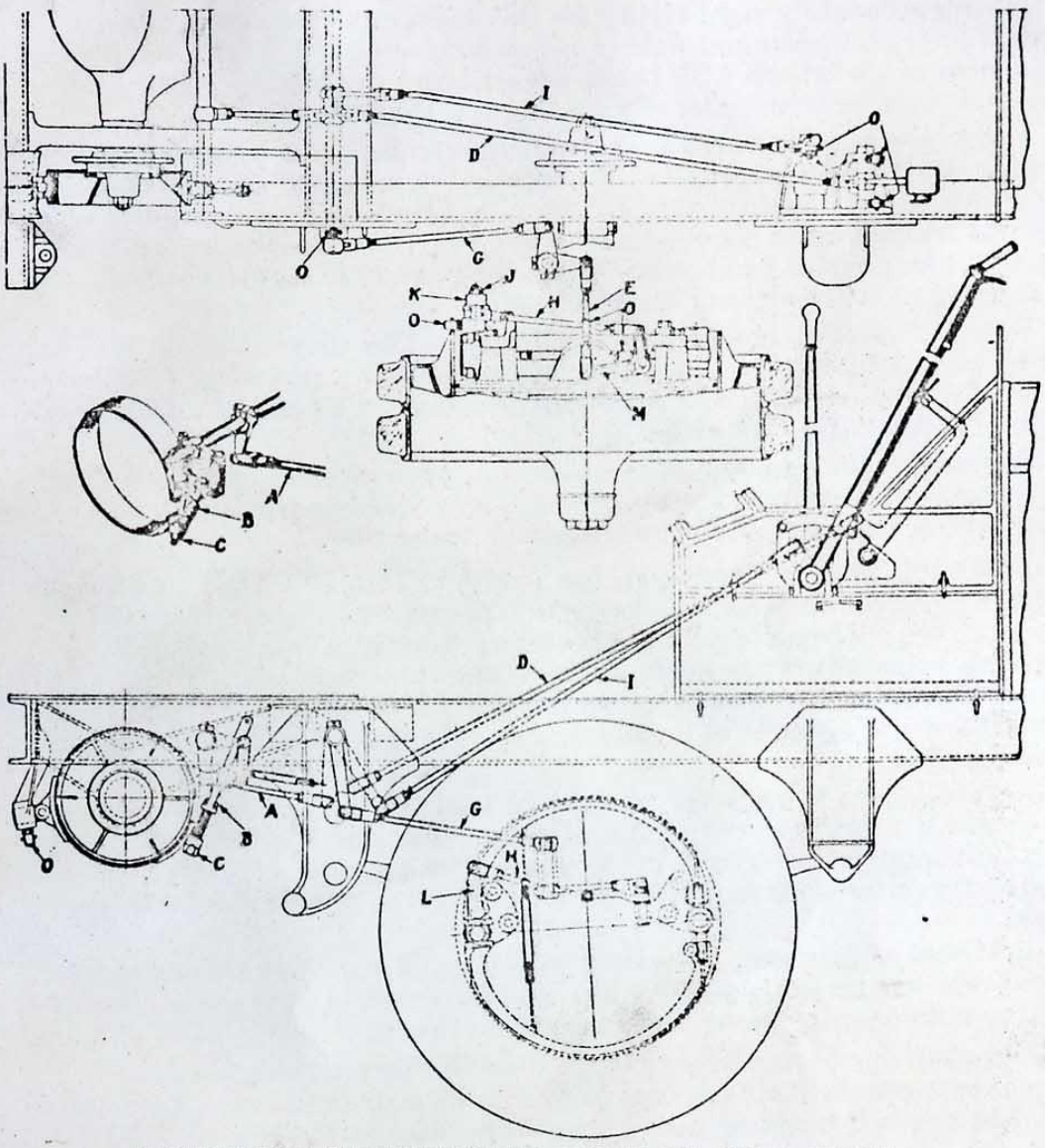


ILLUSTRATION SHOWING BRAKE SYSTEM ON AERIAL TRUCK
Letters "O" Show Points of Lubrication

Next, slightly adjust nut "C," to the right to tighten or to the left to loosen the band. A little practice will enable the mechanic to adjust the tension of these two nuts so as to secure the proper brake band contact throughout the entire circumference of the drum. The proper clearance between band and drum permits an ordinary business card being slipped between them at all points; no greater clearance should be allowed.

When proper adjustment is secured, firmly screw down lock nut "B." If brake adjustment has been correctly made, all rods and levers will stand at right angles to one another when the brake is fully applied.

Do not alter adjustment of rods "A" or "D" unless it is necessary to secure the results outlined above.

Emergency Brake on Aerial and Water Tower — The emergency hand brake is of the expanding type located in the large driving wheel drums. To adjust them observe the following directions:

Jack up wheel, remove cotter pin and loosen locking nut "J" sufficiently to permit of disengagement of the inside notched surface of adjusting collar "K" with the notched surface of lever "L." If brake is to be tightened, pull lever "L" to the rear a few notches from its former position; to loosen the brake, push forward slightly.

Having secured the right setting for this lever, mesh the two notched surfaces of lever and collar and tighten up on locking nut "J." The freedom movement of the wheels with brake released and the holding of the brakes when set, may be tested partially by rotating the wheel by hand.

When proper adjustment is secured, tighten lock nut "J" and replace cotter pin. If a finer adjustment is necessary than can be effected through the above operation, then rod "H" may be lengthened or shortened very slightly. Adjustments should be so made that when brakes are fully engaged, the long end of bell crank "M" to which rod "E" is attached, should be centered over the steering knuckle pin.

Rods "G" and "I" should only be adjusted so that they will stand at right angles with the levers to which they are connected when brakes are fully applied; in this position the maximum leverage is obtained. DO NOT PERMIT BRAKES TO DRAG.

Previous to the adoption of the jackshaft type of brakes on front drive apparatus, both service and emergency sets functioned on the driving wheels; for directions regarding these, see Appendix, page 192.

Rear Wheel Brakes (Special) for Ladder Trucks—These represent special equipment on aerial and water towers and are only necessary in certain localities. They are of the expanding shoe type and practically all necessary adjustments are made at the brake shoe camshaft. To take up wear at this point, first loosen the locking nut on the shaft end sufficient to permit the disengagement of the notched surface of the brake cam lever and adjusting collar.

Move the brake cam lever forward or back as the case requires, then engage the notched surfaces of the adjuster collar and tighten the locking nut. Lost motion throughout the brake system may quickly be taken up through the turnbuckle fitted to the rods connecting with the brake cam levers.

Front Wheel Alignment—The front wheels on all machines when correctly aligned, are not perfectly parallel but slightly "toed in." This is done in order to make steering easier and create even tire wear.

Inspection should regularly be made to see if this condition obtains. The distance between the inner edges of front rims directly in line with the hubs, should be one-half inch less than between the rims at the rear of the axle.

To check the measurements, first straighten up the front wheels, then cut a stick so as to exactly fit between the front rims and with this measure the distance at the rear of the wheels in line with the hubs. If this distance is not one-half inch greater, then remove the bolt holding one end of the cross rod to the steering arm and turn the adjustable clevis in the direction to either lengthen or shorten the distance as called for by the measurement. (See line cut page 120.)

Wheel Bearings—Tapered roller bearings are fitted to all wheel hubs. Inspection should be made of these from time to time. Jack up the axle and rock the wheel sidewise to determine whether or not it is too loose; turning the wheel will indicate if the bearings are too tight.

OIL AND GREASE

Where and When to Apply

Thorough and systematic attention to the oiling and greasing of all moving parts of a fire truck is the most important duty of those in charge.

Conscientiously carried out the instructions given in this chapter will tend to do more toward keeping your apparatus in proper operating condition than anything else you can do.

Good oil and grease properly applied, reduces wear, prolongs the life of each part and is far cheaper than new parts which will otherwise have to be installed.

The operation is quickly accomplished, need not be a dirty one, so often imagined, and in the long run, means far less time spent than where the machine has to be rebuilt simply because lubrication was neglected.

If you neglect this subject, your machine can not be relied upon to do work for which it was designed, and no amount of explanation will hide the true cause for failure.

ATTEND TO LUBRICATION THOROUGHLY AND SYSTEMATICALLY.

Next in importance to looking after each and every point where motion takes place, is the use of nothing but the very best of lubricating oils and greases.

The best is the cheapest in the long run, and any attempt to substitute inferior grades in order to reduce costs, is the poorest kind of economy.

USE THE BEST OIL AND GREASE OBTAINABLE.

To simplify the operation and guide you in the daily, weekly, and monthly application, the following chart will be found of material value. A copy of this printed on stiff board as a wall hanger will be furnished you so that it may be placed near the apparatus and conveniently consulted.

On this chart we have indicated by arrows nearly all points requiring lubrication. Numerous parts are alike on both sides of the apparatus, and in some instances, we have omitted indicating the same point twice in order to avoid confusion.

However, parts that are not so indicated must also receive the same attention as those shown on the chart.

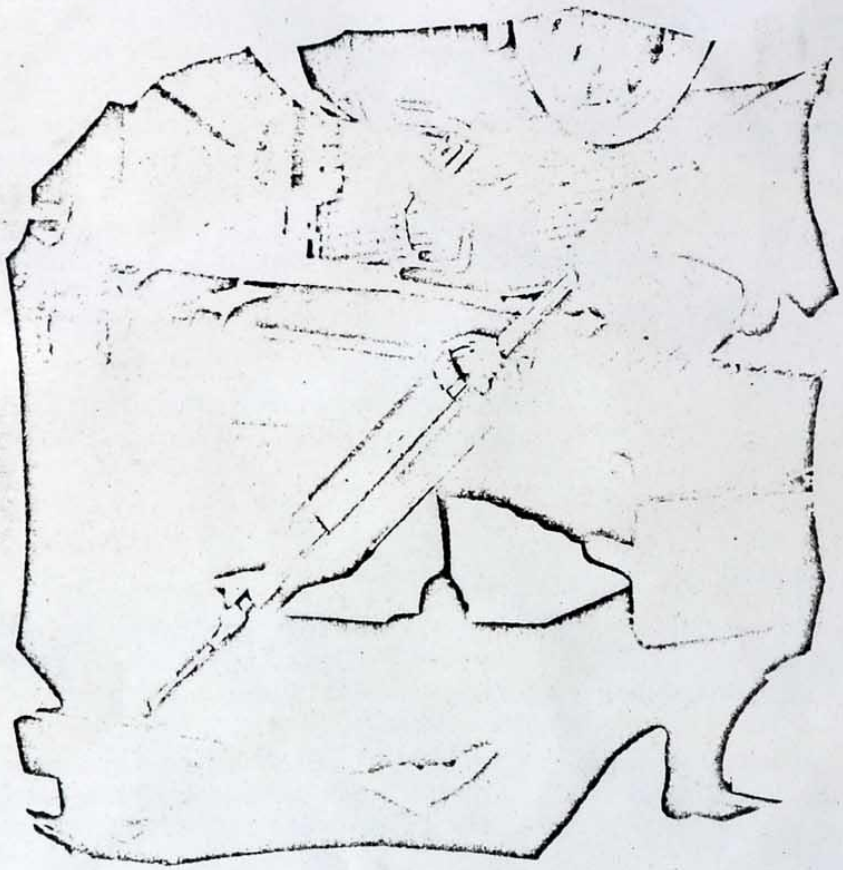
With the exception of such units as Motor, Transmission, Pump and Wheels, all wearing points are fitted with either compression grease cups or nipples for the attachment of the Alemite grease gun.

Once a week go over the whole car, screw all the cups down, then refill and screw down about one-third the way.

It is a good plan to grease the steering gear connections after every run through rain or mud.

Zerk System—In this, nipples are fitted to the points to be lubricated with a powerful grease gun. Apply grease to nipple and force grease through it by pressing against handle. Repeat action until greased sufficiently.

When attending to either the cups or nipples, a cloth should be used to thoroughly wipe off all dirt or grease before and after the operation; this prevents any dirt from entering the bearing, and the collecting of an unsightly mass around the cup or nipple while driving.



USE OF THE ZERK GREASE GUN

In the case of the Zerk gun, thoroughly wipe out the end; otherwise dirt collected from the tool box may be forced into the end of gun.

A cloth is preferable to waste for the above purpose as it is not so inclined to leave lint or threads clinging to the cup or nipple. Clean the gun thoroughly before stowing away in the tool box.

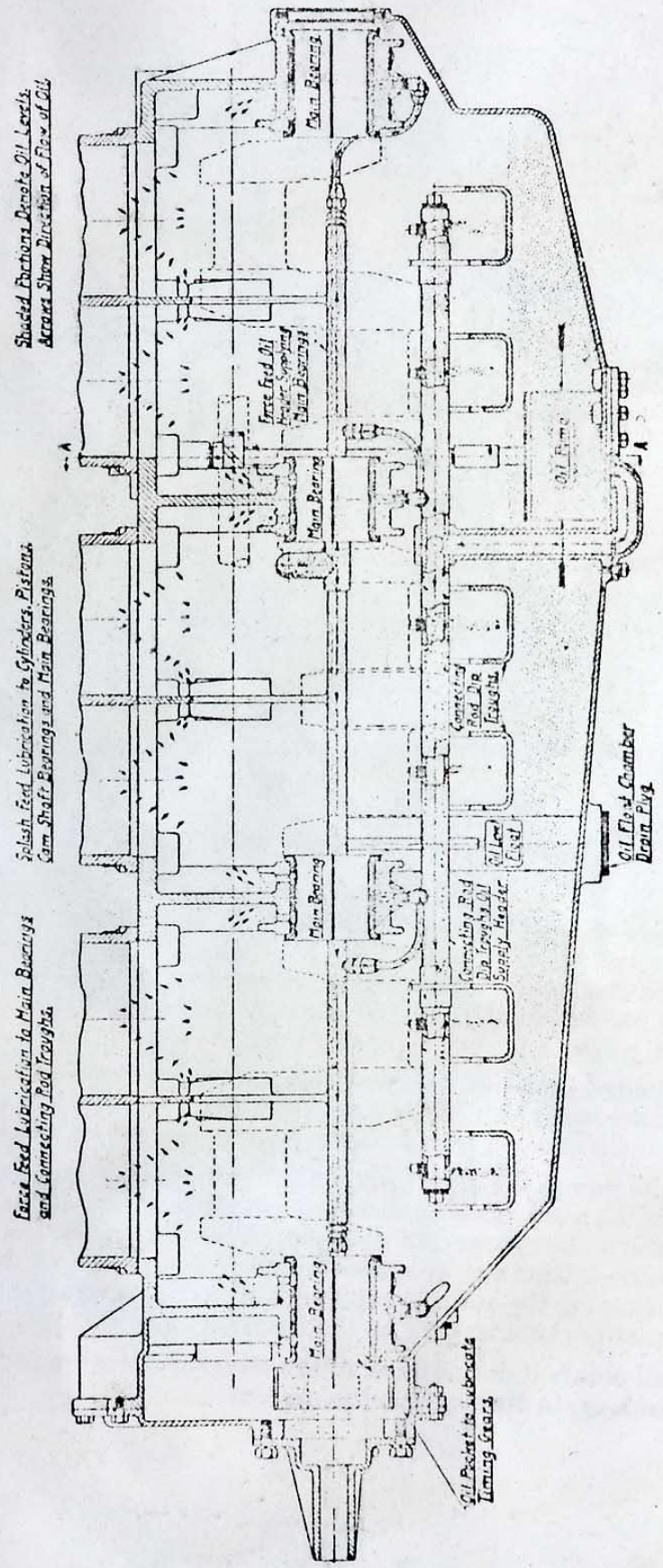
All grease cups or the gun should be filled with a light grade of high quality cup grease. In winter or very cold weather, with 600W heavy oil.

When turning down cups or using the gun, be sure that sufficient pressure is used to thoroughly force the grease to all points where it belongs. This usually is indicated by a slight overflow or oozing from the ends of the passages.

Sometimes grease will harden and choke such passages, this is particularly true of grease cups, it is therefore well to occasionally remove them and clean out the passages with a wire.

The Zerk gun develops a power of 600 pounds per square inch, which is sufficient to overcome any hardening of the grease that may occur.

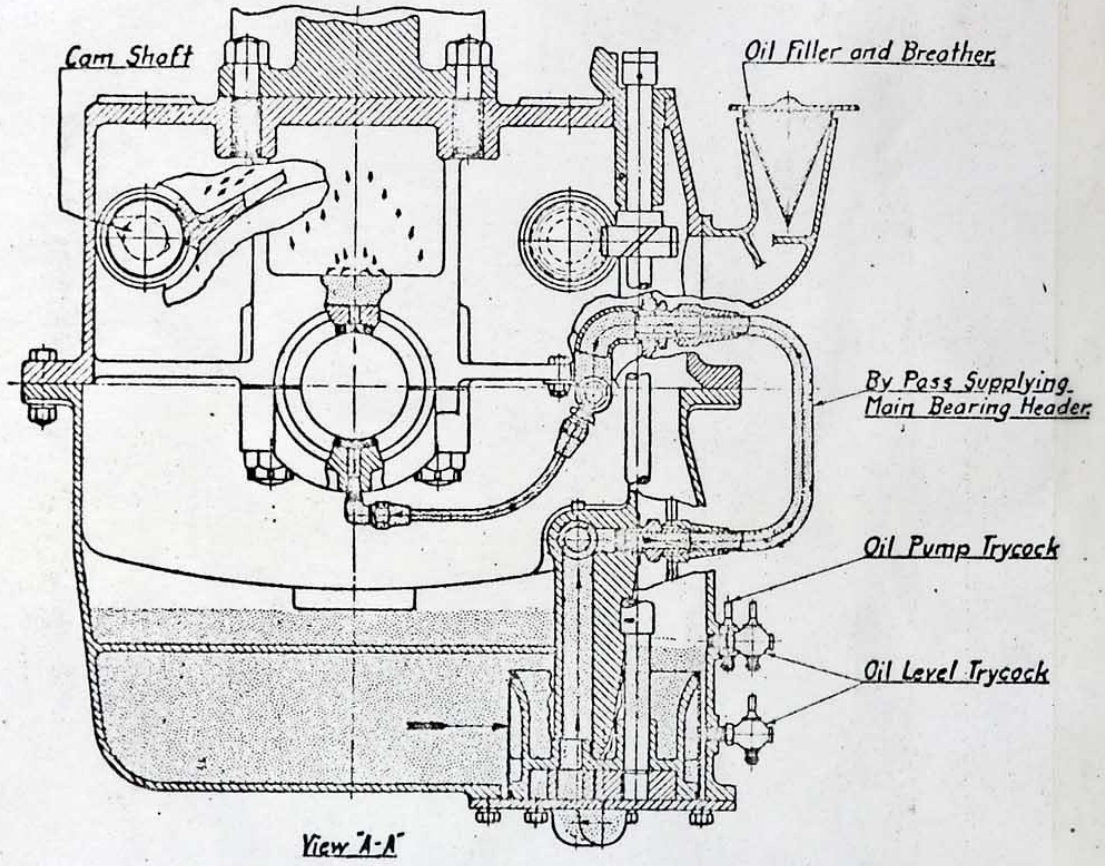
Should a grease cup, cap or nipple become lost or broken off, replace with a new one at once. Study the oil chart carefully and thoroughly so that no part will be overlooked.



LUBRICATION SYSTEM OF MOTOR—SIDE VIEW

MOTOR

The motor is lubricated by what is known as the force feed and splash system, contained entirely within the crank-case, and the oil is used over and over again.



LUBRICATION SYSTEM OF MOTOR—END VIEW

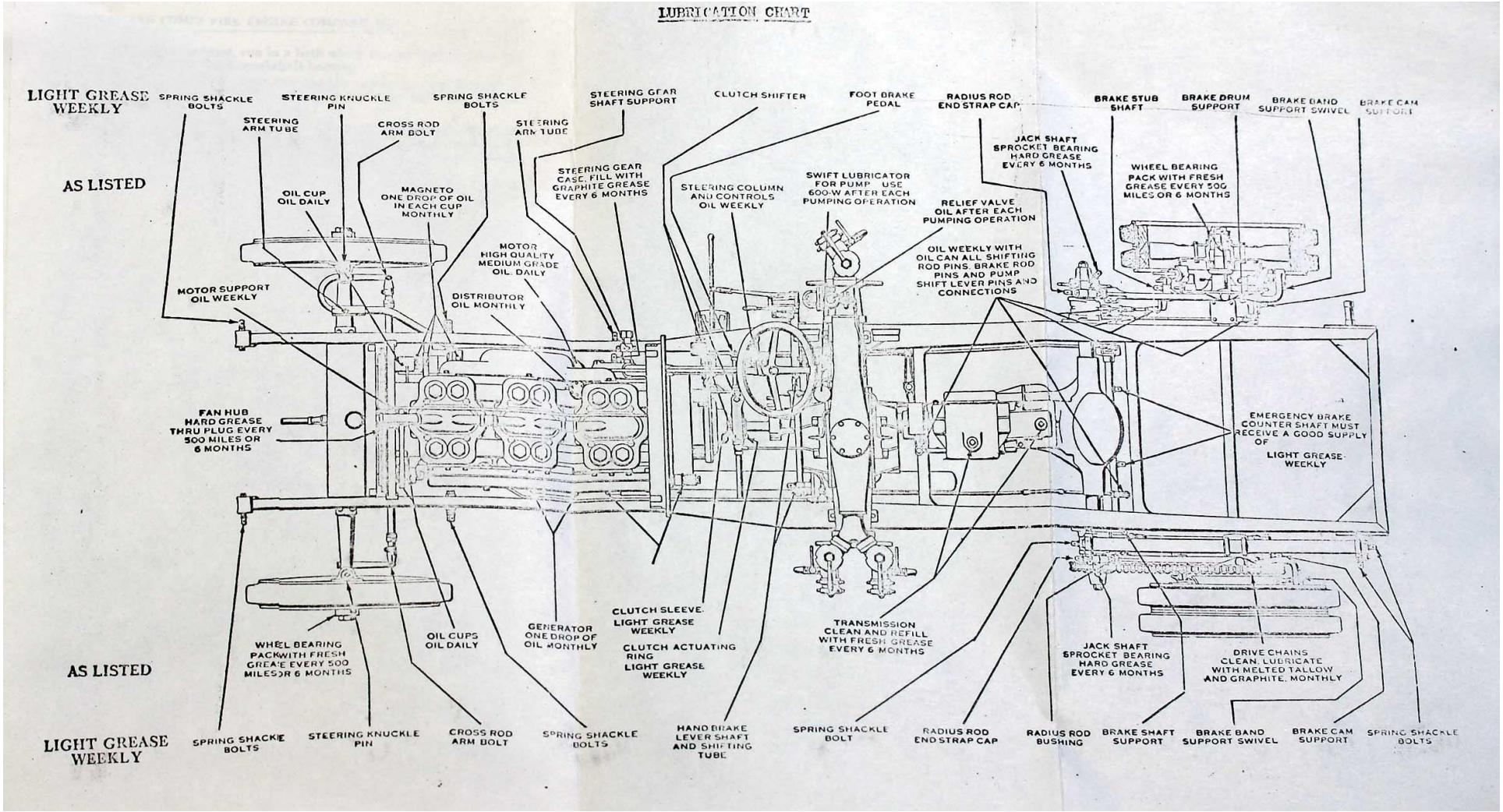
Details of this system are as follows: on six-cylinder motors, the large "breather tube" which is also the oil filler spout, is located on the right side of the crank-case back of the carburetor; on four-cylinder motors, it will be found also on the right side, but directly in front of the magneto. (See illustration, page 44.)

Oil is poured into this breather tube and flows down into the oil pan or "sump" in the lower half of the case, from this reservoir it is drawn through a fine wire mesh strainer into a gear type of pump driven from the camshaft.

From the pump, the oil is forced through large passages and pipes within the case, to the main crankshaft bearings and troughs cast in the lower case and into which the connecting rods dip. This dipping action, besides lubricating the crank bearings, splashes the oil to every part of the motor, thoroughly lubricating the cylinders, pistons, piston pins, push rods, and further runs into cast pockets leading to the camshaft and crankshaft bearings.

From all points it drains back to the oil reservoir where it is strained and pumped back again throughout the system.

LUBRICATION CHART



The timing gears in front, run in a bath which is constantly replenished from overflow from the front crankshaft bearing.

Located at the side of the case near the filler spout, is a rod type of oil level indicator showing the height of the oil in the reservoir. (See illustration, page 44.)

Oil Pressure Gauge—The oil pressure is automatic, controlled entirely by the speed of the motor and is indicated by a pressure gauge mounted on the dash. When the motor is running at normal speed and temperature, the gauge should indicate a pressure of from two to three pounds.

When starting in cold weather and the oil is thick, the pressure may at first run up to ten or twelve pounds, but will return to normal as the oil becomes warm.

Gauge Does Not Register—Should the gauge fail to register, immediately test the "try-cock" on the right side of the crank-case (see illustration, page 44); if oil does not flow, shut off the motor at once and investigate the cause. A failure of the gauge to register when the motor is running, particularly when speeded up, indicates either a lack of oil in the reservoir or clogging of oil pipes or strainer.

In very cold weather and an unheated fire house, it may be that the oil congeals to a point where the pump can not draw it from the reservoir. In such cases, a lighter body of oil should be used during the cold period. If the quality of the oil or the oil level in the reservoir are not responsible for the failure of the gauge to register, before looking elsewhere, test the gauge by disconnecting the oil pipe leading from the crank-case to the gauge. If a strong stream flows out when the motor is started, the gauge is at fault.

If there is no oil flow from the pipe, remove oil pump from bottom of crank-case, thoroughly clean the wire screen and if necessary, take down the case and blow out all pipes and ducts. There will be no clogging of the system if proper inspection is made and care taken to drain off old oil regularly and renew with fresh, at the same time cleaning the crank-case.

Too High a Pressure—When the gauge records a high pressure at low or medium speeds, it is generally due to clogging or obstructions in the pipes, and the trouble should be remedied at once.

Draining Case—Located in the bottom of the crank-case directly under the oil level indicator, is a large plug which should be removed to drain the reservoir (see illustration, page 44); in doing so, remember that the indicator will come out as well. Do not fail to return this indicator when replacing the drain plug. Make sure the indicator rod is not bent and the float slides freely.

Inspecting and Changing Oil—Each week an inspection should be made; start the motor and after running a sufficient time to thoroughly stir up the oil, open the lower pet-cock by the pump (see illustration, page 44) and draw off a cupful. Carefully examine this for dirt, grit and evidence of kerosene. If dirty or diluted, change at once.

All oil should be drained from the motor once every month and fresh used for refilling, provided the weekly inspection does not indicate that this should be done more often.

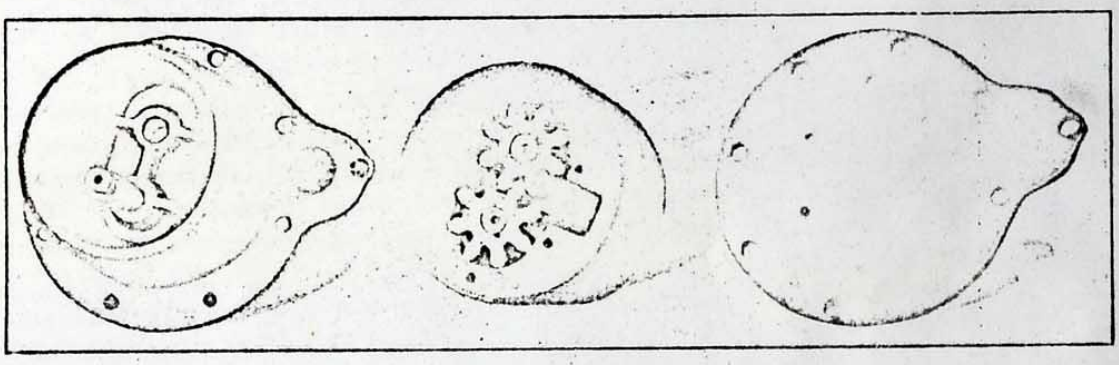
Not alone is there bound to accumulate in the oil a certain amount of metallic dust, carbon and grit, but due to poor quality of present day gasoline, quite a little unburned fuel, largely kerosene, works past the piston and

quickly dilutes the lubricant. It is therefore very important that weekly inspections be made to ascertain the quality of the oil. Take no chances, it is far better to refill with fresh than return the old oil and destroy the bearings, crankshaft or cylinders.

The capacity of the four-cylinder motor reservoir is four and a quarter gallons, that of the six-cylinder, four and three-quarter gallons.

Oil To Be Used—This has always represented a difficult subject with every manufacturer, due to the many brands upon the market and the difficulty in securing tested and proven products in every locality. Nothing but the very best quality should be used, and in its selection and purchase price is of secondary importance.

We are prepared to supply our own brand to users of American-La France apparatus and at the factory we also use Kendall oil in motor and road test work.



OIL PUMP OF MOTOR

Pump—This is of the gear type and located in a slightly rounded well in the crank-case. By removing nine cap-screws in the base of the case, the pump may be dropped for inspection and cleaning purposes. Surrounding the pump gears is a fine wire mesh strainer, which should be thoroughly cleaned with gasoline. Before replacing the pump, it is well to reach in and with a cloth wipe out the oil reservoir. **Never use waste** for this purpose, as threads and other particles are likely to adhere to the case and later on foul the pump screen or passages.

In replacing the pump, it is necessary that its drive shaft first properl meshes in the driving gear coupling which extends downward from the can. shaft. To do this, it is necessary that the pump be held in position while some one very slowly turns the motor over till the end of the drive shaft slips into place. The pump will now seat perfectly and the nine cap-screws holding it to the crank-case may be inserted.

Care should be taken that too much pressure is not exerted in tightening these cap-screws, otherwise the threads in the aluminum case may be destroyed. Be careful that pump gasket is in good condition, or replace with a new one before attaching the pump.

Cleaning the Crank-case—When much dirt and scum are found in the oil it is best to drop the lower half of the crank-case or oil pan and thoroughly clean same with kerosene. To do this, first disconnect outside oil line to gauge and large oil lead on right side between upper and lower sections of the case.

Next remove all bolts holding pan to upper half of crank-case and lower section of the timing gear cover. It is also desirable at this opportunity to clean the oil pockets above the crankshaft and camshaft bearings.

Never use kerosene or gasoline to clean the inside of the crank-case or pan, unless oil pan has been entirely removed. These are bound to collect in various crevices and bearings and later dilute the lubricating oil.

Clean the oil pan thoroughly and wipe well with a cloth. Do not use waste for this purpose, lint and thread are too likely to cling to the rough surfaces and afterward clog the pump screen or tubes. When ready to replace the oil pan, see that paper gaskets are intact; if not, replace with new ones. In doing so, use shellac only to attach gasket to oil pan. The compression contact with the upper portion of the case serves generally to make a tight joint, if not, a little grease may be rubbed over the gasket.

Very Important—The oil pump and oil indicator should be removed from the pan before it is returned to position and bolted to the upper portion of the case and timing gear cover.

Pederson Oiling System—On our older models of motors, we employed what is known as the Pederson Oiling System and in order that an operator may become familiar with this design, in the event of having old apparatus placed under his charge, we furnish a description of this system which will be found in the "Appendix" on page 185.143

Besides the main lubrication system of the motor, there are a few points on the external fittings which should receive attention from an oil can.

Front Cross Motor Support—Oil weekly.

Magneto and Pump Drive-Shafts—Oil cups are located close to the timing gear case. Fill daily.

Magneto—Too much importance can not be placed on properly carrying out instructions regarding the lubrication of this instrument. Too much oil is the cause of numerous magneto troubles, loss of efficiency and in particular, the shortening of the life of the contact points.

If the machine is in very active service, ONCE A MONTH is often enough to attend to the instrument and at such times ONLY APPLY ONE DROP of light oil, such as "Three-In-One" or sewing machine. One drop may seem a very small quantity indeed, but it is quite sufficient for the hardest service. Where the apparatus responds to infrequent calls or does very little pumping, every two or three months is often enough to lubricate this point and then only apply but ONE DROP.

Oil cups with snap covers will be found at the "breaker" end, one on each side of the housing just back of the "timing arm"; both lead to the same bearing and only the one most conveniently located, should be used. At the driving end, two oil cups will be found; the upper one leads to the plain bearing carrying the distributor shaft,—two or three drops of oil may here be applied. The lower cup feeds the ball bearing at the driving end and one drop of oil is sufficient.

Generator—This is located on the left side of the motor back of the water pump on six cylinder motors, and on the right side between the clutch and transmission on four cylinder machines; in the former case, it is driven from the pump drive shaft, and in the latter, by means of a chain from the driving shaft. Two or three drops of best quality engine oil should be placed in each end bearing once a month.

Starting Motor—Mounted on the left, rear side of the motor is provided with oil holes at either end. One or two drops of very light oil ("Three-In-One" or sewing machine), should be applied once a month.

Bendix Drive—This is a type of spiral gear driving device which is fitted to the starting motor shaft and engages with the external gear on the flywheel It should receive a few drops of kerosene monthly.

Ignition Timer and Distributor—This is fitted to pumping cars only, which are equipped with two separate and distinct types of ignition. It appears on the right side of the motor and is driven by the camshaft at the same point as the oil pump. (See illustration, page 44). The side of the upright housing is fitted with an oil cup which should receive attention weekly. Motor oil should be used sparingly.

Every month or two, the top cap of the distributor should be removed and the breaker lever bearing lubricated with a drop or two of oil.

Fan—The hub or barrel of this member is fitted with a plug which can be removed and hard grease inserted. A thorough packing is only necessary about every two months.

Clutch—The American-La France clutch being of the dry plate type, requires lubrication but at three points. The first of these is the pilot ball-bearing at the forward end of the clutch shaft. This bearing and its housing is to be well packed with grease at such times as the clutch is taken down; such grease should be able to stand a high temperature. This bearing should be packed at least every six months.

The oil hole at the rear of the housing, marked "G" on the illustration, page 91, should receive attention from an oil can once a week.

On the outside of the "actuating ring" ("M," same illustration as above) there is a grease cup which should be kept filled and turned down daily.

Clutch Shifter and Shaft—Directly under the floor boards, the "clutch shifter" and the foot brake lever to the right are fitted with grease cups (three in all) which should receive attention weekly.

Hand Brake Lever Shaft—Back of the clutch shifter, the hand brake lever shaft carries two grease cups to be looked after weekly.

Universal Joints—At the factory, the universal joints of the drive shaft are well greased when the car is put together, but owing to the simplicity of design and slight amount of possible wear, there is hardly any necessity of renewing the original supply. We doubt if any of our users have ever lubricated this point and no trouble has ever arisen through their having been run dry.

Transmission—(Other than pumping cars). The change speed gear case should be drained and the interior flushed out with kerosene at least every six months. To accomplish this, first remove the two large drain plugs on the under side of the case; one of these drains the rear or differential compartment; the other, the forward section containing the change speed gears. Both top and rear cover plates should be removed. After the old grease has been removed, flush and clean with kerosene and wipe out all particles of dirt or metallic grit that may have lodged in the bottom of the case.

Next replace the two drain plugs and fill both front and back sections of the case with a good quality of semi-fluid transmission grease. Pack as much as possible in the rear compartment and then fill the forward to a level with the lower portion of the rear main drive shaft bearing.

Should difficulty in shifting gears be encountered during very cold weather, the grease may be slightly thinned down by adding approximately one pint of motor oil to the contents of the case. Our own practice at the factory is to place fifteen pounds of "Keystone" grease and five pounds of No. 677 graphite in the gear case. Be sure to add or place some of this in each compartment, for while both are connected by passages, it may take some time for the grease to work through and if only added to one section, the gears in the other would be inclined to overheat before the lubricant reached them.

Pump Transmissions—On pumping cars of the Rotary Gear and Centrifugal types having their transmissions mounted on top of the road transmission gear sets, the matter of lubrication differs slightly from the foregoing instructions. Pack the rear and front compartment of the road transmission full and then after attaching and securing the pump transmission, place quite a quantity of the lubricant in it.

A proper filling of the transmissions for pumping cars will be approximately about ten pounds of No. 677 graphite and thirty-five pounds of "Keystone" grease. Be sure to cover the bearings of the pump transmission with grease before returning it to position.

Jackshafts—The sprockets bearings on the outboard ends of the jackshafts should be well packed with grease every four or six months; grease cups or Alemite nipples are provided for this purpose.

Transmissions for Rotary Gear Pump No. 38 and No. 39—Unlike our other type of rotary gear pump, the transmission for No. 38 and No. 39 is mounted within the housing of the pump itself. As this transmission contains one or two plain bearings the grease and graphite compound will not answer. At the factory we use the same oil as for the motor, placing two gallons in the transmission or sufficient to run out of the testing cock which will be found on the front of the transmission on the left side.

Right near the "Swift Lubricator" (see illustration, page 149) in the front, will be found the filler spout which is provided with a cover and marked "O" on the illustration. The oil level test cock should be carefully examined not less than once a week; if there is no oil flow, immediately fill the transmission till the oil shows at the cock; this should be kept closed at all times except to test the oil level.

Every six months drain off the oil and refill.

Pumps—Three different types are manufactured, first and foremost being the Rotary Gear design, then the Piston and Centrifugal. Lubrication instructions covering the transmission of all but the Piston pump have been covered in the foregoing paragraphs.

Piston Pump Transmissions—In cars fitted with the piston pump, the transmission is located directly under the driver's seat and should be kept full of 600W oil to the level indicated by the "high" and "low" pet-cocks attached to the front portion of the gear case on the right side. Figure "O" on the illustration, page 158, indicates the position of the oil filler plugs.

The case should be drained every six months and refilled with fresh 600W oil.

Relief Valve (Gear and Piston Pumps)—Piston pump, see "8," illustration on page 158; Standard gear pump, see "8," illustration on page 150; No. 38 and No. 39 gear pump, see "8," illustration on page 149.

After each pumping operation it is well to inspect and lubricate the Relief Valve. Remove the hexagon head cap over chamber "D," illustrated in detail on page 145; push plunger down, wipe barrel clean and lubricate the plunger with very light oil. Unless the plunger is stiff from lack of lubrication it will snap back into position after being depressed; oil and work up and down till it does so.

The lower section of the plunger also passes through a leather gasket shown as "F" on the illustration, directly under the spring. By pressing on the relief valve as far as it will go, the lower part of the plunger is exposed and should be well oiled. Caring for the relief valve is highly important and not difficult; it should be attended to each time the pump is used.

Swift Lubricator—See "6," illustrations on pages 149 and 150. Unscrew cover and fill with 600W oil. At the close of each pumping operation, after all water has been drained from the pump, start same slowly and operate the lubricator a few strokes. This will oil the gears and heads.

There can be no set rule for the filling of the lubricator as the matter is dependent upon pump use. Inspect frequently, and keep the lubricator full.

Pump Gear Shafts—Once every three months remove plugs marked "O" in the illustration on page 150, from pump gear shaft bearing caps and inject grease with a grease gun into one hole till it runs out the other, indicating that the bearing is full.

Should it be desirable to remove a bearing for inspection or further greasing, **only remove one at a time and replace it before taking out another.** This is a very important matter, as by doing otherwise, the proper clearance between pump gears and housing may be disturbed. Be sure and carefully replace and lock the bearing cap in original position before undertaking any work whatever on another one.

Centrifugal Pump—At either end of the large pump shaft is a ball bearing which is lubricated by a grease cup. These should, dependent somewhat upon the use of the pump, be filled weekly. During pumping operations, the cups should be given about one turn every half hour.

Priming Pump—Directly above the primer pump located at the rear on the left side, is an oil cup for lubricating the inside of the Priming Pump. When priming, before water is obtained, the primer pump handles nothing but air, therefore provision has to be made for lubricating during such period.

The primer pump should be started after the apparatus returns to the house and run slowly until all water is expelled. Then oil should be drawn into the priming pump through the oil cup until the former is thoroughly lubricated.

When priming a centrifugal pump, it is always well to open the cup slightly and allow the oil to feed into the priming during the operation. Should the oil supply become exhausted during such operation, shut off the oil cup at once, as otherwise there would be a direct air leak into the suction side of the pump, making priming impossible.

The best lubricant for this cup is heavy quality, steam cylinder oil.

Pin and Connections—At least once each week through the medium of an oil can, lubricate all shifting rod links, brake rod pins and connections. Most of these will be found beneath the foot boards, alongside of the transmission and between the radius rods and frame members.

Connecting the spark and throttle levers on the steering column and the foot accelerator pedal with the carburetor, are many connections and joints;

these also should receive weekly attention from an oil can. (See illustration on page 121).

Brakes—With the exception of brake rod pins, which should be oiled once a week, the lubrication of the balance of the brake system is cared for by grease cups or Zerk nipples. These points are largely grouped around the jackshaft and rear wheels; all should regularly receive weekly attention.

The one safe system to follow is to turn down and fill every grease cup or nipple found throughout the apparatus.

Drive Chains—These should be kept as clean and free from dirt as possible and a very good way to proceed in the matter is to first block the front wheels to prevent the machine from moving and then jack up the rear axle.

Have someone now slowly turn the driving wheel while the operator holds a wire brush or ordinary scrubbing brush against the rear sprocket and allows the chain to scrub itself. In performing this work, guard well against the danger of having fingers or hands caught between the chain and sprocket or loose ends of clothing becoming entangled.

Do not under any condition, attempt to do this work with the motor running—the danger of a serious accident taking place is too great.

When the chains are clean, wipe with a cloth or piece of waste and then apply a mixture of grease and graphite, smearing over the chains and allowing it to work well down into the joints. After this is accomplished, the superfluous grease should be wiped off.

However, as it is not possible to entirely remove the grit and thoroughly lubricate the joints by the above process, we strongly recommend the following procedure: remove drive chains and soak thoroughly in a bath of gasoline or kerosene, brush them off and wipe dry with a cloth. Next, heat a mixture of three parts beef tallow and one part of flake graphite almost to the boiling point, and into this place the chains.

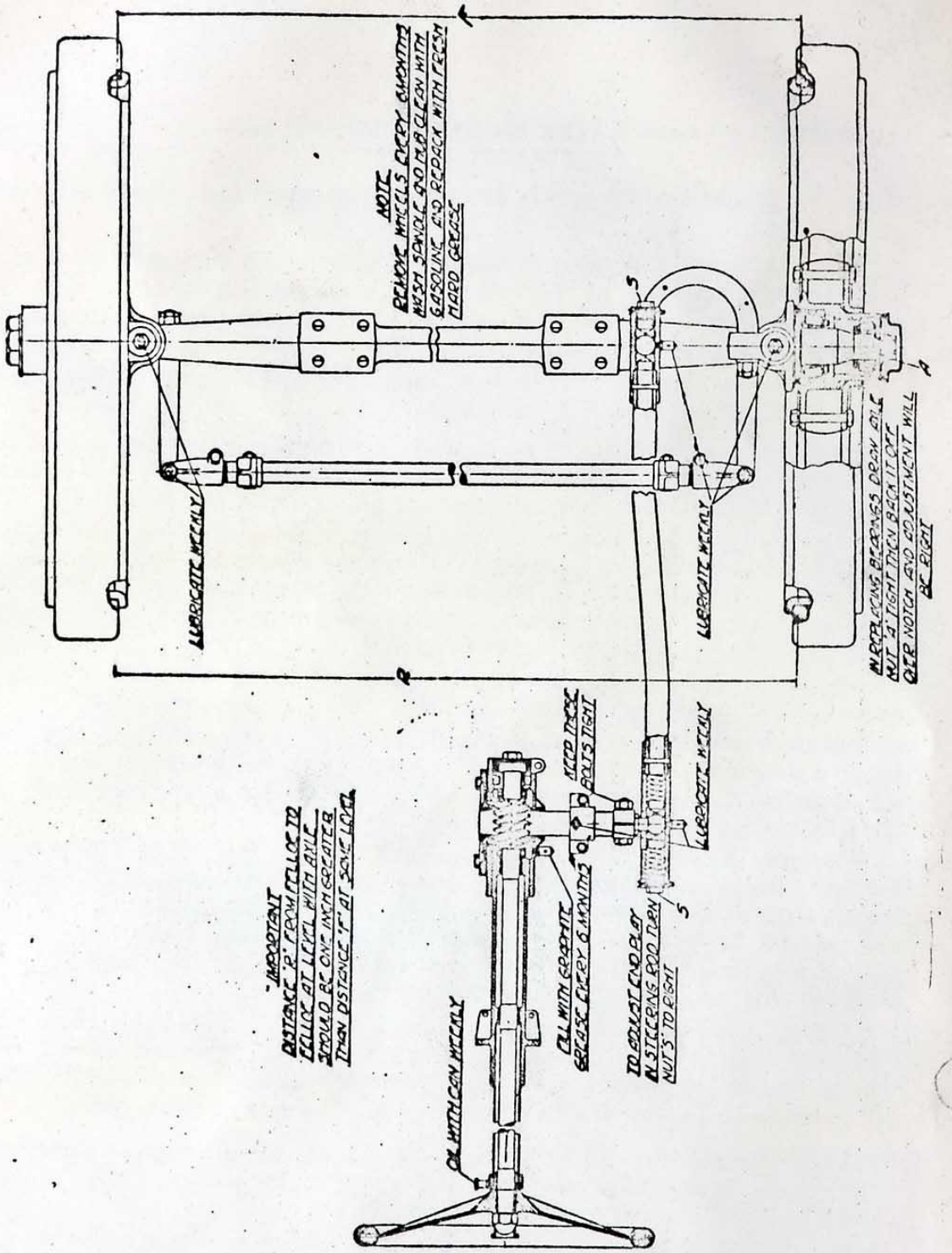
Allow them to remain a sufficient length of time to thoroughly absorb the lubricant in every joint and then place them on a clean surface to dry; after which, replace on the machine. Such care will greatly lengthen the life of both chains and sprockets and increase the efficiency of the vehicle.

Springs—Lubrication of the spring pins and bronze bushings in the eyes is cared for by means of grease cups or nipples which will receive your daily attention along with other similar points.

In addition to this, it is advisable at least every six months to give attention to the spring leaves themselves. Jack up the body of the car till the wheels are just free of the ground, this will slightly separate the leaves one from another. Insert a thin chisel or screwdriver to increase the opening and by the aid of a thin knife blade or broken hack-saw, work graphite-grease as far as possible into the openings. The spring clips should be tightened after this operation.

Steering Gear—Two front and one rear type of steering gear are used on the various types of American-La France apparatus. The first to be described is that used on all but the aerial ladder trucks and water towers.

Both oil and grease are used to lubricate this gear. Directly under the hand wheel and at the shaft end of the throttle lever are fitted oil cups which should receive weekly attention from the oil can. In the large gear housing at the lower end of the steering column is a grease cap or plug by means of which the worm and worm gear may be well packed with graphite grease

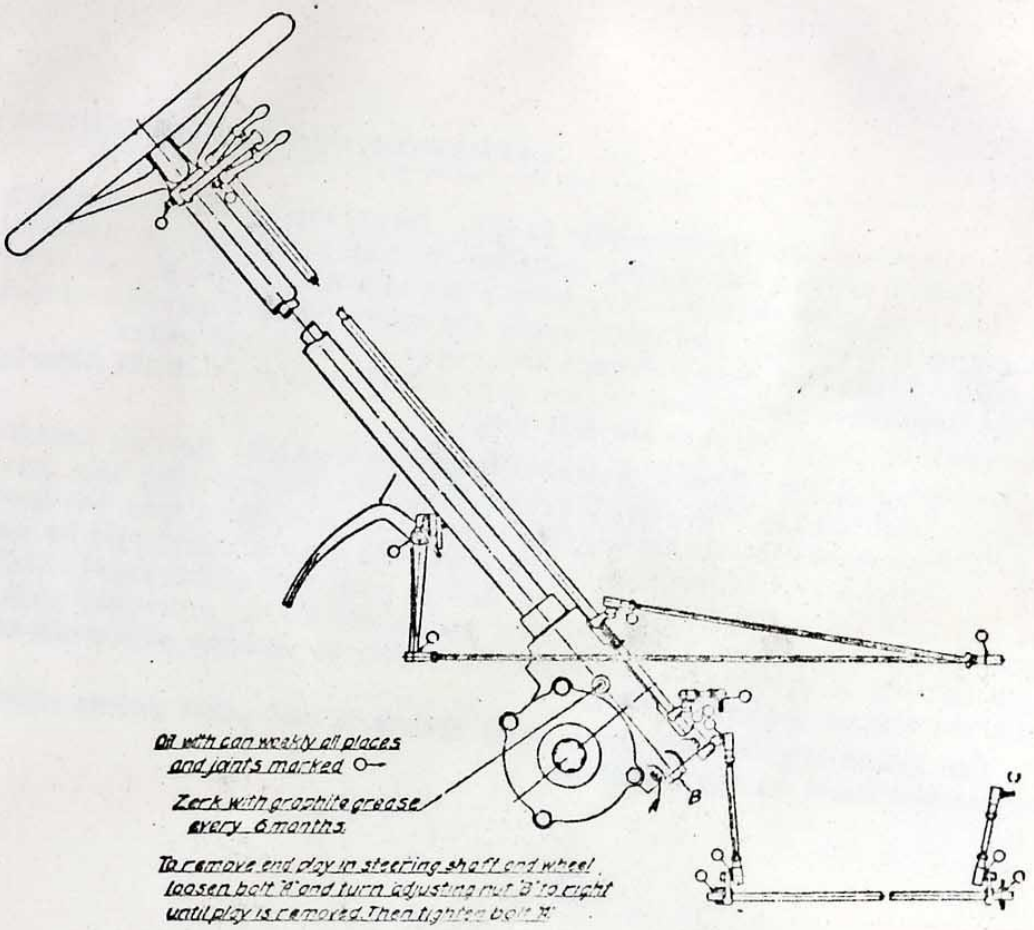


"STANDARD" STEERING CONNECTION

every five or six months. On the worm gear shaft, there is a grease cup or nipple requiring weekly attention.

Both ends of the steering reach rod and the axle tie rod clevis pins also come in for weekly attention.

Steering Knuckle Pins—On all types except the aerial, the pins are fitted with plain bronze bushings; it is very important that the grease cups or Ale-



STEERING COLUMN AND CONNECTIONS TO CARBURETOR AND MAGNETO

mite nipples be completely filled and turned down not less than once a week. A great deal of the difficulty of steering, is due to the neglect at this point.

On aerial trucks, the steering knuckle pins have a plain bronze bushings in the upper section and a tapered roller bearing in the lower; keep both of these well packed with grease.

Aerial Steering Gear—Directly under the hand wheel is located a large housing containing the double reduction gears which are of the spur type. Every five or six months the cover of this housing should be removed and the entire space packed with graphite grease.

Tiller Steer—Every six months the large plug in the housing should be removed and grease inserted. In addition, there are two grease cups on the ends of the short sector shaft of this housing requiring weekly attention.

Wheel Bearings—Are all of the tapered, roller type and at least every five or six months the wheels should be removed and the bearings and hubs thoroughly packed with grease.

Be careful not to damage or disturb the felt washers in the shoulders of the spindles when removing or replacing the wheels.

When returning the wheels and bearings, do not use force.

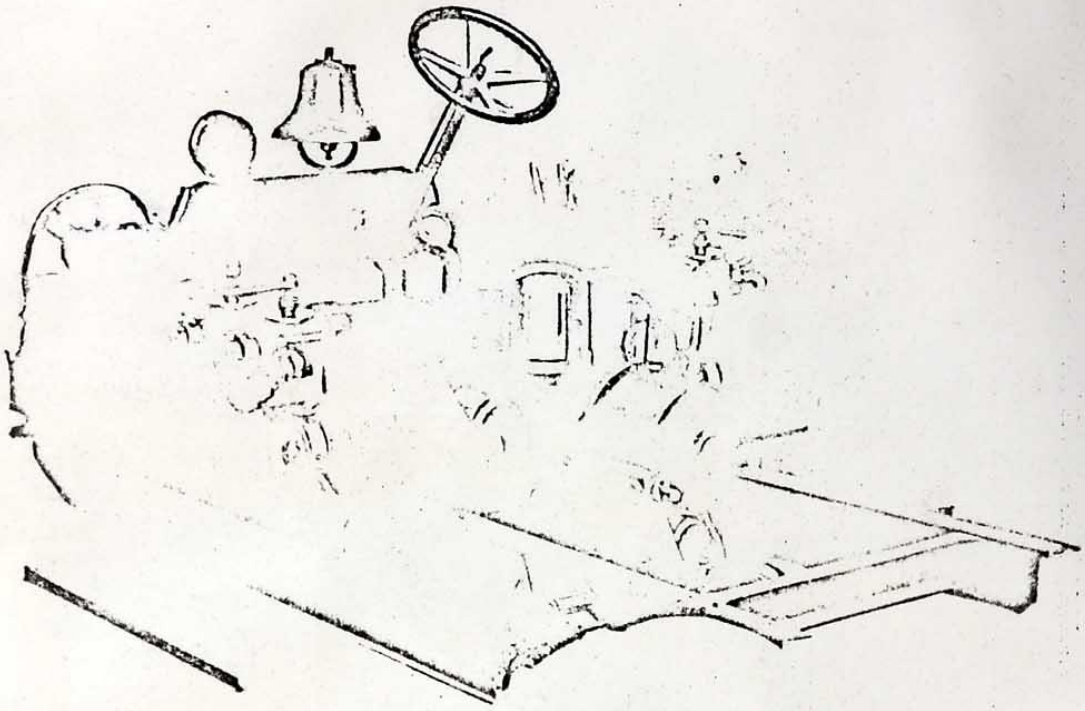
After packing the inner bearing and hub with grease, slip the wheel on the spindle and then insert the outer bearing; this can readily be seated by

moving the wheel slightly from side to side. Next, slip on the washer with raised surface against the bearing and then the nut, pulling up on the latter and then back it off slightly—about one sixth of a turn. Test the wheel by turning with the hands, and lastly apply the cotter pin and spread and lock the ends. Make sure that hub caps are properly seated and secure.

On front drive aerial truck wheels, grease may be inserted in the hubs by removing the pipe plug near the hub cap.

Front-Drive Aerial Truck Axles—Wheel bearings and steering knuckle pins are lubricated in the manner before described. The driving axle, however, differs from others; this is fitted with a universal joint near the inner side of the wheel. The leather boot covering the drive shaft should be well packed with grease every six months, and at such times, the wheel should be removed and the face of the driving pinion and bull gear covered with a light coating of grease, not too much, however, to overflow and work out onto the face of the brake shoes.

The grease cups on the drive shaft sprockets and other points should receive the usual weekly attention.



GEAR TYPE OF PUMP

The American-La France rotary gear pumps are made in capacities ranging from 300 gallons per minute up, and with but a few minor details connected with the "Junior" type, the operation is practically the same.

Before attempting any pumping operations, the operator should familiarize himself with the various pump parts, their purposes and function. Study well therefore the foregoing description which in general, covers the three types of gears as well as the piston pumps. The slight differences or peculiarities inherent in each type will be fully explained in the following pages under their proper divisions.

Important Parts of the Pump

Suction—The large diameter hose sections used to connect the pump to the hydrant or source of water supply. The ends of the suction where connections are made are fitted with heavy rubber gaskets and it is of greatest importance when connecting up the suction, to make sure these gaskets are in place and that the joints are absolutely air tight. Any air leak at a joint or connection will seriously interfere with the lifting of water and in many cases render it impossible.

At the end of the suction resting in a stream or basin, should be attached the strainer provided for such purposes. This is to prevent, as far as possible, foreign matter being drawn into the pump and cooling system of the motor; in the former case, wear will eventually take place within any pump and in the latter, the entire cooling system may become clogged. Therefore do not use fire pumps to pump out dirty basements and sewers; use the syphon system or pumps especially built for that purpose.

In placing the end of the suction in a stream or basin which forms the water supply, it is important that the suction be placed deep enough to prevent any whirlpool forming, as this will allow air to enter the pump as in the case of leaking joints or connections previously mentioned.

TYPE 12 ROTARY GEAR PUMP

The suction end should also not be placed on a sand or mud bottom as such matter will surely be drawn into the pump and cooling system.

Discharge Gates—These are designated as figure "3" in all the pump illustrations; their purpose is to open or shut off the water supply to the various lines of hose.

All discharge gates not connected to hose lines should be kept closed; when about to start pumping operations, open such gates as are connected up.

Bleeder Cocks—See figure "9" on gear pump cuts and figure "11" on piston pump illustration. The purpose of these cocks is to drain the water from the hose lines after pumping has been discontinued. This however, is more easily accomplished by disconnecting the hose from the pump. When starting the pump, one of the nearest bleeder cocks may be opened so as to indicate when water is secured, but this will also be clearly indicated at the time, by the swelling and throbbing of the hose itself. Keep bleeder cocks closed, except for the purpose described in the foregoing.

Pump Drain—On gear pump illustrations the pump drain is indicated by figure "7" and on the piston pump by figures "12." As the name indicates, these valves permit all water to drain out of the pump, an operation which should follow the final shut down of the pump. When about to start to pump, the drain cock should be closed; on the standard types of pump, illustration page 150, the drain is closed by moving lever (No. 7) to the vertical position as shown. Placing it in a horizontal position opens the drain. On type 39 pump, illustration page 149, the lever (No. 7) is operated in a similar manner to the above. On the piston pump, illustration page 158, the four handles, marked (No. 12), are pulled out to drain the pump; as previously stated, the drain should be closed before starting to pump—push the handles in.

Auxiliary Motor Cooling System—This consists of a pipe leading from the large fire pump to the inlet water manifold directly above the water pump of the motor. The flow of water to the motor is regulated by a valve on the fire pump, marked "5" on all cuts. By feeling the temperature of the cylinders from time to time with the bare hand and opening or closing the valve "5" accordingly the proper motor temperature may be maintained. It is about right when the bare hand can touch the cylinders without burning. Care should be exercised when regulating the opening of the auxiliary cooling valve, particularly when the fire pump is operating at high pressure, as a great volume of cold water might suddenly be forced through the motor water jackets and radiator, resulting in damage to these members. It is well to only

give the valve a quarter turn at a time. Constantly watch and feel the motor temperature, as thorough efficiency is only secured by keeping the motor at the proper uniform and even degree of heat at all times.

Upon closing down the fire pump, the auxiliary cooling valve should immediately be closed to prevent the cooling system of the motor and radiator becoming drained;—this is highly important and is very often overlooked with unfortunate results. At a low point in the auxiliary cooling line, located at the left side is a drain cock "D" which, in cold weather, should be opened after closing the auxiliary cooling valve, and after closing valve on motor immediately above circulating pump. This will drain the cooling line and prevent freezing; make sure drain cock ("D") is closed and valve at motor open, before starting the fire pump.

Churn Valve—Figure "4" in all illustrations, controls the by-pass connecting the "suction" and "discharge" chambers of the pump. With this valve open and the discharge gates closed, the water passes from one chamber to the other and continues to circulate through the pump over and over again.

The purpose of the churn valve is to permit the shutting down of the water passing through the lines of hose, whenever desired, without stopping the pump, an operation that would otherwise be necessary.

With the pump in operation, churn valve open and discharge gates closed, it is possible to instantly furnish as many streams of water as there are hose lines connected to the pump, by simply opening the proper discharge gates and closing the churn valve.

When starting the pump for the first time, it is necessary to open one of the discharge gates and then close the churn valve. The pump gears then discharge all air there may be in the pump chamber into the hose and also draw such air as there may be in the "suction" through the pump. This act of exhausting the air in the "suction" and pump creates a vacuum which allows atmospheric pressure to force water into pump, from which it may be discharged under varying pressures.

In case the water pressure at the hydrant is sufficient for the conditions met with at the fire, the pump need not be started at all. Simply connect the suction to the hydrant and a hose line to the pump, then by opening the churn valve, the water enters the suction chamber of the pump from where it passes through the by-pass controlled by the churn valve and out through the hose.

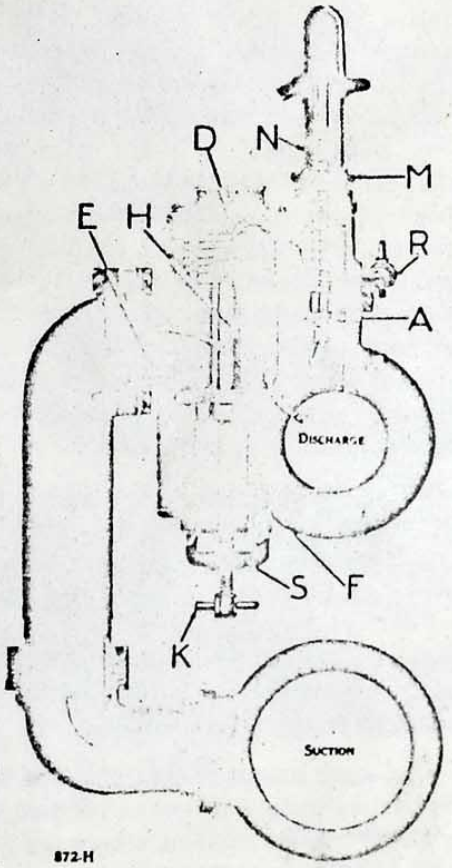
At any time that increased pressure should be required, it is only necessary to start the fire pump and then close the churn valve.

Relief Valves—Figure "8" in all illustrations, acts very much in the same manner as the safety valve on a steam engine, its purpose being to maintain any desired uniform pressure of water discharge into the hose lines. In some ways, its action is somewhat similar to that of the previously mentioned churn valve by-pass; its action, however, is automatic. Should the pump suddenly start delivering water a greater pressure than arranged for by the setting of the relief valve, as is the case when hose lines are shut off at the nozzle, the latter automatically opens a by-pass through which the excess volume of water is passed back to the suction chamber of the pump.

By means of an adjusting nut and a registering scale on the device, the valve may be accurately set to operate automatically at any desired pressure.

It is important that the operator become thoroughly familiar with the

details of the relief valve, in order to better understand and control its action. **Construction of the Relief Valve**—The relief valve is connected to the discharge chamber of the pump. Chamber "D" is connected to the pilot valve by the small passage marked by the arrow. The pilot valve which is referred to by the arrow "N" is controlled by the spring shown in the drawing; this acts on the same principle as that of a safety valve. When the pilot valve is set at any pressure, for example, 120 pounds, and the pressure in the discharge chamber of the pump exceeds 120 pounds, the valve "N" raises. With the lifting of the valve, the water from discharge chamber by-passes as shown by the arrows into chamber "D." The pressure then pushes down the valve "H," and the water from discharge chamber then flows directly into the chamber marked "E" as shown by the curved arrow.



RELIEF VALVE

From chamber "E" the water passes down the return pipe to the suction chamber of the pump. The valve "R" acts as a drain from pilot valve and chamber "D." All the time the relief valve is open, a steady stream will be emitted from the valve "R." Immediately the nozzle is open, and the pressure in discharge chamber goes below the pressure at which the relief valve is set, which we are assuming is 120 pounds, the pilot valve "N" closes, the spring in question taking care of this. The pressure in chamber "D" and pilot valve is then relieved through the cock "R," after which valve "H" is closed through the action of the spring beneath it and the pump resumes pumping. All movements as explained above take place in less than a second.

Screw "K" limits the opening of the valve "H" so that when only one or two lines are being used, just enough water can be by-passed to maintain an even pressure on the gauge. (See page 154.)

Before you try out the relief valve we would recommend that you remove the small hex. head cap over chamber "D," and push the plunger down. The plunger barrel should be wiped out clean, and very light lubricating oil applied to the plunger. Place the thumb on the top of the plunger, and work it alternately up and down until it snaps easily into place. Unless it returns by itself, the relief valve will not operate properly. The only thing which causes it to be stiff is lack of lubrication. The bottom section of this plunger also passes through a leather gasket which is shown by the dark square near its base, "F," directly under the spring. By pushing the relief valve down as far as it will go, the lower part of this plunger is exposed and can be lubricated. This will remove a lot of stiffness. **This plunger should be wiped clean, and lubricated after every pump operation.** It is not asking very much of the operators, as the pump operations are not very many in ratio to the runs the apparatus makes. It is not necessary for us to advise a man in your position of the necessity of lubrication, as we are convinced that you realize this necessity very clearly. Quite often when the pump is not used for several weeks, the packing on Valve "H" becomes dry and causes valve to become very stiff. To avoid this, the cap which forms top of chamber "D" should be removed at least once every two weeks and valve worked up and down until it is perfectly free.

Type 39 Relief Valve—(See illustration, page 149.) On type 39 rotary gear pump, where the relief valve is incorporated with the churn valve, the method of operation is practically the same as above. The pilot valve and its setting is similar and it is connected with the main relief valve by the tube "A." The screw "K" in the center of the churn valve performs the same functions as the screw "K" in the above description. The valve "R" on our standard relief valve is replaced by a small tee and drain valve (not shown) at the bottom of the main relief valve.

Pump Gauges—Pressure and vacuum gauges are attached to all pumps. On the gear type, the pressure gauge appears on the right, forward side and is connected to the cock "P" (illustration, page 150). Gauge cocks should always be closed down to a point just sufficient to give an easy, steady reading at the gauge, without needle vibration.

On the piston pump, illustration page 158, figure "P" indicates the pressure gauge connection, while "V" is that of the vacuum gauge.

Swift Lubricator—This is indicated on illustrations, pages 149 and 150, by the figure "6." When starting the pump, the vacuum necessary to draft the water may be further increased by operating the handle of this lubricator a few strokes.

After pumping operations are completed the pump should be turned slowly until thoroughly drained, then oil the gears by means of the lubricator, a matter of about a dozen strokes.

The lubricator should be kept filled with 600W oil.

Pump Lubrication—On all standard types of gear pumps, see illustration, page 150, the large plug marked "G" permits the introduction of lubricant into the pump transmission gear case.

A mixture of ⅓ No. 677 graphite mixed with ⅔ "Keystone" grease should be added from time to time as necessary.

In front of the pump, marked "O," will be found two plugs in each gear shaft bearing cap; at least twice each year, these plugs should be removed

and by means of a "gun," grease should be forced into the upper hole until it runs out of the lower. Be sure and replace the plugs.

See further instructions on page 157 regarding bearings.

The lubrication of type 39 gear pump, illustration, page 149, is slightly different from that of the standard type. In this design, the pump transmission gears are located in the lower portion of the large pump casing.

The filler plug is marked "O" and in the front portion of the case are two pet-cocks which indicate the high and low level of the oil supply. These cocks should be opened at least once a week; if no oil flows, fill at once with the same oil as used for the motor. When the proper level is reached, be sure and close both pet-cocks.

Every six months at least, the gear compartment should be drained and fresh oil added; about two gallons will be required. Do not use grease.

In the Piston type of pump, see illustration, page 158, the pump transmission is directly under the driver's seat. Two pipe plugs marked "O" are for filling purposes, while two pet-cocks on the front, right side, indicate high and low level. Use 600W oil.

Inspection of the oil level cocks should be made at least once a week, while the case should be drained every six months or oftener and refilled with fresh oil.

Gear Shift Lock—(See illustration, page 150.) The hinged locking plate marked "L" is used to securely hold the gear shift lever of the road transmission in the "neutral" position while the pump is being used. After placing the machine, see that this shifter lever is in the neutral slot and then throw over the locking plate.

Gear Shift Lever—(See illustrations, pages 149 and 150.) This is indicated by the figure "1." On the standard and type 39 pump, the gear shift lever, located on the right side of the car frame, operates two sets of pump transmission gears in addition to the clutch.

The quadrant through which the shifter lever operates is cut with three notches, one each for high speed labeled "Capacity, neutral," and low speed or "Pressure."

Raising the lever upward disengages the motor clutch; it may then be pushed forward or backward till opposite the desired slot indicating Capacity or Pressure and when pressed down into such slot, the gears are engaged as well as the motor clutch in the one movement.

The "Junior" type of smaller capacity gear pump differs from the others inasmuch as there is but one speed, which is operated by a vertical lever placed at the right-hand side of the car at a point between the pump and pump transmission. This lever has an automatic lock on the quadrant which locks the pump gear in mesh or in neutral as the case may be. In starting this pump it is necessary to release the clutch by the foot pedal in the usual way and at the same time engage the gears by a forward movement of the lever.

Gear Shift of Piston Pump (see illustration, page 158) is indicated by figures "1" and "2." In this type there are two shifter levers, each controlling a set of two pump cylinders.

To operate either set of two pump cylinders, first lift either of the gear control levers the height of its slot; this movement disengages the clutch. Next move the lever horizontally to the front or back, according to the slot; this engages the gears, while the lowering of the lever in its quadrant engages the clutch and starts the pump.

The upper lever (No. 1) is in neutral position when it rests in the rear slot. To engage these gears, the shifter lever must be moved forward. The lower lever (No. 2) is in neutral when in the forward section of the quadrant and the gear is engaged when the lever is moved to the rear. According to requirements, either two or all four cylinders may be operated at one time. This combination of control gives great pump flexibility and simplifies operation.

DIRECTIONS FOR OPERATING GEAR TYPE OF PUMPS

Upon arriving at the scene of action, particularly if the suction is to be connected to a hydrant, it is well to place the pumping car slightly ahead so that if necessary, another machine may be drawn up in the rear and connected to the same hydrant. In cities where the water pressure and hydrant design permit of three engines taking from the same source, sufficient space should be left between the first and second machines for the suction of a third passing between them.

When the pumping car has been properly located, apply the emergency brake and see that it is securely locked. Next make sure the gear shift lever of the road transmission is in the neutral position and then throw over into place the locking plate marked "L" in the illustration, so that this lever can not be shifted while the pump is in operation.

Next close or make sure the pump drain cocks are closed; these are controlled by the lever "7" on the right side of the frame. When the lever is in a horizontal position, the cocks are open; turning down to a vertical position closes the cocks.

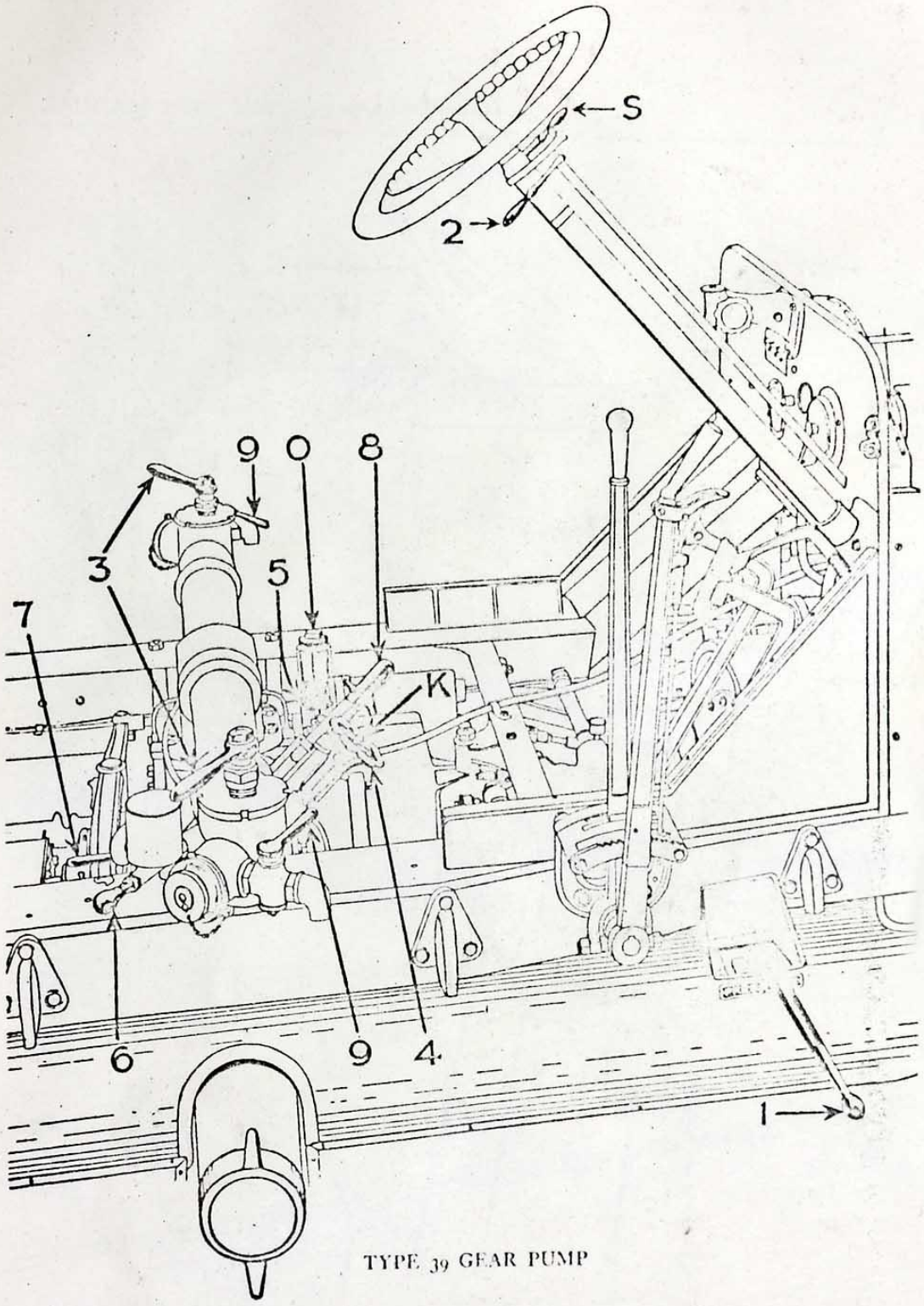
Connecting Suction—Should the water supply be represented by a stream, creek or basin, it is important that the suction strainer be attached to the end of the suction in order to prevent foreign matter from entering the pump. The end of the suction should be covered by sufficient water to prevent the formation of a whirlpool while pumping, which will permit of a certain amount of air entering the suction and pump; this is an important detail and should never be overlooked.

STONES CAUGHT BY INSIDE STRAINER

Neither should the end of the suction be placed on a muddy or sandy bottom as great quantities of dirt will pass through the pump and cooling system of the motor, causing wear in the former and seriously clogging the latter. For this reason, fire departments should never pump out basements or sewers; sewer pumps are built for such purposes and should exclusively be used for such work.

Having placed the strainer in the suction end, make sure that the rubber gaskets are properly inserted in the couplings and that the latter are tight throughout the entire length of the suction from pump to hydrant or source of draft. This is important, as any air leak in this connection will seriously interfere with the securing of water. See that the intake cap on the opposite side of the pump from that of the suction connection is fitted with proper gasket and is screwed on tight.

Hose Layout—Having connected up the suction and guarded against any and all possible air leaks, next attach hose to such discharge gates as are



TYPE 39 GEAR PUMP

to be used. In planning the hose layout and nozzle sizes, the tables on pages 164, 165 166 and 167 will be of great value to the operator.

Close all discharge gates (figure 3) to which hose is not attached and open those which are connected with lines.

toward either the rear or front of the car shifts the pump gear into mesh. Lowering the lever engages the clutch, and starts the pump.

The pressure and capacity gear ratios are designed to take care of the condition implied by their designations. Where it is found necessary to carry a high pump pressure, for example, over 150 pounds, the "pressure" ratio or speed should of course be used. If quantity of water is desired, the capacity ratio should be used; such a condition would call for three or four short hose lines, or short lines with large nozzles. To produce quantity at the nozzle of a long line of hose, it is necessary to establish a high pump pressure in order to overcome the loss by friction in the hose; to accomplish this the pressure ratio should be used.

It is impossible to lay down any hard and fast set of rules governing the use of gear ratios in pumping water, and it is of particular importance at the time of the delivery of pumping cars, to pay particular attention to the Delivery Engineer's instructions.

After an operator has acquired sufficient driving experience to instinctively know when to shift gears in driving, this knowledge will materially assist in the selection of proper gear ratios when pumping. For instance--

Pressure—While ascending a hill the motor will slow down and begin to labor (if the hill is steep enough); under such conditions, naturally you would slip into a lower gear. This allows the motor to speed up and carry the load while the speed of the apparatus remains the same or even possibly increases; the same holds true in pumping. Should you, by mistake, have misjudged the layout of hose and nozzles and started to pump in "capacity," the motor would immediately commence to labor and pound then you tried to increase the pump pressure. This is your cue to slow down and put the pump into the "pressure" gear ratio, just as you dropped into a lower gear in climbing the hill.

Capacity—In answering an alarm, suppose you had started in first speed as you should, and then gone into second but had forgotten to go into high or direct drive,—your motor would be racing, but the apparatus would not attain much speed until the gears were shifted into high. The same applies to pumping.

Should a mistake be made in judging the layout of hose and nozzles,—a short layout and large nozzles or two or three lines and "Pressure" gears engaged, the motor would race without producing any degree of pump pressure. Under such conditions the obvious thing to do is to shift to **Capacity** gear.

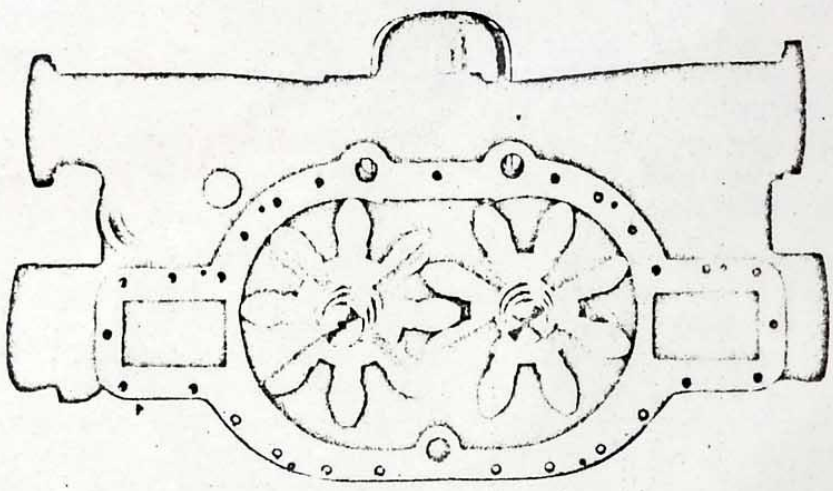
Pump gear shifting is accomplished by lifting lever (No. 1) and moving into either the "Capacity" or "Pressure" side of gate as required, lower lever slowly at the same time opening throttle (No. 2) slightly as the motor picks up the load of the pump.

Next open discharge gates (No. 3) to which hose lines are attached.

Close churn valve (No. 4) and make sure that screw "K" in center of churn valve is turned to the right as far as it will go. Speed up the motor slightly and water should then be obtained in a few seconds.

Churn Valve—The churn valve (No. 4) is located at the right hand or operating side of the pump. This valve controls the by-pass which connects the discharge chamber with that of the suction. With this valve open and the pump in operation with the discharge gates closed, the water passes from

the discharge chamber to the suction chamber. In this way a continual circulation or churning of the water is established. By opening the discharge gates to allow the emission of the water, and by closing the churn valve, the by-pass is closed and the water must then leave the pump by the regular channels.



TYPE 12 ROTARY GEAR PUMP

In order to create a vacuum to lift water, it is necessary to close the churn valve. The air in the pump will then be discharged, causing a vacuum. Atmospheric pressure then causes the water to flow into the pump suction chamber whereupon it is immediately carried by the gears through the regular channels into the discharge chamber, from which point it is forced through the discharge gates into the hose.

The fire pump will not discharge water at an increased pressure with the churn valve open; this is due to the circulation described in the above paragraph. When operating off a fire plug, the plug pressure will force the water through the pump and so out into the fire hose. If the churn valve is left open, however, the running of the pump will not increase the pressure at all.

The instructions for operation of the churn valve can be easily followed. We will first assume that the pump is being operated at suction from a cistern or some other body of water. The proper position for the churn valve while the pump stands in the station is wide open. When ready to commence pumping the fire pump should be placed in gear, the discharge gates opened to which the hose has been attached **and then the churn valve closed.** The pump now exhausts the air in the intake side of the pump and suction; atmospheric pressure immediately forces the water up to the pump and pumping operations commence.

To pick up water, the pump should not be run fast, as an ordinary speed is sufficient. In fact, the ordinary motor idling speed should produce water in a matter of seconds. When water is secured, it is only necessary to operate the throttle to control your pressure. **Do not open the churn valve while the throttle is open.** This causes the motor to race badly and is dangerous. If it is necessary to shut down quickly, close the throttle and then open the churn valve. With the closing of the throttle, the pressure drops at once and the opening of the churn valve is necessary before the discharge gates are shut. **This action makes it unnecessary to disengage the fire pump**

gears each time a shut down of a minute or two is desired; the pump simply continues to turn over slowly while the water circulates through the by-pass. When the order is received to again start pumping, simply open the discharge gates and close the churn valve. This is an operation of seconds and far easier than operating the gear shift.

In operating off a fire plug, it is not necessary to draft the water. The water is delivered to the fire pump, which "steps up" the fire main pressure to such as may be desired. We will suppose that on reaching a fire, it is undecided whether the fire pump will be necessary or not (assuming that the plug pressure is 60 pounds or over). However, it is considered safer to lay a line of hose ready for immediate use; the fire pump is attached and, if only a plug pressure is necessary, the churn valve is opened and the water passes in from the plug through the suction up the churn valve by-pass and so into the pump discharge chamber and out through the fire hose.

The churn valve has a right hand thread. When you screw it to the right you close it and when screwed to the left it opens.

Having thoroughly covered the operation of the churn valve, we now return to describing the general control of the pump. When clutch engages open discharge gates (No. 3) to which hose lines are attached, close churn valve (No. 4) and advance throttle (No. 2) slowly. It is not necessary to run pump at high speed to pick up water; if it does not, consult the vacuum gauge. If this does not show a vacuum, check up the suction, etc., for leaks. If the suction is all right, the vacuum can be increased by operating the swift lubricator (No. 6) a few strokes which should have the desired effect. If after doing so, it is still impossible to obtain water, your pump drain cock (No. 7) may be open or you have an air leak in your suction.

Let it be noted that a "dry" pump does not pick the water up as readily as a "wet" pump. It should not be necessary, however, to "prime" (placing water in suction chamber before attaching suction) the pump; one that will not draft water under ordinary conditions is probably in need of repairs.

There are three things which primarily will prevent proper lifting or drafting of water.

First: Churn valve No. 4 not closed. You cannot pump water with churn valve open. **Close it.**

Second: Relief valve No. 8 stuck open. **Remedy**—see that relief valve is kept properly lubricated as instructed on page 146. Close relief valve by screwing up screw "K," page 150.

Third: Improper suction conditions, as follows: Pump drain cock (No. 7) open. Poor gaskets or no gaskets at all in suction hose. Cap on opposite side of suction not on tight or no gasket in cap. Broken or cracked suction couplings. End of suction hose not covered with sufficient water, consequently drawing air by formation of whirlpool.

After water is obtained, the desired pressure is regulated by the motor hand throttle (No. 2.) It is not considered good practice to be continually closing and opening throttle while pumping. Set your throttle at the position which gives the pressure desired on the pump. The spark control "S" should be advanced as far as possible, consistent with the operation of the motor. The same rules apply as to road work outlined on page 128. Fluctuation, if any, of the pump pressure gauge will be small, a matter of four or five pounds at the outside. Any great fluctuation would naturally point to some outside circumstance, viz., minor motor trouble or obstruction of the

suction or fire hose. Keep the pipe line to gauge throttled or partly shut off to prevent fluctuation; have just enough opening to move the gauge needle.

COOLING OF MOTOR

After water is obtained, open the auxiliary cooling valve (No. 5,) a turn or so, if at ordinary pressure, keeping close watch on the water jacket covers and radiator. Place the hand on these from time to time to judge temperature of the motor, although the apparatus may be equipped with a motometer it is advisable to check up on this for accuracy and safety. If the temperature is a little high, give the feed valve a half turn and observe motor for results. The same holds true if the temperature is too low,—close valve half turn or so and check up result. The idea is that an even temperature produces a smooth running motor. If you find that the motor is too warm and suddenly open the valve two or three turns, the motor will soon be too cool and the reverse operation will have to take place. It can be readily seen that there is no end to this opening and closing, heating up and cooling down. With a little care the temperature can be brought down to an even basis, viz., just so the hand can be placed with comfort and not be burnt by the water jacket cover. When the fire pump is being operated at high pressure, great care should be exercised in opening this valve. High pressure will cause a great deal more water to pass through a pipe of given diameter than a lower pressure would. Therefore, it would be possible to damage the radiator were the operator to suddenly open this valve under high pressure. It is quite often possible to have the motor at the desirable temperature with less than a turn of opening. However, a definite rule cannot be laid down for this phase. The operator must use good judgment and exercise care in these matters. **Upon closing down pump, this valve should be immediately closed to prevent water loss from cooling system.**

Relief Valve—When the pump is started up, care should be exercised that the pump pressure does not exceed that at which the relief valve, (No. 8) is set. If it is desired to exceed this momentarily, the operator can do so by closing screw "K" and valve "R." This places or locks the relief valve in an inactive position. If a shut-off nozzle is being used, however, the relief valve should at once be set to coincide with the pressure being carried at the pump. In other words, if the pump pressure is 120 pounds, set the relief valve adjusting screw "B" so that the figures on slide "C" are even with the top of the small plate which holds the slide in place; open screw "K" as in instructions on page 139. If pump pressure exceeds that of relief valve without this being locked shut, this will, of course, allow a churning condition which will impair the proper efficiency of the fire pump, and likely cause difficulty in reaching a higher pressure than that at which the relief valve is set. Any change of pump pressure during time pump is in operation should, of course, be covered by change in relief valve setting where relief valve is in operation owing to shut-off nozzle being used.

The following are the simple rules of operation covering this relief valve: First, the relief valve must be set at the pressure at which the pump is operated. If the pump is operated at 120 pounds ,screw the valve "B" up or down until the scale on the slide "C" just shows 120 pounds, above the small cross bar, which is held on by two screws. Under each figure on the slide you will note a line is cut. This line should be level with the top of the cross bar. The valve "R" can be partially closed. **This should not be fully closed.** The relief valve will open with the valve "R" closed, but when the nozzle

is turned on it will remain open, as the chambers "D" and "T" cannot relieve themselves. If the relief valve acts stiff at any time and the pressure starts to mount dangerously on the pump gauge, close valve "R"; this will force it to relieve. When the nozzle was opened this valve would have to be opened too, in order that the valve "H" might rise into place again.

The next adjustment is the screw "K." This controls the travel of the valve "H." When setting the relief valve, shut the screw "K" by turning to the right, then back off about 3½ full turns. This should give sufficient opening for handling one or even two lines of hose.

In a few words we have set the valve "B" at 120 pounds, the valve "R" has been partially closed, the screw "K" has been set at 3½ full turns of opening.

Under no circumstances touch the motor throttle when the relief valve is in operation, as this only tends to increase your pressure or decrease it as the case may be. If the relief valve is set properly it will not be necessary for the operator to touch any of the adjustments on the motor. When the water is shut off at the nozzle observe the pump pressure gauge. If the pressure mounts and stays at 140 for instance, the screw "K" should be opened a little farther to allow the valve "H" to drop down, thus relieving the pressure.

The relief valve when set properly will not cause any great rise in pressure on the pump gauge. A rise, if any, will only be momentary, and the pressure should stand at whatever point the valve is set.

The other alternative to a rise in pressure on the pump gauge is a drop in pressure. This drop can easily be noticed, as the relief valve will alternately open and shut, causing the hose lines to jump, and the whole pump to throb. This is a sign that the screw "K" is open too far. It should be closed down carefully until this throbbing stops, and the pressure on the pump gauge registers the same as the setting of the relief valve.

When operating on two or three lines of hose all of which have shut-off nozzles, it will probably be necessary to open valve "K" farther when all lines are shut off. The reason for this is that more valve opening is needed for the increased capacity which will be pumped through three lines of hose.

Should the valve pound or throb and the hose jump when nozzles are shut off, it is an indication that the screw "K" or valve "R" is open too far; close it by turning to the right until the action is steady and even.

Should the pressure on the gauge rise and the motor seem to slow down when the nozzles are shut off, it indicates that the screw "K" is not open far enough; turn it to the left until the pump pressure comes down to that prevailing before nozzles were shut off.

When the nozzles are again opened the relief valve will close and the pumping operation is resumed.

TYPE 39 PUMP

Relief Valve, Type 39—The principle of operation in this relief valve is practically the same as described on page 150. The pilot valve and its setting is exactly the same, and it is connected to the main relief valve by the tube "A." The screw "K" in the center of the churn valve performs the same function as the screw "K" described on page 150. The main relief valve is constructed slightly different from our others and requires no attention as to lubrication **excepting occasionally around the stem of the valve.** The valve "R" on our standard relief valve is replaced by a small

tee and drain valve (not shown) at the bottom of the main relief valve and requires no attention.

Operation—Having obtained the required pressure while pumping, we will say 120 pounds, set the pilot valve until the scale reads 120 above the cross bar, now open the screw "K" two or three turns so that when the nozzles are shut off the pressure on the gauge will remain constant.

In shutting down pump, retard motor throttle, open churn valve. If complete shut down, place shifting lever in neutral position. If temporary shut down, leave in gear; in this way, water is held in pump and to start pumping again it is only necessary to close churn valve.

Make it a habit to close the pump drain cock, No. 7, when you return to the house. Also be sure cooling valve, No. 5, is closed as soon as you stop pumping.

Maintenance—When you have finished a pumping operation, open the drain cock (No. 7) in the base of the pump and allow water to completely drain out of pump. After this is done, allow pump to turn over slowly and operate the swift lubricator (No. 6) a few times and pump is then ready for next operation.

Check oil level in pump transmission and fill with motor oil up to level locks if necessary.

Caution—Always keep gauge lines throttled or partly shut so that the shutting off of hose lines will not ruin the gauge. Leave just enough opening in the gauge line to make the gauge register.

There are several small drain holes in the bottom of this pump which should never be stopped up as they are intended as a safety feature to prevent water entering the pump transmission.

When pumping from hydrants with pressure ranging from 40 pounds upwards, the pump gears will sometimes rattle or make a noise. This is due to the fact that the water pressure from the hydrant is trying to turn the pump gears faster than the motor is turning them. As soon as the churn valve is closed and the pump speeded up so that the pump is boosting the hydrant pressure, this noise will disappear.

When drafting water and the suction strainer becomes clogged, to some extent by foreign matter, it will also have a tendency to cause the pump to run away from water, as it can not secure a sufficient supply.

Once every four months remove the plugs "O" from the pump gear shaft bearing caps and inject grease into the one hole until it comes out of the other, thus indicating that the bearing and cap is filled with grease.

If you desire to remove bearing cap for the purpose of inspecting bearing and refilling with grease always remove and replace **one cap at a time.**

Never remove more than one cap at one time; to do so may result in disturbing the clearance between pump gears and housing. Be sure and replace cap carefully in original position and lock it securely before removing another cap.