INSTRUCTIONS

FOR THE CARE OF

DELCO

Ignition Systems

The

Dayton Engineering Laboratories Co.

Dayton, Ohio

Delco Ignition Systems

The Delco System in its simplest form consists of a storage battery or some other source of direct current, an interrupter or breaker, with its condenser, and a transforming device such as an ignition coil. The details of the systems applied to the different cars vary somewhat, so that certain systems provide for dual ignitions, while others do not.

The systems manufactured in 1912, 1913 and 1914 provide for dual ignition, using the current from the storage battery or generator and also from a separate system of dry cells, although the same breaker was used for both types of ignition on the later 1914 cars. The general features of these systems can be readily noted by reference to the circuit diagrams showing their connections in Figs. I to 5 inclusive. It might also be stated here that in regard to the source of supply of the direct current, when the speed of the gasoline motor is sufficiently great to permit the generator to charge the storage battery, a part of the current for ignition purposes is supplied by the generator. In other words, if the generator is producing, say one ampere and the ignition takes an ampere and a half, one ampere would be supplied by the generator and one-half ampere by the storage battery. On the other hand, if the generator were charging at a rate of five amperes and the ignition required one and one-half ampere, and the ignition
load was the only load on the system, the generator would supply one and one-half amperes for the ignition and three and one-half amperes to charge the storage battery. This should make clear the question of the source of supply, when running on what is known as the "mag" ignition.

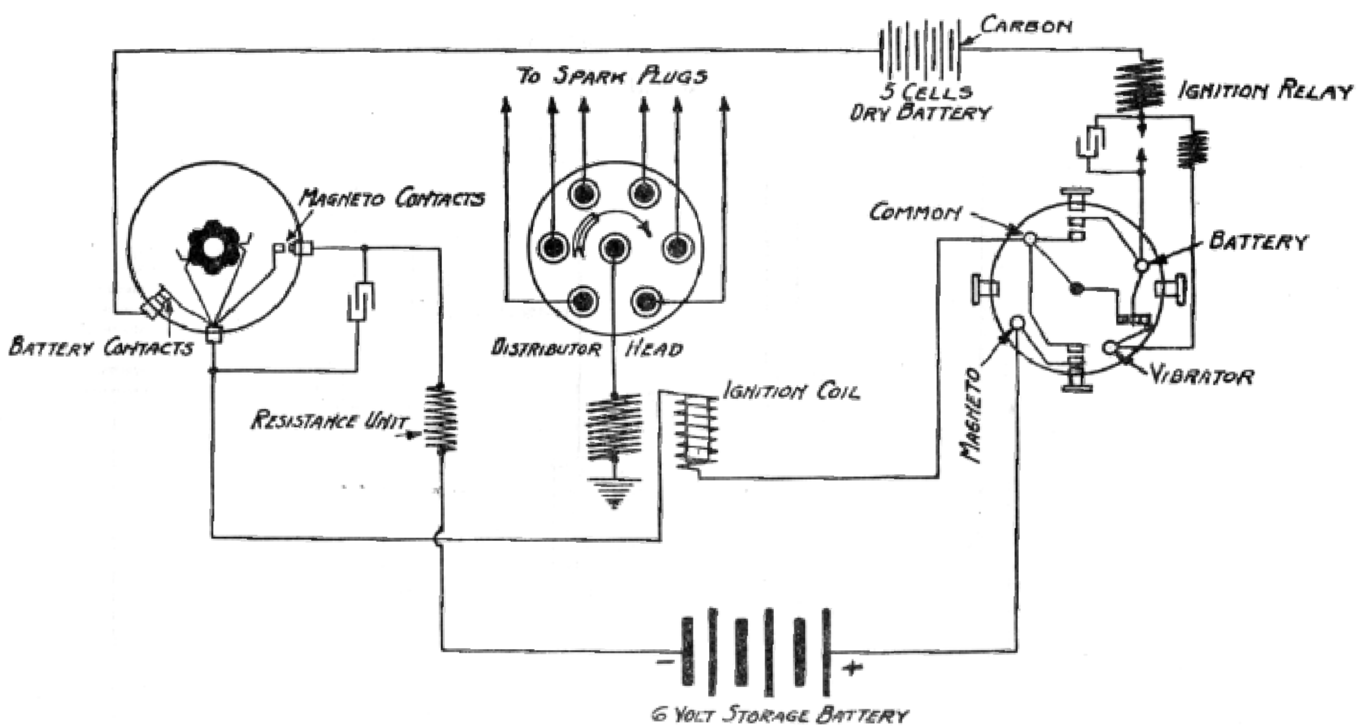


Fig. 1
Circuit diagram of typical system used in 1913.

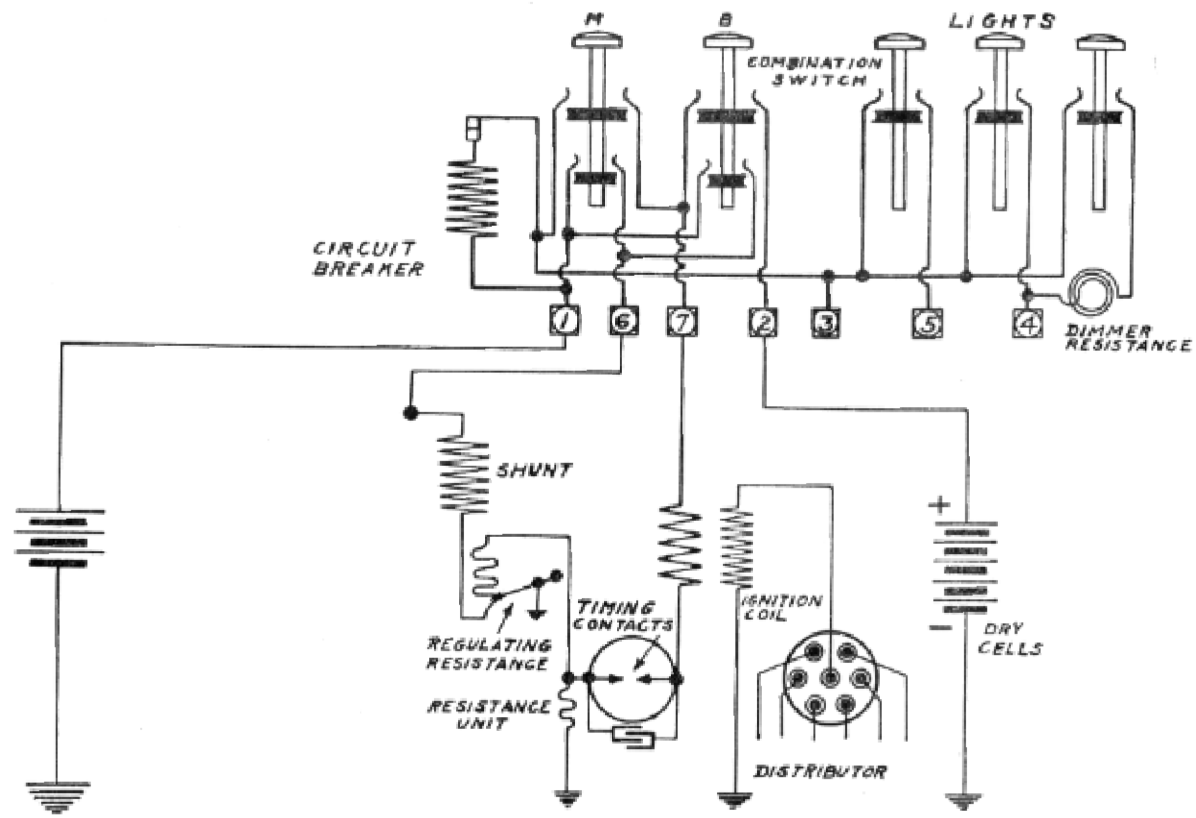


Fig. 4
Circuit diagram of typical 1915 system.

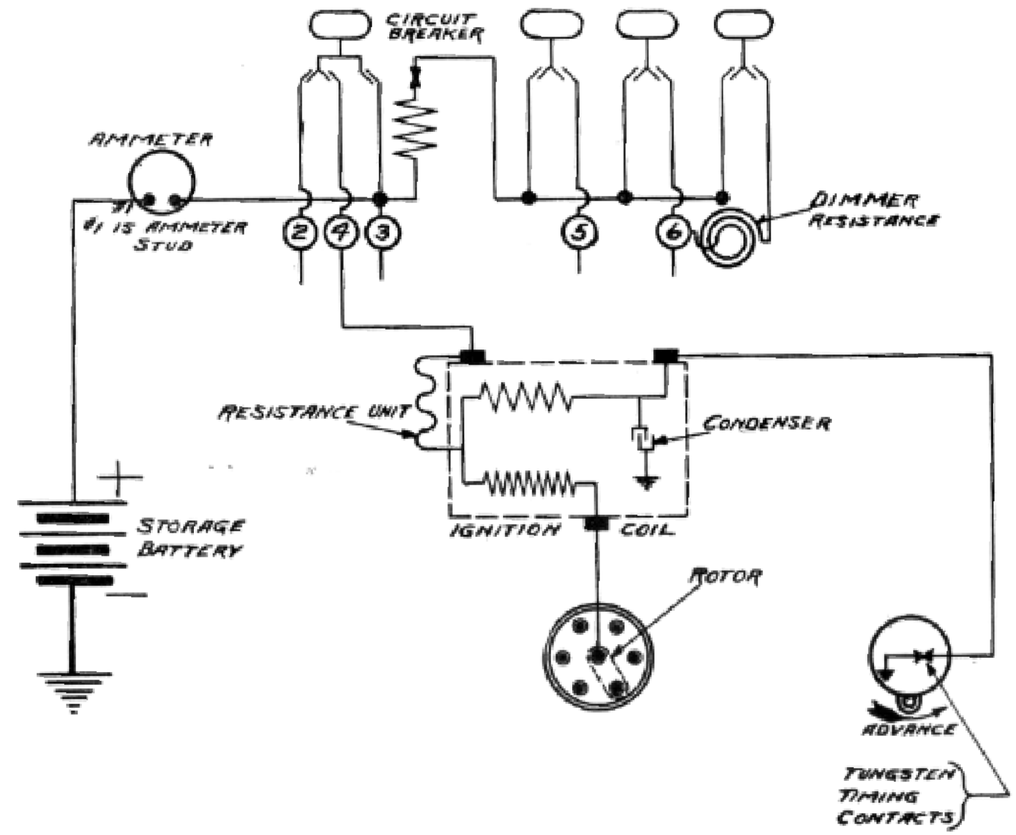


Fig. 5

Circuit diagram of typical 1916 system.

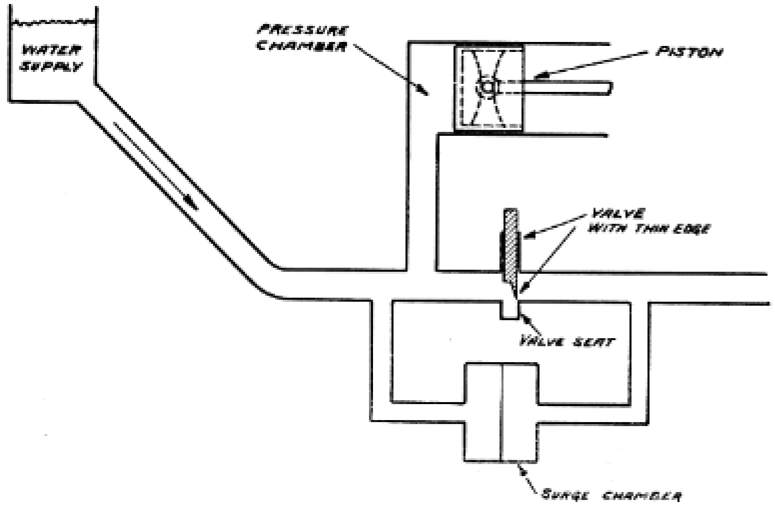


Fig. 6

A hydraulic analogy may be of assistance -in understanding the operation of the ignition system. The electric current in the ignition system may be represented by water flowing in a pipe (see Fig. 6). A certain amount of frictional resistance is encountered by the water in the pipe and this may be compared to the electrical resistance in the ignition circuit. The rate of flow of water in the pipe corresponds to the current in the coil and the inertia of the water to the inductance in the primary of the ignition coil. Now, continuing the comparison still further, if the flow of the water be suddenly stopped, there will be an enormous increase in pressure, due to the inertia of the water. This effect, known as "water hammer," has been noticed by everyone on suddenly shutting off the water flow in an ordinary water supply pipe. Now, if the current in the primary of the ignition circuit be interrupted suddenly, as it is by the timer contacts, there is a great increase in pressure or voltage, due to the inductance in the coil. Some device must be applied in the water system to shut off the water and a valve can be used for this purpose, the valve thus corresponding to the timer contacts which interrupt the current in the primary of the induction coil.

There is one peculiar characteristic of timer contacts which needs some attention at this point. They have a tendency, unless protected in some manner, to burn at the moment of separation, due to the are that is produced at this time. This failing on the part of the timer contacts would correspond in the hydraulic system to a valve with a very thin edge that would be liable to be bent over by the sudden rise in pressure before it is fully closed. In the case of both systems, therefore, it is necessary to arrange for some protection and a condenser is supplied for this purpose in the ignition system and a surge chamber in the case of the hydraulic system. The surge chamber consists of an enlarged chamber with an elastic diaphragm in the middle, connected as shown in Fig. 6 around the valve in the pipe. When the valve begins to close, this surge chamber relieves the pressure to some extent during the operation of closing the valve and so protects the thin edge of the valve from bending. After the valve is fully closed, there is, of course, no further danger of its being bent over. In the case of the electrical system, a condenser supplies a similar protection, reducing the voltage at the timer contacts at the moment of separation and keeping this voltage reduced until they are fully open, thus preventing Arcing at the contacts. After the contacts are fully separated, there is, of course, no danger of their burning.

In order to utilize the pressure produced by the closing of the valve, it is necessary to provide some transforming device, such as a pressure chamber. One is shown in Fig. 6 with a diameter much larger than that of the pipe. As the pressure in the chamber and pipe will both have some unit value (measured in pounds per square inch) the total pressure on the piston will be to the pressure in the pipe as the area of the piston is to, the area of the pipe. By the use of a pressure chamber of large

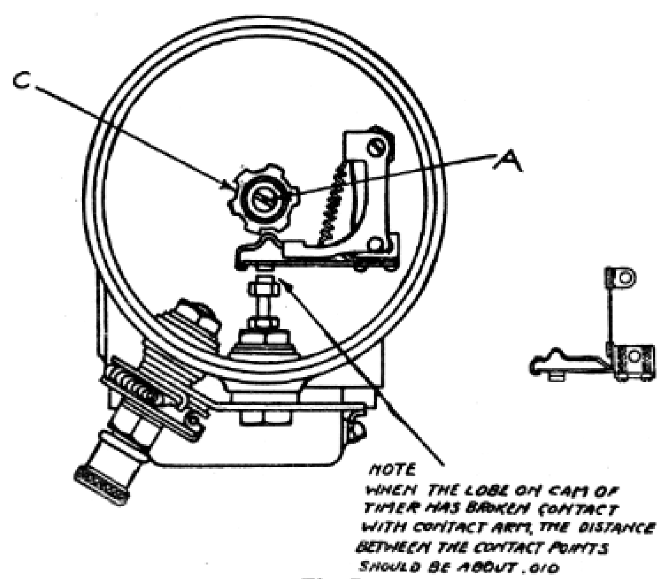


Fig. 7

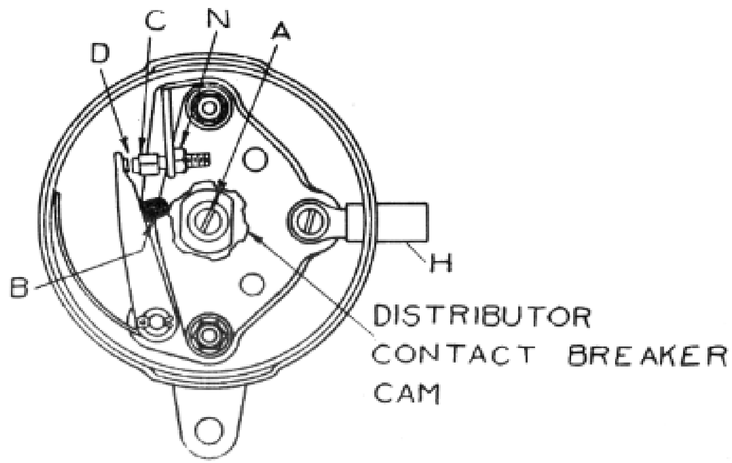


Fig. 8

diameter, compared to that of the pipe, a very considerable force is applied to the piston, but the distance it will travel is very slight. (In making this statement the weight of the piston will be disregarded). In the ignition system it is also necessary to provide some transforming device, and in the case of the Delco systems, it is a simple non-vibrating coil having a relative large number of turns in the secondary and a comparatively small number of turns in the primary. Just as in the hydraulic system, the increased area of the piston is responsible for increased total pressure on it, so the large number of turns on the coil gives a very high voltage at the secondary which is what is needed at the spark plugs. This high voltage is accompanied by a very small current, just as in the hydraulic system a' very high pressure on the piston, is accompanied by only a very slight movement of the piston.

The ignition systems, then, to repeat a statement made earlier, comprises a source of current, an interrupter or breaker, with its condenser and a transforming device, such as a non-vibrating ignition coil, the operation of which has been explained in the preceding paragraphs.

To distinguish the different types of breakers that have been used, they are illustrated in Figs. 7 and 8. The first was used up to and including 1915 and the second is typical of the 1916 production. The earlier type of breaker requires careful adjustment, not only for gap between contacts when broken, but also for pressure between the contacts when closed. When open the gap between the con-

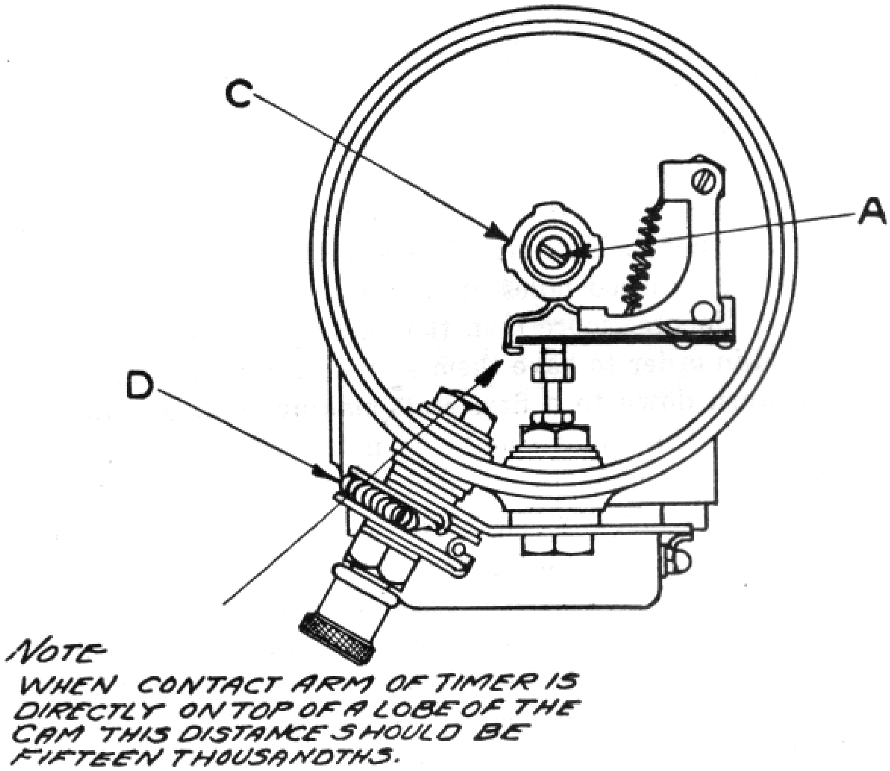


Fig. 9

tacts should be approximately .010" (inches) and when closed, the blade on which the contacts are mounted, should be about .015" (inches) from the outside clip. This is illustrated in Fig. 9. When making any adjustment on this type of breaker, particular attention should be paid to the little pig tail on the contact arm, as, if this is broken, it will cause arcing between the contact arm and the stud on which it moves, which will cause it to stick to the contact arm and which will also cause the spring which operates the contact arm to lose its temper, as well as the blade on the contact arm, It is quite surprising to note the effect of the loss of temper on the blade on which the contact is mounted, but where this occurs, the current in the primary of the induction coil may be reduced to 50 per cent. of its normal value and this will cause a very. serious missing at low speeds. (See Fig. 7).

The second type of breaker, illustrated in Fig. 8, requires only an adjustment at the gap when the contacts D and C are open. This should be set at approximately .018" (inches) and should never have a gap smaller than .010" (inches). The exact value of the gap recommended for any particular car, can be obtained from the manufacturers of the same or from the Service

Department of the Dayton Engineering Laboratories Company on request, and it is recommended that the instructions in the instruction books on this subject be followed explicitly when adjusting contacts. In the case of contacts on brand new cars, a slight wear will be noticed on the fibre stops on the contact arms during the first few hundred miles, the rate of wear accordingly decreasing after the cars have been run this distance, so that unless frequent adjustment is made of the contacts during the first one or two hundred miles of running, it will be necessary to set the gap .005" (inches) more than the value given above. This gap is recommended in order to have them at the proper opening when these stops have worn down to a firm seat, making total gap of 0.225" or .018" (inches). This point should be noted very closely. Owing to the pressure between the contacts and the construction of the breaker, which does not permit any wiping action between the contacts, it is impossible to keep an absolutely smooth and polished surface. A certain amount of pebbling on the surface of the contacts is therefore unavoidable, and to file or polish the contacts in an attempt to keep them bright, will simply use up the metal. It is recommended, therefore, that no attempt be made to keep them looking bright and clean, excepting to remove oil or serious corrosion, which may be caused by an excessive primary voltage applied to the ignition system. Another peculiarity of these contacts on the later type of breaker is that they are apt to show some slight discoloration. However, this will not affect the operation of the breaker in the least. Tests have been made with the idea of finding out just how much additional resistance can be inserted in the Delco system without affecting the ignition noticeably and these tests have shown conclusively that the effect of a slight discoloration of the contacts is to all intents and purposes not measurable with even very fine instruments.

There are five general types of Delco distributors in use, as considered from the standpoint of mechanical construction. The first, illustrated in Fig. 10, has no automatic advance and consists of a vertical distributor shaft, provided with ball bearings at each end, the inner race of these bearings being a cone so as to permit of adjustment and the taking up of end play. At the lower end of the distributor shaft a clamping nut and a lock nut are provided by which this play can be taken up and the shaft can be properly aligned. This permits compensations for a certain amount of wear on these bearings. A spiral s cut in the distributor shaft, and through this spiral slot a pin passes, which is fastened at each end to what is known as a manual advance ring. It is obvious that as the ring is raised or lowered, it will turn the distributor shaft either forward or backwards or. account of the spiral slot. The distributor shaft is driven

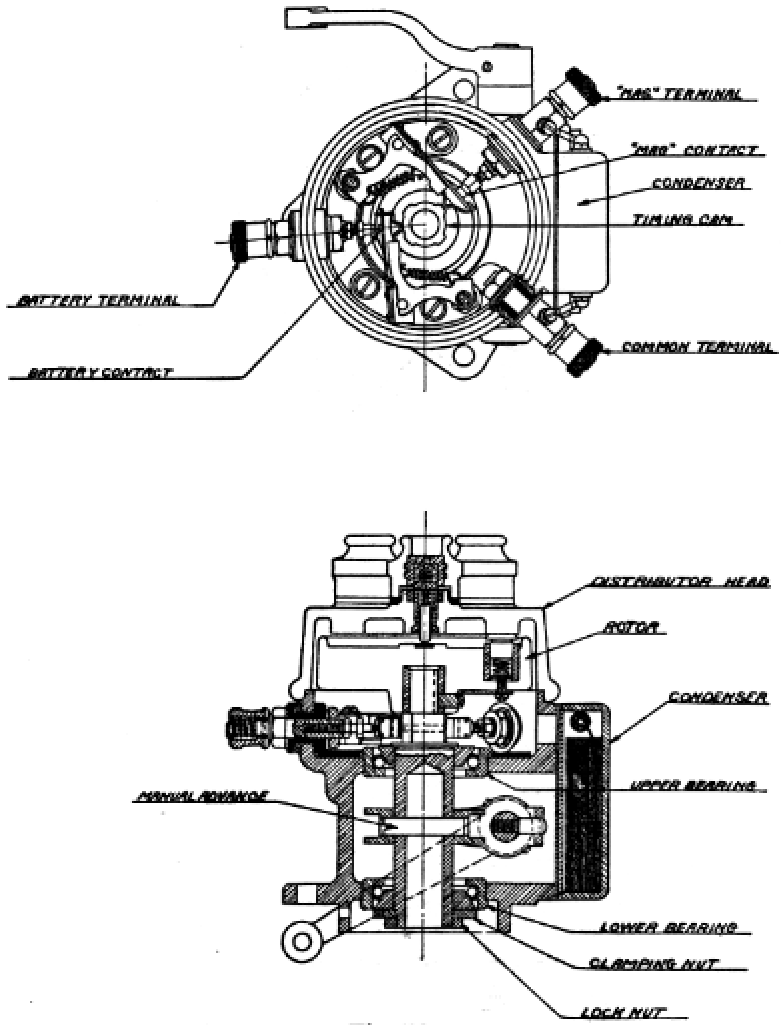


Fig. 10

slot. The distributor shaft is driven through the pin and, therefore, will revolve the angle of advance of the shaft and, consequently, the timing cam, in relation to the position of the pistons, can be changed by raising or lowering the manual advance ring. This is done by means of a yoke which is fastened to the distributor housing and which has two pins which slide in the ring. The yoke is attached by means of linkage to the spark lever, by which easy operation of the manual advance is obtained. This is the general type of distributor manufactured for 1912 and 1913 and requires, in order to change the timing, that the driving shaft be lifted out and set a tooth ahead or behind

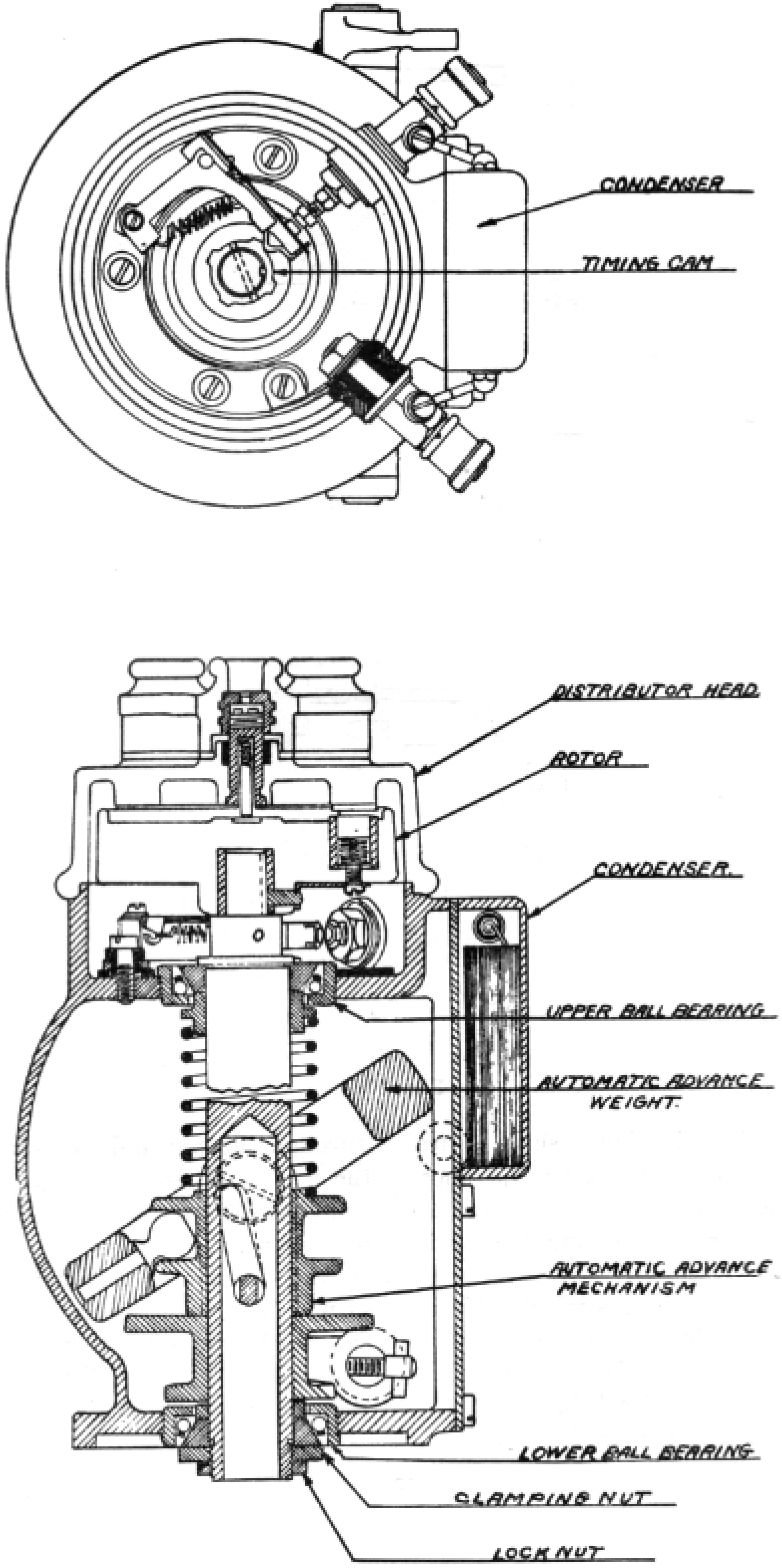

CONDENSER
TIMING CAM
DISTRIBUTOR HEAD
ROTOR
CONDENSER.
UPPER BALL BEARING
AUTOMATIC ADVANCE WEIGHT.
AUTOMATIC ADVANCE MECHANISM
LOWER BALL BEARING
CLAMPING NUT
LOCK NUT

Fig. 11

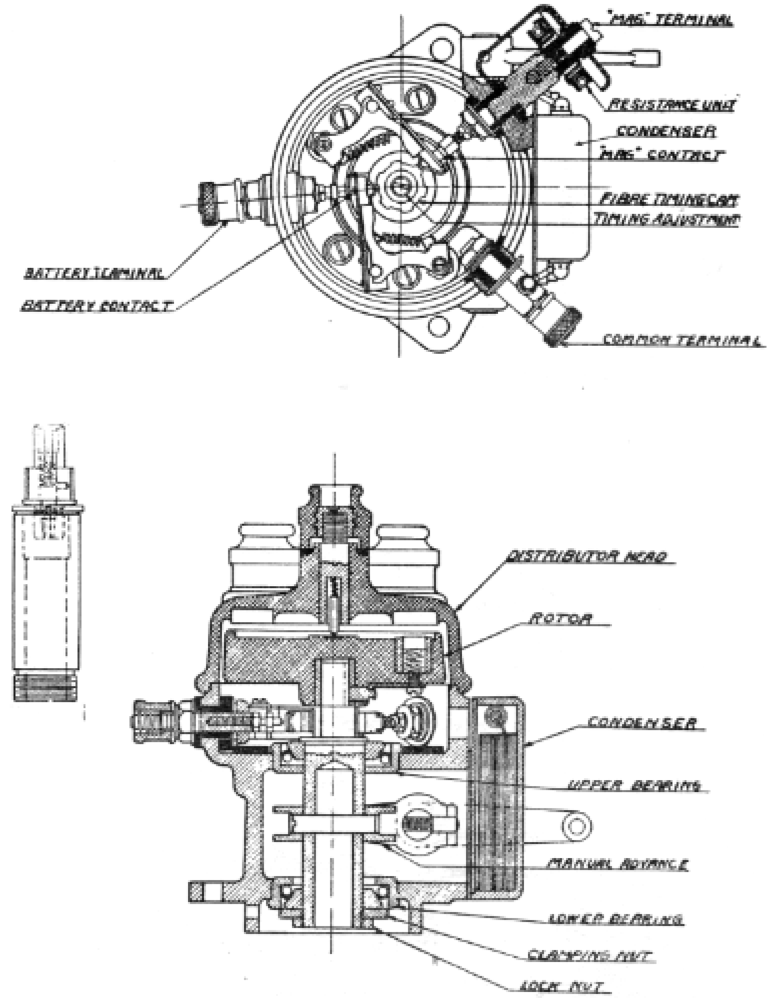
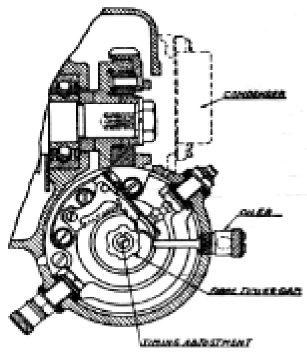


Fig. 12

as the fiber timer cam is attached rigidly to the distributor shaft by a steel pin, In similar types of distributors manufactured in 1914 and 1915, the cam is mounted on what is known as a cam adjustment assembly, which consists of a small shaft, slotted as shown in e figure, the four parts at the lower end being expanded by a screw running down the center. This fits in a cylindrical hole in the distributor shaft proper. By loosening the screw, it is possible to turn the fibre cam around and so time the motor without any change in the connection of the distributor shaft itself. (See Fig. 12).



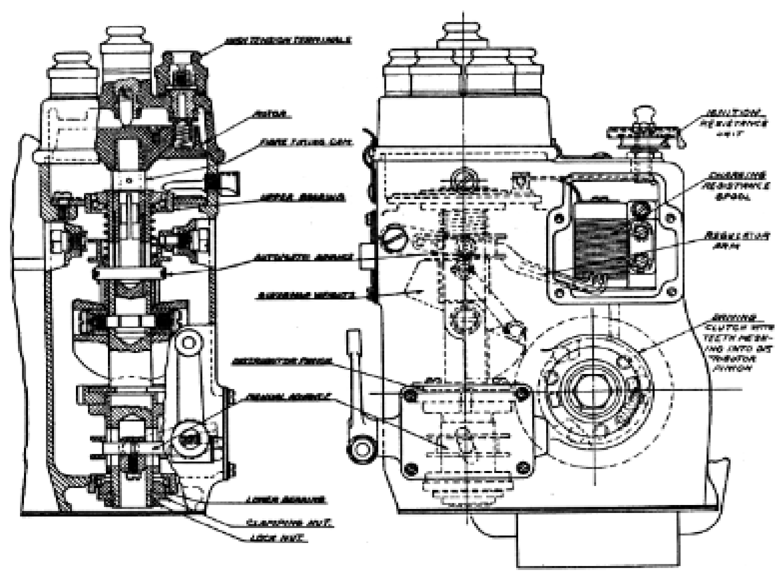
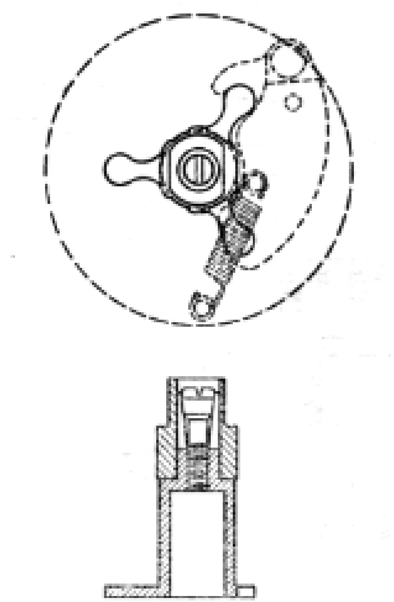


Fig. 13

The second type, which is very similar to the first, with the exception that is provided with an automatic advance, is illustrated in Fig. 11. This shows a section of the distributor and will make its construction plain. The weights operate on the advance ring and so by changing the position of the sleeve with regard to the distributor shaft proper in a manner very similar to the operation of the manual advance ring, they advance or retard the fibre timing cam according to the position of the automatic weights. The methods of timing with this type of distributor are about the same as in the preceding distributor, the ones manufactured in 1913 requiring that the distributor shaft be raised and the distributor pinion be set ahead one or more teeth to AM, change the timing, whereas those manufactured in 1914 and 1915 have an adjustable timing cam by which the timing is readily changed. (See Fig. 12).

The third type of distributor is very similar to the second, excepting that is mounted as an integral part of the motor generator and the -automatic advance in addition operates the regulator arm by which the resistance on the resistance spool is cut in and out of the shunt field current of the motor generator as the speed of the motor generator varies. This is illustrated in Fig 13. The construction and details are similar to those of the second type of breaker, the arrangements for manual advance being similar. The timing is accomplished by changing the adjustment of the timing cam assembly as in the preceding case.

The fourth type, manufactured in 1916, consists of a vertical at the top of which is a disc on which three weights are mounted. These weights are pivoted and held in by springs so that as the speed of the shaft increases they are thrown out by centrifugal force and tend to be held in place by the springs. The spider on which the timing cam is mounted, is advanced or retarded by the action of these weights, the construction of which is shown in Figs. 14 and 15. The bearing in which the



DETAIL OF CAM ADJUSTMENT ASSEMBLY SHOWING OPERATION OF CENTRIFUGAL FORCE GOVERNOR WEIGHTS

Fig. 14

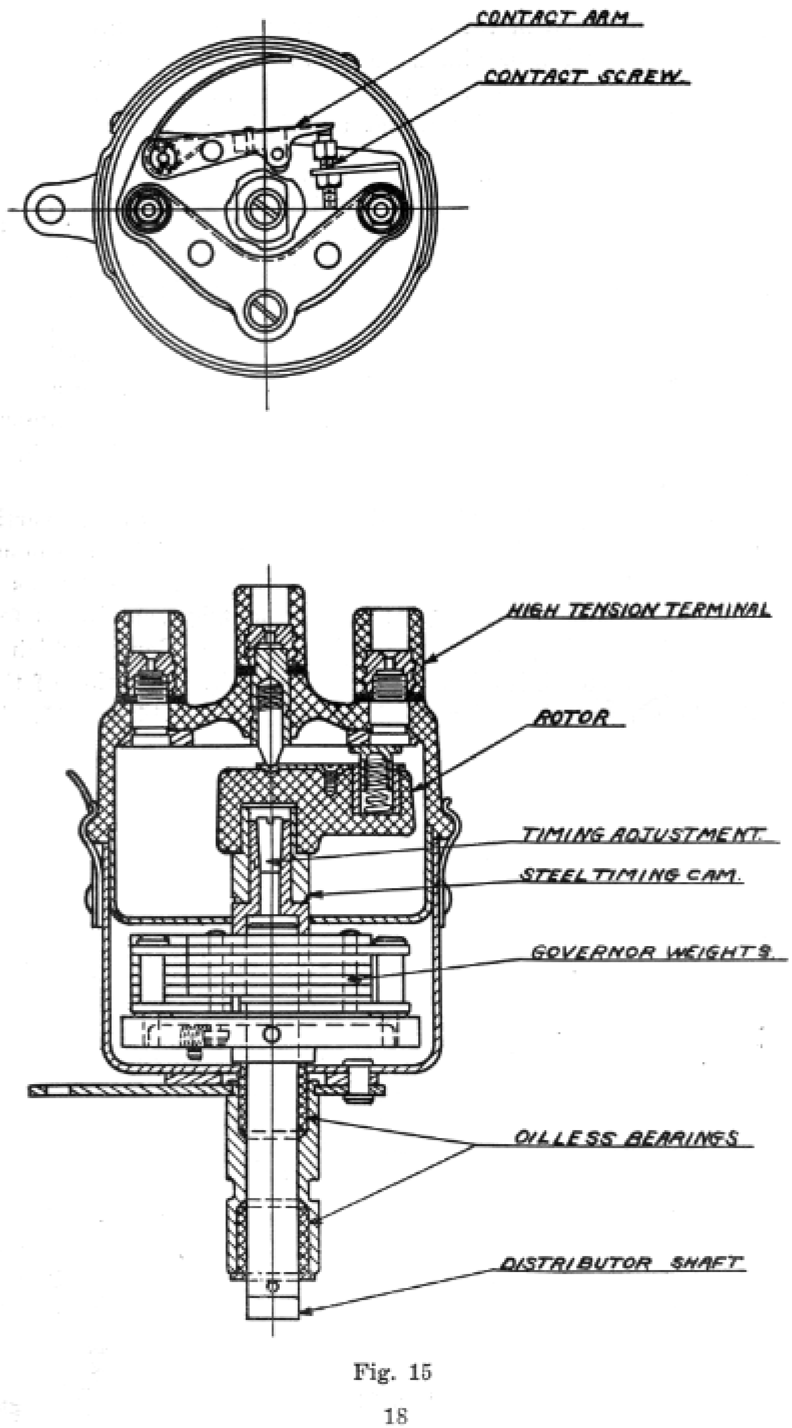

CONTACT ARM
CONTACT SCREW.
HIGH TENSION TERMINAL
ROTOR
TIMING ADJUSTMENT.
STEEL TIMING CAM.
GOVERNOR WEIGHTS.
OILLESS BEARINGS
DISTRIBUTOR SHAFT

Fig. 15

distributor shaft revolves is a plain graphite bearing which requires no lubrication whatever. The manual advance is accomplished by turning the distributor cup on which the breaker is mounted.

The fifth type of distributor, which was also manufactured in 1916, is similar to the above mentioned distributor, with the exception that the automatic advance feature has been omitted,

Special modifications of these distributors are used on the various motor cars manufactured in 1916 and their features can be noted by reference to the instruction books on any particular car. This information can be obtained, as a rule, either from the motor car manufacturer or from the Dayton Engineering Laboratories Company, Service Department, on application. The exact method of timing each car is a matter to be referred to the motor car company itself.

The troubles with the Delco ignition systems are readily located, if a systematic attempt is made to properly analyze them. In the first place, troubles can be divided into two general classes-low tension The first class, i. e., low tension troubles, will be taken up in detail and the causes and remedies discussed.

High voltage in the ignition circuit may be caused by loose conections in the circuit between the generator and storage battery or by a badly overcharged storage battery. These troubles are very easily located by measuring the voltage at the distributor and at the storage battery with a suitable volt meter and comparing the voltage to the voltage on similar cars that are operating in a satisfactory manner. The condition of the various connections can be observed by a careful inspection of the apparatus. The condition of the storage can be observed by noting its specific gravity and by seeing whether the amount of distilled water required every week to keep the battery filled to the proper level, is excessive or not. An excessive current may pass the contacts if the resistance unit is short circuited. This trouble can be

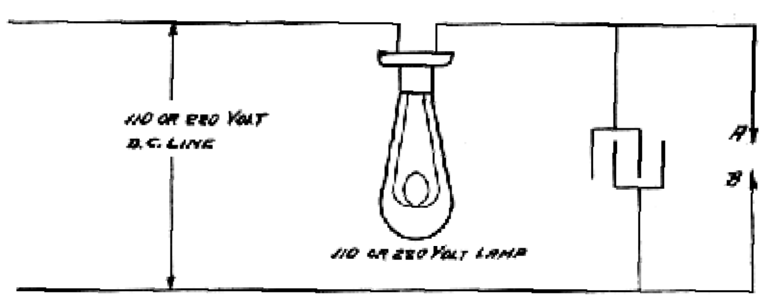


Fig. 16

tested as follows: Remove the distributor head and rotor and turn on the "mag" ignition, holding the contacts together firmly by hand. If the resistance unit is assembled on the distributor properly, it will heat up; if it doesn't heat up, it will indicate that the resistance unit is not in the circuit, and in this event, it should be re-assembled properly.

The effect of high voltage, whether due to loose connections in the generator circuit or to an overcharged battery, will be to permit an excessive current to pass through the timer contacts and a similar effect will be noticed if the resistance unit is short circuited. The contacts will be burned or pitted excessively, although the ignition may appear to be very good and without a miss.

If the condenser is not in good condition, the contacts will burn and pit rapidly, due to the excessive arcing when they are separated, but the ignition will be rather bad if, indeed, it will operate the motor at all, so that the burning of the contacts, due to a bad condenser, can, as a rule, be distinguished from burned contacts due to a high voltage or to a short circuited resistance unit. A very good test for the condenser with which to show whether it is in good condition or not, is to connect it up in accordance with the circuit diagram shown in Fig. 16. For this test a 110 or 220-volt source of DIRECT CURRENT is necessary, a lamp of the same nominal voltage as the circuit an d the wiring shown. The lamp is connected in series with the line and the condenser across the line. Now, if the terminals "A" and "B" are attached together, a very faint spark, which has a snapping sound similar to the sound made when leads from a storage battery are attached together, should occur. If the condenser be disconnected from the circuit, a much different arcing will be observed, somewhat longer and yellower and without the distinct snapping sound mentioned previously. If a condenser, known to be good, is tested in this manner once, it will enable the observer to distinguish between the sparks at the points "A" and "B" obtained with a good condenser and a bad condenser very readily, as a bad condenser will give the same quality of spark as if no condenser at all were in the circuit. This test is a mere qualitative test, but this is about the only satisfactory test which can be found which does no require expensive apparatus. In the earlier systems the condenser was in the form of a flat, oblong box, fastened to the distributor by four screws, but in a great many of the 1916 systems the condenser is mounted inside the black case containing the ignition coil.

In the case of all the breaker assemblies built in 1915 or earlier, particular attention must be paid to the little pig tail, which was mentioned in a preceding paragraph and shown in Pig. 7. If this is broken off the contact

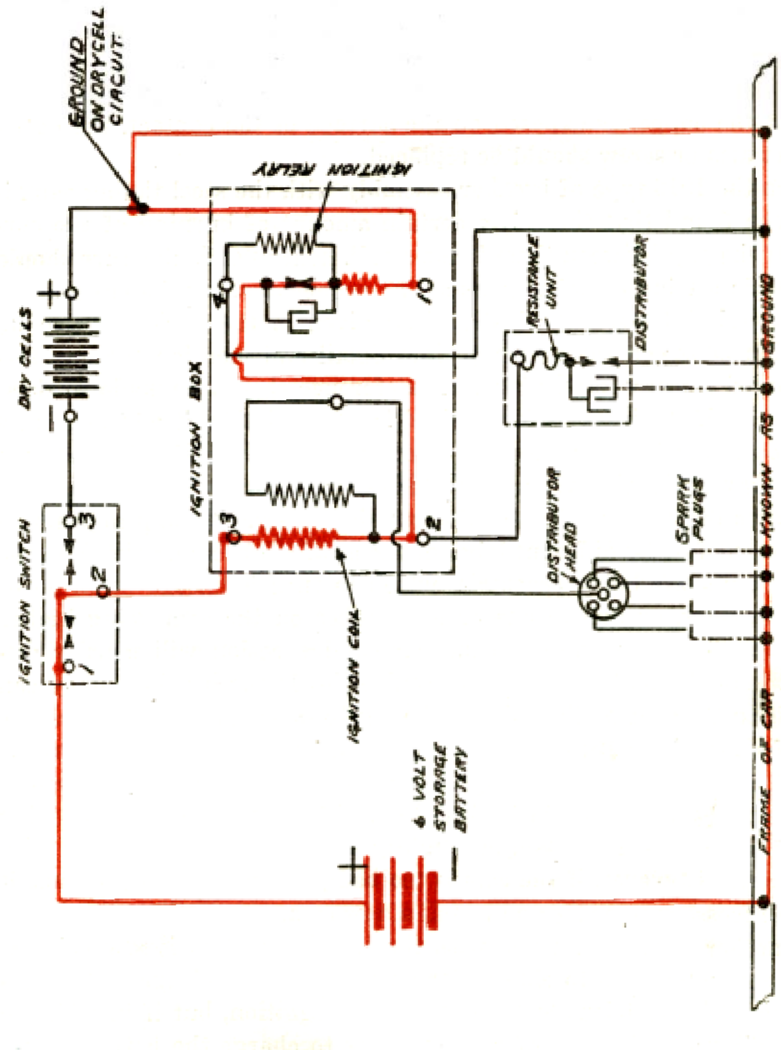

IGNITION SWITCH
DRY CELLS
GROUND ON DRYCELL CIRCUIT
IGNITION RELAY
IGNITION BOX
IGNITION COIL
RESISTANCE UNIT
DISTRIBUTOR
DISTRIBUTOR HEAD
SPARK PLUGS
6 VOLT STORAGE BATTERY
FRAME OF CAR KNOWN AS GROUND

Fig. 17

arm, the latter will tend to stick to the stud on which it moves and will permit of excessive arcing at the contacts and will, as a rule, cause a very decided ignition miss. It will be well, therefore, to make careful examination of the contacts and make sure that they are correctly adjusted from a mechanical point of view and that this pig tail is in place, before proceeding with any of the electrical tests mentioned above. The contacts consist of small discs of tungsten welded to a copper base which in turn is welded to a support, such as a steel screw or contact arm. When the tungsten has completely worn away, so that the copper is exposed on the surface of the contact, the entire contact arm or screw should be replaced. .

On the 1916 type of breaker assembly with the steel timing cam, it has been found that there is a certain amount of burning of the contacts if the gap between them is too small, hence particular care should be used in setting these contacts at the proper distance, before making any electrical tests. The instructions given in the various Delco instruction books on these cars go into detail and mention the gap recommended for any particular car. Reference should be made to these books, and if the information desired is not available, it will be gladly supplied either by the motor car companies or the Service Department of the Dayton Engineering Laboratories Company on request.

Cases may be noted from time to time where the gap appears to be different for the different lobes of the arm. This is due either to the distributor shaft being eccentric, which in turn is caused by loose or worn bearings, or due to one or more lobes on the cam being higher than the others. A thorough mechanical inspection will usually disclose where the fault lies. If the trouble lies in the bearings, they can be tightened up, if of the type used in 1915 or earlier, and also in the case of some of the 1916 machines equipped with ball bearings. In the case of the 1916 apparatus supplied with the bronze graphite bearings, new bearings will have to be installed. If the timing cam has high lobes, these can be smoothed off slightly so as to make them even with the others. However, if the cam is too badly worn to permit of this, it will be necessary to order and install a new cam.

Another cause of trouble with the ignition system is low voltage. If the generator fails to charge for any reason the voltage of the battery should be sufficient to take care of the ignition, but if in addition to the failure on the part of the generator to charge the battery properly, the battery itself is in such bad shape that its plates are sulphated or one or more of its cells are internally short circuited so that the terminal voltage of the battery when supplying current for the ignition is materially less than 5 2/10 volts, an ignition miss may occur. Also if in the ignition circuit there are one or more loose connections, the voltage across the ignition circuit may be insufficient

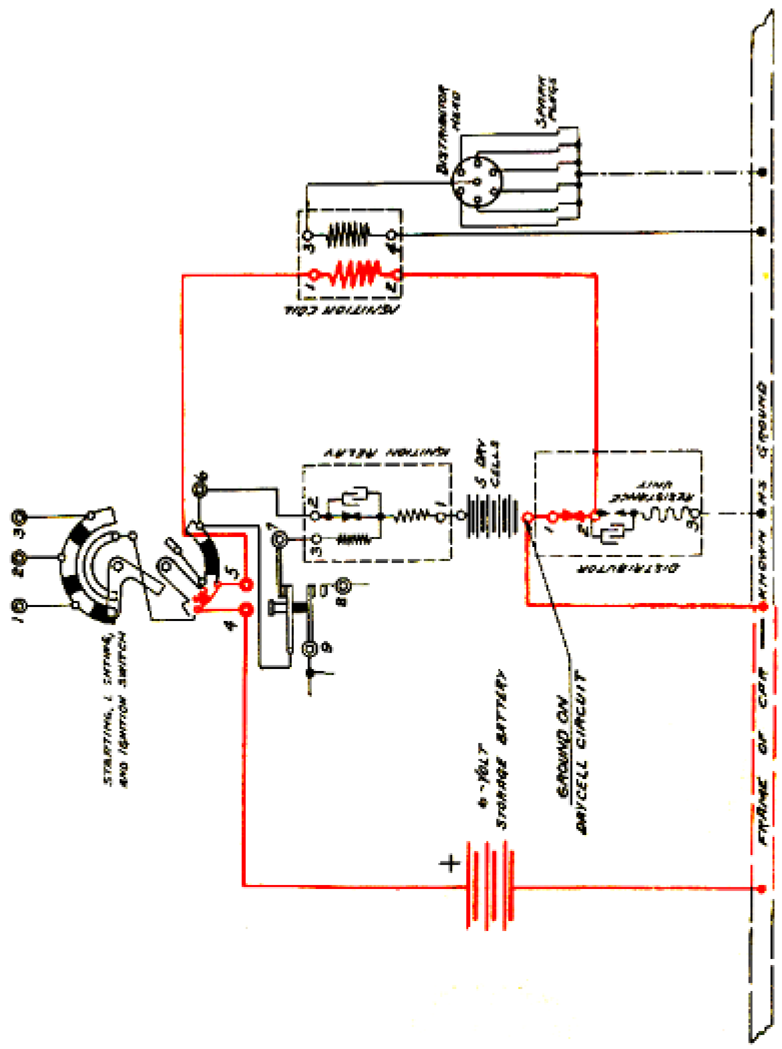

STARTING, LIGHTING, AND IGNITION SWITCH
6-VOLT STORAGE BATTERY
GROUND ON DRYCELL CIRCUIT
FRAME OF CAR
KNOWN AS GROUND
IGNITION RELAY
5 DRY CELLS
DISTRIBUTOR
RESISTANCE UNIT
IGNITION COIL
DISTRIBUTOR HEAD
SPARK PLUGS

Fig. 18

voltage across the ignition circuit may be insufficient to supply the necessary amount of current for satisfactory ignition. A test of the battery by a volt meter while the car is running, with the lights turned off and the ignition on, will enable the battery voltage under such conditions to be determined accurately and a careful inspection of the various connections in the ignition circuit will enable any loose or dirty ones to be found and tightened up.

On the 1914 systems particularly, but on any of the systems with the grounded storage battery and having either the dual type of breaker, as shown in Fig. 17, or the single breaker with the dry cell circuit connected directly to one side of the coil, as in Fig. 18, a ground in the dry cell circuit may act as a second ground in the "mag" ignition circuit and so cause the current to flow through the primary of the coil while the timer contacts are open. This is illustrated by the circuit shown in red in the circuit diagrams, Figs. 17 and 18, and will, of course, render the ignition inoperative on the "mag" side, but may have absolutely ' no effect on the dry cell ignition. A test for such trouble is simply to disconnect the dry cell circuit completely and note the effect on the " mag " ignition. If it removes the trouble, the ground which is causing it should be located and removed.

The coil itself may have an open circuited primary. If the break is clean, it will, of course, be impossible to get any current through the primary of the coil, but it sometimes happens that the ends of the break are touching each other so that a very nearly normal amount of current will pass through the coil while the car is standing still, but the ends will be sufficiently separated when the engine is running, due to vibration, to prevent the requisite amount of current from passing through the coil. This, of course, will cause very unsatisfactory ignition and the most satisfactory method of test for this particular, trouble, is to substitute another coil of the same type and note the effect on the ignition.

The preceding paragraphs cover most of the troubles found in the low tension circuits of the ignition systems. The second class, which includes those peculiar to the high tension circuit, will be discussed below.

Leaks in the high tension wiring permit current to jump from the high tension wire to ground and will cause an ignition miss and may occur at such times as accelerating while hill-climbing, or they may occur regularly and indicate that one or more cylinders are missing. The best way to locate such leaks is to run a separate wire from the distributor head to the spark plug, outside of any conduit that may be on the car, and in this way replace in turn each of the high tension wires until the defective one is found. When found, it should be prop-

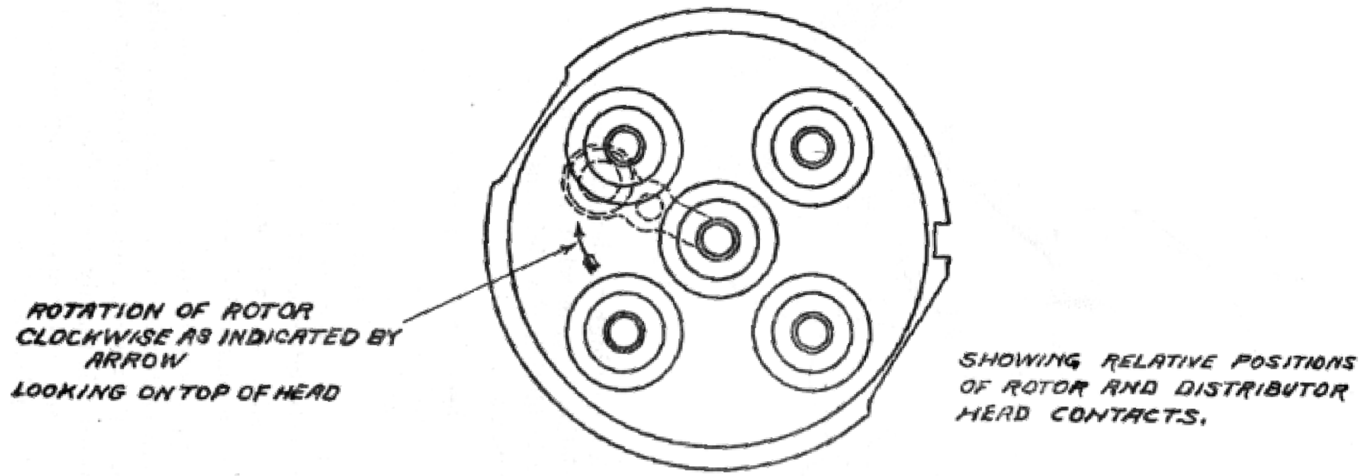

ROTATION OF ROTOR
CLOCKWISE AS INDICATED BY
ARROW
LOOKING ON TOP OF HEAD
SHOWING RELATIVE POSITIONS
OF ROTOR AND DISTRIBUTOR
HEAD CONTACTS.

Fig. 19

Fig. 20

erly replaced with a new high tension lead installed in the conduit, if there be one. Friction tape, or what is known as bicycle tape, should not be used in the insulation of a high tension wire, as it is a very poor insulator for this purpose.

The distributor head itself may cause trouble if the track gets sufficiently dirty to carbonize so that the spark jumps across from one terminal to another and causes pre-ignition. The most satisfactory test for such trouble is to replace the head with another head of similar model and note the effect upon the ignition. It is recommended that the track of the distributor head be kept clean with a rag slightly moistened with vaseline, so as to keep it polished and prevent the rotor button from sticking and thus cutting the track. (See Fig. 20).

If the track appears to be cut up, the rotor should be inspected to make sure that the button is properly assembled with its spring and that the pressure of the rotor button is not too great on the distributor head. If the pressure is unduly great, due possibly to the incorrect installation of the rotor button spring, it may cause abnormal wear on the track. This is particularly true if the button gets "cocked" sideways, and it will then tend to wear the track very badly. The rotor may also give trouble from imperfect insulation between the rotor contact and the ground, i. e., the metal distributor shaft on which it will be mounted when assembled as a part of the distributor. To test this, place it on the side of the distributor shaft and see if a spark from the ordinary ignition coil will jump to ground when held close to the rotor button contact. If the rotor insulation is sufficiently good, either no spark at all or only a very thin pale blue spark will be noted, but if the insulation is bad, a hot spark will jump to the rotor contact and thence to the ground. If the rotor insulation appears to be bad, the entire rotor should be replaced by a new one.

The relative position of the rotor contact to the distributor head contact at the moment when the spark occurs may be sufficiently incorrect to cause pre-ignition. In connection with the generator type Delco ignition, the spark occurs at the instant the timing contacts are opened. Since both the rotor and the breaker cam are both advanced or retarded by both the automatic and manual control, the rotor button will always be in the same position with respect to the high tension terminal in the distributor head when the spark occurs.

Therefore in those systems where an ignition relay is used the rotor button should be in the position with respect to the distributor head contact shown in Fig. 19. This being the relative position of the rotor button and distributor head contact when the timer contacts for the "mag" or generator type ignition are just beginning to break.

In those systems where no ignition relay is used, the rotor button should be directly under the distributor head contact when the timing contacts are just beginning to break.

If this relation is found to be incorrect, it can be changed by the use of adjustable distributor head clips (Delco piece numbers 24995, 24996 and 24997), which will permit of an adjustment of about three-fourths of an inch. These clips cannot be used on distributor heads manufactured in 1916 or later.

An open circuited or partially short circuited secondary in the ignition coil may cause a very weak spark, and if trouble of this sort is found, it will, as a rule, be necessary to replace the ignition coil. By noting the strength of the spark, if it is not sufficiently great and all the preceding tests indicate that the trouble lies in the secondary of the coil itself, it will be well to test the trouble by trying a new coil of a similar type and noting the effect on the ignition. If the trouble is eliminated, the coil should be replaced permanently.

The preceding paragraphs cover in a general way the high tension troubles most frequently met with and the beat methods of locating and eliminating them.

The automatic advance mechanism put out by Delco during the various years from 1913 to the present time, are all driven by the distributor shaft. The amount of advance produced by the automatic governor will, therefore, be controlled by the speed of the distributor shaft and as this is geared or driven positively from the crank shaft, it will depend upon the engine speed. Consider an automatic governor with an advance which starts to operate at 10 miles per hour and gives, say 15' (degrees) advance at 25 miles per hour. In connection with the same distributor, a manual advance will be assumed, which has a total range of 30' (degrees). Now, if at 25 miles per hour, the manual advance be set at 20' (degrees), the total advance for the timing cam will be the sum of 15 and 20 or 35' (degrees). If the manual advance were set at 10' (degrees), the total advance would be 15 plus 10 or 25' (degrees). In other words, at a given speed the automatic advance will be -invariable and to it must be added the hand advance in order to got the total advance of the timing cam. It therefore follows that it will be necessary to adjust the manual advance lever to some extent, say for starting and for very high speeds, while for a range of from 3.0 to 40 miles on these particular machines, after the lever has been set to suit the requirements of the motor at any speed in this range, the automatic advance will make any necessary change to suit the driving conditions over the entire range mentioned above. The figures given are illustrative only of the general principle of the spark advance as produced by the Delco and are not meant to apply in detail to any particular motor.

Another matter frequently disregarded is in seeing that the linkage that connects the spark lever to the lever operating the manual advance on the distributor is properly adjusted. These are correctly adjusted at the various motor car factories, but they may require adjustment after the car has been in service for some length of time, especially if it has been torn down and reassembled. It will be well to obtain instructions from the motor car manufacturers in regard to the details of the adjustment; and in particular, be sure that the motion of the spark lever over the quadrant is followed by a smooth and even movement of the lever on the distributor. There should be no "dead points," as this will result in too great a sensitiveness during the time the distributor lever is actually operated by the linkage. Considerable judgment is required in effecting the adjustment of these parts.

In locating ignition troubles, the fact that certain other troubles may be mistaken for ignition troubles should not be lost sight of. These include particularly incorrect adjustment of the carburetor, defects in spark plugs and incorrect adjustment of the spark plug gaps, excessive oil leakage, improper valve setting, sticking valves, leaks in the intake manifold and the stoppage of gasoline supply. As these points are more properly considered under the head of motor troubles, they will not be discussed in this article, but close attention should be paid to such points when looking over the car for ignition troubles.