WIRING

The wiring diagram illustrated in this section, shows the general arrangement of all chassis electrical circuits together with the relative position of the electrical parts.

Essential specifications and test data on all the electrical units are listed through out the write-up and in the "Specifications" group of each respective section.

Wire Sizes

Each wire in the electrical system is of a specified size, as noted on the wiring diagram. When any wires are replaced, wires of the correct size must be used.

Tracer Colours

The insulation of each wire is of a distinctive colour or combination of colours which assist in tracing various circuits and making connections. These tracing colours are identified by a number noted at each wire shown in the wiring diagram.

Inspection of Wires and Connections

Electrical connections must be tight and clean, Loose and corroded connections will cause a run-down battery, difficult starting, dim lights, and in many instances, damage to the generator.

Testing Circuits

Methods of testing the various electrical circuits are discussed in the various electrical sections, however, many circuits may be tested for a continuous circuit and shorts with the conventional test lamp and low reading volt meter.

Radio Interference

All vehicles, whether equipped with wireless or not, must have provision made to eliminate interference which would be picked up by the set. There are three main methods of eliminating interference in a vehicle and they will be explained under the following titles:—

Bonding.
Shielding.
Suppression.

The elimination of interference should not be attempted by a driver or a mechanic. It should be given to someone qualified to do this work.

Wireless Bonding

Vehicles that are equipped with wireless sets, require the electrical bonding together of all metal units of the vehicle, into one mass of metal. Metal units of a vehicle in motion have the characteristic of developing static electricity within themselves. These electrical charges are not all developed with the same speed nor to the same voltage. Electricity has the property of flowing from bodies holding the greater charge to a body holding a smaller charge.

When this discharge of electricity takes place anywhere within a vehicle equipped with a wireless set, static interference will be picked up by the wireless and cause poor reception.

Wireless bonding is defined as the practice of connecting together electrically the various metal parts of the wheels, chassis, engine and hull of the vehicle, so that they will form one mass of metal which is invariable with respect to any electric currents which may flow in. Bonding is accomplished by providing connectors between the metal parts, of such a nature and so disposed that the electrical currents flow by paths of low and constant resistance and induction. Bonding includes provisions for overcoming "wheel static" due to changes developed on parts of wheels when the vehicle is in motion.

Installation of Bonding

When in service it becomes necessary to install or replace a bonding strap, care should be taken that the correct type of bonding is used and that a good connection is made.

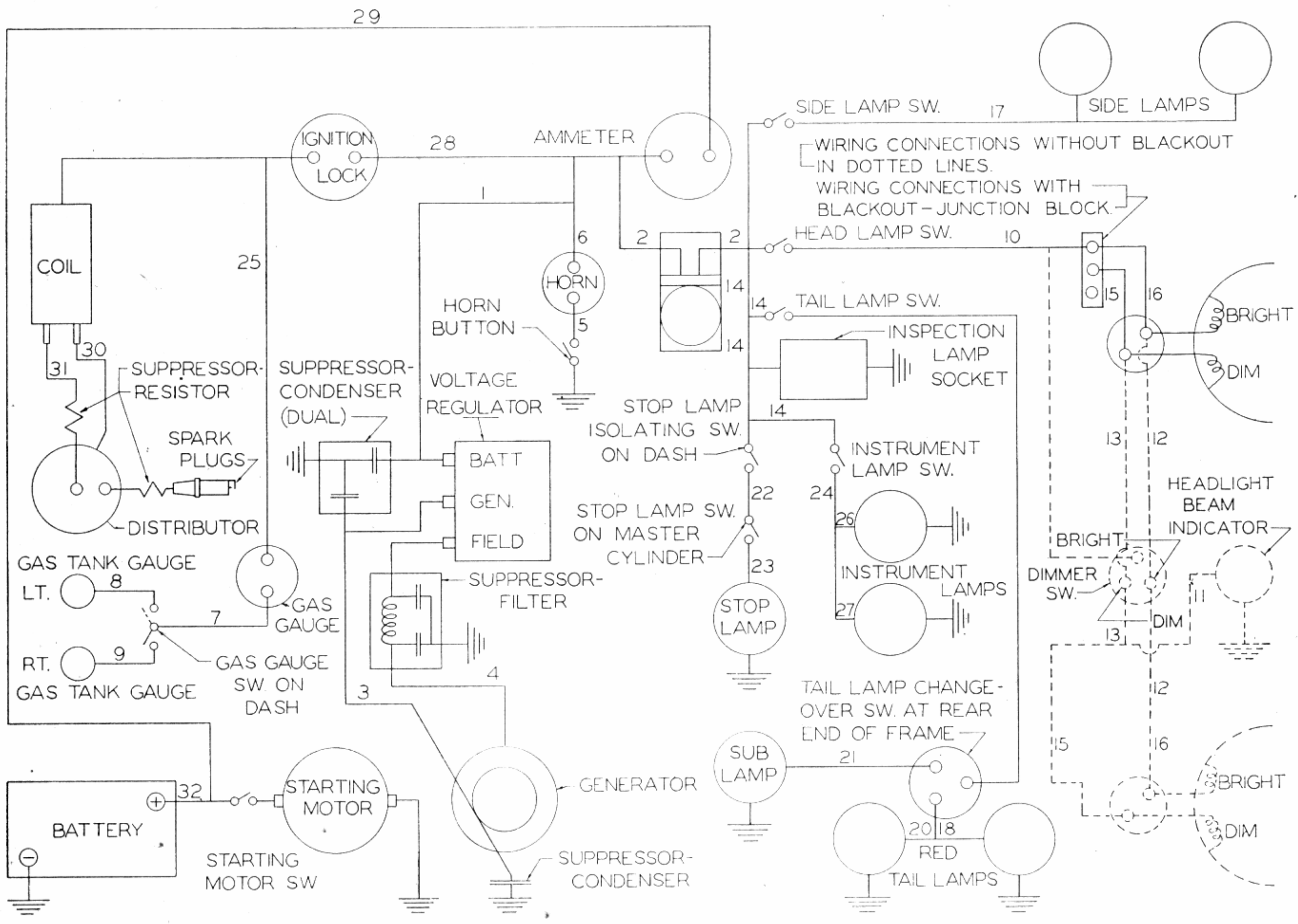
Bonding is made of soft-drawn tinned copper wires, woven into a close mesh. When replacements are made nothing but the specified parts should be used.

Where soldered or sweated joints occur between copper braid and lugs or straps, the soldering should be done so that solder does not run along the braid rendering it inflexible outside the joint. All soldering and sweating should be carried out with a non-corrosive flux. Surplus flux is to be removed in every case.

In all connections between the bonding conductors and the vehicle, the metal should be thoroughly cleaned, and the joint made so that it will give a good, permanent electrical contact. All bolt and nut connections must be provided with a lockwasher and a plain brass washer under the bolt head. Before installation, the contact surfaces should be scraped down to bare metal and a thin film of vaseline or grease placed on the contact surfaces. All connections should be drawn up tight. Remove all surplus grease or vaseline. Care should be taken to see that the terminal lugs are positioned so that the conductors run straight and that the copper braid conductors are not bent or twisted in installation. Copper braid should not be drawn tight nor should it be allowed to sag.

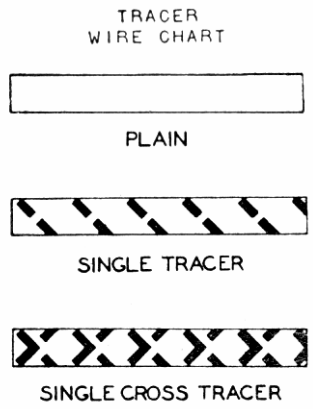
SHIELDING

All electrical wiring of an appreciable length will act as an antenna and radiate high frequency waves when a radio frequency interference component current is passed through the wire. Wireless sets installed in a vehicle will pick up these high frequency waves and result in poor reception. High tension wires will offer the greatest interference, but radiation from these wires is taken care of by a system of suppression. Low tension circuits must also be given considerable attention in vehicles equipped with sensitive sets.



(Dotted line illustrates wiring connections without blackout equipment.)

Wiring Diagram



Wire No.	Gauge No.	Description
1	10	Black and Red Cross Tracer.
2	12	Red Tracer.
3	10	Black Cross Tracer.
4	16	Black Tracer.
5	16	Black Tracer.
6	16	Red Tracer.
7	16	Black Tracer.
8	16	Green Cross Tracer.
9	16	Green Tracer.
10	14	Black Cross Tracer.
11	16	Natural.
12	14	Black Cross Tracer.
13	16	Green Tracer.
14	16	Red Tracer.
15	16	Green Tracer.
16	14	Black Cross Tracer.
17	16	Natural.
18	14	Green Tracer.
19	16	Black Cross Tracer.
20	14	Green Tracer.
21	14	Green Tracer.
22	16	Red Tracer.
23	16	Natural.
24	16	Black & Red Cross Tracer.
25	16	Red Cross Tracer.
26	16	Black & Red Cross Tracer.
27	16	Black & Red Cross Tracer.
28	12	Red Tracer.
29	10	Paper and Yarn Covered Wire.
30	14	Black Tracer.
31	7	M.M. High Tension Wire.
32	1	Starter Cable.

It is, therefore, necessary to provide some means of preventing these high frequency waves from escaping any electrical carrying wires in the vehicle and reaching the radio antenna. This is made possible by means of a system called "Shielding."

Shielding, as the title implies, is a protective covering of fine threads of metal woven together to form a protection around a wire which prevents interference radiating from the wire. All the low tension wires coming from the instrument panel (ignition, lights, instruments, etc.) are grouped into a single wiring harness and, therefore, are shielded with a cover of woven metal which is grounded at both ends of the harness and at intermediate points. This method enables all the low tension wires from the instrument panel to be shielded as a unit, and eliminates the necessity of individually protecting each wire. If any radio interference is found to be caused from the low tension wire group THE WIRING HARNESS AND SHIELDING SHOULD BE REPLACED AS A UNIT. When replacing a wiring harness the wire identification chart on the preceding page will be of assistance in making the correct wire connections. The ground straps of the shielding should be fastened to a suitable ground bolt, making certain that the connecting surfaces are well cleaned and making a good contact.

SUPPRESSION

High tension wires as mentioned under "shielding" radiate high frequency waves which will cause radio interference unless some provision is made to eliminate the interference. This method is known as suppression.

Suppression dampens out or retards the interference at its source by changing electrical constants of the circuit so that they do not readily radiate interference.

Suppressors used for this type of vehicle are usually in the form of resistors, filters, and condensers. For the correct location and size of these suppressors see the wiring diagram on the preceding page.

GENERATOR AND REGULATOR

THE GENERATING SYSTEM

The function of the generating system may be summed up as follows: It converts a small amount of mechanical energy from the engine into electrical energy which is carried through the wiring to the battery where it is stored for future use. In actual operation some of the energy may be used directly from the generator, but for explanatory purposes it is assumed to flow from the generator to the battery and then be drawn from the latter.

The generator used on these vehicles is a two-brush shunt wound machine controlled by a combination current and voltage regulator of the vibrating type. The two regulating units operate independent of each other.

The voltage regulator controls the maximum voltage of the generator and keeps it from exceeding a predetermined value fixed by the setting of the regulator. The actual charging rate to the battery varies, depending on the state of charge in the battery.

The current regulator controls the maximum amperage output of the generator and prevents it from exceeding 32 to 34 amperes, which is the setting of the current regulator, thereby preventing damage to the generator due to overload.

The shunt wound generator controlled by current and voltage regulation is an ideal generating unit which has the ability to supply the necessary current for lights and accessories in addition to charging the battery. The maximum charging rate is available from a speed of approximately 25 M.P.H. to maximum speed. In other words, the maximum output curve is flat and does not fall off at the high-speed end. (Figure 9.)

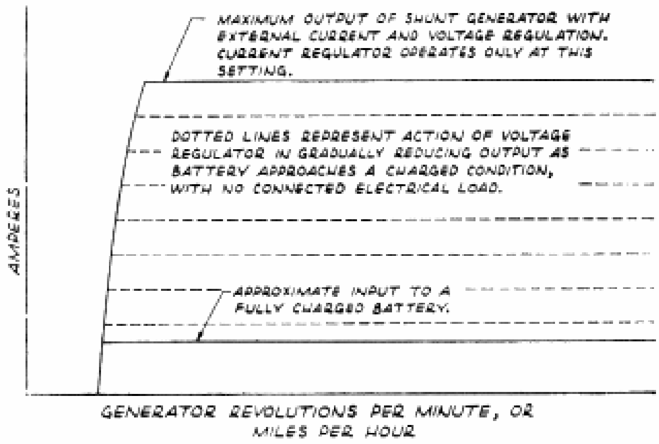


Fig. 9—Generator Output

In addition to the above, the voltage regulator prevents excessive voltage at the lamp bulbs, ignition points, and radio, thereby prolonging their life.

To thoroughly understand the function of the voltage regulator, some knowledge of the characteristics of a storage battery is necessary. Figure 10 shows a series of curves, each depicting the charge indicated by the specific gravity of the acid, as the charging current is increased or decreased. The voltage increases with the charging rate, and is highest for a fully charged (1.280) battery.

Assume that the voltage regulator is set so as to open the contacts when the battery voltage reaches 7.5 volts. With the contacts open, the generator field circuit must go to ground, through the resistance which decreases the field current, the

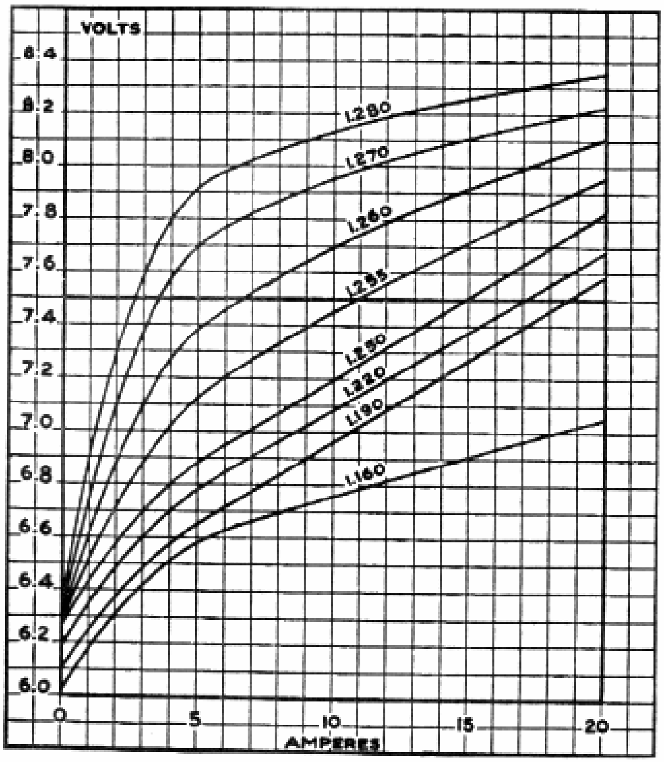


Fig. 10—Battery Charging Curve

generator output and, consequently the battery, terminal voltage. This decrease in battery voltage allows the contacts to close again, and the repetition of this cycle many times each second holds the battery voltage at 7.5 volts. To be a little more accurate, it holds the current into the battery to a value which produces 7.5 volts at the battery terminals as shown on the curves of Figure 10. Suppose the battery is nearly discharged, and has a specific gravity of 1.190. By following the curve marked 1.190 until it intersects the line of 7.5 volts, the current necessary to produce 7.5 volts will be found to be 18.4 amperes. The regulator will hold the current at this value until the battery starts to come up. When the specific gravity has reached 1.220, the current will have been reduced to 16.8 amperes; at 1.250 it will be 14.6 amperes; at 1.255, 10.6 amperes, and so on until at 1.280 the current will have dropped to less than 3 amperes. This method of charging is known as the "Constant Potential System," and is considered to be the ideal way of charging a battery, since it permits a high rate charge for a discharged battery, but tapers off the charging rate as the battery comes up, thereby preventing excessive overcharge.

Current and Voltage Regulator Construction

In discussing the construction of the combination current and voltage regulator, we will cover the voltage regulator first, then the current regulator.

Voltage Regulator

The Voltage Regulator unit consists of an iron core, which with its windings forms an electro magnet. The voltage winding consists of a large number of turns of fine wire. One end of this winding is connected to the generator (GEN) terminal of the regulator and the other end of the winding is grounded. This winding is known as a Voltage Coil because it is connected directly across the generator armature at all times and is subjected to the generator voltage. (Figure 11.)

The series winding on the core consists of a few turns of larger diameter wire, one end of which is connected to the field (F) terminal of the regulator and the other end to the upper point mounting of the current regulator. (Figure 12.) This winding is known as a series coil because it is connected in series with the shunt field of the generator.

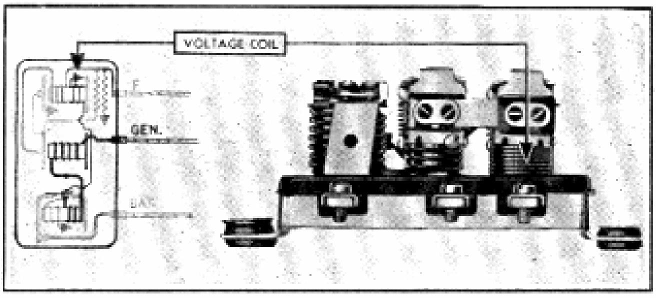


Fig. 11—Regulator Voltage Coil

An iron armature which carries one of the regulator points is mounted over the magnet core, and is hinged to the regulator body. The other point is mounted to the regulator body. Two coil springs are attached between the armature and body to hold the regulator points closed when the regulator is not operating.

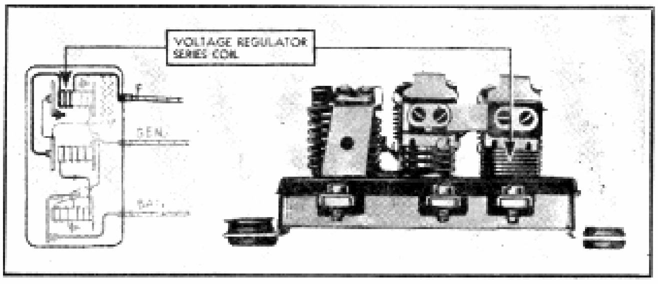


Fig. 12—Voltage Regulator Series Coil

Two field resistance units are mounted on the regulator. However, only the lower resistance unit functions with the voltage regulator. One end of this resistance is connected to field (F) terminal of the regulator and the other end is grounded. (Figure 13.)

Current Regulator

The Current Regulator unit consists of an iron core, over which is wound a few turns of comparatively large wire. One end of this winding is connected to the generator (GEN) terminal of the regulator and the other end is connected to the series winding of the circuit breaker. This winding is known as a series winding because it is connected in series with the generator armature and all the charging current must pass through it as shown in Figure 14.

ground and back to the grounded brush of the generator is established. (Figure 17). At the same time a current flows through the series windings of both the current regulator and circuit breaker, thence through the voltage winding of the circuit breaker to ground and back to the grounded brush of the generator.

When the engine speed is increased the generator voltage rises and when it has built up to 7.2 to 7.4 volts, sufficient current is forced through the voltage winding of the circuit breaker to magnetize its core sufficiently to attract the circuit breaker armature and close the points, establishing a circuit from the generator to the battery as shown in Figure 15.

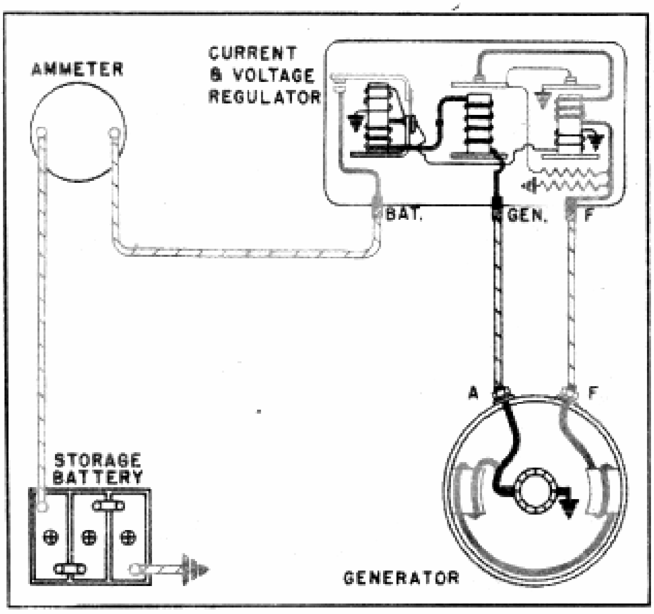


Fig. 17—Voltage Coil Circuit

Voltage Regulator

It will be noted by referring to Figure 17 that the generator voltage is impressed across the voltage winding of the voltage regulator at all times. You will also note that any change in generator voltage will make a corresponding change in the current value passing through the voltage winding of the regulator. Such being the case, the magnetic strength of the voltage winding varies directly as the generator voltage.

As the generator voltage increases to a predetermined value (7.2 to 7.4) fixed by the regulator setting, the magnetic pull on the voltage regulator armature increases until the armature is attracted towards the core, against the spring tension, opening the regulator points.

The shunt field circuit must now pass through the resistance unit. (Figure 18). This adds to the resistance of the shunt field circuit, thereby reducing the current value passing through the field winding.

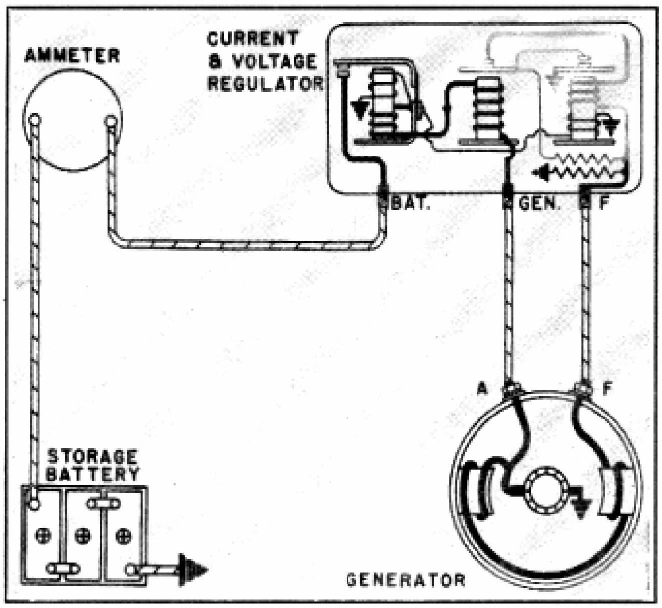


Fig. 18—Field Circuit with Voltage Regulator Points Open

The net result of this is a drop in generator voltage. This, in turn, reduces the current value passing through the regulator voltage winding, reducing its magnetic strength, allowing the spring tension to immediately close the regulator points, eliminating the resistance from the field circuit, thus allowing the generator voltage to build up again. This cycle of operation occurs many times per second, resulting in the voltage being held practically constant.

The purpose of the series winding on the voltage regulator is to speed up the vibration of the regulator armature. It will be noted in Figure 18 that when the regulator points open, the field current passing over the series winding is reduced to zero, resulting in an instant reduction in its magnetic strength, allowing the regulator points to close more rapidly. This, of course, results in holding the generator voltage nearer a constant value.

Current Regulator

When the battery is low and lighting and accessory loads are turned on, the generator voltage may not be forced up high enough to operate the voltage regulator. In this case the current regulator comes into operation.

You will note by referring to Figure 15 that all the current for lights, accessories and charging the battery passes through the series winding of the current regulator. You will also note that any change in the current output of the generator makes the same change in the current value passing through the series winding of the regulator. Such being the case, the magnetic strength of the current regulator series winding varies directly as the current output of the generator.

As the generator output increases to a predetermined value (32 to 34 amperes fixed by the regulator setting) the magnetic pull on the regulator armature increases until the armature is attracted towards the core, against the spring tension, opening the regulator points.

The field circuit must now pass through the upper resistance unit and across the voltage regulator points to ground, and also through the lower resistance unit to ground in order to complete the circuit. These two resistance units being connected in parallel at this time. (Figure 19).

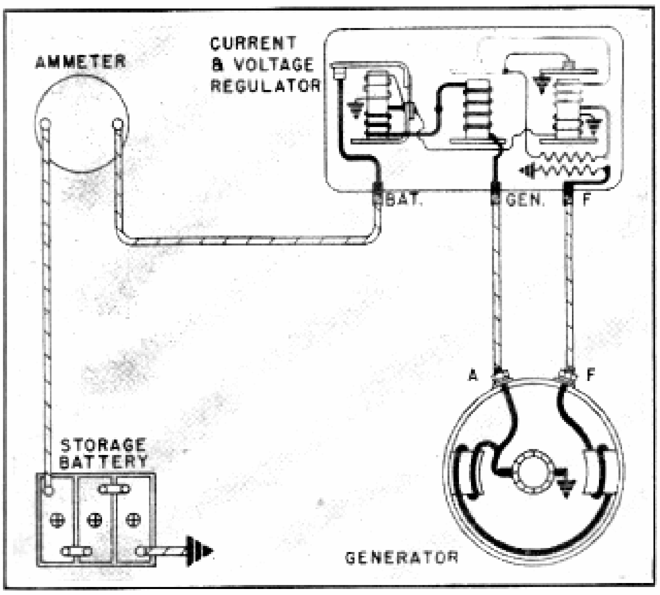


Fig. 19—Field Circuit with Current Regulator Points Open

This adds resistance to the shunt field circuit, thereby reducing the current value passing through the field. This, of course, results in a drop in generator voltage and output. This reduction in current value passing through the series winding of the current regulator reduces its magnetic strength, allowing the spring tension to immediately close the regulator points, eliminating the resistance from the field circuit, thus allowing the generator voltage and output to build up again. This cycle of operation occurs many times per second, resulting in holding the maximum amperage output of the generator at a practically constant value.

Quick Checks to Determine if Units are Operating Properly

The following checks must be made to determine whether or not the units are operating normally. If not, the checks will indicate whether the generator or regulator is at fault so that proper corrective steps may be taken:

1. A FULLY CHARGED BATTERY AND A LOW CHARGING RATE indicates normal voltage regulator operation. To check the current regulator remove the battery wire from the battery (BAT) terminal of the regulator. Connect the positive lead of an ammeter to the battery terminal of the regulator and the negative lead to the battery wire. With the ignition switch in the "off" position, step on the starting switch and crank the engine for about fifteen seconds. Then start the engine and, with it running at medium speed, turn on lights, radio and other electrical accessories and note quickly the generator output, which should be the value for which the current regulator is set. Now turn off the lights, radio and other accessories and allow the engine to continue running. As soon as the generator has replaced in the battery the current used in cranking, the voltage regulator, if operating properly, will taper the output down to a few amperes.

2. A FULLY CHARGED BATTERY AND A HIGH CHARGING RATE.

   (a) Disconnect the field wire from the field (F) terminal of the regulator. This opens the generator field circuit and the output should immediately drop off. It if does not, the generator field circuit is grounded either inside the generator or in the wiring harness. If the output drops off to "Zero" with the field lead disconnected, the trouble has been isolated in the regulator. Reconnect the field lead on the field terminal of the regulator.

   (b) Remove the regulator cover and depress the voltage regulator armature manually to open the points. If the output now drops off, the voltage regulator unit has been failing to reduce the output as the battery came up to charge and voltage regulator adjustment is indicated.

   (Instructions for adjusting the regulator are covered under the heading "Voltage Regulator Adjustment.")

   (c) If separating the voltage regulator contacts does not cause the output to drop off, the field circuit within the regulator is shorted and the regulator should be replaced.

3. WITH A LOW BATTERY AND A LOW OR NO CHARGING RATE check the circuit for loose connections, corroded battery terminals, loose or corroded ground strap, and frayed or damaged wires. The high resistance resulting from these conditions will prevent normal charge from reaching the battery. If the entire charging circuit is in good condition, then either the regulator or generator is at fault.

   (a) With a jumper wire ground the field terminal of the regulator to the engine block or other good ground. Increase the generator speed to determine which unit needs attention. Use care to avoid excessive speed since under these conditions the generator may produce a dangerously high output.

   (b) If the output does not increase, the regulator needs attention. Check for dirty or oxidized contact points or a low voltage setting.

(c) If the generator output remains at a few amperes with the field terminal grounded, the generator is at fault and should be checked further.

(d) If the generator does not show any output at all, either with or without the field terminal grounded, very quickly disconnect the generator lead from the generator (GEN) terminal of the regulator and strike it against a convenient ground with the generator operating at a medium speed. If a spark does not occur, the trouble has now been definitely isolated in the generator and it should be removed and repaired.

If a spark does occur, likely the generator can build up but the circuit breaker is not operating to permit the current to flow to the battery due to burnt points, points not closing, open voltage winding, grounded circuit breaker, or too high voltage setting.

NOTE—Do not operate the generator with the generator lead disconnected for any length of time since this is open circuit operation and the units will be damaged. A burned regulator resistance unit, regulator winding, or fused contacts can result only from an open circuit operation or extreme resistance in the charging circuit. With these conditions check wiring before reinstalling regulator. DO NOT RUN OR TEST GENERATOR ON OPEN CIRCUIT. TO DO SO MAY DESTROY REGULATOR OR GENERATOR.

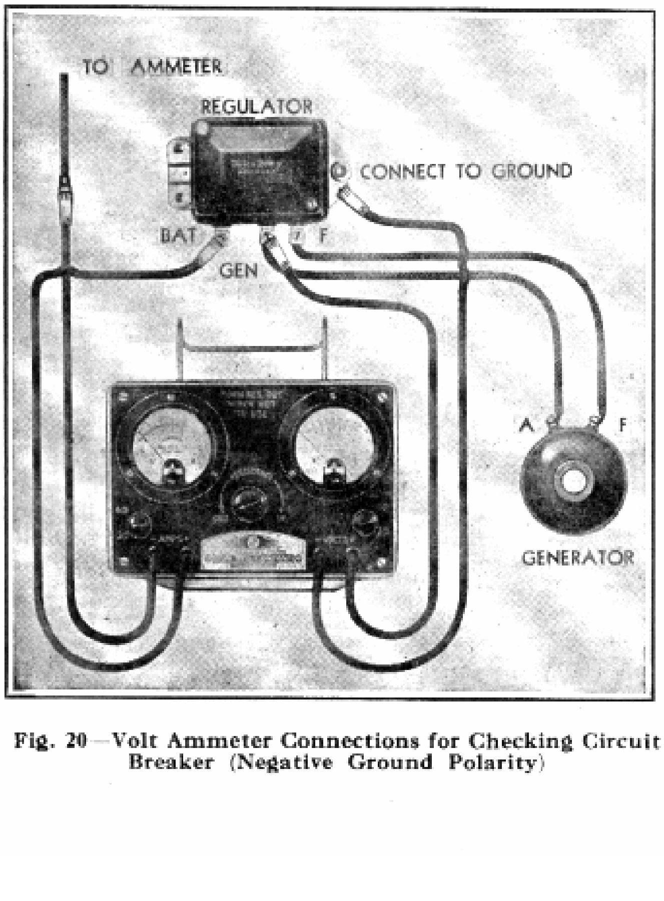


Fig. 20—Volt Ammeter Connections for Checking Circuit Breaker (Negative Ground Polarity)

ADJUSTMENTS

Cut-Out Relay

Disconnect the battery wire from the battery (BAT) terminal of the regulator. Connect the positive lead of the ammeter to the battery terminal of the regulator and the negative lead to the battery wire. Connect the positive lead of the voltmeter to the generator terminal of the regulator and the negative lead to ground. (Figure 20). Gradually increase the engine speed, noting the voltage at which the circuit breaker points close. This should be from 6.3 to 6.9 volts. Slowly decrease the engine speed, noting the discharge current necessary to open the circuit breaker points. This should be from 0 to 4 amperes.

The closing voltage of the circuit breaker may be adjusted by bending the spring post up to increase the spring tension and closing voltage, and down to decrease the spring tension and closing voltage. (Figure 21).

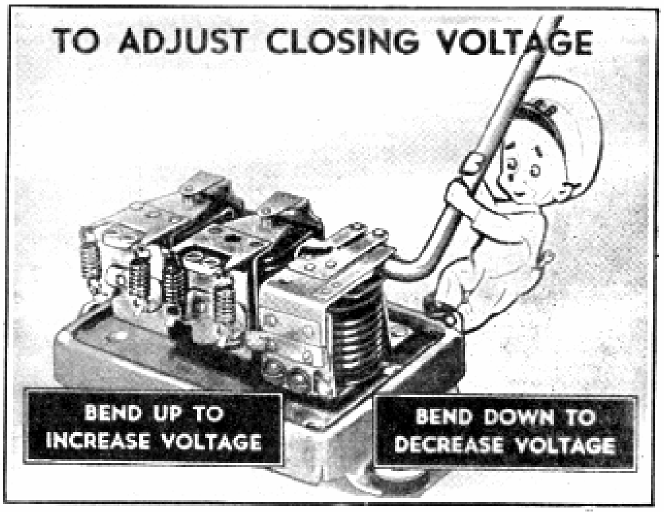


Fig. 21—Adjusting Closing Voltage

After making the above adjustments, if the reverse current necessary to open the points is not within the limits of 0 to 4 amperes, the following adjustments should be checked:

1. AIR GAP—Place finger on armature directly above core and move armature down until points just close. Then measure the air gap between the armature and center of core, which should be .020". If both sets of points do not close at the same instant, bend spring fingers so both sets meet simultaneously. (See Fig. 22.)

   To adjust the air gap, loosen the two screws at the back of the circuit breaker and raise or lower the armature as required. Tighten screws securely after adjustment. (Figure 23.)

2. POINT OPENING—The opening between the points should be .020". Bend the upper armature stop up to increase the point opening and down to decrease the point opening. (See Fig. 24.)

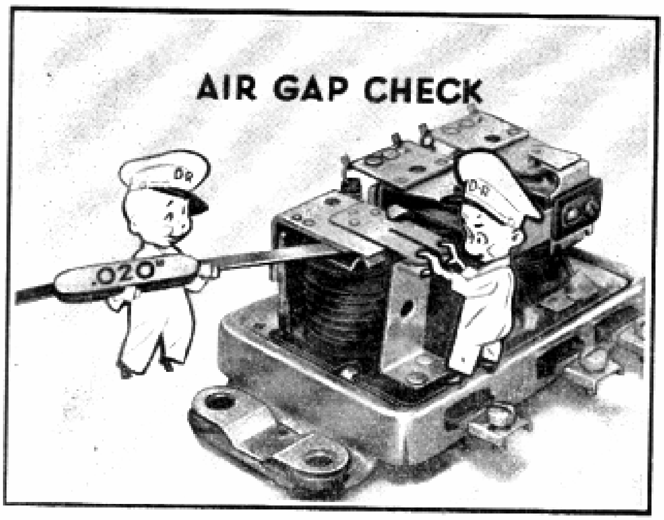


Fig. 22—Checking Air Gap

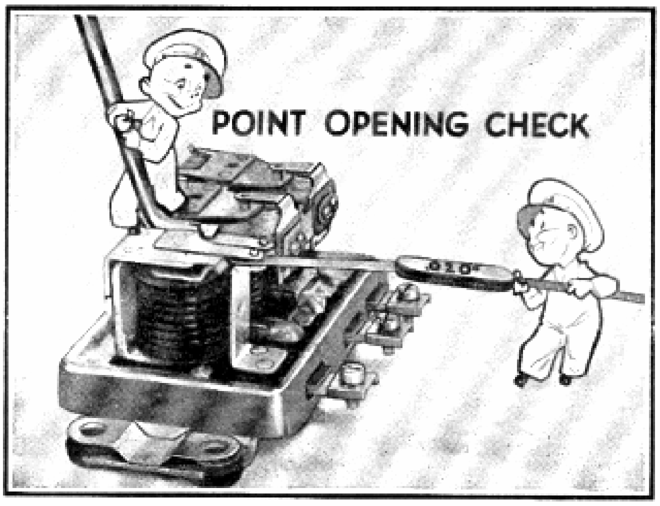


Fig. 24—Adjusting Point Opening

After making the above adjustments the closing voltage and opening amperage should be re-checked and necessary adjustments made.

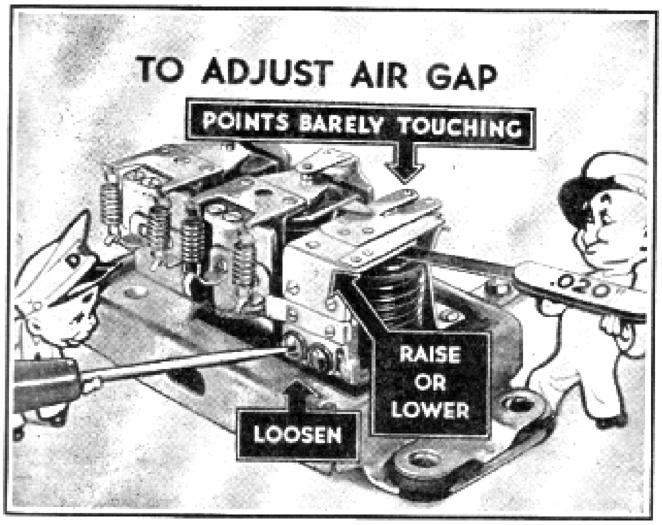


Fig. 23—Adjusting Air Gap

Current Regulator

When checking the current regulator adjustment it is necessary to remove the regulator cover and connect a jumper lead from the voltage regulator upper point support bracket to the armature. This shorts the voltage regulator points and prevents them from operating while the current regulator is being checked. (Figure 25.)

Remove the battery wire from the battery terminal of the regulator and connect the positive lead of the ammeter to the battery terminal of the regulator and the negative lead to the battery wire. Make sure that the ammeter resistance knob is turned to the out position, turn on lights, radio, and other electrical accessories to prevent battery overcharge. Increase the engine speed until output remains constant. The current setting with the unit at operating temperature should be from 32 to 34 amperes.

NOTE—**The engine should be run at medium speed at least ten minutes before making any checks or adjustments on the regulator. This is necessary to bring the regulator up to operating temperature**

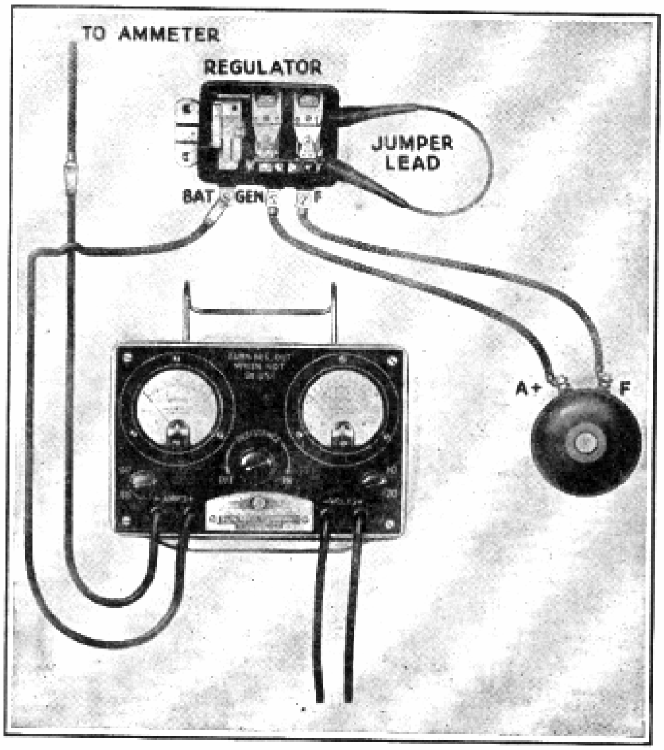


Fig. 25—Volt Ammeter Connections for Checking Current Regulator (Negative Ground Polarity)

1. Current setting of the regulator is adjusted by bending the spiral spring hanger down to increase the current setting, or bending up on the spring hanger to decrease spring tension and lower current setting. (Figure 26.) Nor-

mally, all adjustments should be made on the light spring and the heavy spring should not be touched.

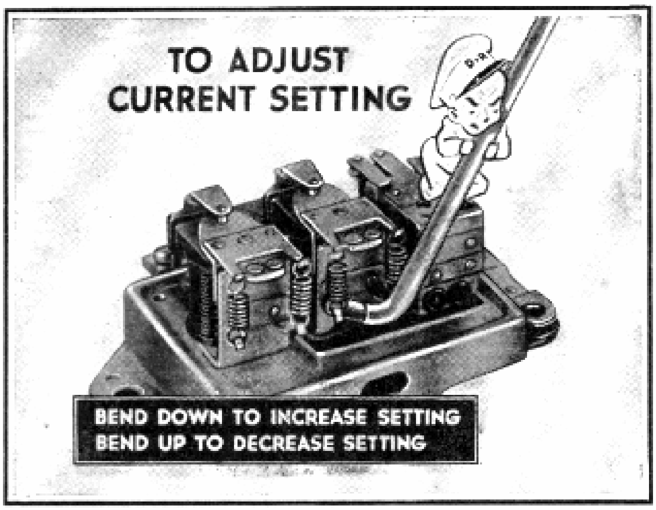


Fig. 26—Adjusting Current Setting

If the unit is badly out of adjustment it may be necessary to remove the light tension spring and adjust by means of the heavy tension spring only for its proper setting. With the generator operating at medium speed, adjust the tension of the heavy spring by bending its spring hanger up or down until the current regulator unit operates at approximately 17 amperes. Next install the light spring and complete adjustments to 32 to 34 amperes. The final adjustment must be made only on the light spring.

2. In some cases it may be necessary to readjust the air gap between the armature and core. To check this adjustment push the armature down all the way by hand, then allow it to come back up until points are just touching. Then measure the air gap, which should be from .075″ to .085″. Adjustment of this air gap may be made by loosening the screws which mount the upper contact support. The support may then be moved up or down as required to provide an air gap of .075″ to .085″.

NOTE—Be sure points are lined up and tighten screws down well after adjustment.

Voltage Regulator

A-V-R Method (Variable Resistance) of Checking Voltage Regulator

When checking the voltage regulator, connect the volt ammeter tester to the regulator as follows:

Remove the battery wire from the battery terminal of the regulator and connect the positive lead of the ammeter to the battery terminal and the negative lead to the battery wire.

Then connect the positive lead of the voltmeter to the battery terminal of the regulator and the negative lead to a good ground. (Figure 27). Start the engine and run it at a speed equivalent to approximately 30 M.P.H.

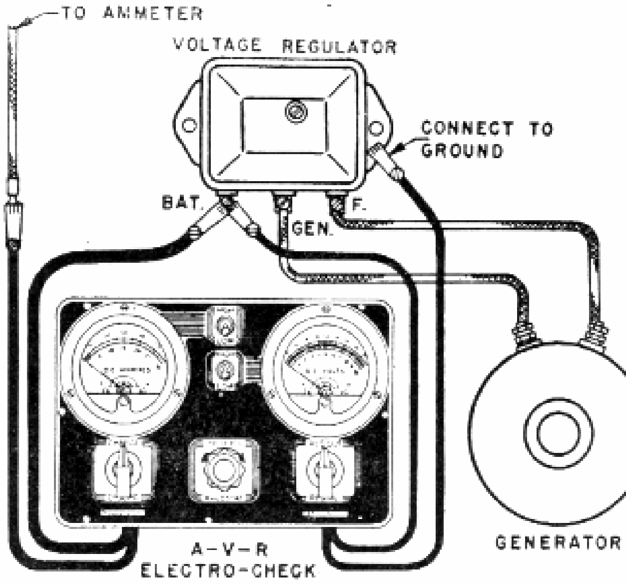


Fig. 27—Checking Voltage Regulator

If the output is less than 8 amperes, turn on lights to permit increased generator output, then cut in the resistance on the volt amperage tester by turning the resistance knob to the right until the output is reduced to 8 to 10 amperes. Operate the generator at this speed for at least 10 minutes to bring the regulator up to operating temperature. Retard the generator speed until the circuit breaker points open, then bring generator back to speed and note voltage setting, which should be from 7.2 to 7.4 volts.

NOTE—When checking voltage regulator setting the regulator cover must be in place.

Stop the engine and remove the regulator cover.

The voltage setting of the regulator is adjusted by bending the spiral spring hanger down to increase the spring tension and increase the voltage setting, or by bending the spring hanger up to decrease the spring tension and lower the voltage. (Figure 28.) Normally, all adjustments should be made on the light spring and the heavy spring should not be touched. If the unit is badly out of adjustment or new springs are required, refer to "Regulator Spring Replacement" in the repair section.

NOTE—Only a slight bend of the lower spring hanger is necessary to change the voltage setting.

In case the voltage does not respond to a slight movement of the spring hanger the following adjustments are necessary:

1. Clean the regulator points according to instructions given in the repair section.

   For the air gap check, open the points by hand and slowly release the armature until the

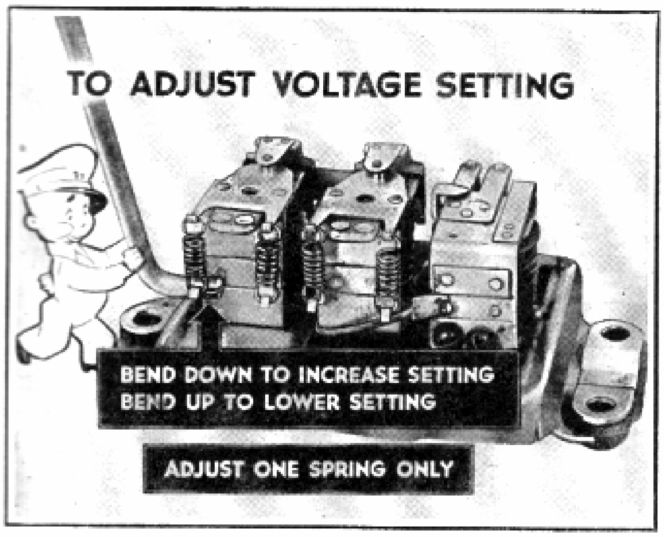


Fig. 28—Adjusting Voltage Setting

points **just touch**, then measure the air gap between the center of the winding core and the armature. The gap should be .070 inch. (See Fig. 29.)

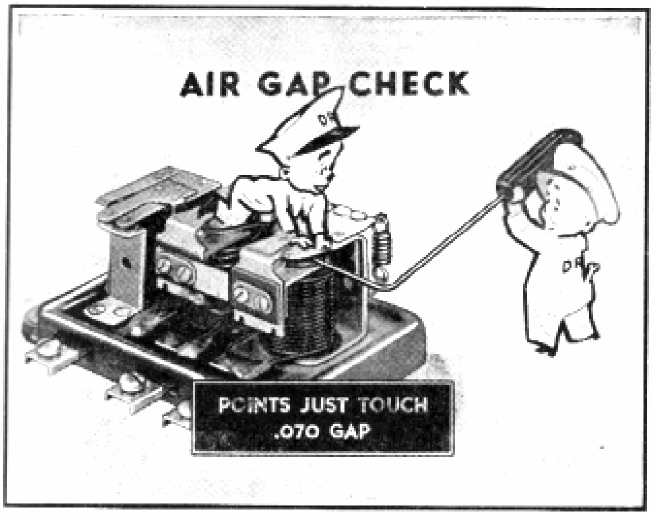


Fig. 29—Checking Air Gap

2. Adjustment of the air gap—Push the armature down all the way by hand. Allow it to come back up until points are just closing; then measure the air gap with a feeler gauge. The distance between the armature and the core should be .070". The air gap may be adjusted by loosening the two upper contact mounting screws and moving the upper contact support up or down as required to secure the proper air gap. (As illustrated in Fig. 30.) Be sure that points are lined up and tighten screws down well after adjustment.

After any adjustments, replace the cover, start the engine, and set it to run at a speed equivalent to 30 to 35 miles per hour. Readjust the variable

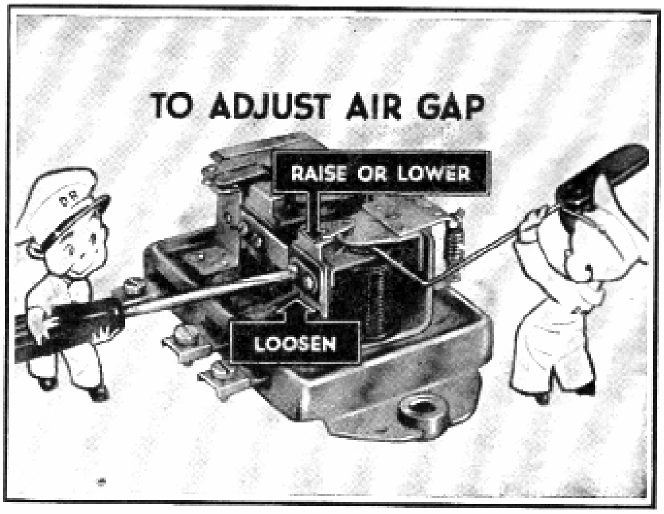


Fig. 30—Adjusting Air Gap

resistance in the volt ammeter to obtain a generator output of 8 to 10 amperes. Now check the regulator voltage, which should be within the limits given above.

REPAIR OPERATIONS

Cleaning Contact Points

Cleaning the contact points of the current and voltage regulator properly is one of the most important operations the mechanic will be called on to perform. Dirty or oxidized contact points arc and burn, cause reduced generator output, and run down batteries. If the points are properly cleaned the regulator will be restored to normal operation. If improperly cleaned improvement in performance will be small and only temporary.

Remove the upper contact support, so that each point may be properly and separately cleaned. Use a thin fine-cut ignition point file and file each point separately. Do not use the file excessively on the

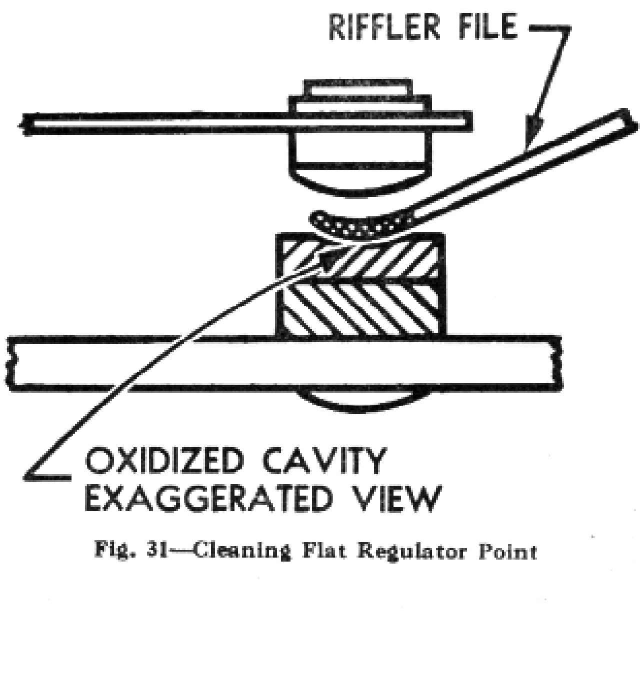


Fig. 31—Cleaning Flat Regulator Point

rounded (smaller) point. If a cavity is found in the flat point, clean it out with a spoon or riffler file. (Figure 31.)

Make sure the cavity is actually cleaned out, so good clean contact is made between the points. Reassemble contact supports, paying particular attention to the position of the insulators, and adjust the air gap.

NOTE—Never use sandpaper or emery cloth to clean the contact points.

Replacing contact support brackets of the voltage regulator unit can be done by removing the two contact mounting screws. New bushings should always be used, since the old bushings may become distorted and will not provide adequate insulation on reassembly.

Voltage Regulator Heavy Spring Adjustment

On voltage regulators that are badly out of adjustment after the points have been cleaned and the air gap set, it may be necessary to check the adjustment of the heavy spring. To do this remove the light spring from the regulator; connect the positive lead to the voltmeter to the generator terminal of the regulator and the negative lead to a good ground. Depress the voltage regulator armature by hand to open the points. Slowly increase the generator speed until the voltmeter reads approximately 3 volts. Release the armature and adjust the heavy spring hanger up or down to secure a voltage reading of 4.5 to 5 volts. Install the light spring and complete the adjustment to 7.2 to 7.4 volts entirely on this spring, as previously explained, without again touching the heavy spring.

NOTE—When the above adjustments are being made, the unit must be at operating temperature and the cover must be in place when voltage readings are taken.

THE ARMATURE MAY BE REPLACED by drilling out the two rivets which mount the armature hinge spring on the regulator frame. Support the frame to avoid bending it, center punch the rivet heads, and use a 3/32 drill. Assemble the new armature with the screws, lockwashers, and nuts supplied with the service armature. Assemble screws down so they will not ground against cover when cover is in place.

Reverse Polarity

If the polarity of the generator is reversed the circuit breaker contact points will vibrate and burn. To make sure the generator has the correct polarity after connecting it with the regulator, momentarily connect a jumper lead between the generator (GEN) terminal and the battery (BAT) terminal of the regulator before starting the engine. The momentary surge of battery current to the generator will correctly polarize the generator.

Radio By-Pass Condenser

The installation of radio by-pass condensers on the field terminal of the regulator or generator will cause the current and voltage regulator contact points to oxidize. Oxidized points cause a high resistance and may result in a low charging rate and a discharged battery. DO NOT CONNECT RADIO BY-PASS CONDENSERS TO THE FIELD TERMINAL OF THE REGULATOR OR GENERATOR.

If a condenser has been installed to the field terminal, disconnect condenser and clean the contact points of both the current and voltage regulator as explained under the heading "Cleaning Contact Points."

GENERATOR

The shunt wound generator, illustrated in Fig. 32, controlled by vibrating current and voltage regulation, is an ideal generating unit. It has the ability to supply the necessary electrical energy for lights, ignition and accessories, and in addition it serves to recharge the battery by furnishing current to make up for the cranking and other power supplied while the generator is not in operation.

This type of generator reaches its maximum output at a lower speed and maintains a constant output throughout the higher speed ranges without the "taper-off" characteristic of the third brush type. This generator cannot be adjusted to increase its output as this is accomplished by use of a cut-out, current regulator and voltage regulator.

The generator and water pump are driven by a belt and pulley on the front end of the engine crankshaft. Air is drawn through at the rear of the generator by a centrifugal fan mounted on the armature shaft, which serves to cool the unit and maintain it at a safe operating temperature.

In order that normal service may be obtained from the generator with a minimum of trouble, a regular inspection and maintenance should be followed. Periodic lubrication inspection of the brushes and commutator, and checking of the brush spring tension as outlined in the following paragraphs will insure normal operation and life to all parts. The disassembly of the generator at stated intervals for a thorough overhaul is recommended as a safeguard against road failures from accumulations of dust and grease, and normal wear of parts.

The external circuit must be kept in good condition. Defective wiring, loose or corroded connections at the battery, cranking motor, ammeter and elsewhere in the circuit must be checked for and eliminated when found. Loose or corroded connections in the charging circuit will cause high voltage which would result in injury to the generator and regulator, as well as short battery, light bulb, and distributor point life. Poor connections in the field circuit will cause a low generator output

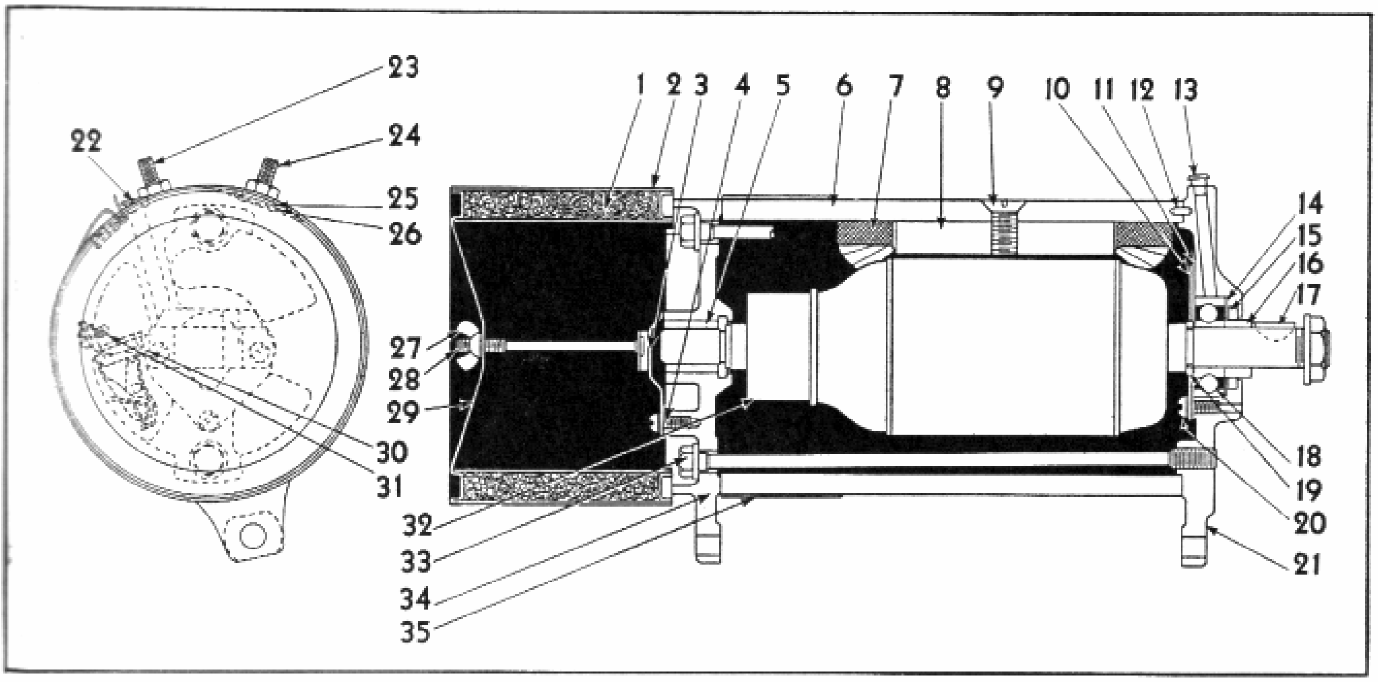


Fig. 32

1. Air Cleaner Copper Gauze.
2. Air Cleaner Outer Shell.
3. Bearing Dust Shield.
4. Bearing Dust Shield Screw.
5. Armature Rear Bearing.
6. Frame.
7. Field Coil Assembly.
8. Pole Shoe.
9. Pole Shoe Screw.
10. Bearing Retainer Plate.
11. Bearing Retainer Plate Gasket.
12. Dowel Pin.
13. Drive End Oiler.
14. Felt Washer Retainer Plate.
15. Felt Washer.
16. Outside Drive End Collar.
17. Drive Pulley Woodruff Key.
18. Drive End Bearing.
19. Inside Drive End Washer.
20. Bearing Retainer Plate Screw.
21. Drive End Frame.
22. Commutator End Oiler.
23. Terminal Stud and Lead Assy.
24. Terminal Assy.
25. Washer.
26. Insulating Washer.
27. Wing Nut.
28. Stud and Bracket Assy.
29. Air Filter Assembly.
30. Main Brush.
31. Screw.
32. Armature Assembly.
33. Thru Bolt.
34. Commutator End Frame Assy.
35. Cover Band Assy.

Lubrication

All the bearings are provided with hinge cap oilers and should have 5 drops of light engine oil every 1,000 miles. Do not lubricate excessively, since excessive oiling may cause oil to gum on the commutator and cause a reduction of the generator output. Never oil the commutator.

Inspection

The cover band should be removed and the commutator and brushes inspected at regular intervals. The frequency of the intervals will be determined by the type of operation. High speed operation, dust and dirt, encountered on the ventilated units, taking full output from the generator, are all factors which increase bearing commutator and brush wear. Generally speaking, generators should be inspected every 5,000 miles.

Commutator

If the commutator is dirty, it may be cleaned with a strip of No. 00 sandpaper. NEVER USE EMERY CLOTH TO CLEAN THE COMMUTATOR. All dust must be blown from the generator after the commutator has been cleaned. If the commutator is rough or out of round or has high mica, remove the generator from the engine and disassemble the armature from the generator. Turn the armature to true up the commutator and remove roughness and high mica. Undercut the mica.

Brush Spring Tension

Check the brush spring tension. Excessive spring tension will cause the commutator and brushes to wear rapidly. Low spring tension will cause a reduced generator output, and arcing and burning of the commutator and brushes. The correct spring tension is 25 oz. See Fig. 33. Check the pigtail lead connections at the brushes to see that they are tight.

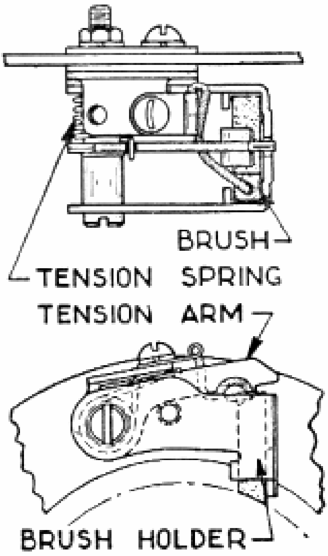


Fig. 33

A poor connection in the charging circuit will cause the generator to build up excessive voltage which may result in burned field or armature windings. A poor connection in the generator field circuit will cause a low output.

Brushes

Always replace worn brushes. Brushes may be seated by the use of a bedding stone. NEVER USE EMERY CLOTH OR SANDPAPER TO SEAT BRUSHES. With the generator operating at a medium speed, press the bedding stone firmly against the commutator and move it back and forth along the commutator to cover the area contacted by the brushes. The brushes should seat satisfactorily in a second or two. Blow the generator out with compressed air after the stone has been used, to remove all particles of abrasive.

Generator Drive Belt

Check the generator drive belt and tighten if necessary. Low belt tension will cause a reduced and unsteady output. Excessive belt tension will cause rapid belt and bearing wear. If the belt is frayed or worn, it should be replaced. See "Fan Belt Adjustment" in "Cooling System" section of this manual.

Generator Overhaul

At intervals of approximately 15,000 miles, the mileage depending upon the type of operation, the generator should be removed from the engine and completely disassembled. This may be done in the following manner.

1. Disconnect the field and positive wires from the generator.
2. Remove the generator brace nut, fan belt and bracket bolts—then remove the generator from the engine.
3. Place the generator in a bench vise. Use the vise as a holding fixture only, being careful not to pinch the generator frame.

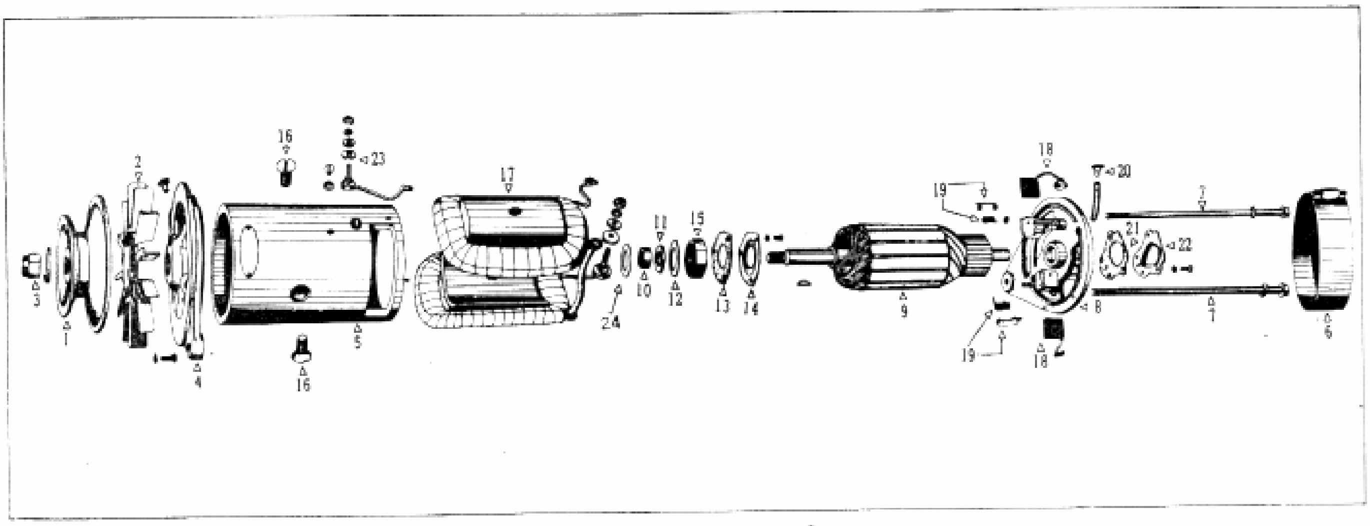


Fig. 34—Component Parts of Generator

1. Pulley.
2. Fan.
3. Pulley Nut and Washer.
4. Drive End Frame.
5. Frame.
6. Cover Band.
7. Through Bolts.
8. Commutator End Frame.
9. Armature.
10. Space Collar.
11. Felt Washer.
12. Felt Retainer.
13. Bearing Retainer Plate.
14. Plate Gasket.
15. Bearing.
16. Pole Shoe Screw.
17. Field Coils.
18. Brush.
19. Brush Arms and Springs.
20. Oiler.
21. Plate Gasket.
22. End Cover Plate.
23. Terminal Stud and Lead.
24. Washer.

4. Remove the generator pulley.
5. Remove the commutator cover band, brush lead machine screws, through bolts and commutator end frame assembly from the generator.
6. Remove the drive end frame and armature.
7. Remove the drive end bearing inside retainer plate, drive end bearing outside space collar and felt washer from the armature shaft.
8. Remove the drive end bearing from the end of the armature shaft.
9. Remove the drive end bearing inside spacer washers, retainer plate and gasket.

Inspection of Generator Parts

While the generator is disassembled, wash all parts in a suitable cleaning fluid. Do not clean the armature or field coils in any degreasing tank, since the compounds used in this type of cleaner may cause damage to the rubber and mica or enamel insulation.

Inspect the ball bearings by revolving them with the fingers. If the bearings feel rough or have any play present they should be replaced.

All worn parts should be replaced. The commutator should be trued in a lathe and the mica undercut, if necessary. Check all wiring and connections, internally and externally, since loose or corroded connections in the charging circuit may cause the generator to build up a dangerously high voltage which might ruin the unit. Poor connections in the field circuit will cause a low generator output.

If any connections are to be soldered, use a Rosin Flux in making the connection. Never use an acid flux on electrical connections.

CHECKING AN INOPERATIVE GENERATOR

If the generator is not performing according to specifications, and it has been checked according to recommended procedure and found to be at fault, proceed as follows to determine the location of trouble.

No Output

When no output can be obtained from the generator, remove the cover band and check for sticking brushes. If the brushes are seating satisfactorily and forming good contact with the commutator, remove the generator from the engine and check as follows with a set of test points and a 110 volt test lamp (Figure 35) to determine what has caused the failure.

1. Raise the grounded brush from the commutator and insulate it from the commutator with a piece of cardboard. Use the test points and check for ground from the generator main brush lead to the generator frame. If the generator is of the type which has the field internally grounded, disconnect the field ground lead, before making this check. Should the test lamp light, indicating ground, raise and insulate all brushes and check in turn the insulated brush-holders, armature commutator, and fields, to locate the ground. If a grounded field is found, check the regulator contact points, since a grounded field may permit a high field current which will cause burned and oxidized points. Repair or replace parts as required.

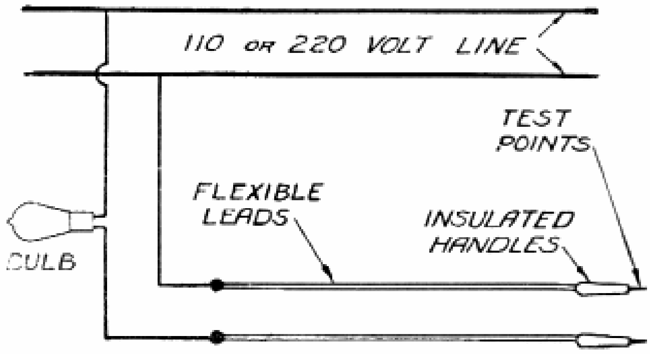


Fig. 35

2. If the generator does not show ground, check the field circuit for open circuit. Repair or replace as required.
3. If the field is not open, check for shorts in the field by checking the field current. Use a battery of the proper voltage and an ammeter, connected in series with the fields. Proceed with care in this check since a shorted field may draw an excessively high current. If the field current is not within specifications, new field windings will be required. Check the regulator contact points if a shorted field is found, since a shorted field may permit a high field current which will cause burned and oxidized points.

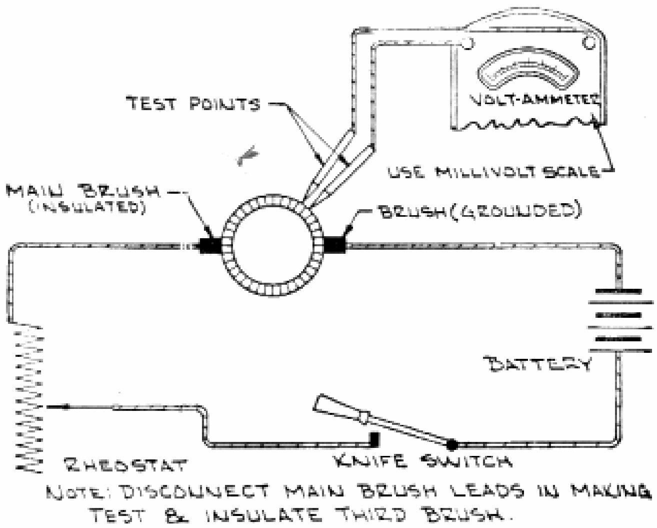


Fig. 36

4. Inspect the commutator bars since an open circuit in the armature, which would result in a low or no output, will cause the commutator bars connected to the open circuited coils to burn. A

further check for open circuit in the armature requires that the armature be removed from the generator and tested as illustrated in Figure 36. Do not use a rheostat for this test. Slowly rotate the armature, checking between adjacent bars with the test points. Any open circuited coils will cause a full battery voltage reading on the voltmeter.

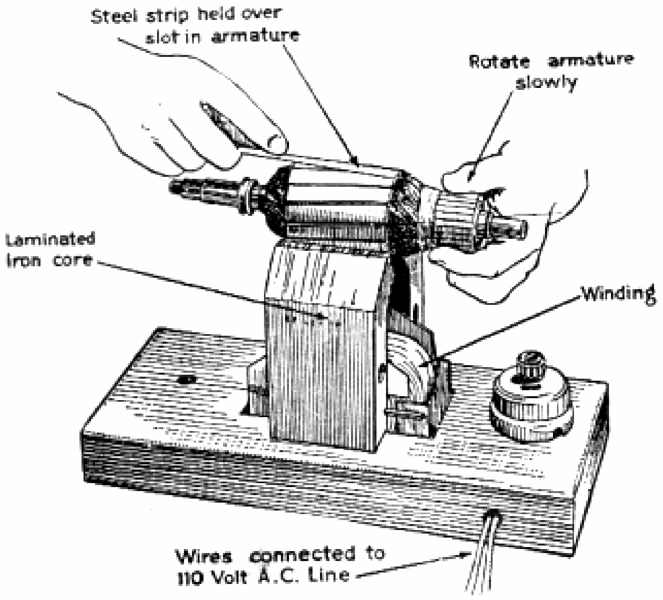


Fig. 37

5. If the trouble has not yet been located, check the armature for short circuit, using a "growler" as illustrated in Figure 37. A thin strip of steel, such as a discarded hack-saw blade, held in place over the armature core as the armature is revolved, will vibrate if a short circuit exists in the armature. Repair or replace as required.

Unsteady or Low Output

With a generator producing an unsteady or low output:—

1. Check the drive belt tension since a loose belt will slip and cause a low and unsteady output.
2. Check the brush spring tension and the brushes for sticking in the holders. If the brushes stick in their holder or if the brush spring tension is low, a low and unsteady output will result, and there may also be arcing and burning of the brushes and commutator. Refer to Figure 33.
3. Inspect the commutator for roughness, grease and dirt, dirt in the slots, high mica, out of round, and burned bars. A dirty commutator, dirt in the slots, high mica, or an out of round commutator will cause low and unsteady output and requires that the armature be set up in a lathe and a light cut taken off the commutator. Undercut the mica. Burned commutator bars indicate an open circuit condition in the armature. Check the armature after disassembly of generator as outlined under NO OUTPUT, paragraphs 4 and 5.

Excessive Output

Excessive output will result in an overcharged battery, light bulb failure, burned contact points, and generator windings. Check with the test leads for a grounded field, if the generator is of the type employing external regulation, and the output remains high in spite of opening the field circuit by disconnecting the lead at the generator "F" terminal. The field may be grounded at the pole shoes due to their cutting through the field winding insulation, at the leads, or at the "F" terminal. Check for burned and oxidized regulator points if a grounded field is found.

Excessive output from a third brush generator which does not have external regulation is likely due to an incorrect third brush setting. Resistance in the charging circuit will have the effect, under certain conditions, of causing an excessive output.

Noisy Generator

Noise in the generator may be caused by loose mounting, drive pulley or gear. Worn or dirty bearings may cause noise and require cleaning and relubrication or, if worn excessively, replacement. Brushes improperly seated may be seated by using a bedding stone as explained under BRUSHES, if they cause noise. A bent brush holder may cause noise and requires replacement.

Installation Caution

After the generator is reinstalled on the engine and reconnected, always connect momentarily with a jumper lead between the generator armature terminal ("ARM" or "GEN") and the battery or ammeter terminal ("AMM" or "BAT") of the relay or regulator BEFORE STARTING THE ENGINE. This allows a momentary surge of battery current to the generator which automatically gives the generator the correct polarity with respect to the battery it is to charge.

NEVER OPERATE THE GENERATOR ON OPEN CIRCUIT. TO DO SO WILL ALLOW IT TO BUILD UP A DANGEROUSLY HIGH VOLTAGE WHICH WILL PROBABLY RESULT IN COMPLETE GENERATOR FAILURE.

Reassembly of Generator

After the parts have been thoroughly tested and inspected and worn or damaged parts replaced, reassemble the generator as follows:

1. Assemble the drive end bearing outside retainer plate to the drive end frame.
2. Assemble the drive end bearing inside retainer plate, gasket, washer, bearing outside felt washers and space collar to the end of the armature shaft.
3. Assemble the drive end frame and inside retainer plate to the armature.
4. Assemble the armature and drive end frame assembly to the generator frame.

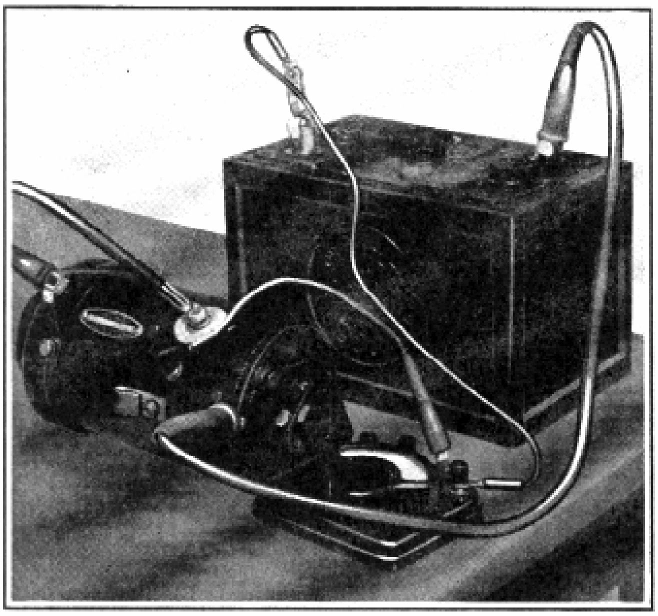


Fig. 38—Motoring Generator

5 Assemble the commutator end frame assembly, through bolts and connect up the brush leads.

Generator Tests

After the generator is completely assembled, and before it is installed on the vehicle the following tests should be made.

Motoring Generator: With a battery and an ammeter in the circuit as shown in Fig. 38, connect the field terminal to ground with a jumper lead; place one lead on Generator positive terminal and the other to the ground. This will operate the generator as a motor. The ammeter reading, with the generator running, should be from 4 to 6 amperes.

When motoring Voltage Regulated Generators (as is used in these vehicles) make sure to connect the positive of the battery to the positive terminal of the generator, otherwise the residual magnetism of the generator will be reversed, thereby reversing the polarity of the generator.

STARTER AND BATTERY

THE STARTING SYSTEM

The starting system has only one function to perform—it cranks the engine in the same manner as was formerly done by hand. In the starting system, there are three units: the battery, the starting switch and the starting motor. (Figure 40.)

The battery supplies the energy, the switch completes the circuit, allowing this energy to flow to the starting motor. The motor then delivers mechanical energy and does the actual work of cranking the engine. The starting equipment is used for a short time only and then remains idle until it is again needed to start the engine. The battery, however, performs other functions.

It should be noted that the starting motor draws a large amount of current for a short period of time, whereas the generator replaces this current by charging the battery at a lower rate for a much longer period of time.

Starter Controls

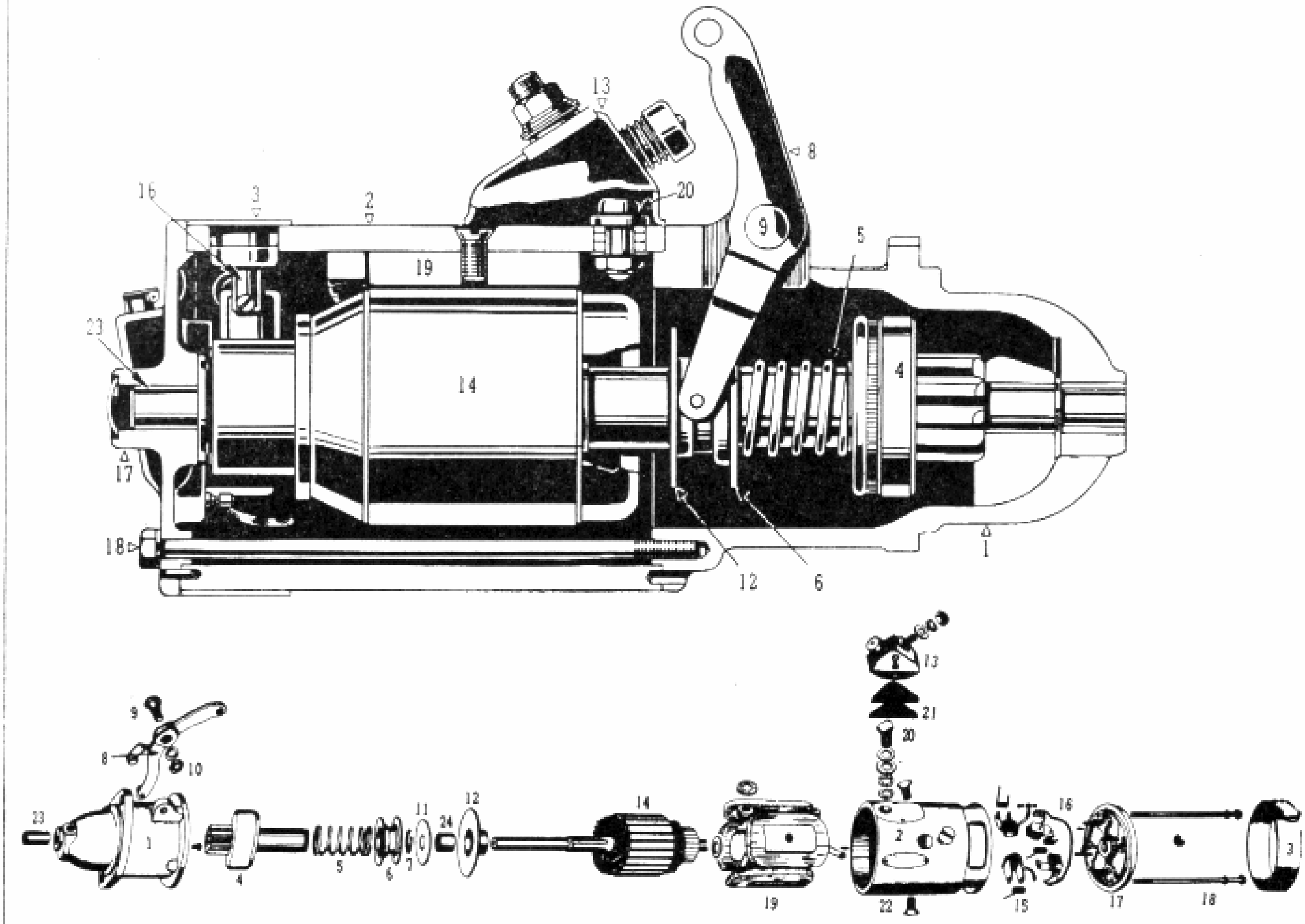
The manual control of the starting system consists of a starter pedal and rods interconnected to the starting motor shift lever through linkage mounted on the bell housing of the engine. Fig. 41. The only maintenance necessary on this manual control is to make sure that the linkage is free and that the return spring at the starting motor shift lever is in good condition.

Starting Motor

The starting motor Fig. 39 is similar in construction and appearance to the generator, but the design of the parts are different. Both motor and generator require frame, field coils, armature, brushes, etc. The operation of the starting motor is the reverse of the generator. In the case of the generator, a loop of wire is revolved in the magnetic field and generates current. In the case of a starting motor, current is supplied to the loop which lies in a magnetic field. As the loop rotates, mechanical energy is produced.

The starting motor is designed to incorporate a Manual Shift Drive Mechanism which assures positive engagement of the starting motor pinion with the flywheel until the engine is started. (Figure 41.) This is of especial benefit when starting a cold engine, as the starting motor will continue to crank the engine as long as the driver depresses the starter pedal.

In this design, the starter pinion in conjunction with an over-running clutch (or roller clutch), a compression spring and a pulley-like sheave are



1. Drive Housing.
2. Frame.
3. Cover Band.
4. Drive Assembly.
5. Drive Spring.
6. Drive Sheave.
7. Drive Lock Ring.
8. Shift Lever.
9. Shift Lever Stud.
10. Stud Nut.
11. Brake Washer.
12. Center Bearing Plate.
13. Starter Switch.
14. Armature.
15. Brush Springs.
16. Brushes and Holders.
17. Commutator End Frame.
18. Through Bolts.
19. Coils and Pole Shoes.
20. Terminal Stud.
21. Switch Insulation.
22. Shoe Screw.
23. Housing Bushing.
24. Center Bushing.

Fig. 39—Section View of Starting Motor

mounted as an assembly on the splined part of the armature shaft. The sheave and spring are mounted to rotate freely on the outer diameter of the tube portion of the assembly. (See Figure 41.)

A multiple spring and roller over-running mechanism (Figure 42), similar to that of a bicycle coaster brake, is located between the outer part of the clutch which is attached to the pinion and the inner part which is splined to the armature shaft.

A lever bolted at its fulcrum to the starting motor housing has a yoke at its lower end which straddles the sheave, integral bosses on its inner sides engage the sheave grooves. Its upper end connects to the starter pedal through linkage.

When cranking the engine, depressing the starter lever causes the lever to shift the pinion gear into mesh with flywheel teeth. Further pedal movement brings an offset portion of the lever into contact with the button on the starter switch, thereby closing the switch contacts. In case the pinion gear is stopped when entering the edge of the flywheel, the compression spring allows the sheave to move along the sleeve, permitting the lever to close the starter switch contacts. The instant the armature starts to rotate, the compression

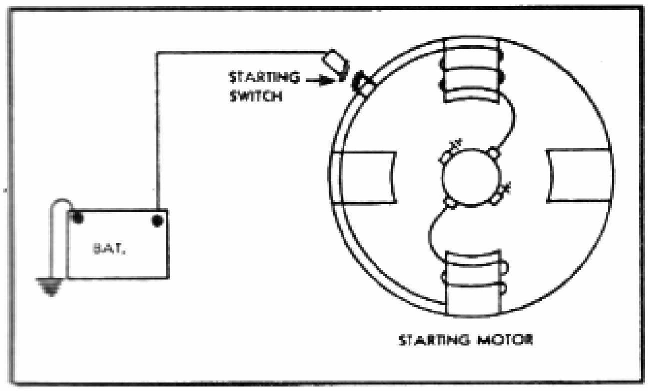


Fig. 40—Starting Motor Circuit

spring pushes the pinion gear into full mesh with the flywheel immediately.

After the engine fires, and before the pinion can be withdrawn from the flywheel teeth, the over-running clutch allows the pinion to spin freely on the armature shaft. The tension of starter pedal return spring holds the pinion out of mesh with the flywheel while the engine is operating.

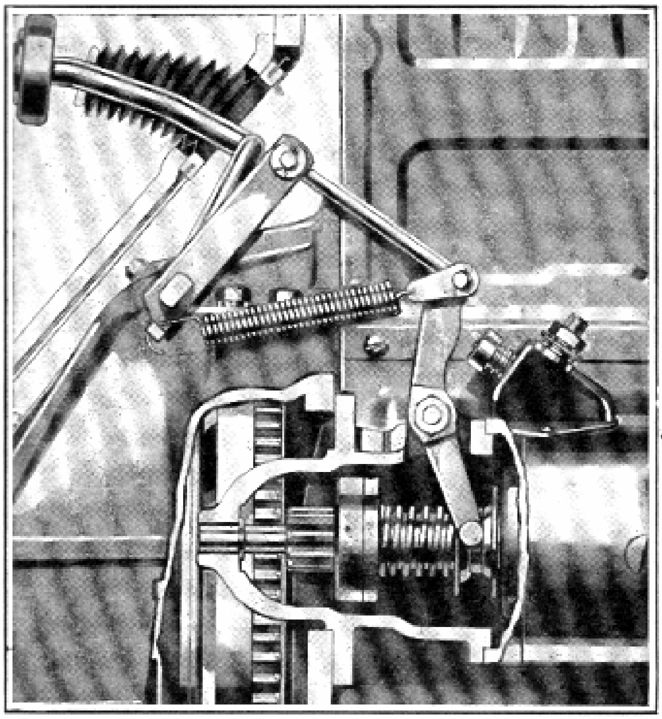


Fig. 41—Starting Motor Control and Cut-Away of Starting Motor Drive

Starting Switch

The starting switch is designed to carry the heavy current required by the starting motor without loss and without heating.

This switch has the contacts so arranged as to provide a wedging action, thus insuring a good connection when the contacts are brought together and also giving the contacts a wiping action which tends to keep them clean.

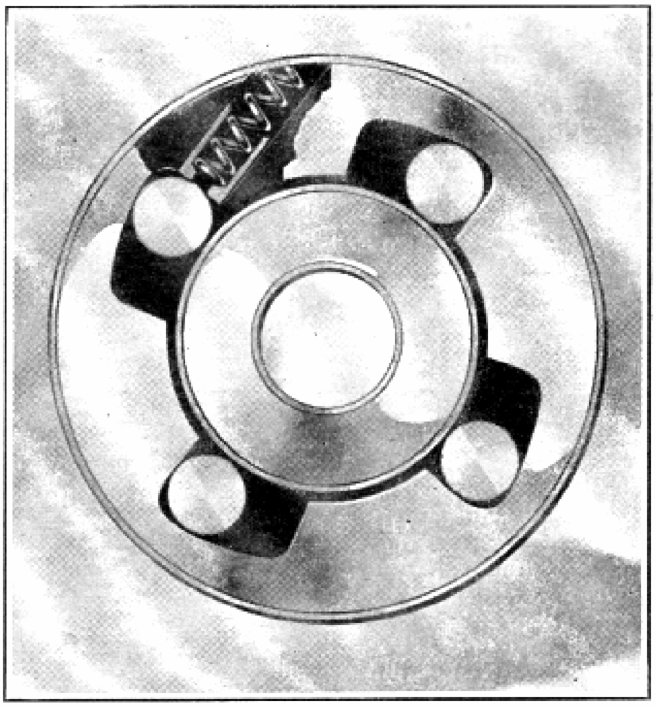


Fig. 42—Over-Running Clutch

Drive Mechanism

The drive pinion and over-running clutch is a self-contained unit and if it becomes damaged in any way the complete unit should be replaced. However, should the spring be broken or the sheave become worn, these parts may be easily replaced by compressing the spring to uncover the lock ring in the tube part of the drive mechanism. Removal of the lock ring permits removal and replacement of both the sheave and spring. Fig. 43 shows a layout of the drive mechanism parts.

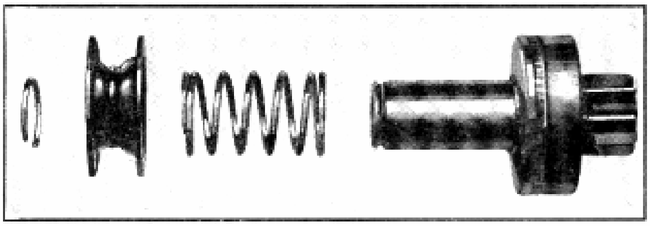


Fig. 43—Starting Motor Drive Mechanism

STARTING MOTOR MAINTENANCE

If a starting motor is not operating properly, and it has been determined that the trouble is in the starting motor, or the starting motor control, a series of checks should be made to determine the trouble and possible remedy.

Before making various checks, the battery connections and the cables from the battery to the starting motor, and from the battery to ground should be inspected. The condition of the battery should also be determined.

Checking Motor on Vehicle

It is often possible to correct the starting motor trouble without removing the unit from the vehicle. The cover bands on the starting motor should be removed, and the brushes and commutator should be inspected at periodic intervals.

Brushes

Replace the brushes if they are appreciably worn. If the brushes are not seating properly on the commutator, they should be worn-in to the contour of the commutator.

Brushes can be worn-in by using a strip of No. 00 sandpaper between the brush and commutator. The rough side of the sandpaper should be toward the brush and should conform to the contour of the commutator. After this sanding operation is completed, the brushes and commutator should be polished and cleaned as described under "Commutator".

Brush Arms should be inspected. If the arms are sticking, the brushes will not make good contact with the commutator.

Brush Spring Tension should be checked. Weak brush spring tension causes arcing, due to a poor contact between the commutator and brushes. This action may result in short brush life and more or less burning of the commutator. Excessive spring tension causes abnormal wear of the commutator, due to increased friction between the brushes and commutator.

Spring tension of all brush arms on the starting motor should be tested by means of a small spring scale. The scale should be connected at the brush. directly under the heads of the screws which hold the brush to the arm. A direct pull should be given and a reading taken just as the brushes leave the surface of the commutator. This reading should be between 24—28 oz.

Commutator

Remove the cover band to inspect the condition of the commutator. If the commutator is dirty or slightly burred, polish it by placing a strip of No. 00 sandpaper between brush and commutator while the armature is revolving. After the polishing operation, remove all dust from the commutator and brushes.

If the commutator is rough and badly worn, remove it from the unit and turn it in a lathe to true it up.

Checking the Starting Motor on a Bench

If the starting motor does not operate properly after the foregoing checks have been made, the unit should be removed from the vehicle and tested on a bench. Suitable instruments such as or equivalent to those indicated under "Tools" should be used to make bench tests. Two bench tests, NO-LOAD and TORQUE, should be made on the starting motor to determine the condition before the unit is disassembled and the component parts tested.

No Load Test

Connect the starting motor in series with a battery of the specified voltage and an ammeter capable of reading several hundred amperes. If an r.p.m. indicator is available, read the armature r.p.m. in addition to the current draw.

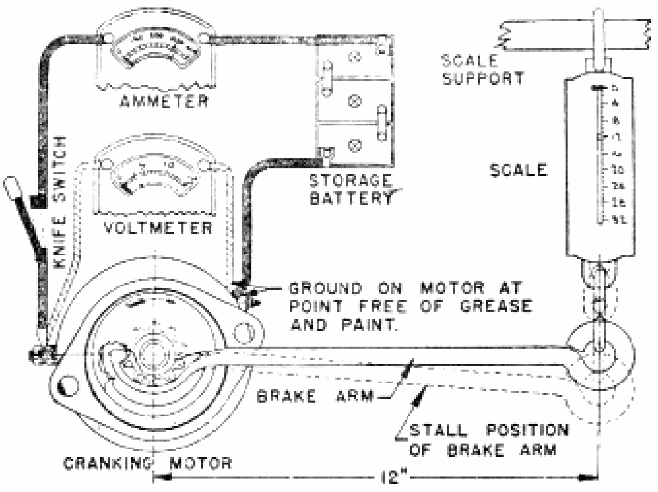


Fig. 44—Torque Test

Torque Test

Torque test equipment such as illustrated in Figure 44 is required to determine if the starting motor will develop its rated torque. The starting motor is securely clamped in position and the brake arm hooked to the drive pinion. If the brake arm is one foot long, the torque, when the circuit to the starting motor is closed, may be read directly from the scale. Some types of torque testers indicate the reading directly on a dial. It is advisable to use in the circuit a high current carrying variable resistance, so that the specified voltage at the motor can be obtained. A small variation of the voltage will produce a marked difference in the torque developed.

Interpreting Results of No Load and Torque Tests:

1. Rated torque, current draw and no load speed indicates normal condition of the starting motor.
2. Low free speed and high current draw with low developed torque may result from:
   - (a) Tight, dirty, or worn bearings, bent armature shaft or loose field pole screws which would allow the armature to drag.
   - (b) Shorted armature.
   - (c) A grounded armature or field.

3. Failure to operate with a high current draw:
   (a) A direct ground in the switch, terminal or fields.
   (b) Frozen shaft bearings which prevent the armature from turning.
4. Failure to operate with no current draw:
   (a) Open field circuit.
   (b) Open armature coils.
   (c) Broken or weakened brush springs, worn brushes, high mica on the commutator, or other causes which would prevent good contact between the brushes and commutator.

Any of these conditions will cause burned commutator bars.

5. Low no-load speed, with low-torque and low current draw indicates:
   (a) An open field winding.
   (b) High internal resistance due to poor connections, defective leads, dirty commutator, and causes listed under 4 (c) above.
6. High free-speed with low developed torque and high current draw indicates:
   (a) Shorted fields.

There is no easy way to detect shorted fields, since the field resistance is already low. If shorted fields are suspected, replace the fields and check for improvement in performance.

High Points on Starting Motor Performance and Checks

1. On this type of starting motor with an over-running clutch, the hand must not be left on the starter control after the engine begins to operate, as this may be injurious to the over-running clutch.
2. Burned commutator bars may often be found to be caused by poor soldering of leads at the commutator riser bars. Excessively long starting periods which allow the starting motor to overheat and the solder to melt and throw out is a common cause of this condition. When burned bars are found, the leads should be re-soldered in the riser bars and the commutator turned down.
3. Be sure the brush holders are free and that the brush leads are not holding the brushes up off the commutator. There must be good firm contact between the commutator and brushes.
4. The commutator must be smooth and round. Roughness or an out-of-round condition causes rapid brush wear and inferior cranking motor performance.
5. The starting motor drive must be kept clean so it will operate freely and return to its normal position after each starting cycle.
6. The battery cables and connections between the starting motor and the battery must be in good condition to insure good starting motor performance.

Disassembling

Remove starting motor parts in the following sequence. Refer to Fig. 39.

1. Remove the cover band (3) switch (13), through bolts (18) and commutator end frame (17).
2. Remove the field coil to brush lead screws.
3. The Commutator end frame and brushes may then be removed from the armature.
4. Remove the motor drive housing (1) with the drive mechanism and armature from the main housing.
5. Remove the shift lever stud and nut (9).
6. Remove the center bearing attaching screw.
7. The drive mechanism including the shift lever can then be removed from the motor drive housing.
8. To disassemble the motor drive mechanism (4, 5, and 6), compress the spring until the lock ring on the shaft is uncovered. The removal of the lock ring will permit the disassembly of the drive mechanism.

Inspection and Test of Parts

Inspect the starter switch terminals, contacts, and insulation. If these parts appear to be defective or worn, replace them with a new switch assembly.

Wash all the drive mechanism in a suitable cleaning fluid with the exception of the clutch and pinion assembly (4).

Check the brushes and commutator described under "Starting Motor Maintenance".

The starting motor parts may be tested in the following manner.

Field Coil Test for Continuous Circuit: Place the test prod leads on the field coil leads. (See Figure 45.) If the test lamp lights, the field coils are O.K. If the test lamp does not light, there is an open circuit in one or both of the field coils.

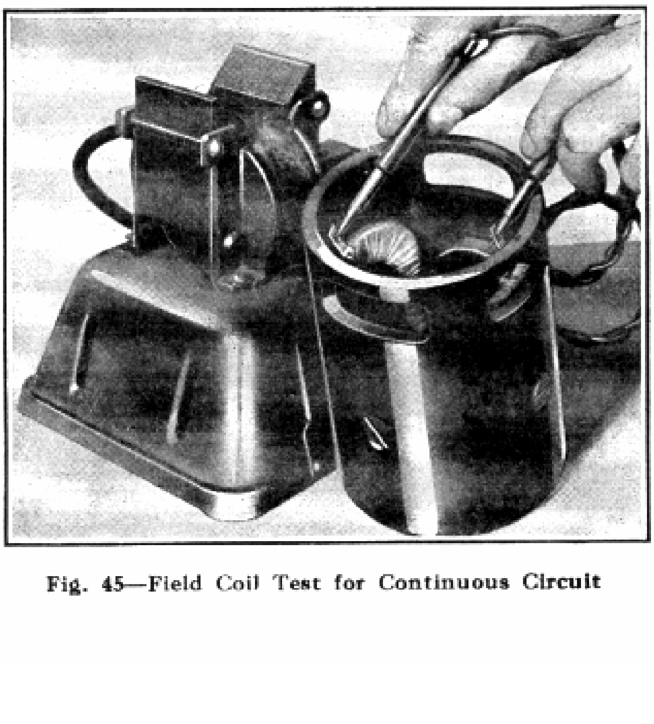


Fig. 45—Field Coil Test for Continuous Circuit

Field Coil Test for Ground: Place one test prod lead to frame and the other to the field coil lead. (See Figure 46.) If the test lamp does not light the field coils are O.K. If the test lamp lights, one or both field coils are grounded.

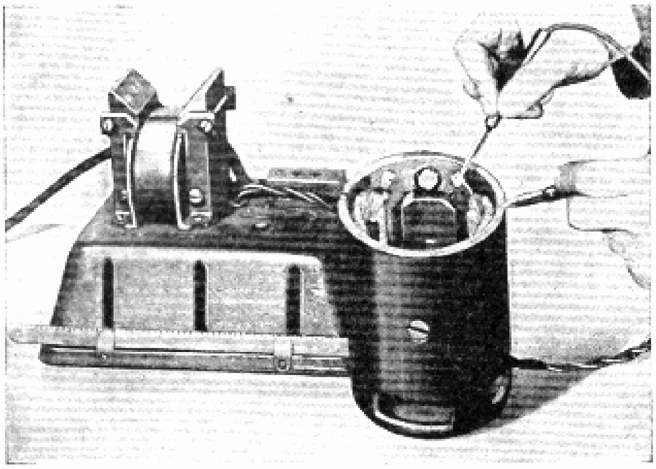


Fig. 46—Field Coil Test for Ground

Individual Field Coil Test for Ground: Break soldered connection between the two field coils and test each one separately replacing the field coil that is grounded.

Field Coil Leads: Inspect the field coil leads where they are soldered at the starting switch terminal to be sure that they are tight.

Armature Test for Ground: Place one test prod on the armature and the other on the commutator. (See Figure 47.) If the test lamp lights, the armature is grounded and should be replaced. If the test lamp does not light, the armature is OK.

Armature Test for Short Circuit: Place the armature on the growler, and with a saw blade over the armature core, rotate the armature and

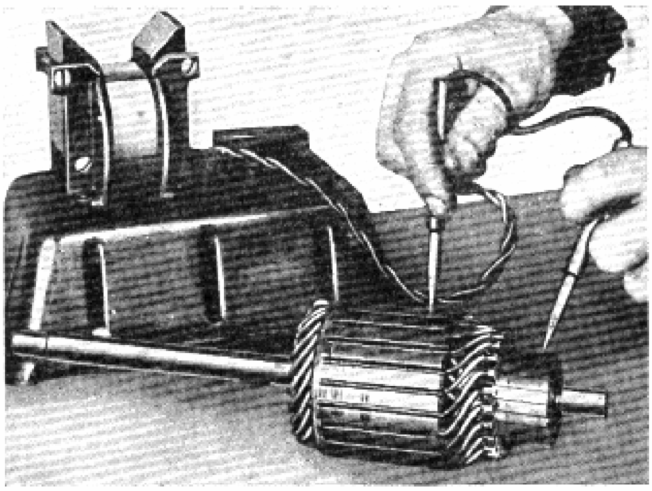


Fig. 47—Armature Test for Ground

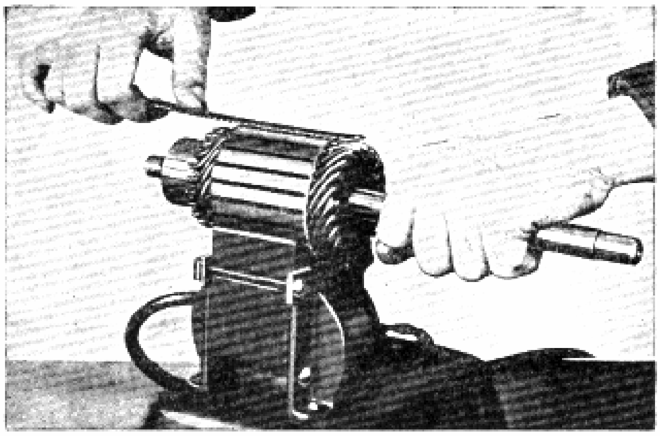


Fig. 48—Armature Test for Short

test. (See Figure 48.) If the saw blade does not vibrate the armature is OK. If the saw blade vibrates the armature is short-circuited and should be replaced.

Commutator: Inspect the commutator for roughness. If it is rough, turn down on a lathe until it is thoroughly cleaned up and sand off the commutator with 00 sand paper.

Insulated Brush Holder Test for Ground: Place one test prod lead to the cover and the other on the brush holder. (See Figure 49.) If the test lamp lights, brush holder is grounded and should be replaced. If the test lamp does not light, the brush holder is OK.

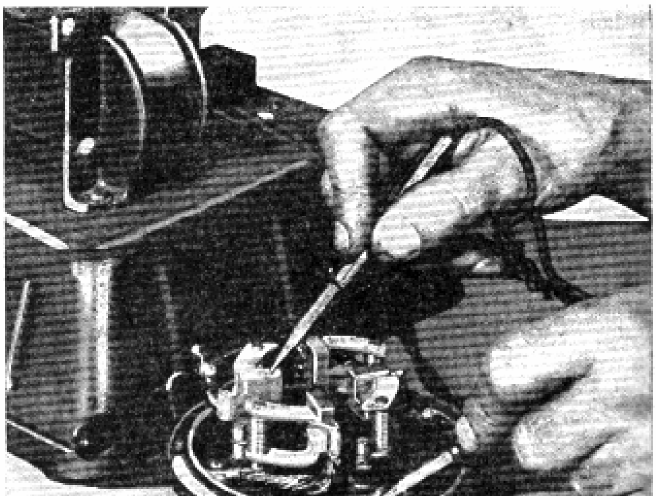


Fig. 49—Insulated Brush Holder for Ground

Brushes: Check the condition of the brushes and if they are pitted or worn, they should be replaced. Check the tension of the brush holder springs; they should have enough tension to hold the brushes snugly against the commutator.

Brush Ground Leads: Diconnect the brush ground leads from the end frame and clean all terminals and replace. Check the insulation of the brush to field coil leads. The insulation should not be broken.

Rear Housing Bushing: Check the condition of the housing bushing. The armature shaft should fit snugly in this bushing; if it is worn it should be replaced.

Reassembling

Reassemble the starting motor in following manner: (Refer to Fig. 39.)

1. Reassemble the field coils and pole shoes to the starting motor body.
2. Install the terminal stud (20) and nut to the field coil. Tighten the stud nut. Place a small bit of solder on the thread end of the stud. Hold a hot soldering iron on the stud JUST LONG ENOUGH TO RUN THE SOLDER on the next stud nut and coil ribbon.
3. Thread the shift lever (8) into the slot in the motor drive housing.
4. Place the drive mechanism into the housing and engage the bosses on the lever in the grooves of the sheeve (6).
5. Install the shift lever stud (9) in the housing and the shift lever.
6. Install the center bearing plate (12), fibre brake washer (11) and the center bearing plate screw.
7. Place the drive end of the armature shaft through the drive mechanism and drive housing.
8. Install the starting motor frame on the drive housing.
9. Install the commutator end frame and brush assembly on the commutator.
10. Make the brush and field coil connections.
11. Install the through bolts.
12. Test after assembly.

Checking Line Voltage

Check the cable leads and connections to determine if they are in good condition without excessive resistance. Excessive resistance produces abnormal voltage drop which may lower the voltage at the starting motor to such a low value that normal operation of the starting motor will not be obtained. Abnormal voltage drop can be detected with a low reading voltmeter in the following manner:

1. Check the voltage drop between the grounded battery terminal (negative) and the vehicle frame. Place one prod of the voltmeter on the battery terminal and the other on the vehicle frame. With the starting motor cranking the engine, the voltage reading should be less than 1/10 of a volt. If it is more than this, there is excessive resistance in this circuit.
2. Check the voltage drop between the ungrounded battery terminal and the starting motor terminal stud while the motor is operated. If the reading is more than 1/10 of a volt, there is excessive resistance in the circuit.
3. Check the voltage drop between the starting motor housing and the vehicle frame. This must be less than 1/10 of a volt.

If excessive resistance is found in any of the three circuits, disconnect the cables, and clean the connections. If the cables appear frayed, replace them with new ones of CORRECT size. Check the condition of the ground strap and replace it if necessary.

Starting Duration

If the engine fails to start after extended cranking, check for other trouble. If the cranking cycle is continued for periods of more than 15 seconds, excessive heat is developed in the motor and there is danger of seriously damaging the circuit.

The Starting Motor housing bearings are lubricated through small hinge oil cups mounted on each end of the assembly. These bearings should be lubricated with three drops of light engine oil every 5,000 miles.

THE STORAGE BATTERY

The storage battery, (Figure 50), may be considered a tank or reservoir in which energy from the generator may be accumulated and stored until it is required.

Since the performance of the electrical equipment depends to a great extent on the condition of the storage battery, its function should be thoroughly understood.

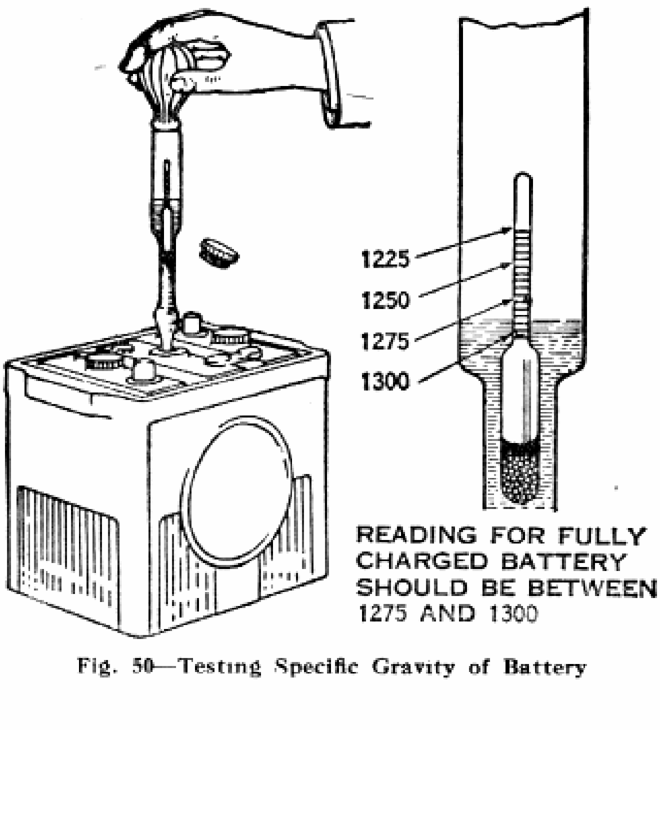


Fig. 50—Testing Specific Gravity of Battery

The battery, popularly referred to as "storage battery," gives rise to a false conception of the true nature of the battery. The battery is in reality an electro-chemical apparatus.

Electricity is not stored away in the battery until needed but is caused to flow into the battery and out by means of two wires attached to it; but none of the electricity stays there; certain changes merely take place within the battery itself.

Charging a battery by causing electric current to flow through it sets up a certain electro-chemical action between its positive and negative plates in the presence of the battery fluid or electrolyte.

When this electro-chemical action known as "charging" has been completed, it is only necessary to make continuous uninterrupted circuit between the positive and negative terminals of the battery through the wiring system and electrical apparatus of the vehicle in order to produce electricity, and when used for a sufficient length of time it is changed to its original or "discharged" condition.

Electric current is generated in the battery in as full a sense as it is in an electric generator.

From the foregoing it will be seen that the efficiency of the battery is in direct proportion to its state of charge; also that in order to obtain the maximum efficiency from the battery, whatever amount of current is withdrawn or generated by the battery must be compensated for by running the generator long enough to restore the battery plates to the condition known as "charged."

The construction of a storage battery is extremely simple. A battery possesses three compartments or cells. Within each cell are two elements, one positive (+), and the other negative (—). Each element consists of a number of plates called "grids," the openings of which are filled with a lead paste. Each group of plates is connected together and separated from the opposite group by separators between each plate.

The liquid in which these plates are immersed is called electrolyte. When the battery is being charged the acid is forced out of the plates and causes the specific gravity of the solution to rise. When the battery discharges, the acid returns into the plates and the specific gravity falls, until in the case of a completely discharged battery, the solution is practically distilled water.

The battery while undergoing a charge emits gasses, during which the battery is said to be "gassing." It also has a tendency to heat if the charging rate is abnormally high; therefore, it is essential that distilled water be added from time to time to replace the loss in water due to "gassing" and evaporation.

At the top of each cell is a vent hole or opening accessible by unscrewing the vent cover. Immediately upon receipt of a battery or a new vehicle the battery should be inspected. All vent covers should be removed and the level of the solution in each cell checked.

Due to the location of the battery it is most important that the water level be checked more frequently than recommended in the past. Water level should be kept not more than ¼" above the top of the plates at all times.

Filling one cell does not fill all, so examine each one and fill as required. If inconvenient to obtain distilled water, use melted natural ice or rain water and under no circumstances use ordinary water. Do not store water for batteries in metallic vessels—use glass.

If the water falls below a point where the battery plates are exposed the plates become hardened and the battery capacity is greatly reduced. Never add acid.

Keep the terminals clean and tight and well covered with vaseline to prevent corrosion.

In order to prevent freezing in cold weather, test the battery frequently and see that the gravity is kept up to at least 1.250. A discharged battery will freeze at a little below the freezing point.

Batteries in new vehicles and those carried in parts stock should receive regular attention in order to prevent sulphation of the plates due to inactivity of the battery.

We recommend the following:

New Batteries in Stock—

1. Check electrolyte on each new battery received—add sufficient distilled water to bring the electrolyte not more than ¼" above the plates.
2. Check the electrolyte and add necessary water at 15-day intervals.
3. If the specific gravity is below 1.225, remove the battery to a charging line and charge at a rate of from 5 to 8 amps. until the specific gravity of the electrolyte reaches 1.275 to 1.300. Allowing the battery to remain on the charging line from three to four hours after the specific gravity of the electrolyte has ceased to rise will insure a more completely charged battery. Before a new battery is put into use, make sure that the specific gravity of the electrolyte messures at least 1.260—preferably higher. Under no circumstances should acid be added to a new battery to increase the specific gravity of the electrolyte.

BATTERY SERVICE OPERATIONS

To be sure that the battery will function properly, it is essential for it to be serviced according to the following instructions:

Checking the Specific Gravity

The specific gravity must not be less than 1.225.

NOTE—When the battery is fully charged the specific gravity of the electrolyte in each cell is 1.275 to 1.300. Therefore, under average conditions, the simplest means of determining the condition of charge is by a specific gravity reading.

Hydrometer Reading

Hydrometers are ordinarily calibrated for a temperature of 60° F., so that if the liquid being measured is at a temperature of 60° F., the reading of the hydrometer will be the true specific gravity reading. If the temperature varies from the calibration temperature, a correction must be made according to the following table:

If Temperature Is	Add	If Temperature Is	Subtract
60°	.000	50°	.004
70°	.004	40°	.008
80°	.008	30°	.012
90°	.012	20°	.016
100°	.016	10°	.020
110°	.020	0°	.024
		—10°	.028
		—20°	.032

Freezing Point

The freezing point of the electrolyte depends on its specific gravity. The following table gives the freezing temperature of battery solution at various specific gravities:

1.100	18 above 0	1.180	6 below 0
1.120	14 above 0	1.200	17 below 0
1.140	8 above 0	1.220	31 below 0
1.160	2 above 0	1.240	51 below 0

Testing the Battery Voltage with a Voltmeter

Attach the positive voltmeter lead to the positive post of the battery and the negative voltmeter lead to the negative post of the battery. The voltmeter should read 6 volts or over. If this reading is not obtained, the battery either needs charging or one of the cells in the battery may be shorted or dead. This test will give the true battery voltage at the time the battery is tested, and if the hydrometer reading showed full charge, the voltage reading should be 6 volts or over. Since it is possible for a battery to read 6 volts or better on this test and still have a weak cell in the battery that would break down under load, it is necessary that the next test be made.

Testing the Battery with a Voltmeter While the Starter is Cranking the Engine

Have the ignition switch turned off. Attach the positive voltmeter test lead to the starting motor switch where the cable from the battery fastens. Attach the negative voltmeter test lead to the engine. Close the starting motor switch and crank the engine for one-half minute. If the battery cranks the engine at a good rate of speed with a voltage reading of 4½ volts or better for one-half minute, no further tests are necessary.

But, if the battery cranks the engine at a low rate of speed with a voltage reading of below 4½ volts it indicates lack of capacity in the battery or trouble in the starting motor circuit. In this latter case, a load test of the battery alone should be made, using a standard engine analyzer battery test unit, or a battery cell tester to determine whether the trouble is in the battery or in the starting motor circuit.

Testing for High Resistance in Positive Battery Cable with a Voltmeter

Attach negative voltmeter test lead to the starting motor switch post where the cable from the battery fastens. Attach positive voltmeter test lead to screw driver, and hold the screw driver point tight on the positive post of the battery. Close starting motor switch to crank the engine.

If the voltmeter does not read more than ¼ of a volt, the positive cable and connections are satisfactory. But if the reading is more than ¼ of a volt, tighten up the connections and replace the starting cable, if needed. Undersize cables and cables badly sulphated or partly eaten away create high resistance and cut down the efficiency of the starting circuits.

Testing for High Resistance in the Battery Ground Strap with a Voltmeter

Attach the positive voltmeter test lead to a ground by clipping it to one of the copper tubes leading from the brake master cylinder. Attach negative voltmeter test lead to screw driver and hold the screw driver point tight against the negative post of the battery. Close the starting motor switch to crank the engine. If the voltmeter shows only a perceptible movement of the needle with a zero reading, the ground strap connections are satisfactory.

NOTE—The preceding two tests are extremely important as resistance in the battery connections may exceed the maximum value for which the voltage regulator is designed, causing serious damage to the contact points in this unit. If a voltmeter is not available to check resistance, the cables should be removed, cleaned and closely inspected.

DISTRIBUTOR, COIL AND SPARK PLUGS

THE IGNITION SYSTEM

The power in a gasoline engine is derived from the burning of gas in the engine cylinders. In order to explode this gas, the electric spark is made to jump a small gap inside the cylinder. The ignition system furnishes this spark. The spark must occur in each cylinder at exactly the proper time and the sparks in the various cylinders must follow each other in the proper order. To accomplish this, the following parts are used: The battery which furnishes the electrical energy; the ignition coil which transforms the battery current to high tension current which will jump the gap in the spark plug; the mechanical breaker which opens and closes the primary circuit at the proper time; the distributor which delivers the spark to the proper cylinders; the spark plug which provides the gap in the engine cylinder; the wiring which connects the various units; the ignition switch for disconnecting the battery when it is desired to stop the engine.

Ignition Circuits

There are two distinct circuits in the ignition system; namely, the primary and secondary.

When these circuits are kept in mind, a better understanding is had of the operation of the system.

The PRIMARY, or low-tension circuit includes the source of electrical energy (battery or generator), distributor contact points and circuit-breaker mechanism, primary circuit of the ignition coil and the condenser.

The SECONDARY, or high-tension circuit includes the secondary circuit of the coil, distributor rotor and cap, high tension wiring and the spark plugs

Operation

When the gni ion switch is closed, cu rent flows from the battery to the starter switch, over the wire to the ammeter, and then to the ignition switch, through the switch to the coil. The current now passes through the primary winding to the distributor across the breaker points to the ground and back to the grounded terminal to the battery. See Fig. 51.)

Current flowing through this circuit builds up a magnetic field about the coil. When the breaker points open, the current tends to keep on flowing and surges into the condenser, attracting a positive charge on one side and a negative charge on the other. A fraction of a second after the breaker points open, the counter pressure in the condenser overcomes the surge pressure on the line and the condenser discharges from the positive charged side back through the primary winding of the coil in the opposite direction to the primary current, through the battery to the ground and back to the grounded side of the condenser, equalizing the two sides of the condenser. The discharge current from

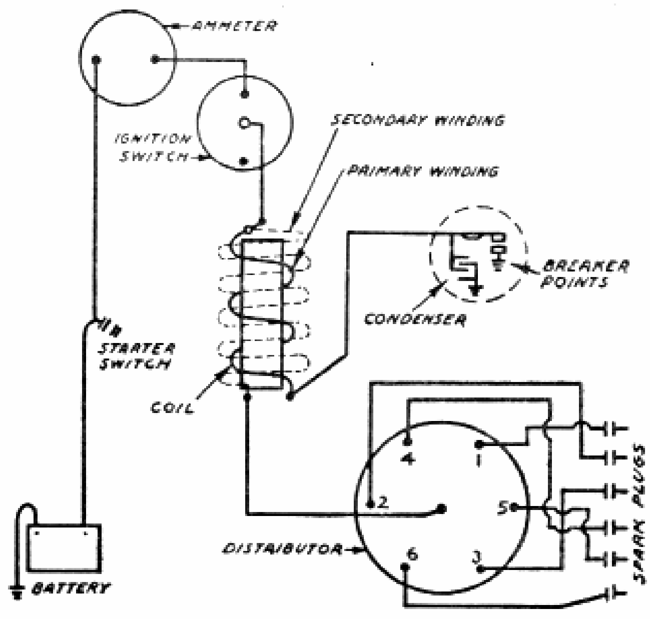


Fig. 51—Ignition Circuit

the condenser, passing over the primary winding tends to reverse the polarity of the coil and results in a very rapid demagnetizing of the coil. This rapid movement of the lines of force across the large number of turns of the secondary winding induces a current of very high voltage which flows from the secondary winding to the high tension terminal of the coil, then to the distributor, across the distributor brush to the spark plug, across gap in plug to ground and back to the other end of the secondary winding, completing the circuit.

THE IGNITION COIL

The purpose of the ignition coil is to transform energy from a low voltage source (battery or generator) into energy at sufficiently high voltage to jump the gap at the spark plug. Briefly, this transformation or induction is accomplished in the following manner:

There are two electrical circuits within the coil, the primary and the secondary. The PRIMARY is wound with comparatively few turns of heavy wire usually on the outside of the SECONDARY. Each end of the primary winding is connected to a low tension terminal.

The SECONDARY is wound with many layers of fine wire around an iron core. Each layer is insulated from the adjacent layer. One end of the secondary winding is connected to a primary terminal, and the other end to the secondary terminal.

When the contact points in the distributor close, current from the generator or battery flows through the primary circuit creating a magnetic field around the windings and core. When the distributor points open, current in the primary circuit does not stop flowing instantly but flows into a condenser which is connected in parallel with the points. As explained the condenser action causes a quick collapse of the magnetic field which induces a voltage in the primary as well as in the secondary windings. This voltage increases until it is sufficiently high to produce a spark at the spark plug.

To fire the present day high-speed engine, an ignition coil must be capable of delivering a high voltage varying from 4,000 to 20,000 volts under all operating conditions. When the immense amount of service a coil is expected to give s taken into consideration, systematic inspection of this unit should be considered one of the important maintenance operations.

Inspection and Testing the Coil

As no definite period can be given for ultimate life of the ignition coil, periodical tests of this unit should be made at 5,000 mile intervals. This interval may be changed depending upon the severity of service to which the vehicle is subjected. If there is any doubt as to the coil's ability, tests should be made regardless of the mileage.

For an accurate test, the ignition coil should be removed from the engine. A visual inspection should first be made of the condition of the terminals and wires before removing the coil. The coil should be tested with an accurate instrument such as or equivalent to the instrument listed at the end of this section. Instructions furnished by the manufacturer of instrument should be followed when making the tests.

The most common ignition coil defects indicated on these testing instruments are: (1) open circuit primary, (2) open circuit secondary, (3) shorted-turns primary or secondary, (4) high voltage break down in the secondary, (5) high resistance in the primary connections.

Replacing the Coil

The ignition coil on this vehicle is mounted directly above the distributor, and is mounted with the high tension terminal down. The coil case should be properly grounded through the mounting bracket. The high and low tension leads must be firmly connected to the coil terminals.

It is important that the primary wires leading from the ignition switch to the coil, and from the coil to the distributor be connected to their proper terminal on the coil. The wire leading from the ignition switch must be connected to the positive (+) terminal of the coil. The wire leading from the negative (—) terminal of the coil must connect to the primary terminal on the side of the distributor housing.

CONDENSER

The operation of the condenser is very little understood by the average mechanic. It is one of the most important units in the ignition system. In order to understand its action and function, we will show a water analogy of condenser action.

In Fig. 52, we have a high pressure water line with a valve located in the line. Just ahead of the valve is located an air chamber called a surge chamber.

When the valve is opened, there is not a full head of water, because it takes some time to set a body of water in motion. During this time energy is stored in this volume of water, because of its speed of movement. If the valve is suddenly closed the pressure of the line plus the momentum of the moving body of water has to be stopped. This is many times greater in pressure than the normal line pressure. The surge pressure forces the water into the air chamber compressing the air. The air then offers a counter pressure which slows down the momentum of the water. A moment later the air pressure in the air chamber overcomes the surge pressure in the line, and forces the water back into the line. This action absorbs the surge without damage to the system.

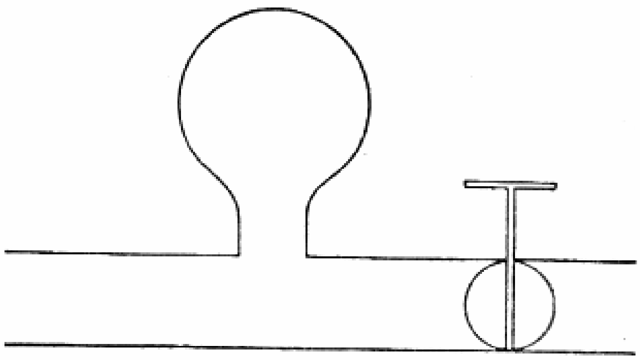


Fig. 52—High Pressure Water Line

The condenser in the ignition system, Fig. 51. acts in exactly the same manner. When the ignition switch is closed, it takes a fraction of a second to establish the full current value flowing in the circuit, just the same as it required some time to set the water in motion. When the breaker points open the current tends to keep on flowing, just the same as the water tends to keep on flowing after the valve is closed. If there was no condenser, this surge of current would arc across the points and burn them, just the same as the velocity of the water would carry away the valve. The current surges into the condenser attracting a positive charge on one side and a negative charge on the other, building up a counter voltage in the condenser, just the same as the water surging into the air chamber, compressing the air, built up a counter pressure in the air chamber. A fraction of a second after the points open, the counter pressure in the condenser overcomes the surge pressure on the line, and the condenser discharges from the positively charged side back through the primary winding of the coil, through the battery to the ground and back to the negative side of the condenser, which is grounded, equalizing the two sides of the condenser. This is fundamentally the same as when the counter air pressure in the surge chamber of the water system, overcame the surge pressure on the line. The surge chamber discharged and forced the water back in the line equalizing the pressure.

Removing and Replacing the Condenser

The condenser can be removed in the following manner:

1. Remove the distributor cap.
2. Remove the retainer clip (Fig. 53) and the terminal. The condenser can then be lifted out of the distributor body.

Refer to Specifications for correct replacement condenser. Make certain that retaining clip and terminals are tight. The pig-tail should be "formed" away from distributor point arms as shown.

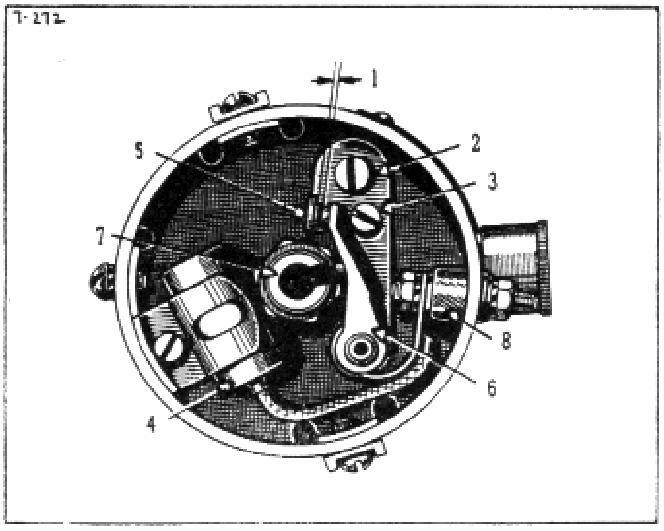


Fig. 53—Breaker Plate and Point Assembly

1. Point Opening.
2. Clamp Screw.
3. Eccentric Screw.
4. Condenser.
5. Breaker Plate.
6. Breaker Lever.
7. Cam.
8. Insulator Terminal.

Testing the Condenser

The condenser should be tested with an instrument such as or equivalent to that shown at end of this section.

Four factors affect condenser operation and each factor must be considered in making any condenser tests.

1. Breakdown is a failure of the insulating material, a direct short between the metallic elements of the condenser. This condition prevents any condenser action.
2. Low Insulation Resistance or leakage prevents the condenser from holding a charge. A condenser with low insulation resistance is said to be "weak". All condensers are subject to leakage, which up to a certain limit is not objectionable. When it is considered that the ignition condenser performs its functions in approximately 1/12000 of a second, it can be seen that leakage can be large without detrimental effects. This phase must be considered, however, in any condenser test.
3. High Series Resistance is excessive resistance in the condenser circuit due to broken strands in the condenser lead or to defective connections. This will cause burned breaker points and ignition failure upon initial start and at high speeds.
4. Capacity is built into the condenser and is determined by the area of metallic elements and the insulating and impregnating materials. Incorrect capacity will result in distributor points pitting.

IGNITION DISTRIBUTOR

Since the spark must occur at a given instant in the engine rotation, the switch must be operated by the engine itself. This switch is called the mechanical breaker, timer or interrupter.

The breaker arm is pivoted at one end and carries at its free end a contact which is held against a similar contact by a spring acting on the breaker arm. The stationary contact is mounted on the breaker plate to permit adjustment of the points. When the contacts are together and the ignition switch is closed, current will flow through the breaker arm contacts and primary winding of the coil.

The cam is positively driven by the engine. As it rotates, the lobes strike the rubbing block in the breaker arm, causing the arm to swing outward, thus separating the contacts. This interrupts the

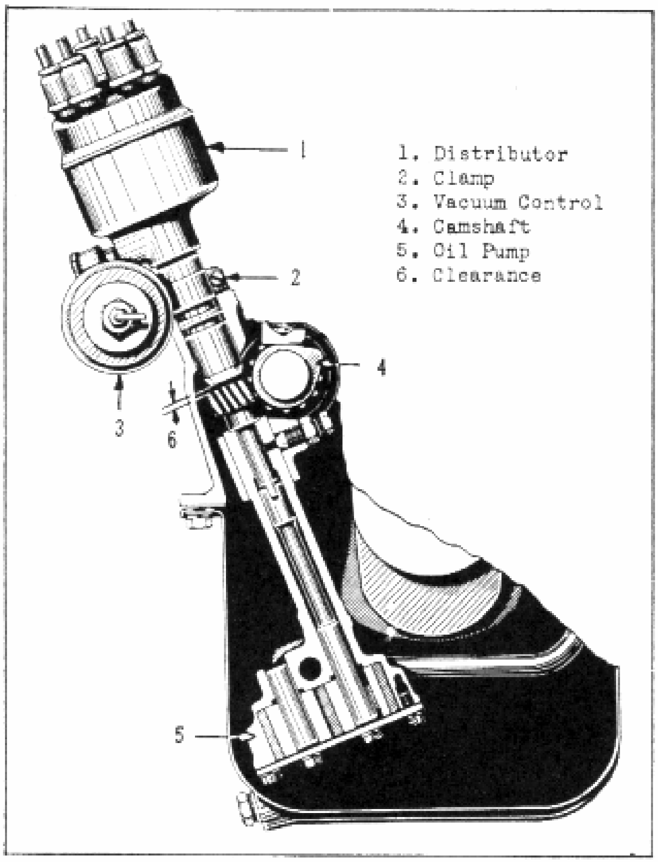


Fig. 54—Distributor Mounting Shown

current which was flowing through the primary winding of the coil, and produces a spark as previously described. As the cam continues to turn, the lobe passes the rubbing block and the spring pulls the breaker arm back until the contacts come together again. The current then flows through the primary winding of the coil and the operation is repeated as before. The cam is not only positively driven from the engine, but it is also "timed" to the engine so that it interrupts the circuit through the coil at the instant the spark is required.

The mechanical breaker is made in this form in order to open the primary circuit quickly and to operate at the highest speed.

Spark Advance Controls

Spark control on this distributor is entirely automatic, being operated by a combination of two advance mechanisms, centrifugal and vacuum.

Centrifugal Advance

Where speed variations are encountered, a spark advance based on engine speed is necessary to develop maximum power. This mechanism is mounted on the distributor shaft and consists of counter-weights and springs.

As the engine is speeded up, centrifugal force begins to throw weights, inside of the distributor body, outward, until at a maximum speed, they reach the point shown in sketch 2 of Fig. 55. In their outward movement, because of the manner in which they are connected with the cam, they advance the position of the cam beyond the point shown in sketch 1 of Fig. 55, and therefore advance the firing or spark of the engine.

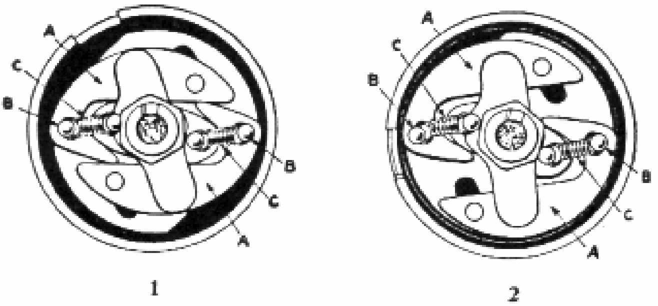


Fig. 55—Mechanical Breaker Advance Mechanism

Vacuum Advance

An engine operating under part throttle can have a spark advance in addition to the centrifugal advance without objectionable ping. With an additional advance obtained by a vacuum advance mechanism, the engine will show greater gasoline economy. The vacuum control consists essentially of a diaphragm and a link acting against a spring. The mechanism is mounted as shown in Fig. 54—56 and is linked to the distributor body. The body is rotated to secure the vacuum control of the spark advance.

The vacuum tube from the control body enters the carburetor just back of the throttle butterfly. As soon as the throttle is opened, the manifold vacuum is admitted to the control producing an advance in addition to and independent of the centrifugal advance.

At higher speeds and with an open throttle, the vacuum diminishes, and the vacuum spark advance drops off. With a wide open throttle at any speed, there is no vacuum advance, all advance under that condition being based on the centrifugal action.

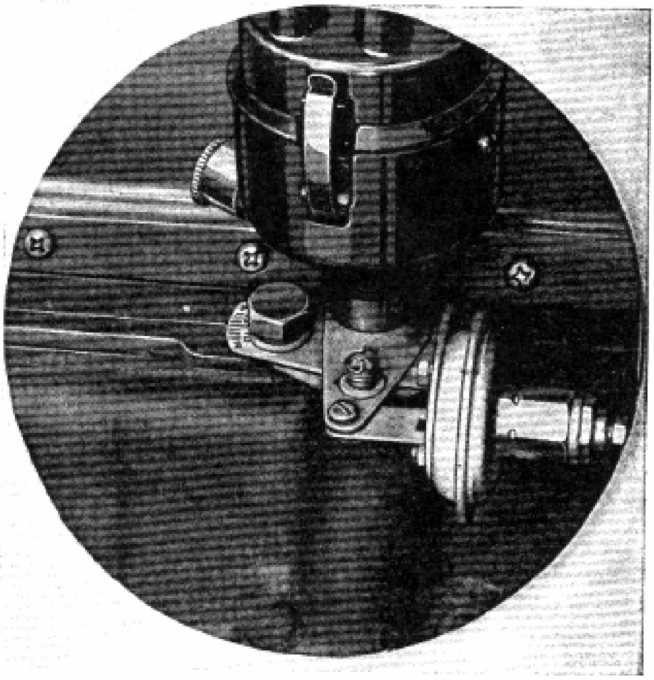


Fig. 56—Distributor Vacuum and Manual Control

Manual Adjustment

In addition to the automatic advance control, manual adjustment, Fig. 56, is provided by which initial setting may be varied to suit the quality of fuel used. Bear in mind, that advance specifications on this distributor are determined after careful tests, and with the use of high grade fuel. Because of various grades of fuel which may be used, slight readjustment of initial setting may be necessary to obtain satisfactory engine performance and fuel economy. Refer to "Adjusting Distributor" in this section.

Distributor Testing

If trouble is suspected with the distributor, first see if electric current is being delivered to the distributor by the primary wire from the switch and battery. If the distributor is functioning properly, the primary current will pass through the breaker arm and contact points direct from the coil when the contact points are closed. To determine whether there is any trouble at this point, disconnect the primary wire at the coil which leads from the distributor to the coil and, with the contact points closed and with the ignition switch turned on, strike the terminal end of the wire against the terminal on the coil. If there is a spark, the current is flowing properly. If no spark is obtained, make the following examinations: Examine the spring on the distributor arm. See that this is not broken and that it is making a good contact with the primary terminal.

Examine the primary wire. See that the insulation is good and that it is properly fastened to the distributor.

Occasionally oil or grease will get into the distributor and form a connection between the case and the insulated contact point. Wipe out thoroughly.

There may be a "ground" in the distributor, due to defective insulation between the supports of the contact points and the distributor housing.

Examine the contact points to see that they are clean, not burned or corroded, and are opening and closing properly.

Inspection

There are definite and important visual inspections and precision checks that must be made on the distributor to determine conditions that may be caused by normal operation of the unit. In most instances, inspection and checks may be made while the unit is in place in the chassis. However, some adjustments and tests, require that the distributor be removed from the engine. A study of "Service Diagnosis" at the end of this section will assist in determining inspection and adjustments to be made.

Inspect the following points on the distributor at regular intervals:

1. Remove the distributor cap. If the cap is cracked or shows evidence of leaks (carbonized paths indicating secondary current leaks), replace it.
2. Inspect the rotor for cracks and excessive wear.
3. Inspect for burned points.
4. Inspect all wiring. Cracked or swollen wires should be replaced.

Breaker Points

Breaker points that are burned or pitted should be replaced or dressed with a clean fine-cut contact file. The file should not be used on other metals and should not be allowed to become greasy or dirty. DO NOT USE EMERY CLOTH TO CLEAN CONTACT POINTS.

Breaker surfaces, after considerable use, may not appear bright. This is not necessarily an indication that they are not functioning satisfactorily.

Oxidized breaker points may be caused by high resistance or loose connections in the condenser circuit, oil or foreign materials on contact surfaces, or most commonly, high voltages. Check for these conditions where burned contacts are experienced.

Breaker Point Opening

The breaker point opening must be set to the proper limits. Points set too closely may tend to burn or pit rapidly. Points with excessive separation tend to cause a weak spark at high speed.

Adjusting Breaker Points

The breaker points on the distributor are fixed in their mounts and are controlled by an eccentric screw moving the mounting plate. To adjust the gap of these points, proceed as follows: Remove the distributor cap and rotor. Hand crank the engine until the breaker arm cam follower is on the peak of the cam. The breaker points are then opened the maximum distance. Loosen the lock screw and turn the eccentric adjusting screw, as shown in Fig. 57, to the right or left, increasing or decreasing the gap to 018". Tighten the lock screw.

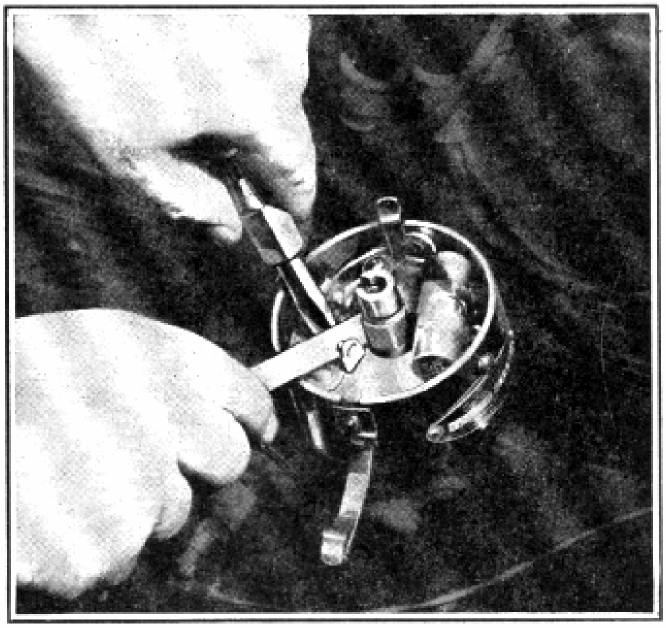


Fig. 57—Adjusting Breaker Points

Removing the Distributor

The distributor assembly may be removed for overhaul and repair purposes in the following manner:

1. Locate No. 1 spark plug terminal on the distributor cap. Mark the distributor housing opposite No. 1 terminal.
2. Hand crank the engine until the timing pointer on the flywheel housing is exactly on the ignition mark (See Fig. 58.) and the rotor is pointing toward the mark on the distributor housing.
3. Remove the manual adjustment clamp bolt.
4. Lift the distributor assembly straight up.
5. Do not turn the engine over while the distributor is out.

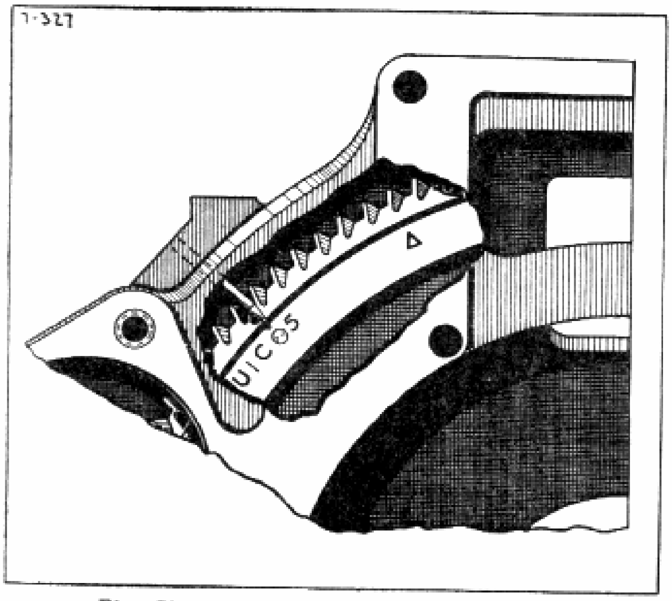


Fig. 58—Flywheel Timing Mark

Lubrication

Keep the grease cup (shown in Fig. 56) filled with medium cup grease. Turn down the cup one turn every 1,000 miles. Add a trace of petrolatum to the breaker cam and add a few drops of light engine oil in the wick in the top of the cam under the rotor, every 1,000 miles.

Disassembly of the Distributor (Refer to Fig. 59)

1. Remove the cap (1) and rotor (2).
2. Remove the condenser (3), breaker lever (4), contact point and support screw, adjusting screw (6), and contact point and support (5).
3. Remove the insulated terminal (17) cap spring (7), and primary terminal.
4. Remove the gear (8), and pull the main shaft and weight assembly through the distributor housing.
5. Remove the weight hold down plate, retaining plate nut and nut washer. Remove the weight springs.
6. Remove the weight hold down plate (9).
7. Remove the cam assembly (10), and weights (11).

Inspection

1. Inspect the shaft for wear, and check its fit in the bearings in the distributor body. If the shaft or bearings are worn, the shaft and distributor body should be replaced.
2. Mount the shaft in "Vee" blocks and check the shaft alignment with a dial gauge. The runout should not exceed .002".
3. Inspect the centrifugal weights for wear or burrs and free fit on their pins.
4. Inspect the cam for wear or roughness. Then check its fit on the end of the shaft. It should be absolutely free without any looseness.
5. Inspect the condition of the distributor points —dirty points should be cleaned and badly pitted points should be replaced.
6. Test the condenser for series resistance, microfarad capacity and insulation breakdown, following the instructions given by the manufacturer of the equipment used.

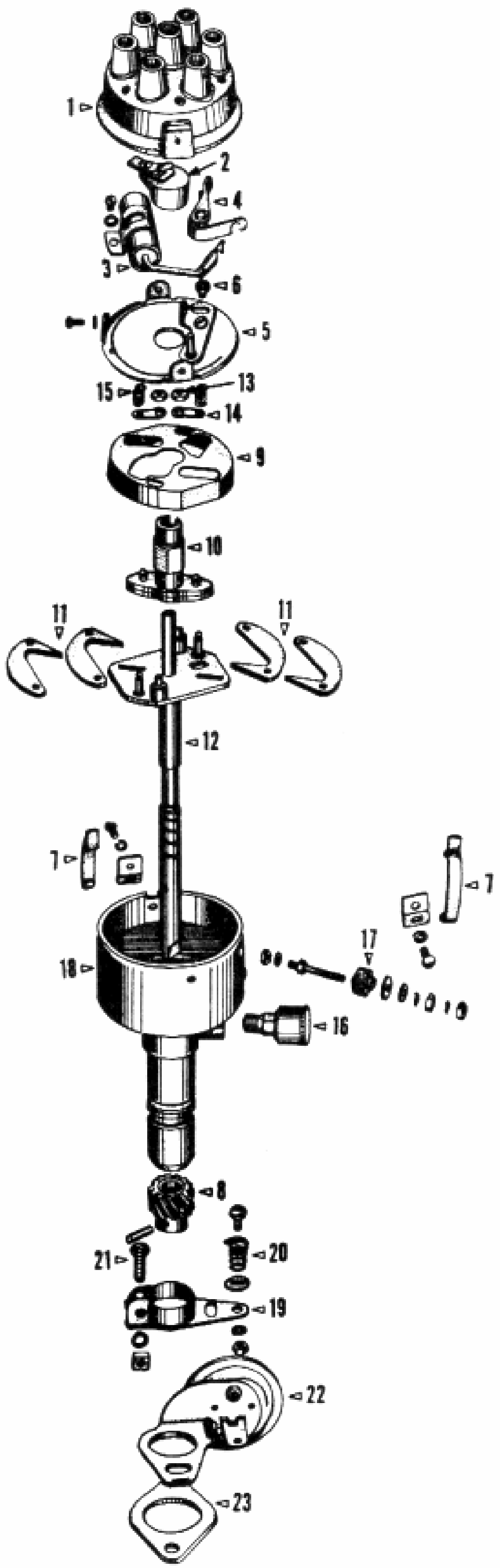
Assembly of the Distributor (Refer to Fig. 59)

Assemble the distributor in the following manner

1. Assemble the weights (11) over the pivot pins on the main shaft and weight plate (12).
2. Install the cam (10), weight hold down plate (9), nuts (13), and washers (14), and springs (15), after tightening the nuts securely, lock them by bending tangs on the lockwashers.
3. Lubricate the shaft and install it in the distributor housing. Reinstall the shaft gear and pin.
4. Install the breaker plate (5), in the distributor housing.
5. Assemble the distributor cap springs (7), to the side of the distributor housing. Spring screws and nuts also hold the breaker plate in place.
6. Install the primary terminal and insulated terminal.
7. Install the contact point and support (5), breaker lever (4), and adjusting screw.
8. Install the condenser (3), and grease cup (16).
9. Adjust the points as described under "Adjusting Breaker Points".
10. Test distributor on "Syncrograph" type of instrument. Refer to "Instrument Tests".

Replacement of Distributor

1. Check the position of the flywheel. The pointer should be on the ignition mark.
2. Before the distributor is inserted in place, see that the rotor is turned to the mark on the distributor housing (facing No. 1 terminal.)
3. While holding the rotor toward the mark, insert the distributor in the crankcase. The tongued portion of the distributor shaft should then mesh with the oil pump shaft without difficulty. The low tension terminal on the distributor body should point toward the rear of the engine when the distributor is in its correct running position.
4. It is important that a slight clearance be maintained between the upper and lower end of the housing at points shown in Fig. 54 at No. 6. When the distributor is first placed in operating position, the lower end of the housing will contact the drive gear. Before tightening the clamp (in back of the distributor on the body), remove the cap and place the fingers under the



1. Cap.
2. Rotor.
3. Condenser.
4. Breaker Lever.
5. Breaker Plate and Support.
6. Adjusting Screw.
7. Cap Spring and Support.
8. Gear and Pin.
9. Hold Down Plate.
10. Cam.
11. Weights.
12. Main Shaft and Weight Support.
13. Weight Hold Down Nut.
14. Hold Down Nut Washer.
15. Weight Springs.
16. Grease Cup.
17. Terminal Stud and Parts.
18. Housing.
19. Distributor Housing Clamp.
20. Clamp Hold Down Screw and Spring.
21. Clamp Screw.
22. Vacuum Control.
23. Vacuum Control Adapter.

Fig. 59—Component Parts of Distributor Assembly

housing and the thumb on the rotor. While holding the rotor down, raise the housing 1/32". This will equalize the clearance at the top and bottom of the housing. Do not raise the housing more than 1/32". Tighten the clamp bolt while the distributor is held in this position.

5. Install the manual control clamp bolt.
6. Connect the correct spark plug wires to the distributor cap. The firing order is 1, 5, 3, 6, 2, 4.
7. Re-time the distributor as directed.

Checking Ignition Timing

One of the most accurate methods of checking ignition timing is by the use of a Neon timing light (See "Tools" at the end of this section"). Check in the following manner.

1. Set the manual advance at the mid point.
2. Attach one lead to the timing light to No. 1 spark plug. Attach the other lead to a convenient ground.
3. Run the engine at idling speed.
4. Hold the light close to flywheel peek hole.
5. Neon flashes are then checked against flywheel markings (Fig. 58) which indicate the piston position at time the firing occurs.
6. The distributor can be retarded or advanced (loosen clamp bolt) until the Neon flashes are perfectly synchronized with flywheel markings.

If a Neon light is not available, a check can be made with a conventional test lamp with engine not running.

1. Loosen the clamp bolt on the distributor.
2. Connect the test light in parallel with the distributor points by connecting one lead of the lamp to the primary terminal on the distributor housing, and grounding the other lead.
3. Turn engine over slowly with a crank until No. 1 is about to fire. Continue to crank very slowly and stop at exact instant the test lamp lights.
4. Check the location of the pointer in relation to the flywheel marking (Fig. 58). If the pointer is within 1/16" of the mark, the timing may be considered satisfactory. Turn the distributor as necessary to bring the setting within the proper limits. Tighten the clamp bolt when the adjustments are made.

Testing Ignition Timing

The preceeding instructions pertaining to the initial timing of the distributor are the result of extensive research and tests. From these tests are determined the correct ignition timing mark (Fig. 58) for the engine used in this vehicle. These tests are made with high octane rating fuel. The engine will perform satisfactorily and economically with that fuel and with initial setting as described.

The manual advance (Fig. 56) is provided for the purpose of compensating for different grades of fuel. This manual advance, set at zero or mid-way when initial setting is made, can be advanced or retarded to permit maximum performance with any particular grade of fuel that may be used in service.

In order to determine the setting of the manual advance for the maximum performance of the engine, a road test should be made using the exact grade of fuel which may be used in service.

After the initial setting is made as previously described, the spark plugs should be cleaned and properly set. The engine should be thoroughly warmed up to operating temperatures.

Manual advance should be set to provide smooth engine performance with a slight "ping" under full throttle at comparatively low vehicle speed.

Bear in mind, that this setting may vary on different vehicles, and that several tests should be made to determine the exact borderline between effortless engine performance and that which produces an excessive degree of "clatter" or "ping".

Instrument Tests

There are several tests which should be made on a distributor by using a special instrument. These tests are particularly necessary after the distributor has been overhauled.

With an instrument such as or equivalent to the "Syncrograph", many tests can be made on distributors with the unit removed from the engine. Such an instrument will make the following tests:

1. Cam angle.
2. Centrifugal spark advance.
3. Vacuum spark advance.
4. Worn cams.
5. Play in shafts.
6. Point pressure.
7. Defective points, etc.

Instructions furnished by the manufacturers should be followed when making tests with these instruments. "Specifications" at the end of this section list all test data necessary to check the operation of distributor.

IGNITION SWITCH

Two types of ignition switches are used. On early produced vehicles a separate key was used. With this type it is necessary to insert the key and turn clockwise to turn on the ignition. A modification of this first type was made later, in which the key was secured in the lock so that it would not be removed.

The second type has no separate key, it simply being necessary to turn the switch lever clockwise to turn on the ignition.

When the switch is turned "on", the low voltage circuit is completed to the ignition system.

Testing the Ignition Switch

The ignition switch may be tested for poor internal contacts in the following manner:

1. The breaker points of the distributor must be closed.
2. Connect a voltmeter across the switch terminals.
3. Turn the switch to the "off" position. The voltmeter should read "O" volts.

Do not attempt to repair defective switches. Replace it with a new part.

Removal and Installation

Disconnect the battery before removing the switch. Make certain that the correct wires are connected to the terminals when the unit is replaced.

After the unit is replaced, turn on the switch and watch the action of the ammeter. If the switch is operative and the connections are correct, the ammeter should show a slight discharge with the switch in the "on" position while the engine is being cranked.

IGNITION WIRING

The wiring is divided into two classes, the low tension and the high tension. The low tension wiring is used in the circuit from the battery to the coil and from the coil to the mechanical breaker. It carries only the current at battery voltage and so no extra insulation is required. The high tension wiring includes the cable from the secondary of the coil to the center of the distributor and the cables from the distributor to the spark plugs. The high tension wiring must be provided with heavy insulation, as the current which it carries is capable of jumping an air gap. This wire is insulated with a thick layer of rubber.

Low and high tension wires and connections of the ignition system should be inspected at regular intervals. Loose connections, frayed or broken wires and oil soaked or wet wires will definitely affect performance of the ignition system.

SPARK PLUGS

The purpose of the spark plug is to provide in the cylinder, a small gap across which the spark can jump and thus ignite the gas. The shell of the spark plug is screwed directly to the engine and it carries one of the points or electrodes. The other electrode is insulated from the shell by a porcelain insulator which will withstand the heat, pressure, and oil in the engine cylinder. These plugs are subjected to severe service during the functioning of the ignition system. They require the same degree of careful inspection and care as do the other units of the system. Servicing of to-day's engines is largely confined to the ignition system. The ignition system is like a chain—no stronger than its weakest link. Many times, cleaning dirty spark plugs and regapping or replacing worn-out plugs is all that is required to restore engine performance, but spark plugs cannot correct faulty operation of other units in the ignition system; these should be checked. Also there are other engine units which affect performance that should be checked to avoid incorrect diagnosis of so called spark plug trouble, such as valve tappets, leaks in the intake manifold, dirt in the fuel system, carburetor leaks, etc. Spark plugs are blamed for many engine ills they do not cause. Never jump to a conclusion when checking engine performance. Eliminate the possible sources of trouble in an efficient and systematic manner. Now assuming that other engine units are operating correctly—let us consider specific service recommendations on spark plugs. There are only four things that happen to spark plugs in service:

1. Worn-out.
2. Insulators dirty or oxide coated.
3. Wrong gap.
4. Broken insulator.

We will discuss these conditions and their remedy in that order.

1. **Spark Plugs Worn Out:**

   Operating conditions entirely govern spark plug wear, and when they are worn out they cannot give any further profitable service. The average life of a spark plug is approximately 10,000 miles. Always replace worn out plugs Fig. 60 with new plugs of the correct type. When installing new spark plugs be sure to set the gap to the correct limit. The spark plugs used in these vehicles under normal operation are "AC.. 44—14MM" and the correct gap setting is .040"".

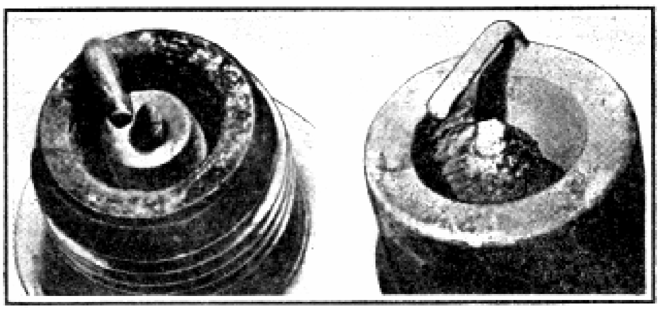


Fig. 60—Worn Out Spark Plug

2. **Insulator Dirty or Oxide Coated:**

   Spark plugs get dirty from black carbon or soot deposits or from oxide deposits and should be cleaned when necessary (Fig. 61). Carbon deposits may be caused by over-rich carburetor, worn pistons, rings, faulty ignition or by using "too cool" a plug.

   Red, brown, yellow or blistered deposits are oxide deposits, and the most prevalent cause of plug failure under to-day's operating conditions. Oxide coating causes intermittent missing, especially at high speeds and on hard pulls. Sometimes it will cause complete failure. Oxide coating is a residue of combustion resulting from materials purposely introduced into the fuel or accidentally brought into the combustion chamber.

Oxide coatings may be classified as:

A. White.
B. Fused.
C. Blistered.
D. Iron Oxide.

The explanation of these conditions is as follows:

(a) White Oxide Coating:

This is a fine white powdery substance which becomes impinged upon the insulator, usually accumulating far up in the shell, but also depositing upon the insulator tip (Fig. 62).

This coating, being dry, is easily removed and it is better to remove it when it first forms, so that it will not have an opportunity to accumulate and melt into a glaze. Spark plug cleaning in an abrasive, air blast type cleaning machine every 3,000 or 4,000 miles will take care of it (Fig. 62).

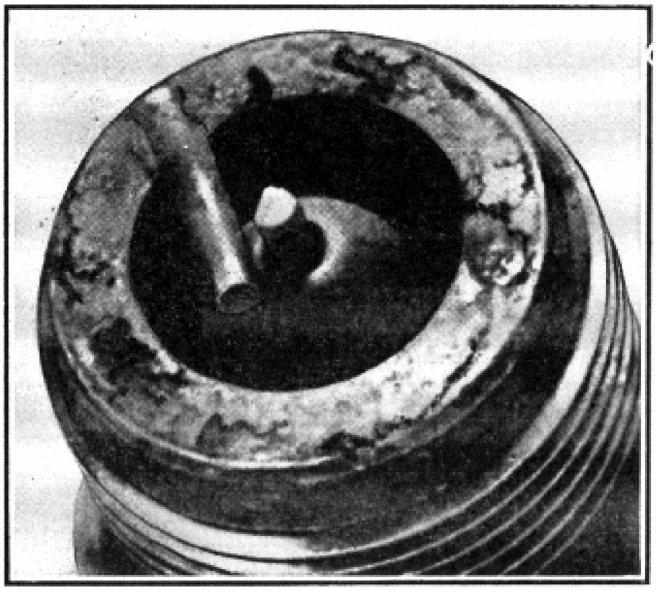


Fig. 61—Dirty Spark Plug

(b) Fused Oxide Coating:

Under high temperature, the white oxide becomes fused or melted by combustion heat and forms a smooth glossy coating over the insulator. An insulator in this degree of oxidation presents the appearance of having been coated with a heavy machine oil. It is light yellow in color with a hard shiny glaze. A plug in this condition will often perform satisfactorily when cool but will miss badly as soon as it becomes warmed up.

Fused Oxide coating is very deceiving. Even after an apparently thorough cleaning, there is still apt to remain on the insulator a practically invisible layer of oxide. The plug looks clean but really isn't. The safest way to handle such plugs is to clean them until you are absolutely sure they are clean and then start all over and clean them again. This coating is difficult to remove and only a double dose of cleaning can insure satisfactory performance.

The use of cooler type of plugs will usually be beneficial where this condition is chronic; but even so, the best safeguard is thorough cleaning at regular intervals.

(c) Blistered Oxide Coating:

This is the extreme case of oxide coating fused with road dust, carbon and other materials. The color is usually a grayish brown and the blisters themselves look like fair sized warts.

These blisters when hot form a good conductor, and quite readily bridge the current from the center electrode to the shell of the plug. This condition is aggravated on plugs having glazed insulators, as the oxide fuses with the glaze of the plug, causing blisters, earlier than can

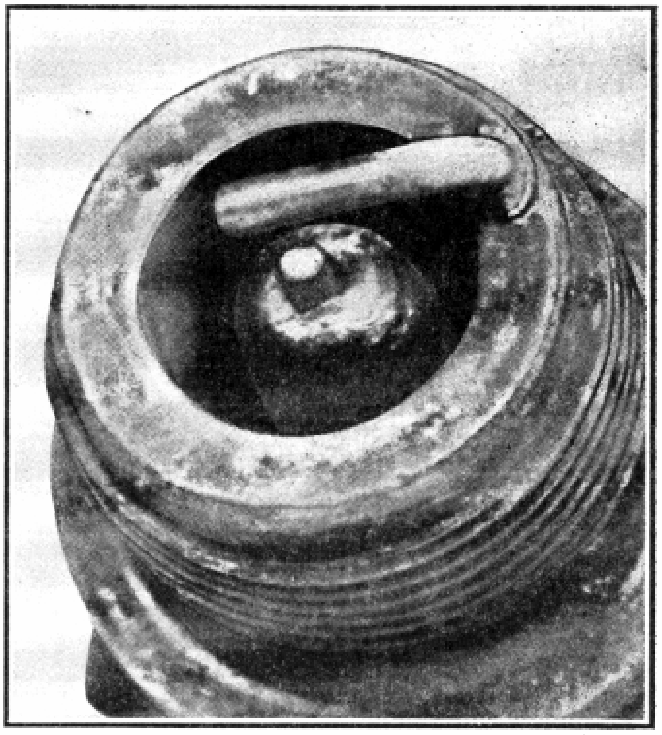


Fig. 62—White Oxide Coated Spark Plug

happen with plugs having unglazed insulator tips, such as the cooler types. An unglazed insulator tip is not so apt to develop oxide blisters.

Once blistered oxide has formed, it is practically impossible to remove. This is due to the thickness and hardness of the blisters themselves, also because they interfere with the proper circulation of the cleaning compound around the insulator.

If this type coating is found on plugs that have not been cleaned for 8,000 to 10,000 miles, the only remedy is to replace the plug. On the other hand, if a blistered oxide coating is formed on plugs that have been cleaned regularly at 3,000 to 4,000 miles and for engines under unusually heavy operating conditions, a cooler type of spark plug will give better results.

(d) Iron Oxide Coating:

This is a dull red coating on the insulator of the spark plug, which, although it is not a conductor when cold, will cause a plug to miss badly at high temperature. It is iron rust picked up in gasoline storage tanks, automobile gas tanks, and fuel lines. Iron oxide is not common to-day due to modern methods of handling gasoline. It can be removed by thorough cleaning.

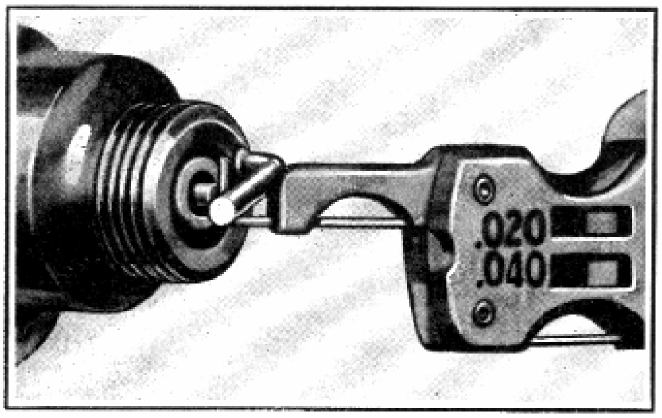


Fig. 63—Setting Spark Plug Gap

3. **Wrong Gap**

A spark plug gap will gradually widen after several thousand miles of normal service, or a gap may widen or wear quickly at low mileage. This indicates that the plug is operating "too hot", often the wrong type of plug. To correct this condition, set the gap to EXACT SIZE specified (.040"). Don't guess or use a "thin dime" or flat feeler gauge. Use round wire gap gauge as shown in Fig. 63.

IMPORTANT:—In regapping, adjust only the side electrode. Never bend the center electrode or breakage of insulator will result. If rapid gap wear occurs at low mileage, replace with a cooler type plug.

4. **Broken Insulator**

This kind of breakage can never be caused by the engine. It is caused by an outside blow, or a poor fitting wrench used when installing or removing plugs, or over tightening in the cylinder head. A broken lower end may occur when operating conditions are abnormally hot or wrong type of plug (too hot) is used. Also this type of breakage may be caused by faulty work when regapping by bending or straining the center electrode. The only remedy for broken plugs is replacement. However, breakage may be prevented by avoiding striking the plugs, using a wrench of correct size and clearance carefully, and by not bending the center electrode.

Installation

A special spark plug wrench should always be used. Use of ordinary wrenches may crack or otherwise damage the porcelain, thus the plug is rendered unfit for further use. Use of torque wrenches is not recommended for installing spark plugs as it is impractical to recommend wrench pressure for all various types and sizes of plugs.

Spark plugs should be screwed down until they "bottom" against the gasket then turned one-quarter to one half turn tight, always use a new gasket.

Cleaning

The proper remedy for dirty plugs is cleaning with a reliable, abrasive, air blast type spark plug cleaner, and regapping to specifications. The entire lower end of the insulator must be white if properly cleaned. Regap firing point to the EXACT limits for the particular engine.

ALWAYS USE NEW GASKETS when reinstalling plugs and check for correct type of plug.

Types

It is important that the correct type of spark plug be used in an engine for best performance. The standard type used in the engine of the vehicle described in this manual is A.C. 44. Make certain that the plugs used are "cool" or "hot" enough for the operating conditions of a particular type of operation. Plugs designed for average driving conditions may not operate satisfactorily if they are constantly driven at sustained high speeds or under heavy loads. If the heat generated in the spark plug cannot get away fast enough, it will build up and the plug will operate too "hot".

Spark plugs, to give good performance in any engine, must operate within a certain temperature range—not too "hot" and not too "cool". The classification of various types of spark plugs as to their thermal (heat) characteristics is known as a "spark plug heat range". Insulators are numbered to show their position in the "heat range". The heat range works like a thermometer—the HIGHER the number the HOTTER the plug—the LOWER the number the COOLER the plug. The heat characteristic of a spark plug is governed by the length of the lower part of the insulator, which is exposed to the combustion flame. For instance when the insulator is long, the heat must travel a long distance to reach the water jacket in the cylinder head of the engine, and the plug will run "hot", whereas if the insulator is short the heat can escape quickly to the water jacket, and the plug will remain "cool."

If spark plugs that are giving trouble are running too cool as indicated by chronic fouling, use a hotter plug—one or two numbers higher than the standard 44 in accordance with the severity of the fouling. If blow-by, pre-ignition or rapid burning away of the electrodes has been encountered, change to a cooler type. One or two numbers lower than 44, according to the severity of the trouble. To summarize,—for good engine performance and long spark plug life, make certain that ignition and other engine units that affect spark plug performance are functioning correctly, and select the proper type of plug to meet the engine operating conditions.

LIGHTING EQUIPMENT

The lighting system on these vehicles includes the battery or generator (the source of current), wiring, controlling switches, lighting units and current limit relay.

Wiring

The general wiring diagram shown in Fig. 8 of this Section illustrates all the lighting system circuits. There are two junction blocks mounted on the engine side of the toe boards which are used for the headlight wiring connections. Although there is only one headlight equipped with each vehicle, provision is made to either install two headlamps or to transfer the headlamp from one side to the other. Headlight wires are provided to both the right and left position even though the vehicle is only equipped with one lamp at production.

All terminals at the lighting equipment units should be inspected periodically. The connections should be clean and tight.

Switches

There are five lighting switches mounted along the top of the instrument panel. One each for the following:

Instrument Light Switch.

Stop Light Switch.

Tail Light Switch.

Front Side Light Switch.

Head Lamp Switch.

For the correct operation of these switches see "Section B. Controls and Instruments".

A switch is provided at the right rear corner of the hull to either turn on the two red tail lights or the one axle white light when the instrument "Tail" light switch is in the "on" position.

If any one of the above listed switches becomes inoperative they should be replaced with new ones.

See the Wiring Diagram in Fig. 8 of this Section for the correct connections of the lighting circuit wires.

Stop Light Switch

A hydraulically operated stop light switch is connected to the brake master cylinder and is so wired with a switch on the instrument panel that it will not complete the circuit unless the instrument switch labelled "Stop" is in the "on" position.

The pressure of the brake fluid, when the brakes are applied, closes the switch contacts.

Testing

If the stop lights do not illuminate when the instrument "Stop" switch is on and the brakes are applied, make sure the bulbs are good before testing the switch. Test the switch in the following manner:

1. Connect one lead of a voltmeter to each terminal of the switch.
2. With the brakes off, the voltmeter should read battery voltage.
3. With the brakes applied, the reading should be "0".
4. If the switch does not check correctly in either test, it should be replaced with a new unit.

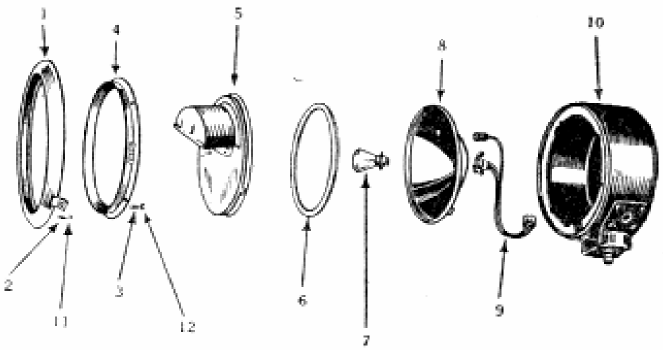


Fig. 64—Headlamp Parts

1. Door.
2. Door Screw.
3. Lens Retaining Ring Bolt.
4. Lens Retaining Ring.
5. Black Out Shield.
6. Lens Gasket.
7. Bulb.
8. Reflector.
9. Junction Block Wire Assembly.
10. Body Assembly.
11. Door Screw Lock Washer.
12. Lens Retaining Ring Lock Washer.

HEADLAMP

Head Lamp Bulb

The only bulb used in this lamp is a double filament, 6 volt, 36 watt bulb and is sufficient to supply adequate light. Proper voltage must be maintained at the headlamp bulb in order to get the maximum illumination output. Such items as a low battery, poor electrical contacts in the wiring system, a poor ground through the headlamp body and its brackets and loose connections in the generator to battery circuit all contribute to a loss in voltage and the burning out of bulbs.

Removal

The headlamp may be removed from the vehicle by disconnecting the terminal at the junction block, and removing the lamp body support nut.

When replacing the lamp, it must be aimed in the straight ahead, horizontal position.

Overhaul (Refer to Fig. 64)

The headlamp may be disassembled in the following manner:

1. Remove the screw from the headlamp rim (1) and lift off the rim.
2. Remove the three screws (3) from the unit retaining rim (4).
3. Lift out the retaining rim (4), blackout shield (5) and gasket (6).
4. The bulb or reflector may now be taken out and tested.

The lamp is reassembled in the reverse order.

Side. Tail, Stop, and Axle Lamps

The two tail and two side lamps, the rear axle lamp and the stop lamp are all of the same design. The lamp body is constructed of two valves, one screwing into the other, thus clamping to the mounting bracket which is positioned between the two halves of the lamp.

Should it become necessary to replace a light bulb or a light glass separate the two halves of the lamp. This will give access to the bulb or the glass. When replacing a bulb, refer to the "Lamp Bulb Specifications" Page R-49 to make certain the correct sized bulb is used.

MISCELLANEOUS ELECTRICAL

This section includes adjustments and tests of electrical equipment not included in the preceding electrical sections. Units described herein are the gas tank gauges, temperature gauge and horn.

Wiring circuits of each unit are shown in the general wiring diagram (Fig. 8).

Temperature Gauge

The temperature gauge system consists of an engine thermal plug electrically interconnected with a registering gauge mounted on the instrument panel with the gas tank gauge. As shown on the wiring diagram in Figure, 8 the gauge and engine unit is interconnected with the ignition switch. The gauge, therefore, does not register until the ignition switch is in the "on" position.

The engine thermal unit is mounted in the cylinder head, at the rear of the engine. Within this unit is a carbon element which is held in constant compression with a coil spring. As the water temperature increases, resistance of the element is changed causing the calibrated gauge to register heat in degree Fahrenheit.

If the temperature gauge does not operate, or shows apparently false readings, check the wires in the circuit for shorts. If the system continues to be inoperative, replace the engine unit with a new part and then check for performance. Do not attempt to repair either the engine unit or the gauge. When installing a new engine unit, do not use thread compound on the unit threads, as this will increase electrical resistance of the unit and cause faulty reading on the gauge.

Gas Tank Gauge

The gas tank gauge system consists of three units, the registering unit, mounted on the instrument panel, and two tank units which are mounted in each fuel tank. As shown on the general wiring diagram in this section of the book, the circuit for this system passes through the ignition switch. The gauge will not register unless the ignition switch is turned on.

Various positions of the tank unit float arm will cut in resistance permitting a current to flow to a calibrated gauge, thereby registering the quantity of fuel in the tank. (Fig. 65).

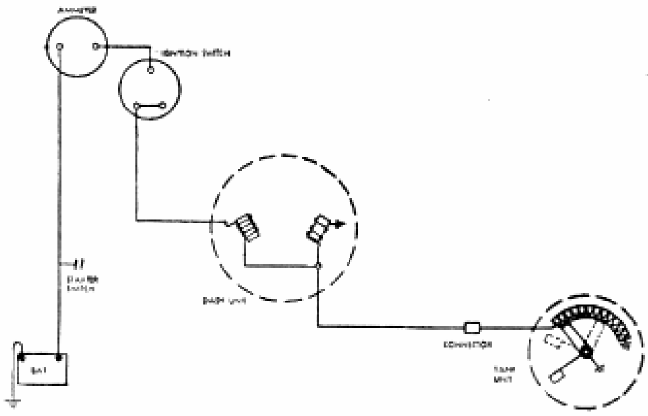


Fig. 65—Gasoline Gauge Circuits

If the tank or gauge units become inoperative, the only remedy is to replace the defective unit.

A gas gauge tester (KMO-204) may be used to localize trouble in either unit. Use the gauge tester (Fig. 66), in the following manner:

1. Turn ignition switch "Off." Disconnect "TANK" wire from the dash gauge unit.

   CAUTION—If the connections are not correct, as above, a short will occur and burn out the tester.

2. Attach the tester wire (red) to the dash gauge "TANK" terminal, and the tester black wire to a ground on the vehicle.
3. Turn the ignition switch "On." Move the tester arm up and down. The dash unit should register "full" and "empty." If the gauge registers correctly, turn the ignition switch off, and reconnect "TANK" wire to the gauge terminal.

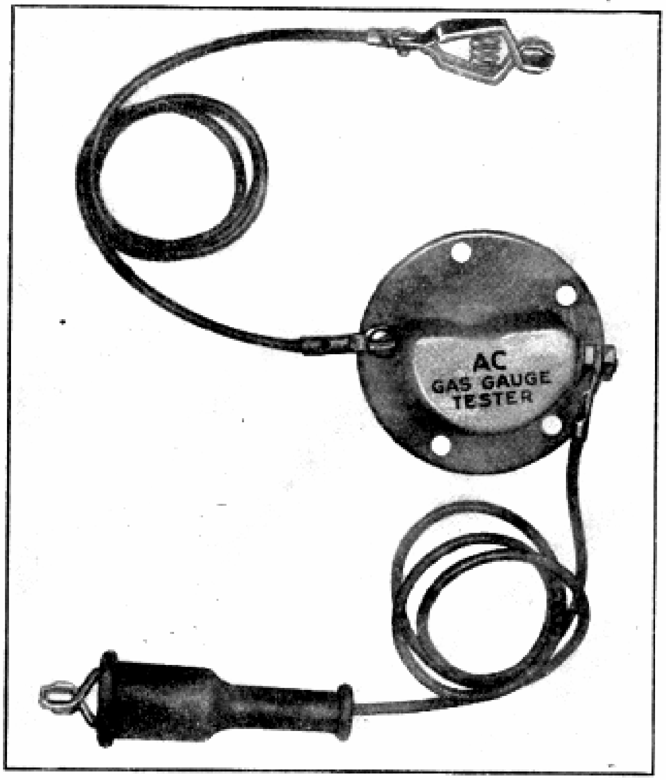


Fig. 66—Gasoline Gauge Tester

4. If the dash gauge does not register, replace it with new unit. Before replacing the gauge, make certain it is getting current from the ignition switch. Test by connecting a 6-volt lamp from the "IGN" terminal on the gauge to a ground.

If the dash unit checks, next check the wiring between the dash and tank units as follows:

1. Disconnect the tank unit wires near the gas tank.

2. Attach the tester wire (red) to one of the connections running to the dash unit, and the tester wire (black) to ground.

3. Turn the ignition switch "On." Move the tester arm up and down. The dash gauge should move from "empty" to "full" if the wiring is in good condition. Test the wiring with the instrument switch in both positions.

4. If the dash gauge reads "empty" at all times or the reading is noticeably lower than during the check at the dash gauge, check for shorts or leaks in the wiring between the dash and tank. If the dash gauge reads above "full" at all times or if it reads higher at "empty" and "full" than the readings obtained when checking at the dash, check for poor connections or breaks in the wiring. Make sure contacts and connections are clean and making good contacts.

If the dash gauge and wiring checks, remove the tank units and test one at a time as follows:

1. Clean all dirt that has collected around each tank unit terminal, as road dirt, particularly calcium chloride, causes an electrical leak that will cause an error in reading.

2. After cleaning the tank unit, connect the unit to the wire leading to the dash, ground the unit with a short piece of wire from the outer edge to the vehicle. Turn the ignition switch "On" and move the float arm up and down. The dash gauge should give corresponding "empty" and "full" readings.

3. If the tank unit does not operate correctly, replace it with a new unit. Always check the new unit as previously described. Check the movement of the float arm by raising it to various positions, observing that it will fall to the "empty" position in every instance.

4. Repeat this test with the other tank unit.

Horn

The electrically operated horn used on this vehicle is a vibrating type unit that operates on a magnetic principle to produce a warning signal. Current from the battery flows through windings within the horn power plant when the circuit is completed at the horn push-button switch. Refer to the Wiring Diagram in Fig. 8 for horn circuit connections.

The following conditions affect the performance of the horn and should be checked before attempting to make any adjustments to the instrument:

Low Horn Voltage

If the horn produces a weak signal, the voltage at the horn should be noted. Connect a voltmeter across the horn terminals. The voltage reading should not be less than 5.2 volts. A lower reading would indicate either a low battery or a high resistance in the horn circuit.

Check the condition of the battery, and if low, recharge.

Loose or corroded connections in the horn circuit should be corrected. Check for defective wiring by connecting separate test leads from the horn to the battery.

A loose connection or poor contact at the horn push-button switch may cause the horn to operate intermittently. Shunt around the horn button to determine whether there is poor contact at the push-button. Whenever wiring is replaced in a horn circuit, the size of wire as indicated in the Wiring Diagram should be used.

Horns usually have a rasping sound when vital parts are broken or loose. A loose backshell may affect its tone. Tighten all collar screws, mounting nuts, and studs, and replace all damaged parts.

The horn will not function properly if the field windings within the horn are open circuited, short circuited, or grounded. Connect an ammeter in the horn circuit at the horn terminal. If there is no indication of current flowing when the contact points are closed, the windings are open circuited. The ammeter will indicate an excessive flow of current if the windings are short circuited or grounded.

Windings may also be checked for a grounded circuit by use of test points and a test lamp. Disconnect the horn leads and touch one test point to one of the horn terminals. If the lamp lights, the field windings are grounded.

Excessive arcing at the contact points may be caused by improper current adjustment. An open circuit in the condenser will cause excessive arcing at the points and in some cases the contacts will be held together.

Horn Adjustment

Attach a wire to the relay terminal where the wire from the horn button connects. The other end of this wire can then be touched to ground during the test to cause the horn relay to operate and the horn to sound. This provides a convenient means of operating the horn during adjustment. If the horn cannot be properly checked on the vehicle, remove it for a bench check.

Remove the horn backshell, Fig. 67, insert a .007" feeler gauge (not more than ¼ inch wide) between the adjusting nut and the contact blade insulator. Do not allow the gauge to touch the horn contact points. Loosen the lock nut and turn the adjusting nut down until the horn will not sound. Then back the adjusting nut off less than one-tenth (1/10) turn and tighten the lock nut.

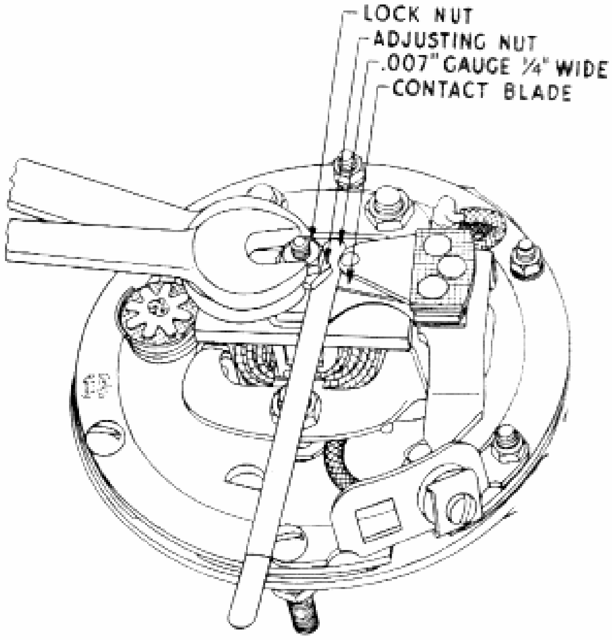


Fig. 67—Adjusting Horn

Check to see if the horn will sound. If it does not, back off the adjusting nut again (less than 1/10 turn), tighten the lock nut and re-test horn. Repeat until the horn just barely sounds. Remove the feeler gauge and replace the cover. The horn tone should now be satisfactory and the current draw will be within specifications.

NOTE:—If there is a notch worn in the adjusting nut where the contact blade vibrates against it, either replace the nut or turn it over so that the worn area is on the top side, otherwise it may prevent a perfect adjustment.

SERVICE DIAGNOSIS AND CORRECTIVE METHODS

(GENERATOR AND REGULATOR)

SYMPTOM AND PROBABLE CAUSE	REMEDY
1. Excessive Charging Rate	
a. Current Regulator.	a. Check and Adjust.
b. Voltage Regulator.	b. Check and Adjust.
c. Defective Generator Field.	c. Check and Correct.
d. Poor Ground Connections.	d. Check and Correct.
2. Low or No Charging Rate	
a. High Resistance Circuit.	a. Check and Correct.
b. Voltage Regulator.	b. Check and Adjust.
c. Current Regulator.	c. Check and Adjust.
d. Generator.	d. Make Bench Test.
e. Fan Belt.	e. Check and Adjust or Replace.

SYMPTOM AND PROBABLE CAUSE	REMEDY
3. Noisy Generator	
a. Belt Tension.	a. Check and Adjust or Replace.
b. Defective Bearings.	b. Replace.
c. Brushes Not Seating Properly.	c. Correct.

(STARTER AND BATTERY)

SYMPTOM	REMEDY
1. Discharged Battery	
(a) Loose or Dirty Terminals.	(a) Clean and Tighten.
(b) Generator not Charging.	(b) Inspect and Test Generator and Regulator as indicated in Starter Section of this book.
(c) Cells Shorted.	(c) Test as described in this section.
(d) Cells Dry.	(d) Add Water as described.
2. Slow Starter Speed	
(a) Discharged Battery.	(a) Recharge Battery.
(b) Loose or Dirty Terminals.	(b) Clean and Tighten.
(c) Worn Brushes.	(c) Replace.
(d) Sticking Brushes.	(d) Free up and check spring tension.
(e) Dirty or Worn Armature.	(e) Clean with sandpaper or undercut.
(f) Worn Bushings.	(f) Replace.
(g) Armature Rubbing Field Coils.	(g) Tighten Field Coils in Starter Housing. Check Bushings.
(h) Burned Starter Switch Contacts.	(h) Replace Switch.
(j) No-load and Torque Incorrect.	(j) Check as described.

(DISTRIBUTOR COIL AND SPARK PLUGS)

In diagnosing any ignition system trouble, the driver or mechanic should visualize the ignition wiring diagram and keep in mind the fundamental action of the two ignition circuits, primary and secondary.

In addition to a fundamental knowledge of the ignition circuits, the mechanic must also bear in mind that many symptoms usually attributed to defects in the ignition circuits are, in some instances, occasioned by defects in other engine operating systems.

There are some symptoms that can be visually and audibly detected, which definitely point to defects in the ignition system, however, other engine operating systems should have routine checks before determining that the ignition system is at fault. Reference should be made to other "Service Diagnosis" sections in respective groups of this book, and to the "Maintenance Requirements" in Section T.

Tracing Ignition System Troubles

If the ignition system is at fault, there are two conditions under which the trouble must be localized, as follows:—

1. **Engine Will Not Start—**

When engine will not start, a simple and effective localizing method is to watch the behaviour of the dash ammeter (or test ammeter) with the ignition switch on and engine cranked with the starter.

The mechanic should first determine if there is a secondary current going to the plugs by removing the spark plug wire, and then noting the spark while engine is cranked. (Hold wire about 1/8" away from engine). If there is no spark, the ammeter action should be noted. If there is a weak spark, follow the sequence shown in the succeeding chart. If there is a good spark and the spark plug is operative, check other systems.

When the ammeter is used to localize the circuit trouble, the ignition wiring diagram must be visualized. There are four separate actions of the ammeter under various conditions:—

A. Normal oscillation of the needle—indicates that the points are "making" and "breaking" the primary current.

B. Constant normal discharge—indicates that only the normal primary current is completed through the circuit.

C. Zero reading—indicates that the primary circuit has not been completed.
D. Abnormal discharge—indicates a short in the primary circuit.

2. **Engine Running—**
If the ignition system is suspected, the mechanic must audibly detect symptoms.

The succeeding charts list various symptoms and probable causes, together with possible remedies. The items are placed in logical sequence and checks should be made in that order.

SYMPTOM	REMEDY

Engine Will Not Start

A—Ammeter shows "0" discharge, when engine cranked, but no spark.

Symptom	Remedy
1. Battery terminal is loose or corroded.	1. Tighten, clean or replace.
2. Circuit between Battery and Ammeter shorted.	2. Check and correct.
3. Defective Ammeter.	3. Replace.
4. Circuit between Ammeter and Switch shorted.	4. Check and Correct.
5. Defective Switch.	5. Replace.
6. Circuit from Switch to Coil shorted.	6. Check and correct.
7. Defective Coil.	7. Replace Coil.
8. Points not closing.	8. Check and adjust Points.
9. Defective Points.	9. Check and replace.

B—Ammeter shows normal oscillations when Engine cranked and weak or no spark.

Symptom	Remedy
1. Defective Coil.	1. Replace Coil.
2. Circuit from Coil to Distributor shorted.	2. Check and correct.
3. Defective Condenser.	3. Replace.
4. Defective Rotor or Cap.	4. Examine and replace.
5. Spark Plug wires defective.	5. Replace.

C—Ammeter shows constant normal discharge with no spark when engine cranked.

Symptom	Remedy
1. Points not opening.	1. Check and adjust.

D—Ammeter shows abnormal discharge with switch "On", Zero with Switch "Off".

Symptom	Remedy
1. Circuit from Switch to Coil shorted.	1. Check and replace.
2. Defective Coil.	2. Replace Coil.

E—Ammeter shows abnormal discharge with Switch "On" or "Off".

Symptom	Remedy
1. Short in Generator Circuit.	1. See Page R-19, this Section.
2. Short in Lighting circuit.	2. See Page R-41, this Section.
3. Circuit between Ammeter and Switch shorted.	3. Check and replace.

Engine Running

A—Continuous mis-firing in one or more Cylinders.

SYMPTOM	REMEDY
1. Defective Spark Plug.	1. Replace.
2. Defective Wires.	2. Replace.
3. Defective Cap or Rotor.	3. Replace.

B—Lack of Power—Overheating.

SYMPTOM	REMEDY
1. Late Timing.	1. Check and adjust.

C—Erratic—Rough Running.

SYMPTOM	REMEDY
1. Early Timing.	1. Check and adjust.

D—Back Firing.

SYMPTOM	REMEDY
1. Crossed Plug Wires.	1. Install in correct firing order.

E—Missing at High Speed—Under Load.

SYMPTOM	REMEDY
1. Plug Gaps incorrect.	1. Check and adjust to .040″.
2. Point tension weak.	2. Check and adjust.
3. Point Gap too wide.	3. Check and adjust to .018″.
4. Points burned or corroded.	4. Clean points or replace if necessary.
5. Defective Plug.	5. Check and correct.
6. Defective Coil.	6. Replace.

F—Pre-Ignition.

SYMPTOM	REMEDY
1. Wrong type Plugs.	1. Replace with correct Plugs.
2. Ignition Timing too far advanced.	2. Check and adjust Ignition Timing.

G—Excessive "Ping" at high speed under load.

SYMPTOM	REMEDY
1. Manual advance set incorrectly.	1. Check and Adjust.

Hard Starting

SYMPTOM	REMEDY
1. Distributor Points burned or corroded.	1. Clean points or replace, if necessary.
2. Points improperly adjusted.	2 Adjust Points to .018″.
3. Spark Plugs improperly gapped.	3. Set Plug Gap at .040″.
4. Spark Plug wires loose and corroded in distributor cap.	4. Clean wire and cap terminals.
5. Loose connection in primary circuit.	5. Tighten all connections in primary circuit.
6. Corroded Battery terminals.	6. Clean Terminals thoroughly.
7. Series resistance in Condenser circuit.	7. Clean all connections in Condenser circuit.
8. Low capacity Condenser.	8. Replace Condenser.

MISCELLANEOUS ELECTRIC

Temperature Gauge

SYMPTOM	REMEDY
1. Does not register.	1. Check wiring. 2. Replace engine unit.

Gas Tank Gauge

SYMPTOM	REMEDY
1. False Reading.	1. Check as described under "Gas Tank Gauge."

Horn, Weak Signal

SYMPTOM	REMEDY
1. Low voltage.	1. Check battery and horn as described.

Rasping Sound

SYMPTOM	REMEDY
1. Not adjusted correctly.	1. Adjust as described.

SPECIFICATIONS

Generator

Make....Delco-Remy
Drive...."V" Belt
Voltage....6—8
Amperes....33
Rotation....CW
Pulley Diameter....3-11/32″
Armature End Play....005″
Commutator out-of-round....002″
Brush Tension....25 oz.

Cold Out-Put

Amperes....37 at 1750 R.P.M.
Volts....8

Regulator

Make....Delco-Remy
Model....1118201

Cut-Out Relay

Air Gap....020″
Point Opening....020″
Closing Voltage....6.3—6.9 Volts
Opening Voltage (Reverse Flow)....0—4 Amperes

Voltage Regulator

Air Gap....070″ to .075″
Voltage Setting—Volts....7.2—7.4

Current Regulator

Air Gap....075″—.085″
Current Setting—Amps....32—34

Battery

Make....G.M. Prest-O-Lite
Plates per Cell....15
Voltage....6
Terminal Grounded....Negative
Ampere Hours at 20 hr. rate....90 to 100
Specific Gravity—
Fully Charged....1275—1300
Recharge at....1200

Starting Motor

Make....Delco-Remy
Rotation....Clockwise
Flywheel Teeth....139
Starter Pinion Teeth....9
Ratio....15.44:1
End Play in Shaft....005″—.050″
Commutator—Out-of-round....003″
Brush Tension....24—28 Ozs.

No Load Test

Amperes....65
Volts....5.0

Torque Test

Amperes....525
Volts....3.37
Torque....12 ft. lbs.

IGNITION SYSTEM

Ignition Coil

Make....Delco Remy
Voltage....6

Condenser

Make....Delco Remy
Capacity....18 to .25 Mfd.
Flash Test....300 Volts D.C.

Distributor

Make....Delco Remy
Model....1110052
Advance....Full Automatic
Type of Advance....Vacuum and Centrifugal
Firing Order....1-5-3-6-2-4
Breaker Point Gap....018″
Breaker Arm Spring Tension....17 to 21 ozs.

Engine R.P.M.

Spark Advance at 2600 R.P.M....24°
Maximum Advance 3500 R.P.M....36°
Timing—Initial Setting....5° B.U.D.C.

Spark Plug

Make....A.C.
Type....44
Size....14MM
Gap Setting....040″

MISCELLANEOUS

Temperature Gauge

Engine Unit—Make....A.C.
Dash Unit—Make....A.C.

Fuel Gauge

Tank Unit—Make....A.C.
Dash Unit—Make....A.C.

Horn

Model....1999806
Make....Delco Remy
Air Gap....027″—.033″
Current Draw....7—9 Amperes

LIGHTING

Lamp Bulb Specifications

Location	Mazda No.	Candle Power	Quantity Per Vehicle
Headlamp	3666	36/6 Watt	1
Instrument Lights	55	1½	2
Tail Lamps	81	3	2
Side Lamps	63	3	2
Stop Lamps	63	3	1
Axle Lamp	81	3	1
Inspection Lamp	1129	21	1
Beam Indicator	51	1	1