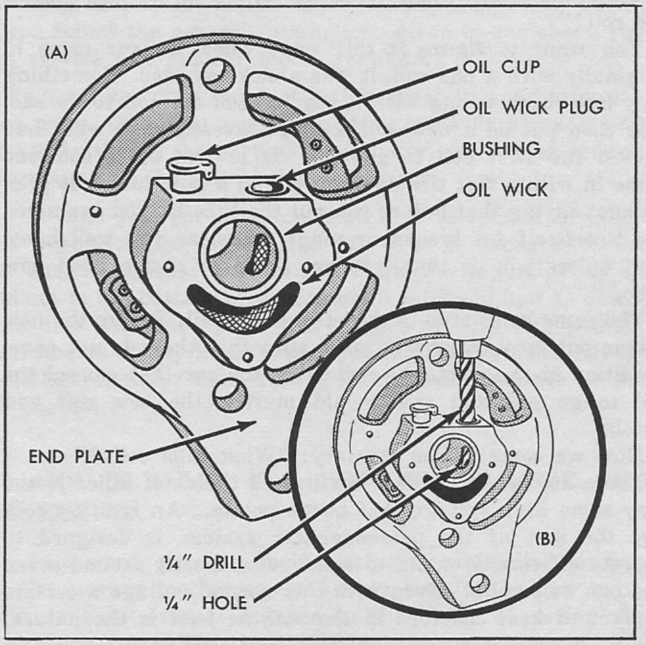
SERVICE BULLETIN No. 66-51

# INSTALLING AN X-4242 GENERATOR BUSHING

*We are called upon, from time to time, to explain the proper method of using the very popular X-4242 generator bushing, which replaces original equipment bushing #812823.*

Both the X-4242 and #812823 bushings have exactly the same internal diameter, .552″. As these bushings are used with a 9/16″ (.562″) generator shaft, the claim is made that the .552″ diameter is too small to fit the .562″ shaft, and this claim sounds reasonable enough at first glance.

It must be remembered, however, that a generator bushing is normally used to replace a worn bushing when rebuilding a generator. In most cases of this type, it will be found that the generator shaft has become worn, to a greater or lesser degree, and that its diameter is now smaller than the original .562″. It is obvious, therefore, that if we furnish a new bushing with an internal diameter to fit a new armature, this diameter would be too large for a worn armature shaft and would result in loose fit and unsatisfactory service. It is also obvious that the amount of armature shaft wear cannot be predicted and that it may vary with each job.




For these reasons, the new bushing is furnished with an undersized hole, and good practice demands that it be individually fitted to the particular armature shaft. We can recommend, for a good all around job, the following step-by-step procedure when installing a new bushing:

*After you have removed the end plate with the bushing from the generator, proceed as follows:*

1. Remove the oil wick.
2. Press out the old bushing.
3. Press out the plug for the oil wick.
4. Press in the new bushing.
5. Drill ¼″ hole in the bushing, as shown in the illustration, which will provide an opening in the bushing for the oil wick.
6. Ream the bushing for the size of the shaft, using an expansion reamer (17/32″ to 19/32″), fitting the hole to the shaft so that the shaft rotates freely and without too much play. The best way to do that is to clamp the reamer in a bench vise and ream the bushing by turning the end plate on the reamer.
7. Replace the oil wick.
8. Replace the oil wick plug.

## SERVICE BULLETIN No. 26-40

# WHAT KILLED THE COIL??

"A customer came in complaining of hard starting and no pickup. I tested his coil and found it was weak—just barely sparked. I put on a new coil and the car worked fine. A week later the customer came back with the same trouble and I found that the new coil was almost dead. What killed the coil?"

You want to figure it this way: when the car came in originally with a bad coil, it was a sick car then. Something may have been wrong with it that caused the coil to go bad. You then put on a new coil without investigating what had caused the first coil to go bad. It is just as if someone came in with a flat tire and you put in a new tube. It goes without saying that before you put the tube in, you examined the tire itself for breaks or rough spots, as you well know that unless you do that, you are liable to ruin a good new tube.

The same holds true in the case of the coil. Before the new coil is put on you have to make sure that there is not some condition in the electrical system of the car that caused the coil to go bad and that would murder the new coil you put in.

Now we come to the mystery: "What kills coils?"

There are several causes for it, and the chief killer is the very same high voltage that burns points. An ignition coil, like the rest of the passenger car system, is designed to operate efficiently on six to eight volts, mostly around seven and one half volts. Even with this normal voltage a certain amount of heat develops in the coil, as heat is the natural result of current flowing through any conductor.

With a high voltage condition, however, the increased voltage naturally causes an increase in the current flowing through the coil and, consequently, an increase in heat. And here is where things become really tough, as *the heat due to current in any conductor is proportional not to the current itself but to the square of the current,* i.e. with a current of two amperes, for instance, the heat will depend on the square of two or four; if the current is increased by only one ampere to three, the heat will depend on the square of three or nine. This means that an increase of one-half in current will produce more than twice the heat.

This is exactly what happens to a coil on a car with high voltage. It is nothing unusual to find that the voltage, especially in the winter time, is ten volts or one-third increase over the normal of seven and a half. In such cases the heat developed in the coil is just about twice the normal, and the coil *must* overheat.

Any coil that is subjected to twice the normal heat for any length of time will gradually weaken, as the high heat will char the insulation in the secondary winding, and cause internal shorts. Eventually the coil will fail completely. It is just as if you were operating a two ton truck under a four ton load—you may get away with it for a while but eventually something will let go.

So you can take it for granted that in most cases where you find burnt points in a car, the coil is also liable to go bad, as both conditions are caused mostly by high voltage.

Another cause for coil failure is an abnormal strain put upon the secondary winding of the coil by resistance in the high tension circuit. This can be caused by a defective radio suppressor, wide gaps between spark plug electrodes, due either to wrong adjustment or natural burning away of the electrodes in service, or a burnt rotor segment. In any one of the above cases the coil is compelled to develop an abnormal amount of voltage in order to overcome the additional resistance, and this abnormal voltage often breaks down the insulation between the layers of the secondary winding.

The above conditions may even cause the spark to jump between the high tension and the primary terminals of the coil, over and along the bakelite top. It is a well known electrical characteristic, that all electrical currents travel in the path of least resistance. Therefore, whenever the resistance of the spark plug gap under compression plus the resistance of the defective suppressor or rotor becomes greater than the resistance of the insulation between the high tension terminal and the primary terminal—the spark will jump there instead of the spark plug gap. This is especially true in damp weather, due to moisture on the bakelite top which reduces the electrical resistance there, or when grease and dirt are present on the coil top. The metallic particles in the dirt also provide a path of low resistance for the spark. Besides, any moisture that would dry up on a clean coil top will keep the dirty top damp.

Often the spark jumps right through the bakelite of a high tension terminal at a point opposite a primary terminal. You will find in most of such cases that the high tension cable is not all the way in the socket.

Leaving the ignition key on overnight or for a long time is another frequent cause for coil breakdown. In this case the uninterrupted current through the primary overheats the coil and kills the insulation. This will cause a coil to fail some time after it is done, just the way a tire bruise may cause a flat several days afterward.

Please remember that an ignition coil is called upon to do an enormous amount of work in a very short time. In order to jump the spark plug gap under compression, anywhere from 7,000 volts upward are required. The only voltage available is the six to eight volts produced by the generator or the battery, and the coil must transform it into spark gap voltage. When you travel at high speed, the coil must perform the stunt of taking six volts, building up magnetism, producing 7,000 volts or more—all at the rate of ten thousand times per minute. This is pretty fast work, you will admit, and any strains in the coil caused by any of the above reasons must affect the life and performance of the coil.

**CAUTION:** Whenever a coil operates, there is a static discharge between the primary terminal and the bakelite top. This discharge is of a hazy purple color and is a normal phenomenon that is present whenever high tension currents are used, whether it be in an ignition coil or powerline. It is plainly visible in the dark, and the more powerful the coil the stronger the discharge.

This static discharge does not in any way interfere with the proper functioning of the coil and must not be mistaken for a spark-jump through the bakelite. A real spark is of a bluish white or reddish white color and has a distinct snapping sound while the static discharge is purple and almost silent.

## SERVICE BULLETIN No. 51-47

# Does Polarity make a difference in an Ignition Coil?

The question of polarity pops up continuously in many automotive electrical applications. Two of the most familiar applications where polarity is an extremely important factor are ignition coils and voltage regulators.

Before discussing polarity, let us define it. In general, polarity means the quality of having opposite poles. In a magnet, for instance, there is a north pole and a south pole; a battery has a positive pole and a negative pole. So far as we are concerned with polarity in the automotive electrical system, the principle to remember is that current always flows from the positive pole to the negative pole.

Let us apply this principle to ignition coil operation and performance. In the automotive system there are two methods of connecting the battery into the system: with the positive battery post grounded, used on Ford cars and most vehicles equipped with Auto-Lite Ignition, and with the negative post grounded, most frequently encountered in Delco-Remy equipped systems.

Now, where the ground is on the negative post of the battery, all operating electrical units are connected to the positive side of the battery, and the current flows from the live (ungrounded) post of the battery, through the units and back into the battery through the chassis of the car (the ground), which is connected to the negative post of the battery.

Where the positive post of the battery is grounded, the current flows in the opposite direction, i.e., through the chassis, then through the units, and back into the battery.

It has been conclusively established that the high-tension spark in the compression chamber of the gasoline engine jumps with greater ease if the live (center) electrode of the spark plug is of negative polarity. As the live electrode of the spark plug is connected directly to the high-tension winding of the ignition coil, it follows that the ignition coil must be so internally constructed that the end of the high-tension winding, which is connected to the spark plug, be of negative polarity. Please remember that this condition must be met, regardless of whether the battery is grounded on the positive or negative side.

From the above, it must not be deduced that an ignition coil will not operate unless the live end of the secondary winding is of negative polarity. What will happen, if the polarity is wrong, is that the efficiency of the coil will drop about 15%, and while this may not have an apparent effect under normal operating conditions, it most certainly will be felt if conditions demand the maximum coil efficiency. For instance, in cold-weather starting, wrong coil polarity has often resulted in failure to start, something that always haunts the winter driver. It is that 15% loss in efficiency, when conditions require peak performance, that is the decisive factor in such cases.

In applications where the older type of coil is used, i.e., the coil without the lockswitch, where it is possible to reverse the primary wires to suit the polarity of the battery, the problem is simple. When the battery is grounded on the negative side, the connections to the coil are made as indicated on the coil top, i.e., the battery wire is connected to the "BAT" or "+" terminal, and the distributor wire is connected to the "DIST" or "—" terminal, depending upon the coil manufacturer's method of marking his coils. When this is done on properly constructed ignition coils, the high-tension winding will be connected to the negative end of the high-tension winding, as required.

Where the battery is grounded on the positive side, the coil wires are reversed, so that the battery wire is connected to the "DIST" or "—" terminal, and the distributor wire to the "BAT" or "+" terminal. Again, the high-tension winding will be of negative polarity.

When it comes to lockswitch coils, however, the story is entirely different. There, the method of connecting the primary wires is predetermined by the construction of the coil, and the wires cannot be reversed. The battery wire always goes to the lock connection, and the distributor wire to the free terminal. We have no way, therefore, to reverse external connections to suit our battery polarity, and the internal wiring of the coil itself must suit the polarity of the particular system in which it is used.

As a very good example of trouble encountered when the coil polarity is wrong, we might mention the case of the Chevrolet since their engine came out with the spark plug sunk into a deep well in the cylinder block. As a result of this construction, the spark plug terminal is in close proximity to the grounded cylinder block, and when a coil of wrong polarity is used, when the engine is started in cold weather, the spark will often jump from the spark plug to the cylinder block instead of firing in the cylinder. This is caused by the fact that, as explained above, the spark in the combustion chamber jumps with greater ease when the live electrode of the spark plug is of negative polarity. Conversely, it is harder for the spark to jump if the spark plug terminal is of positive polarity, and the coil has to develop a higher voltage to make the spark jump in the cylinder. As it is easier for a spark to jump in the open air than under compression, when the voltage of the coil reaches a higher than normally required value, the spark takes the easier path and jumps to the cylinder block rather than inside the cylinder.

Again, we will say that if the proper polarity coil is not used in a car, it will not always result in defective coil operation. But when maximum coil efficiency is demanded by some severe operating conditions, failure will result. In other words, your coil will be just a "fair-weather coil."

It is obvious from the above that in order to guarantee to your customer maximum coil performance under all operating conditions, you must make sure that the coil you install is of the correct polarity for the particular car. We ourselves, have always zealously followed the correct polarity principle in our STANDARD and BLUE STREAK coils. When recently we put out our "Universal" coil, we followed the same principle by furnishing a "positive" coil and a "negative" coil to be used with their respective battery polarities. By carrying the two types of coils you are in a position to make a coil installation 100% correct.

In a subsequent service bulletin, we will go into the subject of polarity as applied to voltage regulators.

**SERVICE BULLETIN No. 21-39**

# "HEAVY DUTY" CONDENSERS

When the subject of "heavy duty" ignition parts is under discussion, the condenser assumes a prominent position. But before explaining the construction of "heavy duty" condensers, we should like to explain the functions of a condenser in general.

The prevailing impression that the condenser is used in the ignition system for the purpose of quenching the arc between the breaker points is correct, but does not tell the whole story. The condenser does much more than that—it actually helps the ignition coil to produce the thousands of volts necessary to cause a spark to jump between the spark plug electrodes under compression. Let us explain:

When the breaker points close, current flows through the pirmary winding of the coil, causing the core to become strongly magnetized, or saturated. During this saturation period there is current and voltage induced in the secondary winding, but the voltage is not sufficiently large to produce a spark strong enough to jump across the spark plug electrodes under compression.

It has been found however that if the core is de-magnetized suddenly and very rapidly, a high voltage is induced in the secondary of more than sufficient magnitude to fire the spark plug. In other words, it is necessary to use some means that will cause the core to change suddenly from being a strong magnet to being no magnet.

And that is where the condenser comes in. As soon as the breaker points open, the change of magnetism in the core causes a surge of current in the primary in the same direction as it has been flowing. This surge charges the condenser; as soon as the condenser is charged to its capacity, it immediately discharges and send a rush of current through the primary in the opposite direction. The quick reversal of current in the primary causes an instantaneous collapse of the magnetic field in the coil, as it demagnetizes the core almost completely. *It is this fast collapse of magnetism that produces the thousands of volts necessary to fire the spark plug.*

Also, the surge of reverse current from the condenser kills the arc between the points that would otherwise form, due to the natural tendency of arc formation whenever an electrical circuit is broken.

There are four elements that may affect the performance of a condenser. Any one of the four can cause trouble even though the condenser may be perfect in respect to the other three.

1. **Moisture.** Moisture is Enemy No. 1 of condenser life and performance. It causes leakage of current inside the condenser, which means that the discharge through the primary is weakened, and the coil does not build up voltage. The result is a weak spark.

A condenser can be completely devoid of moisture when it is made and leaves the factory, but can pick up enough moisture either on the dealer's shelf or while on the car to seriously interfere with good ignition. Good condenser construction calls for permanent sealing of the condenser against the entrance of moisture at any time.

2. **Insulation.** All component parts of the condenser must be extremely well insulated to withstand surges of at least 350 volts and should be able to take higher voltages without breakdown.

3. **Capacity.** The highest engineering authorities have found .24 microfarads to be the ideal capacity for normal passenger car operation. If the capacity is too high, it takes a longer time to become fully charged and it cannot keep up with the action of the coil, causing missing of cylinders. That is why higher capacity condensers must never be used in passenger cars when driven at normal speeds. Mechanics sometimes put in high capacity condensers to cure the burning of points instead of removing the cause of the burning. All they accomplish by this procedure is to introduce one more trouble into the system without curing the original trouble.

On the other hand, a condenser of too low a capacity does not send sufficient current to thoroughly collapse the magnetic field. This results in insufficient secondary voltage output and a weak spark.

4. **Internal Electrical Connections.** Much grief has been caused by insecure internal connections in condensers. Condensers with crimped leads or spring contacts may test perfectly for breakdown, leakage and capacity and be pronounced O.K. by the mechanic. Yet, when put on the car, trouble follows as the uncertain electrical connections sometimes function and sometimes do not—an intermittent trouble most difficult to locate.

A good condenser must have none of the above weaknesses. In other words, like contact points, a condenser should also be of "heavy duty" construction. In the "Blue Streak" condenser, for instance, the following "heavy duty" features are employed.

1. **Moisture Protection.** The brass condenser shell is drawn so that a narrow neck is formed at one end, just large enough to take the lead wire. This wire is covered with neoprene which is heat and oil resisting. After the lead has been inserted, the neck of the shell is crimped so that the neoprene is compressed and acts like a gasket. Thus a permanent, moisture-proof seal is formed at the lead end—the vulnerable spot where moisture usually enters. At the other end of the shell, a heavy metal disc is fitted into it, the shell is spun over the disc and the joint soldered all around.

With the two ends of the condenser closed up as described, the *assembly is absolutely impregnable to the entrance of moisture at any time.*

2. **Insulation.** The most important element in condenser insulation in the paper used to separate the layers of metal foil. Any impurities in the paper or metallic particles will cause an electrical breakdown at that point. The paper used in all our condensers is of a special type, pure of imperfections, and every roll of it is passed between metal rollers which are connected electrically so that any conductive particle in the paper completes the circuit and flashes a signal. The whole winding is vacuum impregnated with a special wax which penetrates into the innermost parts of the winding and seals up all crevices, so that the winding is completely protected..

A condenser made in this manner has plenty of safety margin against electrical breakdown. As a matter of fact, *all* our condensers must take at least 1000 volts D.C. before they are passed as O.K., and will actually stand up under as high as 1500 volts.

3. **Correct Capacity.** As explained before, the condenser

must be of the correct capacity which has been specified as .24 mircro-farads. The "heavy duty" type of condenser never varies more than 10% above and below this value, so that it should never be lower than .215 or higher than .264 micro-farads on a passenger car for average driving conditions. In testing for capacity you must be sure that the tester is correct, as some testers have no compensation for line voltage fluctuations which means that the same condenser may test differently on different days or even on different hours.

We test our condensers on a precision Wheatstone Bridge that is entirely independent of any outside influences and pass no condenser that does not come within the 10% limits mentioned above.

4. Internal Electrical Connections. There is no compromise on this point—*a condenser to be good must have all internal connections securely soldered.* The method of soldering must also be positive. In some condensers the internal grounding strip is brought up along the wall of the shell, carried outside of the shell and crimped with same crimp that fastens the condenser top to the shell and soldered at that spot. What often happens is that, in the crimping, the strip is severed, so that the inside severed end simply lies against the shell and makes a temporary connection. Such a condenser will show up O.K. on test or even on the car when the car is stationary; in driving, however, the slightest bump will shake the loose condenser end and cause intermittent condenser action. Therefore, the soldering should be independent of any mechanical joints. A good method is to solder the strip to the shell through a hole in the bottom of the shell with sufficient slack in the strip to allow for the effects of vibration.

Even the soldering flux must be considered—an acid type of flux makes it easier and quicker to solder but it corrodes the metal strip or the shell itself, causing an open after a short time of service. In a good condenser, a rosin flux is used; although it slows down the soldering operation and adds to the cost of production it is safe because it has no corrosive effect upon metal.

Of the many different makes of condensers a number have some of the above "heavy duty" constructions, but, to the best of our knowledge, the "Blue Streak" condenser is the only one that has every one of the features incorporated in it.

## SERVICE BULLETIN No. 59-49

# PROPER INSTALLATION OF ROTORS ON FORD AND MERCURY

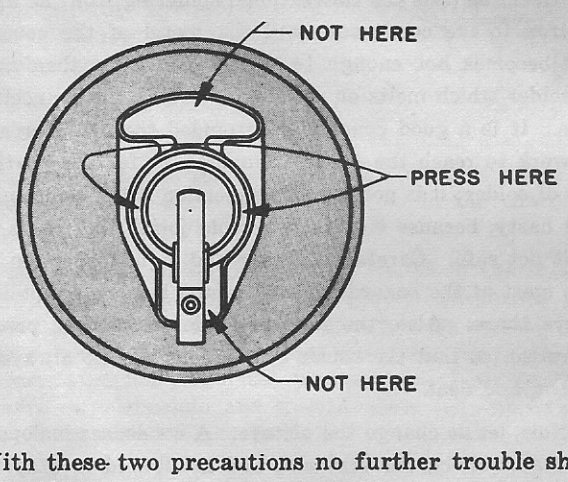
We have been asked to investigate the cause of breakage of rotors on the recent models of Ford and Mercury. Rotors of all makes are subject to this breakage.

Apparently there seems to be no reason for the breakage, as there is sufficient clearance between the metal rotor segment and the firing studs of the distributor. We did quite a bit of experimenting and located what we believe to be the cause of the trouble.

The Ford rotor fits very snugly onto a small diameter distributor shaft (3/8 of an inch as compared with 9/16" and 5/8" on other distributors) and considerable force is required to push down the rotor. Two possibilities for breakage arise:

1. *If the pressure for seating the rotor on the shaft is applied off-center, the slight rocking of the rotor, combined with the snug fit on the small diameter shaft is sufficient to crack the rotor.*
2. *If the rotor is not pushed all the way down, the metal rotor segment hits the body of the distributor head, and the rotor breaks.*

It is suggested that before the old rotor is removed from the shaft, *a mark be made on the shaft at the end of the rotor neck.* When the new rotor is put on, *apply pressure at the center of the rotor* and not at the end, and *make sure that the end of the rotor neck reaches the mark you made on the shaft.*




With these two precautions no further trouble should be experienced.

## SERVICE BULLETIN No. 50-47

# SOMETHING NEW HAS BEEN ADDED

It is a well known fact that well-designed automotive condensers have their internal connections firmly soldered, as distinguished from pressure-type condensers which depend solely upon mechanical pressure for contact. All STANDARD and BLUE STREAK condensers are and always have been soldered, and are known everywhere for their reliability and performance.

However, we are constantly experimenting with the most modern methods and machinery, as we are firm believers in the idea that quality has no ceiling and that a good product can always be further improved.

When that ultra-modern miracle worker, High-Frequency Induction Heating, was made practical during the war, we pounced upon it with the idea of utilizing it for the further improvement of our condensers.

Well, after considerable experimentation, we really have something: a condenser with INVISIBLE SOLDERING. In other words, we will furnish condensers which are positively soldered but without any visible trace of solder.

Let us explain to you the reasons for the change, as well as the method.

First, a word picture of the conventional method of condenser soldering. An operator is soldering an automotive condenser; he uses the conventional soldering iron; he applies the iron to the condenser until the metal of the condenser shell becomes hot enough to melt solder. He then applies the solder which melts on the metal, and so the connection is made. It is a good connection, provided the operator allows the work to reach the proper temperature for the particular type of solder; it is not a good connection if the soldering is a little hasty, because it is then a "cold joint" that looks O. K. but is not safe. Careful soldering and rigid inspection eliminate most of the hazards of cold joints, but the possibility is always there. Also, the flow of solder cannot be precisely controlled, so that the solder connections do not always look uniform and neat.

Now, let us change the picture. A condenser is deposited under a small copper-tube coil and is allowed to stay there for a couple of seconds WITHOUT TOUCHING THE TUBE or anything at all. You see no action of any kind, no heat, no fire, yet the internal connection of the condenser is completely and firmly soldered. You see no signs of solder on the outside of the condenser. In other words, we have a first-class soldered connection, as neat as a pin.

Magic? Yes, modern magic—High Frequency Induction Soldering! You see, we talk of 60-cycle alternating current, which means that the current changes in direction and polarity 60 times each second. Now imagine a machine which causes the current to change 500,000 times each second instead of 60. Although you cannot see it or hear it, it is terrific activity just the same, and every metallic object which is in the field of this activity becomes hot. The degree of heat is controllable, so that we can introduce a condenser into this field and set the heat to the proper degree for soldering of the internal connection.

While we do not care at this moment to go into a discussion of the merits or demerits of pressure type condensers, that method has one virtue—it is neat externally, as no solder is used.

Well, the new, invisible miracle condenser soldering method has everything—external neatness AND a soldered connection.

Another advantage of our new method is that the condenser winding does not heat up as much as in ordinary soldering. To make a good soldered connection with a soldering iron, the heat has to be applied for a considerable length of time, and this allows the heat to spread all through the condenser and the winding. While this does not damage the winding, elimination of the heating of the winding is advantageous as it adds another safety factor to condenser performance. With induction heating, the heat is applied only to the spot that is being soldered, and as the time necessary for soldering is very short, the heat does not spread, and the winding does not heat up.

So far as we know, we are the only ones using this method of soldering condensers. When you get these condensers, please do not confuse them with the pressure type, as externally there will be no difference between the two. Should you cut open one of our condensers, however, you will immediately see the soldering.