Repairing and Rewinding Wurlitzer Magnets

by Ben Levy

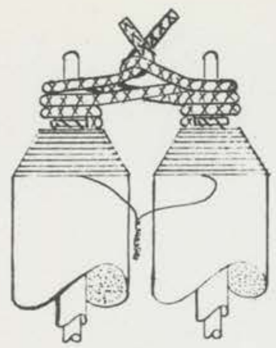

Fig. 4. Suggested way of securing lead-in wires.

PART 2

In Part 1 we learned how to prepare magnets for rewinding if they are "dead." In Part 2, Mr. Levy explains how to repair magnets which aren't quite "dead," how to measure coil resistance, reconnect broken windings, and insure correct polarity. Then he explains how to set up for rewinding coils which require it.

Now you should measure the electrical resistance of each coil. Use a cheap ohmmeter (also called a volt-ohm-milliammeter or multimeter), if you have or can borrow one. If you can't borrow one, they are available from radio-electronic supply houses such as Allied Electronics Corporation, 100 North Western Avenue, Chicago, or wherever TV test equipment is sold in your area. Get the 1000-ohms-per-volt variety if possible; they're cheaper and better suited to this work.

Dip a toothpick end in enameled wire stripper ("Strip-X" is one brand) and coat the tips of the four coil ends carefully to remove the enamel insulation. Wait a few minutes and wipe it off with tissue. Now test the resistance of each coil with the ohmmeter. A pair of small "alligator" clips are handy to use in conjunction with the instrument in order to hold onto the ends of the fine wire. The coils should measure about 90 ohms each. If a coil measures open-circuited (no indication), look for visible coil damage on the outside of the coil, unwind a turn or two at the break, strip the wires, twist together and solder. If you can't find the break, don't waste too much time. Work the coil, core and all, off the pole piece and throw it away or remove the wire and save the coil form for rewinding, if you wish. Soda straws can also be used for coil forms.

If a coil measures considerably less than 90 ohms, there is a short circuit between layers. Sometimes you can cure this by moving some of the wires at the top of the coil around a bit; if you can't find the cause, remove the coil and rewind. It rarely occurs.

Assuming both coils check out OK, you are ready to reconnect them. Twist the two outside coil ends together and solder. Use a small soldering iron with a fine point; if you don't have one you can make one out of any iron by wrapping a piece of solid copper wire around the tip and letting the end stick out a little, using the wire end to solder with. Leave the iron on its stand and take the work over to it. Tuck the soldered ends down between the coils with a toothpick.

Cut a couple of 8" pieces of new insulated lead-in wire, for which purpose discarded lengths of organ cable come in handy. Strip ⅛" of the cotton insulation from one end of each and ½" from the other, and tin both ends with solder. The shorter ends will be soldered to the magnet coil ends and the longer ones will be ready to solder onto the wire ends in the organ chests.

Take one of these and wind it three times around the protruding end of the paper coil form of one of the coils, with the bare end close to the fine wire that it will be soldered to. The winding direction must be such that the long end extends between the magnet poles, as in the original arrangement. Holding it firm with a finger, use a toothpick to wind the fine wire around the tip of the lead-in wire and solder. If there isn't enough fine wire available for this, simply lay them together and solder. Repeat with the other wire and the second coil end. See Fig. 3.

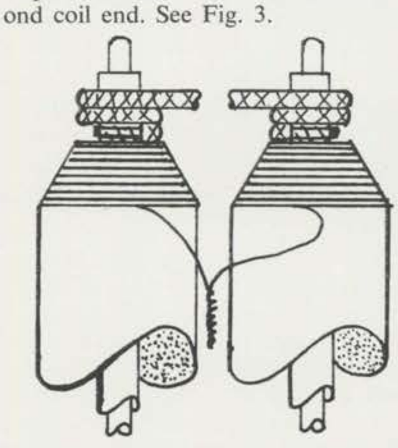

Fig. 3. Reconnection of coils and new lead-in wires.

Take each lead-in wire and make one or more turns around the *adjacent* pole piece for security, making sure the ends finally extend from between the poles, in the same direction. Twist them together once or twice at this point, if desired, not too tightly or you might create a short circuit. Avoid all strain on the fine wire while coiling the lead-in wires and while pulling the turns tight. This is one of the more ticklish parts of the operation. See Fig. 4.

Take the magnetic bridge you removed initially and force it back onto the pole pieces, by squeezing it on in a vise or by tapping it on with a screwdriver and hammer. Now you are ready to test the finished product.

Check the resistance with the ohmmeter. It should measure about 180 ohms or the value of two 90 ohm coils in series. This is really all the testing you need to do, but just for fun you can now check to see that you really have a "horseshoe" magnet. An ordinary magnetic compass such as a boy-scout compass or a carpenter's stud finder is required. Lay the magnet on its side and place the compass near the Bakelite end. The needle of the compass will be attracted toward the iron pole pieces. Move the compass a little until the needle points strongly toward one or the other of the two poles. Now connect your ohmmeter to the magnet, thus energizing it. If the direction of current flow happens to be such that the pole piece toward which the compass is pointing is of the same magnetic polarity as that of the near end of the compass, the needle will swing over and point toward the other pole piece (like polarities repel each other). If the polarity the magnet acquires by the passage of current is opposite to the above, the compass needle will not change position but will be more strongly attracted (unlike poles attract). In this event reverse the ohmmeter connections and the needle will move over. This little demonstration shows that when current flows through the magnet windings one pole end becomes a north magnetic pole and the other a south pole. This is the condition which assures the most powerful attraction between the magnet and the soft iron armature when the magnet is energized. Which pole is which polarity doesn't matter; just so they are different. This point is worth harping on because it is possible to connect the two coils so they form a bar magnet rather than a horseshoe magnet, resulting in a much weaker magnet. If you connect the coils exactly as shown, however, this error is not possible.

See that the connection between the coils is still tucked safely between the coils and that the lead-in wires are neat and firm and not straining the fine wires, dip the magnet end in a can of brushing lacquer and hang upside down to dry. The lacquer cements everything securely in place. Use hooks made by unfolding paper clips.

All this description makes the process sound complicated and difficult, but it takes only about ten minutes to repair a magnet this way, after the alcohol bath, and a day for the lacquer to dry. Save up your dead magnets until you have a dozen or so and do them in batches.

I considered using one of the modern-day coil dips instead of lacquer, but decided against it. Most of them are not removable after once hardening, and make getting into the coils again impossible, should this ever be necessary.

To help find those hard-to-locate breaks in the outer layer of the coil, attach your ohmmeter to one coil end and a needle or a razor blade to the other lead of the ohmmeter. Then poke along the outer layer until the meter reading disappears. Now you have localized the break, and a careful examination at this level of the coil will enable you to find it. Sometimes acid-core solder was used to connect the magnet to the organ, and a spot of acid has fallen on the coil, eating the wires in two at this point. Use the needle to pry up the ends of the wire when you have found the break, so you can unwind a turn and solder.

Any coils which cannot easily be repaired using the above procedure should be removed from the pole piece and a new coil substituted. Use either the original coil form after stripping the wire from it or use a soda straw of suitable inside and outside diameter.

Buy a pound of No. 37 gauge enameled magnet wire. Copper prices are sky-high and wire is very hard to get, but it can be obtained if you keep after it. Since it's so hard to get, you might as well get the right size. Even-numbered sizes are more easily found than the odd ones, but No. 36 is too large and No. 38 is too small, if you want to duplicate the Wurlitzer coils. There is a 25% difference in electrical resistance per foot between consecutive wire sizes, and since the number of feet of wire per coil you would wind with a different gauge wire would also differ in the same direction, the coil resistances would differ by considerably more than 25%. The number of turns per coil, and thus the magnetic strength of the magnet, and the inductance of the magnet, would also differ. Inductance is an important factor affecting the amount of contact arcing developed when the magnet is in use. Since so many factors are affected by a change in wire size, it probably pays to be conservative and stick to the original size, which will ensure that the rewound magnet or coil will be electrically identical to the original, whether or not this happens to be the ideal combination. In this matter I have not conducted experiments, being willing to take Mr. Hope-Jones' word for it. His designs were, in general, pretty well thought out.

If there is a secret for making coil-winding easy, it is in providing a means for keeping the wire under constant, proper tension. If you have this, everything else is easy. The best such device is an electric torque motor. Almost any fractional-horsepower motor should do, but it should have good, smooth bearings and *not* employ a starting device which puts any drag on the rotation, such as some "split-phase" motors employ. A motor employing a condenser for starting and not making use of an internal centrifugal switch is probably best; the one I use is a ½-horsepower radial-arm-saw motor. It will be used only to keep tension on the supply reel, and will be operating only on a very low voltage.

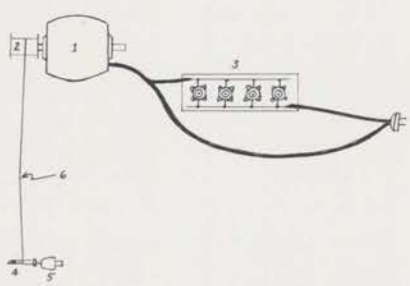

Fig. 5. Schematic drawing of coil winding set up.

LEGEND referring to the numbered parts showing on Figure 5.

1. *Torque motor used to supply proper tension to wire.*
2. *Wire supply reel mounted on motor shaft.*
3. *Lamp sockets in series with line for adjustment of tension.*
4. *Coil form on which coil is being wound.*
5. *Chuck of hand-cranked drill with which winding is done.*
6. *Approximate point at which finger is placed to guide the wire while winding. Angle shown in the wire is illustrative of the amount of deflection of the wire required to insure a smooth winding.*
7. *Caution! Observe that the wire supply reel and the coil form are on the left-hand ends of the motor shaft and the "egg-beater" coil winder. This insures correct winding direction! Do it this way even if you are left-handed!*

Mount three or four porcelain lamp sockets on a board, wire them in parallel with each other, and wire the sockets as a group in series with the motor to the AC line, as shown in Figure 5. With this arrangement, the motor will receive no power unless one or more lamps are screwed into the sockets. The more lamps and the higher the wattage of the lamps, the more pull. I found that 250 watts of lamps in series with the ½-horsepower radial-arm-saw motor seemed to provide just the right amount of tension. The tension measured to be 56 grams, or a little less than two ounces. This value is approximate, of course, and can be varied somewhat. Too low a value makes for loose coils that tend to unravel at the ends, and too large a tension causes the wire to be forced between turns of the underlying layer of the coil and makes winding the coil difficult.

A variable-ratio transformer ("Variac"), if you have one, provides a more precise and elegant control of motor torque than the relatively crude lamp resistance scheme does.

Mount the spool of wire on the motor shaft. If the shaft is long enough, perhaps you can simply wind it with tape until it is large enough to be a good fit, but make sure it doesn't wobble. It's better to make an adapter of wood or metal that will be a "push fit" over the motor shaft and inside the wire spool. It doesn't have to be very tight, but the resulting arrangement should allow the spool to turn concentrically. The spool must be mounted so that the motor will try to pull the wire back onto the spool as it is drawn off during winding. Set the motor on the workbench a foot or so from the front edge where you will be doing your winding, so that the wire can be pulled off the spool toward you. If you use a radial-arm-saw motor, shove it back to the end of its track and lock it there, using the saw bench as a workbench.

For a winding machine, I use an ordinary small "egg beater" hand drill clamped in a vise so that the crank can be turned with one hand while the wire is guided with the other. This setup allows you to turn fast or slowly, stop, or reverse if desired, very easily. To me at least, this little tool is much more desirable than a motor-driven device such as a lathe, which is considerably less under the operator's control. With the tension motor controlling the supply reel, no matter how fast or slowly you turn the crank, or even reverse to correct a flaw, the wire will be under constant tension, the spool supplying or rewinding the wire as required.

In the concluding installment, Mr. Levy will cover the rewinding procedure in detail.