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REPAIR & MAINTAIN
LIONEL POSTWAR LOCOMOTIVES

YOU CAN FIX IT!

REPLACE PICKUP ROLLERS & SHOES

REPAIR UNIVERSAL LIONEL MOTORS

REWIRE STEAM & DIESEL MOTORS

2013
618258

REPAIR PICKUP ROLLERS & SHOES

HOW TO REPLACE THEM ON PREWAR, POSTWAR & EARLY MODERN ENGINES

by Ray L. Plummer Photos by Jim Forbes

Pickup rollers and shoes – those out of sight, out of mind, center-rail electrical contacts that are important in a locomotive's performance – should never be ignored.

Certainly, at a minimum, these pickups should be kept clean so they roll or slide freely, but that alone isn't enough. Even under normal use, they sustain a considerable amount of wear and tear over time. When the pickups have grooves worn into them or are badly pitted from hours of arcing, it's time to replace them.

In fact, the *Lionel Service Manual* recommended changing locomotive rollers or sliding shoes every time the unit was overhauled. This mandate, though probably motivated in part by Lionel's desire to sell replacement parts, made as much technical sense in the past as it does today. With all of the electronic circuitry that has come along in recent years, good electrical contact with the rails is essential.

Though the essential function of pickup rollers and shoes remains the same, the contact design itself has changed. Maintenance procedures vary, depending on the locomotive's vintage and some hardware variations. Basically, we can break the procedures into four categories. Here's how to handle each type of repair.

Some cautionary notes

As described, you'll find roller or shoe replacements a doable job. But there is a caveat or two to consider.

Rollers were made in many shapes and configurations. When replacing rollers, use the old one as a guide.

First, bear in mind that Lionel made many different roller sizes and shapes over the years – some were beveled, some were not, as the photos on this page suggest. Be sure your replacement is the correct one, because exact dimensions are important. Inserting the wrong roller, even if it seems to fit, can result in operational problems, particularly when it goes over switches. If you don't know the part number, take the old roller with you to your Lionel parts dealer.

Second, note the exclusion of Lionel's Bakelite-cased "Scout" motors in this article. They were excluded for good reason: Their pickups were not designed to be easily replaceable. Fortunately, in many cases, the pickups outlasted the motors themselves anyway.

Once you've replaced worn-out pickups, you can let these important electrical contacts hide themselves away again beneath the locomotive and run their course. But never take them for granted. CTT

PRE-1950 SHOES AND ROLLERS

MOST OF LIONEL'S pre-1950 O-27 locomotives and some of its prewar O gauge streamliners were fitted with sliding shoes instead of rollers. Not surprisingly, these shoes wore out faster than rollers.

When rollers were used, they were one-piece units with protruding "shafts" mounted on sprung collector arms, which had holes in them to accommodate the protrusions. If not kept lubricated, these holes became elongated, allowing excessive play and decreasing the roller's efficiency. The rollers themselves were made of soft metals (brass, copper, or a special alloy) that were prone to rapid wear.

You can easily replace these contacts, whether rollers or shoes, with a screwdriver and needle-nose pliers. No actual disassembly is required.

To replace a roller, wedge a screwdriver blade between one end of the roller and the side of the collector arm assembly (**fig. 1**). Twist the tool until the roller tip clears its mounting hole and drops out. As an alternative, needlenose pliers may be used to bend one side of the collector arm until the roller is loose enough to be removed.

Insert the new roller, and bend the collector arm back into position (**fig. 2**). The roller should be free to spin easily in its mounting.

To replace a contact shoe, slide a slot-head screwdriver blade or any other thin metal instrument under the fiber bottom plate, between the shank of the shoe and the leaf spring clip that holds it in place (**fig. 3**). You should be able to feel the hook at the end of the shank, if your tool is inserted correctly – about ¾ inches in from the exposed end of the shoe.

Twist the screwdriver just enough to release the hook from its mooring slot in the spring. (Be careful not to over-bend the spring.) You will then be able to slip the shoe out of its mounting.

Ease the new shoe into the same position. You should hear a click as it snaps into place. In some cases, it may be necessary to lift the leaf spring slightly to get the hook on the shoe shank into the slot (**fig. 4**).

Fig. 1. **After wedging a slot-head screwdriver into position, twist until the old roller tip clears its mounting hole.**

Fig. 2. **Use a pair of pliers to bend the collector arms back together to hold the new one-piece roller in place.**

Fig. 3. **To replace shoes, slide a screwdriver under the fiber bottom plate and between the shank of the shoe and the leaf spring clip until you feel the hook at the end of the shank.**

Fig. 4. **Slide a new pickup shoe into position and listen for the click to confirm the pickup shoe has snapped into place properly.**

POST-1950 REUSABLE ROLLER PIN

FOR POST-1950 locomotives, a new two-piece contact was designed. It used a tougher, sintered-iron roller with a hole running through it lengthwise and a stationary pin riveted to one side of the collector arm.

You can either replace both the worn-out roller and its mounting pin (as described on page 5) or try to reuse the original pin, a shortcut that repair technicians have used for some time with usually good results.

The roller pin must be in good condition – not severely worn – and solidly anchored.

First, with needlenose pliers, bend the side of the bracket with the larger hole away from the pin, then bend the other side of the bracket until the roller clears the bracket assembly (**fig. 5**).

Clean the pin with a solvent to remove any built-up dirt and grease. Slip the new roller into place. Check to see that there is not excessive play between it and the roller pin.

If the fit is acceptable, carefully – and one at a time – bend the brackets back to their original configuration (**fig. 6**).

Check to see that the new roller is able to spin freely. Adjust the mounting bracket, if necessary.

Fig. 5. **With pliers, outwardly bend the side of the bracket that has the larger hole. Then do the same to the other side of the bracket.**

Fig. 6. **Once you've installed the old pin and new roller, squeeze the bracket shut again, making sure the roller is able to turn freely.**

POST-1950 PIN AND ROLLER REPLACEMENT

IF YOUR OLD roller pin isn't reusable, or if you prefer two new parts instead of one, here's how to swap out both parts.

Although the sintered-iron rollers are indeed tougher than the old soft-metal ones, they are also not as easy to replace. To do the job right without the shortcut described on page 4, the whole collector-arm assembly has to be removed from the locomotive first.

To begin, detach the collector arms from the locomotive by taking out the screws or pivot pins that hold the collector arms in place.

Using a file or grinding tool, remove the end of the roller pin that is riveted to the collector arm (**fig. 7**). Note: If you're using a motorized grinding tool, use eye protection and secure the roller assembly in a vise; never use your hands to hold the roller assembly still.

When enough metal is taken off the pin, it should be loose enough to allow its easy removal from the collector arm (**fig. 8**). The roller will come along with it.

Position a new roller between the holes in the collector arm. Slip the new pin's smaller end into the arm's larger hole, then push it through the roller, and then seat it all the way inside the smaller arm hole (**fig. 9**).

Carefully position this entire assembly, with the large hole down, on an anvil or some other hard, unyielding surface. With a light hammer (preferably a ball-peen hammer), lightly strike the small end of the roller pin until it is firmly riveted into place (**fig. 10**).

Check to make sure that the roller is able to spin freely. If necessary, adjust the assembly accordingly. Then reattach the collector arm to the locomotive, and the job is done.

Fig. 7. After detaching the collector-arm assembly from the locomotive, file or grind off the end of the roller pin.

Fig. 8. When you've removed enough metal, use needlenose pliers to remove the roller pin to release the old roller from the arm.

Fig. 9. With the new roller in position, push the new pin through the side of the arm that has the larger hole and then into the smaller hole.

Fig. 10. Using a ball-peen hammer and an anvil, carefully tap the small-hole end of the roller pin until the pin is riveted in place.

LATE POSTWAR AND INTO THE EARLY MODERN ERA

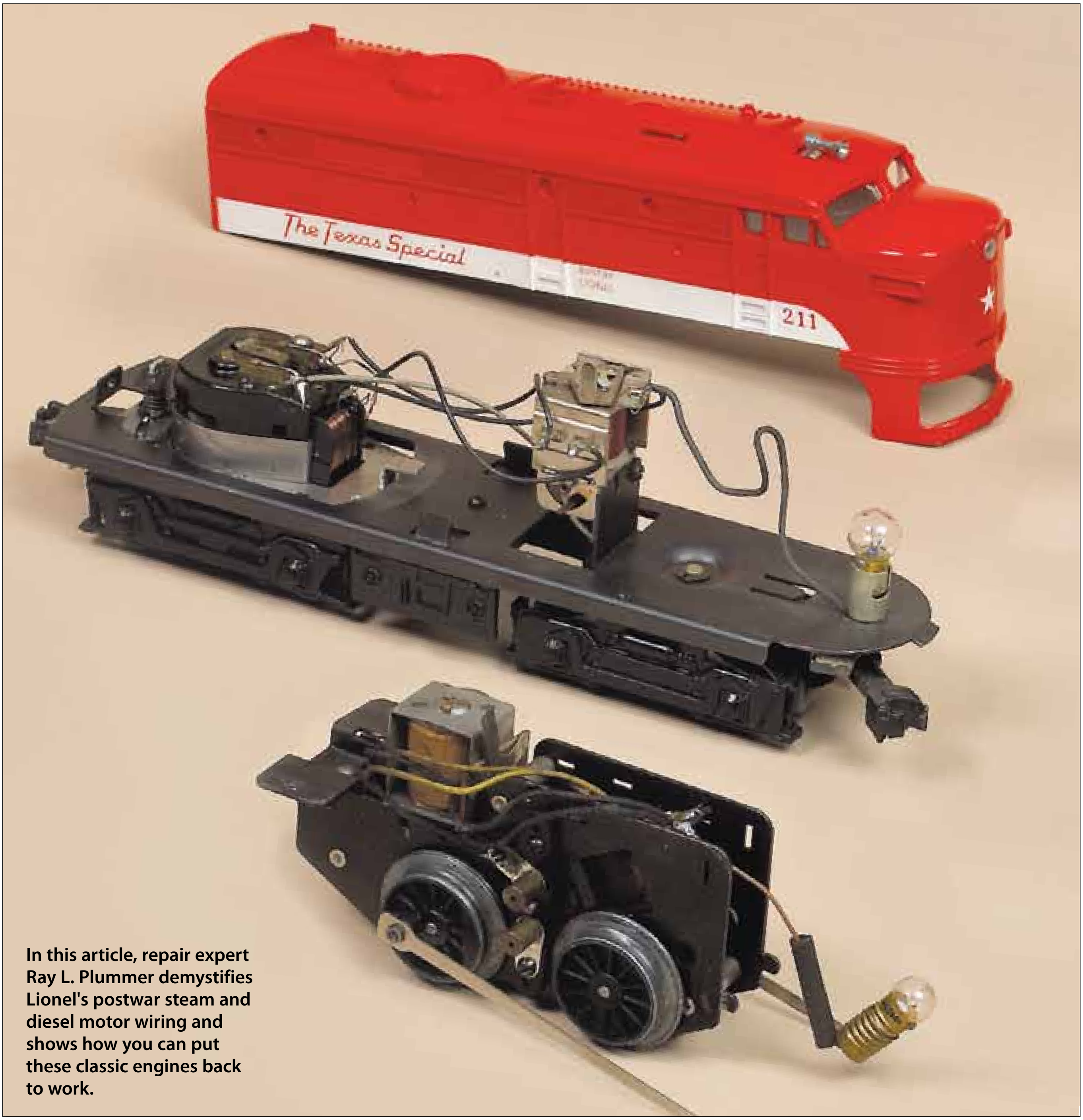
LIONEL'S USE of sintered iron grew rapidly in the postwar era. The theory was that the harder iron rollers would not wear out as fast as the older ones, and they could be permeated with a permanent lubricant, consequently eliminating the need for periodic oiling.

Naturally, tough as they were, they did eventually wear out. Because these rollers were difficult to replace, Lionel later sought other design options.

During the late postwar era and into the modern era (1970 to today), Lionel began using small "snap-in" roller-bracket assemblies that fit into a slot in a leaf contact spring – very much as the old sliding contact shoes did – on a number of low-end steam and diesel locomotives.

Basically, Lionel made the entire roller assembly disposable, allowing service technicians or the locomotive's owner to easily and quickly swap out the parts.

For these locomotives, you can certainly use the same roller replacement techniques outlined above if you wish. However, at just a few dollars each for a complete replacement assembly, it hardly seems worth the effort.



In this article, repair expert Ray L. Plummer demystifies Lionel's postwar steam and diesel motor wiring and shows how you can put these classic engines back to work.

REPAIR MOTOR WIRING

LIONEL WIRED LOCOMOTIVES THREE DIFFERENT WAYS

by Ray L. Plummer

photos by William Zuback • illustrations by Jay Smith

Look inside a bunch of well-used Lionel locomotives and you may find yourself assuming no two were ever wired the same. Questions about internal wiring for Lionel locomotives are certainly understandable.

Tinkering by inquisitive kids, well-meaning adults, and even supply-strapped service technicians often camouflaged the original wiring scheme of a given locomotive. As a result, the internal wiring of many locomotives today can be a jumble of

loose connections, tangled wires, and imperfect repairs.

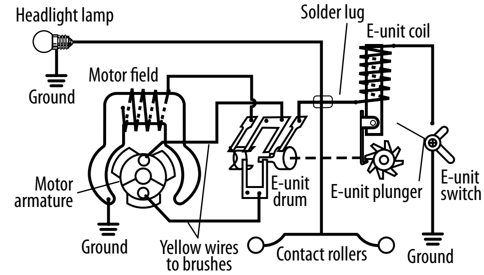
Maybe that's to be expected in a locomotive that's survived for half a century or longer in the hands of numerous owners with varying technical repair skills. At some point, however, you really need to know how a locomotive was originally wired.

Here are three basic wiring patterns – which, for convenience, I'm calling Type A, Type B, and Type C – that Lionel used most often to connect motor components with their mechanical reversing units and center-rail pickups. Almost all of the steam and diesel engines manufactured from about 1930 to the onset of the electronic circuit board age were wired according to one of these patterns.

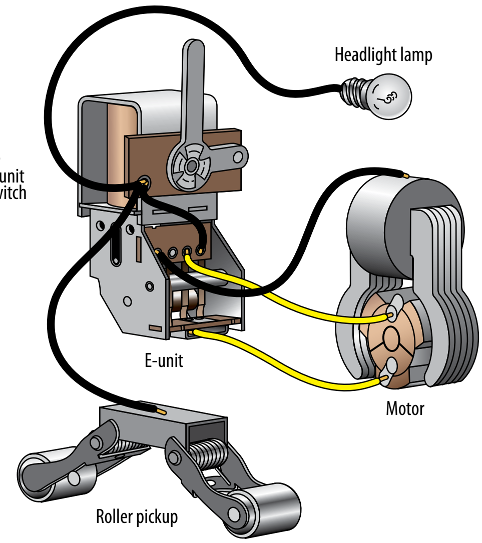
I'm intentionally omitting two other wiring patterns: the sealed can-style motors of the modern era (which utilize electronic technology too complex to sum up in a few short paragraphs), and the infamous Bakelite-encased "Scout" motors used in some postwar starter-set steam locomotives. (They are almost impossible to repair and don't have external wiring anyway.)

Also, I should note that while Lionel did use wire color-coding at times, the code is neither certain nor consistent over time. Plus, service technicians, even those employed by Lionel Service Stations, tended to use whatever hookup wire they happened to have on hand. Therefore, the colors specified in the following descriptions are by no means absolute.

Type A locomotives



Type A wiring



Type A wiring, by far the most common, is found on many steam, diesel, and electric-profile locomotives. Included are the open-frame, spur-geared integrated motor/mechanisms, as well as the separate, heavy-duty motors on worm-geared steamers and the better diesels and electrics.

Designed for use with conventional three-position reversing units, Type A wiring has two distinguishing characteristics: Both brushes have their own individual wires leading to them, and one end of the motor field coil is grounded to the frame, so there is only one wire leading to the field coil.

The center-rail pickup wire (usually black or red) goes to the solder lug on the side of the reversing unit, opposite the lock-out lever contact eyelet.

The solder lug on the side of the reversing unit is also connected to:

• one end of the reversing unit coil,

• the single-finger contact farthest from the solder lug, on the four-contact strip inside the reversing unit (usually a black wire),

• the headlight (in most cases),

• the lead to the smoke generator, if the locomotive has one,

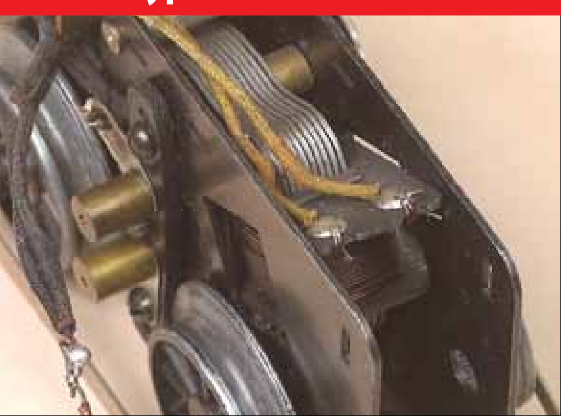
• and the wire to the horn relay coil, if the locomotive has one.

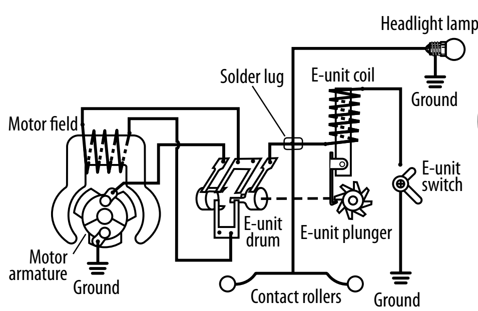
The two-finger contact in the middle of the four-contact strip inside the reversing unit is wired (often this wire is yellow; sometimes it's a blue wire) to one of the brushes.

The single-finger contact closest to the solder lug on the four-contact strip inside the reversing unit is wired to the motor field coil. The other end of the coil is grounded, so there is only one wire to the coil.

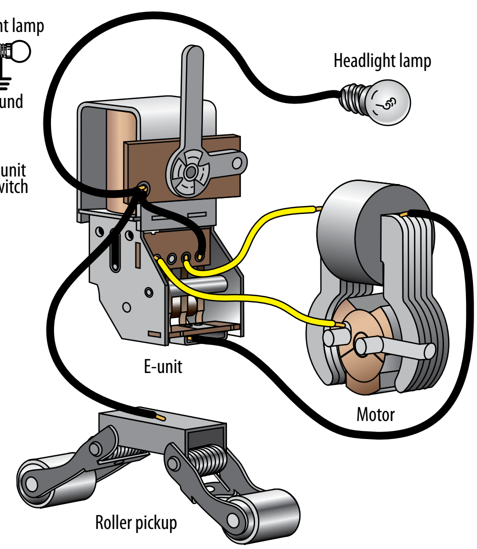
The two-finger contact at the bottom of the reversing unit is connected to the second motor brush (usually with a yellow wire).

Type B locomotives





Type B wiring



Type B wiring is most often found on prewar and early postwar O-27 locomotives. Motor mechanisms are of the integrated, spur-gear variety in sheet-metal or die-cast frames.

Designed for use with three-position reversing units, Type B wiring has two distinguishing characteristics: One of the two motor brushes is grounded to the frame, and there are wires leading to both ends of the motor field coil.

The wire from the center-rail pickup (usually black) is connected to the solder lug on the side of the reversing unit that is opposite to the lock-out lever contact eyelet.

The solder lug on the side of the reverse unit is also connected to:

• one end of the reversing unit coil,

• the single-finger contact farthest from the solder lug, on the four-contact strip inside the reversing unit (usually a black wire),

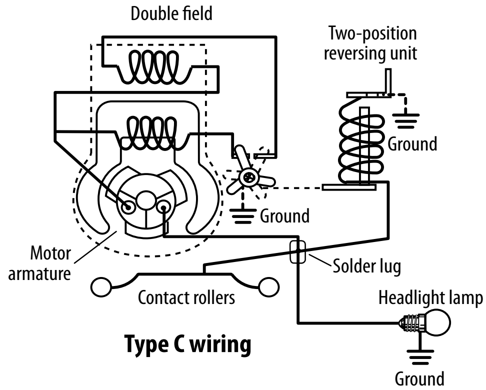
• and the headlight.

The two-finger contact in the middle of the four-contact strip inside the reversing unit is wired to one end of the motor field coil (could be a yellow, blue, or green wire).

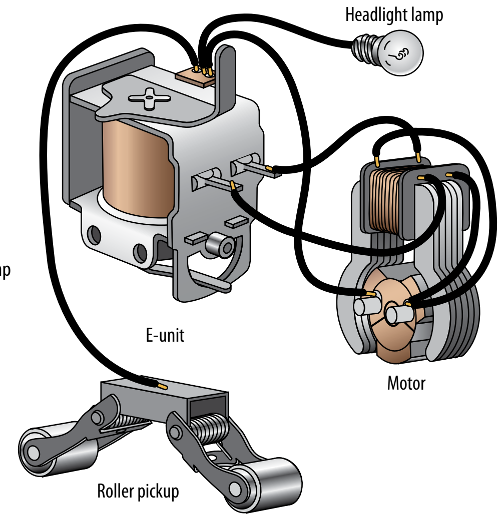
The two-finger contact at the bottom of the reversing unit (often yellow) is wired to the other end of the field coil.

The single-finger contact closest to the solder lug, in the four-contact strip inside the reverse unit (sometimes yellow or green wire), is connected to one brush. The other brush is grounded to the frame with a sheet-metal tab.

Type C locomotives



Type C wiring



Type C wiring is found mainly in low-end diesels and steam locomotives manufactured from 1958 into the modern era. Note also that many of the postwar "motorized units" use variations of Type C wiring.

Designed for use with the two-position mechanical reversing unit, Type C wiring has four distinguishing characteristics: A double-wound field coil with two different wire colors (usually green and copper), one brush wired directly to the center-rail pickup, a reversing unit that functions by choosing between the two field-coil windings for motor direction, and no neutral mode.

The wire from the center-rail pickup goes to the solder eyelet on the side of the reverse unit.

The solder eyelet is also connected to:
- one of the brushes,
- one end of the reversing unit coil,
- and the headlight (in most cases).

One of the solder lugs on the front of the reversing unit is connected to one of the wires coming from the double-wound field coil (usually green).

The other solder lug on the front of the reversing unit is connected to the other wire coming from the double-wound field coil (usually copper).

The two remaining field coil wires are connected together with, and usually at, the second brush.

Other wires you may encounter

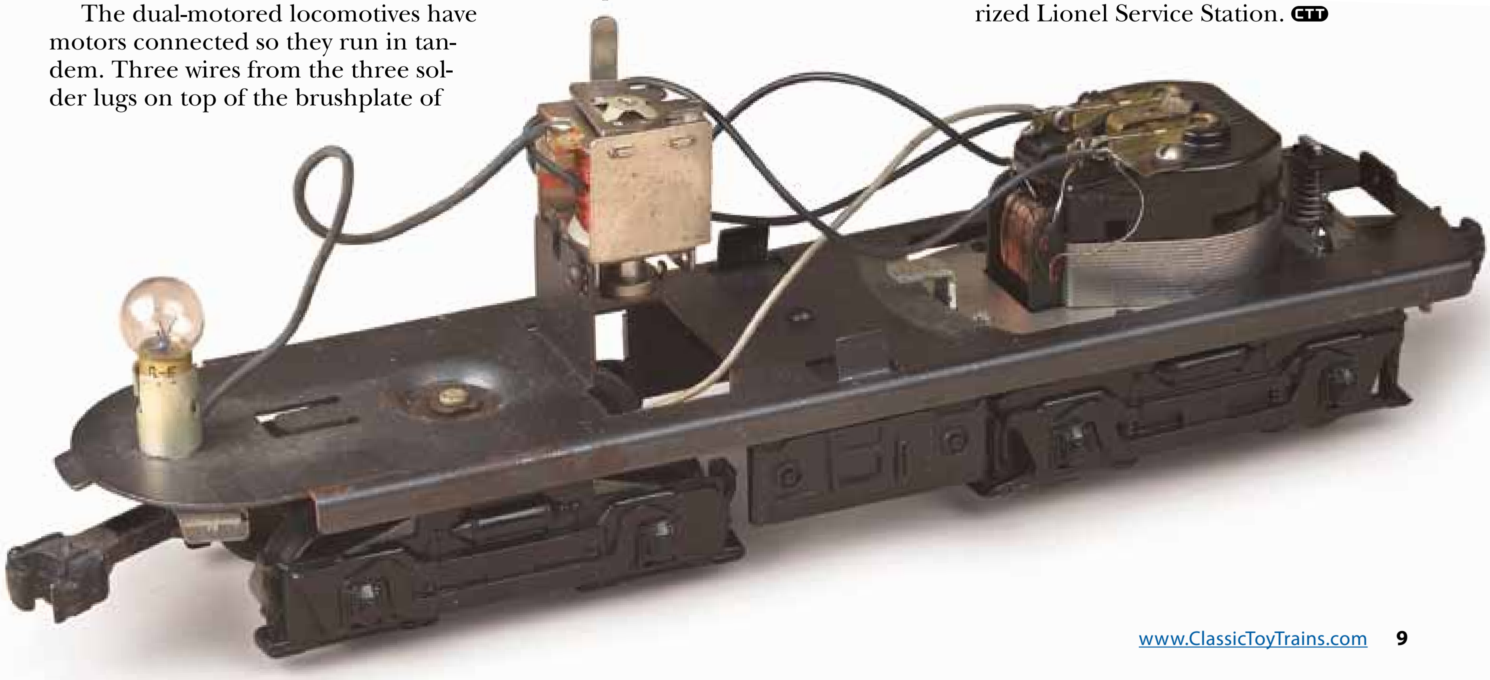
While the wires described and delineated above are the basic ones needed to make a locomotive perform, you may come across other wires, particularly in dual-motored diesels or electrics, locomotives with more than one pickup-roller assembly, and locomotives with internal horns.

The dual-motored locomotives have motors connected so they run in tandem. Three wires from the three solder lugs on top of the brushplate of one motor are connected to the three solder lugs on the brushplate of the other motor. Because of the way the motors are usually positioned in the locomotive's frame, the outer wires cross over in the process.

Wires from multiple pickup-roller assemblies are usually connected together at a convenient point somewhere in the middle of the locomotive. The solder lug on the horn relay that brings track power to the relay coil is a favorite place.

Horn-circuit wiring is actually beyond the scope of this article, because there are so many variations and positions. However, identifying horn wires should be pretty obvious – they are usually connected to the horn itself, the D-cell battery case, or the make-break contacts on the horn relay.

If you traced your wiring using these guidelines and everything seems to be in order, but your engine still won't run, you have a non-wiring problem. Your best bet? Take it to an authorized Lionel Service Station. CTT



Repairing most trains is easier than you may think. Often a simple cleaning and lubrication job is all that's needed to get a balky engine running like a champ. Here's how to do it right.

REPAIR UNIVERSAL LIONEL MOTORS

CLEAN AND REBUILD THE HEART OF YOUR O GAUGE LOCOMOTIVES

by Ray L. Plummer
photos by William Zuback

No matter how old Lionel O gauge locomotives may be, or how tired they seem, most of them can be mechanically rejuvenated to perform satisfactorily. These classic toy train warhorses, ruggedly built, were designed for long life if routinely serviced and maintained. In fact, most of them have withstood the ravages of time better than their original owners!

In many years of repairing locomotives, I have brought hundreds of ailing Lionel basket cases back to life. In all that time, only about a half-dozen (exceptionally pounded, burned, or dissected beyond hope) couldn't be resuscitated.

Repairing most trains is easier than you might think. I once found a 60-year-old train in the loft of a farmer's barn, where it had spent more cold northern winters and hot summers than anyone could remember. A family of mice had even made a nest in the box and left behind over a pound of petrified "evidence."

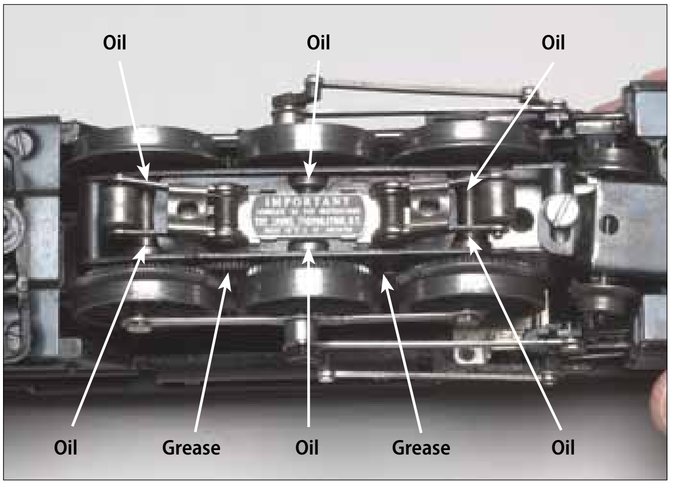
I thought the engine was a goner for sure – until I brushed out all of the debris, cleaned and lubed the motor, and put the juice to it. The thing sputtered twice and took off like a demon was chasing it!

Unless you can top that story, you have no excuse for not at least trying, with some step-by-step guidance.

Meet the motor

All Lionel motors from the company's first O gauge trains in 1915 through the postwar era (and beyond)

Oil the ends of the armature shaft, using a drop of oil dispensed from the end of a toothpick or (even better) a hobby oiler. On steamers with the motor mounted sideways between the drive wheels, the shaft can often be oiled from both sides. On diesels, the top side of the shaft is easily accessible.



While focusing on the motor, don't forget that a properly lubricated drive train not only protects the gears but decreases stress on the motor. Both gears and axles should be lubricated as indicated.

are basic variations on the same concept.

Most of the principles used to clean and repair Lionel electric motors can be applied to trains made by other toy train manufacturers as well. Regardless of their shape or configuration, whether installed in steam, diesel, or electric profile engines, these motors are all three-pole, series-wound universal motors capable of running on either AC or DC low-voltage current.

In the past decade or so, sealed "can-style" motors and electronic circuit boards have all but replaced the old mechanical technology. These new devices are designed to be replaced, not repaired, when worn out, so the servicing tips outlined in this article won't apply.

AC-DC universal motor components

Whether integrated within a steam locomotive framework and drivers, or appearing as a separate assembly screwed to a steamer frame or diesel power truck, all Lionel universal motors have the same basic elements:

- **A stationary field.** This is a stack of steel plates, shaped like a horseshoe and riveted together. The field coil consists of many turns of enamel-coated copper wire, wrapped around the center of the horseshoe.
- **A three-pole armature.** This is another stack of steel plates, shaped like a clover leaf and mounted on a shaft. This assembly spins around within the stationary field. Three coils of enamel-coated wire are wrapped around the three sections of this stack. Each pole piece terminates with a wedge-shaped copper segment on the face of the armature. Together, the three pole pieces form a broken circle known as the commutator.
- **Two brushes.** Usually made of copper-graphite, these little cylinders contact the commutator's surface. Two brush springs hold them firmly in place within individual brush wells, located on an insulated brushplate.

How it works

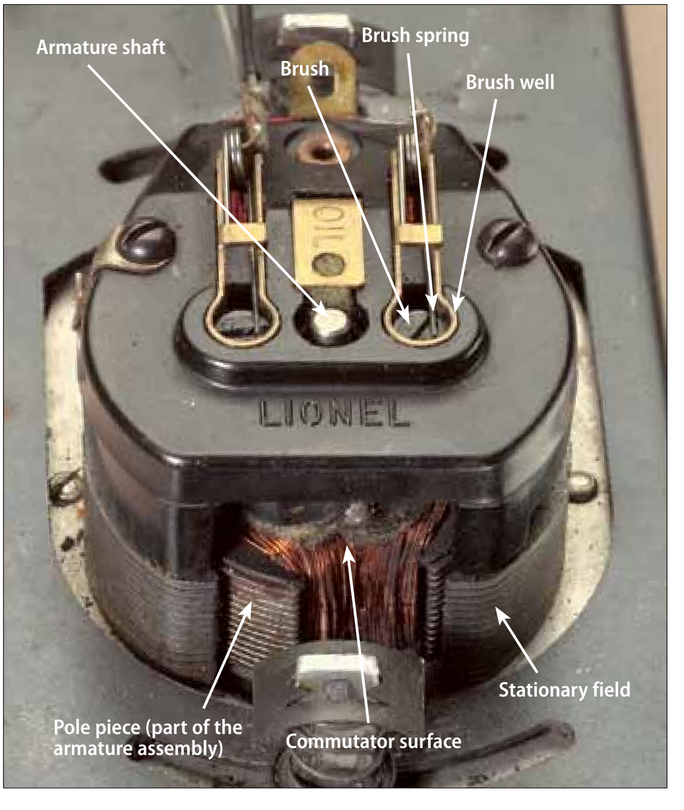
When electricity flows into the field coil, the field turns into an electromagnet, the ends of which attract and repel simultaneously. Because of its horseshoe shape, the attract/repel forces are focused close together at the end of the field. The brushes are wired in series with the field, so electrical current flows into them and into the armature at the same time.

These attract/repel forces cause the armature coil positioned between the ends of the field to move out of the way. When it does, another coil automatically moves into position. It must also move out of the way, and as it does, a third comes into place. This action repeats itself, and soon the armature is spinning rapidly, often developing as many as 4,000 rpm.

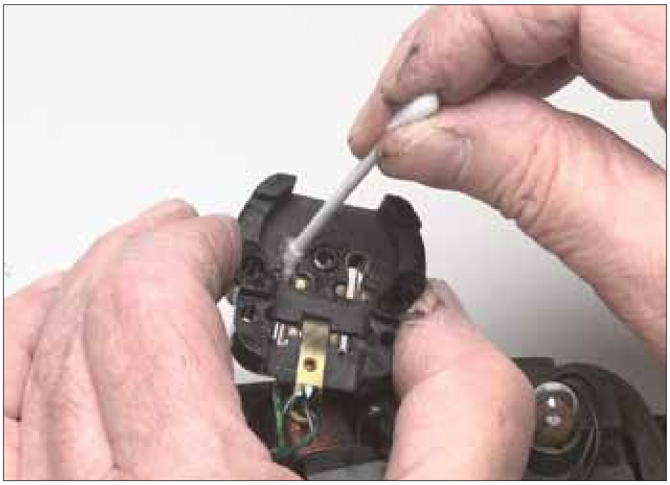
Routine maintenance

Because it revolves so fast, the armature requires frequent attention in the form of regular routine maintenance after two or three hours of running time, or whenever it seems to be needed.

- **Lubrication**. Oil both ends of the armature shaft if they are accessible. One drop of oil dispensed on the end of a toothpick is



On diesels, the brush plate assembly must be removed to gain access to the commutator for cleaning. On some steamers, the commutator face is visible.



After removing the brushes, remove dirt from the brush wells with a cotton swab and a cleaning solvent.

enough. If you apply too much, it will get into the brushes and commutator.

On some motors, only one end of the armature shaft is exposed, while the other end rides in a lubricant-filled reservoir. A third type of motor has a felt oiling wick next to the armature bearing. Give it a drop or two. While you're at it, oil the axles too, one drop on each axle bearing.

(Use common household oil, such as 3-in-1, or any of the special lubricating oils made for model trains. What you use isn't as important as whether you use it regularly.)

Lightly coat the drive train gears with grease. (Use any of the special hobby lubricants or white lithium grease.)

• **Cleaning**. In most cases, you can clean your locomotive's commutator without taking it apart. You can use an aerosol cleaner/lubricant spray, such as LPS-1 (available at hardware and automotive stores) or mineral spirits or alcohol (denatured or isopropyl) on cotton swabs. Wipe down the commutator surface repeatedly until it shines and fresh swabs no longer turn black.

This simple routine performed regularly will keep your motor from arcing severely and running hot, thereby reducing the danger of the armature windings shorting or burning out. And your train will run better too!

Heavy-duty help

There may come a time when your locomotive still runs erratically, or not at all, after routine maintenance. In that case, a bit of troubleshooting, deeper cleaning, or even overhaul may be needed.

• **Motor removal**. Remove the motor mechanism from the locomotive body. How this is done depends upon the type of locomotive. With steamers, it's a good idea to remove the front and rear trucks and disconnect the valve gear, crosshead, and rod assemblies before separating the mechanism from the body. Many are attached with screws through the boiler top or bottom plate. Some also have transverse screws or pins running through the motor sideplates.

Diesel or electric bodies come off more easily. They are usually attached with one or two obvious screws front and rear. Remove the power truck from the frame. This may require unsoldering a few wires. Work slowly and carefully. Don't force anything. Make notes during disassembly so you can retrace your steps when putting things back together.

• **Motor cleaning.** Thoroughly clean the mechanism

Clean the commutator surface with an aerosol cleaner/lubricant spray, such as LPS-1.

inside and out. Remove the accumulation of dust, dirt, and caked-on grease by washing everything in a bath of mineral spirits or some other degreasing solvent.

You can dip the mechanism or apply the solvent with an old paintbrush. Get into every crack and corner, working the dirt loose with the brush. Continue until the entire mechanism is clean. Allow it to air dry completely.

Use caution when working with solvents. They are very combustible and must be used only in a well-ventilated area and away from sparks or flames. Many people limit solvent use to outdoors only.

When you have made sure everything has dried, test-run the mechanism. Sometimes a thorough cleaning will eliminate many of the gremlins. You may want to carefully and sparingly lubricate all bearings first, because the solvent bath removes all traces of lubricant. If you don't do this, you will learn firsthand what "squeaky clean" really means!

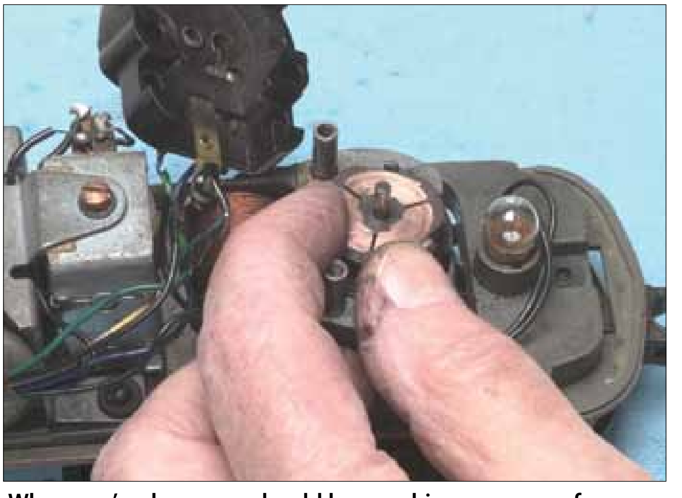
• **Brushplate removal.** Remove the brushplate and motor brushes. You'll find either two or three screws that secure the plate on top of the motor. Be careful not to lose the brushes and the brush springs – sometimes they pop out! Set them aside temporarily.

• **Armature testing.** Test the armature for shorts and open windings. This is par-

Remove the loosened dirt on and around the commutator surface with a cotton swab.

With an emery cloth, smooth and dress the commutator until all pits and grooves are gone.

Use a toothpick to clean the gunk out of the gaps between the poles of the commutator.



When you're done, you should have a shiny copper surface.

ticularly important if your locomotive has been running erratically, noisily, or too slowly. There *should* be electrical continuity between the segments of the commutator face and *no* electrical continuity between the commutator segments and the armature shaft.

This testing is easy if you have a volt-ohm meter (VOM) or another simple continuity tester. If you don't have one, you can use the leads from your transformer by turning the throttle to middle range and then touching one lead to the armature shaft and the other to one of the commutator segments. There should be no spark generated. Repeat this test with the other two commutator segments.

If sparking occurs, the armature is shorted against the shaft and must be rewound or replaced. (Motor rewinding is a highly technical specialty and is beyond the scope of this article. It may be cheaper and easier to replace the armature with a new or high-quality used armature.)

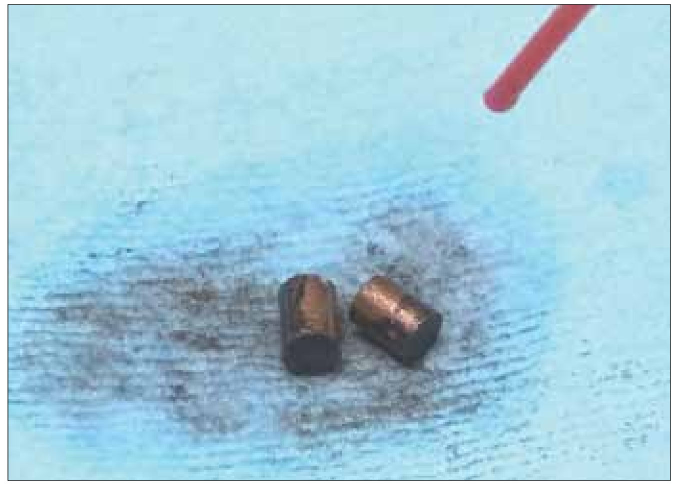
Next, touch one of the transformer leads to one of the commutator segments. Then touch the other lead wire to the other two commutator segments in turn. There should be a small spark produced each time. Go around the commutator and test each segment against the other two. There should always be a spark. No spark indicates a break in the continuity – an open circuit. Again, you may have to rewind or replace the armature. However, one of the coil wires simply may have broken loose from its anchor on the commutator face. If you are lucky, the broken wire will still be long enough to be resoldered back into place.

• **Commutator face.** Clean and dress the commutator face. The LPS-1 cleaner/lubricant or a solvent cleaner (mineral spirits or alcohol) and cotton swabs are probably all you need. Spray the cleaner/lubricant directly into the commutator face and swab until the surface is shiny and clean. Use a round toothpick to remove any gunk lodged between the commutator segments.

In extreme cases where the commutator face is severely worn or pitted, or has circular grooves cut into its surface, lightly dress it with fine emery paper until the grooves and pits are gone. You should see no more black rings or marks, just a clean copper surface.

• **Brushes and springs.** Clean, repair, or replace the brushes and springs. There are at least two sides to the ongoing controversy about replacing brushes. Some service technicians routinely replace brushes and springs every time a motor is taken apart. Others believe in conservation, stretching and bending the brush springs until only a nub of copper-

Use a volt-ohm meter to test the continuity between the segments of the commutator face.



Clean the brushes thoroughly with a solvent and gently file the contact points, if needed.

Also make sure there is no continuity between the commutator segments and the armature shaft.

graphite cylinder remains.

I personally think that brushes should be replaced when they are so short that the brush wells can no longer hold them firmly in place and they wobble from side to side. Brushes should fit snugly within the brush wells, but there should be no binding to inhibit the brushes' free "in-and-out" movement as they ride on the commutator face.

That's why it is important that the wells be thoroughly cleaned too. Spray the insides with LPS-1, and follow up with a cotton swab or pipe cleaner in the smaller diameter wells until all traces of dirt are removed. Unless the brushplate is warped or cracked, you shouldn't have to spend any more time on this assembly.

Clean the brushes themselves with LPS-1 or mineral spirits. Wipe away all black residue from the sides and ends. They were originally a dark copper color and should appear that way again.

If the brushes have worn into a lopsided angle, they should be squared off by gently rubbing them with emery paper or a fine file until their ends are perpendicular to their sides. This will assure good contact with the commutator face.

• **Brush spring tension.** In most cases, little or nothing will need to be done to brush springs. If there is evidence of uneven tension, such as a difference in brush length or the locomotive running faster in one direction than the other, adjust or replace your springs. Tension should be equal on both brushes.

The problem in diagnosing improper spring tension is that either too much or too little can result in the same symptom – a motor that loses power or runs slower than it should.

You'll rarely find too much tension, except in cases where the motor was previously "repaired" by someone who didn't get it quite right. Too little tension is often the result of brushes shortened by excessive wear or springs that have lost their resiliency due to overheating.

The adjustment operation can be tricky and requires patience because it is done by trial and error. Start by putting the mechanism on blocks or clamping it in a vise so that all wheels and gears move freely. Hook transformer leads to one of the third-rail pickups and a spot on the frame that is grounded. Turn the throttle up about halfway.

With the motor running, carefully poke a toothpick into each brush well, to apply more pressure against the spinning commutator. If the motor speeds up, the spring tension is too weak. Adjust the coil springs by stretching them slightly. You can bend flat or wire springs to apply more pressure. Do these bending and stretching operations a little at a time. Keep retesting until the motor no longer speeds up when the brushes are prodded.

Too much tension can be detected by simply loosening the brushplate slightly. With the motor running, back off each brushplate screw a half-turn at a time.

If the motor speeds up appreciably, this can indicate that the spring tension is too great. It could also indicate a faulty or worn brushplate bearing. Flat or wire springs may be bent back to reduce the tension. Shorten coils by snipping off a winding or two. Adjust and test a little at a time until the motor runs at full speed with the brushplate tight.

Perhaps you can see why so many service technicians routinely replace brushes and springs – it usually eliminates the need for these tedious adjustments. But if you're like me and want to save a buck or two, it is worth the extra effort.

That takes care of overhauling the motor. If you've been able to follow my suggestions, your O gauge locomotive should be running at its best. CTT

ON THE WEB CTT+

For more information, check out the Restoration & Repair section under the Collecting tab on ClassicToyTrains.com.