IDENTIFYING DEFECTIVE MOTORS

Pull those broken-down tape decks and defective turntables out of the closet because after reading this, you'll be a motor repairman

By Homer L. Davidson

AROUND AND AROUND IT GOES—DRIVING THE IDLER wheel, rotating the turntable, whirling the compact disc, or turning the drum of the VCR—and where the small motor stops, only the electronic technician or repairman knows. At times it may be erratic and intermittent in operation. Sometimes it never starts at all, due to an open winding or no drive voltage. And sometimes a motor problem has nothing at all to do with the motor. In this article, we'll show you how to find where a motor problem really lies, and what you can do about it.

Checking out motor problems is easy when you have the correct test instruments and know how. Replacing a defective motor is easy and can also be very satisfying. So let's check out some of those dead units that have been collecting dust.

Defective Motor Tests

One method of testing suspect motors is to use continuity checks. Of course continuity measurements may not indicate the motor has dry or frozen bearings, but it can tell you if you have an open winding. Also, the motor may have a shorted winding that will not be detected with continuity tests.

A more effective test you can perform is to measure the resistance of the windings. Low ohmmeter readings across the motor terminals will indicate if the motor windings are open or normal. Most small motors give a very-low ohmmeter reading. The small motor may have a resistance of under 20 ohms. If in doubt, check the schematic diagram.

Also, voltage measurements across the motor terminals may help you uncover a defective motor. Check the low-voltage supply source when a low or improper voltage is found at the motor terminals. Some small motors may have an open resistor in series with the winding (Fig. 1) indicated by lack of voltage across its terminals. Do not overlook a poor switch or wiring connection as the problem's source. You may assume the motor is defective when *correct* voltage is found at the motor terminals. However, zero volts at the motor tells you nothing, since it could indicate trouble with the supply circuit, shorted motor windings, or both.

An intermittent or erratic motor can be tested for by using an external DC voltage applied to the motor terminals. Sometimes rotating the motor shaft may start the motor, indicating intermittent operation. Replace the motor. In electric-motor control circuits, the external-voltage test may indicate a defective motor or control circuit. A variable or universal power-supply source is ideal in locating problems with motor-control IC's or transistors. Those low-voltage control circuits are found throughout the world of portable cassettes, compact-disc players, and camcorders (Fig. 2).

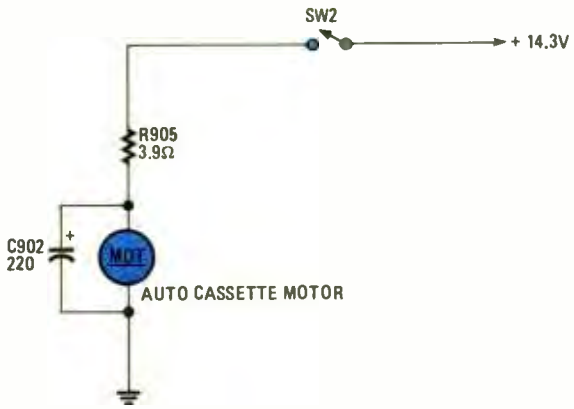


Fig. 1—Suspect a poor switch contact or open isolation resistor when no voltage is measured at the motor terminals in the audio cassette player.

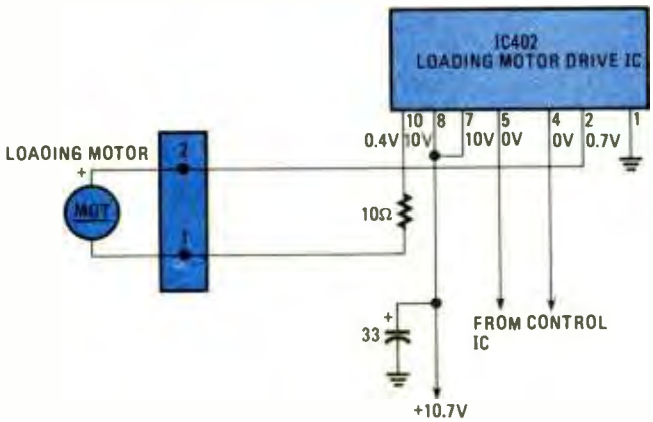


Fig. 2—Improper voltage found at the loading motor in a CD player may be caused by a defective voltage supply.

A Variable DC Source

A 0–5-volt variable-voltage source, in a cabinet with some fixed-voltage sources at 12, 15, and 25 volts could be used to check most DC motors. If you build the *Motor Voltage Box* shown in Fig. 3, the 12 and 25-volt sources may be used to check stereo 8-track, cassette, and auto cassette-player motors.

The 0–5-volt variable source can be used to test the very-low voltage motors found in the average compact disc (CD), camcorder, or portable cassette player. Note that you can reverse the polarity of the 0–5-volt source quickly with S1, a DPDT switch. Potentiometer R1 acts as a small variable-voltage control.

The circuit contains a small power transformer with bridge rectification. Four separate, 3-amp, silicon diodes are located in the bridge circuit. Capacitor, C1 filters out the DC ripple from the silicon rectifiers. Each voltage source has a separate fixed-voltage regulator, filter capacitor, and voltage-dropping resistor. The regulators are 1-watt types.

Etching the Board

All parts, except the transformer and the front-panel components, are mounted on a printed-circuit board like that shown in Fig. 4. Mount the components as shown in Fig. 5.

After etching has been completed, wash off the board, and clean it up with steel wool or a pocket knife. Inspect the wiring for breaks at the circle tie points and correct any. Tin the PC wiring with the soldering iron. Often, if the copper is not completely clean, the solder will not stick. Remove excess copper with a pocket knife. Drill out the component mounting holes with a small 1/16" drill bit.

Mounting the Parts

Mount all small components on the etched board. Keep all the hot parts, such as the regulators, about ½" above the board. Be sure to supply U1 and U2 with heat sinks.

Observe the polarity of the electrolytic capacitors and the IC regulators. Remember, the positive terminals of silicon diodes D2 and D4 connect to the positive terminal of the large filter capacitor C1.

Solder each connection with a low-wattage soldering iron. When done, double check each part for correct mounting and polarity.

After the PC-board wiring is complete, drill two 6-32 holes to mount T1. Make the holes to the right side of the plastic project box. They may be drilled, or made with the small tip of the soldering iron. Bolt the transformer in place. Solder the secondary's 18-volt leads to the PC-board solder pads marked

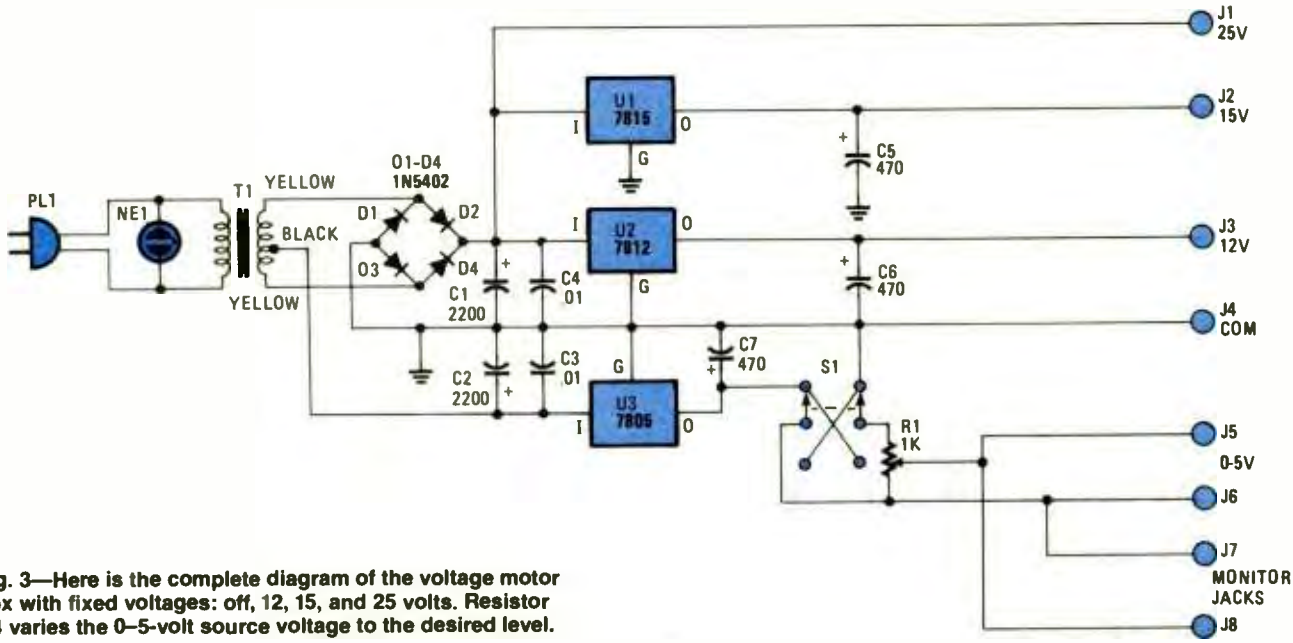


Fig. 3—Here is the complete diagram of the voltage motor box with fixed voltages: off, 12, 15, and 25 volts. Resistor R4 varies the 0–5-volt source voltage to the desired level.

PARTS LIST FOR THE MOTOR VOLTAGE BOX

SEMICONDUCTORS
U1—7815 15-volt regulator, integrated circuit
U2—7812 12-volt regulator, integrated circuit
U3—7805 5-volt regulator, integrated circuit
D1–D4—1N5402, 3-amp, 200-volt, silicon diode

CAPACITORS
C1, C2—2200-µF, 35WVDC electrolytic
C3, C4—.01-µF, 100WVDC ceramic
C5–C7—470-µF, 35WVDC electrolytic

ADDITIONAL PARTS AND MATERIALS
J1–J8—Banana jack
NE1—120-VAC neon lamp
R1—1000-ohm, 1- or 5-watt, wire-wound, potentiometer
S1—DPDT toggle switch
T1—18-volt secondary, CT, 2-amp, power transformer
Deluxe case, approximately 7.5 × 4.33 × 2.22, 3 heat sinks for TO220 cases, AC cord, flexible test leads, hookup wire, PC board, bolts and nuts, solder etc.

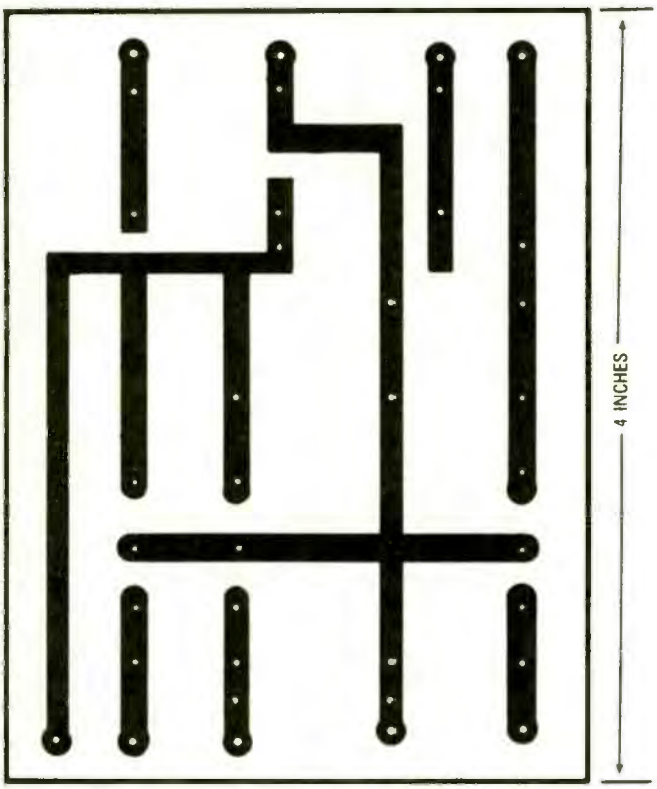


Fig. 4—This foil trace pattern, if used properly, will beautify the circuit layout of the box and simplify wiring.

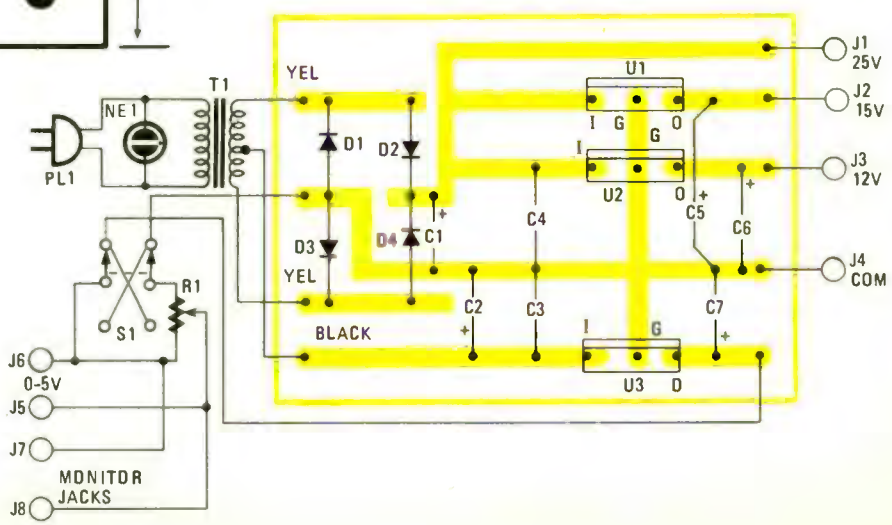


Fig. 5—Here is the parts placement layout of the etched circuit board. Cut the copper clad board from a large piece if you do not have the correct-size board.

YEL, and the center tap to the solder pad marked BLACK in Fig. 5. Do not mount the etched board until all wiring has been completed.

Wrap the wires around the body of a pencil to take up the slack. Tie a 4-inch length of hookup wire to each tie point that connects components on the front panel to the board. You may want to mark the voltage sources on top of the PC board to identify where the connecting wire goes.

Preparing the Top Panel

Drill all mounting holes through the top panel as shown in Fig. 6. Clean off any burrs with a pocket or hobby knife. The various fixed-voltage jacks (red) and the common jack (black) were located near the top of the front panel, while the 0–5-volt and monitor jacks (all are black) were positioned in the lower right.

Mount R4 in the 15/32-inch hole above the 0–5-volt and monitor-jack terminals. The two monitor banana jacks are provided so that the variable voltage can be monitored with a VOM or DMM without fuss.

Wiring it Up

Solder two 6-inch long hookup leads to the AC neon-light indicator, and tie them to the primary leads of the transformer and the AC-line cord. Tape up each set of leads separately. Tuck the taped leads near the base of the transformer. Next, connect and solder all the leads from R4 to S1 and their associated jacks. Tie the monitor jacks' wiring to the variable 0–5 volt DC jacks.

All wires to S1 should be tinned so they can be easily connected to the screw terminals. Check each voltage wire and solder them to their respective voltage terminals. If available, use a black hookup wire for the ground or common jack. If only one color of hookup wire is used, tie a knot in the ground wire for easy identification. Recheck each mounting wire from the board to the correct part on the front panel.

Testing the Box

After double checking all voltage connections and tie wires, the Motor Voltage Box is ready to be tested. Plug in the AC cord—the neon pilot light should light up at once. If not, check for the correct voltage at each IC input and output. Take voltage measurements at all of the fixed-voltage outputs. Feel each IC and heat sink to see if they are very hot. All board components should operate without undue heating.

Now, check out the 0–5-volt motor source. Measure the

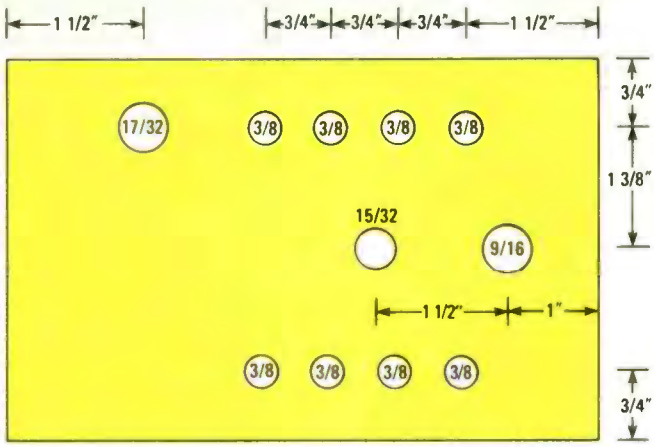


Fig. 6—Although mounting of the panel components is not critical, the fixed voltages are at the top, and the voltage monitor and variable-voltage jacks are at the bottom.

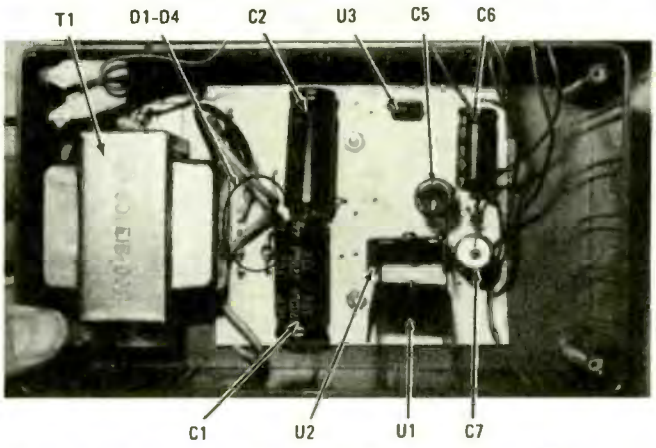
The constant voltage portion can test the various motors found in cassette, 8-track, and auto cassette players, while the 0–5 voltage source can check motors in portable cassettes, CD players, camcorders, and the like.

voltage at the voltage-monitor jacks. Slowly rotate R4 and note the change in output voltage. Flip S1 and the voltage polarity should reverse. Switch S1 reverses the voltage polarity for testing the small motors found in camcorders, cassette players, and compact-disc players. Remember, that voltage will drop when a motor loads the supply.

Checking Cassette Motors

Small motors come in different sizes and shapes. Most of the motors have two terminal wires, but some have three. In a three-wire motor hookup, their is a black wire used as a ground wire. Some motors of either type can change direction by having their voltage polarity reversed. Two small mounting screws usually hold the motor assembly to the metal chassis.

Check the continuity of the motor using the low-ohm range of an ohmmeter. A very-high or out of range reading may indicate bad brushes, an open field coil, or poor terminal connection(s). Measure the voltage across the two motor terminals. Go directly to the motor wire terminal connections for those tests since the common wire may not be grounded to the chassis. The motors may operate with from 3 to 18 volts DC. A portable cassette player's motor may operate on 3 to 6



All small parts are mounted on the PC board after drilling out the ⅛-inch holes in the etched wiring. Do not fasten the board to the bottom of the case until it's tested.

volts, while a boom box player's motor may operate with 6 to 12 volts. For a portable player, you can determine a motor's operating voltage by finding out the total battery voltage.

Suspect a defective motor when there is normal voltage at the motor terminals, but there's no rotation. Remove the small motor belt and rotate the motor pulley. The motor should be replaced if you can feel a pull while manually rotating the pulley or if the motor starts to spin. The intermittent or erratic motor may suddenly stop during operation, or just fail to start up.

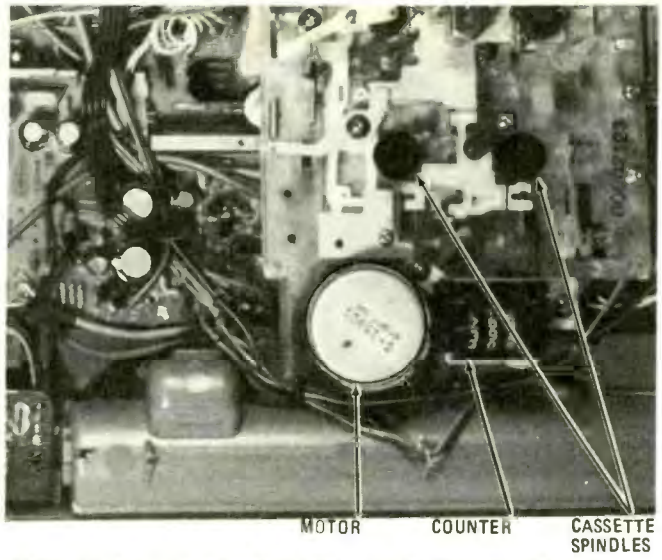
Intermittent rotation may be caused by a dry or frozen motor bearing. A dry bearing may make a squeaky noise as it rotates. Sometimes a drop of light oil on the bearings will provide extra hours of operation. Usually, with a frozen bearing the motor pulley can not be rotated. If the motor bearings are gummed up with old grease, wash out both end bearings with cleaning fluid.

When improper voltage is found at the motor terminals, check the motor-switch isolation resistor or power supply. Mark down the color of both motor terminal wires before removing. Apply the correct voltage to the motor using the Motor Voltage Box. Sometimes by applying an external voltage and watching for motor rotation, you can tell if the motor operates intermittently or slows down, or if it rotates at a constant speed. If the motor appears normal, check the control IC or processor for improper operating voltage.

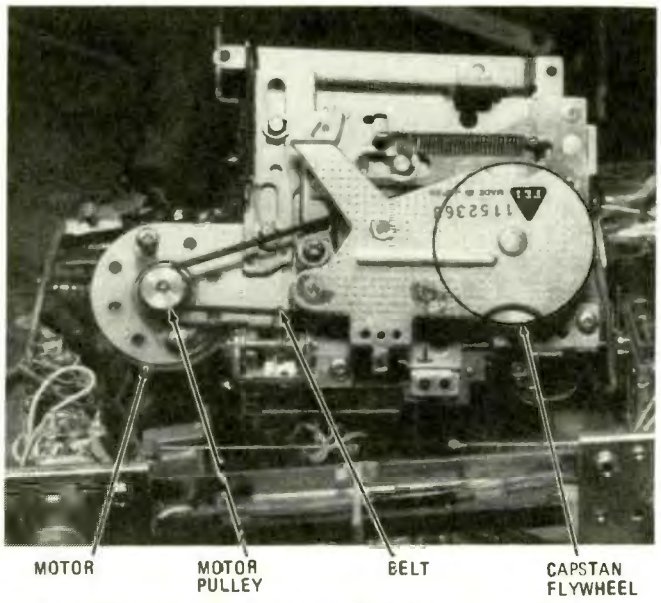
Testing Portable Decks

Portable cassette-player motors are often very small and operate on very-low voltage. Check the total battery voltage to determine the approximate operating voltage. Suspect a dirty leaf switch or shorted windings when no voltage is found at the motor terminals. Do not overlook a stretched or dirty motor belt on finding slow or erratic speeds.

Determine the condition of the small motor by connecting it to the 0–5-volt DC output of the Motor Voltage Box. Connect the positive lead of the box to the positive motor terminal. That will prevent the motor from rotating backwards and throwing out excess tape from the cassette. On any small low-voltage motor, always start with no voltage and slowly increase it. Slowly rotate R4 and notice the speed of the motor. Rotate the control until the correct voltage is applied and the music sounds normal. If the music sounds erratic and uneven, suspect a loose belt or dry capstan/flywheel assembly.



Although the motor terminal wires can be found out in the open for testing, the boom-box cassette player assembly must be removed before removing the motor-mounting screws.

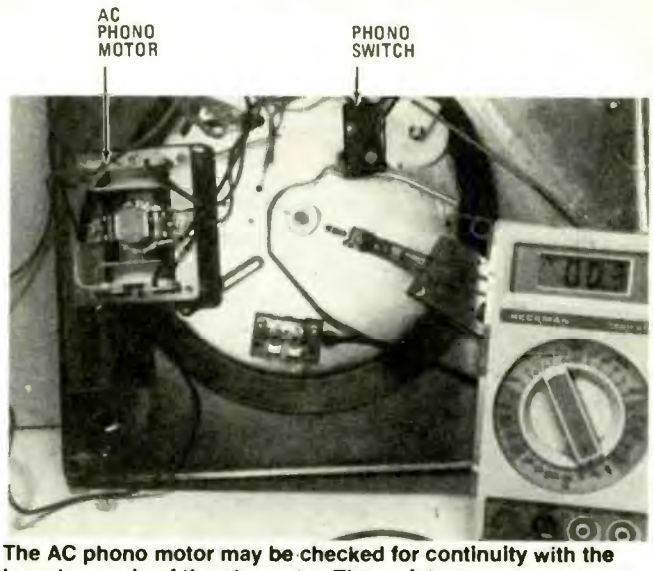


Remove the motor drive belt and rotate the motor pulley to see if the motor starts to rotate with correct voltage applied. Replace the cassette motor if it starts up after hand rotation or seems to pull as it is rotated.

Auto Cassette Motors

The auto cassette player may operate directly from the car battery or a voltage-regulator circuit. The voltage measured at the motor terminals may vary from 12 to 14 volts. If there's no voltage to be measured at the motor terminals, suspect a poor switch contact or open isolation resistor. When you see an improper voltage at the motor, suspect the voltage-control circuitry.

Rotate the motor pulley and notice the magnetic pull of the armature. Doublecheck the motor by removing the motor terminals and connecting them to the 12- or 15-volt DC output of the box. If the motor takes off, suspect a defective motor-control circuit. Let the motor run for several minutes to determine if it's intermittent. Grasp the motor pulley and stop it momentarily. Notice if the motor speeds up at once. Replace the motor if it will not start up or if it is intermittent.



The AC phono motor may be checked for continuity with the low-ohm scale of the ohmmeter. The resistance measurement may be quite low so be sure to set the scale to low.

Disc or Camcorder Motors

The really small motors found in CD players or camcorders may have several leads connected to them. Some of the motors are brushless types. In most CD players, the loading, disc, and carriage motors have only two leads, while in other players the disc and carriage motors may have more. Likewise, the focus, zoom, and iris motors in camcorders may have two motor leads. Sometimes three separate leads are fed to the camcorder motor with the third (usually black) wire grounding the motor assembly.

Be careful when testing or applying external voltage to small motors. Low-range resistance measurements may be made and external voltage may be applied to camcorder motors with two leads.

Remember, some of the motors are designed to operate with a 0.5 volt to 1 volt DC. Start R4 at zero and monitor the applied voltage. If the motor does not turn, flip the DPDT switch. Most of the motors operate in either direction while in operation, except the spindle or disc motor found in CD players. Suspect a defective motor, or a dry rail or gear assembly when the rotation is slow. **Do not** apply external voltage to a small motor with more than three terminals.

Phono Motor Tests

Most of the motors found in phonographs operate from the power line, except for small battery-powered record players. Check the continuity with the low-ohm range of your ohmmeter. Measure the AC voltage across the motor terminals with the player turned on. If the line voltage is found at the motor connections, with normal continuity, suspect a gummed-up motor or open windings.

Spin the motor pulley with your fingers. If the motor starts to rotate after giving it a spin, remove and wash out the bearing with cleaning fluid. Sometimes, if the phonograph is left on for extended periods of time, the motor bearings may get hot and freeze up. A slow phono motor may result from gummed-up bearings, while noisy rotation indicates a dry bearing. A couple of drops of light oil may clear up a slow and squeaky bearing.

Finding where motor-related problems lie is a snap, once you know how. Now that you've read this article, you do! ■