Checking Tape Recorder Heads

By ROBERT JAMES

Direct tests for continuity and other electrical properties are hazardous. Use this safe technique.

THE SYMPTOMS exhibited by a faulty tape recorder may sometimes indicate the possibility that one of the heads is defective. Inability to record, inability to erase, distortion introduced during recording, or absence of the playback signal, for example, may indicate that a record, bias-erase, or playback head is open or otherwise faulty. It would appear logical that the coil in the head could be checked for continuity before more elaborate tests are used on the circuitry itself. However, this is not as simple as it seems.

What could be more straightforward than placing an ohmmeter across the coil? Danger lurks, however. The test instrument sends d.c. through the coil. To begin with, the current may be excessive for the head. This can be overcome, however, if the ohmmeter's highest resistance scale is used, keeping current down to a low value. However, even a relatively low d.c. may magnetize the head. In addition, the transients produced when the ohmmeter is connected or disconnected may induce magnetization. If this effect should be strong enough, it may not be easy to reverse it by normal degaussing.

There is a method for checking continuity safely that also has other advantages. Even with continuity, there may be some change in characteristics of the head. Specifications generally available for tape recorder heads include d.c. resistance, impedance, and inductance. The suggested technique can be expanded to determine these characteristics, with some calculation.

Basis of the method is the application of a.c. to the coil. This has certain hazards too, but they can be avoided by proper use of the circuit in Fig. 1. The voltage source may be any that is low in value. A bell transformer, filament transformer, or the filament winding of any conventional electronic device, including the recorder's own a.c. heater supply, should do. Connect this source in series with the head, a potentiometer, and the a.c. voltmeter as shown.

To protect the head and also provide usable indication, maximum value of the potentiometer should not be less than one megohm. However, the closer it is to the meter's input resistance, the better. Furthermore, it should be set so that its full resistance is in the series circuit before the a.c. is applied. The voltmeter scale used should be the lowest one on which the maximum voltage of the source may be read without slamming the pointer. If you have any doubts, check the secondary's open-circuit voltage first.

Now decrease the resistance of the potentiometer *slowly*, until the meter reading begins to increase—or until it is apparent that it is not going to rise. If no indication can be obtained, the coil is open and the test is over. In this case, the a.c. source can be disconnected at once. If continuity is indicated, the check is also over, but the connection should not be broken at once. Instead, rotate the potentiometer slowly back to its maximum-resistance position and then disconnect the a.c. This precaution, which provides a gradual decay of the a.c. field surrounding the coil, suppresses any transients that might produce residual magnetization.

With an additional resistor and a slight change in the hook-up, we may determine impedance, resistance, and/or inductance. The voltmeter is removed from the series circuit and a resistor (Fig. 2) is inserted in its place. Value of the latter should be such that the current through it, if it were placed directly across the source voltage, would be only a few milliamperes. A 10,000-ohm resistor should be satisfactory for any case, while also simplifying calculations.

The potentiometer is fully in the circuit when power is applied, but it is slowly rotated to zero resistance. The voltmeter is then used to read voltage across the inserted resistor. With both the resistor and the voltage drop across it known, Ohm's Law may now be used to calculate the current. Since the head coil is in series, this is also the current through the latter. By moving the meter to read voltage across the head, we can now use this value and the known current to detemine impedance.

Use ac wall-wart

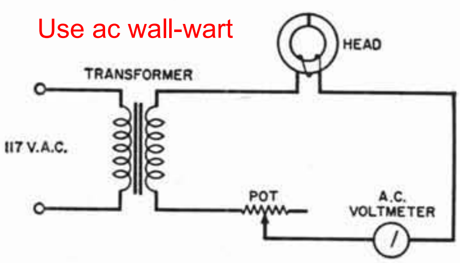
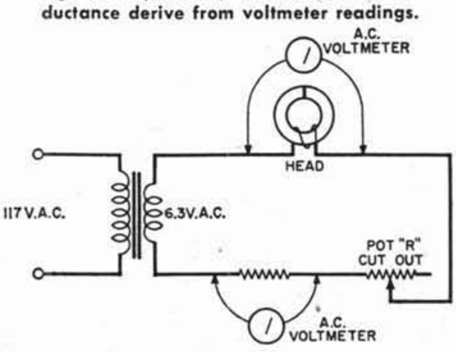


Fig 1. A continuity check that avoids coil damage or permanent magnetization.

Fig. 2. Impedance, resistance, and inductance derive from voltmeter readings.



However, this value is not directly usable, since it is taken at 60 cps. Impedance of record-playback heads is generally given at 1000 cps. For erase heads, the frequency is that of the bias oscillator, which may be from 25 to 100 kc. Furthermore, the d.c. resistance cannot be directly derived from a single-frequency impedance reading. The next step then, using the same basic arrangement as that of Fig. 2 except that an audio oscillator adjusted to 1000 cps takes the place of the 60-cps source, is to take another impedance reading. Once more, the potentiometer is used for a gradual build-up and then decay of the applied voltage. The generator's output level should be adjusted to be approximately that of the original line-frequency source.

From the two figures now available for impedance, it is possible to determine the d.c. resistance by using the following formula: $R = \sqrt{\frac{279Z^2 - z^2}{278}}$, where R is the d.c. resistance, Z is the impedance at 60 cps, and z the impedance at 1000 cps. This formula is based on the fact that there is a fixed ratio, 16.7:1, between the inductive reactance a coil will have at 1000 cps and the reactance it will have at 60 cycles.

Now that d.c. resistance is known, this value can be used in combination with total impedance, at either frequency, to determine inductance. This is done by first finding the inductive reactance. Calculation is still necessary, but the worst is over. The formula is $X_L = \sqrt{Z^2 - R^2}$, where X_L is inductive reactance (either frequency may be used) and Z is the impedance measured at the same frequency.

From this, inductance may be found from $L = X_L/2\pi f$, where L is the inductance in henrys and f is the same frequency at which X_L was calculated. At this point, virtually all the information needed to check the head for changes, by comparing against available specifications, is at hand—or for determining these specifications on a good head for which they are not readily available. A possible additional figure may be wanted: impedance at the erase-bias frequency. The method has already been discussed. With an oscillator at that frequency acting as the a.c. source, the voltage measurements in the test of Fig. 2 are made and impedance is easily calculated.

This method may seem like the long way round. Yet it is seldom that all calculations will be desired, and a slide rule can save much time while preserving high accuracy. Finally, the possible results of using an ohmmeter can be far more troublesome. -30-