

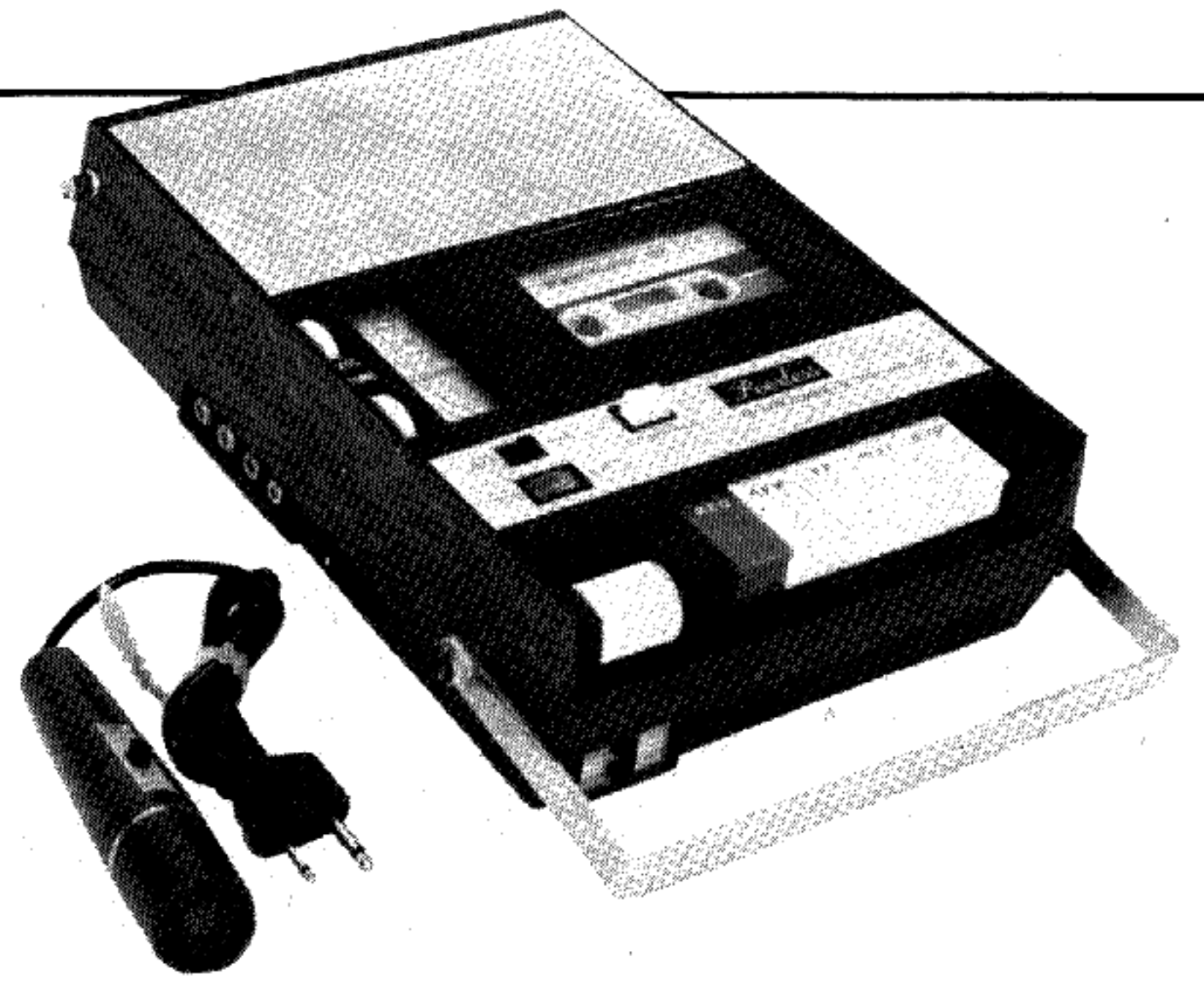
# Tune TAPE

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IF YOU WERE TO ASK THREE TAPE RECORDER experts "What's the theory of recording bias?" (not, of course, to be confused with erase bias), you would probably get two answers. The third expert would probably tell you that he isn't sure—and that you are free to choose any theory that you have heard about—but that for whatever the reason, recording bias is a very good idea and very necessary to the making of high-quality, distortionless tape recordings.

If you then ask "What is recording bias?", the answer from all three experts will be alike. Recording bias is a high-frequency oscillating current that is mixed, at or near the recording head, with the audio signal to be recorded. The frequency of this bias oscillation is not critical, just so long as it is high enough so that it will not beat objectionably with the audio signal—70 kHz, more or less, is a nice bias frequency. The level of the bias signal is very important, and it is established by (1) the design characteristics of the recording head, (2) other items in the electronic circuitry, and (3) the tape selected for use. The source of the bias current can be (but need not be) the same oscillator that provides the erase cur-

# Up Your RECORDER



*There is an optimum value of recording bias for each tape recorder and type of magnetic tape being used. This value varies with equipment age and use. Here's how to "tune" a recorder for best performance.*

rent. There is no disagreement or uncertainty here.

Out of this explanation you grasp the need for adjustment of bias level. Your recorder almost surely does not have a BIAS-ADJUST knob on its operating panel. Assuming the recorder to have been well designed and operating properly when new, its heads will have worn and its electrical components will have aged. And then there is your habit of shopping around among brands and types of tape. Can you do something about bias adjustment? Yes, you can.

A typical bias oscillator and erase/record bias circuits are shown in Fig. 1. They were developed from material supplied by Nortronics, Inc. Most professional recorders have a bias-adjust facility, and, although not shown in Fig. 1, many of them have a switching arrangement that displays the bias current on the VU meter. The bias-adjustment is usually a slotted-shaft gain control somewhere safely inside, and the service manual will recommend attention to bias as often as other maintenance projects like head cleaning and degaussing are performed.

The actual adjustment of bias is a complex procedure requiring external test equipment, and this is also spelled out in the manuals and will not be covered here.

### Incorrect bias

If bias can be adjusted for optimum performance, it is obvious that it can also be mis-adjusted too high and too low. With an audio generator, VOM, and possibly a distortion meter and a scope, both errors can be avoided precisely. However, there are symptoms of bad bias

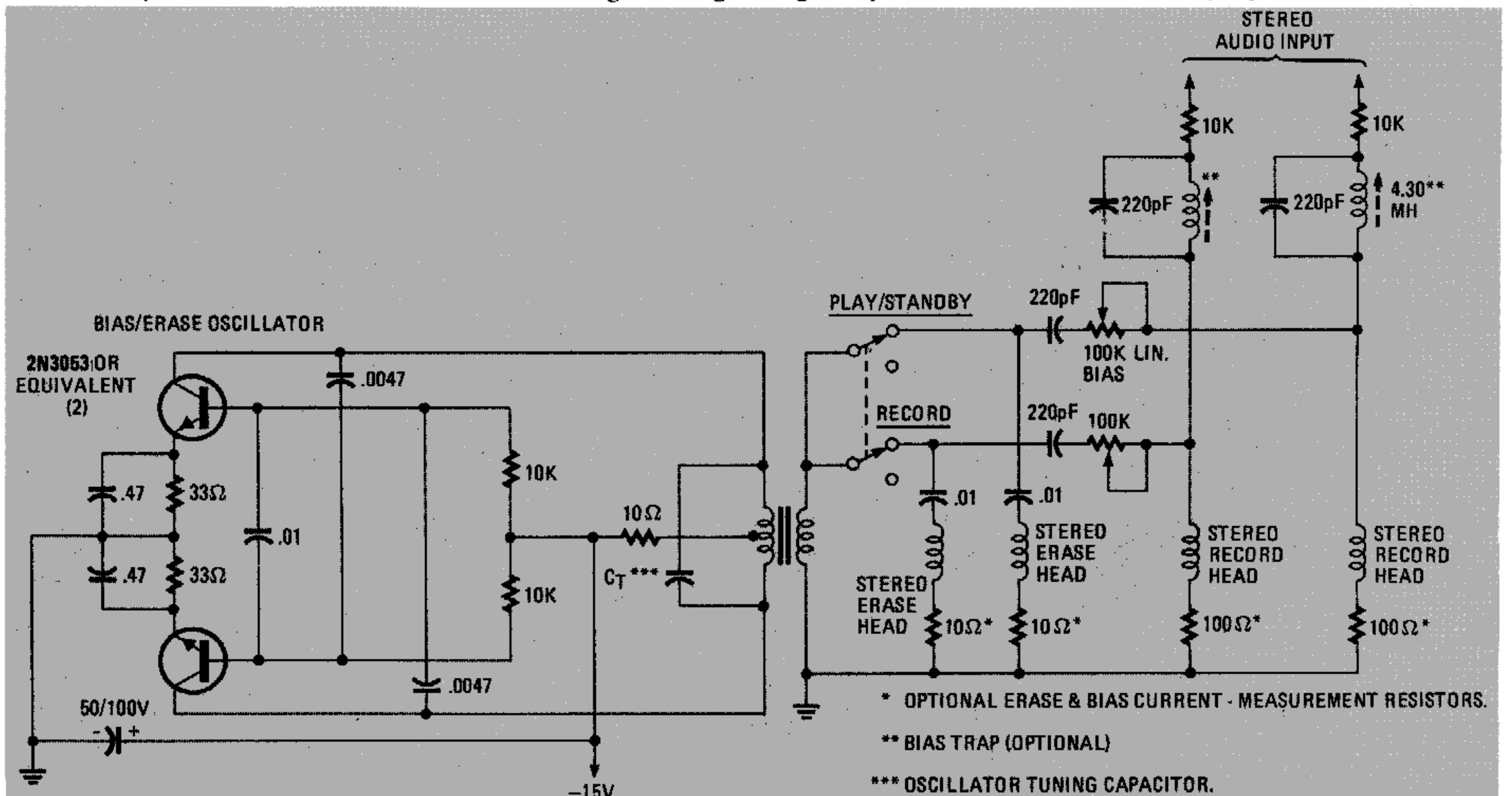
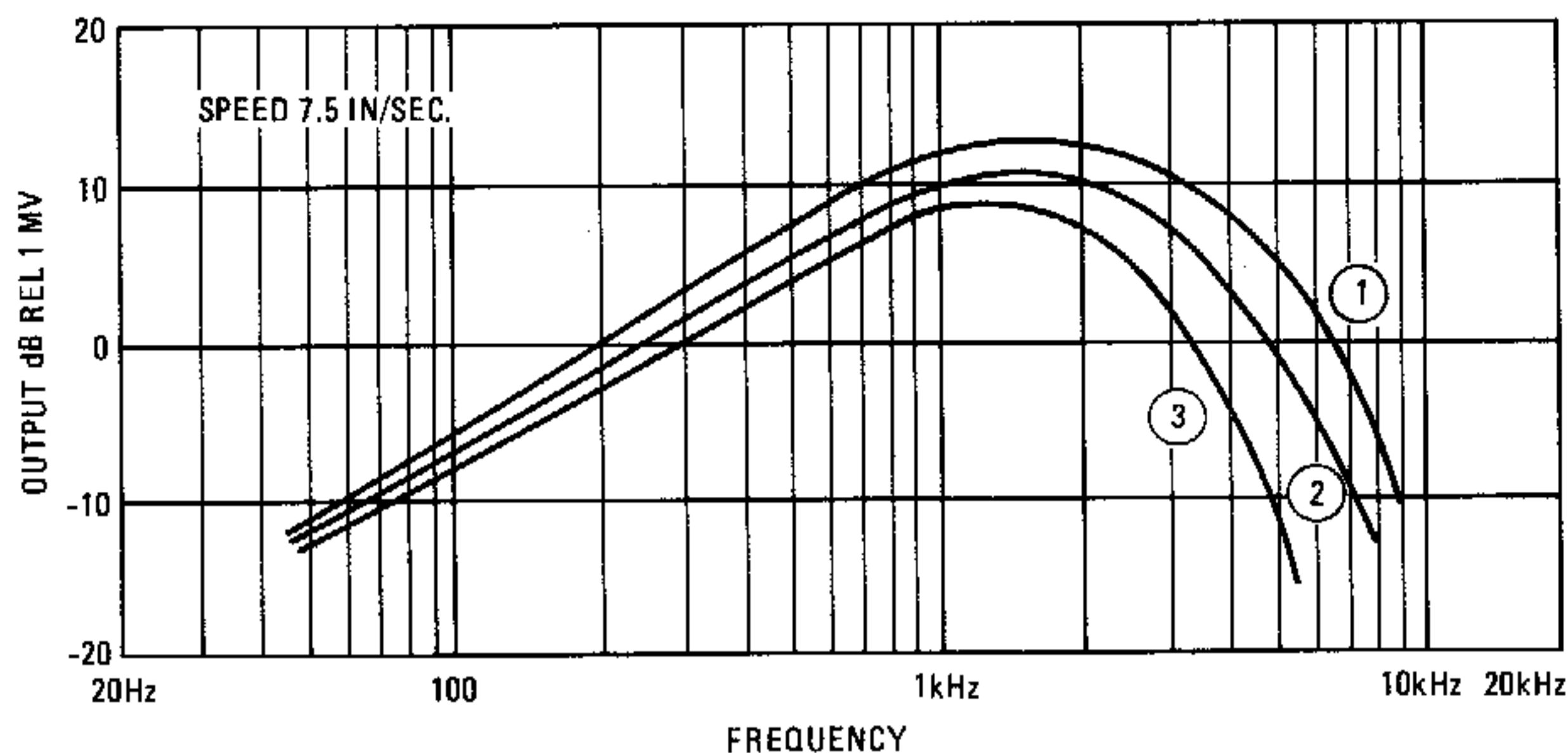
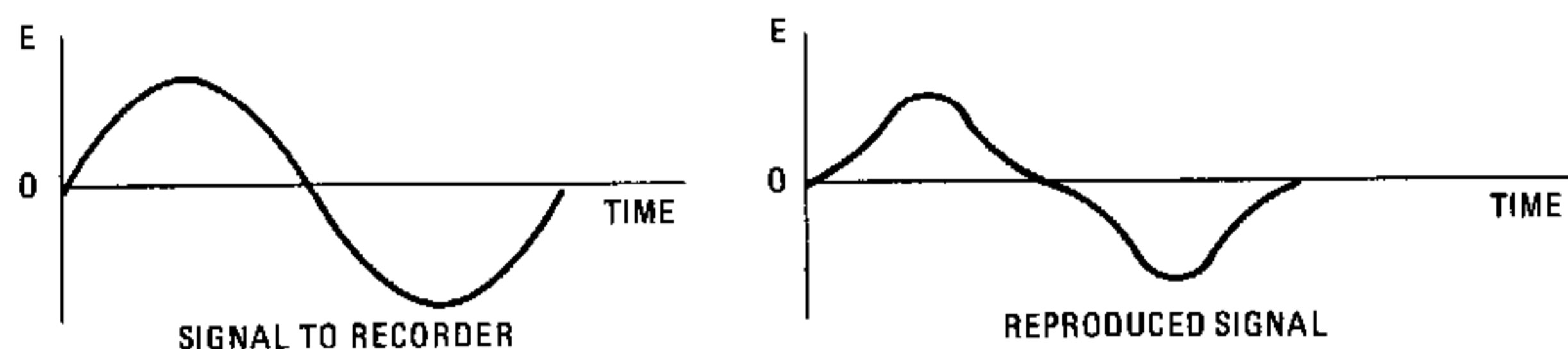


FIG. 1—TYPICAL OSCILLATOR and bias and erase circuits, for a three-head recorder. In a two-head model the record and play functions are assigned to the same head.



**FIG. 2—HOW BIAS AFFECTS HIGH-FREQUENCY RESPONSE.** Curve 1 is made with 3 ampere-turns of bias, curve 2 with 6 ampere turns. Curve 3, made with 12 ampere turns, shows the result of overbias. Erase-effect removes high frequencies which are surface recorded and do not penetrate deeply into the tape coating.



**FIG. 3—TOO LITTLE BIAS** causes pure signal, as at a, to take on a distorted form as at b. Distortion causes unpleasant harshness and a rise in the white-noise content of the signal.

that can be detected "by ear". They are not scientific enough to adjust by, but they are eloquent evidence of trouble that should be corrected in one way or another.

Suppose the bias is too strong. Too much of the bias will do exactly what you would expect; it will erase. This erasure concentrates on the high frequencies that have been recorded very lightly and which will erase with the slightest provocation, See Fig. 2. A too-strong recording bias is not frequently encountered, and there are other more common causes for high-frequency loss or absence.

Now suppose the bias is too weak or lacking entirely. There are two symptoms, the first is distortion (Fig. 3). This distortion may be very conspicuous, like the sound from an over-biased Class-B amplifier (if you happen to have been through this distressing experience). Or it may be quite bland if the distortion doesn't get above the second harmonic. (You hear a lot of this kind of pleasing distortion by composer intent in any live performance of a symphony orchestra). In other words, you can't be sure about all distortion as an aural symptom.

The other symptom is much more reliable. The signal-to-noise ratio goes bad. Maybe the noise comes up to meet the signal, or maybe the signal falls off to within range of the noise. This very audible result is a hissy-sounding tape, and it is a result you don't want—ever.

Now you face your own tape recorder that doesn't have a pot in it for bias-adjust. When the recorder was being designed, though, the bias problem was carefully considered, and just the right

bias was designed in for all appropriate components (while new) and for the recording tapes most likely to be used. The "right" bias is a precisely measured fraction of the total estimated erase current. (The recommended ratio for use with a very popular 1.5-mil acetate tape is 104 mA of erase and 5.2 mA of bias). The bias balancing may have been done under the chassis with R-C components or inside the heads with tapped or series-connected inductances. In the first case, readjustment is messy at best, and in the second, it is impossible.

Now the recorder is tired, or at least it has been used enough that it could be tired. What do you do about a bias that isn't to be adjusted? (It is assumed here that you don't own a scope or a distortion meter).

First you rule out the mysterious possibility that the recorder has suddenly or gradually acquired too much bias. Electronic circuitry very rarely ages in this upward direction. If the symptom is loss of highs, there are other and more likely causes of the trouble.

#### Listening test

So, if you suspect bias trouble at all, assume that your bias is low or missing, and at this point you arrange a listening test. Place the recorder in PLAY function. Gain is full on. Reels are at rest. Listen—to establish a comparison standard. Now play a tape, any tape such as recorded speech that offers intervals of silence through which to listen for white noise (hissing). Don't confuse the white noise with hum or ripple which have pitches of their own. Is the white noise appreciably

worse with the reels turning? If so, the trouble may be low bias. If the recorder is a portable and if you are listening to its self-contained speaker, results may be somewhat inconclusive. If possible, pipe the test run through the audio section of a good hi-fi system. Now the bad, if present, will be convincingly bad.

Next, demagnetize the heads. If you don't have the facility to do this, you will be unlikely to have read this far on the subject of bias. Repeat the whole of the above listening test. Better? If so, the trouble wasn't bias.

Assuming that demagnetizing doesn't correct the defect, suspect next the most likely source of bias trouble, the oscillator. Run an erase test. With the recorder in the RECORD mode, run through a five-minute sampling of normally recorded tape with nothing plugged in to the input jack, and with the GAIN control full off. Then play back the sampling with the GAIN control full on. Is there the slightest evidence of erase failure? If so, the weakness of erasure will suggest the parallel weakness of bias, and you have almost surely found your bias trouble. Ordinary testing of the oscillator tube or transistor will not be adequate. The corrective action is oscillator replacement. If the recorder has a tube system, this is easy. If the system is solid-state, the replacement is a more serious problem.

On the very remote possibility that a weak oscillator is not the cause of the excessive white noise, you will just have to go inside with VTVM and schematic and check around. Check voltages at the oscillator. Check continuity to and through the heads. Are the heads in need of replacement because of worn pole pieces? If you can replace everything that has worn out or changed value, the designed amplitude of your recording bias will have been restored. This is your only bias-adjust, but it is all you need.

So far we haven't mentioned trying other brands or types of tape. Their bias requirements for optimum performance may vary slightly, and some tape manufacturers mention this in their specifications. Try other brands, but don't look for the difference to be shockingly better or worse as to bias compatibility. Acetate-versus-polyester tape doesn't call for a change of bias, and neither does thickness of base. Thickness of coating does make a difference. A popular brand of 1-mil acetate (with a .35-mil coating) will boost high-frequency response with 20% less bias than standard. The same brand name of "high-output" tape (1.5-mil base with .65-mil coating) will improve low-frequency response with standard bias. At recording speeds of 7½ ips or slower, the "standard" bias designed into the recorder is the happy compromise for all popular brands and types of recording tape, and your best effort at bias-adjust should aim at maintaining or restoring this "standard".