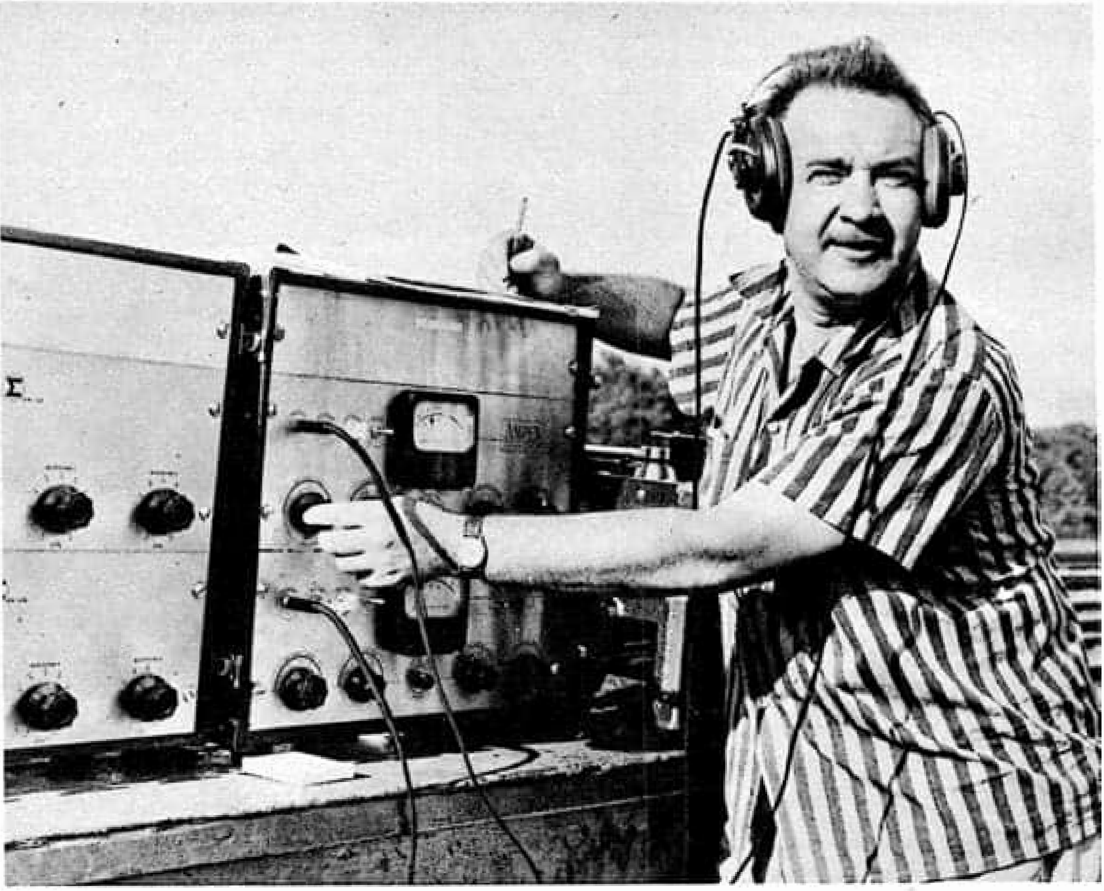
Chapter 6
Preamps and Compensators

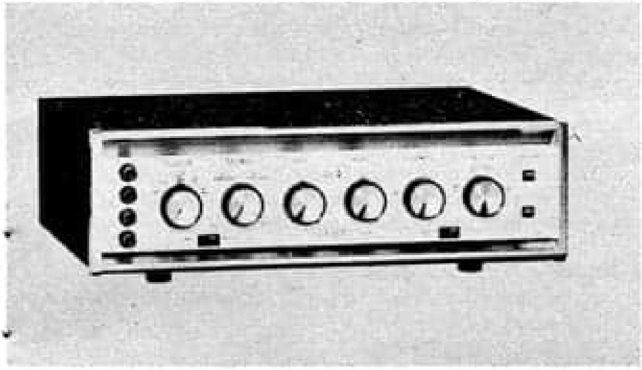


Hi-Fi Systems magazine

Above is Audio Fidelity records' president, Sidney Frey, juggling the controls on an Ampex stereo tape preamplifier during one of this company's on-the-spot recordings. Note impressive monitor headset.

Sherwood S-4400 stereo preamp and 36-watt basic amplifier, $159.50. This unit, when added to single basic amplifier, gives a complete stereo system.

Marantz stereo console has 18 inputs, 3 pairs of outputs, 6 AC outlets, tone, volume and balance controls, tape and record equalizers; $249.00.



As soon as an audio voltage emerges from a phono cartridge, or tape head, or FM radio detector, it next goes into a gadget where it is *distorted.* Or perhaps it would be more accurate to say it is *un*-distorted. For all of these signals were deliberately twisted out of shape during recording or transmission, and now they must be restored to their original condition. It's something like the toys which are knocked-down for ease in shipping, and which Dad has to sweat over in reassembly on Christmas Eve. Only the knocked-down hi-fi signal doesn't put as much wear and tear on old Dad, because reassembly is automatically taken care of for him by the little gadget called the equalizer or *compensator*.

You will remember that in the last chapter we spoke of phono pickups being either *velocity* or *amplitude* responsive. To understand what this means, we have to consider that there are two main types of record-cutting mechanisms. One is called *constant amplitude,* and the other is *constant velocity.*

In the constant amplitude system, the *displacement* of the cutting stylus, the distance it swings from side to side in cutting the groove will depend upon the loudness of the sound. In the constant velocity system, the *speed* with which the stylus moves will depend on the loudness. Some of the important characteristics of the two types are shown in Fig. 1.

The constant amplitude type is shown in Fig. 1(A). Note that for a signal of a given loudness, the groove displacement (or excursion) is the same at all frequencies. This means that at the higher frequencies the stylus must move much faster to cover the same ground. Hence in the constant amplitude system, the velocity or speed of the stylus goes up with increasing frequency.

Compare this with the constant velocity condition in Fig. 1(B). Since the velocity is constant for a given loudness, the stylus simply cannot cover as much distance at the higher frequencies. Hence the groove displacement and therefore the amplitude go down as the frequency goes up.

Here we see the inherent weakness in the constant velocity system. Since the groove displacement diminishes at high frequencies, it can become so slight that it is overcome by the inherent surface noise on the disc. Also, since displacement increases at the bass end, the powerful low frequencies can send the stylus right over into the next groove, to cause *overcutting.*

It would seem from this that the constant amplitude system is by far the better of the two, and there are some authorities who contend just that. But here is just one more case where the theory hasn't been proved in practice. Up until now, at least, nobody has been able to build a constant amplitude cutter which will do what it theoretically should be able to do.

All cutters in commercial use today are of the magnetic variety, which means they are constant velocity. Like a DC motor, their speed (velocity) depends on the amount of voltage fed into their coils. But this still leaves us with the anemic high end and over-powerful bass characteristic of the constant-velocity system. So in practice we use a *modified* constant-velocity system, as shown in Fig. 1(C), which is actually constant velocity only in the midrange, but constant amplitude at both extremes of the audio range.

This is the typical *recording characteristic*, in which there is less bass than normal, and more highs. Now the job of the compensator at the reproducer end is to boost the bass and attenuate the highs by exactly the same amounts as the opposite was done in recording. To do this, it is necessary to know the *turnover* frequencies, which are the points at which the characteristic goes from amplitude to velocity, or the reverse. This is shown in Fig. 2, in which we see the reproducing characteristics most commonly used today.

The RIAA curve is the one commonly used in the United States, while the CCIR curve is generally used in Europe. Note that in both cases the curve is constant velocity throughout the midrange. But note also that the CCIR curve turns over at 353 cps, while the RIAA curve doesn't turn over until 500 cps, nearly a musical fifth higher. Similarly at the upper end, the RIAA curve turns over at 2120 cps, while the CCIR turnover occurs at 3180 cps, again an interval of about a musical fifth.

The simplest compensators today are fixed at the RIAA characteristic, and let it go at that. This is fine, as long as your record library contains nothing but American records, all made within recent years. But if you have many European recordings, or older American material (time was when there were seemingly more recording characteristics than record companies), then you must have an adjustable compensator.

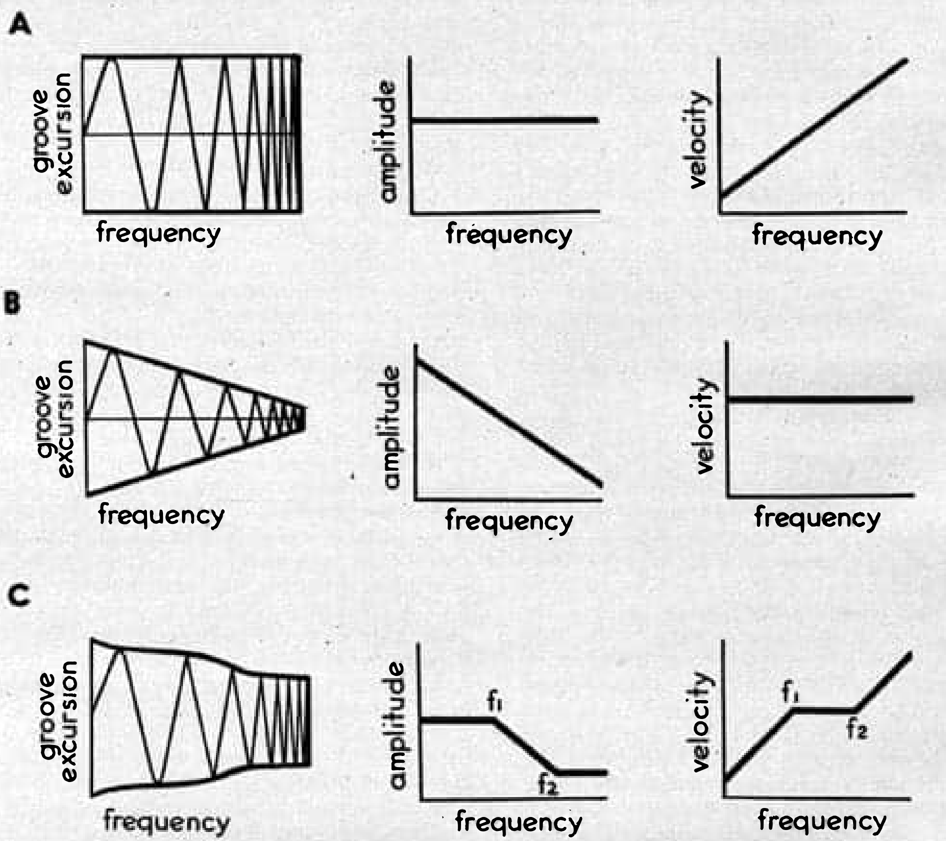
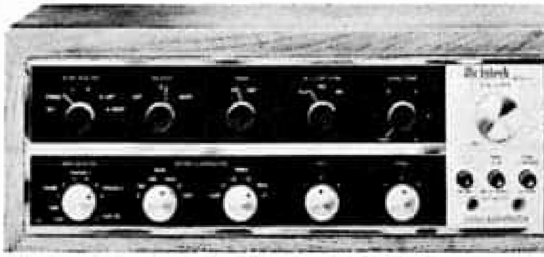


FIG. 1

The next most elaborate compensators cover the most used curves, with selector switch positions having such markings as RIAA, EUR (CCIR) and AES (old Audio Engineering Society). These types take care of both turnover frequencies in one flick of the switch.

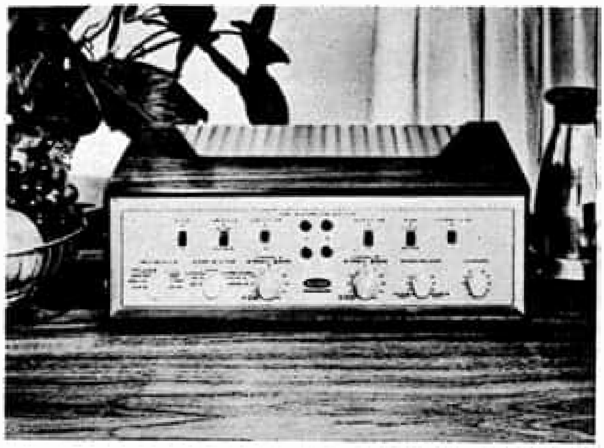
The most elaborate compensators of all, and those with the greatest flexibility, permit separate adjustment of the two turnover frequencies. These, too, may have designations such as RIAA and CCIR, or they may have numerical designations instead. And here is where the going gets a little tricky.

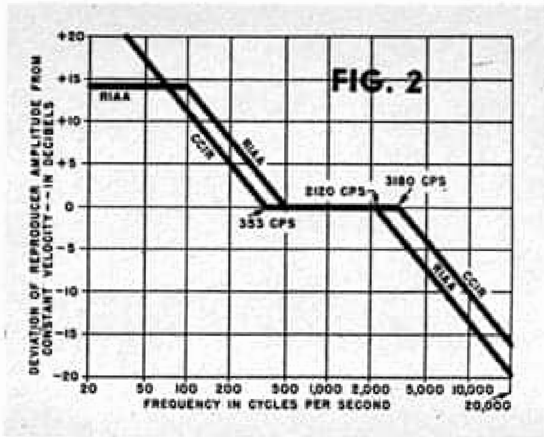
Going back once again to Fig. 2, remember that the low-frequency turnover is 353 cps for CCIR and 500 cps for RIAA. To adjust correctly for either of these record



McIntosh C20 stereo compensator has 2.5-v main output, record and tape equalizers, rumble filter, stereo balance, phase switch, 600-watt outlets.

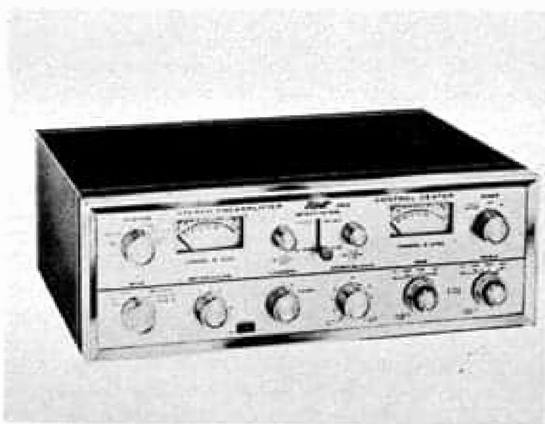
Below, left: H. H. Scott 130 provides stereo balance, has provision for 3rd channel, 10 inputs, tape and record equalization. Response: 19-35,000 cps.



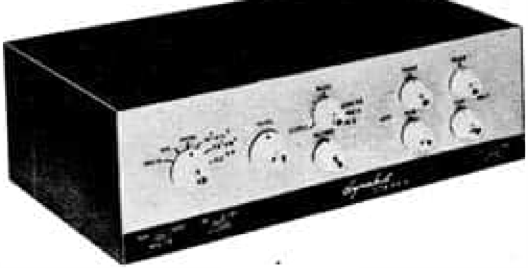


Fisher 400-C Master control has 16 inputs, 11 controls, ganged bass and treble knobs. Push buttons operate tuner, phono and auxiliaries.

Pilot 216-A, $199.50, has two VU meters for balancing each channel or tape output level. Unit has 4 outputs, 14 inputs, internal cathode follower.



Eico stereo preamp is sold assembled, $64.95, or in kit form, $39.95. It has ganged controls, tape and record equalizer, channel reverse, hum balance.



Dynakit stereo preamp sells for $59.95 in kit form, with portions preassembled on printed circuit board. Controls include a channel blend.

Grommes 209 Premier stereo preamp comes with 12 inputs, is self-powered; has a 10-20,000 cps frequency response at ± 0.25 db, four outputs.

Marantz Model 3 electronic crossover for stereo programs has independent on-off and level control for each channel, low and high frequency knobs.

types, it is simply necessary to set the L-F TURNOVER control to either 353 or 500. Or if some other frequency is called for, merely set the switch to that.

So far so good. But to adjust for the other knee in the curve, you won't find the compensator marked "h-f turnover," but instead it will most likely be indicated as H-F ROLLOFF. Although it still is actually a turnover point, it isn't expressed in terms of frequency. To follow this, we'll have to go back once more to Fig. 2.

Follow the sloping legs at the far right of each curve until the line crosses the 10,000 cps point. Note that at this frequency the CCIR curve is at the horizontal level of —10. At the same time the RIAA curve is at about —13. These are the decibels of *roll-off* at that frequency.

In other words, when a record is cut at the CCIR characteristic, the upper turnover is such that the treble boost is 10 decibels at 10,000 cps. Similarly, an RIAA record has a turnover with a treble boost of 13db at 10,000 cps. Now the reproducing compensator must do just the opposite of what the recording equalizer has done. That is, where the record is bocsted, the compensator must roll off, and where the record is rolled off, the compensator must boost.

For reasons which are hidden deep in the antiquity of recording practice, the high-frequency compensator will be labeled in terms of roll-off, either in decibels, or by letter designations such as RIAA, CCIR or AES. But it is *never* spoken of as "high frequency turnover." Since there are in fact two turnovers, perhaps this was done to avoid confusion. But I daresay, gentle reader, that at this point it has done just the opposite for you.

Just to make matters even more confusing, the RIAA curve has still a *third* turnover. You may have noticed in Fig. 2 that the RIAA curve flattens off again below about 100 cps. Recording engineers call this plateau the low frequency *shelf,* and what it amounts to is a little bass boost in recording to get a better advantage over inherent bass noise such as hum and rumble.

Theoretically, in your playback compensator the bass boost should stop at around 100 cps and flatten off to accommodate this shelf. As a practical matter, the odds are very great that this is simply overlooked. The bass boost is there, and it stays there.

Remote control for stereo amplifiers by General Electric, has channel balance and volume controls, sells for $14.95. It can also be used with monaural source. Its weight is 12 ounces.

So you won't have to concern yourself with this one, unless the records sound too bassy to you, in which case you'll just have to adjust your tone control.

Equalization is necessary in tape recorders also, and for reasons similar to those for disc recording. There is the problem of hiss and other high frequency noise at the treble end, plus hum and rumble at the bass end. In addition to these factors there is the peculiar nonlinearity of the tape recorder itself.

Without equalization, the output of a tape recorder will double each time the frequency is doubled. If the output were 2 volts at 1,000 cps, for example, it would be 4 volts at 2,000 cps, 8 volts at 4,000 cps, and so forth. This will go on up to a critical frequency, above which the output will begin to droop again. The unequalized playback below this critical frequency is therefore described as having a normal rise of 6 decibels per octave.

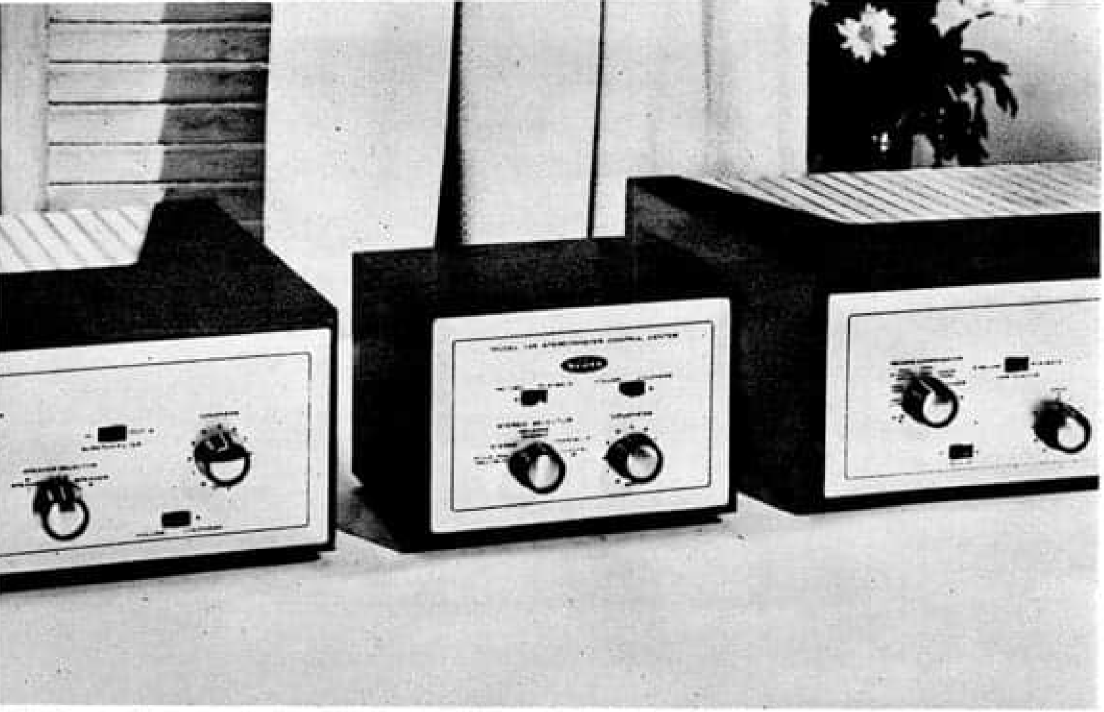
The recording and reproducing characteristics for tape are a combination of the inherent peculiarities of the magnetic process, plus electronic equalization where needed. During recording, the electronic system is flat up to the critical frequency, permitting the 6 db/octave rise to go directly onto the tape. Then where the magnetic system begins to droop, electronic equalization continues with a tip-up of about 6 db/octave.

In playback the reverse holds true. A roll-off of 6 db/octave is inserted electronically up to the critical frequency, but the electronics becomes flat where the inherent magnetic roll-off takes over.

This equalization is normally taken care of automatically in the tape preamplifier, and no adjustment is necessary. In fact, none is possible on most American machines, which makes for difficulties when playing imported tapes.

In tape and disc reproducers, the compensation circuit is usually inserted immediately following the transducer and ahead of any amplification. In FM tuners, it appears between the detector and the first audio stage. In FM parlance, the compensation or equalization circuit is known as *de-emphasis*.

The reason for the name is simply the fact that at the transmitter we have *pre-emphasis* of the high audio frequencies, to provide a better ratio of signal to noise. This takes the form of a 6 db/octave rise



H. H. Scott stereo adaptor sells for $24.95, is used to convert two separate monaural systems to stereo. The drawing below, right, shows how this unit controls and mixes both channels of a stereo program.

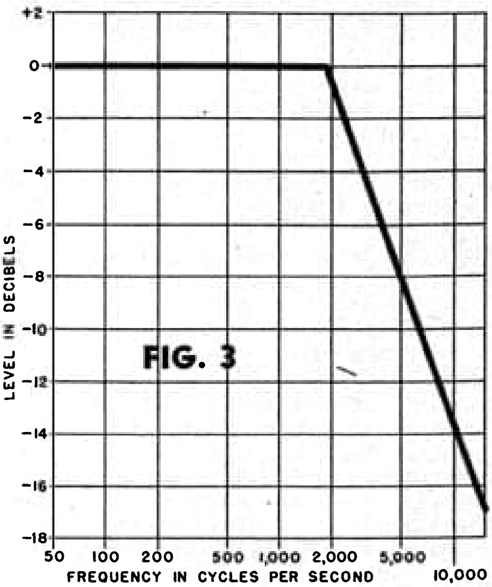
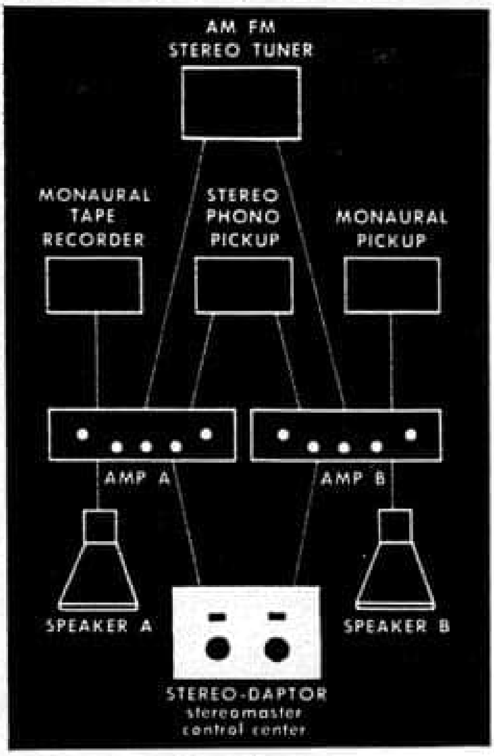


FIG. 3



Left: Lafayette stereo control is self-powered, sells for $27.50 in kit form. It has provision for a third channel, plus a phase and channel reverse switch.

above 2,000 cps. Similarly, the de-emphasis is simply a roll-off of 6 db/octave beginning around 2,000 cps.

This is shown in idealized form in Fig. 3. We say "idealized" because none of these characteristics actually have such straight lines or well-defined bends as shown in these graphs. But if it were possible to build equalizers as sharp as these, that is the way their characteristics would look.

Of all the source devices in the hi-fi system, only the magnetic phono cartridge and the tape reproduce head require any preamplification. The reason for this is the great difference in output voltage between the two types of devices. Tuners, piezo pickups and piezo microphones, all are relatively *high-level* devices, with outputs on the order of a volt or so. Magnetic pickups, tape heads, and most magnetic type microphones have much smaller outputs, on the order of millivolts. The preamplifier is therefore a special accommodation for these magnetic devices only, to amplify their signals and bring them up to a level comparable with the piezo devices.

Although preamplifiers have been known in professional practice for years, they only came into vogue for home use following the introduction of the G.E. Variable Reluctance pickup in the late 1940's. This cartridge was relatively low in price, high in quality, and it represented a major breakthrough at the time in the quest for home hi-fi at reasonable cost. But it also had much lower output than the crystal cartridges which were then standard in home phono systems.

The first preamp for use with this cartridge was a simple little 1-tube amplifier, with fixed compensation. Since record manufacturers of the time liked to keep an aura of mystery surrounding their recording characteristics, there wasn't much point in adjustable compensation anyway.

The simplest preamplifier of this type is essentially a fixed-gain device, without volume control or other adjustments. Its sole function is to increase the feeble output of the pickup-compensator combination to a value which is comparable to that of other common signal sources. The requirements of the preamplifier are very exacting, for any noises which might get into the system at this point would become exceedingly serious after the tremendous amplification which follows.

It is much easier from a design standpoint to keep the preamplifier completely isolated from the main amplifier, rather than take the additional precautions neces-

sary to avoid noise induction from associated equipment. A separate preamplifier, then, is usually to be preferred over one which is part of the main amplifier.

Very often, however, the preamplifier and compensator are constructed as a single unit, and this is an entirely logical and useful combination. The unit may have a self-contained power supply, or it may obtain its necessary operating voltages from the same supply as the main amplifier. The self-contained unit is naturally more expensive, but it avoids possible troubles in obtaining satisfactory isolation between preamp and the main unit.

Now that piezo type cartridges are so much improved in quality, you may be wondering if it isn't possible once again to dispense with the preamp altogether. The answer is yes, provided you never have need to handle any low-level signals.

The Stereo Story

There isn't a great deal to say about stereo compensators and preamplifiers, except that stereo requires two of everything. Although the stereo cartridge uses a single stylus in a single groove, remember that it actually has two separate generators, and each of them must be separately compensated and separately amplified. The same is true of two-track stereo tape heads, and of stereo tuners, except for the AM-FM variety. There will be more on this, however, in the next chapter.

None of the old comp-preamp equipment used with monophonic equipment need be obsoleted by stereo. But it will have to be augmented by a duplicate set for the second channel, preferably identical to the first.

Some persons like to add a third piece of equipment here, called a stereo adapter or control center. Essentially this contains no more than a ganged set of controls connected to the two channels and affords somewhat greater convenience in balancing the outputs of the two loudspeakers.

Most of the technical specifications for preamplifiers are the same as for power amplifiers. These and amplifier controls are discussed in Chapter 8. •