To facilitate elimination of reflections, if the adapter has a point at which the sum (mono) is separated from pilot and subcarrier sidebands, shorting, or disconnecting the main (sum) channel and listening to or looking at (on an oscilloscope) the stereo output, will show up the reflections much more clearly. This is a good reason for preferring the matrix-type receiver or adapter circuit.

The difficulty is that any distortion received may be due to either ghosts or wrong phasing of the regenerated subcarrier. While adjustment of either will produce a null, or minimum distortion point, this is not a guarantee that true minimum has been achieved.

For example, distortion due to a ghost or reflected signal, may be minimized by adjustment of the phasing control on the reinserted carrier (how ever this is achieved in individual models), by what is really an incorrect phase setting. The distortion will be less at this incorrect setting than it would be at the correct setting, while the ghost is there, but it would be even lower if the ghost were eliminated.

Similarly, it is possible that maneuvering the antenna orientation will produce a minimum distortion when the phase adjustment is wrong, but this must be by choosing a deliberate ghost, so to speak, with much more distortion than there should be, were everything correctly aligned.

MATCHING ADAPTER TO TUNER

This is a temporary problem, but a very important one for the first year or two multiplex is operating. Later, the problem will disappear because adapters will no longer be made, only complete tuners with the multiplex features built-in. Meanwhile we have the problem of converting existing systems to stereo by the addition of an adapter.

As with any matching problem, the basic concepts are simple; both levels and impedances need to be right. But the troubles that incorrect matching can cause are in some instances a little more difficult to eliminate with this one.

The impedance of the tuner needs to be such that loading it with the adapter does not produce any kind of distortion. Such distortion can happen for a variety of reasons, and take a variety of forms.

Most tuners are designed to handle the full 75 kc deviation, but only with modulation frequencies up to 15 kc. This means that the amplitudes of sidebands up near the 75 kc limits are very much less than those for sidebands below 15 kc. When stereo comes in, these proportions are changed (Fig. 5-3). Sidebands in the region of the subcarrier frequency (38 kc) can be as large as those below 15 kc.

First question is whether the tuner can handle this change in relative amplitude distribution without distortion either in the intermediate frequencies or in the demodulator. There seems to have been some

thought that this aspect will be more evident with Foster-Seeley discriminators than with ratio detectors, but actually it is a matter of correct design and alignment with either circuit.

The response of the tuner from antenna input, through the intermediate frequencies and limiter(s) must not only be linear over the whole 150 to 200 kc bandwidth (flat-topped), but it must also be capable

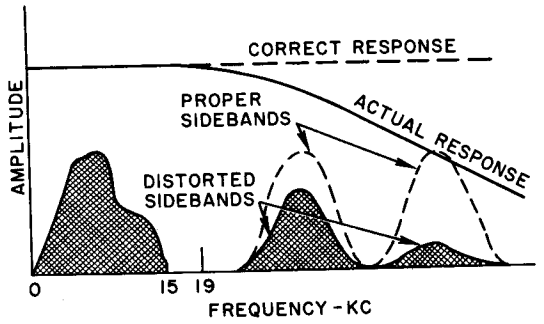

Fig. 5-4. Effect of undue roll-off that would be acceptable for high-quality monophonic, but not for stereo.

of handling the relative amplitude of component sidebands in a stereo broadcast as well as it did the relative amplitudes in a monophonic broadcast.

Next, having settled that little detail, we hope successfully, the discriminator or ratio detector must have a linear response, unaffected by instantaneous sideband amplitude, over the full bandwidth.

With monophonic reception, deficiency in either of these requirements could, to a large extent, be offset by a readjustment in the other circuit. If the discriminator or ratio detector were not quite linear, slight "fudging" of the i-f's could minimize monophonic distortion. But not on stereo.

Now, assuming the tuner checks out for stereo, we still have to add the multiplex adapter. First, the audio stage of the tuner may have a roll-off above 15 kc, even without the normal de-emphasis. Unless something can be done about it, this will cause distortion on stereo because of change in the relative magnitude of the pilot and lower and upper subcarrier sidebands, in that order (Fig. 5-4).

Even assuming the tuner output is flat and undistorted, it needs to be phase linear. Actually, if it is flat to at least 53 kc without compensation, and will handle the stereo signal successfully, it is a fair bet that the phase linearity is not too bad. Any deviation there may be can be reasonably well corrected in the phase adjustment of the adapter, if the tuner is this good.

Assuming the tuner itself checks out, the input leads to the adapter, or the input impedance of the adapter itself, may impose loading on the tuner that could destroy either its linearity of demodulaion of certain components, or its linearity of audio frequency output (here, we take audio to mean the whole stereo complex of frequencies, from low audio to 53 kc).

If all these things check, and the output level from the tuner is such that the adapter level adjustments can handle it (there is no limiter in this type of adapter, as there would have been in the Crosby system) then we are in business, except for the final trims.

MATCHING ADAPTER OR TUNER TO STEREO SYSTEM

At first sight this may seem no more difficult than matching a preamplifier to a power amplifier: just a matter of having levels and impedances right. But there is one important additional feature: the possible presence of ultrasonic residue frequencies.

These are not audible, so long as they do not cause trouble by interacting in some way with something else to produce a further by-product that is audible. An amplifier with unduly extended high-frequency response but inadequate handling capacity in the ultrasonic range (which it never needed before) may cause distortion, with resulting intermodulation products some of which will be audible. Most likely they will show as twitters or whistles.

If you want to *record* your received stereo broadcast, there is an additional hazard: possible interaction between these ultrasonic frequencies and the tape recorder's bias and/or erase oscillator. This will give rise to "birdies" any time there is stereo information.

The best remedy for either of these problems is filtering to remove the offending unwanted frequencies after stereo demodulation and matrixing, at the output of the adapter or stereo tuner. Some tuners will incorporate such filtering as either a standard or an optional feature. But good filtering is expensive, so many may not include it, you do, however, definitely need such filtering.

If this chapter makes the installation of stereo multiplex look complicated, it is because there really are a number of things that might not be right, and it may not always be easy to correct them. However, it is probable too that many installations will be made without encountering any of these problems. By pointing out as many as possible of the things that can go wrong, we hope to minimize the chance that you may come across one that "wasn't in the book".

6 alignment and performance checks ■

As we mentioned in the preface, the first edition of a book such as this must try to be an enlightened "shot in the dark". As this is being written, some test equipment is just being finalized and put on the market by one or two manufacturers. Very few stations have actually begun to broadcast multiplex, nothing has been said about providing test transmissions to help with alignment and performance checks.

In the absence of transmissions designed for the purpose, it will be difficult to align one of these adapters without a special test generator. First we will outline what needs alignment, and how failure of proper alignment can affect performance or to what degree it can be compensated. Then we will suggest ways to do these things, according to facilities that may or may not be available.

LOCAL SUBCARRIER REGENERATION

Whichever type of adapter or tuner circuit is used, it must employ some means to regenerate the subcarrier. Not only must the subcarrier stay accurately in synchronism with the original carrier of the transmitted subcarrier sidebands, it must also be very precisely *in phase* with it, within 3° for undistorted playback.

If the subcarrier is regenerated by frequency multiplying from the pilot 19 kc transmitted, phase adjustment will be relatively simple, being determined once and for all by the precise values in the 38-kc-tuned