

# How Much Modulation?

MUCH criticism has been directed at the present broadcasting structure on the ground that the carrier waves have not been modulated sufficiently. Naturally this criticism has come from persons not familiar with broadcasting requirements.

These critics have pointed out that the carrier wave travels much farther than the modulation and that the carrier is capable of causing interference thousands of miles away from a transmitting station when the signals can only be heard satisfactorily a few hundred miles away. These critics would have hundred percent modulation.

From many points of view this would be exceedingly desirable. But unfortunately there are technical factors involved which limit the degree of modulation that is permissible. One of these is the fact that sound intensities vary, sometimes as much as 100,000 to 1. Another is that as the degree of modulation increases the distortion introduced by the detector in the receiver increases rapidly.

## Range of Sound Restricted

Suppose that the modulation when the sound intensity is unity is one percent. The modulation would then be 100 percent when the sound intensity was 100 units. When the sound intensity was 100,000 units the carrier wave would be 1,000 times overmodulated. Terrific distortion would result.

Now suppose that the modulation was 100 percent when the sound intensity was 100,000 units. Then the degree of modulation when the sound intensity was unity would be .001 of one percent. The quality of the stronger sound would perhaps be tolerable, but that is doubtful. The quality of the weaker sound would be excellent, but that quality would be of no avail for nobody would hear it in the receiver. It would be too weak.

Now as a matter of fact the sound intensity at the modulator does not vary as much as 100,000 to 1. It is never permitted to vary more than 1,000 to 1. Thus the natural relative intensities occurring in orchestral music, for example, are never heard in a radio receiver. The control man at the mixing panel sees to that. He only permits a variation of 1,000 to 1. If he allowed the full variation every listener would at once say that the modulation of the station was terrible. And it would be.

## Listener Not Cheated

But the listener does not need to feel that he is being cheated just because he cannot hear the full intensity range of orchestral music. The illusion of reality is not defeated by the 100 to 1 contraction of the intensity, because even if the listener were in the presence of the orchestra he would not hear the entire intensity range. His ears would accommodate themselves to the intensities automatically, increasing their sensitivity on the weak sounds and decreasing it on the intense sounds.

If this accommodation could be effected automatically in the transmitter the control man would not have much to do. But the microphone is not subject to fatigue to the extent that the ear muscles and the auditory nerves are.

The ear accommodates itself to different sound intensities in somewhat the same way that the eye accommodates itself to different light intensities. It is true both organs show a lag in the accommodation, and during the transition period from weak to strong intensities there is a feel-

## Many Who Suggest Increase as Means of Improving Transmission Don't Know What They're Talking About, and Here Are the Reasons Why

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ing of discomfort and pain. The man at the mixing panels saves the listeners much of this by limiting the sound intensities so that they are bearable.

## Thousand to One Range

Even with the 1,000-to-1 range in the transmission leaves a wide range of degrees of modulation. Suppose the modulation is 100 percent when the sound intensity is 1,000 units. Then it is only .1 percent when the sound intensity is unity. The louder sound should be heard as well 1,000 miles away from the trans-

## Television In Range of SW Adapter

One of the limiting factors in television is the lack of channel width. To have a clear and sharp image of about  $1\frac{1}{2} \times 1\frac{1}{2}$  inches it is necessary to have a channel width of about 100 kc. The maximum width permitted in broadcasting is only 10 kc. This is one reason why pictures now being received are blurred.

Since the broadcast band is already overcrowded by music and speech transmission, there is little hope that any television channel will be assigned in that same receiver depending on the relative loudness of the sound received.

It has been the practice recently to make the average modulation 40 percent without overmodulating on the loud passages. When the modulation is 40 percent the second harmonic in the detected signal is .1 as strong as the fundamental. But the trend seems to be to decrease the modulation in the interest of quality. Thus it has been reported that one high power station is being rebuilt in which the modulation is to be only 8 percent. That means that the second harmonic will be only .02 as strong as the fundamental.

Lower percentage of modulation means that more power must be put into the carrier wave in order that the same sound intensity may be received. That can be done without any harmful effects if the station operates on a cleared channel.

mitter as the weaker at one mile, assuming the same adjustment of the receivers. Or in front of the same loudspeaker the louder sound should be heard 32 times as far as the weaker sound.

The other factor which limits the degree of modulation permissible is the introduction of harmonics in the detector. This increases with the degree of modulation. Suppose the amplitude of the carrier is A and the amplitude of the modulating wave is B, then the ratio of the second harmonic to the fundamental is  $B/4A$ . Thus if the modulation is 100 percent, that is A equals B, the harmonic is  $\frac{1}{4}$  as strong as the fundamental. If it is .1 as strong the distortion is quite noticeable. When the modulation is only .1 percent the strength of the second harmonic is only .025 as strong as the first harmonic or fundamental. This distortion is entirely negligible. Thus both good and bad quality must be expected in the band. It is necessary to look to the short waves for television channels.

Already several bands have been assigned for television purposes and they are being allocated to television experimenters in 100 kc. channels.

The General Electric Co. is sending out television signals over 2XAF, 9,550 kc or 31.4 meters, as well as over WGY, 790 kc. the regular broadcast channel.

When using the Hammarlund short wave adapter for receiving the short wave television signals from 2XAF the 40-meter or medium coils should be used. The signals will come in near the lower end of the dial. In some cases it may be necessary to employ the 20-meter, the smallest coil and set the tuning condenser near maximum. But normally the signals come in the range of the 40-meter coil.

The transmission takes place on Tuesday, Thursday and Friday from 1:30 to 2 p. m. E. D. S. T. and on Sunday from 10:15 to 10:30 p. m. E. D. S. T., simultaneously from 2XAF and WGY. The scanning speed is 20 per second and the number of holes in the scanning disc is 24.

See the constructional article on pages 10 and 11.

## KFI Uses a Crystal; Modulates Only 8%

Los Angeles.

To keep the station on the air as much as possible, the staff of KFI did most of the actual installation during the night after the station had signed off. Each night they tore out a little of the old equipment, add some of the new, then put the old back again so that the station would resume its programs at eight o'clock the following morning.

The station in a publicity release said: "According to Walter Tierney, of the Bell Laboratories in charge of installation, the new crystal control unit with its eight per cent modulation, more than doubles the strength of KFI without increasing the power of the station. Radio fans are asked to wire or write any noticeable change in KFI's reception."

## X-L IN NEW QUARTERS

X-L Radio Laboratories, makers of Variodensers and X-L Push Posts, are in new quarters at 1224 Belmont Avenue, Chicago, where larger floor space and increased equipment permit both greater and more economical production. The former quarters were at 2424 Lincoln Avenue.