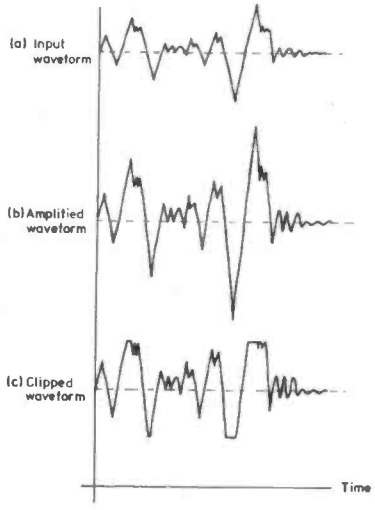

Fig. 4. Effect of AF clipping on speech waveform

As well as harmonic distortion, there is intermodulation distortion produced whenever two or more signals of different frequencies are passed through a non-linear stage. Sometimes in-band components can be generated from intermodulation between an in-band and an out-of-band component, or from two out-of-band components. For example, an 8kHz and a 6kHz signal could mix to produce a 2kHz intermodulation product. This is one reason for filtering the input as well as the output.

Filtering

The harmonics produced by audio clipping must be filtered out before modulation, or they will produce sidebands a rather naughty way from the carrier. A great deal of care is needed with the design of a suitable low pass filter to make sure it does not introduce excessive ringing on the waveform, otherwise the intended peak level will be exceeded. For more information on the transient, step response of low pass filters see references (1) or (2).

When designing low-pass filters for an outboard speech processor, bear in mind the existing transmitter filters.

As far as the input of the clipper is concerned, the usual trick is to have a high pass filter with a gentle slope of 6dB/octave, and a cut-off frequency (−3dB point) of about 1kHz. This has a number of effects. First, it reduces the level of the vowel sounds, which as well as being high in amplitude tend to be low in frequency. Second, the harmonic distortion produced by clipping these sounds is also reduced considerably.

The best filter response depends on the operator's voice, the frequency response of the microphone and the existing response tailoring in the transmitter.

RF clipping

In the early seventies there was a great deal of excitement about RF clipping. This is doen by clipping an SSB waveform instead of raw audio. The advantage of this is that the harmonics produced by the clipping process will be out of the wanted channel, and can be filtered out easily. Fig. 5 is a block diagram of such an arrangement. RF clipping can take the form of an outboard speech processor, that converts audio to SSB, clips it, then turns it back into audio. Alternatively, in SSB transmitters, the clipping can be carried out in the IF stages, where there is an SSB signal ready to be clipped. Many modern rigs do this anyway.

RF clipping does get round the problem of the in-channel harmonics that beset AF clippers. They do, however, suffer from exactly the same intermodulation distortion produced when two or more different frequencies are clipped simultaneously. Also, bandpass or any other filtering will affect the shape of the precisely clipped flat top of the waveform. Thus the only advantage of RF clipping over AF clipping is the ability to remove harmonic distortion completely. As we've already seen, tailoring the response of the signal before clipping can do a great deal to solve this problem at much less complexity than RF clipping. You pays your money and takes your choice.

AF clipping is perhaps not so good for SSB, because the squared-off waveform tends to produce a rather peaky SSB envelope. This effect can be offset to a large extent by the LF role-off filter at the input.

Duty cycle

Any effective method of speech processing will, as intended, increase the average-to-peak ratio of the transmitted signal. It is important that the ratio — known as the duty cycle — is not more than the transmitter can handle. Some transmitters, especially those with PAs that use line output valves, are simply not man enough for the job. They will get very hot and therefore unreliable. Valve life will be greatly reduced. Most modern rigs have quite adequate speech processing in them anyway, and additional processing can do more harm than good. The most important thing is to avoid overdriving the rig — speech processors tend to have plenty of spare gain in them — as this will not increase your power output, except by adding distortion, which may be out of channel. Also, excessive gain will increase background noise and shack reverberation, thus *spoiling* intelligibility.

Many older rigs, and the simpler rigs, do not have any speech processing. In that case then an outboard processor can be a great help. If you want the ultimate then build/buy an RF clipper. If you want something that is a lot cheaper and simpler, that you can build yourself, yet very nearly as good as an RF clipper, you can do little better than read Dave Howes' article in the next few pages.

REFERENCES

(1) D.C. Hamill, Transient response of audio filters, *Wireless World*, vol. 87, p.59-64, August 1981.
(2) F.F. Kuo, Network analysis and synthesis, 2nd edition, Wiley, 1966.

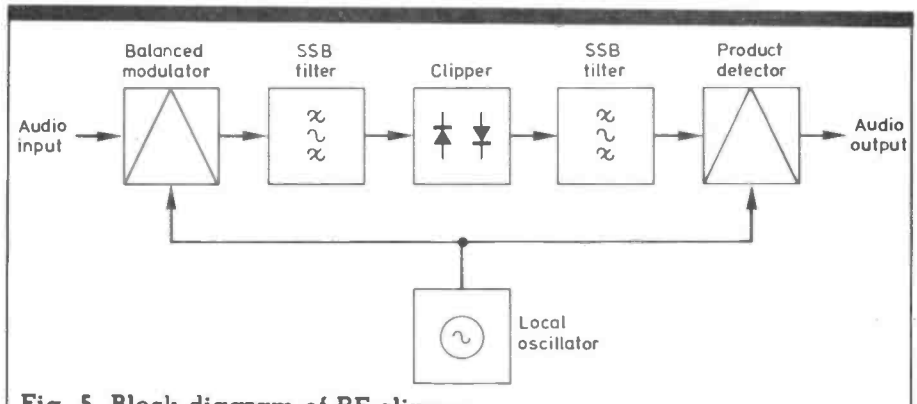

Fig. 5. Block diagram of RF clipper