The Speech Inverter

Scrambles Sound into Unintelligibility, Then Restores It

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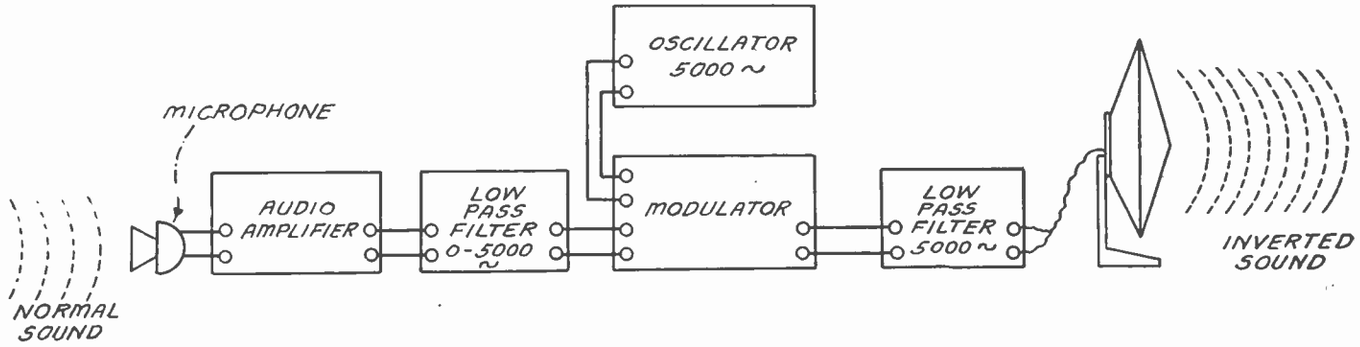

FIG. 1
THIS DRAWING INDICATES THE NECESSARY UNITS FOR A S PEECH INVERSION CIRCUIT

SWIFT communication is a necessity in conducting a war. But this communication must be conducted so that the enemy cannot eavesdrop. It must be secret, or the signals, whether voice or telegraph must be quickly intelligible to the persons for whom intended and unintelligible to the enemy.

To effect the secrecy many difficult codes have been invented, but most of these are decipherable by the enemy and all that is gained by the use of the code is a little time.

Since radio has been used, the necessity for secret codes has been greater than when wire lines were used. When telephony is used codes are difficult because a special jargon would have to be developed, and this would be difficult both to transmit and to receive.

There are cases when a secret method of voice transmission is very desirable when neither party to a conversation could be expected to use a code.

Many schemes for secret radio telephony have been proposed and tried. Some of them offer a certain exclusiveness as it requires special apparatus to make the signals intelligible once they have been transmitted.

Voice Inversion

One of the simplest of these methods is that of voice inversion. In this the voice is turned upside down. The low notes or sounds are made high and the high are made low. This is done twice, once at the transmitter and once at the receiver. The parties to the conversation are not aware of the double conversion, but anyone trying to listen in would be unable to understand any of the noises.

For wartime communication this method is not secret enough for the enemy could equip himself with the same inverting apparatus and he could very quickly discover the key to the code. In fact, he could record the unintelligible noise on a phonograph record and decode it. Again he would only lose a little time. But for ordinary radio conversations the method is suitable, as very few persons would go to the trouble of setting up the inverting equipment or of recording the noises. But even in peacetime there may be conversations of sufficient importance to warrant some one to listen in even under the most difficult conditions.

At present inverted speech is used mainly to entertain audiences and to impress laymen with the wonders of science. As a means of entertainment the idea has certain value, both for the stage and the home. The required apparatus is not much more complex than a radio receiver, and it contains exactly the same components—tubes, condensers, coils and resistors.

Simple in Principle

The principle on which speech is inverted is based simple. It is used in every Super-Heterodyne. In the Super the inverted signal is not selected, and in those circuits in which is is so selected, it is reinverted so that the signal comes out right side up.

The inverter is simply an oscillator and a modulator. The frequency of the oscillator is chosen suitably low. When this frequency is mixed with the normal signal two sidebands are produced, as in all cases of modulation. One of these sidebands is inverted and the other is right side up. The inverted sideband is selected and the other is suppressed.

A scheme which might be of use is indicated in Fig. 1. First we have a microphone on which the normal signal falls. Then follows a speech amplifier which is of the same structure as the audio amplifier in a radio receiver. Following the amplifier is a low pass filter which suppresses all frequencies in the signal above a chosen value. For example, this might suppress all frequencies above 5,000 cycles and let through only those which are of lower pitch.

The output of the speech amplifier is impressed on a modulator, or detector. This corresponds to the first detector in a Super-Heterodyne. On the same modulator is impressed the output of a low frequency oscillator. For example, this may have a fixed frequency of 5,000 cycles, one sideband ranging from zero up to 5,000 cycles and one from 5,000 up to 10,000 cycles.

The sideband from 5,000 up to 10,000 cycles is right side up but it is unintelligible because 5,000 cicles have been added to every signal frequency. The sideband from zero to 5,000 cycles is inverted and is unintelligible for that reason. To prevent the upper sideband from interfering with the lower, a low pass filter is put between the output of the modulator and the loudspeaker. This filter might have a cutoff at 5,000 cycles. Thus only the inverted sideband reaches the speaker.

Numerical Example

The lower and inverted sideband in the above assumed case is 5,000—F, where F is any one frequency in the normal signal. Suppose F is 5,000 cycles, the highest note that the first low pass filter let through. This frequency will be represented in the output of the modulator, and hence in the loudspeaker, by zero. Of course that cannot be heard. Suppose F is 30 cycles, the lowest audible frequency in the signal. This is represented in the output of the modulator by 5,000 less 30, or by 4,970 cycles. Thus the high notes have become low and the low notes have become high. Since the lowest note than can be heard is about 30 cycles, the highest note which will be audibly inverted is 4,970 cycles.

The only note which is not inverted is that which has the mean frequency between zero and 5,000 cycles, that is 2,500 cycles. The frequency of the oscillator might be called the frequency of inversion. It is not at all necessary to make this 5,000 cycles. It may be 3,500 or 10,000 cycles, for example. The filters should be chosen according to the frequency of inversion. But the cutoff frequencies do not have to be the same as the inversion frequency.

Automatic Interpreter

The object of the scheme indicated in Fig. 1 is to make the signals unintelligible. If the system is to be useful there must be a device which reinverts the signal, or a device which automatically interprets the jargon. This device is simply another oscillator and another modulator just like the first. The frequency of reinversion must be the same as the frequency of inversion. If it is not, the tones in the interpreted signal will be either higher or lower than the original tones. And what is ruinous to music is that the tones would not bear the same relation to each other. This would result in dissonance.

The fact that the frequency of inversion can be varied suggests a possible way of increasing the difficulty of interpretation, or of making the transmission more secret. Suppose the frequency of the oscillator varied at definite intervals by definite and prearranged amounts. The frequency of the receiving oscillator would change at the same time and by the same amount. This would make it very difficult for any eavesdropper to find the combination. This variation might be controlled by two machines running at the same speeds. Or the variation in the inversion and reinversion frequency might be continuous and controlled by other oscillators of slow period. This would add the difficulty of synchronization to the communication.

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