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A. D. BLUMLEIN

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RADIO RECEIVER

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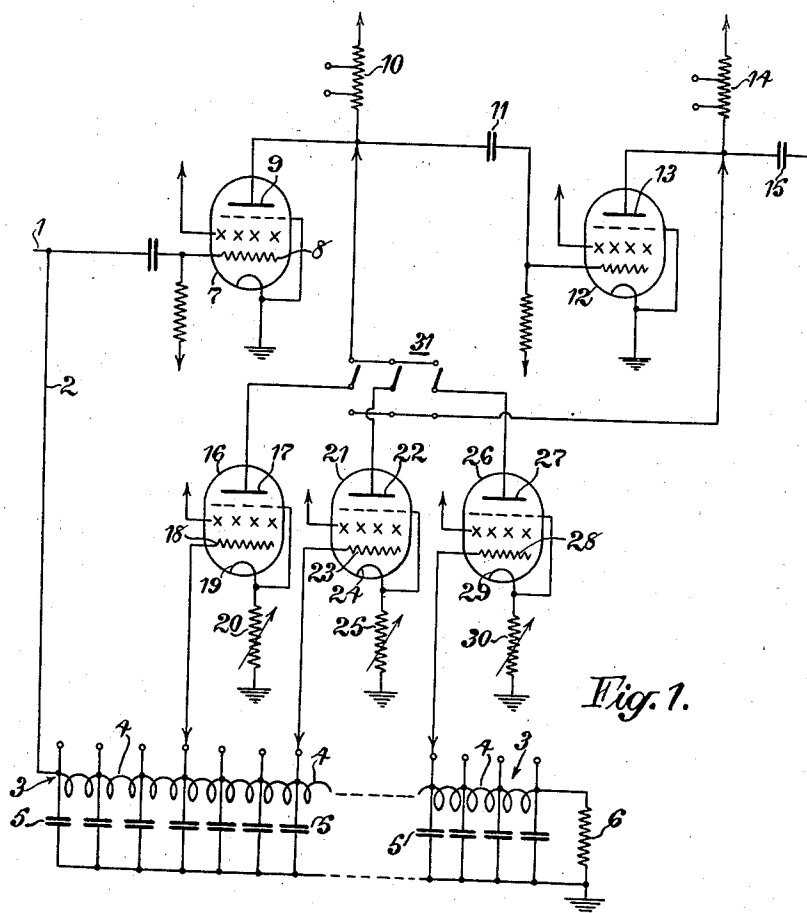


Fig. 1.

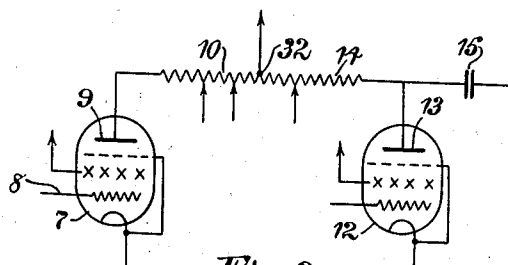


Fig. 2.

INVENTOR
ALAN DOWER BLUMLEIN
BY *H. S. S. S. S.*
ATTORNEY

UNITED STATES PATENT OFFICE

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RADIO RECEIVER

Alan Dower Blumlein, Ealing, London, England,
 assignor to Electric & Musical Industries Limited,
 Hayes, Middlesex, England, a company of
 Great Britain

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6 Claims. (Cl. 250—20)

The present invention relates to methods and apparatus for reducing distortion of electrical signals owing to the reception of multiple signals.

When receiving short wave signals, such, for example, as television or other wide band signals, trouble is often experienced due to reflection from neighbouring buildings and other such large objects of the radio waves.

For example, a direct ray may arrive at the receiving antenna at one moment and a few micro-seconds later an indirect ray reflected from an object may arrive at the antenna. The reflected ray is in general the weaker ray, but nevertheless a distorted signal is produced in the receiver. As applied to television reception such distortion normally takes the form of a second image displaced from the main image and the second image may be positive or negative depending on whether the reflected ray arrives in such a phase as to add to or subtract from the direct ray. In receiving locations close to a number of large buildings several reflected rays may be received and these are liable to cause very bad distortion.

This difficulty may be cured in a number of cases by arranging a directional receiving antenna which receives the direct ray strongly but rejects the reflected ray.

However, such an antenna is difficult to erect and is costly. In addition different receiving locations demand the use of different antenna designs for best reception and thus this remedy is not of general application.

It is an object of this invention to provide a method and apparatus for reducing or substantially annulling the effects of reflected signals, or other multiple signals.

According to the invention a method of reducing or eliminating distortion of desired signals due to the presence of undesired signals having substantially the same wave form as said desired signals but which are displaced in time relatively to said desired signals and are of substantially smaller amplitude, which comprises developing a neutralising signal having substantially the same wave form as the mixed desired and undesired signals but delayed or advanced in time and modified in relation to said mixed signals and then combining said neutralising signal with said mixed signals, said neutralising signal being such that it reduces or neutralises some or all of said undesired signals.

Apparatus for carrying the above method into effect comprising a delay path to which mixed

desired and undesired signals are adapted to be fed and means for deriving from said delay path a neutralising signal having substantially the same wave form as said desired and undesired signals but delayed or advanced in time compared with said desired signals, means for modifying the neutralising signal so as to enable it to wholly or partly neutralise said undesired signals and means for combining said neutralising signal with said desired and undesired signals.

When applying the invention for reducing the effect of reflected rays in television receivers, the correction may be carried out at either radio frequency, intermediate frequency or at modulation frequency. At radio frequency the reflected ray may arrive in any carrier phase relatively to the direct ray, so that for complete annulment the undesired ray has to be corrected for both in phase and amplitude. However, the reflected ray can only produce an increase or decrease of rectifier output so that provided the phase of the corrective signal is adjusted to annul the effect of the reflected ray, the exact phase of the correction is not of importance.

In general there are two methods of correction according to this invention. Suppose, for example, that the direct signal ray is represented by A and the effect of a reflection is to give an additional signal ray KA at the antenna. K is a factor which in general represents a time delay due to the extra path traversed by the reflected ray, and also the extra attenuation due to the reflection losses. In the case of multiple reflection the signal received at the antenna is therefore given by

$$A + K_1A + K_2A + K_3A + \dots$$

where K_1 , K_2 , etc. refer to different reflected rays. Suppose now this signal is supplied to a network, for example, an electrical time delay network, which has a number of outputs, $-K_1$, $-K_2$, $-K_3$, etc. times the input, and these outputs are mixed with the original unmodified ray, then the resultant wave will be given by

$$A + K_1A + K_2A + K_3A + \dots - K_1(A + K_1A + K_2A + K_3A + \dots) - K_2(A + K_1A + K_2A + K_3A + \dots) - K_3, \text{ etc.}$$

The first order terms in K disappear leaving only second order terms in K. If now the reflected rays are weak compared with the direct ray the factors K_1 , K_2 , etc. represent considerable attenuation, that is, their magnitude is small. The second order terms in K are therefore very small so that a considerable reduction in the effect

of the reflected rays is obtained. This may be termed the first method and is applicable to the correction of small first order effects.

As an alternative method of correction, suppose the outputs of the network are fed back into the input circuit of the network. The input is no longer

$$A + K_1A + K_2A + K_3A + \dots$$

but B, which is the result of adding the feedback wave to the original wave. Hence the feedback wave is

$$-K_1B - K_2B - K_3B - \dots$$

Therefore

$$B = A + K_1A + K_2A + K_3A + \dots - K_1B - K_2B - K_3B - \dots$$

which gives

$$B + K_1B + K_2B + K_3B + \dots = A + K_1A + K_2A + K_3A + \dots$$

or

$$B = A$$

The resultant input is thus the required direct signal ray free of the effects of reflected rays. If the reflected rays are stronger than the direct ray this method may not work due to the network involving an amplifier which may cause oscillation. In general therefore the feedback method is capable of substantially annulling the effects of the reflected rays, if the reflected rays are weaker than the direct ray. This method will be termed the second method.

The invention will now be described more in detail with reference to the accompanying drawing in which:

Figure 1 is a circuit diagram of one form of apparatus suitable for carrying out the invention according to the first method hereinbefore referred to, and

Figure 2 is a diagram of a modification of Figure 1.

In this drawing the sources of anode, screen and grid potential for the thermionic valves are not shown, the connection points to these sources being indicated by arrows.

In Figure 1 the modulation frequency output of a receiver subject to reflected ray interference is fed in at 1 and passes through lead 2 to the delay network 3, which is generally indicated as a chain of series inductances 4 and shunt condensers 5 terminated by a resistance 6. The signals are also fed to the control electrode 8 of the pentode valve 7 and are amplified therein, the output being taken across the anode resistance 10 with reversed phase or sense. The output from the valve 7 is again reversed in phase by being passed through the pentode valve 12 through condenser 11. This latter valve is arranged to have unity amplification, in other words, the output across resistance 14 in the anode circuit of valve 12 is equal in magnitude to the output from valve 7. The signals are passed through condenser 15 to the utilisation circuit, as for example, in a television receiver to the control electrode of the picture reproducing device. One or more thermionic valves 16, 21 and 26 are arranged so that their control grids 18, 23 and 28 are tapped on the delay network at suitable points and their anodes 17, 22 and 27 are connected by means of the switch 31 to the anode 9 of valve 7 or to the anode 13 of valve 12. The valves 16, 21 and 26 are preferably of the variable-mu type and each valve is

provided with a variable cathode resistance 20, 25 and 30 which provides bias for each valve and enables the gain of each to be varied individually, both by providing variable degeneration and by reason of changes in bias potential.

Suppose now that in a television receiver the picture is affected by reflected rays in addition to the direct ray. The effect produced may, for example, be a real picture due to the direct ray followed by a ghost picture, say, one microsecond later than the real picture and by a second ghost picture, say, three microseconds after the real picture. Suppose also that the first ghost picture is negative and the second is positive. Then the first valve 16 is connected on the delay network with a time delay of one microsecond from the beginning and its anode 17 is connected to the resistance 10 by means of the switch 31. The delayed signal is thus added algebraically to the main signal since the main signal and the delayed signal are equally reversed in sense by valves 7 and 16. The output of valve 16 is thus in the correct phase to neutralise the unwanted negative ghost picture. The cathode resistance 20 of valve 16 may be adjusted to effect a balance in amplitude. If only a very small signal is required to neutralise the ghost picture an inconveniently high resistance may be required in the cathode circuit of valve 16 in which case the anode of valve 16 may be connected to a tapping on resistance 10. Alternatively the control of amplitude may be effected completely by varying the tapping on resistance 10 to which the anode of valve 16 is connected.

To neutralise the three microsecond late positive ghost picture, the valve 21 is then tapped on the delay network with a three microseconds' delay from the beginning of the network and the anode 22 of the valve is connected via the switch 31 to resistance 14 so as to provide a signal in opposite phase to the second ghost picture. As before the anode 22 may if desired be connected to a tapping on resistance 14 so as to provide a very small signal if the ghost picture is very faint.

Since in the example considered there are only two ghost pictures the third valve 26 is not used, although it can be employed for eliminating a faint secondary ghost picture (assuming that the delay network is of sufficient length) due to the secondary effects produced by one of the original ghosts passing through one of the valves 16 or 21 and producing a second order term.

When an adjustment has been made so as to eliminate the ghost pictures as described above it may be found that the outline of a ghost picture is still visible. This will be due (assuming there are no errors from lack of a flat frequency response characteristic of the apparatus) to incorrect delay in the delay network with respect to the main channel, caused by miscalculating the time intervals between real and ghost pictures. Such outline errors can be corrected by suitably adjusting the tappings along the delay network.

If the sense of the ghost pictures is liable to wander, as for example, due to wandering of the transmitter frequency, the gain controls of valves 16, 21 and 26 may conveniently be ganged with the change over switches on their anodes so that a continuous motion of a single control produces all available magnitudes of correction from full positive to full negative. An alternative way of achieving this effect is by removing the gain

controls from the cathodes of the valves 16, 21 and 26 and arranging the anode resistances 10 and 14 of valves 7 and 12 as shown in Figure 2. The two resistances now form part of a potentiometer with a tapping 32 taken to the positive D. C. supply. This potentiometer has three sliders, which are capable of independent movement, taken to the anodes of valves 16, 21 and 26. With these sliders opposite the tapping 32 no correction is effected. By moving a slider to left or to right an increasing positive or negative correction can be obtained. The time delay of the reflected ray for a given location is not liable to vary so that by making the control accessible a day by day adjustment of correction can easily be made.

Although the invention has been described above as applied to the elimination or reduction of ghost effects in a television receiver, it will be understood that the invention is equally applicable to the elimination or reduction of multiple undesired signals in other forms of radio receivers.

I claim:

1. A television receiving system comprising means to supply television signals accompanied by a plurality of ghost signals, each of said plurality of ghost signals displaced in varying time intervals from said television signals, a first and a second thermionic amplifier, each of said amplifiers having an input and an output circuit, an artificial transmission line, means to supply said television and said ghost signals to both the input circuit of said first amplifier and to said artificial line, means to supply energy representative of said television and ghost signals to the

input circuit of said second amplifier, means to supply output energy from the output circuit of said second amplifier, a plurality of thermionic coupling means, each of said plurality of coupling means having an input and output circuit, connections from said transmission line to the input circuit of each of said coupling means, selective switching means connected to the output circuit of each of said coupling means and to the output circuit of said first and second amplifier.

2. A receiving system as claimed in claim 1 and wherein said means to supply energy representative of said television and ghost signals to the input circuit of said second amplifier comprises a connection from the output circuit of said first amplifier to the input circuit of said second amplifier.

3. A receiving system as claimed in claim 1 wherein the output circuit of said first and said second amplifier includes a potentiometer.

4. A receiving system as claimed in claim 1 wherein the output circuit of said first and said second amplifier includes a common potentiometer.

5. A receiving system as claimed in claim 1 wherein each of said coupling means includes means to regulate the amplitude of energy transferred from said artificial line to the output circuit of said first and said second amplifier.

6. A receiving system as claimed in claim 1 wherein said artificial transmission line comprises a plurality of low pass filter sections connected in cascade and terminated by a passive resistance.

ALAN DOWER BLUMLEIN.