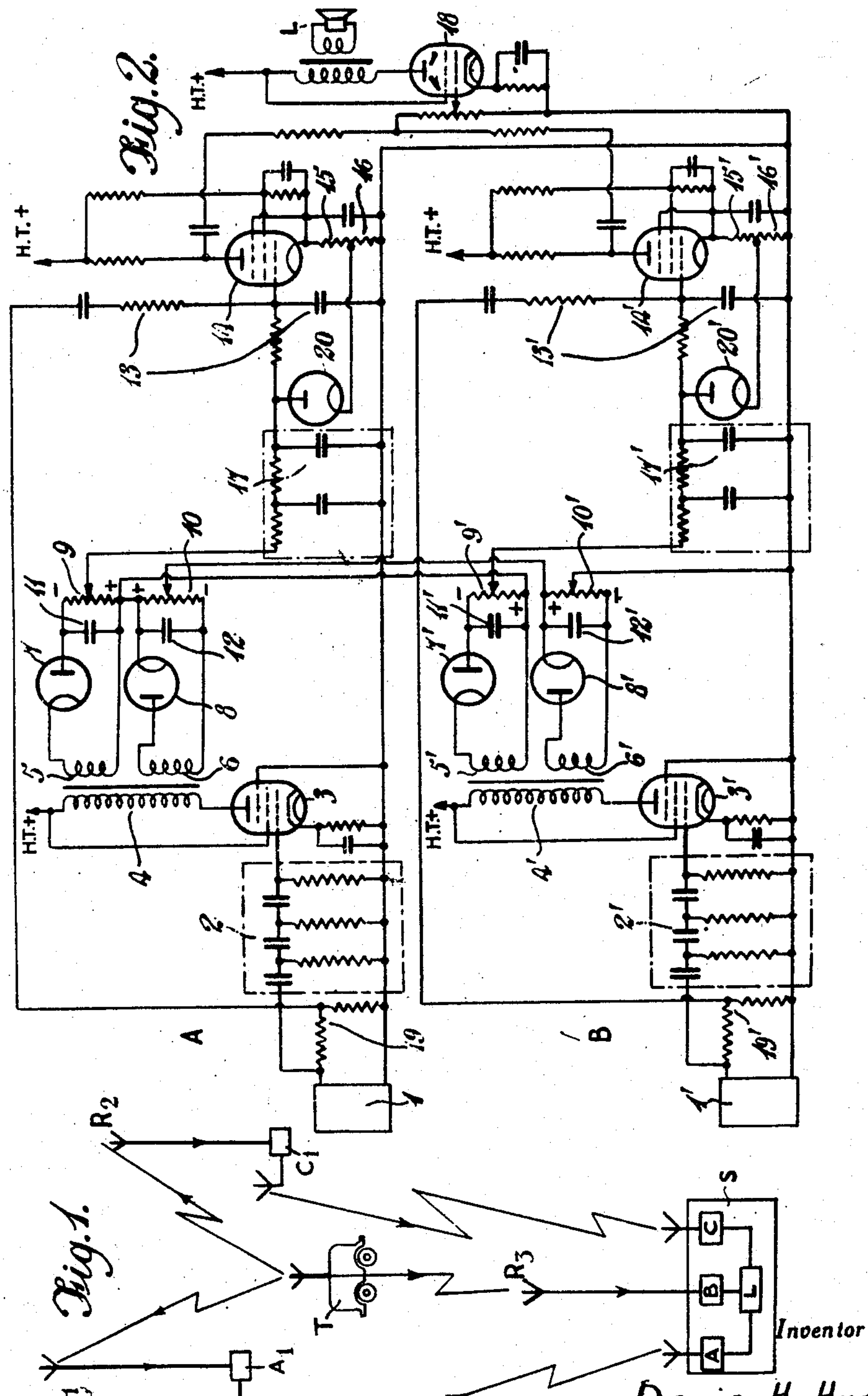
Nov. 15, 1949 D. H. HUGHES 2,488,193

RADIO COMMUNICATION SYSTEM

Filed July 26, 1947



Inventor

Denis H. Hughes

By: Emery, Holcombe & Blair

Attorneys

Patented Nov. 15, 1949

2,488,193

UNITED STATES PATENT OFFICE

2,488,193

RADIO COMMUNICATION SYSTEM

Denis Hawxby Hughes, Cambridge, England, assignor to Pye Limited, Cambridge, England, a British company

Application July 26, 1947, Serial No. 763,939
In Great Britain May 13, 1946

5 Claims. (Cl. 250—20)

1

The present invention relates to radio communication systems of the kind in which a transmitted signal is intended to be received by two or more receivers, the outputs of which operate a common reproducer. Such communication systems may, for example, be used where the transmitter is mobile, in which case a number of receiving stations may be provided which are so spaced as to cover the area within which the mobile transmitter moves, the signal transmitted by the mobile station being received by one or more of the receiving stations, the outputs from which are fed by radio or other links to a main control station where all the received signals are reproduced on a common producer. With such systems, it can happen that the transmitted signal is not received or is only received with low strength by one or more of the receiving stations, in which case such receivers (which operate with automatic volume control) will contribute noise to the output from the common reproducer without contributing any substantial signal and will thus tend to reduce the overall signal-to-noise ratio in the signal reproduced by the common reproducer.

The present invention has for its object to overcome this disadvantage and to provide a system in which the signal-to-noise ratio in the common reproducer is improved.

To this end, the invention consists in controlling the output of each receiver which is fed to the common reproducer inversely in dependence upon the noise in that receiver relative to a function of the aggregate of the noise in the other receivers or to a function of the approximate average noise in all the receivers.

In order that the invention may be more clearly understood, reference will now be made, by way of example, to the accompanying drawings in which:

Fig. 1 shows diagrammatically a communication system of the type to which the invention applies;

Fig. 2 shows a circuit diagram of two receiver channels feeding a common reproducer and operating in accordance with this invention.

Referring to Fig. 1, the signals transmitted by the mobile transmitter T are received by the receiving antennae R1, R2, R3 respectively. The receiving station R3 is shown located adjacent the main control station, so that the signals picked up by the station R3 are directly fed to its associated receiver B. Stations R1 and R2, however, are located remote from the main control station S so that the signals picked up thereby

2

and received by the local receivers A1, C1 are re-transmitted via radio links to corresponding receivers A and C, located in the main control station S. The outputs from the three receivers A, B and C in the main control station are fed to the common reproducing device L.

Whilst the receiving station R3 is shown located adjacent the main control station, it will be understood that the main control station may be remote from all the receiving stations, in which case the signals received by R3 would also be re-transmitted by a radio link to the main control station.

The three receiving stations R1, R2 and R3 are spacially separated in such a manner as to cover the entire area within which the mobile transmitted T is intended to operate, more or less receiving stations being provided depending upon the area to be covered. It will be understood, especially where the mobile transmitter T may move over a relatively large area, that the intensity of the signals received by any one of the receiving stations will depend upon its distance from the mobile transmitter, and the automatic volume control circuits of the individual receivers will operate to increase the gain of the more remote receivers. Thus, a remote receiving station will produce noise in the common reproducer L without contributing any significant amount of signal intelligence.

According to the present invention, the output from each of the receivers A, B and C fed to the common reproducer L is controlled inversely in dependence upon the noise in that receiver relative to the noise in the other or all the receivers.

Fig. 2 shows a receiver circuit diagram for a system with two receiver channels A and B which operates in accordance with this principle. The diagram only shows two channels but it will be clear from the following explanation how the automatic control connections between the various channels may be extended to any number of receiver channels.

Circuit components in channel B, which correspond with the same components in channel A, are indicated by the same reference numerals as are used for channel A but suffixed with a dash.

As shown in Fig. 2, a portion of the output from the detector or audio-frequency amplifier stage 1 of each receiver channel is fed to the grid of an audio-frequency amplifier valve 14 for amplifying the signal intelligence, the connection preferably being made through a low-pass network 13 to eliminate the H. F. noise components. A potential divider 19 may be provided for stepping down the voltage fed to the valve 14. The valve 14 is biassed for less than maximum gain by the resistors 15, 16 connected in its cathode circuit.

Another portion of the output from the receiver 1 is fed through a high-pass network 2, which transmits the noise components of frequencies higher than the required intelligence band but does not pass a significant amount of signal intelligence, to an amplifying valve 3.

In the anode circuit of the valve 3 is connected a transformer 4 having two secondary windings 5 and 6. The voltages developed across the secondary windings 5 and 6 are rectified by the diodes 7 and 8 respectively and the rectified voltages are developed across load resistors 9 and 10, shown as potentiometers. These D. C. voltages are proportional to the noise content of the signal in the associated receiver channel. All A. C. components are substantially eliminated from the outputs across each load resistor 9, 10, by the shunt capacities 11 and 12 respectively, or other filters.

The ratio between the two D. C. voltages taken off from the load resistors 9 and 10 is adjusted to correspond approximately to the number of channels in the system, either by appropriate adjustment of the ratio of the two secondary windings 5 and 6 or by adjustment of the position of the tapping points on the potentiometers, or by a combination of both of these means. Thus, in the case of two channels, as shown in the drawing, the voltage taken from the load resistor 9 (high potential secondary circuit) is normally adjusted to be approximately twice that taken from the load resistor 10 (low potential secondary circuit).

In a similar manner, in the case of the second channel B, D. C. voltages proportional to the noise content of the signal from the receiver B are developed across the potentiometers 9' and 10'. The D. C. voltages taken from the load resistors 10, 10' in the low potential secondary circuits are additively connected in series and the extreme negative end of the chain, namely the tapping point on the resistor 10' in the particular circuit shown, is connected to a point of zero audio-frequency potential, such as to the source of the standing negative bias for the low frequency amplifying stages carrying the intelligence. The extreme positive end of this chain of resistors in the low potential secondary circuits is connected to the positive end of each of the load resistors 9, 9' in the high potential secondary circuits. The negative end (tapping point) of each of the load resistors 9, 9' in the high potential secondary circuits is connected through a decoupling network 17 to the grid of the corresponding amplifier valve 14, 14' for the signal intelligence associated with the same channel of the system.

If it be assumed that the D. C. voltage taken from across the load resistor 9 in channel A is Va and the voltage taken from across the load resistor 9' in channel B is Vb, then, since the voltages taken across the low potential secondary circuits are, as explained above, approximately that proportion of the voltages developed in the high potential secondary circuits which corresponds to the number of channels in the system the voltages taken from the load resistors 10, 10' in the case of the two-channel system under consideration will be

$$\frac{Va}{2} \text{ and } \frac{Vb}{2}$$

respectively.

Since, in view of the circuit connections betwen the potentiometers above described, the voltage obtained from potentiometer 9 is negative and acts in opposition to the aggregate of the positive voltages derived from the potentiometers 10, 10', the resultant bias applied to the grid of the valve 14 will be:

$$-Va+\frac{Va}{2}+\frac{Vb}{2}=\frac{1}{2}(Vb-Va)$$

Similarly in the case of channel B, the bias voltage applied to the grid of the valve 14' will be $\frac{1}{2}(Va-Vb)$.

More generally, for a larger number of channels n, the voltage applied to the grid will be given by the expression;

$$-Va+\frac{1}{n}(Va+Vb\ .\ .\ .\ +Vn) \qquad (1)$$

or, alternatively, by the expression:

$$\frac{1}{n}(Vb+Vc\ .\ .\ .\ +Vn-(n-1)Va) \qquad (2)$$

From Expression 1 it will be seen that the applied bias voltage varies inversely as a function of the noise in the channel concerned relative to the average noise in all the receivers. From Expression 2 it will be seen that the bias voltage also varies inversely as a function of the noise in the receiver channel concerned relative to a function of the aggregate of the noise in the other receivers.

The D. C. voltages taken from the resistors 9, 9' are fed through decoupling networks 17, 17' to bias the grids of the signal intelligence amplifier valves 14, 14' respectively. The biassing voltages will vary in accordance with the above expressions, from which it will be seen that, in the case of channel A, when the noise contents of the two channels are equal, the gain control biassing voltage applied to valve 14 will be zero. When the noise in channel A is more than that in channel B, the resultant bias will be negative and the gain of the amplifier 14 will be reduced. Conversely, when the noise in channel A is less than that in channel B, the resultant bias will be positive and the gain of valve 14 will be increased.

Similarly in the case of channel B, the gain of amplifier 14' will be increased when the noise in channel B is less than that in channel A and will be decreased when the noise in channel B is greater than that in channel A.

The outputs from the two amplifiers 14, 14' are mixed in the mixing amplifier 18 and fed to the common reproducing device L. The final output signal is substantially constant since, when the gain of amplifier 14 is increased, that of 14' is decreased and vice versa.

In order to prevent excessive positive voltage being applied to the grid of the amplifier valve 14, a diode 20 may be provided with its anode connected to the control grid of the valve and its cathode to the junction of the cathode resistors 15 and 16, which point is negative to the potential of the cathode, so that the negative bias on the grid relative to the cathode is never less than that which permits maximum amplification from the amplifier stage.

It will be seen that, with the circuit described, the contribution of each channel of the system to the output from the reproducer L is dependent upon the gain of its own audio frequency amplifier 14, which is in turn controlled by a voltage inversely proportional to the difference between the approximate average of the noise components in all the channels on the one hand and the noise components in the particular channel concerned on the other hand, the gain being increased when this difference is positive and reduced when the difference is negative.

Although a particular embodiment has been described, it will be understood that various modifications may be made without departing from the scope of the invention as defined by the appended claims.

I claim:

1. Radio communication system comprising at least two receivers, a common reproducer fed from the outputs of said receivers, means for controlling the gain of each of the receivers, means for deriving in each receiver two D. C. voltages each proportional to the noise content of the signal received by that receiver, the ratio between the two D. C. voltages being approximately equal to the number of receivers in the system, means for producing a D. C. voltage corresponding to the summation of the lower D. C. voltages produced in each receiver, means for combining this summation voltage in opposite sign with the greater D. C. voltage produced in the said receiver, and means for applying this combined voltage to control the gain of the said receiver.

2. Radio communication system as claimed in claim 1, wherein each receiver comprises a high-pass filter which transmits the noise components of frequencies higher than the frequency intelligence band but does not pass a significant amount of signal intelligence, an amplifying valve, means for feeding the signal received by a receiver through the high-pass filter to the amplifying valve, a transformer having two secondary circuit windings and fed by the output from said amplifying valve, two rectifiers connected respectively with each of said secondary windings, load resistors connected respectively across the outputs of said rectifiers, and output circuit connections to said load resistors such that the two D. C. voltages in said circuit output connections have a

ratio which is approximately proportional to the number of receivers in the system.

3. System as claimed in claim 2, wherein the load resistors of each of the receivers across which the lower D. C. voltages are derived are connected in series, the extreme positive end of the chain being connected to the positive end of each of the load resistors in each of the receivers across which the higher D. C. voltages are derived, the connections to the negative ends of the load resistors across which the higher D. C. voltages are derived being connected to bias an amplifying valve in the signal amplifying channel of corresponding receiver.

4. System as claimed in claim 2, wherein the ratio between the secondary windings is approximately proportional to the number of receivers in the system.

5. System as claimed in claim 2, wherein the load resistors comprise potentiometers, the tapping points on which are adjusted so that voltages derived from the two potentiometers are approximately proportional to the number of receivers in the system.

DENIS HAWXBY HUGHES.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,098,286	Garfield	Nov. 9, 1937
2,249,425	Hansell	July 15, 1941
2,253,867	Peterson	Aug. 26, 1941
2,290,992	Peterson	July 28, 1942
2,303,493	Purrington	Dec. 1, 1942
2,358,448	Earp	Sept. 19, 1944
2,379,799	Haigis	July 3, 1945
2,384,456	Davey	Sept. 11, 1945
2,397,830	Bailey	Apr. 2, 1946