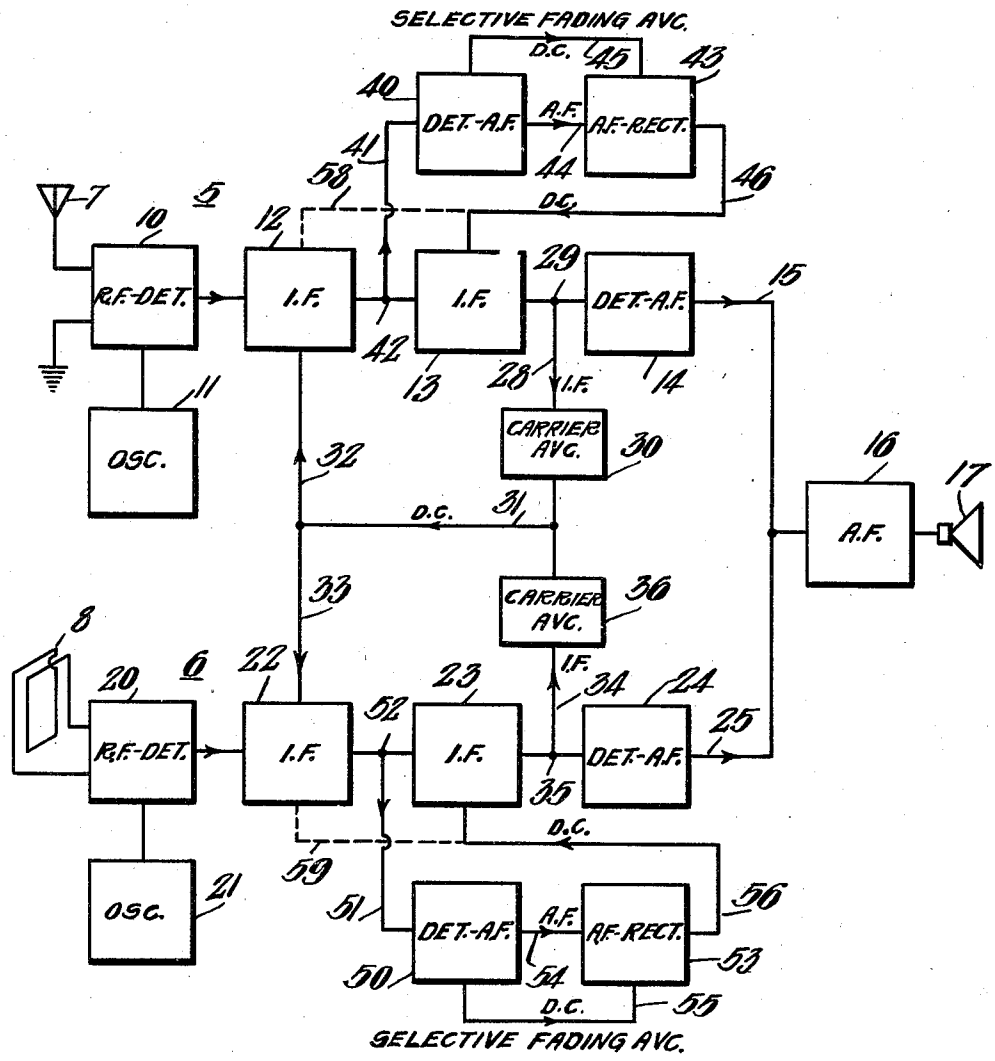
Dec. 22, 1942. G. L. BEERS 2,305,917

DIVERSITY RECEIVING SYSTEM

Filed Aug. 30, 1941



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Patented Dec. 22, 1942 2,305,917

UNITED STATES PATENT OFFICE

2,305,917

DIVERSITY RECEIVING SYSTEM

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Application August 30, 1941, Serial No. 408,987

6 Claims. (Cl. 250—20)

This invention relates to diversity receiving systems, and has for its primary object to provide an improved diversity receiving system which operates to minimize the effects of selective fading to a greater degree than has heretofore been possible.

It is known that at a given location, when receiving the same signal or broadcast station with two receivers, selective fading seldom, if ever, occurs simultaneously on both receivers, if one receiver employs a loop antenna and the other employs a conventional antenna wire of any suitable type. This is also true when two loops are used which are placed so that their planes are at a right angle to each other.

With such an arrangement, the receiver which at any instant is receiving the weaker of two signals may not necessarily be the one in which the selective fading occurs. Therefore, the conventional diversity receiver arrangement is not satisfactory because the stronger and possibly fading signal predominates in controlling the gain of the system. Thus, the operation of the other receiver or receivers is not independent of the control provided by the signal which may have the selective fading.

It is therefore a further object of this invention to provide an improved diversity receiving system which eliminates or minimizes the effects of selective fading without interfering with the operation of one or more signal receiving channels or receivers in the system which at the time are not subject to selective fading conditions.

More particularly, it is an object of this invention to provide selective fading automatic volume control (hereinafter abbreviated to AVC) means combined with carrier wave AVC means in a multiple channel or diversity receiving arrangement which operates as a normal diversity AVC system when selective fading is absent, but in the presence of selective fading in any one of the receiving channels, the selective fading signal is cut off or prevented from reaching the output circuits, while the other receiving channel or channels are permitted to function normally.

The invention will, however, be further understood from the following description, when considered in conjunction with the accompanying drawing, and its scope is pointed out in the appended claims.

Referring to the drawing, the figure is a schematic circuit diagram in block form, of a radio signal receiving system of the diversity or multiple channel type, provided with selective fading control means embodying the invention.

In the system shown, two signal receiving channels 5 and 6 are shown, although the invention is not limited to the use of two channels, and likewise two differing types of antenna or signal collecting means 7 and 8 are shown in connection with channels 5 and 6, respectively, although any suitable diversity receiving antenna means may be utilized.

In the present example, the signal collecting means 7 indicates a wire or conventional antenna while the antenna means 8 is a loop antenna.

The channel 5 includes, by way of example, suitable radio frequency amplifier and detector circuits indicated at 10 and a suitable heterodyne oscillator 11 tunable through any suitable wave band and providing a predetermined intermediate frequency which is applied to an intermediate frequency amplifier 12. This is followed by a second intermediate frequency amplifier 13 and an audio frequency detector and amplifier 14 having an output connection indicated at 15 for the final audio frequency signal. This is applied to an audio frequency amplifier 16 and a loudspeaker or other output device 17.

The second diversity receiving channel or receiver 6 is similarly constituted and includes a R.-F. amplifier and detector 20 and an oscillator 21, tunable through the same signal receiving band or to the same broadcast stations as the first channel. The first detector is followed by a first intermediate frequency amplifier 22 which is coupled to a second intermediate frequency amplifier 23 which is followed by the audio frequency detector and audio frequency amplifier 24.

The two receivers or receiving channels 5 and 6 are connected in parallel at the output ends through the common amplifier 16 and loudspeaker 17, and for this purpose the output circuit 25 of the channel 6 is connected in parallel with the output circuit 15 as indicated.

The receivers or signal receiving channels described, represent any suitable receiver arrangement providing a plurality of diversity receiving channels having a common output means, and are provided with a conventional carrier AVC arrangement comprising a carrier AVC circuit 28 connected at a point 29 in the channel 5 preceding the audio frequency detector and following the second intermediate frequency amplifier. The carrier AVC means is indicated at 30 and provides a D.-C. or negative bias potential control connection 31 with a branch circuit 32—33

for the two first intermediate frequency amplifiers 12 and 22 of the two channels or receivers 5 and 6, respectively.

The channel 6 likewise is provided with a carrier AVC connection 34 connected at a point 35 preceding the audio frequency detector 24 in the receiving channel, and preferably following the second intermediate frequency amplifier 23. The carrier AVC means for channel 6 is indicated at 36 and is provided with the same D.-C. output connection 31 as the carrier AVC means 30 for the channel 5, whereby the two AVC means operate in parallel to control the gain in both channels in parallel.

Thus, signals from both channels 5 and 6 are applied to the normal AVC means 30 and 36. If the signal or carrier wave from channel 5 is stronger than that received by the channel 6 then the AVC potential developed in the branch 30 of the carrier AVC system reduces the sensitivity of both amplifiers 12 and 22 to the same level. However, if the signal or carrier wave form channel 6 is stronger, the sensitivity of both intermediate frequency amplifiers 12 and 22 is likewise reduced in accordance with the signal strength in channel 6. Therefore, regardless of which channel receives the stronger signal, the sensitivity of both amplifiers 12 and 22 is reduced to correspond to, or in accordance with, the stronger signal being received by either of the channels.

As hereinbefore pointed out, this is not sufficient to provide effective control for minimizing selective fading effects for the reason that the selective fading may occur in the channel receiving the stronger of the two signals. Accordingly, additional selective fading AVC means is provided in connection with each channel and so related to the carrier AVC means that the operation of the two means is complementary in the presence of selective fading in either channel, without disturbing the operation of the system in the other channel, and whereby the system is made more effective as a diversity receiving means with minimum disturbance from selective fading.

In the present example, the selective fading AVC means for channel 5 comprises a detector and audio frequency amplifier indicated at 40, having an intermediate-frequency signal input connection 41 with a point 42 on the main channel of receiver 5 preferably following the carrier AVC controlled intermediate frequency amplifier 12 and preceding the second intermediate frequency amplifier 13 which is placed under control, that is, as to gain, of the selective feeding AVC means. The selective fading AVC means further includes an audio frequency rectifier and circuit indicated at 43 which is connected with the output circuit 44 of the detector means 40 which may also include an audio frequency amplifier. It is also connected, as indicated at 45, with the detector 40 to receive the D.-C. component of the rectified intermediate frequency signal. The resulting selective fading AVC biasing potential derived from the rectifier 43 is applied through a connection 46 to the intermediate frequency amplifier 13 to control the gain therein.

The D.-C. component of the rectified intermediate frequency signal supplied through the connection 45 provides a measure of carrier amplitude to determine when selective fading occurs. As soon as the peak audio frequency potential applied to the connection 44 exceeds the D.-C. component in the circuit 45, a negative D.-C. biasing potential is produced at the output circuit 46. This resulting D.-C. biasing potential, through the connection 46, is of a magnitude to cause the intermediate frequency amplifier 13 to be cut off so that no signal reaches the detector 14 and the output circuit 15. Thus, the channel 5 is cut off whenever the percentage modulation exceeds 100%, as in the case of selective fading.

Any suitable means may be provided to supply a selective fading control potential. Such means may function through the rectification of both the carrier component and the modulation component of the received signal. For example, such arrangements may be provided as shown in Beers U. S. Patents 2,236,497 and 2,059,081 and other prior art.

The channel or receiver 6 is provided with a similar selective fading AVC means, comprising a detector and audio frequency amplifier indicated at 50, having an input connection 51 with the intermediate frequency circuit at the point 52 which is at the output of the I.-F. amplifier 22 and preceding the amplifier 23. The audio frequency and D.-C. components of the received intermediate frequency signal are applied to combining and rectifying means 53 through connections 54 and 55, respectively. The combined output or biasing potential for the amplifier 23 is taken through a connection indicated at 56, and the operation in response to selective fading is the same as described for the channel 5.

The combined effect of the two-channel control in cooperation with the carrier AVC means is as follows: Assuming that signals are being received on both channels 5 and 6 from the same broadcast station and that selective fading does not occur on either channel, in this case, the selective fading or percentage modulation AVC means 40—43 and 50—53 do not produce a control voltage and the amplification of the amplifiers 13 and 23 controlled thereby is not affected. However, signals from both channels 5 and 6 are applied to the normal or carrier AVC means 30 and 36, and as hereinafter pointed out, the gain in both channels is reduced to the same value by the stronger of the two signals being received. The system thus operates as a normal diversity receiving system, the common signal being amplified in both channels and applied to the common output means 16 and 17.

Assuming that the selective fading occurs in connection with the signal applied to the channel 5, the percentage modulation of the signal impressed upon this channel is in excess of 100%. Accordingly, the D.-C. and signal potential relationship in the selective fading AVC means 40—43 becomes such that a cutoff negative control potential is applied to the I.-F. amplifier 13, thus preventing the signal in the channel 5 from reaching the carrier AVC means 30, and the detector 14 and the output circuit 15. Thus the carrier AVC means 30 is prevented from controlling the gain in the system which is then controlled wholly by the carrier AVC means 36 with potential resulting from the clear signal being received through channel 6. Both amplifiers 12 and 22 are controlled wholly by the signal through the channel 6, while the channel 5 is cut off.

Thus, the selective fading AVC means 40—43, operating in conjunction with the carrier AVC 36, renders the amplifier 12 and the channel 5 output inoperative to produce signals and from

affecting the operation of the channel 6. This is true, although the selective fading signal in the channel 5 is stronger than the signal without selective fading which is being received by the channel 6.

In case the selective fading signal in the channel 5 tends to cause the amplifier 12 to overload, assuming that it is stronger than the signal in channel 6, the amplifier 12 may also be connected with the selective fading AVC means along with the amplifier 13, as indicated by the dotted connection 58.

This AVC system operates only when a control potential is derived from the selective fading AVC output connection 46, and as soon as the selective fading in the channel 5 terminates, the carrier AVC means 30 assumes joint control with the carrier AVC means 36.

If the selective fading occurs in connection with the signal being received by the channel 6 and the channel 5 receives a normal signal, the same selective fading AVC action occurs in the channel 6 whereby the signal output of the carrier AVC 36 is cut off by the application of a biasing potential to the amplifier 23 through the output connection 56 from the selective fading AVC means. Likewise, since the I.-F. amplifier 23 is cut off, the detector 24 and the output circuit 25 receive no output signal. Hence, the selective fading signal is prevented from reaching the common output means 16—17.

The amplifier 22 may likewise be controlled in parallel with the amplifier 23, as indicated by the dotted connection 59, if it tends to overload in the presence of strong signals through the channel 6, which exceed in amplitude the desired signal through the channel 5.

Thus, it will be seen that a diversity receiving system in accordance with the invention, includes at least two signal receivers or signal amplifying channels having suitable signal collecting means for diversity reception, and a common output circuit provided with both a carrier AVC system which functions to reduce the gain in both or all channels to a common level in response to the strongest signal being received in any channel, and that when selective fading occurs in any channel that channel is rendered inoperative in so far as output signals are concerned, and its normal carrier AVC means is prevented from controlling the remainder of the system, whereby the other clear channel or channels operate without interruption and in a normal manner.

I claim as my invention:

1. In a diversity signal receiving system, the combination with two signal receiving systems having a common output circuit, automatic volume control means for each of said receiving systems interconnected to control jointly the gain in each of said systems, selective fading automatic volume control means connected to derive controlling signals and to control the gain in each of said receiving systems preceding the automatic volume control means therein for preventing the signals through each receiving system from reaching the common output circuit and the automatic volume control means therein.

2. In a diversity signal receiving system comprising a plurality of signal amplifying channels having a parallel output connection, the combination with automatic volume control means for each of said channels, of means for effecting joint control of the gain in each of said channels in response to operation of the automatic volume control means in either channel, and selective fading control means in each of said channels responsive to the carrier wave and modulation components of a received signal preceding said automatic volume control means for preventing the application of signals to the automatic volume control means and signal output from either channel in response to signals having a predetermined high percentage modulation.

3. In a diversity receiving system, a plurality of receivers each comprising signal amplifying means having a common output circuit, automatic volume control means responsive to variations in the strength of a received carrier wave in each of said receivers connected for controlling the gain of said amplifying means jointly so that the gain of each receiver is controlled by the receiver having the highest input level, and selective fading control means in each of said receivers responsive to a predetermined percentage modulation for deriving controlling signals and controlling the gain of said amplifying means preceding the automatic volume control means.

4. A diversity receiving system comprising, in combination, two signal receiving and amplifying channels having common output means, each of said channels including an amplifying portion followed by an audio frequency detector, automatic volume control means connected with each of said channels at a point preceding the detector and following the amplifying portions for controlling the gain of said amplifying portions of both channels jointly, selective fading control means preceding the automatic volume control means in connection with each channel for deriving a controlling potential responsive to signals having a percentage modulation above a predetermined value, means responsive to said potential for cutting off the signal flow to said automatic volume control means and to the audio frequency detector in each channel, whereby the automatic volume control of said diversity receiving system is responsive to the carrier wave amplitude of the channel which is free of selective fading.

5. A diversity receiving system comprising in combination, two signal receiving channels having a common output circuit and each including first and second signal amplifiers connected in cascade, automatic volume control means responsive to carrier wave variations coupled with each of said amplifying channels at a point following the second amplifier therein and having a common output control connection with the first signal amplifier in each of said channels, selective fading control means coupled with each of said amplifying channels between the first and second amplifiers, each selective fading control means having an output circuit connected with the second amplifier in the channel with which it is coupled, the said selective fading control means in each channel being responsive to signals having a percentage modulation above a predetermined value for cutting off the signal flow through the second amplifier therein and the signal output therefrom, and for preventing the operation of the carrier wave automatic volume control means connected therewith.

6. A diversity signal receiving system comprising, in combination, two signal amplifying and detecting channels having a common output means, and each having a first signal am-

plifying portion and a second signal amplifying portion in cascade, automatic volume control means responsive to the signal output of the second amplifying portion in each channel for jointly controlling the gain of the first signal amplifying portions in both channels, and selective fading control means connected with the output of the first signal amplifying portion in each channel for controlling the gain in the second signal amplifying portion of each channel to provide signal cut-off therethrough in response to signals having a predetermined high percentage modulation.

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