

March 19, 1946.

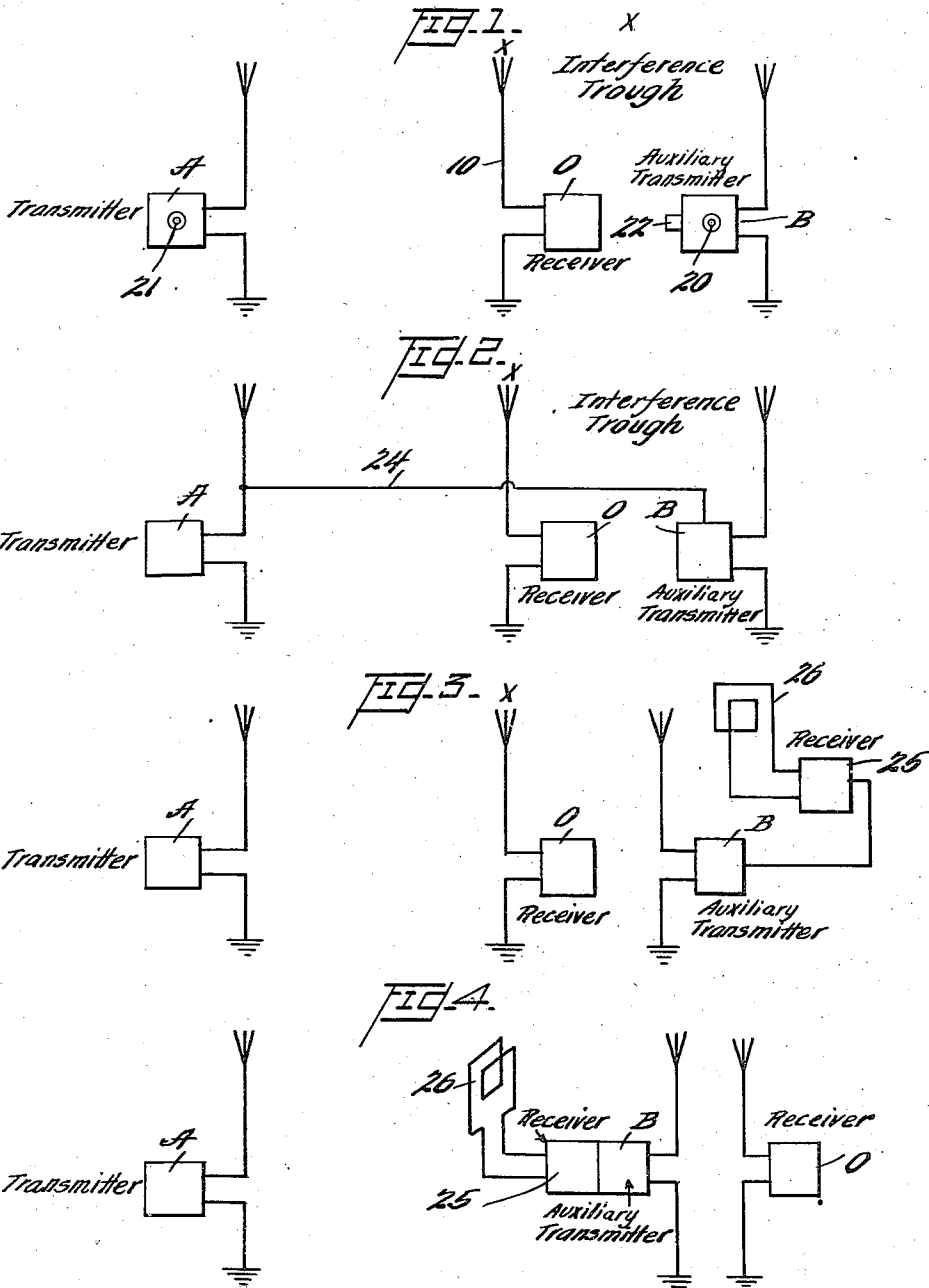
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2,396,883

RADIO RECEIVING AND TRANSMITTING SYSTEM

Filed Aug. 22, 1941

2 Sheets-Sheet 1



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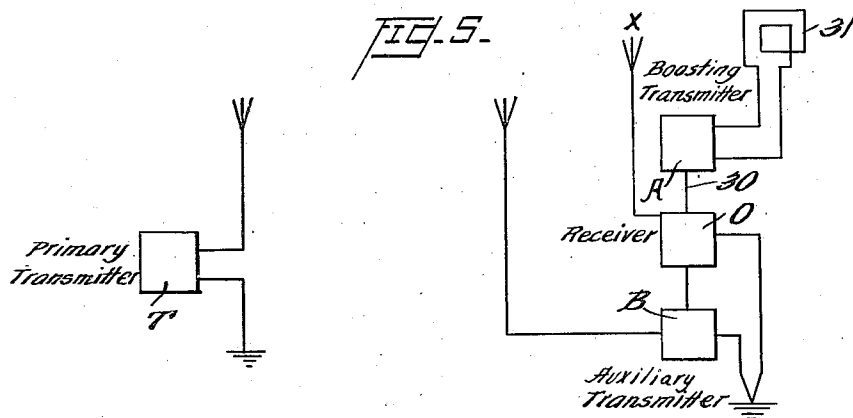
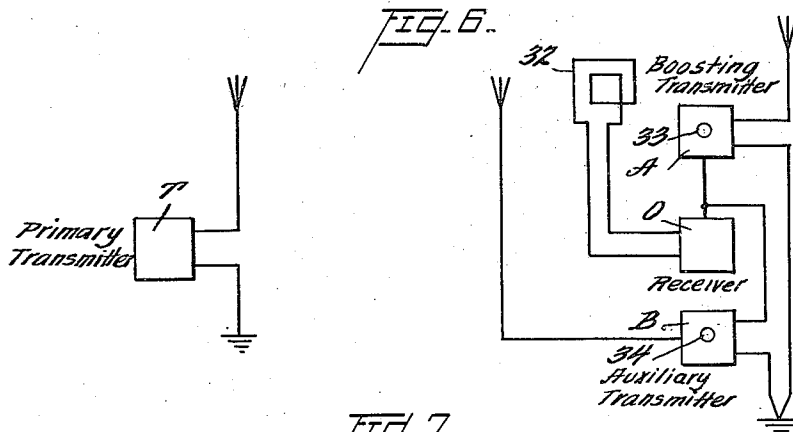
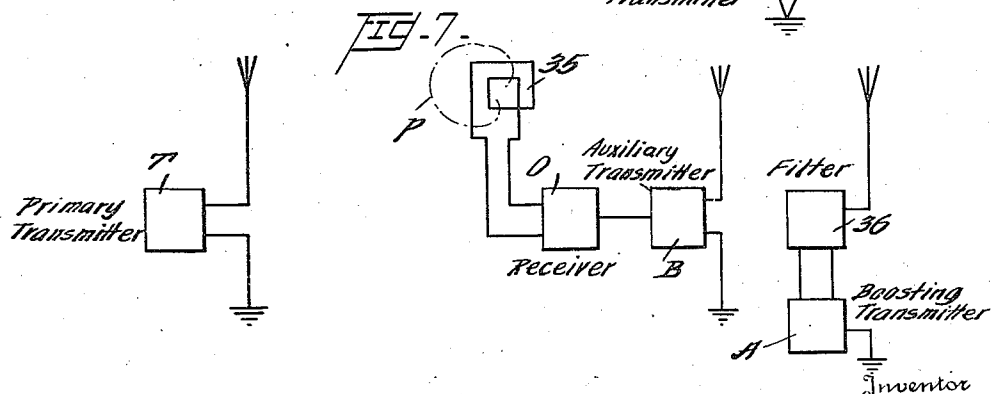
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RADIO RECEIVING AND TRANSMITTING SYSTEM

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RADIO RECEIVING AND TRANSMITTING SYSTEM

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10 Claims. (Cl. 250-6)

This invention relates to radio receiving and transmitting systems. It is often required to employ a receiver at a place where the field strength of a given transmission, such as that of a local transmitter, interferes with the wanted reception of another transmission. This interference is particularly difficult to overcome in cases where the transmissions are on the same or adjacent frequencies or where the field of the first or unwanted transmission (hereinafter called the "strong field") is considerably stronger than that of the other, wanted, transmission. The chief object of the invention is to obviate this form of interference.

The invention comprises a radio receiving system in which an auxiliary transmitter or radiator operating at the same frequency as that producing the strong field is employed to provide therewith an interference pattern and in which the receiver, having regard to the form of collector used, is so located with respect to the interference pattern as to be free or substantially free of interference from these transmissions. There may be one or a plurality of transmitters producing the strong field and one or a plurality of auxiliary transmitters or radiators may be employed to produce the required interference pattern for obtaining the conditions necessary for the receiver to be operated.

According to a further feature of the invention the collector for the receiver has directional characteristics for decreasing still further the effective response which is obtained from the strong field and from the auxiliary transmitter.

A further feature of the invention consists in that the transmission from the auxiliary transmitter or radiator is polarised differently from the strong field and the receiver discriminates between the transmissions according to the difference in polarisation so as to enable yet a further decrease in the effective response from the strong field and from the auxiliary transmitter to be obtained.

If wave transmissions of identical frequency are delivered from two or more points spaced apart an interference pattern is obtained in which the strength of the combined fields varies from place to place to form troughs at places of minimum or zero value and crests at places of maximum value. The precise positions of these troughs and crests depend on the relative phase and path distances of the transmissions. Only some of the troughs have the combined field strength substantially zero and the positions of

these troughs depend on the relative phase and strengths of the transmissions and the attenuation resulting from the path distances.

A further feature of the invention consists in that the collector for the receiver is directional for a wanted transmission so that, depending on the location of the receiver with respect to the strong field, the advantage of directional reception is combined with that obtained by the use of the interference pattern for reducing the interference produced by the strong field.

The type of collector employed depends on the position of the collector. In one manner of carrying out the invention the collector for the receiver is placed at a position corresponding to a point of the interference pattern in which the total field strength is a minimum or at sufficiently low value to enable a wanted transmission to be received. Thus, the collector may consist of an open or vertical aerial situated at a trough of the interference pattern. In another case the collector comprises two open or vertical aerials spaced apart at opposite sides of a trough and connected in parallel or at opposite sides of a crest of the interference pattern and connected in opposition, which collector is rotatable about an axis midway between the aerials. The response of the receiver to the combined field is maintained low when such a collector is rotated through an appreciable angle if the field strengths are of the same order at the collector and there is therefore the advantage that the collector may be positioned favourably for reception of a wanted transmission. There may be more than two aerials, if so desired, or any two such aerials may be replaced by a frame or like aerial which for a crest may consist of a simple frame or loop. A simple frame or loop aerial may thus be employed at a crest of the interference pattern. In another form the collector consists of a frame or loop aerial and a vertical or open aerial connected together to combine the collected signals without substantial relative phase change to produce a zero response at any part in the stationary field by adjustment of the relative values of signals collected from the aerials.

The receiver may be situated at any position with respect to the auxiliary transmitter, having regard to the interference pattern produced by this transmitter and the strong field. It may be convenient for example to position the receiver between and in line with the transmitter producing the strong field and the auxiliary transmitter. In another arrangement the receiver is positioned substantially in line with the auxiliary

transmitter and the transmitter producing the strong field and at that side of the auxiliary transmitter remote from the transmitter producing the strong field, the collector of this receiver being uni-directional with a minimum response in the direction of the two transmitters. Thus, this receiver provides a maximum response for wanted transmissions arriving from other directions.

One application of the invention is to the general purpose of receiving wanted transmissions in the strong field of another transmitter working on the same or an adjacent frequency. Another application of the invention is to a transmitting system in which the transmission from one station is boosted or relayed by another station remote from the first and transmitting the same waves. In such a system in which at the second station the signals from the first station are received and re-transmitted it is necessary to reduce or eliminate pick-up by the receiver of the signals radiated from the boosting station in order to prevent instability.

The invention therefore further comprises a radio boosting or relay system comprising the combination of a boosting or relay transmitter and a radio receiving system as aforesaid, in which the auxiliary transmitter or radiator is employed to provide, with the boosting or relay transmitter, an interference pattern as aforesaid and in which the receiver is employed for receiving the signals from a primary transmitter to provide or control the signals radiated from the boosting or relay transmitter, and is so located with respect to the interference pattern of the boosting or relay transmitter and the auxiliary transmitter as to reduce interference from these transmissions. The collector of the receiver may thus be located at a trough or crest produced by these transmissions, as above described. The auxiliary transmitter may be provided solely for the purpose of producing a point of minimum strength for location of the receiver or alternatively, it may itself constitute another boosting or relay station.

The boosting system may be one in which the transmission from each boosting station is non-directional so as to provide localised areas of high field strength, for instance for broadcasting purposes. Alternatively, a single boosting or relay transmitter and a primary transmitter, or a plurality of the boosting or relay transmitters and receiving systems therefor may be arranged with or without a primary transmitter to provide by interference effects a directional or beam transmission. The aerial systems of the boosting stations themselves may be of a directional character.

In a radio boosting or relay system as aforesaid it is convenient to employ the primary transmitter signals received at the transmitter to provide or control the signals radiated from both the boosting or relay transmitter and the auxiliary transmitter. In an alternative arrangement the primary transmitter signals received at the receiver are employed to provide or control the signals radiated from one of the boosting and auxiliary transmitters and the signals from this transmitter are employed to provide or control the signals radiated from the other of these transmitters.

A further feature of the invention consists in such a radio boosting or relay system wherein the collector of the receiver is equi-distant from the boosting or relay transmitter and the auxil-

iary transmitter. With this arrangement the equivalent distances between the receiver and the two transmitters are equal and there is obtained the advantage that the boosting or relay system may be used for transmissions of different frequencies within a wide range. In an alternative arrangement the collector is differently spaced from the boosting or relay transmitter and the auxiliary transmitter is connected to the nearer transmitter by a line of such length as to provide a path distance equal to that between the collector and the other transmitter. In this way, the receiver may be placed comparatively near to one or other of the transmitters and at the same time the advantage of boosting throughout a range of frequencies is also obtained. By arranging the auxiliary transmitter near to the receiver it may have correspondingly low power.

The auxiliary transmitter may be excited in any convenient manner and either or both of the radiation and induction fields of the transmitters may be utilised in order to produce a minimum response in the receiver. Thus, for example, the receiver may be positioned close to the auxiliary transmitter so as to be within the induction field of this transmitter.

Specific embodiments of the invention will now be described by way of example with reference to the accompanying diagrammatic drawings, in which:

Figures 1 to 4 represent receiving arrangements in the strong field for receiving transmissions on the same or adjacent frequencies, and

Figures 5 to 7 show applications of the invention to boosting a transmission at a remote point.

Referring to Figure 1 of the drawings there is indicated a transmitter A providing a strong field over an area in which it is desired to receive other transmissions, particularly on the same or adjacent frequencies. According to the invention there is set up an auxiliary transmitter or radiator B for delivering the same frequency of transmission as given by the transmitter A. The two transmitters which are thus of identical frequency produce an interference pattern in space so that the combined or resultant field of the two transmissions varies from place to place to form troughs at places of minimum or zero value indicated at x in the drawings and crests at other places. The positions of these troughs and crests depends on the separation of the transmitters and the phase relationship of the transmissions.

A receiver O is located at the position of one of the troughs not necessarily in line with the transmitters A and B. Thus, at the position of this receiver the field strength of the transmitter A is reduced to a low value by the auxiliary transmitter B so as to permit more easily the reception of other transmissions.

It is necessary to select an appropriate form of collector for the receiver O and in the example shown in Figure 1 this collector may be in the form of a vertical or open aerial 10. When the collector is positioned at a trough in the interference pattern it is obviously an advantage that the combined field strength of the transmitters A and B should be zero at this trough. This condition, which requires that the field strengths of the two transmitters should be the same at the position of the collector, may be obtained as shown in Figure 1 by the provision of means 20 controlling the power of the auxiliary transmitter B and/or means 21 controlling the power of the

main transmitter A, if this is also under control. Also, the phase relationship of the transmissions from A and B may be varied for example by control means 22 on the auxiliary transmitter in order to adjust the position of the trough or crest of the interference pattern at the receiver. Moreover, these controls of amplitude and phase may be employed to enable a suitable trough or crest to be located at a given point at which it is required to locate the receiver.

The excitation of the auxiliary transmitter B may be effected in any convenient manner. For example, it may be energised or controlled by line connection 24 with the transmitter providing the strong field as shown in Figure 2, or it may be energised or controlled by a separate radio receiver 25 for this transmission as shown in Figure 3. A directional aerial 26 is conveniently employed for such a separate receiver and positioned to provide a minimum pick-up from the aerial of the auxiliary transmitter B. Although it may be best for good results to position the separate receiver some distance away from the auxiliary transmitter, depending upon the relative strengths of this transmitter and that producing the strong field, it is possible that a position close to the auxiliary transmitter may be chosen providing the relative phases are adjusted as in Fig. 1 for obtaining satisfactory results and consequently the auxiliary transmitter, with or without a radio amplifier energising this transmitter, may be built or operated as an accessory for the auxiliary receiver 25 as shown in Fig. 4.

In many circumstances it is required to boost a given transmission at a remote point, either for increased facility for local reception or for producing in conjunction with the primary transmitter and/or other boosting transmissions, a directional or beam transmission to a point remote from both the primary transmitter and the boosting station or stations. In Figure 5 there is represented a primary transmitter T and at a position remote therefrom a boosting transmitter A operating at the same frequency. This boosting transmitter A is energised by means of a receiver O receiving the transmission from the primary transmitter T. In order that the receiver O shall not be affected to an undesirable extent by the transmission radiated from the boosting transmitter A there is provided an auxiliary transmitter B energised by means of the receiver O, such as to provide therewith an interference pattern as above described, and the receiver O is positioned either at a trough or crest of this pattern, depending on the form of collector used, so that the signals received from the transmitters A and B are a minimum. The transmitters A and B are energised by the signals received at the receiver O in any convenient manner by a wireless link or by a conducting line 30 as shown in Figure 5. The boosting transmitter A may have a loop or other directional aerial 31 and the receiver O may be positioned in a direction of minimum radiation from A in order to reduce the amplitude of the signals received from this transmitter. Thus, for a given power of the transmitter B the receiver O may be placed comparatively close to the transmitter A and yet be subject to substantially equal field strengths of the same order from the two transmitters.

It is of advantage that the boosting station A should be capable of operating to boost any of a number of transmissions within a wide range of frequencies coming from the transmitter T or

any other transmitter. For this purpose, the receiver O is, in the arrangement shown in Figure 5, positioned midway between the transmitters A and B. In consequence, the path distance for the signals between O and A and between O and B is equal and thus the trough or crest of the interference pattern will remain at the same position in space for transmissions of different frequencies over a wide band.

By minimising at the receiver O the effective field strength of the boosting transmitter A, a very considerable improvement is obtained in stability of the boosting station. If the receiver O picks up appreciable signals from the transmitter A a build-up of the signals at the receiver and at the transmitter A is likely to occur to such an extent as to cause instability, and this disadvantage is overcome by the provision of the auxiliary transmitter B and the specified location of the receiver O. The aerial 32 employed for the receiver O may be directional as shown in Figure 6 and so arranged as to receive the primary transmission from the transmitter T more favourably than the transmissions from the transmitters A and B. Furthermore, the aerial of the receiver O may be directional to discriminate between the transmitters A and B i. e. it may have an unsymmetrical polar diagram so as to obtain a zero or nearly zero resultant field at a trough at which it is desired to locate the receiver O. Furthermore, the relative strengths and phases of the transmissions from the transmitters A and B may be adjusted as in Figure 1 by means 33, 34 to give a trough of low resultant amplitude at the position required for the receiver O.

In the boosting or relay system shown in Figure 7 the receiver O is positioned between the primary transmitter T and the auxiliary transmitter B and in line with these transmitters and the boosting transmitter A. In this case, the receiver O may be provided with a uni-directional collector 35 having a polar diagram such as that indicated at p and so arranged that the receiver has maximum response for the transmitter T and a minimum response for the transmitters A and B. In this manner, the response of the receiver O for the transmitter B is further decreased.

The transmitter A may be employed to give local service in the neighbourhood of the transmitter and the auxiliary transmitter B may also be of appreciable power for the same purpose. It may alternatively be of low power, in which case the location of the receiver O near to the transmitter B becomes desirable.

In the case in which the boosting system is to operate over a wide range of transmission frequencies, filters 36 may be provided in the system to prevent radiation from the boosting station of one or more given transmissions or to restrict the operation of the boosting station to selected frequency bands.

I claim:

1. A radio receiving system for use in a strong field of a neighbouring transmitter comprising an auxiliary transmitter operating at the same frequency as that producing the strong field so as to provide therewith an interference pattern, a receiver embodying a collector which is so located with respect to the interference pattern as to reduce the interference from the transmission.

2. A radio receiving system for use in a strong field of a neighbouring transmitter comprising an auxiliary transmitter, means energised by signals from said first named transmitter for maintaining the signals of the auxiliary transmitter at the

same frequency as that producing the strong field so as to provide therewith an interference pattern, a receiver embodying a collector which is so located with respect to the interference pattern as to reduce interference from the transmission.

3. A radio boosting system comprising a boosting transmitter, an auxiliary transmitter operating at the same frequency as the boosting transmitter so as to provide therewith an interference pattern, a receiver adapted to receive the signals from a primary transmitter and to control signals radiated from the boosting transmitter, which receiver is so located with respect to the interference pattern of the boosting transmitter and auxiliary transmitter as to reduce interference from these transmissions.

4. A radio boosting system comprising a boosting transmitter having a directional aerial, an auxiliary transmitter operating at the same frequency as the boosting transmitter so as to provide therewith an interference pattern, a receiver positioned in a direction of minimum radiation from the directional aerial of the boosting transmitter and adapted to receive signals from a primary transmitter and to control signals radiated from the boosting transmitter, which receiver is so located with respect to the interference pattern of the boosting transmitter and auxiliary transmitter as to reduce interference from these transmissions.

5. A radio boosting system comprising a boosting transmitter, an auxiliary transmitter operating at the same frequency as the boosting transmitter so as to provide therewith an interference pattern, a primary transmitter, a receiver adapted to receive the signals of the primary transmitter, and to control signals radiated from the boosting transmitter, and from the auxiliary transmitter, which receiver is so located with respect to the interference pattern of the boosting transmitter and auxiliary transmitter and to reduce interference from these transmissions, the collector of which receiver is arranged to be equidistant from the boosting transmitter and the auxiliary transmitter.

6. A radio receiving system for use in a strong field of a neighboring transmitter comprising an auxiliary transmitter operating at the same frequency as that producing the strong field so as to provide therewith an interference pattern, a receiver embodying a collector which is so located with respect to the interference pattern as to reduce the interference from the transmission, and means for adjusting the phase amplitude of the auxiliary transmitter to provide with the strong field an interference pattern having a trough or

crest at a given position for location of the receiver.

7. A radio boosting system comprising a boosting transmitter, an auxiliary transmitter operating at the same frequency as the boosting transmitter so as to provide therewith an interference pattern, a primary transmitter, a receiver adapted to receive the signals of the primary transmitter and to control signals radiated from the boosting transmitter, which receiver is so located with respect to the interference pattern of the boosting transmitter and auxiliary transmitter as to reduce interference from these transmissions, and means for adjusting the phase amplitude of the auxiliary transmitter to provide with the strong field an interference pattern having a trough or crest at a given position for location of the receiver.

8. A method of reducing, at a signal reception point, radio interference between signal energy from a wanted station and signal energy from an unwanted, less remote station of substantially greater field strength, which includes the step of transmitting signal energy at the frequency of said unwanted station from a second point adjacent said reception point to provide with the energy from said unwanted station an interference pattern, the reception point being so located with respect to said second point and said unwanted station and in the interference pattern thereof that the signal energy from said unwanted station is substantially reduced by the signal energy transmitted from said second point.

9. A radio receiving system for use in a strong field of a neighboring transmitter comprising a main receiver, an auxiliary transmitter in the neighborhood of said receiver, an auxiliary receiver responsive to the first said transmitter and adapted to energize the auxiliary transmitter at the same frequency and a collector for the main receiver so located with respect to the interference pattern provided by the two transmitters so as to reduce the interference from them.

10. A radio receiving system for use in a strong field of a neighboring transmitter comprising a main receiver, an auxiliary transmitter in the neighborhood of said receiver, an auxiliary receiver, responsive to the first said transmitter, and adapted to energize the auxiliary transmitter at the same frequency, and a collector for the main receiver so located with respect to the interference pattern provided by the two transmitters as to reduce the interference from them, which auxiliary transmitter is built as an accessory to the main receiver.

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