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CARRIER FREQUENCY SYSTEM

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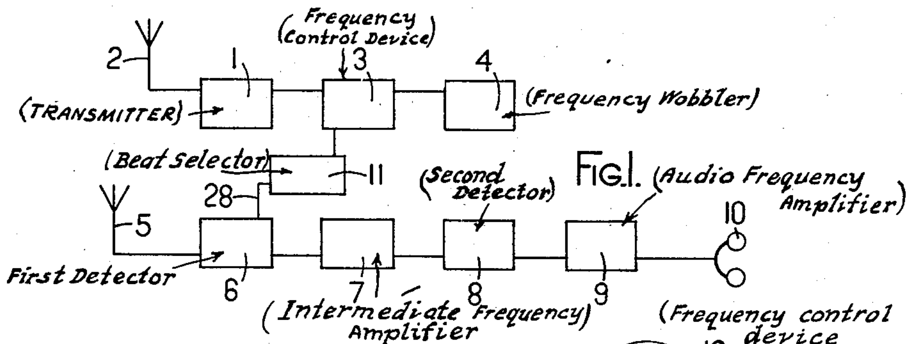

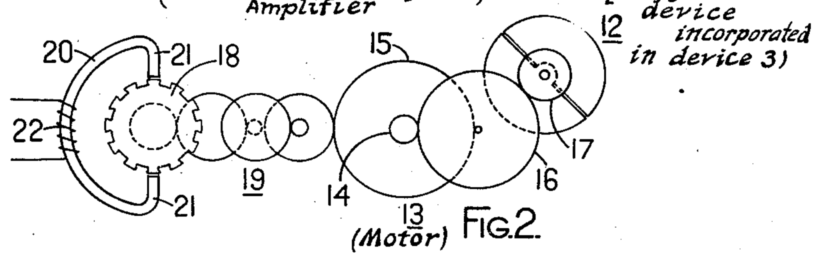

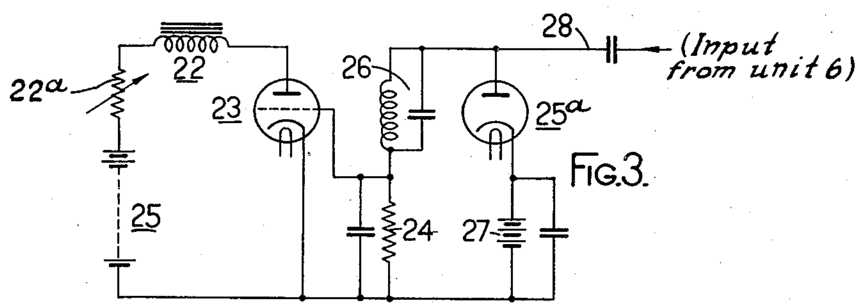

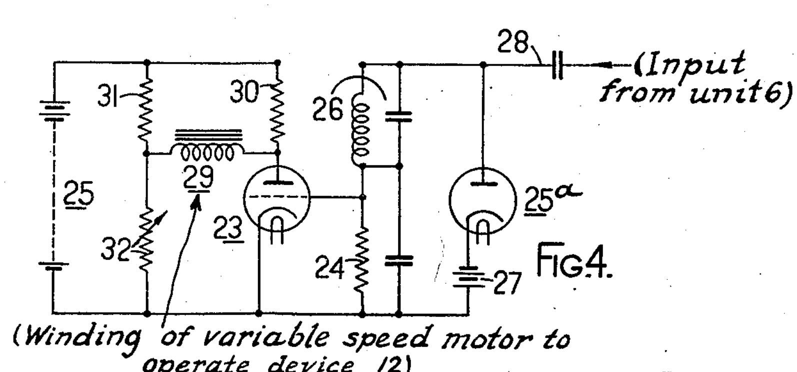

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CARRIER FREQUENCY SYSTEM

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12 Claims. (Cl. 250—6)

This invention relates to carrier frequency electric systems for communication, signalling, indicating, remote control and other purposes.

According to the present invention the carrier frequency of a transmitter-receiver station or each transmitter receiver station, whilst arranged so as to be continuously variable within the predetermined frequency spectrum band, is normally maintained constant at any fortuitous or predetermined frequency within said band, but is caused to vary when and only when another transmitted carrier is received which produces at or before the second detector of the station an interference predetermined as to frequency and preferably also as to amplitude, which interference in the case of a speech-modulated carrier may be a heterodyne interference of, say, 5,000 cycles per second or even less. The frequency is thus either increased or decreased so that the aforesaid frequency interference is automatically removed whereupon the frequency variation is discontinued so that the transmitted frequency is now caused to remain constant at a new value until a further interference may arise when the process above described is repeated, and so on.

Preferably the speed of the frequency shift is approximately proportional to the amplitude of the heterodyne interference so that if a strong interfering signal is suddenly received the interference is the more quickly and more widely removed than is the case of a relatively weak signal.

Thus by this invention a plurality of signals may be simultaneously "received" which are automatically segregated into separate fixed frequency channels separated appropriately in accordance with their signal strength on the receiving aerial. It is, of course, understood that the receiver is substantially aperiodic with respect to the predetermined frequency spectrum band.

In order that the utility of the present invention may be the more fully appreciated it may be helpful here to state that as at present considered, the main object of the invention is to enable a carrier wave to be radiated continuously within a predetermined frequency spectrum band without preventing reception of one or more other carrier waves radiated within said band and from stations at predetermined distances or of predetermined radiation strength, thus enabling an instrument to be produced which will immediately indicate when another transmitter is radiating at a frequency within the aforesaid band and within the range of sensitivity of the receiving instrument. The instrument may thus be called a radio-proximity indicator for use for example by aircraft and by ships at sea. It will be appreciated that since a frequency band for a system in accordance with the invention will require to be allotted by the appropriate government department, the mean wavelength will at the present time have to be short, say five metres. Since the range of such order of wavelengths is inherently short, apart from the power of the transmitter, the instrument according to the invention has great utility in connection with aircraft operating in the neighbourhood of for example an aerodrome or airport since it can provide to that airport or to aeroplanes within its vicinity an indication of one another's proximity. The system is entirely automatic in its warning and is such that the radiations from one craft cannot affect the ability of that craft to receive signals or radiations from another craft. When modulation of the carrier waves is taking place since each station definitely abandons all adjacent channel selectivity, all the modulations are capable of being heard simultaneously. Such is what is implied by a multiplex system in the present specification, as distinct from the transmission of several independent messages simultaneously over a single channel such as by the plural high frequency modulation of a single carrier wave. Thus the system may more aptly be called "conference" system.

Another important use of the invention may be in military operations where for example it is desired that communication should exist between several units, one of which may be a commanding unit from which orders are issued which are required to be received simultaneously by all the other units, which latter may reply at any time and even interrupt the orders if necessary, whilst furthermore the subordinate units can intercommunicate with each other.

To enable the invention to be fully understood it will now be described with reference to the accompanying drawing in which:

Figure 1 is a block diagram illustrating the invention and the requirements thereof.

Fig. 2 is a diagram of a convenient arrangement for varying the transmission frequency and holding it at different values.

Fig. 3 is a circuit diagram illustrating how the braking devices shown in Fig. 1 may be supplied with current and,

Fig. 4 is a diagram showing an alternative arrangement to that illustrated by Figs. 2 and 3.

Referring first to Fig. 1 of the drawing, this figure illustrates one of a plurality of stations adapted to operate in accordance with the invention. The rectangle 1 represents conventionally a radio transmitter having a transmitting aerial 2 and a frequency control device 3 which is adapted under the conditions hereinbefore set forth to maintain the transmission frequency normally constant but to shift it when required. The rectangle 4 is an optional frequency wobbler unit the purpose of which will be hereinafter described.

The station illustrated by Fig. 1 further comprises the receiving aerial 5 feeding the first detector or mixing valve device 6 which feeds in the well known manner an intermediate frequency amplifier 7 followed by a second detector 8, followed, if desired, by an audio frequency amplifier 9 which feeds the telephones 10, or other indicating or control devices.

In Fig. 1 of the accompanying drawing is shown at 11 the interference beat selector or frequency responsive device which is fed from the first detector 6 and which is connected to the frequency control unit 3 in the manner hereinafter specifically described.

The operation of the system shown in Fig. 1 is as hereinbefore set forth, it being understood that the input circuit of the first detector 6 is aperiodic to the predetermined frequency spectrum band but is not responsive to frequencies outside said band, whilst the intermediate frequency amplifier 7 has a band pass characteristic responding to the difference frequencies between carriers from remote stations received by the aerial 5 and the local carrier wave acting as the local oscillator for the superheterodyne receiver.

It will be appreciated that it might be possible, although unlikely, for a zero beat heterodyne effect to arise for a short time in the receiver between the carrier of a remote station and that of the local transmitter in which case whilst there may be violent distortions due to the mixing of the modulations, there would be no voltage acting through the interference beat selector 11 to operate the frequency control unit 3 for separating the frequencies. Such zero beat effect can readily be prevented by continuously wobbling the transmission frequency over a range of say $\pm 5{,}000$ cycles. The frequency wobbler unit for this purpose is indicated at 4 of Fig. 1. As an example the frequency wobbler unit 4 may comprise merely a relatively minute trimming condenser having an element adapted to be moved, conveniently rotated such as by clockwork or an electric motor. Such condenser may be in parallel with the variable tuning device in the unit 3. The frequency wobble affected by the unit 4 is not critical and it is immaterial whether its range varies slightly such as at different settings of the main frequency control unit which is conveniently a condenser. The wobble rate should be either sub-audio or supersonic.

Referring now to Fig. 2, at 12 is shown a variable condenser incorporated in the transmission frequency determining unit 3. This condenser may be the main or the trimming condenser of the transmitter 1. It is common knowledge that instead of a condenser any other means may be provided for silently varying the transmitted frequency within the predetermined frequency spectrum band, such for instance, as a distortable inductance coil or an armature movable relatively to an inductance coil or in other ways which are common knowledge, for example, in the art of automatic tuning-in radio reception.

At 13 is indicated a motor which is conveniently a spring driven clock mechanism having a small pinion 14 and a large one 15. The small pinion 14 meshes with a gear train comprising a large wheel 16 which meshes with a smaller wheel 17 which is rigid with the moving element of the condenser or other variable tuning device 12. The arrangement is therefore such that the motor 13 normally causes to rotate the moving element of the tuning device 12 so as to vary the frequency back and forth cyclically within the predetermined frequency spectrum band of the transmitter.

The large wheel 15 of the motor 13 drives the exemplified soft iron toothed wheel 18 through the multiplying gear train consisting, for example, of the system illustrated at 19. The soft iron toothed wheel 18 co-operates with an electromagnet comprising the yoke 20, poles 21 and winding 22. It will be appreciated that with such an arrangement when the winding 22 is fully energised the wheel 18 and thus the tuning element 12 will be held stationary, whilst with varying energisation of the winding 22 the braking effect will be correspondingly varied and so the speed of the tuning element 12 can be varied between zero and maximum, the latter obtaining when the winding 22 is substantially de-energised.

Referring next to Fig. 3 of the accompanying drawing, it will be seen that for the energisation of the winding 22 it can be connected in the anode circuit of a triode 23 in series with a limiting resistance 22*a* which is preferably adjustable, and with an anode battery 25. The grid of the triode 23 is connected to the load resistance 24 of the diode 25*a*, the negative end of the resistance 24 being connected to the anode of the diode 25*a* through the resonant circuit 26 which is tuned to a frequency slightly higher than the highest modulation frequency for which the system is designed. In accordance with the example hereinbefore given the circuit 26 is tuned to be resonant at 5,000 cycles per second. In the cathode circuit of the diode 25*a* is a "delay" bias battery 27 for preventing the diode from passing current until the heterodyne interference voltage attains a value which will impair the intelligibility of the speech received. By such means the system can be made to ignore interfering signals which are of insufficient strength to cause undesirable interference compatible with the purpose for which the system is being used such for example as either of the purposes hereinbefore stated by way of example.

The anode of the diode 25*a* is connected by the lead 28 to the first detector 6 shown in Fig. 1. It will be appreciated that when the heterodyne voltage exceeds the predetermined value, the normally unbiased grid of the triode 23 will become negative to reduce the current flowing in the winding 22 of the magnet 20 (Fig. 2) the triode 23 normally passing sufficient current to hold the toothed wheel 18 stationary and thus the frequency constant.

No provision should be made for maintaining the control units in synchronism and it is impossible therefore that synchronous conditions can arise in practice except that for short periods zero beat conditions may arise and such can be prevented by the wobbling unit 4 previously referred to. It is desirable furthermore that the clockwork or other motors 13 in the different stations should be arranged to run at different normal maximum speeds and that the laws of the variable tuning devices such as 12 should not be identical in the co-operating stations.

Referring lastly to Fig. 4 of the accompanying drawing, which illustrates an alternative arrangement to that shown in Figs. 2 and 3 but in which the same reference numerals designate similar parts, the anode 2 of the triode 23 includes in a balanced bridge arrangement the winding 29 of electric motor (not shown) and resistances 30, 31, and 32. This motor may be of any known and convenient type such as the motor of an electricity meter and it is preferably of the variable speed type and adapted to rotate or to operate the moving element of the variable tuning device 12 at a speed in accordance with the extent of energisation of the motor winding 29 which as will be appreciated varies in accordance with the voltage of the audible heterodyne which may arise at the first detector 6 (Fig. 1) except for the presence of the delay bias 27 of the diode 25a, which, as with the arrangement shown in Fig. 3, is provided for the purpose of preventing frequency shift unless the heterodyne interference volume is sufficient to impair speech intelligibility.

I claim:

1. The method of conference type carrier frequency intercommunication between a plurality of transmitter-receiver stations, which consists in continuously transmitting from each station a carrier at a frequency which is normally maintained constant somewhere within a predetermined frequency band, effecting aperiodically with respect to said predetermined band the supersonic heterodyne reception of the carrier of at least one of the other stations whilst using the local carrier for the heterodyning, and effecting an automatic shift of the local carrier frequency to another fixed place within said predetermined band when a received carrier produces a heterodyne interference of predetermined frequency.

2. The method of conference type carrier frequency intercommunication between a plurality of transmitter-receiver stations, which consists in continuously transmitting from each station a carrier at a frequency which is normally maintained constant somewhere within a predetermined frequency band, effecting aperiodically with respect to said predetermined band the supersonic heterodyne reception of the carrier of at least one of the other stations whilst using the local carrier for the heterodyning, and effecting an automatic shift of the local carrier frequency to another fixed place within said predetermined band when a received carrier produces a heterodyne interference of predetermined frequency and predetermined amplitude.

3. The method according to claim 1, wherein the rate of the carrier frequency shift is substantially proportional to the amplitude of the heterodyne interference.

4. The method of conference type carrier frequency intercommunication between a plurality of transmitter-receiver stations, which consists in continuously transmitting from each station a carrier at a frequency which is continuously wobbled through a small range about an average frequency which is maintained constant somewhere within a predetermined frequency band, effecting aperiodically with respect to said predetermined band the supersonic heterodyne reception of the carrier of at least one of the other stations whilst using the local carrier for the heterodyning, deriving from said receiver a voltage only when any heterodyne interference of predetermined frequency arises in the receiver, and utilizing said derived voltage to shift the local carrier frequency to another fixed place within said predetermined band.

5. A transmitter-receiver station for conference type carrier frequency intercommunication, comprising in combination a carrier wave transmitter having means adapted to vary the carrier frequency cyclically over a predetermined band, a supersonic heterodyne receiver arranged to utilize the local carrier as local oscillator said receiver having an intermediate frequency circuit substantially aperiodic to the range of intermediate frequency variation with respect to said predetermined band, and means adapted automatically to actuate said carrier frequency varying means when a received carrier of frequency within said band produces a heterodyne interference of predetermined frequency so as to shift the carrier to another fixed place within said band.

6. A transmitter-receiver station as claimed in claim 5, wherein said last mentioned means is responsive also to the amplitude of said heterodyne interference.

7. A transmitter-receiver station for conference type carrier frequency intercommunication, comprising in combination a carrier wave transmitter having means adapted to vary the carrier frequency cyclically over a predetermined band, a supersonic heterodyne receiver arranged to utilize the local carrier as local oscillator, said receiver having an intermediate frequency circuit substantially aperiodic to the range of intermediate frequency variation with respect to said predetermined band, means for deriving from said receiver a voltage only when a received carrier of frequency within said band produces a heterodyne interference of predetermined frequency and amplitude, and means adapted to actuate said carrier frequency varying means in response to said derived voltage and at a rate substantially proportional to said amplitude.

8. A transmitter-receiver station as claimed in claim 7, having additional means for continuously wobbling the carrier frequency over a range small compared with said predetermined band.

9. A transmitter-receiver station for conference type carrier frequency intercommunication, comprising in combination a carrier wave transmitter having a tuning element which is normally fixed but is adapted to vary the carrier frequency cyclically over a predetermined band, a supersonic heterodyne receiver arranged to utilize the local carrier as local oscillator said receiver having an intermediate frequency circuit substantially aperiodic to the range of intermediate frequency variation with respect to said predetermined band, a resonant circuit for deriving from said receiver a voltage only when a received carrier of frequency within said band produces a heterodyne interference of predetermined frequency, and a motor adapted to actuate said tuning element to a new fixed position in response to said derived voltage.

10. A transmitter-receiver station for conference type carrier frequency intercommunication, comprising in combination a carrier wave transmitter having a tuning element adapted to vary the carrier frequency cyclically over a predetermined band, a source of power tending to actuate said tuning element continuously, electroresponsive means for normally holding said tuning element against such actuation, a supersonic heterodyne receiver arranged to utilize the local carrier as local oscillator said receiver having

an intermediate frequency circuit substantially aperiodic to the range of intermediate frequency variation with respect to said predetermined band, means for deriving from said receiver an electrical effect only when a received carrier of frequency within said band produces a heterodyne interference of predetermined frequency, said electroresponsive holding means being energised from said deriving means.

11. A transmitter-receiver station for conference type carrier frequency intercommunication, comprising in combination a carrier wave transmitter having a tuning element which is normally fixed but is adapted to vary the carrier frequency cyclically over a predetermined band, an electric motor adapted according to its state of energisation to actuate said tuning element, a supersonic heterodyne receiver arranged to utilize the local carrier as local oscillator said receiver having an intermediate frequency circuit substantially aperiodic to the range of intermediate frequency variation with respect to said predetermined band, means for deriving from said receiver an electrical effect only when a received carrier of frequency within said band produces a heterodyne interference of predetermined frequency, and means adapted to energise said motor in accordance with said electrical effect so as to shift the transmission frequency to another fixed place within said band.

12. A transmitter-receiver station for conference type carrier frequency intercommunication, comprising in combination a carrier wave transmitter having means which are normally fixed but are adapted to vary the carrier frequency cyclically over a predetermined band, a supersonic heterodyne receiver arranged to utilize the local carrier as local oscillator said receiver having an intermediate frequency circuit substantially aperiodic to the range of intermediate frequency variation with respect to said predetermined band, means for deriving from said receiver a voltage only when a received carrier of frequency within said band produces a heterodyne interference of predetermined frequency, said means comprising a biased rectifier connected to some part of the receiver after the first detector thereof with a load resistance and a circuit tuned to the predetermined interference frequency, and means adapted to actuate said carrier frequency varying means in response to said derived voltage so as to shift the transmission frequency to another fixed place within said band.

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