

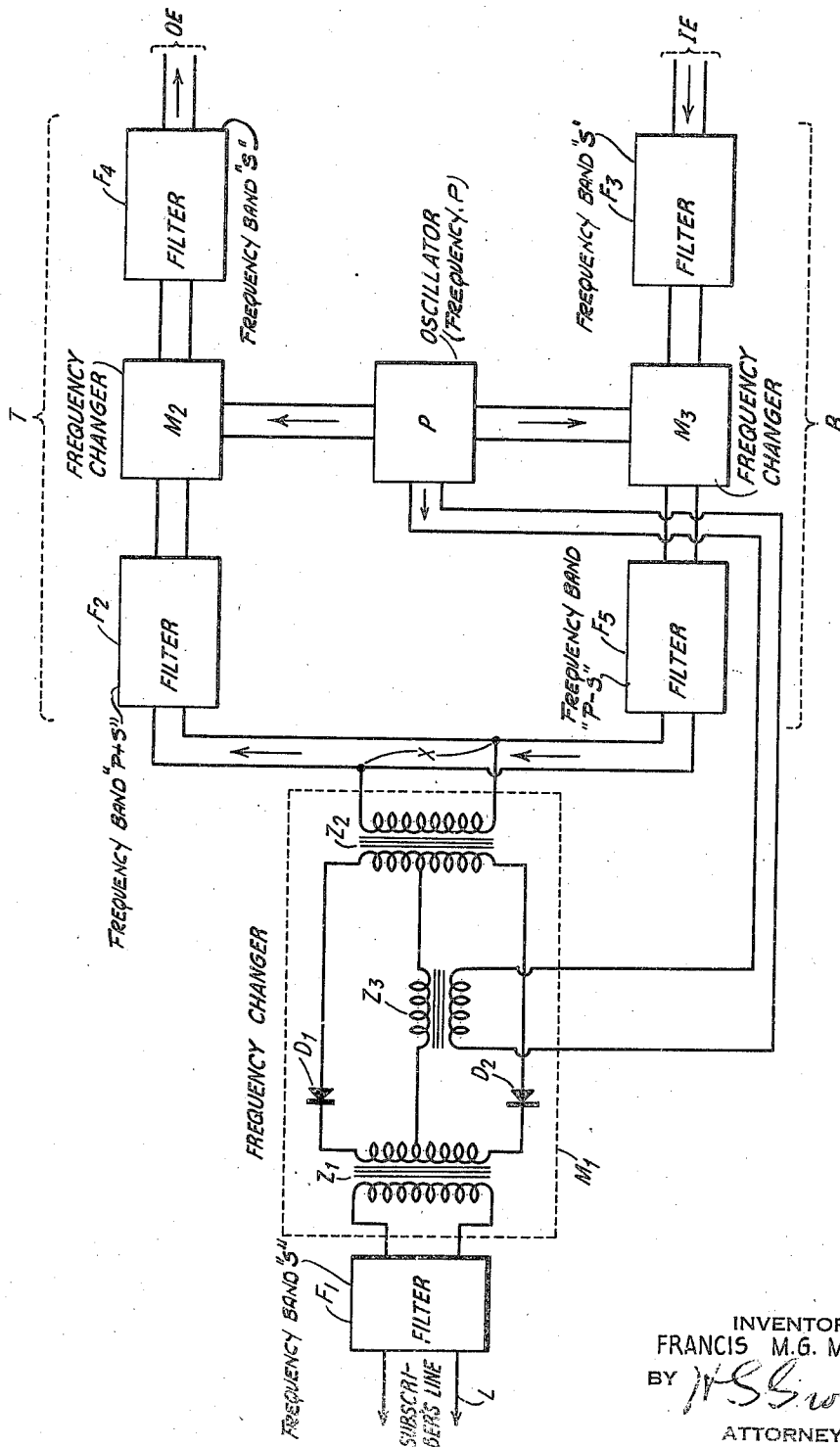
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TWO-WAY RADIO COMMUNICATION SYSTEM

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TWO-WAY RADIO COMMUNICATION
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This invention relates to two-way communication systems and more particularly to terminal arrangements of two-way radio telephone systems, where two one-way oppositely directed signal paths join one two-way signal path. In the normal case the two-way signal path leads to a subscriber. One of the two one-way signal paths leads from the subscriber's line (through the necessary amplifying and other apparatus) to the transmitting aerial. The remaining one-way signal path leads from the receiving aerial (through amplifiers and other necessary equipment) to the subscriber's line. In such arrangements it is, of course, necessary to prevent, so far as possible, the re-transmission of the received signals. In order to confine the received signals to the subscriber's line, so-called hybrid coil sets are commonly employed with the object of securing as good a balance as possible. In practice, however, it is almost impossible to secure perfect balance and more or less serious trouble is met with in connection with the undesired passage of received amplifier signals to the transmitting apparatus at the same station. Although, by taking great care in the design of hybrid coil sets, it is possible to secure a reasonable degree of balance, even if considerable expenditure is made in this connection the degree of balance leaves much to be desired.

The object of the present invention is to meet the above mentioned difficulties and to provide relatively cheap and simple apparatus whereby a high degree of freedom from interference of the nature referred to can be obtained.

The object of the invention is achieved by providing in each of the two one-way paths and also in the two-way path frequency changer means in cascade with frequency selective filter means the frequency changer and filter means being so designed that (1) received signals when transformed and filtered by the frequency changer and filter means in the receiving one-way path will not be of such frequency as to pass through the filter and frequency changer means in the transmitting one-way path, but will be of such frequency as to be transformed by the frequency changer means in the two-way path into signals which will be passed by the filter means in the said two-way path and (2) signals to be transmitted, when transformed and filtered by the frequency changer and filter means in the two-way path will be such as to result, after transformation by the filter and frequency changer means in the transmitting one-way path, in signals of the frequency desired to be transmitted. This frequency will, as a

rule, correspond with the frequency of the energy to be received.

Preferably, but not necessarily, all the frequency changer means employ local oscillations of the same frequency and in this case a single oscillator may be employed to provide local oscillations at the three frequency changing points.

The invention is illustrated in the accompanying drawing, the sole figure of which shows diagrammatically a preferred embodiment. The subscriber's line L in a terminal equipment leads to a filter F₁ which is followed in cascade by a frequency changer M₁, which in turn is connected to the adjacent ends X of the transmitting and receiving one-way paths T and R, respectively. The transmitting one-way path consists of a filter F₂ followed, if desired, by an amplifier, which is in turn followed by a frequency changer M₂ which is in turn followed by another filter F₄. The receiving one-way path (taking the component units therein in the transmission order indicated by arrows) comprises a filter F₃ followed by a frequency changer M₃, followed by a second filter F₅, and thence connected to the points X. If desired, an amplifier (not shown) may be placed in circuit between the filter F₅ and the points X. The three frequency changers M₁, M₂, M₃ receive oscillations for frequency changing purposes, i. e. are "driven" from a common local oscillator P. For convenience in description the local oscillation frequency will also be designated P and the letter S will be employed to designate the frequency (or frequency band) which is required to be transmitted in either direction along the subscriber's lines L and which is required to be transmitted from the output end (OE) of the transmitting one-way path T or be received upon the input end (IE) of the receiving one-way path R. The filter F₁ is designed to pass the frequency S; the filter F₂ is designed to pass (for example) the frequency P+S; the filter F₄ will be designed to pass the frequency S; the filter F₃ will be designed to pass the frequency S; and, assuming as above stated that the filter F₂ passes the frequency P+S, the filter F₅ will be designed to pass the frequency P-S.

Considering the operation of this system it will be seen that signal energy of frequency S appearing at IE from a receiver (not shown) will be passed by filter F₃ and transformed by the frequency changer M₃ into two frequencies P±S of which only the lower side band P-S will be passed by the filter F₅. Since the filter F₂ is selected to pass only P+S energy passed by the filter F₁ cannot pass round past X and be re-trans-

mitted by the apparatus in the transmitting one-way path T. Output energy from F_3 will, however, pass directly to the frequency changer M_1 , where it will be transformed into two frequencies S and $2P-S$. Of these two frequencies the frequency S is selected by the filter F_1 and passes to the subscriber over line L. Similarly signal energy of frequency S coming from the subscriber over line L will pass through the filter F_1 and be transformed by the frequency changer M_1 into two frequencies $P \pm S$. Of these two frequencies one, assumed to be the upper side band frequency $P+S$ will be passed by the filter F_2 and this frequency will be transformed by the frequency changer M_2 into two frequencies S and $2P+S$. Of these two frequencies the filter F_4 selects the frequency S and passes it via OE for transmission by a transmitter (not shown).

It will be noted that the frequency changer M_1 is a two-way frequency changer. It comprises two push-pull transformers Z_1 and Z_2 , each having a center-tap on one of its windings, and the two center-taps being connected together via a lead which includes the secondary of a third transformer Z_3 through which oscillations from the local oscillator P are applied. The remaining ends of the center-tapped windings are connected to one another as shown through paths including any suitable rectifiers D_1 and D_2 , which may be crystals, if desired. This circuit allows considerable suppression of the oscillator output in the signal paths (to F_1 or X) but allows unchanged inputs to pass through it. Further, unless the oscillator input is high, the frequency change is accompanied by attenuation.

The invention is, of course, not confined to cases where a single oscillator frequency is used throughout for all the frequency changers, nor to cases where the upper side band is selected to be passed by the transmitting one-way path and the lower selected for the receiving one-way path.

In carrying out the invention it is quite a simple matter to arrange to invert speech or other signal frequencies for the purpose of achieving secrecy. For example, if the local oscillation frequency supplied at M_2 be not P but $P+L$ the output of the filter F_4 will be $L-S$, that is to say S will have been inverted about L. If the signals reaching F_3 are of the form $L-S$ i. e. S inverted about L and the frequency changer at M_3 be arranged to receive a local oscillation frequency of $P-L$ the output from F_5 will be $P-S$ and the output of F_1 will be S.

It will be noted that the objects of the invention are achieved without the use of any hybrid coil set or equivalent balance arrangement.

I claim:

1. A terminal arrangement for use in two-way communication systems comprising transmitting and receiving one-way carrier frequency paths, a subscriber's two-way line and terminal connected to said paths, means for maintaining carrier waves of like frequency on said one-way paths and on said two-way line, frequency changing and filter means connected in cascade in each of said paths, and means including a single local oscillator for so controlling said frequency changing means that received signals when transformed and filtered in the receiving one-way path will be of a frequency unacceptable to the filtering means in the transmitting one-way path, and yet acceptable for being fed toward the subscriber's two-way line.

2. A terminal arrangement in accordance with claim 1 and having a two-way filter and frequency changing means connected in cascade between said subscriber's line terminal and a junction point on the two one-way paths, the filter portion of said means being adapted to pass a band of frequencies suitable for use on the subscriber's two-way line.

3. An arrangement in accordance with claim 1 further characterized in that the cascade connected filter and frequency changing means is adapted to transmit a desired band of frequencies along the transmitting one-way path and to accept the same band of frequencies received from the receiving one-way path.

4. In a device of the class described a subscriber's line suitable for two-way modulated carrier wave communication, a two-way filter and frequency changing means connected to the terminal of said line remote from the subscriber's station, a transmitting one-way channel and a receiving one-way channel, filtering and frequency changing means interconnecting said one-way channels with said two-way filter and frequency changing means, and means including an oscillator for so controlling all of said frequency changing means that a received signal lying in a given frequency band is converted to one heterodyne frequency, re-converted to the frequency at which received and passed to said subscriber's line, while a signal initiated at said subscriber's station at the same frequency is converted to a second heterodyne frequency, passed through the filtering and frequency changing means connected with said transmitting one-way channel and re-converted to the original frequency which is the same as the desired frequency of transmission.

5. A terminal arrangement for use in two-way communication systems wherein transmitting and receiving one-way signal paths join a two-way signal path and means are provided for impressing carrier waves of like frequency on each of said one-way paths and on said two-way path, said arrangement being characterized in that each of said paths includes frequency changing and filter means in cascade said frequency changing and filter means being so designed that (1) received signals when transformed and filtered by the frequency changer and filter means in the receiving one-way path will not be of such frequency as to pass through the filter and frequency changer means in the transmitting one-way path, but will be of such frequency as to be transformed by the frequency changer means in the two-way path into signals which will be passed by the filter means in the said two-way path, and (2) signals to be transmitted, when transformed and filtered by the frequency changer and filter means in the two-way path will be such as to result, after transformation by the filter and frequency changer means in the transmitting one-way path, in signals of the frequency desired to be transmitted.

6. An arrangement as claimed in claim 5 and having means including a single oscillator connected to said frequency changing means for determining the frequencies of the signals fed to the filter means in the out-going path.

7. In a communication system, the method of transfer of modulated carrier-wave signals of a given frequency band from a two-way communication channel to a one-way transmission channel and of alternative transfer of like signals from a one-way receiving channel to said two-way channel, which comprises filtering said

signals first at the input point where transfer between channels is to be effected, combining said signals with oscillations of a heterodyne frequency to obtain upper and lower side-band frequencies, passing one of said side-band frequencies in one direction for transmission purposes and the other of side-band frequencies in the reverse direction for reception purposes, transforming the side-band frequency so passed into two side-band frequencies one of which corresponds to the pass frequency dealt with in the first step of filtering, and again pass-filtering the signals so derived through to the output point where transfer between channels is to be effected.

8. In a two-way communication terminal station, a subscriber's line terminal, and terminals for transmitting and receiving channels, respectively, a two-way band-pass filter offering a low impedance in both directions to modulated carrier waves of a given frequency band, two one-way band-pass filters each offering a low impedance to carrier waves of the same frequency band, one of the last said filters being in circuit with the transmitting terminal and the other

thereof being in circuit with the receiving terminal, means including an oscillator for producing waves of a suitable frequency to be heterodyned with said modulated carrier waves, means for obtaining sum-and-difference frequencies in respect to the heterodyning of said oscillator waves with said modulated carrier waves, means for filtering one of the sum-and-difference frequencies through from the subscriber's line terminal toward the terminal of the transmitting channel, means for filtering the other of the last said frequencies through from the terminal of the receiving channel toward the subscriber's line terminal, and means under control of output energy from said oscillator for deriving from the filtered sum-frequency the first said modulated carrier wave to be utilized in one direction of said two-way communication terminal station, and for deriving from the filtered difference-frequency the first said modulated carrier wave to be utilized in the other direction of said two-way communication terminal station.

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