

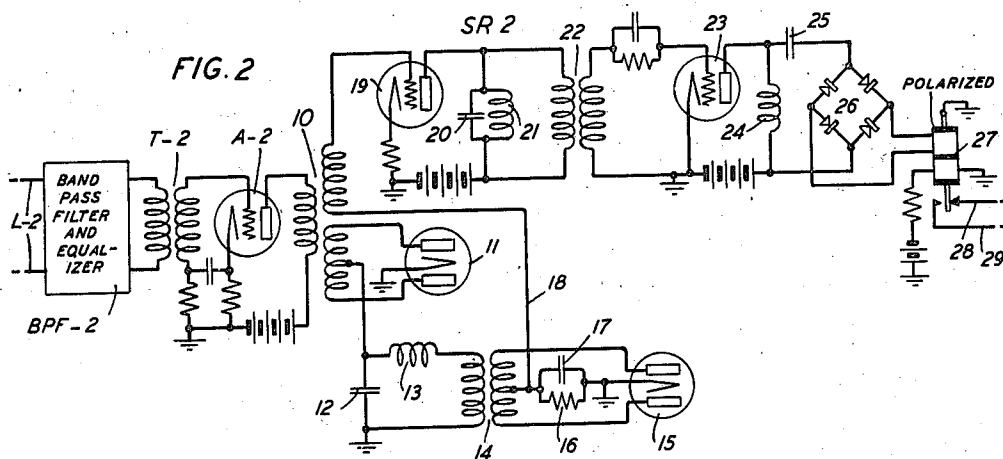
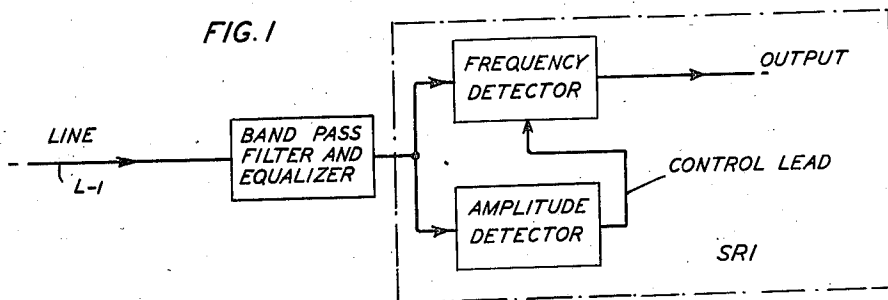
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R. E. RESSLER
SIGNALING SYSTEM

2,310,749

Filed March 31, 1942

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG.3

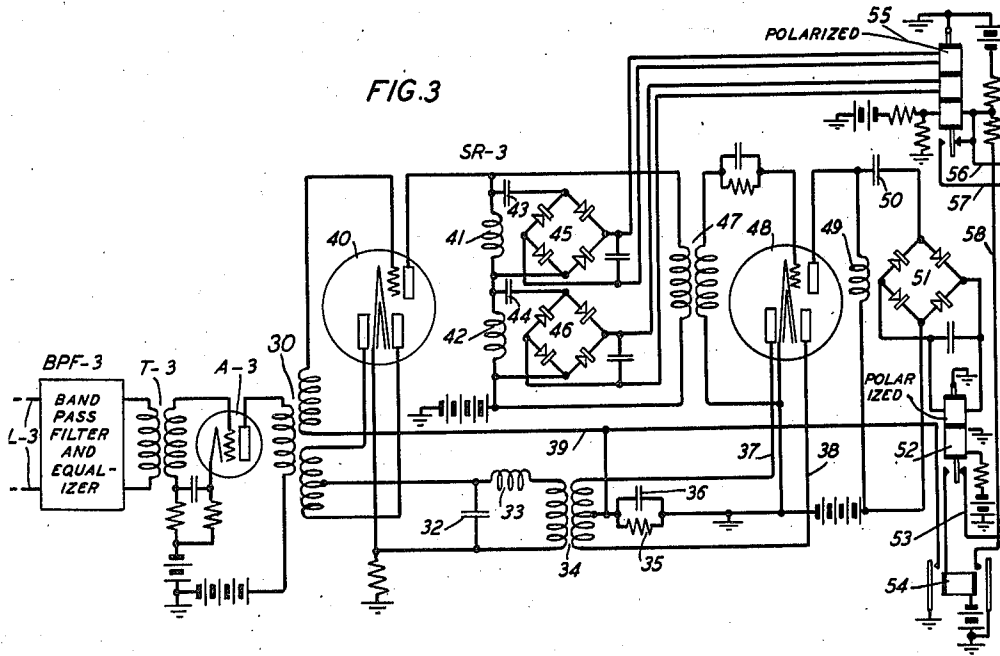
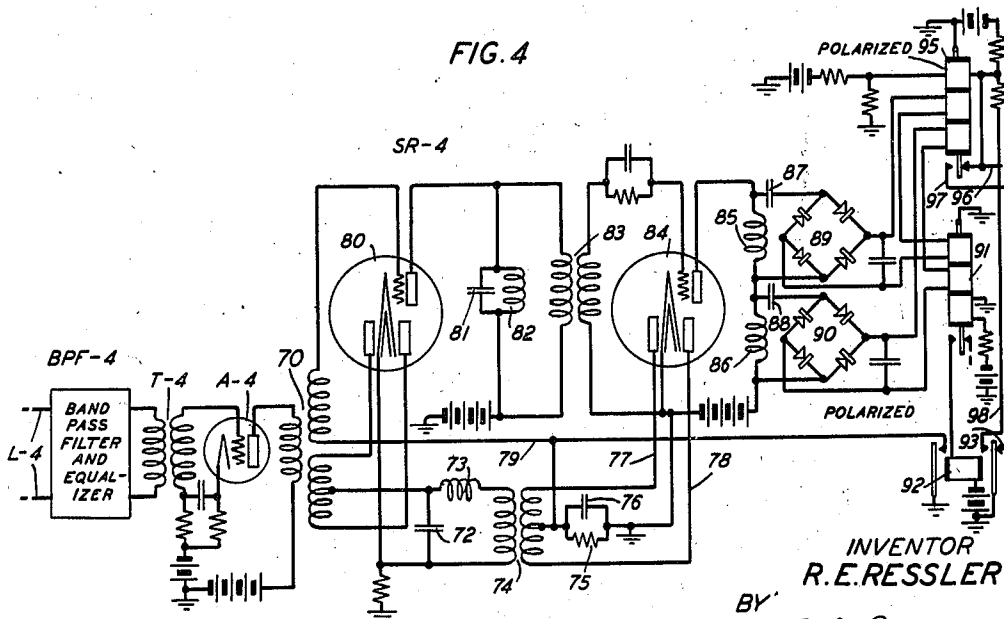


FIG. 4



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SIGNALING SYSTEM

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21 Claims. (Cl. 179-84)

This invention relates to signaling systems and particularly to systems employing voice frequency currents for transmission of signals.

Objects of the invention are an increase in the reliability of signaling systems employing voice frequency currents for signaling and the prevention of false signal operations in response to voice frequency currents other than signaling currents.

In systems in which alternating currents of voice frequency are employed for signaling over lines which are also used for the transmission of speech, various arrangements have been employed to guard against signal operations in response to voice currents or other interfering currents including the frequencies used for signal transmission. This invention is a signaling system comprising a signal receiving circuit arranged to operatively respond to signals consisting of frequency modulated currents of constant amplitude and arranged to prevent signal operation in response to voice currents of varying amplitude, voice currents being subjected to sufficient amplitude modulation to effect the disabling of the signal channel.

A feature of the invention is a signal receiver comprising a signaling channel and a signal relay operatively responsive to signaling current of a particular frequency characteristic and constant amplitude and arranged to prevent operation of the signal relay responsive to current of like frequency characteristic but varying in amplitude.

Another feature of the invention is a signal receiver adapted to respond to signals consisting of current of constant amplitude varying between two frequencies at a constant rate, the variation in frequency with time being preferably sinusoidal in character; operation of the receiver in response to voice currents or other interfering currents which include the signaling frequencies being prevented by the variation in amplitude to which the voice currents or other interfering currents are subjected.

Another feature of the invention is a signal receiver arranged to respond to voice frequency signaling current of constant amplitude varying between two predetermined frequencies at a constant rate; and arranged to receive other signals consisting of current of constant amplitude varying between two other predetermined frequencies at the same rate at which the frequency of the current of a signal of the first-mentioned character is varied.

A further feature of the invention is a signal receiver arranged to respond to signals consist-

ing of current of constant amplitude varying between two frequencies at one rate and arranged to respond to other signals consisting of current varying in frequency between the same two frequencies but varying at a different rate.

The invention will be better understood by considering specific signal receivers in which the invention and its various features are embodied. Three such signal receivers are shown in Figs. 1, 2 and 3 of the drawings which form a part of this specification. The invention is not limited in its application to the receivers shown in the drawings, but is generally applicable to signaling circuits for responding to voice frequency signals.

Referring to the drawings:

Fig. 1 shows in schematic form the general arrangement of a signal receiver SR-1 embodying this invention, consisting of a frequency detector and an amplitude detector connected by a filter and equalizer to a line L-1;

Fig. 2 shows a line L-2 connected by a band-pass filter and equalizer BPF-2 to a signal receiver SR-2 comprising a frequency detector and an amplitude detector;

Fig. 3 shows a signal receiver SR-3 of like character to that shown in Fig. 2 except that it is arranged to respond to voice frequency signals of two different characters; and

Fig. 4 shows another signal receiver SR-4 arranged to respond to voice frequency signals of two different characters.

In a system arranged in accordance with applicant's invention, the signals impressed upon the transmission line are of constant amplitude but vary in frequency between a value F_1 and F_2 , the variation being at a constant rate p . At the receiving end the signal passes from the line through a band-pass filter which passes a band at least as wide as twice the rate at which the frequency is varied and as much wider as is necessary, depending upon the difference between the two frequencies between which the frequency varies. The associated equalizer is adjusted for constant amplitude of the tone at the filter output terminal to compensate for frequency twist in the line and equipment. The output from the filter undergoes a conversion from frequency to amplitude modulation in the frequency detector, the resultant rectified wave having a fundamental frequency equal to the rate at which the frequency is varied or twice the rate at which the frequency is varied depending upon the manner of effecting the conversion. This wave is then passed through a tuned circuit or filter, rectified and applied to the winding of a signal receiver-

ing relay. Amplitude modulated voice currents or other interfering currents of varying amplitude which pass through the band-pass filter cause the amplitude detector to function, the resultant output being employed to disable the signaling channel and thus prevent false operation in response to voice or other interfering currents.

Referring now to the signal receiver SR—2 shown in Fig. 2, the incoming signaling current, varying at a rate p between frequencies F_1 and F_2 , is transmitted through band-pass filter BPF—2, transformer T—2 and amplifier A—2, to the input winding of transformer 10. The equalizer is adjusted to produce constant signal amplitude between frequencies F_1 and F_2 in the output windings of transformer 10. The incoming signal is thus impressed through the upper right winding of transformer 10 on the grid of amplifier tube 19. An antiresonant circuit, comprising the condenser 20 and inductor 21 and tuned to the mean signaling frequency, is connected across the primary winding of transformer 22 in the anode-cathode circuit of tube 19, an alternating current voltage which is amplitude modulated at a frequency $2p$, equal to twice the rate of variation between frequencies F_1 and F_2 , being thereby applied through transformer 22 to the grid of detector tube 23. The anode-cathode circuit of tube 23 includes a network comprising inductance 24 and condenser 25, tuned to the frequency $2p$ so that a voltage of this frequency is applied to the full wave rectifier 26 to operatively energize the upper winding of signal relay 27; and, if there is no current of varying amplitude being received, relay 27 responds to the signaling current. Relay 27 disconnects ground from conductor 28 and connects ground to conductor 29 to effect any desired signal operation.

The lower right winding of transformer 10 is connected across the rectifying tube 11; and variations in the rectified currents are effective to impress an alternating potential across condenser 12 and across inductance 13 and the left winding of transformer 14. The condenser 12 and inductance 13 constitute a low-pass filter which has a cut-off frequency between $2p$ and $2F_1$. If the amplitude of the output wave in the anode-cathode circuit of tube A—2 is constant, no voltage will appear across the secondary winding of transformer 14 after the initial build-up surge; but any amplitude modulation, at frequencies below the cut-off frequency produces an output voltage across the right-hand winding of transformer 14 which is rectified in the tube 15 and appears as a direct current potential across resistor 16 and condenser 17. Any direct current potential thus built up across the resistor 16 and condenser 17 constitutes a negative grid bias which is impressed, through conductor 18 and the upper right winding of transformer 10, on the grid of tube 19; and this grid bias tends to disable the signal channel and thus prevent false operation of the signal relay 27 in response to voice currents or other interference current containing amplitude modulated components of signaling frequencies.

The basic method of discriminating between signals and voice currents, illustrated in the signal receiver SR—2 of Fig. 2, can be readily extended to include means for receiving and reproducing another signal of a different character. The signal receiver shown in Fig. 3 includes a signal relay 52 for responding to signals consisting of current of constant amplitude varying at

a rate p between frequencies F_1 and F_2 and includes a signal relay 55 for responding to signals consisting of signaling current of constant amplitude varying in frequency between frequencies F_3 and F_4 at the same rate p . The receiver includes a dual-diode triode 40 used as an amplifier and full wave rectifier and a dual-diode triode 48 used as a detector and full wave rectifier. Current of signaling frequencies incoming over line L—3 is applied through a band-pass filter and equalizer BPF—3, transformer T—3, and amplifier A—3 to the primary winding of transformer 30, the voltage induced in the upper right winding of transformer 30 being applied to the grid of tube 40. The anode-cathode circuit of tube 40 includes two tuned networks. One of these networks comprises inductance 41 and condenser 43 and it is tuned to the mean frequency between frequencies F_1 and F_2 . The other of these networks comprises inductance 42 and condenser 44; and it is tuned to the mean frequency between frequencies F_3 and F_4 . When the current in line L—3 includes signaling current varying in frequency at a rate p between frequencies F_1 and F_2 , a voltage of the mean frequency between F_1 and F_2 is impressed across rectifier 45, the output current of the rectifier being effective to energize the upper winding of relay 55 in the operating direction; and, when the current in line L—3 includes signaling current varying in frequency at a rate p between frequencies F_3 and F_4 , a voltage of mean frequency between F_3 and F_4 is impressed across rectifier 46, the output current of the rectifier being effective to energize the middle winding of relay 55 in the releasing direction. Relays 52 and 55 are polarized, the lower winding of each being a biasing winding. With both of relays 54 and 55 normal, the current in the biasing winding of relay 55 is in the non-operating direction, the bias being insufficient to prevent the operation of relay 55 by current through its upper energizing winding. With both of relays 54 and 55 operated, the current through the biasing winding of relay 55 is in the operating direction and the bias is sufficient to hold relay 55 operated without current in the upper winding but not sufficient to prevent release of relay 55 in response to energization of the middle winding upon receipt of dial impulse signals over line L—3 as hereinafter described. With relay 55 operated and relay 54 released, the current in the biasing winding of relay 55 is in the operating direction and the bias is sufficient to hold relay 55 operated, the energization of the middle winding in the non-operate direction being ineffective to cause the release of relay 55 as long as relay 54 remains normal. The anode-cathode circuit of tube 40 further includes the left winding of transformer 47 connected in parallel with inductances 41 and 42; and, whenever the current in line L—3 includes signaling current of either character, a voltage of like frequency characteristic is impressed through transformer 47 on the grid of detector tube 48. The anode-cathode circuit of tube 48 includes a network comprising inductance 49 and condenser 50 tuned to frequency $2p$; so that, whenever signaling current of either of the two characteristics is present in line L—3, a voltage of frequency $2p$ is impressed across rectifier 51 to operatively energize the upper winding of relay 52.

Upon transmission of a seizure signal consisting of current of constant amplitude varying in frequency at a rate p between frequencies F_1 and

F2 over line L—3, the upper windings of relays 52 and 55 are operatively energized. The operation of relay 52 closes a circuit for operating relay 54 and disconnects ground from conductor 53 to effect any desired switching operation during the seizure signal. The operation of relay 55 disconnects ground from conductor 56 to reverse the direction of the current in the biasing winding of relay 55 and connect ground to conductor 57 to prepare for the reception of dial impulse signals. The operation of relay 54 connects ground to conductor 58, reducing the biasing current in the lower winding of relay 55. When the seizure signal ends, relays 52 and 54 release in succession, the release of relay 54 being effective to disconnect ground from conductor 58 and thereby increase the current in the biasing winding of relay 55 to give the maximum bias in the operating direction. When a calling operator or calling subscriber connected to the distant end of line L—3 dials a digit of a called route or called subscriber's number, current of the same character as the seizure signal is transmitted over line L—3 preceding the first dial impulse signal, during each interval between impulse signals, and at the end of the last impulse-signal in the train corresponding to the digit dialed. The signaling current preceding the first impulse signal effects the reoperation of relay 52; and the resulting reoperation of relay 54 decreases the current in the biasing winding of relay 55 to render this relay responsive to the succeeding dial impulse. When the current of the first character ceases and the first impulse signal is received, relay 55 is released due to the energization of its middle winding, but relay 52 is held operated since the impulse signal continues the energization of the operating winding of relay 52. Each dial impulse signal is thus effective to release relay 55, thereby disconnecting ground from conductor 57 once for each dial impulse signal received. After the last impulse of the series, the current of the same character as the seizure signal effects the reoperation of relay 55; and, when this current ceases, relay 52 releases but relay 55 remains operated.

When a disconnect signal, consisting of current of the same character as the seizure signal followed by a long impulse of current of the same character as the dial impulse signal, is received, relays 52 and 54 are operated and relay 55 is released to effect the release of any switches through which the connection extends. When the disconnect signal ends, relay 55 does not reoperate and relays 52 and 54 release.

If now voice currents or other interfering currents including the same frequencies as the signaling currents but varying in amplitude are received over line L—3, the voltage induced in the lower winding of transformer 30 is rectified by the cathode and rectifier plates of tube 40, and the rectified voltage is impressed across condenser 32. The left winding of transformer 34, inductance 33 and condenser 32 constitute a low-pass filter which passes current of frequencies below the second harmonic of the lowest important side-band frequency present in the incoming signal wave. Voice or other interference currents of varying amplitude passed by filter BPF—3 are thus effective to induce voltages in the right winding of transformer 34 which are rectified by the cathode and rectifier plates of tube 48 to create a direct current potential across the resistor 35 and condenser 36 which constitutes a negative bias in the grid-cathode circuit of

tube 40. Thus voice or other interference currents create a negative bias which blocks amplifier 40 to prevent false operation of the signaling relay. It is to be noted, however, that each time relay 54 is operated in response to signaling current of either character in line L—3, relay 54 connects ground to conductor 39 to short-circuit resistor 35 and condenser 36, thereby preventing the amplitude detector from disabling the signaling channel so that amplitude surges occurring during the transmission of signals after the operation of relay 54 will be ineffective to bias the grid of tube 40.

Referring now to Fig. 4 the signal receiver SR—4 is arranged to respond to two signals of constant amplitude but varying frequency, the first signal consisting of current varying at a rate $p1$ between frequencies $F1$ and $F2$ and the second signal consisting of current varying at a rate $p2$ between the same frequencies $F1$ and $F2$. This signal receiver has the advantage of not requiring as wide a frequency band for use in signaling as does the receiver SR—3 of Fig. 3. Relays 91 and 95 are similar to relays 52 and 55 of receiver SR—3 except that relay 91 has an additional winding, the upper winding of relay 91 being connected in series with the middle winding of relay 95 and the middle winding of relay 91 being connected in series with the lower winding of relay 95. Current of signaling frequencies in line L—4 is transmitted through the band-pass filter and equalizer BPF—4, transformer T—4 and amplifier A—4 to the input winding of transformer 70, the voltages induced in the upper right winding of transformer 70 being applied to the grid of tube 80. The anode-cathode circuit of tube 80 includes a network, comprising condenser 81 and inductance 82 tuned to the mean signaling frequency, connected in parallel with the left-hand winding of transformer 83, voltages of this frequency being transmitted through transformer 83 to the grid of detector tube 84. The anode-cathode circuit of tube 84 includes two tuned networks, the network comprising inductance 85 and condenser 87 being tuned to frequency $p1$ at which the frequency of the signaling current of the first character is varied and the network including inductance 86 and condenser 88 being tuned to frequency $p2$ at which signaling current of the second character is varied. Thus voltages of frequency $p1$ are impressed across rectifier 89 in response to signaling current of the first character to energize the middle winding of relay 95 and upper winding of relay 91 in series; and voltages of frequency $p2$ are impressed across the rectifier 90 in response to signaling current of the second character to energize the lower winding of relay 95 in series with the middle winding of relay 91; and relay 91 is operatively energized by the one or the other of its operating windings in response to signaling currents of either character in line L—4. The energization of the middle winding of relay 95 in response to signaling current of the first character in line L—4 is effective to operate relay 95; whereas the energization of the lower winding of relay 95 in response to signaling current of the second character is effective to cause the release of relay 95, as herein-after further described. If the current in line L—4 includes voice currents or other currents varying in amplitude, the voltages thus induced in the lower right winding of transformer 70 are rectified in the cathode and rectifier plate circuits of tube 80 and impressed across a network comprising condenser 72, inductance 73 and the

left-hand winding of transformer 74. This network constitutes a low-pass filter having a cut-off frequency below the second harmonic of the lowest important side-band frequency present in the incoming signal wave; and voltages below the cut-off frequency are thus induced in the right-hand winding of transformer 74 and rectified in the cathode and rectifier plate circuits of tube 84 to create a direct current drop in potential across resistor 75 and condenser 76. This direct current difference in potential constitutes a negative grid bias in the cathode-grid circuit of tube 80 so as to block the signaling channel whenever voice current or other current of varying amplitude occurs in line L—4.

Upon transmission of a seizure signal over line L—4, there being no interfering currents to block the signaling channel, relays 91 and 95 are operated by the energization of their upper and middle windings respectively. The operation of relay 95 disconnects ground from conductors 96, thereby reversing the direction of the current in the upper, biasing winding of relay 95 to bias this relay in the operating direction; and connects ground to conductor 97 to prepare the switching apparatus for response to dial impulses. The operation of relay 91 closes a circuit for operating relay 92. Relay 92 disconnects ground from conductor 93 to perform any desired switching operation such as opening the talking transmission circuit, connects ground to conductor 98 to reduce the current in the biasing winding of relay 95, and connects ground to conductor 79 to disable the blocking channel of the signal receiver. When the seizure signal ceases, relays 91 and 92 release in succession, but relay 95 is held operated by the current in the biasing winding. When the calling operator or calling subscriber at the distant end of line L—4 begins to dial the called route or called subscriber's number, signaling current varying in frequency between F1 and F2 at a rate p1 is transmitted over line L—4 preceding the first dial impulse to effect the reoperation of relays 91 and 92; and current of like character is transmitted during the interval between impulses and at the end of the last impulse signal of the train corresponding to the digit dialed. Each dial impulse signal, consisting of current of constant amplitude but varying in frequency at a rate p2 between F1 and F2, effects the energization of the middle winding of relay 91 to hold this relay operated and the energization of the lower winding of relay 95 to cause the release of relay 95. When each dial impulse ends, the signaling current varying in frequency at a rate p1 energizes the upper winding of relay 91 to hold this relay operated and energizes the middle winding of relay 95 to cause the reoperation of relay 95. Thus each dial impulse causes the release of relay 95 to transmit an impulse over conductor 97 to any switching apparatus to be controlled by the dial impulses. After the last dial impulse of the train, relay 95 is reoperated by the current varying in frequency at a rate p1 to again close the circuit over conductor 97 to hold the switching apparatus. When a disconnect signal consisting of current varying in frequency at a rate p1 followed by current varying in frequency at a rate p2 is received, relays 91 and 92 reoperate and relay 95 releases to open the circuit over conductor 97 and effect the release of the switching apparatus. When the disconnect signal ceases, relays 91 and 92 are released in succession and since the disconnect signal is ineffective to re-

energize the middle winding of relay 95, this relay remains in its released condition.

Various modifications may be made in the signal receiver shown in Figs. 2, 3 and 4 within the scope of the invention.

What is claimed is:

1. A signal receiver for responding to signals consisting of frequency modulated signaling current of constant amplitude without responding to amplitude modulated current of like frequencies, said receiver comprising a frequency detector, a signal relay operatively controlled by said detector in response to said signals, and means including an amplitude detector for blocking the operation of said frequency detector to prevent operation of said relay responsive to current varying in amplitude.

2. A signal receiver for connection to a line adapted to transmit voice currents, said signal receiver adapted to respond to signals consisting of signaling current of a particular frequency characteristic and constant amplitude without responding to voice currents or other interference currents of like frequency but varying amplitude, said receiver comprising a signaling channel including a signal relay operatively connected for response to signaling current and a blocking channel responsive only to current of varying amplitude for disabling the operation of said signaling channel.

3. A signal receiver comprising input terminals, a signal relay, means including a frequency detector connecting said relay to said terminals for operation in response to the impression of a signaling voltage varying in frequency at a predetermined rate between predetermined limits, and means including an amplitude detector effective in response to the impression of voltages of varying amplitude across said terminals to render said frequency detector inoperative.

4. A signal receiver comprising input terminals, an amplifier, means including a band-pass filter connecting said terminals to the input side of said amplifier, said filter tuned to pass alternating current within predetermined limiting frequencies, a detector, means including a tuned network antiresonant at the mean frequency between said limiting frequencies connecting the output of said amplifier to the input of said detector, a signal relay, and means including a network resonant at a predetermined frequency connecting said detector to a winding of said relay.

5. A signal receiver comprising input terminals, an amplifier, means including a band-pass filter connecting said terminals to the input side of said amplifier, said filter tuned to pass alternating current within predetermined limiting frequencies, a detector, means including a tuned network antiresonant at the mean frequency between said limiting frequencies connecting the output of said amplifier to the input of said detector, a signal relay, means including a network resonant at a predetermined frequency connecting said detector to a winding of said relay, and means including means for detecting variations in the amplitude of the current passed by said filter for preventing the operation of said relay.

6. A signal receiver comprising input terminals, an amplifier, means including a band-pass filter connecting said terminal to the input side of said amplifier, said filter adapted to pass alternating current within two predetermined limiting frequencies, means connecting the output side of the first-mentioned amplifier to the in-

put side of said other amplifier, a detector, a transformer connecting the anode-cathode circuit of said other amplifier to the input side of said detector, an antiresonant network tuned to the mean frequency of said limiting frequencies, said network connected in parallel with the primary winding of said transformer to impress on said detector a voltage modulated in amplitude at a frequency equal to twice the rate at which the frequency of the voltage impressed on said terminals varies between said limiting frequencies, a signal relay, and means in the anode-cathode circuit of said detector including means tuned to resonance at a predetermined frequency for operatively energizing said relay when the voltage impressed on said terminals varies in frequency between said limiting frequencies at a rate equal to the last-mentioned predetermined frequency.

7. A signal receiver comprising input terminals, an amplifier, means including a band-pass filter connecting said terminals to the input side of said amplifier, said filter tuned to pass alternating current within predetermined limiting frequencies, a detector, means including a tuned network antiresonant at the mean frequency between said limiting frequencies connecting the output of said amplifier to the input of said detector, a signal relay, means including a network resonant at a predetermined frequency connecting said detector to a winding of said relay, and means including means for detecting variations in the amplitude of the current passed by said filter for preventing the operation of said relay.

8. A signal receiver comprising input terminals, an amplifier, means including a band-pass filter connecting said terminals to the input side of said amplifier, said filter tuned to pass alternating current within predetermined limiting frequencies, a detector, means including a tuned network antiresonant at the mean frequency between said limiting frequencies connecting the output of said amplifier to the input of said detector, a signal relay, means including a network resonant at a predetermined frequency connecting said detector to a winding of said relay, and means including means for detecting variations in the amplitude of the current passed by said filter for controlling the operation of said amplifier to prevent the operation of said relay.

9. A signal receiver comprising input terminals, an amplifier, means including a band-pass filter connecting said terminals to the input side of said amplifier, said filter tuned to pass alternating current within predetermined limiting frequencies, a detector, means including a tuned network antiresonant at the mean frequency between said limiting frequencies connecting the output of said amplifier to the input of said detector, a signal relay, means including a network resonant at a predetermined frequency connecting said detector to a winding of said relay, and means including means for detecting variations in the amplitude of the current passed by said filter for impressing a negative bias on the control grid of said amplifier.

10. A signal receiver comprising input terminals, an amplifier, means including a band-pass filter connecting said terminals to the input side of said amplifier, said filter tuned to pass alternating current within predetermined limiting frequencies, a detector, means including a tuned network antiresonant at the mean frequency between said limiting frequencies connecting the

output of said amplifier to the input of said detector, a signal relay, means including a network resonant at a predetermined frequency connecting said detector to a winding of said relay, and means including means for detecting variations in the amplitude of the current passed by said filter for impressing a negative bias on the control grid of said amplifier, sufficient to prevent the operation of said relay.

11. A signal receiver comprising input terminals, an amplifier, means including a band-pass filter connecting said terminals to the input side of said amplifier, said filter tuned to pass alternating current within predetermined limiting frequencies, a detector, means including a tuned network antiresonant at the mean frequency between said limiting frequencies connecting the output of said amplifier to the input of said detector, a signal relay, means including a network resonant at a predetermined frequency connecting said detector to a winding of said relay, biasing means connected in the grid-cathode circuit of said amplifier, and means including means for detecting variations in the amplitude of the current passed by said filter for building up a biasing potential across said biasing means.

12. A signal receiver comprising input terminals, an amplifier, means including a band-pass filter connecting said terminals to the input side of said amplifier, said filter tuned to pass alternating current within predetermined limiting frequencies, a detector, means including a tuned network antiresonant at the mean frequency between said limiting frequencies connecting the output of said amplifier to the input of said detector, a signal relay, means including a network resonant at a predetermined frequency connecting said detector to a winding of said relay, a grid condenser and grid leak resistor connected in the grid-cathode circuit of said detector, and means including rectifying means and a filter adapted to pass current of frequencies below a cut-off frequency lying between twice the last-mentioned predetermined frequency and twice the lowest of said predetermined limiting frequencies connecting said grid condenser and resistor to the first-mentioned filter, whereby the impression of a voltage which varies in amplitude across said terminals effects the building up of a negative biasing potential across said grid condenser and resistor to prevent the operation of said relay.

13. A signal receiver comprising input terminals, a signal relay for operation responsive to signals consisting of current of constant amplitude varying in frequency at a predetermined rate between two predetermined limiting frequencies, and means operatively connecting a winding of said relay to said filter, said means including a band-pass filter adapted to pass current within said limiting frequencies, including a network antiresonant at a mean frequency between said limiting frequencies, and including a detector tuned to a frequency equal to twice said predetermined rate, and means including means for detecting variations in the amplitude of the current passed by said filter for preventing the operation of said relay.

14. A signal receiver comprising input terminals, a band-pass filter connected to said terminals adapted to pass current of frequencies between two predetermined frequencies F_1 and F_2 and to pass current of frequencies between two different predetermined frequencies F_3 and F_4 , a signal means connected to said filter and oper-

active in response to signaling current varying in frequency at a predetermined rate p between frequencies $F1$ and $F2$, and a signal means connected to said filter and operative in response to signaling current varying in frequency at said rate p between said frequencies $F3$ and $F4$.

15. A signal receiver comprising input terminals, a band-pass filter connected to said terminals adapted to pass current of frequencies between two predetermined frequencies $F1$ and $F2$ and to pass current of frequencies between two different predetermined frequencies $F3$ and $F4$, a signal means connected to said filter and operative in response to signaling current varying in frequency at a predetermined rate p between frequencies $F1$ and $F2$, a signal means connected to said filter and operative in response to signaling current varying in frequency at a predetermined rate p between said frequencies $F3$ and $F4$, and means connected to said filter responsive to current of varying amplitude for preventing the operation of either of said signal means.

16. A signal receiver comprising input terminals, a signal relay, a band-pass filter connected to said terminals and adapted to pass current of frequencies between two predetermined frequencies $F1$ and $F2$ and adapted to pass current between two different predetermined frequencies $F3$ and $F4$, means including a network tuned to the mean frequency between $F1$ and $F2$ for operating said relay in response to signaling current varying in frequency at a predetermined rate p between $F1$ and $F2$, and means including a network tuned to the mean frequency between $F3$ and $F4$ for releasing said relay in response to signaling current varying in frequency at said rate p between $F3$ and $F4$.

17. A signal receiver comprising input terminals, a signal relay, a band-pass filter connected to said terminals and adapted to pass current of frequencies between two predetermined frequencies $F1$ and $F2$ and adapted to pass current between two different predetermined frequencies $F3$ and $F4$, means including a network tuned to the mean frequency between $F1$ and $F2$ for operating said relay in response to signaling current varying in frequency at a predetermined rate p between $F1$ and $F2$, means including a network tuned to the mean frequency between $F3$ and $F4$ for releasing said relay in response to signaling current varying in frequency at said rate p between $F3$ and $F4$, and means connected to said filter for detecting variations in amplitude of current passed by said filter for preventing operative response by said relay.

18. A signal receiver comprising input terminals, two signal relays, a band-pass filter connected to said terminals adapted to pass current of frequencies between two predetermined frequencies $F1$ and $F2$ and adapted to pass current

of frequencies between two other predetermined frequencies $F3$ and $F4$, an amplifier connected to said filter, means including a network tuned to the mean frequency between $F1$ and $F2$ operatively connecting one of said relays to said filter for response to signaling current varying in frequency between $F1$ and $F2$, and means including a network tuned to the mean frequency between $F3$ and $F4$ operatively connecting both of said relays to said filter for response to signaling current varying in frequency between $F3$ and $F4$.

19. A signal receiver comprising input terminals, two signal relays, a band-pass filter connected to said terminals adapted to pass current of frequencies between two predetermined frequencies $F1$ and $F2$ and adapted to pass current of frequencies between two other predetermined frequencies $F3$ and $F4$, an amplifier connected to said filter, means including a network tuned to the mean frequency between $F1$ and $F2$ operatively connecting one of said relays to said filter for response to signaling current varying in frequency between $F1$ and $F2$, means including a network tuned to the mean frequency between $F3$ and $F4$ operatively connecting both of said relays to said filter for response to signaling current varying in frequency between $F3$ and $F4$, and means connected to said filter and including means for detecting variations in amplitude of current passed by said filter for preventing the operative response of said relays.

20. A signal receiver comprising input terminals, two signal relays, a band-pass filter connected to said terminals and adapted to pass current between two predetermined frequencies $F1$ and $F2$, means connected to said filter and responsive to signaling current varying in frequency between $F1$ and $F2$ at a predetermined rate for operating one of said relays, and means connected to said filter and responsive to signaling current varying in frequency between $F1$ and $F2$ at a different predetermined rate for operating the other of said relays.

21. A signal receiver comprising input terminals, two signal relays, a band-pass filter connected to said terminals and adapted to pass current between two predetermined frequencies $F1$ and $F2$, means connected to said filter and responsive to signaling current varying in frequency between $F1$ and $F2$ at a predetermined rate for operating one of said relays, means connected to said filter and responsive to signaling current varying in frequency between $F1$ and $F2$ at a different predetermined rate for operating the other of said relays, and means connected to said filter and responsive to current varying in amplitude for preventing the operation of either of said relays.

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