

Nov. 12, 1935.

P. W. WADSWORTH ET AL

2,020,487

ELECTRICAL SIGNALING

Filed May 26, 1934

FIG. 1

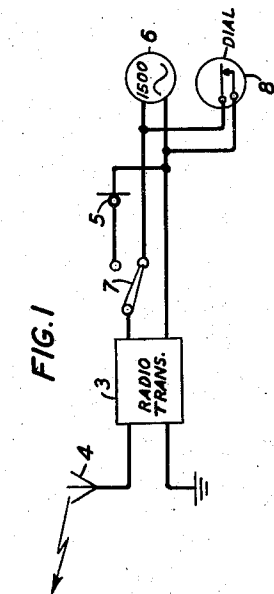
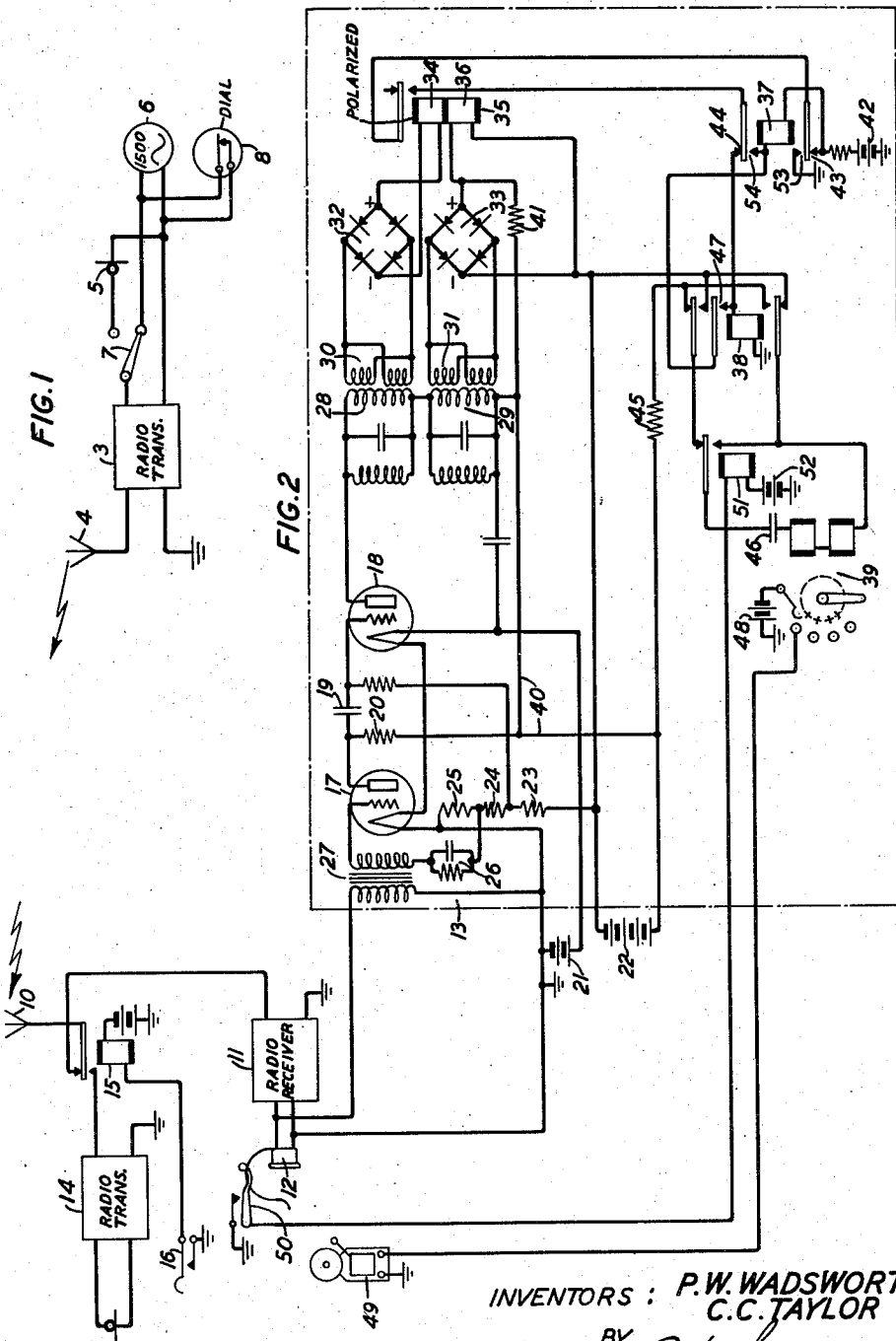


FIG. 2



INVENTORS : P.W. WADSWORTH
C.C. TAYLOR

BY

G.H. Stevenson

ATTORNEY

UNITED STATES PATENT OFFICE

2,020,487

ELECTRICAL SIGNALING

Paul W. Wadsworth, Lindenhurst, and Charles C. Taylor, Bayside, N. Y.; said Wadsworth assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York, and said Taylor assignor to American Telephone and Telegraph Company, a corporation of New York

Application May 26, 1934, Serial No. 727,612

12 Claims. (Cl. 179—84)

This invention relates to electrical signaling and particularly to voice frequency calling for telephone systems especially of the radio or carrier type.

An object of the invention is to reduce the effect of disturbances in electrical signaling systems.

A further object of the invention is to prevent the false operation of voice frequency calling systems by voice or noise currents.

In a specific preferred embodiment of the invention calling in a radio telephone system is effected by transmitting pulses of alternating current of a frequency in the voice range. At the receiver the audio frequency output of the detector or amplifier divides into two parallel paths, one to the voice amplifier and the other to the ringing circuit. The latter comprises an amplifier having an automatic volume limiting action which operates through a circuit having a time constant which is long compared to the duration of a pulse of calling current. The output of this amplifier is supplied to two parallel paths each including a selective circuit and a rectifier. One of these circuits is selective to the calling signal to the exclusion of currents of other frequencies. The other is selective to another signal frequency at which the energy level of voice and noise currents are normally equal to or greater than their energy level at the frequency of the calling signal. The output of the first rectifier is supplied to the operating winding of a polarized relay and that of the other rectifier to the biasing winding of the relay.

Thus in the presence of voice or noise currents only, the effect of currents of the frequency of the calling signal on the operating winding of the relay will be counteracted by the effects of currents of the second frequency on the polarizing winding. On the other hand, when a pulse or pulses of the calling current are being received their effect on the operating winding will predominate and the relay will be operated.

The polarized relay operates a selector of the railway type disclosed and claimed in Patent 1,343,256 to J. C. Field, June 15, 1920. This selector is operated by current reversals, alternate current impulses of opposite polarity each causing the selector to advance one step in the same direction.

The operating current for the selector is obtained from the charging current of a condenser controlled through a pulse dividing relay chain operated by the polarized relay. The effect of the pulse dividing relay chain is to cause the se-

lector to be stepped once only for each combination of a marking and a spacing signal, that is, for the combination of a pulse of calling current and a pause in the transmission thereof.

The use of the pulse dividing circuit has several advantages, particularly in reducing the possibility of false operation of the selector. In this connection it cooperates with the time constant of the condenser supplying operating current to the selector to give an effective band-pass tuning for the calling signal, the relays giving an upper limit of signaling speed and the condenser circuit a lower limit.

The invention is not limited to the embodiment described. In particular, the system is not limited in its application to radio system but is also useful in wire systems both of the voice frequency and carrier type. Also, various features, either alone or in combination will be found very useful in telegraph systems.

These and other features and aspects of the invention may be more clearly understood by reference to the following detailed description in connection with the drawing in which:

Fig. 1 shows diagrammatically the transmitter of a radio telephone station arranged for transmitting telephone and calling signals; and

Fig. 2 shows diagrammatically one of a group of radio telephone stations arranged to receive telephone and calling signals from the station of Fig. 1.

Fig. 1 shows a radio transmitter arranged to transmit radio signals from the antenna. The signals are modulated either by voice currents from the telephone transmitter or by calling currents from the 1500 cycle oscillator. A switch is provided for alternately connecting a telephone transmitter or calling signal oscillator to the transmitter.

The transmission of the calling signals is controlled by dial the pulsing contacts of which normally short-circuit the output of the oscillator. A pulsing speed of 7 cycles per second has been found very satisfactory though, of course, the optimum speed is determined in part by the character of the relays used in the receiving circuit. The dial will transmit codes of impulses for selectively calling other stations.

Fig. 2 shows diagrammatically one of the radio telephone stations which may be called for communication with the station of Fig. 1. The waves from the transmitter of Fig. 1 are received in the antenna and impressed on the radio receiver where they are detected. The voice frequency output of the receiver is branched

between a telephone receiver circuit 12 and a calling signal selector circuit 13.

The radio telephone station of Fig. 2 is also shown as equipped with a radio transmitter 14 which may be alternatively connected to the antenna 10 through the operation of the relay 15 by the key 16, although this feature is incidental to the invention.

The calling signal receiving unit 13 comprises first a two-stage amplifier employing two tubes 17 and 18 coupled in tandem through condenser 19 and resistance 20. Cathode heating current for both tubes is supplied from the battery 21 and space current from the battery 22. A resistance network comprising the resistance units 23, 24 and 25 is connected between the negative terminal of the battery 22 and the cathodes of the tubes to provide normal grid biasing potentials for the tubes 17 and 18. A grid leak-condenser circuit 26 connected to the grid circuit of tube 17 provides volume limiting or control action as will be described in detail hereinafter. The signal output of the radio receiver 11 is impressed on the grid of the tube 17 through a transformer 27. While the amplifier is shown as a separate unit it may be combined in the radio receiver and used for the amplification of voice as well as calling signals.

The output of the tube 18 is impressed on two series connected tuned circuits 28 and 29. Secondary windings 30 and 31 are coupled to the inductances of the tuned circuits 28 and 29, respectively. The circuit 28 is tuned to 1500 cycles, the frequency of the calling signal, while the circuit 29 is tuned to another frequency in the voice range, preferably 600 cycles.

The transformer windings 30 and 31 are connected to bridge type rectifiers 32 and 33, respectively, preferably made up of units of the copper oxide type. The output of the rectifier 32 is supplied to the operating winding 34 of a polarized relay 35 and the output of the rectifier 33 is connected to the biasing winding 36 of the same relay.

The relay 35 operates through a pulse dividing circuit comprising relays 37 and 38 to operate a selector 39 of the type used in railway telephone dispatching systems and disclosed and claimed in Patent 1,343,256 to J. C. Field, June 15, 1920. The selector consists essentially of a polar relay operated by successive direct current pulses of alternate polarity with a ratchet attachment so arranged that successive operations of the relay at the proper speed causes stepping around of the contact wheel. Stop pins at certain points prevent the contact wheel from returning to its normal position when the regular sequence of stepping is interrupted at these points. Any interruption of the regular sequence of stepping when the contact wheel is at any other point causes it to release. After the wheel has rotated through a definite angle which is adjustable it makes a contact. By adjusting this angle and the position of the stop pins for intermediate sets of pulses the selector can be made responsive to any one of a large variation of calling pulse combinations.

The relay 35 is normally polarized in the open position shown by current supplied from the positive terminal of battery 22 through leads 40 and resistance 41. The output of the rectifier 33 adds to this polarizing current to further increase the bias on the relay.

In the absence of calling signals in the output of the radio receiver 11 the noise or voice cur-

rent will normally include components in both the 1500 and 600 cycle range. As is well known static in radio systems and line noise in wire systems are normally made up of components fairly well distributed in the voice range. A study of the amplitude distribution in speech has shown that the component at 600 cycles will be equal to or larger than the component at 1500 cycles, except at infrequent intervals when the 1500 cycle component may be larger than the 600 cycle component but usually only for a very short time of insufficient duration to cause a false operation of relay 35. In this connection, reference is made to a paper entitled "The sounds of speech" by I. B. Crandall, Bell System Technical Journal, October 1925. Consequently, during such periods these components will be amplified in the tubes 17 and 18 and supplied through the selector circuits 28 and 29 to rectifiers 32 and 33, so that there will be present in the winding of the relay 35 not only an operating current from the 1500 cycle component selected by the circuit 28 but also a biasing current of equal or greater amplitude from the 600 cycle component selected by the circuit 29. This tends to increase the biasing current through the winding 36 so as to at least balance out the effect of the current supplied to the operating winding 34.

The effect of speech and noise currents is further reduced by the grid leak-condenser circuit 26 which in the presence of current in the grid circuit of the tube 17 tends to increase the negative bias on the grid and, consequently, to reduce the gain of the amplifier circuit, thus reducing the amplitude of the current impressed on the winding of the relay 35. The time constant of this circuit is made somewhat longer than the length of a dialing pulse. Since speech and noise currents are normally fairly continuous as compared to the period of the dialing pulse, the network 26 will operate to materially reduce the gain of the amplifier in the presence of such currents but its period being long compared to the length of a dialing pulse, the gain will not be materially lowered during such an interval.

In the presence of spurts of 1500 cycle calling signal these components will be selected in the circuit 28, rectified in the rectifier 32 and impressed on the operating winding 34 overpowering the normal bias and any bias which may come from 600 cycle noise currents, thus operating the relay 35. The normal grid potential of the tube 17 is small and an input potential of any material amplitude tends to drive the grid positive charging the condenser of the circuit 26 and thereby lowering the gain of the amplifier proportionately to the volume of signal received to keep constant the total amplifier output which is impressed on the tuned circuits 28 and 29. This constant volume output characteristic of the amplifier aids materially in signaling through a high noise level for when a 1500 cycle tone is impressed on the amplifier, the 600 cycle or biasing frequency component must necessarily be decreased since the total volume is constant. When the input voltage is removed the resistance of the circuit 26 discharges the condenser and permits the gain to again increase. The values of the resistance and condenser elements are so chosen that the gain of the amplifier increases somewhat during a spacing interval between pulses of calling current. Also the constants of these elements are such that the gain of the amplifier will not be materially lowered during a period of time corresponding to a pulse

of calling current but only in a longer period. While the gain starts to go down during a spurt of calling signals, thereby to some extent decreasing the noise current and their effect on the relay 35, the initial spurt of current at the beginning of the calling pulse is large and its action in operating the relay 35 enables calling in the presence of a higher noise level than would be possible without the volume limiting action.

As described above, in the presence of pulses of 1500 cycle calling current the relay 35 will be operated during the pulse and released during the spacing interval between pulses. The operation of the relay 35 by a pulse of 1500 cycle calling current (marking signal) closes the circuit for the operation of relay 38 from the positive terminal of battery 42, resistance 56, contact 43 of relay 37, contact of relay 35, contact 44 of relay 37, and windings of relay 38. The operation of relay 38 reverses the current supplied from the battery 22 to the winding of the selector 39 through resistance 45 and condenser 46. This causes a charging current to flow through condenser 46 and the winding of relay 39 operating the selector and advancing it one step. When the relay 35 releases during a spacing interval in the transmission of calling current, relay 37 operates in series with the relay 38 which remains operated. The operating circuit may be traced from the positive terminal of battery 42 through resistance 56, the winding of relay 37, contact 47 of relay 38, winding of relay 38 to ground and the negative terminal of battery 42.

When a second marking signal, that is, a second pulse of calling current, operates relay 35 the relay 38 is released by a short-circuiting circuit formed around its winding from ground through contact 53 of relay 37, contact of relay 35 and contact 54 of relay 37, and contact 47 of relay 38, to upper terminal of the winding of relay 38. The releasing of relay 38 by this action again reverses the voltage supplied across the condenser 46 and the winding of the selector 39, causing a charging current to flow and advance the selector a second step, (the construction of selector 39 is such that it advances a step for a current in either direction through its operating winding). Relay 37 remains operated during this marking interval. When the relay 35 next releases during the next spacing interval, relay 37 releases and relay 38 remains released, restoring the circuit to the condition shown in the drawing.

Thus the relay 38 reverses the polarity on the condenser and operating winding circuit of selector 39 and operates the selector for each operation of the relay 35, that is, for each combination of a marking and a spacing interval of the calling current.

This pulse dividing circuit acts like a low-pass filter preventing impulses which reoccur within a period shorter than the operating time of the relays 37 and 38 from affecting the selector 39.

The operating mechanism of the selector 38 is operated while the condenser 46 is charging but releases when the charge is completed. The time constant of the circuit from the battery 22 through the condenser 46 and resistance 45 is such that the selector is held operated between successive pulses of calling current but does release between digits permitting the contact wheel in the selector to return to normal when it is not resting on a stop pin, the time between pulses or digits being longer than the pulse interval. This action also aids in protecting against false

operation. If the selector is stepped by an impulse of noise or speech current but no further impulse occurs within the normal pulsing period, the selector wheel will fall back. This action is effectively that of a high-pass filter since the period between impulses which will be effective in stepping the selector must not be longer than the charging time of the circuit of condenser 46.

When digits corresponding to the code setting of the selector 39 have been received it is advanced to its final stop pin and a circuit is closed from battery 48 through the contact of the selector 39 and bell 49 to ground and the other terminals of battery 48, thus operating the bell to give a signal that a station is being called.

When the operator answers by removing the receiver from the switchhook 50 connection is made from ground through the switchhook 50, winding of relay 51 and battery 52, operating the relay 51 and closing a circuit for the discharge of the condenser 46, through lower contact of relay 51 and the winding of selector 39, advancing the selector one step and so returning it to normal, since the digit 1 is used as a release signal and not as a code number.

Similarly the alarm may be stopped from the transmitting station by sending a single pulse which will advance the selector one step and return it to normal.

The selector 39 and consequently the alarm can not be operated when the receiver is off the switchhook 50, since in this position the selector winding is short-circuited through the condenser 46 and not connected to the operating circuit.

Instead of using the relay 51, as just described, the switchhook may be connected directly in parallel with the contacts of relay 35. Thus, when it is operated it will function in the same manner as though a single pulse of dialing current were transmitted.

Although the selector 39 will be inoperative during the time that the station of Fig. 2 is being used to receive telephone messages, if another of the group of similar stations is called by the central station represented in Fig. 1, the selector 39 will be in an operative position while conversation is taking place between those stations. During such a period speech waves will be impressed on the signal receiving circuit 13 and it is such signals as well as noise during idle periods that the features of this invention are adapted to protect against.

What is claimed is:

1. In a telephone system, a sending station, means at said sending station to produce calling signals formed of code combinations of groups of audible tone waves of a frequency falling into one part of the voice band, a receiving station, means to transmit either said audible tone waves or voice waves from said sending station to said receiving station, means at said receiving station to receive the transmitted wave, said means comprising a wave converter responsive to waves in the frequency of said tone wave, a second converter responsive to waves of audible frequencies falling into another part of the voice band in which the energy level for speech is always at least equal to the energy level at the frequency of said tone waves, and control means balanced with respect to the output of said converters whereby said control means will respond to audible tone waves but voice waves and noise waves having components falling within the responsive

ranges of both converters will tend to balance out with respect to said control means.

2. In a telephone system, a sending station, means at said sending station to produce calling signals formed of code combinations comprising groups of audible tone waves of a frequency in the voice band, a receiving station, means to transmit either said audible tone waves or voice waves from said sending station to said receiving station, means at said receiving station to receive the transmitted waves, said means comprising an amplifier having a large gain at the beginning of a group of audible tone waves but whose gain is automatically decreased in response to sustained waves such as voice or noise waves whereby the volume differences between frequencies in different parts of the voice band are limited, said receiving means also comprising a wave converter selectively responsive to waves of the frequency of said tone waves, a second converter selectively responsive to audible waves falling into another part of the voice band, and control means balanced with respect to the output of said converters whereby said control means will respond to said audible tone waves but voice waves and noise waves having components falling within the responsive ranges of both converters will tend to balance out with respect to said control means.

3. In a telephone system, a sending station, means at said sending station to produce calling signals formed of code combinations comprising groups of tone waves, a receiving station, means to transmit said tone waves from said sending station to said receiving station, means at said receiving station to receive said tone waves and other frequencies such as voice waves, said means comprising a wave converter responsive to waves of the frequency of said tone waves, a second converter responsive to other frequencies, a variable gain amplifier arranged to deliver a substantial constant total output volume of interference and signal over a wide range of input volume, and control means balanced with respect to the output of said converters whereby said control means will respond to said tone waves but interfering waves will tend to balance out with respect to said control means.

4. In a telephone system, a sending station, means at said sending station to produce calling signals formed of code combinations comprising groups of tone waves, a receiving station, means to transmit said tone waves from said sending station to said receiving station, means at said receiving station to receive said tone waves and other frequencies such as voice waves, said means comprising a wave converter selectively responsive to waves of the frequency of said tone waves, a second wave converter selectively responsive to other frequencies, said converters being arranged to have equal attenuation at the frequencies to which they are responsive over a wide range of input volume, and control means balanced with respect to the output of said converters whereby said control means will respond to said tone waves but interfering waves will tend to balance out with respect to said control means.

5. In a telephone system, a sending station, means at said sending station to produce calling signals formed of code groups each element of which comprises a marking impulse and a spacing impulse, transmitted at a definite time interval, said marking impulse comprising tone waves, a receiving station, means to transmit said tone waves from said sending station to said receiving station, means at said receiving station to receive

said tone waves and other frequencies such as voice waves, said means comprising an amplifier having a large gain but whose gain is automatically decreased by said tone waves, the amplifier having constants such that its gain decreases appreciably during a marking interval and increases appreciably during a spacing interval, said amplifier gain also being decreased by noise waves, said receiving means also comprising a wave converter selectively responsive to waves of the frequency of said tone waves, a second converter selectively responsive to noise waves falling in another part of the audible band and control means balanced with respect to the output of said converters whereby noise waves having components falling within the responsive ranges of both converters will be limited and tend to balance out with respect to said control means, but said control means will respond to said tone waves, the action of the amplifier assisting it to respond to tone waves of weaker level with respect to the level of the noise waves than would otherwise be possible.

6. In a telephone system, a sending station, means at said sending station to produce calling signals formed of code combinations and convert them into groups of tone waves, a receiving station, means to transmit said tone waves and other frequencies such as voice waves from said sending station to said receiving station, means at said receiving station to receive said tone waves and other frequencies, said means responding to said tone waves that when said tone waves are not present said means so functioning that false indications are not produced by voice or noise signals, said means comprising an amplifier whose gain is automatically decreased in response to sustained waves such as voice waves and noise waves whereby the volume difference between frequencies in different parts of the audible band are limited, said receiving means also comprising a wave converter responsive to said tone waves, a second converter responsive to waves in another part of the voice band, and means balanced with respect to the output of said converters whereby voice waves and noise waves having components falling within the respective ranges of both converters will tend to balance out, the volume differences between the two ranges being so limited by the amplifier that the unbalance remains below a predetermined value.

7. In a telephone system, a selective calling signal receiver for receiving calling signals comprising code combinations each composed of pulses of oscillations of a definite frequency in the voice range and spacing signals in which no pulses are transmitted, said receiver comprising an amplifier including a volume limiting circuit having a time constant such that the gain of the amplifier is slightly reduced while receiving a marking signal and restored to maximum during a spacing signal while being markedly reduced in the presence of sustained waves, and an output circuit for said amplifier including a circuit selective to oscillations of said definite frequency, and a second circuit selective to oscillations of another frequency in the voice range, and a relay having an operating winding responsive to the output of the first selective circuit and a biasing winding responsive to the output of a second selective circuit.

8. A combination according to claim 7 in which the second circuit is selective to waves of another frequency in the voice range at which the energy level for speech is always at least equal to the

speech energy level at the definite frequency of the oscillations comprising a marking signal.

9. A combination according to claim 7 in which the frequency of the oscillations forming the marking signal is of the order of 1500 cycles per second and the frequency to which the second circuit is selective is of the order of 600 cycles per second.

10. In a telephone system, a selective calling signal receiver responsive to a code combination of pulses of oscillations of the order of 1500 cycles per second comprising a circuit selective to oscillations of 1500 cycles per second, a second circuit selective to oscillations of the order of 600 cycles per second to the exclusion of oscillations of other frequencies and a relay having an operating winding responsive to the output of the first selective circuit and a biasing winding responsive to the output of the second selective circuit.

11. In a telephone system a selective calling signal receiver responsive to code combinations of pulses of oscillations of a definite frequency

in the speech frequency range transmitted at a definite rate, said receiver comprising a first circuit selective to oscillations of said definite frequency, a second circuit selective to oscillations of another frequency in the speech frequency range, a relay having an operating winding responsive to the output of said first circuit and a biasing winding responsive to the output of said second circuit, a signal selector operated by said relay, and means for preventing the operation of said selector by operations of said relay at any rate higher or lower than said definite rate of transmission of pulses.

12. A combination according to claim 11 in which the second circuit is selective to a frequency at which the energy level for speech is always at least equal to the speech energy level at the definite frequency of the oscillations of the pulses comprising the calling signal.

20

PAUL W. WADSWORTH.
CHARLES C. TAYLOR.