

Aug. 25, 1942.

H. E. VAUGHAN

2,293,869

SIGNALING SYSTEM

Filed Sept. 14, 1940

2 Sheets-Sheet 1

FIG. 1

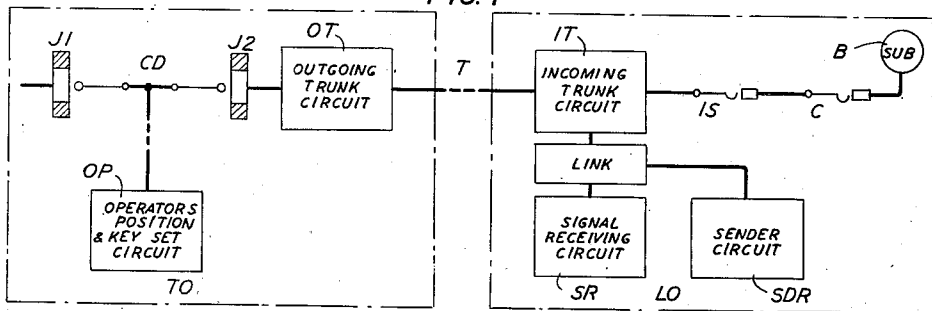
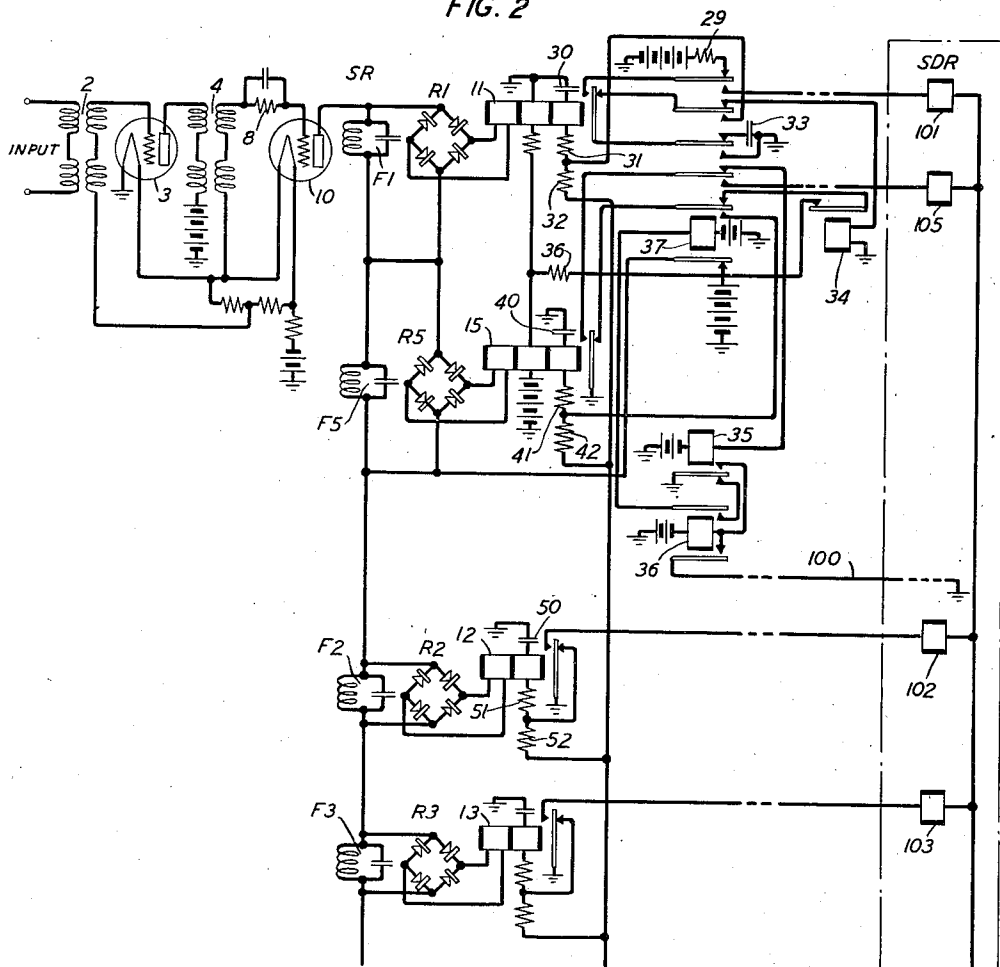


FIG. 2



INVENTOR
H. E. VAUGHAN

BY

R. D. Covell

ATTORNEY

Aug. 25, 1942.

H. E. VAUGHAN

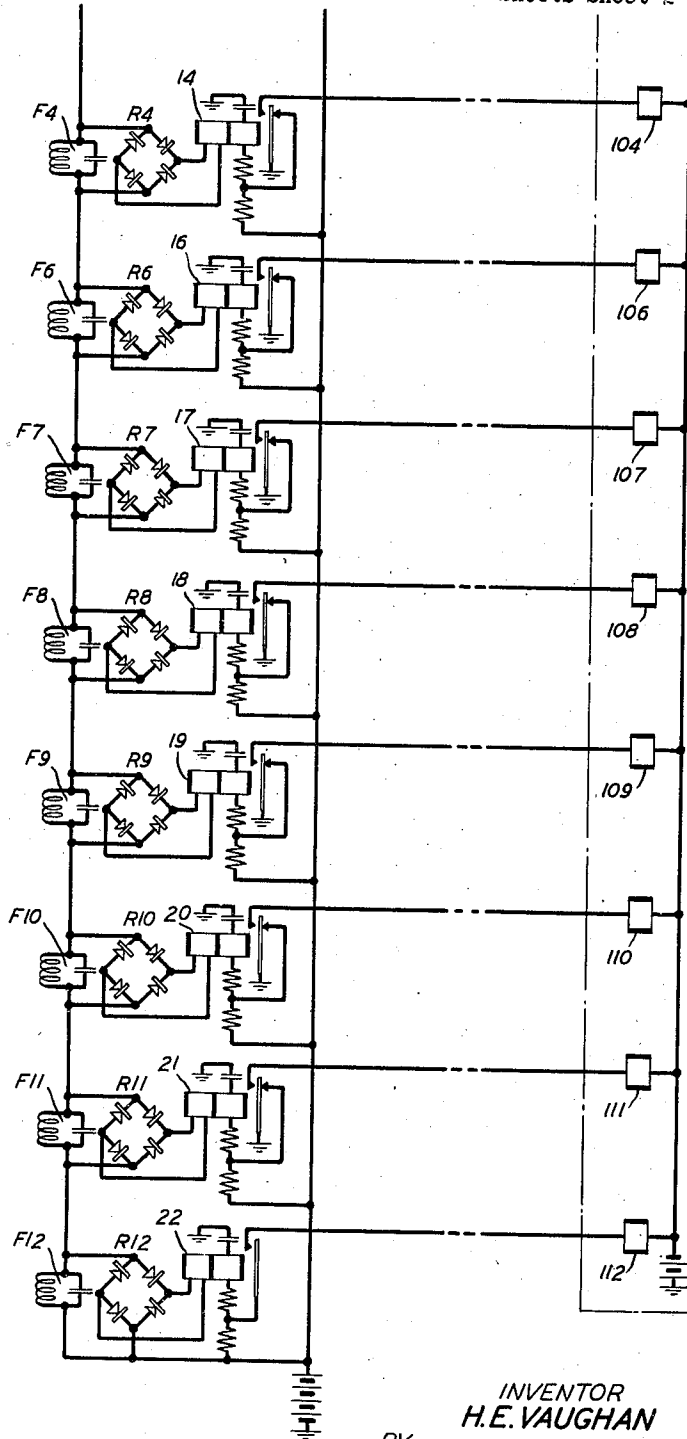
2,293,869

SIGNALING SYSTEM

Filed Sept. 14, 1940

2 Sheets-Sheet 2

FIG. 3



INVENTOR
H. E. VAUGHAN
BY
R. O. Correll

ATTORNEY

UNITED STATES PATENT OFFICE

2,293,869

SIGNALING SYSTEM

Henry E. Vaughan, Valley Stream, N. Y., assignor
to Bell Telephone Laboratories, Incorporated,
New York, N. Y., a corporation of New York

Application September 14, 1940, Serial No. 356,716

5 Claims. (Cl. 177-353)

This invention relates to signaling systems and particularly to voice frequency signaling in automatic and semiautomatic telephone systems.

It is the object of the invention to increase the adaptability, reliability and efficiency of voice frequency signaling and to provide a voice frequency signal receiver which is arranged to receive and selectively respond to an increased number of separate signals.

This invention is a voice frequency signal receiver arranged to receive and respond to a first or conditioning signal comprising current of a first particular frequency followed by current of a second particular frequency, and thereafter to any one of twelve other signals, each other signal comprising current of a different one of twelve signaling frequencies including said first and second particular frequencies. According to one feature of the invention, the signal receiver is arranged so that each of twelve signal relays is selectively connected for response to signaling current of a different one of the twelve frequencies. The arrangement is one in which proper signal response is unaffected by variations in the energy level of the signaling current and differences in the level of the various frequencies at the signal receiver, providing the signal current of each frequency is high enough to effect the operation of a signal relay.

According to another feature of the invention, a signal receiver comprises a plurality of signal relays, each arranged for selective response to current of a different one of a corresponding plurality of frequencies, only one of the signal relays being normally operable, the operation of this relay being effective to render a second one of the relays operable, and the operation of this second relay within a predetermined interval of time after the operation of the one relay being effective to render the other signal relays operable.

A clear and complete understanding of the invention will be facilitated by considering a system in which the invention is embodied, one such system being shown schematically in the drawings which form a part of this specification. The invention is not limited, however, in its application to the particular system shown in the drawings but is generally applicable to any voice frequency signaling system.

Referring to the drawings:

Fig. 1 shows a telephone system comprising a toll office TO and a local office LO; and

Figs. 2 and 3 show a signal receiving circuit SR and an associated sender circuit SDR.

The toll office TO, which comprises a toll board and a number of operators' positions thereat for answering calls incoming from local and other toll offices and for extending connections to other toll offices and to local offices, is represented in the drawings by an operator's position equipment OP which includes a key-set for controlling the sending of selective signals, a cord CD, two jacks J1 and J2 and an outgoing trunk circuit OT connected to jack J2. The local office LO, which comprises switches for completing local and incoming calls and switches for connecting calling subscribers' lines to outgoing trunks is represented in the drawings by the incoming trunk circuit IT, signal receiving circuit SR, sender circuit SDR, incoming selector IS, connector C, and a called subscriber's station B. The signal receiving and sender circuits are common to a plurality of incoming trunk circuits. Upon seizure of a trunk T terminating in office LO, a link circuit connects the incoming trunk circuit IT with an idle signal receiving circuit SR and with an idle sender circuit SDR. Reference may be had to the patent to Carpenter et al. 1,780,906 of November 11, 1930 and the patent to Henry et al. 1,916,761 of July 4, 1933, for disclosure of systems including operators' positions equipped with key-sets and including senders arranged to receive selective signals transmitted upon operation of the various keys of the key-set.

The key-set in the toll office will, in addition to the numerical keys, comprise a KP key, the operation of which transmits a signal to condition the signal receiver SR for response to numerical signals, the ten numerical keys, a start key for use when immediate ringing of the subscriber's station is desired and a start key for use when ringing is to be started under the control of ringing key in the operator's cord circuit. Each of these keys, with the exception of the KP key, will be arranged to effect the transmission of signaling current of a different one of twelve different frequencies in the voice range. The KP key will be arranged to effect the transmission of a signal consisting of current of a first particular one of the twelve frequencies followed by current of a second particular one of the twelve frequencies. For instance, the KP signal may consist of current of the frequency *f*1 used for sending the digit 1 followed by current of the frequency *f*5 used for sending the digit 5. The twelve frequencies *f*1 to *f*12 are spaced apart to be adapted for selective operation of the signal receiver SR; for instance, the

frequencies used may be 425, 485, 550, 630, 720, 820, 925, 1060, 1190, 1380, 1565, 1770.

The sender SDR, which is represented in the drawings by the register and control relays 101 to 112, inclusive, comprises means for sending impulses to control the operation of the incoming selector IS, intermediate selectors (if any), and a connector C.

The signal receiver SR, which is shown in detail in Figs. 2 and 3, consists of an input transformer 2, the primary winding of which is connected to and through incoming trunk circuit IT to the conductors of a trunk line T, a three-element thermionic amplifier tube 3, a three-element voltage-limiting thermionic amplifier tube 10, a transformer 4 coupling the output of tube 3 to the input of tube 10, twelve filters F1 to F12, inclusive, each tuned to a different one of the twelve signaling frequencies f1 to f12, inclusive, transmitted by operation of the various keys of an operator's key-set in the toll office TO, twelve rectifiers R1 to R12, inclusive, twelve signal relays 11 to 22, inclusive, and auxiliary relays 34 to 37, inclusive. The filters F2, F3, F4 and F6 to F12, inclusive, are normally short-circuited by the lower back contact of relay 37 and for this reason relays 12, 13, 14 and 16 to 22, inclusive, are normally inoperative. The contacts of relays 11 and 15 are normally held in the position shown in this drawing by the energization of their middle, biasing windings in series. The biasing winding of relay 15 is normally further energized in series with resistor 36 so that relay 15 is not operatively responsive to signaling current; and relay 11 is, therefore, the only one of the twelve signal relays normally operable. Upon receipt of a conditioning signal, that is, a signal comprising current of frequency f1 followed by current of frequency f5, relay 11 is operated by the current of frequency f1 to render relay 15 operable and relay 15 is then operated by current of frequency f5 to effect the operation of relay 37, as hereinafter described. Relay 37 opens the short circuit around filters F2, F3, F4 and F6 to F12, inclusive, and thus renders all of relays 11 to 22 operable.

Signaling currents and also voice currents are transmitted through transformer 2, amplifier tube 3 and transformer 4 to the grid of tube 10. The resistor 8 in series with the grid of tube 10 limits the voltages impressed on the grid so that tube 10 acts as a peak limiting amplifier to pass at any one time only enough energy to the tuned circuits F1 to F12, inclusive, to effect the operation of one of the signal relays 11 to 22, inclusive. If all the energy thus passed is of one of the twelve signaling frequencies, the corresponding signal relay is operated; but if the energy thus passed includes more than one of the signaling frequencies or includes energy from voice currents or other interfering currents, the amount of energy of each frequency to which filters F1 to F12 are tuned is insufficient to effect the operation of the associated signal relay.

Assume now that a KP signal is transmitted over trunk T to the signal receiver SR, the primary winding of transformer 2 being thereby energized by current of frequency f1 followed by current of frequency f5. Since filter F1 is tuned to constitute a very high impedance at frequency f1, and while substantially all of the energy in the output circuit of tube 10 is of this frequency, the voltage impressed across the left winding of relay 11 effects the operation of relay 11, none of the other signaling relays be-

ing operated. The operation of relay 11 closes a circuit including resistor 29 for charging condenser 33. When the current of frequency f1 ends, relay 11 releases, closing a circuit for discharging condenser 33 through the winding of relay 34, the capacity of condenser 33 being sufficient to maintain the operative energization of relay 34 for about .030 second. Relay 34 opens the circuit through resistor 36, thereby decreasing the biasing current through the middle winding of relay 15 to render this relay operable by its left winding in response to current of frequency f5. If current of frequency f5 is received while relay 34 is operated, and substantially all of the current is of frequency f5, and since the filter F5 is tuned to constitute a very high impedance at frequency f5, the voltage impressed across rectifier R5 and the left winding of relay 15 effects the operation of relay 15, none of the other signaling relays being operated. Relay 15 closes a circuit for operating relay 35; relay 35 closes a circuit for operating relay 36; and relay 36 locks through its lower front contact and conductor 100 to ground in the associated sender circuit SDR. When the current of frequency f5 ceases, relays 15 and 35 release in succession. The release of relay 35 closes a circuit including the upper front contact of relay 36 for operating relay 37. Relay 37 disconnects resistor 29, condenser 33 and relays 34 and 35 from the contacts of relays 11 and 15 and connects these contacts to control the energization of the windings of register relays 101 and 105 of the sender circuit SDR. Relay 37 also opens the short circuit around filters F2, F3, F4 and F6 to F12, inclusive, thereby rendering all of relays 11 to 22 selectively operable responsive to signaling current transmitted over trunk T due to the operation of the numerical keys and start key at a calling operators' position in office TO.

If, after the operation of relay 37 in response to a KP signal, current of frequency f1 is received alone, relay 11 operates, closing a circuit for operating register relay 101 of sender SDR. The operation of relay 11 also opens a short circuit across the right winding of relay 11, thereby causing the charging of condenser 30 through this winding in series with resistors 31 and 32. The right winding of relay 11 is thus energized to hold relay 11 operated for a minimum of 0.30 second, even though the current of frequency f1 does not continue for this length of time, to insure the operation of the register relay 101 in the sender circuit. If current of frequency f5 is received alone, relay 15 operates, closing a circuit for operating register relay 105 and opening a short circuit around the right winding of relay 15 to charge condenser 40 through this winding in series with resistors 41 and 42 so as to maintain the energization of relay 15 long enough to insure the operation of register relay 105.

If current of any one of frequencies f2, f3, f4 and f6 to f12, inclusive, is received alone, the corresponding one of relays 12, 13, 14, and 16 to 22, inclusive, is operated, the operation of each being maintained for a long enough time to insure the operation of the corresponding register relay by the charging of a condenser through its right winding in a similar manner to that in which the operation of relays 11 and 15 is maintained as above described.

When the sender has completed its control of the switches through which connection with the called subscriber's line is completed, the sender

and signaling circuits are released, the disconnection of the holding ground from conductor 100 causing the successive release of relays 36 and 37 to return the signal receiving circuit SR to normal.

What is claimed is:

1. A signal receiver normally adapted to respond to a first signal consisting of current of a first particular frequency followed within a predetermined interval of time by current of a second particular frequency, and thereafter adapted to selectively respond to any one of a plurality of signals, each of said plurality of signals consisting of current of a different one of a like plurality of frequencies including said first and second particular frequencies, said receiver comprising signal relays, one for each of said frequencies, means for selectively passing to the operating winding of each of said relays signaling current of a different one of said frequencies, means normally rendering all of said signal relays except the two relays adapted for operation by current of said first and second particular frequencies operatively non-responsive to signaling current, and means rendered effective by the successive operation of said two relays in response to said first signal for rendering all of said relays selectively responsive to signaling current.

2. A signal receiver normally adapted to respond to a first signal consisting of current of a first particular frequency followed within a predetermined interval of time by current of a second particular frequency, and thereafter adapted to selectively respond to any one of a plurality of signals, each of said plurality of signals consisting of current of a different one of a like plurality of frequencies including said first and second particular frequencies, said receiver comprising signal relays, one for each of said frequencies, means for selectively passing to the operating winding of each of said relays signaling current of a different one of said frequencies, means comprising a control relay normally rendering all of said signal relays except the two relays adapted for operation by current of said first and second particular frequencies operatively non-responsive to signaling current, and means including said two relays responsive to said first signal for operating said control relay to render all of said relays selectively responsive to signaling current.

3. A signal receiver normally adapted to respond to a first signal consisting of current of a first particular frequency followed within a predetermined interval of time by current of a second particular frequency, and thereafter adapted to selectively respond to any one of a plurality of signals each consisting of current of a different one of a like plurality of frequencies including said first and second particular frequencies, said receiver comprising signal relays, one for each of said frequencies, means for se-

lectively passing to the operating winding of each of said relays signaling current of a different one of said frequencies, means comprising a control relay normally rendering all of said signal relays except the two relays adapted for operation by current of said first and second particular frequencies operatively non-responsive to signaling current, means comprising a biasing winding of the signal relay adapted for operation by said second particular frequency normally rendering said relay inoperable, means including the signal relay adapted for operation by current of said first particular frequency for decreasing the energization of said biasing winding to render the relay operatively responsive for a predetermined interval of time to signaling current of said second particular frequency, and means including said two relays for operating said control relay to render all of said signal relays operatively and selectively responsive to signaling current.

4. In combination, a line and a signal receiver connected to said line, said receiver comprising a plurality of signal relays, means selectively connecting an operating winding of each of said relays to said line, said means including filters, one for each relay, each filter tuned to pass to the associated relay current of a different one of a corresponding plurality of frequencies used for signaling over said line, control means rendering all of said relays except a first particular one of said relays non-responsive to signaling current, means rendered effective by the operation of said first relay for rendering a second particular one of said relays operable for a predetermined interval after said first relay releases, and means operated responsive to the operation of said second relay within said interval after said first relay releases for rendering all of said relays operable in response to succeeding signals.

5. In combination, a line and a signal receiver connected to said line, said receiver comprising a plurality of signal relays, means selectively connecting an operating winding of each of said relays to said line, said means including filters, one for each relay, each filter tuned to pass to the associated relay current of a different one of a corresponding plurality of frequencies used for signaling over said line, control means rendering all of said relays except a first particular one of said relays non-responsive to signaling current, means rendered effective by the operation of said first relay for rendering a second particular one of said relays operable for a predetermined interval after said first relay releases, and means operated responsive to the operation of said second relay within said interval after said first relay releases for rendering all of said relays operable in response to succeeding signals, each consisting of current of only one of said frequencies.

HENRY E. VAUGHAN.