Dec. 8, 1936. K. O. THORP 2,063,354

SELECTIVE CALLING CIRCUITS

Filed March 16, 1931 2 Sheets-Sheet 1

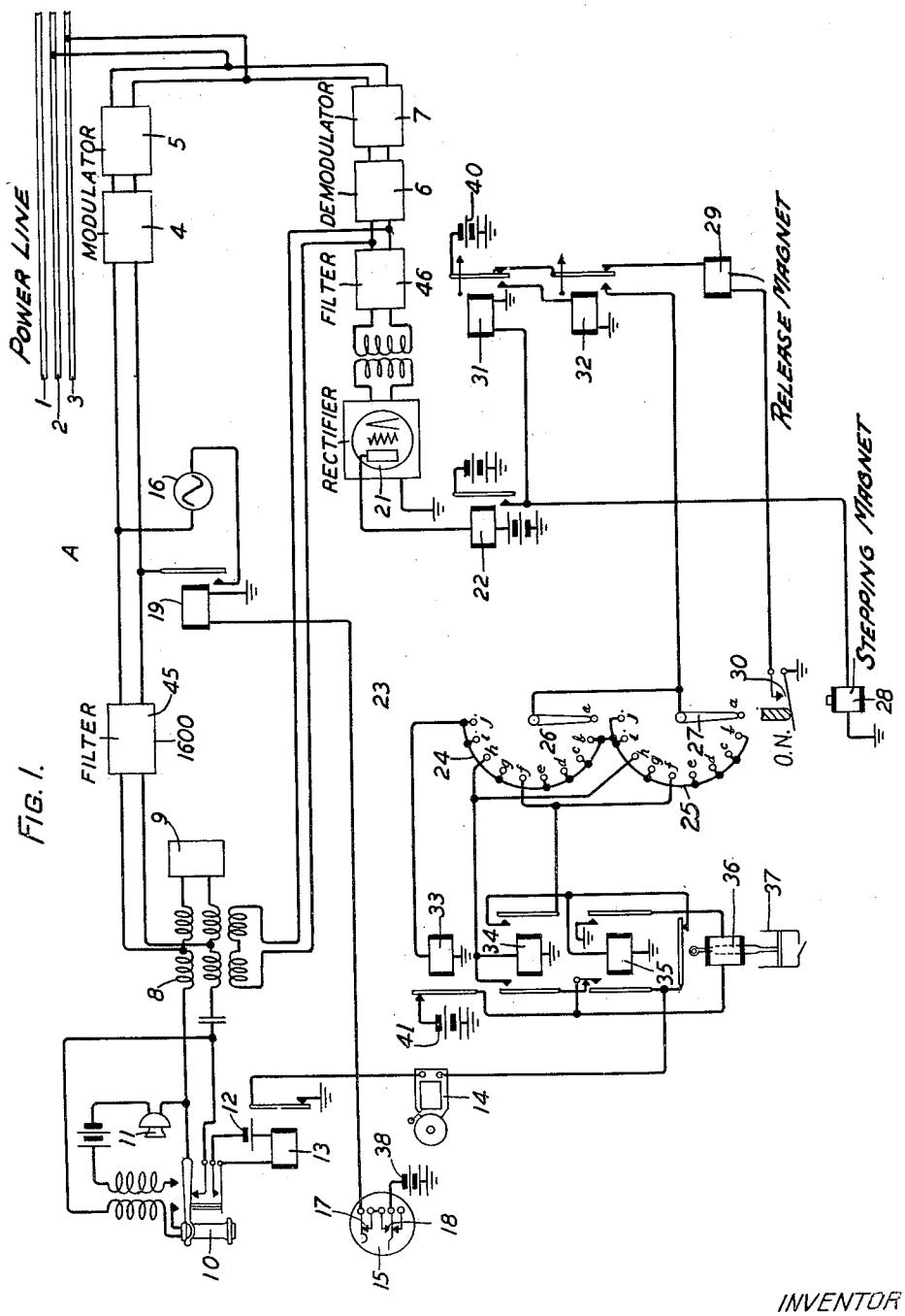


FIG. 1.

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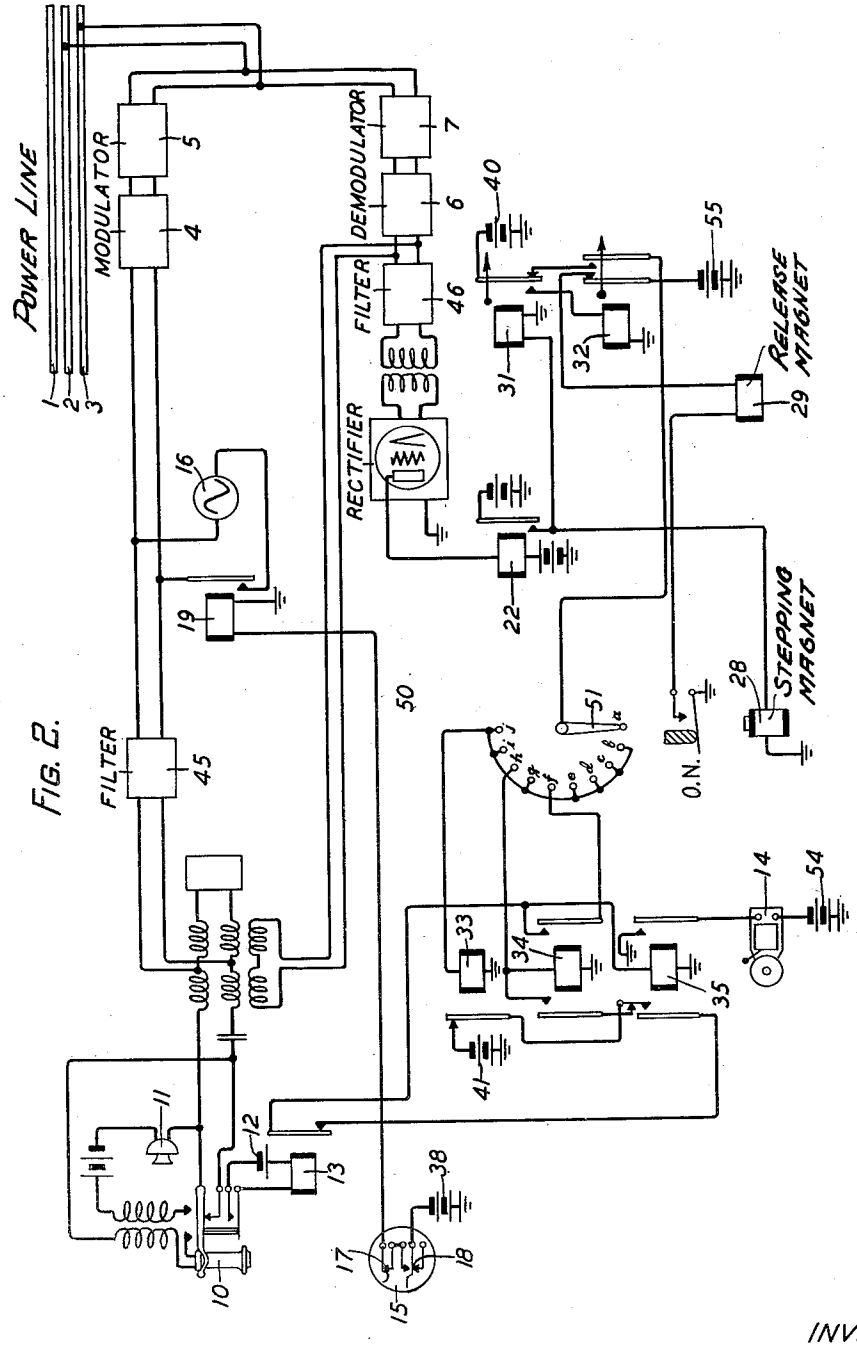


FIG. 2.

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UNITED STATES PATENT OFFICE

2,063,354

SELECTIVE CALLING CIRCUITS

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Application March 16, 1931, Serial No. 522,798

11 Claims. (Cl. 177—332)

This invention relates to selective calling circuits and particularly to selective calling circuits for telephone systems.

One object of the invention is to provide telephone calling circuits employing code signals comprising groups of impulses of current having a frequency within the voice frequency range for selective calling purposes and that shall insure against false operation of the selective calling means during conversation between stations.

Another object of the invention is to provide a telephone system with calling circuits that shall be operated by a series of groups of impulses of current having a frequency within the voice frequency range and that shall have a selector with all idle contact members so connected to a clear-out relay as to insure against operating a call signal during conversation between stations.

A further object of the invention is to provide a telephone system with selective calling circuits that shall be operated by a code signal comprising a series of groups of impulses of current having a frequency within the voice frequency range.

In power-line carrier-telephone systems high frequency modulated signaling currents are impressed on the power lines which normally carry low frequency high tension power currents. The signaling currents are relatively high frequency carrier currents modulated by voice frequency currents. In the patent to C. N. Nebel, No. 1,733,553, dated October 29, 1929, is disclosed a power-line carrier-telephone system wherein two carrier currents are modulated by voice frequency currents and one side band of the second modulation operation is transmitted over the power line for communication purposes. In the system disclosed in the Nebel patent one side band is employed for communication in opposite directions. The present invention is applied to a system of the type disclosed in the Nebel patent.

In the system disclosed in the Nebel patent selective calling between stations is effected by means of carrier current modulated by a group of impulses of current within the voice frequency range. The present invention discloses calling circuits which employ a series of groups of impulses of current within the voice frequency range which are subjected to two modulation operations as disclosed in the Nebel patent and a single side band of the second modulation operation transmitted over the power line to the called station.

In the preferred system disclosing the invention an oscillator producing a frequency within the voice frequency range is intermittently connected to a transmitting channel of the type disclosed in the Nebel patent by means of a suitable telephone dial switch. The impulses of current from the oscillator having a frequency within the voice frequency range are modulated twice and one side band from the second modulation operation is transmitted over the power lines. Code signals of this type are received by the distant called station and are demodulated by a receiving channel of the type disclosed in the above mentioned patent to Nebel. The groups of impulses received from the second modulator in the receiving channel at the called station are rectified and utilized for operating a selector switch. The selector switch employed is preferably of a type used in automatic telephony. The selector switch, after the proper code signal is received, operates a calling signal which is maintained in operative position until the called operator removes his receiver from the switchhook or for a predetermined time interval.

A band elimination filter is provided in the transmitting channel for preventing, during conversation between stations, modulation with the carrier wave of any voice current having a frequency within the range of the voice frequency current employed when selectively calling a distant station. This feature is disclosed and claimed in the patent to E. O. Scriven, No. 1,919,046, dated July 18, 1933.

A band pass filter, which passes only current having a frequency within the voice frequency range employed during selective calling is provided for connecting the calling circuits to the receiving channel at each station beyond the demodulators. By providing a band elimination filter in the transmitting channel and connecting the calling circuits to the receiving channel by a band pass filter it is difficult to operate any of the selectors during communication between stations.

Moreover, all contact members on each selector switch which are not used for controlling code relays to operate a call signal are connected for operating a clear-out relay so as to insure against operating a call signal in case of false operation of the selector.

Fig. 1 in the accompanying drawings is a diagrammatic view of calling circuits constructed in accordance with the invention.

Fig. 2 is a diagrammatic view showing modified calling circuits.

Referring to Fig. 1 of the drawings a signal sta-

tion A is shown connected to a power line comprising conductors 1, 2 and 3. The power line is assumed to carry high tension low frequency power currents. Although only one signal station is shown in Fig. 1 of the drawings it is to be understood that numerous other similar stations are connected to the power line conductors 2 and 3. The transmitting channel at the signal station A comprises modulators 4 and 5 and the receiving channel at said station comprises demodulators 6 and 7. Although the transmitting and receiving channels are shown directly connected to the power line conductors 2 and 3 it is to be understood that suitable coupling condensers or filters are provided for protecting the signaling apparatus and the operators against the high tension current carried by the power lines. The transmitting and receiving channels are connected to an operator's set by means of a hybrid coil 8. A suitable balancing network 9 is associated with the hybrid coil 8. The operator's telephone set comprises a receiver 10 and a transmitter 11. The switchhook for the receiver 10 not only controls the connections of the operator's set but controls a circuit from a battery 12 to a magnet 13. The magnet 13 serves to open the circuit of a call bell 14.

A telephone dial switch 15 of a standard type is provided for connecting an oscillator 16 to the transmitting channel. The switch effects transmission of carrier current modulated by a series of groups of impulses of current within the voice frequency range over the power lines to selectively call a distant station. The oscillator 16 produces a current having a frequency within the voice frequency range and carrier current is modulated with impulses from such oscillator by the modulators 4 and 5. One side band from the second modulator 5 is transmitted over the power lines in the manner disclosed in the above mentioned patent to C. N. Nebel. The telephone dial switch 15 is provided with pulsing contacts 17 and off-normal contacts 18 for controlling the operation of a magnet 19 which connects the oscillator 16 across the transmitting channel.

A band elimination filter 45 is provided in the transmission channel between the hybrid coil 8 and the connection of the oscillator 16 to the transmission channel. The filter 45 serves to eliminate currents within the voice frequency range employed during selective calling from the voice currents during communication between stations. Such currents are eliminated from the voice currents during communication between stations to prevent false operation of a calling signal.

In the system under consideration it is assumed that a code signal comprising three groups of impulses is transmitted over the power line for selectively calling a distant station. All stations are similar in construction and the receipt of a code signal comprising carrier current modulated by a series of groups of impulses of voice frequency current will be described referring to Fig. 1.

The received groups of impulses are demodulated by the demodulators 6 and 7 and then rectified by the thermionic tube 21. In the circuit connecting the tube 21 to the receiving channel is provided a band pass filter 46 which passes only currents having the frequency of the oscillator 16. This filter serves to prevent false operation of a calling signal during communications between stations. The output from the thermionic tube 21 operates a pulsing relay 22 in accordance with the received impulses. The pulsing relay controls a selector switch 23 which in turn controls the operation of the call bell 14. The selector switch comprises two series of contact members 24 and 25 which are associated with two switch arms 26 and 27. The contact members 24 and 25 each comprise contacts *a* to *j* inclusive. The arms 26 and 27 and the contact members 24 and 25 are connected in parallel circuit relation in order to insure against any failure of operation by reason of poor contact engagement between the contact arms and the contact members. The contact arms 26 and 27 are stepped around on contact members 24 and 25 by means of a stepping magnet 28 under the control of the pulsing relay 22. The contact arms 26 and 27 are released from any operated position by means of a releasing magnet 29 under control of off-normal contacts 30 and two slow releasing relays 31 and 32. The selector switch directly controls a clear-out relay 33 and two code relays 34 and 35 which control the circuits for operating the call bell 14. A slow operating relay 36 which is provided with a dash-pot 37 is slow operated in order to open a circuit of a call bell 14 a predetermined time after the closing thereof.

Communication between the stations in the system disclosed in Fig. 1 of the drawings is assumed to be effected in the same manner as in the system disclosed in the above mentioned patent to C. N. Nebel. Accordingly, it is deemed unnecessary to describe in detail the manner in which communication between stations is effected.

When the operator at one station desires to call the operator at a distant station the switch 15 is dialed in accordance with the code signal required to call the distant station. The operation of the dial switch 15 intermittently opens and closes the pulsing contacts 17 to complete a circuit from a battery 38 through the relay 19. This circuit it may be noted is completed through the off-normal contacts 18. The relay 19 connects the oscillator 16 to the transmitting channel in accordance with the code signal required to call the distant station. The code signal supplied to the transmitting channel comprises three groups of impulses of current having a frequency within the voice frequency range. Carrier current is modulated by the code signal of impulses from the oscillator 16 and transmitted over the power line to the distant called station. At the distant station the code signal of modulated impulses is demodulated and rectified for operating the pulsing relay 22 directly in accordance with the code signal. In Fig. 1 of the drawings it is assumed that the code signal for operating the selector of the disclosed station comprises one group of nine impulses, a second group of seven impulses and a third group of five impulses. The first group of nine impulses steps the contact arms 26 and 27 into engagement with the contact members *j*. The slow releasing relays 31 and 32 are held in operative position until after the first group of impulses has been received. The relay 31 is first operated to complete a circuit from the battery 40 for operating the second slow releasing relay 32. After receipt of the first group of impulses the slow releasing relay 31 releases to open the circuit of the second slow releasing relay 32. The relay 31 also completes a circuit from the battery 40 through its armature and the armature of the second slow releasing relay 32, switch arms 26 and 27 and contact members *j* in parallel to the operating coil of clear-out relay 33. The relay 33 is operated to insure that the relay chain is returned to normal position. It is

necessary to return the relay chain to normal position in case any code relay has been previously operated by talking operation or by a false dial operation. The relay 33 when operated insures the breaking of the circuit of the relays 34, 35 and 36 from the battery 41. Upon release of the second slow releasing relay 32 a circuit is completed from the battery 40 through the armatures of the relays 31 and 32, releasing magnet 29 and the off-normal contacts 30 to ground return. The release of relay 32 also removes the battery connection to switch arms 26 and 27 before they leave contact members *j*. This releases relay 33. The releasing magnet 29 is operated to return the switch arms 26 and 27 to initial position.

The second group of impulses comprising the code signal steps the switch arms 26 and 27 into engagement with the contact members *h*. Upon release of the relay 31 a circuit is completed from the battery 40 through the armatures of the relays 31 and 32, switch arms 26 and 27 and contact members *h* in parallel, operating coil of relay 34 and ground return to the battery 40. The relay 34 is provided with two switch arms, one of which closes a locking circuit for the relay through a normally closed contact on relay 35 from the battery 41 and the other switch arm serves to prepare a circuit for operating the code relay 35 when the next group of impulses is received. The switch arms 26 and 27 are returned to initial position by the slow releasing relays 31 and 32 and the release magnet 29 in the same manner as described when considering the first group of received impulses.

Upon receipt of the third group of impulses the switch arms 26 and 27 are moved into engagement with the contact members *f*. The release of relay 31 completes a circuit from the battery 40 through the armatures of the relays 31 and 32, switch arms 26 and 27 and contact members *f* in parallel, armature of relay 34, operating coil of code relay 35 and ground return to the battery 40. The relay 35 is provided with two armatures, one of which completes a circuit from the battery 41 for operating the call bell 14 and a holding circuit for relay 35 from battery 41 through a normally closed contact on relay 36. The other armature of the relay 35 completes a circuit from the battery 41 through the coil of the dash-pot relay 36. After the bell has been operated for a predetermined time the dash-pot relay 36 opens the holding circuit for the relay 35, which in turn opens the circuit of the call bell 14 and the winding circuit of the dash-pot relay 36. The operating of the call bell may also be stopped by removal of the receiver 10 from the switchhook. The switchhook upon the removal of the receiver therefrom completes a circuit for operating the relay 13, which in turn opens the operating circuit for the call bell 14.

The slow releasing relays 31 and 32 in combination with the release magnet 29 return the switch arms of the selector switch 23 to initial position in the manner described above when reference was made to the receipt of the first group of calling impulses.

The contact members *i, g, e, d, c* and *b* of the selector switch 23 are connected to the contact member *j* and the clear-out relay 33 so as to operate the clear-out relay in case of a false operation of the selector switch. If the dial switch should be falsely operated and the selector switch operated or the selector switch be operated during conversation between stations no signal will be sounded unless the code signal for the station is received. The clear-out relay 33 will be operated when the switch arms 26 and 27 are moved from normal position except when moved into engagement with the contact members *h* and *f*.

The calling circuits disclosed in Fig. 2 of the drawings are very similar to the calling circuits shown in Fig. 1 of the drawings and like parts will be referred to by similar reference characters. The transmission of a code signal in the system shown in Fig. 2 is exactly the same as the transmission of the code signal in the system disclosed in Fig. 1. Moreover, the code signal is assumed to comprise three groups of impulses. The oscillator 16 in Fig. 2 supplies impulses of current having a frequency within the voice frequency range which are modulated by the two modulators 4 and 5 and a single side band is transmitted over the power lines. The transmitted code signal is received at a distant station and demodulated and recified in the manner described when reference was made to the system shown in Fig. 1 of the drawings.

The selector switch 50 in Fig. 2 of the drawings comprises a set of contact members *a* to *j* inclusive, which are engaged by a switch arm 51. The switch arm 51 is operated by a stepping magnet 28 similar to the stepping magnet shown in Fig. 1. The stepping magnet 28 is controlled by the pulsing relay 22 which also controls the slow release relays 31 and 32.

Upon the receipt at a distant called station of the first group of impulses in the code signal the slow release relays 31 and 32 are operated and the switch arm 51 is moved into engagement with the contact member *j*. A circuit is then completed upon release of the slow releasing relay 31 for operating the clear-out relay 33. The circuit thus completed extends from the battery 40 through the armature of the relay 31, one armature of the relay 32, switch arm 51, contact member *j*, clear-out relay 33 and ground return to the battery 40. Upon release of the slow releasing relay 32 a circuit is completed from a battery 55 for operating the release magnet 29. The releasing magnet 29 returns the switch arm 51 to initial position.

Upon receipt of the second group of impulses the switch arm 51 is stepped into engagement with the contact member *h*. Thereupon a circuit is completed from the battery 40 for operating the relay 34. The relay 34 is provided with two armatures in the same manner as the relay 34 shown in Fig. 1 of the drawings, one armature serving to establish a holding circuit and the other armature serving to prepare a circuit for operating the relay 35. The switch arm 51 is returned to initial position upon release of the slow releasing relay 32.

Upon receipt of the third group of signal impulses the switch arm 51 is stepped into engagement with the contact member *f* for completing a circuit for operating the code relay 35. The circuit through the code relay 35 may be traced from the battery 40 through the armature of the relay 31, one armature of the relay 32, switch arm 51, contact member *f*, armature of relay 34, coil of the relay 35 and ground return to the battery 40. The code relay 35 is provided with two armatures, one of which establishes a circuit for operating the call bell 14 from a battery 54. The other armature of the relay 35 establishes a holding circuit for itself through the armature of the relay 13 which is controlled by the receiver switchhook. Upon removal of the receiver from the switchhook the relay 13 is

operated to break the holding circuit of the relay 35, which in turn opens the operating circuit for the call bell 14. The switch arm 51 is returned to initial position upon release of the slow releasing relay 32.

The system shown in Fig. 2 of the drawings is provided with an elimination filter 45 and a band pass filter 46 similar to the filters 45 and 46 shown in Fig. 1 of the drawings. Furthermore, the contact members *i*, *g*, *e*, *d*, *c* and *b* of the selector switch 50 are connected to the contact member *j* and the clear-out relay 33 to prevent false operation of a call signal.

In the above described calling circuit means are provided whereby a telephone dial switch may be employed for signaling by carrier current over a power-line carrier-telephone system. The code signal comprises carrier current modulated by a series of groups of impulses of the current having a frequency within the voice frequency range. Although the described system utilizes only three groups of impulses in the code signal it is to be understood that a code signal having more than three groups of impulses may be employed if so desired.

Modifications in the systems and in the arrangement and location of parts may be made within the spirit and scope of the invention and such modifications are intended to be covered by the appended claims.

What is claimed is:

1. In a signal system transmitting code signals, comprising two digits each having one or more signal impulses, means responsive to a code signal, comprising selector mechanism including two switch arms each cooperating with a separate bank of contacts, a stepping magnet operated by said two-digit code impulses for stepping said two selector switch arms ahead, a slow-release relay held operated by said code signal and released at an interval after the transmission of each digit of said code signal, a circuit connected to one of said selector banks and completed upon the first release of said slow-release relay for preparing a signaling circuit, means associated with the other of said selector banks and operative upon completion of the code signal and the second release of said slow-release relay for completing said prepared signaling circuit and means controlled by release of said slow-release relay for returning the switch arm to initial position upon receipt of each digit of the code signal.

2. In a signal system transmitting a code signal comprising a series of groups of impulses for calling purposes, a selector switch having contact members and a switch arm operating over said contact members, control circuits and a calling circuit controlled by said switch, means for operating said switch arm according to each group of impulses of the code signal and for returning the switch arm to initial position after receipt of each group of impulses, and means for completing one control circuit through one of said contact members by operation of the selector switch arm to return the control circuits governed by the switch arm to normal condition upon receipt of the first group of impulses of the code signal, for completing another control circuit through another contact member by operation of the selector switch arm to partially complete the calling circuit upon receipt of the second group of impulses of the code signal and for completing the calling circuit through another contact member by operation of the selector switch arm upon receipt of another group of impulses of the code signal.

3. In a signal system transmitting a code signal comprising groups of impulses for calling purposes, a selector switch having a stepping magnet, contact members and a switch arm moved over said contact members by said stepping magnet, devices connected to certain of said contact members, means for operating said stepping magnet by the impulses of each group of impulses of a code signal, a battery, means for connecting said battery to the switch arm and for completing a circuit from the battery through the switch arm at the end of each group of impulses of the code signal to operate one of said devices, for removing the battery connection to the switch arm before it leaves the contact member on which it stops, and for returning the switch arm to initial position at the end of each group of impulses of the code signal with the battery connection removed from the switch arm during the return movement, a circuit prepared upon operation of one of said devices to operate a second device and a calling circuit operated upon operation of said second device at the end of a code signal.

4. In a signal system transmitting a code signal comprising groups of impulses for calling purposes, a selector switch having off-normal contacts, contact members, a stepping magnet and a switch arm moved over said contact members by said stepping magnet, devices connected to certain of said contact members, means for operating said stepping magnet by the impulses of the groups comprising a code signal to operate the switch arm, means for completing a circuit through the switch arm at the end of each group of impulses comprising a code signal to operate one of said devices, calling means, one of said devices when operated upon receipt of a group of impulses serving to prepare a circuit for operating said calling means and a second device, said calling means being operated in parallel with said second device upon completion of the prepared circuit when the next group of impulses is received, said second device establishing a holding circuit for said calling means, and means operated at the end of each group of impulses of a code signal under control of said off-normal contacts for returning the switch arm to initial position.

5. In a signal system transmitting code signals comprising series of groups of current impulses, a telephone selector switch comprising off-normal contacts, contact members, a switch arm and means for stepping the switch arm over said contact members according to the received code of impulses, means comprising said off-normal contacts for automatically returning said switch arm to initial position after operation by each group of impulses of the code signal, a calling circuit, and means governed by said switch arm in cooperation with said contact members upon receipt of one group of impulses for partially completing said calling circuit and upon receipt of another group of impulses for completing the calling circuit.

6. In a signal system transmitting code signals each comprising a series of groups of impulses of current, a selector switch at a called station having a switch arm, contact members and means for moving the switch arm over the contact members in response to the individual groups of impulses and for returning the arm to initial position upon completion of each group of impulses, code relays connected to certain of said contact members, means comprising said code relays operated by said switch arm in response to indi-

vidual groups of impulses comprising a code signal for operating a signal, a clear-out relay for releasing the code relays, and means controlled by said switch arm for operating said clear-out relay upon receipt at a called station of the first group of impulses of the code signal and when the selector arm is moved upon receipt of a group of impulses to any contact member except the contact members connected to the code relays.

7. In a signal system transmitting a code signal comprising a series of groups of impulses of current, a selector switch at a called station having a switch arm, contact members and means for moving the switch arm over the contact members in response to the individual group of impulses and returning the arm to initial position upon completion of each group of impulses, code relays connected to certain of said contact members, means comprising said code relays operated by said switch arm in response to individual groups of impulses comprising a code signal for operating a signal, a clear-out relay for releasing the code relays, and means controlled by said switch arm for operating said clear-out relay upon receipt at a called station of the first group of impulses of the code signal.

8. In a signal system transmitting impulses for calling purposes, a selector switch having off-normal contacts, contact members and a switch arm movable over said contact members, relay devices connected to said contact members, a stepping magnet for operating said switch arm, two slow release relays, means for operating said stepping magnet in accordance with the received impulses to operate said switch arm, for operating said slow release relays consecutively upon receipt of a group of impulses and for releasing said slow relays consecutively after receipt of a group of impulses, means for completing a control circuit through the switch arm, a selected contact member and one of said relay devices at the end of a group of impulses and upon release of only one of said slow relays, and means under control of the off-normal contacts when both slow relays are released for automatically returning the switch arm to a neutral position.

9. In a signal system transmitting a code signal comprising groups of impulses for calling purposes, a selector switch having a switch arm, contact members and means for moving the switch arm over said contact members according to each group of impulses of the received code signal and for returning the switch arm to initial position after receipt of each group of impulses, code relays and a clear-out relay connected to said contact members, means for completing a circuit through the switch arm and a contact member to operate said clear-out relay upon receipt of the first group of impulses, means operated by the clear-out relay to insure the release of any operated code relay, means for completing a circuit through the contact arm and a contact member to operate a code relay upon receipt of other groups of impulses, and means comprising circuits controlled by the code relays for operating a calling signal upon receipt of the complete code signal.

10. In a signal system transmitting code signals, means responsive to a code signal, said responsive means comprising a pulsing relay responsive to a code signal, a selector mechanism including a switch arm cooperating with a bank of contacts, a stepping magnet operated by said pulsing relay for stepping said selector switch arm ahead, relay means operated by said pulsing relay and released at an interval after said code signal operating said pulsing relay ceases and the code signal current ceases to flow, a signaling circuit connected to one of the contacts of said selector bank and completed by the release of said relay means, and means comprising a slow release relay controlled by said relay means and automatically released a time interval after the completion of the signaling circuit for returning the switch arm to initial position.

11. In a signal system transmitting code signals, means responsive to a code signal, said responsive means comprising a pulsing relay operated by a code signal and selector mechanism including a switch arm cooperating with a bank of contacts, a stepping magnet operated by said pulsing relay for stepping said selector switch arm ahead, means comprising a slow release relay operated by said pulsing relay and released at an interval after said code signal ceases and the code signal current ceases to flow, a signaling circuit connected to one of the contacts of said selector bank and completed by the release of said slow release relay, a release magnet for returning said switch arm to initial position, and means comprising a second slow release relay controlled by said first-mentioned slow release relay and effective a time interval after the completion of the signaling circuit for operating said release magnet to return the switch arm to initial position.

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