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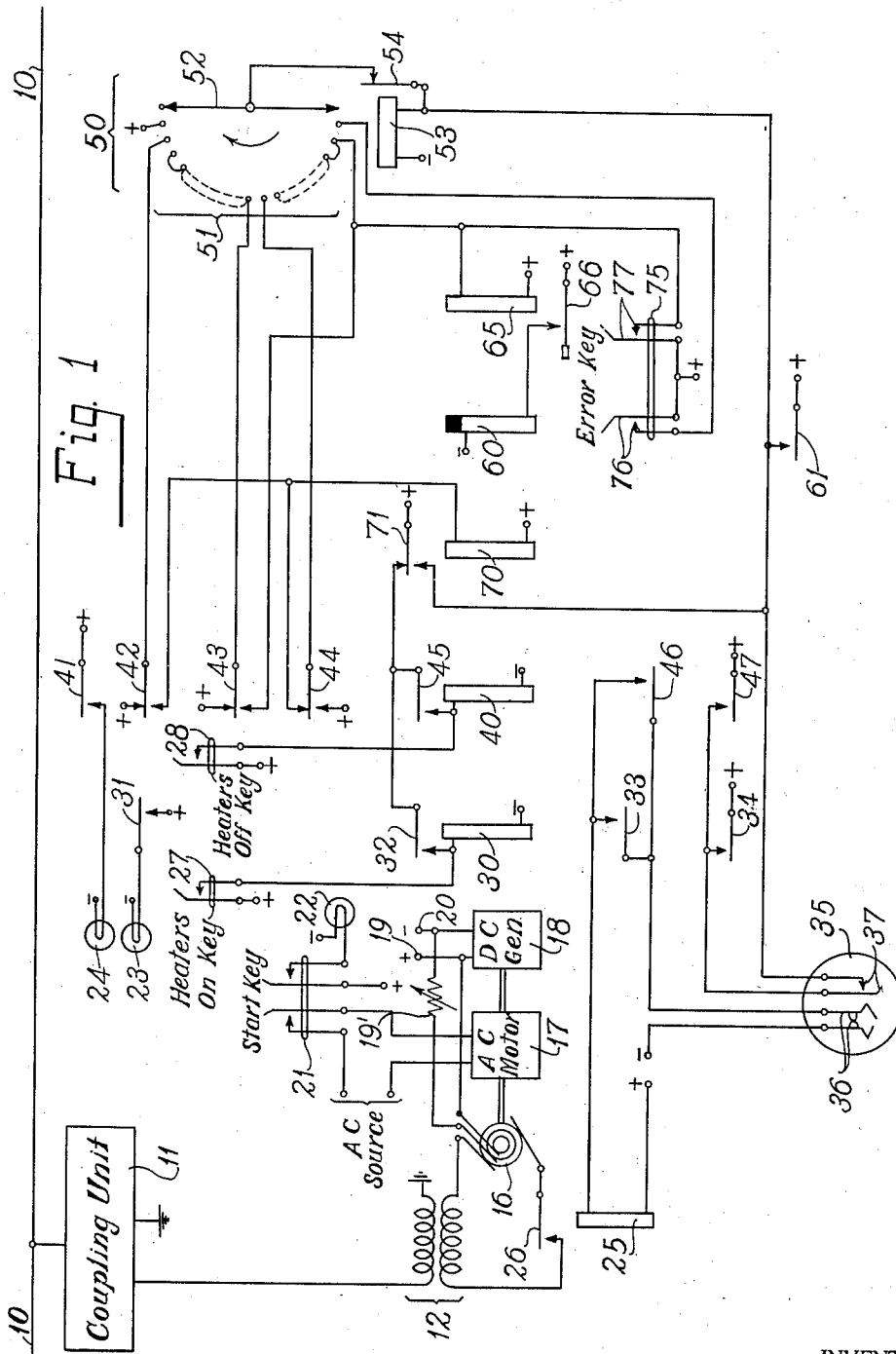
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2,275,146

CARRIER CURRENT CONTROL SYSTEM

Filed April 1, 1939

2 Sheets-Sheet 1



INVENTOR.  
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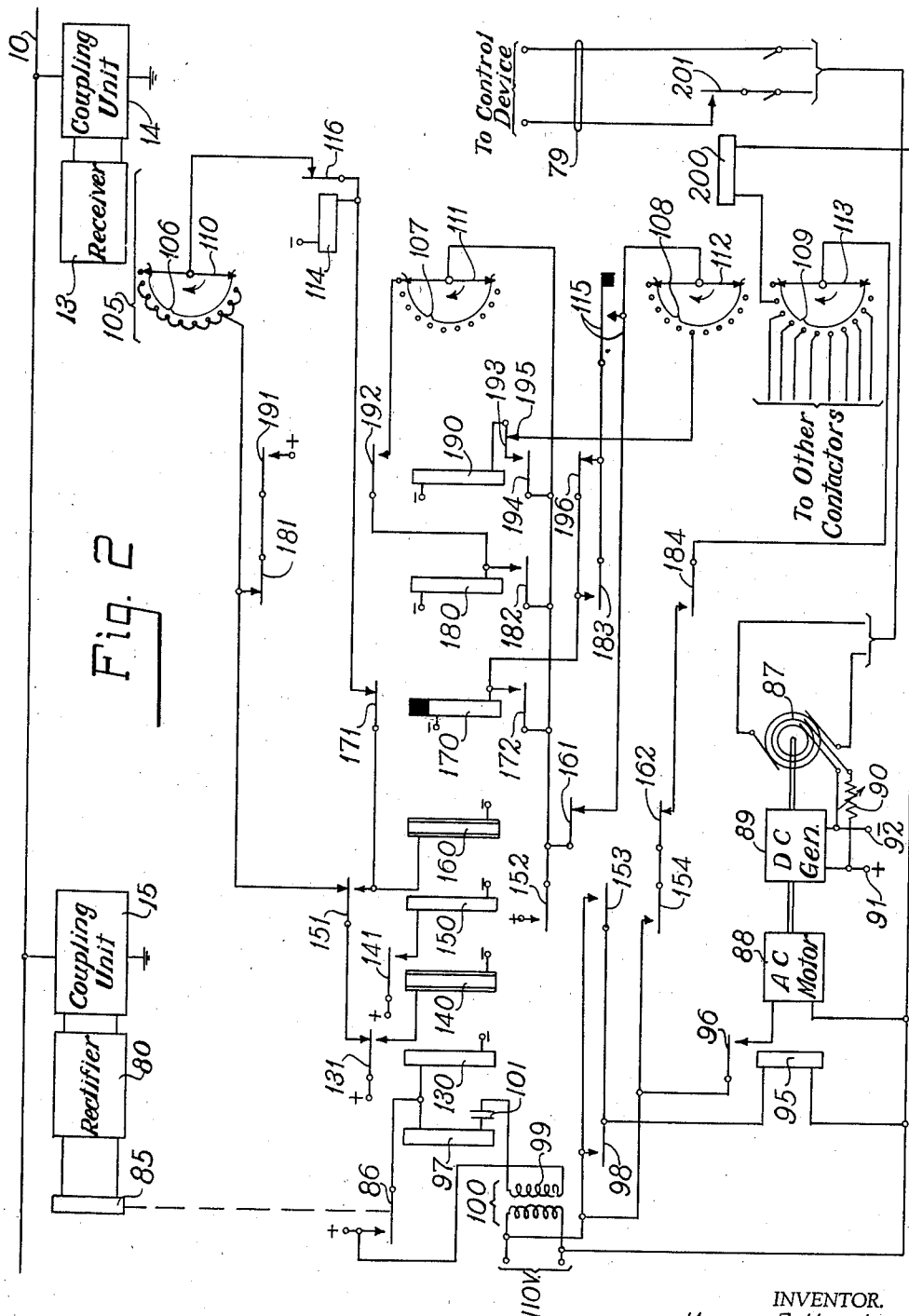
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# CARRIER CURRENT CONTROL SYSTEM

Filed April 1, 1939

2 Sheets-Sheet 2



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## UNITED STATES PATENT OFFICE

2,275,146

## CARRIER CURRENT CONTROL SYSTEM

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10 Claims. (Cl. 177—389)

The present invention relates to carrier current systems and, more particularly, to improvements in systems wherein a power transmission line or the like is utilized as a control channel between a transmitting point and a plurality of control points. Carrier current apparatus utilizing power lines as carrier links has been extensively used for communication and control purposes and has been found to have particular utility in controlling from a central dispatcher's station the connection of heater loads or the like to the power lines.

It is an object of the present invention to provide an improved system of the character indicated which is of simple and economical arrangement; is reliable in operation and is arranged in an improved manner such that a large number of circuits or devices, such, for example, as water heaters, may be controlled from a central dispatching or transmitting point with a minimum amount of apparatus.

It is another object of the invention to provide, for use in a system of the character described, an improved carrier current transmitting unit which utilizes a minimum amount of apparatus; is simple in arrangement; is reliable in operation and is easily operated selectively to control over a single associated carrier channel any one of a plurality of carrier current receiving units each having associated therewith a plurality of devices or circuits to be controlled.

It is a further object of the invention to provide, for use in a system of the character described, an improved transmitting unit of simple and economical arrangement which may selectively be controlled by an attendant to select and control over an associated control channel any desired one of a plurality of associated circuits or devices the energization or deenergization of which may be required.

In general, the objects as set forth above are realized in accordance with the present invention by providing carrier current apparatus for controlling a plurality of secondary carrier current circuits arranged in groups, and comprising a transmitter and a plurality of receivers which are interconnected by a carrier current channel so that the receivers are controlled over the channel from the transmitter in a novel and unique manner. More particularly, the transmitter includes a carrier current source, a circuit for delivering current from the source to the carrier current channel, and apparatus including an impulsing device for momentarily interrupting the delivery circuit one or more times during

each operation of the impulsing device thereby to transmit carrier current pulses by way of the channel to the various receivers. The transmitter further includes timing apparatus, the operation of which is initiated in response to operation of the impulsing device, and circuit means controlled by the timing apparatus for interrupting the carrier current delivery circuit after a predetermined time interval. The timing apparatus is so arranged that its operation is only initiated after a predetermined number of operations of the impulsing device and the operation thereof is sustained through the provision of relay means operable independently of the impulsing device following the initial operation of the timing apparatus. The arrangement of the transmitter is such that the timing apparatus may measure off either of two time intervals, during which carrier current is conducted to the associated carrier channel. The desired interval is selected through the selective operation of a pair of switches representing, respectively, "heaters on" and "heaters off," and the provision of circuit means jointly controlled by these two switches and the timing apparatus for interrupting the carrier current delivery circuit at the end of the time interval corresponding to the operated one of the two switches.

The carrier current receivers commonly associated with the carrier current channel are each associated with a plurality of secondary carrier circuits which are to be controlled and each thereof includes apparatus responsive to a first predetermined digit of carrier current pulses transmitted over the carrier channel for conditioning itself to select one of the associated secondary carrier circuits. This apparatus, as embodied in each receiver, is responsive to a first digit other than the predetermined digit designating the receiver to render the receiver ineffective to select one of its associated circuits or, more particularly, to render the receiver non-responsive to additional carrier current pulses transmitted over the carrier channel. Each receiver further comprises apparatus responsive to a second digit of carrier current pulses transmitted over the associated channel following the predetermined first digit for selecting one of the associated secondary carrier circuits, together with circuit means controlled by the last-named apparatus for operating upon, i. e., for completing or interrupting the selected circuit. More particularly, each receiver includes a stepping switch having a plurality of operating positions individually corresponding to the associated sec-

ondary carrier circuits and pulse responsive apparatus which responds to a received first digit of carrier current pulses to cause the switch to operate to the position corresponding to the number of pulses of the digit. When each of the switches operates to a predetermined position (different for each of the receivers), the control apparatus associated therewith is conditioned for the selection of one of the associated circuits. On the other hand, if the switch is operated to any other position, it is rendered non-responsive to further operation of the pulse responsive apparatus. After being conditioned to respond to a second series of received carrier current pulses, each stepping switch and its associated control apparatus operates to select one of the associated secondary carrier circuits when the second digit of carrier current pulses is received. Thereafter, the control apparatus of the receiver functions to interrupt or complete the particular selected circuit. Each receiver is so arranged that when carrier current is removed from the channel over which it is controlled, the receiver is released and the operated control device is restored to normal.

Further features of the invention pertain to the particular arrangement of the circuit elements whereby the above-outlined and additional operating features are attained.

The novel features believed to be characteristic of the invention are set forth with particularity in the appended claims. The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the specification taken in connection with the accompanying drawings in which Figures 1 and 2 illustrate, respectively, a transmitter and a plurality of receiving units connected and arranged in accordance with the present invention and interconnected by a carrier current channel.

Referring now to the drawings, the system there illustrated comprises a transmitter as shown in Fig. 1 and a plurality of receivers, two of which are shown in Fig. 2; the transmitter and receivers being interconnected by a carrier current channel which includes one conductor 10 of a power transmission line and a ground return path. If desired a second of the power line conductors may be used in lieu of ground to provide a complete carrier current channel. The carrier current output of the transmitter shown in Fig. 1 is impressed upon the carrier current channel comprising the conductor 10 and ground by means comprising a coupling unit 11 and a transformer 12. At each receiving station a coupling unit similar to the unit 11 is provided for filtering the carrier current from the commercial frequency current and for delivering the filtered carrier current to the associated receiver. Thus, the receiver 13 and the other receiver illustrated in detail in Fig. 2 have individually associated therewith coupling units 14 and 15, respectively, which function to filter the carrier currents from the commercial frequency current and to deliver the filtered output to the respective associated receivers. Each of the coupling units 11, 14, and 15 may be of any desired arrangement. Since several well-known embodiments of this type of apparatus are commercially available, these elements of the system have been only schematically shown.

Referring now more particularly to the transmitting apparatus as shown in Fig. 1, this apparatus includes a source of carrier current comprising an alternator 16, arranged to deliver its

high frequency output over an obvious circuit to the primary winding of a transformer 12 and to be driven by an alternating current motor 17 which is preferably of the self-starting synchronous type. The motor 17 also functions to drive a self-excited direct current generator 18 which delivers exciting current to the slip rings of the generator 16 over an obvious circuit including the adjustable field rheostat 19'. This generator may also be utilized to supply current for energizing the various relays, magnets and signal lamps of the transmitter. To this end, the armature leads of the generator 18 are connected to bus terminals 19 and 20 which may, in turn, be connected over bus conductors to appropriate terminals of the indicated circuit elements. In the interests of simplifying the circuit explanation, these bus conductors have been omitted from the drawings but it will be understood that the negative terminal 20 is connected to each of the other terminals shown in Fig. 1 of the drawings marked with a negative battery sign and that the positive terminal 19 is similarly connected to each of the terminals designated by a positive battery sign. For the purpose of initiating the operation of the motor 17, there is provided a start key or switch 21, which switch also functions to control the operating circuit for a signal lamp 22 provided for the purpose of reminding the transmitter attendant or dispatcher that the switch 21 is operated.

The circuit for delivering carrier current from the alternator 16 to the carrier channel comprising the power line conductor 10 and ground is arranged to be controlled by an electromagnetic device in the form of a pulsing relay or contactor 25 which is operative in response to operation of either of two key controlled switches 27 and 28. More particularly, the operating circuit for the pulsing relay 25 is completed in response to operation of either of two relays 30 and 40 which respectively respond to operation of the switches 27 and 28. These relays also individually control the operating circuits for a pair of signal lamps 23 and 24, the lamp 23, when energized, functioning to indicate that the relay 30 is operated and the lamp 24, when energized, functioning to indicate that the relay 40 is operated. The switches 27 and 28 selectively control the time interval during which carrier current is delivered to the carrier current channel and represent, respectively, "heaters on" and "heaters off" time intervals. Each of these switches is of the well-known nonlocking type. The above-mentioned operating circuit for the pulsing relay 25 also serially includes the pulsing springs 36 of an impulsing device 35. This impulsing device is of the dial operated type conventionally used in automatic telephone systems and is capable of transmitting from one to ten impulses during each operation through selective operation of the dial embodied therein. In addition to the pulsing springs 36, the impulsing device 35 includes a pair of shunt springs 37 which are operated into engagement each time the dial of the device is operated off normal and are disengaged only following the return of the dial to its normal position. These shunt springs, in conjunction with the two relays 30 and 40, function to control the operation of the previously mentioned timing apparatus. More specifically, this timing apparatus comprises a rotary stepping switch 50 which is of the well-known minor type. This switch includes a single set of contacts 51 of twenty-five points, a

double-ended wiper 52, and means comprising a motor magnet 53 and a ratchet and pawl mechanism, not shown, for driving the wiper 52 over the contacts of the set 51. The mechanical arrangement of the ratchet and pawl mechanism is such that the wiper 52 is advanced only upon deenergization of the magnet 53 following its energization. Operation of the switch 50 from its normal position as shown in the drawings is initiated in response to operation of the impulsing device 35. For the purpose of sustaining the operation of this switch following its initial or preliminary movement, there are provided a pair of relays 60 and 65; the first-mentioned being of the slow-to-operate type and the last-mentioned being of the well-known pendulum type. More particularly, the relay 65 includes a weighted armature 66 which vibrates when the relay 65 is initially energized and only settles into resting engagement with its associated contact a predetermined time interval thereafter. The switch 50 is arranged to control a relay 70 which is provided for the purpose of causing the carrier current output of the generator 18 to be removed from the carrier channel a predetermined time interval after operation of the switch 50 is initiated.

More particularly, the relay 70 is jointly controlled by the switch 50 and the relays 39 and 40 to cause the pulsing relay 25 to restore a predetermined time interval after operation of the switch 50 is initiated, providing the switch 21 is operated, or to cause the restoration of the pulsing relay 25 after the expiration of a longer time interval in the event the switch 28 is operated. In order to cause the carrier current delivery circuit to be interrupted before either of the two indicated time intervals have expired and in the event of a dialing error on the part of the dispatcher, there is provided an error key 75 which, when operated, functions to complete a normalizing circuit for the rotary switch 50, thereby to cause this switch to be returned to its normal position at a high rate of speed.

Referring now more particularly to Fig. 2 of the drawings, the two receivers there shown are, with the exception of certain wiring differences, exact duplicates. Accordingly, only one of the receivers has been illustrated in detail. The last-mentioned receiver functions to control ten associated circuits, one of which is indicated generally at 73. Each of these ten circuits is adapted to be energized by carrier current and may be utilized directly to control an associated control device or to control such a device over a secondary carrier channel. For example, if the circuit 79 is to be used in an application of the character previously mentioned, that is, for the purpose of controlling the switching unit associated with an electric water heater, the switching unit may be directly connected to the bracketed terminals of the circuit 79 or may be coupled to these terminals over a carrier channel utilizing one or more of the secondary power leads. If desired, the control device which is controlled over the circuit 79 and the other similar circuits may be of the character disclosed in Patent No. 2,064,644, granted December 15, 1936, to John L. Woodworth. As explained in this patent, when the control device disclosed therein is energized by carrier current for a relatively short time interval, the device operates to close the power supply circuit of the associated heater. On the other hand, when the control device is energized by carrier current for a relatively long time in-

terval, it is operated to open the associated power supply circuit and to maintain this circuit interrupted until it is thereafter energized by a short pulse of carrier current. Briefly described, the receiver illustrated in detail in Fig. 2 comprises a rectifier 80 to which carrier current is delivered through coupling unit 15 and which functions to convert the carrier current into direct current for energizing the combined start and pulsing relay 85. If desired, the rectifier 80 may be of the well-known vacuum tube type utilizing one or more stages of amplification for the purpose of increasing the amplitude of the received carrier current sufficiently to insure positive response of the relay 85. In order to energize any selected one of the above-mentioned secondary carrier current circuits, there is provided at the receiving station a carrier current source which comprises a high frequency alternator 87 arranged to be driven by an alternating current motor 88, preferably of the self-starting synchronous type. The motor 88 is also mechanically coupled to drive a self-excited direct current generator 89 which functions to deliver exciting current through an adjustable field rheostat 90 to the slip rings of the alternator 87. It is also contemplated that the generator 89 shall be used to supply energizing current to the windings of the various relays and magnets embodied in the receiver. To this end, the positive and negative terminals 91 and 92, respectively, of the generator 89 are connected by means of bus conductors, not shown, to the respective positive and negative terminals of the relay and magnet windings shown in Fig. 2 of the drawings. The alternating current motor 88 is adapted to be energized from the usual 110 volt alternating current source and includes an operating circuit which is controlled by an alternating current relay or contactor 95. This contactor, in turn, is controlled by an alternating current relay 97 having a winding adapted to be connected in shunt with the secondary winding 99 of a voltage reducing transformer 100 in series with a condenser 101, in response to operation of the combined start and pulsing relay 85.

For the purpose of selecting one of the ten associated secondary carrier circuits, there is also provided in the receiver illustrated in Fig. 2 a circuit selecting switch 105 and control apparatus comprising a plurality of relays 130, 140, 150, 160, 170, 180 and 190. More particularly, the switch 105 is of the well-known rotary type and comprises four sets of contacts 106, 107, 108 and 109, each comprising eleven contacts; wipers 110, 111, 112 and 113 respectively associated with the contact sets in the order named; means comprising a motor magnet 114 and a ratchet and pawl mechanism, not shown, for driving the indicated wipers over their respectively associated contacts; and a set of off-normal springs 115 which are moved into engagement when the wipers of the switch are stepped to the first off-normal position from the normal position illustrated in the drawings. Of the enumerated relays, the relay 130 is a highly sensitive pulsing relay which responds to operation of the combined start and pulsing relay 85; the relay 140 is a slow-acting hold relay; the relay 150 is a slave to the relay 140 and the relay 160 is a slow-acting pulsing digit responsive relay. Of the remaining three relays the relay 190 is provided for the purpose of rendering the switch 105 responsive to a second digit of received carrier current pulses following the receipt of a first digit desig-

uating the receiving unit under consideration as the one receiver which is to effect a circuit controlling operation. This relay further functions to cause the wipers of the switch 195 to be returned to normal during the inter-digit pause between two successively received digits. The relay 183, in combination with the slow-to-operate relay 170, functions to open the operating circuits for the motor magnet 114 at the end of a received second digit of carrier pulses, thereby to render the receiver non-responsive to additional pulses received after a circuit selecting operation has been performed. In this regard it is pointed out that control of the ten secondary carrier circuits associated with the receiver is achieved through the provision of ten control devices, one of which is indicated at 239, which individually correspond to the ten operating positions of the switch 195 and individually include operating circuits extending by way of different ones of the contacts embodied in the contact set 199 of the switch 195. The manner in which these operating circuits are selectively completed will be more readily apparent from the description of the operation of the apparatus appearing hereinafter.

Referring now more particularly to the operation of the system, if it be assumed, for example, that the control device controlled by way of the secondary carrier circuit 79 occupies its open circuit position, and, further, that the dispatcher or attendant desires to effect operation of this control device to close the associated heater or load circuit, the switch 21 is first operated to its off-normal position and shortly thereafter the switch 27 is also operated to its off-normal position. When the switch 21 is operated to its off-normal position, obvious circuits are completed for energizing the motor 17 and the signal lamp 22. As the motor 17 comes up to speed, the voltage across the terminals 19 and 20 of the generator 18 builds up to normal so that with the field rheostat 19' properly adjusted the correct exciting current is supplied to the rotor of the alternator 16. Accordingly, the carrier voltage of this generator builds up to the normal value in the usual manner. Following the interval required for the motor 17 to assume its normal speed, the switch 27 is momentarily operated to its off-normal position to complete an obvious circuit for energizing the relay 30. Upon operating, the relay 30 completes, at its armature 31, an obvious circuit for energizing the signal lamp 23 and closes, at its armature 32, a circuit including the armature 71 for maintaining itself energized independently of the switch 27. Hence, momentary operation of the switch 27 suffices to initiate the operation of the transmitter. Upon operating, the relay 30 also completes the above-mentioned circuit for energizing the winding of the pulsing relay or contactor 25, this circuit extending from the positive terminal 19 of the generator 18 by way of the winding of the relay 25, the armature 33 and the impulsing springs 36 to the negative terminal 20 of the generator 18. When energized over this circuit, the relay 25 operates to complete at its armature 26 the circuit for energizing the primary winding of the transformer 12 from the alternator 16. Thus, carrier current voltage is impressed upon the carrier channel comprising the conductor 10 and ground, which channel extends from the transmitter to each of the receivers controllable from the transmitter.

The rectifier 80 provided in the receiving unit

illustrated in detail in Fig. 2 responds to the carrier current voltage impressed upon the carrier channel by delivering direct current to the winding of the combined start and pulsing relay 85. The relay 85 now operates to complete, at its armature 86, a circuit including the transformer winding 99 and the condenser 101 for energizing the alternating current relay 97. The relay 97, in turn, operates to complete at its armature 98 an obvious circuit for energizing the winding of the contactor 95. This contactor, upon operating, completes at its armature 96 an obvious circuit for energizing the alternating current motor 88. As the motor 88 comes up to speed, the normal output voltage of the direct current generator 89 is built up across the generator terminals 91 and 92 and field current is supplied to the rotor of the alternator 87. Thus, the carrier voltage output of the alternator 87 is built up to its normal value. When the voltage of the generator 89 assumes its normal value, the relay 130 is energized thereby over a circuit extending from the positive generator terminals 91 by way of the armature 86 and the winding of the relay 130 to the negative generator terminal 92. When thus energized, the relay 130 operates to complete at its armature 131 an obvious circuit for energizing the slow-acting hold relay 140. The last-mentioned relay, in turn, operates to complete at its armature 141 an obvious circuit for energizing the relay 150. When the relay 150 operates, it prepares at its armature 151 a circuit for energizing the slow-acting relay 160 and the motor magnet 114 in parallel. At its armature 152, the relay 150 prepares a point in the common portion of the holding and operating circuits, traced hereinafter, for the relays 170, 180 and 190. At its armature 153, the relay 150 completes an obvious multiple circuit for maintaining the contactor 95 operated. Finally, at its armature 154, the relay 150 prepares a point in the common portion of the operating circuit for the control device 200 and the operating circuits for each of the other nine control devices associated with the receiver. Following the operation of the relay 150, the receiver illustrated in Fig. 2 is conditioned to respond to carrier current pulses transmitted by way of the carrier channel from the transmitter shown in Fig. 1 in response to operation of the impulsing device 35.

While the operation of the receiver shown in detail in Fig. 2 has alone been described, it will be understood that each of the other receivers associated with the carrier channel comprising the conductor 10 and ground responds to the application of carrier voltage to this channel in an identical manner.

A short time interval after operation of the switch 27, and shortly following the completion of the receiver operations just described, the transmitter attendant operates the impulsing device 35 in accordance with the digit designating the receiver associated with the group of circuits including the particular circuit which is to be operated upon. In the case under consideration, wherein the circuit 79 is to be operated upon, the attendant dials a first digit of six impulses. During the forward movement of the dial embodied in the impulsing device 35 and immediately the dial is moved off normal, the shunt springs 37 are moved into engagement to complete a circuit for energizing the operating magnet 53 of the minor switch 50, this circuit extending from the positive generator terminal 19 by way of the

armature 34, the shunt springs 37 and the winding of the magnet 53 to the negative generator terminal 20. When energized over this circuit, the magnet 53 conditions the associated ratchet and pawl mechanism, not shown, to step the wiper 52 one step from its normal position as shown in the drawings. During the return movement of the dial embodied in the impulsing device 35, the pulsing springs 36 are opened and closed a number of times determined by the number of the digit dialed. In the case under consideration, these springs are opened and closed six times. Each time the springs 36 are moved out of engagement, the above-traced operating circuit for the relay 25 is interrupted, causing this relay to restore and open at its armature 26 the circuit over which carrier current is delivered to the carrier current channel. Accordingly, during the first operation of the impulsing device 35, six carrier current pulses are transmitted over the channel to each of the receivers associated therewith. At the end of the sixth impulse, the dial of the impulsing device 35 is fully restored to normal, so that the springs 36 are closed and the shunt springs 37 are moved out of engagement to interrupt the above-traced circuit for energizing the magnet 53. As a consequence, the ratchet and pawl mechanism associated with the magnet 53 operates to advance the wiper 52 one step from normal or into engagement with its associated first contact.

Considering now the manner in which the receiver illustrated in detail in Fig. 2 responds to the carrier current pulses of the first digit dialed at the transmitter, it is pointed out that the relay 85 follows the carrier current pulses by restoring during each interval when the carrier current delivery circuit is interrupted at the transmitter. Accordingly, it will be seen that the relay 85 functions to repeat the carrier current pulses as direct current pulses to the pulsing relay 130, the relay 130 being caused to restore each time the carrier current delivery circuit is interrupted at the transmitter. Upon restoring at the beginning of the first pulse, the relay 130 completes the above-mentioned circuit for energizing the slow-acting relay 160 in parallel with the motor magnet 114 of the rotary switch 105, this circuit extending from the positive generator terminal 91 by way of the armature 131 to the armature 151 where it divides; one branch extending through the winding of the relay 160 to the negative generator terminal 92, and the other branch extending by way of the armature 171 and the winding of the magnet 114 to the negative generator terminal 92. When energized over the circuit just traced, the relay 160 operates to open at its armature 161 a point in the circuits, traced hereinafter, for energizing the relays 170 and 190, respectively. At its armature 162, the relay 160 opens a point in the common portion of the circuits for energizing the control devices corresponding to and including the device 209.

Each time the relay 130 restores in response to a received carrier pulse to complete the above-traced circuit for energizing the motor magnet 114, this magnet in cooperation with its associated ratchet and pawl mechanism, not shown, operates to advance the wipers of the switch 105 one step. Accordingly, at the end of the first digit, these wipers are left standing in engagement with the contacts corresponding to the number of pulses of the digit. The relay 160, due to its slow-to-release character, remains

operated during pulsing. When the wipers of the switch 105 are operated to their respective first off-normal positions, the off-normal springs 115 are moved into engagement to prepare a circuit, traced hereinafter, for energizing the slow-to-operate relay 170. In the case under consideration wherein the first digit dialed comprises six carrier current pulses, the wipers of the switch 105 are left standing in engagement with their respectively associated sixth contacts. Shortly following the end of this digit and with the relay 130 in its operated position, the slow-acting relay 160 restores to complete the above-mentioned circuit for energizing the relay 190, this circuit extending from the positive generator terminal 91 by way of the armature 152, the armature 161, the wiper 112 and its associated sixth contact, the contact 195, the armature 193, and the winding of the relay 190 to the negative generator terminal 92. When energized over the circuit just traced, the relay 190 operates to complete a holding circuit for itself, this circuit extending from the positive generator terminal 91 by way of the armature 152, the armature 194, the armature 193, and the winding of the relay 190 to the negative generator terminal 92. Also, upon operating, the relay 190 opens at its armature 196 a point in the circuit, traced hereinafter, for energizing the slow-to-operate relay 170, and prepares at its armature 192 a circuit for energizing the relay 180. At its armature 191, the relay 190 completes an alternative circuit for energizing the motor magnet 114, this circuit extending from the positive generator terminal 91 by way of the armature 191, the armature 181, the multiplied contacts of the contact set 106, the wiper 110, the armature 116 and the winding of the magnet 114 to the negative generator terminal 92. Due to the circuit interrupting action of the armature 116 controlled by the magnet 114, this magnet operates buzzer fashion rapidly to restore the wipers of switch 105 to normal at which time the off-normal springs 115 are opened. When the wiper 110 attains its normal position in engagement with its associated eleventh contact, the above-traced normalizing circuit for the switch 105 is interrupted. The return of the switch wipers to normal also results in energization of the relay 180 over a circuit extending from the positive generator terminal 91 by way of the armature 152, the wiper 111 and its associated eleventh contact, the armature 192 and the winding of the relay 180 to the negative generator terminal 92. Upon operating, the relay 180 completes, at its armature 182, an obvious locking circuit for itself, and opens, at its armature 181, a further point in the above-traced switch normalizing circuit. At its armature 183, the relay 180 prepares the above-mentioned circuit for energizing the slow-to-operate relay 170. Following operation of the relay 180, the apparatus embodied in the receiver illustrated in detail in Fig. 2 of the drawings is conditioned to respond to a second series of carrier pulses transmitted thereto from the transmitter shown in Fig. 1 of the drawings.

The circuit group or receiver selection achieved in response to the first digit dialed at the transmitter is obtained by connecting the relays, corresponding to the relay 190 and included in the other receivers, to be energized in response to operation of their respectively associated rotary switches to different off-normal positions. In this regard, it will be clear from the preceding

description that the rotary switches respectively embodied in the several receivers are operated in unison in response to the carrier current pulses of the first digit. Only the relay 190 of the receiver shown is, however, connected to be energized when the wipers of these switches are left standing in engagement with their respectively associated sixth contacts at the end of the first digit. The corresponding relays of the other receivers are connected to be energized when the wipers of the respectively associated rotary switches are left standing in engagement with other contacts at the end of the first digit of carrier current pulses. For example, the relay embodied in the receiver 13 and corresponding to the relay 190, may be connected to be energized when the rotary switch of this receiver is operated to its second off-normal position in response to the carrier current pulses of the first digit. As a further example, a third of the receivers may be so connected and arranged that the relay embodied therein and corresponding to the relay 190 is energized following the transmission of a first digit comprising three carrier current pulses. By virtue of this arrangement, any one of ten different receivers may, with the arrangement shown, selectively be conditioned to respond to the carrier pulses resulting from the dialing of a second digit at the transmitter.

To illustrate the manner in which a receiver is rendered non-responsive to further carrier current pulses when a first digit other than the digit designating the receiver is dialed at the transmitting station, the response of the receiver illustrated in Fig. 2 to a first digit comprising three impulses may be considered. In this case, the wipers of switch 105 are left standing in engagement with their respectively associated third contacts at the end of the digit. Accordingly, the operating circuit for the relay 190 is not completed. Since this relay fails to operate, the operating circuit for the slow-to-operate relay 170 is energized for a substantial time interval during the inter-digit pause between the first and second digits. This circuit is completed in response to the restoration of the relay 160 and may be traced as extending from the positive generator terminal 91 by way of the armature 152, the armature 161, the off-normal springs 115, the armature 196 and the winding of the relay 170 to the negative generator terminal 92. After an interval following the completion of this circuit, the relay 170 operates to complete, at its armature 172, an obvious holding circuit for itself. At its armature 171, the relay 170 opens a point in the above-traced circuit for energizing the motor magnet 114 of the rotary switch 105. Thus, this rotary switch is rendered non-responsive to further carrier current pulses transmitted to the receiver. Since the relay 190 fails to operate, the wipers of the switch 105 are left standing in their third off-normal positions until carrier current is removed from the carrier channel to initiate the release of the receivers in the manner explained subsequently. Since the operating circuit for the relay 190 extends only by way of the sixth contact of the contact set 103, it will be apparent that the operations just described occur in any case when a first digit other than the digit six is dialed at the transmitter. It will further be apparent that since any one of ten different digits comprising from one to ten pulses may be dialed at the transmitter any one of ten different receivers may be conditioned,

to the exclusion of all of the other receivers, to respond to the pulses of the second digit.

The character of the second digit dialed at the transmitter depends upon the particular one of the secondary carrier circuits which is to be operated upon. In the present case wherein the circuit 79 is to be completed and the control device 200 associated with this circuit can only be energized by way of the tenth contact of the contact set 109, a second digit of ten impulses is dialed at the transmitter. The receiver illustrated in Fig. 2 of the drawings responds to the carrier current pulses of the second digit in a manner substantially similar to that just described with reference to the carrier current pulses of the first digit. More particularly, the relay 130 follows the carrier current pulses and transmits corresponding pulses to the motor magnet 114 of the switch 105 so that the wipers of this switch are advanced to the off-normal position corresponding to the number of pulses making up the second digit. Also, the relay 160 operates at the beginning of the first pulse of the digit and due to its slow-to-release characteristic, remains operated until the digit is ended. Further, the off-normal springs 115 are closed to prepare the circuit for energizing the relay 170 when the wipers of the switch 105 are operated to their respective first off-normal positions. In the present case wherein ten carrier current pulses are transmitted to the receiver during the dialing of the second digit, the wipers of the switch 105 are left standing in engagement with their respectively associated tenth contacts when the digit is terminated. Shortly after the last carrier pulse is received and with the relay 130 operated, the relay 160 restores to complete an alternative circuit for energizing the slow-to-operate relay 170, this alternative circuit extending from the positive generator terminal 91 by way of the armature 152, the armature 161, the off-normal springs 115, the armature 183, and the winding of the relay 170 to the negative generator terminal 92. Upon restoring, the relay 160 also completes the operating circuit for the control device 200 associated with the selected secondary carrier circuit 79. This circuit may be traced as extending from one terminal of the alternating current source by way of the winding of the control device 200, the tenth contact of the contact set 109, the wiper 113 and the armatures 164, 162, and 154 to the opposite terminal of the alternating current source. When energized over this circuit, the control device 200 operates to complete at its armature 201, the secondary carrier circuit 79, whereby the switching unit terminating this carrier circuit is energized by the carrier current output of the alternator 87. Following the operation of the control device 200, no further operations occur in the receiver until carrier current voltage is removed from the carrier channel comprising the conductor 10 and ground.

During operation of the impulsing device 35 to cause the second digit of ten carrier pulses to be transmitted over the carrier channel, the shunt springs 37 are moved into engagement to again complete the above-traced operating circuit for the operating magnet 53. At the end of the digit and when the dial embodied in the impulsing device 35 returns to normal, the indicated shunt springs are moved out of engagement to interrupt the operating circuit for the magnet 53, thus permitting the ratchet and pawl mechanism associated with this magnet to advance the wiper

52 a second step or into engagement with its associated second contact. With the wiper 52 in this position a circuit is completed for energizing the pendulum type relay 65, this circuit extending from the positive generator terminal 19 by way of the winding of the relay 65, the second contact of the contact set 51, the wiper 52, the armature 54, and the winding of the magnet 53 to the negative generator terminal 20. Due to the relatively high resistance of the winding of the relay 65, the magnet 53 is insufficiently energized over the circuit just traced to operate. The relay 65, however, attracts its associated armature 66 which, due to the weight carried by the free end thereof, starts to vibrate, intermittently to complete an obvious circuit for energizing the slow-to-operate relay 60. After a predetermined and substantially fixed time interval, the vibration of the weighted armature 66 dies out and this armature settles into engagement with its associated working contact, thereby to maintain the relay 60 continuously energized. A short time interval thereafter, the slow-to-operate relay 60 operates to complete at its armature 61 an obvious alternative circuit for energizing the magnet 53. This magnet now operates to condition the associated ratchet and pawl mechanism to step the wiper 52 a third step and to open at its armature 54 the above-traced circuit for energizing the relay 65. As a result, the two relays, 65 and 60, sequentially restore in the order named, the last-mentioned circuit thereof, functioning to open at its armature 61 the alternative circuit for energizing the magnet 53. When the magnet 53 is deenergized, the wiper 52 is advanced to its third off-normal position and the armature 54 is released to re-complete the above-traced operating circuit for the relay 65. Since the second to eighth contacts of the contact set 51 are multiplied together, the cycle of operations just described and involving the two relays 60 and 65 and the magnet 53, is repeated seven times. When the wiper 52 is stepped to its ninth off-normal position or into engagement with its associated ninth contact, a circuit is completed for energizing the relay 70, this circuit extending from the positive generative terminal 19 by way of the winding of the relay 70, the armature 44, the ninth contact of the contact set 51, the wiper 52, the armature 54, and the winding of the magnet 53 to the negative generator terminal 20. Due to the relatively high resistance of the winding of the relay 70, the magnet 53 is insufficiently energized to operate when the circuit just traced is completed. The relay 70, however, operates to open at its armature 71 the previously traced holding circuit for the relay 30, causing the last-mentioned relay to restore. Upon restoring, the relay 30 opens, at its armature 31, the circuit for energizing the signal lamp 23, and interrupts, at its armature 33, the circuit over which the contactor 25 is being held energized. The contactor 25 now restores to open the circuit over which the carrier current voltage of the alternator 16 is being impressed upon the carrier channel comprising the conductor 13 and ground. The relay 70, upon operating also completes, at its armature 71, an obvious alternative circuit for energizing the magnet 53. This magnet in turn attracts its armature 54 to open the operating circuit for the relay 70 causing this relay to restore and open the operating circuit for the magnet 53. The ratchet and pawl mechanism associated with this magnet now advances the wiper 52 into engagement with its associated tenth contact.

When the wiper 52 is stepped to its tenth off-normal position, a switch normalizing circuit is completed for energizing the magnet 53. This circuit may be traced as extending from the positive generator terminal 19 by way of the armature 43, the multiplied tenth to twenty-second contacts of the contact set 51, the wiper 52, the armature 54, and the winding of the magnet 53 to the negative generator terminal 20. Due to the circuit interrupting action of the armature 54, the magnet 53 is repeatedly energized over the circuit just traced to cause the wiper 52 to be driven toward its home position. Since the twenty-fourth contact of the contact set 51 is connected directly to the positive generator terminal 19 and the twenty-third contact of the contact set 51 is connected to this generator terminal over a path including the restored armature 42 of the relay 40, the stepping operation of the switch 50 occasioned by energization of the magnet 53 over the normalizing circuit just traced, continues until the wiper 52 is returned to its home position. When this occurs the switch normalizing circuit is interrupted. Also, when the wiper 52 is disengaged from the multiplied second to eighth contacts of the contact set 51, the operating circuit for the relay 65 is interrupted. Accordingly, the two relays 65 and 60 are deenergized. Thus, all of the relays embodied in the transmitter shown in Fig. 1 of the drawings are restored to normal. When the attendant observes the deenergized condition of the signal lamp 23 he is informed that the desired control operation has been completed and he may then restore the start key 21 to its normal position to arrest the operation of the motor 17 and the generators 16 and 18 driven thereby. Also, when the start key 21 is returned to normal, the operating circuit for the signal lamp 22 is interrupted and this lamp is deenergized. Thus, the transmitter is fully released.

When the carrier current voltage is removed from the carrier channel comprising the conductor 10 and ground, the relay 85 embodied in the receiver illustrated in detail in Fig. 2 is deenergized and restores. In a similar manner the corresponding relays embodied in the other receivers coupled to the carrier channel also restore. Upon restoring, the relay 85 initiates the sequential restoration of the relays 97, 130, 140, and 150 in an obvious manner. With the two relays 97 and 150 deenergized, the operating circuit for the contactor 95 is interrupted causing this contactor to open, at its armature 96, the operating circuit for the motor 88. Accordingly, operation of the motor 88 and the two generators 87 and 89 are arrested. When the relay 150 restores, it opens, at its armature 152, a point in the common portion of the operating and holding circuits for the three relays 170, 180, and 190 causing any operated ones of these relays to restore. Upon restoring, the relay 150 also functions to interrupt at its armature 154 the above-traced operating circuit for the control device 230, whereby the last-mentioned device is released to interrupt the secondary carrier current circuit 79. At its armature 151, the relay 150, upon restoring, completes an alternative circuit for energizing the motor magnet 114 of the switch 105, this circuit extending from the positive generator terminal 91 by way of the armature 131, the armature 151, the multiplied first to tenth contacts of the contact set 106, the wiper 110, the armature 116 and the winding of the magnet 114 to the negative generator terminal 92. Due

to the circuit interrupting action of the armature 116, the motor magnet 114 operates buzzer fashion rapidly to return the wipers of the switch 105 to their respective normal position at which time the off-normal springs 115 are opened. When the wiper 110 is returned to its normal position, the switch normalizing circuit just traced and including the armature 116 is interrupted. Thus, the wipers of the switch 105 are left standing in their respective normal positions. In connection with the restoration of the switch 105 to normal, it will be noted that the switch normalizing circuit is initially completed substantially simultaneously with the deenergization of the driving motor 88 for the generator 89. Due to the mechanical inertia of the moving system driven by the motor 88, however, the voltage developed by the generator 89 is sufficient to enable the switch normalizing operation of the rotary switch 105 to be fully effected before the voltage of the generator 89 drops to an abnormally low value.

Although the release of the receiver shown in detail in Fig. 2 has alone been considered, it will be understood from the description pertaining to this receiver that the other receivers coupled to the carrier channel are restored to normal in an identical manner.

In the event the dispatcher attending the transmitter shown in Fig. 1 desires to cause a switching unit associated with one of the secondary carrier channels to be operated to the open circuit position, the key 28 is actuated to its off-normal position instead of the key 27 following operation of the start switch 21. For example, if the dispatcher desires to energize the control device or switching unit controlled over the secondary carrier circuit 79, to cause this device to be operated to its open circuit position, he will first operate the start switch 21 to its off-normal position to initiate the operation of the transmitter and the receivers in the manner previously described. A short time interval thereafter, the key 28 is operated to its off-normal position to complete an obvious circuit for energizing the relay 40. The relay 40 performs the same operations as are described above with reference to the relay 30, i. e., it completes at its armature 46 the previously traced circuit for energizing the contactor 25, prepares at its armature 47 the circuit for energizing the operating magnet 53 of the switch 50 and completes at its armature 45 a holding circuit for itself. In addition, the relay 40 completes at its armature 41 an obvious circuit for energizing the signal lamp 24, opens at its armature 44 a point in the previously traced operating circuit for the relay 70, and prepares at its armature 42 an alternative operating circuit for the last-mentioned relay. At its armature 44, the relay 40 also impresses positive generator potential upon the ninth contact of the contact set 51 embodied in the rotary switch 50. Finally, at its armature 43, the relay 40 disconnects positive generator potential from the multiplied tenth to twenty-second contacts of the contact set 51 and connects these multiplied contacts to the multiplied contacts numbered from two to eight inclusive, of the indicated contact set. The purpose of the operations just described is to insure that the relay 70 will not be operated until the wiper 52 of the switch 50 is moved, under the control of the relays 60 and 65 and the operating magnet 53, over the associated contacts numbered from two to twenty-two inclusive. Such movement of the

wiper 52 obviously requires a considerably greater time interval than that required for movement of the wiper over the contacts numbered from two to eight, inclusive, of the contact set 51. This, of course, means that carrier current is maintained upon the carrier channel comprising the conductor 10 and ground, for a considerably longer time interval than in the case when the relay 30 was operated in response to operation of the key 27. Specifically, the arrangement is such that when the key 27 is operated to cause the operation of the relay 30, carrier current is conducted to the carrier channel for a period of ten seconds following the completion of the dialing operation; whereas when the key 28 is operated to cause the operation of the relay 40, carrier current is conducted to the carrier channel for twenty seconds following the completion of the dialing operation at the transmitter.

After the key 28 is operated to its off-normal position to perform the function just described, the impulsing device 35 is actuated in the manner previously explained and in accordance with the two digits designating the secondary carrier circuit to be operated upon. The manner in which the receivers associated with the carrier channel respond to the carrier pulses is exactly the same as set forth above with reference to operation of the impulsing device 35 following operation of the key 27. Here again, since the circuit 79 is to be completed, the control device 200 is energized over the previously traced circuit shortly following the conclusion of the second digit. Also, at the end of the second digit, sustained operation of the rotary switch 50 is maintained through the above-described interaction between the operating magnet 53 and the two relays 60 and 65. The stepping operation of the rotary switch 50 under the control of the indicated relays continues until the wiper of this switch is moved into engagement with the ninth contact of the contact set 51, at which time, a circuit independent of the relays 60 and 65 is completed for energizing the operating magnet 53. This circuit extends from the positive generator terminal 19 by way of the armature 44, the ninth contact of the contact set 51, the wiper 52, the armature 54 and the winding of the magnet 53 to the negative generator terminal 20. Due to the circuit interrupting action of the armature 54, the magnet 53 in cooperation with its associated ratchet and pawl mechanism now operates rapidly to advance the wiper 52 to its tenth off-normal position at which time the slow stepping of the wiper is continued under the control of the two relays 60 and 65. Thereafter, and when the wiper 52 is stepped into engagement with its associated twenty-third contact, the above-mentioned alternative circuit is completed for energizing the relay 70, this circuit extending from the positive generator terminal 19 by way of the winding of the relay 70, the armature 42, the twenty-third contact of the contact set 51, the wiper 52, the armature 54, and the winding of the magnet 53 to the negative generator terminal 20. When the relay 70 operates, it initiates the release of the transmitter and of the various receivers coupled to the carrier channel in the exact manner previously described. During this release of the apparatus, the control device 200 is deenergized to interrupt at its armature 201, the selected secondary carrier current circuit 79. Also, during the release of the apparatus and when the relay 70 operates, the holding circuit for the relay 40 is interrupted

causing the last-mentioned relay to restore to open the operating circuit for the signal lamp 24 and to restore the normal circuit connections associated with the contact bank of the rotary switch 50. Upon operating, the relay 70 also completes the previously traced alternative circuit for energizing the magnet 53, whereby this magnet is caused to restore the wiper 52 to normal and the relays 70, 60 and 65 are released.

As previously indicated, the error key 75 is provided for the purpose of rapidly normalizing the apparatus in the event the dispatcher, after partially performing a circuit control selecting operation, discovers an error in his procedure. For example, if the dispatcher discovers, after dialing the first digit of a circuit designating number, that he has dialed the wrong digit or that he has operated the wrong one of the two keys, 27 and 28, he may operate the error key 75 and cause the apparatus to be restored to normal before any of the secondary carrier current circuits have been affected. When the key 75 is operated to its off-normal position, positive generator potential is impressed by way of the switch springs 76 and 77 directly upon the first and the multiplied second to eighth contacts of the contact set 51. Also, if the relay 40 is the operated one of the two relays 30 and 40, positive generator potential is impressed by way of the springs 77 upon the multiplied tenth to twenty-second contacts of the contact set 51. Alternatively, if the relay 30 is the operated one of the two relays 30 and 40, positive generator potential is impressed upon the last-mentioned contact multiple over the previously traced path, including the restored armature 43 of the relay 40. Immediately the above described paths are completed, the operating magnet 53 of the switch 50 is energized over the switch normalizing circuit including the circuit interrupting armature 54. As a result, the wiper 52 is rapidly driven to its normal position. During such movement of the wiper 52, one of the two previously traced circuits is completed for energizing the relay 70, which relay upon operating, initiates the release of the apparatus in the exact manner previously described.

The receiver shown in Fig. 2 is not claimed in this application. It is claimed in divisional application Serial No. 330,979 filed April 22, 1940.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein, and it is contemplated to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A control station for supplying control current to an associated control channel and comprising, in combination, a current source, a circuit for delivering current from said source to said channel, means including an impulsing device for controlling said circuit to transmit coded combinations of current pulses by way of said channel and for holding said circuit completed at the end of the pulse transmission, timing apparatus comprising a switch having a normal position and operative to a number of off-normal positions, circuit means controlled by said impulsing device for causing said switch to operate from one position to a succeeding position in response to each operation of said impulsing device to cause the transmission of a combination of current pulses over said channel, means re-

sponsive to the operation of said switch to a predetermined off-normal position for sustaining the operation of said switch independently of said impulsing device, and means responsive to the operation of said switch to a second predetermined off-normal position for interrupting said circuit and for causing said switch to be returned to its normal position.

2. A control station for supplying control current to an associated control channel and comprising, in combination, a current source, a circuit for delivering current from said source to said channel, means including an impulsing device for controlling said circuit to transmit coded combinations of current pulses by way of said channel and for holding said circuit completed at the end of the pulse-transmission, timing apparatus comprising a stepping switch including an operating magnet, said switch having a normal position and being operative to a number of off-normal positions, switch operating and normalizing circuits for energizing said magnet, contacts controlled by said impulsing device for completing said operating circuit each time said impulsing device is operated to cause the transmission of a combination of current pulses over said channel, relay means controlled by said stepping switch and operative in response to operation of said stepping switch to a predetermined off-normal position for periodically completing said operating circuit, thereby to cause said stepping switch to be operated to a second off-normal position, and means responsive to the operation of said switch to said second off-normal position for interrupting said first-named circuit and for causing said switch normalizing circuit to be completed.

3. A control station for supplying control current to an associated control channel and comprising, in combination, a current source, a circuit for delivering current from said source to said channel, an electromagnetic device for controlling said circuit, a normally incomplete operating circuit for said electromagnetic device, a switch, a relay operative in response to operation of said switch to complete said operating circuit, means including an impulsing device having contacts serially included in said operating circuit for interrupting and completing said operating circuit one or more times, thereby to cause current pulses to be transmitted by way of said channel, a holding circuit for said relay completed in response to operation of said relay, timing apparatus comprising a switch having a number of operating positions and operative from one position to a succeeding position in response to each operation of said impulsing device, means responsive to the operation of said last-named switch to a predetermined position for sustaining the operation of said last-named switch independently of said impulsing device, thereby to cause said last-named switch to be operated to a second predetermined position, and means responsive to the operation of said last-named switch to said second predetermined position for interrupting said holding circuit, thereby to cause the sequential restoration of said relay and said electromagnetic device.

4. A control station for supplying control current to an associated control channel and comprising, in combination, a current source, a circuit for delivering current from said source to said channel, an electromagnetic device for controlling said circuit, a normally incomplete operating circuit for said electromagnetic device, a

switch, a relay operative in response to operation of said switch to complete said operating circuit, means including an impulsing device having contacts serially included in said operating circuit for interrupting and completing said operating circuit one or more times, thereby to cause current pulses to be transmitted by way of said channel, a holding circuit for said relay completed in response to operation of said relay, timing apparatus comprising a stepping switch including an operating magnet, said switch having a normal position and being operative to a number of off-normal positions, switch operating and normalizing circuits for energizing said magnet, contacts controlled by said impulsing device for completing said switch operating circuit each time said impulsing device is operated, relay means controlled by said stepping switch and operative in response to operation of said stepping switch to a predetermined off-normal position for periodically completing said switch operating circuit, thereby to cause said stepping switch to be operated to a second off-normal position, and means responsive to the operation of said switch to said second off-normal position for interrupting said holding circuit, thereby to cause the sequential restoration of said relay and said electromagnetic device, and for causing said switch normalizing circuit to be completed.

5. A control station for supplying control current to an associated control channel and comprising, in combination, a current source, a circuit for delivering current from said source to said channel, means including an impulsing device for controlling said circuit to transmit coded combinations of current pulses by way of said channel and for holding said circuit completed at the end of the pulse transmission, timing apparatus comprising a switch having a number of operating positions and operative from one position to a succeeding position in response to each operation of said impulsing device to cause the transmission of a combination of current pulses over said channel, means responsive to the operation of said switch to a predetermined position for sustaining the operation of said switch independently of said impulsing device and at a predetermined speed, means responsive to the operation of said switch to a second predetermined position for interrupting said circuit, an error switch, and circuits controlled by said error switch for causing said first-named switch to operate to said switch predetermined position at a substantially higher speed.

6. A control station for supplying control current to an associated control channel and comprising, in combination, a current source, a circuit for delivering current from said source to said channel, a pair of switches, means responsive to operation of either of said switches for completing said circuit, means including an impulsing device for controlling said circuit to transmit coded combinations of current pulses by way of said channel and for holding said circuit completed at the end of the pulse transmission, timing apparatus operative in response to operation of said impulsing device to cause the transmission of a combination of current pulses over said channel, and means controlled by said timing apparatus for interrupting said circuit after a predetermined time interval which begins with the end of the pulse transmission or for a longer time interval depending upon which of said switches is initially operated.

7. A control station for supplying control cur-

rent to an associated control channel and comprising in combination, a current source, a circuit for delivering current from said source to said channel, a pair of switches, means responsive to operation of either of said switches for completing said circuit, means including an impulsing device for controlling said circuit to transmit coded combinations of current pulses by way of said channel and for holding said circuit completed at the end of the pulse transmission, timing apparatus operative in response to operation of said impulsing device to cause the transmission of a combination of current pulses over said channel, means controlled by said timing apparatus for causing said circuit to be interrupted, and circuit means jointly controlled by said first-named means and said timing apparatus for causing said last-named means to operate after a predetermined time interval which begins with the end of the pulse transmission or for a longer time interval depending upon which of said switches is initially operated.

8. A control station for supplying control current to an associated control channel and comprising, in combination, a current source, a circuit for delivering current from said source to said channel, a pair of switches and relays individually controlled thereby, means responsive to operation of either of said relays for completing said circuit, means including an impulsing device for controlling said circuit to transmit current pulses by way of said channel and for holding said circuit completed at the end of the pulse transmission, timing apparatus comprising a rotary switch including a set of contacts and a wiper for engaging said contacts, circuit means controlled by said impulsing device for initiating the operation of said rotary switch, an additional relay operative to cause said circuit to be interrupted, and a pair of circuits selectively prepared by one of said first-named relays for energizing said additional relay, one of said pair of circuits being completed in response to a predetermined movement of said wiper over said contacts only when said one relay is deenergized and the other of said pair of circuits being completed in response to a different predetermined movement of said wiper over said contacts only when said one relay is energized.

9. A control station for supplying control current to an associated control channel and comprising, in combination, a current source, a circuit for delivering current from said source to said channel, a pair of switches and relays individually controlled thereby, means responsive to operation of either of said relays for completing said circuit, means including an impulsing device for controlling said circuit to transmit pulses by way of said channel and for holding said circuit completed at the end of the pulse transmission, timing apparatus comprising a rotary switch including a set of contacts and a wiper for engaging said contacts, circuit means controlled by said impulsing device for initiating the operation of said rotary switch, means controlled by movement of said wiper over said contacts for sustaining the operation of said switch independently of said impulsing device, an additional relay operative to cause said circuit to be interrupted, and a pair of circuits selectively prepared by one of said first-named relays for energizing said additional relay, one of said pair of circuits being completed in response to a predetermined movement of said wiper over said contacts only when said one relay is deenergized

and the other of said pair of circuits being completed in response to a different predetermined movement of said wiper over said contacts only when said one relay is energized.

10. A control station for supplying selecting and control pulses to an associated control channel and comprising, in combination, a circuit for transmitting said pulses to said channel, means including an impulsing device for controlling said circuit to transmit a plurality of coded combinations of selecting pulses over said channel and to initiate the transmission of a control pulse over said channel following the transmission of said plurality of combinations of se-

5 lecting pulses, a timing device having a plurality of settings and operative to a new setting in response to each operation of said impulsing device to cause the transmission of a combination of selecting pulses over said channel, means responsive to the operation of said timing device to a predetermined setting for sustaining the operation of said timing device at a substantially constant rate, and means responsive to the sustained operation of said timing device to a second predetermined setting for controlling said circuit to terminate said control pulse.

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