Oct. 9, 1945. F. A. HUBBARD 2,386,609

TELEPHONE SYSTEM

Filed July 3, 1943 2 Sheets-Sheet 1

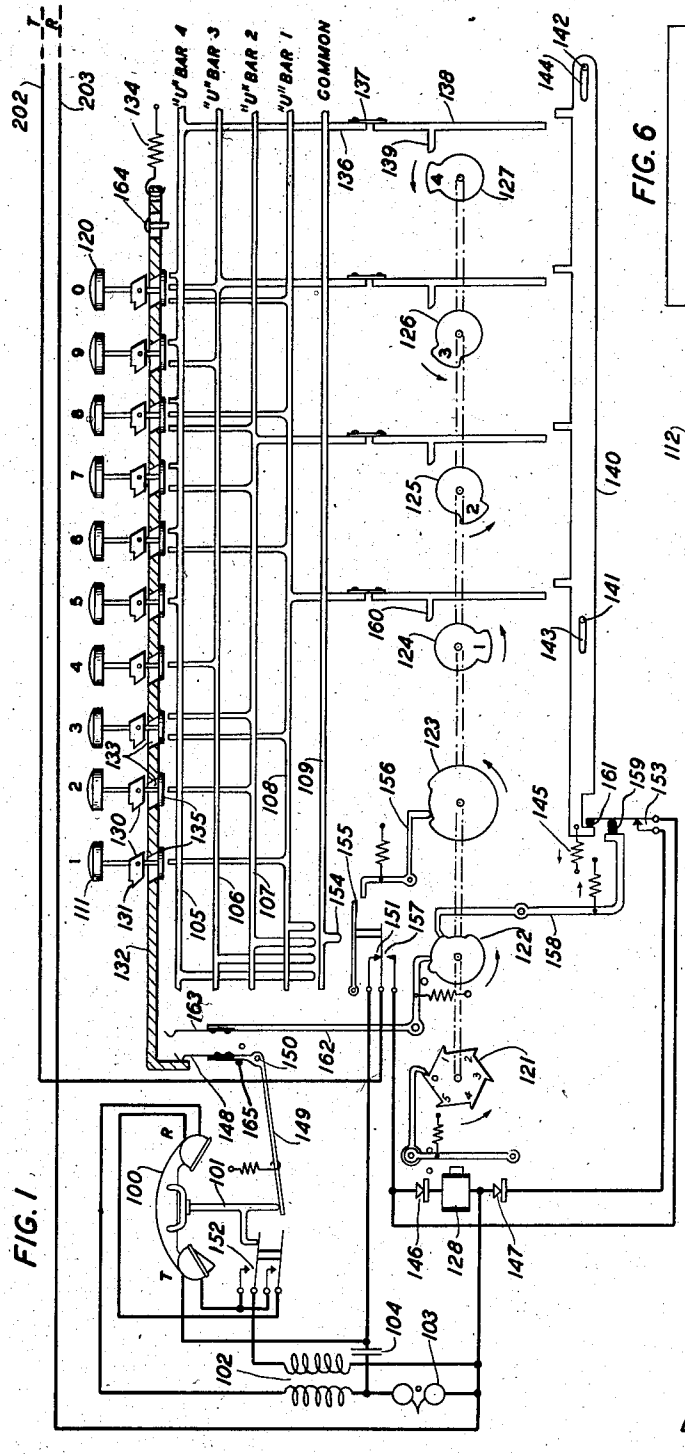

FIG. 1

CODE		REGISTER RELAYS
KEY	BARS	
1	1	1'
2	2	2'
3	1, 2	1', 2'
4	3	3'
5	1, 4	1', 4'
6	2, 4	2', 4'
7	1, 2, 4	1', 2', 4'
8	3, 4	3', 4'
9	1, 3, 4	1', 3', 4'

FIG. 6

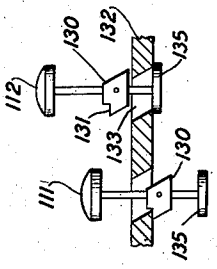

FIG. 4

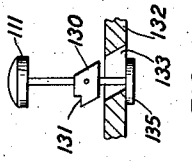

FIG. 3

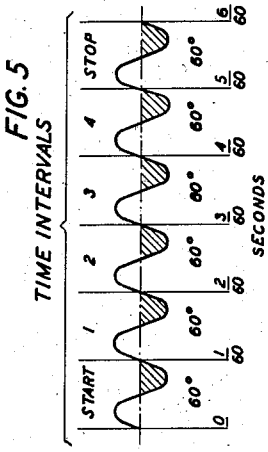

FIG. 5

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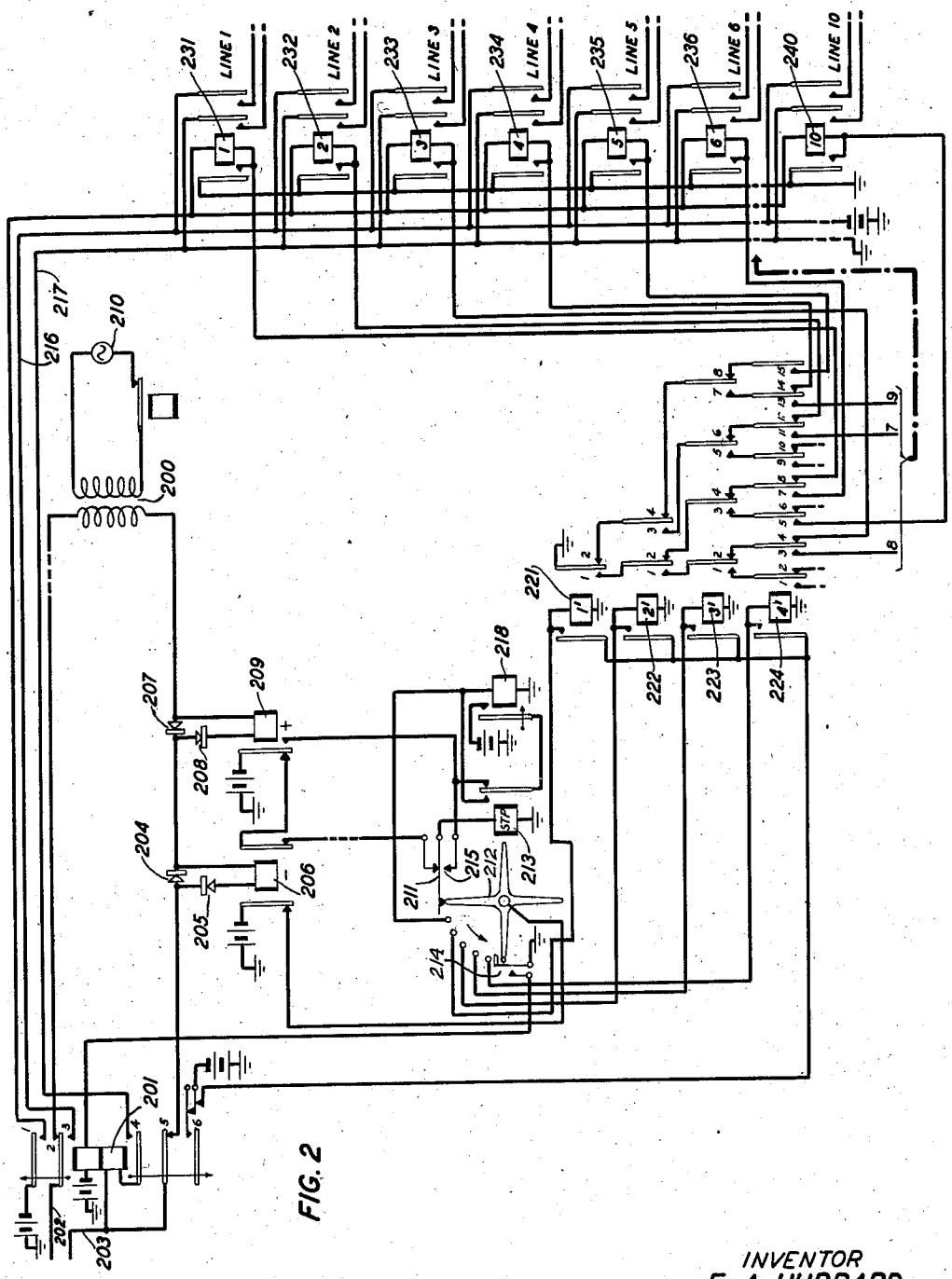

FIG. 2

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TELEPHONE SYSTEM

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Application July 3, 1943, Serial No. 493,410

2 Claims. (Cl. 179—90)

This invention relates to signaling and communication systems and particularly to telephone systems of the key calling type.

Key calling systems have been devised primarily to provide facilities whereby telephone connections between a calling subscriber's line and any of a group of frequently called lines may be completed expeditiously and with a minimum of effort on the part of the calling subscriber. Such systems are characterized by a subscriber's telephone set which is provided with a plurality of individually operable keys or key buttons, each of which may be assigned to a particular one of the frequently called lines. However, such a telephone set may also be used, with suitable receiving equipment to control the establishment of ordinary telephone connections.

The key calling, executive type system, in order to obtain a sufficiently large code, has required complex mechanisms for generating, timing and spacing the code pulses.

In accordance with the present invention, alternating current supplied from the receiving equipment is employed, said current controlling the timing and spacing of the pulses.

More specifically the code is obtained by suppressing predetermined alternate half cycles of a fixed number of cycles of the signaling current under the control of the key-set.

Furthermore, the receiving equipment includes means responsive to the intermediate half cycles of the signaling current for controlling the registration of the code.

These and other features of the invention will be more apparent from a consideration of the following description in connection with the drawings, in which:

Fig. 1 is a schematic showing of the equipment at the calling station and the circuits thereat;

Fig. 2 shows the circuits for receiving the code pulses;

Fig. 3 shows one key ready for operation;

Fig. 4 shows the key locking arrangement;

Fig. 5 is a time-current diagram for one code cycle; and

Fig. 6 is a table indicating the bars at the calling station and register relays at the receiving station operated in response to the depression of each key.

For a disclosure of a key calling telephone set showing a typical arrangement of the keys and bars, reference may be made to applicant's copending application Serial No. 479,417, filed March 17, 1943, which became Patent No. 2,375,109 on May 1, 1945.

Referring first to Fig. 1 together with Figs. 3 and 4, the telephone set includes the handset 100, cradle 101, coil 102, ringer 103 and condenser 104. In addition, the telephone set is equipped with a set of ten keys 111 to 120, a set of U-bars 105 to 109 and a set of rotatable cams 121 to 127 with a driving magnet 128.

On each key is mounted a camming collar, for example, collar 130 which has sloping sides and a set back portion forming a shoulder 131. Below the collars is a plate 132 having openings 133, the sides of which slope at the same angle as the sides of the collars. The plate 132 is slidably mounted in any desirable manner and is normally held in the position shown, by the action of the strong spring 148 resting against stop 165. When the handset 100 is removed from the cradle 101, spring 148 is disengaged from plate 132 and plate 132 moves under the control of the weaker spring 134 until the openings come into registration with the collars on keys 111 to 120, as shown in Fig. 3. The position of plate 132 at this time is fixed by pin 164. When a key, for example, key 111 is operated, the collar 130 enters the opening 133 moving the plate 132 to the left. When the key is completely depressed, plate 132 passes beyond shoulder 131 and is then drawn back by spring 134 to rest on shoulder 131 so that key 111 and plate 132 are jointly locked, as shown by the key at the left in Fig. 4. With plate 132 in this position, openings which registered with the collars of the other keys following the removal of the handset from the cradle are displaced sufficiently so that the collars would strike the top of the plate and no other key can be depressed (see Fig. 4).

Below the plate 132, each key terminates in a disc-like member 135 which is in position to act on extensions of one or more of the U-bars 105 to 108. The U-bars 105 to 109 are resiliently mounted so that they tend to return to the position shown and to return a depressed key to normal when released by plate 132. The upward extensions on the U-bars 105 to 108 are provided according to the code set forth in Fig. 6. Bar 109 is acted on by studs on all the other bars so as to be moved whenever any key and its associated code U-bars are operated.

Each of the code bars 105 to 108 has a single operating arm to which is flexibly mounted an operating lever controlled by one of the cam wheels 124 to 127. For example, U-bar 105 has an arm 136 to which lever 138 is fastened by means of the flat spring 137. On lever 138 is a

stud 139 which extends into the path of rotation of the projection on cam wheel 127 only if bar 105 is depressed. With bar 105 depressed the end of lever 138 overlaps the pin on bar 140 and the rotation of cam wheel 127 acting through stud 139 causes bar 140 to move to the right for a purpose to be discussed later. Bar 140 is slidably mounted by means of pins 141 and 142 and slots 143 and 144 and is held in the position shown by means of spring 145.

The code generating cam wheels 124 to 127 are driven by means of magnet 128 and ratchet wheel 121 which also drive control cam wheels 122 and 123. The functions of cam wheels 122 and 123 will be explained in connection with the functions of the substation circuits. In series with the winding of magnet 128 are rectifiers 146 and 147 so poled that current can flow through the winding of magnet 128 only in one direction.

When the subscriber wishes to initiate a call he will remove the handset 100 from the cradle 101, thereby permitting lever 149 to rotate around pin 150 and remove spring 148 from plate 132, so that the openings of plate 132 register with the collars 130, etc. on the keys.

The release of the cradle 101 also causes any suitable equipment at the receiving circuit to complete a circuit from the secondary winding of coil 200 at the receiving station, over contact 2 of relay 201, tip conductor 202, normal contact 151, through the transmitter of handset 100, switchhook contact 152, right winding of repeating coil 102, to ring conductor 203, contact 5 of relay 201, through rectifier 204 in parallel with rectifier 205 and relay 206 and through rectifier 207 in parallel with rectifier 208 and relay 209 back to the secondary winding of coil 200.

Alternating current from the source 210 is transmitted through coil 200 to the circuit above traced but is ineffective until one of the keys 111 to 120 has been depressed. On the other hand, if this arrangement were associated with a central office circuit using common senders, the premature operation of a key would be ineffective until the source of alternating current has been connected to the line.

Assuming that key 120 is depressed and locked as above described, the U-bars 105, 106 and 108 are depressed, in turn operating common bar 109. Bar 109 has a stud 154 which acts on lever 155, thereby opening contact 151 and closing contact 157.

The line circuit now extends from conductor 202, over contact 157, through rectifier 146, winding of magnet 128 to conductor 203. A parallel path extends from contact 157 over contact 153 through rectifier 147 to conductor 203. Rectifiers 146 and 147 are so poled that positive half cycles of the alternating current pass through the winding of magnet 128 while negative half cycles go by way of rectifier 147 and contact 153.

Therefore, at the first positive half cycle, magnet 128 operates, acting on ratchet wheel 121 to move cam wheels 122 to 127 through one step. One complete revolution of ratchet wheel 121 is made in six steps requiring six cycles of the alternating current. At the beginning of the first step lever 158 drops into the depression on cam wheel 122 causing stud 159 to open contact 153 so that the negative half cycle which follows is suppressed as a start signal. Toward the end of the first step cam 123 operates lever 156 to lock lever 155 and hold it down until the end of revolution, thereby insuring the restoration of the cam wheels to normal.

The next step of ratchet wheel 121 in response to the second positive half cycle brings the projection on cam wheel 124 into engagement with stud 160, since U-bar 108 was depressed, thereby moving bar 140 to the right and opening the contact 153 by means of stud 161. Therefore, the first of the code negative half cycles is suppressed.

At the third step the projection on cam wheel 125 is in a horizontal position, but, since U-bar 107 was not depressed the cam wheel 125 is ineffective and the second negative half cycle passes over contact 153 to the receiving circuit.

At the fourth and fifth steps, respectively, cam wheels 126 and 127 act on their associated studs and cause the suppression of the third and fourth negative half cycles of the code.

During the sixth step which brings the cam wheels back to normal, lever 162 rides over a projection on cam wheel 122, thereby pressing spring 163 against plate 132 to release key 120. At the end of the step lever 162 is dropped back to normal and plate 132 may again resume a position in registration with the keys. At the same time that cam wheel 122 releases the operated key, cam wheel 123 permits lever 156 to drop back to its normal position and lever 155 is restored, opening the circuit through magnet 128.

This arrangement may be used with ten keys as shown for key calling a group of ten lines or in accordance with a decimal numbering scheme. In the former case, no further action takes place until the handset 100 is restored to the cradle 101, while in the latter case, the depression of the key for the next digit would cause another cycle of operations as above described. If desired, the code shown in Fig. 6 and which resembles a part of that used in the above-mentioned patent may be similarly expanded to cover a fifteen-key executive type calling arrangement.

In any case, when the handset is restored, the cradle depresses lever 149, which presses spring 148 against plate 132 to render the key-set inoperative.

If the handset is restored before the code pulsing cycle is completed the pressure of spring 148 on plate 132 first permits the operated key to restore, in turn restoring the U-bars and then blocks all of the keys. Since lever 155 is locked under the control of cam wheel 123, the pulsing circuit remains closed and the cam wheels are restored independent of the U-bars. Since the depressed key has been restored no further elements of the code will be transmitted.

It is to be understood that the mechanism shown is merely one possible embodiment of the invention and any suitable mechanism can be used which will provide for the progress of the contact control means to five positions in succession, and for selectively opening the contact at one or more of those positions.

Referring now to the receiving circuit of Fig. 2, the rectifiers 204 and 205 render relay 206 responsive only to negative half cycles, while the rectifiers 207 and 208 render relay 209 responsive only to positive half cycles. Therefore, although the means which connects the alternating current to the line would also close the circuit for magnet 213 relays 206 and 209 respond to uncoded alternating current by operating alternately and ineffectually.

As set forth in the description of Fig. 1, the first step of the cam wheels following the depression of a key causes the suppression of the

first negative half cycle as a start signal so that relay 206 cannot operate. Since relay 209 is unresponsive to the negative half cycle, relays 206 and 209 are both unoperated and a circuit is closed from battery, over the back contact of relay 209, right back contact of relay 206, normal contact 211, controlled by brush arm 212, winding of stepping magnet 213 to ground. Magnet 213 rotates brush 212 one step. The movement of brush 212 opens normal contact 211, thereby opening the original energizing circuit of magnet 213 and closing at contact 215 an alternative circuit for magnet 213 which is completed at the next positive half cycle, from battery over the front contact of relay 209, and contact 215 to the winding of magnet 213 and ground. Magnet 213 advances brush 212 to the second terminal.

According to the foregoing description of Fig. 1, the code for the digit 0 was transmitted which calls for the suppression of the first, third and fourth half cycles. Therefore, during the first negative half cycle of the code, relay 206 is not operated and a circuit is closed from battery over the back contact of relay 206, brush 212 and its second terminal, winding of register relay 221 to ground.

Relay 209, in response to the ensuing positive half cycle, causes the advance of brush 212 to its third terminal. Since the second negative half cycle is not suppressed, relay 206 operates opening the register operating circuit, leaving register relay 222 unoperated.

Brush 212 is advanced to its fourth and fifth terminals by the third and fourth positive half cycles and, since the third and fourth negative half cycles are suppressed, relay 206 does not operate during either half cycle and register relays 223 and 224 are operated. Relays 221, 223 and 224 lock to battery over contact 6 of relay 201.

In response to the fifth positive half cycle, brush 212 is moved into position to close contact 214, thereby completing a circuit from ground over contact 214, through the upper winding of relay 201 to battery. Relay 201 disconnects the alternating current source from the calling line and closes a holding circuit for itself under the control of the calling line from battery, conductor 216, contact 3 of relay 201, conductor 202, contact 151, through the transmitter of handset 100, switchhook contact 152, right winding of repeating coil 102, conductor 203, lower winding and contact 4 of relay 201, conductor 217 to ground. Relay 201, at its contact 1, connects battery to the windings of the line selecting relays 231 to 240. With register relays 221, 223 and 224 operated the circuit of relay 240 is completed over contact 5 of relay 224, contact 3 of relay 223, contact 2 of relay 222 and contact 1 of relay 221 to ground. Relay 240 locks to ground at its left contact and at its right contact extends conductors 216 and 217 to line No. 10. Any convenient means may be employed for signaling the called line. Relays 240 and 201 remain operated throughout the conversation. When handset 100 is restored to the cradle, the locking circuit of relay 201 is opened, in turn opening the locking circuit of relay 240, restoring both to normal.

The operation of relay 201 also opens contact 6 after a delay, releasing the register relays 221 to 224. When brush 212 steps beyond contact 214 the switch is again normal and off-normal contact 215 is opened by the next brush, which takes up the function of brush 212.

Relay 218 guards the receiving circuit against the abnormal advance of brush arm 212 to its second position. Relay 218 is slow to operate and cannot operate during the normal operation of the receiving circuit. If, for any reason, brush 212 should be advanced to its second position and remain there, when relay 206 is no longer operated by the alternating current, relay 218 operates in a circuit from ground through the winding of relay 218, brush 212 in its second position, to battery at the back contact of relay 206. With relay 218 operated, a self-interrupting circuit is closed for magnet 213 from battery over the front contact of relay 218, back contact of magnet 213, off-normal contact 215 through the winding of magnet 213 to ground, thereby stepping the switch back to normal where the opening of off-normal contact 215 brings the switch to rest. At each operation of magnet 213 a circuit is closed from battery over the front contact of relay 218 and the front contact of magnet 213 to the winding of relay 218 and ground to hold relay 218 operated until the switch is normal.

The particular advantages of this present code transmitting and receiving arrangement as compared to ones previously proposed are that it requires no timing mechanism at the key-set; that it employs a minimum number of contacts in the code transmitting circuit and that the start of the code transmission is under the control of the current supplied from the receiving equipment so that no signal can be transmitted before the means for receiving it is ready.

What is claimed is:

1. In a telephone system, a calling substation, called substations, transmitting means at said substations, selecting equipment common to said substations, means for transmitting the designation of a called substation from said calling substation to said selecting equipment comprising a loop circuit connecting said transmitting means and said selecting equipment, means for applying alternating current to said loop circuit, distributing means in said transmitting means, distributing means at said selecting equipment, means to simultaneously drive said distributing means in response to a plurality of half cycles of said alternating current having one polarity, and means under the control of the distributing means at said transmitting means to suppress the intermediate half cycles of said alternating current, a register comprising a plurality of relays at said selecting equipment, means under the control of the distributing means at said selecting equipment for placing said relays successively under the control of said transmitting means during said intermediate half cycles, and means operated by said register to connect said calling substation with the called substation.

2. In a telephone system, a calling substation, called substations, transmitting means at said substations, selecting equipment common to said substations, means for transmitting the designation of a called substation from said calling substation to said selecting equipment comprising a loop circuit connecting said transmitting means and said selecting equipment, means for applying alternating current to said loop circuit, distributing means in said transmitting means, distributing means at said selecting equipment, means to simultaneously drive said distributing means in response to half cycles of said alternating current having one polarity, rectifying means to prevent the passage of half cycles of the opposite polarity,

keys at said calling substation, and means under the joint control of said keys and of said transmitting distributing means for rendering said rectifying means effective in accordance with a predetermined code, means at said receiving station responsive to current of said opposite polarity, a register comprising a plurality of relays, means under the control of said selecting distributing means for placing said relays successively under the control of said responsive means to record said code, and means operated by said register to connect said calling substation with the called substation.

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