

Dec. 24, 1940.

L. C. ROBERTS

2,225,887

SIGNALING SYSTEM

Filed Jan. 27, 1939

7 Sheets-Sheet 1

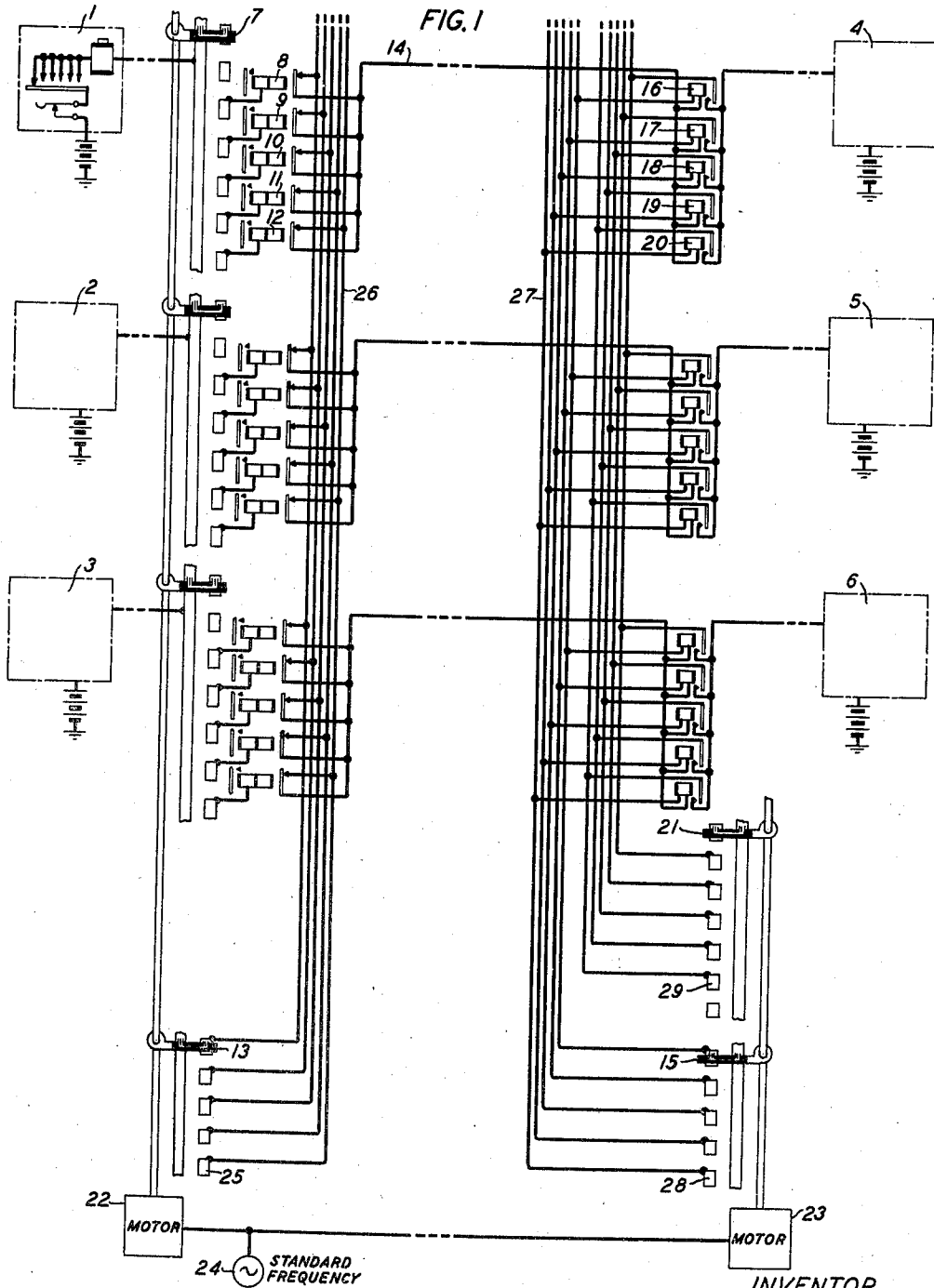


FIG. 2

FIG. 3	FIG. 5
FIG. 4	FIG. 6

FIG. 7

FIG. 8	FIG. 9
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INVENTOR
L. C. ROBERTS

BY

John A. Hall
ATTORNEY

Dec. 24, 1940.

L. C. ROBERTS

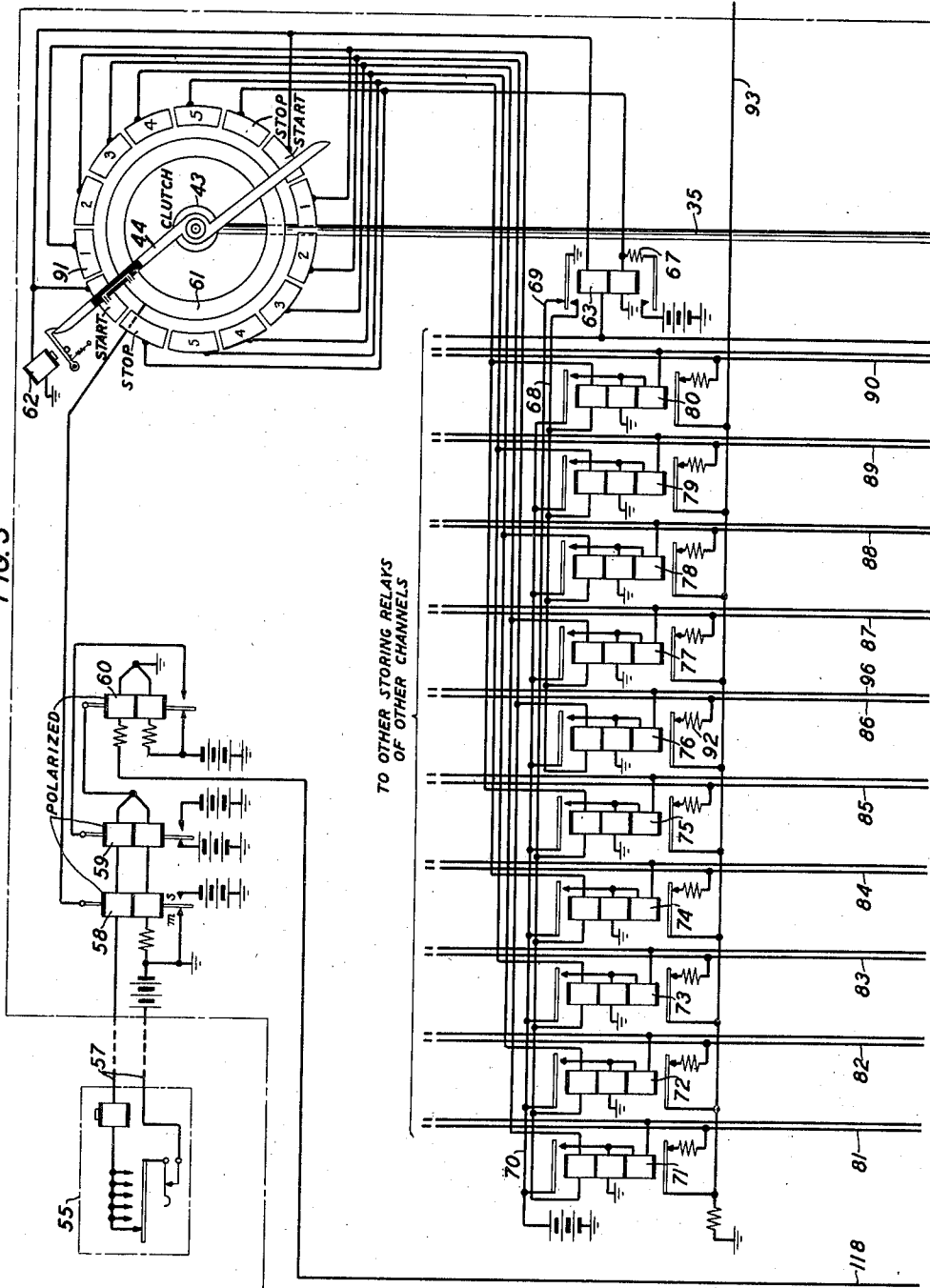
2,225,887

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FIG. 3



INVENTOR
L.C. ROBERTS
BY *John A. Hall*
ATTORNEY

Dec. 24, 1940.

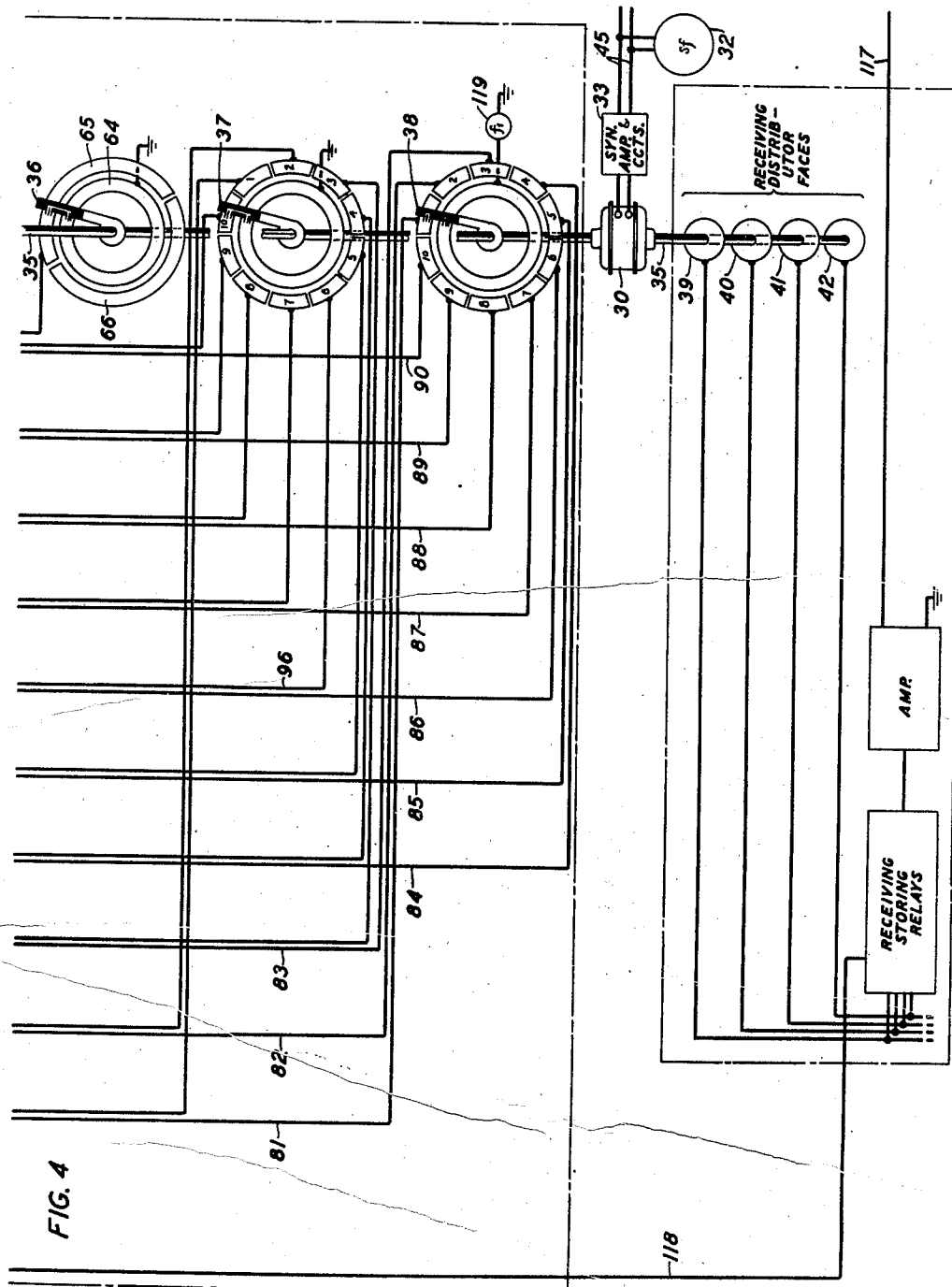
L. C. ROBERTS

2,225,887

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INVENTOR
L.C. ROBERTS
BY *John A. Hall*
ATTORNEY

Dec. 24, 1940.

L. C. ROBERTS

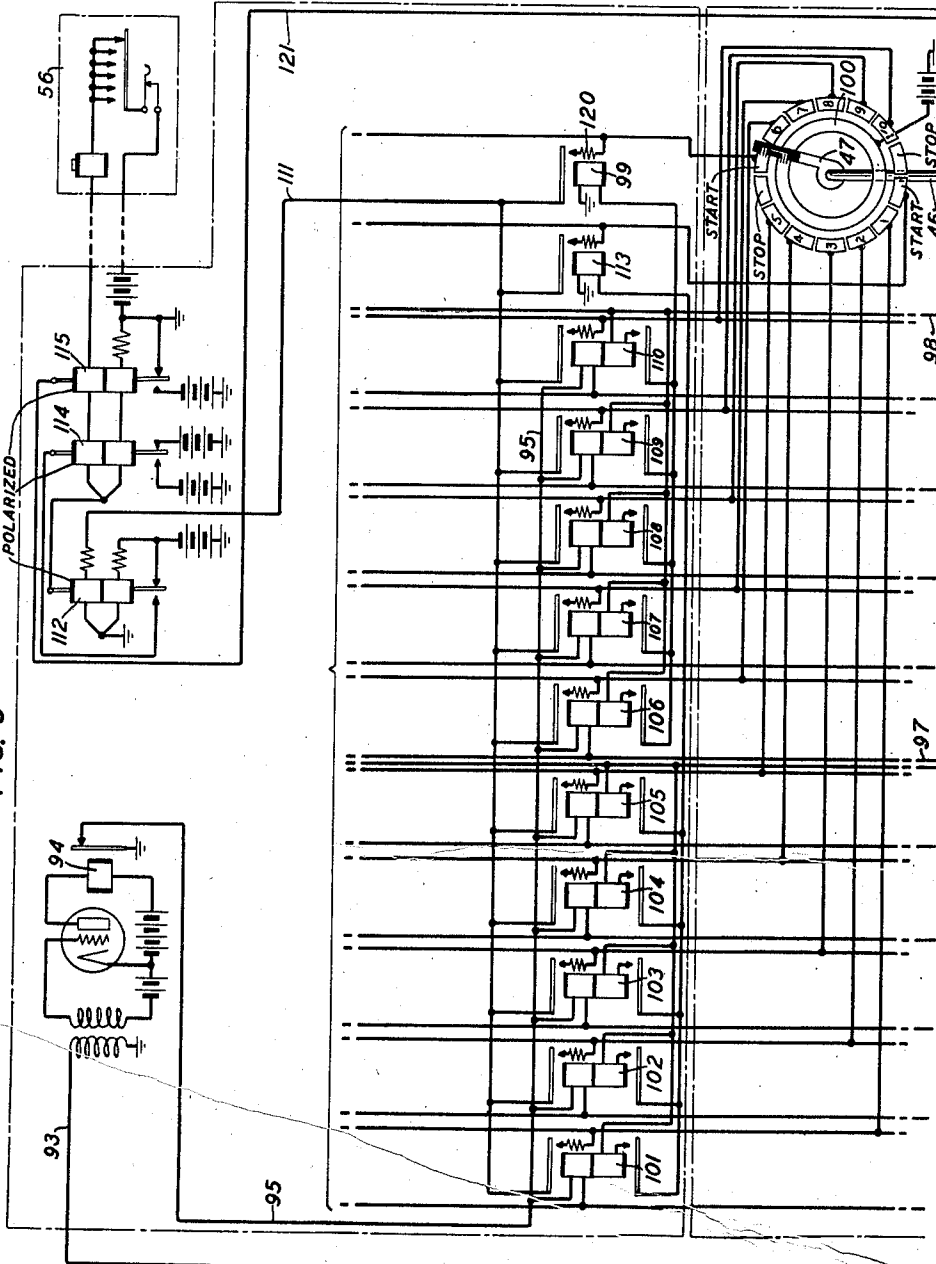
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FIG. 5



INVENTOR
L.C. ROBERTS
BY *John A. Hall*
ATTORNEY

Dec. 24, 1940.

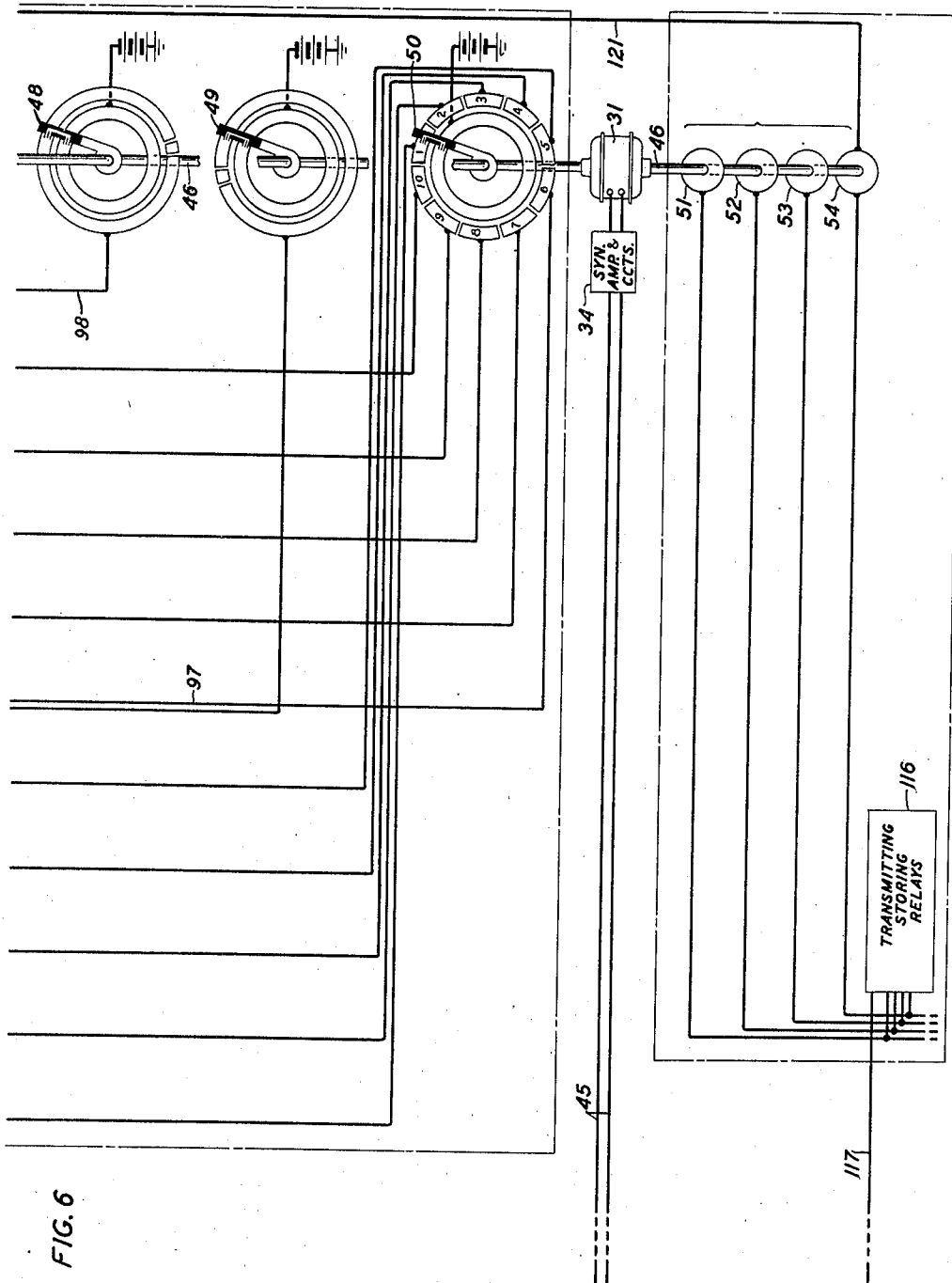
L. C. ROBERTS

2,225,887

SIGNALING SYSTEM

Filed Jan. 27, 1939

7 Sheets-Sheet 5



INVENTOR
L.C. ROBERTS
BY *John A. Hall*
ATTORNEY

Dec. 24, 1940.

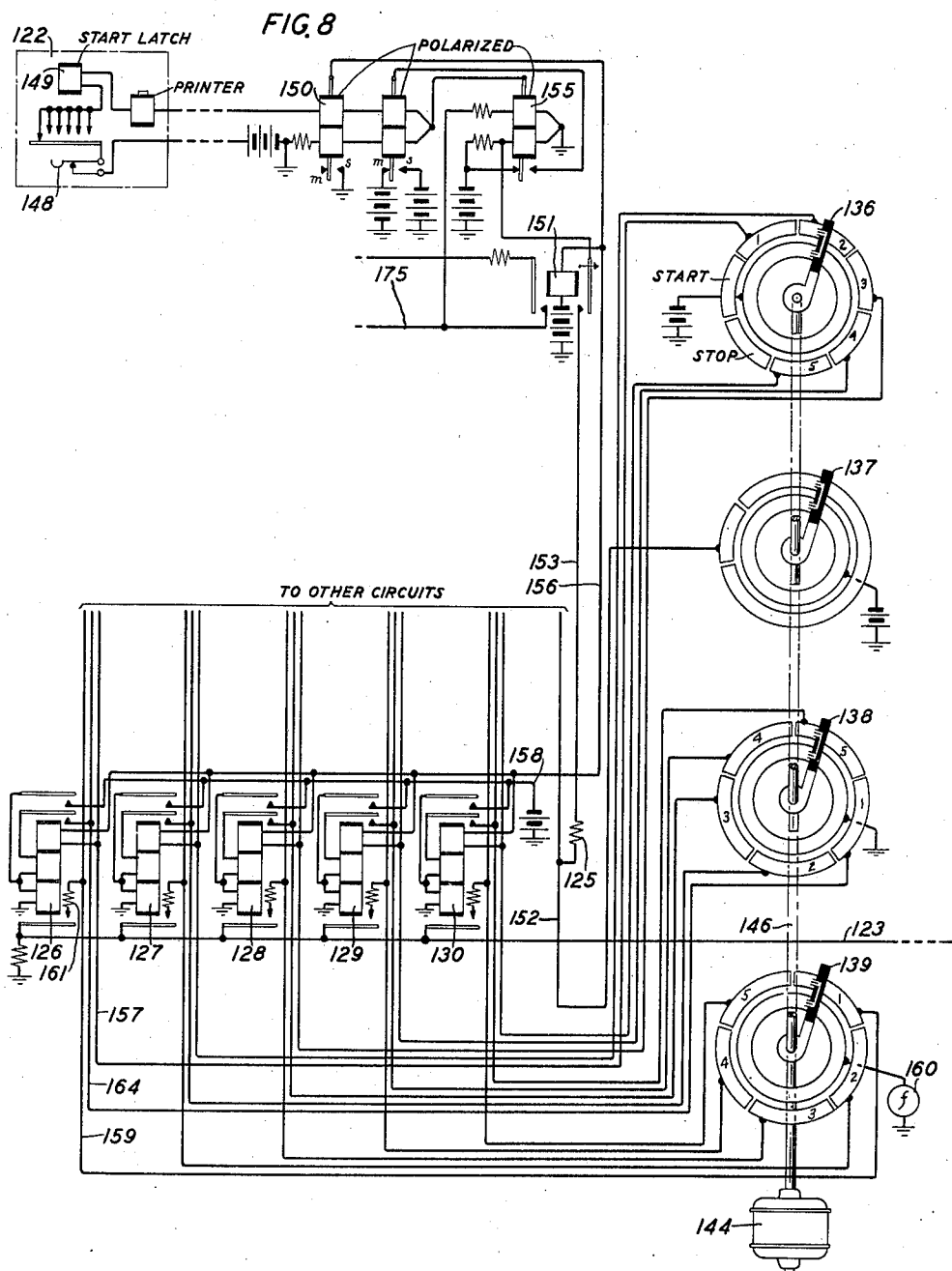
L. C. ROBERTS

2,225,887

SIGNALING SYSTEM

Filed Jan. 27, 1939

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INVENTOR
L. C. ROBERTS
BY *John A. Hall*
ATTORNEY

Dec. 24, 1940.

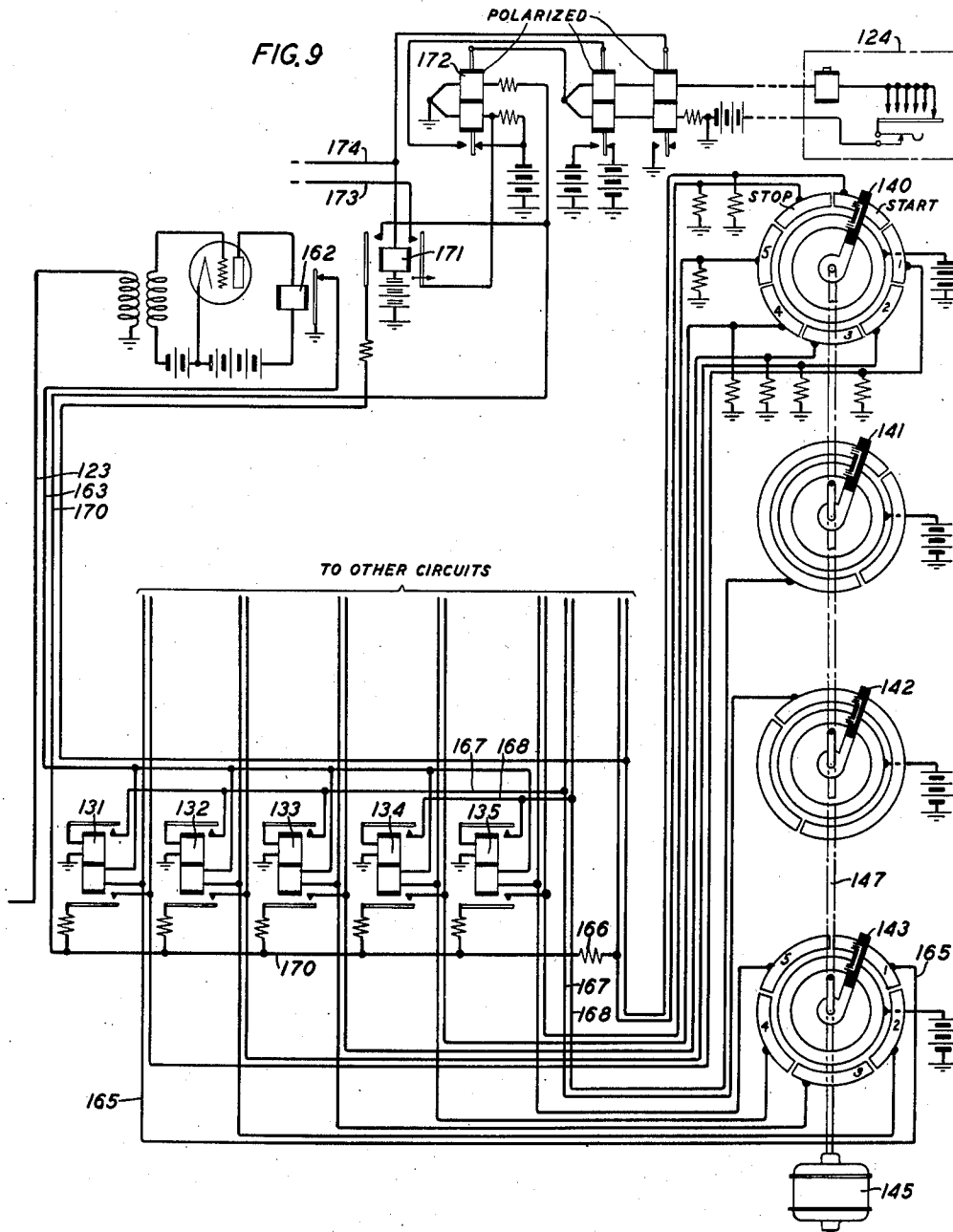
L. C. ROBERTS

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SIGNALING SYSTEM

Filed Jan. 27, 1939

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INVENTOR
L. C. ROBERTS
BY *John A. Hall*
ATTORNEY

UNITED STATES PATENT OFFICE

2,225,887

SIGNALING SYSTEM

Leland C. Roberts, Towaco, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application January 27, 1939, Serial No. 253,093

7 Claims. (Cl. 178—52)

This invention relates to signaling systems and particularly to permutation code telegraph systems wherein messages are sent from station to station over lines extending for considerable distances through a plurality of offices.

It is an object of the invention to gain greater efficiency by using the lines as nearly up to full speed as possible. Where long lines extend between offices the rate of sending is limited by the frequency band-width of such lines while the loops extending from the offices to the stations are by reason of their greater frequency band-width capable of higher speeds. Hence it is proposed to send over the station loops by start-stop means and over the lines by straight codes containing only the signaling impulses with the start and stop impulses eliminated. Thus the code used over the lines has two less impulses than the code used over the loops and therefore higher speed may be used over the loops or poorer in quality and less expensive lines may be used. In general this object has been attained by other systems of the prior art, but the means herein set forth constitute an improvement by virtue of the employment of novel arrangements, having greater simplicity, a higher degree of dependability and lesser first cost.

A feature of the invention is the use of common synchronous distributors for controlling the translation of the start-stop codes in the station loops from or into the straight codes of lesser length in the lines. Where there are a plurality of lines extending from station to station through several offices, such lines, instead of being provided with individual synchronous distributors at all offices for this purpose as heretofore, now are provided with relatively inexpensive but sturdy and reliable relay means controlled by synchronous distributors common to all the lines.

Another feature of the invention is the use of a means common to the various offices for maintaining synchronism between the distributors in these offices without the necessity for using the circuits themselves for sending synchronizing impulses. There has been established a source of standard frequency which maintains an accuracy of something like one part in a million and this has already gone into use and has found a number of important industrial applications. Since lines now extend from the source of this standard frequency to most of the large cities of the country, it is a simple matter to employ this already established means at small cost to keep the synchronous distributors in the

various offices operating accurately together. If the network of lines under the present invention becomes large enough, a standard frequency for this use only may be used.

A further feature of one form of the invention is the use of start-stop sending means controlled by start impulses from the receiving end. Where continuously operating synchronous distributors are employed at the offices to control the individual line code translating and relaying means, the start-stop means employed for transmitting over the loops must be made to start at definite times and, hence, it has been so arranged here that start impulses are sent out by the said common and continuously operating distributors to start the sending of code impulses from the other end of the loop.

The drawings comprise seven sheets, the first of which in Fig. 1 shows the invention in schematic form. The four sheets, comprising Figs. 3 to 6, inclusive, when placed as shown in Fig. 2, illustrate the invention in more detail in the form of a circuit diagram. The two remaining sheets, comprising Figs. 8 and 9, when placed as shown in Fig. 7, illustrate another form of the invention again in more detail in the form of a circuit diagram.

In Fig. 1 there are three teletypewriter stations 1, 2 and 3 placed in communication with three other stations, 4, 5 and 6, respectively. In this highly schematic diagram only one-way transmission is indicated but it will be quickly apparent to those skilled in the art that this is merely illustrative and in no manner restrictive for the essential elements of one-way transmission being made known, it then becomes merely the exercise of engineering skill to adapt these principles to two-way transmission and over the various well-known types of transmission circuits. Here the station 1 sending signals has the individual impulses distributed by an individual distributor denoted by its contact arm 7 to a set of recording relays 8 to 12, inclusive, by means of which through the control of impulses supplied by common distributor 13 transmits coded impulses over the path 14. At the distant end of path 14 the common distributor 15 causes the selective actuation of relays 16 to 20, inclusive, and these through the agency of common distributor 21 properly actuate the receiving apparatus at teletypewriter station 4.

The individual distributor 7 has seven small segments, a stop, a start, and five code segments so that the relays 8 to 12 are energized in accordance with a five-unit start-stop code. The

common distributor 13 has only five small segments so that the impulses transmitted over the path 14 comprise only the code impulses and not the start or stop impulses.

5 The common distributor 15, like the distributor 13, has but five small segments but the other common distributor 21 has the full seven segments for operating the regular start-stop apparatus at the receiving station.

10 It should be noted that the distributor 13 is common to all the incoming lines from stations such as 1, 2 and 3, and that distributors 15 and 21 are common to all outgoing lines to stations such as 4, 5 and 6.

15 It should further be noted that all distributors in one office are controlled by a single source of power such as motor 22 or motor 23 and that all such sources of power are controlled from a single source of standard frequency 24. This source of standard frequency of extreme precision is well known and has been in commercial use for some time, and having been found to be dependable, is usable here to maintain exact synchronism between these various distributors even when placed at great distances from one another.

Assuming that relays 8 to 11, inclusive, for instance, have been energized and locked, then when distributor 13 gets to its segment 25, a circuit will be established through the common bus 26, contact and armature of relay 12, path 14, relay 20, common bus 27 and segment 28 of distributor 15. Distributors 13 and 15 are in exact synchronism so that they effectively pass over their corresponding segments at exactly the same instants and, hence, in the case assumed, relay 20 will be energized. Distributor 21, passing over its segment 29 somewhat later, will, through the agency of relay 20, send an impulse to the station 4.

40 It will be understood that in actual practice the distributor 15 will be adjusted to lag behind the distributor 13 by an amount corresponding to the propagation time of the line 14. It will further be understood that several distributors corresponding to distributor 15 may be provided at an office to care for groups of transmission lines of different propagation times. Thus, if line 14 is comparatively short and has a very small propagation time, the distributor 15 need lag behind distributor 13 by only a short time. On the other hand there may be entering this office lines from other points which will be comparatively longer than line 14 and in that case another distributor like 15 could be provided which would lag still more behind distributors corresponding to 13 at such other points.

55 Circuits illustrating the invention in more detail are shown in Figs. 3 to 6, inclusive. Figs. 3 and 4 show the arrangements at one office and Figs. 5 and 6 show the arrangements at another and distant office. At the first office there is a source of power illustrated as a motor 30 and at the second office a similar motor 31. A source of standard frequency 32 which may be located at either office or any other convenient location, supplies control power through line 45 and amplifying and regulating means 33 and 34 to the motors 30 and 31 to maintain exact synchronism. Each motor is actually driven by some local source of power.

70 Motor 30 drives a shaft 35 to which distributor arms 36, 37 and 38, and arms for distributors 39, 40, 41 and 42 are rigidly and permanently attached. Shaft 35 also drives a plurality of

arms such as 44 through the agency of clutches, such as that indicated at 43. Such clutch arrangements are well known and will, therefore, not be described in detail.

Motor 31 drives a shaft 46 to which distributor arms 47, 48, 49 and 50, and arms for distributors 51, 52 and 53 are rigidly and permanently attached and a plurality of arms for distributors such as 54 are driven through clutches. All of these rigidly attached arms are shown in the same position to indicate exact synchronism.

Two teletypewriter stations are indicated at 55 and 56, and circuits are shown in detail for transmission from station 55 to station 56 and are indicated for transmission in the reverse direction. Station 55 is connected at a distance from the central office, denoted in general by all the remaining diagram on Figs. 3 and 4, by means of the loop 57. Code impulses sent from station 56 operate sending relay 58 and break relay 59, while the operation of relay 60 causes the operation of the receiving apparatus at station 55, all in a manner well known. Relays 58, 59 and 60 are each shown in their marking position.

At the central office each incoming station circuit has an individual distributor such as that shown in the upper right corner of Fig. 3 and denoted by its arm 44 and clutch 43. Such distributors may be driven by the common shaft 34 or any other means or they may be in any other well-known form and it is not necessary that they be driven in exact synchronism with shaft 35 or that there be any fixed relation between the positions of the arms 44 and 36, for instance. It is only necessary that they are driven at a speed to correspond with the speed of the code contact mechanism at station 55 and at approximately the speed of shaft 35.

Code impulses are sent from station 55 in the form of seven unit codes, the first being invariably a spacing start impulse, the second to sixth being the five permutation impulses forming the code proper, and the last being invariably a marking stop impulse. The starting impulse being a spacing impulse, relay 58 moves to its spacing contact and thereby connects negative battery to its tongue and thence to solid ring 61, and through the distributor brush on arm 44 either in the position shown or 180 degrees advanced therefrom to a starting segment so that clutch release magnet 62 becomes energized. In parallel therewith the upper winding of transfer relay 63 has battery applied thereto. Now, if at the instant that this happens, arm 36 is in the position shown or in any other position where contact is made between solid ring 64 and segment 65 rather than segment 66, then the ground connection of segment 65 will cause relay 63 to become energized and this relay will lock through its lower armature, resistance 67 and its lower winding. It will be noted that the upper armature of relay 63 grounds conductor 68 so as to render relays 76 to 80, inclusive, subject to energization, and that the arm 38 will not reach the common conductors 86 to 90 until after the arm 44 has had ample time to affect these relays.

The arm 44 is shown making a connection between ring 61 and a start segment. The next succeeding five segments correspond to the five places for the five impulses of the code and the sixth is a stop segment. As the arm 44 passes over these segments, relays 76 to 80, inclusive, will be operated or left unoperated, according to the position of relay 58 on its spacing contact or

on its marking contact. If relay 58 is on its spacing contact when arm 44 reaches its first code segment, then relay 76 will become operated from the negative battery on the tongue of relay 58, ring 61, segment 91, upper winding of relay 76, conductor 68, front contact and upper armature of relay 63 to ground. Relay 76 locks through its middle winding, front contact and upper armature to positive battery on common conductor 70. In this manner the permutation code sent by station 55 is written up on relays 76 to 80, inclusive—an energized relay representing a spacing impulse and a deenergized relay representing a marking impulse.

Sooner or later after the relay 76 has come under the influence of arm 44, the arm 38 will connect a source of current 119 to common conductor 86 and thence through the resistance 92 to the back contact of relay 76. If this relay is deenergized, current from source 119 will be connected to the lower armature of relay 76, thence to the transmission conductor 93 extending to the distant office where it will cause the energization of relay 94. Thus, relay 94 will respond to each marking impulse recorded on relays 76 to 80, inclusive, and become deenergized for each spacing impulse.

Distributor arm 37 controls the deenergization of relays 76 to 80 and as it effectively follows after arm 38, it will not affect these relays until after the record written up on them has been used. Thus, as the arm 38 moves to the position where the source of current 119 is connected to common conductor 87, the arm 37 grounds common conductor 96 and, if relay 76 is energized, it causes opposing current to flow in the lower winding thereof to cause the deenergization of this relay.

When the arm 44 has passed over the five code segments, it next passes over a stop segment and now ground is extended from the marking contact of relay 58 to the lower winding of relay 63, and, due to the resistance 67, this relay is shunted down and becomes deenergized. If another code signal immediately follows, then the magnet 62 will be energized as before but, the arm 36 now having reached long segment 66, the relay 63 will not be energized and, hence, conductor 69 will be grounded and this time relays 71 to 75, inclusive, will be subject to energization. They, in turn, will be operated to write up the code signal and transmit the record over conductor 93.

If another code signal is not ready to be sent from station 55, then arm 44 comes to rest and, therefore, a relay 63 may or may not become energized when arm 44 moves again, due to the position of arms 36 to 38 at that time.

At the distant office, represented generally by Figs. 5 and 6, it will be noted that a set of relays 101 to 110, inclusive, correspond to relays 71 to 80, inclusive. It will also be noted that, exact synchronism being maintained between arms 38 and 50, at the instant that source of current 119 is connected to the armature of relay 76 by arm 38, that battery is connected to the upper winding of relay 106 by arm 50 through wire 97 and, hence, if relay 76 denotes a marking condition by its deenergized position, relay 106 will not be energized since relay 94 has removed ground from conductor 95 and the battery now connected to common conductor 97 is ineffective. Hence, relays 101 to 110, inclusive, assume conditions corresponding to relays 71 to 80, inclusive.

Just before relay 106 is to be thus affected, distributor arm 48 reaches a position where it

removes battery from conductor 98 so that any one of relays 106 to 110, inclusive, which may have been energized on a previous rotation of the distributor arms, will now become normal awaiting the writing up of a new code. Similarly, arm 49 causes the deenergization of any one of relays 101 to 105, inclusive, just before these relays are to be affected.

Now, when any one of relays 106 to 110, inclusive, becomes energized, relay 99 becomes energized and will remain in this condition until arm 48 releases such energized relays. Consequently, when distributor arm 47 nearly reaches the position in which it is shown, it will make a connection from battery, ring 100, start segment, resistance 120, front contact and armature of relay 99, conductor 111 to relay 112. Relay 112 moves its armature to its spacing contact and thus sends a start signal to the teletypewriter at station 56. Then, as the arm 47 moves forward, it connects battery successively to the front contacts of relays 106 to 110 and, each time an energized relay is encountered, relay 112 responds and sends a spacing contact to station 56.

If, while the code recorded on relays 106 to 110, inclusive, is being taken off and transmitted to station 56, another code is being recorded on relays 101 to 105, inclusive, relay 113 will be energized. When arm 47 makes about a half revolution from the position shown, a start signal will be sent to station 56 and as arm 47 moves forward another code will be transmitted to this station.

For transmission in the other direction, station 56 will operate the relays 114 and 115 and the record transmitted over conductor 121 will be written up on storing relays indicated at 116 within the broken line rectangle at the bottom of Fig. 6. This rectangle represents apparatus similar to that shown in the large broken line rectangle in Figs. 3 and 4. The record there made is transferred over the path 117 to receiving apparatus in the broken line rectangle at the foot of Fig. 4 which represents the apparatus in the large broken line rectangle of Figs. 5 and 6, and impulses sent therefrom over conductor 118 to relay 60 which, in turn, sends the message to station 55.

The arrangements shown in Figs. 3 to 6 are representative as other variations are within the scope of the invention. For instance, all the distributors are herein arranged to take care of two codes per revolution as this seems to be a preferred arrangement but they could, with little alteration, be arranged to take care of but a single code, as is schematically indicated in Fig. 1.

The system diagrammatically illustrated in Figs. 8 and 9 shows an arrangement of this nature. Here there is a set of five recording relays 126 to 130, inclusive, for recording the code from station 122 and sending it out over the transmission conductor 123 to a corresponding set of five recording relays 131 to 135, inclusive, at the distant end. This latter set of five relays takes the five-unit code sent over the conductor 123 and transmits it to the station 122, translated into a seven-unit start-stop code.

It is to be noted also in this embodiment of the invention that there are no individual distributors provided. Each of the distributors 136 to 139, inclusive, is common at the sending end of the line to the various sets of recording relays, such as 126 to 130, which are themselves individual to the subscribers' loops. Each of the distributors 140 to 143, inclusive, is common at the

receiving end of the lines to the sets of relays, such as 131 to 135, inclusive, which are individual to the subscribers' loops at that office.

It will be understood, as hereinbefore explained, that the motors 144 and 145 at the various offices are kept in exact synchronism with each other so that the shafts 146 and 147 keep the various distributor arms rotating synchronously.

In this embodiment of the invention, the subscriber at station 122 starts sending by operating key 148 momentarily. This key causes the operation of the sending relay 150 at the office end of the loop which operates to its spacing contact and causes the energization of slow releasing relay 151. This relay is designed to release its armature only after a period corresponding to at least the length of a code signal. Relay 151 then being operated, a connection will be made from battery through the arm 137 to the common conductor 152 when the arm 137 gets to a point corresponding to the start segment of arm 136. This battery connection will be extended over individual conductor 153, resistance 125, the front contact and armature of slow releasing relay 151 to the upper winding of relay 155. Relay 155 operates in this circuit to its spacing contact and transmits a spacing signal to the station 122. At that point the start latch magnet 149 operates and causes the permutation code contacts at that point to begin their cycle of operations.

If, as the arm 136 moves off its start segment to its first code segment, the first place in the code signal being sent by station 122 is a spacing signal and consequently relay 150 is on its spacing contact, a connection will be established from ground, the armature of relay 150, conductor 156, the upper winding of relay 126, common conductor 157, the first segment affected by brush 136, to battery. Relay 126 will be operated in this circuit and lock from ground through its lower winding, its upper armature and front contact to battery on conductor 158. Each of the following relays, 127 to 130, inclusive, will in turn be subject to energization as the arm 136 sweeps over its segments corresponding to the second, third, fourth and fifth places of the code. In this manner, the code signal sent by the station 122 is recorded on the relays 126 to 130, inclusive.

As the brush 136 moves off the first place segment leaving relay 126 either energized or deenergized, according to whether relay 150 was on its spacing or its marking contact just previously, the brush arm 139 will come to the position shown. In this position, a source of current 160 is connected to the segment on which it is shown as resting and, thus, the source of current 160 will be connected to common conductor 159 and through a resistance 161 to the front contact of relay 126. If relay 126 has been energized by the sending of a spacing signal, then this source of current will be connected through the lower armature of relay 126 to transmission conductor 123 which at the other end affects the receiving apparatus to operate relay 162. Thus, relay 162 will operate each time a spacing signal is sent and will remain deenergized each time a marking signal is sent. This, in turn, means that conductor 163 will present to the relays 131 to 135, inclusive, a ground connection for each marking signal and an open connection for each spacing signal.

The brush arm 138 effectively trails behind the brush arm 139 so that if the brush arm 139 is on its second segment, brush arm 138 is on its first

segment, that is, after the record written on the relays 126 to 130, inclusive, has been transferred to the transmission conductor 123, the brush arm 138 wipes out the record by connecting ground, for instance, to conductor 164 through the middle winding of relay 126 so that a magnetization equal and opposite to that produced by the lower winding is now set up and relay 126 becomes deenergized.

As the brush arms 136 to 139 rotate, the arm 136 will come to a stop segment and thereafter to a start segment. At this time, brush arm 137 will again send a start signal to the subscriber's station 122 and another code will be written up on relays 126 to 130, inclusive. It will be remembered that this depends on the energization of slow releasing relay 151 and that to maintain this relay energized there must be at least one spacing segment per code. If, therefore, the station 122 ceases to send code signals, relay 150 will remain on its marking contact and relay 151 will become deenergized.

At the receiving end, relays 131 to 135 are sequentially rendered operable by the movement of brush arm 143. If this arm is in a position corresponding to the first code signal position of brush arm 139 at the distant office, a spacing signal having the control of energization of relay 126 will now cause the transmission of current from source 160 over the transmission conductor 123 and thus the energization of relay 162 whereby ground is removed from conductor 163 so that at this time relay 131 being under the influence of brush arm 143 will not be energized. If, on the other hand, a marking signal had resulted in the non-operation of relay 126, then relay 162 would not have been operated and ground would be connected to conductor 163, thence through the lower winding of relay 131, the common conductor 165, brush arm 143, to battery, so that relay 131 would become energized on the marking signal. Similarly, relays 132 to 135 will be energized or nonenergized according to the transmission of marking or spacing impulses as the brush arm 139 successively passes over the segments leading to the relays 127 to 130, inclusive.

If relay 131, 132, or 133 become energized, these relays will lock from ground over their upper windings, upper armatures and front contacts, to common conductor 167, through brush arm 142 to battery, which connection is effective while brush arm 143 is passing over contacts associated with relays 131, 132, 133. Relays 134 and 135 lock to common conductor 168 associated with brush arm 141 so that these relays will be maintained energized until the brush arm 140 has reached the segment on which it is shown and passed thereover. A start signal for station 124 will be transmitted by the open circuit condition when brush 140 passes over the segment on which it is shown, relay 171 not being operated. Relay 172 controls the sending of spacing and marking impulses to the station 124. The connection just described will send a spacing pulse to station 124. Thereafter, as arm 144 progresses it will successively connect battery to the front contacts and lower armatures of relays 131 to 135, inclusive, and, thus, send marking impulses when these relays are energized and spacing impulses when they are non-energized.

Transmission in the other direction is indicated here only by the conductors 173 and 174 corresponding to conductors 153 and 156 and by conductor 175 at the other end corresponding to conductor 163.

What is claimed is:

1. A signaling system comprising offices distant from each other, a plurality of signaling stations, lines, each extending from one of said stations through said offices to another of said stations, means at said offices for relaying signals over the lines passing therethrough and for translating such signals from one code to another, means at each office common to said lines for controlling said relaying and translating means and means common to said offices for controlling said first common means.

2. A signaling system comprising offices distant from each other, a plurality of signaling stations, lines, each extending from one of said stations through said offices to another of said stations, a relaying and translating means in each of said lines at each of said offices for relaying signals passing over said lines and for translating such signals from one code to another, means at each office common to said lines for controlling said relaying and translating means and means common to said offices for controlling said first common means.

3. A signaling system comprising offices distant from each other, a plurality of signaling stations, lines each extending from one of said stations through said offices to another of said stations, means individual to each of said lines at each of said offices for receiving and recording signals in one code, and transmitting corresponding signals in another code, means at each office common to said lines for controlling said individual means and means common to said offices for controlling said first common means.

4. A signaling system comprising offices distant from each other, a plurality of signaling stations, lines each extending from one of said stations through said offices to another of said stations, means for signaling from station to station by codes of a uniform and given number of signal elements per character in the portions of said lines between said stations and said offices and by corresponding codes of a uniform and lesser given number of signal elements in the portions of said lines between said offices, code changing means individual to each line at each of said offices, means at each of said offices

common to the lines thereat for controlling said code changing means and means common to said offices for causing said code changing controlling means to operate in synchronism.

5. A signaling system comprising offices distant from each other, a plurality of signaling stations, lines each extending from one of said stations through said offices to another of said stations, means for signaling from station to station by permutation code, means for using controlling impulses in addition to the code impulses for each character between said stations and said offices and only the permutation code impulses between said offices, relay storing means individual to each line at each of said offices for effecting the said translation of code with controlling impulses to and from code without controlling impulses and means at each of said offices common to the lines thereat for controlling said relay means.

6. A signaling system, comprising offices distant from each other, a plurality of signaling stations, lines each extending from one of said stations through said offices to another of said stations, start-stop means for signaling between said stations and said offices, and continuously operating synchronous means for signaling between said offices, said last means being common to said lines.

7. A signaling system comprising offices distant from each other, a plurality of signaling stations, lines each extending from one of said stations through said offices to another one of said stations, means for signaling from one station to another comprising start-stop permutation code sending means at one station, individual start-stop receiving means at a first office, an individual set of storing relays thereat controlled by said start-stop means, permutation code sending means common to said lines at said office cooperating with said storing relays, another set of storing relays at another office individual to said line, permutation code sending means at said other office common to said lines cooperating with said individual set of storing relays and start-stop receiving means at said other station controlled thereby.

LELAND C. ROBERTS.