July 9, 1940. H. J. CUNNINGHAM ET AL 2,207,314

COMMUNICATION SYSTEM

Filed Nov. 13, 1937 5 Sheets-Sheet 1

FIG. 1

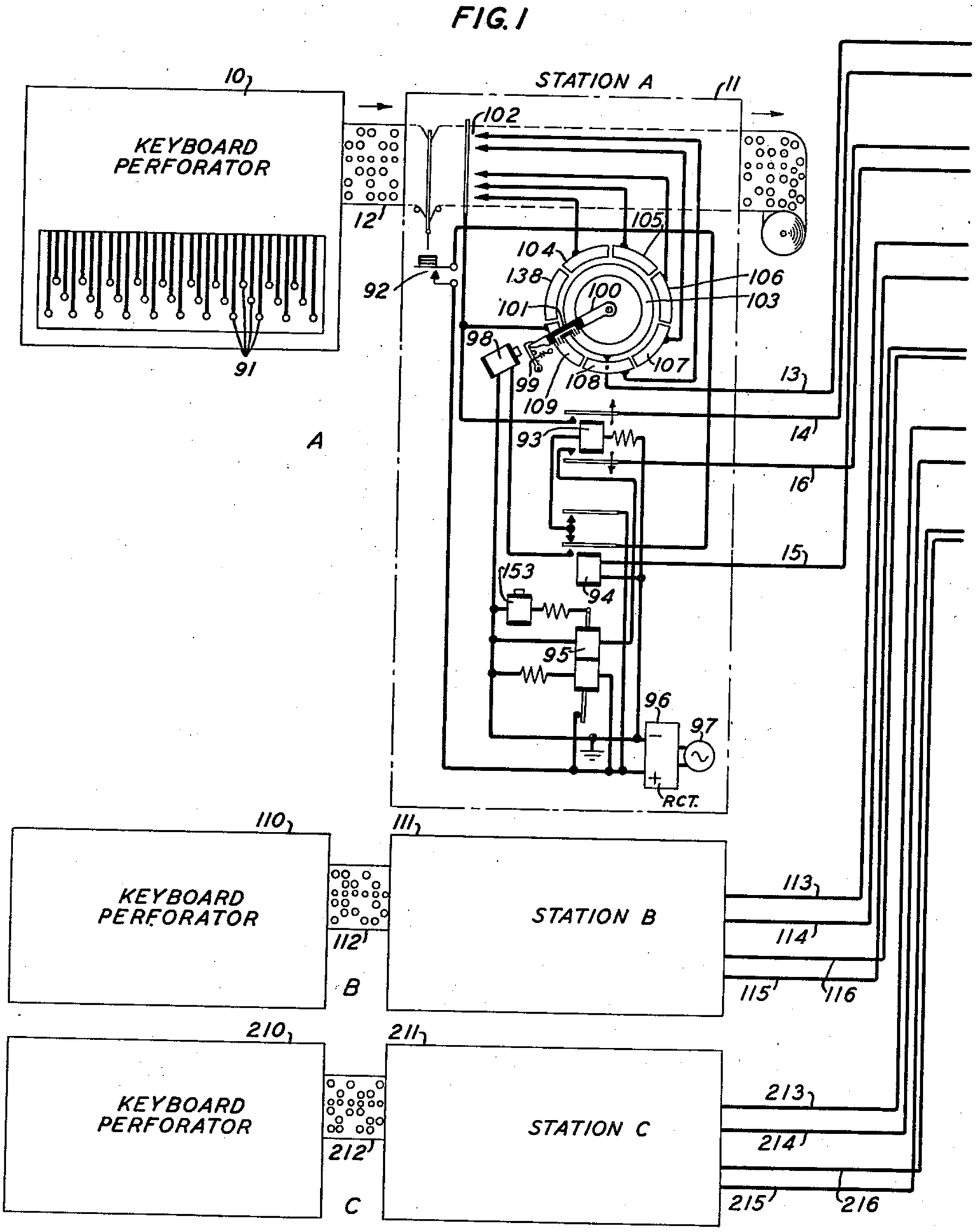

FIG. 5

FIG. 1	FIG. 2	FIG. 3	FIG. 4

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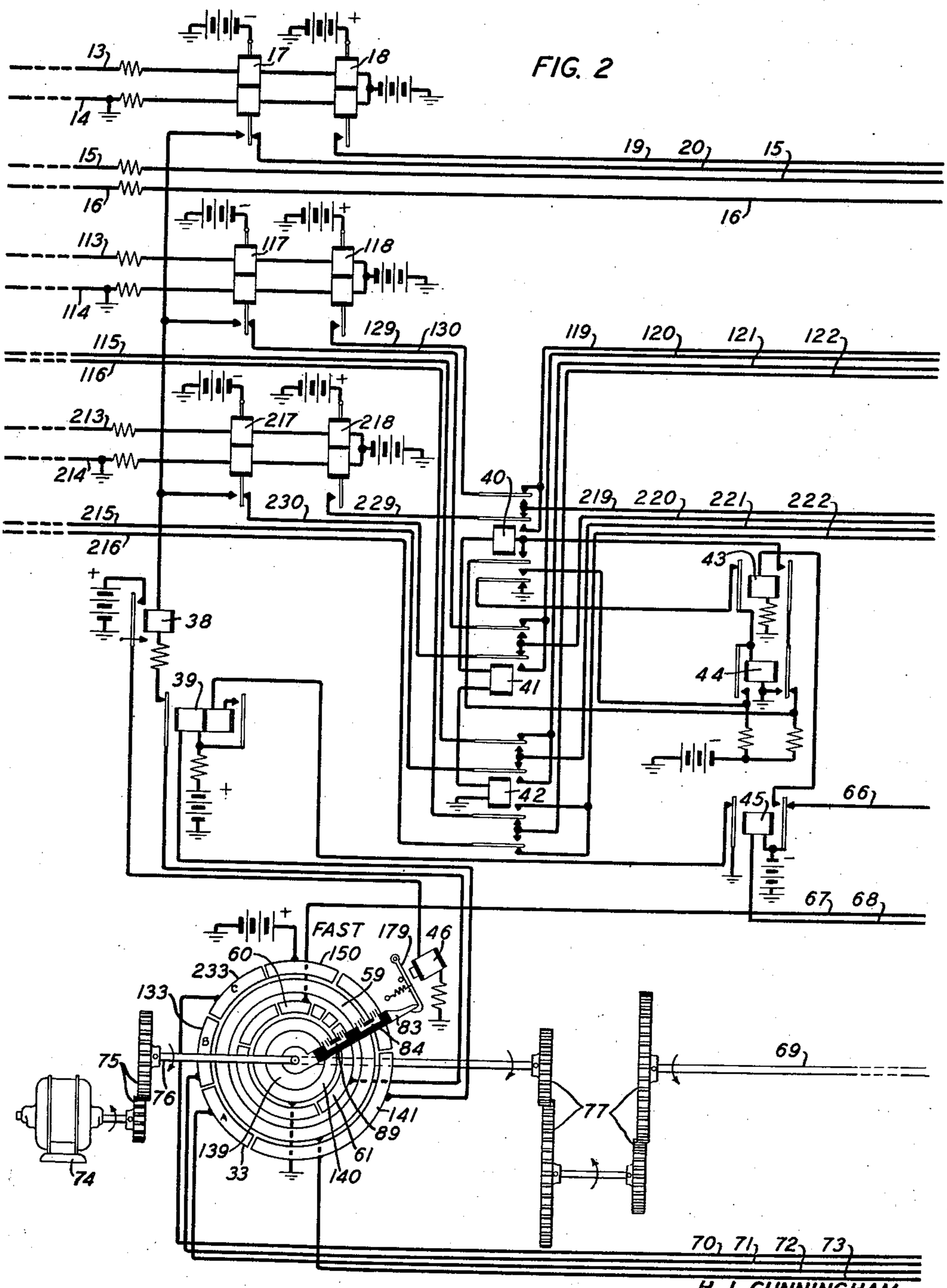
COMMUNICATION SYSTEM

Filed Nov. 13, 1937 5 Sheets-Sheet 2

FIG. 2



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COMMUNICATION SYSTEM

Filed Nov. 13, 1937 5 Sheets-Sheet 3

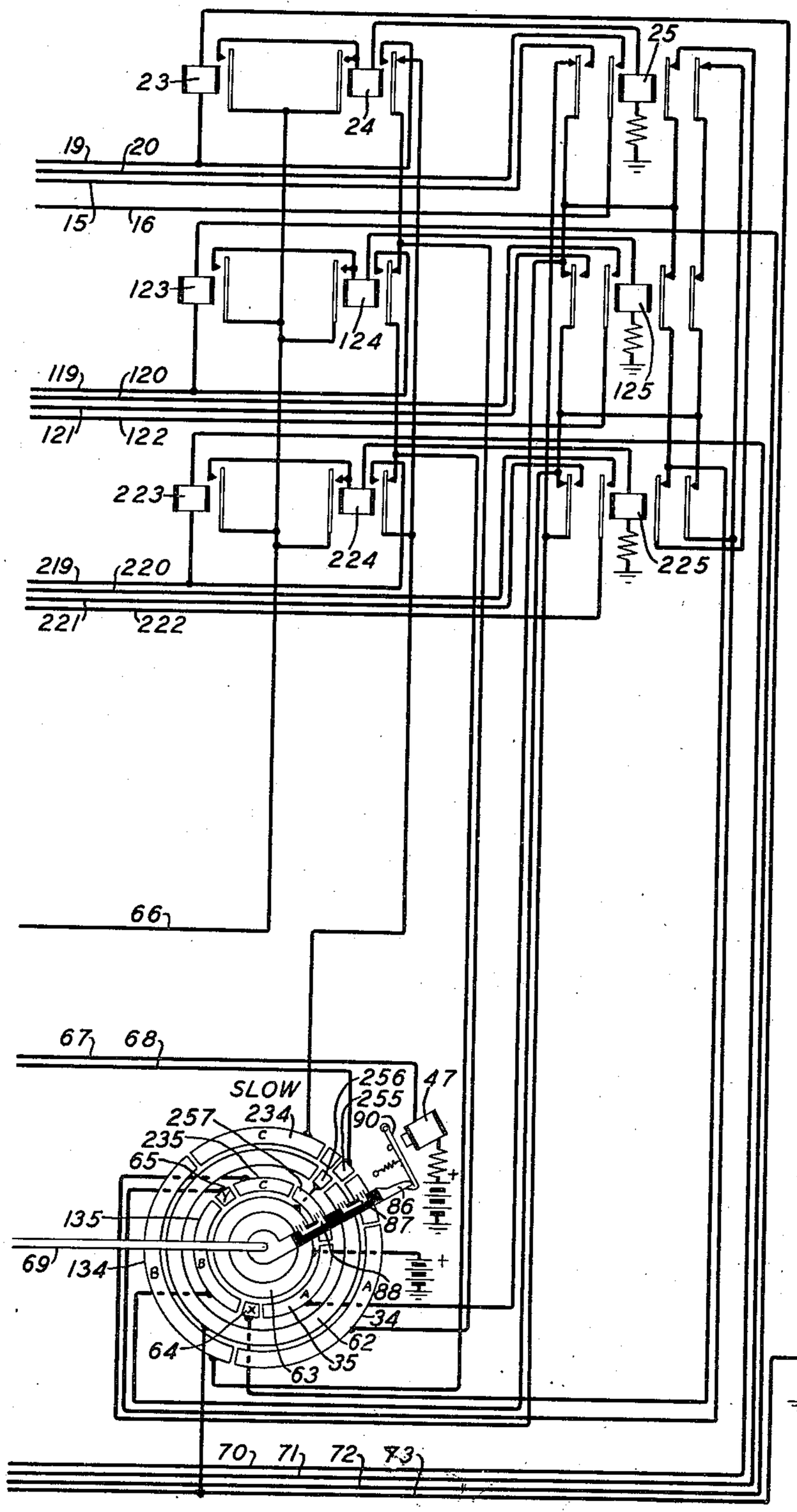

FIG. 3

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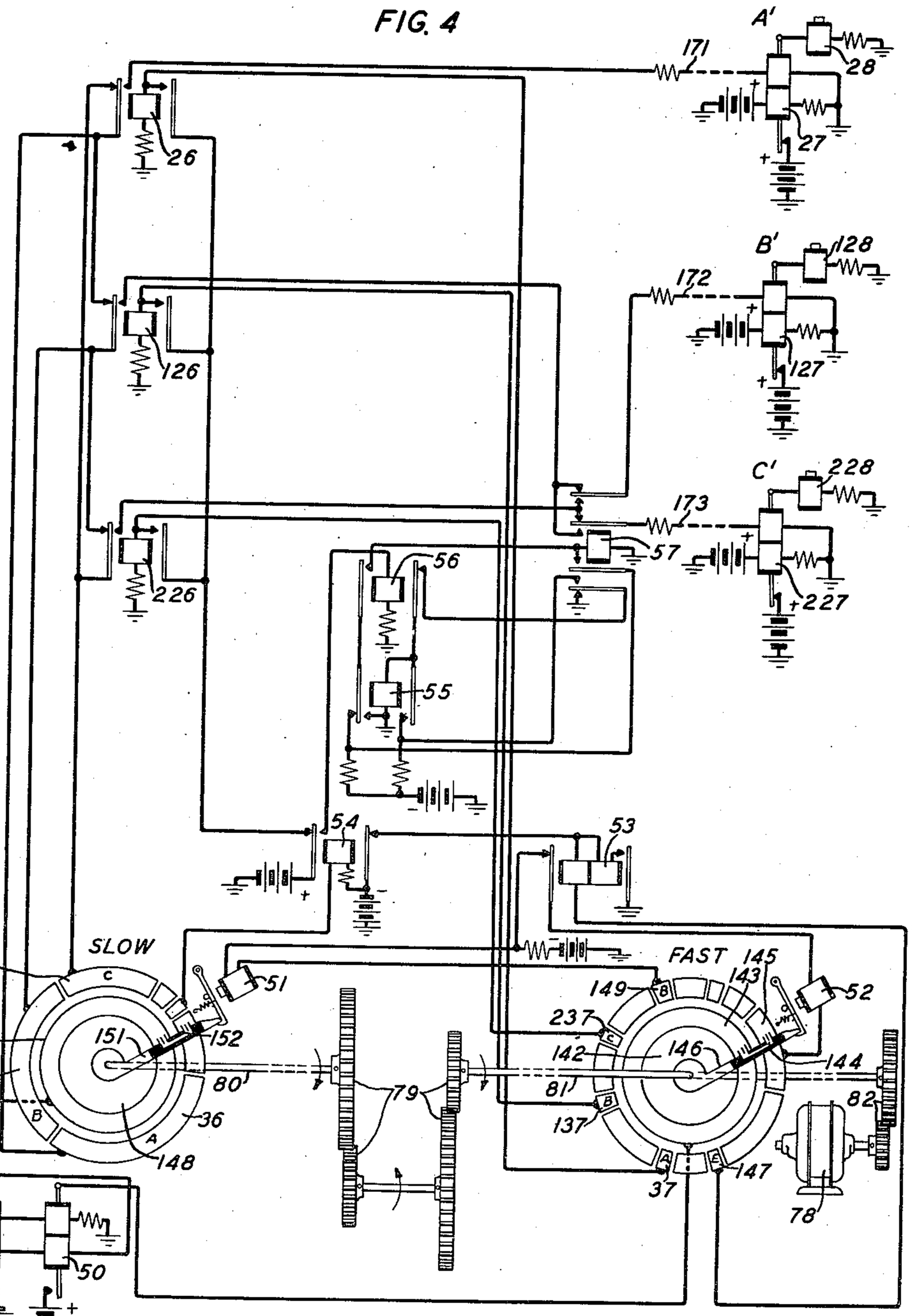
COMMUNICATION SYSTEM

Filed Nov. 13, 1937 5 Sheets-Sheet 4

FIG. 4



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COMMUNICATION SYSTEM

Filed Nov. 13, 1937

5 Sheets-Sheet 5

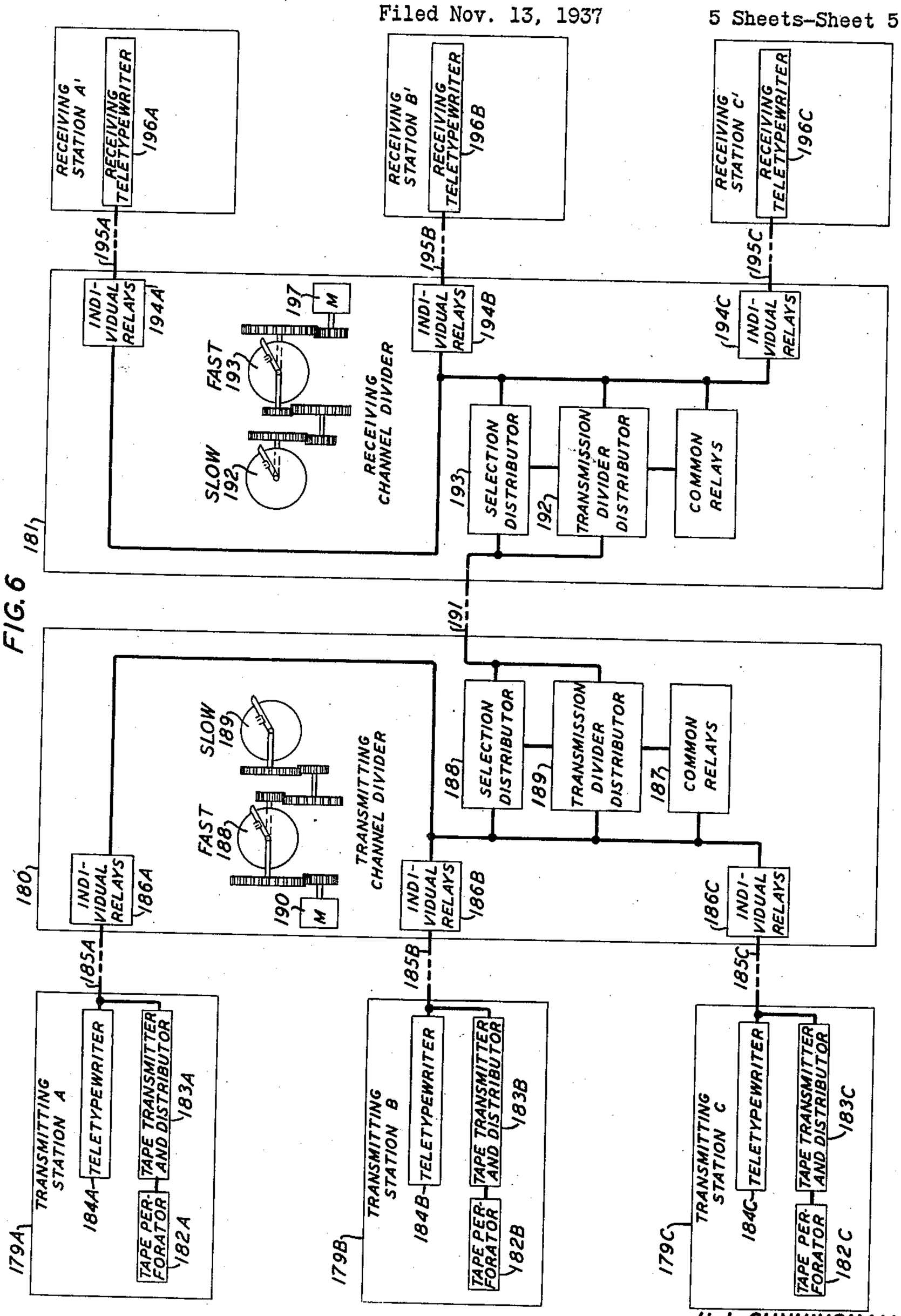

FIG. 6

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Patented July 9, 1940 2,207,314

UNITED STATES PATENT OFFICE

2,207,314

COMMUNICATION SYSTEM

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Application November 13, 1937, Serial No. 174,469

7 Claims. (Cl. 178—52)

This invention relates to communication systems in which a plurality of stations may transmit over the same communication path or channel at substantially the same time by automatically dividing the channel time between the number of stations which are transmitting over it substantially simultaneously, and more particularly to improvements in the telegraph system described in the application of Borgenson et al. Ser. No. 174,468, filed Nov. 13, 1937.

An object of this invention is to provide an improved communication system in which the greatest possible channel time is used for transmitting message currents over it.

A further object of this invention is to secure a more even and more equitable division of the channel or line time between the various stations which wish to simultaneously communicate over it.

In accordance with a specific embodiment of this invention a high speed and a low speed start-stop distributor are connected to each end of the main line or channel. A plurality of extension lines are operatively connected to the distributors connected to each end of the main line. The high speed distributor is provided to transmit directing impulses over the system for indicating the stations which will transmit impulses during the next rotation of the low speed distributor. In addition, a circuit arrangement is provided for reversing the connection between the slow speed distributor and two of the extension lines for securing a better time distribution between the extension lines when only a portion of them are active, i. e., when they wish to transmit impulses. The circuit is also arranged for transferring the connection between the distributors and idle extension lines to active extension lines so that substantially the entire main line time is utilized for transmitting message currents.

The foregoing and other objects of this invention may be more readily understood when the following description of a preferred embodiment is read with reference to the attached drawings in which

Figures 1, 2, 3 and 4 show details of a telegraph system embodying the invention;

Fig. 5 shows the manner in which Figs. 1, 2, 3 and 4 are arranged for the complete system; and

Fig. 6 shows in diagrammatic form the elements of the system.

The elements of the system and its general manner of operation will be best understood with reference to Fig. 6. The specific embodiment of the invention as shown is arranged for the simultaneous transmission from three extension stations. It is to be understood, however, that the invention is not limited in any way to three stations which may transmit over a single conductor but may be employed for any number of extension stations.

As shown in Fig. 6, three transmitting extension stations A, B and C are connected to a transmitting main station 180. This main station is in turn connected to a second main station 181 to which are connected three receiving extension stations A′, B′ and C′. In accordance with this invention station A always transmits to station A′, station B always transmits to station B′ and station C always transmits to station C′.

Each of the respective extension stations A, B and C is provided with a tape perforator 182A, 182B, and 182C, a tape controlled transmitting distributor 183A, 183B, and 183C, and a receiving or recording telegraph device 184A, 184B, and 184C. The respective extension stations are connected over circuits 185A, 185B, and 185C to the main station 180. In general, the connections 185A, 185B, and 185C between the transmitting stations and the main station 180 include more than a single telegraph channel and in a preferred embodiment of this invention they include more than a single telegraph channel in each direction between these stations.

The main station 180 is provided with groups of relays 186A, 186B, and 186C which are individual to the circuits extending to each of the extension stations. A group of common relays 187 is provided to control the high speed distributor 188 and the low-speed distributor 189. These distributors are driven by motor 190, as shown in diagrammatic form at station 180.

The distributors 188 and 189 are in turn connected to line 191 which extends to the receiving main station 181. Receiving station 181 is provided with a group of common relays which control the slow receiving distributor 192 and the high speed receiving distributor 193. These distributors are connected both to line 191 and to the relay equipments 194A, 194B, and 194C individual to the circuits associated with each of the extension stations. The relay circuits 194A, 194B, and 194C are connected over lines 195A, 195B, and 195C to the receiving extension stations A′, B′, and C′. These extension stations are provided with receiving teletypewriters 196A, 196B, and 196C or other suitable receiving telegraph apparatus. Lines 195A, 195B, and 195C are not limited to a single one-way communica-

tion channel. However, in general this will be sufficient since it is only necessary to transmit the signal impulses to the receiving stations as they are received from the main line. At the receiving main station 181 the fast and slow distributors are driven by motor 197 at substantially constant speed and at substantially the same speed as the distributors 188 and 189 at station 180.

A one-way communication system is shown in Fig. 6. It is to be understood, however, that a similar system may be provided for transmission in the opposite direction, in which case both stations A and A', B and B', and C and C' will be provided with the same transmitting and receiving apparatus.

Reference will now be made to the system shown in Figs. 1, 2, 3 and 4 when arranged in accordance with Fig. 5.

Fig. 1 shows three subscribers' stations A, B and C connected to a central station shown in Figs. 2 and 3. The central station shown in Figs. 2 and 3 is connected by line 58 to a central station shown in Fig. 4, which in turn is connected to three subscribers' stations A', B' and C'.

Line 58 connecting the two central stations may include any suitable telegraph channel including a radio or a carrier current channel. This channel may include suitable repeaters, including regenerative telegraph repeaters, terminal and intermediate composite sets, open-wire lines and cable lines as well as other equipment usually associated with long telegraph or toll lines.

Station A, shown in Fig. 1, is connected to the central station, shown in Figs. 2 and 3, by lines 13, 14, 15 and 16. Station B is similarly connected over lines 113, 114, 115 and 116, while station C is connected over lines 213, 214, 215 and 216.

Station A is provided with a telegraph keyboard perforator 10 by means of which the subscriber or operator at station A perforates tape 12 in accordance with the information to be transmitted to station A' connected to the second central station, shown in Fig. 4. Station A (see Fig. 1) is also provided with a tape transmitter 11 which is employed to transmit the signals recorded in tape 12 to the distant station. This tape perforator and transmitter may be of any suitable type and employ any desired code. Examples of apparatus of this type are described in detail in U. S. Patents 1,965,572, Burky et al., July 10, 1934; 1,965,602, Lake, July 10, 1934; 1,969,891, Lake et al., August 14, 1934; 2,019,505, Reiber, November 5, 1935; and 2,055,567, E. F. Watson, September 29, 1936.

When the operator at station A wishes to transmit messages to station A' she will operate keys 91 of the keyboard perforator 10, which in turn cause tape 12 to be perforated in accordance with the operation of keys 91. As soon as there is a sufficient supply of perforated tape 12, contacts 92 of the tape transmitter 11 will be closed. This completes a circuit for the operation of relay 93 from ground, through the winding of relay 93, the inner break contacts of relay 94, tape control contacts 92 to the positive terminal of rectifier 96. It is assumed that rectifier 96 is energized from source 97 and that the motor and other equipment usually provided for perforators and transmitters is also energized. This additional equipment is not shown or described in detail because it is well known and understood in the art and because it operates in its usual manner.

Relay 93 in operating completes a line circuit from ground connected to line 14 at the central station (see Fig. 2), over line 14, through the upper contacts of relay 93, segment 109, brush 101 and segment 103 of the transmitting distributor, line 13, to the central exchange, and through the upper windings of relays 17 and 18, to battery. Current flowing in this circuit causes relays 17 and 18 to move to their left-hand positions. These relays are normally maintained in their right-hand positions by current flowing in an obvious circuit through their lower windings. However, the current flowing through their upper windings in the above described line circuit overpowers the effect of the current flowing through the lower windings of these relays and causes the relays to move to their left-hand positions. Relay 17 in operating to its left-hand position completes a circuit from negative battery through its armature and left-hand contacts, winding of relay 38, left-hand contacts of relay 39, segment 61 of the fast transmitting distributor 139, brush 89 and segment 140 to ground.

Relay 38 in operating completes an obvious circuit for the operation of the start magnet 46 of the fast distributor 139. Start magnet 46 in operating releases the brush arm 83 for rotation.

Brush arm 83 is driven through a friction clutch, not shown in detail, from shaft 76, which is in turn driven through gears 75 by motor 74. Motor 74 is connected to a source of power which causes it to operate continuously at a substantially constant speed. Details of the motor control circuit, as well as the friction clutches have not been shown or described in detail because they are well known and operate in the usual manner.

Brush arm 83 in rotating carries brushes 84 and 89. During the time brush 84 is passing over segment 141, a circuit is completed for the operation of relays 39 and 48 from ground, through the upper winding of relay 48, segment 53 of the fast distributor 139, brush 84, segment 141, to positive battery through the left-hand winding of relay 39.

Relay 39 in operating interrupts the operating circuit of relay 38 through its left-hand contacts and completes a locking circuit from positive battery, through its right-hand contacts and winding of relay 39, to ground, through the left-hand contacts of relay 45.

Relay 48 is normally held in its right-hand position by current flowing through its lower winding. However, the current flowing through its upper winding through the above-described circuit overcomes the effect of the current flowing through the lower winding and causes its armature to move to its left-hand position. Relay 48 in operating to its left-hand position interrupts the circuit of line 58 which causes relays 49 and 50 at the second central exchange station, shown in Fig. 4, to also move to their left-hand positions due to current flowing through their upper windings. Relay 50 in operating to its left-hand position completes a circuit for the operation of the start magnet 52 of the fast receiving distributor 142, from battery, through the left-hand contact and armature of relay 50, segment 143 of distributor 142, brush 144, segment 145, through the winding of the start magnet 52 to battery through the left-hand contact of relay 53.

Start magnet 52 in operating releases brush arm 146 which starts to rotate with shaft 81 through a friction clutch, not shown. Shaft 81 is rotated through gears 82 by motor 78. Motor 78 continuously operates and rotates shaft 81 at substantially the same speed that motor 74 rotates shaft 76. The governors or other speed con-

trol apparatus of these motors are of the type usually employed for start-stop telegraph systems. Shafts 76 and 81 need not be rotated in exact synchronism, it being sufficient if they are rotated at substantially the same speed. It is usually desirable to cause shaft 81 to rotate slightly faster than shaft 76 so that the two brush arms 146 and 83 will always start to rotate substantially together. In addition, the start relay 38 is made slow in operating to allow sufficient time to insure that the receiving distributor brush arm has time to complete its revolution before the transmitting distributor starts on the next revolution. These synchronizing arrangements are well known and are employed in the usual start-stop telegraph systems so they need not be described in greater detail here.

During the time brush 144 is passing over segment 147 a circuit is completed for the operation of relay 53 from positive battery, through the left-hand contact and armature of relay 50, segment 143 of fast distributor 142, brush 144, segment 147, the left-hand winding of relay 53 to negative battery through the right-hand contacts of relay 54. Relay 53 in operating interrupts the operating circuit of the start magnet 52 and completes a locking circuit from ground, through its right-hand contacts and right-hand winding, to battery through the right-hand break contacts of relay 54.

Brush arms 83 and 146 now continue to rotate substantially in synchronism and complete one revolution. During the time brush 84 of the fast transmitting distributor is passing over the center portion of segment 33, brush 144 of the fast receiving distributor 142 passes over segment 37. During this time a circuit for the operation of relays 23 and 48 in series may be traced from positive battery, through the armature and left-hand contacts of relay 18, winding of relay 23, segment 33, brush 84 and segment 59 of the fast transmitting distributor, to ground through the upper winding of relay 48.

Relay 23 in operating completes a circuit for the operation of relays 24 and 25 in series from battery through the right-hand break contacts of relay 45, the contacts of relay 23, to ground through the windings of relays 24 and 25.

Relay 24 in operating completes a locking circuit for holding relays 24 and 25 operated from battery, through the right-hand break contacts of relay 45, left-hand contacts of relay 24, to ground through the windings of relays 24 and 25. Relay 24 in operating also completes a transmission circuit from the left-hand contacts of relay 18, the right-hand armature and make contacts of relay 24, to segment 34 of the slow transmitting distributor.

Relay 25 in operating completes a transmission path from the right-hand contacts of relay 17, the innermost left-hand make contacts of relay 25, over line 16, lower contacts of relay 93 to ground through the winding of the receiving relay 95 of the recording teletypewriter equipment at station A. Relay 25 in operating also completes a circuit from ground, through the winding of relay 94 at station A, line 15 and left-hand outer make contacts of relay 25, to segment 35 of the slow transmitting distributor.

The above described circuit for operating relays 23 and 48 in series causes relay 48 to remain in its left-hand position during the time brush 84 passes over segment 33 of the fast transmitting distributor. Consequently, relay 50 will be maintained in its left-hand position by current flowing through its upper winding in an obvious circuit during the time brush 144 of the fast receiving distributor 142 is passing over segment 37. During this time a circuit is completed for the operation of relay 26 from ground, through the winding of relay 26, segment 37, brush 144 and segment 143 of the fast receiving distributor to positive battery through the armature and left-hand contacts of relay 50. Relay 26 in operating completes a locking circuit from battery through the left-hand break contacts of relay 54 and the right-hand make contacts of relay 26, to ground through the winding of relay 26. Relay 26 in operating also completes a circuit from segment 36 of the slow receiving distributor 148 to line 171.

If the subscribers at stations B and C wish to transmit messages at substantially the same time they will also operate their keyboard perforators 110 and 210, respectively, and cause the operation of the corresponding relays associated with the lines connected to these stations through the remainder of the revolution of brush arms 83 and 144. First, it is assumed that each of the stations A, B and C wish to transmit at the same time, i. e., all the lines are active.

Just before brush arm 83 comes to rest, it completes a circuit for the operation of start magnet 47 of the slow transmitting distributor from ground through segment 140, brush 89 and segment 60 of the fast transmitting distributor, to battery through the winding of start magnet 47. In a similar manner, brush arm 144 of the fast receiving distributor completes a circuit for the operation of the start magnet 51 of the slow receiving distributor 148, from battery, through the winding of start magnet 51, segment 149, brush 144 and segment 143 of the fast receiving distributor, to battery through the armature and left-hand contacts of receiving relay 50. During the time brush arm 144 is passing over segment 149, receiving relay 50 is maintained in its left-hand position by relay 48, which in turn is maintained in its left-hand position in a circuit from battery through segment 150 of the fast transmitting distributor, brush 84 and segment 59, to ground through the upper winding of relay 48.

It should be noted that the line time required to transmit the directing impulses as described above is independent of any limitations of speed, segment length, etc., of the slow distributors. Instead, it is limited only by the line and associated high-speed distributors and thus it requires a minimum of line time to transmit the directing impulses so the maximum line time is available for the transmission of message currents.

The brush arms 86 of the slow transmitting distributor and 151 of the slow receiving distributor are rotated through friction clutches by shafts 69 and 80, respectively. Shaft 69 is rotated by motor 74 through gears 75, shaft 76 and gears 77, while shaft 80 is rotated by motor 78 through gears 82, shaft 81 and gears 79. Shafts 69 and 80 are rotated at substantially the same speed just as shafts 76 and 81 are. When these brush arms 86 and 151 are released they rotate substantially together through 360 degrees. During the time brush 87 is passing over segment 34 of the slow transmitting distributor, brush 152 passes over segment 36 of the slow receiving distributor, and so on.

During the time brush 88 of the slow transmitting distributor passes over segment 35, it connects positive battery thereto and causes the

operation of relay 94 at the subscriber's station A in the circuit over lead 15, pointed out above. The operation of relay 94 completes a holding circuit for holding relay 93 operated from ground, through the winding of relay 93 and uppermost make contact of relay 94 to the positive terminal of rectifier 96. Relay 93 is slow in releasing so that it will remain operated during any short time interval between opening of the contacts of relay 94 in its (relay 93) operating circuit and the closing of the contacts of relay 94 in the holding circuit of relay 93. Relay 94 in operating also causes the operation of the start magnet 98 in a circuit from the positive terminal of rectifier 96, through the tape control contacts 92 and upper inner make contact of relay 94, to ground through the winding of start magnet 98.

The operation of start magnet 98 withdraws stop latch 99 and releases the brush arm 100. When brush arm 100 is released it is driven through a friction clutch, not shown, and causes brush 101 to successively connect segments 138, 104, 105, 106, 107, 108 and 109 to line 13. This causes the transmitting distributor at the subscriber's station to transmit telegraph signal impulses in accordance with the perforations in tape 12. The contacts 102 connected to these segments are controlled by the perforations in tape 12 so that these contacts are connected to line 14 through the contact of relay 93 when there is a perforation in tape 12 under or over the respective contacts.

After brush arm 100 has made one revolution, apparatus not shown but well understood in the art, causes tape 12 to be advanced one position and the above operation repeated to transmit the next signal impulse. At the central station relays 17 and 18 are operated in accordance with the telegraph signal impulses transmitted from station A. The impulses are repeated by relay 17 through the inner left-hand make contacts of relay 25 to the receiving relay 95 at the subscriber's station, which in turn repeats the impulses to the printer magnet 153 at the subscriber's station to record the transmitted signals for a home copy. It should be noted that relay 95 is normally maintained in its left-hand position by current flowing in an obvious circuit through its lower winding and is operated to its right-hand position by current flowing through its upper winding over line 16. It should also be noted that relay 17 reverses the signal impulse, that is, the circuit from the right-hand contact of relay 17 is completed or closed during the time the circuit through its upper winding and line 13 is open or interrupted and vice versa. However, since relay 95 interrupts the circuit of the printer magnet 153 when the circuit of line 16 is completed, relay 95 again reverses the signal impulses so that the circuit of magnet 153 is closed during the time line 13 is closed and is opened during the time the line 13 is opened. Thus magnet 153 receives substantially the same signals as transmitted over line 13.

Relay 18 also follows the signals transmitted over line 13 and repeats them to relay 48 in a circuit from the contacts of relay 18, the right-hand make contacts of relay 24, segment 34, brush 87 and segment 62 of the slow transmitting distributor through the upper winding of relay 48. Relay 48 in turn repeats the signal impulses to relays 49 and 50 at the second central station over line 58. Relay 49 in following these signal impulses repeats them to the line relay 27 at the subscriber's station A' over a circuit from the contacts of relay 49, segment 154, brush 152 and segment 36 of the slow receiving distributor, left-hand armature and make contact of relay 26 over line 171 to the upper winding of receiving relay 27 at the subscriber's station A'.

Here again relay 48 causes the signal impulses to be inverted, that is, current flows in line 58 during the time no current flows in line 13, while no current flows in line 58 during the time current flows in line 13. Relay 49 repeats the inverted signal impulses to relay 27 at the subscriber's station A'. However, relay 27 at the subscriber's station A' again inverts the signal impulses so that the current flowing through the receiving printer magnet 28 corresponds to the transmitted current flowing in line 13 and thus the receiving printer equipment at station A' receives the same signals as transmitted from station A and correctly responds thereto.

When brush 88 passes off segment 35 it interrupts the circuit of relay 94 and permits this relay to release. Relay 94 in releasing permits the stop magnet 98 of the transmitting apparatus 11 to release, which in turn releases latch 99 and causes the brush arm 100 to come to rest after the completion of the revolution then in progress. This interrupts the transmission from station A. It should be noted that the segment 34 should be somewhat longer than the segment 35 since the transmission from station A is not interrupted at once when brush 88 passes off segment 35 but continues until brush arm 100 comes to rest against the stop latch 99. During this short interval of time it is necessary that the transmission path from station A be completed through the slow transmitting distributor as well as the slow receiving distributor at the second station to the subscriber's station A'. It is also desirable to have relay 93 slow in releasing so as to insure maintaining line 14 closed until brush arm comes to rest if both contacts 92 and relay 94 release at about the same time. This insures the proper transmission of the last code combination.

If during the time interval that the transmission path is completed from station A to station A' the supply of perforated tape 12 becomes exhausted, the tape stop contacts 92 will be opened. This interrupts the circuit of the start magnet 98 which releases stop latch 99 and causes brush 100 to come to rest at the completion of the revolution then in progress. Then when relay 94 releases at the end of the interval of time during which the transmission path is completed between stations A and A', the circuit at station A will return to its normal condition.

During the succeeding intervals of time during which brush 87 is passing over segments 134 and 234 similar transmission circuits are completed from station B to station B' and from station C to station C', during which times the apparatus at these stations transmits the signal impulses to corresponding stations B' and C' in the same manner as described above for station A.

At the end of the first revolution, just before brush arm 86 comes to rest, a circuit is completed for the operation of relay 45 from negative battery through its winding, segment 255 of the slow distributor, brush 87, segments 256 and 63 of the slow distributor to positive battery. Relay 45 in operating interrupts the locking circuit of relay 39 and permits this relay to release.

Relay 39 in releasing connects the winding of relay 38 to segment 61 and permits relay 38 to again be operated if any of the subscribers at stations A, B or C still have additional information to be transmitted to the corresponding stations A', B' and C', whereupon the above-described cycle will be repeated.

The operation of relay 45 also interrupts the locking circuits for relays 24, 25, 124, 125, 224 and 225 and permits these relays to release so that they may be again reoperated under control of the fast distributor during its next revolution. Relay 45 in operating also completes an obvious circuit for the operation of relay 43. Relay 43 in operating completes a circuit for the operation of relays 40, 41 and 42 from ground, through the windings of relays 42, 41 and 40, the right-hand contacts of relay 43, the right-hand break contacts of relay 44 to battery. The operation of relays 40, 41 and 42 reverses the transmission and control circuits between stations B and C, as described below. The operation of relay 40 completes a locking circuit for relays 40, 41 and 42 from ground, through their windings, the innermost lower make contacts of relay 40, to battery.

When brush 86 passes off segments 255 and 256 it interrupts the circuit of relay 45 and permits this relay to release. Relay 45 in releasing prepares the locking circuits for relays 39, 24, 25, 124, 125, 224 and 225 so that these relays may again be locked operated under control of the various subscribers' stations and distributors. Relay 45 in releasing also interrupts the operating circuit of relay 43, which in turn releases. In releasing relay 43 completes an operating circuit for relay 44 from ground through the winding of relay 44, the left-hand break contacts of relay 43, the lower make contacts of relay 40, to battery. Near the end of the next revolution of the slow transmitting distributor relay 45 is again operated and again interrupts the locking circuits of relays 39, 24, 25, 124, 125, 224 and 225, as described above. The second operation of relay 45 again completes the operating circuit for relay 43. The operation of relay 43 at this time, however, short-circuits the windings of relays 40, 41 and 42 by connecting ground from the right-hand make contacts of relays 44 and 43 to the right-hand winding terminal of relay 40. This causes relays 40, 41 and 42 to release and restore the control and transmission circuits from stations B and C to their original condition. When relay 45 again releases after brush 87 passes off segments 255 and 256, it in turn causes relay 43 to release. Relay 43 in releasing short-circuits the winding of relay 44 by connecting ground fom the lower break contact of relay 40, through the left hand contact of relay 43 to the upper winding terminal of relay 44. This causes relay 44 to release, at which time the relays in the associated circuits at the first central station are in the same positions they originally were at the beginning of the first revolution of the slow distributor. During the succeeding revolutions of the slow distributor the above cycle of operation of relays 45, 44, 43, 42, 41 and 40 is repeated, which reverses the control and transmission circuits between stations B and C during alternate revolutions of the slow transmitting distributor.

At the second central station the operation of relays 54, 55, 56 and 57 is similar to the operation of relays 45, 44, 43, 42, 41 and 40 at the first central station. At the end of the first revolution of the slow receiving distributor relay 54 is operated, which in turn interrupts the locking or holding circuits of relays 53, 26, 126 and 226 and permits these relays to return to their normal positions. Relay 54 in operating also completes the operating circuit for relay 56, which in turn causes the operation of relay 57. When relay 54 releases, just before brush 152 comes to rest, it releases relay 56, which in turn completes the operating circuit for relay 55. The operation of relay 57 reverses the transmission circuits to stations B' and C'. Near the end of the second revolution of the slow receiving distributor 148, relay 54 is again operated and operates relay 56. The operation of relay 56 short-circuits the winding of relay 57 by connecting ground to its left-hand terminal. Relay 57 releases and restores the transmission circuits to stations B' and C' to their original condition. When relay 54 again releases it in turn releases relay 56. Release of relay 56 at this time connects ground to the upper winding terminal of relay 55, causing relay 55 to release. Thus at the end of the second revolution these relays at the second central station are again returned to the same condition they were at the beginning of the first revolution.

During the first revolution of the slow distributors the transmission and control paths from station B to station B' may be traced through relays 117, 118, leads 129, 130, 115 and 116, the normal or break contacts of relays 40, 41 and 42, leads 119, 120, 121 and 122, relays 123, 124 and 125, slow transmitting distributor segments 134 and 135, slow receiving distributor segments 154 and 136, relay 126 and normal or break contacts of relay 57 to station B'. Similar transmission and control paths may be traced through the corresponding relays 217, 218, 223, 224 and 225, slow distributing segments 234 and 235 to station C' through segment 236 of the slow receiving distributor and relay 226.

During the next revolution of the slow distributors relays 40, 41, 42 and 57 will be operated and interchange the transmission and control paths between stations B and C so that during the second revolution of these distributors the transmission and control paths from station B may be traced as follows: From station B over lines 113, 114, 115 and 116, through relays 117, 118, the operated contacts of relays 40, 41 and 42, over leads 219, 220, 221 and 222, through relays 223, 224 and 225, slow transmitting distributor segments 234 and 235, slow receiving distributor segments 154 and 236, relay 226 and operated contacts of relay 57 to station B'. Similar transmission and control circuits may be traced from station C through the slow distributor segments 134, 135, and operated contacts of relays 40, 41 and 42 to station C' through the slow receiving distributor segment 136 and operated contacts of relays 126 and 57.

Thus during the first revolution of the slow transmitting distributors the first transmission interval is assigned to station A, the second interval to station B and the third interval to station C, while during the second revolution the first transmission interval is again assigned to station A, the second transmission interval is now assigned to station C and the third transmission interval to station B. During the third revolution and each odd succeeding revolution, time intervals are assigned as during the first revolution of the slow distributors. During the even-numbered revolutions time intervals are assigned to stations

A, B and C as described during the second revolution of the slow distributors.

It is essential that the position of relay 57 at the second central station correspond to the position of relays 40, 41 and 42 at the first central station so that the transmission circuit from station B will always be connected to the transmission circuit to station B' and the transmission circuit from station C will always be connected to the transmission circuit to station C'.

The object of alternately reversing the transmission path from stations B and C to stations B' and C' during alternate revolutions of the slow distributors is to evenly divide the time assigned to any two of the stations if only two of the subscribers thereat wish to transmit messages simultaneously, i. e., one of the extension lines to the subscribers' stations is idle and the other two are active. In the foregoing description it was assumed that each of the subscribers at stations A, B and C wished to simultaneously transmit to the corresponding stations A', B' and C'. However, if the subscribers at only two of the stations wish to simultaneously transmit to their associated stations, two intervals of time will be assigned to one of the stations and one interval of time to the other station during the first revolution of the slow distributors. During the second revolution of the slow distributors only one interval of time will be assigned to the first station and two intervals of line time will be assigned to the second station.

Assume, for example, that the subscribers at stations A and B wish to simultaneously transmit messages to the corresponding stations A' and B' but that the subscriber at station C does not wish to transmit information to station C'.

During the first revolution the fast distributors at both the first and second central stations, relays 24, 25, 124 and 125 at the first station will be operated and relays 26 and 126 at the second central station will be operated. During the first interval of line time during which brushes 87 and 88 are passing over segments 34 and 35 of the slow distributor the transmission and control circuits are completed from station A through these segments 34 and 35 to line 58. At the second central station the transmission circuit is completed from the receiving relay 49 connected to line 58 through segment 36 and relay 26 to station A' over line 9.

During the second interval of line time the control and transmission circuits from station B are completed through segments 134 and 135 to line 58 and thence through segment 136, relay 126 and the break contacts of relay 57 to station B'.

During the third interval of time during the first revolution of the slow distributor when brushes 87 and 88 are passing over segments 234 and 235 the transmission and control circuits are completed from station B through the make contacts of relays 124 and 125 and the break contacts of relays 224 and 225, to segments 234 and 235 of the slow transmitting distributor to line 58. At the second central station the transmission path is extended from the contacts of relay 49 through the segment 236 of the slow receiving distributor, the normal contacts of relay 226, the operated contacts of relay 126, the normal contacts of relay 57 to station B' over line 172.

Thus during the first interval of time during the first rotation of the slow distributors the transmission path is completed between station A and station A'. During the second and third intervals of time the transmission path is completed between station B and station B'.

During the first interval of time during the second revolution the transmission path from station A will again be completed to station A' over the same circuits described during the first interval of time during the first revolution of the slow distributors. During the second interval of time of the second revolution of the slow distributors, however, the transmission path from station A to station A' is completed. As pointed out above, during the second revolution of the slow distributors relays 40, 41 and 42 at the first central station and relay 57 at the second central station are operated. This means that during the second revolution of the fast distributors at these stations relays 24, 25, 224 and 225 at the first station and relay 26 and 226 at the second central station are operated. Thus during the second interval of time during the second revolution of the slow distributor the control and transmission circuits may be traced from station A through the operated contacts of relays 24 and 25 and the normal or break contacts of relays 124 and 125 through segments 134 and 135 of the slow transmitting distributor to line 58. At the second central station the transmission circuit extends from the receiving relay 49, through segment 136 of the slow distributor 148, the normal or break contacts of relay 126 and the operated or make contacts of relay 26 to station A' over line 171.

During the third interval of time of the second revolution of the slow distributors the transmission path from station B may be traced through the make contacts of relays 224, 225 and segments 234 and 235 of the slow transmitting distributor to line 58. At the second central station receiving relay 49 repeats the received signal impulses to station B' over a circuit through segment 236 of the slow receiving distributor 148, the operated contacts of relay 226 and the operated contacts of relay 57 over line 172.

Thus during two revolutions of the slow distributors the line time is equally assigned between stations A and B. Similar circuits may be traced for transmission between any of the other two sets of stations whereby the line time is always equally divided or assigned to the two stations at which the subscribers wish to simultaneously transmit signal impulses to their associated stations.

If only one of the subscribers wishes to transmit from his station to the associated station substantially the entire line time is assigned to the station at which the subscriber wishes to transmit. Assume, for example, that the subscriber at station A is the only subscriber wishing to transmit messages to station A' at a given time. Under these conditions only relays 24 and 25 at the first central station and relay 26 at the second central station will be operated during the rotation of the fast distributors.

During the first interval of time of the first revolution of the slow distributors transmission circuit from station A to line 58 is the same as described above when two or three subscribers all wish to transmit simultaneously. During the second interval of time the control and transmission circuits from station A may be traced from station A, through the make contacts of relays 24 and 25 through the break contacts of relays 124 and 125, the segments 134 and 135, to line 58. At the second central station the transmission circuit extends from the receiving relay 49, to

segment 136 and the break contacts of relay 126 and make contacts of relay 26 to station A' over line 171. During the third interval of time during the first revolution of the slow distributors the transmission and control circuits extend from station A to line 58 through the make contacts of relays 24 and 25, break contacts of relays 124 and 125 and the break contacts of relays 224 and 225, through segments 234 and 235. At the second central station the transmission path extends from the receiving relay 48, through segment 236 of the slow receiving distributor 148, through the left-hand break contacts of relay 226, the left-hand break contacts of relay 126 and the left-hand make contacts of relay 26 to station A' over line 171. During the second revolution of the slow distributor the time intervals are again all assigned to station A over the similar circuits described above during the first revolution except that the connections between the last two sets of distributor segments 134, 135 and 136 and 234, 235 and 236 are reversed.

Similar circuits are provided whereby substantially the entire line time may be assigned to station B if the subscriber at station B is the only subscriber wishing to transmit at a given time. Other similar circuits are also provided whereby the line time is substantially all assigned to station C if the subscriber thereat is the only subscriber desiring to transmit at a given time.

As pointed out above, when all three subscribers are transmitting certain time must be allowed between transmissions by the various subscribers to insure that the transmission circuit has been switched from one to the other. Inasmuch as the distributors at both stations are not run at exact synchronism this interval of time must also include sufficient time to allow for the difference in speed of the distributors at both ends of the line. In order to provide for this time interval the segments 35, 135 and 235 are separated from each other by short segments 64, 65 and the control segment 257. If all the subscribers wish to simultaneously transmit the circuits of short segments 64 and 65 are interrupted by relays 25, 125 and 225. The time interval during which brush arm 86 carrying brush 88 passes over these segments is sufficient to insure proper switching of the transmission path from each station to the succeeding station.

If, however, the transmission during any two succeeding time intervals is to be to the same station this time interval is not required because it is not necessary to switch the transmission path from one station to the next. Assume, for example, as described above when subscribers at only stations A and B wish to transmit to their associated stations at a given time. During the second and third intervals of time of the first revolution of the slow distributor the line is assigned to station B. Thus between these two intervals of time it is not necessary to perform any switching functions. Consequently, under this condition the circuit of segment 65 is completed to segment 135 through the outer right-hand break contacts of relay 225. Similarly, during the first and second intervals of time during the second revolution the line time is assigned to station A. Consequently, it is not necessary to perform any switching between these time intervals. Under these conditions, segment 64 is connected to segment 35 through the inner right-hand break contacts of relay 125.

Similarly, if the subscriber at only one station is transmitting at a given time it is unnecessary to perform any switching functions between the various time intervals so that segments 64 and 65 are connected over circuits similar to those described above to segments 35 and 135. Brushes 87 and 152 should be of a bridging type so that they will make contact with the next succeeding segment before they break contact with the segment over which they are passing. This will insure that the transmission path between the various stations is not interrupted or interfered with when brush 87 or 152 passes on one segment to another in case the transmission is from the same station during the time the brushes are passing over both of the segments.

In this manner the line time usually employed for switching may be employed for transmitting the signal impulses between the transmitting and associated receiving stations.

What is claimed is:

1. A communication system comprising a main line, extension lines, means for establishing an operative connection between each of said extension lines and said main line comprising a slow speed start-stop distributor connected to said main line, means for extending all of said operative connections to only active extension lines, and additional distributor means for transmitting directing impulses over said main line to indicate the active extension lines.

2. A telegraph system comprising a main line, a start-stop distributor connected thereto, a plurality of extension lines, means for establishing an operative connection between each of said extension lines and said distributor, and means for alternating the connections between two of said connections and said distributor.

3. A communication system comprising a main line, a plurality of extension lines, a start-stop distributor connected to said main line, means for establishing an operative connection between each of said extension lines and said distributor, switching means included in said operative connection for extending all of said connections to only active extension lines, and means for securing a more efficient distribution of main line time between said operative connections, comprising a second high speed start-stop distributor also included in said operative connection, and reversing relays connected in said connection for alternately reversing the connection between two of said operative connections.

4. A telegraph system comprising a main line, a high speed start-stop distributor connected to each end of said line, a low speed start-stop distributor also connected to each end of said line, an operative connection between said distributors for starting said slow distributor during each revolution of said high speed distributor, a plurality of extension lines, an operative connection between said extension lines and said distributors for completing a transmission path from each active extension line to said main line during each revolution of said slow distributor, and apparatus connected between said high speed distributor and said extension lines for transmitting during each revolution of said high speed distributor directing impulses for indicating the extension lines over which signal impulses will be transmitted.

5. In a telegraph system comprising a main line, a plurality of extension lines, means for establishing an operative connection between each of said extension lines and said main line comprising a slow speed start-stop distributor

connected to said main line and each of said extension lines for providing a communication path between each of said extension lines and said main line during a portion of each revolution thereof, apparatus connected to said distributor for extending all of said paths to only active extension lines, a high speed start-stop distributor connected to said main line for transmitting impulses thereover indicating the active extension lines.

6. In a telegraph system, a main line, a plurality of extension lines, operative connections between each of said lines and said main line comprising a start-stop distributor connected to said main line and to each of said extension lines for completing a communication path between said extension lines and said main line during a portion of each revolution thereof, and instrumentalities connected between two of said extension lines and said distributor for reversing the connections between said lines and said distributor during alternate revolutions of said distributor.

7. In a telegraph system, a main line, a number of extension lines cooperating with one end of said main line, the same number of extension lines cooperating with the other end of said main line, means for establishing an operative connection between each of said extension lines and respective ends of the main line comprising a slow speed start-stop distributor connected to said main line and to each of said extension lines, apparatus connected to two of said operative connections for interchanging the connection between said operative connections and said main line during alternate revolutions of said distributor, additional apparatus for extending all of said operative connections to active extension lines, a high speed distributor connected to each end of said line controlled by said extension lines, a control circuit connected to said high speed distributors for transmitting over said main line control impulses which indicate the extension lines which will be active during succeeding revolution of the slow speed distributor, and means for starting said slow speed distributor during each revolution of said high speed distributor.

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