

Feb. 10, 1925.

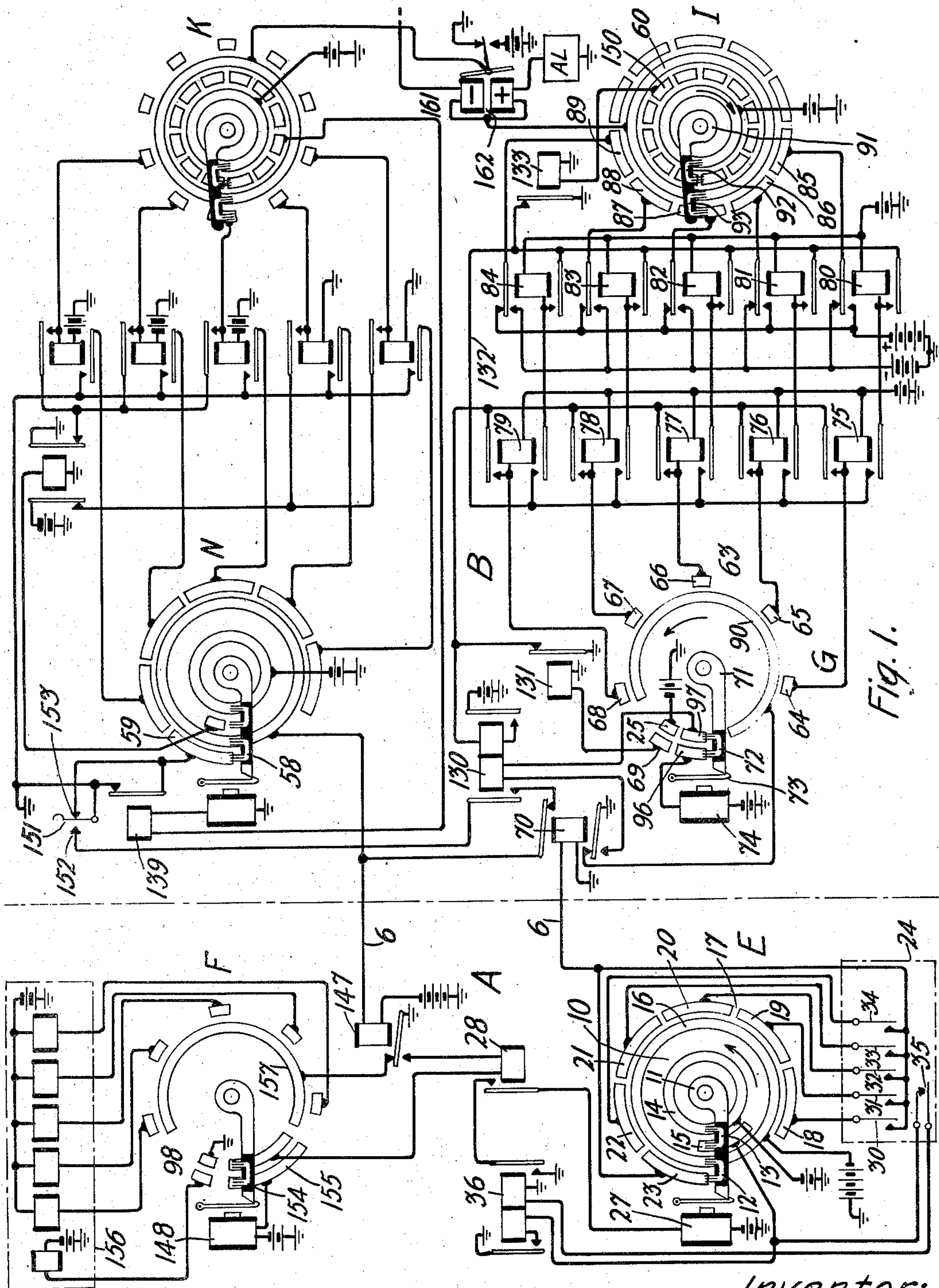
1,525,523

G. S. VERNAM

PRINTING TELEGRAPHY

Filed Nov. 21, 1921

2 Sheets-Sheet 1



Inventor:
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by *gr/406* Att'y.

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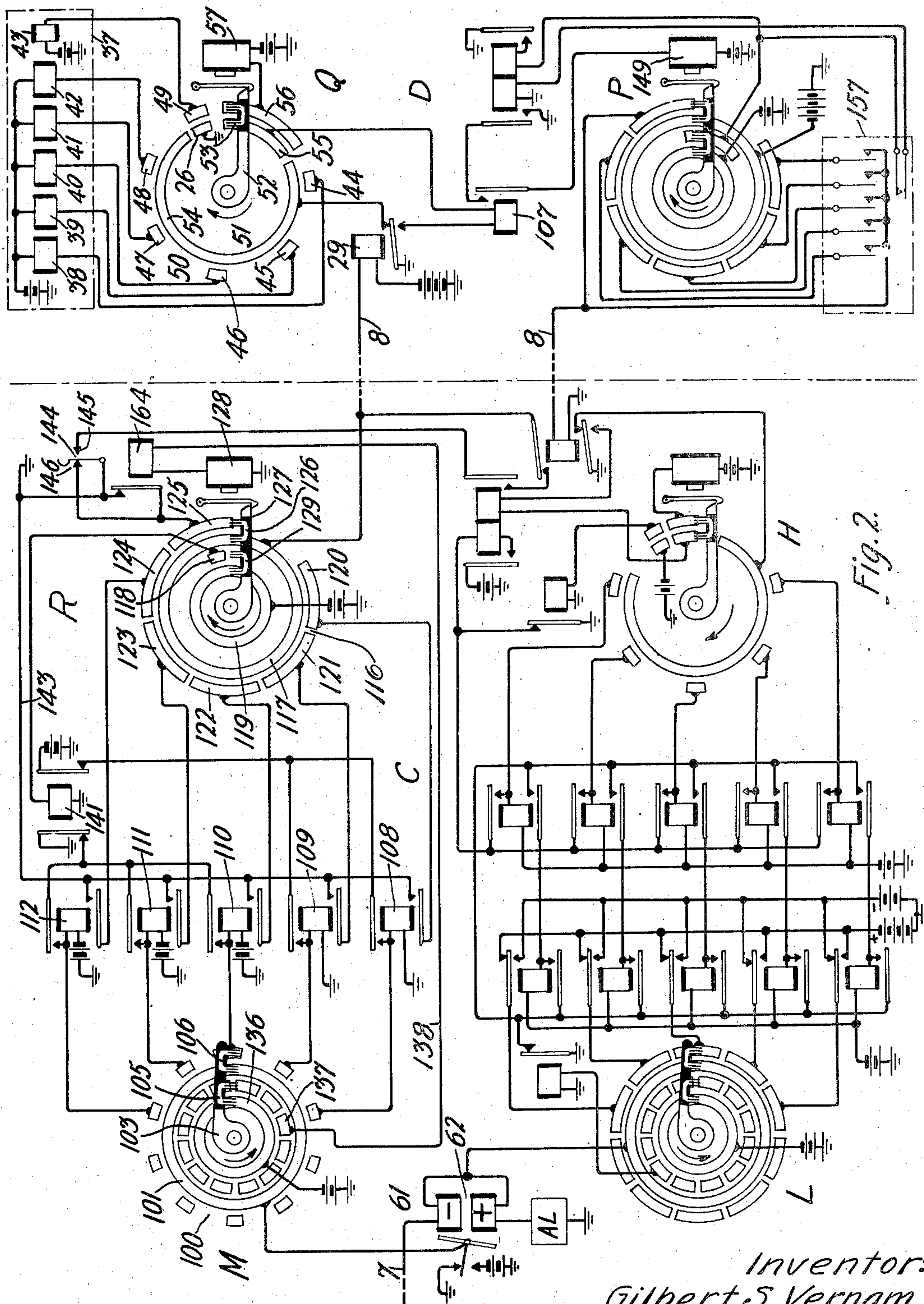
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Inventor:
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UNITED STATES PATENT OFFICE.

GILBERT S. VERNAM, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

PRINTING TELEGRAPHY.

Application filed November 21, 1921. Serial No. 516,795.

To all whom it may concern:

Be it known that I, GILBERT S. VERNAM, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Printing Telegraphy, of which the following is a specification.

This invention relates to printing telegraph systems.

An object of the invention is the provision in a system providing duplex operation, of means whereby the system may be readily and expeditiously changed from full duplex to half duplex operation, and vice versa.

The present invention contemplates the provision of a plurality of main or central stations interconnected by a line conductor, and at which duplex equipment is located and switching means whereby the system may be changed to provide either full or half duplex service between such stations. Specifically, the invention provides a plurality of main or central stations interconnected by a line conductor, and at which duplex equipment and synchronous multiplex telegraph apparatus are located, and having extension circuits extending therefrom to branch offices which are provided with telegraph apparatus of the start-stop type for transmitting code combinations of message impulses to the central station where they are automatically and simultaneously transferred to the duplex line conductor, and vice versa, and switching means for providing either full or half duplex service.

As generally known, the term "full duplex" refers to a system wherein message impulses may be transmitted in both directions over a single line conductor simultaneously. The term "half duplex," however, refers to a system provided with duplex equipment in which messages can be transmitted in either direction alternately, that is, messages can be transmitted only in one direction at a time.

The invention is illustrated in the accompanying drawings which represent one embodiment of the invention, and when arranged so that Figure 1 is to the left of Fig. 2, a complete system is shown diagrammatically.

The invention in general comprises a branch office "A" which is connected with a main or central office "B" by an extension circuit 6, a central or main station "C" con-

nected with the main station B by a duplex line conductor 7 and a distant branch office D which, like branch office "A," is connected with its associated central station C by an extension circuit 8.

At the branch office A there are located transmitting and receiving equipments E and F respectively, which are electrically connected with equipment at the main office B by the extension circuit 6, which may be a duplex line conductor or two wires, as illustrated in the drawings. Both of the central offices B and C are provided with receiving distributors G and H of the start-stop type serving to receive the code combinations of message impulses from the respective sub-stations, and transferring them to the multiplex synchronous distributors I and L, also located at the offices B and C respectively, through the instrumentalities of a plurality of sets of storing relays. Also located at these central offices are multiplex synchronous distributors K and M, each of which serve to receive the signaling impulse from the duplex line conductors 7, and transfer the same to start-stop distributors N and R, respectively. Like branch office A, branch office D is provided with a transmitting distributor P and a receiving distributor Q, which serve their respective purposes.

The transmitting equipment E comprises an intermittently rotary distributor 10 having a brush arm 11 which carries a pair of brushes 12 and 13, which in turn are arranged to make contact with rings 14, 15, 16 and 17. The outer ring 17 is divided into a plurality of segments 18, 19, 20, 21, 22 and 23 which are connected with the respective contacts of a transmitter shown diagrammatically at 24. In order that the brush arm 11 will be stopped once per revolution, a release magnet 27 is provided which is under the control of relay 28 which, in turn, is under the control of line relay 147.

The transmitter 24 consists of a plurality of movable contact members 30, 31, 32, 33 and 34 which are connected to respective ones of the segments forming the outer ring 17 of the distributor 10. Also arranged in the transmitter 24 is a common contact 35 which controls the energization of relay 36 and which is closed upon each actuation of the transmitter 24. Although the transmitter

24 has been shown diagrammatically as a key-board transmitter, any well-known type of transmitter may be substituted therefor which will provide equally good results.

At the central office B, there is shown a receiving distributor G of the start-stop type and a synchronously-driven distributor I which has its ring 60 connected with the apex of the ratio arms 161, one terminal of which is connected with the line conductor 7 while the other extends to the artificial balancing network AL. Connected in the ratio arms 161 is a receiving relay 162 which, like all relays used for duplex service, responds only to incoming impulses and is made non-responsive to outgoing impulses. Thus, upon the operation of the multiplex distributor I, this relay will not respond to impulses which may be transferred from the start-stop distributor G to the line conductor 7.

The start-stop distributor G comprises an outer ring 63 and an inner ring 90. Forming a part of the outer ring is a plurality of segments 64, 65, 66, 67, 68 and 69 each of which corresponds to respective ones of the segments on the transmitting distributor 10. By the proper orientation of these segments, and inasmuch as they are smaller than the transmitting segments of the distributor 10, the central portion of the signaling impulses transmitted over the extension circuit 6 to line relay 70 will be picked up from each segment at the sending face at the branch office A. The distributor G also comprises a brush arm 71 carrying a brush 72 and which is held against rotation by a latch 73 under the control of release magnet 74.

Interposed between the start-stop distributor G and the multiplex or synchronously-operated distributor I, is a pair of sets of storing relays which serve to provide an overlap between the signals forming the various combinations. The first set comprises relays 75, 76, 77, 78 and 79 which have their windings connected with segments 64, 65, 66, 67 and 68, respectively. Thus, upon the passage of the brush 72 over these segments and the energization of relay 70 in response to the operation of the transmitter 24, these relays will be energized and locked up. The second set of storing relays comprises relays 80, 81, 82, 83 and 84 which are under the control of the first set of storing relays and are also locked up upon their energization. Thus, after a set of impulses has been transmitted from the distributor G through the storing relays 75 to 79 inclusive, the storing relays 80 to 84 inclusive, will be energized depending upon which ones of the relays forming the first set are energized, after which the relays 75 to 79 can again be energized for storing up the next succeeding combination of message impulses. Storing relays 80 to 84 inclusive, have their upper

armatures connected with segments 85, 86, 87, 88 and 89 forming a part of the outer ring of the distributor I which comprises a continuously rotating brush arm 91 which has secured thereto, brushes 92 and 93. Upon the rotation of the brush arm 91 and the passage of the brush 93 over the segments to which the armatures of the storing relays 80 to 84 are connected, message impulses will be transmitted over the line conductor 7.

The apparatus just described constitutes the equipment located at the central or main office B and which serves to transmit impulses from the branch office A to the duplex line conductor 7 and then to the central office C from whence the message impulses are transmitted to the distant branch office D.

The apparatus at the central office C which receives the signals transmitted from the transmitting apparatus located at the central office B comprises a multiplex distributor M and a distributor of the start-stop sort R. The multiplex distributor M comprises, among other parts, a ring 100 and a ring 101, the latter of which is connected to the armature of receiving relay 62, while the former is divided into a plurality of smaller segments. Like the distributor I, a continuously revolving brush arm 103 carrying brushes 105 and 106 is also provided. Connected to the smaller segments forming a part of the outer ring 100, are the windings of storing relays 108, 109, 110, 111 and 112, which serve to store the impulses before being transferred to the start-stop distributor R. The start-stop distributor R, comprises rings 116, 117, 118 and 119, the outer ring of which is divided into segments 120, 121, 122, 123, 124 and 125, the first five of which are connected to the lower armatures of storing relays 108 to 112. For bridging the ring 117 with the segments forming the outer ring 116 is a brush 126 carried by a brush arm 127 which is normally held against rotation by a latch under the control of release magnet 128. The brush arm 127 also carries a brush 129 which serves to bridge the rings 118 and 119.

The receiving equipment Q at the branch office D comprises a receiving printer diagrammatically shown at 37, which comprises the usual selecting magnets 38, 39, 40, 41 and 42 and the printing magnet 43. The respective magnets have their windings connected with segments 44, 45, 46, 47, 48 and 49 forming a part of the outer ring 50 of the distributor 51. The distributor 51, like the distributor G has a brush arm 52 carrying a brush 53 which is arranged to bridge the segments forming a part of the ring 50 with the inner ring 54 for controlling the energization of the respective

ones of the selecting magnets depending upon the energization of line relay 29 which has its front contact connected with the ring 54. Both of the rings 50 and 54 have included therein, segments 55 and 56 upon which the brush 53 normally rests thereby controlling the energization of release magnet 57 which normally retains the brush arm 52 against rotation.

Inasmuch as the apparatus associated with the other channel of the system is identical with the equipment just described, further description thereof is considered unnecessary here.

The operation of the equipment just described is as follows: Assume for the sake of clearness that the branch office A desires to communicate with the branch office D, in which case the transmitter 24 will be operated to set up a particular combination depending upon the message desired to be transmitted. Let it also be assumed that it is desired to transmit a character in which contacts 30, 32 and 34 of the transmitter 24 are actuated to close their respective contacts. As previously described, upon each operation of the transmitter 24, contact 35 will be closed for conditioning an energizing circuit for release magnet 27. Release magnet 27 is, however, controlled by relay 36 which is energized and locked up upon the closure of contact 35 and relay 28 which, in turn, is operated upon the deenergization of line relay 147. In order to provide proper phase relation between the various distributors, the transmitting distributor 10 is placed under the control of the receiving distributor 98 which, in turn, controls the energization of relay 28, but which is not energized until line relay 147 is deenergized owing to the brush 58 of the distributor N passing off of segment 59. Immediately following the passage of the brush 58 off the segment 59 which will be once per revolution of the brush arm of the multiplex distributor K, line relay 147 is deenergized and a circuit is completed extending from battery through the winding of release magnet 148 of the receiving distributor 98, winding of relay 28 and the back contact and armature of line relay 147 to ground. Relay 28, when energized, completes an energizing circuit for release magnet 27 which extends from battery through the winding of release magnet 27, armature and contact of relay 28 and the right-hand off-normal contact of relay 36, which is, at this time, locked up through the brush 13 to ground. Release magnet 27, in energizing, releases the arm 11 for rotation, whereupon the brush 12 consecutively completes circuits extending through the segments 18, 19, 20, 21 and 22, and the contacts of the transmitter 24 which have been operated, through the winding of line relay 70 at the

central office B. However, the instant the brush 12 passes off of segment 23, and open circuit condition is established, whereby line relay 70 which is normally energized over a circuit extending from battery, ring 16 of the distributor 10, brush 12, segment 23 and the winding of relay 70 to ground, is released. The release of relay 70 establishes a circuit extending from battery through the winding of release magnet 74 of the distributor G, segment 96, brush 72, segment 97, left-hand winding of relay 130, and the lower back contact of line relay 70 to ground. The brush arm 71 is thereby released for rotation owing to the withdrawal of the latch 73 upon the energization of release magnet 74. Contact 30 of the transmitter 24 being closed, an energizing circuit for line relay 70 is established upon the passage of the brush 12 over segment 18. Relay 70 in energizing, connects ground with segment 90 so that upon the passage of the brush 72 over segment 64, an energizing circuit is completed for storing relay 75 extending from battery, winding of storing relay 75, segment 64, brush 72, segment 90 and the front contact and armature of line relay 70 to ground. Relay 75, in energizing, completes through its upper contact, a holding circuit extending from battery through the winding, upper contact and armature thereof and the normal contact and armature of clear-out relay 131 to ground. The contact 31 of the transmitter 24 being opened, line relay 70 thereby releases its armature upon the passage of the brush 12 over segment 19, whereupon storing relay 76 remains deenergized upon the passage of the brush 72 over the segment 65 individual thereto. For the remaining setting of the transmitter 24, contacts 32 and 34 being closed, conditions similar to those described in connection with contact 30, will be established for causing the energization and locking up of storing relays 77 and 79 upon the passage of the brush 72 over the corresponding segments. Storing relay 78, will, however, not be energized owing to contact 33 being opened so that an open circuit condition is established upon the passage of the brush 12 over the segment individual thereto. Just prior to the completion of the cycle of rotation by the arm 71, brush 72 bridges segments 69 and 25 whereby clear-out relay 131 is energized to open the locking circuit of the storing relays 75 to 79 inclusive thereby restoring the same to normal.

Storing relays 75, 77 and 79 having been energized, energizing circuits for storing relays 80, 82 and 84 forming a part of the second set of storing relays will be completed over a circuit extending from battery through the windings thereof, lower armature and contact of the energized ones of the

storing relays of the first set, conductor 132, and the back contact and armature of clear-out relay 133 associated with the multiplex distributor I, to ground. The remaining ones of the storing relays forming a part of the second set of storing relays will remain deenergized because the corresponding relays of the first set were not energized. Like the storing relays of the first set, the energized ones of the relays of the second set will be locked up over a circuit extending from battery through the winding and lower armature thereof and the back contact and armature of clear-out relay 133 to ground. Upon the passage of the brush 93 of the multiplex distributor I over the respective ones of the segments, a polarity of battery depending upon the energization of the storing relays of the second set will be applied to the apex of the ratio arms 161 and thence over the line conductor 7 to the central station C. Upon the passage of the brush 93 over segment 85 to which the upper armature of storing relay 80 is connected and, owing to the fact that this relay is energized, an impulse of a positive polarity will be transmitted to the central station C which passes through the windings of receiving relay 62 for causing the reversal of its armature. The battery is thus connected with the ring 101 so that upon the passage of the brush 106 of the distributor M over the segment to which the storing relay 108 is connected, this relay will be operated inasmuch as the winding of this relay is connected to ground. However, prior to or about the same time that the brush 106 is passing over the segment to which the winding of the relay 108 is connected, the brush 105 completes a circuit extending from battery through ring 136, segment 137, conductor 138, winding of lag-control relay 164 and the winding of release magnet 128 of the distributor R, whereupon release magnet 128 is energized for permitting of the rotation of brush arm 127. As the brush arm 91 continues to rotate, conditions depending upon the position of the armatures of the storing relays of the second set will be set up for causing the corresponding positioning of the armature of receiving relay 62 at the central station C. Thus, upon the passage of the brush 106 over the segments to which the windings of storing relays 109, 110, 111 and 112 are connected, these relays will be energized depending upon the energization of the storing relays of the second set located at the central office B. For the particular selection chosen, the storing relays 108, 110, 112 will be energized over circuits similar to those traced in connection with storing relay 108. The energized ones of these storing relays will also be locked up through contacts controlled by clear-out relay 141, depending upon the polarity of

the battery applied to the windings thereof.

Following the passage of brush 93 off of segment 89, brush 92 engages segment 150 whereupon clear-out relay 133 is energized for opening the holding circuit of storing relays 80 to 84 inclusive to restore these relays to normal.

The brush arm 127, being now released for rotation, consecutively connects the segments 120, 121, 122, 123, 124 which are connected with respective armatures of the storing relays 108 to 112, in circuit with the winding of line relay 29, but prior to the passage of the brush 126 over the segment 120, an opened circuit condition is established, whereupon line relay 29 is deenergized. Line relay 29, in deenergizing, completes a circuit extending from battery through the winding of release magnet 57, segment 56, brush 53, segment 55, winding of relay 107 and the back contact and armature of line relay 29 to ground. The deenergization of line relay 29 in this manner not only causes the energization of release magnet 57 which permits of the rotation of brush arm 52 of the distributor 51 but also as previously described in connection with the distributor 10 at the branch office A, completes an energizing circuit for release magnet 149 of the transmitting distributor P located at station D. Upon the passage of the brush 126 over segment 120 and owing to the fact that storing relay 108 is energized for the particular selection chosen, line relay 129 will thus be energized, over a circuit extending from battery through the winding of line relay 29 ring 117, brush 126, segment 120, lower armature and contact of storing relay 108 and conductor 143 to ground, so that upon the passage of the brush 53 over a segment 44, a closed circuit condition is established for the selecting magnet 38 of the printer 37. The energizing circuit of selecting magnet 38 extending from battery through the winding of this magnet, segment 44, brush 53, ring 54, and the front contact and armature of line relay 29 to ground. Thus movement of the selecting bar under the control of this magnet will be effected at this time.

Upon the passage of the brush 126 over a segment 121 and inasmuch as storing relay 109 is not energized, the line relay 29 will not be energized. Upon the passage of the brush 53 over segment 45, the circuit for causing the energization of selecting magnet 39 will be open at the front contact and armature of line relay 29, and magnet 39 will not be operated. Conditions similar to those just described for selecting magnet 38 will be established upon the passage of the brush 36 over segments 46 and 48, respectively, for causing the energization of the corresponding selecting magnet 40 and 42 of the receiving printer 37. However, since

the storing relay 111 is not energized for this selection, no effect will be produced on the selecting magnet 41 upon the passage of the brush 53 over the segment individual thereto.

Shortly before the brush arm 127 completes its cycle of rotation, an energizing circuit is established for clear-out relay 141 which extends from battery, through ring 119, brush 129, segment 118 and the winding of clear-out relay 141 to ground. Clear-out relay 141, in energizing, opens holding circuits of the storing relays 108 to 112 which have previously been energized thereby by restoring their armatures to normal in order that the next succeeding group of impulses may be stored therein.

Following the passage of the brush 53 over the segment 48 and the passage thereof over segment 49 a circuit is completed extending from battery through the winding of printing magnet 43, segment 49, brush 53, segment 26 of ring 54 to ground. Thus, the signals transmitted from the branch office A will be recorded on the receiving printer 37 at the branch office D over one channel of the duplexed line 7.

It is, of course, understood that the branch office D may, in a manner similar to that just described, communicate with the branch office A by the use of transmitting equipment P which will transfer the impulses forming the code combinations to the extension circuit 8. As before, impulses will be transmitted to the receiving distributor H at station C where they will be transferred to the multiplex distributor L from whence they will be transmitted over the line conductor 7, thence to the receiving multiplex distributor K and transferred to the start-stop distributor N from whence they are transmitted to the receiving equipment F located at the branch office A. The operation of the transmitter 157 at the branch office D will therefore be recorded on the printer 156, located at station A.

Assume that it is desired to transmit in one direction at a time, that is, to provide half duplex service between branch offices A and D, in which case the keys 151 and 144 at stations B and C will be actuated to close contacts 152 and 145 and open contacts 153 and 146, respectively. The opening of contact 153 removes the short circuit from about the contact of the lag-control relay 139, while the closure of contact 152 extends the circuit to the right-hand armature of the loop-control relay 130. With the connections formed in this manner, the energizing circuit of the line relay 147 at the branch office A is now under control of the lag-control relay 139 and is independent of the distributor N except that the energizing circuit therefor is completed through the brush 58, but it is not necessary, as in the

previous case, that the brush 58 move off of the segment 59 in order to deenergize the line relay 147 and thus effect the closure of the energizing circuit of relay 28 which controls the energization of the release magnet 27 of the distributor 10. The starting impulse, which, as previously described, is transmitted from the multiplex distributor to the distributor N, will therefore occur sooner than in the case of full duplex operation and the receiving brush arm 52 and 154 at the subscriber's stations A and D will start sooner.

It also becomes necessary when the system is used for half duplex operation that the distributor face of the distributors 51 and 98 be oriented counter-clockwise until the brushes 53 and 154 of each of the receiving distributors is near the end of the segments 55 and 56 as shown in both Figs. 1 and 2.

Assuming now that the transmitter 24 is operated to set up a particular combination by the setting of the contacts 30 to 34 and, as previously described, the brush arm 11 is released for rotation, the impulses will be transferred to the extension circuit 6 in a manner similar to that previously described. In this case, however, the circuit of line relay 147 is completed through the left-hand contact of loop-control relay 130 which, after once being energized, is locked up and remains in such position until the distributor G has completed its cycle of rotation. Line relay 147 at the branch office A will then respond to each actuation of line relay 70. This circuit may be traced from battery through the winding of line relay 147 at the branch office A, the upper armature and front contact of line relay 70, left-hand contact and armature of loop-control relay 130, contact 152 of the key 151 to ground. Thus, upon each rotation of the distributor 10 at the branch office A, the receiving distributor at this office will also be rotated for associating the selecting magnets of the receiving printer 156 with the ring 157 which is connected with the contact of line relay 147, whereupon the selecting magnets will be energized depending upon the energization of line relay 147 for producing what is commonly known as a home record. During the time that the transmitting mechanism 24 is operating and the half duplex keys at both of the central stations are thrown into the position previously described, the receiving mechanism 156 at the station A records the operation of the transmitter 24, thus acting as what may be termed a home recorder. When the system is operating half duplex, it is very essential that the transmitting equipment at station B be not operated inasmuch as the printing mechanism at the several stations would respond to the operation of this equipment and thereby effect a mutila-

tion of the signals recorded on the receiver 156 at station A. The operation of the remainder of the system is identical with that described in connection with the full duplex service between the branch offices A and D and a further description is considered unnecessary.

Although the invention has been illustrated in connection with a system wherein code combinations of message impulses originating at a branch office are transferred to a main or central office at which synchronous printing telegraph apparatus is located and thence over a duplex line conductor to a second central or main station having equipment similar to that just referred to from which it is transferred to an extension circuit to the distant branch office, it is, of course, obvious that the invention may be readily applied to other type of systems without departing from the spirit and scope of the present invention.

The invention claimed is:

1. In a telegraph system, a plurality of stations interconnected by a line conductor, duplex equipment located at each of said stations for providing full duplex service over said line conductor, receiving and transmitting mechanisms at each of the stations, switching means for changing said system from full duplex to half duplex operation, and circuit connections established due to the operation of said switching means for rendering the receiving mechanism at the transmitting station responsive to the operation of said transmitting mechanism.

2. In a telegraph system, a plurality of stations interconnected by a line conductor, duplex equipment located at each of said stations for providing full duplex service over said line conductor, synchronous multiplex telegraph apparatus associated with said line conductor, transmitting and receiving mechanisms operatively associated with said synchronous multiplex telegraph apparatus, switching means for changing said system from full duplex to half duplex operation, and circuit connections established upon the operation of said switching mechanism for rendering the receiving

mechanism at the transmitting station responsive to the operation of said transmitting mechanism.

3. In a telegraph system, a plurality of stations connected by a duplex line conductor, multiplex synchronous apparatus at each of said stations, a start-stop system extending from one of said stations to a distant station, means for transmitting code combinations of message impulses over said multiplex system, means for automatically transferring said message impulses from said multiplex system to said start-stop system, means at said distant station for recording such impulses, and means for changing said system from full duplex to half duplex operation.

4. In a telegraph system, a plurality of stations connected by a duplex line conductor, multiplex synchronous apparatus at each of said stations, a start-stop system extending from one of said stations to a distant station, means for transmitting code combinations of message impulses over said multiplex system, means for automatically transferring said message impulses from said multiplex system to said start-stop system, means at said start-stop station for recording said impulses, and switching means for changing said system from full duplex to half duplex operation.

5. In a telegraph system, a plurality of stations connected by a duplex line conductor, multiplex synchronous apparatus at each of said stations, a start-stop system extending from one of said stations to a distant station, means for transmitting code combinations of message impulses over said multiplex system, intermittently rotary distributors for automatically transferring said message impulses from said multiplex system to said start-stop system, means at said distant station for recording said impulses, and switching means associated with each of said multiplex synchronous apparatus whereby said system may be changed from full duplex in half duplex operation.

In testimony whereof, I have signed my name to this specification this 15th day of November, 1921.

GILBERT S. VERNAM.