Aug. 30, 1932. G. S. VERNAM 1,874,664

MULTIPLEX TELEGRAPHY

Filed Sept. 4, 1930 4 Sheets-Sheet 1

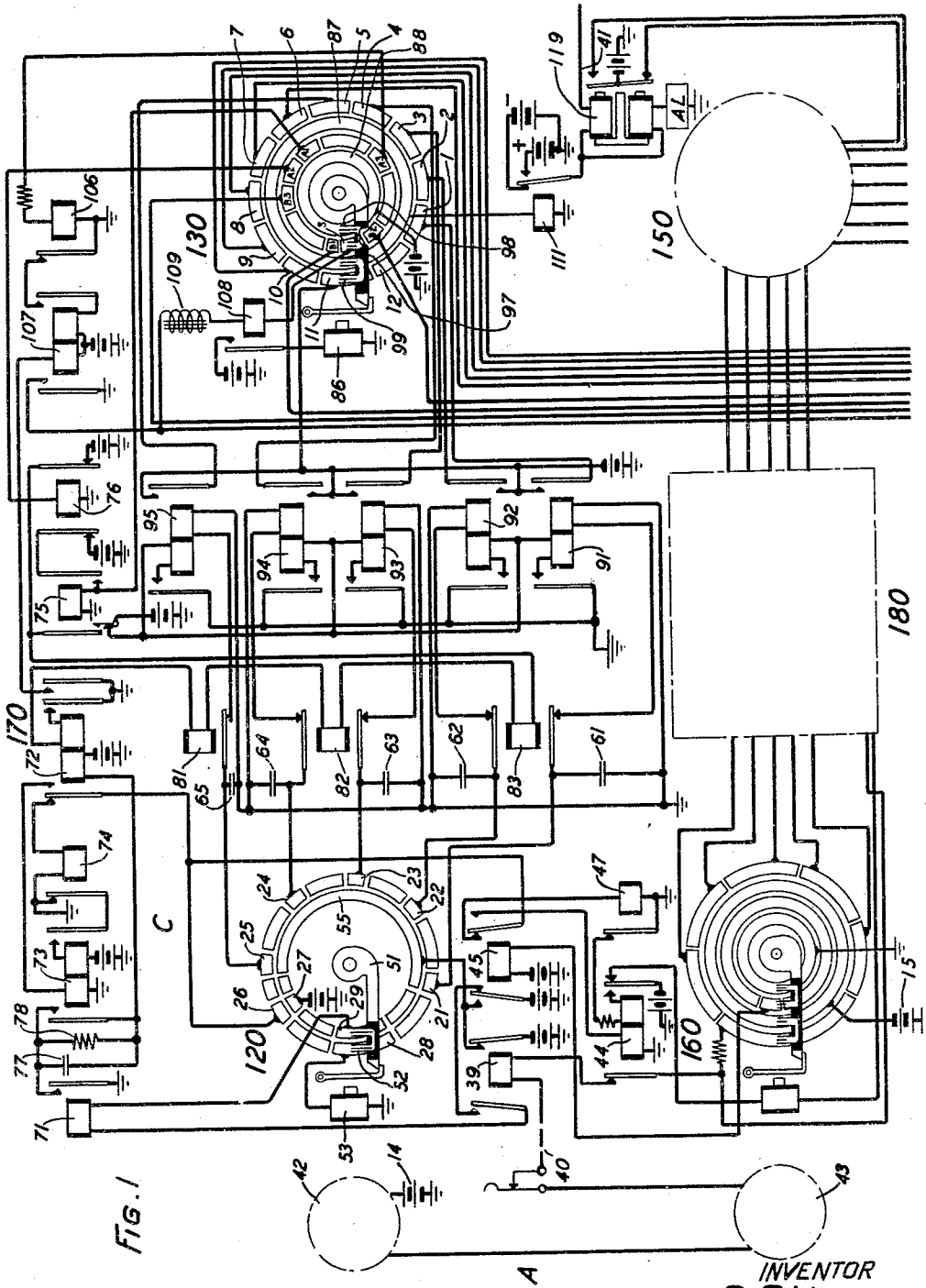


FIG. 1

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MULTIPLEX TELEGRAPHY

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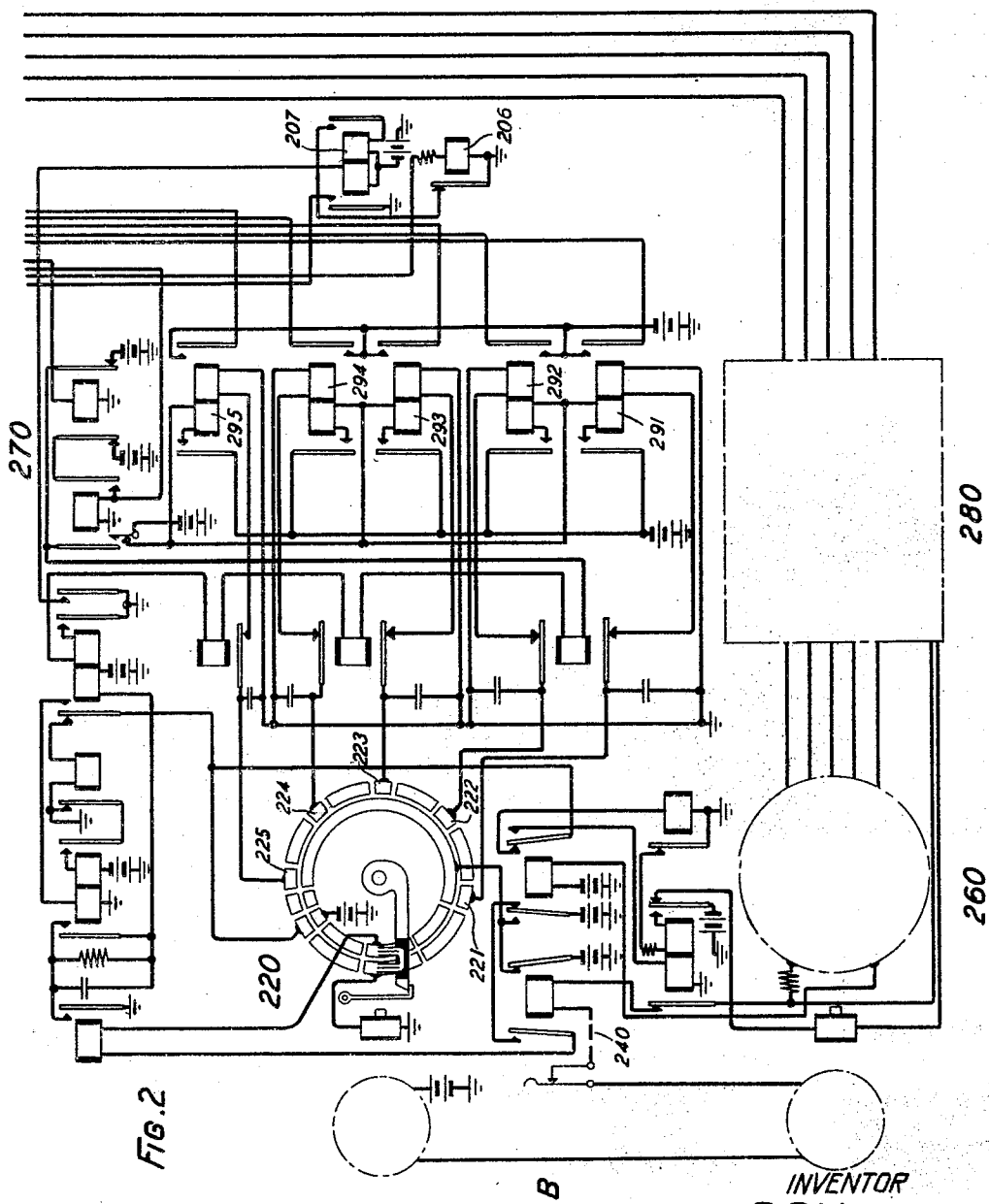


FIG. 2

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Filed Sept. 4, 1930 4 Sheets-Sheet 3

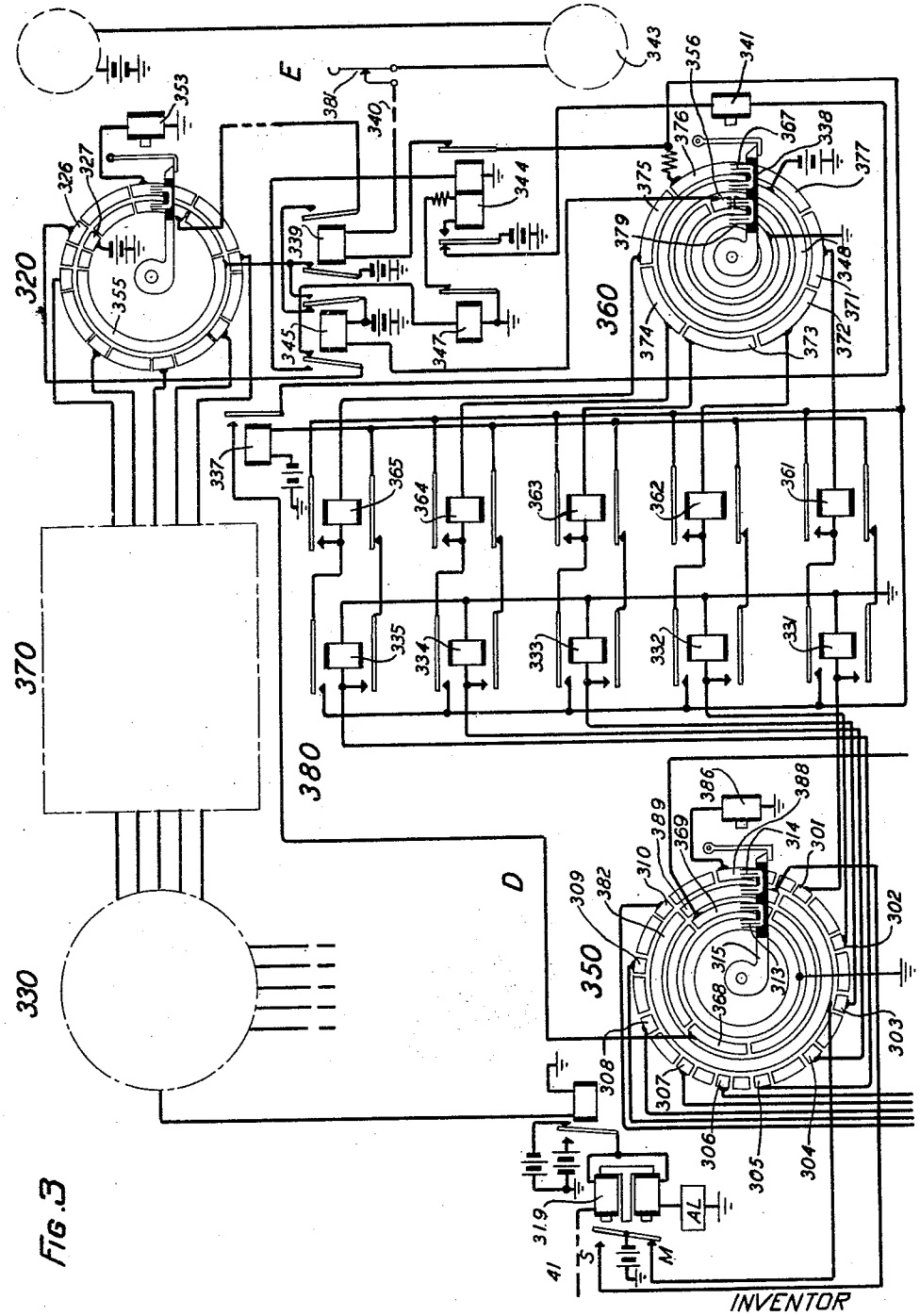


FIG. 3

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MULTIPLEX TELEGRAPHY

Filed Sept. 4, 1930 4 Sheets-Sheet 4

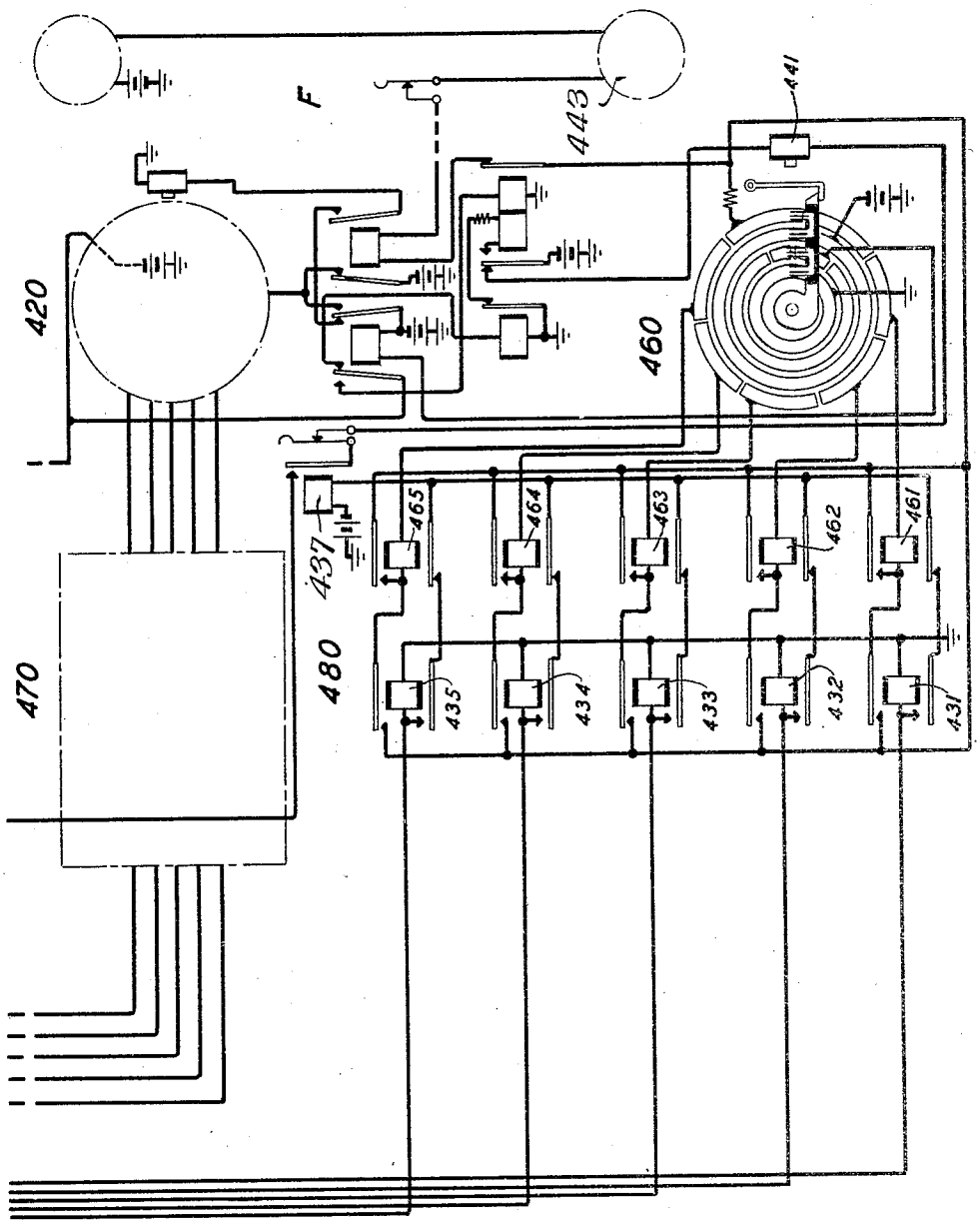


FIG. 4

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UNITED STATES PATENT OFFICE

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MULTIPLEX TELEGRAPHY

Application filed September 4, 1930. Serial No. 479,752.

This invention relates to telegraph systems, and more particularly to repeaters for printing telegraph signal impulses.

The general object of this invention is to provide a system whereby a plurality of telegraph messages originating at separate stations may be transmitted over a plurality of branch lines or extension circuits to a main or central station, where apparatus is located for simultaneously transferring the code combinations of message impulses to a line extending therefrom to a similar central station.

More particularly, an object of this invention is to simplify the apparatus and operation of repeaters in telegraph systems of the type described. To this end the invention contemplates the elimination of complicated and expensive synchronizing, phasing and speed correcting apparatus incident to the use of synchronously rotating distributors.

A common form of multiplex telegraph repeater transfers signal impulses received from a number of extension circuits to a single line by means of a multiplex distributor. The distributor rotates continuously and is maintained in synchronism with a similar distributor at the other end of the line. An example of such a repeater is disclosed in Patent 1,509,886 issued September 30, 1924 to G. S. Vernam.

In accordance with the above objects, this invention comprises a start-stop multiplex distributor adapted to repeat over a single line, and at the same time, messages received from two or more extension circuits. Combinations of message impulses are received simultaneously from each of the sources, the impulses from one source bearing no definite phase relation with respect to those of the other sources. The combinations of impulses are stored and repeated in phase with each other.

According to one of the embodiments of this invention, there is provided intermediate the receiving and transmitting apparatus of the repeating station, means, such as a group of relays, operative in conjunction with a second group of relays for providing a complete overlap between the selections received from the extension circuits and those transmitted to the line conductor. In other words, the first impulse of a particular combination representing a signal character may not be repeated until after the last impulse of the same combination has been received.

Another object of this invention is to provide a repeater of the character described which automatically discontinues transmitting impulses over the main line when neither of the stations from which signals have been received is transmitting. The use of a start-stop distributor for multiplex telegraphy in place of one of the isochronous or continuously rotating type, obviates the necessity of sending idle signals across the line to maintain the distributors in synchronism while no message signals are being repeated.

Other objects of this invention will appear more clearly from the following description taken in connection with the accompanying drawings and appended claims.

One embodiment of the invention is illustrated schematically in the accompanying drawings. The figures of the drawings should be arranged so that Figures 3 and 4 are to the right of Figs. 1 and 2, respectively, while Figs. 2 and 4 are arranged below Figs. 1 and 3, respectively.

Referring more particularly to the several figures of the drawings:

Fig. 1 shows a west repeating station, disclosing in detail apparatus for transmitting west to east from an outlying station, and in outline, receiving apparatus for east to west communication;

Fig. 2 shows that part of the apparatus at the west repeating station which is individual to a second outlying station;

Fig. 3 shows an east repeating station with the west to east receiving apparatus shown in detail and the east to west transmitting apparatus in outline; and

Fig. 4 shows that part of the apparatus at the east repeating station which is individual to a second outlying station.

General description of apparatus

The invention in the embodiment disclosed comprises a branch office A (Fig. 1) which is

connected to a west repeater station C by an extension circuit 40, and another branch office B connected to station C by an extension circuit 240 (Fig. 2). An east repeater station D (Fig. 3) similar to station C is connected to the latter by a duplex or other line 41, and is connected in turn with two outlying branch offices E and F (Figs. 3 and 4, respectively). By means of the central or repeater stations, branch office A may communicate in either direction with the branch office E while branch offices B and F are similarly in communication with each other.

At the branch office A, a transmitter 42 and receiver 43 are connected in series to form part of the extension circuit 40. The extension circuit may be in the form of a line conductor having a ground return or a pair of wires. The extension circuit 40 is arranged for half-duplex operation, but it will be understood that a duplex circuit could be substituted therefor if desired, in the manner suggested by Patent 1,509,886 supra.

The west repeater station C is provided with extension receiving distributors 120 and 220 of the start-stop type and adapted to receive the code combinations of message impulses from the respective substations or branch offices A and B and transfer them to a multiplex distributor 130, also of the start-stop type. Also situated at station C, is a multiplex start-stop distributor 150 which receives and distributes the signaling impulses from the line 41 connecting the repeater stations and transfers these impulses to the start-stop extension distributors 160 and 260, respectively. The signaling impulses are transferred from the extension distributors 120 and 220 to the multiplex sending distributor 130 by means of transfer arrangements 170 and 270, respectively, each comprising a series of condensers and storing relays which provide a complete overlap between the received and the retransmitted selections of impulses. In a corresponding manner the impulses received from the line 41 are transferred from the receiving multiplex distributor 150 to the extension distributors 160 and 260 by means of transfer arrangements 180 and 280, respectively.

The apparatus at the east repeater station D is a duplicate of that at station C, the distributors 330, 350, 320, 360, 420 and 460 at the east repeater station D corresponding to distributors 130, 150, 120, 160, 220 and 260, respectively, at the west repeater station C. Similarly, the transfer arrangements 370, 380, 470 and 480 at station D correspond to similar arrangements 170, 180, 270 and 280, respectively at station C.

Apparatus at outlying station

At the outlying station A, the transmitting and receiving equipment 42 and 43 may comprise the usual start-stop distributors. Equipment of this type as disclosed in Vernam Patent 1,509,886, above cited, is suitable for the purpose. In general, the function of the transmitter 42 is to open and close the circuit 40 in accordance with a predetermined code. In the code employed by Vernam Patent 1,509,886, each letter, figure or other character is designated by a combination of five open and closed impulses. Each combination of five impulses is preceded by an open or start impulse and is followed by a closed or stop impulse.

Transmitting apparatus—west repeating station

At the west repeater station C, the line 40 extends through a line relay 39 and is connected through distributor 160 to battery 15 whenever the distributor 160 is at rest. Assuming then, that transmitter 42 is transmitting a closed impulse and that distributor 160 is at rest, a circuit is completed from positive battery 14 at station A, transmitting apparatus 42, receiving apparatus 43, line 40, line relay 39, contact of break relay 44 and distributor 160 to negative battery 15. During west to east transmission break relay 44 is unoperated and control relay 45 is operated. The function and operation of these relays are the same as those of corresponding relays 344 and 345 (Fig. 3) to be described subsequently.

The extension distributor 120 comprises an inner ring 55 and an outer segmented ring formed of a number of segments 21, 22, 23, 24 and 25 corresponding to the five selecting impulses transmitted by station A. These segments are short, and by proper orientation of the segments, the central portion of the signaling impulses will be picked up for each segment. The distributor 120 also comprises a brush arm 51 carrying brush 52, the brush being adapted to connect the segments in succession to the inner ring 55. The brush arm is restrained against rotation by a latch under the control of a release magnet 53. The distributor 120 further comprises a pair of segments 26 and 27 and a pair 28 and 29, the segments of each pair being connected in succession by brush 52. When the arm 51 is at rest, brush 52 short-circuits the segments 28 and 29.

Interposed between the start-stop extension distributor 120 and the multiplex distributor 130 is a transfer arrangement 170. This arrangement includes a set of condensers in combination with a single group of storing relays operable in accordance with the signal transmitted and controlled by a series of transfer relays which are under the control of both the extension distributor 120 and the multiplex distributor 130. The set of condensers and the single group of storing relays serve to provide a complete overlap between the selection received from the extension dis-

tributor 120 and those transmitted over the line 41 by the multiplex distributor 130, so that the signals will be correctly transmitted over line 41 irrespective of what the phase relation is between the brush arm of the extension distributor 120 and the brush arm of the multiplex distributor 130, provided that the mean speed of the brush arm of the extension distributor when transmitting signals is equal to or slightly less than that of the brush arm of the multiplex distributor 130. The condensers 61 to 65, inclusive, are each grounded on one side, and on the other side are connected directly to the receiving segments 21 to 25, respectively, forming the outer ring of the extension distributor 120 and will be charged in accordance with the operation of line relay 39. During certain periods of operation, however, the impulses received on the segments 21 to 25, inclusive, will be transferred directly through the armatures and contacts of transfer relays 81, 82 and 83 to the right-hand windings of the set of storing relays 91 to 95, inclusive, as will be more clearly described hereinafter. The energization of the transfer relays 81, 82 and 83 is controlled jointly by the extension distributor 120 and the multiplex distributor 130 so that no mutilation or piling up of the signaling impulses will result when one distributor is out of phase with respect to the other. Upon the energization of the storing relays 91 to 95, inclusive, a locking circuit is established therefor which is under the control of the multiplex distributor 130, and which will be released once per revolution thereof. This locking circuit includes the normally closed contacts of storing clearout relay 75, which is energized when the multiplex distributor brush passes over segment A—1. After a set of impulses has been transmitted from the distributor 120 to the condensers 61 to 65, inclusive, and upon the release of the transfer relays 81, 82 and 83, a discharge circuit is established for these condensers extending to the right-hand winding of corresponding ones of the storing relays 91 to 95, which thereupon attract their armatures and establish their own locking circuit. These relays will be locked up through their own contacts and left-hand windings. Thus, after their initial energization they are maintained energized independently of the condensers 61 to 65. It is through the contacts of relays 91 to 95 that the polarity of the impulses corresponding to the various characters is varied.

In order that the impulses may be transferred from the respective parts of the circuit so that no mutilation of the signals will result, such transfer is under the joint control of the extension distributor 120 and the synchronous multiplex distributor 130, as will be more clearly described hereinafter.

The multiplex distributor 130 is also of the start-stop type and comprises an arm 97 normally restrained against rotation but adapted to be released by a release magnet 86. A brush 99 on arm 97 rests, when idle, upon a segment 11 and when going through one cycle of revolution passes over segment 12 and segments 1 to 11, connecting these segments in the order mentioned to a continuous ring 87, from where the impulses which have been stored upon the segments 1 to 10 are transmitted over the line 41. Segments 1 to 5, inclusive, are connected to storing relays corresponding to segments 21 to 25, respectively, of the extension distributor 120, while segments 6 to 10, inclusive, are similarly connected to correspond with segments 221 to 225, inclusive, of distributor 220.

Another brush 98 on the distributor arm 97 rests, when idle, upon segment S, and in going through a cycle of revolutions passes over segments B2, A3, A1, A2, B3, B1 and S, connecting these segments in the order mentioned with a continuous ring 88 which is connected to battery. Segment A1 is engaged by brush 98 just after brush 99 has passed off segment S, and the former segment is adapted to energize a storing clearout relay 75 for unlocking the storing relays 91 to 95. Segment A2 is passed over immediately subsequent to segment A1 and energizes a transfer clearout relay 76 for unlocking the transfer relays 81, 82 and 83. During the time that brush 99 is passing over segments 1 to 5 corresponding to the A channel, brush 98 passes over segment A3 thereby energizing stop relay 106 which unlocks start control relay 107 in case the latter is energized at that time.

Segments B2, B3 and B1 control apparatus in the B channel (Fig. 2) corresponding to apparatus controlled by the segments A2, A3 and A1, respectively. The B segments have the same relative position as the A segments and are oriented with respect to the latter so that segment B1 immediately follows segment 10. The B1 segment, however, is shortened to make room for segment S upon which the brush 98 rests when idle. The S segment energizes the start relay 108 for releasing the arm 97 unless neither distributor 120 or 130 is receiving in which case the start control relays 107 and 207 of both channels will be deenergized.

Receiving apparatus—east repeating station

The apparatus at the central station D, which receives the signals transmitted from the transmitting apparatus located at the central station C comprises a start-stop multiplex distributor 350 and a pair of start-stop extension distributors 360 and 460, respectively. The multiplex distributor 350 comprises among other parts an elongated segment 382 cooperating with an outer ring which is divided into a plurality of short segments, 301–310, inclusive. Like the dis-

tributor 130 an intermittently revolving brush arm 315 carrying brushes 313 and 314 is also provided. The segment 382 is connected to the marking contact of receiving relay 319. Connected to the spacing contact of this relay is a segment 389 connectible by brush 314 to segment 388 and release magnet 386. Connected to the segments 301–305 forming a part of the outer ring are the windings of a set of storing relays 331 to 335, which, in combination with a series of control relays 361 to 365, inclusive, provide an overlap between the selections received on the multiplex distributor 350 and those transmitted by the extension distributor 360 to the outlying station E.

The extension distributor 360 comprises an outer ring divided into a plurality of segments 371 to 377. The first five of these segments are connected to the windings of the control relays 361 to 365 which are energized upon the passage of the brush 314 over the segments individual thereto, depending upon whether the relays 331 to 335 are at this time energized. The control relays 361 to 365 will remain energized until the brush 314 has passed off the segments to which they are connected due to the establishment of a locking circuit therefor through their own contacts. For bridging the outer ring of the distributor 360 with the inner ring 348, the brush 367 is carried by a brush arm 338, which is normally held against rotation by a release latch under the control of a release magnet 341. The release magnet 341 is controlled through the contacts of a control relay 337. The energizing circuit of magnet 341 is completed after the brush 314 has passed off segment 305 and the energizing circuit of relay 337 is completed upon the energization of any one of the relays 331–335. By means of this relay, release magnet 341 is adapted to be connected to segment 368 after the brush 314 has passed off segments 301–305.

A distributor 460 similar in construction to distributor 360 receives the impulses from segments 306 to 310 of distributor 350 which segments correspond to the B—F channel. Connecting these segments with distributor 460 are a set of storing and control relays 431–435 and 461–465 arranged similarly to corresponding relays in the A—E channel. A segment 369 in distributor 350 is engaged by brush 313 after brush 314 has passed off segments 306–310. Segment 369 is connected through the contacts of a release control relay 437 to a release magnet 441 of distributor 460, when relay 437 is energized in response to the energization of one of the storing relays 431 to 435.

The receiving equipment 343 and 443 at the branch offices E and F may be the usual start-stop receiving apparatus employing a five-unit code. A receiver suitable for the purpose is described in Patent 1,509,886 supra.

Operation—west to east transmitting

The operation of the equipment previously described is as follows: Assume that the branch office A desires to communicate with the branch office E, in which case the transmitter 42 will be operated to set up a particular combination depending upon the message desired to be transmitted. Let it also be assumed that station A transmits a character made up of spacing and marking impulses arranged as follows: Mark, space, mark, space, mark, these impulses being preceded by a space or start impulse and followed by a mark or stop impulse.

Transmission of message impulses by the station A causes line relay 39 to release whenever a space or open impulse is transmitted. Inasmuch as the east to west transmitting distributor 160 is at rest, control relay 45 is constantly energized while break relay 44 is deenergized. Line relay 39 having released its armatures, an energizing circuit for the release magnet 53 of the start-stop distributor 120 is established over a circuit extending from battery through the left armature and contact of control relay 45, left-hand armature and contact of line relay 39, winding of impulse relay 71, segment 29, brush 52, segment 28 and the winding of release magnet 53 to ground. The release magnet 53 is energized over the circuit just traced and withdraws its release latch from engagement with brush arm 51, permitting its rotation. Relay 71 is also energized over the same circuit as the release magnet 53 and in attracting its armature causes a momentary charging of the condenser 77, which is normally short-circuited by the high resistance 78, through the left-hand winding of transfer operating relay 72. Relay 72 thereupon attracts its armatures, which conditions an energizing circuit for relay 73, but that circuit is not completed until the bridging of segments 26 and 27 by the brush 52. At the inner right-hand armature and contact of relay 72, an energizing circuit is established for the transfer relays 81, 82 and 83 extending from ground, through the inner right-hand armature of relay 72, right-hand winding of relay 72, windings of relays 81, 82 and 83 in series and the right-hand armature and contact of transfer clearout relay 76 to battery. Relay 72 is locked up over the circuit just traced and is maintained energized until the energization of relay 76 and the consequent release of sending clearout relay 75, as will be described later.

Upon receipt from station A of a marking or closed impulse as the first of a combination of five code impulses, the energizing circuit for line relay 39 is again established, which attracts its armatures and applies battery to the ring 55 of the distributor 120. Accordingly, upon the passage of the brush 52 over the segment 21, a circuit is established, where-

upon the condenser 61 is charged. The second impulse being a spacing or open impulse, line relay 39 again is deenergized and when the brush 52 passes over the segment 22, the condenser 62 individual to this segment will not be charged. The third and fifth impulses being closed, conditions similar to those described in connection with contact 21 will be established for causing the charging of condensers 63 and 65 in accordance with the energization of relay 39 upon the passage of the brush 52 over the segments individual to each condenser. Condenser 64, will, however, not be charged for its selection owing to an open circuit condition of relay 39 upon the passage of the brush 52 over the segment to which this condenser is connected.

Just prior to the completion of a cycle of rotation of the brush arm 51 and provided relay 72 is still energized, an energizing circuit will be established for relay 73, extending from ground, through the left-hand winding of relay 73, front contact and left armature of relay 72, segment 26, brush 52 and segment 27 to battery. Relay 73 is thereupon energized and locked up, which establishes at its left-hand contact a short-circuit for the condenser 77. Otherwise, no effect is produced due to the energization of this relay.

If relay 72 be deenergized at the time brush 52 crosses segments 26 and 27, then relay 74 will be energized instead of relay 73. Relay 74 will open the locking circuit of relay 73, releasing it, if it had previously been energized.

The brush 98 of the multiplex distributor 130 in passing over segment A1 completes an energizing circuit for relay 75. Relay 75 at its left-hand contact opens the locking circuit of the storing relays 91 to 95, inclusive, thereby restoring to normal any of these relays which have previously been energized, and also establishes an auxiliary locking circuit for relay 72 for preventing the release of this relay and transfer relays 81, 82 and 83. The position of segment A1 is chosen so that storing clearout relay 75 is energized immediately after brush 99 has passed off segment 5 at which time the signals stored upon relays 91–95 will have been transmitted to the line 41. Just as the brush 98 leaves segment A1 the initial energizing circuit for relay 75 is broken, but relay 75 remains locked by its right-hand armature. Upon the passage of brush 98 over segment A2 an energizing circuit for transfer clearout relay 76 is established. Relay 76 in energizing opens the locking circuit of relay 75 which thereupon releases its armature and again conditions a locking circuit of the storing relays 91 to 95, while at the right-hand armature of relay 76 and at the left-hand armature of relay 75 the locking circuit of transfer operating relay 72 is broken, thereby causing the deenergization of this relay and consequently the deenergization of transfer relays 81, 82 and 83. Upon the release of the transfer relays 81, 82 and 83, the condensers 61 to 65 are connected directly with the right-hand windings of the storing relays 91 to 95, respectively, whereupon those condensers which have been previously charged are discharged and cause the energization of the corresponding relays. These relays will thus be energized and locked up over a circuit controlled by storing clearout relay 75. Inasmuch as the condensers 62 and 64 for the particular selection chosen were not charged, no result will be produced on the storing relays 92 and 94 corresponding to these condensers, upon the deenergization of the transfer relays 81, 82 and 83. When brush 98 passes off segment A2, the relay 76 is released, thus preparing the locking circuit for relay 72 so that the relays 81, 82 and 83 will be energized upon the subsequent operation of relay 72 during the next cycle of rotation of distributor 120.

If the multiplex distributor brush 98 passes over segment A2 so as to deenergize relays 81, 82 and 83 before the start-stop brush 52 has passed over segment 25, one or more of the storing relays will be operated directly on an impulse from the corresponding receiving segment. In such cases the corresponding condensers serve only to slightly prolong the current impulses through the storing relay.

When the phase relation between the brush arms 51 and 97 of the extension distributor 120 and the multiplex distributor 130, respectively, is such that the brush 98 is passing over segment A2 at the time that relay 71 is energized by a starting impulse, relay 72 will be energized but it will not be locked up unless relay 76 releases to establish a locking circuit for relay 72 before the cessation of the brief impulse through its left-hand winding allows relay 72 to release and open the locking circuit at its inner right-hand contact. If relay 72 fails to lock up, relays 81, 82 and 83 will not be energized and the signal selection will be transferred directly from the extension distributor 120 to the storing relays 91 to 95. If during the succeeding revolution the multiplex brush arm 97, which runs at a slightly higher average speed than brush arm 51, has gained sufficiently so that relay 76 can release in time to lock up relay 72, relays 81, 82 and 83 will be energized and the signal selection will be stored on the condensers to be transferred later to the storing relays in the manner previously described. In such a case relay 72 will remain operated for nearly a complete revolution of the brush arms with the result that relay 73 will be energized and locked up when brush 52 crosses segments 26 and 27. The left-hand armature and contact

of relay 73 will short-circuit condenser 77, thus prolonging the next operating impulse to the left-hand winding of relay 72 to insure that it will remain operated until its locking circuit is established at the right-hand contact of relay 76.

When the brush arm 97 has advanced in phase relation to the brush arm 51 to an extent such that relay 72 is released when brush 52 crosses segments 26 and 27, an energizing circuit is established for relay 74, which, as previously described, controls the locking circuit of relay 73. Relay 74 in energizing merely opens the locking circuit for relay 73, which is then restored to normal for removing the short-circuit from about condenser 76. Thus, upon engagement of brush 52 with segments 28 and 29, a condition similar to that described for the initial operation of the system will be brought about, that is, the condenser 77 will be charged and a momentary surge of current through the winding of relay 72 produced for causing the energization and locking of this relay.

Starting the multiplex sending distributor

The starting and stopping of multiplex distributor 130 is under the control of a start control relay 107 and a segment A3 on the multiplex distributor. Relay 107 is energized by the operation of transfer operating relay 72 and is locked in a circuit extending through the back contact of stop relay 106. When the arm 51 of distributor 120 releases, the impulse relay 71 causes the relay 72 to operate. Assume that all three distributors 120, 220 and 130 are at rest and distributor 120 receives a combination of impulses representing a signal character. Relay 71 operates causing relays 72 and 107 to operate and lock in succession. Relay 107 operates the start relay 108 in series with a choke coil 109 whereupon the release relay 86 is energized. Because of the choke coil 109, release of the arm 97 is delayed until arm 51 of distributor 120 has traveled a part of a revolution.

As the brush 98 of distributor 130 passes over segment A3, stop relay 106 will be energized to unlock start-control relay 107, but the latter remains energized through its main winding and immediately upon the release of relay 106, relocks. When the brush 98 reaches the stop segment S, the release magnet 86 will operate immediately because relay 107 will be energized at that time. If, during the second cycle of rotation of the multiplex distributor arm 97, distributors 120 and 220 are at rest, start control relay 107 will be unlocked and deenergized when segment A3 is passed over. When the arm 97 reaches its stop position it will not be released immediately, but will wait until one of the distributors 120 or 220 energizes its corresponding relay 107 or 207.

Thus it will be seen that by means of the start control relays 107 and 207 distributor 130 will remain at rest as long as neither of the extension distributors 120 or 220 is transmitting. If one or both of the extension distributors is in use, a circuit will be prepared for the start relay 108 through one or both of relays 107 and 207 whenever the segment S is passed over.

During the passage of the brush 99 over segments 12 and 1 to 11, inclusive, a circuit for relay 111 is closed or opened depending upon whether or not a charge is stored upon the particular segment passed over. A duplex circuit connecting stations C and D includes a line 41 terminating with a relay 119 and an artificial line AL. The armature of relay 111 is connected to the apex of the ratio arms of the duplex circuit in such manner that a space or open circuit condition of the relay 111 is transmitted over the duplex line 41 as a positive impulse, while a mark or closed circuit condition of relay 111 is transmitted in the form of a negative impulse. Each cycle of the brush 99 effects the transmission of twelve impulses over line 41. The first, a start impulse, is always a spacing impulse because segment 12 is not connected to battery. The next ten impulses may be marking or spacing depending upon whether or not charges are stored upon the respective segments 1–10 by the storing relays 91–95 and 291–295. In case the B channel is transmitting and the A channel idle, the transmitted impulses corresponding to segments 1–5 will all be spacing. The twelfth impulse which is transmitted from segment 11 is marking and continues until the distributor arm 97 is released for another cycle.

Operation—receiving end

When the multiplex distributor 130 is at rest, brush 99 connects relay 111 to battery through segment 11. Relay 111 is energized and a marking current flows from negative battery, armature of relay 111, over line 41 and through windings of receiving relay 319. This marking current connects battery to the ring 382 of distributor 350. As soon as the distributor 130 starts rotating, a spacing signal is transmitted over line 41 and the armature of relay 319 moves to its spacing contact. As a result, release magnet 386 is energized in a circuit traced from battery, spacing contact of relay 319, segment 389, brush 314, segment 388, release magnet 386 to ground. The distributor arm thereupon releases and the succeeding ten impulses are distributed to the respective segments 301–310.

The second impulse received is a marking impulse and the battery associated with relay 319 is thereupon connected with the elongated segment 382 of the multiplex distributor 350, so that upon the passage of the brush 314

over the segment 301 to which the storing relay 331 is connected, this relay will be energized. Relay 331 in attracting its lower armature establishes a locking circuit for itself extending from battery through the winding of relay 337, lower armature and contact of relay 361, lower armature, contact and winding of relay 331 to ground. This relay 331 will thus remain energized until the locking circuit is broken at the contact of the control relay 361. Relay 337, which conditions an energizing circuit for the relase magnet 341 of the extension distributor 360, is also energized over the circuit just traced. It may also be noted at this point that relay 337 is energized upon the energization of any one of the storing relays 331 to 335. As the brush arm 97 (Fig. 1) continues its rotation, conditions depending upon the position of the armatures of the storing relays 91 to 95 will be set up for causing the corresponding positioning of the armature of relay 319 at the central station D. Accordingly, upon the passage of the brush 314 over the corresponding segments, storing relays 331 to 335 will be energized in accordance with the positioning of the armature of relay 319. For the particular selection chosen, storing relays 333 and 335 will be energized over a circuit similar to that traced in connection with relay 331. The energized ones of these storing relays will also be locked up through their contacts in a similar manner. Upon the passage of the brush 314 over the segments to which the relays 332 and 334 are connected, these relays will not be energized owing to the position of the armature of relay 319 at this time.

Following the passage of the brush 314 over segment 305, brush 313 engages segment 368 and completes the energizing circuit for release magnet 341 of the distributor 360. Release magnet 341 upon being energized will draw the release latch from engagement with the brush arm 338, thereby permitting its rotation. It is to be noted at this point that the control relay 345 which is normally energized, is connected to the segment 356 and is controlled by the brush 379 passing over this segment. The length of the segment 356 is such that relay 345 releases and closes its back contacts prior to the deenergization of line relay 339 which is deenergized upon the passage of the brush 367 off segment 376. Thus, the release of the start-stop distributor 320 is prevented as the energizing circuit of its release magnet is open at the front contact of control relay 345.

The brush 367 carried by the brush arm 338 consecutively connects the segments 377 and 371 to 376 with the continuous ring 348. Thus upon the passages of the brush 367 over the segments to which the windings of the control relays 361 to 365 are connected, these relays will be energized and locked up for a period equal to the length of the segments to which they are connected, provided the corresponding storing relays are energized. During the engagement of the brush 367 with the segment 377 an open circuit condition is established whereupon line relay 339 is released. The release of the line relay does not affect the distributor 320 as the circuit controlled by the right-hand armature of this relay is open at the front contact of control relay 345.

The brush 367 in passing over segment 371 causes the transmission of a closed circuit condition through the line 340 since the storing relay 331 for the particular selection chosen is energized. As the brush passes over segment 372, and inasmuch as the storing relay 332 is not energized, the control relay 362 will also not be energized and thus an open circuit condition will be transmitted to the line 340. Similarly, the line 340 will be closed during the time that the brush 367 passes over segments 373, 375 and 376 and will be open while the brush is passing over segments 374 and 377. At the receiving end of the line 340, the receiving printer 343 interprets these open and closed impulses into corresponding signal character in a manner well known in the art.

Upon the passage of the brush 313 off segment 368 the energizing circuit of release magnet 341 is broken, thereby causing the deenergization of this magnet and the restoration of its release latch to normal for causing the stoppage of the brush arm 338 after it has completed one cycle of rotation.

Interruption by receiving operator

In the event that the operator at branch office E desires to interrupt the transmission of the operator at branch office A, it only becomes necessary for such operator to actuate break key 381. Assuming that a message is being received as previously described, the operation of the break key 381 holds the extension circuit open to break or interrupt the distant sending station. When the brush 379 of distributor 360 passes on to segment 356, control relay 345 will be operated momentarily and it will connect the circuit of the release magnet 353 to negative battery through the back contact of line relay 339 thus starting the brush arm of distributor 320. The circuit for release magnet 353 is not shown in full, but will be understood from an inspection of the corresponding circuit for release magnet 53 in Fig. 1. The brush arm 338 of the distributor 360 will again be set in rotation as the break release relay 347 is deenergized and the circuit of the release magnet 341 is completed through the front contact of the relay 337. This will cause the release of the control relay 345, thus connecting the common segment 355 of the distributor 320 to negative battery and operating all five of the storing relays in the

storing device 370 to send out the letter signals.

When the brush of the distributor 320 passes over segments 326 and 327 a circuit is completed for the break relay 344. This relay opens the extension circuit 340, establishes a holding circuit through a back contact on the break release relay 347, and at the same time opens the starting circuit for the release magnet 341 associated with the distributor 360. Inasmuch as the extension circuit is now open, the energizing circuit of the release magnet 353 of the distributor 320 is again completed when the brush 379 of the distributor 360 passes on to segment 356. During this second revolution, an idle signal is sent over the line as the line relay 339 is released and the control relay 345 is operated. The brush of the distributor 320 in crossing over segments 326 and 327 completes an energizing circuit for break release relay 347. This relay operates and opens the locking circuit of the break relay 344 restoring the circuit of the release magnet 341 to normal.

When the break relay 344 releases, the above operations will be repeated unless the opeator has released the break key 381 in the meantime. If the break key has been released, the extension circuit will be closed as soon as the break relay 344 releases, as described above. If the distant station has now stopping sending, no further selections will be received and the brush arm of the distributor 360 will stop, operating the control relay and restoring the circuit to its normal condition. The former receiving station or the branch office E may now commence sending.

The effect of this break operation at the other end of the line will now be described. At station C (Fig. 1) signals are being transmitted from the branch office A and the receiving brush arm 51 will be rotating, but the sending brush arm of the distributor 160 will be normally at rest. The control relay 45 will be energized and this will prevent the operation of the break relay 44.

When the letter signal referred to above is received, all five of the selecting relays, which correspond to the relays between the distributors 350 and 360 (Fig. 2), will be operated and the starting circuit for the release magnet of the distributor 160 will be closed through the local segments on the multiplex distributor 150. When the brush arm of distributor 160 starts, the control relay 45 will release and this will prepare a circuit for operating the break relay 44. When the brush 52 of the distributor 120 crosses segments 26 and 27, a circuit is completed for the break relay 44 which will operate and lock itself, open the extension circuit and open the circuit of the release magnet of distributor 160.

The control relay 45 being released, the brush arm 51 of the distributor 120 will stop against its release latch for a brief interval. This control relay will operate when the brush of the distributor 160 crosses over the segment corresponding to segment 356 of the distributor 360, and this will start the brush arm 51 of the distributor 120 again. Brush 52 on again crossing segments 26 and 27 causes the energization of break release relay 47, which, as previously described for break release relay 347, causes the deenergization of break relay 44.

The operation of the break relay 44, as described above, will hold the extension circuit open for slightly more than the time of one revolution of the brush arm. This will break the substation in the same manner as when operated over a start-stop circuit, thus stopping transmission from that station.

Although the invention has been disclosed and described with reference to a particular type of system, it is obvious that various modifications may be made without departing from the spirit and scope of the present invention.

For example, the invention is not limited to a five unit code, but may be applied to a six unit code, four unit code, etc. To adapt the apparatus for operation for a different combination code, it is merely necessary to increase or decrease as the case may be, the number of distributor segments, storing relays, condensers, etc., to correspond with the number of impulses in each signal combination.

What is claimed is:

1. In a communicating system, a plurality of signal sources, a plurality of transmission circuits connected to said sources, a repeater comprising a distributing device for terminating each of said circuits, a single transmission circuit, another distributing device for transmitting over said single circuit signals received from one or more of said plurality of circuits, and a signal responsive device for starting and stopping each of said distributing devices.

2. In a communication system, a repeater as defined in claim 1 which further comprises holding mechanism for restraining said distributing devices from rotation while no signals are being received from any source.

3. In a telegraph system, a main line and a plurality of extension circuits, each connected to said main line through a repeater, said repeater comprising a rotary distributor connected to each extension circuit, and a rotary distributor connected to said main line characterized in this, that said main line distributor is of the start-stop type.

4. In a circuit for the communication of intelligence, a repeater comprising a plurality of rotary distributors each adapted to receive signals over one channel only, another rotary distributor adapted to transmit

over a plurality of channels signals corresponding to the received signals, a signal responsive device responsive to certain of the received signals for starting the receiving distributor from rest, and a second signal responsive device responsive to the same signals for starting the multi-channel distributor from rest.

5. A telegraph repeater comprising a rotatable device for receiving signal impulses, a multi-channel start-stop distributor for transmitting impulses corresponding to the received impulses in polarity but differing in signal frequency and storing devices for storing the received impulses whereby to provide an overlap between the received and transmitted impulses.

6. A telegraph repeater comprising a rotatable signal receiving mechanism, a rotary multi-channel distributor for transmitting signals corresponding to the received signals, storing means intermediate the receiving mechanism and the distributor for providing an overlap between the received and the transmitted signals, and an electrically operated latching device for restraining the distributor from rotation while no signals are being received.

7. In a telegraph system, a plurality of separate sources of message impulses, rotatable devices for receiving code combinations of message impulses from said sources, a single transmission circuit, distributing means for transmitting corresponding combinations of impulses over said circuit, a device controlled by impulses from said sources for starting said distributing mechanism from rest, and storing elements for storing the received signals, whereby to provide a complete overlap between the signals received from each source and corresponding signals transmitted to the circuit.

8. A telegraph repeater comprising a single channel receiving distributor, a multi-channel transmitting distributor adapted to transmit combinations of signal impulses corresponding to signal combinations received by the receiving distributor, but at a different signal frequency, a device responsive to one of a combination of received impulses for starting the receiving distributor from rest and another device also responsive to said one impulse for starting the transmitting distributor from rest subsequently to the starting of the receiving distributor.

9. In a telegraph system a repeater comprising a main line and a plurality of extension lines radiating therefrom, a rotary distributor connected to the main line and adapted to receive combinations of impulses therefrom, an electromagnetic device under the control of the received impulses for repeatedly starting the distributor from rest, and other electromagnetic devices under the control of the distributor for transferring certain combinations of the received impulses to one extension line and other combinations to a different extension line.

10. In a telegraph system, a main line, a rotary multiplex distributor adapted to receive combinations of impulses from said main line, a plurality of rotary extension distributors each adapted to transmit over an extension line, combinations of impulses determined by the impulses received from the main line, relaying devices responsive to certain of the received main line impulses for controlling the starting and stopping of the multiplex distributor and other relaying devices under the joint control of the received main line impulses and of the multiplex distributor for starting one of the extension distributors.

In testimony whereof, I have signed my name to this specification this 3rd day of September, 1930.

GILBERT S. VERNAM.