

Dec. 19, 1933.

W. T. REA

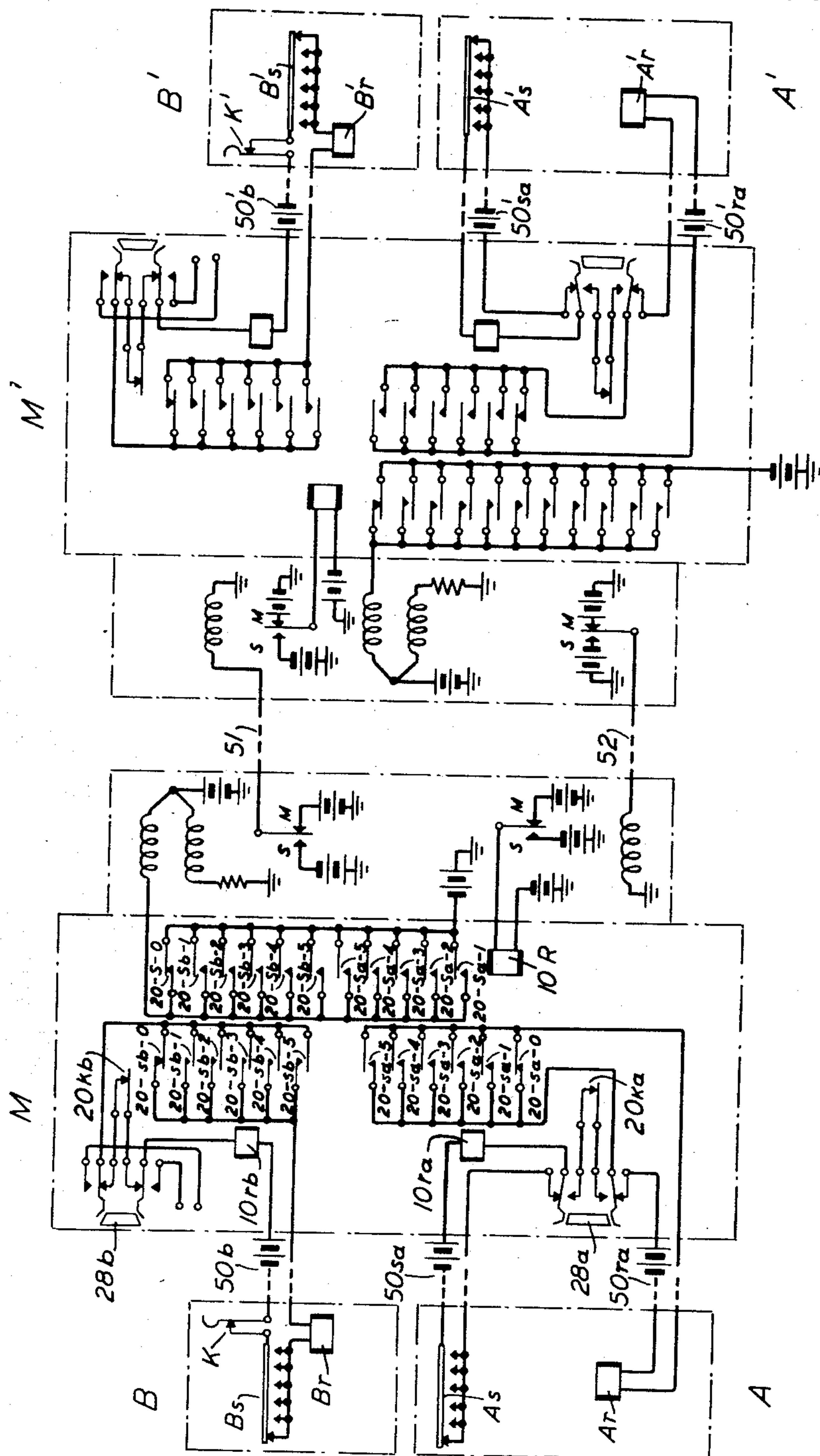
1,940,370

TELEGRAPH SYSTEM

Filed Dec. 20, 1932

3 Sheets-Sheet 1

FIG. 1



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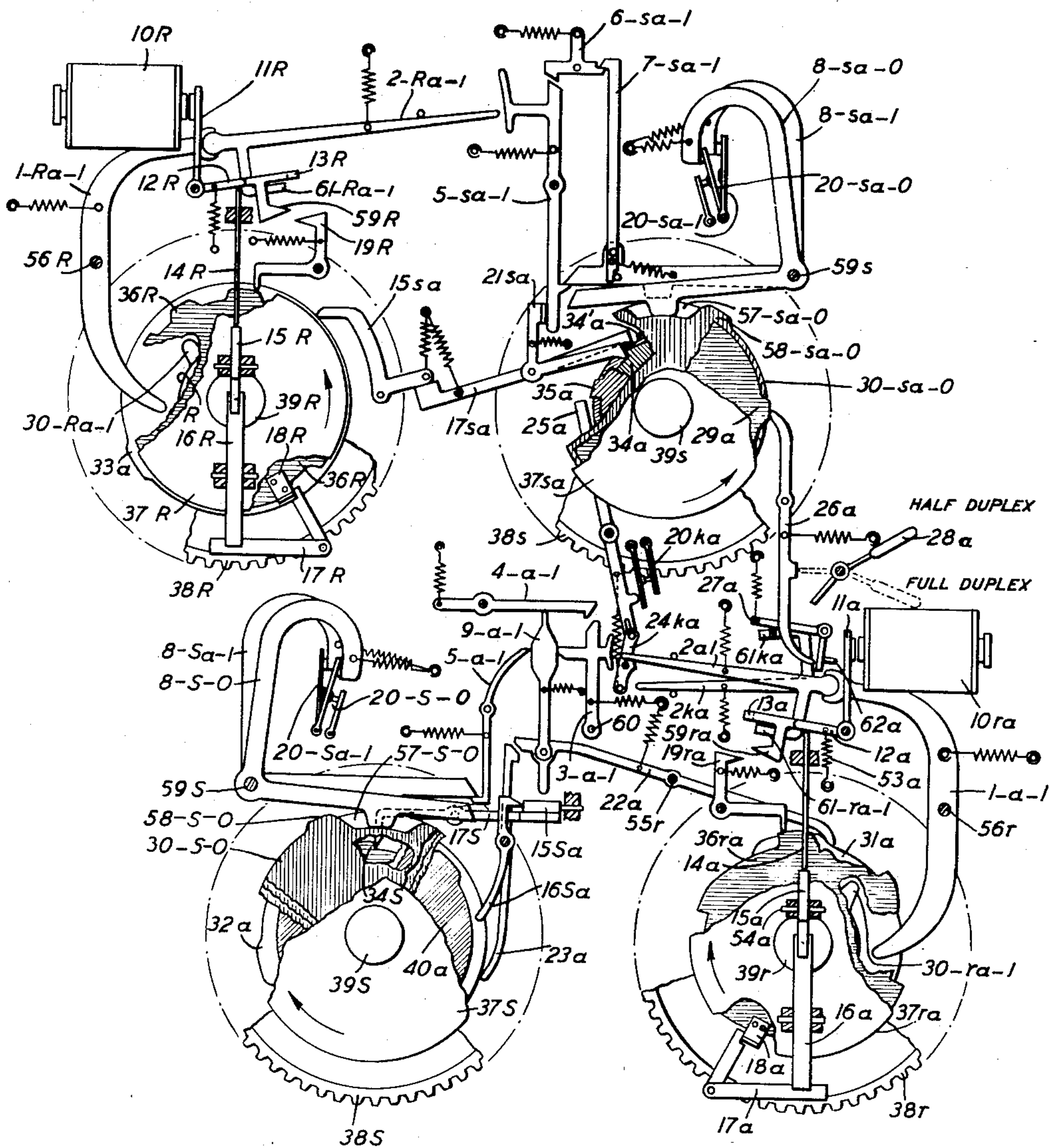
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TELEGRAPH SYSTEM

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FIG. 2



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TELEGRAPH SYSTEM

Filed Dec. 20, 1932

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BY

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UNITED STATES PATENT OFFICE

1,940,370

TELEGRAPH SYSTEM

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Serial No. 648,113

7 Claims. (Cl. 178—53.1)

This invention relates to telegraph systems and more particularly to repeaters for telegraph permutation signals.

The object of this invention is to provide a telegraph system wherein a plurality of telegraph messages originating at separate telegraph stations or subscribers' telegraph stations may be transmitted over associated branch lines or extension circuits to a main or central station where apparatus is located for simultaneously transferring code combinations of telegraph signals between said extension circuits and a multiplex line extending from the central station to a similar central station.

Examples of such systems are disclosed in U. S. Patents to G. S. Vernam, 1,874,664, Aug. 30, 1932, and G. S. Vernam 1,509,886, September 30, 1924, both of which employ a complicated circuit arrangement having a group of relays and rotary distributors located at the central station.

The object of this invention is to improve and simplify the apparatus located at the central station by eliminating all the local circuit relays and the local battery by mechanically selecting, storing and retransmitting the signals.

According to the invention, a start-stop multiplex system is provided with start-stop extension line circuits. These extension line circuits extend from a main multiplex station to a subscriber's station and are sometimes referred to as subscribers' circuits or loops. The invention employs mechanical start-stop receiving distributors working from subscribers' loops through appropriate mechanical linkages into mechanical start-stop sending distributors connected to a multiplex line. Also mechanical start-stop receiving distributors work from the multiplex line through other appropriate mechanical linkages into mechanical start-stop extension sending distributors, which transmit to subscribers' loops. These mechanical distributors use cams, rods, levers, latches, and pawls in place of the usual electrical relays and circuits. A half duplex feature for use with half duplex extensions is provided which enables the receiving magnet associated with a receiving distributor and the contacts associated with an extension sending distributor to be connected in series in the same subscriber's loop without the possibility of the incoming signals being repeated again into the multiplex line. A break feature has been provided for use with half duplex extensions which acts to convert the opening of a subscriber's loop, while signals are being received by that loop, into a special break signal which, after pass-

ing over the multiplex line, will cause the multiplex equipment at the distant station to transmit to the distant transmitting loop a spacing or break signal of sufficiently long duration to break the transmission of signals from the start-stop printer connected to that loop.

Other objects and features will be quite apparent from the following description of one specific embodiment of the invention when read in connection with the accompanying drawings in which:

Figure 1 illustrates in diagrammatic form the electrical circuit and connections of the system, while Fig. 2 shows the end view of the apparatus located at the central point, and Fig. 3 shows a partial bottom and sectional view of the same apparatus.

For ease of explanation, full duplex operation of the system will be described first. The apparatus at the multiplex station will be divided into a sending side and a receiving side. The sending side includes the extension receiving distributors, the multiplex sending distributor, and the storing and transferring mechanisms connecting these distributors. The receiving side includes the multiplex receiving distributor, extension sender distributors and the mechanical connections between these distributors. In order to further simplify the description, the same parts in the different views will be designated the same. In addition a composite symbol consisting of two numerals separated by a letter or letters will be used to designate many of the parts of the invention. The first numeral designates the type of part, and the letters refer to the different portions of the apparatus. The letters, S, R, s, r, a, b and k refer to the multiplex sender, the multiplex receiver, extension sender, extension receiver, extension "A", extension "B" and the break mechanism respectively, and the last numeral, if any, indicates with which impulse of the signal combination the part has to do. Also only the essential parts are shown, the details of the motor drive and supporting frame having been omitted to simplify the drawing so that the operation of the system may be readily understood.

One specific embodiment of the invention will now be described, but it is to be understood that this description is not to restrict or limit the scope of the invention as defined in the appended claims.

Refer to Fig. 1 of the drawing which shows the system in which "A" and "B" represent two extension stations connected to the multiplex

station M by loops 50—sa, 50—ra, and 50b. Station M is connected over lines 51 and 52 to a similar multiplex station M'. Extension stations "A" and "B" similar to "A" and "B" are connected by loops 50'—sa and 50'—ra and 50'—b, to station M'. At each multiplex station receiving magnets 10—ra and 10—rb are associated mechanically with the group of multiplex sending contacts 20—S—0, 20—Sa—1 to 20—Sa—5, and 20—Sb—1 to 20—Sb—5 on the sending side of the system and the multiplex receiving magnet 10—R is associated mechanically with the sending contacts 20—sa—0 to 20—sa—5 and 20—sb—0 to 20—sb—5 on the receiving side of the system.

Detailed description of full duplex operation of the sending side

The detailed operation of the sending side of the device and the functions of its various parts as illustrated in Figs. 2 and 3 will be explained by consideration of what takes place when signals from extension station A actuate the extension receiving magnet 10—ra of the start-stop extension distributor. Assume that the duplex lever 28a is the full duplex position so that the duplex control lever 26a will not be actuated. The extension cam drums ra and rb are rotatably mounted on shaft 39—r and are driven by a gear 38—r keyed to shaft 39—r through friction clutches 37—ra and 37—rb. The multiplex cam assembly S is similarly mounted on shaft 39—S. Gears 38 are driven through a train of gears by a motor at constant speed (not shown). Normally both extension distributor cam assemblies ra and rb and the multiplex cam assembly S are held stationary and a steady marking signal is being sent by the multiplex distributor. Now suppose a signal consisting of a start impulse, five selecting impulses and a stop impulse is received from extension station "A". When the current in magnet 10—ra falls to zero, the magnet armature 11—a will be retracted by spring 53—a, pressing armature extension 12—a, through a sliding pin 14—a, against intermediate lever 15—a. Intermediate lever 15—a rotates on pivot 54—a pressing downward one end of the stop pawl latch 16—a causing the other end to rise. This releases stop pawl 17—a which rotates in a counter-clockwise direction releasing stop arm 18a and allowing the receiving cam assembly to rotate. As the cam assembly starts its rotation the projection on the transfer cam 31—a actuates transfer lever 22—a which is pivoted at pivot 55—r. This lever is locked in the operated position by means of transfer release latch 23—a. The transfer operate lever 22—a operates intermediate lever 15—Sa which is locked in position by start latch 16—Sa. The operation of the intermediate lever 15—Sa operates stop pawl 17—S and disengages it from the stop cam 34—S thereby permitting the multiplex sending cam assembly to rotate. This will continue to rotate until both transfer lever 22—a and intermediate lever 15—Sa have been released by the operation of, first, the transfer release latch 23—a and then the start latch 16—Sa by cams 32—a and 40—a, respectively. The former will occur as a second pulse of extension "B" is being transmitted and the latter as the fourth pulse of extension "A" is being transmitted on the second revolution of the transmitting cam assembly or after the transmitting cam assembly has rotated approximately 240° and 480° respectively.

Extension "B" will also cause the transmitting cam assembly to rotate in a like manner except that the release of the transfer operate lever 22—b and intermediate lever 15—Sb (see Fig. 3) will occur after the transmitting cam assembly has revolved approximately 30° and 270° respectively.

Thus the transmitter will be started by the starting of either extension receiver and will continue to rotate until both the transfer levers 22 and the intermediate levers 15 have been released by the operation of, first, the transfer release latches 23 and then the start latches 16—S by cams 32 and 40 respectively.

After the extension receiving and multiplex transmitting cam assemblies have started rotating, the signal selecting and storing mechanisms are acted upon by projections 30—ra—1 to 30—ra—5 on the extension receiving cam assembly and by the armature extension 13—a. There are five complete selecting and storing mechanisms associated with extension "A", one for each impulse of the signal combination and they are operated in turn by the projections 30—ra—1 to 30—ra—5 of the extension receiving cam ra. For instance, as the first selecting impulse actuates magnet 10—ra, the armature extension 13—a is operated to the marking or spacing position in accordance with this first impulse. At approximately the middle portion of the impulse period sword lever 1—a—1 mounted on pivot 56—r is actuated by projection 30—ra—1 and moves sword 2—a—1 toward the left. If armature extension 13—a is in the spacing position, it will engage the arm 61—ra—1 of sword 2—a—1 causing the sword to swerve and to miss the bearing surface of storing pawl 3—a—1, leaving it in the position illustrated. If, however, the armature extension is in the marking position, it will not engage the extension 61—ra—1 of sword 2—a—1 and the sword will move forward and rotate the storing pawl 3—a—1 about pivot 60. This storing pawl will be locked in the operated position by means of storing pawl latch 4—a—1. In a like manner the other four units of the printer signal combination will be set up on their corresponding storing pawls 3—a—2 to 3—a—5, respectively.

A locking pawl 19—ra and cam 36—ra cooperate with the extension 59—ra of armature 11—a to lock the armature in either the marking or spacing position during the middle portion of an impulse period. This is a well known method of improving the operating margin of the extension magnet 10—ra and the extension receiving distributor mechanism.

The transfer mechanism provides the complete overlap feature which is necessary in order that signals being received by the extension receiving distributors at random times may be stored until such a time as the multiplex sending distributor will transmit all the selecting impulses belonging to a particular signal combination in correct sequence.

The transfer lever 22—a, which as explained above, was operated as the extension receiving cam assembly started and acted to start the multiplex sending cam assembly, also carried with it transfer wedges 9—a—1 to 9—a—5 withdrawing them from between storing pawls 3—a—1 to 3—a—5 and sending latches 5—a—1 to 5—a—5. This acts to prevent the motion of the storing pawls from being transmitted to the sending latches at this time. The transfer mechanism will remain operated until the projection on the transfer cam 32—a operates transfer release latch

23—*a*. This will not occur in the instance we are considering until the time that the multiplex sending cam assembly is transmitting the second pulse of the signal combination received from extension "B"; that is until extension "A" has stored up the first four pulses of its signal combination.

When the projection on the transfer cam 32—*a* actuates the transfer release latch 23—*a*, transfer lever 22—*a* will be restored to its unoperated position by means of a spring and will carry with it the transfer wedges 9—*a*—1 to 9—*a*—5 forcing these wedges between the storing pawls 3—*a*—1 to 3—*a*—5 and the sending latches 5—*a*—1 to 5—*a*—5. If a particular storing pawl is in the marking or operated position, this operation will actuate the corresponding sending latch 5—*a* and disengage the corresponding sending lever 8—*Sa*. If the storing pawl is in the spacing position, the sending lever will remain engaged with the sending latch. When a sending lever 8—*a*—1 to 8—*a*—5 is released, its lug bears on the associated transmitting cam 30—*Sa*—1 to 30—*Sa*—5, respectively, which has an indentation 57—*S* and an elevation 58—*S*. When the indentation of each cam reaches the appropriate position, said associated lug will fall into it if the associated sending latch has been operated, allowing the sending lever to rotate in a clockwise direction about pivot 59—*S* and to close the sending contacts 20—*Sa*. This results in a marking signal being sent to the line. If on the other hand the sending lever has remained engaged with the sending latch, the sending contacts associated therewith will remain opened and a spacing signal will be sent to the line.

After the transfer wedges have effected the transfer of the selecting impulses from the storing pawls to the sending latches, they continue their motion releasing the storing pawl latches 4—*a*—1 to 4—*a*—5 and will allow the storing pawls 3—*a*—1 to 3—*a*—5 to be returned by springs to the spacing position, ready to receive the next combination of selecting impulses.

After the sending contacts 20—*S* have acted to transmit the selected impulses to the multiplex line, the associated sending levers 8—*S* will be restored to engagement with the sending latches 5—*a* by means of the elevations 58—*S* on cams 30—*S*.

If the selecting pulses are set up on the storing pawls 3—*a* at a time at which the transfer lever 22—*a* has already been released by the operation of the release latch 23—*a*, the motion of the storing pawls will be transmitted immediately through the transfer wedges 9—*a* to the sending latches 5—*a* so that the selecting combination will be immediately transmitted without having been stored.

The multiplex sending distributor has eleven sending levers and sets of sending contacts, ten of which transmit the ten selective impulses received from the two extensions. The eleventh, designated 20—*S*—0, which operates once every time the multiplex sending cam assembly revolves, serves to transmit the multiplex start and stop impulses. The eleven sets of sending contacts are connected in parallel as shown in Fig. 1.

Detailed description of full duplex operation of the receiving side

The receiving side is constructed much the same as the sending side. The multiplex receiving cam assembly *R* is rotatably mounted on the shaft 39—*R* and is driven by gear 38—*R* through friction clutches 37—*R*. The extension sending

cam assemblies *sa* and *sb* are mounted on shaft 39—*s* and driven by gear 38—*s* through friction clutches 37—*sa* and 37—*sb* respectively. Several of these repeaters may be mounted adjacent to each other and driven through suitable gears from a common motor.

The start mechanism of the multiplex receiving distributor is practically identical with that of the extension receiving distributors as described above. The release of magnet armature 11—*R* by a start impulse acts through the armature extension 12—*R*, slide pin 14—*R*, intermediate lever 15—*R* and stop pawl latch 16—*R* to release the stop pawl 17—*R* thus disengaging stop arm 18—*R* and allow the multiplex receiving cam assembly to rotate in a counter-clockwise direction.

After the multiplex receiving distributor cam assembly has started rotating, the signal selecting mechanisms are acted upon by the cam projections 30—*R* on the multiplex receiving cam assembly *R* and by the armature extension 13—*R*. For instance, as the first selecting pulse of the twelve-unit multiplex signal actuates magnet 10—*R*, the armature extension 13—*R* is operated to the marking or spacing position in accordance with this signal impulse. At approximately the middle of the impulse period sword lever 1—*Ra*—1 is actuated by a projection 30—*Ra*—1 and moves sword 2—*Ra*—1 towards the right. If the armature extension is in the spacing position, it will engage the arm 61—*Ra*—1 of sword 2—*Ra*—1 causing the sword to swerve and miss the bearing surface of the sending latch 5—*sa*—1, leaving it in the position illustrated. If, however, the armature extension 13—*R* is in the marking position, it will not engage the arm 61—*Ra*—1 of sword 2—*Ra*—1 and the sword will move forward and operate the sending latch 5—*sa*—1 which will be locked in the operated position by means of the intermediate latch 6—*sa*—1. In a like manner the other nine of the selecting units of the multiplex signals will be set up on their corresponding sending latches.

The sending latches 5—*sa*—1 to 5—*sa*—5 are associated with extension sending distributor "A" while sending latches 5—*sb*—1 to 5—*sb*—5 are associated with the extension distributor "B". Consider only for the moment extension "A". The cam assembly *sa* is prevented from rotating by the engagement of the release lever 21—*sa* with stop cam 34—*a*. Release lever 21—*sa* is so shaped and situated that it will be acted upon by any of the five sending latches 5—*sa*—1 to 5—*sa*—5 associated with extension "A". If any one of the first five selecting impulses of the multiplex signal as received by the multiplex receiving distributor is marking, i. e., if no idle signal pertaining to extension A is received, one or more of the sending latches 5—*sa*—1 to 5—*sa*—5 will be operated. The operation of one or more of these sending latches actuates release lever 21—*sa* which disengages stop cam 34—*a*. The extension sending distributor cam assembly will then be permitted to rotate only a very slight amount until it is stopped by the engagement of stop cam 34'—*a* with stop pawl 17—*sa*. After the five selecting pulses destined to be transmitted to extension "A" have been set up on the sending latches 5—*sa*—1 to 5—*sa*—5, the elevation of cam 33—*a* will operate intermediate lever 15—*sa* which will actuate stop pawl 17—*sa*, thereby disengaging stop cam 34'—*a*, and allow the extension sending distributor *sa* to complete a revolution and so transmit the signal to ex-

tension "A". It will thus be seen that stop pawls 17—sa and 17—sb are operated once for every revolution of the multiplex receiving distributor, but neither will cause its associated extension sending distributor to start unless there has been previously set up a signal combination on the sending latches associated with that particular distributor.

As an extension sending distributor sa or sb rotates, those sending levers 8—s, which have been released by the operation of their associated sending latches 5—s, are actuated in turn as they are reached by the indentation of cams 30—s thereby closing contact pairs 20—s in succession so as to transmit the correct signals to the associated extension loops. Contacts 20—sa—0 and 20—sb—0 are actuated by the operation of sending levers 3—sa—0 and 8—sb—0 whenever their distributors rotate, and they act to transmit the start and stop pulses. All contacts associated with a given extension are connected in parallel as shown in Fig. 1. As each sending lever 8—s associated with a selecting impulse operates, it carries with it a release pawl 7—s which trips the intermediate latch 6—s releasing the sending latch 5—sa. The sending latch 5—sa is then ready to receive the impulse of the next signal combination. When the end of the indentation of sending cam 30—s reaches the lug associated with sending lever 8—s, the sending lever will be returned to engage it with the sending latch 5—sa by cam elevations 53—s. This return will, of course, tend to operate the sending latch but it will not move far enough to cause it to reengage with the intermediate latch 6—s.

Detailed description of half duplex operation

The detailed description of the half duplex operation of the system may be more easily understood by considering only extension "A". Now suppose that the duplex lever 28—a is operated to the half duplex position as shown in Fig. 2. To arrange the multiplex repeater for half duplex operation it is necessary to place contacts 20—sa and magnet 10—ra in series with the extension loop and to include break contacts 20—ak, which are normally operated, in series with the loop also. These circuit changes may easily be accomplished by switching contacts controlled by duplex lever 28—a. This is illustrated in Fig. 1. The duplex lever and associated switch are shown in the half duplex position for the circuit cooperating with extension "B". As shown, the extension receiving magnet 10—rb, contacts 20—kb, and contacts 20—sb—0 to 20—sb—5 are all connected in series with the loop 50—b to extension station B.

Control lever 26—a will now be free to release when it is not engaged by the elevation of cam 29—a. When it is in the position shown in the drawing, as it will be when the extension sending distributor is maintained at rest by release lever 21—sa or stop pawl 17—sa, the armature 11—a may release under the influence of a start signal thereby allowing the extension receiving distributor to start and signals may then be sent from the loop through the sending side of the multiplex repeater and over the multiplex line to the distant station. However, if a distant extension is transmitting signals and if these signals are being received by the receiving side of the multiplex repeater, the extension sending distributor sa will be revolving and control lever 26—a will be continuously released except for the time during each revolution when the extension

sending distributor is momentarily in the position shown in the drawing. At this time contacts 20—a—0 maintain a closed loop. While the control lever 26—a is released, it holds operated control pawl 27—a. Pin 62—a which is attached to this control pawl 27—a engages magnet armature 11—a holding it in the marking position. Hence the incoming signals to the loop which pass through the winding of magnet 10—a will not operate armature 11—a and hence they will not be passed back to the originating station.

Now suppose that signals are incoming from the distant station and are passing through the receiving side of the multiplex repeater into the loop circuit of extension "A" and that the subscriber "A" wishes to obtain control of the circuit. In order that this may take place the distant end loop must be caused to open for a sufficient time to enable the break mechanism of the printer thereat to operate. The mechanism which facilitates this procedure comprises cam 30—ra—k, sword operate lever 1—ka, sword 2—ka, break pawl 24—ka, break lever 25—a and break cam 35—a together with control lever 26—a and control pawl 27—a.

First consider the action of the break feature at the near end or breaking end of the circuit. Assume that signals are coming from the multiplex line through the receiving side of the multiplex repeater to the subscriber's loop. The extension sending distributor sa will be rotating. The subscriber, wishing to obtain control of the circuit, operates break key "K" (see Fig. 1) which opens the loop circuit. This stops the flow of current through magnet 10—a but its armature 11—a will be held operated by control lever 26—a. The next time the extension sending distributor reaches the position shown in Fig. 2 control lever 26—a will operate momentarily, releasing armature 11—a, and allow the extension receiving distributor to start.

The extension sending distributor will start again when the next signal is received and release control lever 26—a which operates armature 11—a and holds it in the marking position. This will cause the extension receiving distributor to place all five sending levers 8—Sa—1 to 8—Sa—5 in the marking position. The multiplex sending distributor will therefore send out to the multiplex line a "letters" signal for extension "A".

When the extension receiving distributor has rotated beyond the position allotted to the fifth impulse, or approximately 320°, sword 2—ka will be operated and since its arm 61—ka will be engaged by control pawl 27—a which is held operated by control lever 26—a, the sword will strike the upper half of break pawl 24—a operating it and also break lever 25—a. When lever 25—a operates, it opens contacts 20—ka which are in series with the loop and also engages break cam 35—a. Thus the loop is opened and the extension sending distributor stops at the end of its revolution. The open loop causes armature 11—a to release again, since with the extension sending distributor at rest, control lever 26—a is operated. The receiving distributor makes one revolution during which an idle signal is sent over the multiplex line since armature 11—a will remain in the spacing position during this time. After the extension receiving distributor has again rotated 320° sword 2—ka is again actuated by its associated operating lever 1—ka. Since the control lever 26—a is operated, the control pawl 27—a will not engage the sword arm 61—ka and the sword will strike the lower end of break pawl

24—*a*. The break pawl will rotate in a clockwise direction and will return break lever 25—*a* to the position shown in the drawing. Break lever 25—*a* disengages the break cam 35—*a* of the extension sending distributor and closes break contact 20—*ka* thereby closing the loop circuit.

has rotated approximately 320° sword 2—*ka* will be actuated and since control lever 26—*a* is operated, the arm of the sword will not engage control pawl 27—*a* and the sword will strike the lower end of break pawl 24—*a* causing break lever 25—*a* to release. This closes contact 20—*ka* and disengages break lever 25—*a* from break cam 35—*a*.

The operation of the break lever as described above will hold the loop open for slightly more than the time of one revolution of the extension sending distributor. This will operate the break lock of the subscriber's printer since no stop pulse has been transmitted during this revolution.

It is to be understood that the mechanism shown in the drawing is not exactly to scale nor are the parts shown therein exactly proportioned. The mechanism illustrated and described discloses one embodiment of the invention and the principles of operation of the various component parts of the mechanical multiplex repeaters. However, there may be many other embodiments and modifications which do not depart from the spirit of the invention as defined in the following claims.

What is claimed is:

1. A mechanical start-stop multiplex telegraph system having start-stop extension loop circuits which comprises a mechanical start-stop receiving extension distributor and a mechanical start-stop sending extension distributor connected to each extension loop circuit, a mechanical start-stop sending multiplex distributor and a mechanical start-stop receiving multiplex distributor connected to each end of the multiplex system, mechanical storing devices cooperating with the start-stop extension receiving distributors, mechanical transfer means connecting said storing devices to the mechanical start-stop multiplex sending distributor, and mechanical transfer means connecting said mechanical start-stop receiving multiplex distributor to said mechanical start-stop sending extension distributors.

2. A start-stop mechanical multiplex telegraph system for connecting start-stop extension circuits with a start-stop multiplex line, comprising mechanical sending and receiving extension distributors associated with each extension circuit, mechanical start-stop sending and receiving multiplex distributors connected to the multiplex line, mechanical linkages for connecting the distributors associated with the extension circuits to the multiplex distributors, and means for converting the extension distributors from half duplex operation to full duplex operation.

3. A mechanical telegraph repeater for interconnecting a multiplex telegraph circuit and a plurality of extension circuits which comprises a receiving magnet and a group of transmitting contacts associated with each of said multiplex and said extension circuits, a group of storing pawls and a group of receiving cams associated with said receiving magnet, means for actuating said storing pawls from said receiving magnets and said receiving cams in accordance with the received impulses, a group of transmitting cams associated with each group of transmitting contacts, a cam operated lever and latch associated with each transmitting contact, and means for transferring the signals stored by said storing pawls to said transmitting levers and latches.

4. A telegraph repeater in accordance with claim 3 comprising a switch for connecting the sending contacts associated with said extension circuits in series with the receiving magnet as-

If the loop has now been closed by the release of the break key and the distant end subscriber has stopped sending the extension receiving distributor will stop and the near end subscriber may send. If the loop is still opened by the break key and the distant end subscriber has stopped sending, the extension receiving distributor will continue to rotate causing a series of idle signals to be transmitted to the multiplex line. If the loop is still held opened by the break key and the distant end subscriber continues to send, the cycle of operation described in the last four paragraphs will be repeated, i. e., alternate "letters" and "idle" signals will be sent over the multiplex line to the distant station.

Whenever the distant end subscriber ceases sending and the near end subscriber closes his break key the extension sending and receiving distributors will stop and the near end subscriber may then send.

Now consider the operation of break mechanism at the distant end of the line. Since signals are being transmitted from the subscriber's station, the extension receiving distributor will be rotating, but the extension sending distributor will be normally at rest. Control lever 26—*a* will be held operated and this will prevent break lever 25—*a* from operating since when sword 2—*ka* is actuated, which will occur once every revolution of the extension receiving distributor, its arm 61—*ka* will not engage control pawl 27—*a* and the sword will tend to bear on the lower end of break pawl 24—*ka*. However, since the break pawl is in the position shown in the drawings and since it reached that position by a "snap" action under the influence of its holding spring, it will not be engaged by the sword.

When the "letters" signal referred to in the description of the near end operation is received all five sending latches 5—*sa*—1 to 5—*sa*—5 will be operated and as hereinbefore described the extension receiving distributor will be started. When it starts, control lever 26—*a* releases, operating control pawl 27—*a* which holds armature 11—*a* in the marking position. When the extension receiving distributor reaches a point 320° through its revolution, the sword 2—*ka* is actuated and since its arm 61—*ka* engages control pawl 27—*a*, the sword 2—*ka* strikes the upper end of break pawl 24—*a* causing break lever 25—*a* to operate. Break lever 25—*a* opens contacts 20—*ka* in series with the loop and engages break cam 35—*a* thereby stopping the extension sending distributor. It should be noted that if lever 25—*a* is operated when cam projection 35—*a* is opposite it, lever 25—*a* will be operated and rest against this elevation. Due to the holding spring lever 25—*a* will follow the cam and stop the distributor at the end of the next revolution.

Since control lever 26—*a* will then be released armature 11—*a* is maintained in the marking position and the extension receiving distributor will stop at the end of its revolution. However, at the end of the extension sending distributor's revolution, it will be stopped by the engagement of break lever 25—*a* with break cam 35—*a*. This operates control lever 26—*a* which causes the receiving distributor to start again. When it

sociated with the same extension circuit, and means for mechanically interlocking said receiving magnet and transmitting cam associated with the transmitting contacts whereby said extension circuit operates half duplex, and means associated with said receiving magnet, receiving cams, and transmitting cams for transmitting a break signal from said extension circuit, while receiving signals, to the extension circuit transmitting said signals thereto.

5. A mechanical telegraph repeater for repeating telegraph permutation signals from a plurality of start-stop extension lines to a start-stop multiplex line comprising a receiving magnet associated with each of said extension lines, a plurality of cams associated with each magnet, a storing pawl for each element of the permutation signal associated with each of said line magnets, means controlled jointly by said cams and said magnets for actuating said storing pawls in accordance with received signal impulses, a plurality of transmitting cams, a plurality of transmitting contacts connected to said multiplex line, and means for controlling said transmitting contacts by said transmitting cams and said storing pawls.

6. A mechanical telegraph repeater for repeating telegraph permutation signals from a start-stop multiplex line to a plurality of start-stop extension lines which comprises a receiving magnet connected to said multiplex line a plurality of cams associated with said magnet, a plurality of storing latches associated with said magnet and cams, means for actuating said storing latches by said magnet and cams in accordance with the received signals, a group of transmitting cams and contacts associated with each ex-

tension line, and means for actuating said transmitting contacts by said transmitting cams in accordance with the signals stored by said storing latches.

7. A telegraph repeater comprising a plurality of mechanical start-stop extension receiving distributors, mechanical storing devices associated therewith, a mechanical start-stop multiplex transmitting distributor, transfer means connecting said storing devices to said multiplex transmitting distributor, and means for starting said extension receiving distributors in response to telegraph signals received thereby, means for automatically starting said multiplex transmitting distributor when any of said receiving extension distributors start, a plurality of mechanical start-stop extension sending distributors, one being associated with each extension receiving distributor, a mechanical start-stop receiving multiplex distributor, mechanical linkages connecting said receiving multiplex distributor to said sending extension distributors, means for starting said receiving multiplex distributor in response to signals received thereby, and means for automatically starting the sending extension distributors for which the multiplex receiving distributor has received a signal combination, means for interconnecting said extension receiving distributor and associated sending extension distributor for half duplex operation of said associated extension distributors, break means for transmitting and receiving a break signal through said interlocked distributors, and a switching device for blocking said interlocking and break means for full duplex operation of said extension distributors.

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