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TELEPHONE EXCHANGE SYSTEM.

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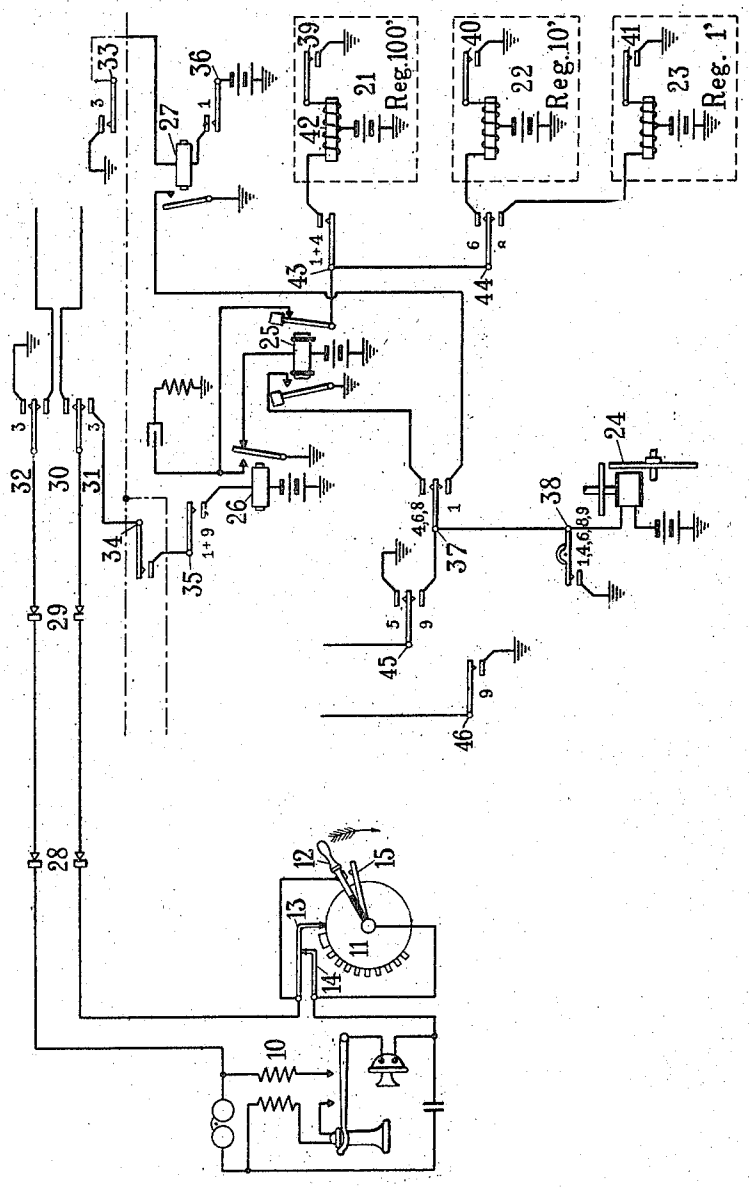
1,156,416. Patented Oct. 12, 1915.



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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SYSTEM.

1,156,416. Specification of Letters Patent. Patented Oct. 12, 1915.

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To all whom it may concern:

Be it known that I, FRANK ROBERT McBERTY, a citizen of the United States, residing at 49 Boulevard Leopold, Antwerp, Belgium, have invented certain new and useful Improvements in Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to telephone exchange systems and particularly to systems wherein a desired connection is to be extended or partially extended by means of automatic switching apparatus at a central station under the control of manually operable apparatus at the substation of the subscriber desiring the connection.

In British Patent specifications Nos. 26,099 of 1910 and 21,259 of 1911 there are shown systems in which upon the initiation of a call a calling line is automatically associated with a registering and controlling mechanism. The designation of the call as determined by the subscriber by the operation of his sending apparatus being received and stored up in such mechanism, which mechanism, in turn, controls the operation of the necessary automatic selector switches to extend such calling line as desired in accordance with such designation.

As shown herein, this invention is applied to systems of the general type disclosed in the British specifications referred to, but it will be understood by those skilled in the art that the invention is not limited to such systems but may be applied to systems widely varying in character, as, for example, to systems in which the selector switches themselves are directly controlled from the subscriber's sub-station.

One of the principal features of the invention relates to such an arrangement of circuits and apparatus that the controlling circuit between the subscriber's sub-station and the parts or switches to be controlled is, effectively, a straight metallic circuit without artificial resistances and embodying and requiring no ground connections whatever at the sub-station.

Still another feature of the invention has to do with a system in which the variably adjustable parts are "power driven", that is, driven by power mechanically supplied at such parts and continuously available whereby the setting of such parts is accomplished accurately and positively although at a relatively high speed.

More specifically the invention also relates to a control system for such variably adjustable parts to be variably set in consequence with a subscriber's sub-station sender whereby such parts will be driven into the proper set position under the control of two circuits, one under the control of the subscriber and the other locally controlled, such circuits operating alternately to set this part in motion and subsequently to bring it completely into a position corresponding to a complete stage of operation of such part.

According to another feature of the present invention the power driven selector switches are advanced in steps under the control of current variations produced in their clutch magnets by the sending device, the extent of movement of the switches at each step being fixed independently of the rate of operation of the sending device.

Other novel features of the invention will sufficiently appear in the detailed description thereof hereinafter set forth.

The drawings hereto attached, forming a part of this specification, illustrates so much of a telephone exchange system of the character described in the British specifications above referred to as is necessary for a complete understanding of the invention. The subscriber's sub-station is shown at 10 and consists in part of the usual transmitter, receiver, induction coil, bell, condenser and hook switch. It also includes the impulse sending device 11. This impulse sending device, which is diagrammatically shown, illustrates a sub-station sender in which the operation consists of setting of a movable part thereof to a point indicative of the successive digits desired designating the desired subscriber's line and in which after the movable part has been moved to any given digit it is released and restored to normal, the controlling impulses being produced only in such restoring movement and corresponding in number to the digit to which such movable part has been set. In the sender shown such impulses are in the form of circuit interruptions. More specifically in the sender shown, the handle 12 will be moved in the direction indicated by the arrow to a point from which in its restoring movement the movable part will interrupt the contacts

13, 14 a number of times corresponding to the digit to which such part has been set. It will be observed that these interruptions will be all short interruptions except the last one before the movable part comes into normal position. It might be noted that this last interruption is long only in comparison to the other interruptions caused by the movable part and is, as a matter of fact, relatively short. It will, furthermore, be observed that in the form of sender shown the interruption of the circuit during the forward movement of the movable part is prevented by a closure of a shunt around the contacts 13, 14 by the handle 12, which is loosely mounted on the shaft of the movable part, coming in contact with the contact 15 which is fixed upon such shaft. It is obvious that the same result might be accomplished in a number of equivalent manners.

To the right of the drawings are shown number register mechanism 21, 22, 23, being respectively a 100's register, a 10's register and a units register. Associated with these registers and with other apparatus of the registering and controlling mechanism, such other apparatus not being shown, is a timing means such as for instance sequence switch 24. This sequence switch is of the type shown in British specification No. 20840 of 1911, and therefore need not be described herein. This sequence switch 24 controls all of the sequence switch contacts indicated below the dotted line of the drawings herein and thereby determines at what time each of these registers should be energized. Each of the registers is also structurally precisely similar to the sequence switch shown in the British specification referred to, with the one exception,—that the power magnet thereof, instead of having but a single winding as in the sequence switch shown in the British specification, has two power windings differentially arranged, one adapted to be controlled by the external control circuit of such sequence switch, and the other adapted to be controlled by the local or positioning contact of the sequence switch itself. This differentially wound power magnet constitutes an electromagnetic clutch by means of which the power is applied to the register switches by coupling the switch with a constantly rotating power shaft. This difference is plainly illustrated in the drawings, and the utility thereof will be hereinafter made clear.

Controlling the registers 21, 22 and 23, and also controlling the sequence switch 24 through the intermediation of the slow operating relay 25 is the rapid highly sensitive line relay 26. Also associated with the registering controlling mechanism is what may be called a starting relay 27, the function of which will be herein described.

Upon the initiation of a call the calling line will be connected through automatically operating switches, indicated at 28, 29, with a connecting circuit generally indicated at 30. The apparatus associated with this connecting circuit, which, however, forms no part of this invention and therefore is not shown, will cause the sequence switch controlling the contacts 31, 32 and 33 to be driven into its third position, thereby closing and maintaining closed the contacts 31 bottom and 32 top and the contact 33. Another sequence switch set in operation by the sequence switch associated with the connecting circuit but which, since it forms no part of the invention herein is not shown, will then be set in operation to close the sequence switch contact 34.

To initiate a call the subscriber must remove his receiver from its hook switch and the operations just described will take place in consequence thereof. Immediately upon the closure of the sequence switch contacts 31, 32 and 34 a circuit will be established which may be traced from battery through the line relay 26, sequence switch contact 35, sequence switch contact 34, sequence switch contact 31 bottom, out over the line, through contacts 13 and 14, the sub-station transmitter, the primary winding of the induction coil at the sub-station, back over the other side of the line and through sequence switch contact 32 top, to ground and back to battery. This will energize the line relay 26. At the same time that this circuit is established a circuit is closed over sequence switch contact 33 and sequence switch contact 36, to energize the starting relay 27. This latter relay upon its energization closes at its armature a circuit through sequence switch contact 37 bottom, driving such sequence switch out of its first and, under the control of its local contact 38, into its fourth position. During this movement of the sequence switch 24 no change takes place in the circuit for line relay 26 hereinbefore described.

In the registers of the type shown at 21, 22 and 23, and in British specification No. 20,846 of 1911, a local spring controlled by the register, indicated respectively at 39, 40 and 41, is opened only when its register is in its normal or some other proper stopping position. This spring 39, 40 or 41 is closed in all other positions of its register. As the mechanical construction and operation of the registers form no part of this invention, their disclosure in the present specification and drawings does not seem necessary. The operation of such registers and of the apparatus associated therewith is fully described and shown in patent to F. R. McBerty and Lipa Polinkowsky, No. 1,137,223 of April 27, 1915. When, therefore, the line relay 26 was first energized by the establishment of circuit through the sub-

scriber's sub-station, a circuit was closed for the register 21 from battery over the left hand winding of the power magnet thereof indicated at 42, sequence switch contact 43, right hand armature and back contact of the slow operating relay 25 and through the front contact and armature of the line relay 26. Immediately, therefor, the power magnet 42 of the register 21 is energized and, power being thereupon applied to the movable part of such register, such part moves out of its normal position and will continue to move until in an intermediate position between its normal and first stopping position the local contact 39 is closed. Immediately that this contact 39 is closed a second circuit for the power magnet 42 of such register is completed through the right hand winding thereof, which winding is differentially arranged with respect to the left hand winding thereof. Current is now passing through both of the windings of the power magnet and it will be deënergized and the movable part of the register will come to a stop, remaining in such intermediate position until upon the deënergization of the line relay 26 the circuit through this left-hand winding is opened, when, the circuit over the local contact 39 being still maintained, the power magnet 42 is again energized and the movable part of the register will be brought into its first stopping position. There it will come to a stop owing to the opening of the local contact 39. This deënergization of the line relay 26 will in the normal operation of the system only occur when after the movable part of the sub-station sender has been adjusted to the desired position, such part starts in its movement back to normal. Assuming that the subscriber has moved the movable part of his sub-station sender to such a position that four impulses, (three short and one long breaks) will be produced in its restoration. The first break in the circuit will cause the deënergization of the line relay and the consequent movement of the register 21 into its first stopping position as just described. After this short break, the circuit will be again established to energize the line relay 26 which by attracting its armature will again start the movable part of the register 21 in motion. This part will continue to move until it comes into the second intermediate position when the local contact 39 is again closed and the movable part will stop and await the subsequent deenergization of the line relay 26 upon the second breaking of the subscriber's controlling circuit. As we have assumed that the subscriber has so set his sub-station sender that four impulses will be produced it will be apparent that the register 21 will upon the fourth breaking of such circuit come into its fourth stopping position. At this time, however, owing to the longer break of the circuit and the contacts 13, 14, the line relay 26 will be deënergized sufficiently long to accomplish the energization and the attraction of the armatures of the slow operating relay 25 over the back contact and armature of such line relay 26. The left hand armature of the relay 25 will thereupon close a circuit over sequence switch contact 37 top to drive the sequence switch 24 out of its fourth and under the control of the contact 38 into its sixth position. This movement of the sequence switch 24 opens the sequence switch spring 43 and closes the sequence switch contact 44 top thereby accomplishing what is known as the "change over" from one register to another and associating the register 22 with the line relay 26 in place of the register 21. The right hand armature of the slow acting relay 25 has meanwhile maintained the circuit from the relay to the register 21 open. Meanwhile the circuit has been again closed at the contacts 13, 14 after the longer break and the subscriber has been setting his sub-station sender to indicate the second digit of the desired line. Upon the release of the movable part of the sub-station sender and during its restoration to normal the second series of impulses will control the operation of the register 22 to move it into its desired set position, the operation being precisely the same as has been hereinbefore described in connection with the register 21. As such register 22 comes into the desired set position the longer impulse will be transmitted over the controlling circuit and the slow operating relay 25 again energized to accomplish the change-over by driving the sequence switch 24 out of its sixth into its eighth position. In this position the sequence switch contact 44 bottom now being closed the setting of the register 23 will take place under the control of the subscriber's sub-station sender in precisely analogous manner.

All three digits of the desired line now having been transmitted from the subscriber's sub-station sender and registered or stored up at the register 21, 22, 23, such registers are in condition to control the selection of the desired line over the necessary automatic selector switches as will be well understood by those familiar with the art. As the sequence switch 24 left its fourth and passed through its fifth position, at which time the register 21 had been completely set, it closed the sequence switch contact 45 top which may start in operation such other portions of the apparatus as it may at that time be desirable should be started in operation to extend the desired connection. Furthermore, when the sequence switch 24 was driven out of its 8th position by the third energization of the slow

operating relay 25, it closed the sequence switch contacts 45 bottom and 46. This latter contact completes a circuit to initiate the operation of any other apparatus necessary or desirable to produce the proper operations to extend the desired connection. At this time the sequence switch contact 45 bottom is closed in order that after the setting of the circuit extending apparatus, not shown, the sequence 24 and all of the contacts controlled thereby may be restored to normal condition. It will be further observed that as the sequence switch moved out of its first position the sequence switch contact 36 was opened so that the starting relay 27 is no longer able to control the sequence switch 24 during the operation of the apparatus shown.

If at any time after the initiation of the operations of the apparatus shown the subscriber desires to restore such apparatus to normal, he need only replace his receiver upon this hook switch. This will accomplish the interruption of the controlling circuit longer than any of the interruptions caused by the sub-station sender apparatus. The line relay 26 will therefore be deënergized for a relatively considerable period and the slow operating relay 25 being also operated will drive the sequence switch 24 directly into its ninth position, in which position it will rest until all of the other apparatus which may have been started in operation by the closure of the sequence switch contact 45 in its fifth position is restored to normal due to the prolonged breaking of the circuit at the sub-station. Then responsive to the closure of a circuit including the sequence switch contact 46 the sequence switch 24 will be driven into its normal position.

It will be observed that the relative lengths of the interruptions to accomplish the three different operations referred to are such that the short interruptions will not be sufficiently long to cause the energization of the relay 25. The longer interruption due to the operation of the sub-station sender will be shorter than the time in which the sequence switch moves through one position,—that is, for example, from position 4 into position 6, or from position 6 into position 8. The restoring interruption due to the operation of the subscriber's hook switch need only be long enough for the sequence switch 24 to move to and out of its position 8. It may also be noted with regard to the short interruptions that it is not necessary that the armatures of the line relay 26 in responding to the short interruptions do any more than break the circuit at its first contact, it being wholly unnecessary for the proper operation of the system that any circuit be established at the back contact thereof except at the relatively longer interruption of the circuit by the sub-station sender or the interruption of the circuit by the restoring of the receiver to its hook switch.

I claim:—

1. The combination with a progressively operable switch, continuously operating power means and an electromagnet for associating said power means with said switch, of means including a sending device having a contact in circuit with a winding of said electromagnet adapted by variable intermittent operation of said contact to variably adjust said switch, the extent of movement of said switch being independent of the rate of intermittent operation of said device.

2. The combination with a progressively operable switch, continuously operating power means and an electromagnet for associating said power means with said switch, of means for advancing said switch in steps by intermittently varying the current in a winding of said electromagnet, and means for fixing the extent of movement of the switch at each step independently of the rate of intermittent current variation in said winding.

3. In a telephone exchange system, an impulse receiving circuit, a relay in said circuit, a variably operable switch, a constantly operating power means, a magnet for associating said switch with said power means upon the closure of a single contact of said relay, means for opening and closing said contact, and means whereby after a definite movement of said switch it will be stopped until said contact is again closed.

4. In a telephone exchange system, an impulse receiving circuit, a relay in said circuit, a variably-operable power-driven switch adapted to be moved under the control of a single contact of said relay, and a local circuit controlled by said switch itself adapted to stop said switch after it has moved a definite distance in response to the closure of said contact and until said contact is again closed.

5. In a telephone exchange system, a power-driven switch adapted to be moved to any one of a plurality of positions, a differentially-wound electromagnetic clutch for applying the power to said switch, an external control circuit the closure of which will start said switch in motion, and a local circuit the closure of which when such external control circuit is closed will bring such switch to a stop.

6. In a telephone exchange system, a power-driven switch adapted to be set to any one of a plurality of positions, a differentially-wound electromagnetic clutch to apply the power of said switch, an external control circuit including one of the windings of said clutch adapted to initiate the movement of said switch from one position to the next, a local circuit closed by said switch between such positions and adapted

to stop said switch intermediate of said positions if the external circuit is still closed, and to cause the completion of the movement of said switch to the next position when such external control circuit is open.

7. In a telephone exchange system, a power-driven switch adapted to be moved to any one of a plurality of positions, an external control circuit, a relay adapted to close such circuit to initiate the movement of said switch from one position to another, and means contained in such switch itself for stopping such switch when said relay is maintained either energized or deënergized.

8. In a telephone exchange system, a plurality of automatically-operating switches, an impulse transmitting mechanism located at a distant station adapted to control the variable setting of such switches by impulses produced in such circuit and to cause the "changeover" from one of such switches to another by means of an impulse differing from such setting impulses in duration but of the same character.

9. In a telephone exchange system, a plurality of automatically-operating switches, an impulse producing mechanism at a distant station adapted to set said switches one after another by impulses produced in the subscriber's circuit by the operation of said mechanism and to cause the "changeover" from one of said switches to another by impulses differing from said setting impulses in duration but of the same character, and a single relay included in the circuit of said impulse transmitting mechanism controlling both the setting of a switch, and the "changeover" from such switch to the next switch to be operated.

10. In a telephone exchange system, a plurality of automatically-operating switches, an impulse-transmitting mechanism, a circuit with which such switches are brought into association one after another, such switches being adapted to be set by means of impulses produced by said mechanism in such circuit, the "changeover" of the control from one of said switches to the next to be associated with said circuit being caused by means of an impulse in said circuit similar in character to the setting impulses but different in duration, and a single relay in said circuit directly controlling the "changeover" from one of said switches to the next, and the setting of each of such switches.

11. In a telephone exchange system, a plurality of automatically-operating switches, a control circuit with which such switches are adapted to be associated one after another and to be severally controlled thereover, a relay in such circuit operated by short impulses therein to control the setting of a switch at that time being controlled, and timing means associated with said relay and operated by a longer impulse in said circuit to terminate the control of one of said switches and to place another of such switches under the control of said relay.

12. In a telephone exchange system, a plurality of automatically-operating switches adapted to be variably set one after another, an external control circuit, a relay in said circuit operating in response to impulses therein to control the setting of a switch at that time under the control thereof, and a sequence or steering switch associated with said relay and operating in response to the operation of such relay for a longer impulse to transfer the control of said relay from one of said switches to another.

13. In a telephone exchange system, the combination with a plurality of multi-position automatic register switches, of an electromagnetic clutch for each switch having two energizing windings, a control circuit including a fast relay and an impulse wheel, a circuit for energizing said clutch by one of its windings in any position of said switch, said circuit leading through the front contact of said fast relay, a local circuit including the other winding differentially closed by the switch itself in each intermediate position, a slow relay, and a sequence switch, said slow relay actuating said sequence switch after each series of impulses produced by said impulse wheel to successively transfer the front contact of said fast relay to the succeeding registers.

In witness whereof, I hereunto subscribe my name this 30th day of December A. D. 1913.

FRANK R. McBERTY.

Witnesses:
L. F. Woodward,
N. Curt Hern.