G. W. LORIMER.

SIGNAL TRANSMITTER FOR TELEPHONE EXCHANGES.

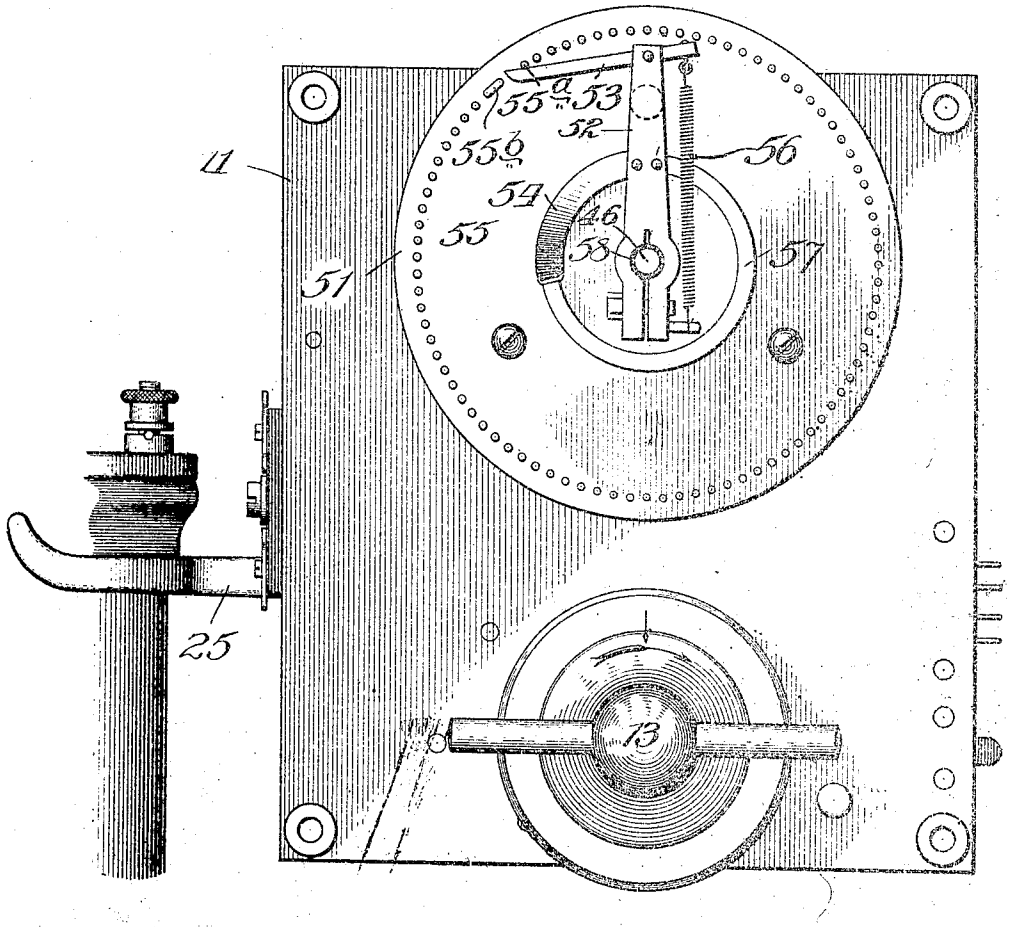
APPLICATION FILED APR. 11, 1906. RENEWED AUG. 7, 1911.

1,024,088.

Patented Apr. 23, 1912.

6 SHEETS—SHEET 1.

Fig. 1.



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6 SHEETS—SHEET 2.

Fig 2

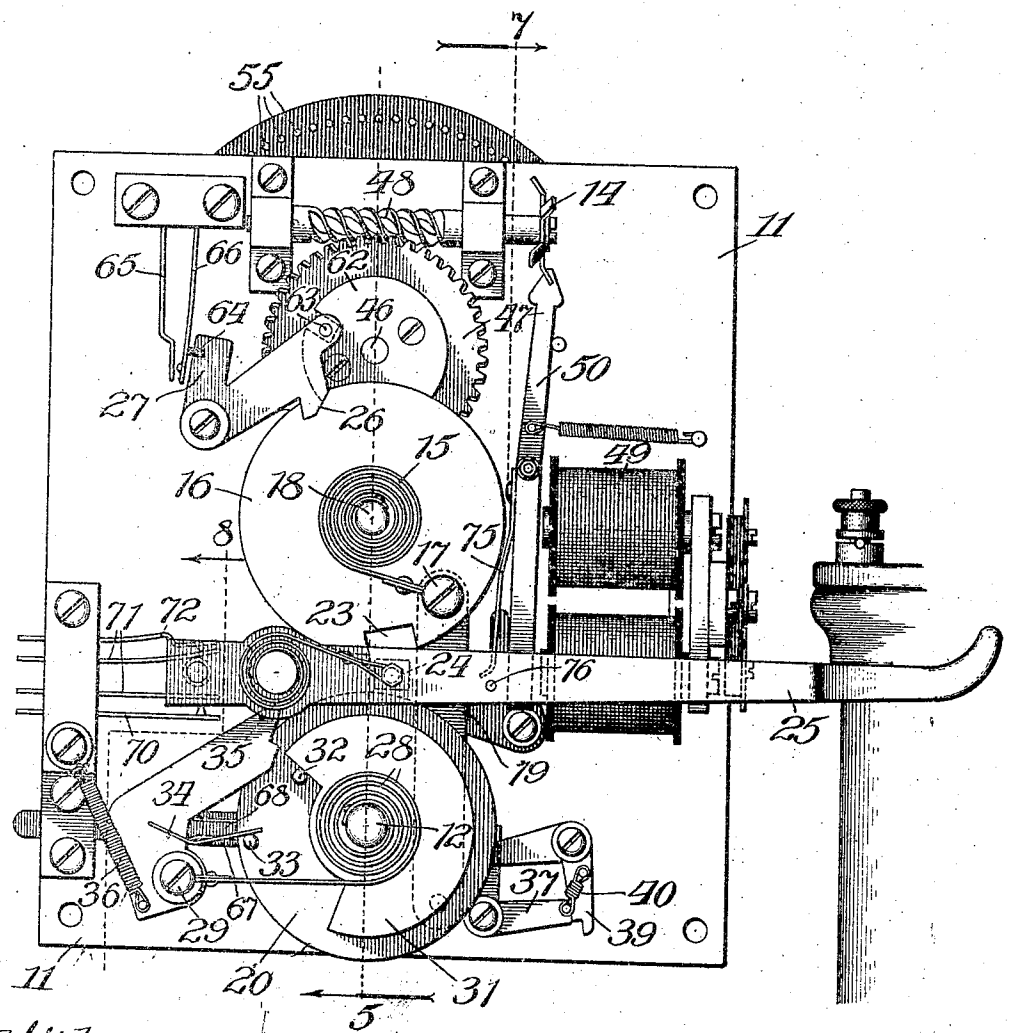

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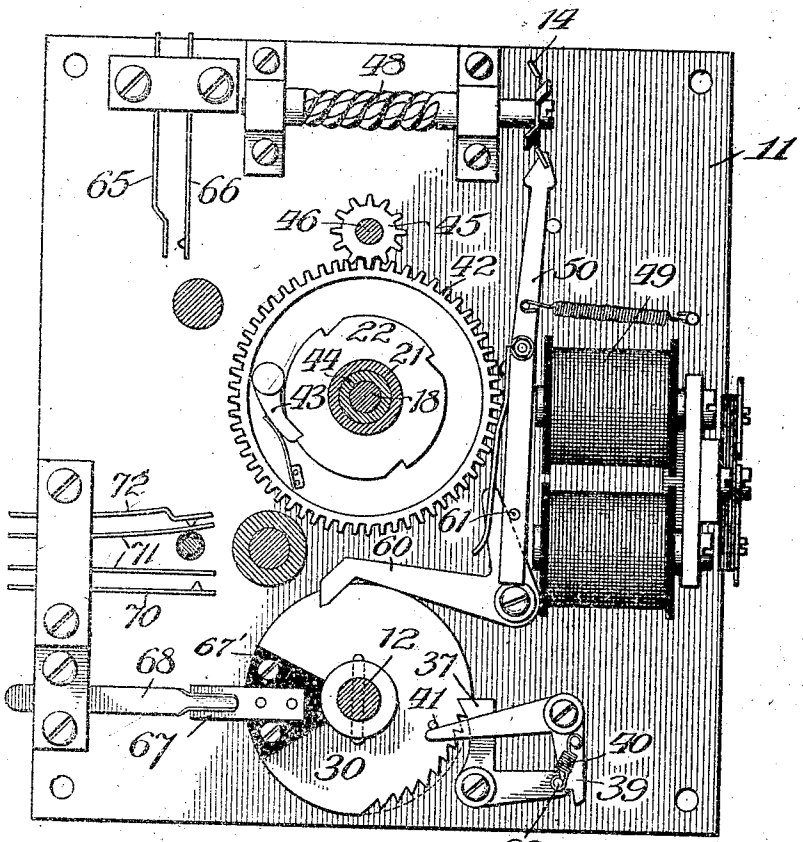
Fig. 3.



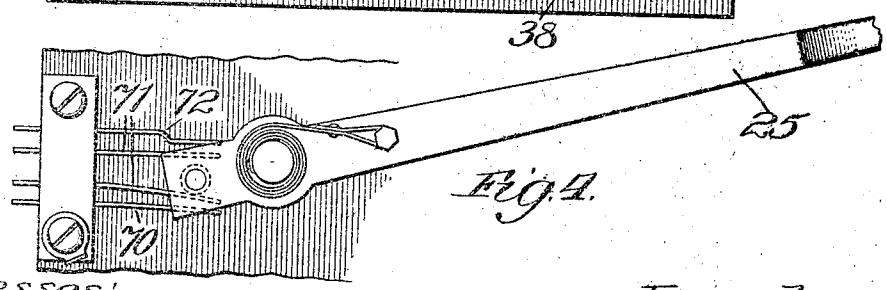


Fig. 4.

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6 SHEETS—SHEET 4.

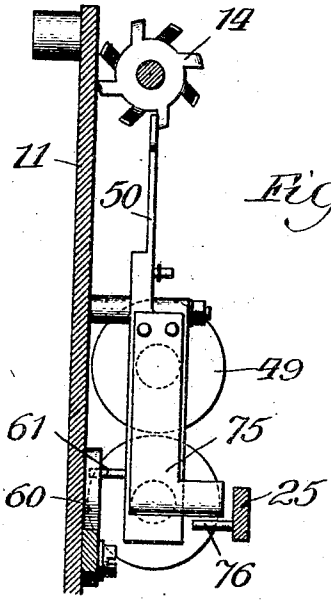

Fig. 7.

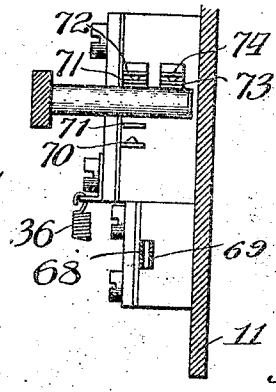

Fig. 8.

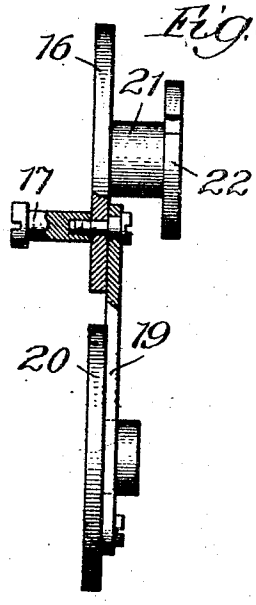

Fig. 6.

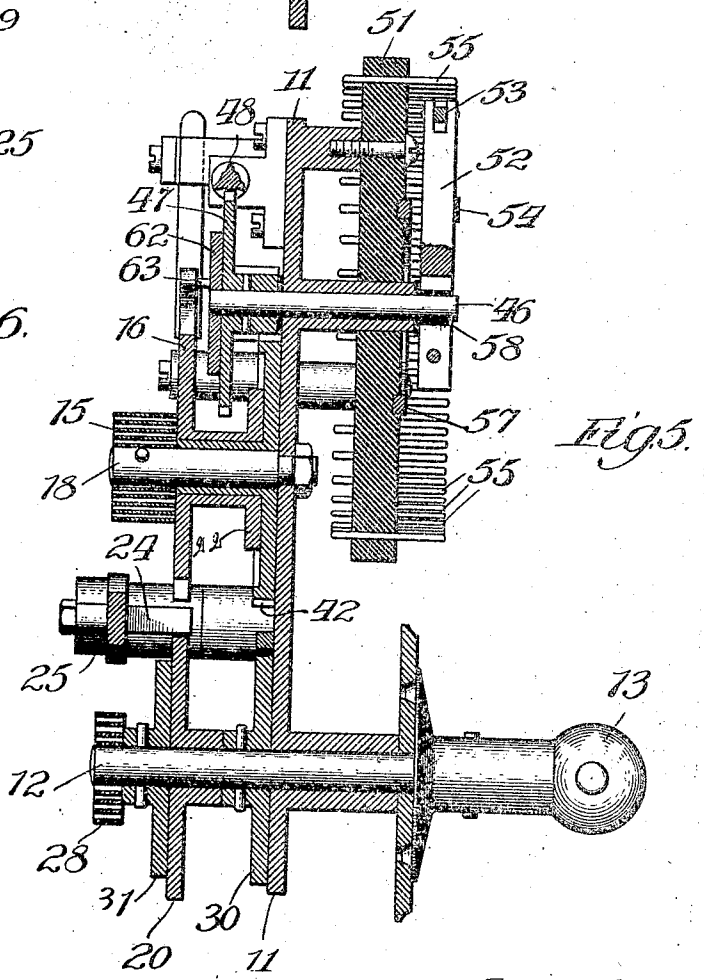

Fig. 5.

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6 SHEETS—SHEET 5.

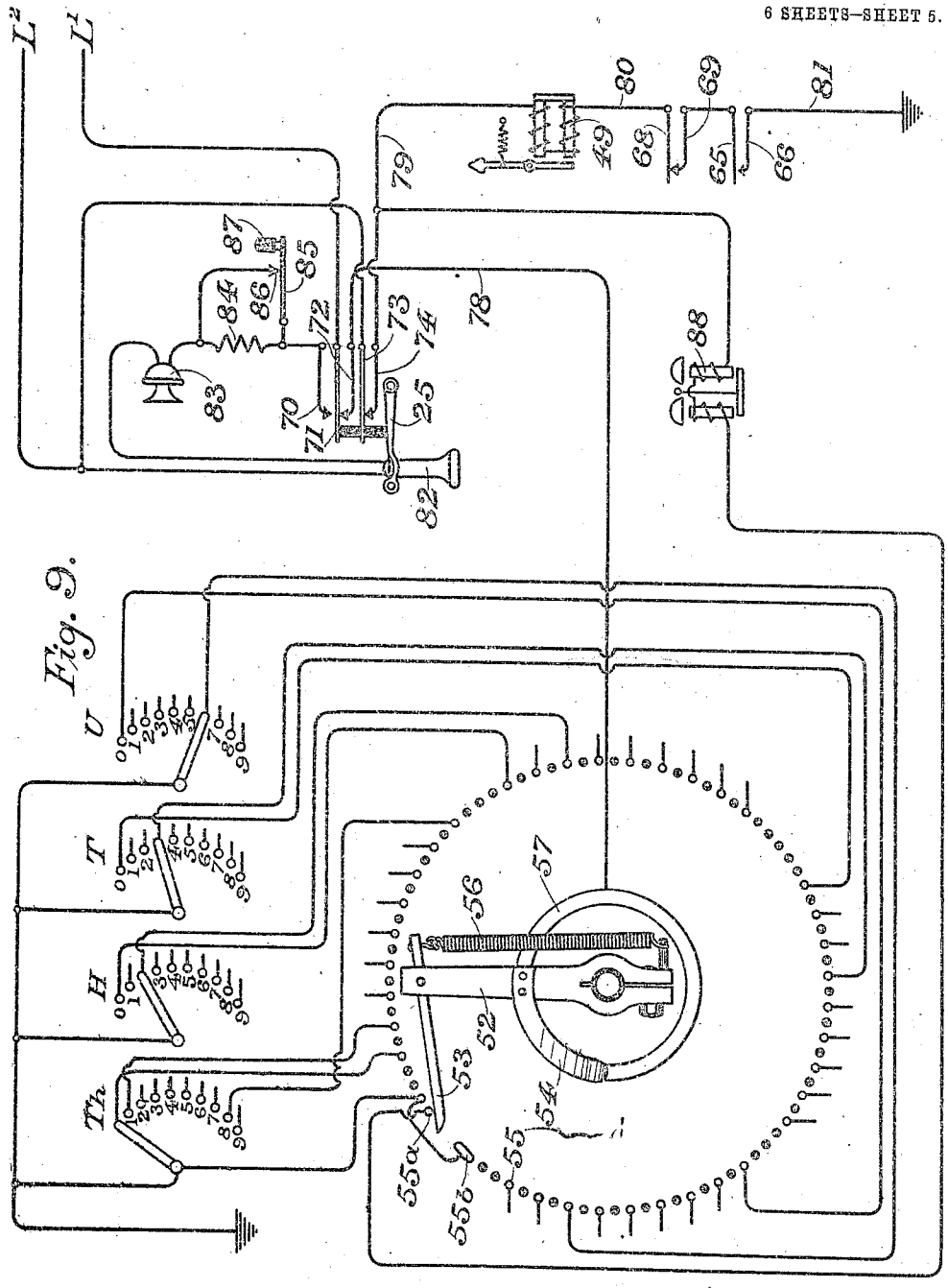

Fig. 9.

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6 SHEETS—SHEET 6.

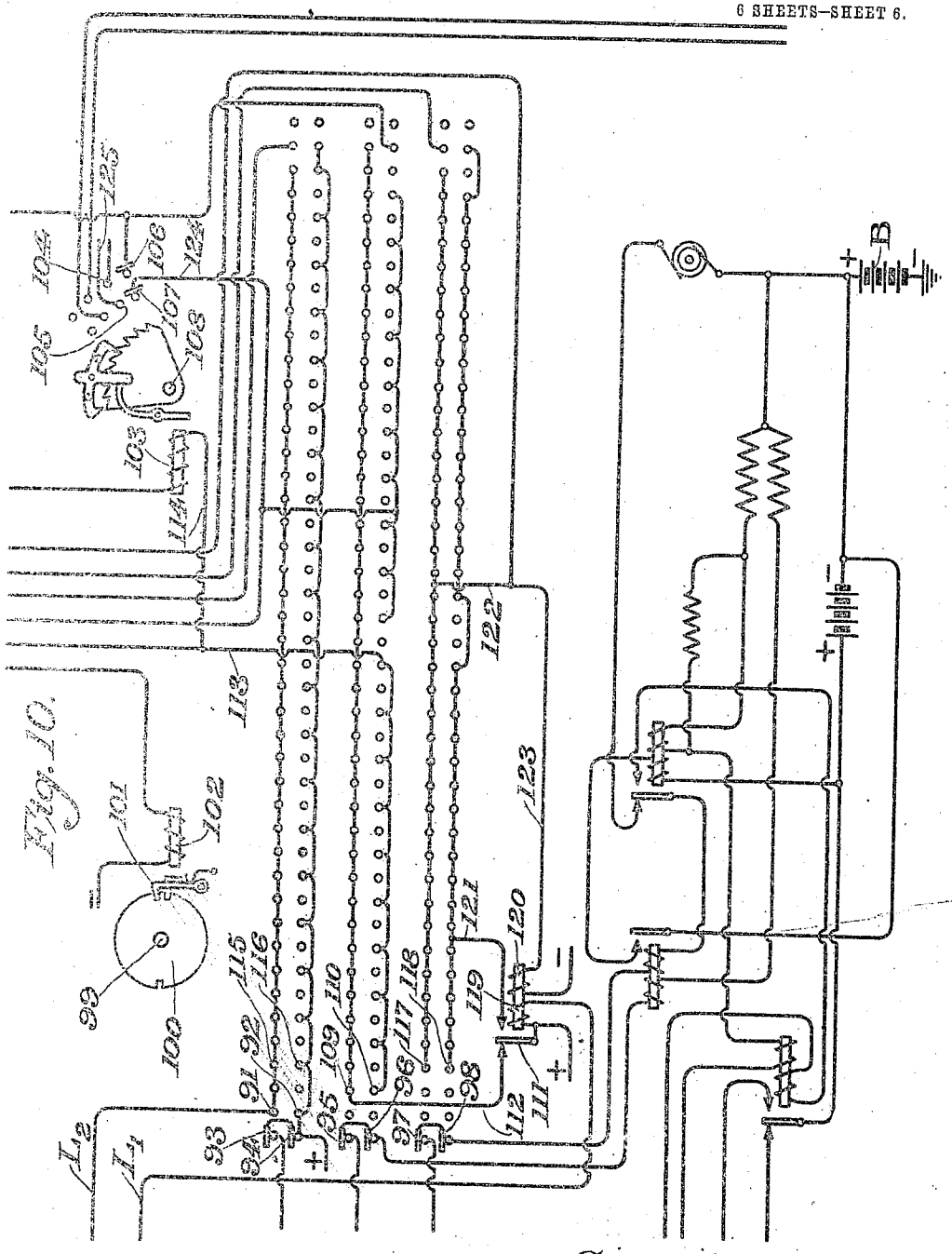

Fig. 10.

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UNITED STATES PATENT OFFICE.

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SIGNAL-TRANSMITTER FOR TELEPHONE-EXCHANGES.

1,024,088. Specification of Letters Patent. Patented Apr. 23, 1912.

Application filed April 11, 1906, Serial No. 311,139. Renewed August 7, 1911. Serial No. 642,818.

To all whom it may concern:

Be it known that I, GEORGE W. LORIMER, a citizen of the United States of America, and a resident of Piqua, county of Miami, and State of Ohio, have invented a new and useful Improvement in Signal-Transmitters for Telephone-Exchanges, of which the following is a specification.

My invention relates to substation equipments in automatic telephone exchanges, and has for its object the transmission and control of electrical signals or impulses by way of the telephone line between the substation and the central office, and the prevention of accidental or intentional interference with the transmission and control of these impulses or signals by a wrong act on the part of a person operating my invention.

The general character of the automatic exchange system with which my invention is designed to operate is as follows: The central office contains circuit-selecting switches so related to each other and to other circuit-controlling devices as to enable any line entering the central office to be placed in connection with any other line entering the central office and not already engaged. The circuit-selecting switches and their associated devices are of a type in which certain of the operations are performed by the rotation of circuit-carrying brushes over circuit-carrying contacts, this rotation being adapted to be arrested at a time when the brushes are in engagement with the contacts desired to be selected. This central office equipment and the device of my present invention are adapted for use with telephone lines of two wires each. The earth may serve as a third conductor for common use by the many substations and the central office, or in lieu of the earth a common return conductor may be used. Electric current for the operation of the circuit-selecting switches and associated devices in the central office and of electromagnetic mechanism at the substation is provided from some convenient source, preferably located in the central office.

Upon a call being instituted by a substation, the central office mechanism responds to the temporary grounding of one of the wires leading to the substation and as a result of current flowing from the central office over that wire to the substation ground places the line so calling in a relation to the circuit-selecting switches such that the succeeding operations of selecting the called line may proceed. In this process of selecting the called line the central office equipment sends impulses to the substation, these passing over the wire of the line which was not used for the preliminary impulse above described. The result of this series of impulses is to produce synchronous motion of parts in the substation and in the central office. The circuits and moving parts in the central office are so arranged that when, during this series of impulses over one of the wires, a ground shall be placed temporarily on the other wire at the substation, the circuit-selecting switch then in motion at the central office will be arrested in its motion as a result of the impulse caused by that grounding. As a plurality of central office switches may be associated successively with the calling line, one at each of several different stages of the setting up of a connection, so the entire series of impulses under description may be divided into several groups, each corresponding to the progressive motion of one central office switch, and each adapted to stop that motion when an impulse is produced, as described, in the wire not used for the series of impulses which control synchronism.

It is thus the object of my invention to respond to impulses in one circuit and by motion of its parts to make such contacts as will cause impulses in another circuit, to the end of placing its own line in connection with a desired other line.

My invention is illustrated in the following drawings in which similar letters refer to similar parts throughout the several views, and in which:

Figure 1 is a front view; Fig. 2 a rear view; Fig. 3 a rear view with certain parts removed; Fig. 4 a view of the hook switch for the telephone receiver; Fig. 5 a section on a central line as indicated in Fig. 2; Fig. 6 a detail of the gear train; Fig. 7 a sectional view as indicated in Fig. 2; Fig. 8 a sectional view as indicated in Fig. 2, Fig. 9 a circuit of an instrument embodying my invention. Fig. 10 is a circuit diagram of portions of the central office circuits and apparatus involved in the operation of the call sending device described in this application.

My invention is adapted to be associated

with telephone instruments of the usual type, including a transmitter and a receiver with such other elements as are requisite for the formation of a proper substation telephone set, in harmony with the particular system of transmission and signaling which is adopted for a specific installation. It is also adapted to be associated with a signal-receiving device, such as the alternating current ringer in general use, and with an indicator by which the subscriber may set up visibly before him the digits of the number of the line he wishes to call. Such an indicator for use with my present invention requires to be able to make certain connections as described later herein, and may well be of the particular type more fully disclosed in Letters Patent of the United States No. 790,966, granted to me on May 30th, 1905. In this present specification I will confine myself to describing this indicator only to such a degree as is essential to a complete understanding of my present invention.

Where I have used the terms "clockwise" and "anti-clockwise", without other limitation, I mean as the mechanism is viewed from the front, facing the handle 13 and the dial 50. When these directions of rotation are to be viewed otherwise, the figure showing the view is referred to.

By reference to Figs. 1, 2, 3 and 5, it will be seen that the base plate 11 supports all other parts, and that a chief feature of the entire structure is a spring-driven train of gears adapted, yet controlled by certain restrictions, to be wound by the shaft 12 and the handle 13 and to be run down by the rotation of the escapement 14. The spring by which the train is driven is 15, one end of which is attached to the disk 16, by the post 17, and the other to the post 18 with which the disk 16 in concentric. This post 18 is rigidly and non-rotatably attached to the base plate 11.

The disk 16 is joined by the link 19 to the disk 20. The construction is more clearly shown in Fig. 6. This junction is on such surfaces in the two disks, and at such angular positions, as to cause them to rotate in similar directions and at similar rates, quite as if the two disks were rigidly mounted on a common shaft.

The disk 16 is rigidly mounted on the hub 21, which carries a ratchet wheel 22, the latter having but four teeth in its periphery, these being equally spaced at intervals of ninety degrees, as more clearly shown in Fig. 3. The disk 16 further has two stops cut in its periphery, one, 23, being adapted to be engaged by the lug 24 on the back of the switch hook 25, and the other, 26, being adapted to be engaged by the tooth of the pawl 27.

The shaft 12, when turned in the direction indicated by the arrow, in Fig. 1, tends to wind up the spring 28, one end of which is attached to the shaft and the other to the post 29 rigidly mounted on the base plate 11. The shaft 12 carries the two disks 30 and 31. A portion of the latter disk is cut away, as shown in Fig. 2, so that by contact with one of the shoulders so left with the pin 32 on the disk 20, the latter disk may be turned by a clockwise rotation of the shaft 12 by the handle 13. Such a rotation of the disk 20 will cause a similar rotation of the disk 16. The disk 20 carries another pin 33 whose office it is when in normal position, as shown in Fig. 2, to engage the flat spring 34 in the pawl 35, keeping the tooth of the latter out of engagement with the disk 31, although this pawl would otherwise be drawn into such engagement by the spring 36; that is, the pawl 35 will engage the disk 31, preventing a clockwise motion from normal position, unless the pin 33 holds the pawl out of such engagement.

The disk 30 is a ratchet wheel having about a quadrant of its periphery cut with teeth adapted to be engaged by the pawl 37. By rotation of the shaft 12 successive teeth are engaged by the pawl 37, which is normally in engagement with the first tooth. But the handle 13 cannot be turned backward until it has been turned far enough for the pawl 37 to pass all the teeth which are cut and ride upon the uncut periphery of the disk 30, for the following reason: As the outer line of the teeth in this ratchet portion is in a circumference of less diameter than the full diameter of the disk 30, the pawl 37 when on the full periphery will be thrown out farther than in passing over the top of any single tooth. At such a time, therefore, the pin 38 in the end of an arm of the pawl 37 will be engaged by a shoulder on the end of the pawl 39. Pawls 37 and 39 are drawn toward each other by the spring 40 and when the engagement between them occurs at the pin 38, the tooth of 37 will be held out of the ratchet in the disk 30, so that if otherwise permitted this disk and the shaft 12 may return in an anti-clockwise direction to normal position; but in so returning, the pin 41, carried by the disk 30, will engage the end of the pawl 39, tripping its other end from the pin 38 and so allowing the pawl 37 to fall again into engagement with the first tooth of the ratchet in 30. It will thus be seen that while it is not possible to turn the handle 13 backward from any position in an incomplete clockwise turning, it will be free to return after it has passed its entire ratchet under the pawl 37, and would so return if released by the hand, because of the retractile action of the spring 28.

The post 18, described as concentric with the disk 16, serves as a shaft on which is carried the gear 42. This gear carries the

pawl 43, adapted to engage either of the four teeth in the periphery of the disk 22. The gear 42 is provided with a sleeve 44, which serves the double purpose of a hub concentric with the post 18 and of an axis for the sleeve 21, which joins the disks 16 and 22. When, therefore, the clockwise turning of the shaft 12 occurs, the described construction causes the disk 22 to turn. The relation of parts is such that when the handle 13 has turned the shaft 12 through the full angle provided for it, the disk 22 has turned a quarter revolution and the pawl 43 has engaged the next succeeding tooth. As the spring 15 is now wound up by a quarter turn of the disk 16, it is exerting force tending to turn the gear 42 in a clockwise direction, as viewed in Fig. 3. But the spring 15 thus wound may not run down at once. The gear 42 engages the spur 45, which is carried on the same shaft 46 as the gear 47, the spur 45, shaft 46 and gear 47 being united together rigidly. The latter meshes with the worm 48, whose shaft carries on one end the escapement 14.

The electromagnet 49 has an armature 50, the extreme end of which is so related to the escapement 14 that when the end of the armature opposite the magnet poles is drawn toward and released from them the escapement will be allowed to advance step by step. Alternate teeth of the escapement are bent in opposite directions. As shown in Figs. 2 and 3, any tooth which is bent toward the worm 48 will be engaged by the armature when it is attracted by the magnet 49; conversely, any tooth which is bent away from the worm will be engaged by the armature when it is not attracted by the magnet 49. To cause a flow of current, therefore, through the magnet 49, alternately attracting and releasing the armature 50, will permit the worm 48 to rotate and thus permit the running down of the spring 15 in an amount governed by the number of impulses through the magnet 49 and with a corresponding definite rotation of the shaft 46 and others in the train with it.

The shaft 46 extends through the base plate 11 to the front, reaching also completely through the insulating disk 51. The extreme end of the shaft 46 carries the arm 52 but is insulated from it. The arm 52 is provided with the brushes 53 and 54. The former is adapted to engage any one of a plurality of conducting pins or studs 55, mounted in the insulating disk 51, on a circumference having the axis of the shaft 46 as a center. These conducting pins are shown in Figs. 1, 5 and 9, and in the latter figure are shown as open circles if used as conducting terminals for wires, or as solid circles if they serve merely the purpose of insulating stops upon which the brush 53 may rest between contacts with adjacent wire-connected points. The brush 53 is held outward against these pins by the retractile action of the spring 56 and the brush 54 rests upon the ring 57, which, as shown in Fig. 9, forms a terminal for a conductor of the circuits. This conductor is thus constantly extended to the tip of the brush 53 and no electrical connection exists between the arm 52 and the shaft 46 which carries it, as an insulating bushing, 58, intervenes. The pin 55^a is that upon which the brush 53 rests when the mechanism is in its normal position, and a circuit is so completed as per a description later herein.

The previously described operation of turning the handle 13 to the end of winding up the spring 15 is obstructed in certain positions of other parts of my device. For example, the slot 23 in the disk 16 when in normal position is adapted, as shown in Fig. 2, to be engaged by the lug 24 on the back of the switch hook 25. If, then, the telephone receiver which this hook is adapted to carry shall not be on that hook, the lug 24 will engage the slot 23, preventing the disk 16 from rotating to wind up the spring 15. It is therefore impossible for a patron to turn the handle 13 to institute a call, unless the receiver hook 25 be down. Furthermore, it is impossible to turn the handle after it has once been turned completely to the right and allowed to return, because the pawl 35 now engages the disk 31, due to the absence of pressure of the pin 33 against the spring 34.

When the disk 30 is in its normal position, before a call is instituted, the pawl 60 engages a tooth in its periphery. This tooth is distinct from that series forming the ratchet or the pawl 37, and permits the pawl 60, when engaged by it, to keep its rear arm out of engagement with the pin 61, which projects from the under side of the armature 50. When the disk 30 is first turned in calling, the pawl 60 is lifted, and so by the pin 61, the armature 50 is pressed toward its pole pieces, being so placed in a position similar to that into which it would be attracted if the magnet 49 were energized. During the full operating position of the disk 30, therefore, the armature 50 will be held as if attracted by its magnets and may only be released to recede from its magnets when the pawl 60 again drops into its normal place when the handle 13 has gone back to normal position. It will be seen therefore that in instituting a call the turning of the handle 13 clockwise and its return anti-clockwise to the normal position will give the armature 50 a stroke, releasing the escapement 14 by two teeth to advance the brush 53 from the normal contact pin 55^a, with a resulting effect on the circuits. It is at the step of the second tooth

that pin 55ª is abandoned by the brush 53. It will also be seen that during a movement of the handle 13 in instituting a call no impulses in the magnet 49 could move the arm 50 to release the escapement 14, as it is mechanically held by the pawl 60 from any receding motion from the magnet.

The gear 47 carries concentric with itself a disk 62, which has one notch in its periphery adapted to be engaged by a pin 63 on the under side of the pawl 27. The pawl 27 is lifted out of the notch 26 in the disk 16 when a call is instituted. At the same time the pin 63 is lifted out of the single notch in the disk 62. As the gear 47 and the disk 16 both revolve, though in opposite directions, when the train is being run down, and as this gear and disk are in the same train, the parts of the pawl 27 may return to engagement as described when the train returns to the condition shown in Fig. 2. The disk 62 is motionless during the preliminary turning of the disk 16 to wind up the spring 15, and the pin 63 is lifted out of the notch of disk 62 by the action of the engaging inclined surfaces of notch 26 and pawl 27, but when the train is running down, or returning to the condition shown in Fig. 2, the gradual return of pawl 27 to its normal position (by the sliding of the inclined surfaces of 26 and 27) is prevented by the engagement of the pin 63 with the periphery of the disk 62, whereby the return of the pawl 27 is delayed until the disk 62 and gear 47 have returned fully to their normal positions, when by passing under the pin 63 of the abrupt shoulder of the notch of disk 62 the pawl 27 is permitted to return quickly into the notch 26. When the pawl 27 is being carried on the periphery of either disk 16 or 62, its insulating point 64 forces together the two contact springs 65 and 66, while in the normal position of the pawl 27 these springs are out of contact with each other.

The disk 30 carries a conducting piece 67, but is insulated from it. This conducting piece has no other electrical office than to make contact in the normal position of the disk 30 between the springs 68 and 69.

The switch hook 25 actuates springs 70, 71, 72, 73 and 74, these being assembled so that certain contacts are made when the hook 25 is down and certain others are made when it is up. The exact relation of the contacts made and broken can be best seen in Fig. 9, in which the parts are conventionalized and in which the spring 71 oscillates between the parts 70 and 72, while the spring 73 is adapted only to make contact with the piece 74 when the receiver is on the hook. In Fig. 9, springs 71 are shown as a single spring, which they really are, considered electrically, though they may conveniently be two in mechanical form.

The armature 50 carries a spring 75, so formed at its free end that the pin 76, carried by the switch hook 25, will pass freely by this formed end while passing upward, but will engage, in passing downward, with the result that the armature 50 on such downward motion of the hook switch will be thrown toward its magnet poles as if it were attracted by them. The relation of the springs 75 and the pin 76 may best be seen by comparing Figs. 2 and 7. This movement of the armature 50 will release a tooth of the escapement wheel 14, thus permitting a final step to the brush 53 to return it to its normal position upon hanging up the receiver after conversation. Further now in Fig. 9, certain of the pins, such as 55, 55ª and others in that circle, will be seen to be connected to contacts in the four series of switch points, each series having a radial arm. The four radial arms associated with these series switch points are connected to each other and to ground or to a common return wire. Each arm is adapted to be set to contact with either of the ten pins in its series and thus to ground the conductor leading from that pin to a pin on the disk 51 or dial, as it may be called. Nine points in each of the four series are provided with such wires, but the tenth point has no wire connection whatever. These four series of contact points with their levers form the device to which I have previously referred herein as an indicator. It will be seen that the left hand indicator lever in Fig. 9 rests upon its first or upper point and that this is connected to a pin on the dial. The second contact of the lefthand indicator lever is connected to the conducting pin of the dial which stands next to the right. Successive indicator pins associated with that lever are connected to successive conducting pins in what may be called the first quadrant of the dial, and similarly the second, third and fourth quadrants, counting clockwise, belong respectively to the second, third and fourth indicator levers, counting from the left. It is the province, therefore, of each indicator lever to ground one and only one of the conducting pins in its quadrant of the dial, and in practical use the positions of the indicator levers are indicated by some digit, 0 to 9, any such digit except 9 indicating a position in which one of the pins of the quadrant belonging to that lever is grounded. If the lever be upon the tenth or last pin of the indicator no pin in its dial-quadrant will be grounded.

The central office apparatus is so designed as to coöperate with the substation signal transmitter as follows: Current impulses are sent from the central office over line L^2 to ground, successively energizing and deënergizing electro-magnet 49, thus permitting brush 53 to step around and successively

connect with the points in its circle in proper synchronism with selective stepping devices in the central office, the selective stepping devices at the central office being further controlled by ground circuits encountered upon L^1. Thus when in the condition shown in Fig. 9, the arm 52 revolves in response to control of electro-magnet 49, the brush 53 comes into electrical connection with the fifth point when the central office stepping apparatus is in a position corresponding to "0" thousands, since the digit arm "Th" is set upon "0" thousands. In similar manner the position of the digit arms H, T, U are signaled to the central office through the occurrence of grounds upon L^1 in the travel of the brush 53 as controlled by impulses from the central office over L^2. Such control is taken for the four quadrants independently to provide for the four digits. A separate stepping device at the central office pertains to each digit and is individually controlled by the brush 53 when in the corresponding quadrant. This central office stepping device is controlled by a series of impulses associated with the impulses which step the brush 53 forward, the central office stepping device being stopped when a ground is encountered upon L^1. For the selection of digit "0" on any digit arm, the ground is placed upon the first conducting pin of the quadrant; to select digit "9" on any digit arm, no ground is used, the central office stepping device not being stopped by a ground upon L^1, such stoppage being unnecessary as the stepping device is provided with ten steps and for the selection of this digit "9," the stepping device passes to its last possible position. As the ground on L^1 is required only for those digits in which the central office stepping device requires to be stopped before its extreme position is reached, it follows that at times the grounds encountered by the brush 53 may be fewer than four, and in the case of selection of the number 9999, no ground whatever would be encountered by the brush 53.

As the province of the indicator is to set up the digits of the called line's number, and that of the dial to have one pin in each quadrant grounded for control of the central office machines, it will be seen that with the exact construction described the patron may call any number from 0000 to 9999, or a total possible maximum of 10000 different numbers.

By providing five levers in the indicator, and five series of pins in the dial, any number to 99999 can be called, a total of 100000 different numbers. In like manner any greater or less number of indicator levers and series of dial pins may be provided.

In Fig. 9 there are shown four indicator levers, respectively marked Th. H. T. and U, signifying that a given lever shall be used to indicate the digit standing in thousands, hundreds, tens or units place in the called number. The digits 0 to 9 adjacent to the points of each indicator are designate the particularity of the digit in each such period. The lever positions shown in Fig. 9 are such as to call the number 236.

The pin 55^b of the dial is for convenience and certainty made somewhat wider of contact surface than are the remaining pins. This is connected electrically to the pin adjacent to and adjoining on the right the pin 55^a. This is in turn connected to ground.

The switch hook 25 being down and a call having been instituted by winding up the train as described, the return of the handle 13 to normal position steps the brush 53 from the pin 55^a to the adjacent one through the described motion of the armature 50. In this condition the circuit may be traced from ground via 53, 52, 54, 57, conductor 78, contact 72, spring 71, wire L^1, to the central office. The central office apparatus, responsive to this grounded condition of the wire L^1 will appropriate the line formed of L^1 and L^2, thereafter sending impulses over the wire L^2 via spring 73, contact 74, conductor 79, magnet 49, conductor 80, contacts 68, 69, contacts 65 and 66 and conductor 81, to ground. It will be recalled that the contacts between 68 and 69 as well as 65 and 66, respectively are closed in this condition of parts. The successive impulses so received by the magnet 49 advance the arm 52 by successive steps, the first impulse causing it to step off of the grounded pin adjacent to 55^a. In passing through the first quadrant the brush 53 engages a grounded pin unless the left hand indicator is set for the digit 9. The same will be true for each other quadrant, as controlled by the position of the corresponding indicator lever. The proper stoppage of central office circuit-selecting switches will be effected by impulses over wire L^1 when these grounds occur, or no stoppage will be effected if the digit be 9, and by successive impulses the brush 53 ultimately will rest on the contact 55^b. In that position of the train, the hook switch 25 can rise if the receiver be removed, although the pawl 27 will not yet have fallen to break contact between springs 65 and 66. Upon the lifting of the lever 25, the making of contact of 71 with 70 and the breaking of 73 from 74 establish an ungrounded talking circuit from L^1 to L^2 through the receiver 82 and transmitter 83 or through any other arrangement of telephone instruments which may be preferred. The resistance 84, which is high relative to other parts of the circuits of the system, will be included in series with the line and telephone circuit if the spring 85 and contact 86 be separated by pressure on the button 87. During conversation this button

is not depressed, but for other purposes of signaling the resistance 84 will be placed in series with the line by such a pressure. Throughout the conversation which ensues, the circuit from the conductor 79 through the magnet 49 to ground remains intact. At the close of the conversation, therefore, when the receiver is once more placed upon the hook 25, contact 73 with 74 will reclose the wire L^2 through the former circuit including the magnet 49. An impulse from the central office at this time will operate the magnet 49 and advance the brush 53 to its normal pin 55^a. In order that it may be insured that the brush will so advance even in the event of no such impulse being received from the central office, the mutual relations of the spring 75 and pin 76 exist.

The device 88 is a polarized ringer or other suitable signal device of the type usual in telephone practice. When the brush 53 is on the normal pin 55^a a circuit from wire L^1, through the hook switch contacts, ring 57, arm 52, brush 53, pin 55^a, and ringer 88 to the wire L^2, will indicate how a signal may be received as a response to ringing currents placed upon the metallic line.

Although the figures do not show the wood or metal box usually provided as a mounting and protection for the parts of a substation telephone, it will be apparent that my invention is adapted to be so mounted, the base plate 11 being attached to the inner side of say the door or front of such a casing. The shaft 12 is adapted to extend through such door, the handle 13 being on the outer or outside.

The apparatus at the central office consists of trunking and connecting devices, and may be separated into two classes, namely: devices for connecting a calling line to an idle trunk, and devices for connecting the trunk thus taken with the line desired for conversation. The signal transmitter of my invention is independent of the devices of the first class, and for that reason I have not shown them; plugs and jacks answer the purpose, or each line may be directly connected to apparatus of the second class without devices of the first class. The latter alternative I have chosen for illustration, and I show the line L^1 L^2 of Fig. 9, passing into Fig. 10 and there connected to a device of the second class, such portions of the apparatus being shown as will illustrate the operation of the signal transmitter and central office apparatus so far as the determination and execution of the first directory digit is involved.

In Fig. 10 the parallel rows of circles 91, 92 represent fixed contacts in a cylindrical contact bank, each horizontal row consisting of forty-four contacts extending entirely around the cylindrical surface. There are six such rows or circles of contacts, being substantially three double rows. Movable brushes 93, 94, 95, 96, 97, 98 are pivotally mounted axially within the cylinder and are adapted to move over the rows of contacts. Brushes 93—94 are connected and form substantially a double bridging brush for the upper double row of contacts; the same is true of the pairs of brushes 95—96 and 97—98. The construction here described is well known in the art and is specifically set forth in British patent to Wise, No. 8,648 of 1901. The brushes are mounted upon shaft 99 which carries the clutch disk 100 engaged by the clutch dog 101, the dog being controlled by the electro-magnet 102; the brushes move continuously over the contacts when the dog is withdrawn from the clutch disk. An auxiliary rotary switching device is shown controlled by the electro-magnet 103. In this device is a double arc of waiting contacts 104—105, etc., a pair of movable brushes 106—107 carried by the shaft 108 concentric with the waiting contacts, and the electro-magnet 103 having an armature adapted to control the movement of the brushes over the contacts step by step. Such other of the elements of Fig. 10 as are involved in the operation of the signal transmitter will be understood by the following description of the operation of the device. The position of the brush 53 in Fig. 9 is that occupied by that brush when the signal transmitter is not in use. It has been described that upon institution of a call, the brush 53 is set forward mechanically two steps; that the first step is not sufficient to cause the brush 53 to pass the pin 55^a, and that the second step of the brush 53 causes it to leave the pin 55^a and to pass into contact with the adjacent pin which is connected to earth at the substation. In this position the circuit may be traced from positive side of battery through the relay helix 119 to L^1 and thence through 71, 72, 78, 57, 54, 52, 53 and second pin to earth.

As the device of Fig. 10 begins to revolve, the bridged brushes 93—94 connect the positive terminal of battery through contacts 91—92 to L^2 thus completing a circuit over L^2, 73, 74, 79, 49, etc., to earth, energizing 49 and causing brush 53 to take one step which breaks the circuit through helix 119, just described, and places the brush 53 in contact with the third pin, which is an insulated one. As the brushes 93—94 pass farther, the circuit through them is interrupted at 94—92, and by the consequent de-energization of 49 the brush 53 is advanced another step and now rests in contact with the fourth pin which also is an insulated one. Next, the brushes 95—96 make connection with contacts 109—110 and a circuit is completed from positive side of battery

through 111, 112, 109, 95, 96, 110, 113, 114, 103, and to earth, energizing 103 and causing the brushes 106—107 to step forward one step into connection with contacts 104—105 respectively, which are the contacts corresponding to the "0"-thousand group of subscribers' lines. Next, brushes 93—94 connect contacts 115—116, and brushes 97—98 simultaneously connect contacts 117—118: the former pair of brushes close a circuit from positive terminal of battery to L^2 and thence through 73, 74, 79, 49, etc., to earth, causing brush 53 to make a step and to pass into contact with the fifth pin, which is connected to earth at the substation; by this movement of the brush 53 a circuit is closed from the positive terminal of battery through the relay helix 119 to L^1, 71, 72, 78, 57, 54, 52, 53, fifth pin, thence to the first or No. "0" point of the thousands digit indicator, and inasmuch as the thousands digit arm in Fig. 9 is set upon that point, the circuit is completed to earth at the substation thus energizing the relay helix 119 and attracting the armature 111: by the attraction of the armature 111, the circuit is closed from positive pole of battery through 111, 121, 118, 98, 97, 117, 122, 123, relay helix 120 to negative pole of battery, which circuit is a locking circuit to maintain the relay armature 111 independently of the continuance of the substation contact of brush 53. By this locking of the armature 111, the conductor 112 is isolated from the battery terminal and further closing of the circuit above described as energizing magnet 103 is impossible. In the continuance of the motion of the brushes, the brushes 93—94 repeatedly energize and de-energize magnet 49 and thus step the brush 53 over the first quadrant of the signal transmitter, while brushes 97—98 hold closed the locking circuit of the relay winding 120. As the brushes leave the twenty-first contact of their respective rows, the locking circuit of the relay helix 120 is broken: the brush 53 at this time has passed beyond the first quadrant of the signal transmitter and is entering the second quadrant. As before, the brushes 93—94 send current impulses over the line L^2 to propel the brush 53, the brushes 95—96 send current impulses through 111—112 and thence through wire 121 and 125 to some further device for interpreting the second or hundreds digit as determined by the setting of the hundreds digit arm in Fig. 9. As in the case of the thousands digit, impulses will be sent by brushes 95—96 until brush 53 encounters a grounded pin in the signal transmitter, whereupon the armature 111 will be attracted by energization of helix 119 and will be retained by energization of helix 120, thereby preventing further impulses and thus determining the control of the distant brushes acting to select in response to control by the hundreds digit arm of the signal transmitter in a manner analogous to brushes 106—107 in response to control of the thousands digit arm of the signal transmitter. The third and fourth quadrants of the signal transmitter are controlled by a further device similar to that of Fig. 10, and the digital signals from the brush 53 are similarly interpreted.

It has been set forth that the signal transmitter of this application is adapted to cooperate with a type of automatic telephone switching system already disclosed elsewhere and understood in the art to which this present invention pertains, only such portions of the entire system being herein disclosed as are required to illustrate the operation of the signal transmitter.

I claim—

1. In a signal transmitter for telephone exchanges, a spring-driven gear-train, manual winding means therefor, an electromagnetic escapement for said gear-train under control of the central office, a dial comprising adjacent series of contacts, a brush driven by said gear-train and adapted successively to engage all the contacts of said dial, a disk carried by said manual winding means and having a notch in its edge: and a bell crank lever normally engaging said disk in its notch and normally extending near a movable part of said escapement, said bell crank lever being adapted to be moved when said manual winding means is operated and then to be held by the edge of said disk in such position that it extends into the path of said movable part of said escapement whereby said escapement is mechanically locked against electromagnetic operation during the act of winding.

2. In a signal transmitter, a spring-driven gear-train, manual winding means therefor, an electromagnetic escapement for said gear-train, a dial comprising adjacent series of contacts, a brush driven by said gear-train and adapted successively to engage all the contacts of said dial, and a lever positioned to engage the movable part of said manual winding means and a movable part of said escapement, whereby by the movement of said winding means to institute a call, said lever is moved and said escapement is actuated mechanically to advance said brush from its normal position.

3. In a signal transmitter for automatic exchanges, a main-spring and a gear-train driven thereby, an electromagnetic escapement for said gear-train, a dial comprising adjacent series of contacts, a brush driven by said gear-train and adapted to engage the contacts of said dial, and manual winding means for said main-spring self-lock-

ing against return to normal position when said main-spring is partly wound and self-locking against further winding after return to normal position and before full operation of said gear-train.

4. In a signal transmitter for automatic exchanges, a main-spring and a gear-train driven thereby, an electromagnetic escapement for said gear-train, a dial comprising adjacent series of contacts, a brush driven by said gear-train and adapted to engage the contacts of said dial, and manual winding means for said main-spring self-locking against return to normal position when said main-spring is partly wound and self-locking against further winding after return to normal position and before full operation of said escapement.

5. In a signal transmitter for telephone exchanges, a main-spring, a gear-train driven thereby, an electromagnetic escapement for said gear-train, a circuit for said escapement, a contact dial, a brush adapted successively to engage the contacts thereof, and manual winding means for said main-spring self-locking against return to normal position when said main-spring is partly wound and adapted to interrupt said escapement circuit when the winding means is not in normal position.

6. In a signal transmitter for telephone exchanges, a main-spring, a gear-train driven thereby, an electromagnetic escapement for said gear-train, a circuit for said escapement, a contact dial, a brush adapted successively to engage the contacts thereof, and manual winding means for said main-spring self-locking against return to normal position when said main-spring is partly wound and adapted to interrupt said escapement circuit when said main-spring is partly wound.

7. In a telephone signal transmitter, a main-spring and manual winding means therefor, a gear-train driven by said main-spring, an electromagnetic escapement for said gear-train, a circuit for said escapement, and means adapted to open said circuit at the beginning of the manual operation of said winding means and to hold said circuit open until the return to normal of said winding means.

8. In a telephone signal transmitter, a main-spring and manual winding means therefor, a gear-train driven by said main-spring, an electromagnetic escapement for said gear-train, a circuit for said escapement, and means adapted to open said circuit during the manual winding of said mainspring, and further means for opening said circuit when said gear train is in its normal position of disuse.

9. In a substation telephone, a main spring, a gear-train, a handle adapted to wind said main spring, pawls adapted to obstruct said handle against return to normal position until said main spring has been wound to a predetermined degree and to obstruct said handle against return to normal position after a winding to a predetermined degree, and to prevent the further operation of said handle until said gear-train has returned to normal position.

10. In a substation telephone, an electromagnetic escapement and a gear-train controlled thereby, a switch-hook locking said gear-train when elevated, a contact-dial and a brush therefor, means adapting said brush successively to close circuits through contacts of said dial, one circuit being possible for each digit of a called telephone number, and mechanical means adapted to advance said brush from position of conversation to normal position when said switch-hook is depressed.

11. In a substation telephone, a rotary signal transmitting mechanism having a stop position completing circuits for conversation upon a call originating at the substation telephone, and having another stop position completing circuits adapted for conversation upon calls terminating at the substation telephone; a switch hook lever forming a part of the substation telephone; and mechanical mutually engaging members upon said lever and upon the signal transmitting mechanism whereby by the downward movement of said lever after conversation the signal transmitting mechanism is advanced by mechanical control to its position for receiving calls.

12. In a substation telephone, a contact dial and a brush therefor, a gear train driving said brush, an escapement governing the movement of said gear train and having a vibratory member; a hook switch lever; and coöperating members upon said lever and upon the vibratory member of said escapement and adapted to engage each other by a downward motion of said lever whereby said brush is advanced by a downward movement of said switch lever.

Signed by me at Piqua, county of Miami, State of Ohio, in the presence of two witnesses.

GEORGE W. LORIMER.

Witnesses.

GEORGE ALBERT VAUGIER,
CHARLES ROSSO LAWRENCE.