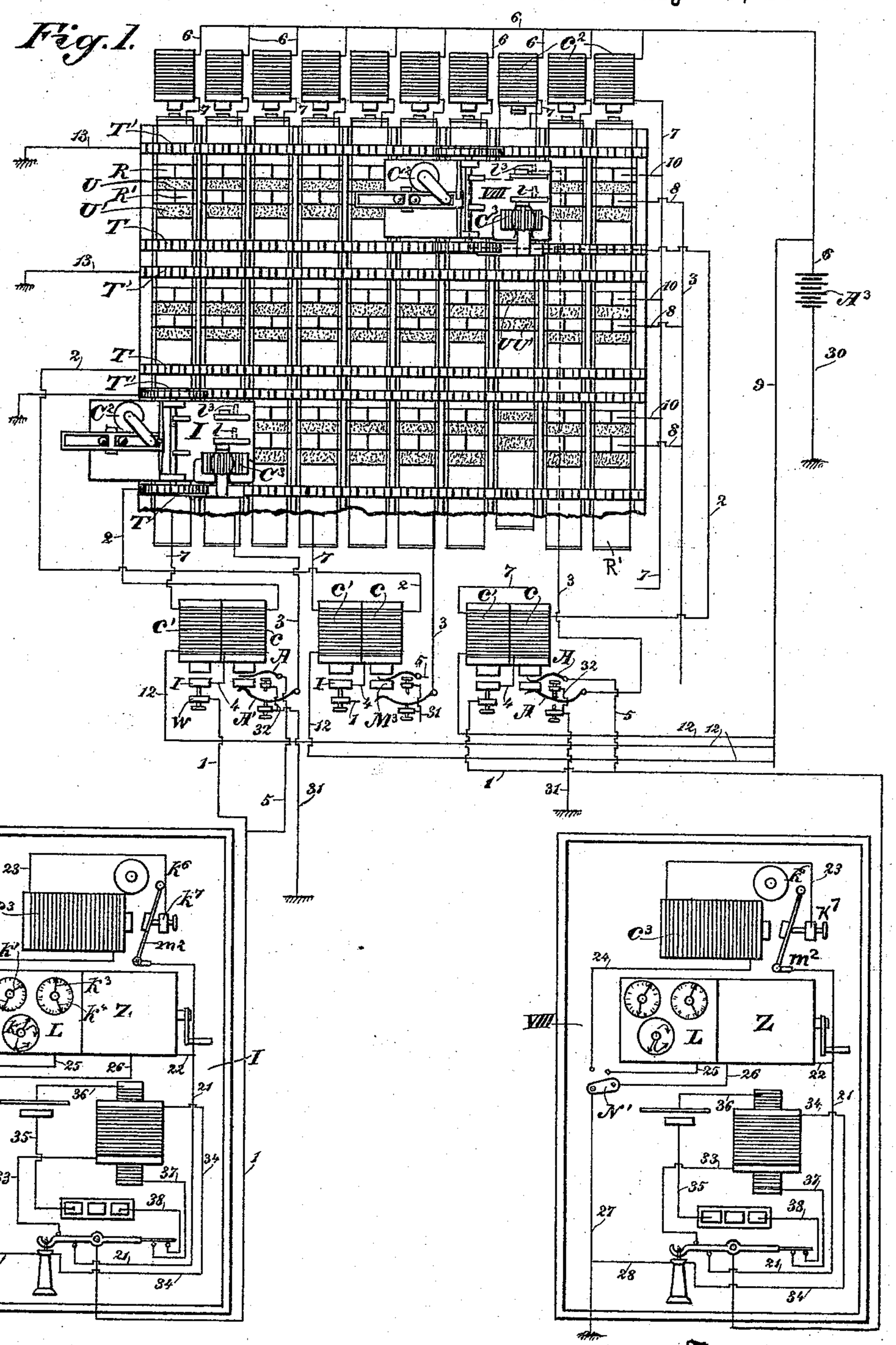
(No Model.) 4 Sheets—Sheet 1.

W. Y. SHIBATA.

TELEPHONE EXCHANGE.

No. 543,160. Patented July 23, 1895.

Fig. 1.



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(No Model.)

4 Sheets—Sheet 2.

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TELEPHONE EXCHANGE.

No. 543,160. Patented July 23, 1895.

Fig. 2.

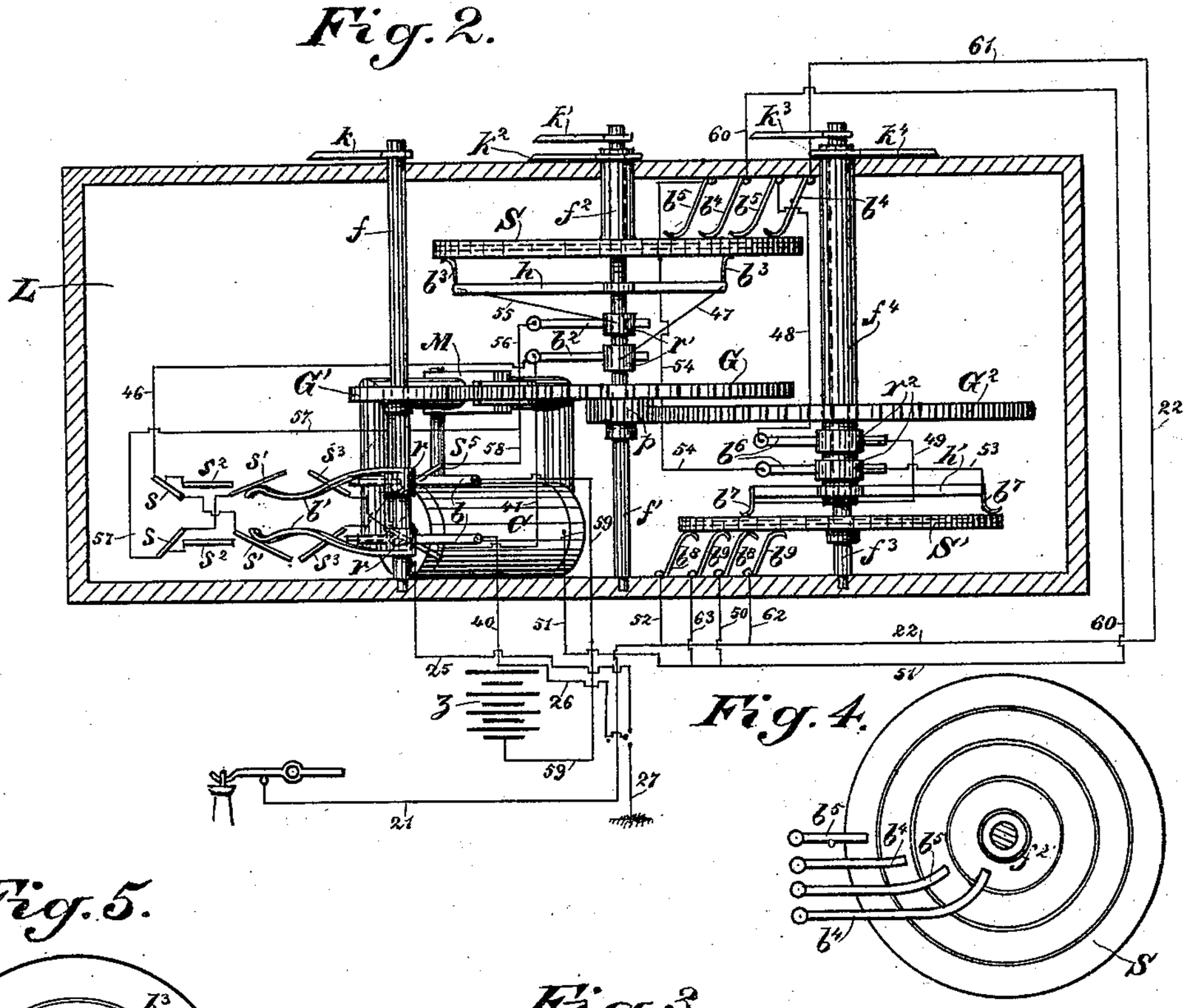


Fig. 4.

Fig. 5.

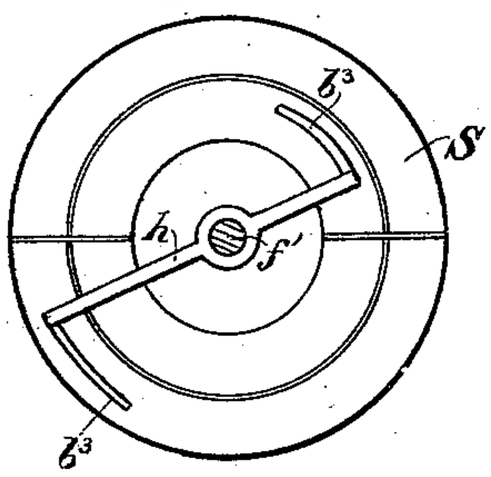
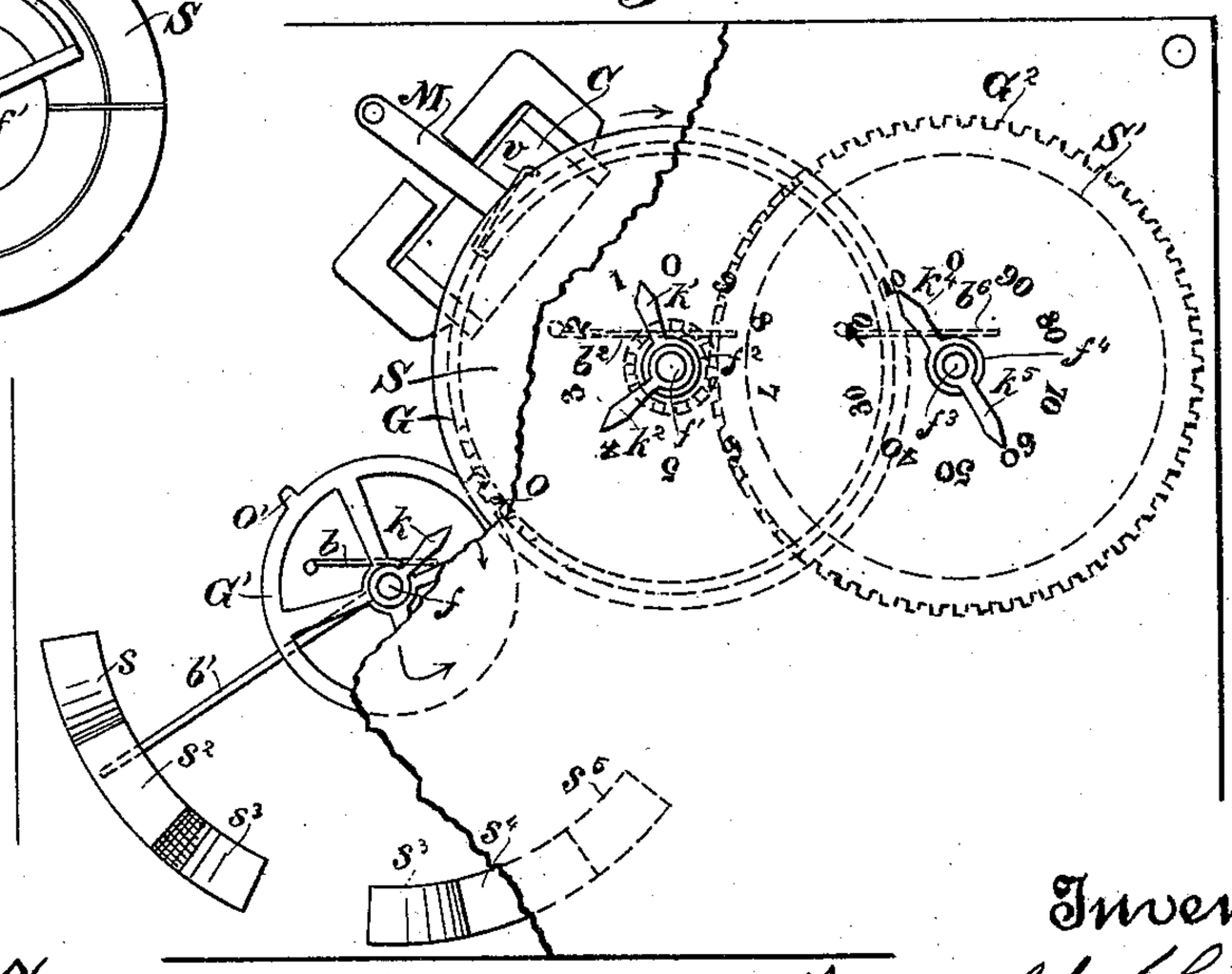


Fig. 3.



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No. 543,160. Patented July 23, 1895.

Fig. 6.

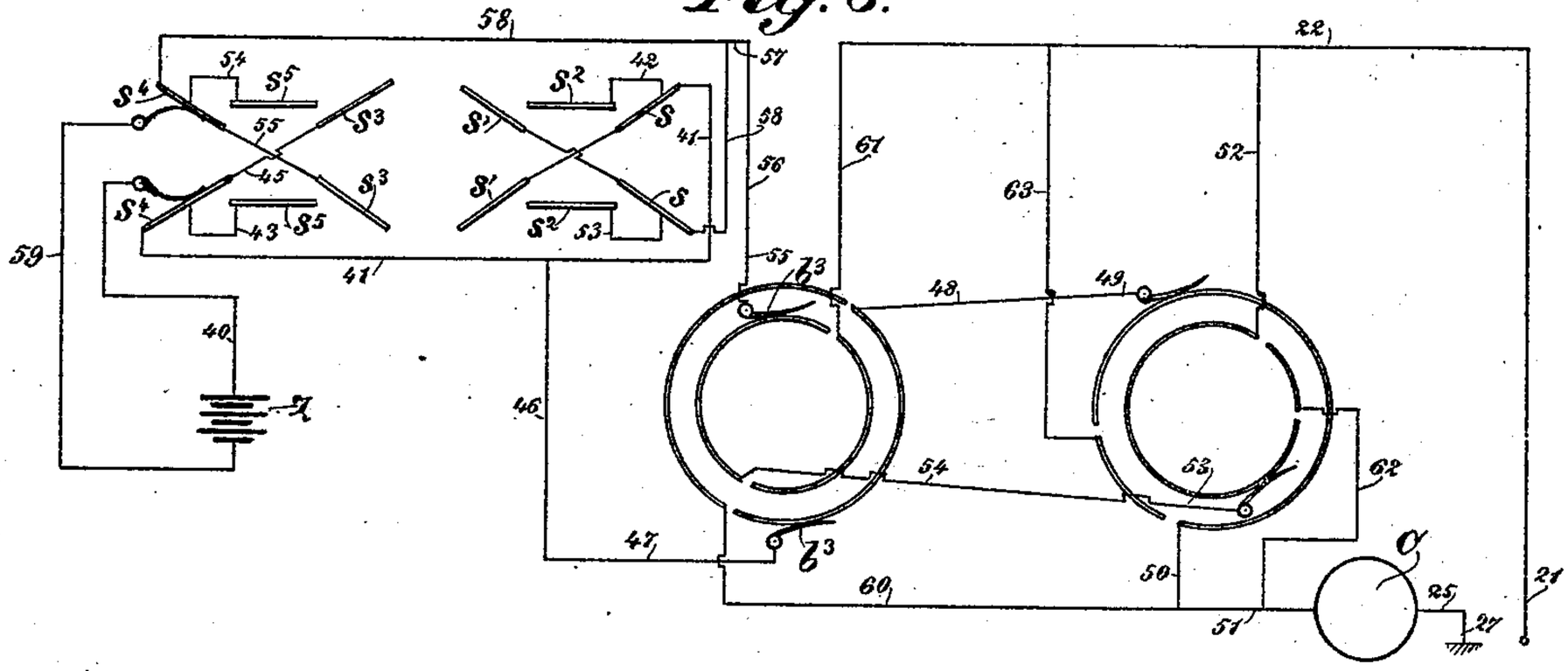


Fig. 7.

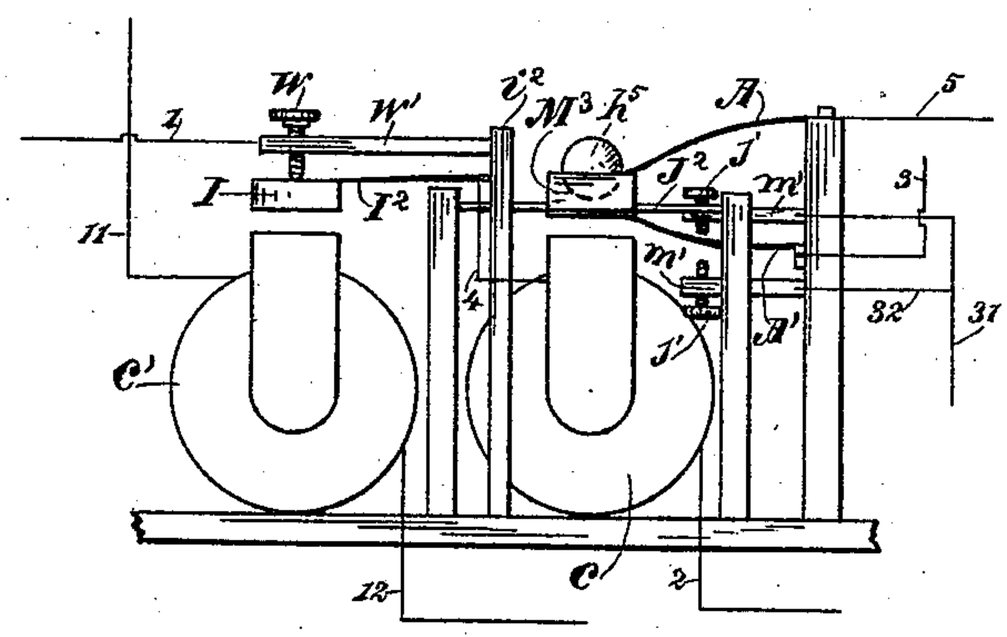
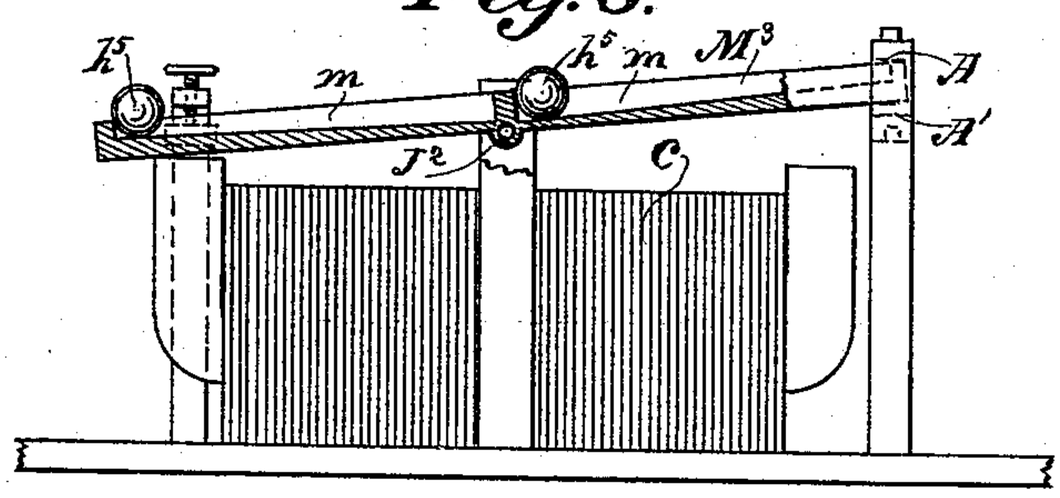


Fig. 8.



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TELEPHONE EXCHANGE.

No. 543,160. Patented July 23, 1895.

Fig. 9.

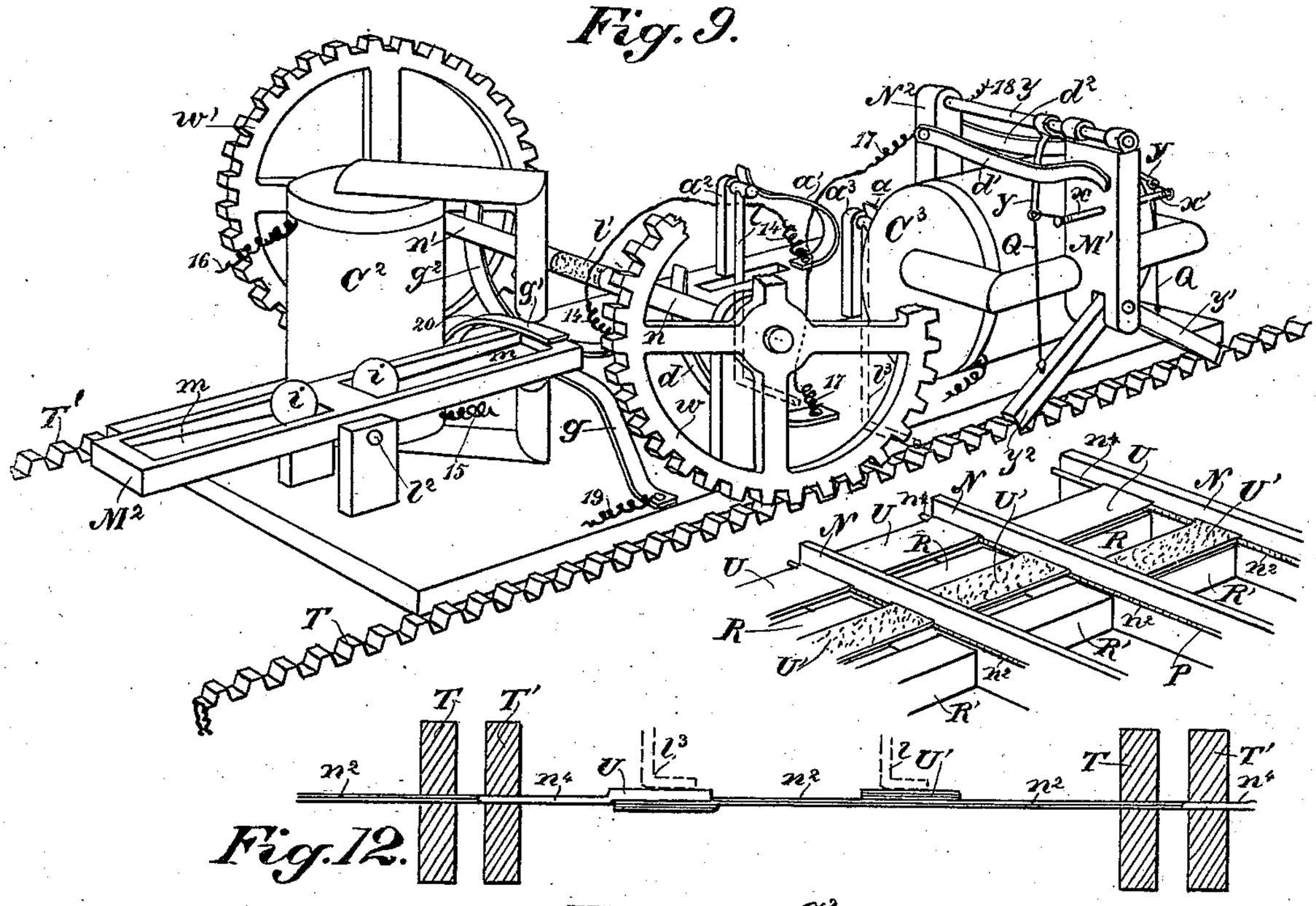


Fig. 12.

Fig. 10.

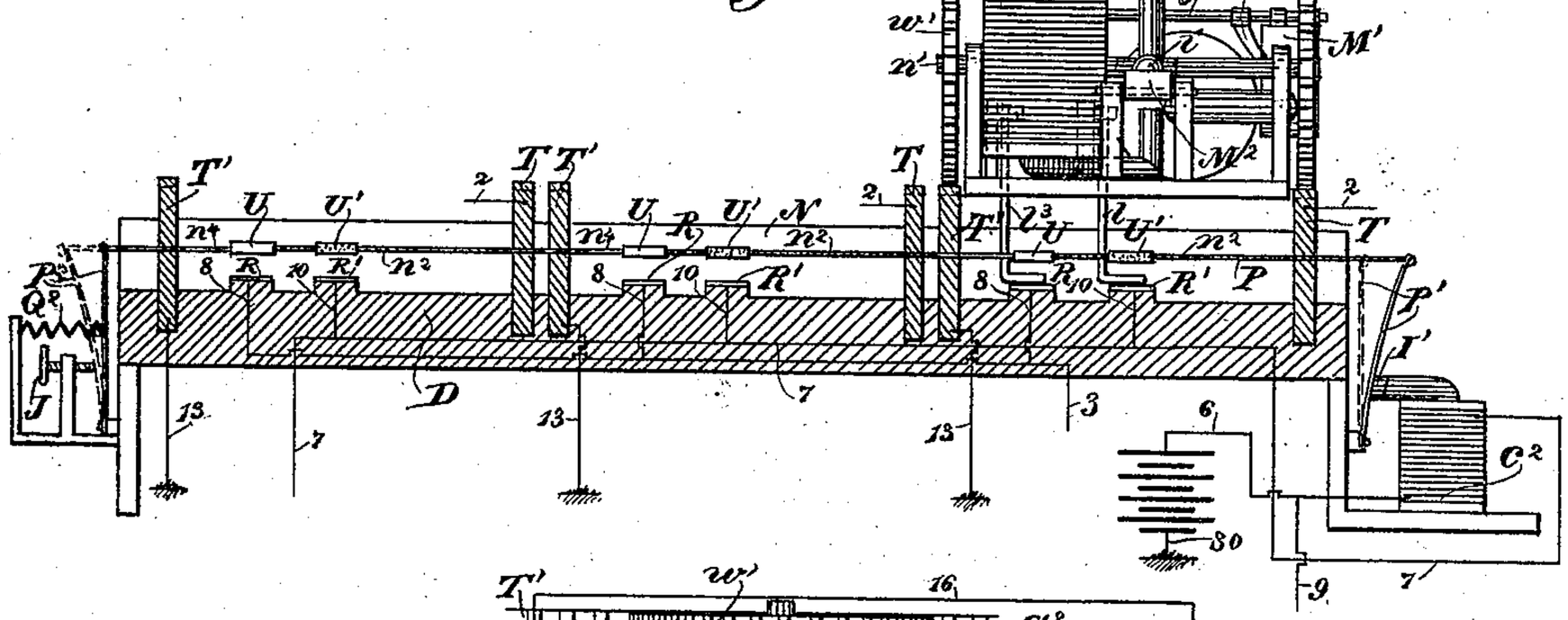
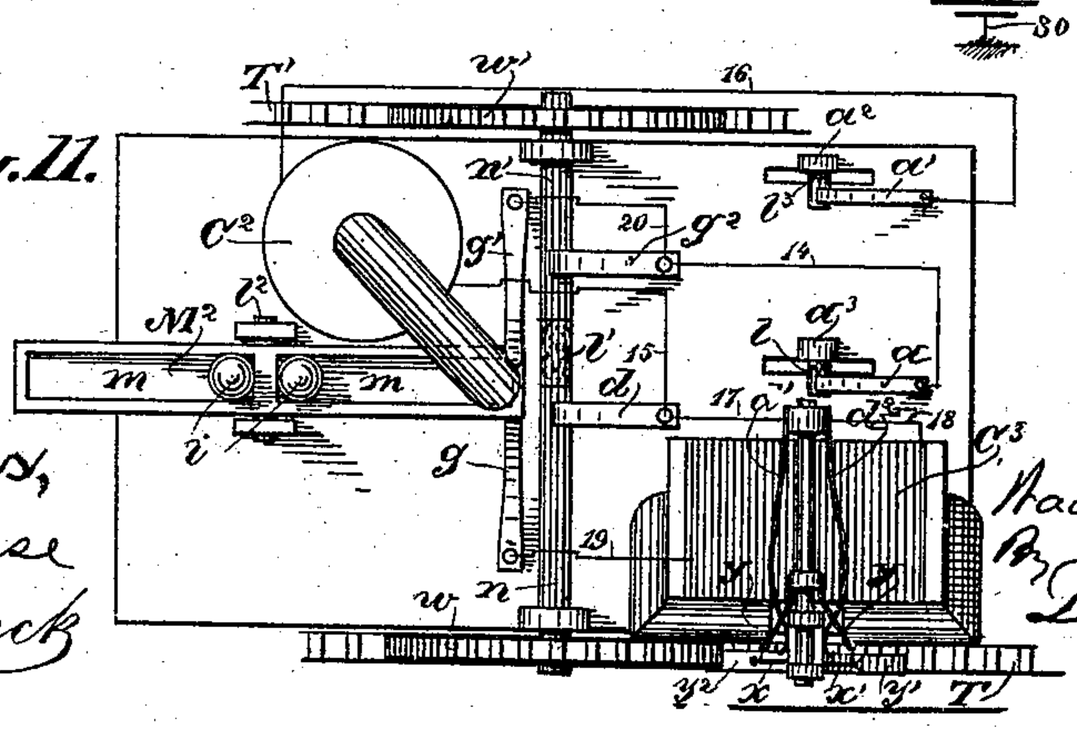


Fig. 11.



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UNITED STATES PATENT OFFICE.

WADA Y. SHIBATA, OF SAN FRANCISCO, CALIFORNIA.

TELEPHONE-EXCHANGE.

SPECIFICATION forming part of Letters Patent No. 543,160, dated July 23, 1895.

Application filed October 11, 1894. Serial No. 525,615. (No model.)

To all whom it may concern:

Be it known that I, WADA Y. SHIBATA, a citizen of Japan, residing in the city and county of San Francisco, State of California, have invented an Improvement in Telephone-Exchanges; and I hereby declare the following to be a full, clear, and exact description of the same.

My invention relates to an automatic telephone-exchange system in which each subscriber is enabled to connect himself at pleasure with any other subscriber and to disconnect himself therefrom.

It consists in certain details of construction which will be more fully explained by reference to the accompanying drawings, in which—

Figure 1 is a general diagrammatic view of my system, showing an arrangement of the central office with two subscribers. Fig. 2 is a view of the inside indicating and reversing device. Fig. 3 is a view showing the relation of the indicating-pointers and other parts. Fig. 4 is a top view of one of the switches. Fig. 5 is a bottom view of the same. Fig. 6 is a diagrammatic view of the reversing and switching device. Fig. 7 is an end view of a subscriber's set of circuit-breakers in the main office. Fig. 8 is a side view of the same, showing the circuit-breaker for the coil C and section. Fig. 9 is a perspective view of the subscriber's car. Fig. 10 is a section through the blocks at right angles to the brackets. Fig. 11 is a plan view of the car. Fig. 12 is a detail view of the protectors.

In Fig. 1, which represents the central office of the exchange system, where the different telephone-line wires 1 are concentrated, they are arranged so that they may be connected in circuit with each other, when desired, by means of cars movable over tracks T and T′, which extend transversely over the lines of wires. The mechanism is arranged at the central office upon an exchange frame or box, into one side of which the telephone-wires 2 and the ground-wires 13 enter, and in another side the wires 3, which are branches of the main wires 1 and the wires 7. The tracks T and T′ are laid over bars D, which are suitably supported, as shown in Fig. 10. There are as many of the tracks T and T′ as there are subscribers and as many of the bars D as there are tracks. These bars D are made of wood and are provided with metallic contact-points R, which are electrically connected with the wires 3 by means of wires 8, and other contact-points R′, which are connected by wires 10 to the wires 7, and these are to be connected automatically by means of what I term "connectors" l and l^3, depending from the operating-car, upon which they are suspended, so that when brought into proper relation they will connect the tracks on which the car is traveling with the wires 3 and 7, and thus close the circuit for communication as well as that of the battery A^3.

The operating-cars traveling upon the tracks T T′, which connect with the main telephone-wires and the ground-wires, act to close the circuit between these tracks. The operating-car is mounted upon wheels $w\,w'$, which are adapted to travel upon the tracks and across the frame. These wheels have teeth, as shown in Figs. 1 and 9, which engage with corresponding teeth in the tracks, so that when the wheels are rotated and in engagement with these teeth they will cause the car to advance in one direction or the other. The shaft of these wheels is made of two metallic portions $n\,n'$, connected by an insulated portion l', as shown in Fig. 9, and this prevents the current flowing directly from one wheel to the other through the shaft. Upon the car is mounted the motor-magnet c^3, which is designed to control the swinging permanent magnet M′, Figs. 9 and 10. This magnet M′ is suspended by its upper end from a supporting-bracket y attached to the standard N^2, so that the lower end of this magnet may swing about its fulcrum-point, and it swings between a central point and one of the ends of the core of the electromagnet C^3 when the latter is energized and de-energized. To the lower end of this swinging magnet M′ are pivoted the pawls $y'\,y^2$, which diverge from their pivot-points and extend downwardly, so that their lower outer ends may engage the teeth of the track T T′. By a suitable mechanism, hereinafter described, one of these pawls may be raised out of contact with the teeth, and, the other remaining in contact with the teeth, it will be seen that the oscillations of the magnet M′ will first draw this pawl forward over

one tooth and drop it into the next space; then when the magnet moves in the opposite direction, by pressing against this pawl it will act to propel the car in that direction, and when the car is to be reversed the other pawl is dropped into contact with the teeth and this first one is raised. This operation is performed as follows: The magnet M′ has fixed upon its upper end the arms or brackets $x\,x'$, having loops or openings in their outer ends which serve for the attachment of light silk threads Q. These threads have their lower ends attached to the pawls $y'\ y^2$, as shown in Fig. 9, and, extending up through eyes in fixed brackets y, they lead to the ends of the arms $x\,x'$, to which they are fixed. As the arms $x\,x'$ partake of the oscillating motion of the magnet M′ it will be seen that when the magnet is moved in one direction it draws on one of the cords and thus lifts the pawl connected therewith and relaxes the other cord, allowing that pawl to drop into engagement with the teeth of the track. The core of the motor-magnet C^3 is projected, as shown plainly in Fig. 9, so that the ends approach each side of the swinging magnet M′, and as this magnet C^3 is energized and de-energized it will alternately attract and release the swinging magnet M′, and thus actuate the pawls $y'\ y^2$, as described. The pawl y' will be raised out of engagement with the track T′, while pawl y^2 remains in engagement. When the magnet M′ is energized it attracts the armature, and as the latter is held stationary by the pawl and track the magnet and the car to which it is fixed will be attracted and consequently advanced. The arm y, which is attached to pawl y', will now be depressed, and through the cord Q will lift the pawl y' out of engagement with the track, and this movement of the carriage will drag the pawl y^2 one tooth or more. One end of the core acts to swing the magnet M′ in one direction when the current is passing in one way, and when the current is reversed the opposite end of the core acts upon the opposite side of this magnet and its connected pawl.

The closing and opening of the circuit through the magnet C^3 is made as many times as desired by means of the operating mechanism to be hereinafter described, and the car will be advanced one tooth by each of these actions. Thus if a subscriber desires to communicate with No. 4 and his indicator shows that the car is at No. 20, then the car must be returned sixteen points until it is at the point to connect with No. 4; but if, on the contrary, the number to be communicated with is No. 30, the car will then be advanced to that point.

The opening and closing of the circuit of the magnet C^3 is effected by means of the circuit-breakers $d'\ d^2$, (shown in Figs. 9 and 11,) and these are actuated alternately by the swinging of the magnet M′. The current is sent through wire 17, circuit-breaker d' M′ d^2 18, coil, and 19, drawing M′, to one of the armatures, thus separating M′ from d^2, and this releases M′ and allows it to return to its normal position between and in contact with d' and d^2, and this establishes the current again.

While the motor-magnet C^3 is not energized the swinging magnet M′ will normally be held between the ends of the cores of the magnet C^3, and will thus make the circuit complete, as will be hereinafter described. When it is actuated to move the car in either direction it oscillates between this central position and one end of the core.

The connectors $l\ l^3$ are suspended from brackets a^2 and a^3, Figs. 9 and 11, their lower ends depending, so that as the car is drawn along the lower ends of the connectors resting upon the surface beneath will stand at an angle of about thirty degrees from a perpendicular when dragging over the non-conducting surfaces U U′, which are inserted between the bars D. Whenever the car is stopped and reversed so as to return a little way by means of the reverse current sent through the motor-magnet C^3, these connectors $l\ l^3$ will drop into a perpendicular position and will then rest upon the contact-points R R′, which are exposed beneath them, and will thus close the circuit for communication to ring the bell, and also close the circuit of the battery A^3. (Shown in Fig. 1.) The points R R′ are ordinarily uncovered, and are only covered when contact is formed to protect other subscribers. The brushes $a\ a'$ connect with these swinging connecting-arms $l\ l^3$.

Upon the opposite end of the car from the motor-magnet C^3 is the magnet C^2. (Shown in Figs. 9, 10, and 11.) By means of this magnet a horizontally-tilting permanent magnet M^2 is actuated. This magnet M^2 is pivoted at a central point, as shown at l^2, Figs. 9 and 11, and is actuated so as to oscillate between the ends of the cores of the magnet C^2 whenever the latter is energized, and the oscillation of this magnet acts through circuit-breakers $g\ g'$ to open and close the circuit of the motor-magnet C^3. This magnet M^2 has depressions or channels formed in its upper surface, as shown at m. The bottoms of these depressions are inclined, so that they are deepest near the center, where there is a transverse bar separating them. In each of these depressions a ball i is adapted to roll, and when the magnet is in its normal horizontal position these balls remain at the inner adjacent and deeper ends of the grooves or channels in which they travel; but when the magnet is oscillated first one and then the other of the balls will roll toward the outer end of the magnet as it is alternately declined at one end and the other, and when it is so inclined the ball rolling outward will remain at that point until the magnet regains its normal position. The balls i are for the purpose of assisting the movements of the magnet M^2, Fig. 9, or M^3, Fig. 8, in their tilting movements, and to bring them back to their equilibrium principally. If, for instance, it is tilted and drawn down at one end, the ball at that side of the

center rolls outward and its additional weight assists to maintain the contact. When released from the attraction of the electromagnet, the tilting magnet is returned to its normal position between the elastic circuit-breakers *g g'* in the case of magnet M^2, and A A' for M^3, the tendency of these being to hold the magnet horizontal. The inclination of the troughs in which the balls roll is such that when the magnet is tilted in either direction the bottom of the trough on the lower side is only enough out of a horizontal line to insure the ball rolling out to the end while the other one remains in its place, and as soon as the magnet begins to return to its horizontal position by the back-pressure of the springy piece *g'*, which has been depressed, the bottom will be inclined the opposite way and the ball will return to the center, where the two balance and assist in keeping the equilibrium of the magnet. In order to return the magnet M^2 to its normal position, a current is sent in the reverse direction through the magnet C^2, and this is effected by means of the switching-plates of the indicator, which will be hereinafter described.

At the central office circuit-breaking coils *c c'* and also protecting-magnets c^2 are located, there being as many of these magnets as there are subscribers' wires. The magnet *c'* acts upon armatures I, Figs. 1 and 7, which are held normally by springs I^2, attached to the standard i^2, (shown in Fig. 7,) and these springs cause the armature I to press against the lower end of an adjusting-screw W, fixed in an arm or bracket W'. When the armature is attracted by the circuit-breaking magnet *c'*, it opens the circuit between the armature and the screw and the magnet c^2, Fig. 10, acts upon the armature I', which carries the arm P', one end of which is connected with a supporting-foot and the other or movable end is connected by a spring-actuated arm P^2 upon the opposite side of the bed or frame D, as shown in Fig. 10, so that the effect of the spring Q^2 will be to normally draw the arm P^2 and through it the arm P', and the armature I', connected with the arm P', will be drawn away from the core of the magnet c^2. The breaking of the circuit I W causes the cutting off of the subscriber's wire 1 to 4, to coil *c*, to 2, to track T, and so on. This action of the spring Q^2 brings the arm P^2 into contact with the adjusting contact-screw J.

The connection between the upper ends of the arms P' and P^2 is made as shown in Fig. 10, and these connecting strips or plates carry the non-conducting protectors U, and when the arms P' P^2 are drawn into the position just previously explained by the springs Q^2 these protectors stand in such position with relation to the contact-points R R' as to allow the connecting-arms *l* l^3 of the cars to close the circuit between them and these contact-points; but when the magnet c^2 is energized it attracts the armature I' into contact with its core, and thus drawing the arm P', overcoming the resistance of the spring Q^2, it moves the protectors U to such a point that they cover the contact-points R R', as shown in full lines in Fig. 10. The object of this is to prevent any other car than the one which at that time has made connection with two of the contact-points R R' from closing a circuit with the contact-points of the same bar. These protectors lying over these contact-points will prevent the connecting-arms *l* l^3 of any car from coming into contact with the contact-points of the same bar.

The lines P, which connect the arms P' P^2 and which carry the protectors U, consist of a suitable conducting material and a non-conducting material. The protectors U' are made entirely of non-conducting substance, while the protectors U have the upper portion made of a conducting substance and the lower surface of a non-conducting substance. The object of this is so that when the armature I' is attracted by the magnet c^2 and the protectors are drawn over the contact-points R R' another car than the one being operated might attempt to connect with the same subscriber; but in the effort its depending connecting-arms *l* l^3 will move over and form contact with the non-conducting protectors U' and the conductors U, instead of touching the contact points, and as the upper surface of the protectors U is of conductive substance and is attached to or connected with the conducting portion of the line P, and this conducting substance, which is on the lower side of the protectors U, touches the track T', it will be seen that the connecting-arm l^3 will complete its circuit through the track T' and will ground through the wire 13, which is designed to cut off the circuit of the motor-magnet c^3 of the car, and so the position of the car will be regulated with relation to the indicator hereinafter described. When a car is to be operated, its arm l^3 will make contact with R and connect through wires 8 and 3, and the effect is entirely different, but when arm l^3 contacts with U it forms a connection through n^4 with track T' and wire 13 to earth.

The circuit-breaking magnet *c*, Figs. 1 and 7, is designed to act upon the oscillating permanent magnet M^3, (shown also in Fig. 8,) and its vertical oscillation upon its central pivot-point J^2 will be similar to that described for the magnet M^2. This magnet M^3 has grooves or channels made in its upper surface and balls h^5 rolling therein in the same manner as was described for M^2. While this magnet M^3 retains its normal position, the circuit-breakers A A' press upon the magnet and complete the circuit between the wires 3 and 5; but when it is acted upon so as to swing up or down by the energizing of the magnet *c*, it breaks this circuit, and at the same time the circuit-breaker A' will press upon one of the regulating-screws which are fixed in the respective brackets *m'*. Then the brackets *m'*, the ground-wires 31 and 32 form a circuit. This is designed so that while the first sub-

scriber is communicating with the second, the third, who might try to communicate with the first, would be cut off from the second by the circuit-breakers A A′, and the current would flow through the ground-wire 31, so that the magnet M^2 would cut off the circuit of the motor-magnet C^3. This prevents the car from moving to interfere with the communicating parties, and the indicator will show the position of the car.

The circuit for operating the car will be as follows: Suppose that the car of subscriber No. 8 is at the proper place on the eighth bar and subscriber's car 1 is at the first bar, as shown in Fig. 1. If No. 1 wishes to call No. 8, he first moves his car from its position to the bar of No. 8 by turning the switch N′ to connect with the wire 25, and he moves his indicator, (shown in Figs. 2 and 3,) until it coincides with the figure 8. Then he turns the handle of the generator. When this is done a current is induced which flows through wires 22 21 1, the regulating-screw W, the armature I, wire 4, electromagnet *c*, wire 2, the track T, and into the operating-car through the wheel *w* to the shaft *n*, the brush *d*, which has one end suitably secured and the other pressing upon the shaft *n*, Figs. 9 and 11, the wire 17, the circuit-breakers *d′ d²*, wire 18, the coil C^3, the wire 19, circuit-breakers *g g′*, wire 20, brush g^2, shaft *n′*, wheel *w′*, track T′, ground-wires 13 and 27, switch N′, wire 25, and thence to the generator. To move the car in the opposite direction the wheel G′ is turned, and with it the brush *b′* is moved from S^4 to S. Figs. 2 and 6. This causes the wire 3 to become negative and wire 13 positive, Fig. 10. This current being completed, as above described, back to the generator, the circuit takes place every time the indicator covers a figure. Therefore to reach the eighth bar the indicator passes the figures between 1 and 8, and this will bring the car on the bar 8 of the person to be called. Now, in order to ring the bell of the person called the following circuit is established: First, the switch N′ of the subscriber 1 is connected with wire 26, wires 22 21 1, regulating-screw W, the armature I, the wire 4, electromagnet *c*, wire 2, track T, wheel *w*, shaft *n*, brush *d*, wire 15, electromagnet C^2, wire 16, brush *a′*, the connecting-arm l^3, contact-point R, the wires 8 and 3, circuit-breakers A A′, the wires 5 and 1 of the box of subscriber No. 8, wire 21, arm m^2 with its armature, the regulating-screw k^7, wire 23, the electromagnet c^3, wire 24, switch N′, ground-wires 27 on No. 8 and 27 of No. 1, switch N′ of subscriber No. 1, wire 26, then to the generator. The circuit from the battery A^3 to move the protectors acts through the electromagnets c^2, wires 7, branch wire 10, contact-points R′ of the bar, the connecting-arm *l*, wire 14, arm y^2, shaft *n′*, wheel *w′*, the track T′, the ground-wire 13, thence back through 30 to the battery A^3. The branch circuit from battery A^3 serves to break the connection I, by means of the wires 9 12, electromagnet *c′*, wires 7 10, contact R′, connecting-arm *l*, wire 14, shaft *n′*, wheel *w′*, track T′, wire 13 to the earth, through wire 30 back to battery A^3. This circuit will cut off the circuit on wire 1 from the subscriber 1 through armature I, wire 4, electromagnet *c*, wire 2, track T, through the car by means of the wheels and shaft, contact R, wires 8 and 3, magnet M^3, wire 5, wire 1 of the subscriber 8, thence to the earth and thence back to the box of subscriber 1. This latter circuit is now unnecessary and is prevented by the before-described branch circuit from A^3. When communication has been completed the subscriber or caller at No. 1 makes contact with the switch N′, with wire 25, and this sends a current, and then the switch N′ is moved to wire 24 to make the circuit for the purpose of ringing the bell. When the communication is to be broken, subscriber No. 1 once more moves the car by turning the switch to 25, then turning the generator. This will move the car one tooth, or far enough to raise the connecting-arms *l* l^3 from the contact-points and cause them to rest upon the paper or non-conducting surface N, thus breaking all the circuits which have been closed by the car and these connecting-arms and also the circuit for the protectors, which are now released and pulled back by the spring Q^2, as the current through the electromagnet c^2 has been cut off and the magnet released. The subscriber No. 1 now turns the switch back again to 24, and this will bring the bell-circuit in readiness for another call. The non-conducting surfaces N are for the purpose of separating the different bars, and by allowing the hanging arms *l* l^3 to rest upon them all parts are electrically disconnected. It will be evident from this construction that it is not necessary for subscriber No. 1 to move this car back to its proper position, as the car is now inoperative; but any other subscriber can, nevertheless, communicate with him by simply moving his car so as to connect with the bar 1 of subscriber No. 1, and they can then form immediate communication with No. 1 without the aid of his car, as the wires leading from his initial-bar are all connected directly with the box at his home. The car No. 1 being always on the same track, any connection from any box will be transmitted to this track and thence to the car thereon through its wheel *w*.

Fig. 2 shows the indicators. These indicators consist of gears G, pinion-wheel *p*, electromagnet C, permanent magnet M, brushes *b b*, *b′ b′*, b^2 b^2, b^3 b^3, b^4 b^4, b^5 b^5, b^6 b^6, b^7 b^7, b^8 b^8, b^9 b^9, brush-holders *h h′*, minute-hands *k k′* k^2 k^3 k^4, shafts *f f′* f^3, sleeves f^2 and f^4, and collars *r r*, *r′ r′*, and r^2 r^3. The gearing G′ has only two teeth. To the shaft *f* two wings *r r* and minute-hand *k* are fastened. These wings are both insulated and have brushes *b′ b′*. If the minute-hand *k* be so placed over one of the arrow-heads written on the face of the indicator one of the teeth of the gear G′ touches

gear G and at the same time the brushes b' b' touch the switches s s. The shaft of the gear G holds rings r' r' insulated from each other and the brush-holder h of the brushes b^3 b^3. The brushes b^2 b^2 press on the rings r' r' and the brushes b^3 b^3 on the switching-plate S, which is attached to the shaft f^2. This shaft has a minute-hand k^2 and the other shaft f' a minute-hand k'.

On the lower surface of the switching-plate S there are fastened four pieces of metal, forming two circles, as shown in Fig. 5; but they are insulated from each other, and on the upper surface of the plate there are four metallic rings insulated from each other, as shown in Fig. 4. These rings on the upper surface of the plate are connected with those on the lower surface, forming four pairs, and the brushes b^4 b^4 b^5 b^5 press on the rings. Gear G^2, brush-holder h', and rings r^2 r^2 are fastened on the sleeve f^4, and the switching-plate S' on the shaft f^3. The gear G^2 in practice will be about four times as large as the pinion-wheel p which engages it.

On the upper surface of the switching-plate S' are four pieces of metal forming two circles and on the lower surface are four rings. These are connected each to each, forming four pairs, as those on the switching-plate S. If a current be sent through the circuit, the electromagnet C acts on the permanent magnet M, which carries an escapement pawl v on its end, which comes in contact with the gearing G. The gearing G acts on the gearing G', and the pinion-wheel p on the gear G^2. The brushes b' b' move with the gear G'. When the indicator k on gear G' is first moved it will bring one of its teeth into engagement with the gear-wheel G and cause the contact-springs b' to contact with the pieces s and close a circuit from the battery z of the generator Z through wire 40, brush b' shaft f, to b' s 58 56 b^2 55 b^3 S b^4 61 22 21 to telephone-wire W I 4 c 2 T, wheels W n d 17 d' M' d^2 18 C^3 19 g g' 20 g^2 n', wheel w' T' 13 to earth, returning by 27 25 C 51 60 b^4 S b^3 47 b^2 41, contact-pieces to s b' b 59 to z. While passing through coil C it will energize it, and the armature M will be thrown to one side and its pawl v will move the gear G far enough to register by the indicator k' one bar of a subscriber.

As stated before, the tooth of gear G' has been first moved into contact with the teeth of G, and as this gear G was moved by the pawl v, G' has been carried along also and the contact-springs b' have been shifted from the plates s s to the plates s' s', causing an opposite current to be sent to the car, operating the armature M^2, so as to cut off the standing current to the coil C^3 and de-energizing the same, so as to cause the car to stand still and also attracting the pawl-carrying magnet M' back to its normal position again to track ready to take another tooth; but the springs b' will have been shifted still farther to the next plate s^2 s^2 before the tooth on gear G' has been entirely freed from gear G, and now will remain in that position, establishing the first-mentioned current to move the car forward until the brushes b^3 have reached the opposite plates on the switch S, which have been set at first by its indicator k^2 over the figure 8. This action will cause the current to pass from battery z 40 b b' s^2 57 56 b^2 55 S b^5 48 b^6 49 b^7 S' b^8 50 51 C 25 27 to earth, returning up 13 T' w' n' g^2 20 g' g 19 C^3 (causing the car to move a little backward to let the connectors hang perpendicular and therefore rest on their respective contact-pieces) 18 17 d n w T 2 c 4 I W' 1 21 22 52 b^8 S' b^7 57 b^6 54 b^5 S b^3 47 b^2 46 s^2 b' b' 59 to the battery, thus completing communication.

In order to move the car any number of subscribers in the opposite (backward) direction, I place the indicator k over the opposite arrow on the face-plate. This will bring the tooth o' in contact with gear G, and the spring-arms b' will now rest on the plates s^3 s^3 and travel over s^4 s^4 s^5 s^5 in the same manner as over the previous set of plates, and cause the same effect, with the exception that the operating-current will now flow in the opposite direction and will attract the armature M' oppositely, and so cause the opposite pawl y' or y^2 to engage the track and push the car backward. When the brushes b' b' move a little they fall on s' s'. In such a case an opposite current from the preceding one passes through the circuit, and the electromagnet C works oppositely from the manner previously described. Then the brushes b' b' slip off from s' s' and touch s^2 s^2 to send the current in the same direction as formerly. Having but one tooth, the gearing G' is thus disengaged from gearing G, and the brushes b' b' remain on s^2 s^2.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a telephone exchange system, parallel non-conducting bars having independent metallic conducting plates extending across them and connected in alternate groups with the line wires as shown, tracks having their upper surfaces toothed, extending across above the bars and plates, cars having gear-wheels adapted to engage the teeth of said tracks, electro magnets, means for transmitting a current through the electro magnets, swinging permanent magnets movable between the cores of the electro magnets and caused to oscillate about their fulcrum points by the energizing and de-energizing of the electro magnets, pawls hinged to the lower end of the swinging permanent magnet adapted to engage the teeth of the track, and non-conducting cords connected with the pawls and with arms upon the swinging magnet, said cords passing through guides whereby the swinging of the magnet to one side will disengage one of the pawls and engage the other so that the car will be moved constantly in one direction, and the reversal of the cur-

rent will reverse the position of the pawls so as to move the car in the opposite direction.

2. In a telephone exchange, the parallel non-conducting bars, independent metallic conducting plates secured thereto and connected with the subscribers' telephones of the system, cars movable upon the tracks transversely above the plates, electro magnets, with means for energizing and de-energizing, and swinging permanent magnets movable between the cores of the electro magnets, pawls fulcrumed upon the electro magnets and non-conducting cords connected with the pawls and with arms upon the permanent magnets, whereby the movements of said magnets in one direction will raise one of the pawls and engage the other with the teeth of the rack bars upon which the cars travel, and circuit breakers d' d^2 by which the opening and closing of the circuit of the electro magnet is effected.

3. In a telephone exchange system, a series of parallel non-conducting bars, independent metallic plates secured transversely thereto, tracks mounted transversely above said bars cars adapted to travel upon the tracks, arms depending from the cars adapted to form contact upon the various plates, non-conducting shields and magnets by which they are movable in conjunction with the movements of the car so as to expose only the points through which communication is to be made, hinged swinging permanent magnets carrying pawls which engage toothed racks whereby the car is advanced in one direction or the other, and devices whereby either of the pawls are disengaged and the others engaged with the rack to advance the car in either direction, circuit breakers whereby the opening and closing of the circuit of the electro magnets are effected and a horizontal centrally fulcrumed tilting permanent magnet, and a second electro magnet whereby it is tilted to act through circuit breakers to open and close the circuit of the first named electro magnet.

4. In a telephone exchange system, a series of parallel non-conducting bars with the independent metallic plates, tracks, cars adapted to travel thereon and mechanism for advancing the cars in either direction, horizontal tilting magnets and corresponding electro magnets with circuit breakers whereby the electrical circuit is opened or closed to advance the car, said horizontal permanent magnets having inclined troughs and balls adapted to roll therein to and from the center as the magnet is tilted about its fulcrum point.

5. In a telephone exchange system, the circuit breaking coil c c', the movable armatures I, with the holding springs I^2 and adjusting screw W in combination with the movable projecting strips and the magnet c^2 and lever arms whereby said strips are alternately moved to cover the contact surfaces or expose them.

6. In a telephone exchange system, the series of parallel non-conducting bars, independent metallic plates secured transversely thereto, tracks mounted above said plates, cars adapted to travel upon said tracks with arms depending from the cars adapted to form contact between the plates, shields movable with reference to the metallic conducting plates so as to allow or prevent connection between said plates and the cars which are movable upon the tracks above them, one of the protectors in each set being made entirely of non-conducting substance, and the other having the lower portion made non-conducting and the upper of conducting substance so as to ground the current of any other subscriber attempting to communicate with one already in communication.

7. In a telephone exchange system, a series of parallel non-conducting bars, independent metallic plates secured transversely thereto, tracks mounted transversely above the plates, cars adapted to travel upon said tracks, arms depending from the cars adapted to form contact between the various plates, non-conducting shields and means whereby the cars and shields are moved, exchange boxes located at the station of each subscriber, indicators movable over dials upon the boxes at the subscribers' stations, with switches and contacts whereby the cars at the central station are moved upon their corresponding tracks until communication with any desired subscriber is obtained.

In witness whereof I have hereunto set my hand.

WADA Y. SHIBATA.

Witnesses:
S. H. NOURSE,
GEO. H. STRONG.