(No Model.)

5 Sheets—Sheet 1.

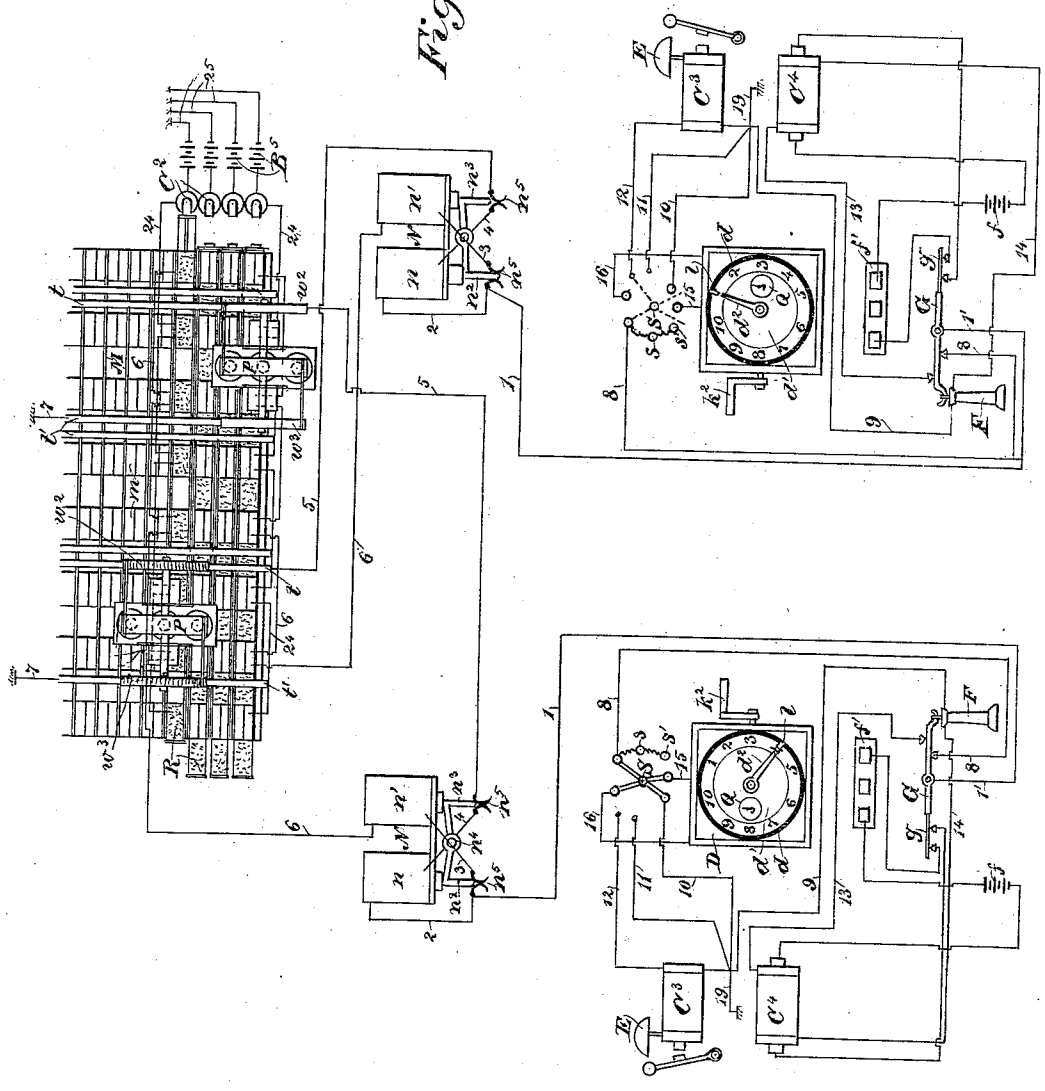
W. Y. SHIBATA.

TELEPHONE EXCHANGE.

No. 543,708.

Patented July 30, 1895.

Fig. 1.



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(No Model.) 5 Sheets—Sheet 2.

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TELEPHONE EXCHANGE.

No. 543,708. Patented July 30, 1895.

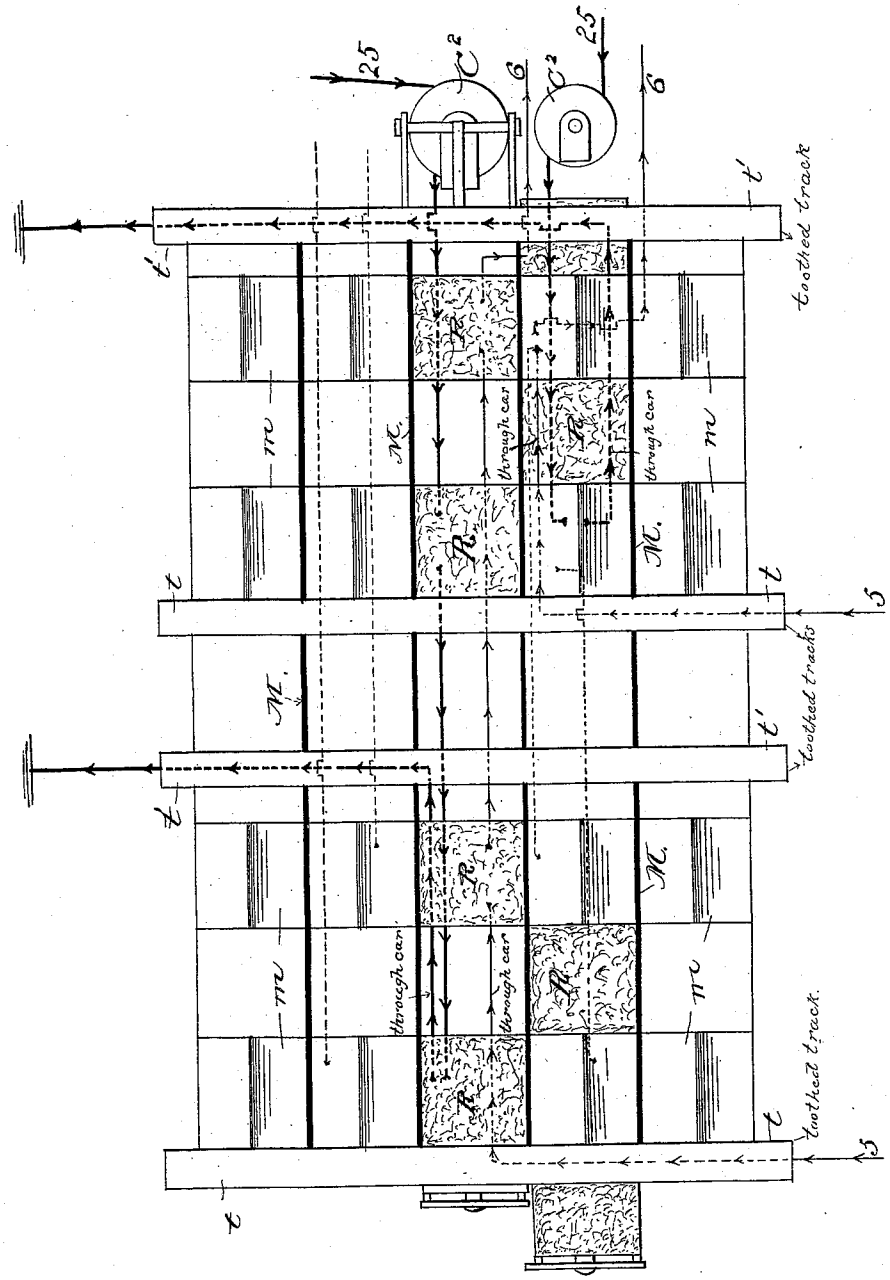

Fig. 1ª.

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(No Model.) 5 Sheets—Sheet 3.

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TELEPHONE EXCHANGE.

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Fig. 2.

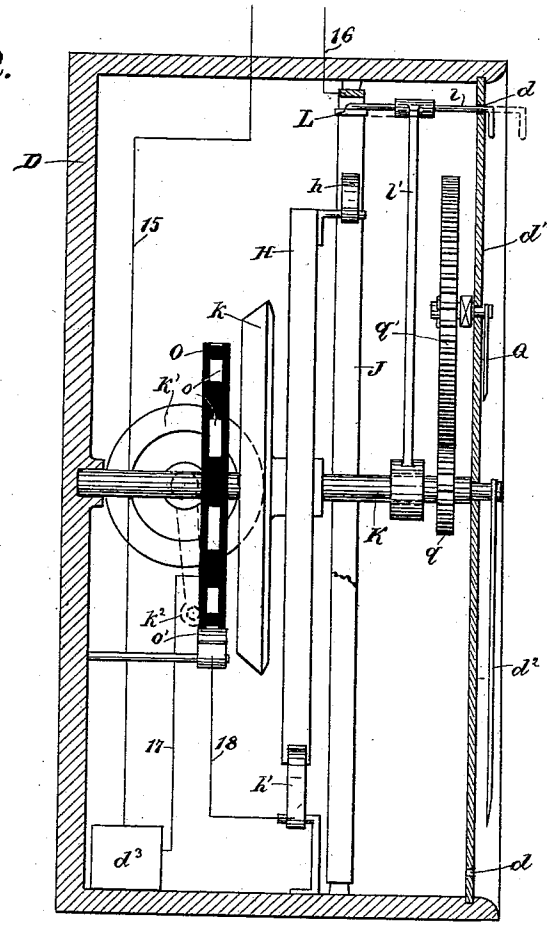


Fig. 3.

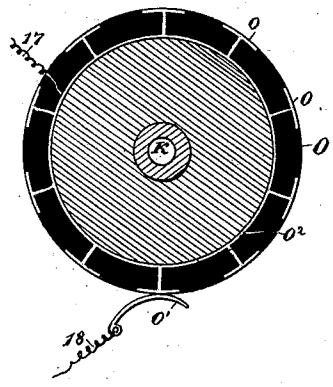
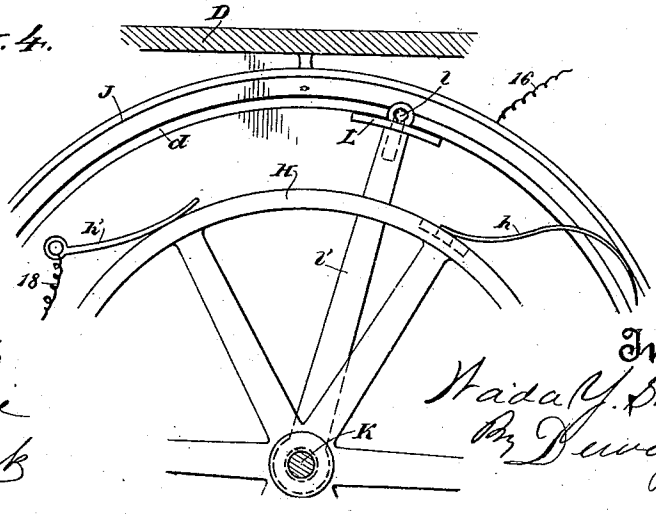


Fig. 4.



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(No Model.) 5 Sheets—Sheet 4.

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TELEPHONE EXCHANGE.

No. 543,708. Patented July 30, 1895.

Fig. 5.

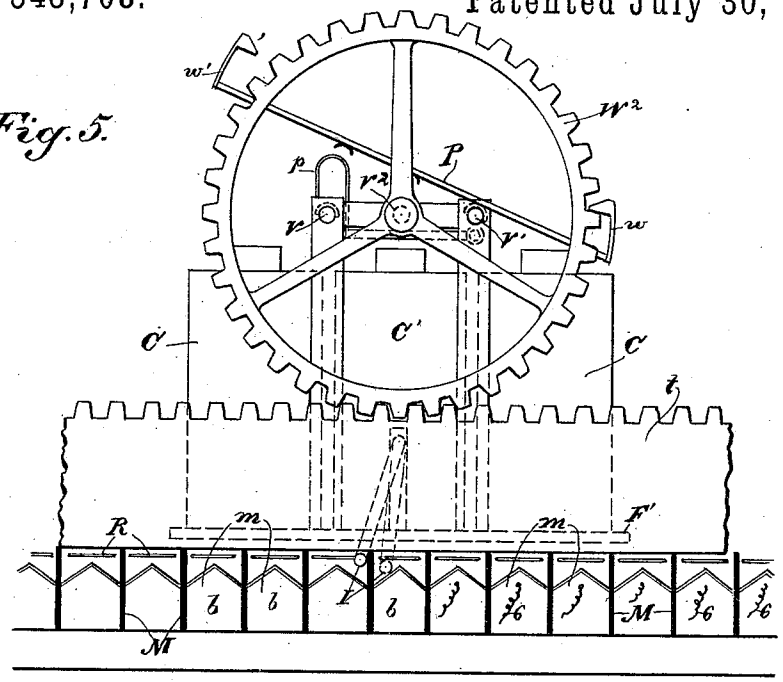


Fig. 6.

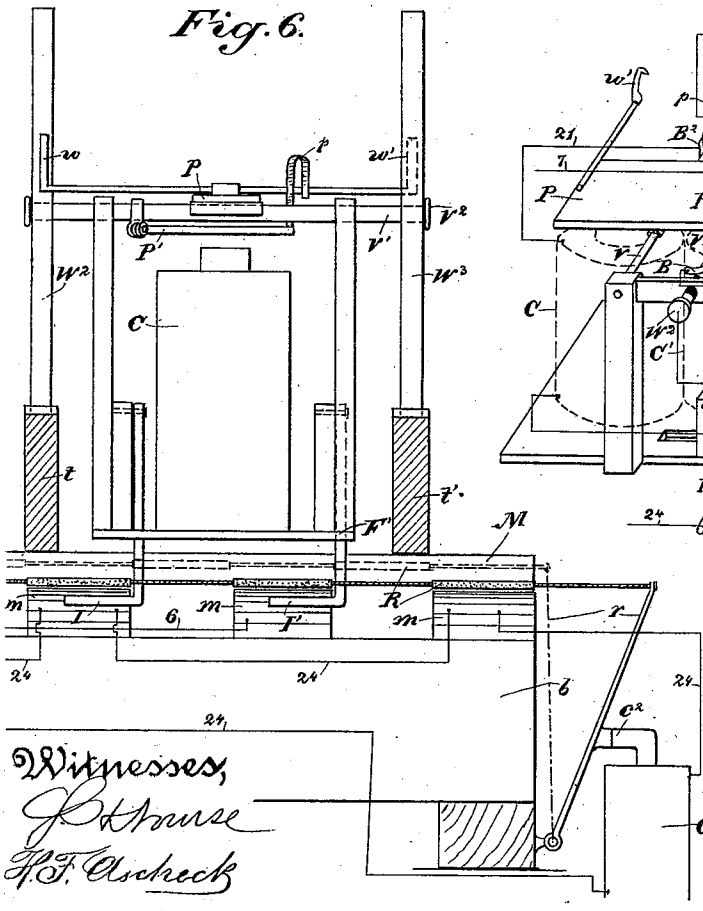
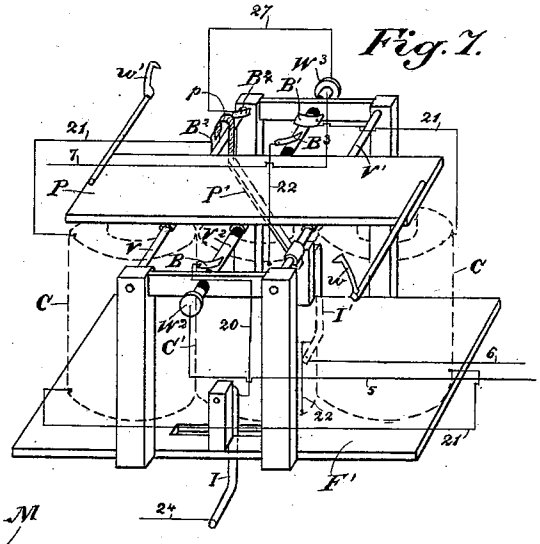


Fig. 7.



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(No Model.) 5 Sheets—Sheet 5.

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TELEPHONE EXCHANGE.

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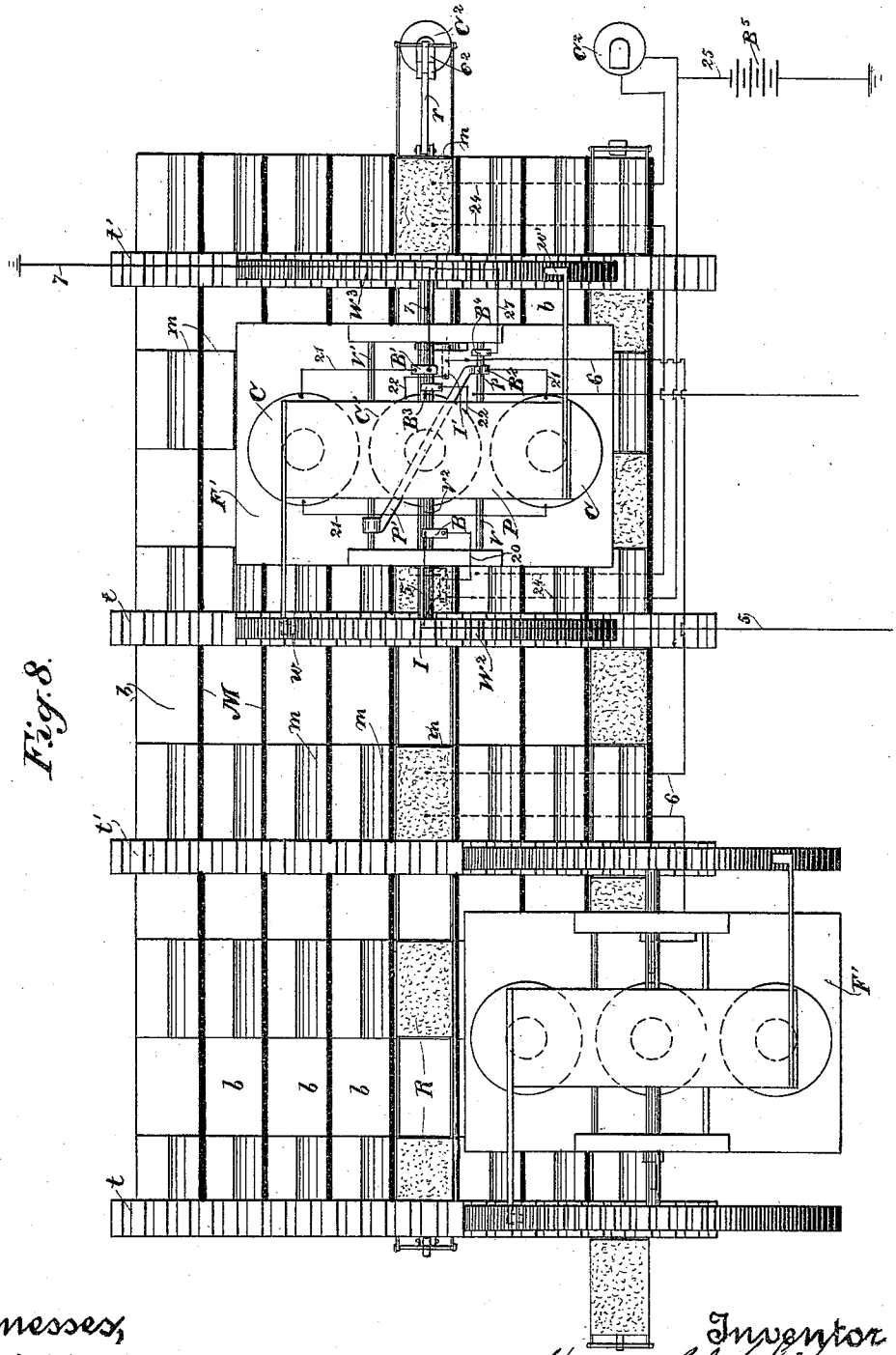

Fig. 8.

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UNITED STATES PATENT OFFICE

WADA Y. SHIBATA, OF SAN FRANCISCO, CALIFORNIA.

TELEPHONE-EXCHANGE.

SPECIFICATION forming part of Letters Patent No. 543,708, dated July 30, 1895.

Application filed November 24, 1893. Serial No. 491,872. (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, whereby 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 diagrammatic general view of my apparatus. Fig. 1ª is a diagrammatic view showing two pairs of tracks and the conducting-strips, and showing also the course of the wires and their connection. Fig. 2 is a vertical cross-section through the indicator-box, showing its interior. Fig. 3 is a cross-section through the disk O. Fig. 4 is a detail view showing part of the ring J, the wheel H, and their connections. Fig. 5 is a side elevation of the car F and track. Fig. 6 is an end view of the same. Fig. 7 is a skeleton view of the car, showing principally the wire connections. Fig. 8 is an enlarged plan showing two of the cars upon the track. Fig. 9 is a diagrammatic figure showing the connections between the caller, through the central exchange, to the one called.

In carrying out my invention I employ a number of parallel wooden bars *b* clamped together, and to which are secured metallic strips *m* at intervals, and they are insulated from each other by vertical non-conducting strips M. These metallic plates are connected together into two groups by wires 6 and 24. One of each of these wires connects with the line-wires and the other with the magnet C^2 and battery B^5, as shown in Figs. 1 and 6. Transversely to these bars extend tracks *t t'*, upon which the cars F' are adapted to travel. These cars carry a mechanism to be hereinafter described, through which a communication is made with the track, so that a car running upon the tracks *t* and *t'* will communicate through one track *t* with the operating mechanism by which the car is caused to move across the plates *m* and through the other track, which connects with the ground, so as to form a complete circuit, the current passing from one track through the connections upon one side into the apparatus on the car, thence through the other side and track to the ground.

By means of an intermittent current produced by apparatus controlled by the sender any car is advanced so as to connect with the wire of the number with which it is desired to communicate. Upon these cars are mounted an apparatus consisting of the electromagnets C, C, and C', the permanent magnets P and P', with wires and connecting-brushes, and the hinged bent arms I and I', which are adapted to move over the plates *m* upon the bars *b* when the car moves transversely to these bars.

Toothed wheels upon the cars engage teeth upon the rack-bars or tracks *t t'*, and pawls actuated by the mechanism upon the car engage the teeth of the wheels and advance them along the track when an intermittent electric current is passed through the mechanism, as before stated.

n n' are electromagnets, and n^2 n^3 are arms of non-conducting material at the central station, hinged together at n^4 and actuated by the electromagnets *n n'*, so that when moved down they separate the spring contact-pieces n^5, which are normally closed together to complete a circuit, but which are separated by the operation of the magnets, so as to break the circuit at the proper time. This breaking of the circuit takes place when communication is opened with any subscriber and prevents any interference by other subscribers while this connection continues.

When the contacts n^5 of any subscriber are separated, no current can pass at that point and no interference can take place by others. The arms n^2 n^3, of non-conducting material, are connected and fulcrumed, as shown at n^4, so that one of them is forced down when the other is drawn up by the core of its electromagnet being energized to force the opposite arm between its contacts n^5.

F is the receiver at any subscriber's house, and S is the automatic switch, which is set to connect the desired wires and make the

proper connections when communication is to be opened between subscribers.

k^2 is a crank with suitable gearing within a case D, and d^2 is an indicator movable over a dial numbered to correspond with the list of subscribers. Now, when it is desired to communicate with any subscriber, the indicator d^2 is turned until it points to the number of the subscriber with which it is desired to communicate. The switch S being first turned correspondingly to connect any of the points surrounding it, as shown in Fig. 1, and the crank k^2 turned, the current will pass through the connecting-wires and the switch and will transmit a current through the mechanism upon the car, which will move the latter over the tracks until the arms I I′ have formed contact with the plates m upon the connecting-wires through which communication is to be made with the desired subscriber.

D is a case containing the dial d', and the indicator-pointers Q and d^2 are fixed to shafts projecting through this dial, so that when the shafts are turned these pointers are moved over the figures upon the face of the dial. The shafts of the two pointers are caused to rotate with relation to each other by gears q q', Fig. 2.

The shaft K, upon which the indicator-hand d^2 is fixed, carries a bevel-gear k, which is engaged by a bevel-pinion k' fixed upon the shaft of the crank k^2.

A circular slot d is made around the periphery of the dial, and through this slot projects a rod l, which slides in a sleeve upon the outer end of a radial arm l', the inner end of which turns loosely upon the shaft K.

Upon the shaft K is fixed a non-conducting disk O having within it a circular conducting-ring o^2, and this ring has radially-projecting arms at intervals, carrying upon the outer ends plates o, which are sunk flush with the surface of the periphery of the disk, as shown.

o' is a brush pressing upon the surface of the disk, so that when the latter is rotated these plates o pass beneath the brush, one end of which is connected with the wire 18, while the interior metallic ring o^2 is connected with the wire 17.

Whenever the shaft is turned and stopped at a point where the brush o' rests upon either of these contact-plates o, a current will pass and a continued revolution of the disk alternately makes and breaks the connection and produces an intermittent current, which is transmitted through the mechanism upon the car to advance the latter along its track until, by the revolution of the wheel H, the circuit-breaker withdraws the spring h and interrupts the current.

F is the receiver. f' is the microphone connected therewith.

f is the battery for the microphone; C^4, the induction-coil; E, the bell; and C^3 is the electromagnet for actuating the bell-hammer.

G is the automatic switch, and g is the spring by which the local circuit is opened or closed when the receiver F is placed upon the hook or removed therefrom.

d^3, Fig. 2, is the generator or battery within the case D.

The operation would then be as follows: If any subscriber desires to communicate with another subscriber—as, for instance, as shown in Fig. 1, with number 4—the arm l' is moved around the shaft K, so that the arm l travels in the slot d in the dial to the number of the subscriber to be communicated with. When the desired point is reached the arm l is then pushed in to bring the circuit-breaker L into the path of the spring h. The switch S is moved to the proper position, and an intermittent current is induced by turning the crank k^2, which advances the car at the central station until the circuit-breaker L acts to cut off the current, when the car will have been advanced to the desired station, as indicated by the pointer d^2.

When the telephone is out of use the switch S stands so that wire 23 makes connection with wire 12 and with the point s'.

When the connection is to be made with the subscriber, the switch is turned so as to make connection between wires 16 and 11, and also between 15 and s. The handle k^2 is then turned and a current is caused to flow through wires 15, 8, 1, 2, 4, 5, and through the shaft V^2 upon the car F′, thence through wire 21, electromagnet C, through wire 21, 7, and through the ground, returning through wire 19, 11, 16, 18, and 17, to the generator, as shown in Fig. 1.

The apparatus upon the car F consists of the electromagnets C, C, and C′, a permanent tilting magnet P, supported above the ends of these magnets, carrying pawls w w', and capable of being moved downwardly at either end when these electromagnets are energized, and a magnet P′, hinged to the shaft V′, and carrying a circuit-breaker p at its movable end, which is adapted to make or break contact with the brush B^2 on the shaft V.

The magnet P, in its normal position, rests in a horizontal position upon the two shafts V and V′, and when it is in that position either of its ends will be near enough to be attracted by the electromagnet C, which is energized. The magnet P has semicylindrical arcs fixed upon its lower surface, which rest upon the shafts V V′, and when the magnet P is tilted by the attraction of either magnet C, the arc upon that side turns about the shaft upon which it rests, while the opposite end of the magnet P is correspondingly lifted up, as shown in Fig. 5. When the magnet C is de-energized the magnet P falls by gravitation to its normal position, resting upon the shafts V V′. The alternate attraction and release of the magnet by either of the electromagnets C will continue to tilt it in this manner as often as the circuit is made and broken by the subscriber.

The pawl w or w', as the case may be, en-

gages the teeth of the wheel upon the same side with the attracting electromagnet C, as follows: The teeth upon the periphery of the wheel are formed about the center of the wheel, but as the magnet P tilts about a fulcrum V or V′, which is between the center and periphery of the wheel, the arc of movement of the pawl is smaller than the arc of the wheel, and consequently intersects it, and every time the pawl on one side is depressed it engages a tooth upon that side and advances the wheel one tooth. For the same reason, as the opposite end of the magnet P describes an arc larger than that of the wheel, its pawl will move away from the teeth as it rises and will not act upon them. After the acting-pawl has moved the wheel forward one tooth and the electromagnet C is de-energized, the magnet P will fall by gravitation to its normal position upon the shafts V V′, and as the pawl moves back in its arc movement it also moves away from the teeth and passes the next succeeding one by reason of the bevel of its upper side and the elasticity of its arm. If the car is to be advanced in the opposite direction the other electromagnet C will be used, and the pawl upon the opposite end of the magnet P will act, because the fulcrum will then be changed to the shaft V or V′ nearest to that side.

The operation of the magnets C C is for the purpose of attracting the permanent magnet P, so that when the current flows one way one end of the magnet will be depressed and the other repulsed and the pawl w or w' engaging the teeth of the wheel W^2 causes it to revolve, and its engagement with the rack-bars will cause the car to be moved in one or the other direction. A reverse current will cause the reverse movement of the car. The magnet or coil C′ acts to cut out the coils C by attracting the armature P′ and pressing the brush B^2 away from the bar V, thus cutting off the connection of coil C, 21, B^2, bar V, brush B^4, 27, W^3, track t', ground-wire 7, and also that of the other coil C as being in the same circuit. The coil n is to prevent the caller being disturbed by other subscribers, and n' is to prevent a short circuit from the caller's office to the ground.

Suppose the set to the right in Fig. 1 was the caller. The current on wire 1 2 will energize n, and therefore separate the connection at n^5, leading the current through n, 4, n^5, 5, through the central station, as shown by arrows in the diagrammatic view, Fig. 9, to the electromagnet n' to wire 3, n^5 to 1 of the one to be called on. As soon as the car has arrived on the called person's bar, the arm I forms connection with the wire 24, magnet C^2, battery B^5, wire 25 to earth and on the other end from the car to track t', wire 7 to the earth.

The car F is moved by the action of the pawls w w', which are carried upon the ends of the movable permanent magnet P and are adapted to engage the teeth of the gear-wheels w^2 w^3 when the actuating-magnets are alternately energized, and thus cause these gear-wheels to travel over the rack-bars of the tracks t t', as shown in Fig. 5.

The shafts V V′ and V^2 extend across beneath the magnet P, and the magnet forms contact with these shafts when it is drawn downwardly. Connected with these shafts are brushes B, B′, B^2, B^3, and B^4, respectively, and connected with these brushes are wires 20, 21, 27, 22, 24, 7, and 6. Upon the ends of the shaft V^2 are the wheels W^2 and W^3, which travel respectively upon the tracks t t' and are caused to advance thereon, as previously described.

When at rest the magnet P lies upon the shafts V V′ V^2, as shown in Fig. 7. When connection is made from any telephone-switch S and the crank k^2 is turned, an intermittent current is sent through the magnet C, Fig. 5, and it alternately attracts and releases the magnet P and causes it to tilt about its fulcrum-point upon the shaft V′. The spring-pawl w engages a tooth of the wheel W^2, and thus advances it a tooth at each downward movement of the magnet end, and it springs out and disengages at each upward movement of the end of the magnet, thus advancing the car by intermittent movements with each completion and break of the current by the turning of the crank k^2 and mechanism in the box D until the current is interrupted by the circuit-breaker L before described.

When the car is to be advanced to make connection between two points, the current passes through the electromagnet C^2, (shown at the lower right-hand corner in Fig. 6,) and its armature c^2, attracting the hinged movable arm r, moves the rubber sheets R and draws them over such of the plates m, with which it is not desired to make a contact, thus practically insulating all of such plates, so that the arms I I′ upon the car will be dragged across these sheets in an inclined position, and out of contact with the said plates m, until they reach a point just above such of the other plates m with which connection is to be made. The arm l, Fig. 2, is then returned to zero. The switch S is set to make connection, so that the electromagnet C upon the left side in Fig. 5 is energized, and will act to tilt the left end of the magnet P downward about its fulcrum-point, which is thus transferred to the shaft V. This causes the pawl w' to engage the teeth upon the left side of wheel W^2 and thus move the car back until the arms I I′ drop into a vertical position between the non-conducting sheets R, and they will then form contact with the plates m m not covered by them to connect the desired points. When the arm I′ makes contact with its plate m, an electric current flows from magnet C^2 to wire 24, to plate m, to arm I′ and wire 22, and through the central coil C′, Fig. 5, and energizes it so that it attracts the permanent magnet P′. This forces the circuit-breaker p between the shaft V and the brush B^2, and the other arm

I, making contact with its plate m, completes the circuit from battery B^5, Figs. 1 and 8.

When the current is sent through the apparatus to move the car in the reverse direction, as above described, the switch is turned to connect 16 and 8 and 15 with 10, Fig. 1. The current then flows through 15, 10, 19 to the ground and returns through 7, 27, 21, electromagnet C at the left upon the car, shaft V^2, wires 5, 4, 2, 1, 8, 16, 18, 17 to d^3.

When the connection is made through the car F and the arms I and I′ with the plates m, representing the subscriber to be communicated with, the call-bell is rung, the current passing through 17, 18, 16, 1, 2, 4, 5, shaft V^2, wire 22, electromagnet C′ upon the car, arm I′, wires 6, 3, 1, 8, 23, 12, and electromagnet C^3 to ring the bell, thence through wire 19 to the ground, returning through 19, 10, 15 to d^3. The telephone thus standing for communication, the circuit is completed through wires 14, 13, 1, 2, 4, 5, shaft V^2, wires 22, connecting-arm I′, wires 6, 3, 2, 1, 13, 14, and 9 to the ground.

The arms n^2 n^3, hinged at n^4, are actuated by the electromagnets n n', as before described, whereby when the current passes through one of these magnets the arms opposite thereto will be forced between its springs n^5, as shown in Fig. 1, and separate these springs and break the connection between the wires connecting them, so that no current can be passed from any other line of wire while this communication is taking place.

Each bar b represents a subscriber and each subscriber has a carriage and has a certain track which crosses the bars of all the other subscribers. Now, for example, the carriage of a subscriber at the left of Fig. 1, who has called, has reached subscriber No. 4. Consequently his wire 6 thus becomes connected with the switch S, (disconnecting his wire 6 with any other subscriber,) and thence, through wire 1, is led to the caller's receiver. The wire 6 of subscriber 4 leads the current through his magnet n, and thence to his receiver by the hereinbefore-described wires, and so the connection is formed between the two subscribers.

As soon as the carriage has arrived at subscriber 4 the arms I and I′ have dropped on the plates m m, thus making connection between the wires 24 through arm I, 20, brush B, shaft V^2, brush B^3, and wire 22. The magnet C′ thus being energized attracts P′ and breaks connection between C C at B^2, and consequently stops any further movement of the carriage. The current passing through wire 22, arm I, wire 6 to n energizes n', pushing n^2 forward and disconnecting the wire 5, thus preventing this subscriber from calling anyone else while this condition continues. Thence the current passes through 3, 1, 8, 23, 12, C^3, 19 to the ground, thus completing the circuit from 25 through B^5, 24, energizing C^2, attracting the arm r to c^2, Fig. 1, to draw the rubber plates R above the strips m of subscriber 4's bar, and thus preventing anyone else from connecting with him.

In calling subscriber 4 we first move arm l to No. 4 and then press it inwardly, thus bringing L into the path of the elastic arm h, Fig. 4. Now we turn the crank K^2, and this brings the first plate o in connection with brush o', thus leading the current from the battery d^3, Fig. 2, through 17, 18, H, h, 16, 8, 1 (disconnecting 3, n', and 6 of caller to prevent another from connecting with him at the same instant), thence to 4, 5, rail t, wheel W^2, shaft V^2, brush B′, wire 21, and electromagnet C, (energizing C, attracting armature P, and turning wheels W^2 and W^3, through pawl w, the distance of one subscriber's bar b,) 21, C, B^2, V, B^4, 27, W^3 to track t' and wire 7 to the ground. A further movement of the crank brings the insulated part of wheel O in contact with the brush o', thus interrupting the former current, but the continued rotation of the crank brings the next plate o in contact with the brush o', and the former current is established again, moving the carriage over the next subscriber's bar, and so on till the bar of subscriber 4 is reached. A further movement of the crank will now bring the arm h against the circuit-breaker L and keep the former out of contact with ring J, thus arresting the current used to advance the car, and any further turning of crank K^2 would simply move arm l with h around the dial.

In returning the carriage the crank is turned in the opposite direction, the switch at S is set so that the current in wire 1 becomes now reversed (from positive to negative) and consequently the other magnet C on carriage F′ becomes energized, and the fulcrum of the lever P being transferred to the shaft V as the lever is tilted the pawl w is engaged and the wheel turned in the opposite direction, thus moving the carriage backward the width of an adjacent subscriber's bar, and so on till the carriage is back to its initial position.

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

1. In a telephone exchange, the series of parallel non-conducting bars, independent insulated metallic plates fixed thereto, toothed tracks extending transversely across above the sets of metallic plates, cars adapted to move across said tracks, arms depending from said cars upon opposite sides and adapted to form contact with plates in two different lines and conducting wires connecting the sets of plates with each other in independent groups, and connecting with the exchange subscriber, and interrupting non-conducting sheets, movable over the bars to prevent contacts while a car is being moved forward, substantially as herein described.

2. In a telephone exchange system, a series of non-conducting bars having independent metallic plates mounted transversely thereon, toothed tracks extending transversely above said plates, having depending contact bars

by which connection is made between two sets of plates, electro magnets and permanent magnets mounted upon a car with means for rotating the wheels of the car whereby the latter is advanced along the tracks above the plates, and non-conducting protectors adapted to extend above the plates, and over which the contact bars move when the car advances in one direction, said protectors having intermediate open spaces through which the contact bars drop by a reverse movement of the car, substantially as herein described.

3. In a telephone exchange system, parallel non-conducting bars having independent metallic conducting plates extending transversely across them, and connected in alternate groups and with the line wires as shown, tracks having their upper surfaces toothed, extending transversely across above the bars and plates, cars having gear-wheels adapted to engage the teeth of said tracks, permanent and electro magnets, means for transmitting a current through the electro magnets whereby the permanent magnets are alternately attracted and repulsed, pawls carried by said magnets adapted to engage the teeth of the wheels and rotate them so that the cars are moved along the track, depending conducting arms supported from the car and adapted to form a contact with the metallic conducting plates beneath, non-conducting shields, an electro magnet and intermediate mechanism whereby said shields are moved so as to prevent contact between the depending arms and the plates until the car reaches the point at which connection is to be made, and wires connecting the different subscribers in the circuit with the independent plates whereby the different telephones of the line may be automatically connected with each other from any station, substantially as herein described.

4. In a telephone exchange system, the parallel non-conducting bars, the independent metallic conducting plates secured thereto and connected with the subscribers' telephones of the system, cars movable upon tracks transversely above the plates, and arms depending from the cars adapted to form contact with the plates as they pass above them, electro magnets n n' and non-conducting arms n^2 and n^3, hinged with relation thereto and with contact springs n^5 so as to be actuated to separate said springs and break the contact between wires connected with the springs whenever a circuit is established between two telephones, whereby interruptions from other lines are prevented, substantially as herein described.

5. In a telephone exchange system, a series of parallel non-conducting bars, independent metallic plates secured transversely thereto, tracks mounted transversely above said plates, and cars adapted to travel upon said tracks, arms depending from the cars adapted to form contact between the various plates, non-conducting shields and an electro magnet 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 non-conducting arms and electro magnets acting thereon, spring connections between the lines of wire adapted to be separated by the action of the arms so as to cut off communication from other lines of wire when two points in the system have been connected, substantially as herein described.

6. In a telephone exchange system, a case having a circular dial numbered to correspond with the subscribers connected with the system, a central shaft and a hand or pointer fixed thereto movable over the dial to point to either of the figures thereon, a stationary ring fixed within the case, an arm projecting through an annular slot around the periphery of the dial and adapted to form or break contact by pushing it in or pulling it out, a disk or wheel fixed to the shaft and rotatable therewith, a brush by which connection is made between a wheel and a conducting wire, a spring arm h by which connection is made between the stationary outer rim, and the rim of the movable disk or wheel, and a circuit breaker by which contact between this spring arm and the rim is broken so as to intercept the current when the movable disk has been rotated to a point corresponding with that indicated upon the dial, substantially as herein described.

7. A case having a dial fixed to one side, with figures representing the subscribers connected with the line and hands movable over the dial to correspond with the number with which it is desired to communicate, a central shaft having a disk O fixed to it with metallic plates and connections whereby an intermittent current is produced when the disk is rotated, gear-wheels and a crank by which the shaft and disk are rotated, a wheel or disk fixed to the shaft having connection made between its periphery and one of the conducting wires by means of a brush h', a stationary ring, a spring arm h by which communication is made between the ring and the rotary wheel H, a contact breaker L, and an arm l movable through a slot in the periphery of the dial whereby the contact breaker is moved into the path of the spring arm h at a point coinciding with the number upon the dial with which communication is to be made, so that the circuit is interrupted when the spring arm upon the wheel H has reached the contact breaker, substantially as herein described.

8. In a telephone exchange system, the dial, dial case and pointers corresponding with the number of stations or subscribers in the system, a switch S by which connection is made with the wires from each station, a central station having independent conducting plates, cars adapted to move over said plates, and mechanism upon the cars whereby they are caused to advance by intermittent electrical currents produced by turning a crank and mechanism at either station, conducting arms

carried by the car adapted to make contact with said plates, non-conducting shields, and an electro magnet whereby they are moved to cover the plates before the car starts whereby the conducting arms move over the shields without contact with the plates, spaces between the shields through which the conducting arms are allowed to drop into a vertical position by a reverse movement of the car after it reaches the desired point whereby communication is effected, substantially as herein described.

In witness whereof I have hereunto set my hand.

WADA Y. SHIBATA.

Witnesses:
S. H. NOURSE,
H. F. ASCHECK.