No. 777,972. PATENTED DEC. 20, 1904.

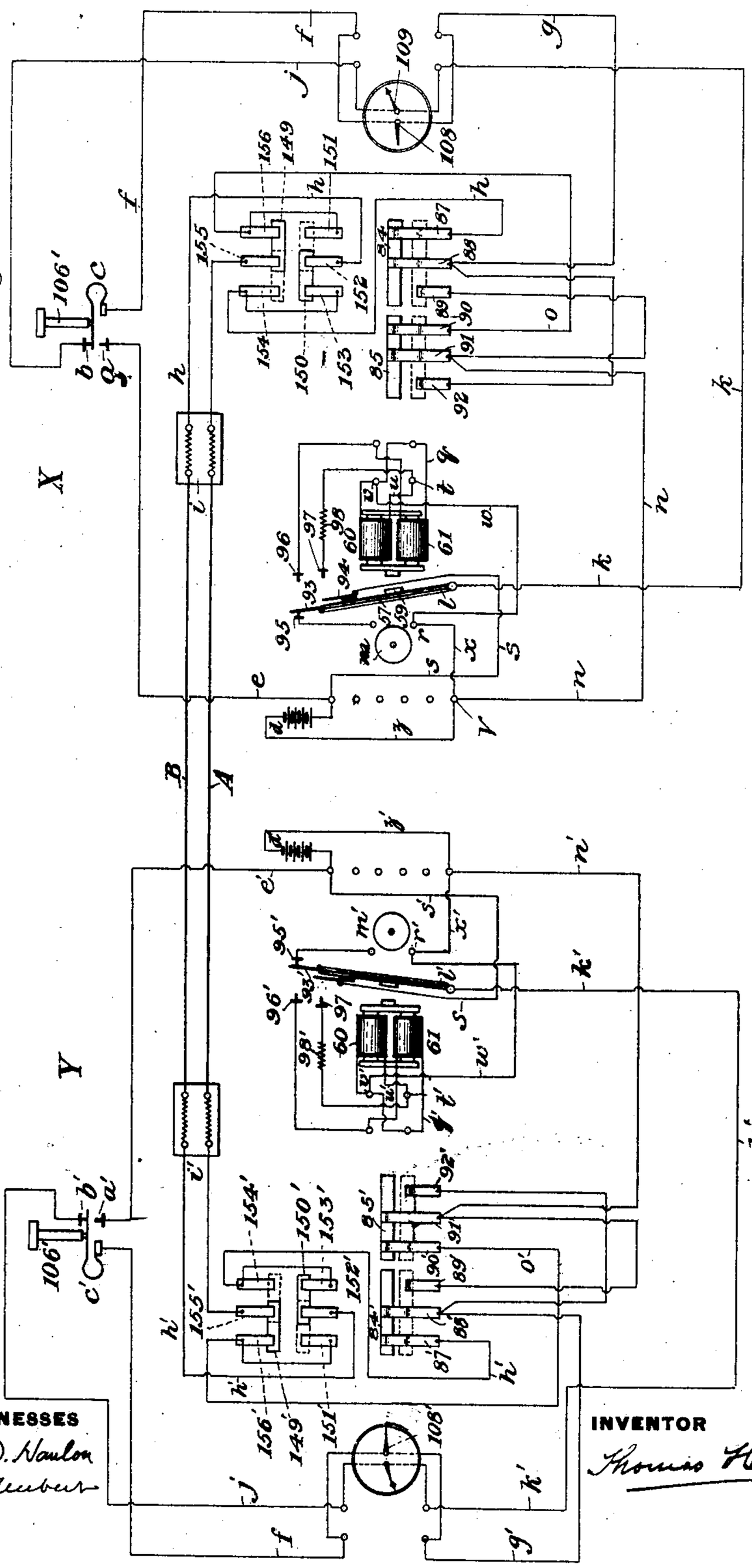
T. H. PATENALL.

HIGH-SPEED PERMISSIVE TRAIN SYSTEM AND APPARATUS THEREFOR.

APPLICATION FILED SEPT. 19, 1902.

NO MODEL. 8 SHEETS—SHEET 1.

Fig. 1.



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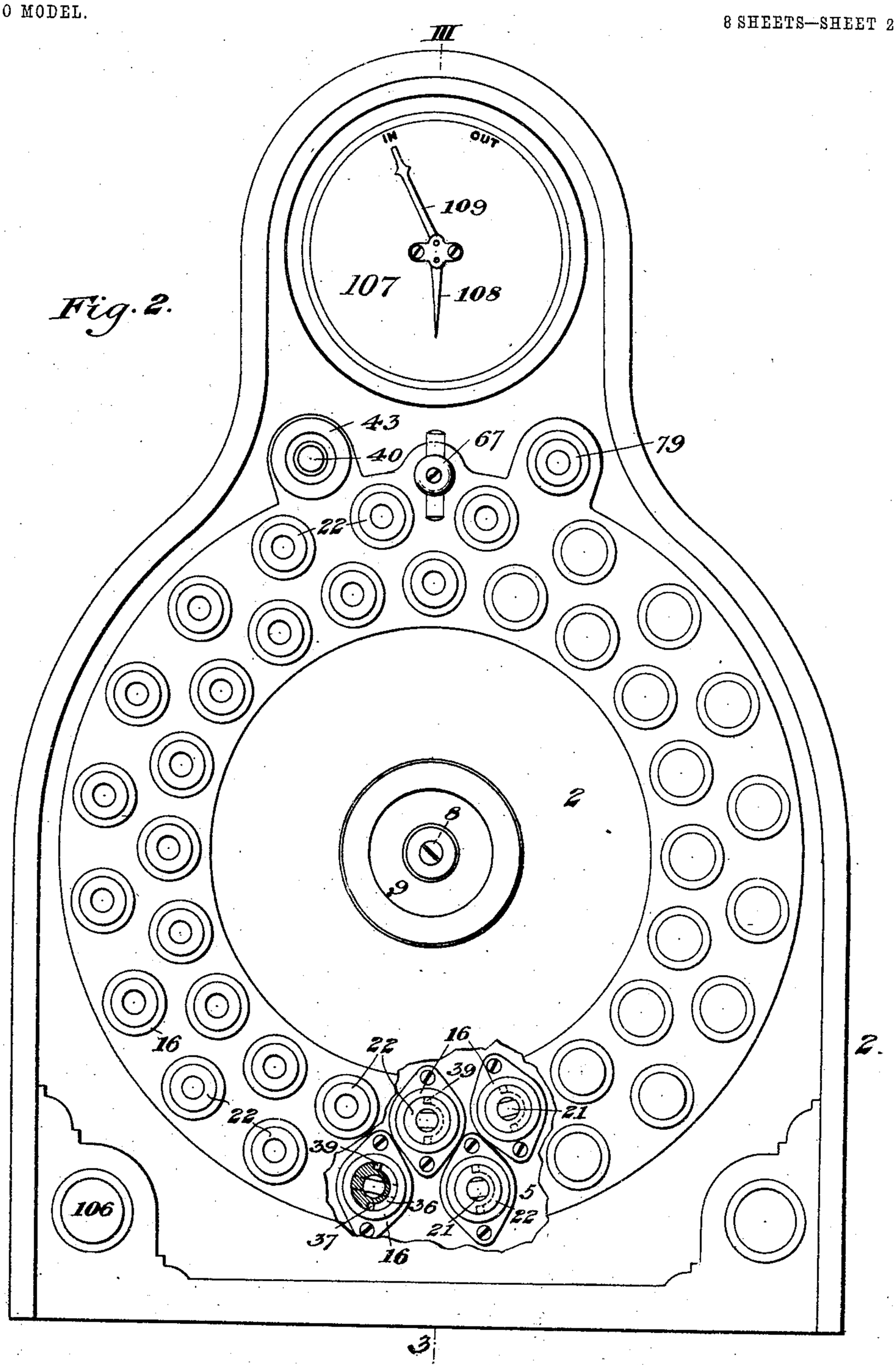
NO MODEL. 8 SHEETS—SHEET 2.

Fig. 2.



WITNESSES

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NO MODEL. 8 SHEETS—SHEET 3.

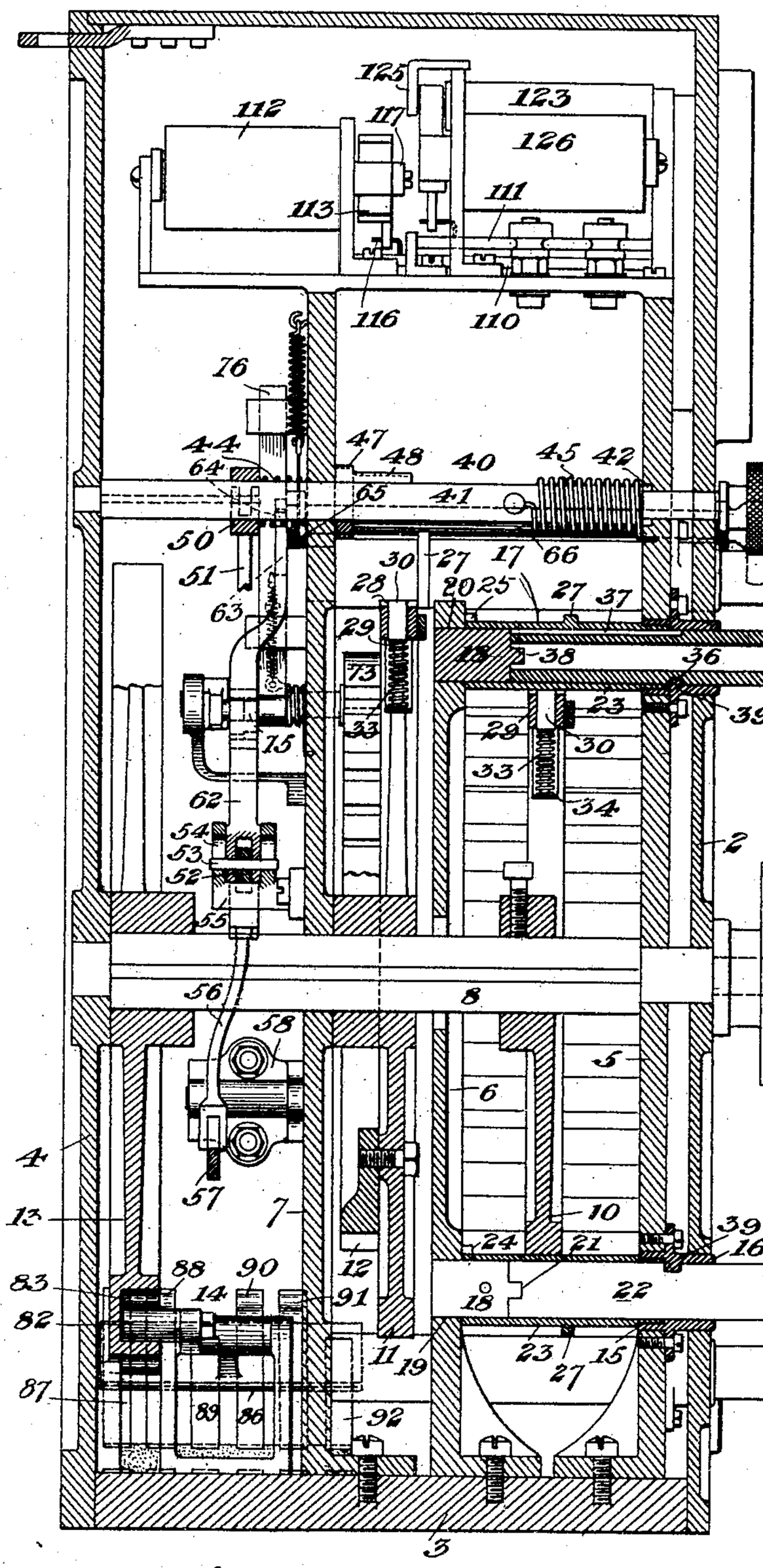

Fig. 3.

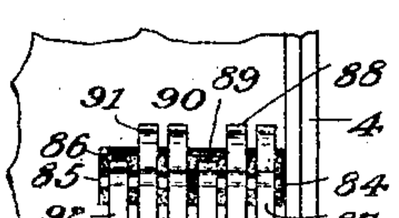

Fig. 7.

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NO MODEL. 8 SHEETS—SHEET 4.

Fig. 4

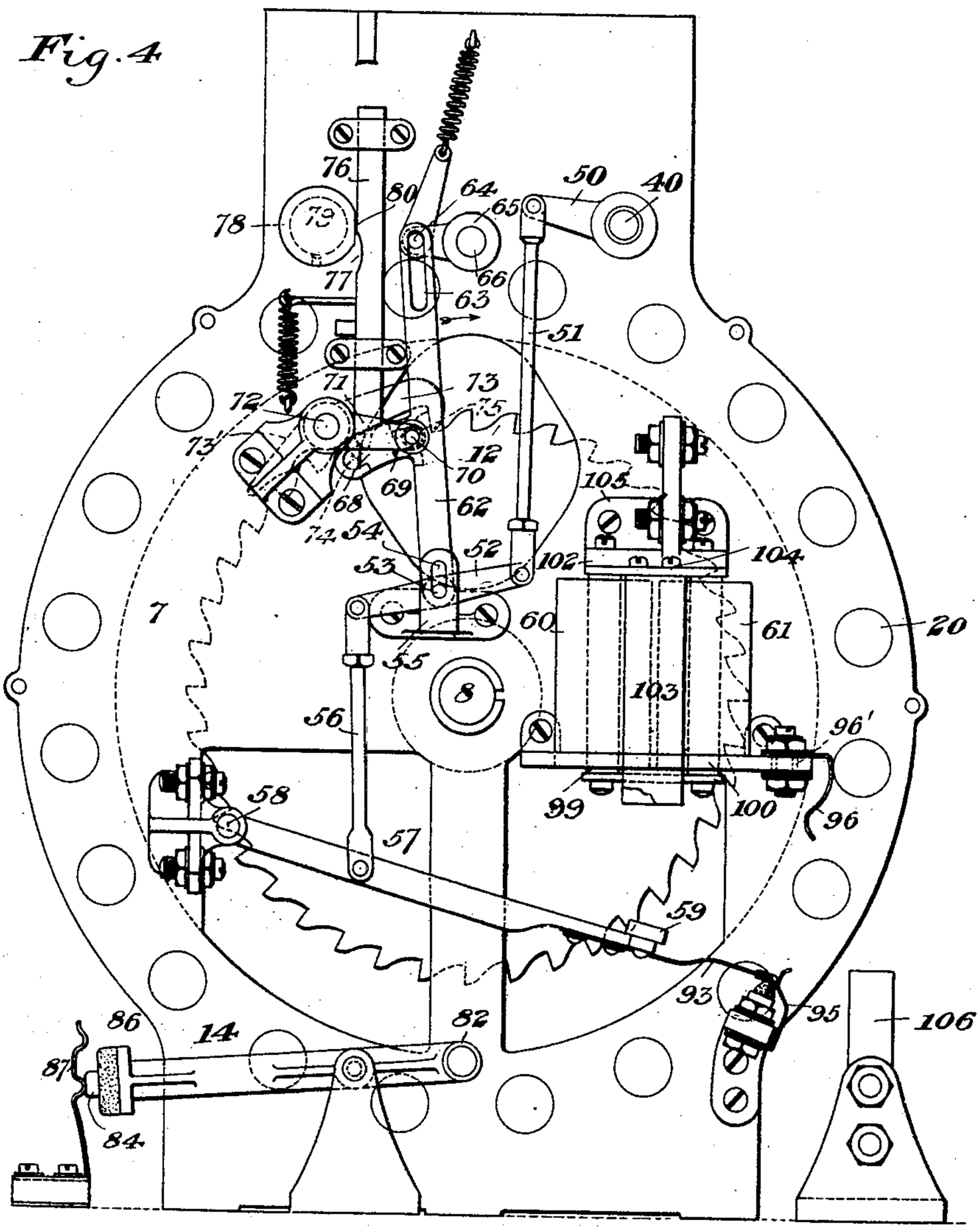

Fig. 6.

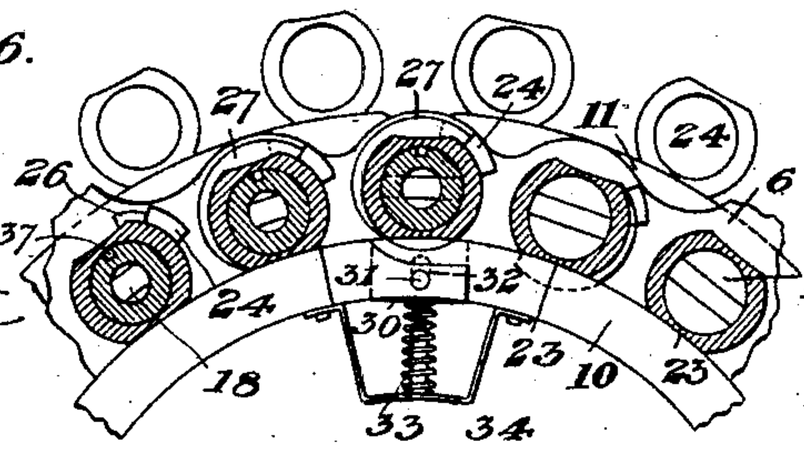

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Fig. 5.

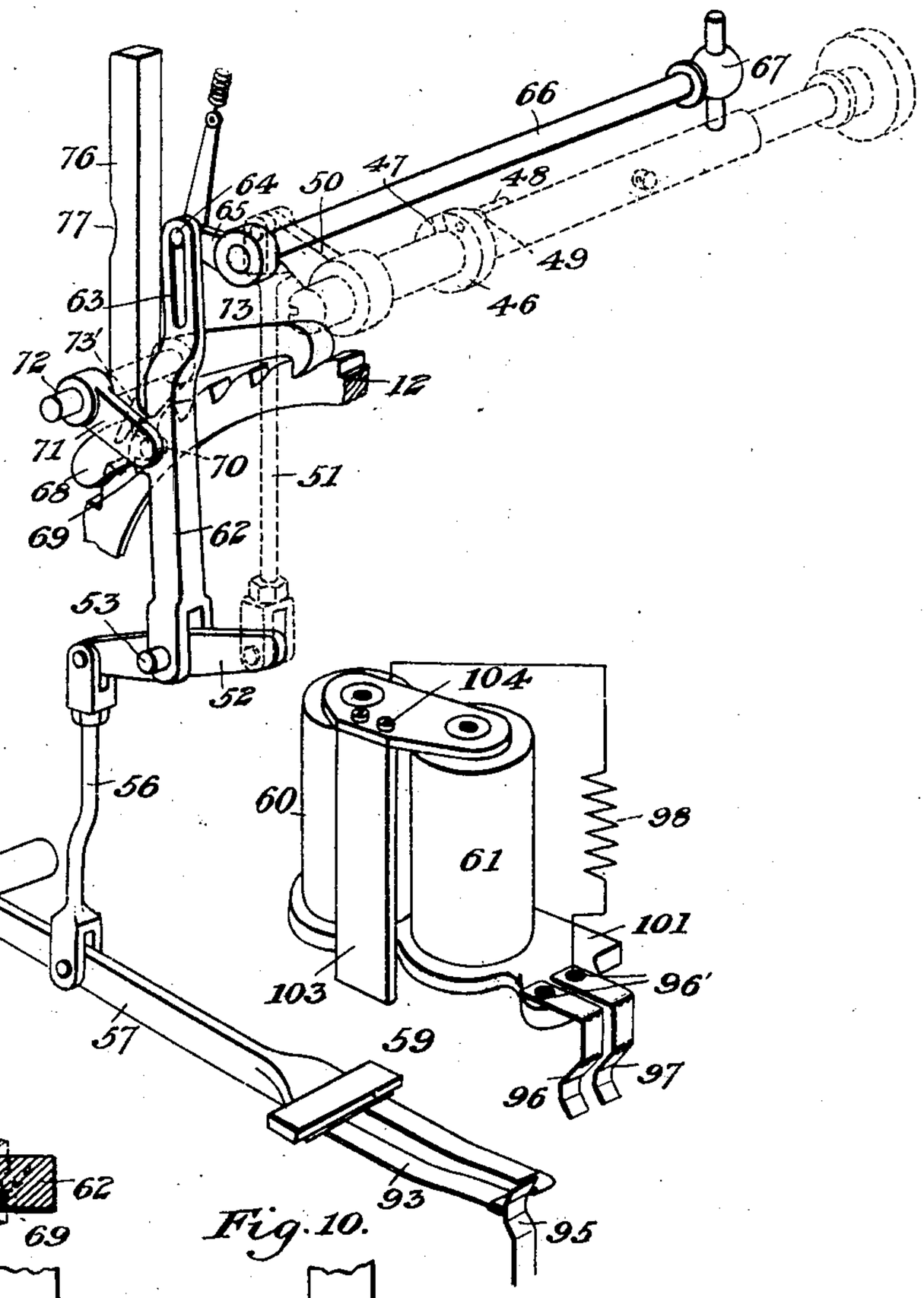


Fig. 8.

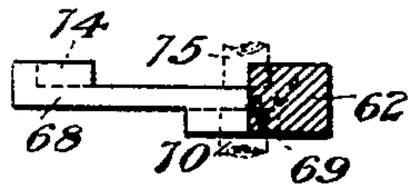


Fig. 9.

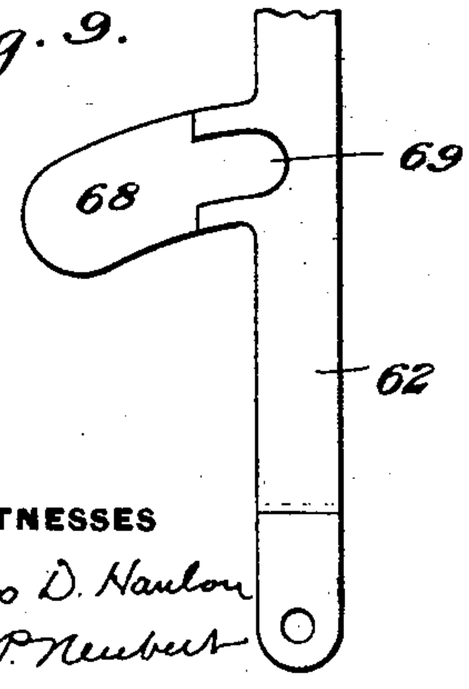
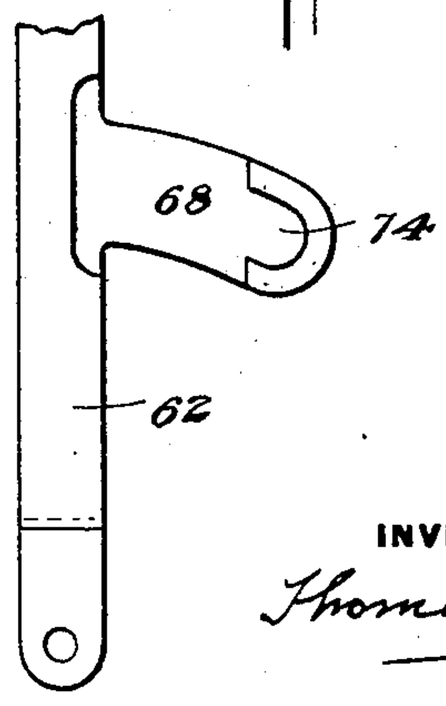


Fig. 10.



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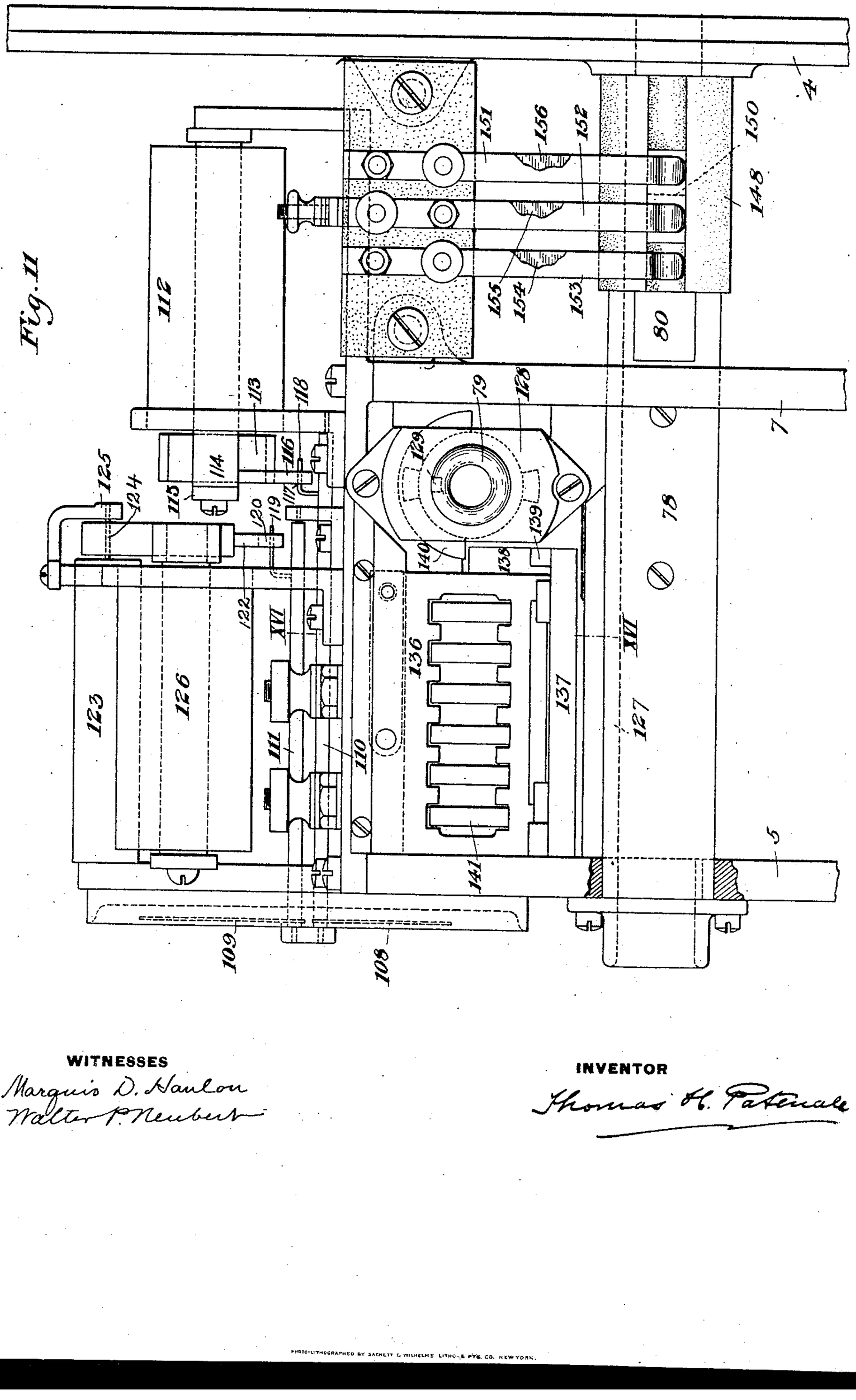
NO MODEL. 8 SHEETS—SHEET 6.

Fig. II



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NO MODEL. 8 SHEETS—SHEET 7.

Fig. 12.

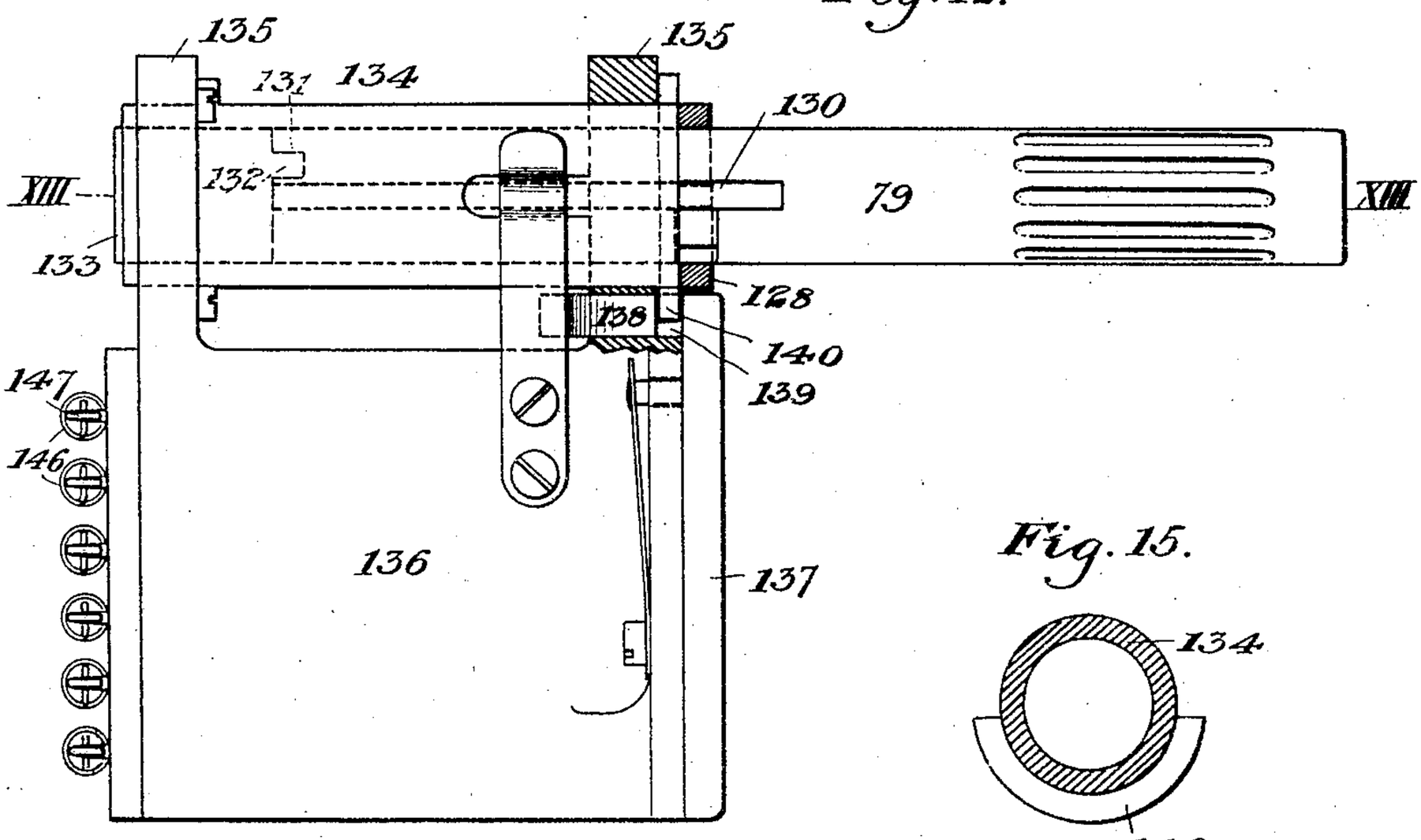


Fig. 13.

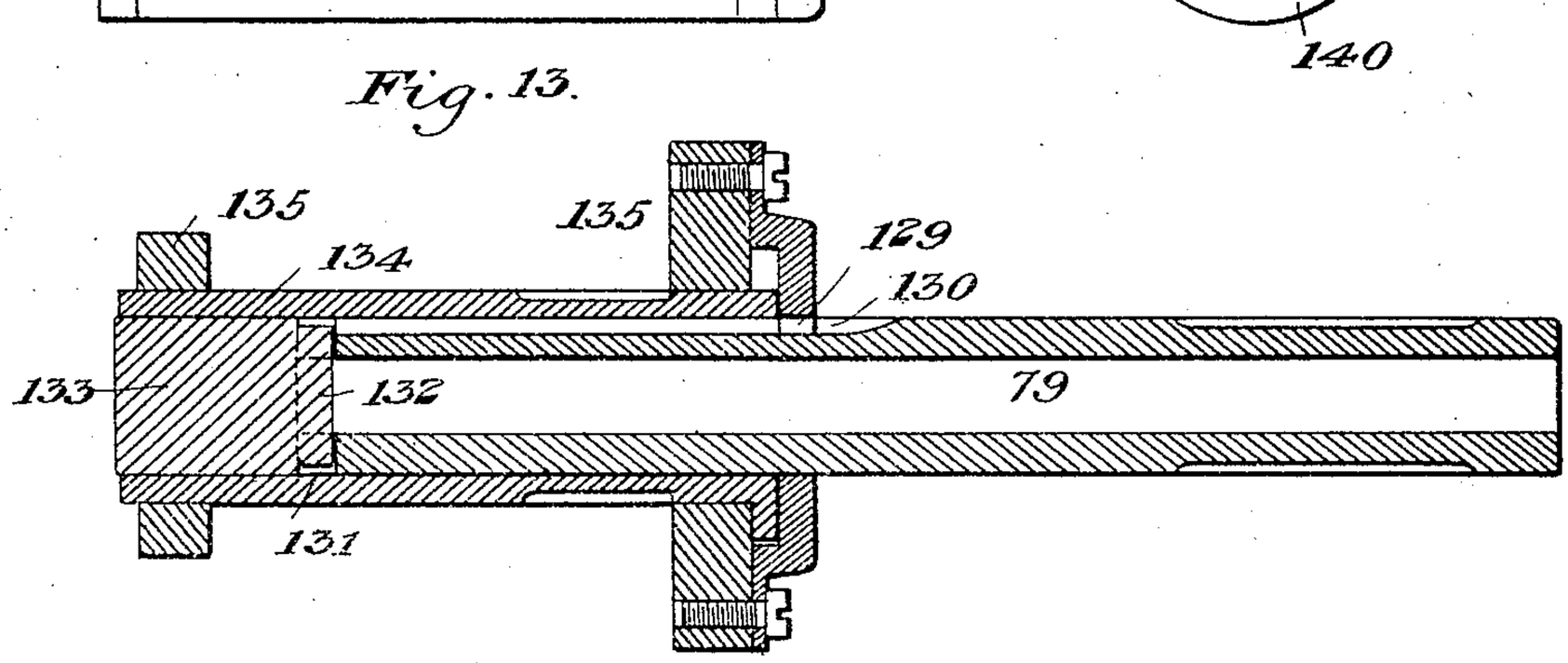
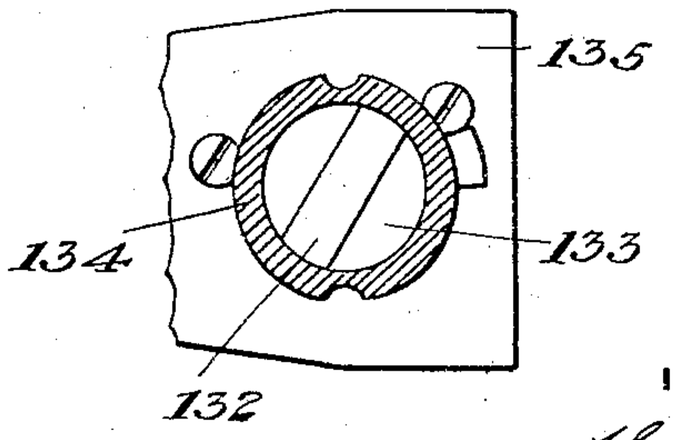


Fig. 14.

Fig. 15.



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NO MODEL. 8 SHEETS—SHEET 8.

Fig. 16.

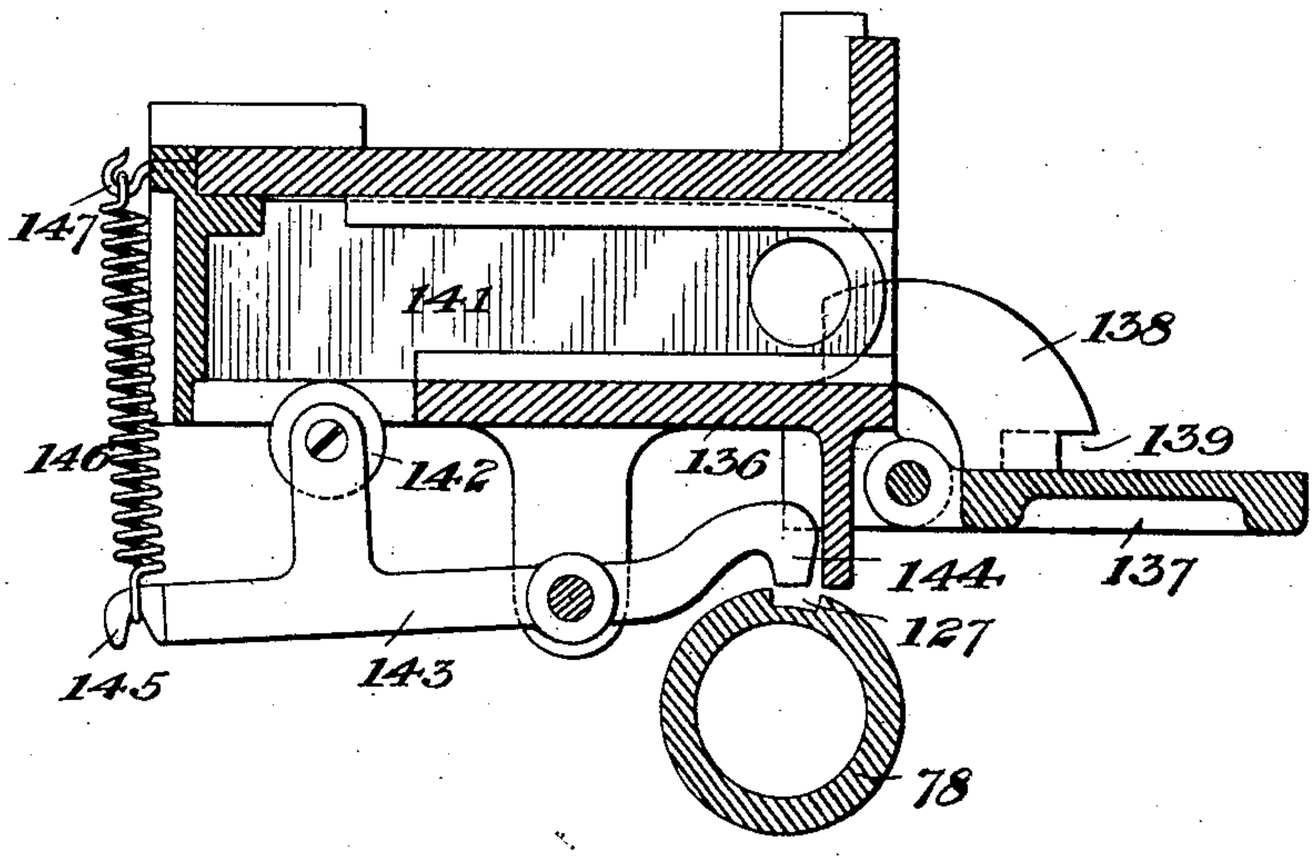
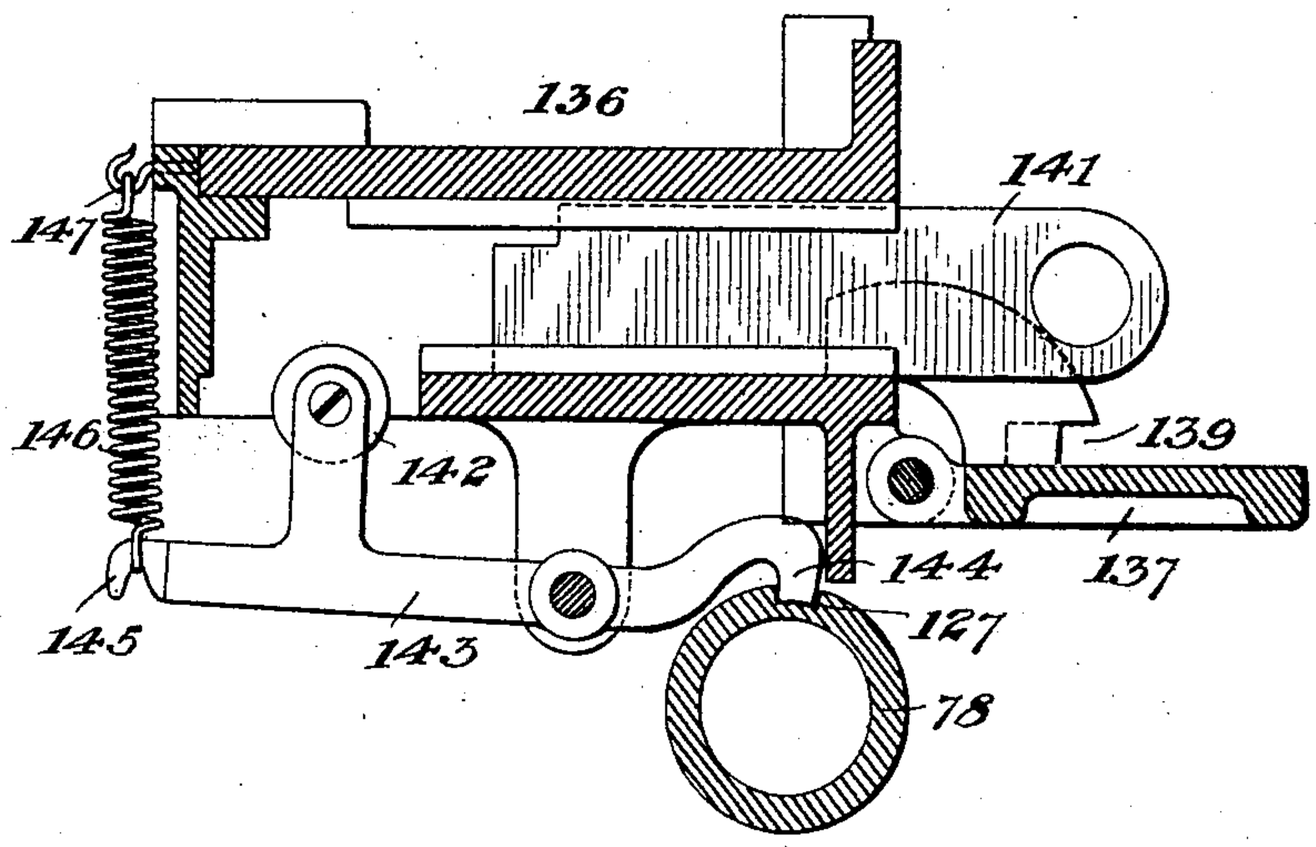


Fig. 17.



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No. 777,972. Patented December 20, 1904.

UNITED STATES PATENT OFFICE.

THOMAS H. PATENALL, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR TO THE UNION SWITCH AND SIGNAL COMPANY, OF SWISSVALE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

HIGH-SPEED PERMISSIVE TRAIN SYSTEM AND APPARATUS THEREFOR.

SPECIFICATION forming part of Letters Patent No. 777,972, dated December 20, 1904.

Application filed September 19, 1902. Serial No. 124,022.

To all whom it may concern:

Be it known that I, THOMAS H. PATENALL, of Wilkinsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful High-Speed Permissive Train System and Apparatus Therefor, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, in which—

Figure 1 is a diagrammatic view showing two staff instruments and the circuit connecting them. Fig. 2 is a front elevation, partly broken away, showing the staff instrument which I employ. Fig. 3 is a vertical section on the line III III of Fig. 2. Fig. 4 is a rear view of the portion of the mechanism which locks and unlocks the ordinary or absolute staffs and the permissive staff. Fig. 5 is a perspective view of a portion of the mechanism shown in Fig. 4. Fig. 6 is a detail view of the portion of the locking-wheel and supports for the ordinary or absolute staffs. Fig. 7 is a detail view of the circuit-changer and its contacts, the casing of the instrument being broken away. Figs. 8, 9, and 10 are detail views of the lock-link. Fig. 11 is a detail side elevation, on a larger scale, showing the permissive attachment which I employ, the casing of the instrument being removed. Fig. 12 is a top plan view of the tablet or ticket holding case, showing the permissive staff in position to unlock the same. Fig. 13 is a vertical section on the line XIII XIII of Fig. 12, showing the staff in position to turn the locking-socket. Fig. 14 is a cross-sectional view showing the locking-socket and the stops thereof. Fig. 15 is a detail cross-section of the locking-socket, showing its locking-rim. Fig. 16 is a cross-sectional view on the line XVI XVI of Fig. 11, showing the ticket-box door open to permit the withdrawal of a ticket or tablet; and Fig. 17 is a similar section showing one of the tickets or tablets partially removed and the permissive-staff socket locked against rotation to prevent the changing of circuits.

My invention relates to a high-speed train-staff system and apparatus therefor, which is employed for the facilitating of the safe operating of trains at high speed on railways and is particularly adapted to single-track railways.

The object of my invention is to provide a permissive system in a train-staff apparatus, whereby after the apparatus has been locked by the withdrawal of the staff or operating-piece additional train movements may be made in the same direction without interfering with the original blocking operation; and it consists in the addition to the apparatus described by me in a former application, Serial No. 101,716, filed April 7, 1902, in the Patent Office, of a staff or other operating-piece which is supplemental to the ordinary staff used for despatching single trains in one direction, electrical connections controlled by the movement of this staff, and tablets which are locked in the instrument until released by this supplemental or permissive staff.

In the drawings I illustrate the apparatus which I employ in carrying out my high-speed permissive-train-staff system.

As introductory to the description of the permissive feature of this apparatus, which constitutes the principal part of this invention, I will now describe that portion of the apparatus which is used in connection with the movement of a single train in one direction before describing the permissive attachment which I employ.

In the drawings, 2 represents the main frame or casing of the instrument.

3 is the base-plate upon which the operative mechanism is supported.

4 is the back plate of the casing, which is removably secured to the base 3 and the side portions of the casing 2.

5, 6, and 7 are socket-supporting standards, the standard 5 being nearest the front of the machine and forming a support for all of the staff-sockets. The middle standard 6 serves as the end support for the short-staff sockets, and the standard 7 forms the end support for the long-staff sockets. Mounted in the supports 5 and 7 and also in the front of the casing 2 and the rear cover-plate 4 is a

central shaft or spindle 8, provided at its front end with a knob 9, rigidly secured thereto. At a point intermediate of the standards 5 and 6 a socket-locking wheel 10 is rigidly secured, and between the standards 6 and 7 I secure another socket-locking wheel, 11, to which is attached a ratchet-wheel 12. Near the rear end of the shaft 8 and adjacent to the rear cover-plate 4 I secure a cam-wheel 13, which is provided with a peripheral cam-groove arranged to operate a circuit-changer 14. The standard 5 is provided with holes 15, which receive the escutcheons 16, and these escutcheons form the front bearing for the sockets 17, which extend between the standards 5 and 6 and 5 and 7. By changing the size of the bore of the sockets 17 and changing the external diameter of the staffs I am enabled without any other changes in the instrument to adapt it to any desired size of staff which is required in order to permit the desired speed of the trains to be maintained. The rear end of the sockets 17 are supported by a plug 18, which fits tightly within the bore of the socket and is secured thereto by a suitable screw. These plugs extend beyond the socket and through holes 19 and 20 in the standards 6 and 7, respectively. The plugs 18 are provided with a central projection 21, which is preferably formed integrally with the plug, and this projection engages with the corresponding notch in the end of the staff 22 when the staff is in its place in the instrument. The external portion of the staff-socket 17 is provided with dished portions 23, which are preferably somewhat concave and fit the periphery of the locking-wheels 10 and 11. The dished portion 23 of the staff-socket, which is adjacent to the locking-wheel, prevents the socket 17 from being turned except when the locking-wheel is in the proper position to allow it to be done. In order to limit the amount of rotation which may be given to the staff-socket, I provide upon the standards 6 and 7 stops 24 and 25, and the rear end of the staff-socket is provided with a projection 26, which is arranged so as to engage one or the other of the stops 24 and 25, according to the position of the socket. At an intermediate point on the exterior of the socket 17 I form a cam-shaped projection 27, which serves as a lock to prevent the locking-wheels from being turned backwardly except when the staff is in the socket and the socket is turned to lock the staff in the instrument. In the periphery of the locking-wheels 10 and 11 I form a dished portion 28, which is preferably a little larger than the diameter of the cylindrical portion of the staff-socket. At this point a slot 29 is cut through the periphery of the locking-wheels, and a spring-pressed block 30 is inserted in the slot, and its outer face is curved in conformity to the radius of the locking-wheel. This block 30 is prevented from going beyond its proper position by a pin 31, which engages a slot 32, formed in the block. This block is backed by a spring 33, which normally holds it in the position shown in Fig. 6; but when the socket is turned the block 30 moves inwardly against the action of the spring and permits the cylindrical portion of the staff-socket 17 to enter the depression 28 in the periphery of the locking-wheel. The spring 33 is supported by a suitable bracket 34, secured to the inner portion of the rim of the locking-wheels 10 and 11.

The staffs which I employ for any pair of instruments which are designed to be operated in conjunction with each other are exact counterparts. The outer end portion of the staff 22 is preferably knurled. This knurled portion serves as a grip for the hand to enable the staff and its socket to be easily turned in the ordinary operation of the instrument. At an intermediate point a transverse groove 36 is cut, which extends, preferably, a little more than half-way around the body of the staff. This transverse groove connects at one end with a longitudinal groove 37, which extends from the transverse groove to the end of the staff. The inner end of the staff is provided with a notch 38, which is adapted to engage the projections 21 on the staff-socket plugs 18. By simply changing the relative position of the notch 38 to the longitudinal groove 37 I am enabled to produce a large variety of locking combinations, the socket-plugs 18 being placed in the sockets in such a manner that the projections 21 will correspond to the particular set of staffs intended for any pair of instruments. The longitudinal groove 37 and the transverse groove 36 are always cut in the same relative positions.

By making the staff-socket plugs long or short, according to the distance between the standards 5 and 6 and 5 and 7, the latter being shown in the drawings as long socket-plugs and the former as short ones, the projections 21 on these plugs are brought into the same vertical plane, and I am thereby enabled to use staffs having standard transverse and longitudinal grooves. The front bearing for each of the staff-sockets 17 is formed by an escutcheon 16, which is provided with a tongue 39, which engages the longitudinal groove 37 in the staff as the staff is being inserted or withdrawn, and this tongue serves as lock to prevent the withdrawal of the staff from the instrument when it is turned so as to bring the wall of the transverse groove into engagement with the tongue 39, the position of the staff-socket 17 being such that it cannot be turned so as to bring the longitudinal groove 37 opposite to the tongue 39 except when the locking-wheel, with its depression, is opposite the socket, so as to permit it to be rotated.

A spindle 40 is loosely mounted in the standards 5 and 7 and the rear cover-plate 4. The

body portion 41 of the spindle is slightly larger than the end portions, and a socket 42 is formed in the rear of the standard 5 to enable this enlarged portion 41 to be moved endwise by the operator pulling the knob 43 outwardly against the action of the spring 44. A torsion-spring 45 is secured to the spindle 41 at one end and to the standard 5 at the other. A locking-disk 46 is secured to the standard 7 and is provided with a notch 47, which receives a key 48 when the spindle is in its normal position. The locking-disk 46 is provided with a suitable stop 49, which limits the backward movement of the spindle and presents the key 48 in registry with the notch 47 when the spindle 41 is in normal position, the forward movement of the spindle being limited by a mechanism which will be hereinafter described. At a point rearwardly from the spring 44 is secured a crank-arm 50, and to the outer end of this arm a link 51 is loosely connected. The opposite end of this link is connected in a similar manner with a rocking lever 52, mounted upon a pin 53, which is supported in a slot 54, formed in a bracket 55, which is secured to the standard 7. The other end of the rocking lever 52 is pivotally connected to a link 56, which at its other end is connected to the armature-lever 57, this lever being pivotally supported by a bracket 58, which is also secured to the standard 7. The armature-lever 57 is provided with the armature 59, which after being placed up to the pole-pieces of the magnets 60 and 61 is retained there when the aforesaid magnets are energized.

The lock-link 62 is pivotally connected at its lower end to the pin 53 and at its upper end is guided by the slot 63, which engages a pin or roller 64 upon the crank-arm 65 of the permissive spindle 66, which is supported in the standard 7 at its rear end and at its front end in the standard 5. This spindle is provided with a suitable knob 67, by which it is rotated to change the position of the lock-link 62. The lock-link 62 is provided with a projection 68, having a recess 69 open at one end adapted to receive a pin or roller 70 upon the crank-arm 71, secured to the shaft 72, which carries the locking-pawl 73, the pawl 73 engaging with the teeth of the ratchet-wheel 12. The opposite side of the projection 68 is provided with a recessed portion 74, which is adapted to receive a pin or roller 75, secured to the end of the permissive locking-bar 76 when the lock-link 62 is turned upon the pin 53 in the direction of the arrow shown in Fig. 4. The permissive locking-bar 76 is provided with a notch 77, which when in its raised position registers with the socket 78 of the permissive staff 79. When in the position shown in Fig. 4, the flattened portion 80 of the permissive-staff socket engages the bar 76 and prevents the socket from being turned.

When the parts are in the position shown in Fig. 4, the ordinary or absolute staff mechanism is in a position to be released. When it be desired to operate the permissive mechanism, the permissive spindle 66 is rotated so as to bring the recess 74 on the projection 68 into engagement with the pin 75 on the locking-bar and at the same time disengaging the roller 70 from the recess 69 on the opposite side of the lock-link 62. If the spindle 40 be pulled out and the key 48 disengaged from the locking-disk 46 and the spindle be rotated clockwise, this movement will depress the crank-arm 50 and through the link connection 51 will depress the rocking lever 52 upon the pin 53 as its fulcrum and will elevate the opposite end of the lever 52 and through the link connection 56 raise the armature 59 up to the pole-pieces of the magnets 60 and 61 through the medium of the armature-lever 57. If the current is flowing through the magnets 60 and 61, of a proper polarity, the magnets will be energized and the armature 59 will be held up. The link 56 where it is pivotally connected to the lever 52 forms a fulcrum for this lever, by the movement of which the locking-pawl 73 is disengaged from the ratchet-wheel 12, this movement being accomplished by releasing the spindle 40, which under the action of the torsion-spring 45 will be rotated counter-clockwise and in so doing will lift the link 51, which is connected to the crank-arm 50 on the spindle, and as the link is connected to the opposite end of the lever 52 from that with which the link 56, just described, is connected will lift the lever 52 and cause the pin 53, upon which the link 62 is pivoted, to move upwardly in the slot in the bracket 55 upon the pivotal connection with the link 56 as a new fulcrum. This upward movement of the link acting upon the crank-arm 71 will cause the rock-shaft 72 to rotate and lift the pawl 73 in its bearing sufficient to disengage the hooked portion of the pawl from the teeth of the ratchet-wheel 12. At the same time that the hooked portion of the pawl 73 is disengaged the tail portion 73′ of the pawl is depressed, so as to engage a tooth of the ratchet-wheel 12, thereby forcing the hooked portion of the pawl into the next succeeding tooth, so that when the ratchet-wheel 12 is moved so as to bring one of the locking-wheels into such a position that the next succeeding staff-socket may be turned, as previously described, the staff in this socket may be removed. The spindle 40 having returned to its normal locked position by the action of the torsional spring 45 and the compression-spring 44, the key 48 enters the notch 47 and is held by the notch in the locking-disk 48 in such a way as to prevent the spindle 40 from turning. The crank-arm 50, which is keyed to the spindle 40, is held against rotation by the key 48, and the link 51, which is pivotally attached to the crank-arm 50, serves at its lower end, where it is attached to the locking-lever 52, as a new fulcrum for said lever, so that as the ratchet-wheel 12 is

rotated and the teeth engage the tailpiece 73′ of the pawl 73 this engagement of the tailpiece causes the shaft 72 to turn in its bearing, and thereby depress the crank-arm 71, which is rigidly secured to the shaft 72. The link 62, which connects the crank-arm 71 to the pin 53 of the rocking lever 52, forces said rocking lever downwardly until the pin 53 reaches the lower end of the slot 54, and at the same time the link 56 moves downwardly and forces the armature-lever 57, which supports the armature 59, away from the pole-pieces of the magnets 60 and 61, thereby breaking the electrical circuits. This movement of the ratchet-wheel 12, which is accomplished by rotating the shaft 8, on which it is mounted, at the same time turns the cam-wheel 13 and operates the circuit-changer 14, which is pivotally mounted on a bracket 81, secured to the base-plate 2 of the instrument. One end of this circuit-changer is provided with an antifriction-roller 82, which engages the cam-groove 83 on the cam-wheel 13, and as the roller is acted upon by the groove the circuit-changer is moved up or down as the groove in the cam-wheel moves the roller. When the permissive part of the apparatus is to be unlocked, the position of the lock-link being changed, the pawl 73 is unaffected by the release of the preliminary spindle, and the locking-bar 76 is raised into position to bring the notch 69 into position to allow the permissive-staff socket to be turned.

As shown in Figs. 1 and 7, the contact-strips 84 and 85 are insulated from each other and from the long arm of the circuit-changer 14 by a piece of insulating material 86. These contact-strips 84 and 85 engage suitable spring contact-fingers 87, 88, 89, 90, 91, and 92. The contact-fingers 87 and 90 are provided with two contact-points. The fingers 88 and 91 are provided with a single contact-point at the upper end and in line with the upper contact-points of the springs 87 and 90. The contact-fingers 89 and 92 are shorter than the others and are provided with a single contact, which is in line with the lower contact-points on the springs 87 and 90. It will thus be seen that the springs 87 and 90 have contacts which are common to both of the other sets of springs and that the contact-strips 84 and 85 close the circuits between springs 87 and 88 and 90 and 91, respectively, when the circuit-changer is in its upper position, and between the contact-fingers 87 and 89, 90, and 92, respectively, when the circuit-changer is in its lower position.

A pair of spring-fingers 93 and 94 are secured to the armature-lever 57, and these fingers are insulated therefrom. They are provided with suitable binding screws or connections for the wires, which form a part of the main and local circuits hereinafter described. These fingers 93 and 94 are suitably tipped, so as to form contact-points at their end, and when the armature-lever is in its lower or normal position the finger 93 rests against a suitably-insulated stop and in contact with a spring-finger 95, which is properly insulated from its supporting-bracket, and this spring is provided with suitable binding post or screw, to which one of the wires forming a part of a bell-circuit, hereinafter described, is connected.

A pair of contact-springs 96 and 97 are secured to the magnet-spectacle for the magnets 60 and 61 and are suitably insulated therefrom by a suitable bushing 96′. These contact-springs 96 and 97 are brought into contact with the spring-fingers 93 and 94, when the armature-lever 57, carrying the armature 59, is raised up to the pole-pieces of the magnets 60 and 61 by the mechanism previously described. The circuit thus established closes the circuits at this point on the line-coil and the local coil.

Between the contact-spring 97 and the local coil 60 is placed a resistance-coil 98. This resistance 98 is inserted in the local circuit for the purpose of making the point of attraction at the central point of the magnets and armature and is proportioned according to the length of the line between the train-staff stations. The armature 59 is weighted to such an extent that the combined energy of the magnets 60 and 61 is necessary in order to hold it in raised position. The magnets are independent of each other so far as the electrical circuits of which they form a part are concerned. The cores 99 and 100 of the magnets 60 and 61 are connected at their upper and lower ends by straps 101 and 102 at the front and back ends of the magnets, respectively. A rectangular pole-piece 103 is secured to the upper back strap 102 by suitable screws 104 and coacts with a projecting piece on the front strap 101, so that the lower end of the pole-piece 103 and of the projecting portion of the strap 101 are flush with each other and form the pole-pieces common to both magnets 60 and 61. The pole-pieces thus formed constitute a stop which limits the movement of the armature and at the same time forms the points at which the armature is held when the magnets are energized. These magnets 60 and 61 are wound exactly alike, and when both are energized by a current of the same polarity as the current flows out of each the current of one magnet opposes the current of the other and meeting at a central point of their common pole-piece 103 the combined energy of the magnets attracts the armature 59 when raised and holds it in its raised position. If the polarity of the magnets 60 and 61 be different, due to the change of polarity in the main circuit, the currents passing through the magnets 60 and 61 will not oppose each other, but will flow in a closed circuit through the magnets and across the strips 101 and 102; but when it flows in a closed circuit the attractive

power of the magnets is destroyed to such an extent that the weight of the armature will cause it to fall away when released by the operator. The magnets 60 and 61 in addition to being supported by the spectacle are further supported by a bracket 105, secured to the standard 7.

Secured to the base 2 of the instrument by suitable brackets and supports is a push-key 106 of well-known construction and diagrammatically illustrated in Fig. 1.

In the upper portion of the casing 3 is a dial-plate 107, which is provided with a pair of indicating-needles 108 and 109. These needles are mounted upon rock-shafts 110 and 111, respectively, and the lower needle 108 indicates, if it moves to the right, that the circuit is closed and the current flowing. This needle is operated by a magnet 112, which is of ordinary construction, except that the pole-pieces are extended so as to permit the armature 113 to swing transversely between them, the armature being pivoted upon a pin 114, which is mounted in the spectacle at one end, and in a brass strip 115, connecting the end of the pole-pieces. The lower end of the finger 116, which is secured to the armature 113, is provided with a slot 117, which engages a pin 118, secured to the rock-shaft 110 in such a manner that when the armature is attracted the needle 108 will be moved by the engagement of the pin 118 with the finger 116, which is attached to the armature. The upper needle 109, which is mounted upon the rock-shaft 111, is provided with a pin 119, which engages a slot 120 in an extension 121 of the armature 122, which is polarized by the permanent magnet 123 through induction. This armature is pivoted upon a suitable pin 124, supported on the permanent magnet at one end and in a bracket 125, secured to the spectacle of the magnet 126. The needle 109, controlled by the polarized armature of magnet 126, indicates when the staff is in or out and when in the position shown in the drawings shows that it is in the instrument, in the manner hereinafter described.

The permissive staff 79 and its socket 78 cannot be turned in order to release the staff from the instrument until the locking-bar 76 has been raised so as to bring the notch 77 into such a position that the notch registers with the staff-socket and affords the necessary clearance for the socket to rotate. If the staff and socket be rotated to unlock the staff, the groove 127 is carried from its lower position to its upper position, as shown in Figs. 16 and 17, and when the staff is withdrawn from the socket it is inserted through the escutcheon 128, which is provided with a tongue 129, which engages a groove 130 in the staff 79. The front end of the staff is provided with a notch 131, which engages a projection 132 on the plug 133, which is rigidly secured to a locking-socket 134, which is supported in suitable bearings 135, formed at one side of the tablet-box 136. This box is provided with a door 137, pivoted at its lower side to the box 136, and is provided at one side with a finger or locking-segment 138, which has a notch 139, which when the door is closed receives the locking-rim 140 of the locking-socket 134, as shown in Fig. 12. The box 136 is provided with a receptacle having grooves for the reception of the tablets 141, and when the tablets are in the receptacle their lower edges engage with the rollers 142, mounted upon rocking levers 143, which are provided with a locking-detent 144 at their forward end, and the opposite end is provided with a hook 145, to which is secured one end of a coil-spring 146, the other end of which is attached to the box at 147. If the door be unlocked by the turning of the locking-socket 134, so as to disengage the rim 140 from the notch 139, the door will drop, and the tablets may then be withdrawn, and as soon as one of the tablets is withdrawn sufficient to free the roller 142 the spring 146, acting upon the lever 143, will depress the detent 144 and engage the groove 127 in the permissive-staff socket 78, thereby preventing this staff-socket from being rotated until all the tablets have been returned to the box and the box locked. The permissive staff, which is withdrawn from the locking-socket of the tablet-box, will not fit to operate any of the ordinary staff-sockets, and none of the ordinary staffs are capable of operating the permissive-staff socket or of unlocking the tablet-box, the grooves and notches in the staffs and the corresponding plugs being differently disposed with respect to each other.

The permissive-staff socket is provided, preferably at its rear end, with a circuit-changer, which consists of an insulated barrel 148, provided with contact-strips 149 and 150 on opposite sides of the barrel and insulated from each other, the contact-strip 149 making contact with contact-springs 151 and 152 when the parts are in the position shown in Fig. 11, the contact-spring 153 resting upon the insulation. The contact-springs 154 and 155 upon the opposite side of the insulated barrel are in contact with the contact-strip 150, and the contact-spring 156 rests against the insulation. When the parts are in the normal or locked position, the spring contact-fingers 152 and 153 are in contact with the strip 150, and the contact-springs 155 and 156 are in contact with the strip 149, the contact-springs 154 and 156 resting upon the insulation.

The instrument at station X, in which the permissive staff is, has its contact-pieces 149 and 150 so located with respect to the locking-groove of the staff-socket that the position of the contact-strips corresponds with the position of the contact-strips 149′ and 150′ at station Y, except that the grooves in the permissive-staff socket at this station are oppo-

sitely located, the permissive-staff socket at station Y being empty and the locking-levers 143 being in engagement with the groove 127.

I will now describe the circuits I employ and by which the staff instruments at staff-stations are connected, so as to work in conjunction with each other.

Referring to the diagram Fig. 1 of the drawings, X and Y represent two staff instruments, which are connected by the line-wires A B and are counterparts of each other, and the parts at station Y, which correspond to those at station X, are designated by the prime-mark. At station X is key 106 of ordinary construction and having the usual spring by which the circuit is closed or broken. *a* and *b* are the front and back contacts, and the push-key 106 is provided with a line-spring *c*, by which circuit is closed at the contact-points *a* and *b*. Connection between Y and X is established by the following circuits: Starting at battery *d*, which serves as a main and local battery at station X, a wire *e* leads from the positive side of said battery to the front contact-point *a*, and by pressing the spring *c* against the contact *a* the current will then flow out through the wire *f* and through the magnets of the lower indicator 108, thence through the wire *g* and spring 88, which makes contact with strip 84, which is also in contact with spring 87, and thence through wire *h*, thence through contact-springs 154 153, contact-strip 150 to contact-spring 152, thence continuing on wire *h* to a suitable lightning-arrester *i*, from which leads the line-wire B, through which the current flows to a corresponding lightning-arrester *i'* at station Y, and thence through wire *h'* to contact-spring 152', contact-strip 150', thence to contact-springs 153' and 154', continuing on wire *h'*, spring 87' and contact-strip 84', thence through spring 88' and wire *g'*, through the magnets of the lower indicator 108', and thence through the wire *f'* to line-spring *c'*, thence to the contact *b'*, from which leads the wire *j''*, which is connected to the magnets of the upper indicator 109', thence through the wire *k'* to a wire *l'*, carried by the armature-lever 57', to which is attached a spring 93', which makes contact with point 95'. The current then passes to the bell *m'*, energizing magnets for the same, thence through wire *n'* to spring 91', through contact-strip 85' and spring 90', from which spring the wire *o'* leads to the lightning-arrester *i''*, and from the lightning-arrester *i''* the current flows through the line-wire A to the corresponding lightning-arrester *i* at station X, and thence through the wire *o*, contact-spring 90 and strip 85, thence through the spring 91, which is connected by wire *n* to the negative side of battery *d*. The operator at X pushes the push-key 106 the required number of times to inform the operator at Y that he desires to withdraw a staff from his instrument. The operator at Y responds with the requisite number of impulses by pressing his push-key 106' and on the last impulse holds the circuit closed until he gets notification from X that the staff is withdrawn in a manner which will be described hereinafter. As soon as the operator at X receives the last impulse he immediately closes the circuit on the main-line coil 61, at the same time closing the local circuit on the coil 60. Under these conditions the instrument can be operated and a staff withdrawn, and the following is a description of the circuits which are established permitting this to be done: Starting from the battery *d'* at station Y, the current flows through wire *e'*, contact *a'*, the line-spring *c'*, and the wire *f'*, thence through the lower indicator-magnets 108', thence through the wire *g'* to the spring 88', which contacts with the strip 84', this strip making contact with the spring 87', which is connected to wire *h'*, thence through contact-springs 154' 153', contact-strip 150', and thence through contact-spring 152' and through wire *h'*, thence through the lightning-arrester *i''*, the current flowing from the lightning-arrester *i''* through the line-wire B to station X through the corresponding lightning-arrester *i*, thence through the wire *h*, thence through contact-spring 152, contact-piece 150, contact-springs 153 154, thence through wire *h*, the contact-spring 87, the contact-strip 84, the spring 88, which is in contact therewith, and wire *g*, thence through the magnet of the lower indicator 108, and from this indicator through the wire *f* to the line-spring *c*, contact *b*, wire *j*, and thence to the magnets of the upper indicator 109. From this indicator the wire *k* leads along a wire *l*, attached to armature 57, this wire being connected to a spring 93, secured thereto and insulated therefrom, the spring making contact with point 96, which is connected by a wire *p* with the main coil 61. The current then flows through the magnet, energizing the same, thence out through wire *q*, which is connected to a binding-post *r*, which is also connected to wire *n*, thence through wire *n* to contact-spring 91, through the contact-strip 85 and spring 90, which is connected by wire *o* to the lightning-arrester *i*. From this point the main-line wire A carries the current to station Y and through lightning-arrester *i''*, thence through wire *o'* to contact-spring 90' through the contact-strip 85' and the contact-spring 91', to which is secured the wire *n'*, which leads to the positive side of battery *d'*. The local circuit at X, established simultaneously with the main circuit just described, is as follows: Starting at the positive side of battery *d*, the current will flow through wire *s* to the spring 94, thence to the point 97 through the resistance 98 to the binding-post *t*, and from thence a wire *u* leads through the local magnet 60, thence to a binding-post *v*, through the wire *w* to the binding-post *r*, from

which leads the wire *x* to the binding-post *v*, from which the wire *z* leads to the negative side of battery *d*. Both the main-line magnet 61 and the local magnet 60 are now energized and hold up the armature 59, carrying the contact-springs 93 and 94 in contact with points 96 and 97, maintaining the main and local circuits. This arrangement of main and local circuits causes the current to flow from the battery through the magnet of the local circuit always in one direction and to flow through the magnet of the main circuit in a direction which is determined by the position of the contact-strips 84 and 85 of the circuit-changer 14 with reference to the contact-springs 88 to 92, inclusive, which engage the strips, and the position of the circuit-changer is dependent upon whether a staff is released or locked. The act of unlocking a staff, so as to permit it to be withdrawn from the instrument, shifts the contact-strips 84 and 85 of the circuit-changer 14 into the position shown by dotted lines in Fig. 1. This change in the position of the contact-strips 84 and 85 onto the lower set of contacts formed on springs 87, 88, 89, and 92 reverses the current flowing from battery *d* at station X to station Y, and also reverses the current from battery *d'* coming into station X from station Y, thus preventing either set of magnets 60 61 or 60' 61' from being energized sufficiently to hold up the armature 59 59', thus preventing another staff from being taken out until the staff previously taken out has been replaced in one or the other instrument by either operator under the normal conditions of operation of the system, and if this staff be taken to station Y and inserted in this instrument, locked therein, this act will shift the contact-strips 84' and 85' into the position shown in dotted lines, Fig. 1, at station Y, and the instruments at Y and X will then be in a condition to permit another staff to be taken out, when the instrument is used as an absolute instrument. If the permissive portion of the instrument is used, in order to withdraw the permissive staff from the instrument its socket must be rotated, and this movement changes the position of the contact-strips 149 and 150 into the position shown in dotted lines at station X. The permissive staff is then used to unlock the tablet-box and the tablets are taken out, and these tablets, together with the permissive staff, are sent to the operator at station Y. The shifting of the contacts at station X reverses the current flowing from battery *d* at station X to station Y, and also reverses the current from battery *d'* coming into station X from station Y, thus preventing either set of magnets 60 61 or 60' 61' from being energized to a sufficient extent to hold up the armature 59 59'. This prevents another staff from being taken out of either instrument until the permissive staff is returned to its socket and locked therein or taken to station Y and inserted in the permissive-staff socket at this station and locked therein. This act will shift the contact-strips at station Y into the position shown in dotted lines in Fig. 1, and the instruments at both stations will again be in unison, the condition of the instrument under normal operation of the system being such that an even number of staffs used in two coöperating instruments must at all times be present in one or the other instrument or the number of staffs in both must constitute an even number of staffs, this being necessary, as the system is designed to be so operated; otherwise the electrical circuits will be rendered inoperative, owing to the fact that the withdrawal of a staff for single train movements or the permissive staff and tablets controlling a multiplicity of train movements alters the electrical circuits, and these circuits can be restored to a normal condition only by reinserting the staff and tablets which have been removed in making the train movements.

Having fully described the electrical circuits employed and the operation of the parts of the instrument in connection with the description of their construction, a brief description of the operation of the instruments as a whole will be sufficient to enable my invention to be readily understood and the manner in which it is used in practice.

In describing the operation of high-speed train-staff system we will suppose that a section of single track is controlled by it. Two instruments are required, one at each end of the section, each instrument containing the number of staffs required to operate the traffic properly. One end of the section we will call X and the other Y. X has a train that he wishes to send forward to Y. X presses the bell-push 106 the prescribed number of times, (called for on bell code,) which rings the bell at Y. Y answers and holds in his bell-push 106', which moves over the lower or current indicator 108 to the right. X, seeing this indicator standing over, at once pulls out and turns to the right the preliminary spindle 40, releases same, (which returns automatically to its normal position,) as described, and turns lock-wheel handle 9 to the left, then turns staff 22 to the left and withdraws same. (The act of turning the lock-wheel handle changes the circuit-controller 14, and the upper indicator will move to "Staff out.") As soon as X has withdrawn the staff he presses in his bell-push, which will move the upper indicator 109' at Y to "Staff out," at the same time ringing the bell, calling the attention of Y to the fact. The staff having been withdrawn is placed in a rubber pouch, (if to be delivered by hand,) or if to be delivered at speed in a rubber pouch with a steel ring attached, and the ring and pouch containing staff is placed in the mechanical deliverer, (fixed near the staff-sta-

tion.) Upon passing Y the catcher takes the ring, pouch, and staff. Y then takes the ring, pouch, and staff from the catcher and takes out the staff and places the same in his instrument, turning staff 22 to the right and then turning the lock-wheel handle 9′ to the right, which locks the staff in. Then Y presses in bell-push 109′, which notifies X that the train has passed out of section, and upper indicator at 109 moves over to "Staff in." X then acknowledges this by pressing in his bell-push 106, which moves upper indicator 109′ at Y to "Staff in." The instruments are again normal, and another movement can be made from X to Y or from Y to X. The operators at the staff-stations use the permissive staff and tablets when it is desired to send more than one train in the same direction, the permission to do so and the unlocking of the permissive staff being accomplished in the manner already described. The operator at X, for example, unlocks the tablet-box by using a permissive staff which has first been withdrawn from its socket and placed in a socket provided for it in the tablet-box, and after unlocking the box by turning this socket the door of the tablet-receptacle opens, and he then gives a tablet to the first train, one to the second train if it is to be followed by a third, and to the last train to be sent in that direction the remaining tablets and the permissive staff are sent to the operator at station Y, who places them in his instrument, after which the instruments at stations X and Y are ready to proceed, as before, either using the absolute or permissive system, as traffic demands. The advantage of providing such instruments with apparatus that permits the safe operation of a multiplicity of trains safely in the same direction without interfering with the block set against trains coming in the opposite direction will be appreciated by those familiar with the requirements for the speedy and safe operation of trains under a staff system.

Many changes may be made in the form and arrangement of the parts by the skilled mechanic and electrician without departing from the spirit and scope of my invention, since

What I claim is—

1. A high-speed permissive train-staff system, comprising a call-circuit, main and local circuits, lock-controlling magnets, an armature therefor, a mechanism adapted to lift the armature to the magnet, said armature being held up when said magnets are energized, staffs, for single train movements, a permissive staff for multiple train movements, and locks for both kinds of staffs, controlled by said magnets; substantially as described.

2. A high-speed train-staff system comprising call, main and local circuits which connect instruments distant from each other, said instruments having staffs for single train movements and a permissive staff for permitting a multiplicity of train movements, a receptacle containing devices for successive train movements, a lock for said receptacle adapted to be unlocked by the permissive staff, and a lock for said permissive staff controlled by the locks for the other staffs, said lock and the receptacle-lock being electrically connected, and arranged to form a part of the main and local circuits, the direction of the currents flowing through said circuits depending upon the insertion or withdrawal of a staff; substantially as described.

3. A high-speed train-staff system having electric circuits connecting staff instruments, said instruments having a tablet-receptacle, a permissive staff, said receptacle being unlocked by said staff, and an electrically-controlled lock actuated by said electric circuits for said staff, and a circuit-changer for said electric circuits, arranged to be operated by said permissive staff, whereby its electrically-controlled lock permits or prevents the manipulation of the permissive staff, and the unlocking of the tablet-receptacle; substantially as described.

4. A high-speed permissive train-staff system, having an electric circuit, the combination of a staff instrument comprising a plurality of staffs controlling single-train movements, and a permissive staff independent of the other staff arranged to permit a multiplicity of movements in the same direction, electrically-controlled locking devices for said staffs, and a circuit-changer arranged to be operated when one of either class of said staffs are withdrawn from the instrument, such movement effecting a change in the polarity and path of the current thereby controlling the locking mechanism for the staffs, permitting or preventing their manipulation according to the position of the circuit-changer and the path of the current; substantially as described.

5. A high-speed train-staff instrument, having a permissive staff, a lock for said staff, and a tablet-receptacle controlled by said permissive staff; substantially as described.

6. A high-speed train-staff instrument, having a permissive staff, an electrically-controlled lock for said staff, a tablet-receptacle and a lock therefor, said lock being controlled by said staff; substantially as described.

7. A high-speed train-staff instrument, having a permissive staff, an electrically-controlled lock for said staff, a tablet-receptacle, a lock therefor, said permissive staff unlocking said receptacle, the withdrawal and manipulation of the permissive staff being controlled by electric circuits connecting the same with a distant instrument; substantially as described.

8. A high-speed train-staff instrument, having a permissive staff, a lock for said staff, a tablet-receptacle, a lock therefor, said staff being adapted to unlock the tablet-receptacle,

locking mechanism controlled by the tablets arranged to prevent the position of the permissive-staff lock from being changed until all the tablets are replaced and the staff withdrawn from the lock of the tablet-receptacle; substantially as described.

9. A high-speed train-staff instrument, having a permissive staff, a socket for said staff, a lock for said staff-socket, a tablet-receptacle, a lock therefor, said staff being adapted to unlock the tablet-receptacle, locking mechanism controlled by said tablets arranged to prevent the position of the permissive-staff-socket lock from being changed until all the tablets are replaced and the staff withdrawn from the lock of the tablet-receptacle; substantially as described.

10. A staff instrument having staffs for single train movements, and a permissive staff permitting a multiplicity of train movements in the same direction, a tablet-receptacle containing tablets which constitute the authority for such train movements, the tablet-receptacle being opened by the permissive staff, the staffs of each kind being non-interchangeable; substantially as described.

11. A staff instrument forming part of an electrical circuit, having staffs for single train movements and a permissive staff permitting a multiplicity of train movements in the same direction, circuit-changers in said circuits, the position of said circuit-changers being altered by the operation and withdrawal of a staff for either kind of train movements; substantially as described.

In testimony whereof I have hereunto set my hand.

THOMAS H. PATENALL.

Witnesses:
MARQUIS D. HANLON,
WALTER P. NEUBERT.