No. 777,971. PATENTED DEC. 20, 1904.

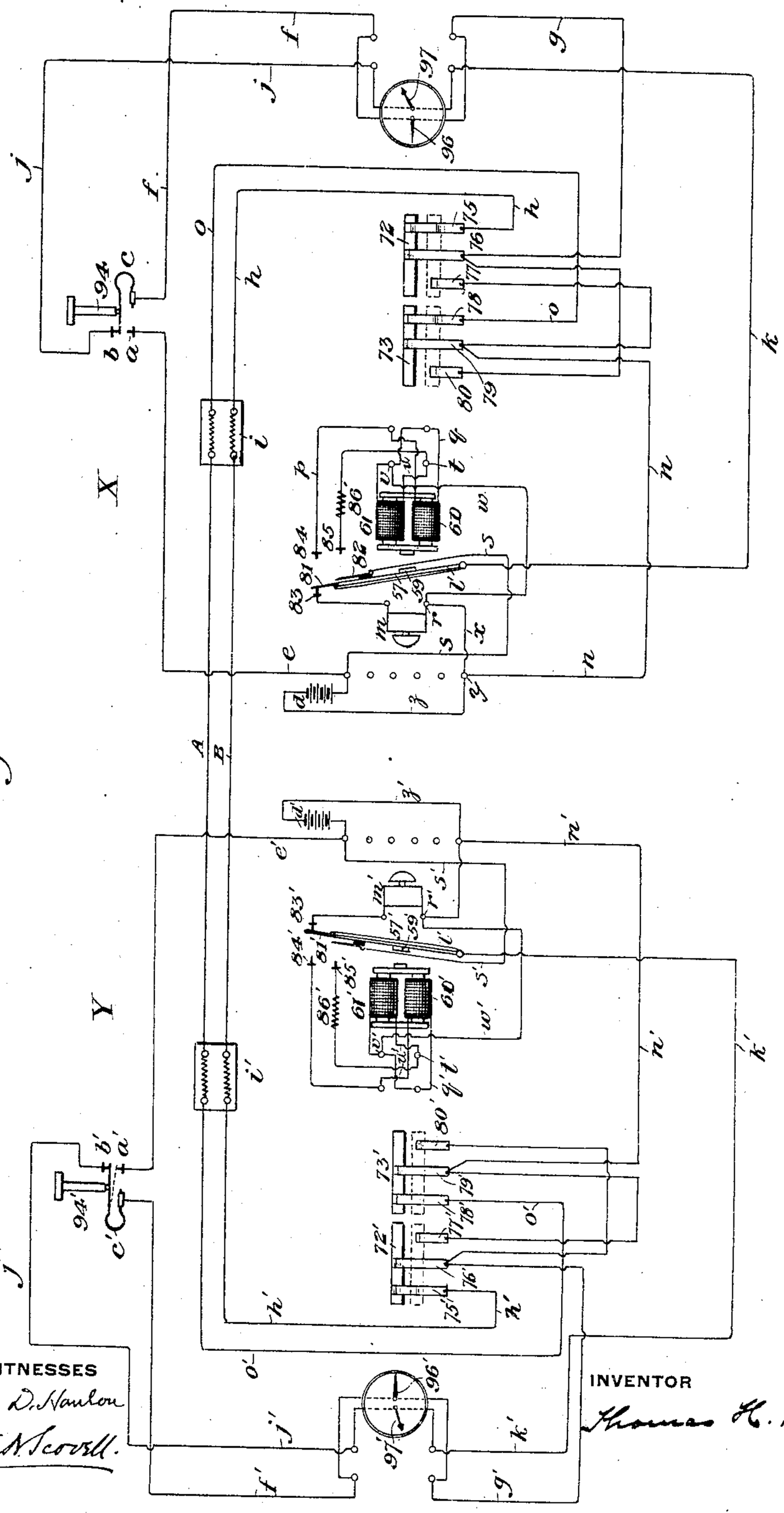
# T. H. PATENALL.

## HIGH SPEED TRAIN SYSTEM AND APPARATUS THEREFOR.

APPLICATION FILED APR. 7, 1902.

NO MODEL. 9 SHEETS—SHEET 1.

Fig. 1.




WITNESSES

Marquis D. Naulon

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INVENTOR

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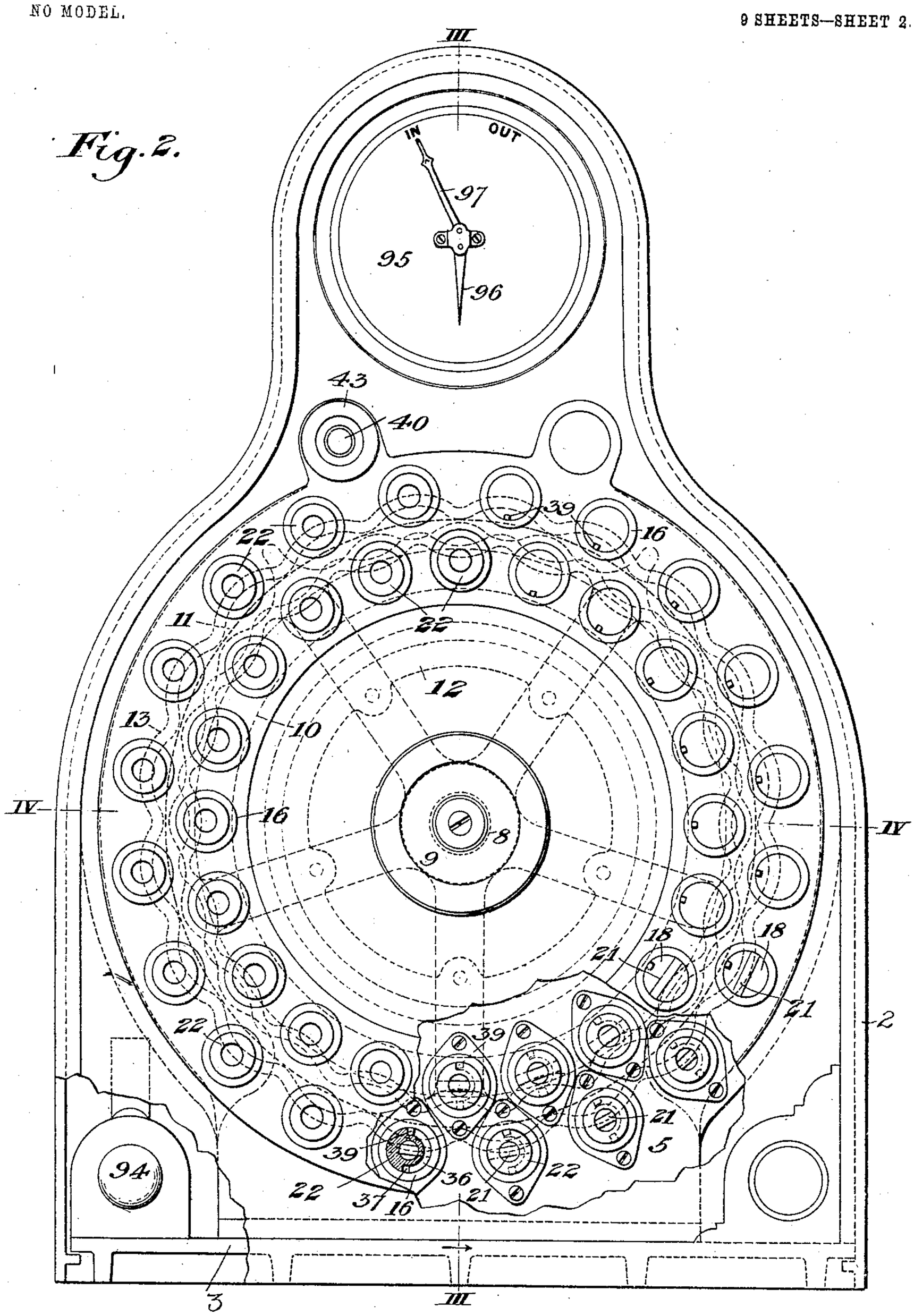
NO MODEL. 9 SHEETS—SHEET 2.

Fig. 2.

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NO MODEL. 9 SHEETS—SHEET 3.

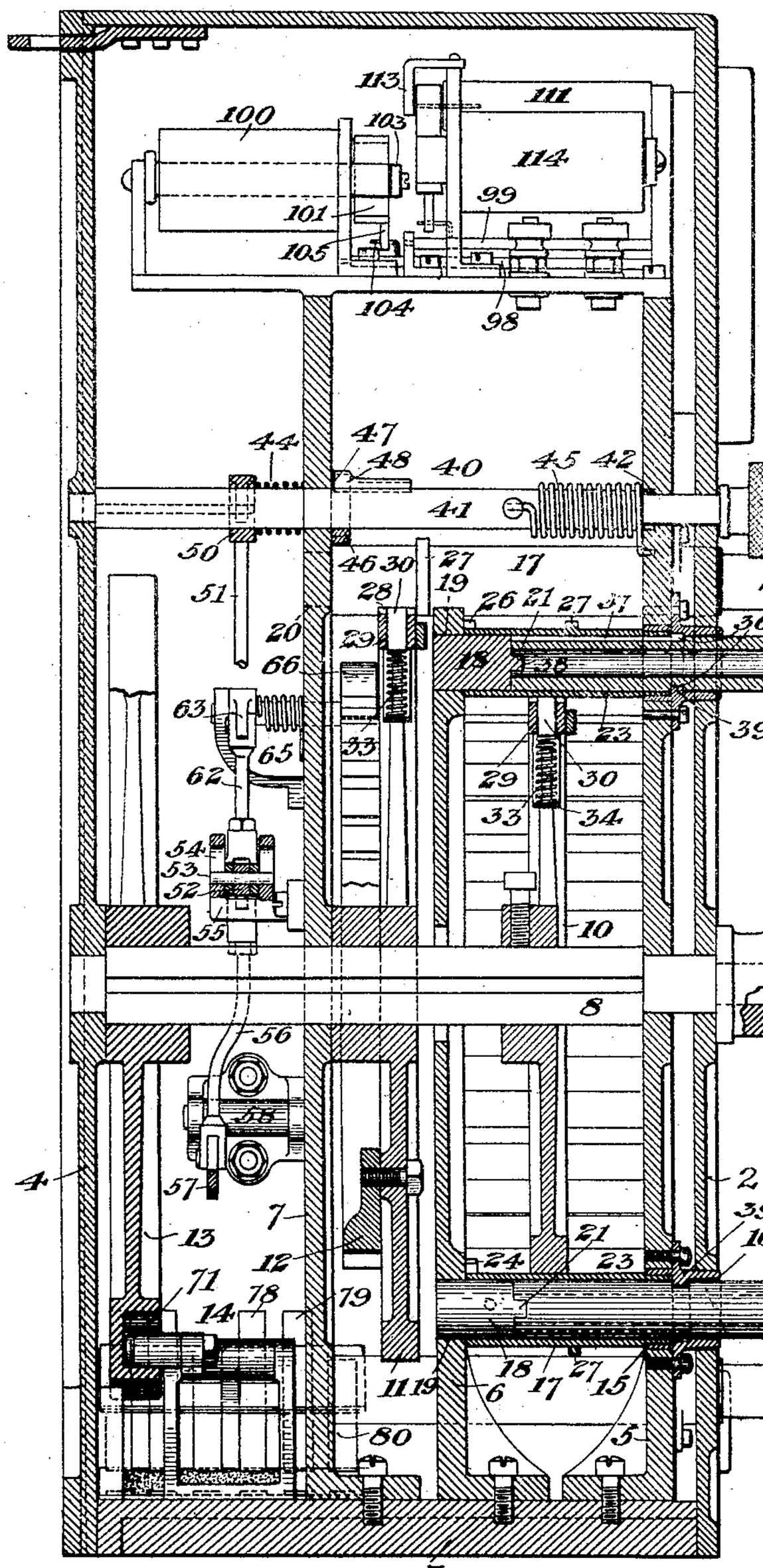
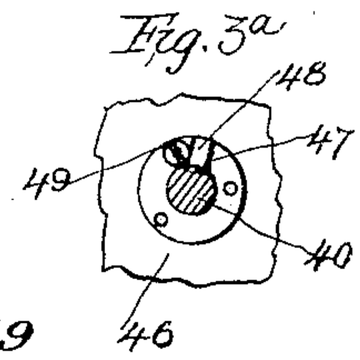



Fig. 3.

Fig. 3a

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NO MODEL. 9 SHEETS—SHEET 4.

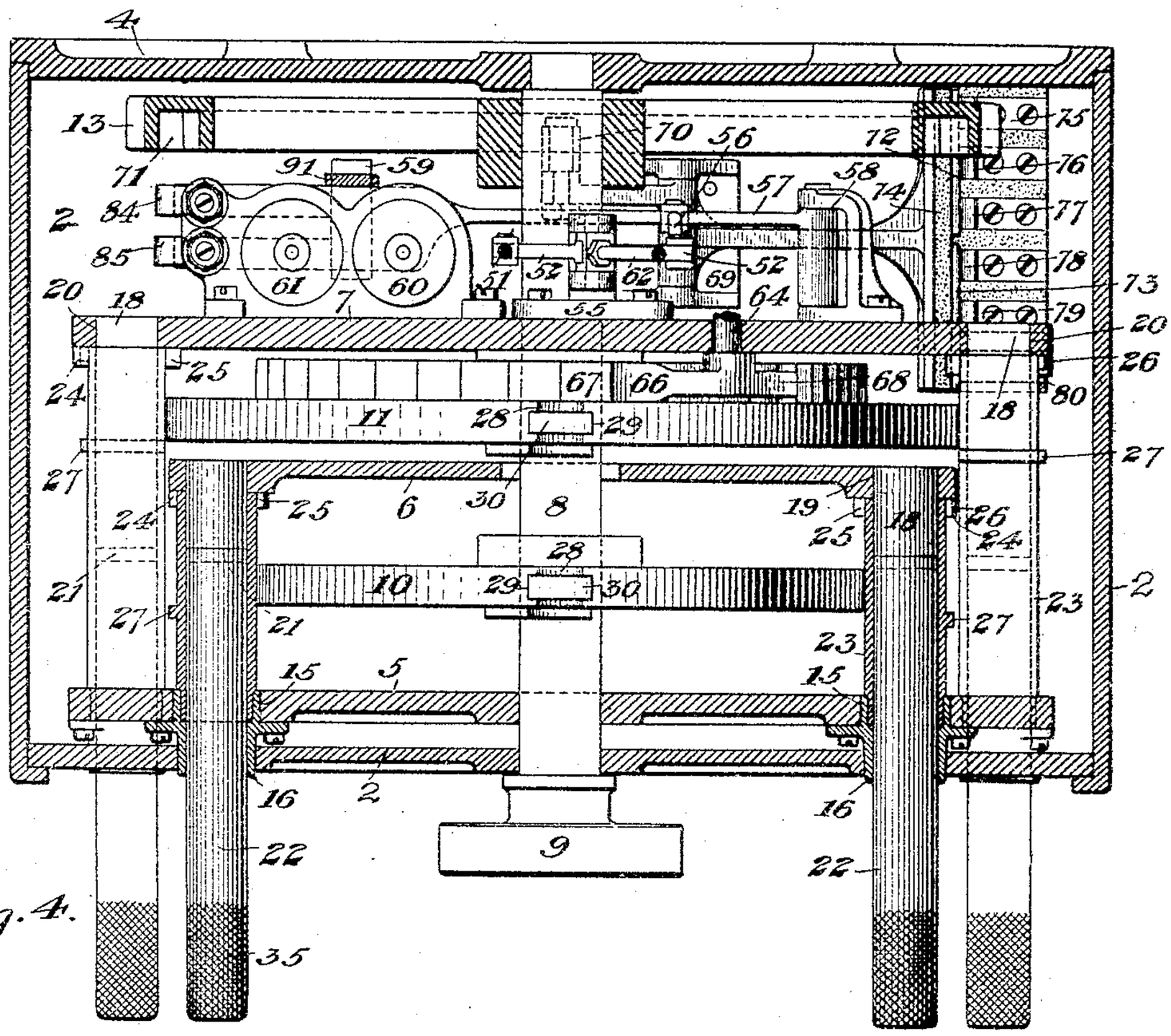
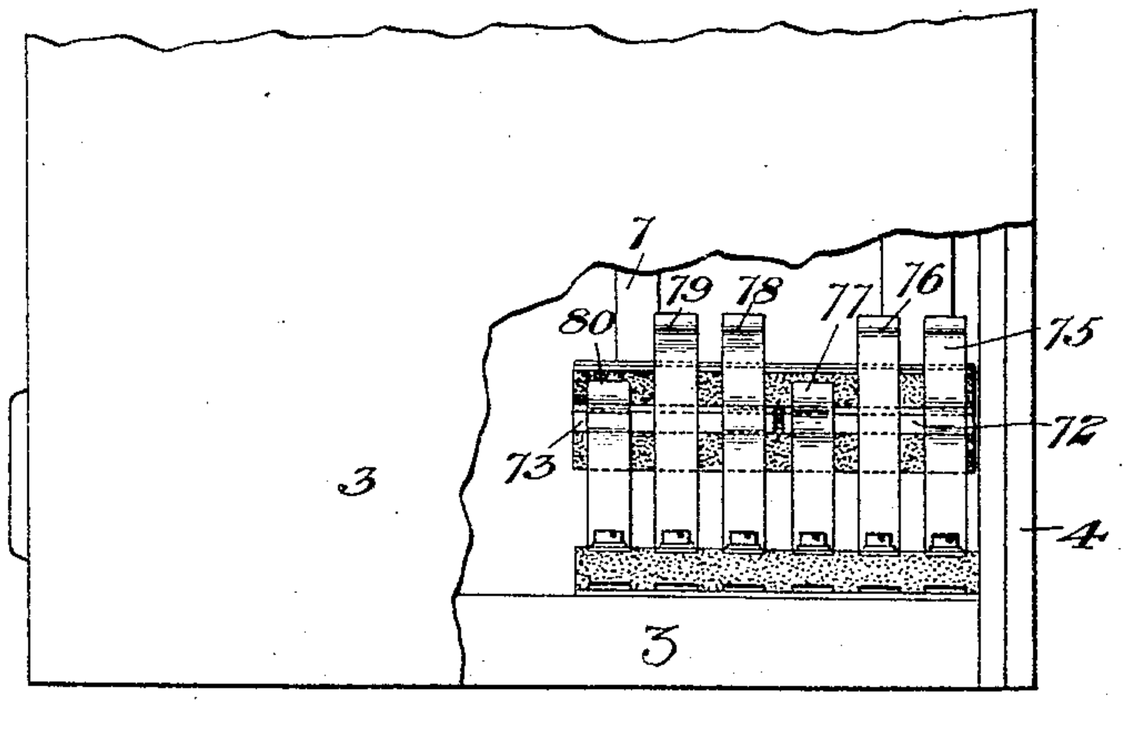



Fig. 4.

Fig. 8.

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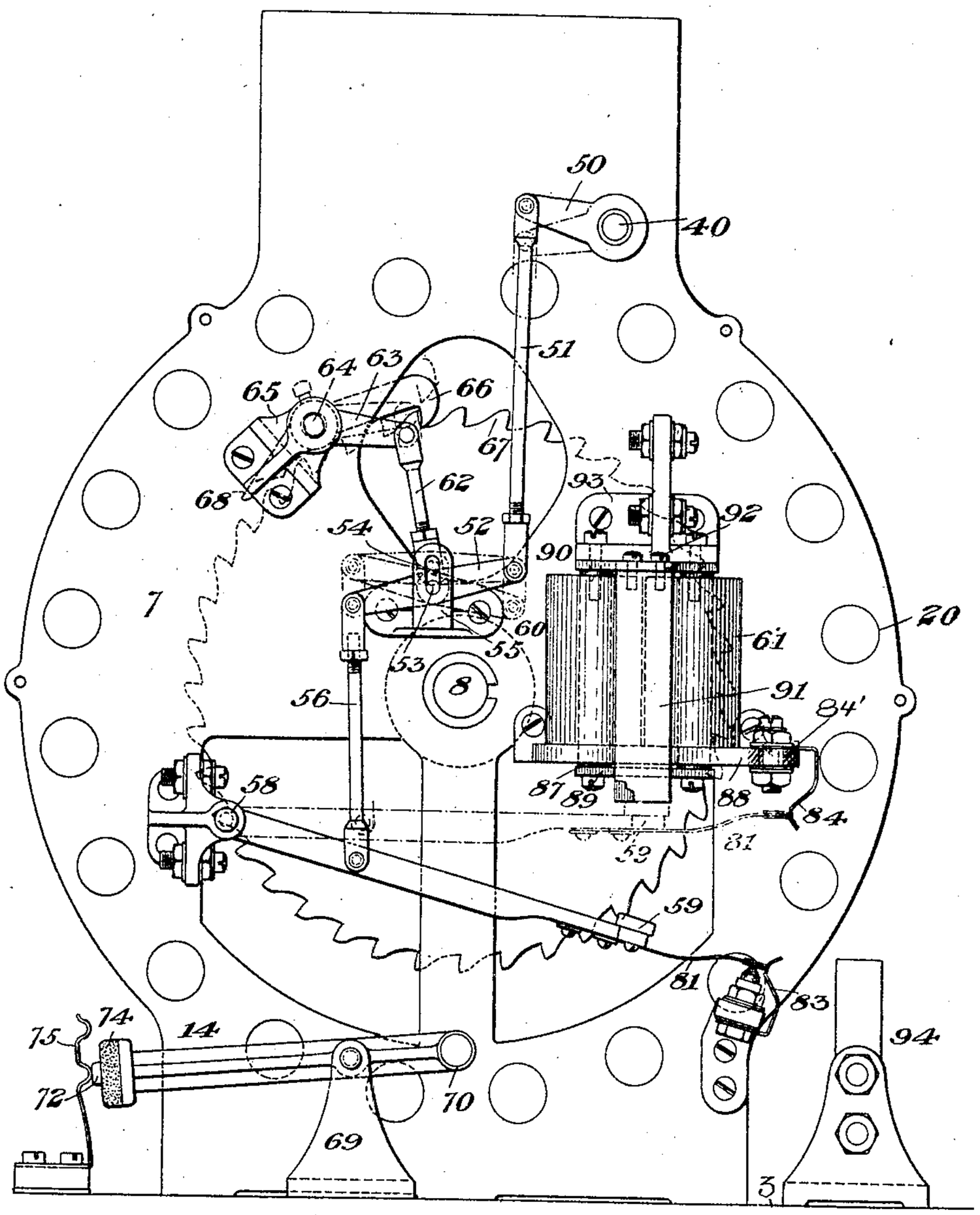
APPLICATION FILED APR. 7, 1902.

NO MODEL. 9 SHEETS—SHEET 5.

*Fig. 5.*

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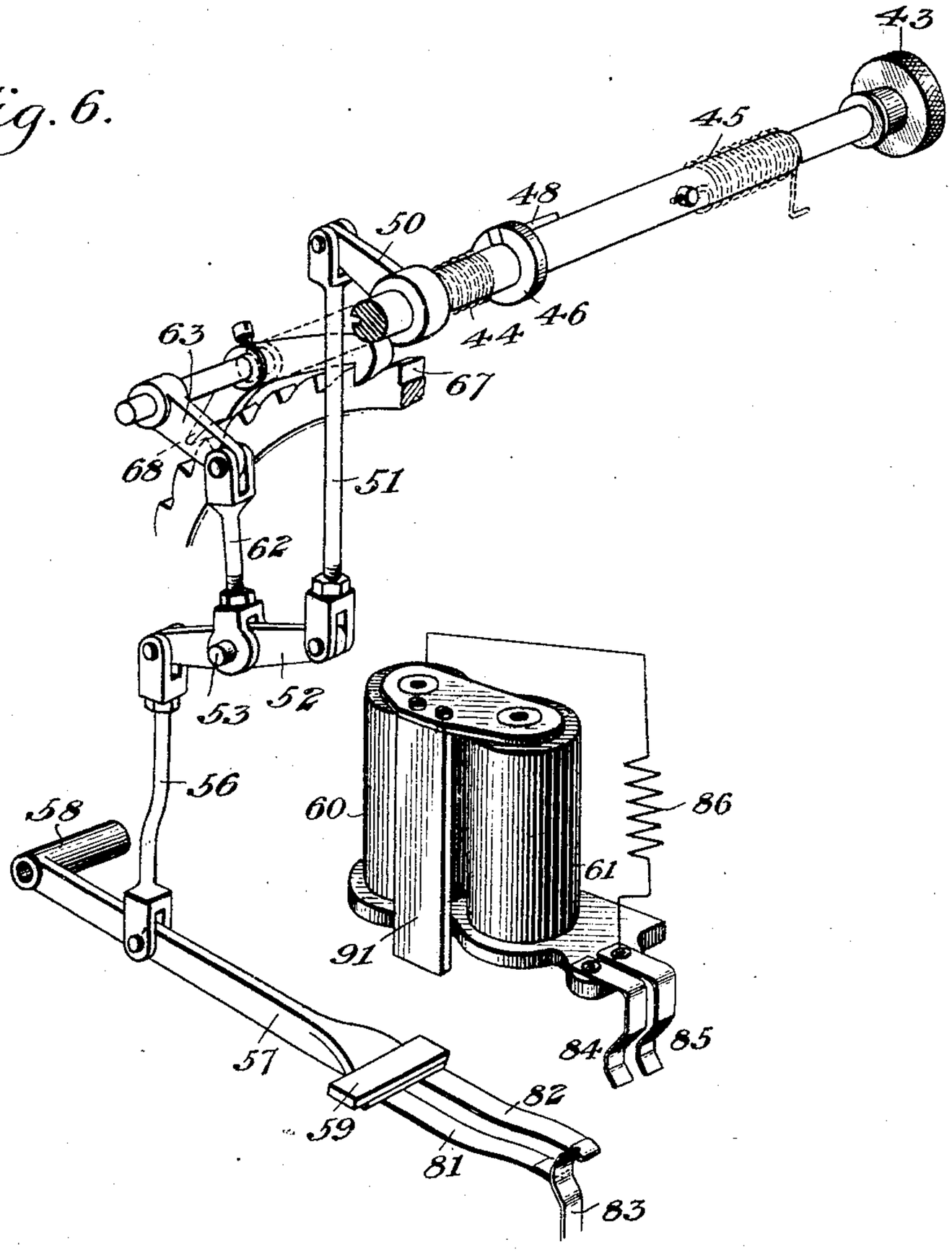
APPLICATION FILED APR. 7, 1902.

NO MODEL. 9 SHEETS--SHEET 6.

*Fig. 6.*

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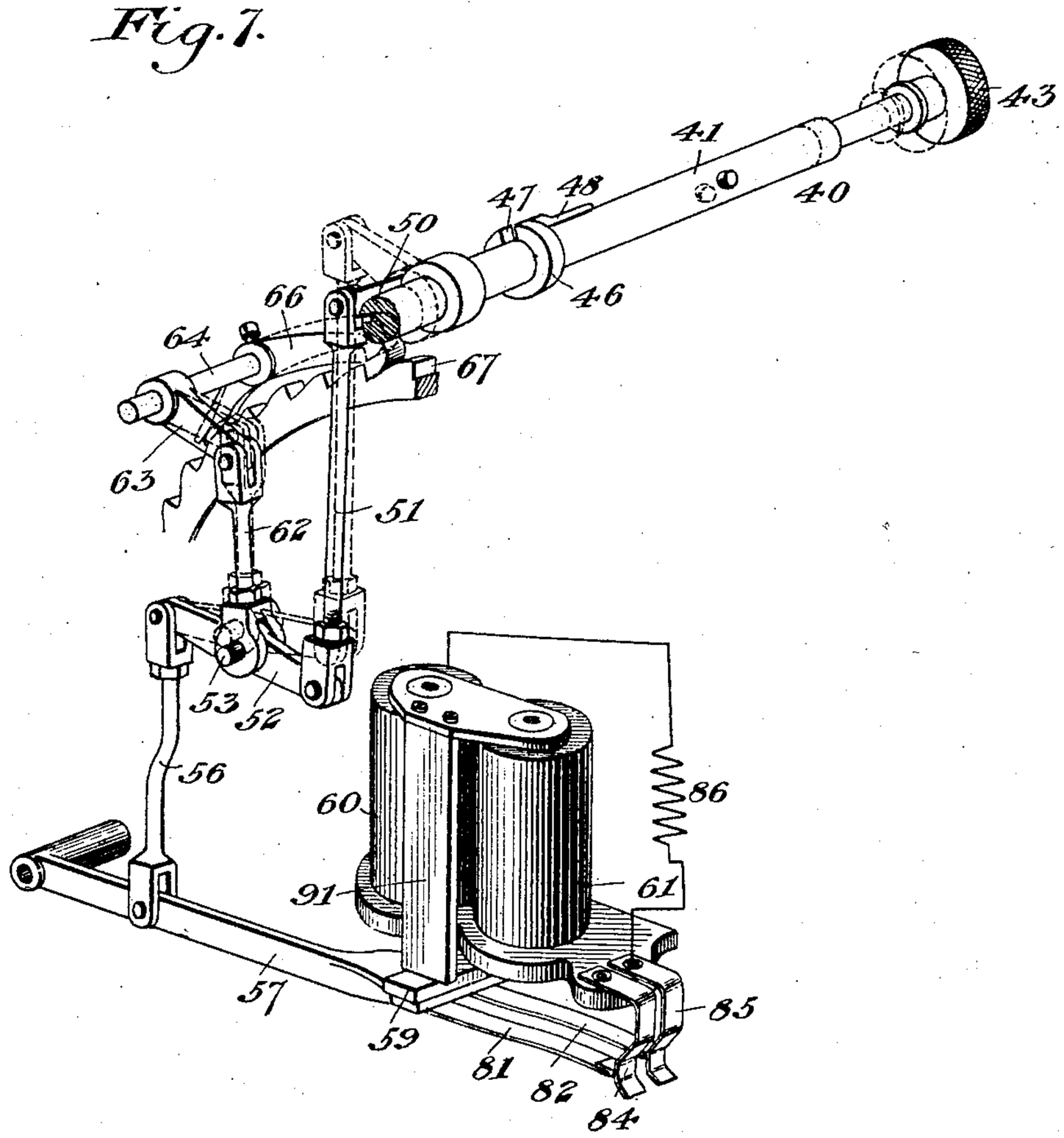
APPLICATION FILED APR. 7, 1902.

NO MODEL. 9 SHEETS—SHEET 7.

*Fig. 7.*




WITNESSES

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# HIGH SPEED TRAIN SYSTEM AND APPARATUS THEREFOR.

APPLICATION FILED APR. 7, 1902.

NO MODEL. 9 SHEETS—SHEET 8.

Fig. 9.

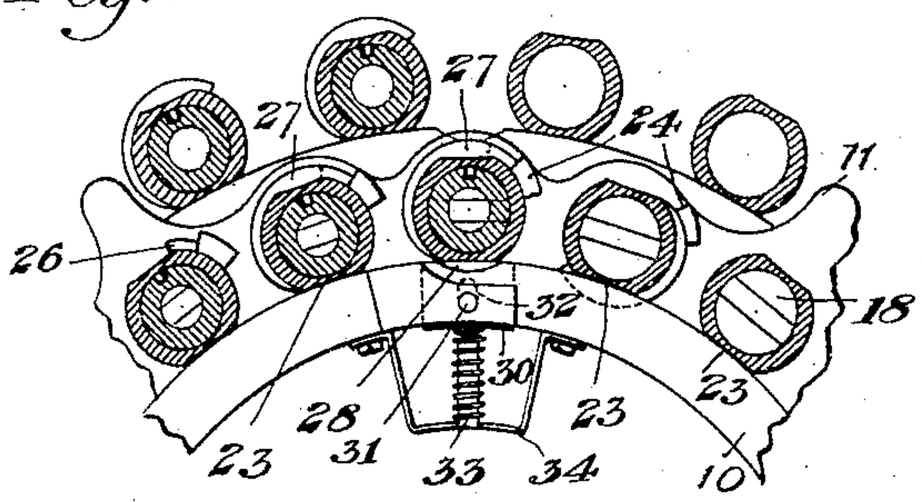


Fig. 10.

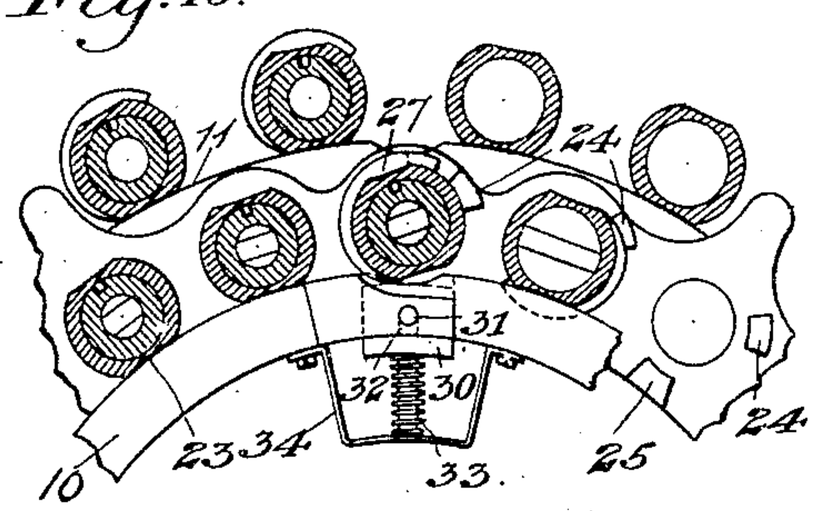


Fig. 11a.

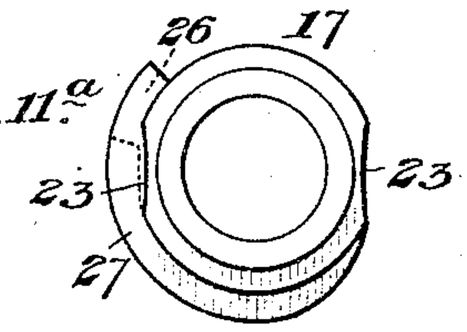


Fig. 11.

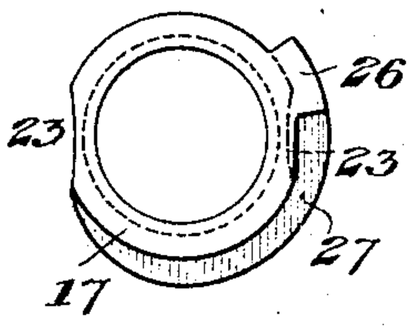


Fig. 12.

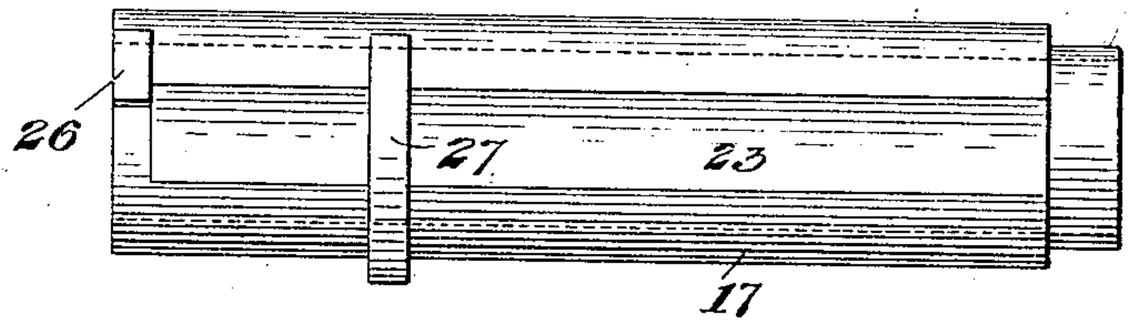


Fig. 13.

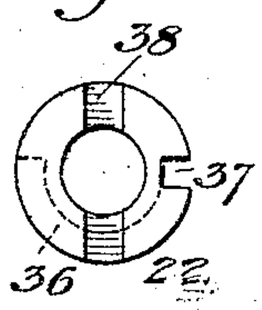


Fig. 14.

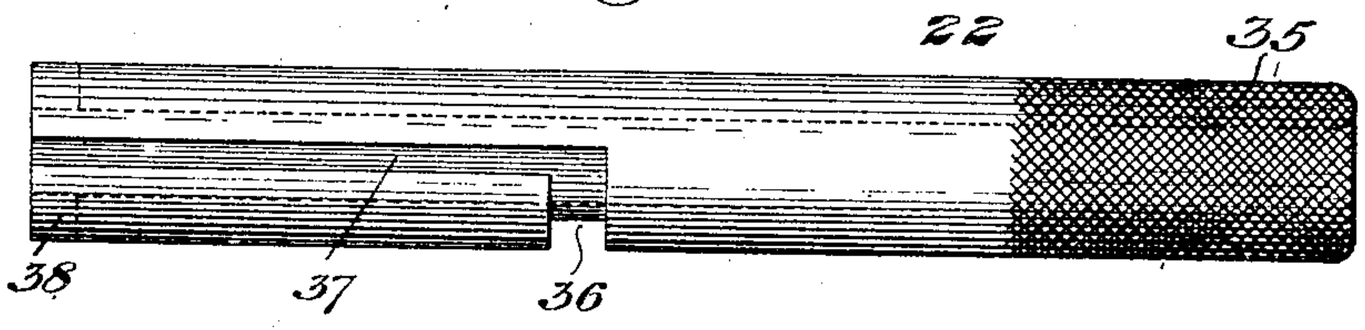


Fig. 15.

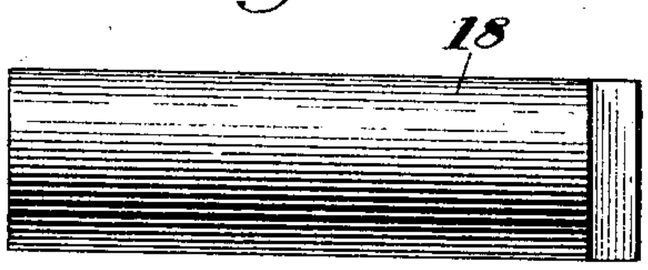


Fig. 16.

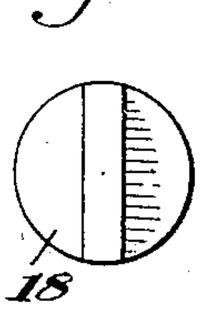


Fig. 17.

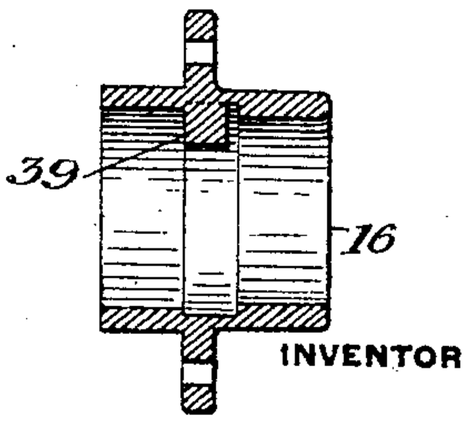


Fig. 18.

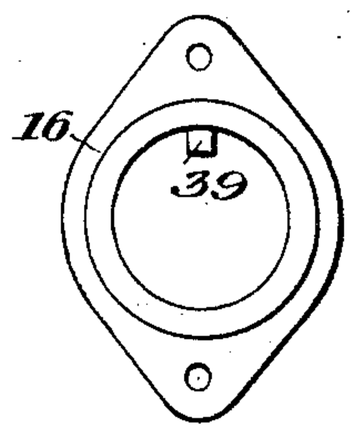


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Fig. 19.

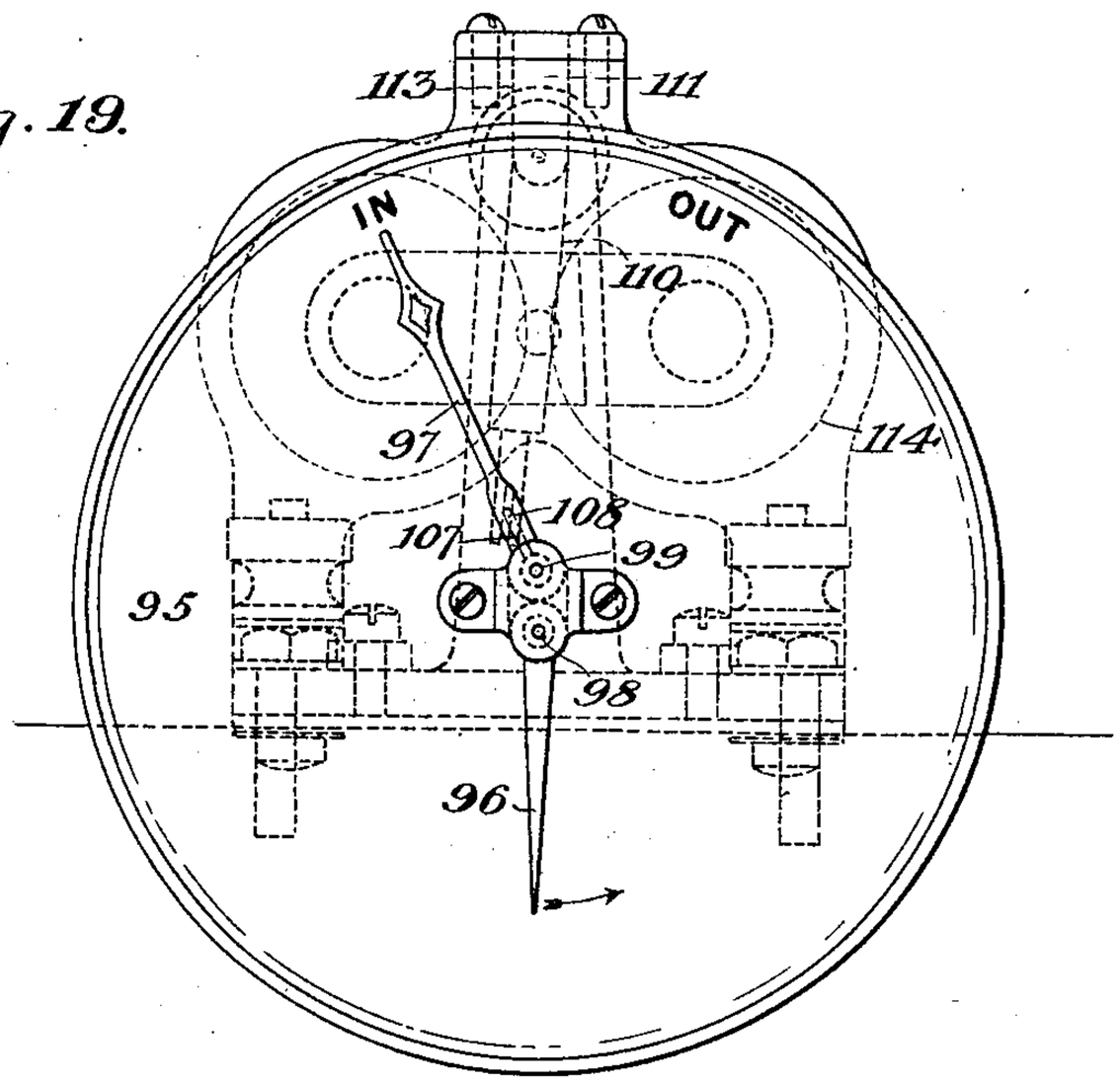
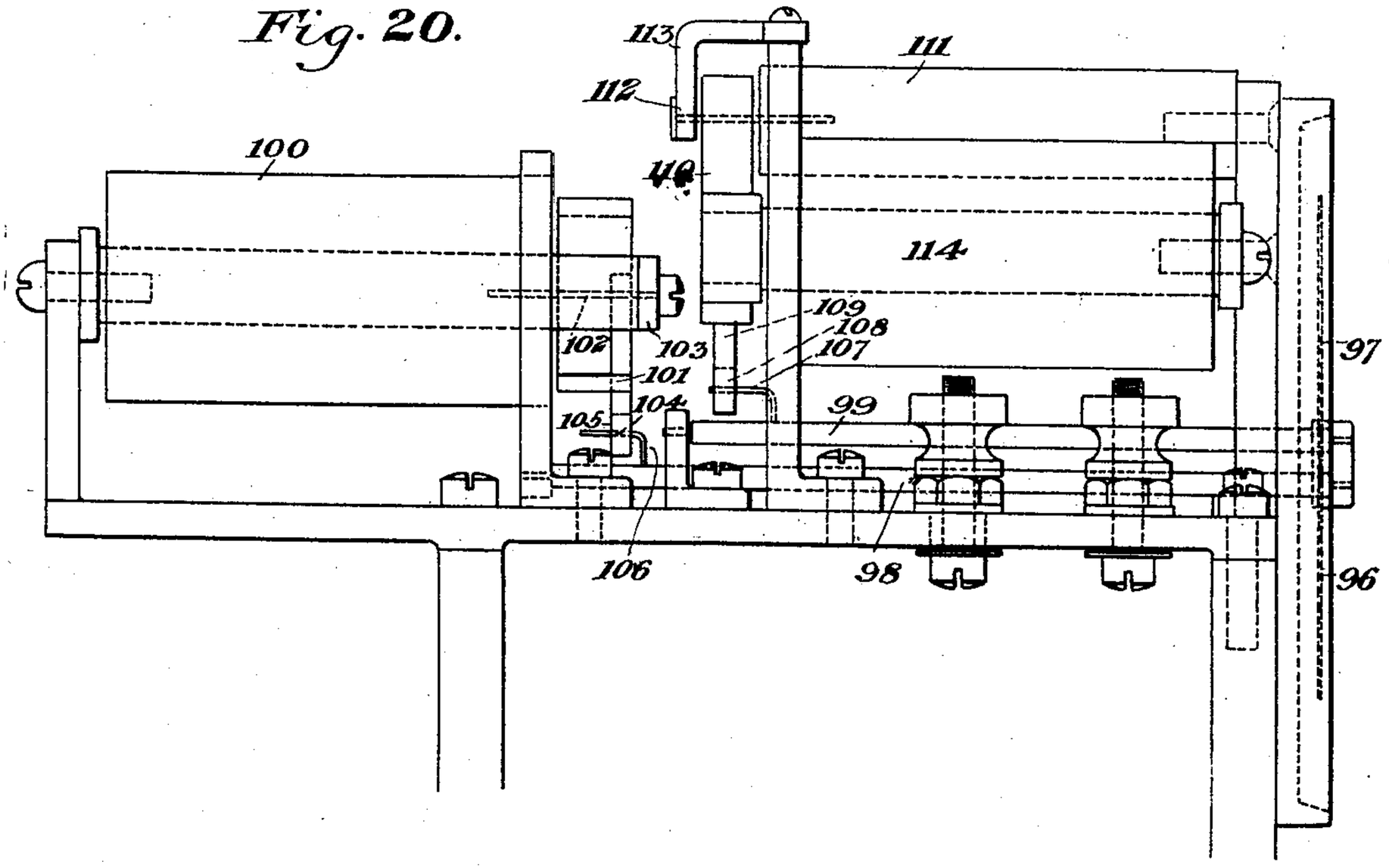



Fig. 20.




WITNESSES

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Walter N. Coovell.

INVENTOR

Thomas H. Patenall

No. 777,971. Patented December 20, 1904.

# UNITED STATES PATENT OFFICE.

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

## HIGH-SPEED TRAIN SYSTEM AND APPARATUS THEREFOR.

SPECIFICATION forming part of Letters Patent No. 777,971, dated December 20, 1904.

Application filed April 7, 1902. Serial No. 101,716.

*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 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 diagrammatically two staff instruments and the circuits connecting the same. 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 looking in the direction of the arrow. Fig. 3[a] is a detail of the preliminary spindle-locking disk. Fig. 4 is a horizontal section on the line IV IV of Fig. 2. Fig. 5 is a rear view of a portion of the mechanism, the casing, back plate, and cam-wheel being removed. Fig. 6 is a perspective view of the preliminary spindle and the mechanism connected thereto shown as removed from their supports in the normal position. Fig. 7 is a similar view showing the preliminary spindle pulled outwardly, so as to permit the position of the parts to be changed so as to establish the circuit on the local magnet and one point on the line-magnet. Fig. 8 is a partial side elevation of the instrument, showing the circuit-changer and its contacts, the casing being broken away to expose these parts. Figs. 9 and 10 are detail sectional views showing the staffs, sockets, and socket-supports, showing the portion of the locking-wheels for the inner and outer series of sockets, Fig. 10 showing one of the sockets as it is being turned to take out a staff and locking the wheel to prevent its being reversed. Fig. 11 is an end view of one of the staff-sockets. Fig. 11[a] is a view of the opposite end of a staff-socket, the bore of this socket being reduced to enable a smaller staff to be used. Fig. 12 is a plan view of the same. Fig. 13 is an end view of one of the staffs, and Fig. 14 is a plan view of the same. Fig. 15 is a plan view of one of the socket-plugs, and Fig. 16 is an end view of the same. Fig. 17 is a sectional view of one of the escutcheons which forms the bearing for a staff-socket and a lock preventing the withdrawal of the staff until the same has been turned, and Fig. 18 is a front view of the escutcheon. Fig. 19 is a front view of the indicator-dial, showing the operating parts in dotted lines; and Fig. 20 is a side elevation of the same.

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

My invention is designed to afford a high-speed train-staff system in which the circuits employed are free from complication and the apparatus used in connection therewith is compact, efficient, and certain in its operation.

The object of my invention is to provide an instrument which permits but one staff to be withdrawn at a time, the act of withdrawal locking the instrument, by means of electrical connections, with another instrument, both instruments being locked until the proper electrical conditions are restored by the insertion of the staff which has been withdrawn from one of them by replacing it in the same instrument or in the other instrument with which it is arranged to work in conjunction.

A further object of my invention is to enable the trains to proceed at high speed, and this feature of my invention is attained by making the staff which I employ small and easily handled, enables me to place a large number of staffs in a single instrument, and also facilitates the exchange of staffs, it being possible to exchange a small staff at a much higher rate of speed, and this is of great importance in a staff system.

A further object of my invention is to provide a staff and socket therefor which permits a large number of locking combinations to be made, which prevents the wrong staffs being placed in the instrument, and this I accomplish in a simple and efficient manner without changing the size of the parts.

My invention consists of further details of

construction of the electromagnets which I employ for the main and local circuits and for the indicator and other combinations and arrangements of parts more fully hereinafter described, and pointed out in the claims.

In the drawings, referring to Figs. 2 to 18, inclusive, I illustrate the apparatus which I employ in carrying out my high-speed train-staff system. In these figures, referring to Figs. 2, 3, 4, and 5, 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. This feature of my invention is important, as the size of the staff may be varied without necessitating changes in the staff instrument other than the sockets for the staffs. The rear end of these 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, as shown in Figs. 3, 4, 9, and 10. 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. 9; but when the socket is turned, as shown in Fig. 10, 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 form of staff which I employ is shown in detail in Figs. 13 and 14, and all of the staffs for any pair of instruments which are designed to be operated in conjunction with each other are exact counterparts of each other. The outer end portion of the staff 22 is preferably knurled, as shown at 35. 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 a 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 40 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. When the hand of the operator is released from the knob 43, the stop 49 holds the key 48 in proper position to enter the notch 47 in the locking-disk 46, 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 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.

A link 62 is pivotally connected at its lower end to the pin 53 and at its upper end is connected to a crank-arm 63, which is keyed to a short rock-shaft 64, which is supported in a suitable bearing 65, and this shaft 64 extends through the standard 7 and at its outer end is provided with a pawl 66, having a hooked end portion which is adapted to engage the teeth of ratchet-wheel 12, which is secured to the locking-wheel 11.

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 direction, the magnets will both be energized and the armature 59 will be held up. The armature 59 being held up by the magnets 60 and 61, as shown in dotted lines in Fig. 5, 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 66 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 63 will cause the rock-shaft 64 to rotate and lift the pawl 66 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 66 is disengaged the tail portion 68 of the pawl is depressed, so as to be engaged by the next succeeding tooth of the ratchet-wheel 12, thereby forcing the hooked portion of the pawl into the next succeeding tooth as 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, thereby permitting the staff in this socket to be removed.

The spindle 40 having returned to its nor-

mal 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 68 of the pawl 66 this engagement of the tailpiece causes the shaft 64 to turn in its bearing, and thereby depress the crank-arm 63, which is rigidly secured to the shaft 64. The link 62, which connects the crank-arm 63 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 in a bracket 69, secured to the base-plate 2 of the instrument. One end of this circuit-changer is provided with an antifriction-roller 70, which engages the cam-groove 71 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.

As shown in Figs. 4, 5, and 8, the contact-strips 72 and 73 are insulated from each other and from the long arm of the circuit-changer 14 by a piece of insulating material 74. These contact-strips 72 and 73 engage suitable spring-contact fingers 75, 76, 77, 78, 79, and 80. The contact-fingers 75 and 78 are provided with two contact-points. The fingers 76 and 79 are provided with a single contact-point at the upper end and in line with the upper contact-points of the springs 75 and 78. The contact-fingers 77 and 80 are shorter than the others and are provided with a single contact, which is in line with the lower contact-points on the springs 75 and 78, as shown in Figs. 5 and 8. It will thus be seen that the springs 75 and 78 have contacts which are common to both of the other sets of springs and that the contact-strips 72 and 73 close the circuit between springs 75 and 76 and 78 and 79, respectively, when the circuit-changer is in its upper position and between the contact-fingers 75 and 77, 78 and 80, respectively, when the circuit-changer is in its lower position, as shown in Figs. 5 and 8.

A pair of spring-fingers 81 and 82 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 81 and 82 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 81 rests against a suitably-insulated stop and in contact with a spring-finger 83, 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 84 and 85 are secured to the magnet-spectacle for the magnets 60 and 61 and are suitably insulated therefrom by a suitable bushing 84′. These contact-springs 84 and 85 are brought in contact with the spring-fingers 81 and 82 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 85 and the local coil 60 is placed a resistance-coil 86. This resistance 86 is inserted in the local circuit for the purpose of making the point of attraction at the central point of the magnets and the armature and is proportioned according to the resistance of the line between the train-staff stations. The line-coil 61 and the local coil 60 are like an ordinary magnet, but differ from each other in the amount of resistance. The magnets are independent of each other so far as the electrical circuits of which they form a part are concerned. The cores 87 and 88 of the magnets 60 and 61 are connected at their upper and lower ends by straps 89 and 90 at the front and back ends of the magnets, respectively. A rectangular pole-piece 91 is secured to the upper back strap 90 by suitable screws 92 and coacts with a projecting piece on the front strap 89, so that the lower end of the pole-piece 91 and of the projecting portion of the strap 89 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.

The magnets 60 and 61 are wound exactly alike, and when both are energized by battery or electric currents of the same polarity as these currents flow out of each the current of one magnet opposes the current of the other, and meeting at a central point of their common pole-pieces 91, of suitable conducting material, the combined energy of the magnets attracts the armature 59 when raised and holds it in its raised position. If the polarity of the mag-

nets 60 and 61 be different, due to the change of polarity in the main circuit, the independent currents passing through the magnets 60 and 61 will not oppose each other, but will flow in a closed electric circuit through the magnets and across the strips 89 and 90, which are of suitable conducting material; 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 93, secured to the standard 7.

Secured to the base 3 of the instrument by suitable brackets and supports is a push-key 94, of well-known construction and diagrammatically illustrated in Fig. 1.

In the upper portion of the casing 2 is a dial-plate 95, which is provided with a pair of indicating-needles 96 and 97. These needles are mounted upon rock-shafts 98 and 99, respectively, and the lower needle 96 indicates, if it moves to the right, that the circuit is closed and the current flowing. This needle is operated by a magnet 100, which is of ordinary construction, except that the pole-pieces are extended so as to permit the armature 101 to swing transversely between them, the armature being pivoted upon a pin 102, which is mounted in the spectacle at one end and in a brass strip 103, connecting the end of the pole-pieces. The lower end of the finger 104, which is secured to the armature 101, is provided with a slot 105, which engages a pin 106, secured to the rock-shaft 98 in such a manner that when the armature is attracted the needle 96 will be moved by the engagement of the pin 106 with the finger 104, which is attached to the armature. The upper needle 97, which is mounted upon the rock-shaft 99, is provided with a pin 107, which engages a slot 108 in an extension 109 of the armature 110, which is polarized by the permanent magnet 111 through induction. This armature is pivoted upon a suitable pin 112, supported on the permanent magnet at one end and in a bracket 113, secured to the spectacle of the magnet 114. The needle 97, controlled by the polarized armature of magnet 114, indicates when the staff is in or out and when in the position shown in the drawings Figs. 2 and 18 shows that it is in the instrument in the manner hereinafter described.

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 the station X is key 94, 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 94 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 96, thence through the wire *g* and spring 76, which makes contact with strip 72, which is also in contact with spring 75, and thence through 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'*, spring 75', and contact-strip 72', thence through spring 76' and wire *g'* through the magnets of the lower indicator 96', 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 97', thence through the wire *k'* to a wire *l'*, carried by the armature-lever 57, to which is attached a spring 81', which makes contact with point 83'. The current then passes to the bell *m'*, energizing magnets for the same, thence through wire *n'* to spring 79', through contact-strip 73' and spring 78', 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 78, and strip 73, thence through the spring 79, which is connected by wire *n* to the negative side of battery *d*. The operator at X pushes the push-key 94 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 94' 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. This is accomplished by raising the armature 55, having the contact-pieces 80 81, up to the magnets 60 61 by means of the preliminary spindle 40 and the link and lever connections previously described. 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 96', thence through the wire $g'$ to the spring 76', which contacts with the strip 72', this strip making contact with the spring 75', which is connected to 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 $h$, the contact-spring 75, the contact-strip 72, the spring 76, which is in contact therewith, and wire $g$, thence through the magnet of the lower indicator 96, 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 97. From this indicator the wire $k$ leads along a wire $l$ attached to armature 57,, this wire being connected to a spring 81, secured thereto and insulated therefrom, the spring making contact with point 84, 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 79, through the contact-strip 73 and spring 78, 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 78, through the contact-strip 73' and the contact-spring 79', 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 82, thence to the point 85 through the resistance 86 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 $y$, 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 81 and 82 in contact with points 84 and 85, 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 72 and 73 of the circuit-changer 14 with reference to the contact-springs 75 to 80, 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, permits the shaft 8, carrying the cam-wheel 13, to be turned a distance equal to the space between the staff-sockets. This shifts the contact-strips 72 and 73 of the circuit-changer 14 into the position shown by dotted lines in Fig. 1. This change in the position of the contact-strips 72 and 73 onto the lower set of contacts formed on springs 75, 76, 78, and 80 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'. The construction of these magnets is such that the combined energizing of both main and local coils by the currents flowing opposite each other will sustain the armature and the circuit-closing strips carried thereby, and when the direction of the current is the same in both coils the armature will not be attracted and the lever will drop down and the locking-pawl cannot be disengaged, thus preventing another staff from being taken out until the staff previously taken out has been replaced in one or the other instrument, and if this staff be taken to station Y inserted in this instrument, and locked therein this act will shift the contact-strips 72' and 73' into the position shown in dotted lines, Fig. 1, at station X, and the instruments at Y and X will then be in a condition to permit another staff to be taken out.

The electrical circuits under normal operative conditions of the instruments are such that the staffs of two coöperating instruments must be present in one or the other instrument or the sum of the staffs in both must constitute an even number, as the system is designed to be operated in this manner. The electrical circuits will be rendered inoperative if one staff is missing, since the withdrawal of a staff alters the electrical circuits and can only be restored to a normal condition by re-inserting the staff in one or the other instrument.

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 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 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 94 the prescribed number of times (called

for on bell code,) which rings the bell at Y. Y answers and holds in his bell-push 94′, which moves over the lower or current indicator 96 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 97′ 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 into a rubber pouch (if to be delivered by hand or if to be delivered at speed into 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-station.) 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 94′, which notifies X that train has passed out of section, and upper indicator at 97 moves over to "Staff in." X then acknowledges this by pressing in his bell-push 94, which moves upper indicator 97′ at Y to "Staff in." The instruments are again normal, and another movement can be made from X to Y or one from Y to X.

The advantages of my invention result from the compactness of the instrument, the lightness of the staffs employed, the absolute locking of the staffs in instrument against manipulation except under proper conditions in both staff instruments, the large number of locking combinations possible, and the greatly-increased speed at which trains using a staff system may be run over single-track railways by reason of the employment of lightweight small-sized staffs, the use of small staffs not requiring the trains to slow down to gather them up.

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 train-staff system comprising a call-circuit, a main circuit, a local circuit, an electromagnet in said main circuit and an electromagnet in said local circuit, a circuit-closer arranged to close the call-circuit when the main and local circuits are broken, and to close the main and local circuits, and break the call-circuit, when said circuit-closer is raised, and to be maintained in its closed position when both the main and local magnets are energized by currents of the proper polarity, staffs and staff-locking mechanism, by which the staff is locked, and a circuit-changer operated in conjunction with the staff-lock, whereby the change in the circuits which include said magnets is effected when a staff is inserted or withdrawn; substantially as described.

2. A high-speed train-staff system comprising a call-circuit, a main circuit, a local circuit, an electromagnet in said main circuit and an electromagnet in said local circuit, arranged in proximity to each other, a circuit-closer arranged to close the call-circuit when the main and local circuits are broken, and to close the main and local circuits and break the call-circuit, when the said main and local circuits are closed, said circuit-closer being maintained in its closed position when both the main and local magnets are energized by currents of the proper polarity, staffs and staff-locking mechanism, by which the staff is locked, and a circuit-changer arranged to be moved so as to alter the path of the current so as to permit or prevent the conjoint action of said magnets when a staff is inserted or withdrawn; substantially as described.

3. A high-speed train-staff system, comprising staff-stations provided with staff instruments having staffs and staff-locking devices, said instruments being electrically connected, a circuit-closer, electromagnets which coact when currents of the proper polarity flow therethrough, to uphold said circuit-closer, said circuit-closer being arranged to be operated so as to enable a staff to be removed or inserted, and a circuit-changer operated when a staff is removed or inserted, the direction of the flow of the current in one of said magnets being altered by the said circuit-changer, depending upon its position; substantially as described.

4. A high-speed train-staff system, comprising staff-stations, provided with staff instruments, having staffs and staff-locking devices, said instruments being electrically connected, a circuit-closer, electromagnets which coact when currents of the proper polarity flow therethrough, to uphold said circuit-closer arranged to be operated so as to enable a staff to be removed or inserted, locking mechanism controlled by said circuit-closing device, and a circuit-changer also operated when a staff is removed or inserted, the direction of the flow of the current being altered in one of said magnets by the said circuit-changer, depending upon its different position; substantially as described.

5. A high-speed train-staff system, comprising a call-circuit, main and local circuits, locking-magnets, an armature and mechanism

adapted to lift the armature to the said locking-magnets, said armature being held up when the magnets are energized so as to act conjointly, and a staff-lock controlled by said magnets; substantially as described.

6. A high-speed train-staff system, comprising a call-circuit, main and local circuits, magnets forming a part of said main and local coils, an armature, circuit-closers common to said circuits, mechanism whereby the armature is lifted, a staff-lock controlled by said main and local coils, said coils coacting to hold up said armature, to enable said staff-lock to be unlocked and a staff to be withdrawn; substantially as described.

7. A high-speed train-staff system, having electric circuits, the combination of a staff instrument comprising a support, staffs mounted therein, electrically-controlled locking devices arranged to hold the said locking devices in position to permit the withdrawal of a staff, and a circuit-changer arranged to be operated when said locking devices are manipulated to permit the insertion or withdrawal of a staff, said circuit-changer altering the path of the current when the staff-lock is manipulated; substantially as described.

8. A high-speed train-staff instrument, comprising a holder, a plurality of staffs, a locking-wheel to prevent turning of said staffs except at the proper time, a depression in said locking-wheel affording room for one of said staffs to be turned; substantially as described.

9. A high-speed train-staff instrument, comprising a plurality of staffs, a locking-wheel therefor, a depression therein, a movable piece fitted in said depression, and having its outer face shaped to the contour of the locking-wheel, said depression affording space for turning the staff, and said movable piece preventing displacement; substantially as described.

10. A high-speed train-staff instrument, having staffs, locks for said staffs, and lock-controlling mechanism for said staffs, comprising a spindle, link-and-lever connections therefor, said lever having changeable fulcrum-points to effect the locking and unlocking operations of said lock-controlling mechanism; substantially as described.

11. A high-speed train-staff instrument, comprising a support, hollow sockets mounted therein, staffs fitting said sockets, a lock for the staff, a rotary locking-wheel engaging the socket which prevents it from being turned, except under proper conditions, and an electrically-controlled lock for said wheel; substantially as described.

12. A high-speed train-staff instrument, comprising staffs, locking devices for preventing the rotation of said staffs, a spindle, link-and-lever connections therefor, said lever having a floating pivot, a locking-piece connected to said connections, whereby the staff-locking device is released and the staff is locked or released; substantially as described.

13. A high-speed train-staff system, comprising a staff instrument, electrical circuits therefor having a support, staff-sockets, and staffs mounted therein, a lock for the staffs, a lock for the sockets, a spindle, link-and-lever connections therefor, said lever having a floating pivot, a locking-piece operated by said lever, and an armature also operated thereby, electromagnets forming a part of said electric circuits arranged to hold up the armature, and thereby shift the fulcrum of said floating lever, so as to hold the lever in its new position, thereby releasing the locking-piece and the lock controlling the staffs and sockets, substantially as described.

14. A high-speed train-staff system, comprising electrical circuits, a staff instrument consisting of a support, staffs mounted in rotatory bearings therein, a lock for said staffs, a spindle for unlocking the same, a lever connected to said spindle at one end, an armature secured to the opposite end of said lever, an electromagnet adapted to hold said armature up and maintain the lock in unlocked position, when energized, after said armature is lifted up by the spindle-and-lever connection, and an intermediate connection upon said lever, having a locking-piece attached thereto, a pin forming a floating pivot at the point where said intermediate connection is made, said pivot forming the initial point of movement of the lever, and the opposite ends of said levers forming the fulcra upon which said lever moves, to effect the engagement or disengagement of the locking-piece when the magnet is energized and the spindle is rotated, the staff-lock being locked or unlocked thereby; substantially as described.

15. In a high-speed train-staff system, comprising electrical circuits, the combination of a staff instrument, consisting of a fixed support, staffs mounted concentrically therein, a central shaft, devices carried by said shaft whereby the turning of the staffs is prevented, and other locking devices electrically controlled, whereby the locking devices on the shaft are controlled; substantially as described.

16. A high-speed train-staff instrument, comprising a support, a plurality of staffs mounted in bearings, concentrically therein at fixed distances apart, a central operating-shaft, locking devices mounted thereon, and other locking devices electrically controlled, whereby the former are locked, except under proper conditions; substantially as described.

17. A high-speed train-staff instrument, comprising a plurality of staffs, sockets for each of said staffs which maintain a fixed relation to each other, and said staffs being concentrically located around an operating-shaft, a staff-socket lock, and devices upon each staff and its support which controls the rotation of

the staff and prevents its withdrawal, except under proper conditions; substantially as described.

18. A high-speed train-staff instrument, comprising a support, a plurality of staffs, sockets therefor, rotatably mounted in said support, a locking-wheel whereby said sockets are locked, and a second lock whereby said locking-wheel is locked: substantially as described.

19. A high-speed train-staff instrument, comprising a support, a plurality of staffs, a lock on said support for the staff, sockets rotatably mounted in said support, a locking-wheel, and a lock for said locking-wheel, electrically maintained in unlocked position by a corresponding instrument at a distant point; substantially as described.

20. A high-speed train-staff instrument, comprising staffs, a support therefor, a shaft, said staffs being concentrically disposed about said shaft, locking devices secured to said shaft, whereby the staffs are locked, a spindle also mounted in said support, a locking-piece arranged to lock the staff-locking devices, and connections between said spindle and locking-piece, whereby the same are operated to release said staff-locking devices; substantially as described.

21. A high-speed train-staff instrument, comprising a frame or casing forming supports, a plurality of staff-receiving openings in said supports, each of said staffs being inserted and withdrawn endwise from its supporting-opening, and a lock for the staffs; substantially as described.

22. A high-speed train-staff instrument, comprising a support, a plurality of staffs, sockets for said staffs, mounted in fixed bearings in said support, and a lock for said sockets and staffs; substantially as described.

23. A high-speed train-staff instrument comprising a support, a plurality of staffs and staff-sockets, locks therefor, said staff-sockets being rotatably mounted in said support, said rotation of the staff-socket permitting the insertion and withdrawal of the staff when the locking devices are unlocked; substantially as described.

24. In a high-speed train-staff system, the combination of two or more staff instruments, consisting of supports, rotatory staffs mounted therein, electrically-controlled locking devices for said staffs, electrical circuits and connections for said locking devices, arranged so that the insertion and withdrawal of a staff in one of said instruments changes the electric circuits and locks the other instruments with which it coöperates; substantially as described.

25. In a high-speed train-staff system, comprising lock-controlling electrical cirucits, the combination of a staff instrument consisting of a support, sockets mounted in said support, staffs adapted to fit said sockets, locking projections and grooves for said staffs and sockets, which prevent the withdrawal of a staff, except under proper conditions; substantially as described.

26. A high-speed train-staff instrument, comprising a support, and having cylindrical staffs, and sockets therefor mounted in fixed bearings, and locking devices for the staffs and sockets; substantially as described.

27. A staff for high-speed train-staff system, having a cylindrical body, and provided with a longitudinal groove and transverse locking-groove; substantially as described.

28. In a high-speed train-staff instrument, staffs having a cylindrical body, a socket therefor, end supports for the sockets, grooves in said staffs, and a lock on one of said supports, and locking devices for the sockets, whereby the rotation, and withdrawal of the contained staff is prevented, except under proper conditions; substantially as described.

29. In a high-speed train-staff instrument, the combination of a hollow socket, a plug secured therein, a staff adapted to fit the bore of said socket, and provided with means, at its inner end, to engage said plug, whereby said socket may be rotated; substantially as described.

30. A high-speed staff instrument, having a hollow socket, and a staff adapted to fit said socket, a lock for said socket, a flattened portion on said socket adapted to be engaged by a locking device provided with a single releasing depression; substantially as described.

31. A high-speed train-staff instrument, comprising a support, bearings in said support, sockets fitting said bearings, having a standard outside dimension, the inside dimension being made to suit the diameter of staff selected, said sizes being determined by the speed desired in operating the system; substantially as described.

32. An electromagnet having two coils side by side, and forming part of two independent electrical circuits, pole-changing devices in said circuits, said magnets having their pole-pieces connected by metal strips, thereby forming a closed magnetic circuit, an external pole-piece, common to both magnets, an armature adapted to be held against said pole-pieces, and to be held in this position when the currents passing through the coils are of opposite polarity, the pole-pieces common to both magnets, concentrating the lines of force therein, and thereby sustaining the armature, the flow of the magnetic current being diverted from the path followed when but one coil is energized or current of a single polarity is passing through said magnets; substantially as described.

In testimony whereof I have hereunto set my hand.

THOMAS H. PATENALL.

Witnesses:
A. M. STEEN,
JAMES W. BAKEWELL.