J. D. TAYLOR.

RAILWAY SWITCHING APPARATUS.

APPLICATION FILED APR. 18, 1904.

916,220.

Patented Mar. 23, 1909.

11 SHEETS—SHEET 1.

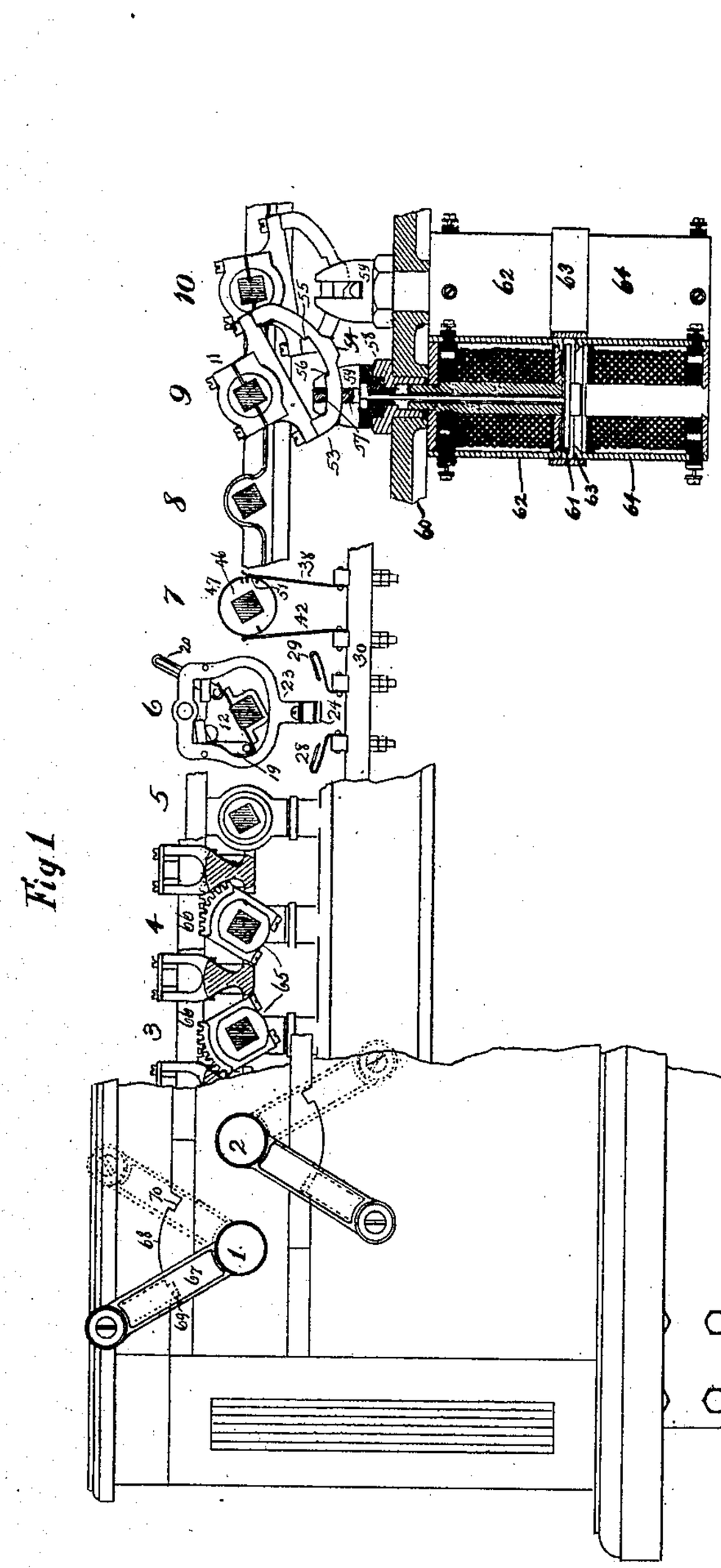

Fig 1

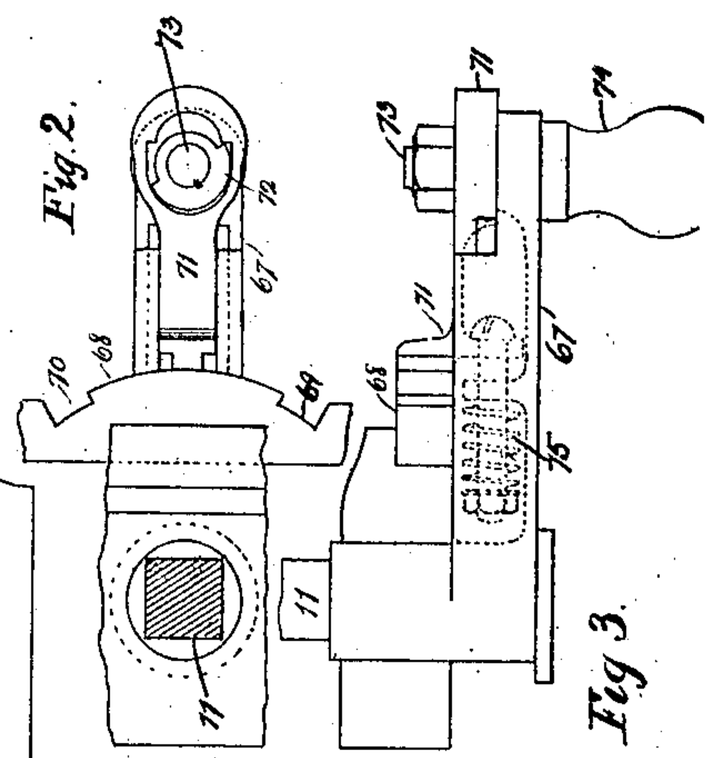

Fig. 2.

Fig 3.

Fig. 4.

Witnesses
Chas. J. de Berard Jr.
Gustave E. Lemmerich

Inventor
John D. Taylor
By his Attorney
Geo. E. Lemmerich

J. D. TAYLOR.

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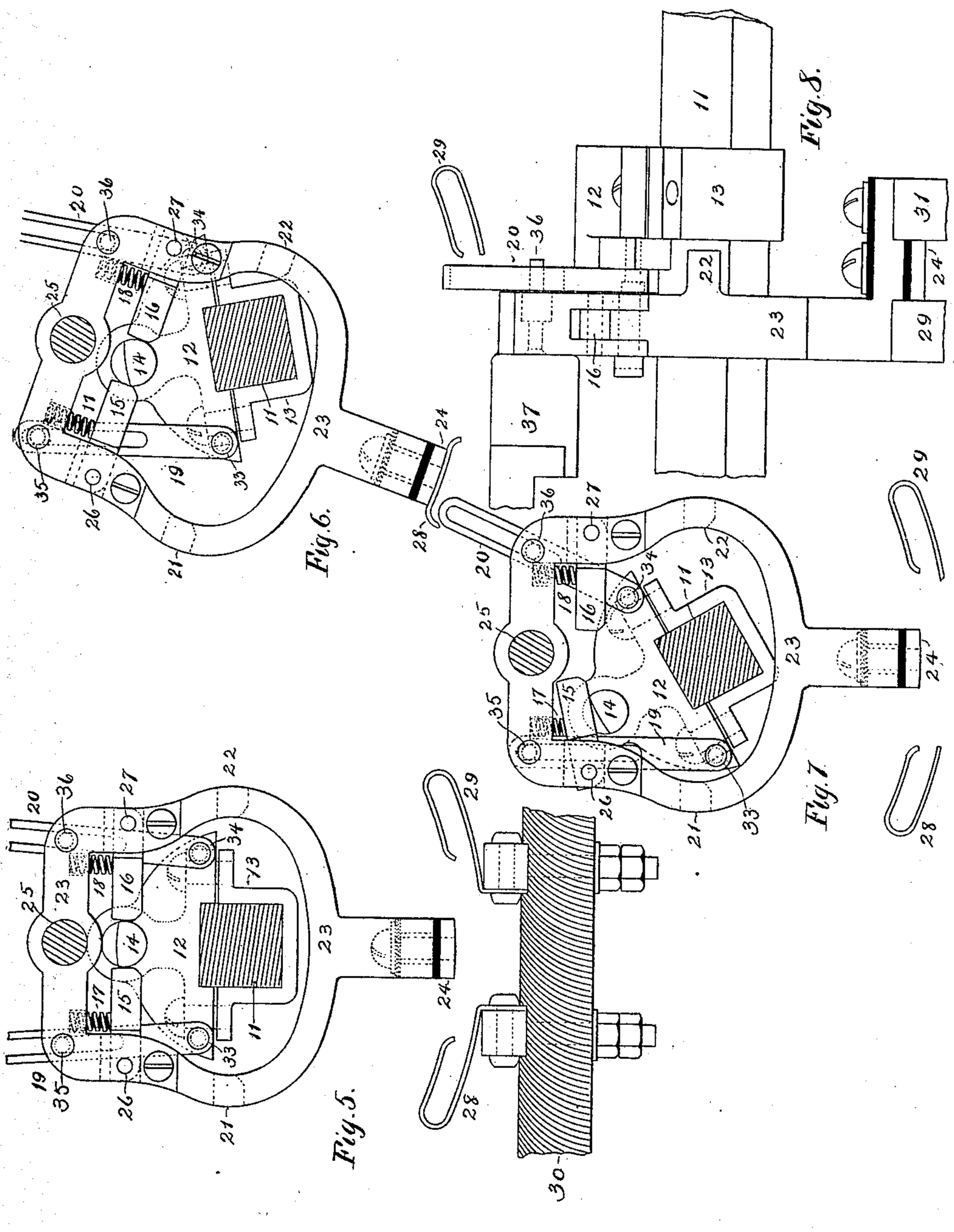

Fig. 6.

Fig. 8.

Fig. 5.

Fig. 7

Witnesses

Chas. J. McBerard Jr.

Gustave E. Lemmerich

Inventor

John D. Taylor

By his Attorney

Geo. E. Lemmerich

J. D. TAYLOR.

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11 SHEETS—SHEET 3.

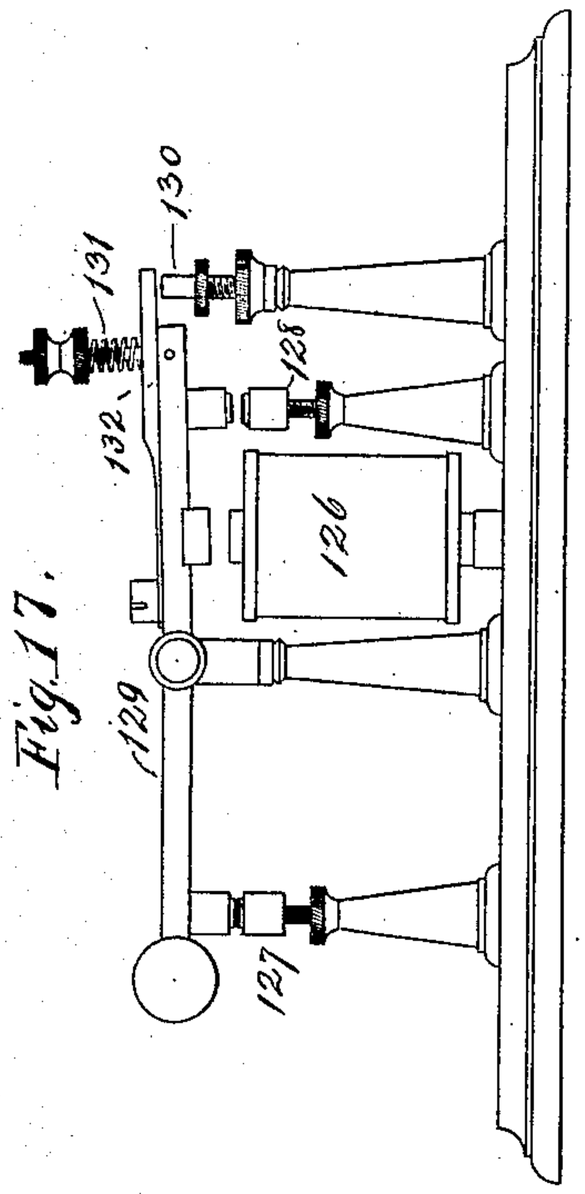

Fig. 17.

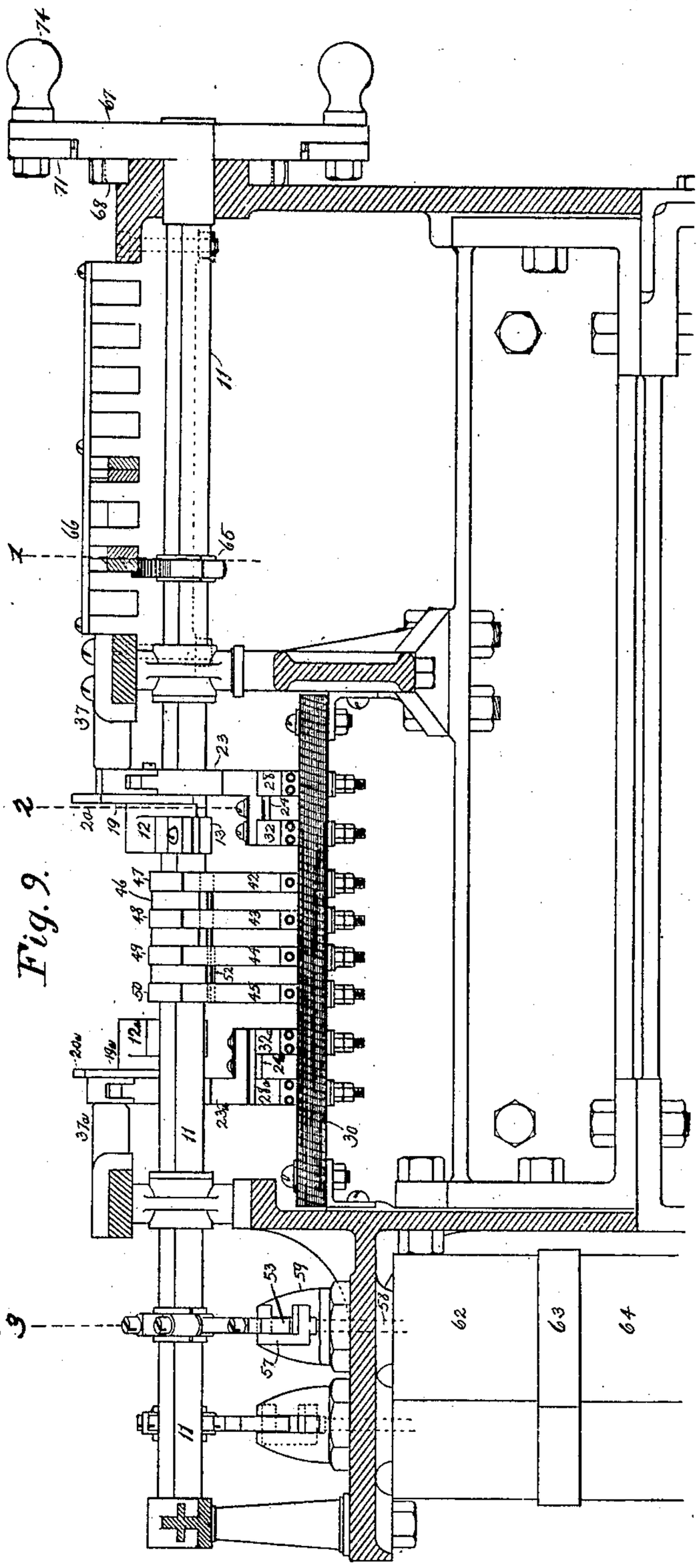

Fig. 9.

Witnesses

Chas. L. de Bernardi Jr.

Gustave E. Lemmerich

Inventor

John D. Taylor

By his Attorney

Geo. E. Greene.

J. D. TAYLOR.

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11 SHEETS—SHEET 4.

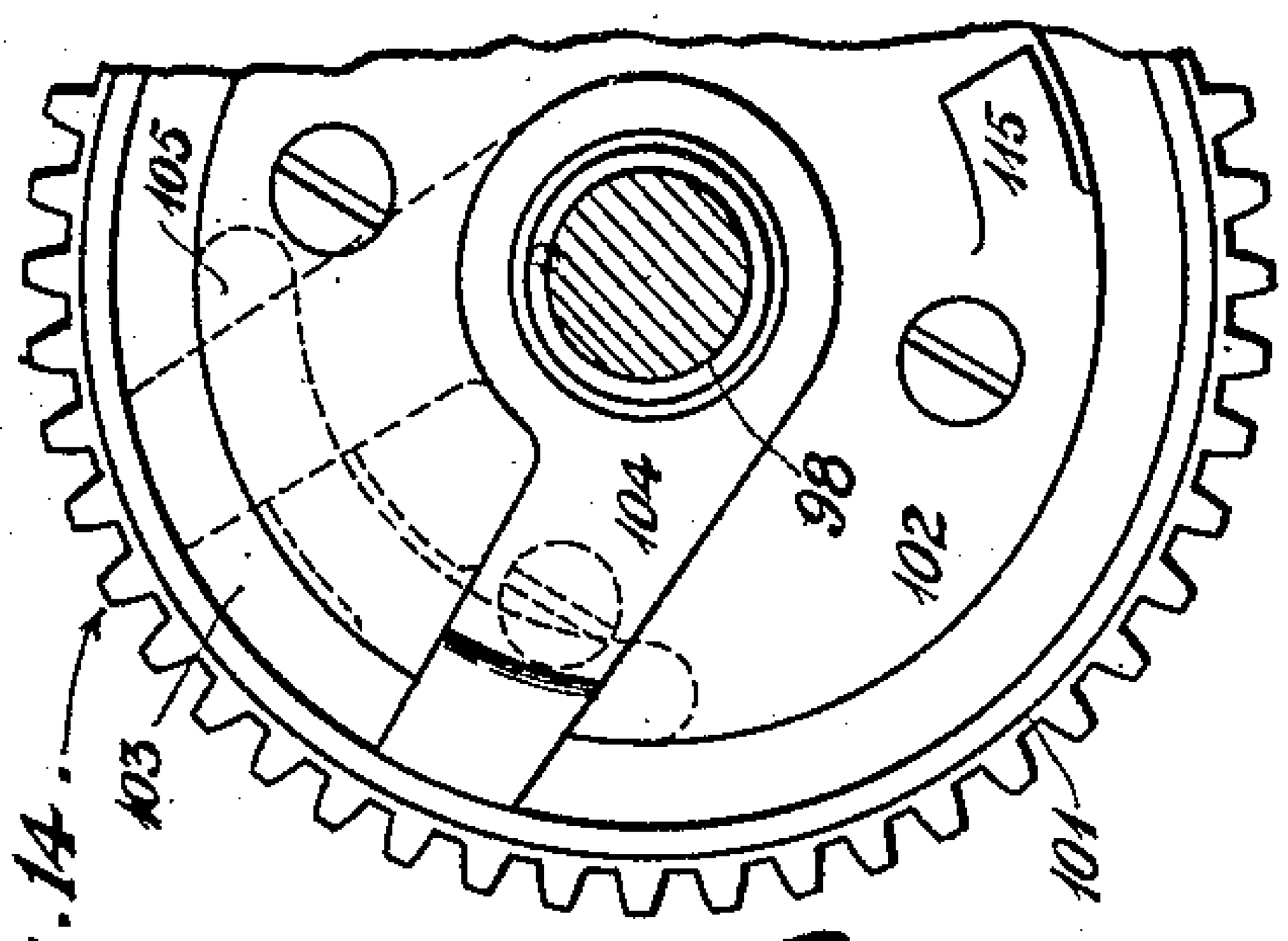

Fig. 14.

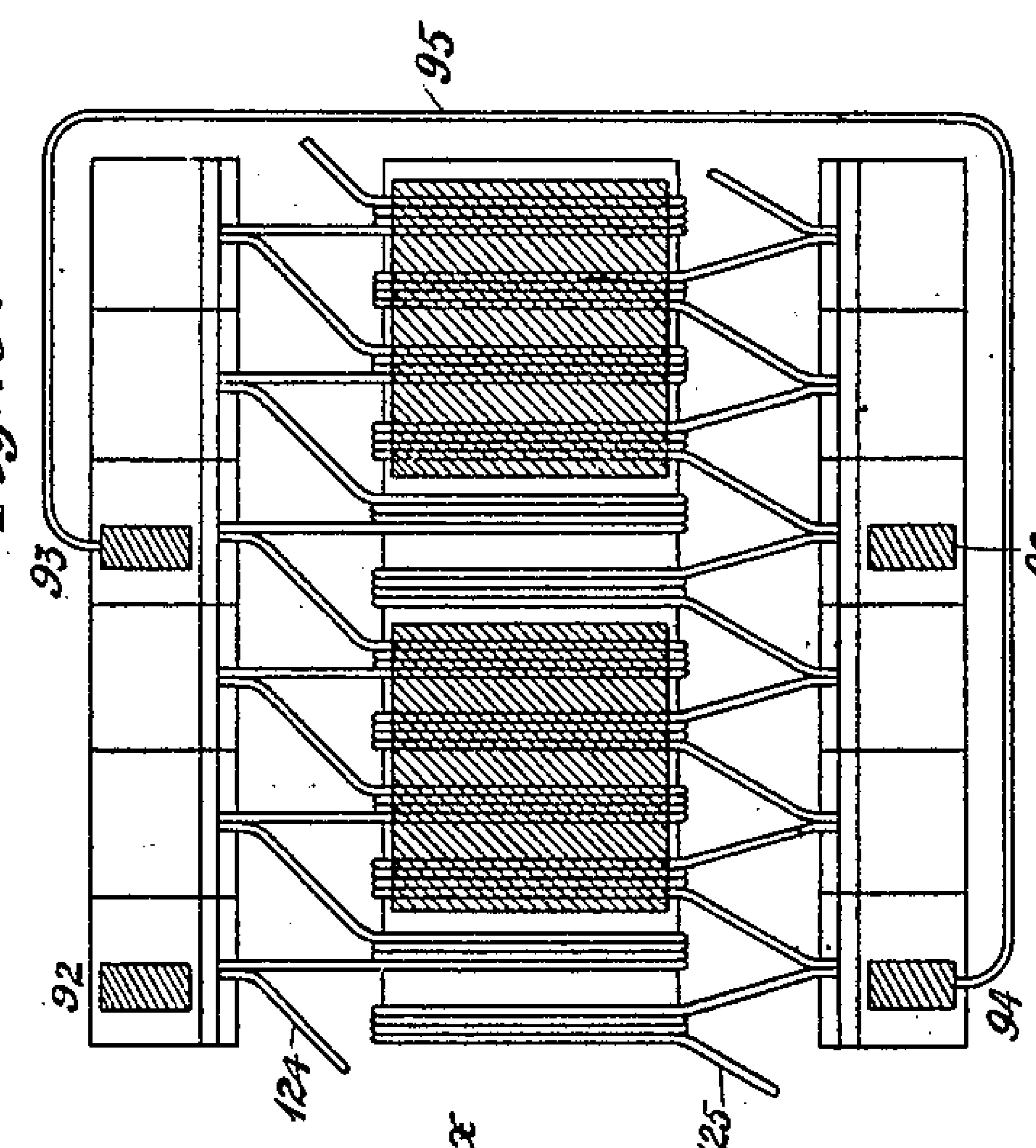

Fig. 13.

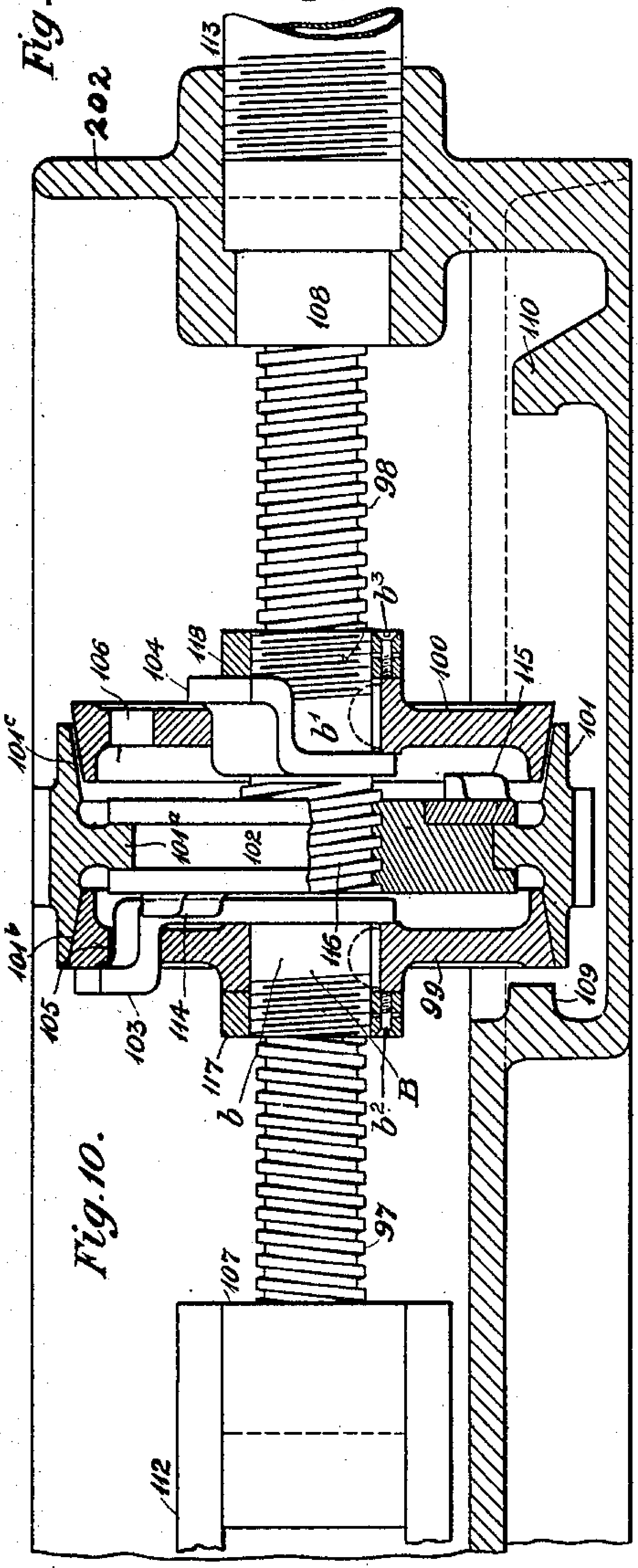

Fig. 10.

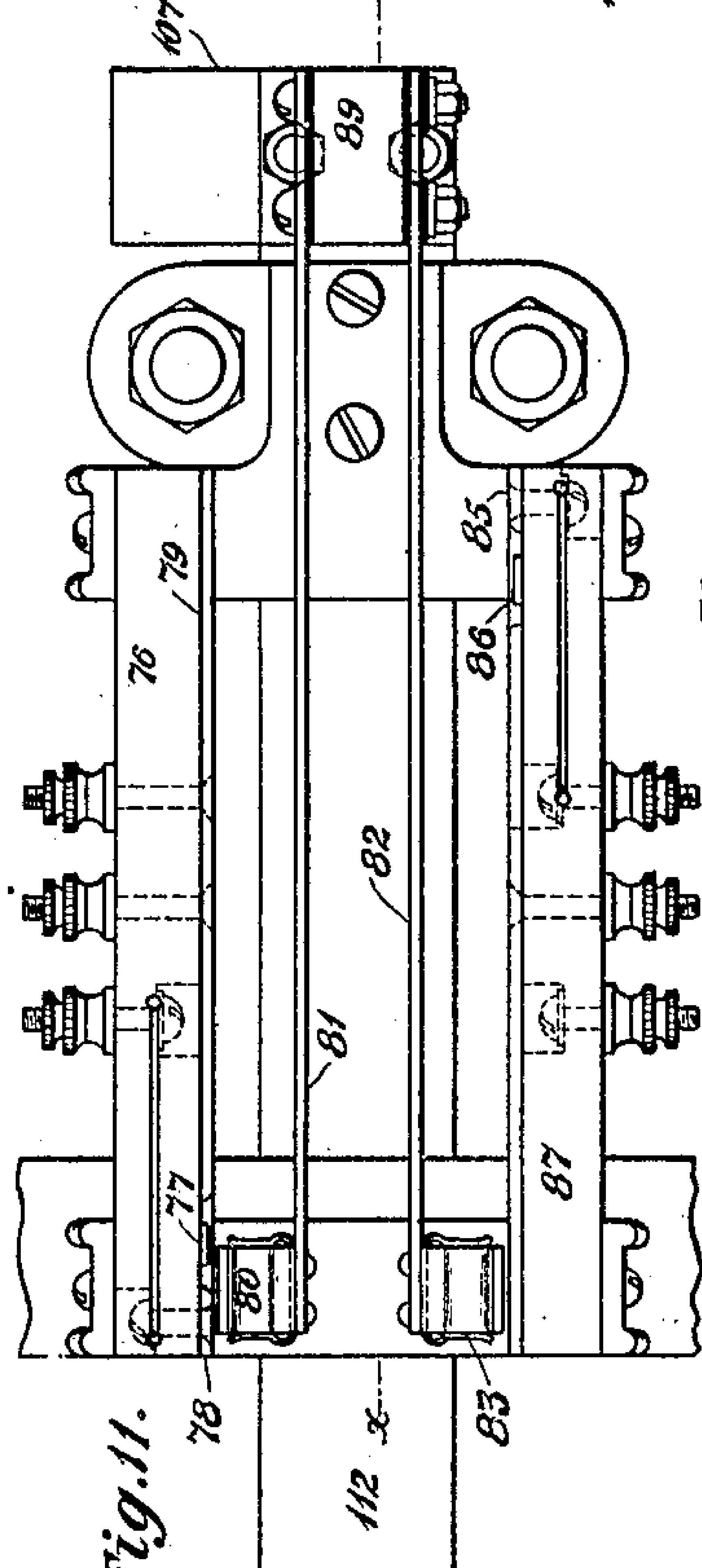

Fig. 11.

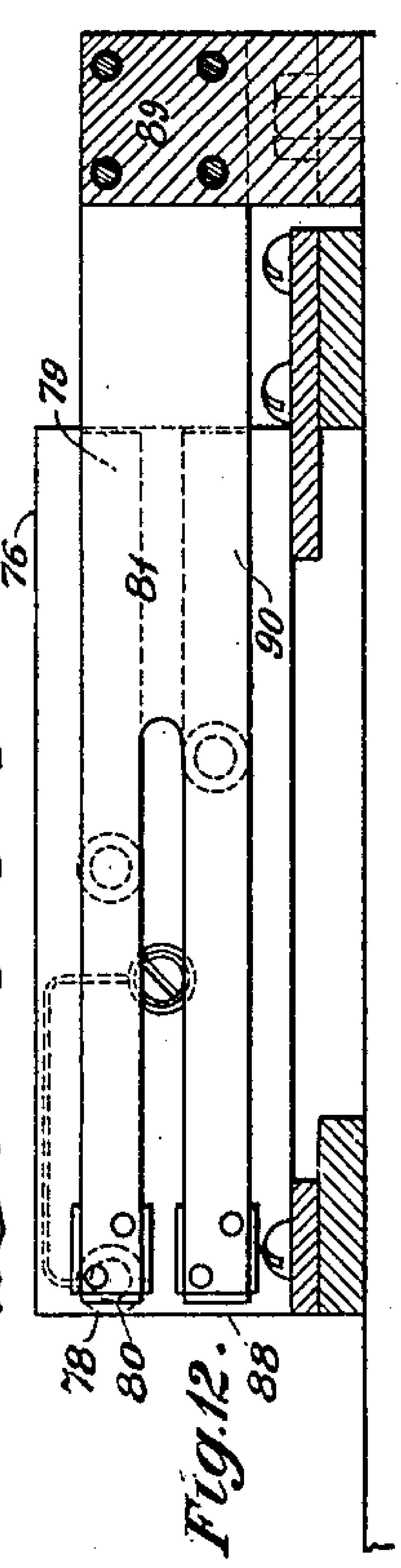

Fig. 12.

Witnesses

C. W. Van Nostrand

P. Herman Wagner.

Inventor

John D. Taylor

By his Attorney

Fred E. Crane.

J. D. TAYLOR.

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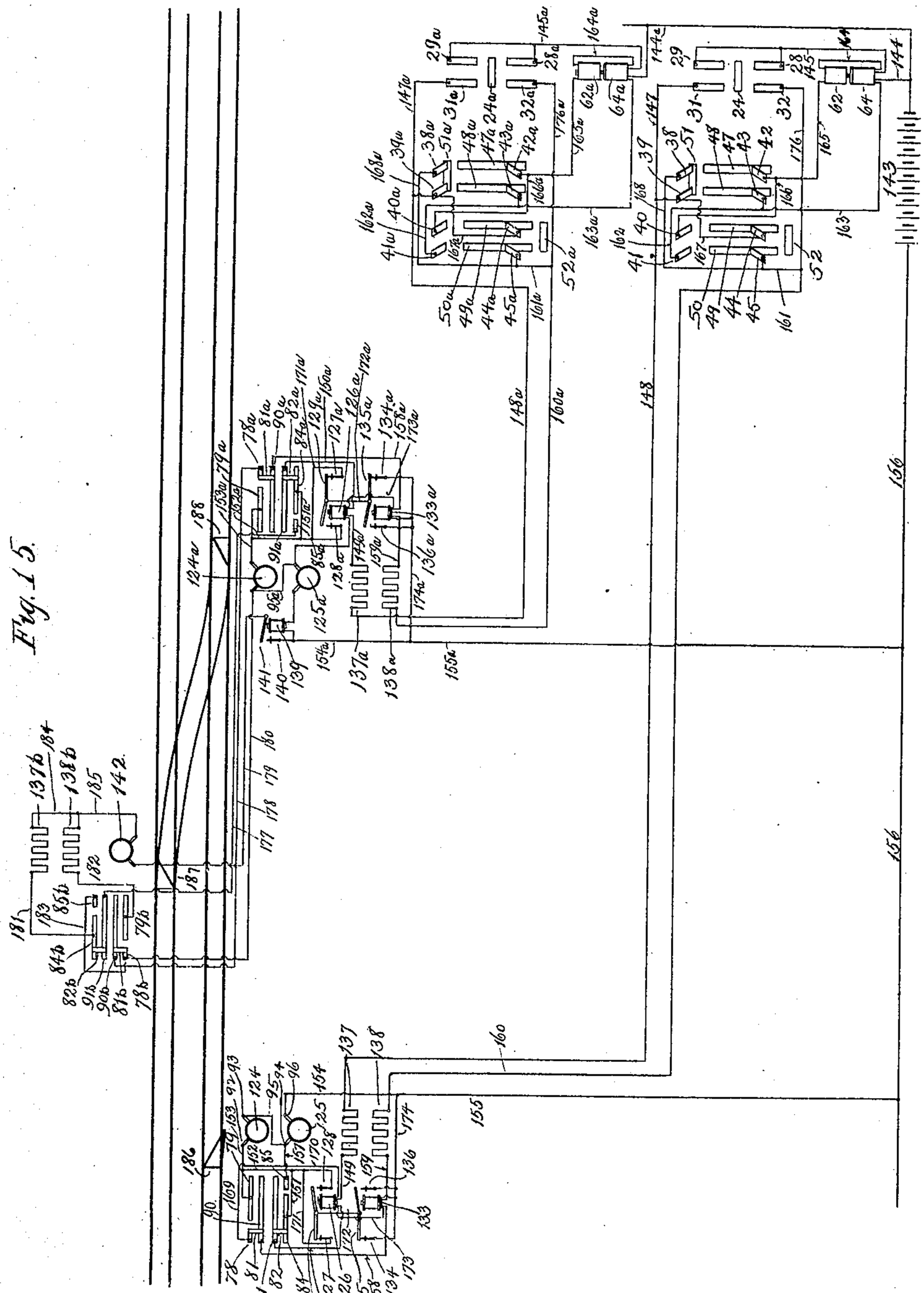
11 SHEETS—SHEET 5.

Fig. 15.



Witnesses
Chas. J. de Berard Jr.
Gustave E. Lemmerich

Inventor
John D. Taylor
By his Attorney
Geo. E. Bruce.

916,220.

J. D. TAYLOR.

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11 SHEETS—SHEET 6.

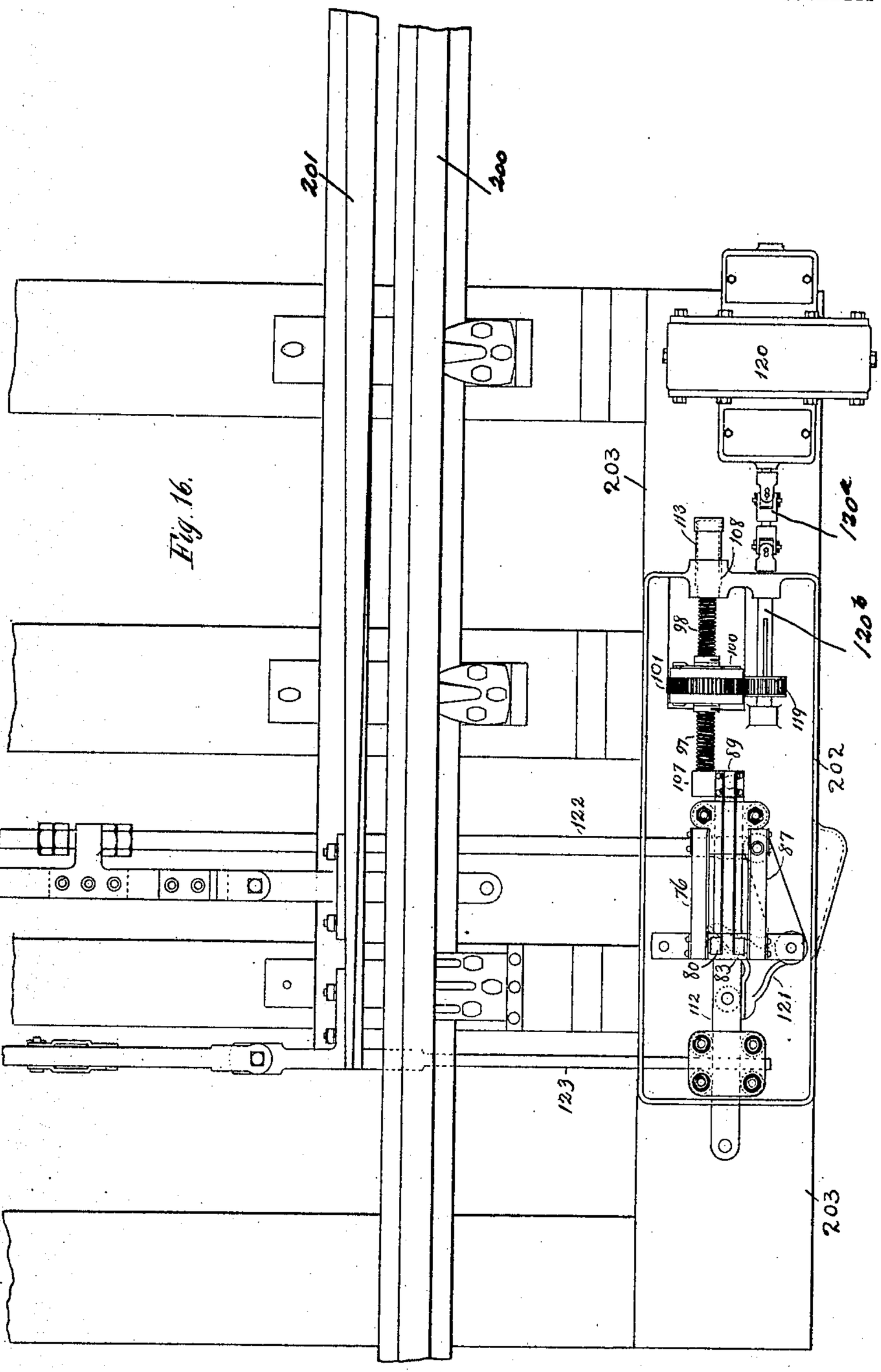

Fig. 16.

Witnesses
Chas. J. Williams Jr.
Gustave E. Lemmerich

Inventor
John D. Taylor
By his Attorney
Fred. E. Crane.

J. D. TAYLOR.

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11 SHEETS—SHEET 7.

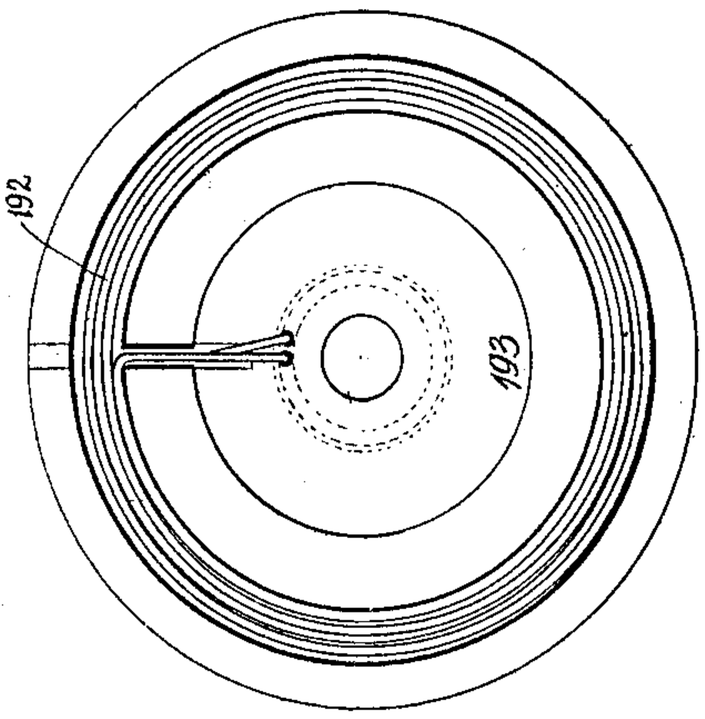

Fig. 19

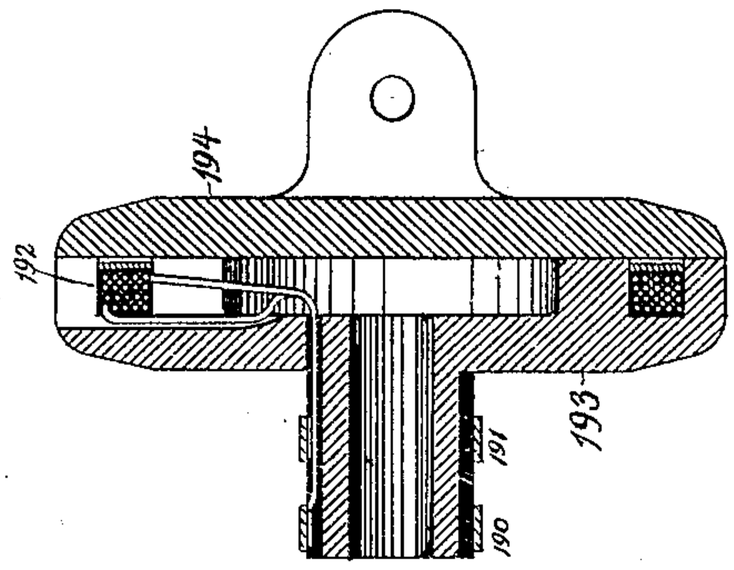

Fig 20.

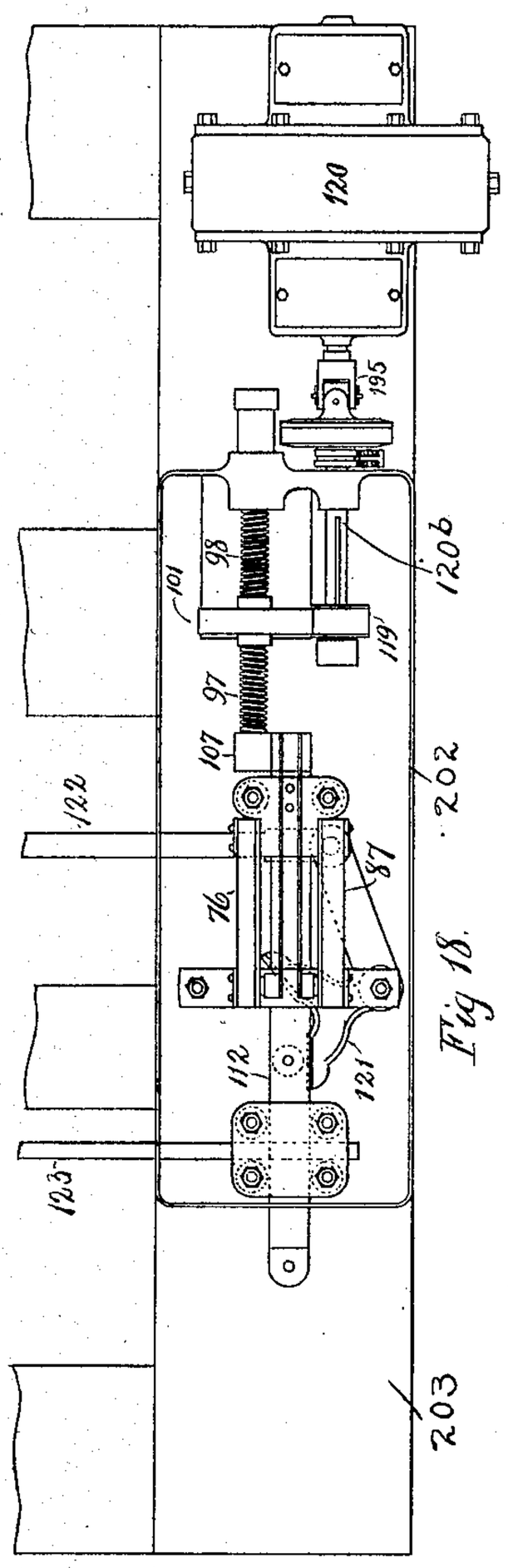

Fig 18.

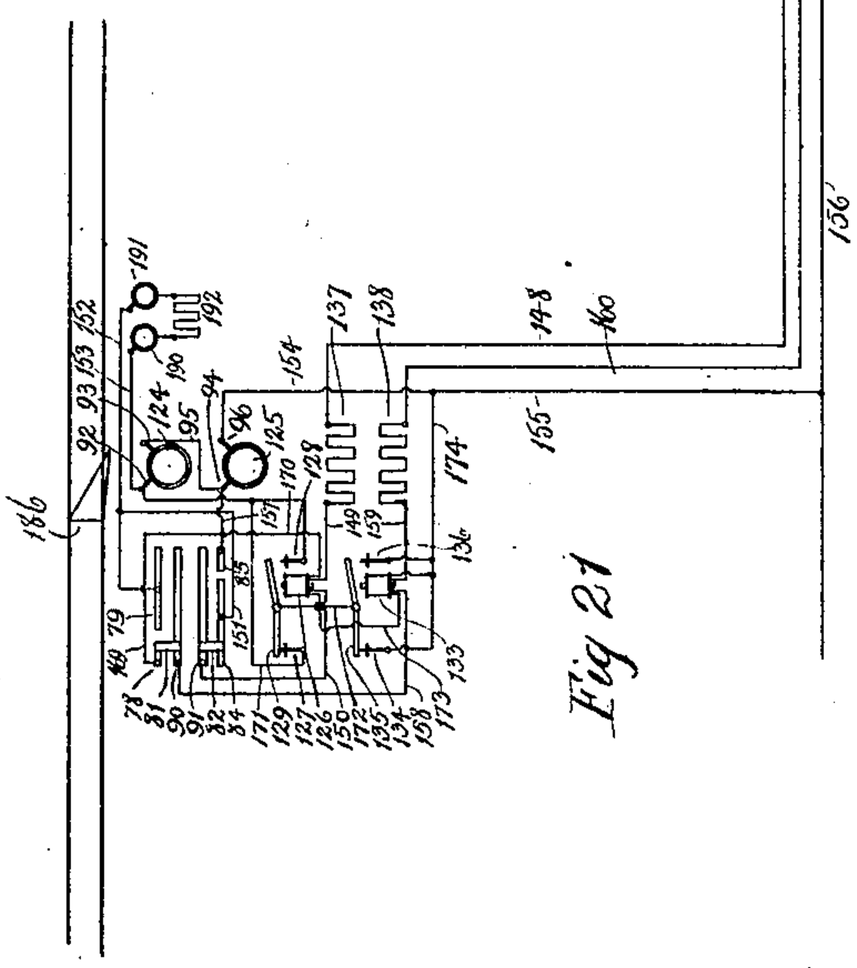

Fig 21

Witnesses

Chas. J. deBerard Jr.

Gustave E. Lemmerich

Inventor

John D. Taylor

By his Attorney Fred. E. Crane.

J. D. TAYLOR.

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11 SHEETS—SHEET 8.

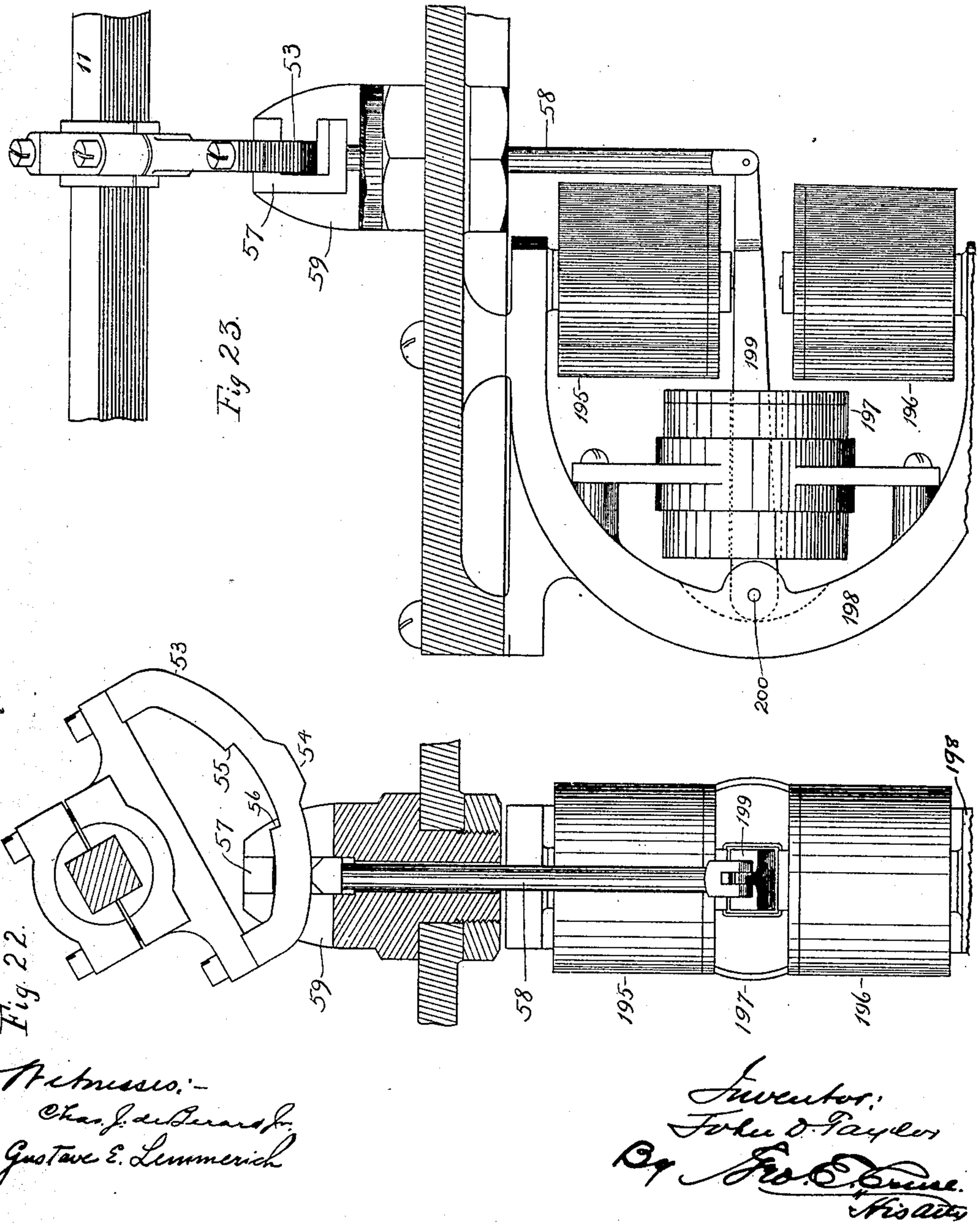

Fig. 23.

Fig. 22.

Witnesses:—
Chas. J. de Berard Jr.
Gustave E. Lemmerich

Inventor:
Forest D. Taylor
By Geo. C. Greene.
His Atty

J. D. TAYLOR.

RAILWAY SWITCHING APPARATUS.

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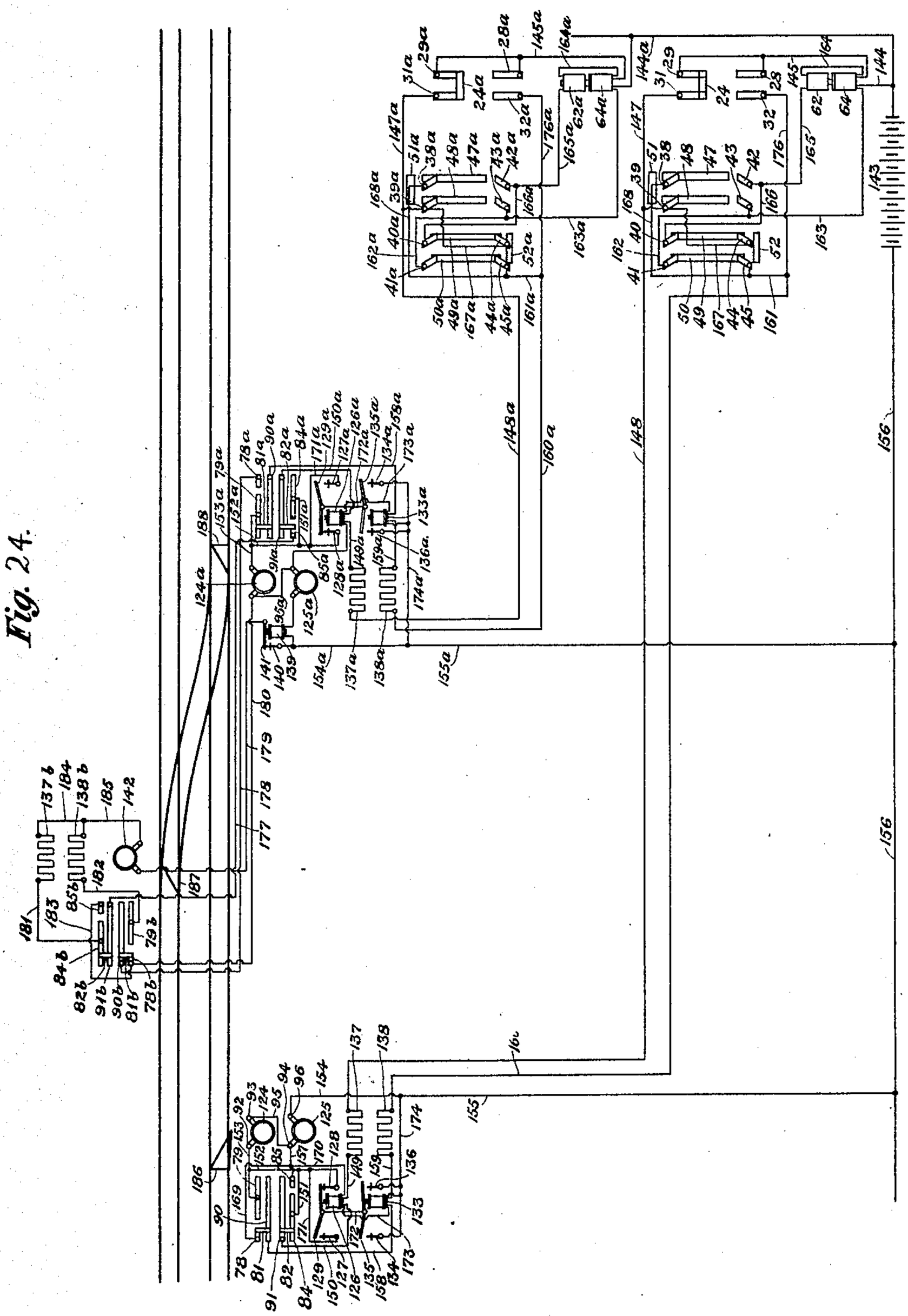
11 SHEETS—SHEET 9.

Fig. 24.



Witnesses
C. W. Van Nostrand
P. Herman Wegner.

Inventor
John D. Taylor
By his Attorney
Geo. C. Crane

J. D. TAYLOR.

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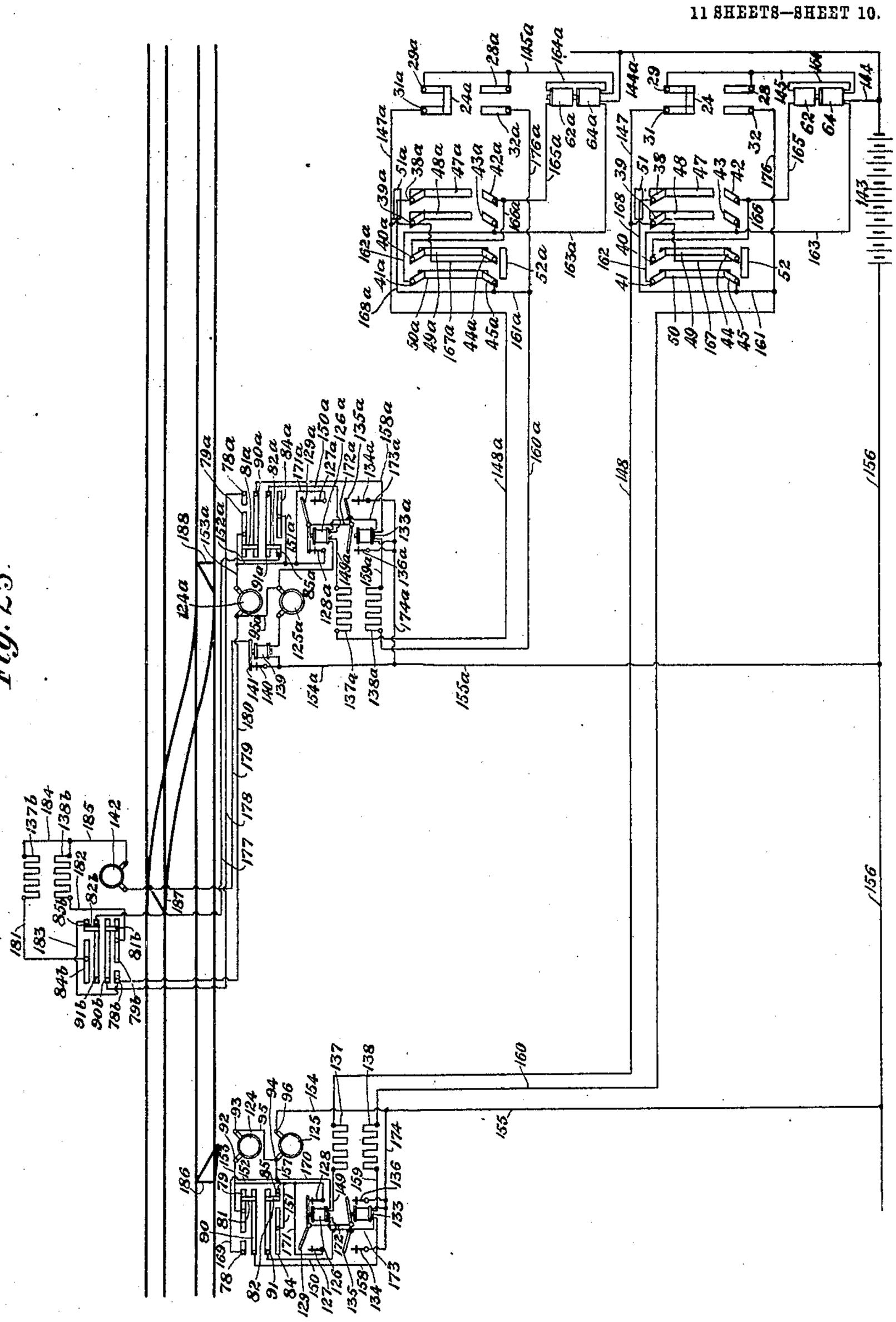
11 SHEETS—SHEET 10.

Fig. 25.



Witnesses
C. W. Van Nostrand.
P. Herman Wegner.

Inventor
John D. Taylor
By his Attorney
Edw. C. Cruse.

J. D. TAYLOR.

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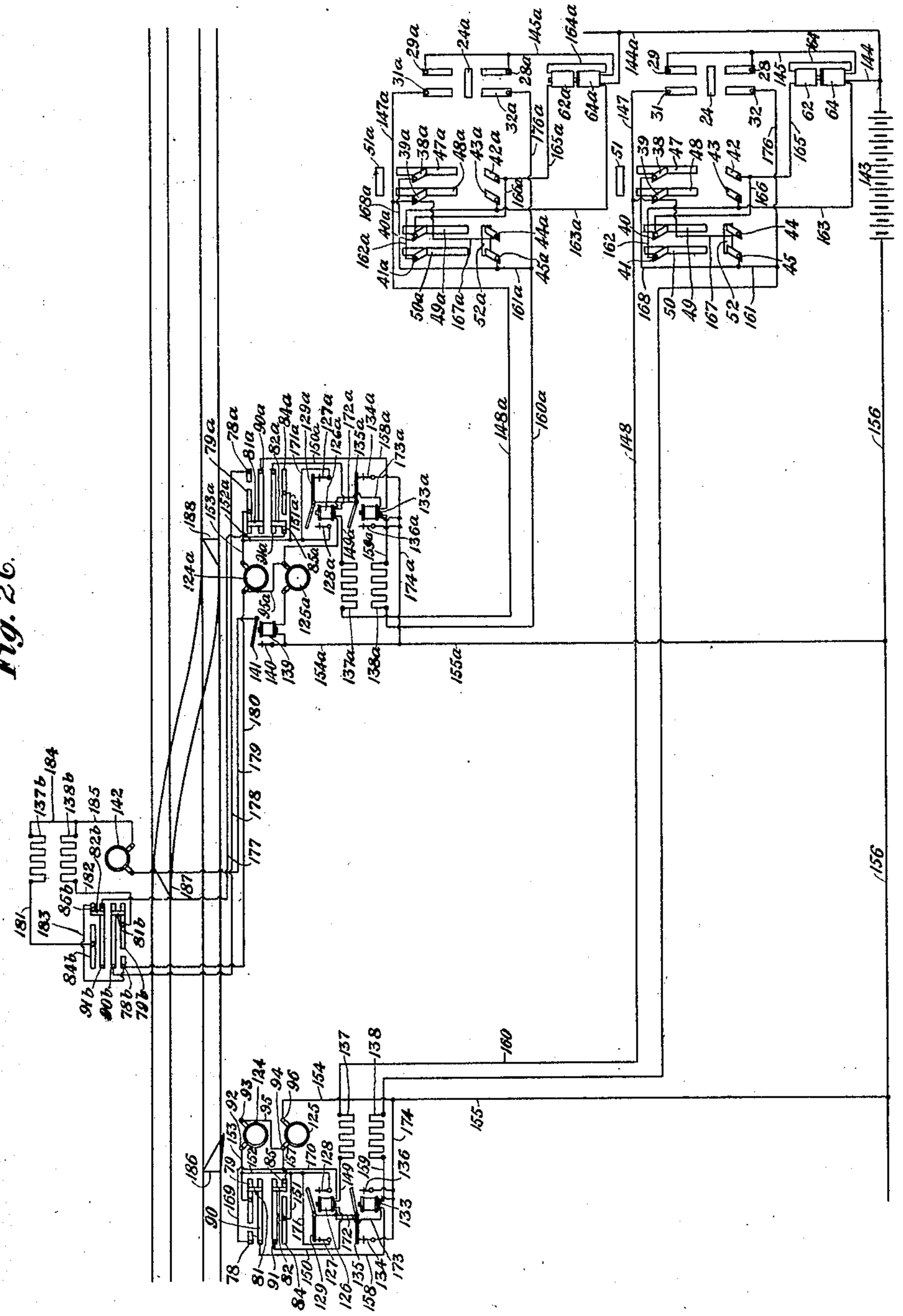
Patented Mar. 23, 1909.

11 SHEETS—SHEET 11.

Fig. 26.



Witnesses
C. W. Van Kostrand.
P. Herman Wegner.

Inventor
John D. Taylor
By his Attorney
Geo. E. Crane

UNITED STATES PATENT OFFICE.

JOHN D. TAYLOR, OF NEW YORK, N. Y., ASSIGNOR TO THE UNION SWITCH AND SIGNAL COMPANY, OF SWISSVALE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

RAILWAY SWITCHING APPARATUS.

No. 916,220. Specification of Letters Patent. Patented March 23, 1909.

Application filed April 18, 1904. Serial No. 203,645.

To all whom it may concern:

Be it known that I, JOHN D. TAYLOR, of the city of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Railway Switching Apparatus, of which the following is a specification.

My invention relates to that class of apparatus in which an electric motor is employed for operating the switch and lock movement.

The supply of current to the electric motor in this class of apparatus is generally controlled from what is termed an "interlocking machine" which is located in a cabin or tower. In these machines there are a number of levers some or all of which control the supply of current to the electric motors comprised in the switching apparatus. Such levers are generally provided with mechanism, known in the art as "indicating mechanism," which mechanism is actuated to release its lever upon a complete operation of the apparatus controlled thereby to move and lock the switch rails, thus permitting the lever to be moved to its final position and release or lock, through what is known as "mechanical interlocking," other levers which may control other apparatus for operating signals or other switch rails.

An object of my invention is to provide a strong and reliable current for actuating an electro-magnet or other analogous form of motor comprised in the indication mechanism under all conditions.

Another and especial object is to so construct and arrange the indication mechanism that it cannot be affected by currents from the prime source of energy no matter what condition of crossed or grounded wires may exist.

Still another object of my invention is to provide means for preventing false movements of switches by stray currents due to crossed wires, and to accomplish this without interfering with the proper operation of other switches of the system not involved with the crossed wires.

I preferably attain the first mentioned object by so constructing the operating motor of the switching apparatus that it may be driven by current from the prime source of energy at the same time that it is generating current for the indication mechanism; the second object preferably by so arranging the circuits that a terminal of the motor, while generating the current for the indication mechanism is raised to a higher potential than the highest point of the prime source of energy, also by constructing the electro-magnet of the indication mechanism and arranging its circuits so that it is in connection with the high potential point of the source of energy throughout the operation of the switching apparatus and throughout the generation of the current for the indication mechanism, and so that it is not susceptible to current flowing from the high potential point of prime source of energy but is susceptible to current flowing toward it from a point of still higher potential. This accomplished it is evident that a false indication can not be given no matter how many wires may be crossed or grounded. I preferably attain the last mentioned object by arranging and constructing the controlling apparatus at the switch so that current is required to flow through both operating wires for effecting either movement, "normal" or "reverse". Through one wire the current is limited by resistance which may be the coils of the electro-magnet of the indication mechanism, while through the other the full operating current flows. Therefore, for a switch to be moved as a result of a cross with a live wire, it is necessary that both its operating wires should be crossed with the said live wire and that the connection between a certain one of the said operating wires and the said live wire should have a suitable resistance while the connection between the other of said operating wires and the said live wire should be good enough to permit a strong enough current to flow to effect the movement, a condition next to impossible of accidental occurrence.

My invention is equally applicable to a signal operated by an electric motor and a lever for controlling the operation of the motor, which lever is provided with an indicating mechanism comprising an electro-magnet or other analogous form of motor.

I will describe a railway switching apparatus comprising an electric motor, a lever for controlling the supply of current to the motor, an indicating mechanism for the lever and an arrangement of circuits embodying my invention, and then point out the novel features thereof in claims.

In the accompanying drawings, Figure 1 is a view partly in elevation and partly in

vertical section of a portion of an interlocking machine showing a control for the supply of current to a motor comprised in a switching apparatus, and an indicating mechanism embodying my invention. The vertical section is taken in three different planes indicated by the lines 1, 2, and 3, Fig. 9. Figs. 2 and 3 are detail views of a controlling lever. Fig. 4 is a perspective view of a portion of a circuit controller embodied in the interlocking machine. Figs. 5, 6, and 7, are each detail views partly in elevation and partly in vertical section showing different positions of the control means for the supply of current to the motor. Fig. 8 is a detail view in side elevation of the control means shown in Figs. 5, 6, and 7. Fig. 9 is a view partly in elevation and partly in vertical longitudinal section of an interlocking machine. Fig. 10 is a detail view partly in elevation and partly in vertical section of a clutch device embodied in the switching apparatus. Figs. 11 and 12 are respectively a top plan view and a vertical and longitudinal sectional view of a circuit controller which is provided adjacent the switching apparatus. Fig. 13 is a diagrammatical view of an armature of an electric motor embodied in my invention. Fig. 14 is a detail view in side elevation of a part of the clutch shown in Fig. 10. Fig. 15 is a diagrammatical view of a railway, a cross-over and switch rails, switch apparatus for moving the switch rails, control levers and their related parts and an arrangement of circuits between the control levers and motors of switching apparatus. Fig. 16 is a top plan view of a switching apparatus and a circuit controller. Fig. 17 is a side elevation of a relay embodied in my invention. Fig. 18 is a top plan view of another switching apparatus. Figs. 19 and 20 are views of an electric clutch embodied in the apparatus shown in Fig. 18. Fig. 21 is a detail view showing an arrangement of circuits to include the electric clutch. Fig. 22 is a front elevation of a modified form of indicating mechanism embodying my invention. Fig. 23 is a side elevation thereof. Figs. 24, 25 and 26 are views similar to Fig. 15, but showing different conditions of the circuits and positions of the apparatus.

Similar characters of reference designate corresponding parts in all of the figures.

I will first describe a switch and lock movement for operating a switch rail or rails; second, a form of motor which may be employed for operating the switch and lock movement; third, a circular-controller for the supply of current to the motor; fourth, an indicating mechanism, and fifth, an arrangement of circuits which may advantageously be employed.

Referring now to Figs. 16, 10 and 14, 200 designates one of the two opposite lines of track rails of a railroad and 201 one of a pair of switch rails or points, or it may be a derail. Adjacent the switch rail 201 is an apparatus for moving the switch rail from one position to a second position and from the second position to the first position. One position is generally termed "normal" and the other "reverse". The railway switching apparatus as here shown, comprises an electric motor 120, the armature of which rotates in opposite or reverse directions, a switch and lock movement and a clutch mechanism between the armature of the motor and the switch and lock movement. The switch and lock movement and the clutch mechanism of the apparatus are preferably inclosed in a two part casing 202, one of which parts may be mounted on a base 203, which is secured to the ties and the other of which parts may be employed as a cover. The switch and lock movement as here shown comprises an alligator jaw 121 and a motion bar 112 which also acts to lock a rod 123 connected with the switch rail in each of the two positions of the switch rails. The alligator jaw is connected by a link with a rod 122 which rod is connected with a bridle rod connecting the two switch rails. In case there is only one switch rail (a derail) the rod 122 may be connected directly to it. The alligator jaw is rocked on its pivot by a roller carried by the motion bar 112. The motion bar is reciprocated longitudinally in this form of the invention through the clutch mechanism. The armature of the motor is connected by a universal coupling 120^a with a shaft 120^b suitably journaled in the lower half of the casing 202. The shaft 120^b is provided with a longitudinal opening which receives a pin or feather provided on a pinion 119. The pinion 119 is provided with annular flanges between which extends the peripheral portion of a spur gear 101. The pinion 119 also meshes with the spur gear 101 and upon a lateral movement of the spur gear 101 the pinion is made to travel with it.

The spur gear 101 is comprised in the clutch mechanism which will now be described.

B (Fig. 10) designates a shaft, one end portion thereof being provided with a left hand screw 97, and its other end portion with a right hand screw 98. At about the middle of the shaft B a third screw thread 116, is provided. On each side of the thread 116 are portions b, b^1, each of which is provided with a screw thread to receive locking nuts 117, 118. Keyed on the portions b, b^1, are disks 99, 100, each of which is provided with an inclined or cone-shaped flange. The locking nuts 117, 118, are held on the screw threads of the portions b, b^1, by means of screws b^2, b^3. The screw thread 98 of the shaft B works in and out of a nut 108, which is firmly fixed in the casing 202 and into and out of a cylindrical cap 113, also secured in

the casing 202, which cap is intended to protect the screw thread 98 when it projects beyond the casing 202. The screw thread 97 of the shaft B works in a nut 107 which is suitably secured in the motion bar 112.

102 designates a sheave which works on the screw thread 116. The sheave 102 is provided with a circumferential groove to receive an internal flange 101^a provided on the spur gear 101. The spur gear 101 is also provided with flanges 101^b and 101^c, the interior surfaces of which are beveled or cone-shaped. These flanges 101^b and 101^c are adapted to alternately co-act with the cone-shaped flanges of the disks 99 and 100.

103 and 104 designate arms which are loosely mounted on the portion b, b^1 of the shaft B. These arms are formed to project through segmentally shaped openings 105, 106, which openings are provided in the disks 99 and 100. The shape of these openings is illustrated in dotted lines in Fig. 14.

The operation of this form of clutch mechanism is as follows: Upon the rotation of the spur gear 101 by the pinion 119, the sheave 102 is made to rotate with it. This is due to the fact that the surface of contact between the spur gear 101 and the sheave 102 is at a greater radial distance from the center of rotation than the bearing between the sheave 102 and the shaft B. The rotation of the sheave 102 causes it to travel to the right or left on the thread 116 according to the direction of rotation of the spur gear 101. Assuming now that the rotation of the sheave 102 is such as to cause it to travel to the left of Fig. 10, it carries with it the spur gear 101 and causes its flange 101^b to engage with the flange of the disk 99. This frictional engagement causes the disk 99 to rotate with the spur gear 101, and the rotation of the disk 99 with the spur gear 101 will cause the shaft B to rotate and to have a longitudinal movement due to its working out of the fixed nut 108. The longitudinal movement of the motion bar 112 is twice the longitudinal travel of the said shaft B, due to the joint action of the threads 97 and 98 moving out of their respective nuts. As the shaft B reaches the end of its longitudinal movement toward the left, the arm 103 will engage a lug or projection 109 in the casing 202 and when this engagement occurs the sheave 102 is stopped from rotation, this stoppage being due to a projection 114 carried by the sheave engaging the arm 103. After the sheave 102 is stopped from rotating, the spur gear 101 continues to rotate, it slipping in the circumferential groove of the sheave 102, and this continued rotation tends to move the shaft B and the disk 99 in a longitudinal direction toward the left. The pitch of the screw 116 is such that the shaft B and the disk 99 will travel longitudinally to the left at a speed faster than the longitudinal travel of the spur gear 101, and it will thus be seen that the flange 101^b of the spur gear 101 will become disengaged from the flange of the disk 99 to prevent any further longitudinal movement of the shaft B. The disengagement of the spur gear from the disk 99 does not take place until after a complete movement of the switch rails and until after they have been locked in the position to which they have been moved. Upon a reversal of the motor a reverse rotation is given the spur gear 101 and through it a reverse rotation of the sheave 102 to cause the sheave and spur gear to move into engagement with the disk 100. After this last engagement takes place the shaft B will be rotated in a reverse direction to cause a longitudinal movement of the shaft B toward the right. This longitudinal movement of the shaft is due to the screw thread 98 working in the fixed nut 108. The longitudinal movement of the motion bar 112 to the right is accomplished at the same speed as toward the left due to the shaft working in the nut 108 and in the nut 107. The disengagement of the spur gear 101 from the disk 100 is accomplished in the same manner as described in connection with the spur gear 101 and the disk 99 through the engagement of the arm 104 with the lug 110 and the engagement of the lug 115 carried by the sheave 102 with the arm 104.

The armature of the switch operating motor is of special construction. This is illustrated in Fig. 13. The armature has two sets of coils, two commutators and two sets of brushes. During the time of movement of the switch rail, the operating current passes through the two windings in series and the action is the same as though there were but a single winding of the same number of turns as contained in both windings, that is, the current enters at say the brush 92, passes through the winding 124, leaves at the brush 93, passes through the wire 95 to the brush 94, passes through the winding 125 and leaves at the brush 96. (See also the diagrammatical views, Figs. 15, 24, 25 and 26.) The brush 96 is connected by a wire (a common return) to one pole, herein termed the low potential pole, of a battery or other source of current supply located in the tower or cabin, and two other wires (operating wires) lead from the tower or cabin and are throughout the entire movement of the switch rail or rails, except near the end of the movement of the switch rail or rails, both electrically connected to the brush 92. One of the two operating wires is connected in the tower or cabin, when a movement of the switch rail or rails is to be made, through a low resistance winding of an electro-magnet of the indication mechanism, hereinafter referred to as the direction coil, to the other pole, herein termed the high potential pole, of the

battery or other source of current supply, and the operating other wire is connected to the same pole of the battery through high resistance windings of electro-magnets in the indicating mechanism to be hereinafter referred to as neutralizing and indication coils. At the end of the switch rail's movement in either direction the first named connection to the high potential pole of the battery is shifted from the brush 92 to the brush 94, through a circuit controller located preferably at the switch rails, the clutch being disengaged at this time. By this change of circuits, the motor is driven by current from the battery flowing through the single winding 125, while the winding 124, itself a source of electro-motive force, is inserted between the two wires above mentioned including the coils of the indication mechanism, consequently a current flows from the brush 92 through the wire connected to it, through the windings of the electro-magnets of the indicating mechanism and through the other operating wire to brush 94, thence through wire 95, brush 93 and winding 124 to brush 92. As is well known, a motor when running, driven by an electro-motive force, will develop a counter-electro-motive force almost equal to the driving electro-motive force. Just enough difference subsists to force the current against the ohmic resistance. When the motor, therefore, is driven by current in the winding 125, the counter electro-motive force of this winding is nearly equal to, and opposed to the battery electro-motive force. The winding 124, because it has an equal number of turns rotating at the same speed, and in the same magnetic field as the winding 125, will have an equal electro-motive force and in the same direction, developed in it. During indication there are, therefore, two sources of electro-motive force, producing current in two circuits; one source is the battery acting on a circuit including the winding 125 and the direction coil of the indication apparatus; the other source is the winding 124, producing current in a circuit including all the coils of the indication apparatus. The direction coil and one of the two above mentioned wires is common to both circuits. The current from the winding 124 flows through the indication and neutralizing coils in a direction opposite to that in which it would be possible for a battery current to flow. The wire (common return) joining the brush 96 to the low potential pole of the battery may be common to any number of motors. It is plain that the battery may be reversed without affecting the result. It is also a matter of indifference as to which of the brushes 92 or 96 is joined to the common wire. The reversal of rotation of the armature is effected by having two windings on the field magnet of the motor. One of the two wires above mentioned is connected to a brush of the armature through one of the field windings while the other wire is connected to a brush of the armature through the other field winding. The polarity of the field magnet is of one or the opposite sign as the main operating current flows through one or the other field winding. It will be seen, therefore, that the motor employed is in the form of a dynamotor.

A circuit controller which may be employed to shift the operating current from the brush 92 to the brush 94 is shown in Figs. 11 and 12. As here shown the circuit controller comprises brushes 81 and 82, which are carried by a block 89 attached to a movable part of the apparatus, for example the bar 112, but are insulated therefrom and from one another. The brush 81 carries two contacts 60 and 88. The contact 88 throughout the entire movement of the switch presses on a metallic strip 90, and the contact 80 throughout the whole movement except a small part near say the normal position of the switch and lock movement presses on a strip 79. Near the end of the normal movement it passes from the strip 79 to the short strip 78. Shortly after beginning the reverse movement it passes back to the long strip 79. While the brush 81 is connecting the strips 79 and 90 the normal operating wire remains in connection with the brush 92. When the brush 81 passes from strip 79 to strip 78, the said wire is shifted from brush 92 to brush 94, the said normal operating wire being connected to the strip 90, the brush 92 to the strip 79 and the brush 93 to the strip 78. The space between the strips 78 and 79 need be wide enough only to prevent actual short circuiting of the winding 124. An arc can not be drawn across because when brush 81 is leaving the strip 79 the potential of the brush is higher than the strip 79 but immediately it makes contact with 78 the potential of 79 is raised above that of the brush 81. The arc will therefore be immediately destroyed. The block 77 is used only to prevent the contact 80 dropping too deep and catching on the end of the strip to which it is passing. The brush 82 is exactly like 81 and presses on similar contact strips, the short strip 85, corresponding to 78 being at the reverse end. The contact strips are supported on slabs of insulating material 76 and 87. The contact strips and brushes are diagrammatically illustrated in Fig. 15.

Referring now to Fig. 1 which is a view of an interlocking machine showing a front elevation of two of the controlling levers and sections at various planes to show the working parts, 1 designates a lever projecting upwardly, the full lines showing its normal position and the dotted lines its reversed position. 2 designates a lever projecting downwardly, its reverse position being shown in

full lines and its normal position in dotted lines. The levers alternately project upwardly and downwardly to economize space. At 3 and 4 are shown the drivers which move the locking bars. As these are well known, and the mechanical locking may be the well known Saxby and Farmer mechanical locking no further description is necessary. At 5 is shown a bearing of the operating shaft. At 6 is shown the circuit controller for making and breaking the circuits of the switch or signal operating motor at the machine.

The circuit controller is shown in detail in Figs. 5, 6, 7 and 8. At 7 is shown a circuit controller for controlling the circuits of the electro-magnet of the indicating mechanism. This circuit controller is shown more in detail in the perspective view of Fig. 4. At 8 is shown another bearing for the operating shaft. As 9 is shown the indicating mechanism in normal position and at 10 the same just before the normal indication is received. The corresponding reversed positions are similar but opposite to these. These parts are all shown in side elevation in Fig. 9, which is a transverse section of the interlocking machine showing the distribution of the working parts along the operating shaft 11. As all the levers in a machine are equipped alike the various sections shown in Fig. 1 may be considered as sections on different levers or of the same lever at different planes. The circuit controller shown at 6 and the indication mechanism are arranged on the shafts 11 in a manner commonly known as "staggered," as shown in Fig. 9, to economize space between levers.

The operating lever has an angular movement only and for convenience of description I will say that the extreme angular movement covers an arc of 60 degrees and that the movement from either extreme position until it is stopped by the indication mechanism is 40 degrees. It can, therefore, play through an arc of 20 degrees between indication points. This play of 20 degrees permits shifting the circuit controllers from one side to the other and thus of changing the direction of movement of the switch at will. The lever is locked in either of its extreme positions against accidental movement by a latch 71, shown in detail in Figs. 2 and 3, which is caused to drop into a notch 69 or 70 in the segment 68 by a spring 75. The latch can be withdrawn from the notch by turning a handle 74 either to right or left, the said handle being connected with a cam 72 by a bolt 73.

The indication mechanism as here shown (see Fig. 1) comprises an arc 53 clamped to the shaft 11 and passing through a slot in a guide 59 bolted to the frame of the machine, a slotted lock 57 which is held in a slot in the guide 59 at right angles to the first mentioned slot, and electro-magnetic means comprising electro-magnets 62 and 64, a common armature 61, and a rod 58 connecting the said lock 57 with the armature 61. The arc 53 passes through the slot in the lock 57 and has a recess formed in its upper side forming shoulders 55 and 56, which are engaged by the upper arm of the lock 57. It also has a projection 54 on its under side at about the middle of said recess which acts to depress the lock 57 so as to insure its engaging with the shoulders 55 or 56. The shoulders 55 and 56 are far enough apart to permit the arc and consequently the shaft 11 to move through an arc of 20 degrees without the lock 57 being operated to permit this movement. The armature 61 rests on the poles of the magnet 64. The magnet 64 has two windings, one a few turns of large wire through which the operating current flows and the other a large number of turns of small wire. The magnet 62 has one coil of large number of turns. The indication current flows through this coil and the fine wire coil of the magnet 64 in series. For convenience I will style the coil of the magnet 62 the "indication coil," the fine wire coil of the magnet 64 the "neutralizing coil" and the heavy wire coil of the magnet 64 the "direction coil."

The operation of the indicating mechanism hereinbefore described is as follows: When a lever is moved, the arc 53 moves with it to bring the recess therein beneath the lock 57. In moving to this position the projection 54 forces the lock downward into the recess and between the shoulders 55 and 56. When the lock 57 is between the shoulders 55 and 56, the lever is prevented, by the lock engaging with either of the shoulders, from being moved to either of its final positions, and when the lock is removed from between the shoulders, the lever is free to be moved to either of its final positions. The lock, therefore, is rendered effective by the movement of the lever, and in this form of the invention, it is rendered ineffective to prevent complete movement of the lever upon the energization of the magnet or "indication coil" 62. The operating circuit, that is, the circuit in which current flows to energize the switch operating motor, includes the direction coil of magnet 64. This is true whether the track switch is being moved from its normal to its reverse, or from its reverse to its normal position so that the operating current always flows through the direction coil. The indication coil on magnet 62 and the neutralizing coil on the magnet 64 are joined in series with each other and are located in a shunt to part of the operating current. During the movement of the switch rails in either direction current from the battery flows through the shunt path and consequently through the indication and neutralizing coils, but the connections are such

that it flows through the neutralizing coil in such direction as to increase the magnetism produced by the operating current flowing through the direction coil. After the switch rails have been moved from one of their two positions to the other, the indication current is generated, and this current flows through the fine wire winding of the magnet 64 and the winding of the magnet or "indication coil" 62 in the opposite direction, and after a time, the indication current passing through the fine wire winding of the magnet 64, will neutralize the magnetic effect produced by the current from the battery 143 flowing through the large wire winding of the magnet 64, so that the magnet or "indication coil" 62 will attract the armature 61 and thus render the lock ineffective by lifting the lock 57 from between the shoulders 55 and 56. The arrangement of these coils as will hereinafter appear is such that the operating current will flow through the large wire winding of the magnet 64 in one direction through one path, and that current will flow through the winding of the magnet 62 and the fine wire winding of the magnet 64 in series, in the same direction as the operating current through the coarse wire winding of the magnet 64 and through another path. The indication current which is generated after the switch rails have been moved and locked flows through the fine wire winding of the magnet 64 and the winding of the magnet 62 in series but in a direction opposite to the flow of the current during the movement of the switch rails by the switching apparatus. The indication current is designed to neutralize, by flowing through the fine wire winding of the magnet 64, the magnetic effect produced by the operating current flowing through the large wire winding of the same magnet. When this neutralization takes place the magnetic effect produced by the current in the winding of the magnet 62 will attract the armature 61 and thus remove the lock 57 from between the shoulder 55 and 56. It will be seen, therefore, that the function of the two windings of the magnet 64 is to insure the flow of the indicating current through the fine wire winding of the magnet 64 and the winding of the magnet 62 in the proper direction to render the lock ineffective, and these windings respond to release the lever by current flowing through them in one direction only. A current in the neutralizing coil of opposite sign to that of the indication current would tend to strengthen the magnet 64 and so prevent the armature being lifted, or the absence of current in the direction coil would also prevent the armature being lifted as in that case the magnet 64 would be energized and retain the armature. When, however, the proper currents circulate in the coils the armature 61 will be lifted and through the connecting rod 58 will lift the lock 57 clear of the recess in the arc 53 and permit the lever to be moved to its final position. It will be seen, therefore, that the function of the two windings of the magnet 64 is to insure the flow of the indicating current through the fine wire winding of the magnet 64 and the winding of the magnet 62 in the proper direction to render the lock ineffective, and these windings respond to release the lever by current flowing through them in one direction only. The first 20 degrees of movement of the lever effects the locking of other levers whose movement would conflict with the new position of the said lever, the final 20 degree movement which can only be made after the arc 53 is released from the lock 57 releases other levers whose movement is compatible with the new position of the said lever while the middle 20 degrees of movement does not affect the locking.

In Figs. 5, 6, 7 and 8, I have illustrated a form of circuit controller which may advantageously be employed, the functions of which are to connect either the normal or reverse operating wire with the source of current supply as may be required to effect the proper movement of the switch, and to disconnect the said wire from the battery after indication has been received. The term source of current supply is herein employed in its broadest sense, and is illustrated in the drawings as a battery, which term will be hereinafter used except in the claims. The said circuit controller comprises a swinging contact carrier 23 pivoted at 25, as shown, to the frame of the machine and carrying a contact strip 24; and two pairs of brushes 28 and 32 and 29 and 31. The brush 32 does not show in any of the views except Fig. 15. In Figs. 5, 6 and 7 it is directly back of the brush 28 and in Fig. 8 back of the brush 31. In its normal contacting position the contact strip 24 connects the brushes 28 and 32, and in its reverse contacting position it connects the brushes 29 and 31. The parts are so proportioned that its engagement with one or the other pair of brushes is fully made when the lever is stopped by either of the shoulders of the arc 53 of its indicating mechanism. The mechanism for effecting the movements of the controller may comprise a driver 12 carrying a pin 14 for engaging a tongue 15 or 16, the said driver 12 being clamped to the shaft 11, while the tongues 15 and 16 are pivoted to the carrier 23 at 26 and 27 respectively, and links 19 and 20 pivoted to the driver 12 at 33 and 34 respectively. Fig. 5 shows the relative position of the parts when the lever is at the middle point of its movement. The pin 14 lies between the tongues 15 and 16. If moved to the left it will press against the

tongue 15 and cause the contact strip to move toward the brush 28. If moved to the right it will press against the tongue 18 and cause the contact strip 24 to move toward the brush 29. The tongues 15 and 16 are pressed downwardly by the springs 17 and 18, respectively, but are prevented from going any further down than shown by shoulders adjacent the slots in the carrier 23 in which slots they are pivoted. The upper portions of the links 19 and 20 are slotted and pins 35 and 36 project from the carrier 23 and through these slots respectively. Fig. 6 shows the relative position of the parts when the lever is at the normal indication point. The contact 24 connects the brushes 28 and 32 in this position. A slight further movement of the driver 12 to the left which can take place after indication has been received will cause the tongue 15 to slip off the pin 14 and will cause the link 19 to engage the pin 35 and still further movement will, through the link 19, move the carrier so as to withdraw the contact 24 from the brushes 28 and 32. Fig. 7 shows the position of the parts when the lever is in the complete normal position. The carrier 23 is prevented from swinging far enough past the middle to cause the contact 24 connecting the brushes 29 and 31 by the carrier 12 which has moved so as to lie in the path of the lug 21 projecting from the carrier 23. The reverse movements are exactly similar as can be seen from the symmetry of the parts. It will thus be seen that the circuit controller hereinbefore described will close an operating circuit to supply power to a motor upon an initial movement of the lever in either direction, and upon a final movement of the lever, the circuit controller will open or break the operating circuit and will not again close the same operating circuit upon a movement of the lever from its final position.

The relay shown in Fig. 17 is used in connection with the operating motor to prevent stray currents from crossed wires or other causes from moving the switch. The lever 129 is weighted to stand in contact with the post 127 when the magnet 126 is not energized. The lever carries at the end opposite the weight a spring 132 reinforced by the adjustable spring 131. The spring 132 projects beyond the end of the lever 129 to engage with the stop 130. The stop 130 is so adjusted that the lever 129 can be withdrawn from the stop 127 without bending the spring but for the lever to contact with the stop 128 the spring 132 must be bent and 131 compressed. The spring 131 is so adjusted that a current of one strength, say two amperes in the coil of the magnet 126 will withdraw the lever 129 from the contact 127 but will not put it into contact with 128 while another current of greater strength will draw the lever down to contact with 128. Two of these relays are used at each switch with the exceptions to be noted in describing the circuits, and each constitutes an electro-magnetic means for controlling a shunt circuit around the motor. The magnet 126 has two windings one of few turns of large wire which I will style the "series" coil and one having a large number of turns of small wire which I will name the "shunt coil", the uses of which will appear in describing the circuits.

The functions of the circuit controller shown at Fig. 4 are to connect the two operating wires together when the lever is in either of its extreme positions and for connecting the indicating and neutralizing coils in series across from one operating wire to the other when the lever is at either of the indicating positions. The connections of the coils to the operating wires at one indicating position must be the reverse of that at the other indicating position since the functions of the wires themselves are reversed. This reversal is also effected by the controller shown in Fig. 4. Its operation can be better described in connection with the circuit diagrams shown in Figs. 15, 24, 25 and 26.

In Fig. 15 all the parts are shown in "normal" position; in Fig. 24 the circuit controllers operated by the levers are shown at the "reverse" indicating position, the switch 188 at full "reverse" position, and the switches 186 and 187 just at the beginning of their "reverse" movement; in Fig. 25 the circuit controllers operated by the levers and all the switches are shown at "reverse" indicating position; in Fig. 26 all parts are shown at full "reverse" position. To reverse the switch 186 its corresponding lever is moved until stopped by the lock 57 of its indication mechanism. This movement causes the contact strip 24 to connect the brushes 29 and 31, the contact strip 49 to connect the brushes 40 and 44 and the contact strip 50 to connect the brushes 41 and 45 (see Fig. 24). Circuits of the battery 143 are thereby closed as follows (see Fig. 24): from battery 143 through wire 144, direction coil of magnet 64, wire 145, brush 29, contact 24, brush 31, wire 147, operating wire 148, field coil 137, wire 149, series coil of magnet 126, wire 150, contact 91, brush 82, contact 84, wires 151, 152, 153, windings 124 and 125 of switch operating armature, wires 154, 155 and common wire 156 back to the battery 143. A shunt path to part of this circuit is from wire 147 through wire 167, brush 44, contact 49, brush 40, wires 166, 165, indication coil of magnet 62, wire 164, neutralizing coil of magnet 64, wires 163, 162, brush 41, contact 50, brush 45, wire 161, operating wire 160, field coil 138, wire 159, series coil of magnet 133, wire 158, contact 90, brush 81, contact 78, wires 169, 157 to winding 125, where it joins the previous

named circuit. The current in the first named circuit energizes the magnet 64 by passing through the direction coil wound thereon, energizes the switch operating motor field magnets by passing through the field coil 137, energizes the magnet 126, by passing through the series coil wound thereon and causes the motor armature to rotate by passing through the windings 124 and 125 thereon. This current in the series coil of magnet 126 is strong enough to draw the lever 129 down against the stop 128.

The current in the shunt path traced above passes through the indication coil but has no effect on the armature because it passes also through the neutralizing coil of magnet 64 in a direction to assist the current in the direction coil to energize the magnet 64. It passes through the field coil 138 in a direction to decrease the magnetism produced by the current in the coil 137, but its effect is slight because the current in this shunt path is limited to a small amount by the resistance of the indication and neutralizing coils. In passing through the series coil of the magnet 133 it energizes the said magnet sufficiently to withdraw the lever 135 from the stop 134, but not sufficiently to make the said lever contact with the stop 136. In passing through the winding 125 it assists in rotating the switch motor armature. The rotation of the switch motor armature through the mechanism previously described causes a longitudinal movement of the bar 112 and through it the movement of the rail switch. The brushes 81 and 82 also move in conjunction with the bar 112 being carried thereby. Immediately after the movement commences the brush 81 is shifted from the contact 78 to the contact 79. This, however, does not alter the status of the shunt path except to make the current pass through the winding 124 in addition. Near the end of the movement the brush 82 is shifted from the contact 84 to the contact 85 and the circuit first above named is altered so that the current enters the switch motor armature through the contact 85 and wire 157 instead of through the contact 84 and wires 151, 152 and 153 so that it passes through the winding 125 only (see Fig. 25). The shifting of the brush 82 from the contact 84 to the contact 85 is effected at about the same time that the armature is disengaged from the switch and lock movement by means of the clutch, preferably a little before this but not afterward. The operating current passing through the winding 125 only, drives the motor while the current due to the electromotive force of the winding 124, flows from the brush 92 through wire 153, contact 79, brush 81, contact 90, wire 158, series coil of magnet 133, wire 159, field coil 138, operating wire 160, wire 161, brush 45, contact 50, brush 41, wires 162, 163, neutralizing coil of magnet 64, wire 164, indication coil of magnet 62, wires 165, 166, brush 40, contact 49, brush 44, wire 167, operating wire 148, field coil 137, wire 149, series coil of magnet 126, wire 150, contact 91, brush 82, contact 85, wires 157, 95, winding 124 to brush 92. This current passes through the neutralizing and indication coils in a direction opposite to that before traced from the battery through them. The current in the neutralizing coil of magnet 64 therefore opposes that in the direction coil and as the indication current rises gradually from zero it will reach a point when its effect in the neutralizing coil exactly balances the effect of the operating current in the direction coil. When these effects are balanced the magnet 64 becomes deënergized and the magnet 62 which is energized by the indication current flowing in the indication coil, lifts the armature 61, and with it the lock, and thereby releases the lever to complete its movement. The final part of this movement withdraws the contact 24 from the brushes 29 and 31 and thus cuts off all current from the battery. The final movement also withdraws the contacts 49 and 50 from the brushes 44 and 45, respectively, and places the contact 52 so as to connect the brushes 44 and 45 (see Fig. 26). A movement in the opposite direction is exactly like that just described so that it will be unnecessary to follow it in detail.

To explain the use of the relay shown in Fig. 17: Suppose the switch 186 and its controlling apparatus to be in the normal position as shown in Fig. 15, the wire 148 would be the next operative wire, that is the next wire to be connected with the battery 143 when the switch 186 is to be moved. Now if a live wire, that is a wire connected with the high potential point of the battery 143 and to the motor of switching apparatus about to be operated, should become crossed with the wire 148, current would flow from said live wire through the cross to wire 148, thence through field coil 137, wire 149, series coil of magnet 126, wire 150, contact 91, brush 82, contact 84, wires 151, 152, 153, windings 124 and 125 of the switch motor armature, wires 154, 155, and 156 back to battery. Current would also flow from operating wire 148 through brush 39, contact 51, brush 38, wires 168, 161, operating wire 160, field coil 138, wire 159, series coil of the magnet 133, wire 158, contact 90, brush 81, contact 78, wires 169, 157, winding 125, and wires 154, 155, 156. On account of the connection between the operating wires 148 and 160 having no appreciable resistance, the current in the two paths last above named will be nearly equal and will energize both magnets 126 and 133 sufficiently to cause them to draw the levers 129 and 135 against the stop 128 and 136 respectively, which will shunt the current away from the armature

windings 124 and 125 and send it from wire 151 through contact 128, lever 129, wire 172, lever 135, stop 136 and wire 174 to wire 155. The current above mentioned which reached the winding 125 through the wire 157 is now divided, one half going by the winding 125, wires 154, 155 to the common wire, the other half going by way of the wire 95, winding 124, wires 153, 152, stop 128, lever 129, wire 172, lever 135, stop 136, wires 174, and 155 to the common wire. Thus it is seen that the path of the stray current that flowed through the two armature windings in series has been shunted entirely from them by the action of the relays, while that which passed through the winding 125 only has been divided so as to flow equally through the windings 124 and 125 in opposition, and consequently can have no effect to rotate the armature. The short circuitings of the armature windings will cause a very heavy current to flow from the live wire which is crossed with the operating wire 148, and will result in blowing the fuse in the said live wire but will have no other effect on any other part of the apparatus. If the current which reaches the motor from the crossed wire should pass to it in equal quantities through the operating wires 148 and 160 the effect toward rotating the armature would be *nil*, even without the relays, because the current in one of the field coils would neutralize the effect of that in the other, but the current in these two paths would seldom be equal or near enough to equality to depend on this for safety, on account of the resistance of the operating wires 148 and 160 themselves. Again suppose a live wire to be crossed with the operating wire 148 and that the operating wire 148 is broken at some point between the cross and the cabin, or that the operating wire 160 is broken at any point, current would then pass from the live wire to the operating wire 148 thence through the field coil 137, series coil of magnet 126, armature windings 124, and 125, thence to common return as in the preceding case. This would energize the magnet 126 causing its lever 129 to make contact with its stop 128 but since no current is flowing in the coils of the magnet 133 its lever 135 remains in contact with the stop 134 and the current is again shunted away from the armature windings flowing from the wire 151, through stop 128, lever 129, wire 172, lever 135, stop 134, wires 174 and 155 back to the common wire. In this case also the current drawn from the live wire crossed with the operating wire 148 would be so heavy as to blow the fuse in the said live wire, if properly protected by a fuse, but if not it could not cause the armature to rotate on account of its being shunted by a path of no resistance. If the wire 148 should be broken between the point at which it is crossed and the switch operating motor, or if the said live wire should be crossed with the operating wire 160 it is plain that no effect would be produced on the switch movement regardless of the relays, since the operating current passed through the operating wire 160 to move the switch and its operating mechanism in the positions shown.

Near the commencement of the generation of the indication current the series coil of one of the magnets 126 or 133 will have no current flowing in it, because the current in this circuit changes sign and must pass through zero to do so. To prevent its lever 129 or 135 as the case may be falling back against its stop 127 or 134 and so short circuiting the armature of the motor, a shunt coil is put on each of the magnets 126 and 133 connected in series with one another and the terminals of the series connected to the terminals of the motor armature winding 125. When the armature is in rotation a difference of potential is produced at the terminal of the winding 125 which causes part of the current from the battery to be diverted from the said winding 125 so as to flow from the wire 157 through wire 170, shunt coil of magnet 126, wire 173, shunt coil of magnet 133, and wire 174 to wire 155 where it joins the part flowing through the winding 125 thence through wires 155 and 156 back to battery. The current in these shunt coils thus produced holds the lever 129 or 135 while the current in the indication circuit is changing sign. It will also be observed that the current in the series coil of the magnet which has the indication and neutralizing coils in series with it rapidly decreases as the motor armature speeds up, due to the rise of potential at the brush 92, but the current in the shunt coils increases just as rapidly as the electro-motive force of the motor armature increases, so that the magnetic effect of the combined shunt and series coils remains nearly constant. When the indication current is being produced, the current in the series coil opposes that in the shunt coil, but as the armature potential must be greatly increased to produce the indication current, the current in the shunt coil is thereby greatly increased also, so that the combined effects of the two coils still remain about as before. To make the above statements clearer, I will say that, as above noted, the counter electro-motive force of a motor when running, is nearly equal to the electro-motive force of the battery or other source driving it. When the motor is driven, to move the switch rails, through both windings 124 and 125 in series, the counter electro-motive force of both windings together is nearly equal to, but a little less than, that of the battery, so that each winding has nearly half the electro-motive force of the battery. But when the motor is driven by current through the winding 125

only, the electro-motive force of each winding is nearly equal to that of the battery, or about double what it was during the movement of the switch rails. The shunt coil, however, has no effect when the motor armature is stationary as there is then no difference of potential between the brushes 94 and 96, so that the shunt coil does not interfere in any way with the protection against crosses.

At 187 and 188 are shown two switches forming a crossover between two tracks. As in all cases when one of the switches is to be moved, the other must or should be moved also, it is convenient to operate the two by means of one controlling lever. I illustrate a means for doing this, using only one controlling lever with the same circuit controllers and indication apparatus as would be used for a single switch, and with two control wires between the cabin and the nearest switch and four between the two switches. I will describe the circuits set up in reversing the switches. The lever being moved toward the reverse until stopped by the indication lock, the contact 24^a is made to connect the brush 29^a and 31^a, and the contacts 49^a and 50^a to connect the brushes 40^a and 44^a, and the brushes 41^a and 45^a respectively, when current will flow from the battery 143 through wire 144^a, direction coil of magnet 64^a, wire 145^a, brush 29^a, contact 24^a, brush 31^a, wires 147^a, 148^a, field coil 137^a, wire 149^a, series coil of magnet 126^a, wire 150^a, contact 91^a, brush 82^a, contact 84^a, wires 151^a, 152^a, 153^a, motor armature windings 124^a, 125^a, coil of the relay 139, wires 154^a, 155^a and 156 back to the battery 143. In this case as before there is a shunt path for current to flow through the indication coil of the magnet 62^a, the neutralizing coil of the magnet 64^a, and the series coil of the magnet 133^a.

The current in the above described circuit through the field coil 137^a and the armature windings 124^a and 125^a causes the rotation of the motor armature and the reversal of the switch 188. When the movement is completed (see Fig. 24), the brush 82^a is shifted from the contact 84^a to the contact 85^a and the clutch is disengaged as before described. Current then continues to flow from the contact 91^a through brush 82^a, contact 85^a, wire 177, contact 91^b, brush 82^b, contact 84^b, wire 181, field coil 137^b, wires 184, 185, armature 142, wire 179, relay lever 141, stop 140, wires 154^a, 155^a and 156 to battery 143. This current causes the rotation of the armature 142, and the reversal of the switch 187. When the movement of the switch 187 is completed (see Fig. 25) the brush 82^b is shifted from the contact 84^b to the contact 85^b thus cutting off current from the armature 142 and continuing the circuit from the contact 91^b through the brush 82^b, contact 85^b, wires 183, 180, 95^a, armature winding 125^a, coil of relay magnet 139, wires 154^a, 155^a, and 156 back to battery 143. The full potential of the battery 143 is thus applied to the winding 125^a, and causes the armature to rotate and the winding 124^a to develop the indication current, which flows from said winding 124^a through wire 153^a, contact 79^a, brush 81^a, contact 90^a, wire 158^a, series coil of magnet 133^a, wire 159^a, field coil 138^a, operating wire 160^a, wire 161^a, brush 45^a, contact 50^a, brush 41^a, wires 162^a, 163^a, neutralizing coil of magnet 64^a, wire 164^a, indication coil of magnet 62^a, wires 165^a, 166^a, brush 40^a, contact 49^a, brush 44^a, wire 167^a, operating wire 148^a, field coil 137^a, wire 149^a, series coil of magnet 126^a, wire 150^a, contact 91^a, brush 82^a, contact 85^a, wire 177, contact 91^b, brush 82^b, contact 85^b, wires 183, and 180 back to the armature winding 124^a. This indication current releases the lever to make its final movement as before described with reference to 186. It will be seen that a motor with a single armature winding is used at the switch farthest from the cabin. The indication current is developed in all cases by the armature of the motor of the switch nearest the cabin. These conditions could, however, be reversed and work equally as well.

The arrangement shown requires the least amount of wire. The same motor can be used for developing the indication current for both movements and the switches can be operated in the same order in making both the "normal" and "reverse" movements, that is, the switch 188 always moves first.

In the description of the "reverse" movement just given it has been seen that switch 188 moved first. To show that this is also true for the "normal" movement I will trace the "normal" operating circuit. For this purpose I will refer to Fig. 26 and assume that the lever has been moved to the "normal" indicating position, which would put the contact 24^a in connection with 28^a and 32^a. At the same time 47^a bridges 38^a and 42^a and 48^a bridges 39^a and 43^a. Current will then flow from battery 143 through wire 144^a, direction coil of magnet 64^a, wire 145^a, contacts 28^a, 24^a, 32^a, wires 176^a and 160^a, field coil 138^a, wire 159^a, series coil of magnet 133^a, wire 158^a, contacts 90^a, 81^a, 79^a, wire 153^a, armature winding 124^a, wire 95^a, armature winding 125^a, relay 139 and wires 154^a, 155^a and 156 back to battery. This current causes switch 188 to be operated and at the end of its movement the movable contact 81^a is removed from 79^a and is made to bridge 90^a and 78^a when the circuit is continued from 90^a through contacts 81^a, 78^a, wire 178, contacts 90^b, 81^b, 79^b, wire 182, field coil 138^b, wire 185, armature 142, wire 179, relay lever 141, stop 140, wires 154^a,

155[a] and 156 to battery. This causes the movement of switch 187 which when completed separates the contacts 81[b] and 79[b] and causes 81[b] to bridge 90[b] and 78[b]. The circuit is then continued from 90[b] through 81[b], 79[b], wires 108, 95[a], armature winding 125[a], relay coil 139 and wires 154[a], 155[a] and 156 to battery. This last circuit causes the development of the indication current as before described. The two switches are protected against crosses that might occur between the nearest switch and the cabin by the magnets 126[a], and 153[a] in the same manner as described for 186. The distant switch is guarded against crosses that might occur between the two switches by the relay 139 which controls the return branch of the circuit from the distant switch, the relay being energized only by current reaching it through either of the operating wires 148[a] or 160[a]. Normally, therefore, both the operative wire and the connection to the common wire are disconnected, so that for this switch to be effected by a stray current due to crossed wires it would be necessary that one of the above mentioned wires should be crossed with a wire leading from the high potential point of the battery at the same time that the other is crossed with another wire leading from the low potential point of the battery, a condition next to impossible to occur by accident.

The brush 81 is shifted from the contact 79 to the contact 78 near the end of the normal movement and after the lock bolt has been applied to the lock rod 123 and at the beginning of the reverse movement it is shifted back to the contact 79 before the lock bolt is withdrawn from the said lock rod 123. Likewise the brush 82 is shifted from the contact 84 to the contact 85 after the lock bolt has been applied to the lock rod in its reverse position, and at the beginning of the normal movement is replaced in contact with 84 before the lock bolt has been withdrawn, so that throughout the entire part of the movement while the switch is unlocked the two operating wires 148 and 160 lead to the brush 92, the first through the field coil 137, and the second through the field coil 138, so that if a movement in a certain direction is in progress and it is desired to change it, it can be done by shifting the lever from one indication point to the other, and through it the contact 24 from one pair of brushes, 29, 31, or 28, 32, to the other pair, and thus withdrawing the operating current from one of the field coils and causing it to flow through the other, the current, however, passing through the armature windings 124, and 125 in the same direction in either case. Current through the field coil 137 produces magnetic polarity in the field magnet opposite to that produced by current in the coil 138, so that the direction of rotation of the armature is changed by shifting the current from one of the field coils to the other.

Referring now to Figs. 18, 19, 20 and 21 instead of a mechanical clutch, I employ an electric clutch. The clutch comprises two parts 193 and 194, one of which is connected by a universal coupling 195 to the armature shaft of the motor 120 while the other is carried by the shaft 120[b]. One of the parts 193 carries a magnetizing coil 192 which is located in an annular recess provided in said part, the terminals of which coil are connected with collector rings 190 and 191. The magnetizing coil is included in the operating circuit for the motor (see Fig. 21) during the time the motor is moving the switch rails, but at the end of the movement when the operating current is supplied to the winding 125 of the armature the electric clutch releases. The current which reaches the motor in the shunt path will flow through the coil 192, but this current because of the high resistance of the indication and neutralizing coils and the high potential at the brush 92 is so weak as to have no appreciable effect on the coil 192.

I do not limit myself to the specific construction herein set forth, but may in lieu of the apparatus illustrated use the equivalents thereof, as for example, in lieu of the differential arrangement of magnets 62 and 64, I may use a polarized apparatus in which the directive or polarizing force is supplied by the operating current flowing through a coil, which is the equivalent of the direction coil herewith illustrated and the motive force is supplied by the indication current, which to be effective must have a certain direction with reference to the polarizing current. Such an arrangement is illustrated in Figs. 22 and 23. In these said figures, 197 designates a coil suitably supported from a frame 198 and having a movable core 199 pivoted at 200 and connected at its free end with the rod 58. 195 and 196 designate two magnets between adjacent poles of which the core 199 swings or vibrates. The operating current passes through coil 197 thereby polarizing the core 199 and through the magnets 195 and 196 which are included in the shunt path for the operating current in such direction as to draw down the core 199 and have the lock effective to limit the movement of the lever. The indication current when generated must, to release the lock, flow through the magnets 195 and 196 in such direction as to lift the core and with it the lock 57. The essential features of the invention in this particular being that the operating current continues to flow during the generation of the indication current and that the indication current flows through the indication motor coil in a direction opposite to that in which a current from the battery could flow through it.

I have used the terms "normal" and "re-

verse" in speaking of movements, directions and positions in the sense in which they are used by signal engineers generally in speaking of the position of a switch or signal.

I have not illustrated means for operating signals, but it will be apparent that the invention illustrated and described can with modified construction be used equally well for operating signals.

What I claim as my invention is:

1. In a railway switching apparatus, the combination of an electric motor, a clutch mechanism operated thereby, and a switch and lock movement operated by the clutch mechanism, said clutch mechanism comprising a shaft having its end portions reversely threaded, a fixed nut in which one end portion works and a second nut carried by a movable part of the switch and lock movement.

2. In a railway switching apparatus, the combination of an electric motor, a clutch mechanism operated thereby, and a switch and lock movement operated by the clutch mechanism, said clutch mechanism comprising a shaft having its end portions reversely threaded, a fixed nut, a second nut carried by a movable part of the switch and lock movement, two disks and a spur gear for alternately engaging the disks.

3. In a railway switching apparatus, the combination of an electric motor, a clutch mechanism operated thereby, and a switch and lock movement operated by the clutch mechanism, said clutch mechanism comprising a shaft having its end portions reversely threaded, a fixed nut, a second nut carried by a movable part of the switch and lock movement, two disks, a spur gear for alternately engaging said disks, and a pinion for rotating said spur gear in reverse directions.

4. In a railway switching apparatus, the combination of an electric motor, a clutch mechanism operated thereby, and a switch and lock movement operated by the clutch mechanism, said clutch mechanism comprising a shaft having its end portions reversely threaded, a fixed nut, a second nut carried by a movable part of the switch and lock movement, two disks, a spur gear for alternately engaging said disks, a pinion for reversely rotating said spur gear, and means for at times to permit of a disengagement of the spur gear from a disk.

5. In a railway switching apparatus, the combination of an electric motor, a clutch mechanism operated thereby and a switch and lock movement operated by the clutch mechanism, said clutch mechanism comprising a shaft having its end portions reversely threaded, a screw thread at its middle portion, nuts in which the end portions of the shaft work, one of which is carried by a movable part of the switch and lock movement, disks fixed to the shaft, a sheave working on the middle thread, and a spur gear rotated from the motor for rotating the sheave, and adapted to engage the disks alternately.

6. In a railway switching apparatus, the combination of an electric motor, a clutch mechanism operated thereby, and a switch and lock movement operated by the clutch mechanism, said clutch mechanism comprising a shaft having its end portions reversely threaded, a thread at its middle portion, nuts in which the end portions of the shaft work, one of which is carried by a movable part of the switch and lock movement, disks fixed to the shaft, a sheave working on the middle thread, a pinion rotated from the motor for rotating the sheave, and adapted to alternately engage said disks, and means for preventing the rotation of the sheave at times to thereby permit of a disengagement of the spur gear from a disk.

7. In a railway switching apparatus, the combination of an electric motor, a clutch mechanism operated thereby, and a switch and lock movement operated by the clutch mechanism, said clutch mechanism comprising two disks, a spur gear adapted for frictional engagement alternately with the disks and means for moving the spur gear into engagement with the disks alternately.

8. In a railway switching apparatus, the combination of an electric motor, a clutch mechanism operated thereby, and a switch and lock movement operated by the clutch mechanism, said clutch mechanism comprising two disks, a spur gear adapted for frictional engagement alternately with the disks, means for moving the spur gear into engagement with the disks alternately, and means for at times disengaging the spur gear from the disks.

9. An indicating mechanism for a lever of an interlocking machine comprising a lock and electro-magnetic means which respond, to operate the lock, to current flowing in one direction only and which direction is opposite to any current through it from a source of current not intended for the operation of the electro-magnetic means.

10. The combination with a switch operating mechanism comprising an electric motor and a source of current for the motor, of a means located at the switch for generating a current counter to current from the source, and an indication mechanism responsive to the counter current but not to the source.

11. The combination with a switch and lock movement, of a motor for operating said switch and lock movement, a means at the switch for generating an indication current, means for controlling the circuit connections to said motor and means whereby at one time it will act solely as a motor and

at another time as a motor and generator, the circuit connections, a lever for controlling said circuit connections and a lock for said lever which is operated by the generated current.

12. In combination with a railway switching apparatus comprising a switch and lock movement and an electric motor the armature of which has two windings both of which are employed when motor is operating the switch and lock movement after which one is employed for generating an indication current, a source of current for said motor, a lever for controlling the supply of current from said source to the motor, and an indicating mechanism for said lever comprising a lock and electro-magnetic means for releasing the lock which responds to the generated current.

13. In combination with a railway switching apparatus comprising a switch and lock movement and an electric motor the armature of which has two windings, both of which are employed when the motor is operating the switch and lock movement, and one of which is employed for generating an indication current after the operation of the switch and lock movement, a source of current for said motor, a lever for controlling the supply of current from said source to the motor, an indicating mechanism for said lever which is operated by the current generated by the armature winding, circuit connections between the lever and motor, and a circuit controller operated by the switching apparatus for shifting the operating current from both armature windings to one of said windings.

14. In combination with a railway switching apparatus comprising a switch and lock movement and an electric motor the armature of which has two windings both of which are employed when the motor is operating the switch and lock movement after which one is employed for generating an indication current; a source of current for said motor, a lever for controlling the supply of current from said source to the motor, an indicating mechanism for said lever which is operated by the current generated by the armature winding, circuit connections between said source of energy and motor which are controlled at one point by the lever, and a circuit controller operated by the switching apparatus for shifting the operating current from both armature windings to one of said armature windings.

15. The combination with a switch operating mechanism, of a source of current, a motor capable of generating a counter electro-motive force different from the electro-motive force of the source, means operated by the final movement of the switch mechanism for putting the motor into condition to generate its counter electro-motive force, and an indication mechanism responsive to the counter electro-motive force and not to the electro-motive force of the said source.

16. An indicating mechanism for the lever of an interlocking machine comprising a lock, an electro-magnetic means for holding the lock in engagement with the lever when the electro-magnetic means is energized in one sense and for disengaging the lock from the lever when the electro-magnetic means is energized in the opposite sense, means operated by the lever to make the lock effective to limit the movement of the lever, an electric circuit closed by the movement of the lever to energize the electro-magnetic means in the sense to make the lock effective, and means extraneous to the lever for reversing the current in the electro-magnetic means.

17. The combination with a lever of an interlocking machine, of an indicating mechanism therefor comprising electro-magnetic means which are responsive to current flowing in one direction only, a railway switching apparatus comprising an electric motor which is arranged to generate a current for the said electro-magnetic means, which current will flow through said electro-magnetic means in the direction to have it respond and opposite to any current through it from a source of current for the motor, and the source of current for said motor under the control of the lever.

18. The combination with a lever of an interlocking machine, of an indicating mechanism therefor comprising electro-magnetic means which are responsive to currents in one direction only, a railway switching apparatus comprising an electric motor, said motor being arranged to generate a current for the said electro-magnetic means which will flow through said means in the direction to have the electro-magnetic means respond and while the motor is being positively driven by an operating current, and the source of current for operating said motor under the control of the lever.

19. The combination with a lever of an interlocking machine, of an indicating mechanism therefor comprising electro-magnetic means which are responsive to current flowing in one direction only, a railway switching apparatus comprising an electric motor which is arranged to generate a current for the electro-magnetic means, while the motor is being positively driven by a current from a source of current therefor, which generated current will flow through said electro-magnetic means in the direction to have it respond and opposite to any current through it from the source of current for the motor, and the source of current for the motor under the control of the lever.

20. The combination with a railway switching apparatus, comprising a switch and lock movement and an electric motor, said motor having two armature windings both of which are used when the motor is operating the switch and lock movement, and one of which is utilized for driving the armature while the other is used for generating a current for an indicating mechanism, a lever for controlling said motor, and an indicating mechanism for said lever.

21. In combination with a railway switching apparatus, comprising an electric motor, a source of energy for said motor, a lever for controlling the supply of energy to said motor, an indicating mechanism for said lever, said indicating mechanism comprising an arc movable with the lever, a lock for engaging said arc to limit the movement of the lever, and a pair of electro-magnets, one of said electro-magnets being provided with two windings, one of which windings is in series with the winding of the other electro-magnet.

22. In combination with a railway switching apparatus comprising an electric motor, a source of energy for said motor, a lever for controlling the supply of energy to said motor, and an indicating mechanism for said lever comprising a lock and two electro-magnets, one of which electro-magnets has two windings and one of said windings being in series with the winding of the other electro-magnet, said lock being effective to limit the movement of the lever upon an initial movement of the lever, and ineffective when the magnetic effect of the electro-magnet having two windings is neutralized and the other electro-magnet energized.

23. In combination with a railway switching apparatus comprising an electric motor, a source of energy for said electric motor, a lever for controlling the supply of energy to said electric motor, and an indicating mechanism for said lever, said indicating mechanism comprising a lock and two electro-magnets, one of which electro-magnets being energized from the source of energy for the electric motor and the second electro-magnet being energized by current produced by the operation of the motor to render the lock ineffective and which current neutralizes the magnetic effect of the electro-magnet energized from the source of energy from the motor.

24. In combination with a railway switching apparatus comprising a dyna-motor, a source of energy for said dyna-motor, a lever for controlling the supply of energy from said source, and an indicating mechanism for said lever comprising a lock and two electro-magnets, one of which electro-magnets being energized from said source of energy and the second electro-magnet being energized by current produced by the motor generator to have the lock ineffective upon the neutralization by current from the dyna-motor of the magnetic effect of the first electro-magnet.

25. In combination with a railway switching apparatus comprising a motor generator, a source of energy for said motor generator, a lever for controlling the supply of energy from said source to the motor generator, and an indicating mechanism for said lever comprising a lock and two electro-magnets one of which electro-magnets has two windings and one of said windings being in series with the winding of the second electro magnet, said locking mechanism being effective to limit the movement of the lever upon an initial movement of the lever to connect the source of energy with the motor generator and to have current from said source pass through a circuit including the winding of one magnet to the motor generator in one direction and through the other winding and the winding of the other electro-magnet in series in the same direction through another circuit, and ineffective when the magnetic effect of the electro-magnet of two windings is neutralized by current generated from the motor generator and passing through the winding in series with the second electro-magnet in an opposite direction.

26. The combination with a railway switching apparatus comprising an electric motor, said motor having two armature windings both of which are used when the motor is operating the switch and lock movement, and one of which is utilized for driving the armature while the other is used for generating a current for an indicating mechanism, a source of current for said motor, a lever for controlling the supply of current to said motor, an indicating mechanism and means for shifting the operating current from both to one of said armature windings.

27. The combination with a railway switching apparatus comprising an electric motor, said motor having two armature windings, both of which are used when the motor is operating the switch and lock movement, and one of which is utilized for driving the armature while the other is used for generating a current for an indicating mechanism, a source of current for said motor, a lever for controlling the supply of current to said motor, an indicating mechanism, and means operated by the switch and lock movement for shifting the operating current from both to one of said armature windings.

28. In combination with a switch and lock movement comprising a motor, a source of current for said motor, operating circuits, a lever, a lock for said lever to limit the movement of the lever at an intermediate point in each direction and a circuit controller actuated by said lever for closing an operating circuit at an intermediate point

in one direction of movement of the lever, for breaking the operating circuit thus made upon a final movement of said lever and without again making said circuit upon a movement of the lever in an opposite direction.

29. In combination with a switch and lock movement comprising a motor, a source of energy for said motor, a lever and operating circuits for controlling the supply of energy to said motor, a lock for said lever to limit the movement of the lever at an intermediate point in each direction, and a circuit controller actuated by said lever for closing an operating circuit at an intermediate point in one direction of movement of the lever, for breaking the operating circuit thus made upon a final movement of said lever and without again making said circuit upon a movement of the lever in an opposite direction.

30. In combination with a switch and lock movement comprising a motor, a source of power for said motor, circuit connection intermediate the source of power and the motor, a circuit controller for said circuit connections, and a lever having initial, intermediate and final movements for operating said circuit controller, said circuit controller operating to close the circuit connections at the end of the intermediate movements of the lever, to break the circuit connections made upon final movement and not to again make the circuit broken upon an initial movement of the lever from a final position thereof.

31. In combination with a switch and lock movement comprising a motor, a source of current for said motor, circuit connections between the motor and source of current, a lever and a circuit controller, for controlling the circuit connections, said circuit controller comprising a pivoted carrier and means operated from the lever for rocking the carrier upon intermediate movements of the lever and other means operated from said lever upon a final movement thereof to rock the carrier to break the circuit connections made and to leave the carrier in such position ready to close another circuit connection without again closing the circuit connection previously broken.

32. A circuit controller for railway switching apparatus which includes an electric motor, comprising pairs of brushes which are included in the motor circuits, a contact strip for alternately engaging said pairs of brushes, a pivoted carrier for said contact strip, tongues carried by said carrier, a lever, a pin carried by said lever for alternately engaging said tongues to rock the carrier on its pivot, and a pair of links connected with said lever and having a loose connection with the carrier for moving said carrier to disengage the contact from either pair of brushes.

33. A circuit controller for railway switching apparatus which includes an electric motor, comprising a contact strip, two pairs of brushes with which said strip alternately engages, said brushes included in operating circuits for the motor, a pivoted carrier for carrying said contact strip, and a lever and intermediate means for rocking the carrier on its pivot.

34. A circuit controller for railway switching apparatus which includes an electric motor, comprising a contact strip, two pairs of brushes with which said strip alternately engages, said brushes included in operating circuits for the motor, a pivoted carrier for carrying said contact strip, a lever and a driver carried by said lever for rocking said carrier on its pivot.

35. A circuit controller for railway switching apparatus which includes an electric motor, comprising a contact strip, two pairs of brushes with which said strip alternately engages, said brushes included in operating circuits for the motor, a pivoted frame for carrying said contact strip, a lever, a driver provided with a pin, and pivoted tongues carried by said frame with which the pin engages.

36. A circuit controller for railway switching apparatus which includes an electric motor, comprising a contact strip, two pairs of brushes, with which said contact strip alternately engages, a lever for moving said contact strip into engagement with either pair of brushes, and means actuated by a further movement of the said lever in the same direction for separating said strips from said brushes, and for preventing the said strip from again contacting with the same pair of brushes on a reverse movement of the lever.

37. A circuit controller for railway switching apparatus which includes an electric motor, comprising a contact strip, two pairs of brushes with which said contact strip alternately engages, a lever for moving said contact strip, and means for at times moving the contact strip from either pair of brushes, said means comprising a pair of links.

38. A circuit controller for railway switching apparatus which includes an electric motor, comprising a contact strip, brushes with which the contact strip alternately engages, a pivoted carrier carrying the contact strip, a lever for rocking said carrier on its pivot through part of its movement, and means also operated upon the final movement of said lever for rocking said frame to disengage the contact strip from the brushes.

39. A circuit controller for railway switching apparatus which includes an electric motor, comprising a contact strip, brushes with which the contact strip alternately engages, a pivoted carrier carrying the contact strip, a lever for rocking said carrier on its pivot through part of its movement, and means comprising a pair of links having a

loose connection with the carrier for rocking said carrier to disengege the contact strip from the brushes.

40. The combination with a railway switching apparatus comprising an electric motor, a source of current for said motor, a plurality of circuits between said source of current supply and the motor, a lever for controlling said circuits, and electro-magnetic means provided in each circuit for controlling one or more shunt circuits around the motor.

41. The combination with a railway switching apparatus comprising an electric motor, a source of current for said motor, two circuits between said source of supply and motor having one wire in common, a lever for controlling said circuits, and electro-magnetic means provided in each circuit for controlling one or more shunt circuits around the motor.

42. The combination with a railway switching apparatus comprising an electric motor, a source of current for said motor, two relays for controlling one or more shunt circuits around the motor, each of said relays comprising two windings, an operating circuit for the motor which includes one winding of one relay and a second or shunt circuit including a winding of the other relay, the other windings of said relays being included in a circuit which includes the armature of the motor.

43. The combination with a railway switching apparatus comprising a motor, a source of current for said motor, an operating circuit for the motor, a second or shunt circuit and relays included in said circuits for controlling one or more shunt circuits around the motor, each of said relays comprising a winding which is in circuit with the armature of the motor.

44. The combination with a railway switching apparatus comprising an electric motor, a source of current for said motor, circuit connections between the motor and source of current, and electro-magnetic means included in said circuit connections for controlling one or more shunt circuits around the motor.

45. The combination with a railway switching apparatus comprising an electric motor, the armature of which is rotatable in opposite directions, a source of current supply for said motor, two circuit connections between said motor and source of supply comprising a common wire, and electro-magnetic means included in each of said circuits each of which controls a shunt circuit around the motor leading to the common wire.

46. The combination with a railway switching apparatus comprising a motor, a source of current supply for said motor, circuit connections between the source of current and motor, a lever for controlling said circuit connections at a point, an indicating mechanism for said lever comprising a lock and electro-magnetic means responsive in operating the lock to currents flowing in one direction only and other electro-magnetic means for controlling one or more shunt circuits around the motor.

47. The combination with a railway switching apparatus comprising a motor, having two armature windings both of which are used when moving the switch rails and one of which is used to generate a current for an indication mechanism after the switch rails have been moved, a source of current supply for said motor, circuit connections between the source of current supply and motor, a lever for controlling said circuit connections, the indicating mechanism comprising a lock and electro-magnetic means responsive only to the generated current to operate the lock, and a circuit controller operated by the switching apparatus for shifting the operating current from both armature windings to one of the armature windings.

48. The combination with a railway switching apparatus comprising a clutch, an electric motor, which has two armature windings one of which is used to generate a current after the switch rails have been moved, and means to render the clutch inoperative after the switch rails have been moved, of a source of current supply for the motor, circuit connections leading from the source of supply to the motor, a lever for controlling said circuit connections, an indicating mechanism for said lever comprising a lock and electro-magnetic means responsive to operate the lock only to the generated current, and a circuit controller operated by the switching apparatus to shift the operating current before the clutch is inoperative from both armature windings to one of said windings.

49. The combination with a railway switching apparatus comprising a clutch, an electric motor, which has two armature windings one of which is used after the switch rails have been moved to generate a current, and means to render the clutch inoperative after the switch rails have been moved, of a source of current supply for the motor, circuit connections leading from the source of supply to the motor, a lever for controlling said circuit connections, an indicating mechanism for said lever comprising a lock and electro-magnetic means responsive to operate the lock only to the generated current, a circuit controller operated by the switching apparatus to shift the operating current before the clutch is inoperative from both armature windings to one of said windings,

and electro-magnetic means also included in said circuit connections controlling one or more shunt circuits around the motor.

50. The combination with a pair of switching apparatuses, each comprising an electric motor, a source of current for said motors, circuits between the source of current and one of said motors, and from said motor to the other motor, a lever for controlling the first mentioned circuit connections, circuit controller operated from one motor to control the circuit connections to the other motor and electro-magnetic means provided in the first mentioned circuit connections for controlling the circuit connections between the motors.

51. The combination with a pair of switching apparatuses each comprising an electric motor, a source of current for said motors, circuit connections between the source of current and said motors and from one motor to the other, electro-magnetic means for controlling the last mentioned circuit connections which electro-magnetic means are included in the first mentioned circuit connections, and a lever for controlling the circuit connections between the source of supply and the motors.

52. The combination with a pair of switching apparatuses, each comprising a motor, the motor of one apparatus also arranged to generate a current for indicating mechanism, a source of current for both of said motors, circuit connections between the source of current and the motors, a lever for controlling said circuit comections, and an indicating mechanism for the lever, the circuit connections being such that upon a movement of the lever the motors will be operated to move the switch rails, and after the switch rails have been moved a current will be generated by one of said motors to operate the indicating mechanism.

53. The combination with a pair of switching apparatuses, each comprising a motor, one of said motors being arranged to generate a current for an indicating mechanism, a source of current for said motors, operating and indicating circuit connections, a lever for controlling said circuit connections, an indicating mechanism for the lever, a circuit controller operated by the apparatus including the motor arranged to generate a current, for controlling the operating circuit to the motor of the other apparatus, and another circuit controller operated by the last mentioned apparatus for controlling the indicating circuit connections.

54. The combination with a railway switching apparatus comprising an electric motor and a source of current for said motor, of a shunt path around said motor and electro-magnetic means for opening said shunt when the said apparatus is to be operated.

55. The combination with a railway switching apparatus comprising an electric motor and a source of current for said motor, of a shunt around said motor, a circuit controller in said shunt and electro-magnetic means for operating said circuit controller to open said shunt when the said apparatus is to be operated.

56. The combination with a railway switching apparatus comprising an electric motor, a source of current for said motor and two operating circuits connecting said motor and said source, of a safety device comprising a shunt around said motor to prevent current flowing through said motor and electro-magnetic means for opening said shunt at proper times; said electro-magnetic means being included in said circuits and requiring current in both of said circuits to render it operative to open said shunt.

57. The combination with a railway switching apparatus comprising an electric motor, a source of current for said motor and two operating circuits connecting said motor and said source, of a safety device comprising a shunt around said motor to prevent current flowing through said motor and means for opening said shunt at proper times, said means comprising circuit controllers included in said shunt, an electromagnet in each of said circuits for operating said circuit controllers and a resistance in one of said circuits to limit the current to less than the minimum required to operate said motor.

58. The combination with a switch operating mechanism comprising an electric motor and a source of current for the motor, a means at the switch for generating a current counter to the current from said source, a lever and circuit connections between the source of electric motor and said means, and an indicating mechanism for said lever responsive to the counter current, but not to current from the source.

In testimony whereof I have signed my name to this specification in the presence of two subscribed witnesses.

JOHN D. TAYLOR.

Witnesses:
GEO. E. CRUSE,
A. HERMAN WEGNER.