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A. L. DE LEEUW.

SYSTEM FOR CONTROLLING RAILWAY TRAINS.

No. 546,308. Patented Sept. 17, 1895.

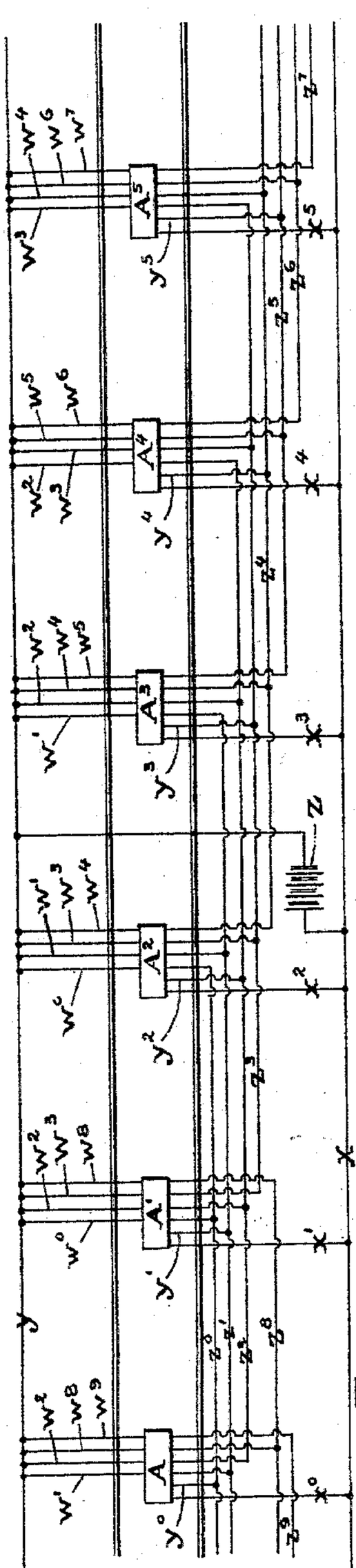

Fig. 1.

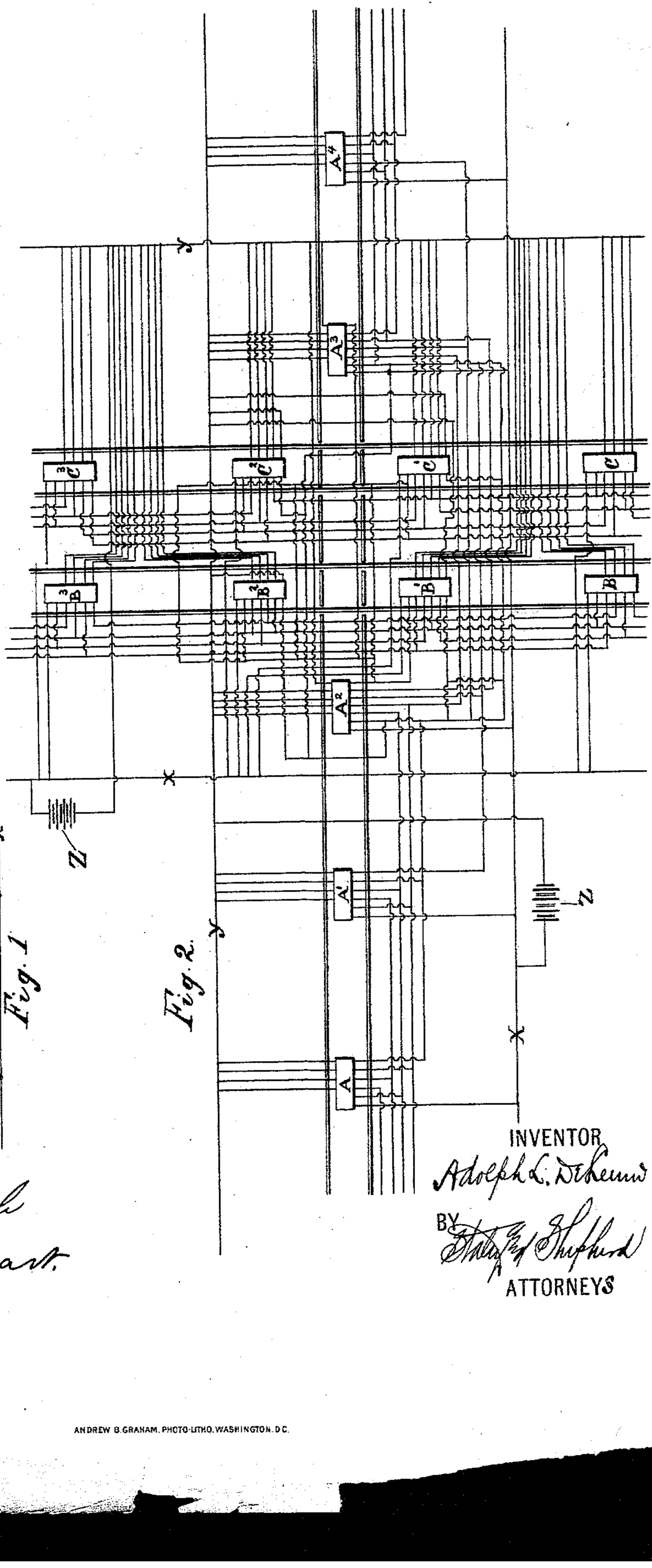

Fig. 2.

WITNESSES:

Chas. I. Welch

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INVENTOR

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BY Dickerson & Shepherd

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A. L. DE LEEUW.

SYSTEM FOR CONTROLLING RAILWAY TRAINS.

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Fig. 5.

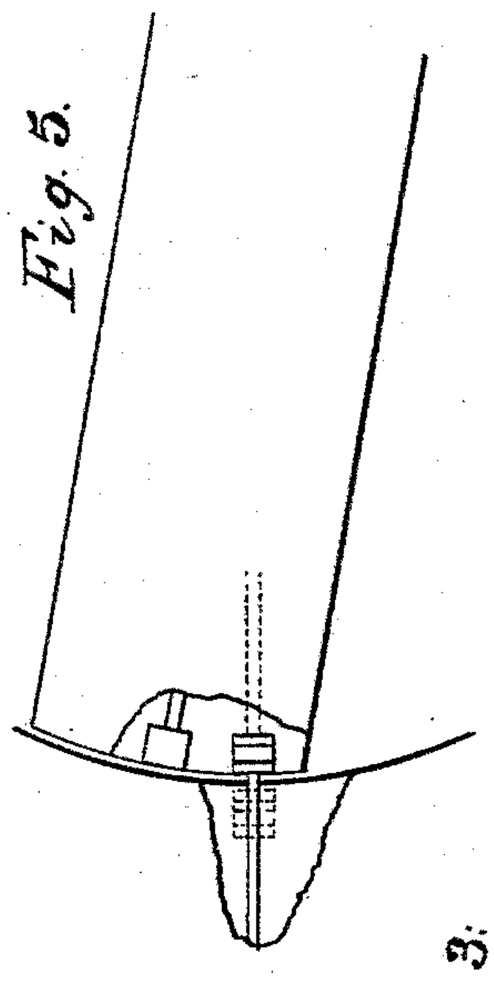
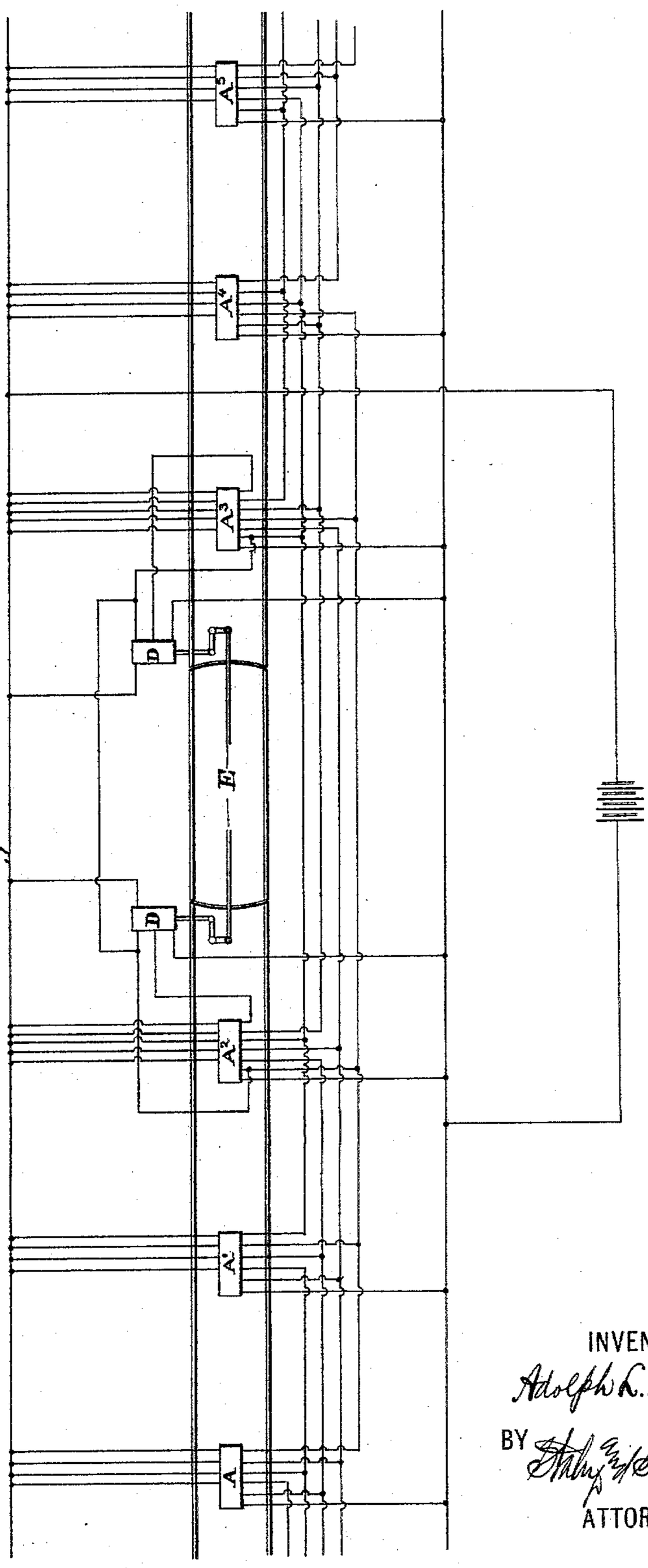


Fig. 4.

Fig. 3.



WITNESSES:

Chas. I. Welch

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A. L. DE LEEUW.

SYSTEM FOR CONTROLLING RAILWAY TRAINS.

No. 546,308. Patented Sept. 17, 1895.

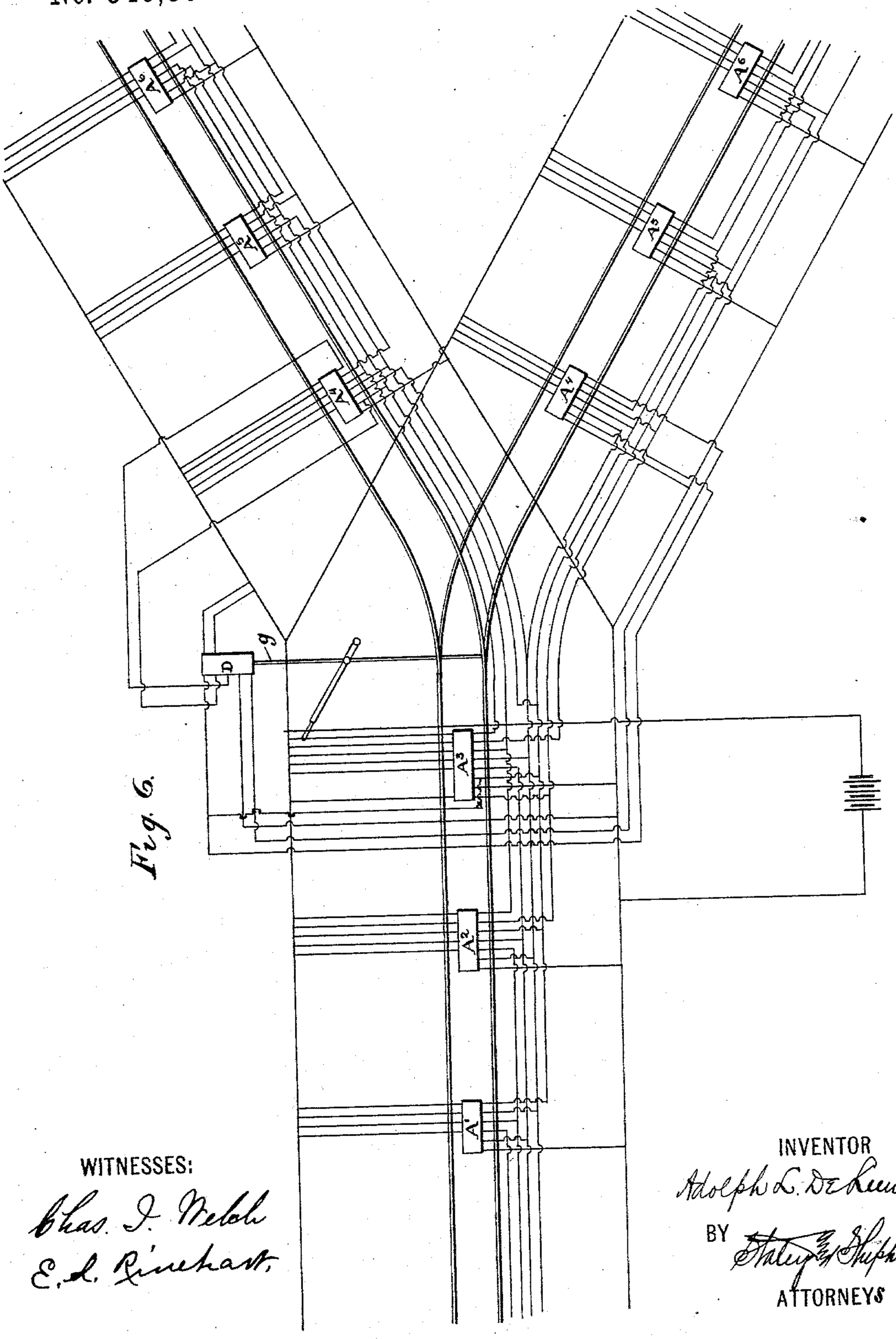

Fig. 6.

WITNESSES:

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A. L. DE LEEUW.

SYSTEM FOR CONTROLLING RAILWAY TRAINS.

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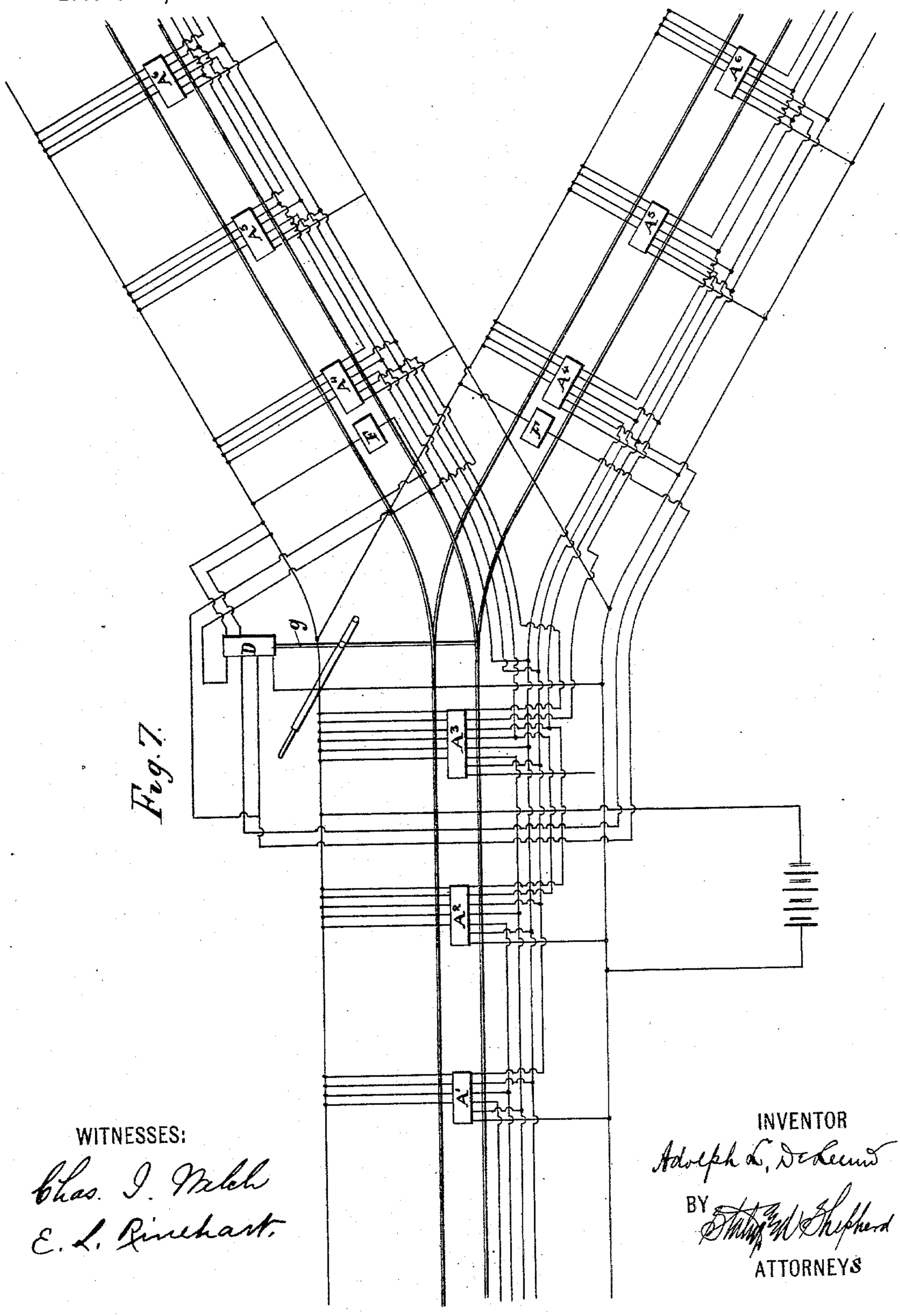

Fig. 7.

WITNESSES:

Chas. I. Mich

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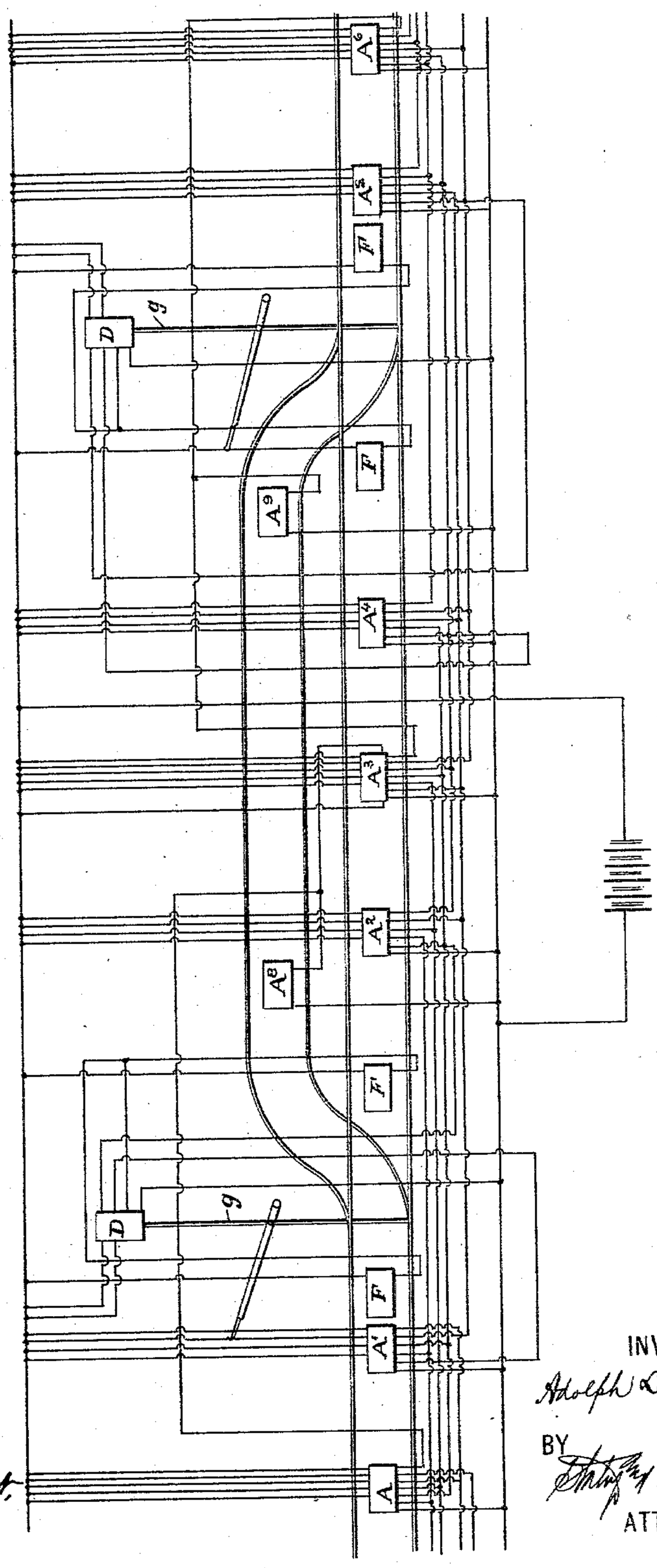
A. L. DE LEEUW.

SYSTEM FOR CONTROLLING RAILWAY TRAINS.

No. 546,308. Patented Sept. 17, 1895.

Fig. 8.



WITNESSES:

Chas. I. Welch

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A. L. DE LEEUW.

SYSTEM FOR CONTROLLING RAILWAY TRAINS.

No. 546,308. Patented Sept. 17, 1895.

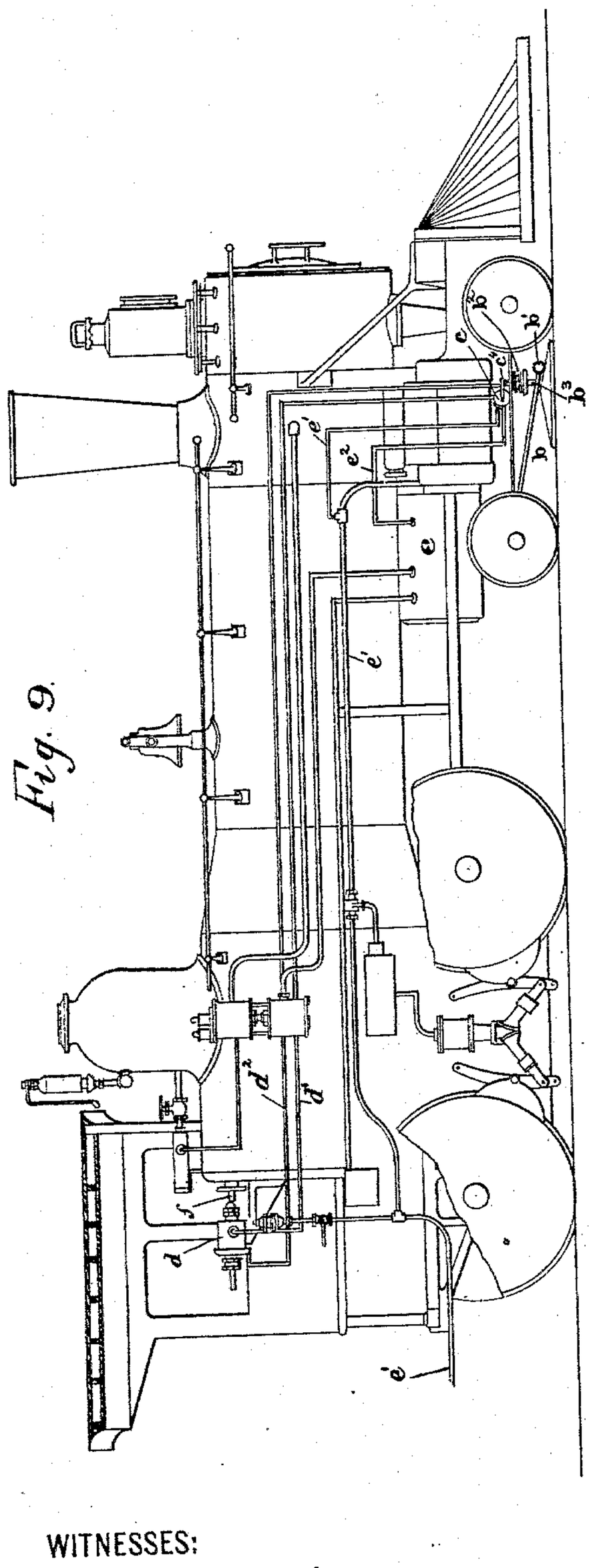

Fig. 9.

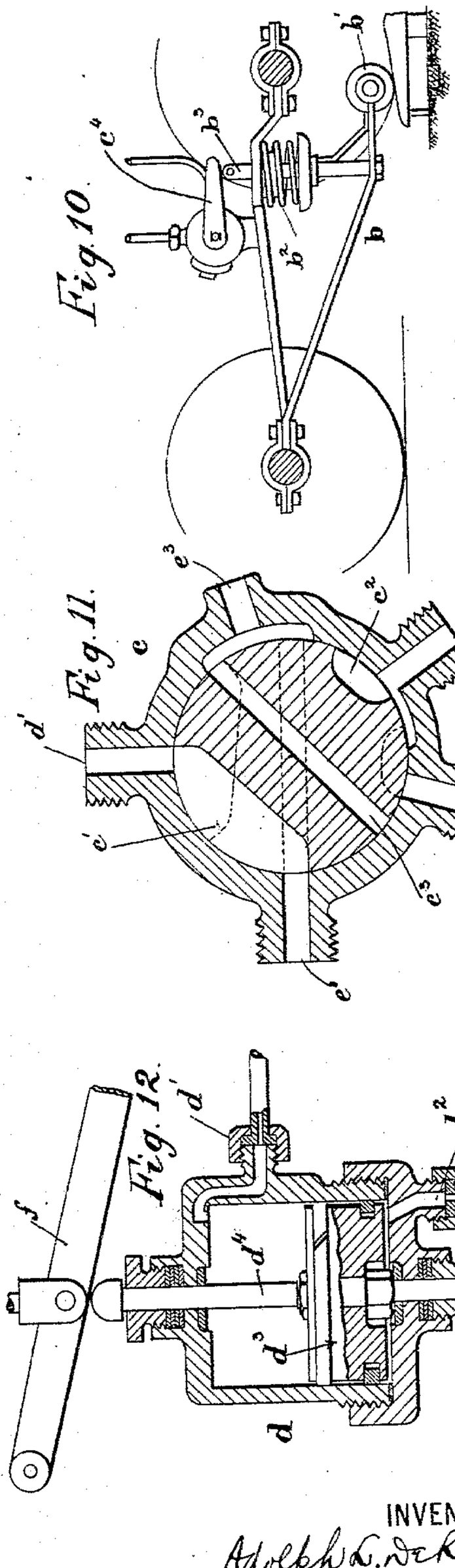

Fig. 10.

Fig. 11.

Fig. 12.

WITNESSES:

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SYSTEM FOR CONTROLLING RAILWAY TRAINS.

No. 546,308. Patented Sept. 17, 1895.

Fig. 13.

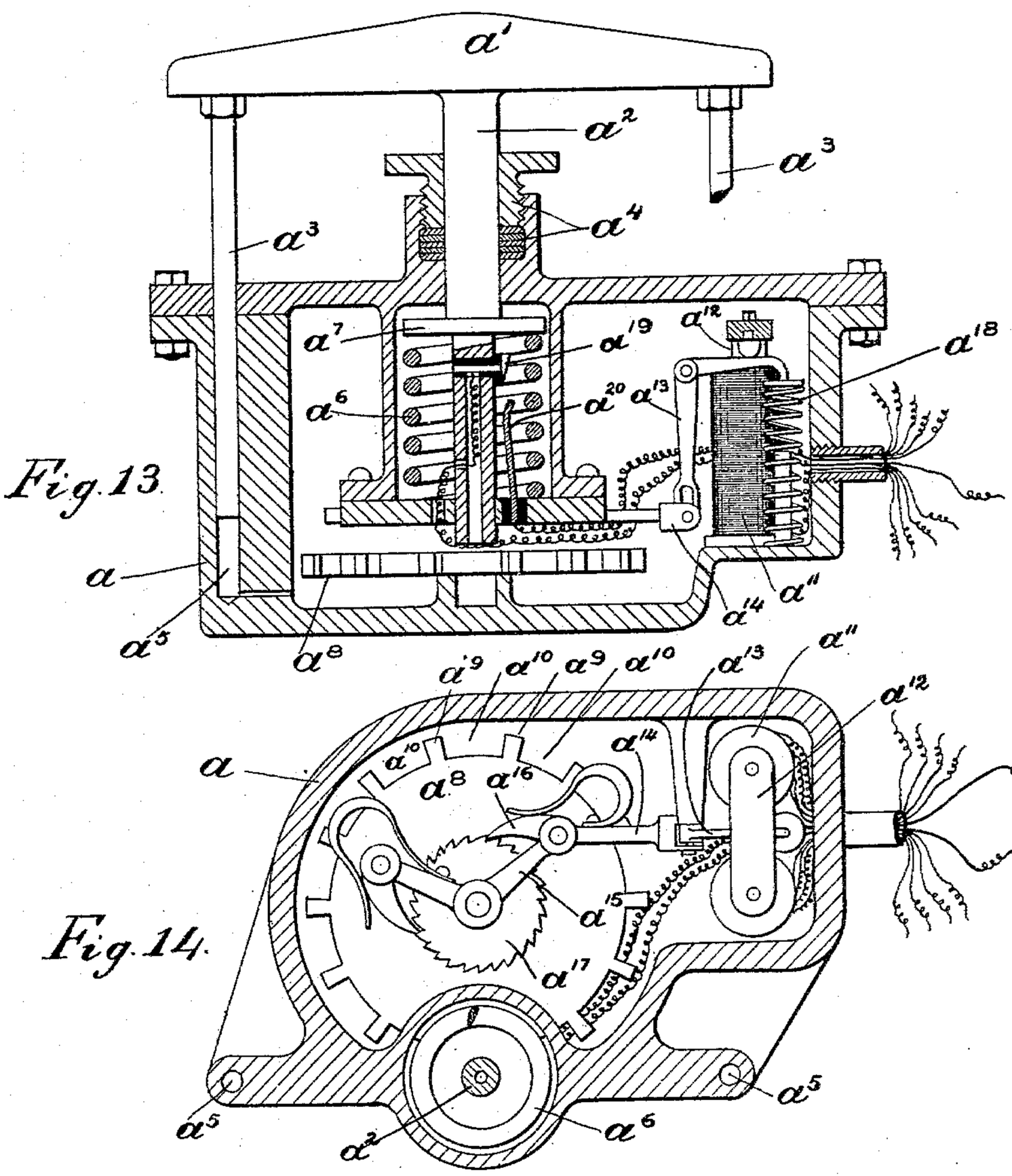
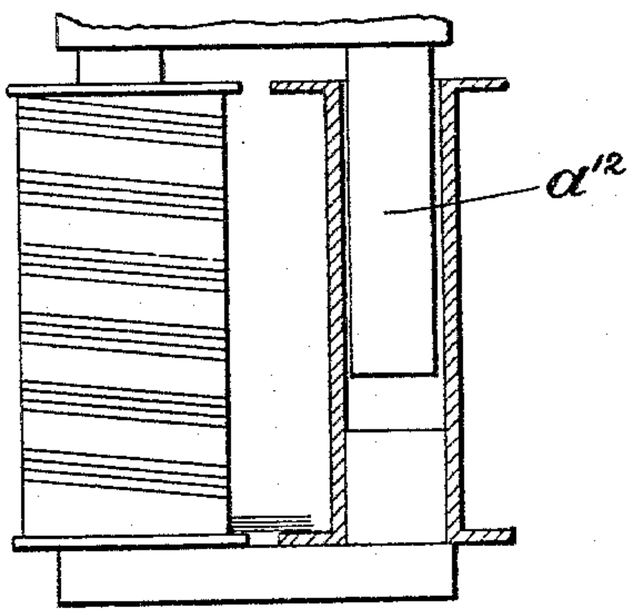


Fig. 14.

Fig. 15.



Witnesses
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By his Attorneys
Church & Church & Shepherd

(No Model.) 11 Sheets—Sheet 8.

A. L. DE LEEUW.

SYSTEM FOR CONTROLLING RAILWAY TRAINS.

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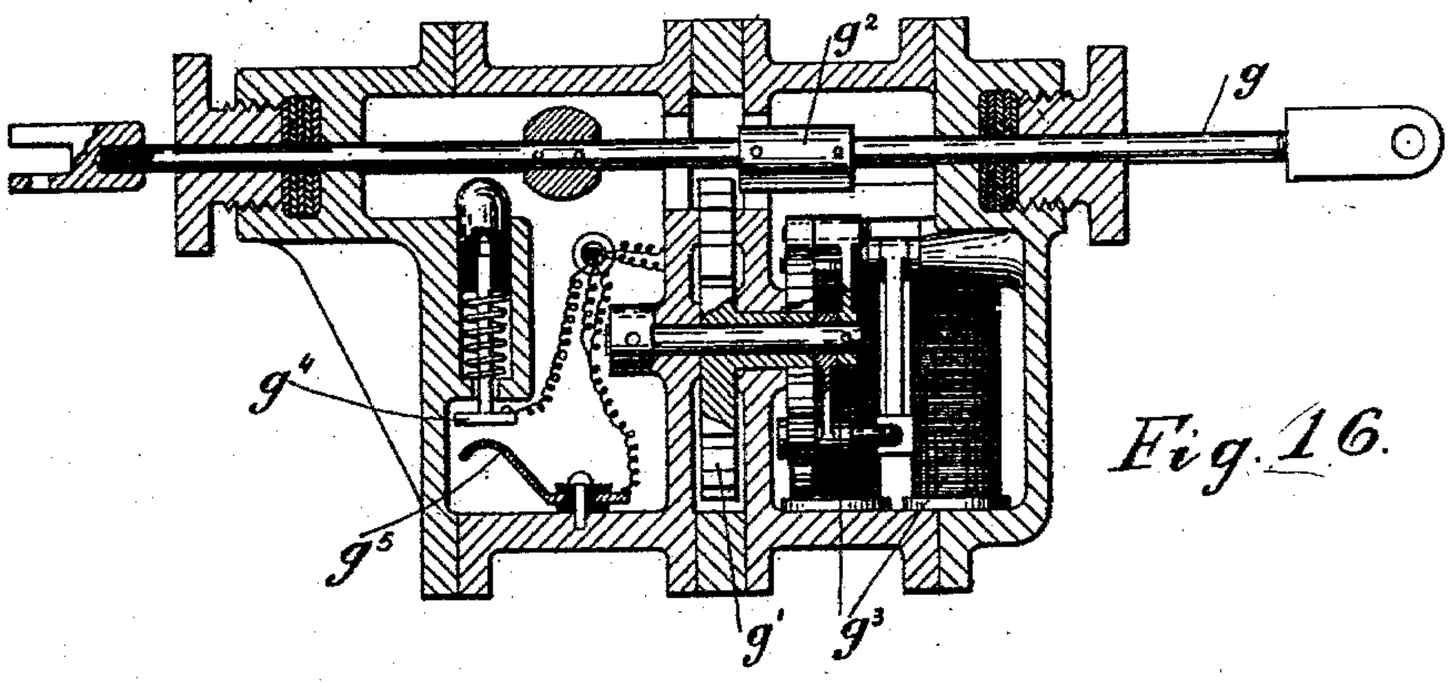

Fig. 16.

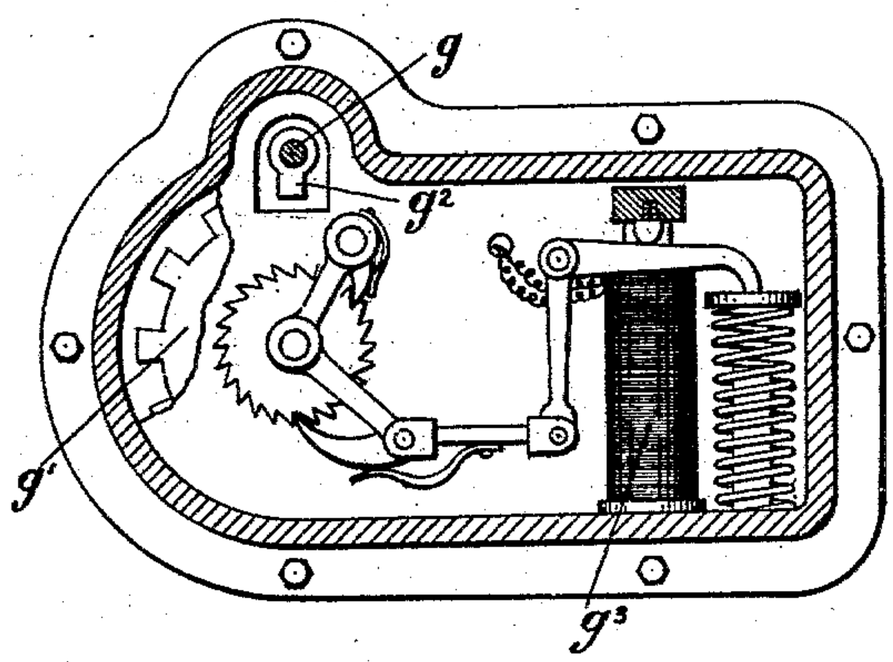

Fig. 17.

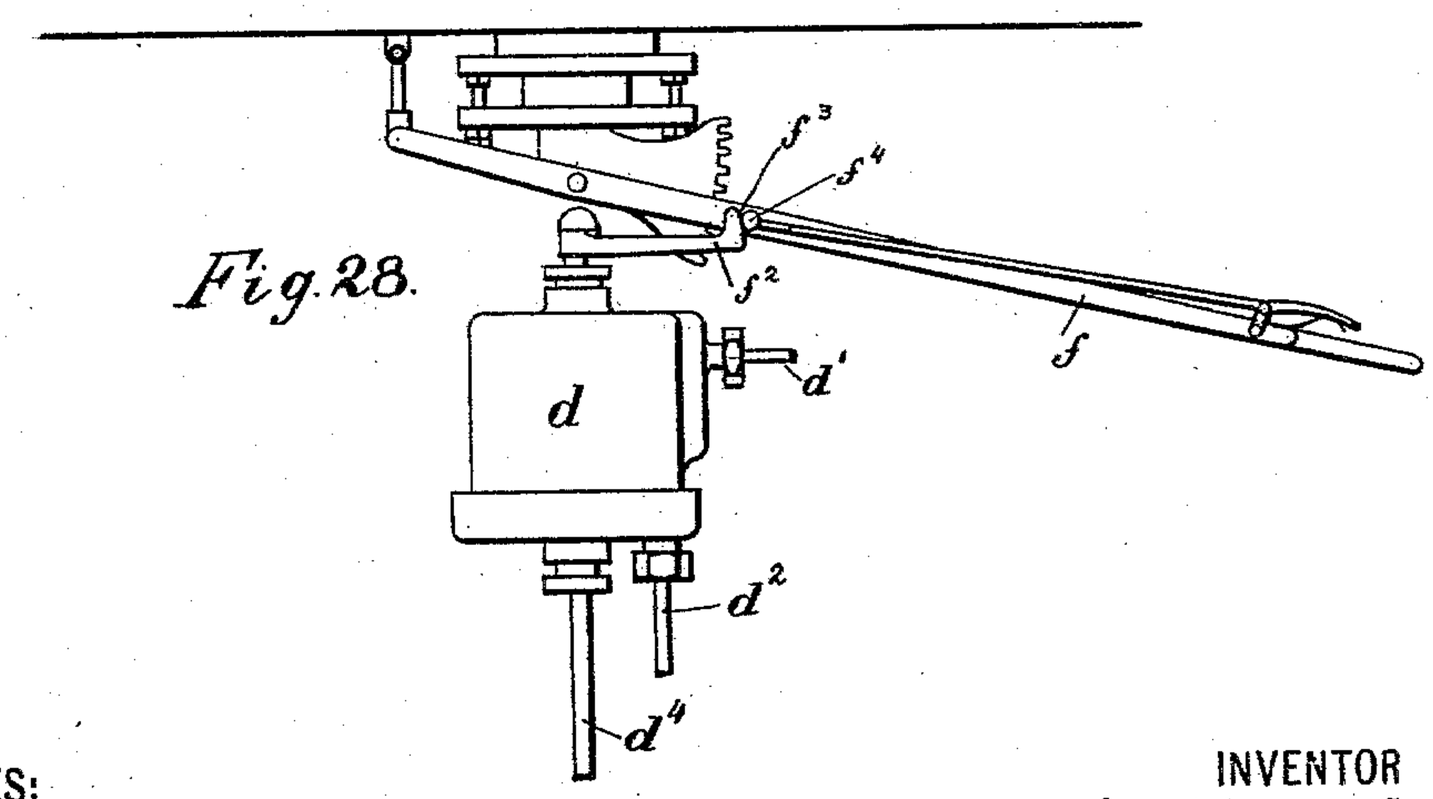

Fig. 28.

WITNESSES:

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A. L. DE LEEUW.

SYSTEM FOR CONTROLLING RAILWAY TRAINS.

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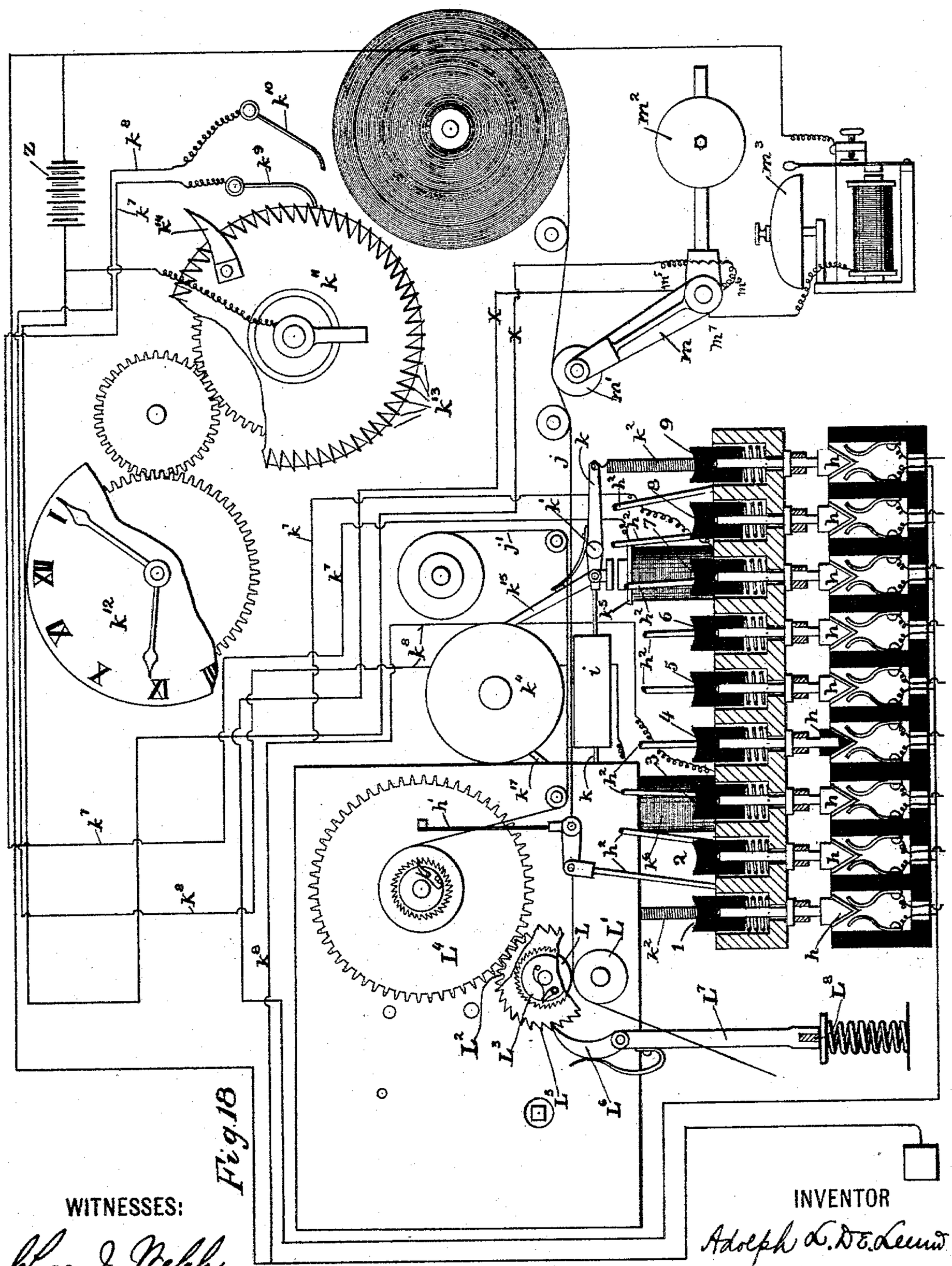

Fig. 18

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SYSTEM FOR CONTROLLING RAILWAY TRAINS.

No. 546,308. Patented Sept. 17, 1895.

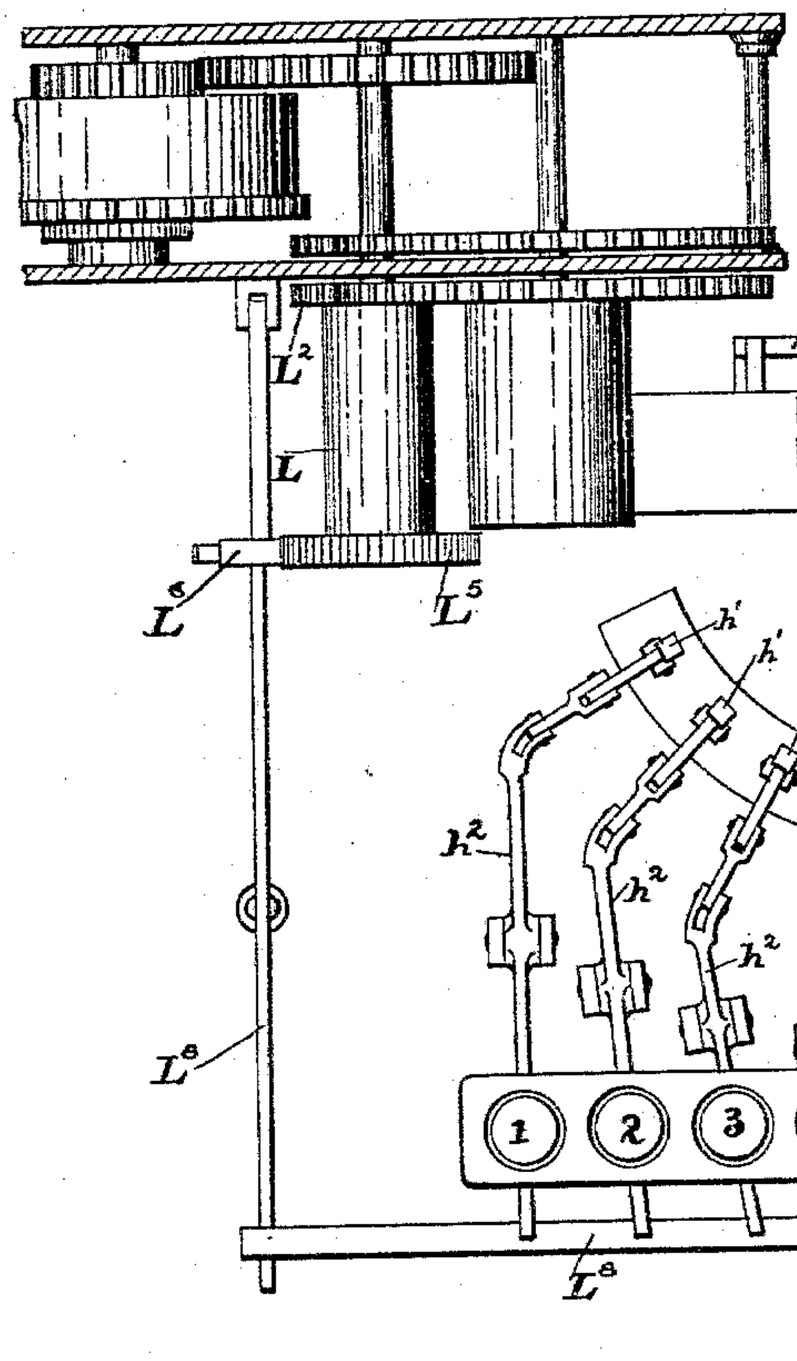


Fig. 19.

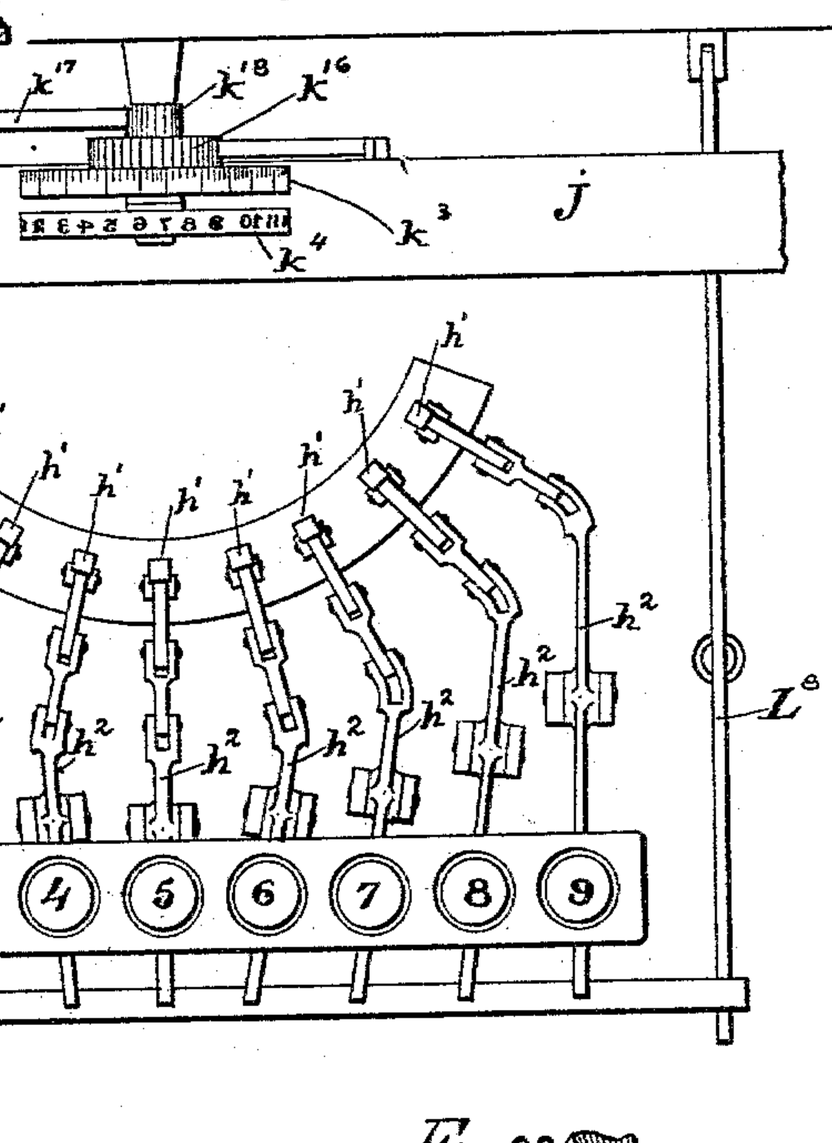


Fig. 20.

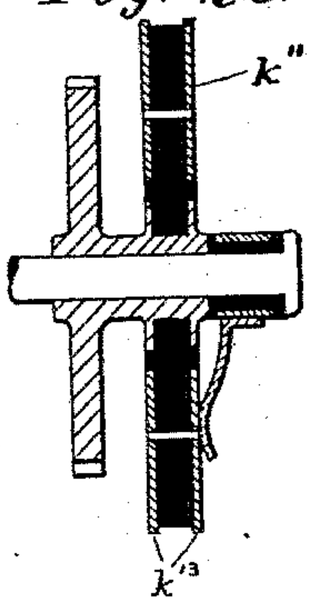


Fig. 21.

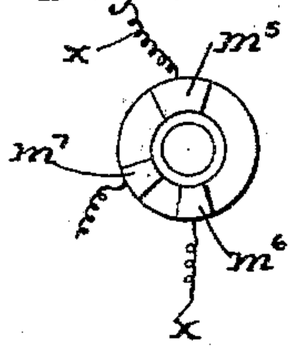


Fig. 22.

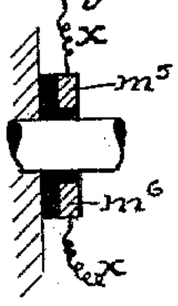


Fig. 23.

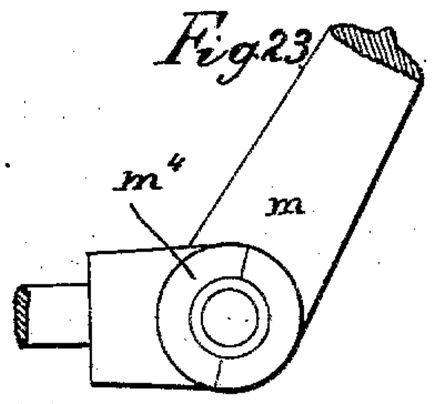
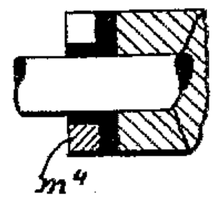


Fig. 24.



WITNESSES:

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A. L. DE LEEUW.

SYSTEM FOR CONTROLLING RAILWAY TRAINS.

No. 546,308. Patented Sept. 17, 1895.

Fig. 25.

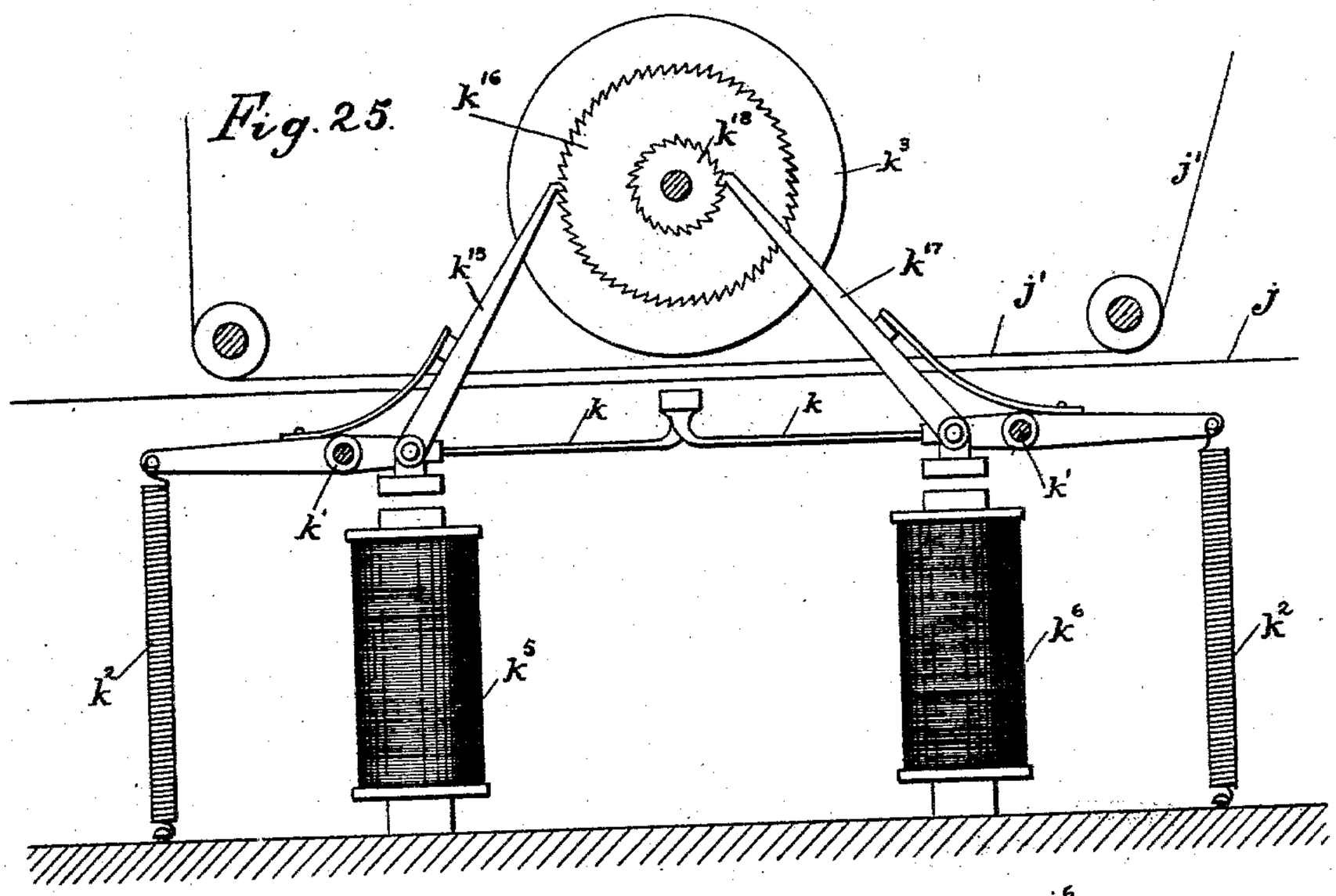


Fig. 26.

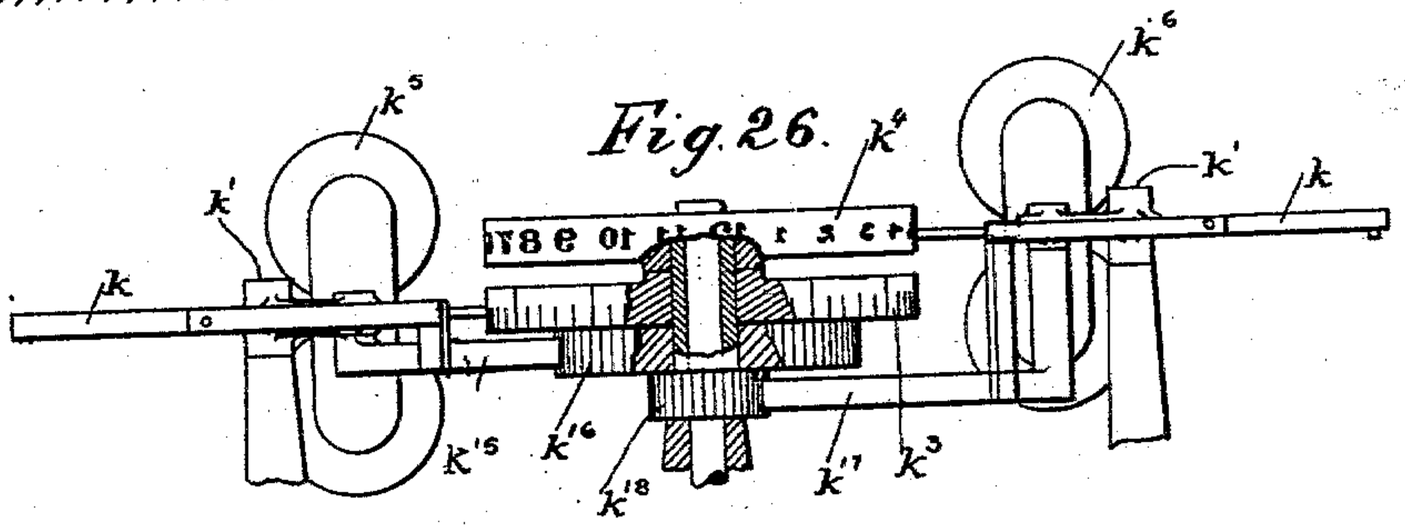
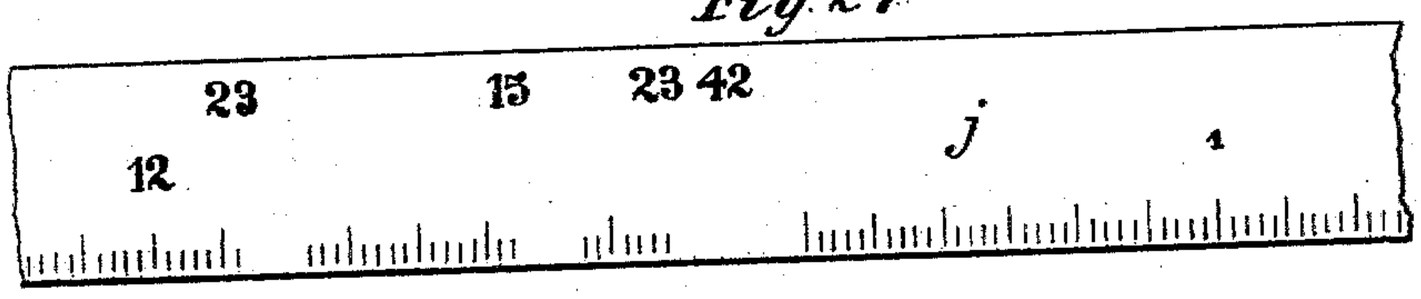


Fig. 27.



WITNESSES:

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ATTORNEYS.

UNITED STATES PATENT OFFICE.

ADOLPH L. DE LEEUW, OF SPRINGFIELD, OHIO, ASSIGNOR OF ONE-THIRD TO PHILIP E. MONTANUS, OF SAME PLACE.

SYSTEM FOR CONTROLLING RAILWAY-TRAINS.

SPECIFICATION forming part of Letters Patent No. 546,308, dated September 17, 1895.

Application filed January 25, 1894. Serial No. 498,060. (No model.)

To all whom it may concern:

Be it known that I, ADOLPH L. DE LEEUW, a subject of the Queen of Holland, (but having made oath of my intention to become a citizen of the United States,) residing at Springfield, in the county of Clark and State of Ohio, have invented certain new and useful Improvements in Systems for Controlling Railway-Trains, of which the following is a specification.

My invention relates to a system for automatically controlling railway-trains.

The object of this invention is to provide a system by which accidents of the most common and destructive character on railways may be absolutely prevented, the primary feature of the invention being found in the fact that under certain conditions which are likely to lead to accidents of a serious nature the control of the train ceases to be dependent upon human agency, the devices employed in the system being of such a nature that the controlling mechanism of the locomotive attached to a moving train is positively and automatically operated to stop the train by mechanical devices forming a part of the system, as will hereinafter more fully appear.

A further object of the invention is to provide means by which at certain central stations the operation of the automatic devices may be controlled when under the existing conditions of said automatic devices they would prevent the trains from approaching said central station.

A further object of the invention is to provide means for registering each movement of the operator at the central station, which has for its feature the changing of the normal condition of the automatic mechanism which would normally effect the stoppage of the train, the registering mechanism being also adapted to register the exact time at which the operation takes place.

In carrying out my invention I equip the road throughout at intervals with certain peculiarly-constructed devices, which under certain conditions are adapted as a locomotive passes over the same to set into operation mechanism carried by the locomotive which shall shut off the steam supplied to the engine and set the brakes on the train, this mechanism being so arranged as to be completely out of the control of the engineer or any trainman. These respective devices are connected electrically one with the other in such a way that if the track is clear the locomotive passes over in the normal way; but in the event of a train on the same track within a certain distance, either in the front or rear of the moving train, then either or both of said trains will by the operation of the devices composing the system automatically be brought to a standstill. The same system also includes in its application the operation of drawbridges, switches, or other devices of similar character, which under abnormal conditions would lead to serious accidents, so that in the event that a bridge or switch is open or any other similar abnormal condition exists in the track, then the mechanical devices of the system will positively stop the train, these devices being independent of the operation of signals or the manipulation of devices by human agency, other than to see that the devices are in proper repair and working condition.

In the accompanying drawings, Figure 1 is a diagrammatic view of a single line of railway-track equipped with my improved automatic devices. Fig. 2 is a similar view of the same, showing the method of equipping and connecting the devices at a railway-crossing, a line of double track being illustrated as crossing a line of single track. Fig. 3 is a diagrammatic view showing similar connections in a single line of track crossing a drawbridge, Figs. 4 and 5 being details of the same. Fig. 6 is a diagrammatic view illustrating the connections of a single line of railway-track branched into two branches. Fig. 7 is a diagrammatic view of the same, showing a modification. Fig. 8 is a diagrammatic view showing a single line of track having a side track connected thereto. Fig. 9 is an elevation of a locomotive, showing the equipment necessary to carry out the system as applied thereto. Figs. 10, 11, and 12 are detailed views of portions of the same. Figs. 13, 14, and 15 are detailed views of the devices which are arranged in the track. Figs. 16 and 17 are detailed views of similar apparatus modified for

use at switches, drawbridges, and for similar purposes. Fig. 18 is a diagrammatic view of a central station equipped with devices and apparatus for controlling, under certain conditions, the automatic portions of the system. Figs. 19 to 27, inclusive, are details of the same. Fig. 28 is a detail of the throttle-valve mechanism.

Like parts are represented by similar letters and figures of reference throughout the several views.

In carrying out my invention I equip the entire line of road to which the system is to be applied with what I term "locking-boxes" A A' A^2 A^3, &c., these boxes being placed, preferably, between the rails and at any suitable interval apart—as, for example, at each half-mile of track—the distance at which they are located apart being determined by the exigencies of the road to be equipped. These locking-boxes A each contain a combination of electrical and mechanical devices adapted as a locomotive passes over the same to contact with an attachment on said locomotive, the contact under a normal condition producing a yielding movement of the upper part of each locking-box, this yielding movement being adapted to produce electrically a change in the mechanical connections of the preceding and succeeding boxes, this mechanical change being such as will lock the upper portion of the box and prevent its yielding when brought into contact with the locomotive attachment, the result being that a yielding movement of the locomotive attachment will be produced, which through suitable mechanical devices will effect the stopping of the motive power and the application of the brake-power to the train to which said motive power is attached. Electrical connections may be established, so that any suitable number of boxes in front and in the rear of the one operated may be affected thereby, the plan which I have illustrated as exemplifying my system being to connect electrically each locking-box with four other locking-boxes, the boxes being adapted in the operation of the system and by the passing over the same of a locomotive to be alternately locked and unlocked.

In Fig. 1 the boxes are illustrated in diagram, each of said boxes being connected electrically and in multiple arc to a battery or other suitable source of electric supply z through line-wires x and y. Each of said boxes consists of an outer casing a and an upper movable platen a', supported on a central plunger-rod a^2 and having at each end guide-rods a^3. This plunger-rod a^2 passes into the interior of the outer casing a, preferably through an ordinary gland or stuffing-box a^4, to insure the tight closing of the interior of said casing, the guide-rods a^3 being adapted to operate in suitable guiding portions a^5 formed on the side of said casing. The platen a' is normally supported by a spring a^6, one end of which rests against the bottom of the outer casing and the other against a collar a^7 on the rod a^2, this spring being adapted to yield under a certain definite pressure, say from three hundred to four hundred pounds, applied to the the platen a'.

Below and at one side of the plunger a^2 is a revolving disk a^8, having on its periphery a series of teeth a^9, alternating with a series of spaces a^{10}. This disk a^8 is so located that the spaces and teeth a^9 and a^{10} are adapted to successively come opposite and below the lower end of the plunger-rod a^2, the construction being such that when a space is below said plunger-rod the platen a' is free to move downwardly against the pressure of the spring a^7, and when a tooth a^9 is under said plunger-rod the platen is held rigidly against the downward movement.

Each of the boxes is further provided with an electromagnet or solenoid a^{11}, the armature a^{12} of which is connected through a bell-crank lever a^{13} to a push-rod a^{14}, the opposite end of which is connected to a pivoted frame a^{15}, carrying a pawl a^{16}, adapted to engage in the teeth of a ratchet-wheel a^{17}, connected to the disk a^8 in such a manner that the reciprocation of the push-rod a^{14} produces a partial revolution of the disk a^8. The solenoids a^{11} are each formed with a multiple winding—that is to say, a number of separate and independent wires are wrapped together and around a core in such a manner that an electric current through either of said wires will serve to magnetize the core and produce a movement of the solenoid. A spring a^{18} is adapted to operate in opposition to the movement of the solenoid and serve to return the parts connected thereto to their normal positions when the core of said solenoid is demagnetized.

The plunger-rod a^2 is provided with an insulated metallic contacting-face a^{19}, adapted as the plunger is moved downwardly to contact with an insulated metallic plate a^{20}, preferably in the form of a spring, so as to establish an electrical connection from said metallic face to said metallic plate. These metallic parts a^{19} and a^{20} are included in an electrical circuit with line-wires x and y, the connections from said line-wires to the respective boxes being indicated by x^0 x' x^2 y^0 y' y^2, &c. The connection between one of the contacting parts of each box is made direct to the battery-line x, as indicated, the other contacting-point of each box being connected, through the medium of the conductors y^0 y', &c., to auxiliary conductors z^0 z' z^2, &c., which extend in opposite directions from the box containing the contacting devices, so as to include one or more locking-boxes on each side of the locking-box containing the contacting devices. From these auxiliary lines z^0 z', &c., connections are established through the conductors w^0 w' w^2, &c., to the other battery-line y, one of the multiple windings of each of the solenoids being included in the circuit with these respective conductors w^0 w'

w^2, &c. The result of this construction is that each time the platen of one of the locking-boxes is depressed an electric connection is established from the battery or other source of supply through the solenoids of a series of boxes arranged on opposite sides of the box operated, the connections in the diagram which I have used to illustrate my system being such as will establish such an electrical connection through four boxes, two of which are in front and two in the rear of the box operated. Each time an electric current passes through one of the solenoids an impulse is given to its core, which, through the medium of the connections described, produces a partial revolution of the disk contained in the box, so as to bring either a tooth or a space under the plunger of said box. Now, in the practical operation of the system, the first box from the terminal station from which the train is to be started is unlocked and the second box is locked. For instance, in Fig. 1, a train starting passes first over box A, which is unlocked. The next box A′, however, is locked before the train starts, the remaining boxes in the series being unlocked. As the train passes the box A an electric impulse is sent through the solenoids of the boxes A′ A^2, which, through the mechanism described, results in unlocking the box A′ and locking the box A^2. The box A′ is thus put into condition to permit the locomotive to pass over the same while the box A^2 is locked. In passing over the box A′ the electrical impulse produced by the depression of the platen of said box unlocks the box A^2 and locks boxes A and A^3. In passing over A^2 the electrical impulse unlocks boxes A and A^3 and locks A′ and A^4, and so on through the series. The electrical impulse caused by the depression of the plunger in the box over which the locomotive is passing being directed through four boxes, two of which are at the front and two at the rear, results in the locking of two of said boxes and the unlocking of the other two boxes, one of the boxes thus locked and unlocked being at the front and the other at the rear of the operating box.

The upper part of the platen a' of each box is beveled from each side toward the center, with the highest point thereof at the center. Upon each locomotive which operates in the system I employ a yielding contacting device b, preferably supplied with a roller b', arranged in line with and adapted to contact with the respective platens of the locking-boxes. This yielding support b' is supplied with a spring b^2, which is adapted to yield under a pressure five or six times greater than the pressure necessary to compress the spring a^6 in the locking-box—say, for instance, under a pressure of eighteen hundred pounds. Now, if the locking-box over which the locomotive passes is unlocked, the yielding support b' on the said locomotive produces a yielding movement of the platen of said box, with the result hereinbefore mentioned. If, however, the platen of said box should be locked, as before described, then a yielding movement of the support b' will be produced, which, through the mechanism and connections herein to be described, will result in shutting off the motive power and applying the brakes to the locomotive and the train connected thereto. For carrying out this part of my invention I preferably employ pneumatic pressure obtained from the ordinary pump and reservoir used in all locomotives of a modern type to operate the brakes, and I accomplish this by the employment of peculiar and novel connections in connection with a valve, which is adapted under certain abnormal conditions to establish a communication from the train-pipe which supplies the brakes to the atmosphere, thus exhausting said train-pipe and applying the brakes in the usual manner, the said valve being further provided with a construction and connections which will at the same time establish a communication from the air-reservoir to an auxiliary cylinder arranged in proximity to and in connection with the throttle-lever in such a manner as to positively close the throttle-valve and thus shut off the steam from the engine-cylinders.

The constructions which I have illustrated for carrying out this part of my invention are shown in Figs. 9 to 12, inclusive, and Fig. 28. In these figures, c represents the valve; d, the auxiliary cylinder; e, the air-reservoir, connected to the usual engineer's valve for controlling the supply from the reservoir e to the train-pipe and thus operating the brakes in the usual manner, and f the throttle-valve lever. I provide the cylinder d with connections d' and d^2 at each end thereof and on opposite sides of a piston d^3, having a piston-rod d^4, which is adapted to contact with the throttle-valve or valve-lever f. In order that the piston d^3 shall remain wholly inactive under normal conditions and out of contact with the throttle-lever f, I establish a communication through the connection d' to the train-pipe e'. This communication being established through a port c' in the valve c, the pressure in the train-pipe is thus normally supplied through the connection d' to the cylinder d, so as to hold the piston d^3 at one end of the cylinder and out of contact with the throttle-lever f. The connection d^2 from the opposite end of the cylinder is normally in communication with a port c^2 in the valve c, a connection being established from the reservoir e to the valve c through the pipe e^2, which is normally closed by said valve. The valve c is further provided with a port c^3, which extends through the valve and is normally in communication with the atmosphere through an opening e^3. Now the valve c is so constructed that a partial revolution thereof, bringing the respective ports to the position indicated in dotted lines in Fig. 11, accomplishes the following results: The train-pipe e' is brought into communication with the port

c^3, so as to establish a direct communication through said port from said train-pipe to the atmosphere. The port c' establishes a communication, through the connection d', from the front end of the cylinder d to the atmosphere. The port c^2 establishes a communition, through the connections e^2 and d^2, from the reservoir e to the rear end of the cylinder d. The exhausting of the train-pipe thus produced sets the brakes. The exhausting of the front end of the cylinder d and applying air-pressure at the rear end thereof produces a forward movement of the plunger which positively closes the throttle-valve, the constructions being such that these operations are positively performed and cannot be interfered with by operatives in the locomotive-cab. A connection is established through the plunger b^3 to a handle c^4 on the valve c, so that an upward movement of the yielding arm or support b' produces the necessary movement of the valve to accomplish the function before described. The connection between the plunger-rod b^3 and the crank-arm c^4 of the valve c is a loose connection, so that the valve c is moved by the upward movement of the plunger-rod, but remains in this position as the plunger-rod returns to its normal position, so that after the operation of setting the brakes and closing the throttle-valve is performed these parts cannot be returned to their normal condition until the valve c is operated by human agency. This valve c is preferably located under the locomotive, near the front thereof, and entirely out of reach of any person located on the locomotive, so that it becomes necessary, in order to place the train in its normal condition, that the valve c be returned to its normal position by some one not at the time on the locomotive or the train attached thereto. It will be seen, now, from the above description, that it becomes impossible for a locomotive, attached to a train or otherwise, to pass over a locking-box which is locked at the time of passing without automatically stopping the said locomotive and train. Referring again to Fig. 1, and assuming a train passing from box A to box A^2 and another train passing in the opposite direction from box A^5 to box A^4, if the first-mentioned train reaches box A^3 prior to the time the second train reaches A^4, the operation of the box A^2 will lock the box A^4 and stop the second train at A^4. The passing of the second train over box A^5 has locked box A^3, so that the first train cannot pass A^3, and thus the possibility of the trains approaching each other to any dangerous degree is absolutely prevented. The same would be true if the trains were moving in the same direction. Assuming that the second train was passing from A^4 to A^5, the passing over of box A^4 locks A^3 and prevents the first train from passing box A^3 until the second train has passed A^5, thus unlocking box A^3 and locking box A^4.

In a crossing, such as indicated in Fig. 2, in addition to the connections so far described to the locking-boxes, I construct the locking-boxes immediately on each side of the crossing and on all the tracks of the crossing with branch circuits from the circuit-closer. One of these operates in the system and in connection with the other boxes in the line of track to which it belongs, the same as before described. The other is connected to each of the boxes nearest the crossing in the other tracks which cross the line of track containing said boxes. Now, referring to the diagram in Fig. 2, a single line of track having boxes A A′ A^2, &c., is shown crossing a double line of track having boxes B C B′ C′ B^3 C^2, &c. In this case the boxes A^2 A^3 on one track and B′ B^2 and C′ C^2 on the other tracks each has its circuit-closer in circuit with the solenoids in the corresponding boxes in the other line of track. The result of this construction is that not only are the boxes in one line of track operated as before, but whenever a train approaches a crossing and passes the box nearest to said crossing, then the corresponding boxes in all the other lines of track crossing said track are locked, so as to prevent any train from approaching said crossing in either direction until the train has passed said crossing and opened the box on the other side thereof, which restores said boxes to their normal conditions.

For switches, drawbridges, and similar devices I employ a peculiarly-constructed box, which is connected mechanically to the switch-lever or locking-bar of the drawbridge, as the case may be, and electrically with the boxes in the track, the construction being such that when a switch is thrown a circuit-closer in the box locks certain of the locking-boxes, which will prevent trains from moving except in the proper direction, the boxes in the track being in electrical connection with said switch-box, so as to automatically lock said switch and prevent it from being thrown when the throwing of said switch would endanger an approaching train. A box of this character is illustrated in Figs. 16 and 17, in which g represents a switch-rod. g' is the disk, having teeth and spaces adapted to operate in connection with the collar g^2 on said rod, so as to lock said rod or permit it to slide through said space, as before described, for the locking-box, a solenoid g^3 being adapted to operate said disk, a circuit-closing device consisting of the contacting parts g^4 and g^5 being adapted by the reciprocation of the rod g to open or close a circuit which extends in multiple arc through such of the locking-boxes in the system as are to be operated by the opening and closing of the switch. In Fig. 3 I have shown such boxes placed at D D operating in connection with the locking-bars of a drawbridge, (represented at E.) The locking-boxes A A′, &c., which are on opposite sides of the drawbridge, are adapted to send an impulse through the solenoids of the boxes D D, as well as through the other boxes in the system

to which they are connected, and thus lock the boxes D D whenever a train approaches the drawbridge in either direction, so as to pass said boxes A^2 A^3. The circuit-closers in the respective boxes D D are in turn connected to the respective boxes A^2 A^3, so as to lock said boxes whenever the locking-bar is moved to unlock the bridge. In Fig. 6 such a box D is shown in connection with the switch-bar *g*, which operates a switch at a point where a single line of track branches in different directions. In this case the box A^4 in either branch is locked by the turning of the switch whenever said switch is turned, so as to give the other track the right of way. At the same time, if a train approached so as to pass box A^3 or either of the boxes A^4, the box D is locked so that the switch cannot be operated. In Fig. 6 the circuit-closer in the switch-box D operates in connection with the ordinary box of the system.

In Fig. 7 I have shown a similar construction, in which I place auxiliary boxes F in the branch tracks, which are in circuit with the circuit-closers of the switch-box D, these boxes having nothing in common with the ordinary bowes A' A^2, &c., of the system, but being simply locked and unlocked by the throwing of the switch, one of said boxes being locked when the switch is thrown in one direction and the other being locked when the switch is thrown in the opposite direction. The locking of the switch-bar, however, is accomplished the same as before whenever a train approaches said switch so as to pass the regular locking-box of the system which is nearest to the switch on either side thereof.

In Fig. 8 I have shown the arrangement for a side track. D D represent switch-boxes operating in connection with the locking-bar *g* of the switches, as before. F F, &c., are special locking-boxes connected electrically to the box D on each side of the switch, and are locked whenever the switch is thrown, so as to prevent a train from approaching said switch in either direction. The box D is also in electrical connection with the boxes of the system which are nearest to said switch on the opposite sides thereof, so that the switch is automatically locked whenever the train passes the box nearest to said switch on either side. The boxes A^8 and A^9 in the side track have circuit-closing devices only and are not locking-boxes. These boxes simply serve to restore the regular boxes of the system to their normal conditions after the train has entered the side track and the switch is closed, as in the case of one train side-tracking for another train. As an illustration, a train passing from box A to A' unlocks box A' as it passes box A. At the same time it locks box A^2 in the main track on the opposite side of the switch. Having passed A' it unlocks A^2, but locks A^3. The train proceeds past box F, when the switch is opened and the train enters. Now, if the box A^3 remains in this position it would be impossible for a train to proceed on the main track, even though the switch is closed. The box A^8, therefore, with its circuit-closer, is adapted, as the train passes the same, to unlock the boxes A and A^3, which were locked by the passing of box A'. The same or the equivalent result is accomplished by passing the box A^9, either by the train going off from the side track or a train entering the side track. If a train, having entered the side track, passing box A^8, for instance, goes off the side track at the other end by crossing box A^9, then boxes A^3 and A^6, being unlocked, are locked by an electrical impulse from box A^9, thus shutting off the possibility of the approach of a train on the main track from either direction, and at the same time re-establishing the proper relations of the boxes in front and in the rear of the train on the main track. The same result would be accomplished if the train went off the side track in the direction from which it entered, as by recrossing A^8 boxes A and A^3 will be locked, so that the train may proceed in either direction and maintain the uniformity of the system of locking and unlocking the boxes at the front and rear of it as it proceeds.

From the above explanation it will be seen that the result of automatically preventing a train from moving on a track in the event of impending danger is accomplished by simply changing the condition of the locking-boxes—that is, by locking and unlocking said boxes—the result of locking or unlocking being performed in exactly the same manner—that is, by sending an electrical impulse through the boxes—so that if a box is locked an electrical impulse passing through the same unlocks it. If it is unlocked the same impulse will lock it. By having the boxes arranged so as to be alternately locked and unlocked at the front and rear of a train, a train proceeding clears its own way in the event of no unusual disturbances in the boxes. It can readily be seen that while this system will operate with perfect results on that portion of railways where there is no necessity for trains ever approaching each other except within certain limits, which may be prescribed by the distance at which the boxes are separated, yet such a system would materially interfere with the rapid movement of trains at terminal stations, or at such points where it is necessary that trains approach each other more nearly or follow each other in more rapid succession than could be accomplished by automatically opening and closing the boxes. For this purpose I have devised for use at such stations a system by which the conditions in the boxes near said station may be changed from locked to unlocked, or vice versa, by an operator at the terminal station, the system being such that a complete record is kept not only of the operation of said boxes, but of the exact time at which said operation takes place. This system is illustrated in diagram in Fig. 18.

1, 2, 3, 4, 5, 6, 7, 8, and 9 represent keys, any number of which may be used. Each of these

keys is provided with a circuit-closer, (shown at h,) which is adapted as the key is depressed to close an electrical circuit through the solenoid of a box which corresponds in number to the number of the key. The depression of any key, therefore, changes the condition of the box electrically connected to said key. If said box is locked, it unlocks it; if unlocked, it locks it. These keys, 1, 2, 3, &c., are further provided, something after the manner of any ordinary type-writer, with type-bars h', operated through suitable levers h^2 from said keys to cause the outer ends of said type-bars to strike at a common point above a stationary platen i. These type-bars carry at their outer extremities numbers corresponding to the numbers of the keys, and a continuously-moving tape j is arranged above said platen and below an inking-ribbon j', so that as the type-bars are forced down against said platen the number of said key is impressed upon the tape practically the same as would be accomplished by a type-writer. The platen i extends for a portion of the width of the ribbon only, and an impression made by the type-bar of any key is made on one edge of the tape j. Adjacent to this stationary platen i and below the tape j are two movable hammers $k\,k$, each pivoted at k' and provided at its outer end with a spring k^2.

Immediately above the inking-ribbon j' and above each of the hammers $k\,k$ are what may be termed printing-wheels $k^3\,k^4$, said wheels being journaled independently on a common shaft located above the respective hammers $k\,k$, so that an upward movement of either hammer will cause an impression to be made on the moving tape j from the periphery of the printing-wheel corresponding to said hammer. The periphery of one of these printing-wheels is divided into spaces corresponding to the hours of the day, and is numbered from "1" to "12" or from "1" to "24," as preferred. The other wheel has on its periphery a series of long and short projections adapted to imprint on the tape a corresponding series of long and short marks. Sixty of these projections are placed on the periphery of the wheel, corresponding to the number of minutes in an hour, every fifth mark being a long mark and thus indicating a space of five minutes. Each of said hammers k is adapted to be operated by the electromagnets $k^5\,k^6$, each included in an ordinary battery-circuit $k^7\,k^8$, with circuit-closers $k^9\,k^{10}$. These circuit-closers are operated by teeth on a revolving wheel k^{11}, which wheel is connected by a train of gearing to a clock k^{12}. The circuit-closer k^{10} is adapted to contact with teeth k^{13}, of which there are sixty in the wheel k^{11}, the circuit-closer k^9 being adapted to contact with a single tooth k^{14} on said wheel. This wheel k^{11} is adapted to revolve synchronously with the minute-hand of the clock, and makes one complete revolution at each hour. Every minute, therefore, an electrical impulse is sent through the circuit k^7 and through the electromagnet k^5, which results in compressing the spring k^2, which when released by the interruption of the current through the magnet causes the hammer k to fly upwardly and carry the tape against the wheel k^3, and thus make an impression corresponding to the projection on said wheel. A pawl-lever k^{15}, adapted to operate in a ratchet-wheel k^{16}, causes the wheel k^3 to move one notch at each movement of the hammer, so that the impressions from said wheel are imprinted upon the moving tape j in a continuous manner, every fifth impression making a longer mark than usual. When the projection k^{14} contacts with the circuit-closer k^{10}, a similar result is produced by the electromagnet k^6 in connection with the printing-wheel k^4, a number corresponding with the hour of the day being thus imprinted upon said tape at a different point in the width thereof, the said wheel being provided with a pawl k^{17} and ratchet k^{18} to produce the necessary movement thereof, as before described. The tape j, as before stated, is moved continuously and uniformly from some suitable clock mechanism, preferably by means of operating-roller L L', between which the tape passes. The roller L is provided with a pinion L^2, which is connected thereto through the medium of a pawl-and-ratchet device L^3, which latter is adapted to permit the roller L to move forwardly at a greater rate of speed than the pinion. The pinion is connected to a gear-wheel L^4, which transmits motion thereto through any suitable clock mechanism. The roller is further provided with a ratchet-wheel L^5, adapted to be engaged by a pawl L^6 on the end of a reciprocating rod L^7, which is connected to a pivoted frame L^8, the front bar of which lies immediately under and is adapted to contact with the operating-levers h^2 of the keys 1, 2, 3, &c. The depression of a key, therefore, produces a reciprocating movement of the pawl L^6, which moves the ratchet L^5 and turns the roller L, thus producing a sudden movement of the paper tape j immediately after the impression from the type connected to said key has been made. Now, the result of this construction is as follows: The tape passing uniformly and continuously over the respective hammers has imprinted thereon every minute a mark, every five minutes a longer mark, and every hour a number indicating the hour. If any of the keys are operated, the number of said key is also imprinted on the tape, and at the same time a space is formed between the marks corresponding to the number of keys that have been operated, the appearance of such a tape being shown in Fig. 27, in which the numbers 12 and 1 through the center of the tape indicate the hours of the day. The marks at the lower side indicate the minutes between said hours. The numbers on the top 23, 15, 23, and 42 indicate the keys which were depressed between the hours twelve and one. The spaces between the minute-marks indicate the exact time that the keys were de-

pressed, from which it appears that box 23 was operated at six minutes after twelve o'clock, box 15 was operated at twenty-two minutes after twelve o'clock, boxes 23 and 42 were operated at twenty-nine minutes after twelve o'clock.

To provide against the possible failure to secure a record in the event that the paper tape *j* should become broken or exhausted, I employ a circuit-breaker in the circuit between the battery *z* and the battery-line *x*, which furnishes the circuit to the circuit-closers under the respective keys. This I accomplish by providing a movable arm *m*, having a roller *m'* operating against the under side of the tape, said arm being held in this position by a weight m^2, sufficient tension being applied to the tape to hold the arm *m* in its normal position, in which a circuit is closed through said arm from the battery *z* to the respective circuit-closers under the keys. In the event that the paper tape should become broken or exhausted, the weight m^2 moves the arm *m* and breaks the circuit *x x* and closes a circuit through a magneto-bell m^3, which sounds an alarm. The contacting devices for accomplishing this result are shown in Figs. 21 to 24, inclusive. The arm *m* has near the center a long contacting-face m^4, which lies adjacent to metallic contacting-plates m^5 m^6 m^7. Of these m^5 is connected to the circuit-closing keys, m^6 to the battery, and m^7 to the alarm-bell. The contacting-face m^4 on the arm normally rests against the plates m^5 m^6 and establishes a circuit from the battery through *x x* to the circuit-closing keys. If the paper should become broken, the weight m^2 causes the arm *m* to make a partial revolution, so as to move the contact-face m^4 away from the plate m^5 and in contact with the plate m^7, thus breaking the connection to the circuit-closing keys and establishing a circuit to the alarm-bell m^3, means being thus provided by which the failure to produce a record is obviated, since the boxes cannot be operated unless the paper tape is intact.

In Fig. 28 I have shown means for disconnecting the throttle-lever *f*, so that it may be moved by the piston in the cylinder *d* in the event that said throttle is supplied with the usual holding device for holding it in any position of adjustment. This consists of an extended arm f^2, having a cam-face f^3, adapted to bear against a stud f^4, connected to the usual spring-bolt which secures the throttle-valve, so that the first movement of the piston-rod d^4 disconnects said spring-bolt, leaving the throttle-valve lever *f* free to be moved by said piston-rod.

In illustrating my invention I have shown devices of the simplest character for carrying out my system. It is obvious that they may be modified in various different ways. I do not, therefore, in any way limit myself to the constructions shown; but

I claim, broadly, as my invention—

1. A system for automatically controlling railway trains, a series of stations arranged at intervals in the railway track, each of said stations consisting essentially of a moving part, and an intermittently moving mechanism for alternately locking and unlocking said moving part, an electric contacting device connected to said moving part, and electrically operative mechanism for moving said locking device, and an electrical connection in multiple arc from each of said contacting devices to the electrically operated mechanism of two or more stations arranged on opposite sides thereof, substantially as specified.

2. In a railway, a series of boxes each having a yieldingly supported platen, a rotating holding device having alternately-arranged spaces and projections which successively engage and disengage said platen, electrically operative mechanism for rotating said holding device by an electrical impulse, an electrical contacting device in each of said boxes adapted to be moved by said platen, and an electric circuit between the circuit breaker of one of said boxes and the electrically operative mechanism in two or more other boxes arranged on opposite sides thereof, substantially as specified.

3. The combination in a line of railway, of moving contacting devices, and an electrically operated locking device therefor, and an electrical connection from said contacting devices to the electrical operative locking device in two or more other boxes which are connected in multiple arc, substantially as specified.

4. In a system for controlling railway trains, a series of boxes arranged at intervals in a line of railway track, each of said boxes being connected in multiple arc to two or more of the other boxes, and mechanical devices in each of said boxes adapted, by an electrical impulse, to change said box from its normal condition to an abnormal condition, and means in each of said boxes for sending an electrical impulse through the other boxes connected thereto by a passing car, when said box is in its normal condition, a yielding contact device on said car adapted to operate said box when in its normal condition, and to be operated thereby when the box is in an abnormal condition, and a connection from said yielding contact device to mechanism for controlling said car, substantially as specified.

5. In a railway system, a series of contacting devices arranged in the railway track, an electrical connection in multiple arc from each of said boxes to two or more of the other boxes, and contacting devices in each of said boxes adapted, under normal conditions, to send an electrical impulse to the other boxes connected therewith, a moving car adapted to operate said boxes when in their normal conditions and thus effect a change in the other boxes connected thereto, and means, substantially as described, for controlling said

car by contacting with a box in its abnormal condition, and a central station electrically connected to said boxes so as to send an electrical impulse through either of them, and thus change the condition thereof, substantially as specified.

6. In a system for controlling railway trains, a series of sub-stations arranged at intervals, and an electric connection in multiple arc from each of said stations to two or more of the other stations, contacting devices at each of said stations adapted to be operative by the passing of a car to effect a change in the other stations connected thereto from its normal condition, and mechanism connected with said car to automatically stop the same when the car contacts with an abnormally changed station, and a central station electrically connected to each of said sub-stations, and means, as described, for sending an electrical impulse from said central station through either of the sub-stations so as to change the condition thereof, substantially as specified.

7. In a railway, a series of contacting devices, and a car adapted to travel on said railway having mechanism to engage successively with said contacting devices, means connected with each of said contacting devices for changing one or more of the other contacting devices when said contacting device is operated by the passing car, and a central station electrically connected to each of said contacting devices, and means at said central station for effecting a change in either of said contacting devices, substantially as specified.

8. In a railway, a series of boxes each having a yieldingly supported platen, a locking device in each of said boxes for holding said platen in a rigid position, and electrically operative mechanism for controlling said locking device, a circuit closer in each of said boxes connected in multiple arc with the electrically operative mechanism in two or more of said boxes, in combination with a moving car having a contacting device to engage said platen and mechanism connected therewith for stopping said car, substantially as specified.

9. The combination, in a railway and with a moving car, of a series of boxes each having a yieldingly supported platen, an electrical circuit closer connected therewith so as to close an electric circuit by a movement of said platen, a locking device for engaging and disengaging said platen, and electrically operative mechanism for operating said locking device, the electrically operative mechanism in each of said boxes being connected in multiple arc with the circuit closer in two or more of the other boxes, substantially as specified.

10. The combination with a movable platen, a spring for supporting the same, and a moving disk adapted to lock or unlock said platen, electrical contacting devices adapted to be operated by a movement of said platen, and an electro-magnet, the armature of which is connected to said disk, the contacting device of said platen being connected to one or more of the electro-magnets of adjacent platens, substantially as specified.

11. In a railway, and in combination with a movable car thereon, a box having a movable spring supported platen with electrical contact devices connected thereto, a revolving disk having a series of alternating teeth and spaces adapted to alternately come under a projection on said platen, a pawl and ratchet device connected to said disk and operated by an electro-magnet in said box, contacting devices for said car to engage with said platen, and means, as described, for sending an electrical impulse through said box to lock or unlock said platen, substantially as specified.

12. In a railway having a movable track section, a moving bar for holding said track, and a box connected to said bar containing locking devices for locking or unlocking said bar, an electro-magnet connected with said locking devices and adapted to operate the same, a contacting box arranged in the railway and locking devices in said contacting box, and electrical connections from said contacting box, and means, as described, for locking either of said devices when the other is operated, substantially as specified.

13. The combination with a series of sub-stations in a railway track, of a central station having an electrical connection to each of said sub-stations, a common continuously moving time recording device, and means connected with said device for operating said sub-station for recording the number of said sub-station on the common recording devices when said station is operated, substantially as specified.

14. The combination with a series of sub-stations in a railway track, and a central station, a series of contacting devices in electrical connection with the respective sub-stations, and time recording devices at said central station, and mechanism connected with each of said contacting devices adapted, when operated so as to operate a sub-station, to record the number of the station operated and to produce an unusual movement of the time recording devices, substantially as specified.

15. The combination with a series of sub-stations in a railway track, of a central station having an electrical connection to each of said sub-stations, and time recording devices adapted to electrically record the time on a moving strip, as described, and means, as described, for breaking the electrical connection and thus preventing the operation of a sub-station in the event that the strip is broken, substantially as specified.

16. The combination of a central station with a series of contacting devices connected to a series of sub-stations, printing devices connected to each of said contacting devices adapted to imprint a character corresponding to said sub-station when said sub-station is operated, a moving strip to receive said im-

print, and electrically operating devices to automatically mark said strip at uniform intervals of time, and means, as described, for destroying the electrical connection to each of said devices and thus prevent the operation of any of the sub-stations, substantially as specified.

In testimony whereof I have hereunto set my hand this 23d day of December, A. D. 1893.

ADOLPH L. DE LEEUW.

Witnesses:
PAUL A. STALEY,
FRANK W. GEIGER.