No. 750,471. PATENTED JAN. 26, 1904.

L. LYNDON & E. A. SPERRY.

SYSTEM OF ELECTRICAL GENERATION, DISTRIBUTION, AND CONTROL.

APPLICATION FILED JAN. 17, 1903.

NO MODEL. 4 SHEETS—SHEET 1.

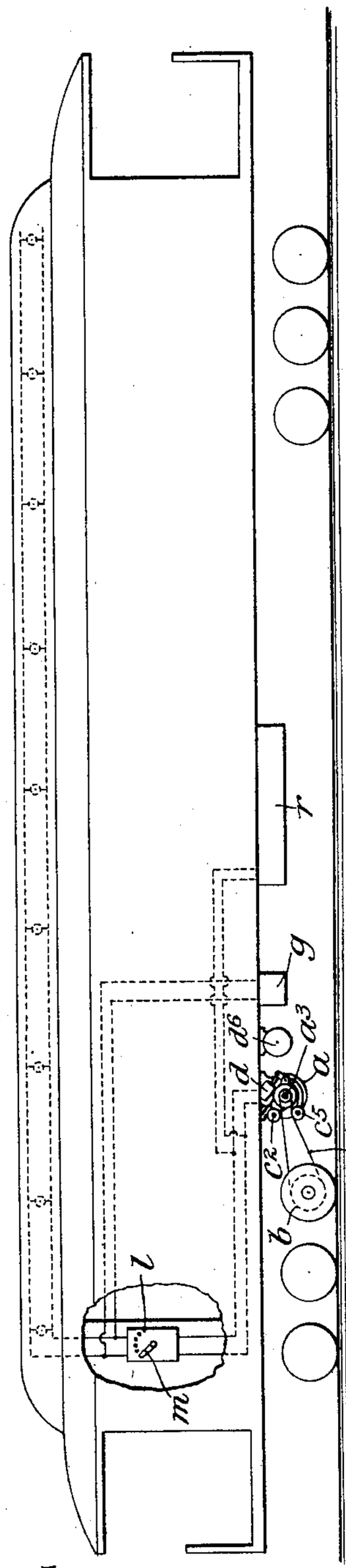

Fig. 1.

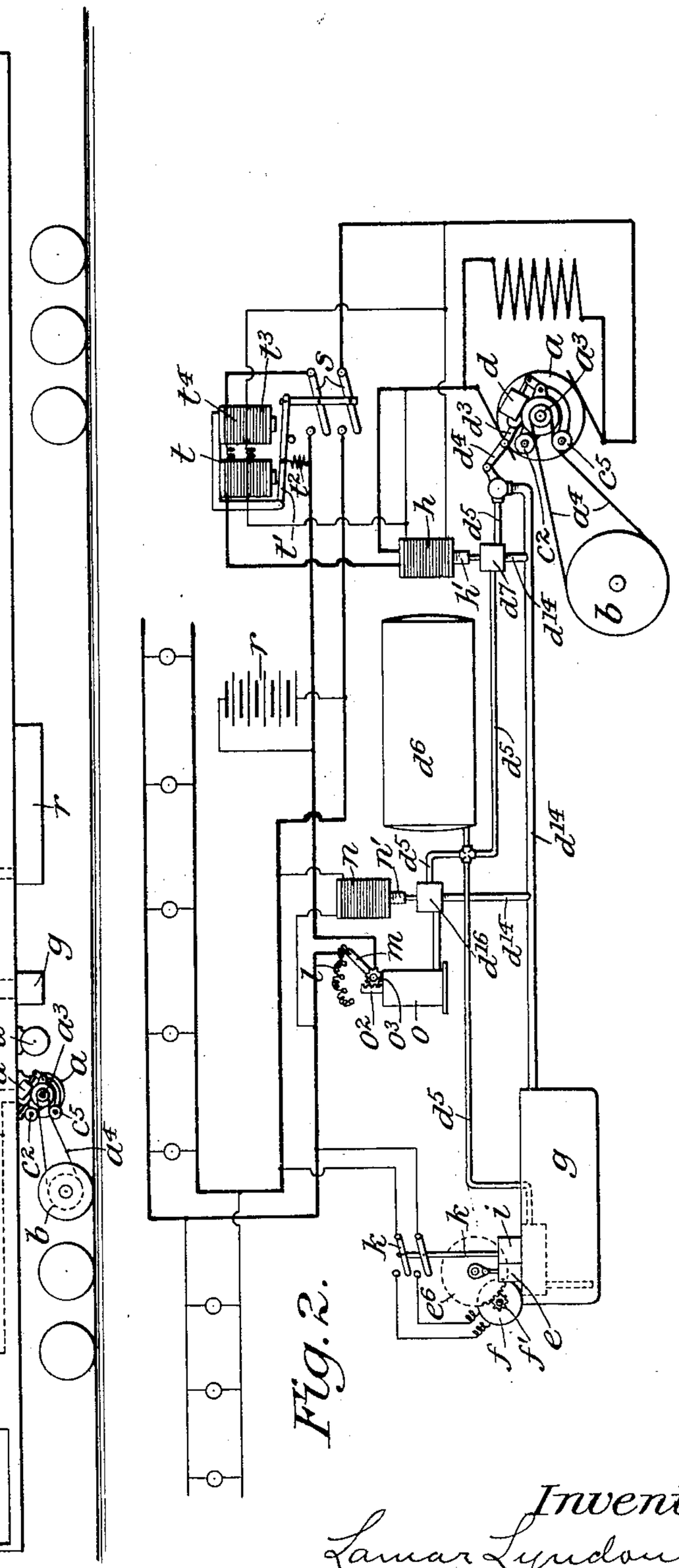

Fig. 2.

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NO MODEL. 4 SHEETS—SHEET 2.

Fig. 3.

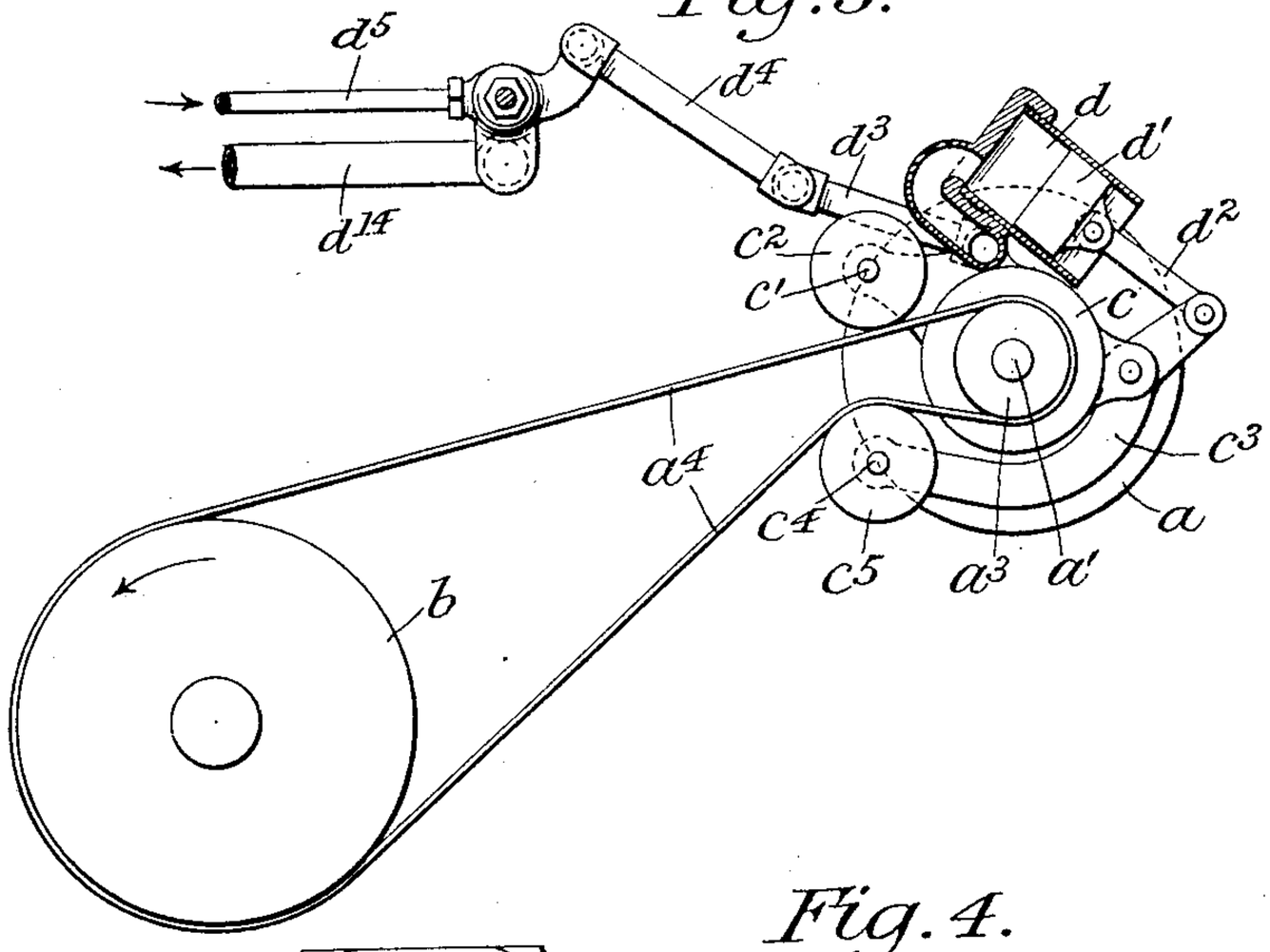
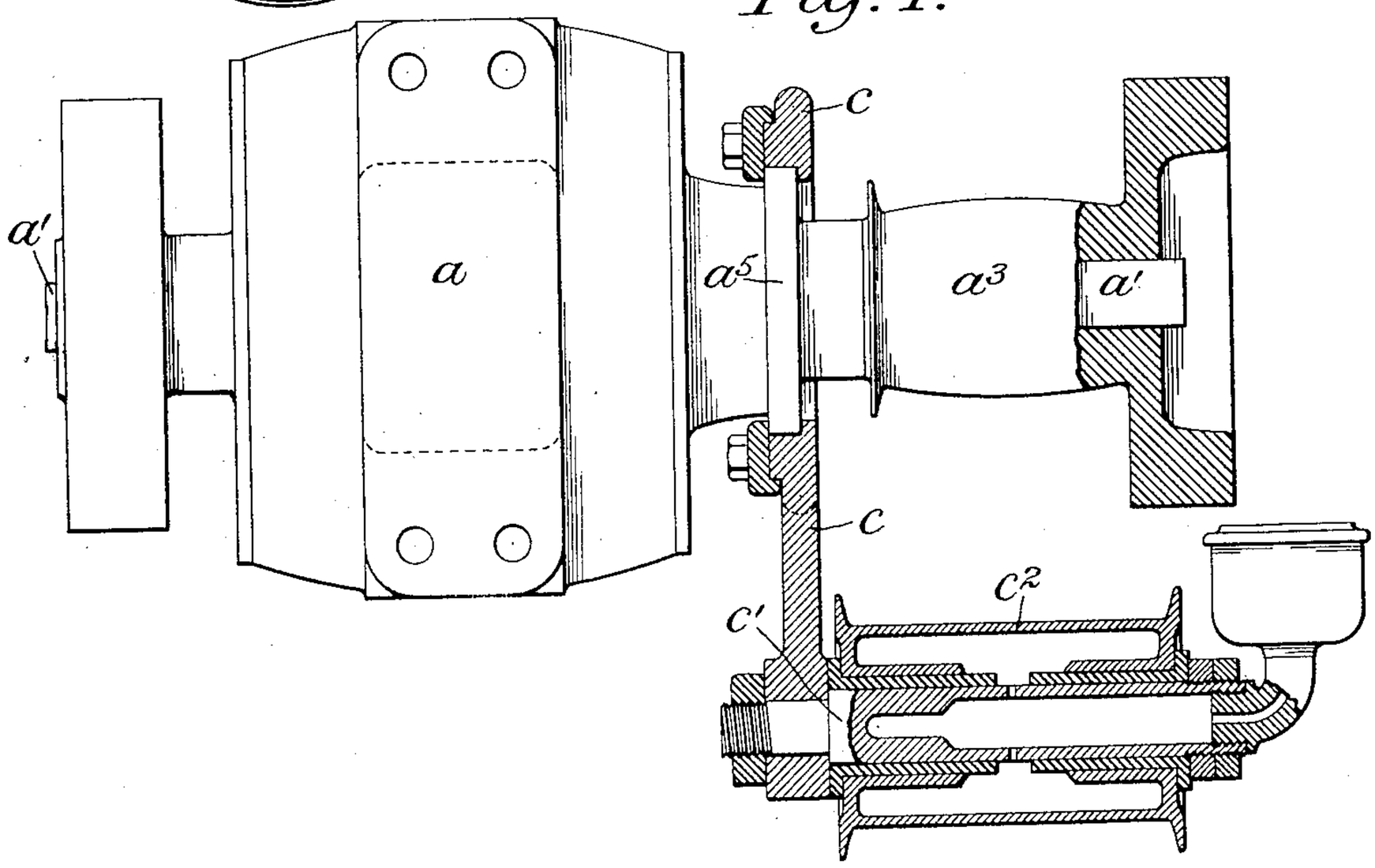


Fig. 4.



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NO MODEL. 4 SHEETS—SHEET 3.

Fig. 5.

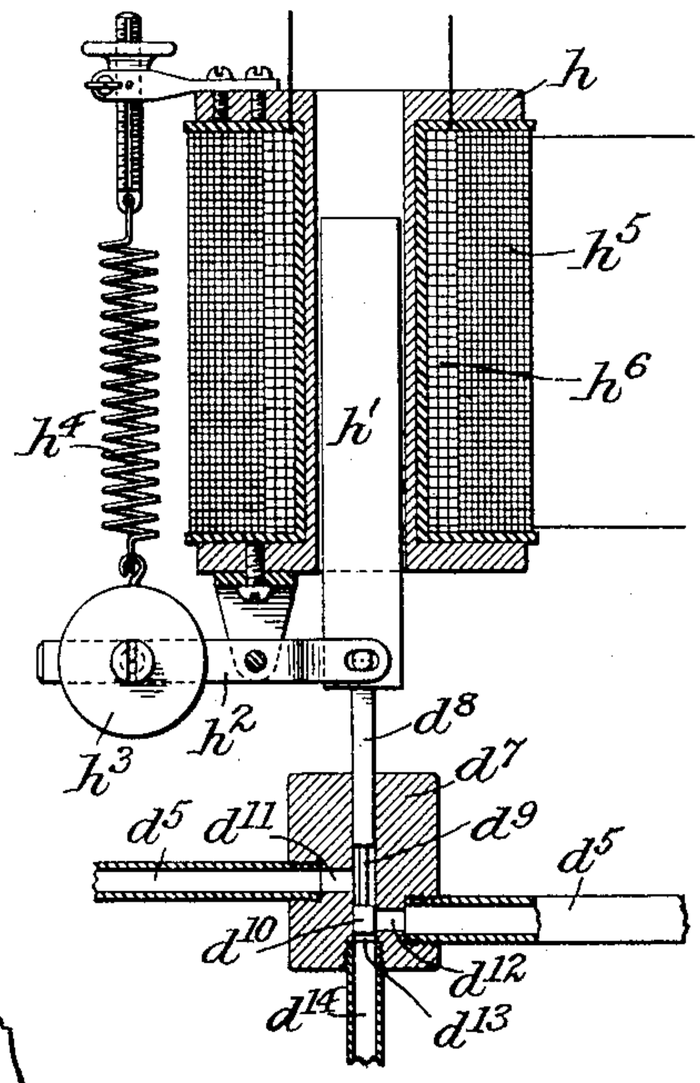


Fig. 6.

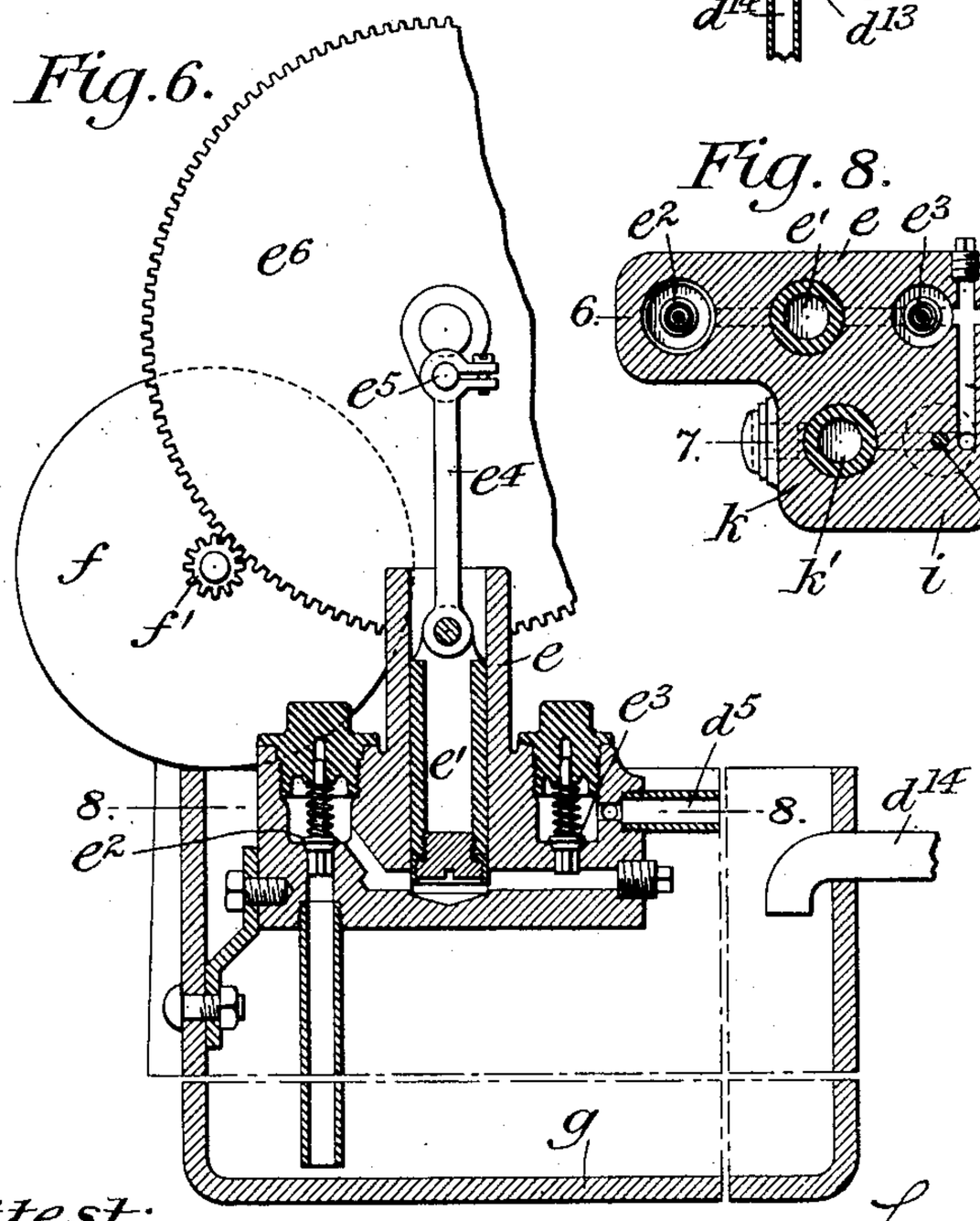
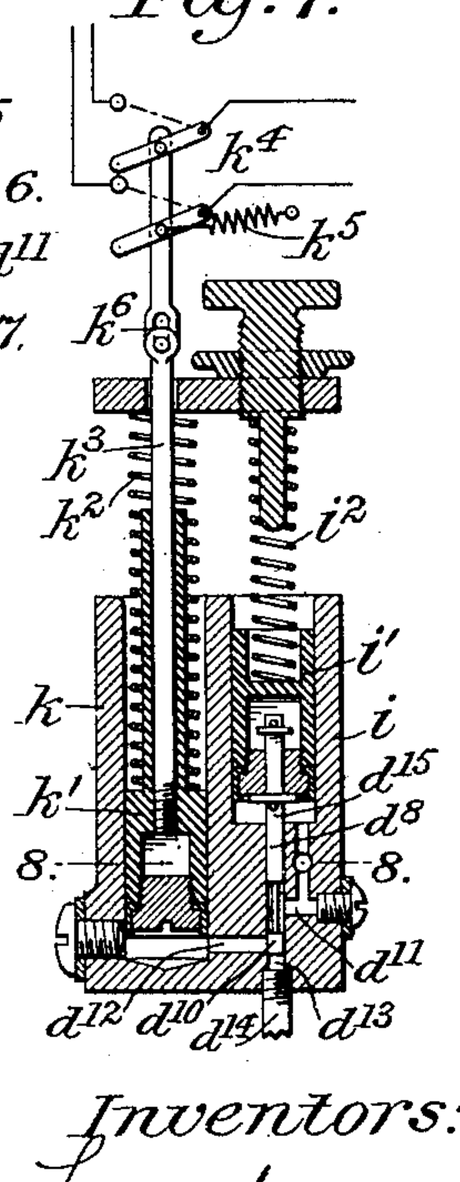


Fig. 8.

Fig. 7.



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NO MODEL. 4 SHEETS—SHEET 4.

Fig. 9.

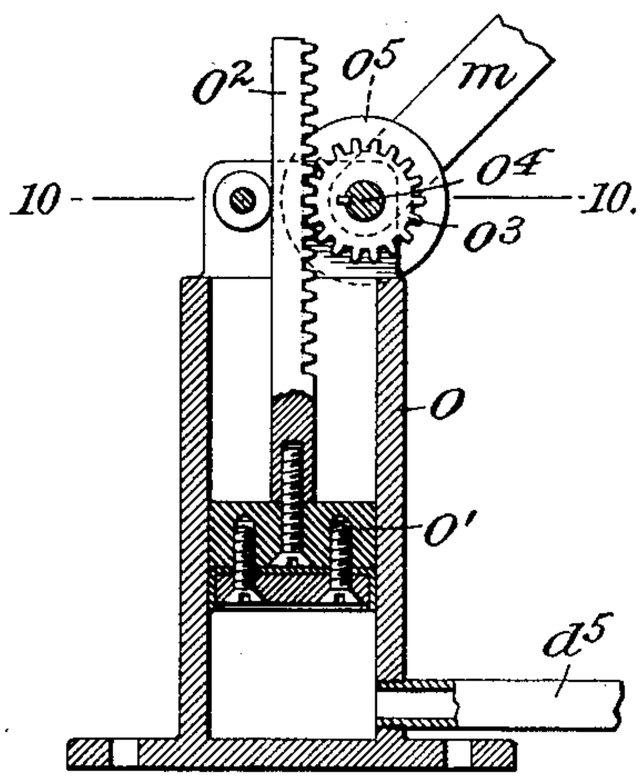


Fig. 11.

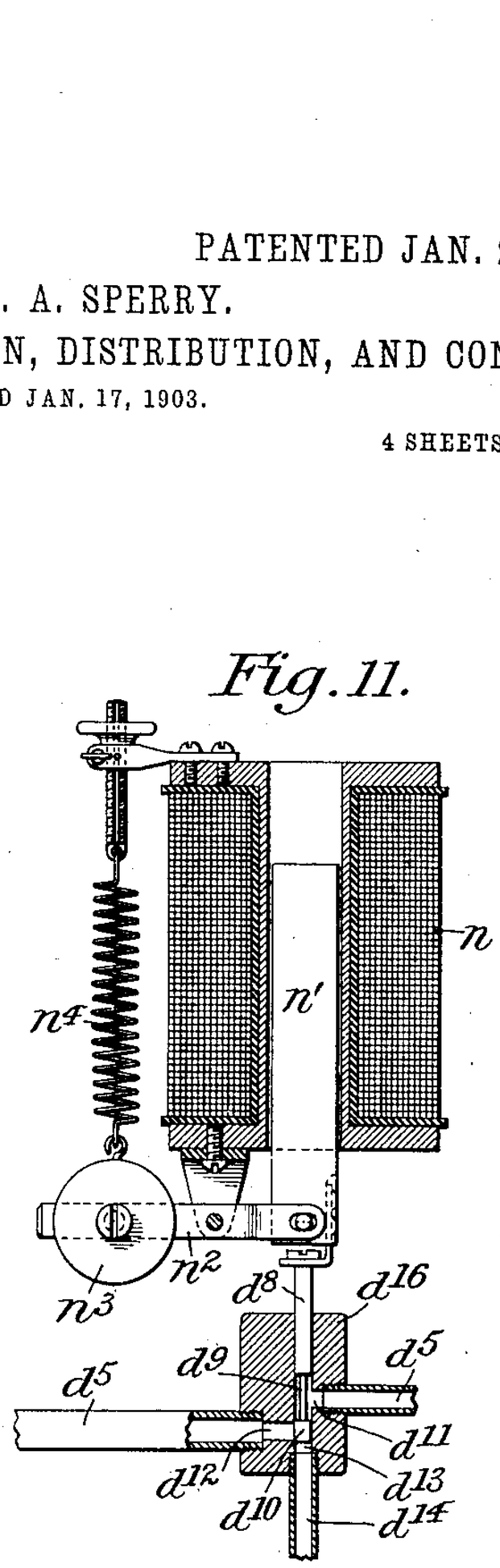


Fig. 10.

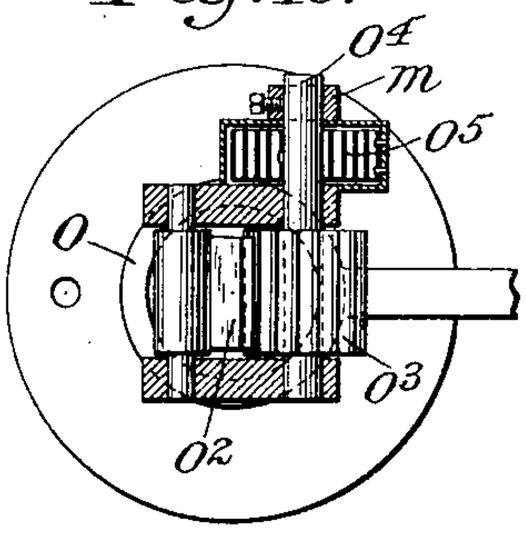
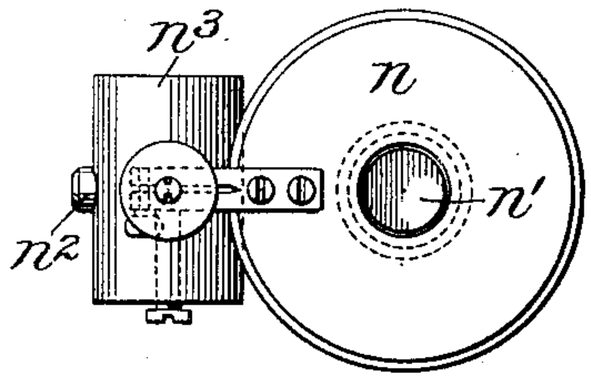


Fig. 12.



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No. 750,471. Patented January 26, 1904.

UNITED STATES PATENT OFFICE.

LAMAR LYNDON, OF NEW YORK, N. Y., AND ELMER A. SPERRY, OF CLEVELAND, OHIO, ASSIGNORS TO NATIONAL BATTERY COMPANY, OF JERSEY CITY, NEW JERSEY, A CORPORATION OF NEW JERSEY.

SYSTEM OF ELECTRICAL GENERATION, DISTRIBUTION, AND CONTROL.

SPECIFICATION forming part of Letters Patent No. 750,471, dated January 26, 1904.

Application filed January 17, 1903. Serial No. 139,399. (No model.)

To all whom it may concern:

Be it known that we, LAMAR LYNDON, residing in the borough of Manhattan, in the city of New York, in the State of New York, and ELMER A. SPERRY, residing in Cleveland, in the county of Cuyahoga, in the State of Ohio, citizens of the United States, have invented certain new and useful Improvements in Systems of Electrical Generation, Distribution, and Control, of which the following is a specification, reference being had to the accompanying drawings, forming a part hereof.

This invention relates to systems and apparatus for the generation, distribution, and control of electric current and has been developed more especially with a view to the solution of difficulties incident to variations in speed of the source of power by which the generator is driven.

The particular application of the invention with reference to which it was developed and in which it finds its concrete expression is railway-car lighting in which current is generated through the movement of a car or train, the generator being ordinarily driven from a car-axle. In such an application of the invention provision should be made to maintain uniform strength of current notwithstanding considerable variation in the speed of the car. The effect upon a system of a reversal of the direction of movement of the car should be anticipated and accommodated. Provision should be made for discontinuing the operation of the generator under conditions which are unfavorable to the continued generation of current through the movement of the car, as when the train approaches a terminal and takes the short radius curves, switches, and crossovers common in a terminal yard. The automatic supply of current to the lighting-circuit of the car when the speed falls below a predetermined rate should be provided for. The medium through which the automatic regulation and control of the various parts of the system are effected should be of such a character as to be substantially unaffected by considerable variations in temperature and the other conditions of use. The different various devices should be so constructed as to be substantially unaffected by the vibrations and other conditions of use, and in general the system should be adapted to overcome difficulties incident to the character of the source of power and to the conditions under which the system is used. Devices by which some of these requirements are met are fully described and covered in the application of Elmer A. Sperry, one of the present applicants, Serial No. 134,035, filed December 5, 1902, which is subordinate to the present application, wherein is covered the broad invention embodied in mechanical and electrical devices described in said application, Serial No. 134,035, so far as the same is the joint invention of the present applicants. The general object of the present invention is therefore the same as that set forth in said application, Serial No. 134,035—viz., to produce a system which will give thoroughly satisfactory results under all conditions of use, either for the lighting of railway-cars or for other analogous purposes.

It will be obvious that the general object can be attained and the general features of construction and arrangement can be embodied by and in specific structures which differ more or less in detail. One of such embodiments will be particularly described hereinafter with reference to the accompanying drawings, in which it is illustrated, and in order that the functions of the several mechanical parts may be more readily comprehended a general description of such embodiment of the invention without reference to the drawings will now be presented.

The generator or dynamo is driven, as by a belt, from one of the car-axles, and in order that the slip of the belt may be taken advantage of to assist in the regulation of the electromotive force through the speed of the dynamo a belt-tightener is provided for the purpose of slackening or tightening the driving-belt. The action of the belt-tightener to slacken or tighten the belt is controlled by the pressure of a suitable fluid medium, preferably an oil which will resist low temperatures, the pressure being developed by the action of

a pump driven by a motor which is in circuit with the dynamo or batteries supported thereby. A valve in the pipe system may be suitably controlled, as by a solenoid or other electromagnetic device in circuit with the dynamo to vary the pressure at the point where it performs its work in controlling the belt-tightener, whereby any variation in the voltage of the current shall effect the movement of the belt-tightener to tighten or slacken the belt, and thereby to correct the variation in the voltage and restore it to the normal. The motor for driving the pump is also subject to the control of the pressure of the fluid medium, so that its operation shall cease when the pressure rises above a predetermined degree and shall be resumed automatically when the pressure falls below a predetermined degree. To compensate for variation in the electrical translating devices, as in the number of lights in circuit, so that the voltage of the current supplied to the remaining lights shall remain substantially uniform, and to compensate for variations in voltage of battery or dynamo, suitable resistance is included in the circuit and means are provided for throwing in or out more or less of such resistance, such means being operated by the pressure of the fluid medium and controlled by the action of a solenoid or other electromagnetic device included in circuit with the lamps. A storage battery is to be included in the circuit in order that the necessary lighting current may be provided when the car is stationary or the speed of the car falls below a predetermined minimum.

In the accompanying drawings, wherein is illustrated the particular embodiment of the invention chosen for explanation, Figure 1 is an outline, in side elevation and partly broken out, of a railway-car equipped with the invention embodied in a lighting system. Fig. 2 is a diagrammatic view illustrating the general relation of the several mechanical and electrical elements of the system in the same application thereof. Fig. 3 is a view, partly in elevation and partly in vertical section, illustrating the means for controlling the slip of the belt by which the dynamo is driven. Fig. 4 is a detail view, on a larger scale, of a portion of the belt-tightener with the dynamo and its driving-pulley. Fig. 5 is a view in vertical section of the solenoid and valve operated thereby for controlling the pressure upon the piston shown in Fig. 3. Fig. 6 is a view in vertical section on the plane indicated by the line 6 6 of Fig. 8, showing the pump. Fig. 7 is a view in vertical section on the plane indicated by the line 7 7 of Fig. 8, illustrating the device for starting and stopping the pump automatically. Fig. 8 is a horizontal section on the plane indicated by the line 8 8 of Figs. 6 and 7. Fig. 9 is a view in vertical section illustrating the mechanical devices for operating the rheostat. Fig. 10 is a view in horizontal section on the plane indicated by the line 10 10 of Fig. 9. Fig. 11 is a view in vertical section of the solenoid and the valve operated thereby for controlling the pressure upon the plunger shown in Fig. 9. Fig. 12 is a top plan view of the parts shown in Fig. 11.

The dynamo (indicated at a) may be of any suitable construction and is supported beneath the car-floor or in any other convenient location. It may have a driven pulley a^3 mounted on its shaft a' and be driven by a belt a^4 from a driving-wheel b on the car-axle. For the purpose of controlling the speed, and therefore the electromotive force, of the dynamo through the friction of the driving means suitable mechanical devices may be provided, such as a belt-tightener, which is arranged to act upon the belt and is itself controlled by devices presently to be described. The particular construction of the belt-tightener forms no part of the present invention, and for a detailed description of the belt-tightener shown in the accompanying drawings reference may be had to the aforesaid application, Serial No. 134,035. For the purposes of the present case it is sufficient to say that a frame or ring c is mounted to oscillate or swing upon a circular flange a^5 of the dynamo-casing, said frame having a pin or stud c', upon which is mounted an idler c^2, adapted to rest against one side of the belt. To the frame c is pivoted an arm c^3, also having a pin or stud c^4, carrying an idler c^5, adapted to rest against the other side of the belt. The mechanical devices for acting upon the belt-tightener to slacken or to tighten the belt are mounted upon the frame c and are adapted to increase or diminish the distance between the two idlers c^2 and c^5.

One object of the invention being to provide for the operation of the belt-tightener by a fluid medium, the mechanical devices for operating the belt-tightener comprise a cylinder d, which is fixed upon the oscillating frame c, as indicated above, and a piston d' in said cylinder and connected by suitable link d^2 with the arm c^3, the fluid medium, under pressure from a suitable source, being admitted to the cylinder behind the piston. Oil of a suitable quality placed under elastic pressure by a suitable pump is the most satisfactory medium for the transmission of the required power to the mechanical element, such as the piston d', by which the tightening of the belt is effected, lending itself most readily to the peculiar requirements of the case, the belt-regulating devices thus becoming sensitive and quickly responsive in operation, while acting with certainty under conditions of constant and excessive vibration and of widely varying temperatures. Furthermore, such devices are readily controlled through variations of the voltage of the current produced by the dynamo, so that such current is generated as required and remains substantially uniform notwithstand-

ing considerable variations in the speed of movement of the car. The cylinder d accordingly is connected by a suitable pipe system, including sections d^3 and d^4, which are movable to accommodate the movement of the cylinder with the frame c, and a fixed section d^5, with an oil-pressure tank d^6, and a pump e, operated by a motor f, which is in circuit with the translating devices and the storage battery hereinafter referred to. The tank d^6 may be an ordinary tight tank, having a single inlet for connection with the pipe system d^5 and preferably contains a volume of air which acts as an elastic cushion for the oil which is delivered by the pump e. The latter is placed in convenient relation to an oil-pan g, which contains the supply of oil and receives the oil through the return-pipes from the several actuating devices, the pump being preferably mounted above the oil-pan at any convenient point within the car and being of ordinary construction, comprising a reciprocating plunger e', an inlet-valve e^2, and an outlet-valve e^3, the discharge being connected with the pipe system d^5. The plunger e' may be connected by a pitman e^4 with a crank or crank-pin e^5, carried by the shaft of a gear e^6, which is in mesh with a driving-pinion f' on the shaft of the small motor provided for the operation of the pump. Means are provided whereby the operation of the pump shall be dependent upon the pressure on the fluid medium, the pump being automatically thrown out of operation when the pressure rises above a predetermined degree and also thrown into operation when the pressure falls below a predetermined degree. It is desirable to provide for a direct control of the pressure on the piston-head d' by variations in the voltage of the current. To this end a solenoid h is included in circuit with the dynamo. Its core h' is statically balanced, being connected by a lever h^2 with a counterweight h^3, so that the core shall not be affected by the vertical vibrations of the car, and also with an adjustable spring h^4, which opposes the pull of the solenoid upon the core. The core of the solenoid controls a valve d^7, interposed in the pipe system, by means of which admission of oil to the cylinder d is regulated and by which the oil in the cylinder may be in part released and permitted to return to the oil-pan, so that the belt may slacken. As shown, the valve comprises a plug or stem d^8 turned down, as at d^9, to form a passage between the head d^{10} and the body of the valve. The valve-chamber has a port d^{11} communicating with the pressure-tank, a port d^{12} communicating with the cylinder d, and a port d^{13}, communicating with the oil-pan through a return-pipe d^{14}. The valve is shown in its normal position, the port d^{12} being closed. If now the voltage of the current increases, the core will be raised so that the head d^{10} of the valve shall be moved to establish connection between the port d^{12} and the port d^{13}, thereby relieving the pressure beneath the piston d' in the cylinder d and permitting the belt to slacken, and therefore to slip, whereby the speed of the dynamo is reduced. If, on the other hand, the voltage of the current decreases, the spring h^4 draws down the core h', thereby moving the valve-plug d^8 to establish communication through the channel d^9 between the ports d^{11} and d^{12}, thereby permitting more oil to pass into the cylinder d, and thereby to tighten the belt and increase the speed of the dynamo.

It will be understood that the ordinary fine-wire winding h^5 of the solenoid h is included in a shunt from the main circuit of the dynamo. Under some circumstances, as when a great quantity of current is flowing over the circuit, it is desirable to assist the fine winding of the solenoid in its action upon the core to open the valve and relieve the pressure behind the belt-controlling piston in order that the dynamo may be checked and abnormal overload and consequent burning out prevented. Accordingly a winding h^6 of coarse wire is first laid, up and down, about the sleeve of the solenoid and is connected in series with the armature-winding of the dynamo. A resistance may be thrown across the connections of this coarse winding and when the quantity of current rises to a predetermined degree, for which the windings of the solenoid and the resistance are duly proportioned, the coarse winding will assist the fine winding and insure the prompt opening of the valve and the consequent checking of the dynamo. This particular device forms no part of the present invention, which contemplates the connection of the solenoid or its equivalent in the circuit in any manner suitable to the accomplishment of the intended purpose.

Whether any other device be employed to regulate the pressure in the cylinder d, as above described, or not, it is desirable to provide means, as above suggested, whereby the pump shall be stopped whenever the pressure on the fluid medium increases above a predetermined maximum and shall be started again whenever the pressure falls below a predetermined minimum. To accomplish this, a pressure relay device, as shown in Figs. 7 and 8, is employed. This device comprises a cylinder i, having a plunger i', moved in one direction by an adjustable spring i^2. The cylinder i is in communication with the pipe system d^5, so that the plunger i' is shifted by variations in the pressure, and the plunger controls a valve d^{15}, which may be in all respects the same as the valve d^7, the same reference-letters being employed to indicate like parts. The port d^{11} of the valve d^{15} is in communication with the pressure-tank, the port d^{13} is in communication with the return-pipe d^{14}, and the port d^{12} is in communication with a cylinder k, in which is a plunger k', adapted to be moved in

one direction by the pressure in the cylinder and in the opposite direction by a spring k^2. The stem k^3 of the plunger is operatively connected with a switch k^4 in the branch of the circuit which includes the motor f, the switch being opened when the plunger k' moves downward under the influence of the spring k^2 and being closed as it is moved upward by the pressure of the fluid medium in the cylinder k. It will now be understood that when the pressure in the pressure-tank increases above the predetermined maximum the plunger i'' will be moved upward against the spring i^2, thereby permitting the pressure beneath the plunger k' to be relieved by the movement of the valve-plug d^8, which establishes communication between the ports d^{12} and d^{13}. On the other hand, if the pressure in the system falls below the predetermined minimum the plunger i'' will descend against the reduced pressure in the cylinder i, moving the valve-plug d^8 downward to establish communication between the ports d^{11} and d^{12}, thereby admitting the fluid medium to the cylinder k and raising the plunger k' to close the switch k^4 and start up the pump again. A non-centering spring k^5 is connected to the switch to retain the switch and the plunger in their extreme positions, lost motion being provided for between the plunger and the switch, as by a slot-and-pin connection, as at k^6, to facilitate the quick movement of the switch.

In order that the voltage of the current supplied to the lamps shall be substantially uniform notwithstanding variations in the number of lamps in use or in the current supplied by the dynamo or batteries, or both, and especially to utilize the full range of the battery voltage, it is desirable to include in the lamp-circuit a variable resistance, the amount of resistance included being controlled automatically. As represented in the drawings, Figs. 2, 9, 10, 11, and 12, the device comprises an ordinary variable resistance l, a movable contact-arm m, and mechanical devices electrically controlled and actuated for shifting the arm m. As represented in the drawings, a solenoid n is included in the main circuit, while its core n' is statically balanced, being connected by a lever n^2 with a counterweight n^3 in order that the core may not be affected by vibrations and with an adjustable spring n^4, which opposes the action of the solenoid. The core is operatively connected with a valve d^{16}, which is in all respects similar to the valve d^7, heretofore described. The parts of the valve d^{16} are indicated by like letters of reference, and no detailed description of the valve is necessary. The port d^{11} is in communication with the pressure system and the port d^{13} with the return-pipe system d^{14}, while the port d^{12} is in communication with a cylinder o, in which is disposed a plunger o'. A rack o^2, carried by the plunger, engages a pinion o^3 on the shaft o^4, which carries the movable resistance-arm m. A coil-spring o^5 may be applied to the shaft o^4 to oppose the pressure in the cylinder o and restore the parts to normal position when the pressure therein is reduced. It will be understood that when the voltage increases the core n' will be drawn up, and the valve d^{16} will be operated to connect the cylinder o with the return-pipe system d^{14} through the ports d^{12} and d^{13}, thereby permitting the plunger to descend and the arm m to be moved to include more resistance in the lamp-circuit, and that if the voltage falls the spring n^4 will cause the core to move downward, actuating the valve d^{16} to admit pressure to the cylinder o through the ports d^{11} and d^{12}, thereby moving the plunger and the arm m in a direction to reduce the amount of resistance included in the circuit.

A storage battery r is arranged to be included in circuit to maintain the lights when the car is stationary or moves at a speed less than the predetermined minimum. It may be recharged from the dynamo, and provision is made whereby the dynamo shall be cut out when the current generated is less than supplied by the battery. To this end a switch s, having a member in each leg of the main circuit, may be arranged to be controlled by a differential magnet t, the armature t' of which is operatively connected with the switch and has attached a spring t^2 to open the switch when the armature is released by the magnet. One set, t^3, of the coils of the magnet is included in a shunt from the main circuit and energizes the magnet to hold the armature normally up with the switch closed. The other set, t^4, of the coils of the magnet is included in one leg of the main circuit in series with one of the switch members, the coils being wound in the same direction as those of the set t^3. Thus if the electromotive force of the current from the battery exceeds that of the current from the dynamo the rush of current backward through the coils t^4 will neutralize the effect of the coils t^3 upon the core of the magnet and permit the armature to drop. When the electromotive force of the dynamo is increased sufficiently, the coils t^3, included in the shunt, will energize the magnet sufficiently to again attract the armature and restore the connection between the dynamo and the lamp-circuit.

The operation of the system will be understood from the foregoing description without further explanation.

It will be understood that such of the details of the electrical and mechanical devices herein described as are claimed in the aforesaid application, Serial No. 134,035, and are not claimed in this application have been illustrated and explained herein merely as convenient and practical embodiments of the main features of the invention and can be replaced by other devices of like general nature and operating to produce similar results which

will readily suggest themselves. It will also be understood that it is not intended to limit the invention, except as may be pointed out in the claims hereinafter, to any particular construction or arrangement of devices necessary to accomplish the results herein pointed out.

We claim as our invention—

1. The combination of a variable power source, an electric generator, a variable power transmission between the power source and the generator, fluid-pressure-operated devices for varying the transmission of power, and electrically-actuated devices in the circuit and including a statically-balanced moving element for controlling said devices.

2. The combination of a variable power source, an electric generator, a variable power transmission between the power source and the generator, fluid-pressure-operated devices for varying the power transmission, a two-way valve for controlling said devices, and electrical devices in the circuit to actuate said valve.

3. The combination of a variable power source, an electric generator, a variable power transmission between the power source and the generator, fluid-pressure-operated devices for varying the power transmission, a balanced valve to control said devices, and electrical devices in the circuit to actuate said valve.

4. The combination of a variable-speed-power source an electric generator, a variable-friction power transmission between the power source and generator, fluid-pressure-operated devices for varying the friction, and electrically-actuated devices in the circuit and including a statically-balanced moving element for controlling said devices.

5. The combination of a variable-speed-power source, an electric generator, a variable-friction power transmission between the power source and the generator, fluid-pressure-operated devices for varying the friction, a two-way valve for controlling said devices, and electrical devices in the circuit to actuate said valve.

6. The combination of a variable-speed-power source, an electric generator, a variable-friction power transmission between the power source and the generator, fluid-pressure-operated devices for varying the friction, a balanced valve to control said devices, and electrical devices in the circuit to actuate said valve.

7. The combination of a power source, an electric generator, a variable power transmission, electric translating devices, a current-controller between the translating devices and the generator, actuating devices for both the current-controller and the variable power transmission, and a common source of power for said actuating devices.

8. The combination of a power source, an electric generator, a variable power transmission, electric translating devices, a current-controller between the translating devices and the generator, actuating devices for both the current-controller and the variable power transmission, a common source of power for said actuating devices, and a motor for said source of power in circuit with the translating devices.

9. The combination of a source of power, an electric generator, a variable power transmission, electric translating devices, a current-controller between the translating devices and the generator, actuating devices for both the current-controller and the variable power transmission, and electrical devices in the circuit to control the actuating devices.

10. The combination of a source of power, an electric generator, a variable power transmission, electric translating devices, a current-controller between the translating devices and the generator, actuating devices for both the current-controller and the variable power transmission, and statically-balanced electrical devices in the circuit to control the actuating devices.

11. The combination of a power source, an electric generator, a variable-speed power transmission, electric translating devices, a current-controller between the translating devices and the generator, fluid-pressure-actuating devices for both the current-controller and the variable power transmission, and a common source of fluid-pressure for said actuating devices.

12. The combination of a power source, an electric generator, a variable-speed power transmission, electric translating devices, a current-controller between the translating devices and the generator, fluid-pressure-actuating devices for both the current-controller and the variable power transmission, a common source of power for said actuating devices, and a motor for said source of power in circuit with the translating devices.

13. The combination of a source of power, an electric generator, a variable-speed power transmission, electric translating devices, a current-controller between the translating devices and the generator, fluid-pressure-actuating devices for both the current-controller and the variable power transmission, and electrical devices in the circuit to control the actuating devices.

14. The combination of a source of power, an electric generator, a variable-speed power transmission, electric translating devices, a current-controller between the translating devices and the generator, fluid-pressure-actuating devices for both the current-controller and the variable power transmission, and statically-balanced electrical devices in the circuit to control the actuating devices.

15. The combination of a power source, an electric generator, a variable-power-transmis-

sion device for the generator, devices in operative relation with the generator to establish fluid-pressure, means operated by the fluid-pressure to control the variable-power-transmission devices, electrical actuating means for said fluid-pressure devices and circuit connections between the generator and the electrical actuating means.

16. The combination of a power source, an electric generator, a variable-power-transmission device for the generator, devices in operative relation with the generator to establish fluid-pressure, and means operated by the fluid-pressure to control the variable power transmission, electrical actuating means for said fluid-pressure devices and shunt connections between the generator and the electrical actuating means.

17. The combination of a power source, a shunt-wound electric generator, a variable-transmission device for the generator, devices in operative relation with the generator to establish fluid-pressure, and means operated by the fluid-pressure to control the variable power transmission, electrical actuating means for said fluid-pressure devices and circuit connections between the generator and the electrical actuating means.

18. The combination of a power source, an electric generator, a variable-power-transmission device for the generator, devices in operative relation with the generator to establish fluid-pressure, and means operated by the fluid-pressure to control the variable power transmission, electrical actuating means for said fluid-pressure devices, circuit connections between the generator and the electrical actuating means, and a storage battery in circuit with the generator.

19. The combination of an electric generator, a variable-power-transmission device for the generator, devices in operative relation with the generator to establish fluid-pressure, and means operated by the fluid-pressure to control the variable power transmission, electrical actuating means for said fluid-pressure devices, circuit connections between the generator and the electrical actuating means, a storage battery in circuit with the generator, and a switch between the generator and the battery.

20. The combination of a source of power, an electric generator, a variable-power-transmission device for the generator, electrically-actuated devices in operative relation with the generator to establish fluid-pressure, and means operated by the fluid-pressure to control the variable power transmission, electrical actuating means for said fluid-pressure devices, circuit connections between the generator and the electrical actuating means, a storage battery in circuit with the generator, a switch between the generator and the battery, and electrical devices included in the circuit to control said switch.

21. The combination of a group of electric translating devices, a storage battery, an electric generator, a variable-speed-power source for the generator, means for controlling the speed of the generator, a switch between the generator and battery, a rheostat between the generator and the translating devices, means to operate said switch and said rheostat, and electrical devices included in the circuit to control the operation of said speed-controlling means.

This specification signed and witnessed this 15th day of January, A. D. 1903.

LAMAR LYNDON.
ELMER A. SPERRY.

In presence of—
LUCIUS E. VARNEY,
ROSWELL S. NICHOLS.