No. 735,250. PATENTED AUG. 4, 1903.

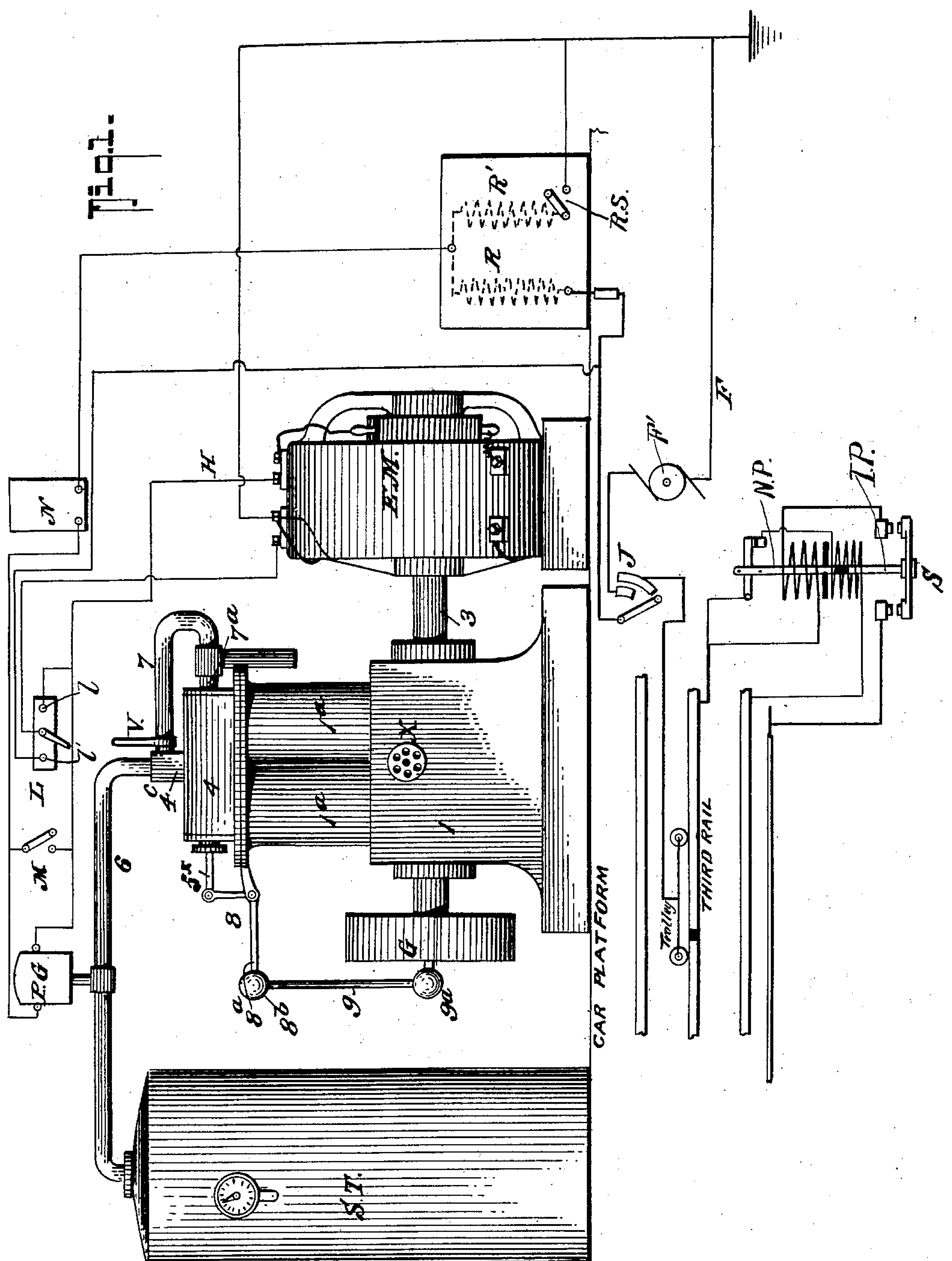
G. T. HANCHETT.

ELECTRIC RAILWAY SYSTEM.

APPLICATION FILED JULY 18, 1902.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.



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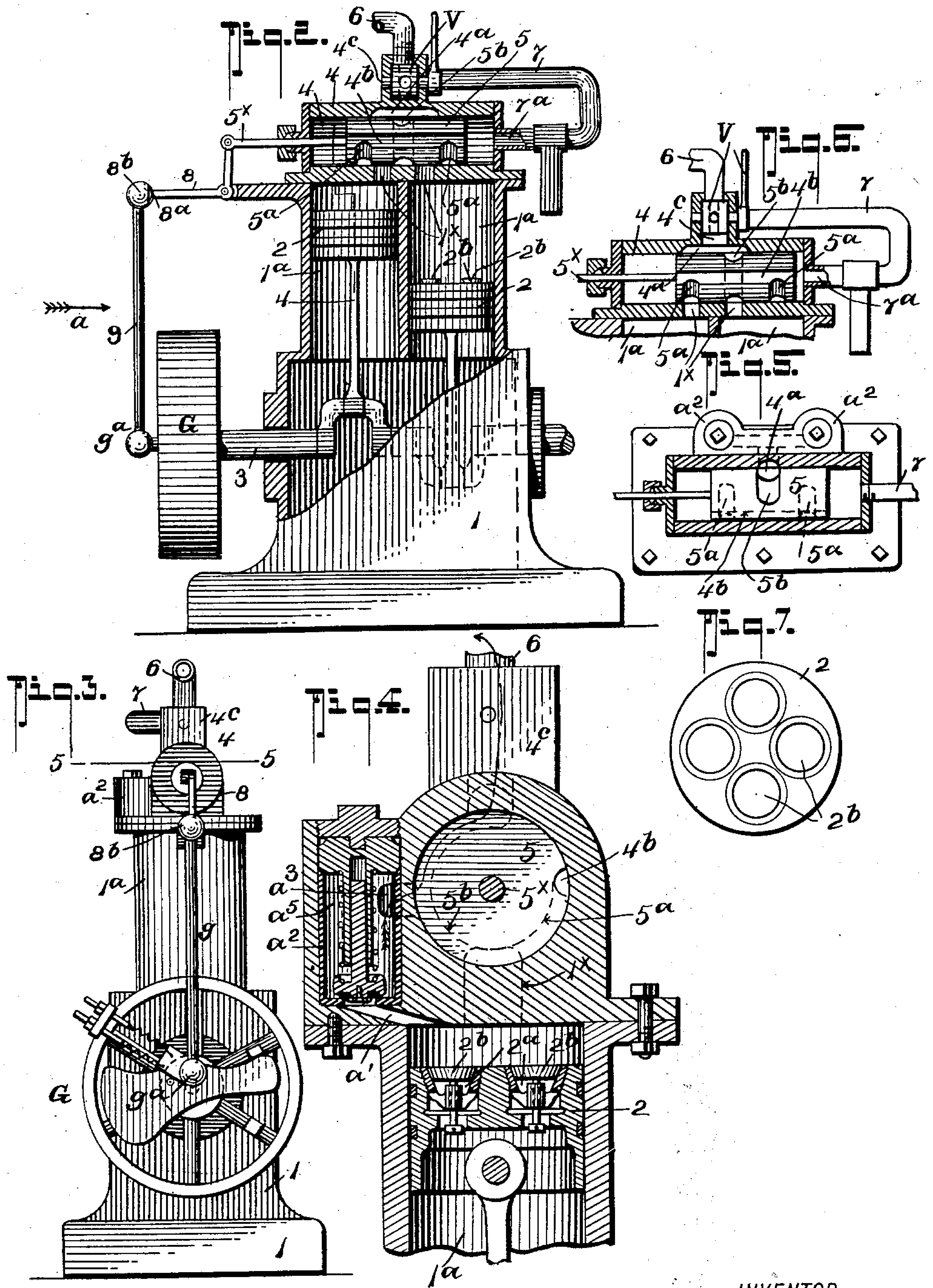
3 SHEETS—SHEET 2.



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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 8.

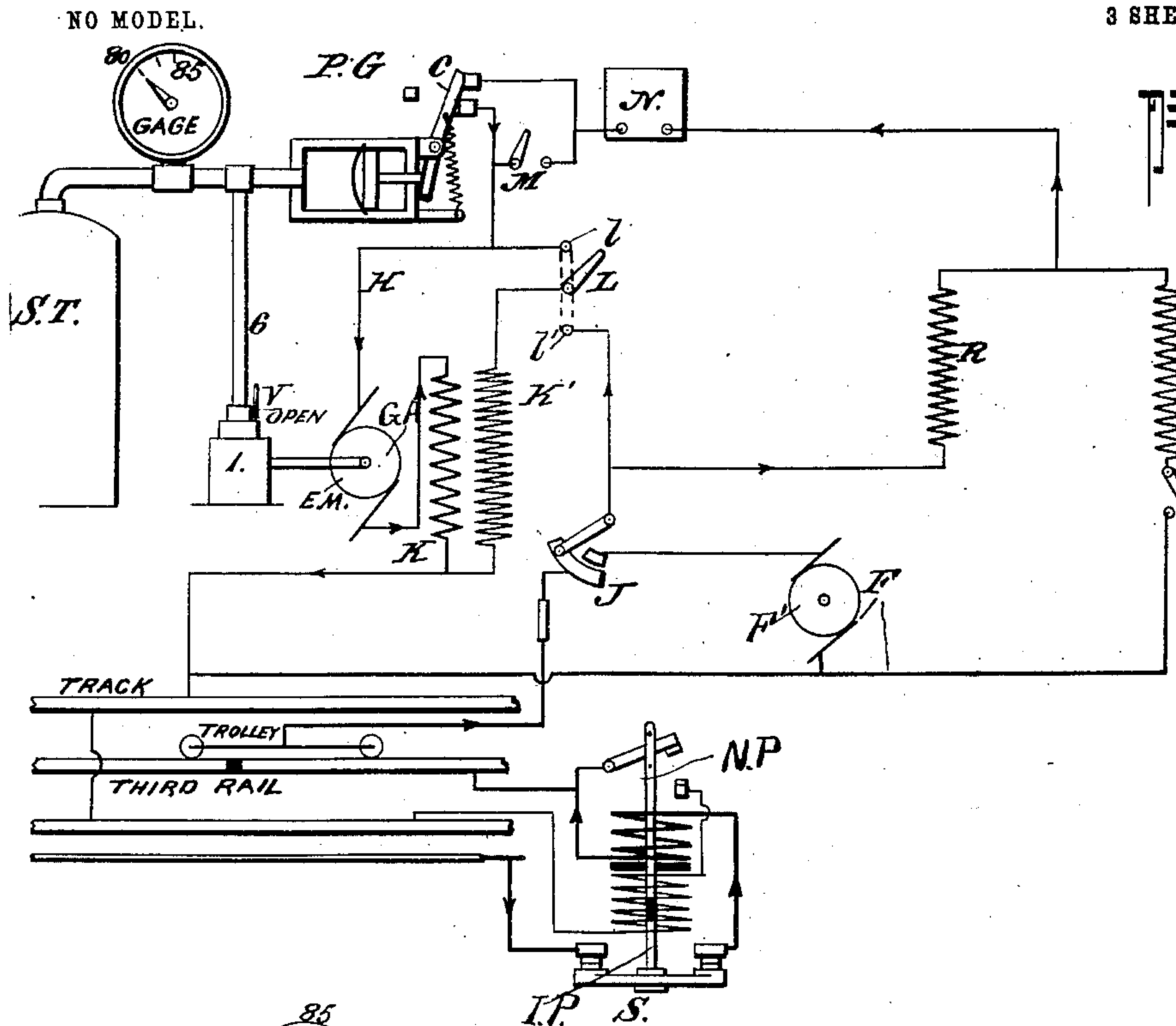
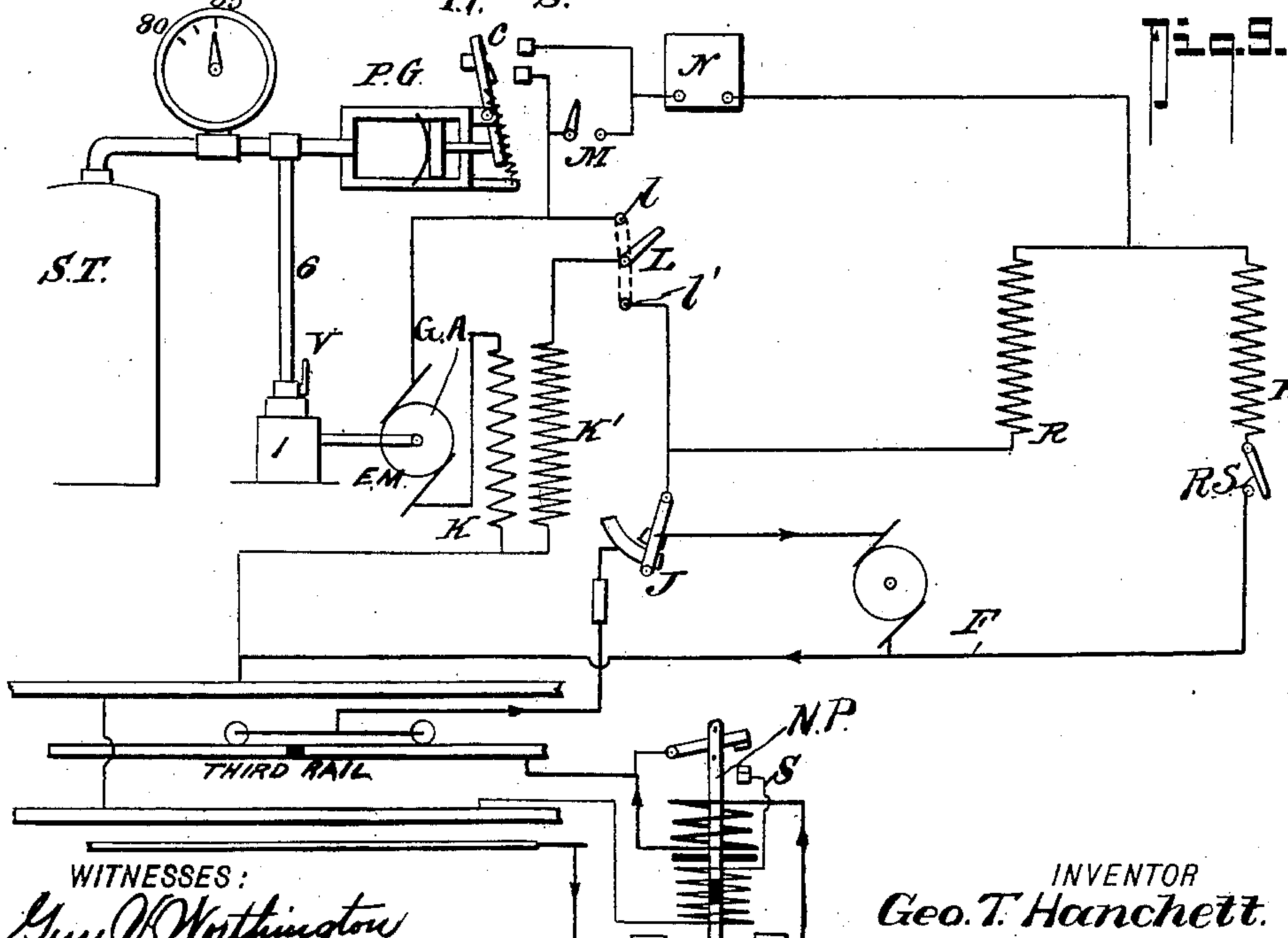


Fig. 9.



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No. 735,250. Patented August 4, 1903.

UNITED STATES PATENT OFFICE.

GEORGE TILDEN HANCHETT, OF HACKENSACK, NEW JERSEY, ASSIGNOR TO DUDLEY FARRAND, RECEIVER, OF NEWARK, NEW JERSEY.

ELECTRIC-RAILWAY SYSTEM.

SPECIFICATION forming part of Letters Patent No. 735,250, dated August 4, 1903.

Application filed July 18, 1902. Serial No. 116,099. (No model.)

To all whom it may concern:

Be it known that I, GEORGE TILDEN HANCHETT, residing at Hackensack, in the county of Bergen and State of New Jersey, have invented certain new and useful Improvements in Electric-Railway Systems, of which the following is a specification.

My invention primarily seeks to provide an improved means for producing and controlling a local energy on a car for actuating electric-switch mechanisms located outside of the car, especially of that type utilized for picking up a main or feeder line current and leading it to the motor on the car carrying the said local energy.

My invention comprehends a novel coöperative arrangement of a dynamo-electric machine and air-compressor mechanism, including a storage-tank, whereby the dynamo-electric machine can be utilized as a generator or as a motor and which also includes means for automatically governing the shifting action of the said dynamo-electric machine, whereby said coöperative arrangement of parts can be operated in a positive and effective manner and without undue waste of power.

My invention in its more complete make-up includes, first, a governor operated under varying speed for shifting the mechanism from a compressor to an engine position; second, a novel arrangement of valve devices in the cylinder-head and valve-equipped cylinder-heads especially designed to effect their desired purpose without interfering with the action of the mechanism as an engine and at the same time enable said mechanism to act as an air-compressor when necessary; third, a peculiar and novel arrangement of the compressor-circuit, a pneumatic governor contained therein, the object of which is to connect the machine to the line, and thereby apply the line-voltage and making the apparatus or mechanism become a compressor at such times when the tank is needing air and to disconnect it from the line when the tank is pumped up to its proper pressure, thereby causing the machine to become an engine.

In its more subordinate features my invention embodies certain combinations and details of construction hereinafter fully described, and specifically pointed out in the claims, reference being had to the accompanying drawings, in which—

Figure 1 is a diagrammatic view illustrating the general arrangement of my improved electric-railway system. Fig. 2 is a side elevation of the "compressor or engine mechanism," parts being shown in section. Fig. 3 is an end elevation of the mechanism shown in Fig. 2 looking in the direction of the arrow *a* on Fig. 2 and illustrating the centrifugal or inertia governor and valve-shifting means operated thereby. Fig. 4 is a transverse section taken on the line 4 4 of Fig. 2. Fig. 5 is a detail horizontal section taken practically on the line 5 5 of Fig. 2. Fig. 6 is a detail section of one of the piston-head puppet-valves. Fig. 7 is a plan view of one of the valve-equipped piston-heads. Fig. 8 is a diagram illustrating the correlation of the parts when the system is being used for compressing air. Fig. 9 is a similar view illustrating the system at rest after the air in the storage-tank has reached a predetermined maximum pressure and car-motors in circuit with the main-line feed, the direction of which is indicated by the arrow-heads.

In the practical application of my invention the same embodies an air-compressor mechanism 1, mounted on the motor-car platform and which in its general make-up may be of the ordinary construction; but the same includes certain details and peculiar arrangement of valves and pistons, the coöperative arrangement of which is shown in Figs. 2, 4, and 5, by reference to which it will be noticed the pistons 2 2 are of the inverted-trunk pattern, the heads of which have a number of outlets 2^a, controlled by upwardly-opening puppet-valves 2^b, the purpose of which will presently appear.

3 designates the double crank-shaft, which carries at one end a centrifugal governor mechanism G, presently again referred to, and at the other end it joins with and forms a part of an electric motor E M.

The cylinders 1^a 1^a each have a port $1^\times$ $1^\times$ disposed near the center of a valve-chest 4, in which is reciprocally held a cylindrical valve 5, the peculiar construction of which and its combination with the centrifugal governor and intermediate devices and the air-feedways in the chest 4 forms an essential feature of my invention.

The valve 5 at the opposite ends has transverse channels or grooves 5^a 5^a, that extend around about two-thirds (more or less) the circumference of the valve, (see Fig. 4,) and the said grooves 5^a are provided for coöperating with the ports $1^\times$ $1^\times$ in the cylinders 1^a 1^a in a manner presently explained, and the said valve 5 is also provided with a transverse groove 5^b, intermediate the grooves 5^a, which coöperates with an air-channel 4^a, extending lengthwise of the chest-wall. (See Fig. 5.) The grooves 5^a also coöperate with a second longitudinal air-channel 4^b in the valve-chest, also shown in Fig. 5.

Midway the chest 4 has an outlet 4^c, with which connects the pipe 6, that leads the air to the storage-tank S T, as clearly shown in Fig. 1.

V designates a three-way valve, mounted on the outlet 4^c, the purpose of which is to open up direct communication between the valve-chest 4 and the pipe 6, cut off said pipe 6, or place it in communication with an exhaust-pipe 7, that discharges to atmosphere, and by a lateral 7^a also communicates with the valve-chest 4.

Each cylinder 1^a has a second outlet (indicated by a' a') that discharges into a valve-controlled pocket a^2, that discharges into a passage a^3, that communicates with the channel or groove 4^a in the valve-casing 4, and the valve a^5 in the pocket a^2 is automatically held to its closed position and acts as a check-valve to prevent backflow from the storage-tank to the cylinders 1^a 1^a.

The governor mechanism G, before referred to, in its general nature is of a well-known form, with its variable portions made especially sensitive to changes of speed at the critical point, where the mechanism shown in Figs. 2 and 3 changes from an engine to a compressor. In the practical construction the variable portions are so made that a drop of speed of, say, twenty-five revolutions will effect a large motion of the governor and a corresponding shift of the piston-valve 5. This latter operation may be effected by any available mechanical connections between the goveror and the piston—for example, by a bell-crank lever 8, joined with the rod $5^\times$ of the piston 5 and having its arm 8^a connected by a ball-and-socket joint 8^b with a connecting-rod 9, connected with the governor G by a ball-and-socket joint 9^a, the latter being so positioned relatively to the axis of the governor G that when the mechanism shown in Figs. 2 and 3 operates as an engine for pumping air to the storage-tank the said axis of the joint 9^a will be nearly in longitudinal plane with the axis of the governor-shaft, (see Fig. 2,) and thereby remain practically inert so far as imparting a shifting motion to the piston 5, which during the operation of pumping air remains nearly stationary and in the position shown in Fig. 1; but when the said mechanism, Figs. 2 and 3, is operating as an engine for creating energy the said joint 9^a will be positioned eccentric to the axis of the governor, and as it rotates with the governor imparts motion to the bell-crank 8 and shifts the valve 5 in a manner presently more fully set out.

The manner in which the mechanism shown in Figs. 2, 3, 4, and 5 operates is explained as follows: When operating as an engine, the inertia-governor is thrown to such a position that the valve 5 properly reciprocates, thereby causing the central lateral groove 5^b to properly register with the ports $1^\times$ $1^\times$ to admit a fluid-pressure to the cylinders 1^a 1^a alternately. The air is exhausted from the cylinders on the outward stroke of the pistons by reason of the fact that the outer grooves 5^a then register with the ports $1^\times$ $1^\times$, which allows air to pass through them and through the longitudinal channel 4^b to the exhaust-pipe 7^a. When the pressure in the storage-tank reaches a predetermined or minimum point, the pump-governor operates, and thereby connects the dynamo-electric machine to the third-rail shoe and produces an electric motive force between the third rail and the track-rail, which picks up the switch S, thereby connecting the dynamo-electric machine to the power-house. The motor in the practical construction is so designed that under the influence of the power-house pressure it will operate at an increased speed and to move the governor so as to shift the point G^a to a position nearly central with the axis of rotation. Such adjustment of parts has the effect of practically stopping the motion of the valve 5 and leaving it in such position that the ports $1^\times$ $1^\times$ are closed. As the machine continues to run under the influence of the dynamo-electric machine and the pistons descend the puppet-valves 2^b are lifted and allow the cylinders to fill with air from the crank-casing 1. The ascending piston closes its puppet-valves under the influence of pressure, and being then unable to force air through the ports $1^\times$ by reason of the stoppage of the valve 5 above them then forces the air through the auxiliary passage a', which lifts the valve a^5 and allows for a free escape of the air through the passage 4^a and thence to the storage-tank. The action just described takes place without reversing or stopping. When the pressure has reached a predetermined maximum point, the pump-governor acts again and disconnects the dynamo-electric machine from the power-house. Through this loss of power the machine then slows down, the governor acts, the valve 5 again begins to reciprocate in a proper manner and to admit air into the cylinders from the storage-tank and exhaust the same into atmosphere, thereby converting the compressor into an engine again for giving power to the dynamo-electric-machine shaft to drive the same as a generator. It will be appreciated by those skilled in the art that the puppet-valves 2^b can never open while the machine is running as an engine, for the reason that when so operating the pressure in the cylinder is always higher than the atmospheric pressure. In like manner the valve a^5 cannot operate when the machine is running as an engine, for the reason that the tank-pressure is always higher than the cylinder-pressure. Therefore the puppet-valves, which act when the engine is a compressor, do not in any way interfere with its operation as an engine. The ports $1^\times$, which admit and exhaust the air when the machine is operating as an engine, cannot interfere with its operation as a compressor, for the reason that the shifting-valve 5 does not open them when the machine is so acting. This automatic shifting of the air in reverse directions may be accomplished in various ways; but I prefer to utilize a pneumatic governor in the compressor-circuit—that is, in the pipe joining the air-tank with the valve-chest 4. This pneumatic governor *per se* may be of any approved construction. In the drawings I have illustrated said governor (designated by P G) as including an electric controller having a spring-tension to its closure position and joined with a piston operating under diaphragmatic action governed by the varying pressure in the storage-tank S T.

The operation of my improved system in its entirety is as follows: Assuming the parts to be in the position shown in Fig. 1, the switch S being open, the controller J cut out, and the pneumatic governor P G in its cut-out position; furthermore, assuming the pressure in the storage-tank to be at its maximum and the controlling-valve V closed and and all parts at rest, the operator first throws the switch-lever of the switch L onto the contact l, and thereby brings the shunt-winding K′ of the dynamo-electric-machine field into circuit with the dynamo-electric-machine armature G A. This is for the purpose of "building up" the field of the dynamo-electric machine from its own energy, since a shunt-wound generator will "build up" more readily than a series-wound one. The operator next opens the valve V to make communication between the storage-tank S T and the valve-chamber or chest 4. This causes the air-compressor 1 to operate as an air-engine. As soon as the air-pressure in the tank has fallen below a predetermined minimum point the pneumatic governor will close the circuit at the pneumatic governor P G, which is normally open when the pressure in the tank S T is at a maximum. As the parts are now running the dynamo-electric machine E M is generating a potential nearly equal to the main-line potential and at the same time energizing its own field. The operator next moves the controller J to its first notch. This allows the current generated by the dynamo-electric machine to flow to the third rail and from thence to the high-resistance winding of the switch S to the ground or traction rail and from thence back to the dynamo-electric machine. This current produces a magnetic field in the solenoid of the switch S in the usual well-known manner, thereby "sucking up" the iron plunger I P and cutting in the main-line circuit through the low-resistance solenoid-winding and cutting out the local dynamo-electric-machine circuit through the high-resistance solenoid of the switch S. Now since the potential of the main line is always slightly in excess of that generated by the dynamo-electric machine E M this excess potential will force a current through the dynamo-electric machine in the opposite direction through which it had been formerly flowing, and thereby cause the generator E M to "speed up" and act as a motor to compress air in the tank S T, as before described. As soon as the air-pressure in the tank S T is again at its maximum the pneumatic governor P G again cuts out the dynamo-electric-machine circuit, it being understood that before the air in the tank S T again reaches a maximum pressure the operator will have turned the controller J to the second notch to "cut in" the traction-motors F. As soon as the air is again at its maximum pressure in the tank S T and the dynamo-electric-machine circuit cut out by the pneumatic governor P G the operator closes the valve V. The trolley is so constructed as to bridge the insulation between two successive sections of the third rail. Therefore each successive rail-section will be brought into circuit by having its switch "picked up" by the current in the preceding section, which preceding section immediately the trolley passes over it becomes disenergized. Should the car be brought to a full stop and the controller J turned entirely off, as shown in Fig. 1, the foregoing cycle of operations will be repeated. Should it be desirable to stop the car and start again without going through the above cycle of operations, the operator will first close the switch R S, thereby short-circuiting a portion of the main-line current through the two banks of resistance R R′, and this current is only sufficient to hold switches closed. He then returns the controller J to the first notch, as shown in Fig. 8, which cuts out the traction-motors, and allows the car to come to rest. To start again, it is only necessary to turn the controller J to the second notch, as shown in Fig. 9, which again cuts in the traction-motor F′. Should it be desired to keep the dynamo-electric-machine field energized at all times, the shunt-coil K′ is brought into circuit with the main line by turning the switch-lever L to the contact l'.

I provide the usual short-circuit switch M and safety blow-out N, which operates in the ordinary manner. While I have described my dynamo-electric machine as having its field energized by the shunt-coil K′, yet I desire it understood that such action is not absolutely necessary, as the series coil K will answer the same purpose.

In Fig. 8 I have shown the position the various parts assume just after the dynamo-electric machine E M has furnished current to pick up the switch and the main-line current just placed in circuit and just before the controller J is turned to the second or traction-motor notch, the dynamo-electric machine E M now acting as a motor and driving the air-pump l to bring the pressure in the storage-tank S T up to the maximum again. In Fig. 9 I have shown the same parts in the positions they assume just at the instant when the pressure in the storage-tank is again at a maximum, the pneumatic governor P G having just cut out the dynamo-electric-machine circuit and the controller J being on the second or traction-motor-circuit notch. At this time the dynamo-electric machine has been running as a motor to store air in the tank; but the instant the pneumatic governor cuts out the dynamo-electric machine from the main-line circuit the air-pump then begins again to act, this time as an engine, driving the dynamo-electric machine E M as a generator again, and as soon as the pressure in the tank has fallen again to the predetermined minimum the pneumatic governor again cuts in the main-line circuit and the above cycle of operations is again repeated. So long as the main line is in circuit the dynamo-electric machine E M causes air to be stored in the tank until a predetermined maximum pressure is reached, when the pneumatic governor cuts out the main line until the pressure is again at a predetermined minimum. These operations are continuously repeated as long as the main-line current is available or until the valve V is turned off.

While I have described my invention as being especially adapted for use in picking up switches for cutting in and controlling the main-line current, it will be apparent to those skilled in the art that the dynamo-electric machine E M may be utilized for a limited time to furnish current to operate the traction-motor F in case the main-line circuit becomes broken. In this way the car may be run over one or more dead sections of the third rail, if desired, and as is sometimes found necessary—for instance, when one or more switches become inoperative or when the current has been cut off from a section of third rail while making repairs, &c.

In the drawings the switches S are shown as of the solenoid type, the plunger consisting of the iron or magnetic portion I P and the non-magnetic portion N P, as shown, and the circuits F designate the traction-motor circuit, H the compressor-motor circuit, J the ordinary controller common to both circuits, R R′ resistance-coils, K and K′ the field-windings for the compressor-motor, L and M circuit-closing switches of the usual type, and N a safety blow-out.

From the foregoing, taken in connection with the accompanying drawings, it is believed the complete operation and the advantages of my invention will be readily understood by those skilled in the art to which it appertains.

It will be noticed the placing of puppet-valves on the hollow piston-heads, as described, adapted to cöoperate with the shifting valve devices, permits of passing air from exterior into the cylinder, but not in reverse direction. While I prefer to place the puppet-valves in the piston-head for the purposes stated, I desire it understood I do not limit myself to such exact arrangement of said valves to produce the results stated. Neither do I confine myself to the exact arrangement of the means for interfering with the distribution of the air to the cylinders for engine purposes, as these may be varied or modified without departing from my invention or the scope of the appended claims. For example, the governor devices may alter the motion of the controlling-valve 5 so far that the machine may become a compressor without using the puppet-valves referred to at all, for in the practical arrangement of my mechanism the valve 5 may be arranged to shift back and forth at the proper times, so as to open the port $1^{\times}$ to admit air to the tank and to open to the exhaust when the piston is drawing in air. The parts are also so arranged that the shifting valve does not entirely stop when the engine becomes a compressor. It still has a short motion, but not sufficient to uncover the ports $1^{\times}$. (Shown in Figs. 2 and 10.) It will, however, be understood the parts can be arranged so as to entirely stop the valve by means of having the joint 9^{a} of the governor devices adjusted to the center of the axis of rotation; but this is not absolutely necessary.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. A means for transforming energy for the purposes described, comprising a dynamo-electric machine, a fluid-pressure mechanism for driving the dynamo-electric machine, a device governed by the fluid-pressure to cause the dynamo-electric machine to act as a motor to furnish energy to restore said fluid-pressure.

2. A dynamo-electric machine, fluid-pressure drive mechanism connected with the shaft thereof adapted when driven by the fluid-pressure to operate the dynamo-electric machine as a dynamo, and mechanical devices electrically connected with the dynamo-electric machine for causing the dynamo-electric machine to act as a motor to operate the fluid-pressure drive mechanism to restore the fluid-pressure.

3. In an electric-railroad system as described, a drive mechanism adapted to be alternately adjusted to serve as an engine and as an air-compressing means, a dynamo-electric machine coupling with said mechanism

and mechanical devices electrically connected with the dynamo electrical machine for controlling the drive mechanism to cause it to act either as a dynamo-electric-machine driver, or as an air-compressing means driven by the dynamo-electric machine when it, the dynamo-electric machine, acts as a motor.

4. A dynamo-electric machine, an air-compressor coöperatively joined therewith, an air-storage tank, and valved connections intermediate the tank and compressor, in combination with means controlled by the varying pressure in the storage-tank for using the dynamo-electric machine as a generator or as a motor, as conditions may require.

5. In a mechanism for the purposes described, an air-compressor, dynamo-electric machine coöperatively joined therewith, a storage-tank, valved connections intermediate the tank and the compressor, said air-compressor including a shiftable valve for distributing air to or from the piston-chambers of the compressor, or interferring with such distribution, and an inertia governor mechanism coupled with the drive-shaft for the compressor and the dynamo-electric machine, and linked with the aforesaid shiftable valve.

6. The combination with a dynamo-electric machine, an air-compressor, a crank-shaft, common to the compressor and the dynamo-electric machine, an air-storage tank; of means controlled by the varying pressure in the storage-tank for cutting out current that operates the compressor and motor as means for storing power and adjusting the said compressor and dynamo-electric-machine devices to operate under fluid-pressure for generating electric current, as set forth.

7. In a mechanism as described, the combination with the dynamo-electric machine, the dynamo-electric-machine crank-shaft, a piston connected to the crank-shaft, a cylinder for the piston, said piston having valved outlets for bringing into communication the cylinder at the opposite sides of the piston, a storage-tank, a valve-chest coöperating with the piston-cylinder, said cylinder having a direct and an indirect channel communication with the said chest, a valve for closing off the indirect channel on the downstroke of the piston, and adapted to open by air-pressure from the cylinder, said direct and indirect channels having a common outlet to the storage-tank, a slide-valve within the chest for controlling the direct channel or air-feed to or from the storage-tank to the piston-chest, and means controlled by the variable speed of the crank-shaft for operating the shiftable valve, all being arranged substantially as shown and for the purposes described.

8. The combination with an air-storage tank and a dynamo-electric machine; of an engine mechanism connected with the storage-tank and the dynamo-electric machine, adapted to be alternately operated by motor-power to charge the storage-tank or by fluid-pressure from the tank to operate the dynamo-electric machine as a generator, said engine mechanism including shiftable valve devices for controlling the inflow and outflow of air to the piston-chamber, and means controlled by the variable speed of the engine-shaft for setting the said valve devices to meet the conditions required.

9. The combination of an air-storage tank, a dynamo-electric machine and an engine mechanism connected with the said dynamo-electric machine and storage-tank, said engine mechanism including valve devices, including a sliding valve for controlling the inflow and outflow of air between its piston-chambers and the storage-tank, and mechanism controlled by the variable speed of the engine-shaft, for holding the sliding valve over its ports when the engine is operated by the dynamo-electric-machine power to pump air into the storage-tank, and to move said slide-valve to control the fluid-pressure from the storage-tank to said cylinders, for operating the engine to impart motion to the dynamo-electric machine to cause it to act as a generator, for the purposes stated.

10. A mechanism for the purposes described, comprising, an air-compressing means, an air-storage tank, a dynamo-electric machine coupled with the compressing means, adapted under certain conditions to impart motion to the compressor means for creating pressure in the storage-tank, a controller in the dynamo-electric-machine circuit governed by the pressure in the air-storage tank, and adapted under a predetermined maximum pressure to cut out the dynamo-electric machine as a driving power, and under a predetermined minimum pressure to restore the circuit to said motor and cause it to again serve as a driving power, a centrifugal governor on the dynamo-electric-machine shaft, valve devices forming a part of the air-compressing means, including a shiftable valve in the air-conveying means between the compressor and the storage-tank, said shiftable valve, controlling the in and out flow of the air from the piston-chamber of the compressor, and connections joining the said shiftable valve and the governor on the dynamo-electric-machine shaft for controlling the air-feed to the compressing means, when they are operated under fluid-pressure to drive the dynamo-electric machine, for the purposes specified.

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