No. 708,026. Patented Sept. 2, 1902.

W. H. CLARKE.

ELECTRIC CONTROLLER.

(Application filed Oct. 11, 1901.)

(No Model.)

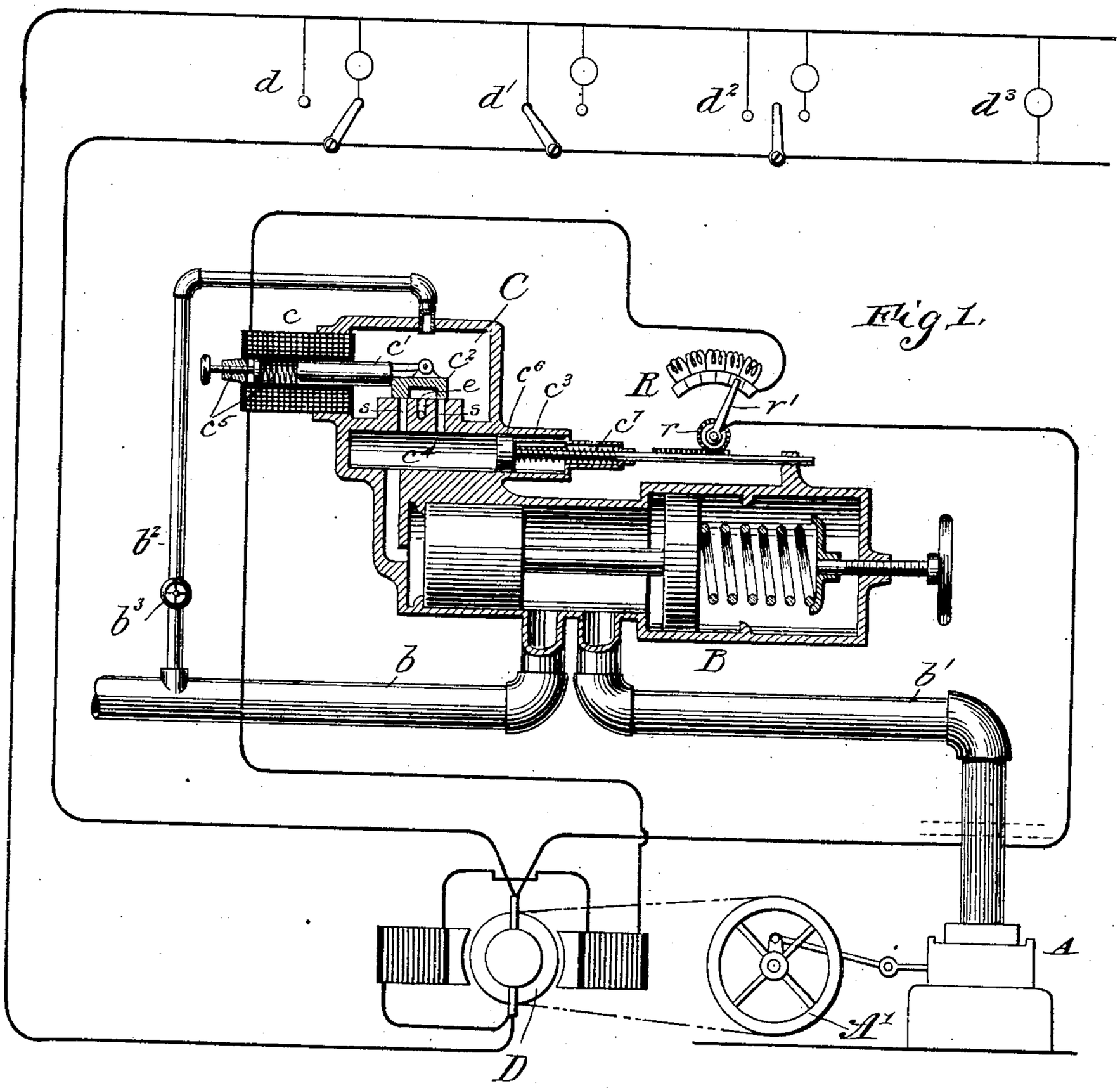


Fig. 1.

Fig. 2.

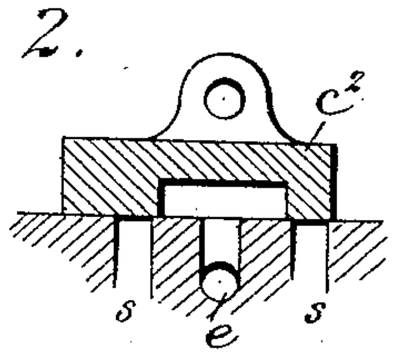
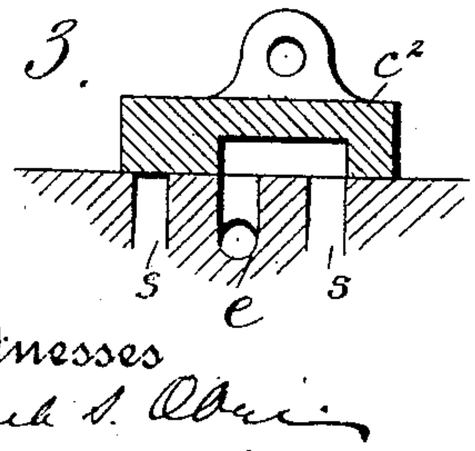


Fig. 3.



Witnesses
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Fig. 4.

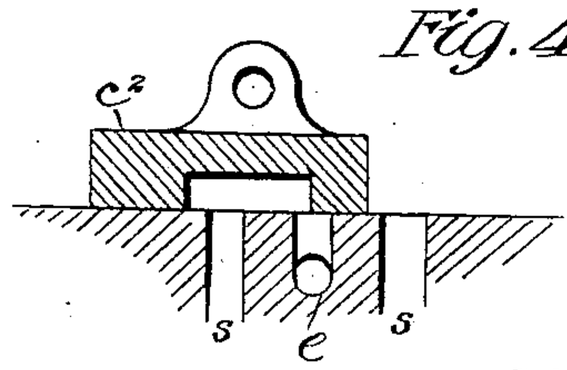
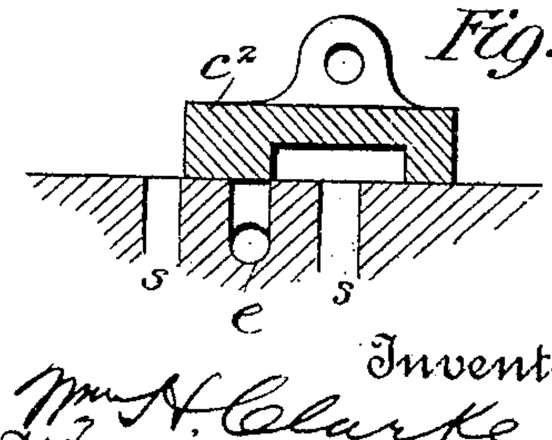


Fig. 5.



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UNITED STATES PATENT OFFICE.

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ELECTRIC CONTROLLER.

SPECIFICATION forming part of Letters Patent No. 708,026, dated September 2, 1902.

Application filed October 11, 1901. Serial No. 78,317. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM H. CLARKE, a citizen of the United States, residing at the city of New York, in the borough of Brooklyn and State of New York, have invented certain new and useful Improvements in Electric Controllers, of which the following is a full, clear, and exact description.

This invention relates to electric controllers for fluid-pressure motors, such as steam-engines, driving manufacturing or electric plants of any description. Its primary objects are, first, to furnish a very sensitive governing mechanism for such engines, so that a practically uniform speed may be maintained under all variations of normal load; second, to provide means for anticipating sudden and considerable changes of load, thus holding the speed constant despite such changes; third, to provide means for suddenly stopping the plant in case of accident to the machinery or operatives. These objects are accomplished by the use of certain improved mechanism in conjunction with a part of the devices shown and described in my application for patent on an electromagnetic valve-controller, filed May 10, 1900, Serial No. 16,119.

My invention is illustrated in the accompanying drawings, in which—

Figure 1 represents an elevation of my improved controlling mechanism in part section and perspective, and Figs. 2, 3, 4, and 5 show the slide-valve c^2 of Fig. 1 in its various positions.

Like letters refer to like parts in each figure.

B represents a differential piston-pressure-reducing valve such as is described in my previous application above mentioned. Boiler-pressure is admitted thereto through the supply-pipe b, and the reduced pressure is delivered to the steam-motor A through pipe b'. The driving-pulley of such motor is shown at A′ and is belted to the shunt-dynamo D.

The chamber C contains the solenoid c, fitted securely into one side thereof and provided with the armature c' and adjusting spring and screw c^5. The slide-valve c^2 is secured to the armature and moves therewith.

b^2 is a branch pipe for admitting high-pressure steam from pipe b to the chamber c. The various positions assumed by slide-valve c^2 in governing supply and exhaust ports s and e of chamber C are shown in Figs. 2 to 5, as hereinafter explained.

b^3 is a stop-cock manually governing the admission of pressure from pipe b to chamber C. Fluid-pressure in chamber C is admitted by slide-valve c^2 to chamber c^4, from which a pipe is run to one side of the minor piston of reducing-valve B. The armature-chamber of solenoid c is open to and forms a part of chamber C. The rheostat R and solenoid c are included in the field-circuit of dynamo D. Each of the switches d, d', and d^2 is provided with one open and two contact points. One of the latter short-circuits the main circuit, as shown at switch d', and the other is used for connecting an incandescent lamp or other current-consuming device across the mains of dynamo D, as indicated at d. Each switch is preferably placed near one of the larger power-consuming machines of the plant and may be either manually operated or connected to the mechanism by which the said machine is started and stopped. Any desired number of these switches may be included in the circuit and distributed among the various floors of the plant. The fixed resistance d^3 serves to maintain a minimum voltage in the main circuit should all of the switches be thrown to open contact, as at d^2. Chamber c^4 is extended to the right by cylinder c^3, in which the piston c^6 is fitted. Its stem is provided with gears which mesh with those of the wheel r, operating the rheostat-arm r'. Fluid-pressure on piston c^6 is opposed by spring c^7.

As will be understood by reference to my previous application for patent, above referred to, the reducing-valve B delivers the desired pressure to steam-motor A regardless of varying boiler-pressure.

The operation may be described as follows: Before steam is admitted to supply-pipe b the reducing-valve will be in the position shown, there being no pressure at that time to oppose the action of its spring, and there being no current then passing through solenoid c its coils will be deënergized and its spring will force the armature c' to the right-hand position, wherein the slide-valve c^2 will close the exhaust-port e and uncover one of the supply-ports s, as per Fig. 5. When the motor is to be started, stop-cock b^3 is closed and boiler-pres-

sure is admitted to pipe *b*, the reducing-valve, and delivery-pipe. Assuming that the electric circuit is unbroken, it will be understood that as the speed of the dynamo increases the strength of solenoid *c* will also increase, and its armature will be gradually drawn to the left against the resilience of spring c^5. When the desired speed of the motor and dynamo has been attained, the stop-cock b^3 is opened, admitting pressure to chamber C and the upper side of the slide-valve c^2. Presuming that at this time the solenoid-spring is so adjusted that the slide-valve is in the position shown in Fig. 2, it will exclude pressure from chamber c^4. If then by reason of a light load on the motor A the speed should still further increase, the solenoid will draw its armature and slide-valve to the left until when in the position of Fig. 4 the right-hand supply-port *s* will be opened, admitting pressure to chamber c^4 and left side of minor piston of the reducing-valve, forcing it to the right and partly throttling the end of pipe *b*, reducing the volume of steam actuating the motor A, and thus slowing the latter slightly. Pressure thus admitted to chamber c^4 will also pass to cylinder c^3 and force piston c^6 to the right until the resulting compression of spring c^7 is sufficient to balance such pressure. This movement of piston c^6 and its stem will operate the rheostat-arm r' through gear-wheel *r* to throw additional resistance into the field-circuit of generator D, and thus restore the slightly-increased voltage to the normal, which will cause the solenoid-armature *c'* and slide-valve c^2 to resume the normal position of Fig. 2, retaining pressure in chamber c^4, and thus holding piston c^6 and rheostat-arm r' in the positions assumed in above operation. From this it will be seen that both the action of the reducing-valve in slightly diminishing the speed of motor A and that of the rheostat R in introducing additional resistance in the field-circuit of the generator combine to restore the normal voltage in the main circuit. It is therefore evident that this device comprehends not only an accurate and sensitive steam-engine governor, but also an efficient automatic voltage-regulator for electric-lighting systems using the shunt type of generator.

The pressure held in chamber c^4, as above described, acts, in conjunction with the differential pressure between the pistons, to hold the latter at a point where the combined pressures are balanced by the force of the reducing-valve spring exerted in the opposite direction. If the lamps at *d*, *d'*, and d^2 are now thrown into circuit, the resulting drop in voltage will decrease the power of solenoid *c*. Its spring will then force the armature to the right, causing the slide-valve to move to the position of Fig. 3 and connect the exhaust-port *e* with right-hand supply-port *s*. The consequent decrease of pressure in chamber c^4 will allow the spring of reducing-valve to move its pistons somewhat to the left, admitting more steam to the motor. The drop in voltage will also result in a limited movement to the left of piston c^6 through above-described reduction of fluid-pressure in chamber c^4, and the rheostat R will thus be actuated to restore the normal voltage in the manner heretofore described. It will thus be seen that the variation of fluid-pressure delivered to the motor A, preserving a constant speed under changing load, and the operation of rheostat R to restore normal voltage through the field-circuit, as described, work conjointly in effecting the desired result.

As before stated, each of the switches is placed near its power-consuming machine, and when it is desired to start the latter its switch is first thrown to connect its lamp across the mains and the belt is immediately thereafter shifted or other connecting device operated to throw the machine in gear with the shafting or other power-transmitting mechanism driven by the motor A. This will result in an almost instantaneous movement of the armature *c'* to the right in the manner before described, and the slide-valve will assume the position shown in Fig. 3, allowing a part of the pressure to escape from chamber c^4. The reducing-valve will thereupon be forced slightly to the left, admitting additional pressure to the motor, the effect of which will be felt at or about the time the extra load above mentioned is thrown in, and the speed of the plant will thus be maintained in spite of the increased load. When a machine is to be stopped, the reverse action takes place, and it is evident that this operation will be the same should several machines be connected or disconnected at the same moment, provided the switches are first moved as described. In the majority of steam plants as at present operated, where the motor is governed by one of the many types of centrifugal regulator, such accessions of load are accompanied by a temporary slowing down of the plant, after which a slow acceleration to normal speed takes place. This oftentimes results in great inconvenience, loss of time, &c., in the operation of the plant.

If it is desired to suddenly stop the plant for the purpose of saving life or property, as when operatives or goods become entangled in the machinery, a switch may be thrown to contact, as at *d'*, short-circuiting the armature of dynamo D and deënergizing its field-circuit. The solenoid being thus demagnetized, its spring will force the slide-valve to the position shown in Fig. 5, admitting full pressure to chamber c^4, equalizing pressure on the minor piston of reducing-valve B and leaving the larger piston free to force both to the extreme right stroke, thus shutting down the motor promptly.

It will be seen from the foregoing that whatever the number of lamps connected across the main circuit the slide-valve c^2 will almost immediately assume the position of Fig. 2 through the operation of rheostat R in restoring normal voltage and will thereafter be

held in that position until the existing pressure in chamber c^4 be varied by another alteration of the load of dynamo or motor or by leakage past the reducing or slide valves.

In the case of electric motors operated from a main circuit for driving tools, small machines, &c., it is common practice to provide each with a switch by which the main current is turned on or off and a manually-operated starting-rheostat by means of which the desired speed of the motor is attained before the full current strength is admitted to its armature and fields. In the adaptation of my improved regulating system to such a motor-operated plant the rheostat R would be in the main circuit and a shunt would be run from the armature-terminals of the motor through the solenoid *c*. Assuming that fluid-pressure is at all times present in chamber C, it will pass to chamber c^4 freely, the slide-valve being in the position shown in Fig. 5 before the motor is started. The piston c^6 will be thus forced to the right extreme stroke, throwing the maximum resistance in series with the motor. When the main switch is thrown to contact, the motor will start slowly, and as the current builds up in the main circuit mentioned the solenoid-valve will be drawn to the left, assuming the position of Fig. 3 and allowing the pressure on piston c^6 to gradually escape until sufficient resistance has been cut out of the main or motor circuit to allow the motor to accelerate to normal speed. In case of a series-wound motor any variation thereafter from the desired speed of the motor will result in the operation of the solenoid-valve and rheostat to restore such speed in the same manner as has been heretofore described. It is thus evident that this improved system comprehends an automatic starting and regulating device for electric motors.

Where alternating generators are used in electric-light or motor work, the rheostat R and solenoid *c* may be wired in series across one of the low-tension circuits.

When the regulating system as illustrated and described herein is employed in connection with an ordinary steam plant, it is evident that a dynamo of very small size will supply ample current for the circuit and that it may be run at a very high rate of speed as compared with that of the operating-motor. Hence a very slight variation of speed at the motor will be accompanied by a considerable change in the strength of the electric circuit, and even where no separate switches and lamps *d*, *d'*, d^2, and d^3 are used my improved system will be found to be more sensitive in quickly responding to an increase or decrease of the main load on the motor than are governors of the ordinary centrifugal type. It will also be seen that this system is perfectly automatic in rapidly checking or stopping the plant in which it is used in case of accidents frequently happening in such service—viz., the breaking of belts or wires, belts running off of their pulleys, rupture of steam-pipes, &c.—oftentimes resulting in the racing of engines, bursting of fly-wheels, and consequent destruction of life and property. The system is also applicable to marine service, in which the necessity sometimes arises for quickly stopping and reversing engines to prevent impending collision.

The springs and adjusting-screws of the reducing-valve and solenoid enable the operative in charge to readily fix the speed of the motor as desired and to fully control this governing system.

Having described my invention, I claim—

1. In an electric regulator, the combination of a motor, a differential piston controlling the motor, a generator operated by said motor, an electric circuit connected therewith, a rheostat in said circuit, and means governed by the differential piston and rheostat for maintaining a constant speed of the motor, substantially as described.

2. In an electric regulator, the combination of a generator, a rheostat and a solenoid included in the field-circuit of said generator, a piston connected with the rheostat, and a valve operated by the solenoid and controlling the admission of fluid-pressure to said piston, substantially as described.

3. In an electric regulator, the combination of a fluid-pressure motor, an electric generator operated by said motor, a reducing-valve governing the admission of fluid-pressure to said motor, an electromagnetic valve connected with the generator, a rheostat in the field-circuit of the generator, a fluid-pressure motor for the rheostat, and a port or passage governed by said electromagnetic valve for admitting pressure to the rheostat-motor and the reducing-valve, substantially as described.

4. In an electric regulator, the combination of a fluid-pressure motor, a generator operated by said motor, a circuit connecting the armature-terminals of said generator, a short-circuiting switch for said circuit, and means governed by said switch for cutting off the supply of fluid-pressure to the motor, substantially as described.

In witness whereof I subscribe my signature in presence of two witnesses.

WILLIAM H. CLARKE.

Witnesses:

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FRANK S. OBER.