No. 625,792. Patented May 30, 1899.

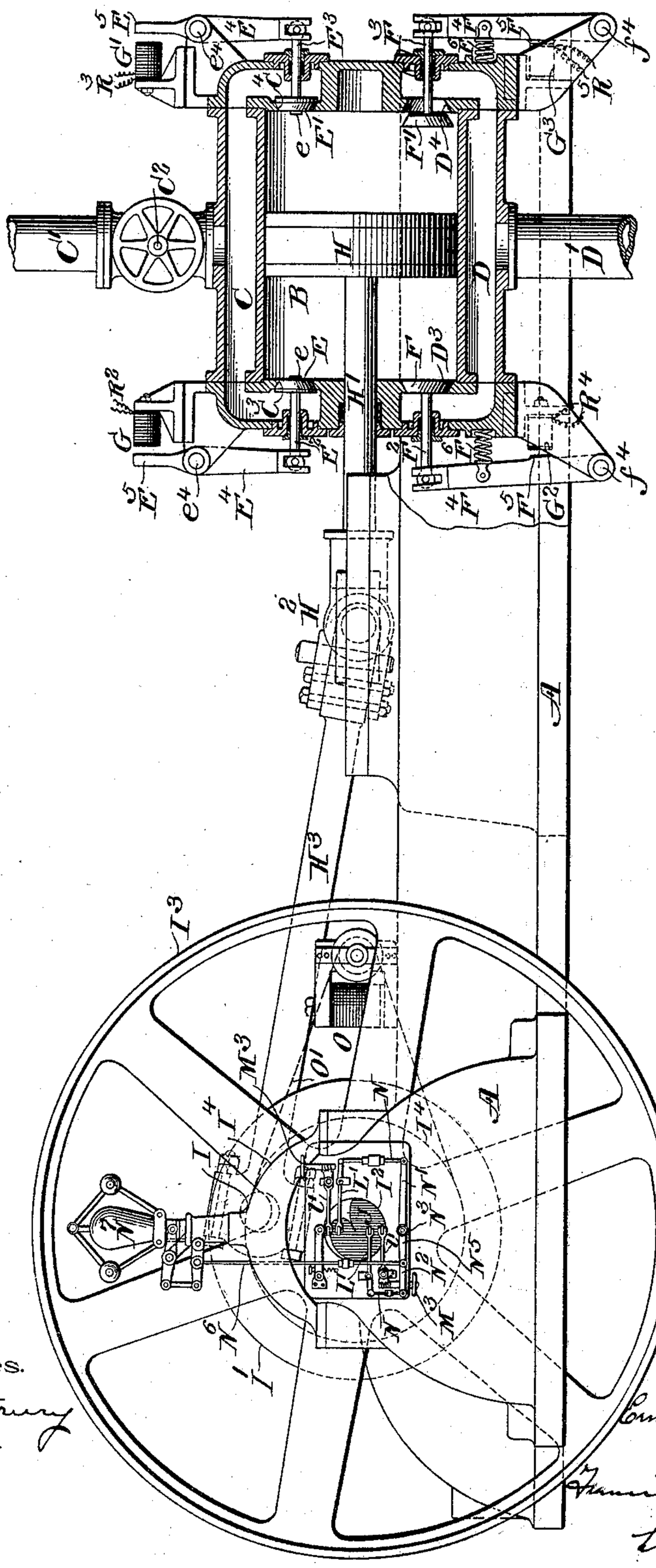
E. W. NAYLOR.

ELECTROMAGNETIC MECHANISM FOR ACTUATING ENGINE VALVES.

(Application filed Aug. 2, 1898.)

(No Model.) 3 Sheets—Sheet 1.

FIG. 1.



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(No Model.) 3 Sheets—Sheet 2.

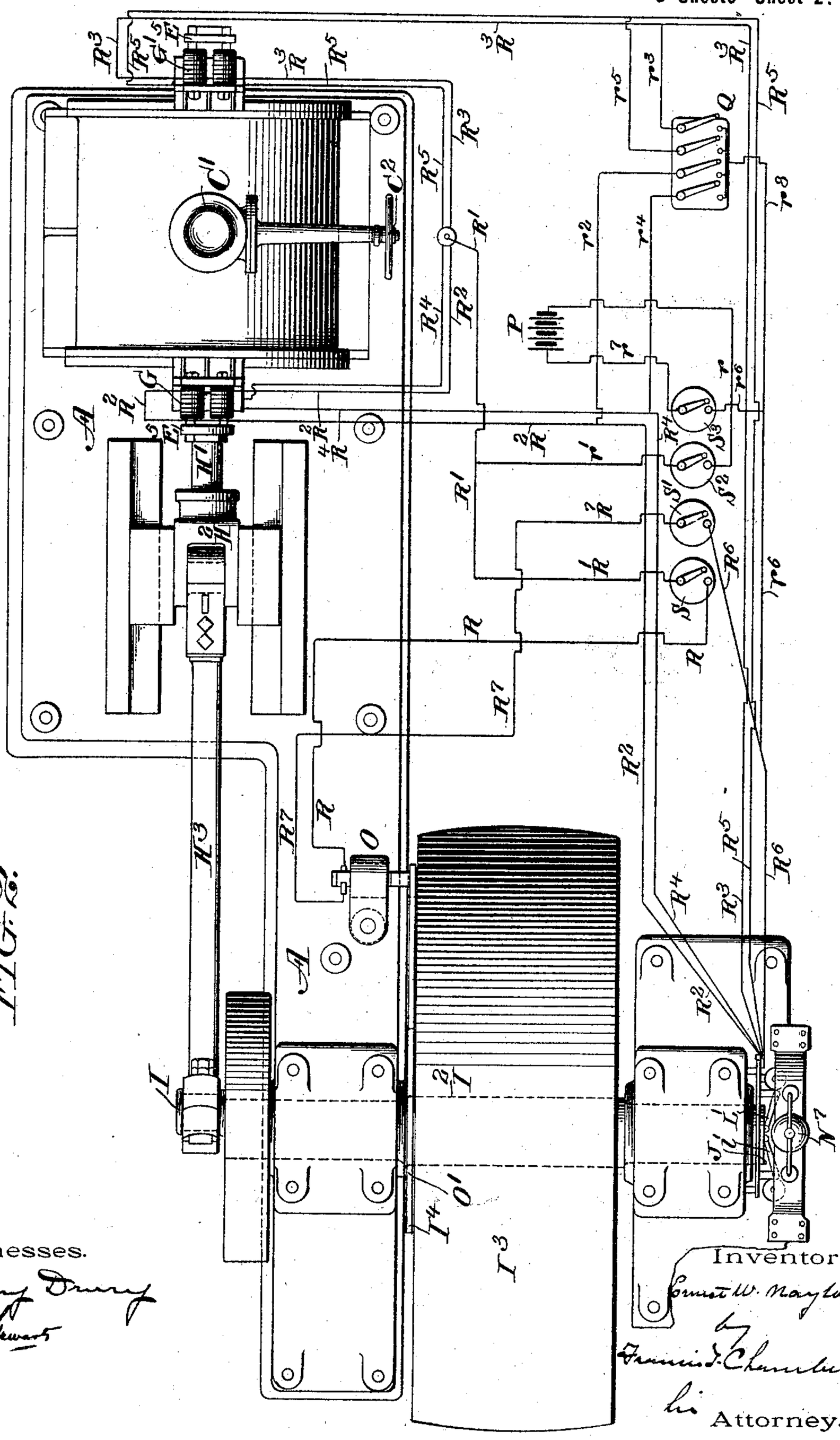

FIG. 2.

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(No Model.) 3 Sheets—Sheet 3.

FIG. 3.

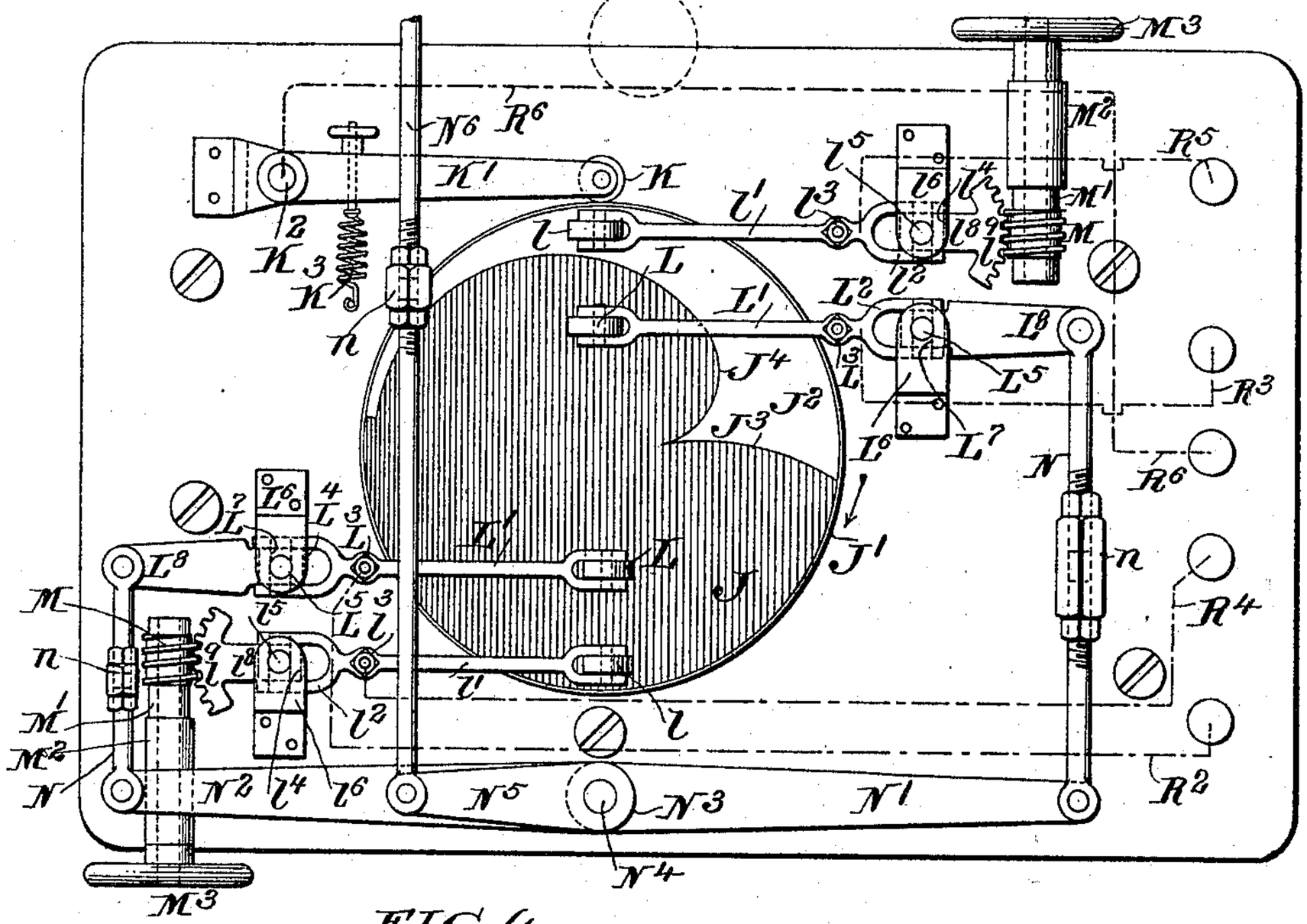


FIG. 4.

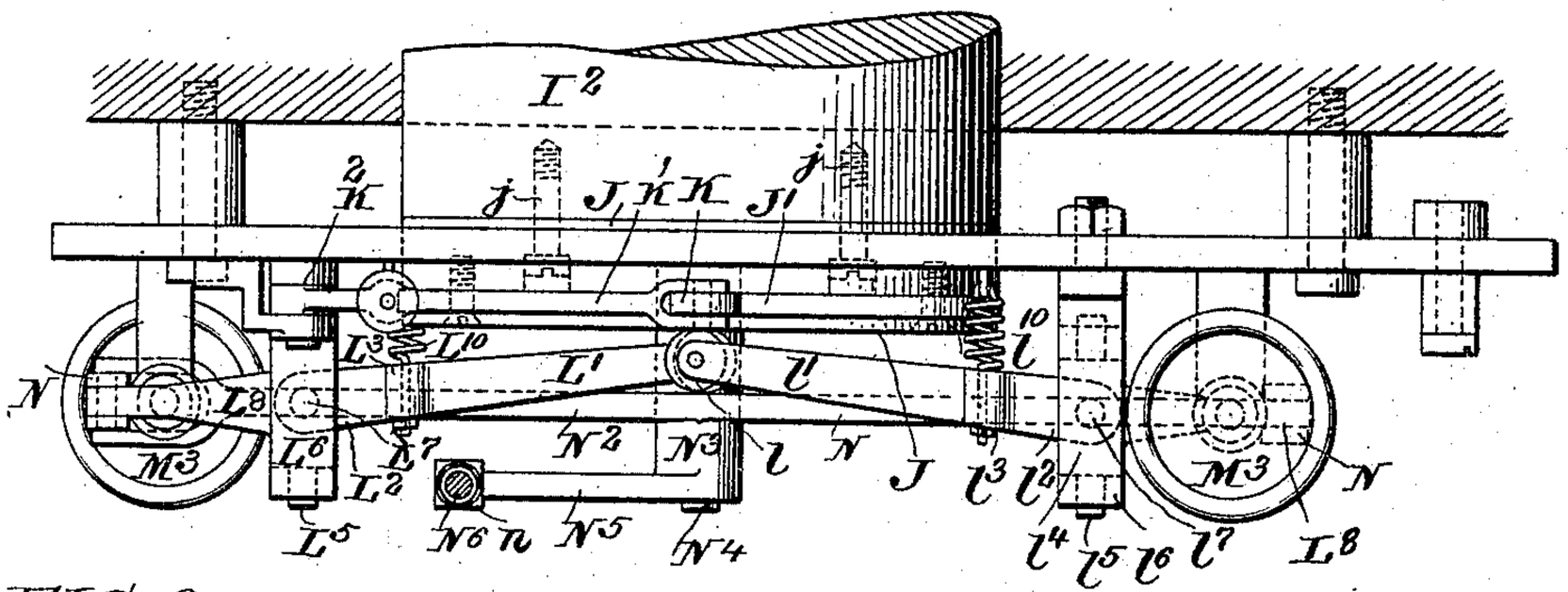


FIG. 6.

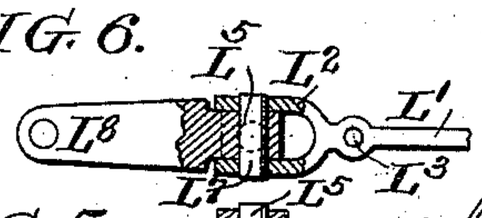


FIG. 5.

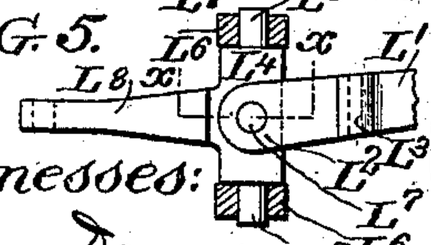
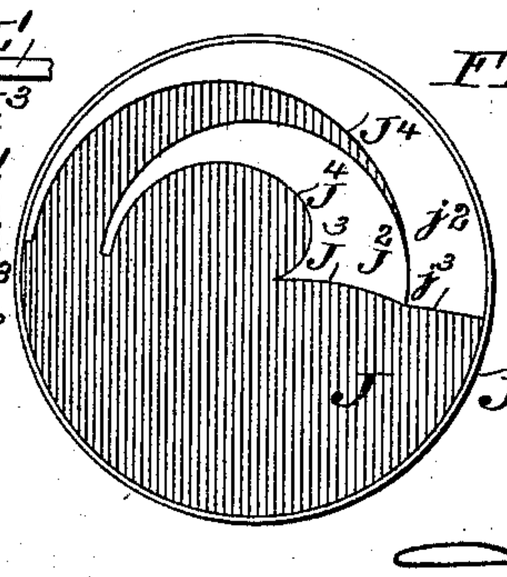


FIG. 7.



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UNITED STATES PATENT OFFICE.

ERNEST W. NAYLOR, OF PHILADELPHIA, PENNSYLVANIA.

ELECTROMAGNETIC MECHANISM FOR ACTUATING ENGINE-VALVES.

SPECIFICATION forming part of Letters Patent No. 625,792, dated May 30, 1899.

Application filed August 2, 1898. Serial No. 687,481. (No model.)

To all whom it may concern:

Be it known that I, ERNEST W. NAYLOR, a citizen of the United States of America, residing in the city and county of Philadelphia, in the State of Pennsylvania, have invented a certain new and useful Improvement in Electromagnetic Mechanism for Actuating Engine-Valves, of which the following is a true and exact description, reference being had to the accompanying drawings, which form a part thereof.

My invention relates to valve-actuating mechanism, and has for its object to provide a simple and efficient electromagnetic valve-actuating device in connection with the admission and exhaust valves, or both, of engines, having particularly in view to enable the engineer to alter the period of admission of the steam or other propelling fluid in an engine and also to alter the compression, both of these adjustments being practicable in my apparatus while the engine is running.

A further object is to provide for the automatic control of the cut-off effected by the admission-valve by means of a governor, my device being of such character that the governor can take care of the engine from a cut of one per cent. to one hundred per cent., as may be desired.

Further objects which I have in view to obtain to a high and efficient degree are the avoidance of the usual valve-gear, substituting for them a simple electromagnetic mechanism, also the normal generation of electric current by the engine, coupled with provision for obtaining a current from other sources in starting the same, and also provision for manually operating each valve independent of the automatic valve-actuating mechanism.

Another object of my invention is to provide a construction of the electromagnetically-operated valves and a combination thereof with the cylinder of the engine whereby the amount of power required to actuate the valve is reduced to a minimum and whereby in case of breakage the danger of further damage from the piston striking with dangerous force on the cylinder-heads is obviated.

The nature of my improvements will be best understood as described in connection with the drawings, in which they are illustrated, and in which—

Figure 1 is a side elevation of a steam-engine provided with my improvements, the cylinder being shown in section passing through the valve-ports. Fig. 2 is a plan view of the engine, coupled with a diagrammatic view of the electric circuits and connections used therein. Fig. 3 is an elevation of the revolving disk and contact-plates, together with the adjustable contact points or rods, which mechanism forms the leading feature of my invention. Fig. 4 is a side elevation of the mechanism shown in Fig. 3. Fig. 5 is an elevation showing in detail the pivotal connections of the contact-rods operating on the face of the disk. Fig. 6 is a plan view of the same mechanism, partly in section, as on the line $x\,x$ of Fig. 5; and Fig. 7 is a plan view of a modified disk and contact-plates.

A indicates the bed or frame of the engine, B the cylinder, and C the live-steam chamber connected with the steam-pipe C′, C^2 indicating a throttle-valve in said steam-pipe, and C^3 and C^4 the conically-seated steam-passages leading from the heads of the cylinder, the seats being adapted for valves which open outward.

D is the exhaust-chamber of the engine, connected with an exhaust-pipe D′ and opening into the cylinder through its heads by means of conically-seated valve-passages D^3 and D^4, the seats being adapted, as shown, for valves which open inward.

E and E′ are conically-faced valves operating in connection with the valve-seats C^3 and C^4 and connected by valve-stems E^2 and E^3 with valve-actuating levers E^4 E^4, said levers being pivoted at e^4 e^4 and provided with armature extensions E^5 E^5, arranged in such relation to electromagnets G and G′ that when the said electromagnets are energized the armatures will be attracted, moving the levers E^4 on their pivots and opening the valves E or E′ in accordance with the energizing of the magnets G and G′.

At e e I have indicated inwardly-extending projections on the valves E and E′, which when the said valves are closed extend into the cylinder in such position as to be struck by the

piston (indicated at H) in case it moves farther toward the head of the cylinder than it does in the normal working of the engine—as, for instance, in case of the breakage of the piston-rod H′.

F and F′ indicate the exhaust-valves of the engine, provided with conical faces adapted to seat themselves on the ports D^3 and D^4 and to open by movement into the cylinder of the engine. These valves are connected by rods F^2 and F^3 with valve-actuating levers F^4 F^4, pivoted, as shown, at f^4 f^4 and provided with armatures F^5 F^5, arranged in such relation to electromagnets G^2 and G^3 that they will be attracted and the levers moved to open the valves F and F′ as the electromagnets G^2 and G^3, respectively, are energized.

At F^6 F^6, I have indicated springs the function of which is to normally hold the exhaust-valves closed.

H^2 indicates the cross-head whereby the piston-rod H′ is connected with the connecting-rod H^3 and through it with the crank-pin I, which, as shown, is secured on a disk I′, attached in turn to the main shaft I^2 of the engine, I^3 indicating the belt-wheel of the engine, and I^4 a belt-wheel provided for transmitting power to a dynamo.

J indicates a disk which, as shown and as conveniently constructed, is secured directly on the end of the shaft I^2, as shown, for instance, in Fig. 4, by means of screws *j j*. It will be understood, however, that the disk may be situated in any convenient place so long as it is positively driven by a connection from the moving parts of the engine. The disk or the shaded portions thereof, as shown in Figs. 3 and 7, are made of or covered with a non-conducting material.

J′ indicates a peripheral contact-plate of conducting material, and J^2 a face contact-plate having a sickle-like form and an inner edge J^4 in the form of a curve receding from the center of the disk J, about which center it will be understood the disk revolves.

J^3 indicates the front edge of the contact-plate, and its position and shape, as well as that of the curved edge J^4, must of course be nicely calculated to work in connection with the particular contact-points operating on the front of the disk, and for the results desired in the operations of the valves of the engine I have shown the face contact-plates as fixed on the front of the disk; but it will be understood, of course, that they can be made adjustable thereon without departure from my invention and that such adjustability would in some cases be desirable. Any convenient mechanism for shifting the contact-plates and securing them in position may be used.

In Fig. 3 I have shown a single contact-plate J^2 on the face of the disk, and in Fig. 7 I have shown two contact-plates, the inner one indicated by the symbol J^2 and the outer one by the symbol j^2. This double arrangement may be advantageously used in some cases, the inner contact-plate working in connection with the contact point or points controlling the admission-valve of the engine and the outer contact-plate working in connection with the point or points controlling the exhaust-valves of the engine. It will be understood that all of the contact-plates, both peripheral and face plates, are in electrical connection with each other.

K indicates a contact-point, here shown in the form of a friction-roller, and secured to a contact-arm K′, pivoted to a fixed point at K^2 and held by means of a spring K^3 in constant contact with the peripheral contact-plate J′.

L L are contact-plates, here shown as rollers secured to contact-arms L′ L′, situated on opposite sides of the center of the disk, upon the face of which the rolls press, the arms having their outer ends forked, as indicated at L^2, and secured by a pivot-pin L^7 to a block L^4, connected in turn by pivot-pins L^5 L^5 to stationary arms or braces L^6 L^6.

L^8 in each case indicates a lever-arm connected to and extending from the block L^4, and L^3 indicates a spring attachment by means of which springs—such as L^{10}, Fig. 4—are connected to draw the rods L′ downward and hold the contact-rolls L on the face of the disk. The lever-arms L^8 L^8 connect by rods N N with lever-arms N′ N^2, connected to a hub N^3, pivoted on a stud N^4 and provided with a lever-arm N^5, which by means of a rod N^6 is connected to a governor, (indicated at N^7 in Fig. 1.)

n n indicate adjusting-nuts which, as shown, are seated in the rods N N and N^6 and by means of which the contact-arms and rolls can be manually shifted and adjusted on the face of the disk.

The connecting mechanism, it will be observed, is such that each movement of the hub N^3 effects a simultaneous and equal movement of the contact-rolls L L toward and away from the center of the disk.

The contact-rolls L L are through their arms L′ L′ connected with electric-circuit wires R^2 and R^3, which in turn are connected with and include another circuit—the electromagnets G and G′, which, as already explained, actuate the admission-valves of the engine. The other contact-points—to wit, the rolls indicated at *l l*, connected with the contact-arms *l′ l′*, the constructions and connections of which arms are substantially identical with those of the arms L′ and are indicated by the small instead of the capital letters—are connected through circuit-wires R^4 and R^5 with the electromagnets G^2 and G^3, actuating the exhaust-valves of the engine; but as the exhaust-valves do not require automatic regulation I provide for the manual adjustment of the contact-rolls *l* in any convenient way. Thus, as shown, I secure upon the lever-arms l^8 segmental racks l^9, engaged by a worm M, secured on a shaft M′, having a bearing at M^2 and actuated by a hand-wheel M^3.

It will be observed in Fig. 3 that the contact-arm K′ is connected with a circuit-wire R^6, and turning to Fig. 2 of the drawings, where the circuit connections are plotted out diagrammatically, it will be seen that the belt-wheel I^4 is connected by a belt O′ with the dynamo (indicated at O) and that from one pole of said dynamo a circuit-wire R extends to a switch S, and when said switch is closed through a wire R′ making electrical connection with four wires, one, R^2, passing through the electromagnet G to one of the contact-arms L′, another, R^3, passing through the electromagnet G′ to the other contact-arm L′, another, R^4, passing through the electromagnet G^2 to one of the contact-arms L′, and a fourth, R^5, passing through the electromagnet G^3 to the outer contact-arms L′. By this arrangement it is obvious that each electromagnet will be energized and its corresponding valve opened whenever its corresponding contact-arm is through its points or roll in contact with the plate J^2 or j^2 and the circuit from the dynamo thus closed passing through the peripheral contact-plate J′ and its contact-arm K′, and obviously the cut-off and the compression of the engine can be nicely regulated by shifting the contact-points on the face of the disk so as to vary the period of their contact with the plate or plates J^2 or j^2.

Where, as I have shown in the drawings and prefer to use, the electric current used in actuating the valves is derived from a dynamo driven by the engine, it is of course desirable that provision should be made for actuating the valves in starting the engine, and I therefore couple my electrical connections with a second source of electrical energy, which may be of any convenient character, a storage battery, as indicated at P, Fig. 2, being well adapted for the purpose. From one pole of the battery a circuit-wire r leads to a switch S^2, and, when said switch is closed, through a wire r' to the wire R′. From the other pole of the battery a wire r^7 leads to a switch S^3, and, when said switch is closed, through a connection r^6 to the connection R^6, which last-mentioned connection extends from the contact-arm K′ to a switch S′, and, when said switch is closed, through the circuit-wire R^7 to the dynamo O. The construction described is such that by closing the switches S and S′ and opening the switches S^2 and S^3 the dynamo will provide all the current to actuate the valves, while by opening the switches S and S′ and closing the switches S^2 S^3 the battery or other source of supply will be coupled to the valve mechanism.

In starting the engine it is desirable to provide means for actuating the valves manually, and this I accomplish by the system of switches indicated at Q, the four switch-buttons shown being coupled by connection R^8 with the wires r^6 R^6 and each button being connectable by an individual lever and through wires R^2, R^3, R^4, and R^5 with the wires r^2, r^3, r^4, and r^5 and so that by closing any switch the corresponding electromagnet in the circuit-wire connected will be energized irrespective of the position of the contact-disk.

By arranging the admission and exhaust valves as described it will be obvious that proper compression being provided for in the operation of the engine each valve will be acted upon to open it when the pressure on both sides of such valve is substantially balanced. Consequently but little power in the electromagnet actuating the valve is required. It will also be obvious that the construction of valves shown is such as to enable the piston to use practically all of the steam admitted to the cylinder to the best advantage, but little waste steam being permitted, and, as already noted, by providing the projections *e* on the admission-valves in case of a breakage the piston will strike against and open the admission-valve before striking the head of the cylinder and by admitting steam prevent a destructive blow, while the immediate closing of the valve after the admission of a small quantity of steam will prevent a dangerous rebound in the piston.

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

1. In combination with a valve of an engine, an electromagnet arranged to actuate said valve, a source of electrical energy, a rotating disk showing a sickle-like contact-plate with its inner edge formed in a curve receding from the center of the disk, a contact-point resting on the face of the disk and adjustable to and from the center thereof, and an electrical circuit embracing the electromagnet aforesaid having one terminal in constant electrical contact with the contact-plate and another in electrical contact with the point aforesaid and through it in intermittent contact with said plate.

2. In combination with an admission-valve of an engine, an electromagnet arranged to actuate said valve, a source of electrical energy, a rotating disk showing a sickle-like contact-plate with its inner edge formed in a curve receding from the center of the disk, a contact-point resting on the face of the disk and adjustable to and from the center thereof, a governor connected to said contact-point as specified and so as to move it toward the center of the disk as the speed increases, and an electrical circuit embracing the electromagnet aforesaid having one terminal in constant electrical contact with the contact-plate and another in electrical contact with the point aforesaid and through it in intermittent contact with said plate.

3. In combination with an engine having admission and exhaust valves and separate electromagnets arranged to actuate them, a source of electrical energy, a rotating disk having one or more sickle-shaped contact-plates secured on its face with its or their inner edges forming curves receding from the center of the disk contact-points resting on

the face of the disk and adjustable to and from its center, an electrical circuit including the electromagnet controlling the admission-valve, one terminal of said circuit being in constant connection with a contact-plate and another in connection with a contact-point operating to intermittently contact with said plate, a governor arranged to move said contact-point toward and from the center of the disk, another electrical circuit including the electromagnet actuating the exhaust-valve and having one terminal in constant connection with a contact-plate and its other terminal in constant connection with the second contact-point and means for adjusting the said last-mentioned contact-point on the disk.

4. As a circuit-controller for electrically-actuated valves, a rotating disk having one or more sickle-shaped contact-plates on its face with their inner edge or edges formed in a curve receding from the center of the disk.

5. As a circuit-controller for electrically-actuated valves, a rotating disk having one or more sickle-shaped contact-plates on its face with their inner edge or edges formed in a curve receding from the center of the disk, and a peripheral contact-plate in electrical connection with said face-plate.

6. In combination with a circuit-controller for electrically-actuated valves consisting of a rotating disk having one or more sickle-shaped contact-plates with its or their inner edges forming a curve receding from the center of the disk, two sets of contact-points symmetrically disposed on each side of the center of the disk as specified and so as to alternately make and break contact with said contact plate or plates.

7. In combination with a circuit-controller for electrically-actuated valves consisting of a rotating disk having one or more sickle-shaped contact-plates with its or their inner edges forming a curve receding from the center of the disk, and a peripheral contact-plate in electrical connection with said face plate or plates, two sets of contact-points symmetrically disposed on each side of the center of the disk as specified and so as to alternately make and break contact with said contact plate or plates, a contact-point in constant contact with the peripheral plate, a source of electrical energy, circuit connections therefrom one connecting to the contact-point resting on the peripheral plate and the other branching so as to connect independently through its separate valve-actuating devices to the face contact-points aforesaid.

8. In a valve-actuating device, substantially as specified, the combination of the revolving disk J and sickle-shaped contact-plates secured thereon, with one or more contact-rods, as L′ pivotally supported as specified to swing in an arc approaching and receding from the center of the disk, and having also capacity to move to and from said disk, and means for moving said arm or arms on its or their pivotal supports.

9. In a valve-actuating device substantially as specified the combination of the revolving disk J and peripheral and sickle-shaped contact-plates secured thereon, with one or more contact-rods as L′ pivotally supported as specified to swing in an arc approaching and receding from the center of the disk, and having also capacity to move to and from said disk, means for moving said arm or arms on its or their pivotal supports and a contact-arm as K′ bearing against the peripheral plate.

10. A steam-engine cylinder having in combination admission-valves E E′ opening outward from the ends of the cylinder, exhaust-valves F F′ opening inward from the ends of the cylinder and electromagnets arranged in connection with each valve to open the same.

11. A steam-engine cylinder having in combination admission-valves E E′ opening outward from the ends of the cylinder and provided with extensions *e e* adapted to extend into the cylinder when said valves are closed, exhaust-valves F F′ opening inward from the ends of the cylinder and electromagnets arranged in connection with each valve to open the same.

12. In combination with an engine having electromagnets arranged to actuate its valves, a dynamo actuated by the engine, a connection from one pole thereof to each electromagnet and through each said magnet to a contact-point, a variable contact device arranged to operate in connection with said contact-points and having electrical connection with the other pole of the dynamo, a second source of electrical energy also connected in circuit with the electromagnets and contact devices and switches whereby the dynamo and second source aforesaid can be cut into and out of circuit.

13. In combination with an engine having electromagnets arranged to actuate its valves, a source of electrical energy, a connection from one pole thereof to each electromagnet and through each said magnet to a contact-point, a variable contact device arranged to operate in connection with said contact-points and having electrical connection with the other pole or source of electrical energy and means for independently closing the connection through each electromagnet at will.

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