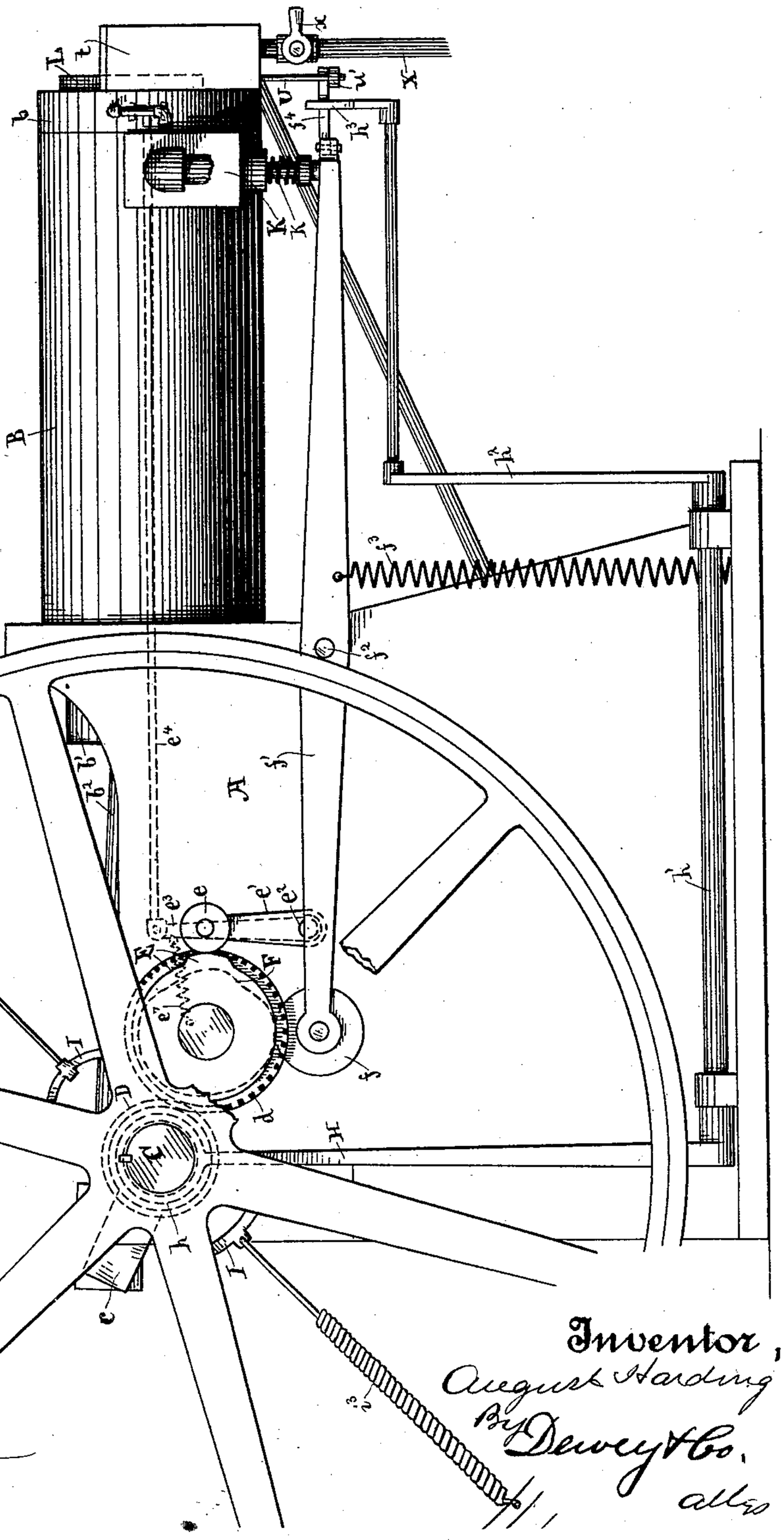
(No Model.) 3 Sheets—Sheet 1.

A. HARDING.

EXPLOSIVE ENGINE.

No. 452,520. Patented May 19, 1891.

Fig. 1.



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(No Model.) 3 Sheets—Sheet 2.

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Fig. 2.

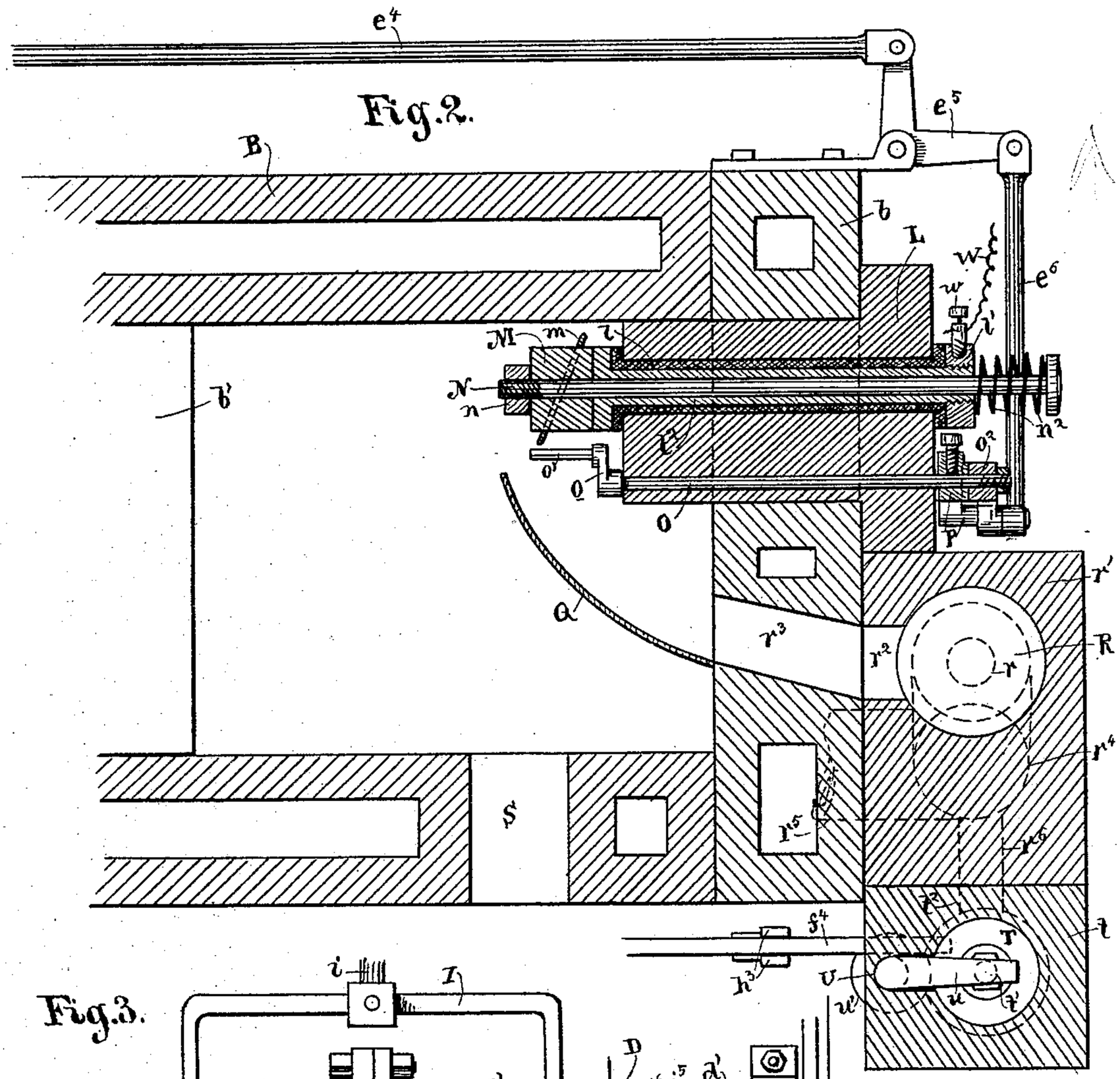
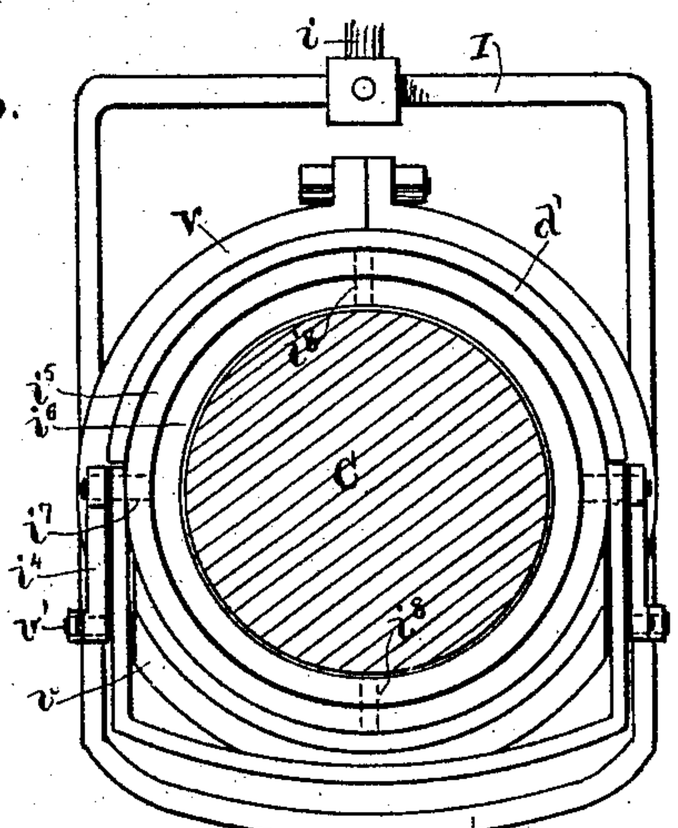


Fig. 3.



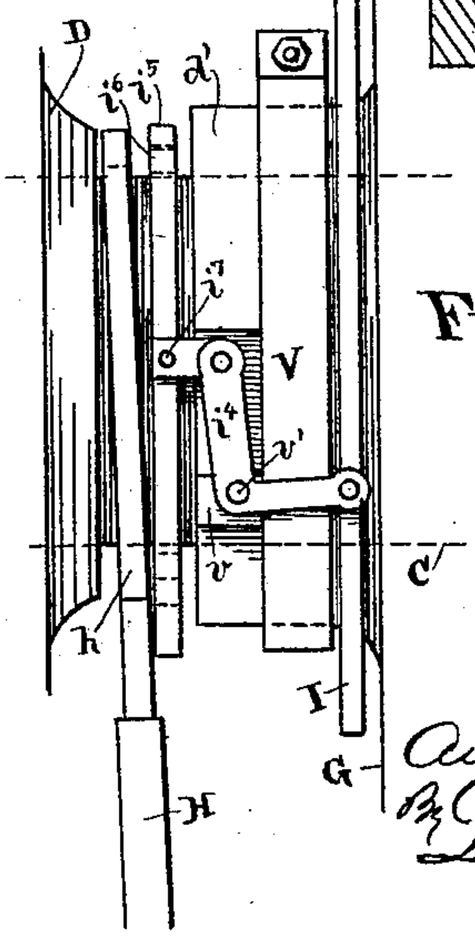


Fig. 4.

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(No Model.) 3 Sheets—Sheet 3.

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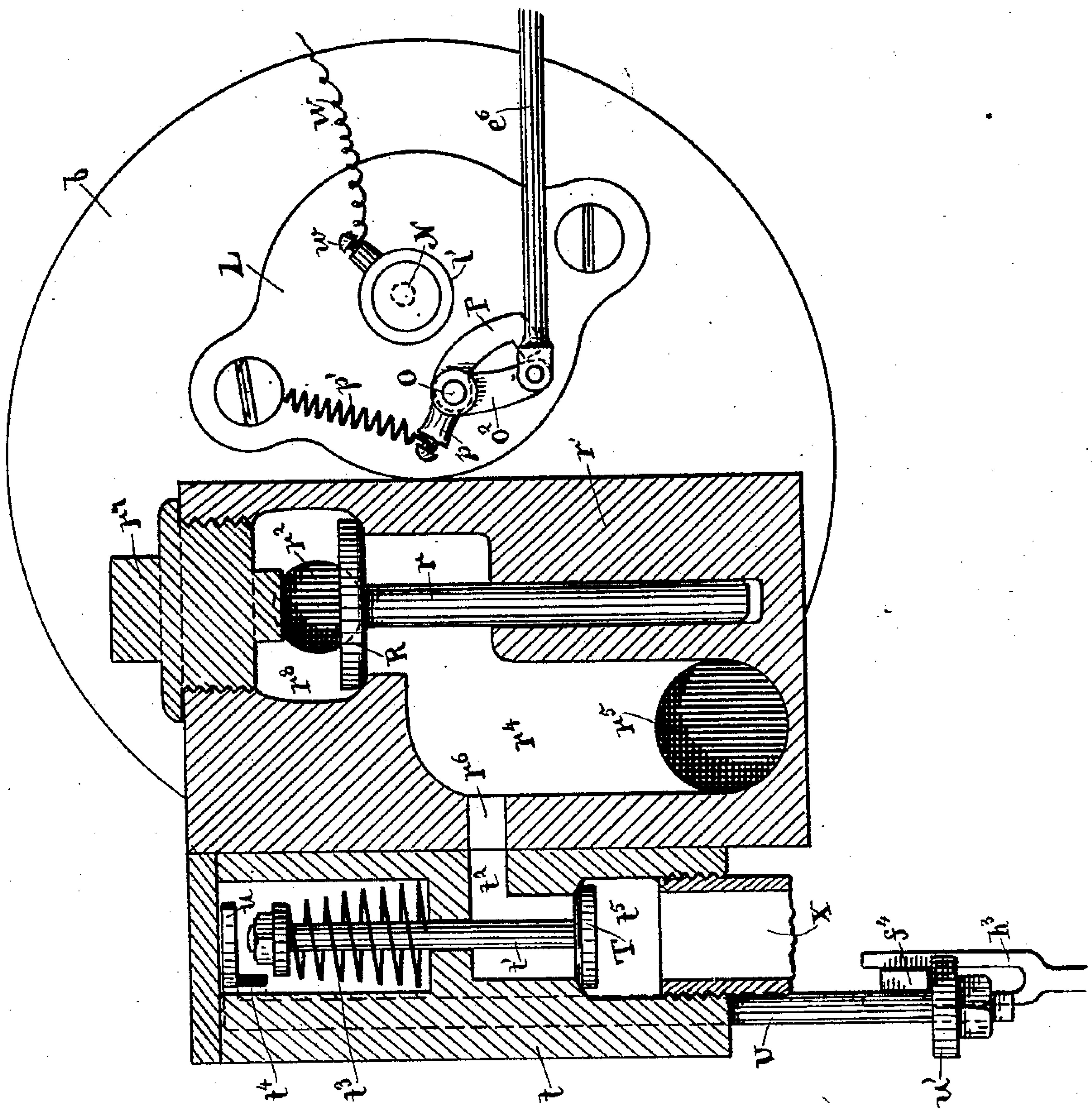
Fig. 5.



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UNITED STATES PATENT OFFICE.

AUGUST HARDING, OF OAKLAND, CALIFORNIA.

EXPLOSIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 452,520, dated May 19, 1891.

Application filed December 10, 1890. Serial No. 374,227. (No model.)

To all whom it may concern:

Be it known that I, AUGUST HARDING, a citizen of the United States, residing at Oakland, Alameda county, State of California, have invented an Improvement in Explosive-Engines; and I hereby declare the following to be a full, clear, and exact description of the same.

My invention relates to that class of explosive-engines in which the explosion is effected by means of an electric spark.

My invention consists in the novel igniting device and mechanism, and in the novel governing mechanism, all of which will be hereinafter fully described, and specifically pointed out in the claims.

The general object of my invention is to provide an explosive-engine the igniting device of which is durable and readily renewable and the governing mechanism is simple and effective.

Referring to the accompanying drawings for a more complete explanation of my invention, Figure 1 is a side elevation of my engine. Fig. 2 is a horizontal section of one end of the cylinder, the igniting mechanism, and the inlet-valve chest. Fig. 3 is a front elevation of the device on the engine-shaft forming part of the governing mechanism. Fig. 4 is a side view of the same. Fig. 5 is a vertical section of the inlet-valve chest and an end elevation of the cylinder.

A is the frame of the engine.

B is the cylinder having the head *b* at one end, the piston *b'*, and the connecting-rod b^2, which joins a crank *c* of the engine-shaft C, on which is mounted the fly-wheel G.

Referring to Fig. 2, I will describe the igniting device and mechanism. Into the head *b* of the cylinder is let the plug L. Through this plug passes the rod N, which carries the stationary electrode. This rod passes through and is mounted in a sleeve l^2, which is thoroughly insulated from the plug by means of the covering *l* of suitable insulating material. On the outer end of the sleeve l^2 is screwed the nut *l'*, which carries the post *w* of the electric circuit W, whereby said sleeve and its contained rod N form part of the circuit. On the inner end of the rod is a carrier-block M held to place by a nut *n*. A spring n^2 on the outer end of the rod serves to hold these parts well together. Around the carrier-block M is fitted the metallic disk or washer *m*, which forms the stationary electrode of the device. This washer, though it may be placed straight, is preferably placed at an angle, as shown, the object of which I shall presently describe. Through the plug L passes the rock-rod O, having on its inner end a crank *o*, with a projecting pin *o'*, which forms the movable electrode. This pin lies normally out of contact with the electrode *m*. The rod O is a rocking one to effect the movement of its electrode, and said rod not being insulated from the metal portions of the engine receives the electric current from said portions, the engine itself being in the electric circuit. The rocking motion of the rod O, which carries the movable electrode, is effected by the following mechanism: Referring to Fig. 1, D is a gear-wheel on the engine-shaft C. This wheel meshes with a gear-wheel *d* on a counter-shaft, said counter-shaft carrying a cam E. e^2 is a rock-shaft, from one end of which extends upwardly a crank-arm *e'*, carrying in its top a roller *e*, against which the cam E operates. On the other end of the rock-shaft e^2 is a crank-arm e^3, from which extends forwardly a connecting-rod e^4, the forward end of which is connected with a bell-crank lever e^5, Fig. 2, said lever being connected with a horizontal rod e^6, the other end of which is connected with an arm o^2. P is a lever rigidly connected with the outer end of the rock-rod O, from which also extends an arm *p*, Fig. 5, with which a spring *p'* is connected. Mounted freely on the outer end of the rock-rod O is the arm o^2, which has connected with its outer end the horizontal rod e^6, and against the outer end of this arm the end of the lever P rests, as is shown in Fig. 5. A spring e^7 is connected with arm e^3 to return the parts.

The operation of this igniting mechanism is as follows: By means of the cam E the rock-shaft e^2 is suitably operated to transmit motion through the several connections to the arm o^2. The normal position of the rock-rod O is such that the electrode *o'* is separated from the electrode *m*. The cam E is so fashioned that during the necessary time this

normal position shall be maintained, but when the cam acts and the rod e^6 is forced forward, the arm o^2 moves forward, and the lever P under the power of spring p' follows it, and thus rocks rod O, thereby causing electrode o' to come in contact with electrode m. Then when the cam relieves the parts the spring e^7 returns them, and the arm o^2, pressing against lever P, effects the turning of rod O and the separation of the electrodes, thereby producing the spark.

As before stated, the electrode m might be placed in a straight position, and by turning its rod N, which is adapted to be axially turned at such times as may be desired, a fresh portion of the electrode m would be presented to the action of the electrode o', but by placing it at an angle, as shown, I have the additional advantage of not only, by the turning of said electrode, presenting a new portion of it, but also reaching a new portion of the electrode o', because of the angle of the electrode m, thereby effecting a great durability in the two electrodes.

Another advantage of this construction of igniting mechanism lies in the fact that both electrodes are carried by a plug L, which can be readily removed from the cylinder-head and another inserted when desired.

The exhaust of the engine takes place by the following mechanism: K in Fig. 1 is the exhaust-chest. k is the stem of the exhaust-valve, which is controlled by a spring and is operated by means of the lever f', which is pivoted at f^2 and is controlled by a spring f^3. The forward end of this lever lies directly under the lower end of the valve-stem k and the rear end of the lever carries a roller f. On the counter-shaft heretofore mentioned is carried a cam F, which bears against the roller f. This cam is so fashioned and timed as to operate the lever f' to lift the stem of the exhaust-valve at proper times to effect the exhaust. The inlet is shown in Figs. 2 and 5. In Fig. 2 r^3 is the inlet-port through the end of the cylinder. Within the cylinder is a directing-plate Q, the object of which is to direct the incoming gas upon the electrodes to keep them cool or have a tendency so to do. In the chest r', on the end of the cylinder, is made the port r^2, communicating with the port r^3, said port opening from a chamber r^8, Fig. 5, having the screw-plug r^7 for a top and controlled by the upwardly-rising valve R, the stem of which is r. Under this valve is the mixing-chamber r^4, having an air-inlet r^5 and a gas-inlet port r^6.

t is a chest having within it the gas-chamber t^5, with which the gas-pipe X communicates, said pipe being controlled by a cock x. This chamber is controlled by a valve T, having a stem t' with a spring t^3 above. The chamber t^5 has a port t^2 communicating with the port r^6. Now by depressing the valve T the gas is allowed to enter, and passing through the ports t^2 and r^6 enters the chamber r^4, and there meeting with the air which enters through the port r^5 is mixed with it, and the pressure of the gas and air raises the valve R, so that the gases pass in through the ports r^2 and r^3 to the cylinder.

The means for operating the inlet-valve T are as follows: In Fig. 5 U is an upwardly-extending rod having an arm u bent at right angles and entering the chest t through an elongated slot t^4. The arm u lies directly above the upper end of the stem t' and when lowered comes in contact with said stem and depresses the valve T, thereby opening it. The rod U is operated by an arm f^4, Figs. 5 and 1, which is pivoted to the forward end of the lever f', said arm bearing upon a nut u' on the lower end of the rod U. Now when the cam sufficiently relieves the lever f' the spring f^3 pulls the forward end of said lever down, whereby the arm f^4, bearing down on the nut u', pulls down the rod U, and thereby opens the valve T.

The governing device will now be understood. It is obvious that if the arm f^4, which operates the inlet-valve, be pushed to one side, so that it will not come in contact with the nut u', the rod U will not be operated and the valve T will not be opened to admit any gas. The arm f^4 is for this purpose pivoted, as before stated, to the lever f', and its movement is effected as follows: Referring to Figs. 4 and 3, V is a bearing-ring, which is firmly clamped about the hub d' of the fly-wheel G. This ring has bearing-arms v, to which are pivoted at v' the connected bell-crank levers i^4. About the hub d' is fitted the elongated bail I, which has a free transverse movement without contact with any portion. Referring to Fig. 1, one side of this bail has a rod i carrying a weight i', the outer end of said rod fitting freely in the deep socket i^2 in the rim of the fly-wheel G. With the other side of the bail I is connected a spring i^3. One of the arms of each bell-crank lever i^4 is pivoted to the bail I, as shown in Fig. 4. The other arms are connected at i^7 by a pivotal joint with a ring i^5, having within it a second ring i^6, pivoted to the first at i^8, said pivotal points being at right angles to the pivotal connections of the outer ring at i^7, thereby effecting a universal joint in the two rings. About the shaft C, between the shaft-bearing and the rings i^5 and i^6, is the yoke h, having connected with its lower end the crank-arm H of the rock-shaft h'. (Shown in Fig. 1.)

It will be seen that when the speed of the engine is increased unduly the centrifugal force of the weight i' will pull the bail I over to one side. This movement of the bail, acting through the bell-crank levers i^4, will push the rings i^5 and i^6 along the shaft, and these rings, coming in contact with the yoke h, will push it over, thereby moving the crank-arm H and rocking the shaft h'. The contact of the rings i^5 and i^6 with the yoke h is an equal one throughout the entire circumference, due

to the construction and movement of the two pivoted rings i^5 and i^6, which bear up squarely against the yoke h, notwithstanding the movement of the bell-crank levers and inclined position of the yoke. Referring to Fig. 1, the other end of the rock-shaft h' has a crank-arm h^2 bent at its upper end into an extension, the outer end of which carries a fork h^3, which embraces the arm f^4, which, as before stated, operates the inlet-valve. Now by the rocking of the shaft h', as heretofore described, the arm f^4 is moved over from contact with the nut u' of the rod U, and the inlet-valve is therefore not operated, consequently reducing the speed of the engine.

In Fig. 2, r^5 represents the water-jacket of the cylinder, and S the exhaust-port.

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

1. In an explosive-engine, and in combination with the movable electrode-pin o', the inclined disk or washer forming the opposing electrode and adapted to be axially turned when desired to present new contact-surfaces between the two electrodes, substantially as herein described.

2. In an explosive-engine, the removable plug L in the cylinder, the removable electrode o', and the inclined disk or washer forming the opposing electrode, said electrodes carried by and passing through said plug, whereby they can be readily removed when desired, substantially as herein described.

3. In an explosive-engine, the combination of the insulated axially-movable rod N, passing into the cylinder, the inclined disk or washer on its inner end and forming one of the electrodes, the rock-rod O, passing into the cylinder, and the pin o' on its end forming the other electrode, substantially as herein described.

4. In an explosive-engine, the combination of the removable plug L in the cylinder, the insulated sleeve in said plug, the axially-movable rod in said sleeve having on its inner end the carrier M, the inclined washer or disk of said carrier forming one of the electrodes, the rock-rod O in said plug, and the pin o' on the inner end of said rod forming the other electrode, substantially as herein described.

5. In an explosive-engine, the rock-rod O, carrying one of the electrodes, in combination with the means for rocking said rod, consisting of the lever P, fast on said rod, the arm o^2, loose thereon and against which the lever P bears, the movable rod e^6, connected with the arm o^2, and the spring p', substantially as herein described.

6. In an explosive-engine, the turn-rod O, carrying one of the electrodes, in combination with the means for rocking said rod, consisting of the lever P, fast on said rod, the arm o^2, loose on the rod and against which the lever P bears, the rod e^6, connected with the arm o^2, the bell-crank lever e^5, the connecting-rod e^4, the rock-shaft e^2, having the crank-arm connected with said rod e^4, the crank-arm e' of said rock-shaft having the roller e, the cam E, deriving motion from the engine-shaft, and the springs p' and e^7, substantially as herein described.

7. In an explosive-engine, the inlet-valve for the gas and the rod U for opening it, in combination with the pivoted arm f^4, operating against said rod to open the valve, and a mechanism comprising a rock-shaft having a fork embracing the pivoted arm, and controlled by the speed of the engine for throwing said arm into and out of connection with said rod, substantially as herein described.

8. In an explosive-engine, the swinging arm f^4, operating the inlet-valve of the engine, in combination with the governing device, whereby the arm is thrown into and out of operation by the speed of the engine, consisting of the movable spring-controlled bail I, having on one side the connected weight, the bell-crank levers i^4, connected with said bail, a ring movable on the engine-shaft and connected with said bell-crank levers, a yoke on the engine-shaft moved by said ring, and connections between said yoke and swinging arm f^4, substantially as herein described.

9. In an explosive-engine, the swinging arm f^4, operating the inlet-valve of the engine, in combination with the governing device, whereby the arm is thrown into and out of operation by the speed of the engine, consisting of the movable spring-controlled bail I, having on one side the connected weight, the bell-crank levers i^4, connected with said bail, a ring movable on the engine-shaft and connected with said bell-crank levers, a yoke on the engine-shaft moved by said ring, a crank-arm connected with the yoke, the rock-shaft h' of said crank-arm, and having the crank-arm h^2 with fork h^3 embracing the arm f^4, substantially as herein described.

10. In an explosive-engine, the combination of the centrifugally-acting bail I, the oppositely-pivoted and concentric rings i^5 and i^6, and bell-crank levers connecting the ring i^5 with the bail, the yoke h, against which the concentric rings operate, the rock-shaft h', having the crank-arm connected with the yoke h, the swinging arm f^4 for operating the inlet-valve of the engine, and connections between said arm and the rock-shaft h', whereby it is thrown into and out of operation, substantially as herein described.

11. In an explosive-engine, the combination of the pivoted spring-controlled lever f' for operating the exhaust of the engine, the swinging arm f^4, carried by said lever for operating the inlet-valve of the engine, the cam deriving motion from the engine-shaft and operating the lever f', the centrifugally-operated bail I, the sliding rings connected with said bail, the yoke h, operated by said rings,

and connections between said yoke and the swinging arm f^4, whereby it is thrown into and out of operation, substantially as herein described.

12. In an explosive-engine, the spring-controlled inlet-valve T, having the stem t', in combination with the vertically-movable rod U, having an arm u, operating above and upon the stem t' to open the valve, substantially as herein described.

In witness whereof I have hereunto set my hand.

AUGUST HARDING.

Witnesses:
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WM. F. BOOTH.