No. 862,847. PATENTED AUG. 6, 1907.

J. V. RICE, Jr.

GAS ACTUATED ROCK DRILL.

APPLICATION FILED APR. 16, 1903.

3 SHEETS—SHEET 1.

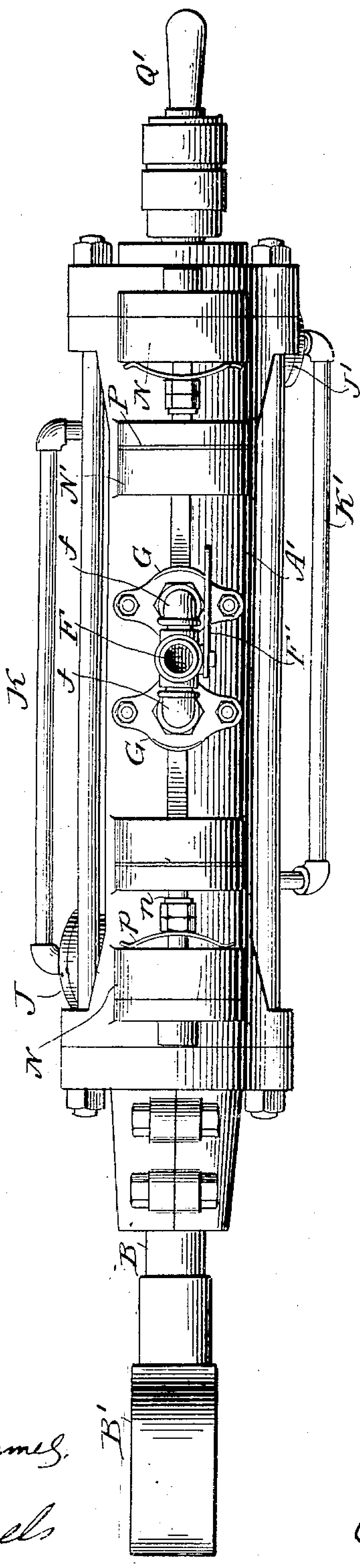

Fig. 1.

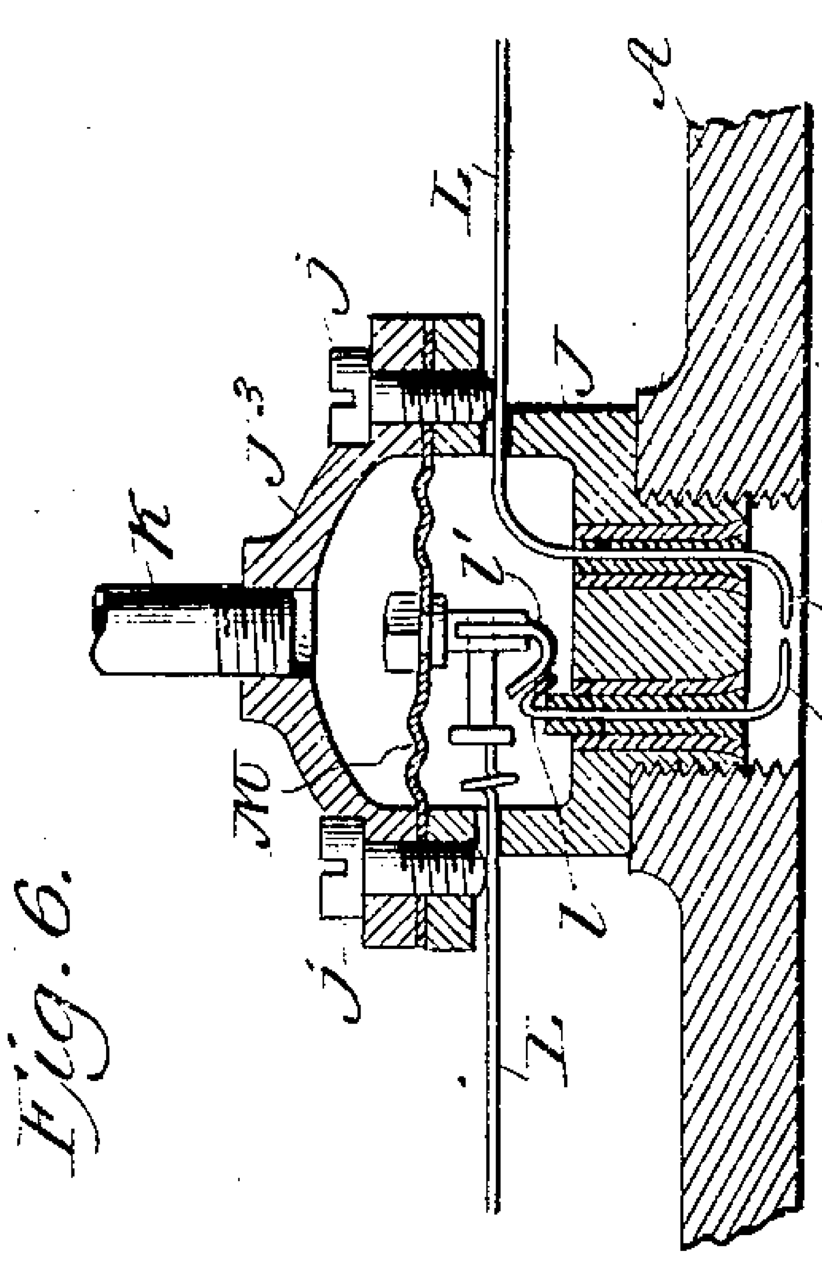

Fig. 6.

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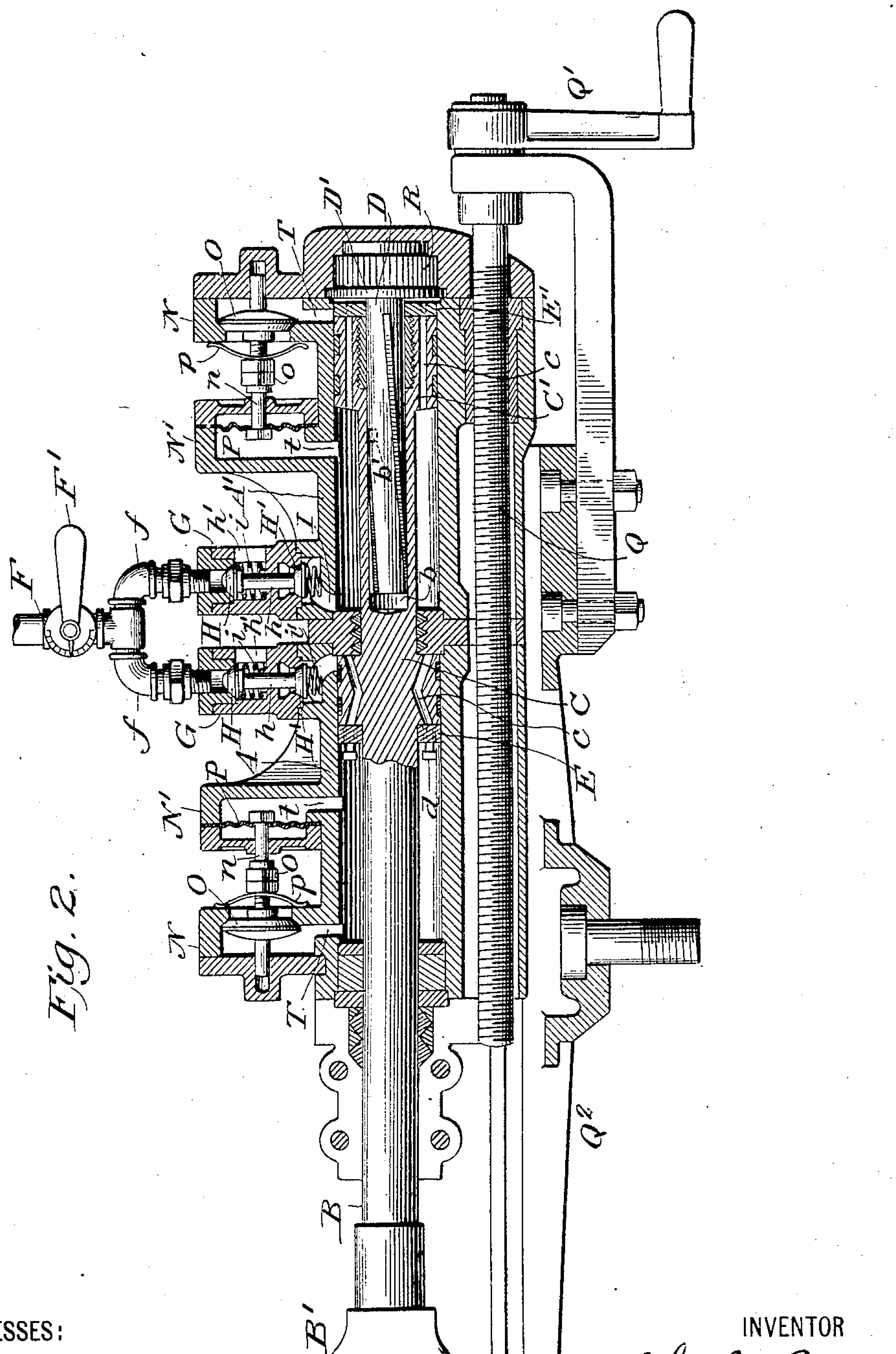

Fig. 2.

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3 SHEETS—SHEET 3.

Fig. 3.

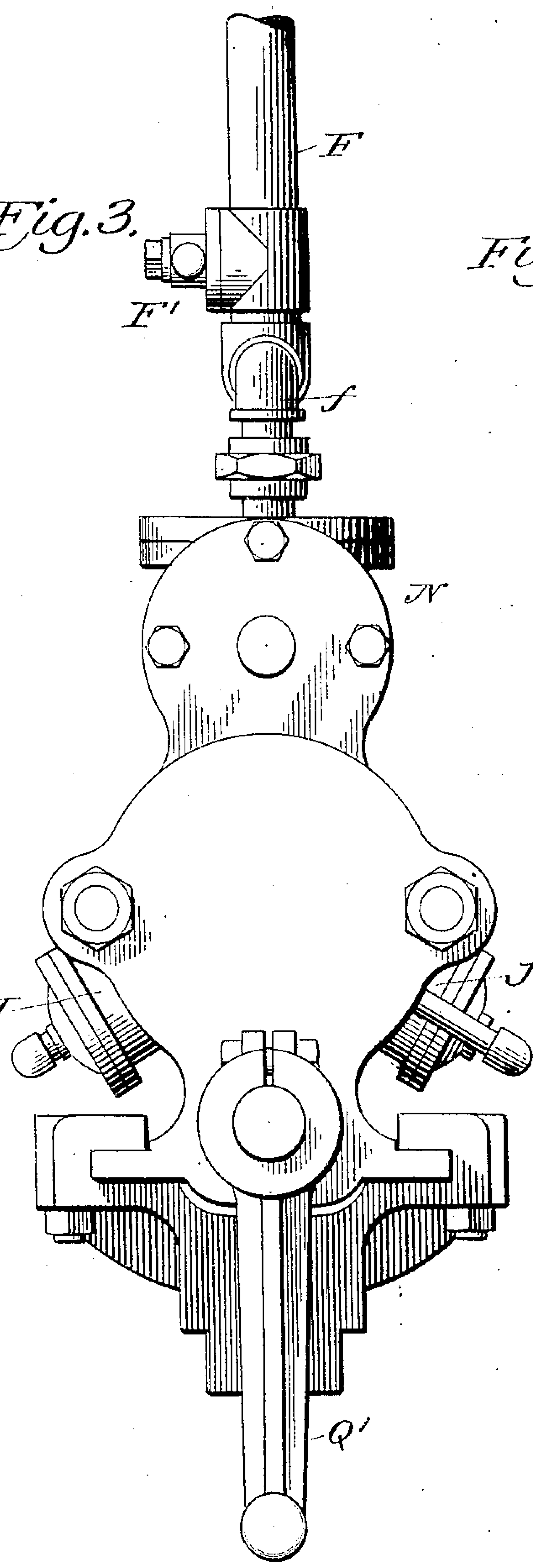


Fig. 4.

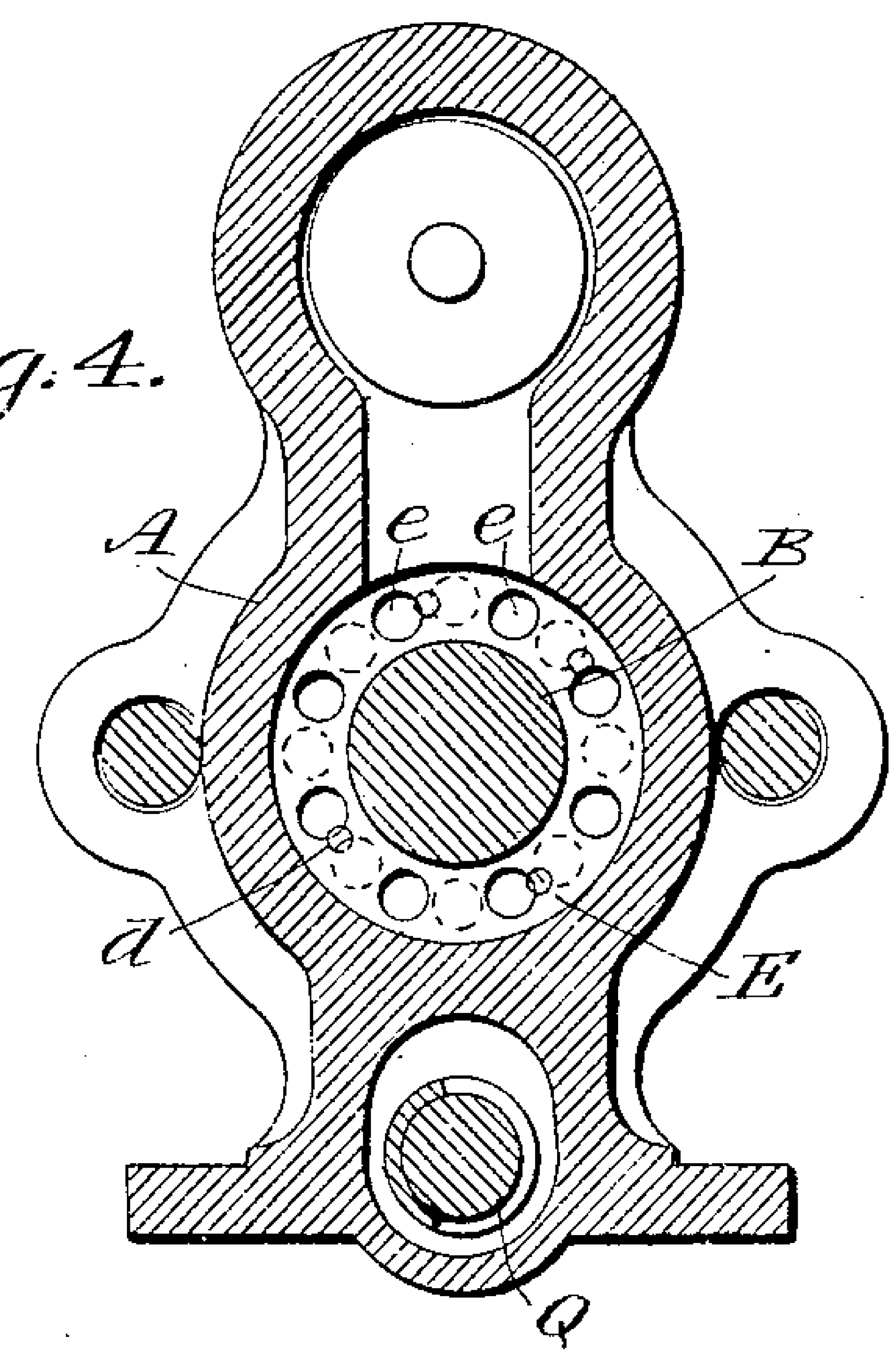
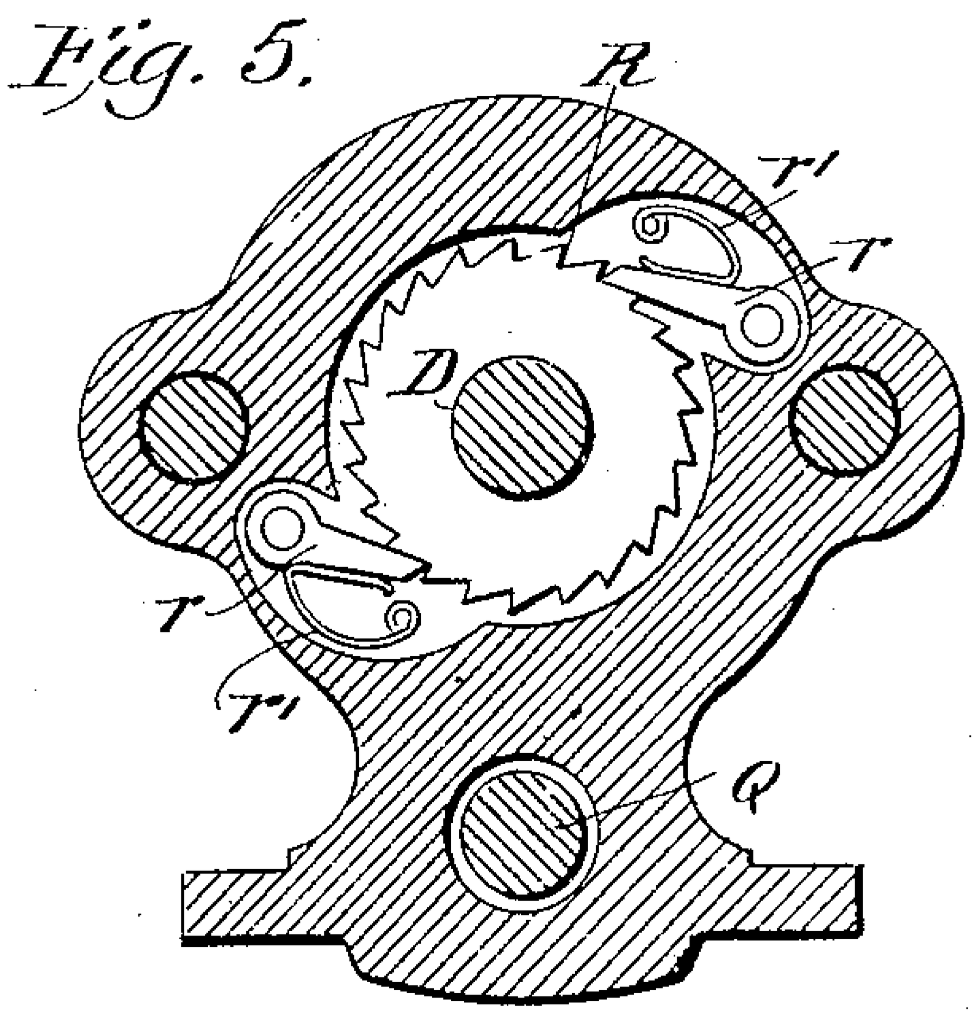


Fig. 5.



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UNITED STATES PATENT OFFICE.

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GAS-ACTUATED ROCK-DRILL.

No. 862,847. Specification of Letters Patent. Patented Aug. 6, 1907.

Original application filed June 8, 1895, Serial No. 552,163. Divided and this application filed April 16, 1903. Serial No. 152,965.

To all whom it may concern:

Be it known that I, JOHN V. RICE, Jr., a citizen of the United States of America, and a resident of Edgewater Park, county of Burlington, State of New Jersey, have invented certain new and useful Improvements in Gas-Actuated Rock-Drills, of which the following is a specification.

This invention has reference to an improvement in gas, explosive, or other internal combustion engines, for various uses, and especially for use with rock-drills and similar cutting mechanism for operating upon hard substances such as stone, coal and the like, the object of the invention being to provide a simple and efficient mechanism whereby a gas or other explosive substance may be permitted to actuate the drilling devices.

The subject matter of the present application relates to the general structure of the engine or motor that actuates the drill, and it is a division of another application for Letters Patent filed by me originally on June 8th, 1895, Serial Number 552,163, which application resulted in the issue of my Letters Patent No. 749,324, dated January 12, 1904, entitled improvements in electric sparking ignition apparatus for gas rock drills.

The invention therefore consists essentially in the construction, arrangement and combination of parts substantially as will be hereinafter more fully described and then particularly pointed out in the appended claims.

In the annexed drawings illustrating my invention, Figure 1 is a top plan view of my new and improved gas-actuated rock-drill. Fig. 2 is a longitudinal sectional view of the same with certain parts in elevation. Fig. 3 is an enlarged end elevation. Fig. 4 is a transverse sectional view. Fig. 5 is another transverse section and shows the arrangement of ratchet and pawls for rotating the drill. Fig. 6 is an enlarged detail sectional view of one of the gas igniting devices.

Similar letters of reference designate corresponding parts throughout all the different figures of the drawing.

My drill mechanism consists essentially of a double acting gas, explosion, or internal combustion motor, as hereinafter described and claimed, for actuating a drill. There may be one or more cylinders, and one or more pistons, arranged in a variety of ways. The particular specimen of mechanism illustrated and described is given by way of example only.

A A^1 designates two cylinders of substantially the same form, character and size, said cylinders being placed in rectilineal alinement with each other so as to constitute together in reality a single body or cylinder, having an intermediate division in order to provide two separate bores or chambers for the reception of two separate free pistons or piston heads, that are positively connected together by means of some suitable connector or connecting rod, it being further noted that these chambers serve as combustion chambers wherein the explosions of the gas take place for the purpose of imparting the necessary impulses to the pistons for operating the drill mechanism; and in each cylinder there is a charge-receiving or compression chamber and a separate explosion chamber, the two chambers being separated from each other by a free piston, which may be considered as a self-balanced piston. Within these cylinders A A^1 is a longitudinal piston rod B which runs through suitable packed bearings in the end of cylinder A and in the division between the cylinders, and is employed to transmit power to the drill. To the outer end of rod B the drill proper is attached at B^1, any suitable means being employed to effect the attachment. The cylinders A A^1 are jointly supported in the same casing carried by some suitable supporting frame, as Q^2 on which, they, together with all the other connected parts, are adjustable by means of a screw, as Q, having handle Q^1, or by some other equivalent and convenient device.

I wish it understood that I do not confine myself to any special mechanism for supporting or adjusting the drill mechanism. Neither am I to be restricted to any particular form in the making of the general framework of my device, but I reserve the liberty of constructing and arranging all such parts in whichever manner may seem most appropriate and satisfactory.

On the piston rod B within cylinder A is a piston C made preferably integral with rod B, and likewise on rod B within cylinder A^1 is a similar piston C^1, these pistons C C^1 being of proper size to neatly fit the bore of the respective cylinders within which they are situated. The pistons are both provided with passages running transversely through them, which passages are arranged in a circular series, see Fig. 4. The passages in piston C have the reference letter *c*, and in piston C^1, the reference letter *c′*. By observing piston C it will be noticed that the passages *c* are preferably inclined inwardly from each side of the piston, so that one half of each passage has an inclination at an angle to the remaining half, it being thought that this form or direction of passage is preferable for many reasons. In the piston C^1 the passages *c′* are straight and parallel to the axis of the piston. It is immaterial, however, what the form, direction or number of these piston passages may be, it being only essential that they shall provide a quick, easy transit for the gas or other explosive mixture from one side of the piston to the other from the charge-receiving chamber to the explosion chamber in a manner to be presently more fully explained. Each of the pistons is provided with a valve plate or ring for controlling the passage of the gas through the aforesaid passages.

The piston C is provided at its left hand side with the valve plate or ring E, which is of annular form, and is loose upon the piston rod B and is consequently slidable thereon. The valve ring E is adapted to cover the left hand end of the several passages c. In addition to being loosely mounted upon the piston rod B it is further held by means of the rigid pins or headed studs d, that are fixed in the adjoining face of piston C and which pass loosely through suitable openings in the valve ring E. Said studs d serve the purpose of preventing the ring E from rotating and also of limiting its movement away from the face of the piston C.

The ring E is provided with a series of circular holes or perforations e that are not co-incident with the passages c but alternate therewith as shown in Fig. 4, so that when the valve ring E is closed against the face of the piston C the passages c will be closed, but when it is removed slightly from the end of said passages, then the gas can not only pass through the passages c but can also pass through the openings e in the ring E, and thus can be transferred from one side to the other of the piston. This movement of the gas takes place in exhausting. When the piston C moves to the left hand, see Fig. 1, it will carry with it the ring E, which will, of course, be in close contact with the piston C and will cover the passages c, but when piston C is moving toward the right hand the valve ring E will no longer be close against the face of piston C, but being loose upon the rod B, as we have seen, it will fall back clear of the piston C and against the heads of the studs d, thereby allowing the passages c to be opened, and consequently when the piston C is pursuing its movement toward the right hand the gas or other explosive mixture has a free opportunity to pass through the openings in the piston and the valve thereof. A similar explanation may be made with regard to the valve E^1, belonging to the other piston C^1. Said valve ring E^1 is located at the right hand side of piston C^1 instead of at its left, as is valve ring E with respect to piston C. The arrangement and operation of valve ring E^1, however, is exactly similar to that of valve ring E, and hence further explanation of the same is unnecessary at this time.

The portion of the piston rod B which lies within the cylinder A^1 is made hollow to provide a tubular cavity b to receive the grooved rod D which is made integral with the disk D^1 and the ratchet wheel R, see Figs. 2 and 5. The ratchet wheel R is situated in a recess in the right hand head of cylinder A^1 and is engaged by two pawls r r, which pawls are kept in engagement with the teeth of the ratchet wheel by means of the springs r' r'. These pawls r r, while they permit the rotation of the ratchet wheel in one direction, effectually prevent it from rotating in the other. The spiral grooves cut in the rod D are engaged by the lug or lugs b', or by internal ribs as the case may be on the inside of the cavity b already referred to. It will be evident, therefore, that in consequence of this arrangement of the piston rod with the ratchet mechanism, said piston rod will during one reciprocation be permitted to pursue a rectilineal movement without rotating, while at the next reciprocation it will not only pursue a rectilineal movement but will also rotate to a greater or less extent in order to accomplish the necessary shifting of the drill at the end of each stroke, in like manner with the customary operation of rock-drills. For instance, when the piston rod moves to the left the rod D will in consequence of its connection with the piston rod rotate loosely and the ratchet wheel R will slip idly over the teeth of the pawls, but on the reverse movement when the piston rod moves up or works to the right the pawls r r will keep the ratchet wheel from rotating, thereby causing the rod D to remain stationary, and the result will follow that the piston rod will be rotated to a greater or less extent.

At each end of my improved drill machine is a gas igniting device which is preferably electrically operated. One of these devices is located, therefore, at the outer end of each of the cylinders A A^1. I will now proceed to describe the construction and arrangement of the parts of the gas igniting mechanism.

J denotes a casing which is screwed into the side of the cylinder A and is closed by the outer cover J^3 fastened to casing J by means of the screws j or any other suitable devices. At the center of the cover J^3 a pipe K is attached thereto which leads to the cylinder A^1 and enters the wall thereof at a point a short distance from the right hand end of said cylinder, see Fig. 1. On the wall of the cylinder A^1 at a point about opposite to the point of entrance of pipe K is situated a casing J^1 similar in form and function to the casing J and similarly attached to the cylinder. From the casing J^1 a pipe K^1 leads to the cylinder A and enters the wall thereof at a point approximately opposite to the casing J, see Fig. 1 and also Fig. 3.

The casings J and J^1 being of similar construction, an explanation of one of them will be sufficient for both. By referring to Fig. 6, it will be seen that the casing J is divided interiorly into two compartments by means of a flexible diaphragm M, which is held in place by having its edge inserted between the casing J and the cover J^3. This diaphragm is made of any suitable flexible or yielding material, such as, for instance, a thin steel plate, and is preferably corrugated in order to increase the contact surface of the gas therewith, as well as to improve its resilient power. The gas which enters the casing J through the pipe K acts against one side of the diaphragm M but does not pass to the other side thereof. On this latter side are two electric wires or conductors, L L, running from some suitable point and passing through the casing J until they enter the adjoining cylinder A or A^1 as the case may be, where the two points or electrodes, L^1 L^1, at the ends of these two wires, are situated in close contact with each other and adapted to give a good spark when the electric circuit is closed. One of the wires L, which passes through the casing J, is a continuous wire but the other is broken into two parts, having two inclined contact ends, l l', the end l' being carried by the flexible diaphragm M, while the end l is stationary on casing J. It will be observed that a pressure against the opposite side of diaphragm M will cause the wire end l' to come into contact with wire end l, although these two ends are normally out of contact with each other, being separated for a short distance in order that the electric circuit may normally be open. The feature of having these ends l l' inclined as shown is of importance in maintaining an accurate contact between them for the necessary length of time after contact has once been made. When contact between these ends is so made as stated, it will be evident that by conductivity a spark will be produced between the electrodes L L[1], which spark will necessarily ignite the volume of gas within that part of the cylinder where the electrodes are located. Thus we have a gas igniting device for each cylinder which will ignite a volume of gas at the end of each piston stroke in order to give the necessary impulses to the piston, as will be hereinafter more fully explained.

At the adjoining ends of the cylinders A A[1] are the ports I, which are induction ports, and through which the gas or other explosive mixtures or combined gas and air enters the respective cylinders for use therein. At the opposite ends of the cylinders A A[1], the side walls thereof are provided with the outlet or eduction ports T T through which the exhaust takes place. Also at a point, say about midway between the induction ports I and the eduction ports T are situated the auxiliary outlet ports *t*, through which the gas passes to act on the diaphragm that operates the exhaust valve. In connection with the inlet ports I are arranged suitable inlet valves, and in connection with the ports T *t* are arranged suitable exhaust valves.

I will now explain the construction and arrangement of my improved exhaust valves.

N and N[1] designate small chambers which are secured upon the wall of said cylinder A, there being a similar pair of chambers on the cylinder A[1]. The port T establishes communication between the bore of cylinder A and the chamber N, and the port *t* establishes an entrance from the bore of cylinder A to the chamber N[1]. The exhaust valve O is located within the chamber N, and preferably has a beveled periphery in order that it may fit more accurately upon a beveled seat. The valve O is secured upon the valve stem *n*; one end of the stem is supported in a recess in the wall of casing N, while the other end passes through a bearing in the wall of the casing N[1] and is attached to the flexible diaphragm P, which is secured transversely across the interior of the chamber N[1]. A flat spring *p* is carried by the rod *n* and bears against the outer side of casing N at a point contiguous to the seat of valve O. On the rod *n* is a nut *o*, engaging a screw-threaded portion of said rod and acting to adjust the tension of the spring *p*. It will be evident that a pressure within the chamber N[1] upon the diaphragm P will move the rod *n* and open the valve O. When this pressure is relaxed the tension of the diaphragm P will restore the valve O to its closed position, and the spring *p* will assist in the restoration, and will also keep the valve closed until a pressure again acts upon the diaphragm P.

I will now explain the construction and operation of the valve mechanism for admitting gas, vapor, a mixture of gas and air, or some other suitable explosive compound, into the two cylinders through the inlet ports I I.

F denotes a gas supply pipe running from some suitable gas supply.

At the end of the pipe F are the two elbows *f f*, which connect with the two valve casings G G, which are constructed similarly to each other and are both secured upon the aforesaid cylinders.

The pipe F is provided with a valve F[1] for graduating or regulating the supply of air which the pipe F may deliver to the casings G G. These casings G G are provided with lateral openings *h′ h′*, which admit air to mingle with the gas in order that the compound may be delivered to the ports I.

H H denote valves which are situated in the upper ends of the casings G G and are adapted to open downwardly against the pressure of the spiral spring *i* tensioned beneath these valves. Each valve H is placed loosely upon a vertical rod *h*, which has a bearing in a horizontal part integral with the body of the casing G, said part consisting simply of open work webs or bars between which the fuel can pass.

To the lower end of the rod *h* is rigidly attached a second valve H[1], which likewise opens downwardly and has arranged beneath it a spiral spring *i′*, which is tensioned against the base of casing G, adjacent to the port I. The upper end of each stem *h* has a head which is above the valve H, and which, when the stem is drawn down, pulls against the valve H and causes the latter to descend and open. These inlet valves may operate either as suction valves or they may be forced open by the entering gas. It will be evident that, as each piston or piston head moves away from the port I with which it operates, a suction will be produced which will open the inlet valve and draw gas and air into the charge-receiving chamber of said cylinder on one side of the piston. When the valve H[1] opens, thereby compressing the spring *i′*, the stem *h* will be drawn downward to a certain extent through its bearing, and this will result in the drawing down and opening of the valve H, thereby compressing the spring *i*, and, of course, as soon as the valve H is opened, gas will pass from the elbow *f* downward through the port I, and the air which enters the casing G through the lateral opening H[1] will mingle with the gas and enter with it into the cylinder. It will also be observed that the pressure of the gas upon the valve H may cause the latter to open independently and allow a certain pressure to escape through the opening *h′*. Thus the valve H may open and the valve H[1] remain closed. The springs *i i′* operate obviously to close the valves to which they respectively belong, when the opening force is removed. Although I have herein shown and described these inlet valves, yet I distinctly wish it understood that I do not intend to be confined to their use. They are presented here merely by way of example, and I reserve the liberty of employing such substitutes therefor as experience and good judgment may suggest.

I will now describe the operation of my improved rock-drill. Suppose, for instance, that the parts are in the position shown in Fig. 2, and that the pistons begin to reciprocate toward the left under the impulse of an explosion occurring in the explosion chamber at the right hand end of piston C[1]. As the piston C travels toward the left, the gas in advance thereof will be compressed and as soon as the piston passes the port there can obviously be no longer any effect upon the diaphragm P of the exhaust valve, and consequently said valve will remain for the time being firmly closed. Also in consequence of the movement of the piston C toward the left, a suction will be created at the right hand end of said piston, which will draw gas into the charge-receiving end of cylinder A through the port I. At the same time that gas is being drawn in through port I into cylinder A, port I belonging to cylinder A^1 will not admit gas because the inlet valve at that point will be closed, there being, as has already been shown, a reverse arrangement of all the parts belonging to cylinder A^1 from what appertains with respect to cylinder A. As the piston C^1 moves toward the left, the gas in advance thereof will also be compressed, and also the valve ring E will be released from the passage c', and hence the store of gas at the left of piston C^1, which entered cylinder A^1 during the previous movement of piston C^1, will pass through the passages c' c' and also through the perforations in the valve ring E^1 until it gets to the other side of the valve E^1. Also as the piston C^1 travels past the port t, the increase of pressure due to the explosion will act through the port t and against the diaphragm P, opening valve O, so that the spent gas may exhaust therethrough. At the moment that the piston C^1 passes the mouth of the pipe K, see Fig. 1, the increase of pressure just mentioned will pass quickly through said pipe K into chamber J, where it will operate upon the diaphragm, and cause a spark in the end of the cylinder A in the midst of the volume of gas, which I have just said was being compressed in the explosion chamber of cylinder A by the advance movement of piston C. An explosion will immediately ensue which will thrust the piston C, and consequently the piston C^1, rapidly in the reverse direction, and the same operation will take place in the various parts of the apparatus as has just taken place during the reciprocation of the piston in the opposite direction.

I wish it distinctly understood that what I have herein described and illustrated is to be taken simply as an example of my invention. I reserve the liberty of varying from the precise structural details and peculiarities of arrangement herein shown so far as it may be necessary to do so in giving ample scope to my claims, and in securing to me the broadest posible protection in the manufacture and use of my invention.

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

1. In an explosive engine, the combination with a cylinder having a charge-receiving chamber and an explosion chamber, of an inlet port near one end, valve means controlling said port, an exhaust port near the opposite end, pressure-actuated valve means controlling said port, an intermediate lateral port between the two ends for the outlet of pressure gases to actuate said means, a piston between the charge-receiving and the explosion chambers, said piston having valve means for transferring the explosive mixture from the charge-receiving chamber to the explosion chamber, and means for causing an electric spark to explode the gas to propel the piston alternately in opposite directions.

2. A rear compression internal combustion motor having a double-acting unignited charge compressing free piston, and a free power transmitting element connected therewith.

3. A motor having a self-balanced piston situated between chambers for confined compressed explosive charges of gas or vapor, and power transmitting means connected with such piston.

4. A plurality of compressing chambers and separate explosion chambers, free connected piston heads in the explosion chambers, and means for supplying explosive charges from the compressing to the explosion chambers and firing the same to propel said piston heads reciprocally in both directions.

5. A plurality of compressing and explosion chambers, free piston heads therein, positively connected for mutual reciprocation, means for supplying explosive charges to the compressing chambers, transferring the charge to the explosion chamber and firing the same therein to propel the piston heads reciprocally in both directions.

6. A plurality of explosion chambers each having inlet and exhaust ports, free piston heads in said chambers positively connected for mutual reciprocation to open and close said ports and to supply explosive charges to said chambers through said inlet ports, means for firing said charges and a free power transmitting element actuated by the piston heads.

7. Explosion chambers, means for supplying unignited explosive charges of gas or vapor to and firing the same in said chambers, free piston in said chambers positively connected for mutual reciprocation, an axially moving free power transmitting element connected with said piston heads and a guide for said element.

8. Separate charge compressing and explosion chambers in pairs, free piston heads, one for each pair, means positively connecting the piston heads for mutual reciprocation, a free power transmitting element connected with the piston heads, and means for causing the compression and explosion of a charge by and against each piston head at each complete reciprocation.

9. The combination with separate charge compressing and explosion chambers arranged in pairs, of free piston heads, one for each pair, means positively connecting said piston heads and means for causing the compression and explosion of a charge by and against each piston head at each complete reciprocation.

10. In an explosion engine, a body provided with separate charge compressing and explosion chambers, a free piston between said chambers, and a free power transmitting element connected with the piston.

11. A body having separate charge compressing and explosion chambers in pairs, supply ports, each connecting a compression chamber with an explosion chamber, an inlet for each compression chamber and an exhaust port for each explosion chamber; free piston heads for said pairs respectively, positively connected for mutual reciprocation, each closing the supply and exhaust ports of its explosion chamber during compression and explosion; means for causing explosions for propelling the piston heads respectively, and a free power transmitting element connected with the piston heads.

12. A body provided with a plurality of separate charge compressing chambers and explosion chambers respectively, free piston heads therein, positively connected for mutual reciprocations, and a free power transmitting element connected with the piston heads.

13. A body provided with a plurality of alined separate charge compressing chambers and explosion chambers respectively, axially alined free piston heads in said chambers, positively connected for mutual reciprocation, and a free power transmitting element connected with the piston heads and arranged in axial alinement with the chambers.

14. A body provided with a plurality of alined separate charge compressing chambers and explosion chambers respectively and a bearing; free piston heads in the chambers, an axially movable element in the bearing and means for positively connecting the element with the piston heads.

15. Separate charge compressing and explosion chambers, piston heads therefor, positively connected for mutual reciprocation and having variable termination of stroke at both ends; means for supplying explosive charges to said explosion chambers through said compression chambers, and means for firing the charges in each explosion chamber when the piston head therefor is within the zone of its stroke termination.

16. A plurality of axially alined close-ended separate charge compressing and explosion chambers in pairs, a free piston head for each pair, a connector positively connected with said piston heads, and a free power transmitting element connected with the connector.

17. Explosion chambers, means for supplying unignited explosive charges of gas or vapor to and firing the same in said chambers, free piston heads in said chambers rigidly connected for mutual reciprocation, a free power transmitting element connected with said piston heads and a guide for said element.

18. A casing, a cylinder, a piston therein, a second cylinder, a piston therein, a piston rod connecting said pistons, means for holding a tool connected to said piston rod, means to cause an explosion of gases against first one and then another of said pistons to reciprocate the same, said cylinders being connected to said casing, said casing being slidably mounted in a frame, and means to slide said casing along said frame.

19. A plurality of cylinders, each of said cylinders containing a piston, said pistons being connected, means for connecting a drill or other tool to said pistons, means for causing an explosion of gases against first one of said pistons and then against another of said pistons to reciprocate the same, a casing, said cylinders being mounted in said casing, a frame, said casing being slidably mounted in said frame, and means to move said casing along said frame.

20. A plurality of cylinders, each of said cylinders containing a piston, said pistons being connected, means for connecting a drill or other tool to said pistons, means for causing an explosion of gases against first one of said pistons and then against another of said pistons, means for cushioning said pistons throughout the length of their stroke, a casing, said cylinders being mounted in said casing, a frame, said casing being slidably mounted in said frame, and means to move said casing along said frame.

21. Two pistons connected by a piston rod and arranged in their respective cylinders, means for connecting a drill or tool to said piston rod, means to cause an electric spark and explode a gas alternately against each piston at the end of each stroke, a casing, said cylinders being mounted in said casing, a frame, said casing being slidably mounted in said frame, and means to move said casing along said frame.

22. A plurality of oppositely arranged cylinders, a piston in each cylinder, said pistons being connected, a charge receiving-chamber in each cylinder, each piston sliding in one of said charge receiving chambers, an explosion chamber opposite each charge receiving-chamber, but separated therefrom by a piston, means for causing an electric spark alternately in each explosion chamber to explode a gas therein to propel the adjacent piston, a casing, said cylinders being mounted in said casing, a frame, said casing being slidably mounted in said frame, and means to move said casing along said frame.

23. In an explosive engine, the combination of two cylinders in rectilineal alinement with each other, each cylinder having a charge-receiving chamber and an explosion chamber, two pistons connected by a piston rod and arranged in their respective cylinders, means for connecting a drill or tool to said piston rod, gas inlet ports on the wall of the cylinders, double-chambered and diaphragm-operated exhaust valves likewise on the walls of the cylinders, secondary exhaust ports intermediate between the inlet ports and the exhaust valves, and valve means on the pistons for transferring the explosive mixture from the inlet side of the pistons to the explosion side, substantially as set forth.

24. In an explosive engine, the combination with a cylinder, having a charge-receiving chamber and also an explosion chamber, a piston in the cylinder between the two chambers, valve means on said piston for transferring the explosive mixture from the charge-receiving chamber to the explosion chamber, an igniting means for firing the mixture so as to propel the piston alternately in opposite directions, an exhaust valve casing having two compartments together with the exhaust valve construction having a valve proper located within one of the said compartments, a stem which passes through both compartments, and a diaphragm in the other compartment connected to and operating said stem, both of said compartments communicating with the explosion chamber of the cylinder through lateral ports, substantially as described.

Signed at New York this 30th day of Sept. 1902.

JOHN V. RICE, Jr.

Witnesses:

JOHN H. HAZELTON,

FRED E. TASKER.