No. 896,777. PATENTED AUG. 25, 1908.

R. S. TROTT.

GAS OPERATED ROCK DRILLING ENGINE.

APPLICATION FILED DEC. 26, 1906. RENEWED FEB. 15, 1908.

Fig. 1.

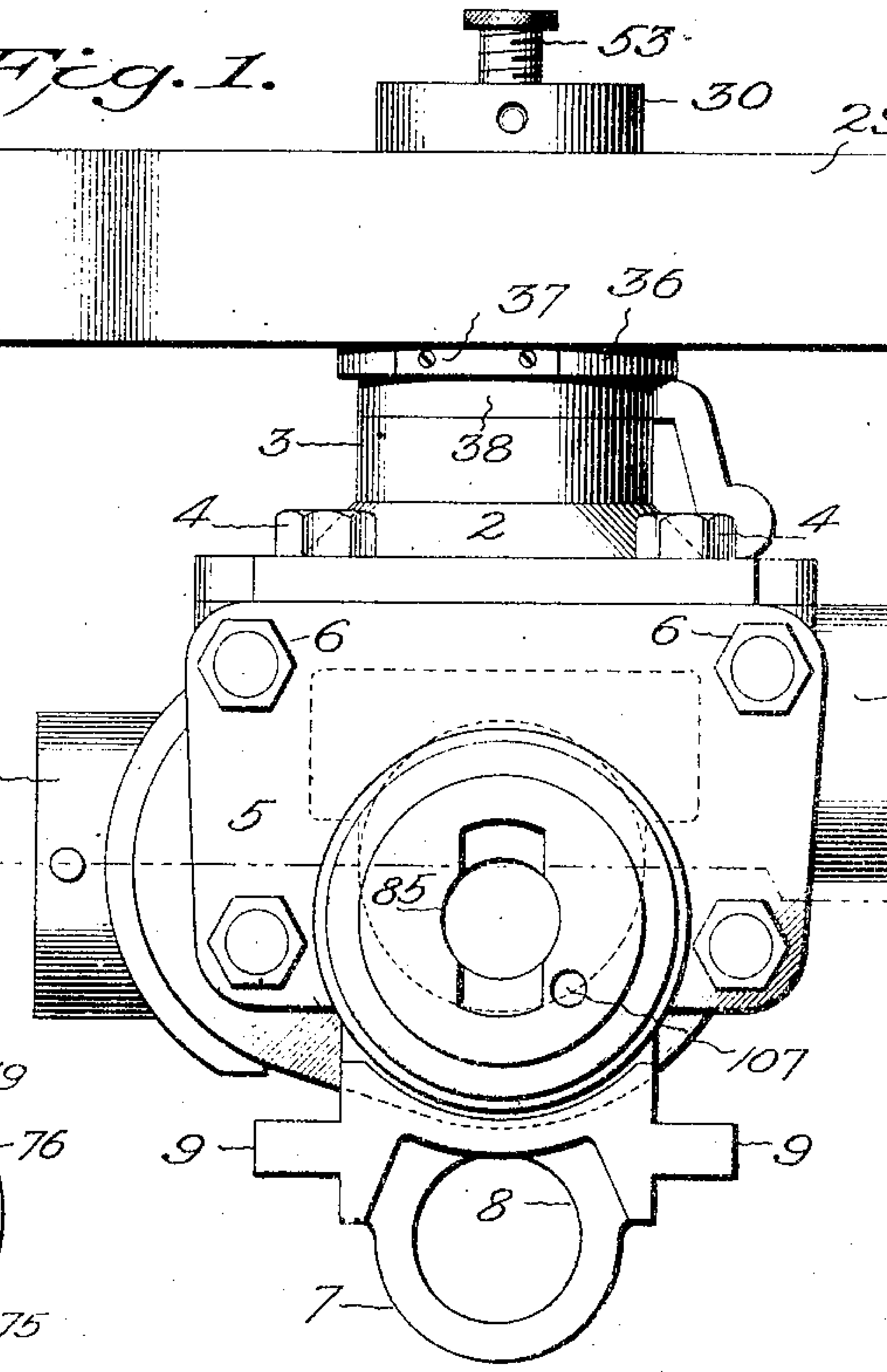


Fig. 18.

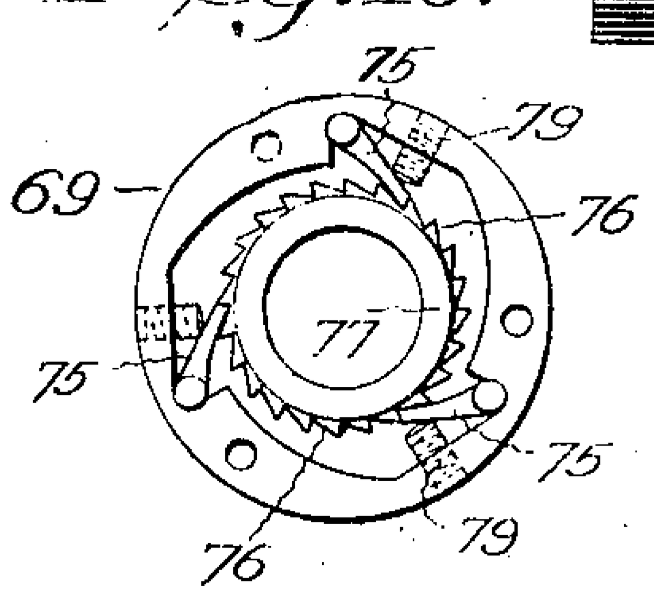


Fig. 17.

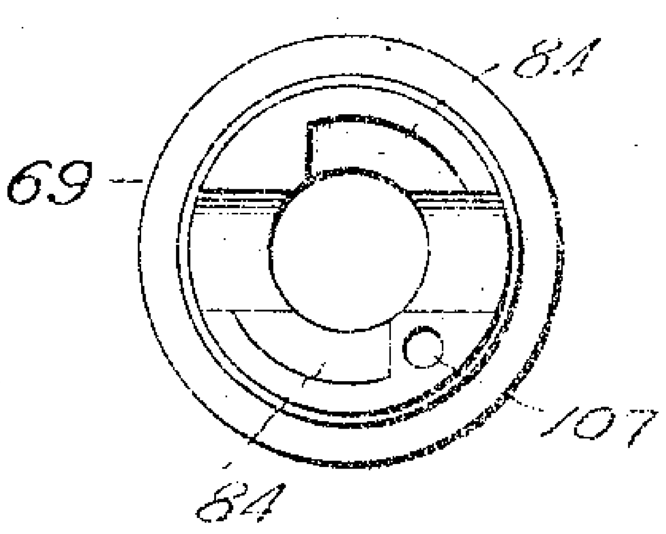


Fig. 2.

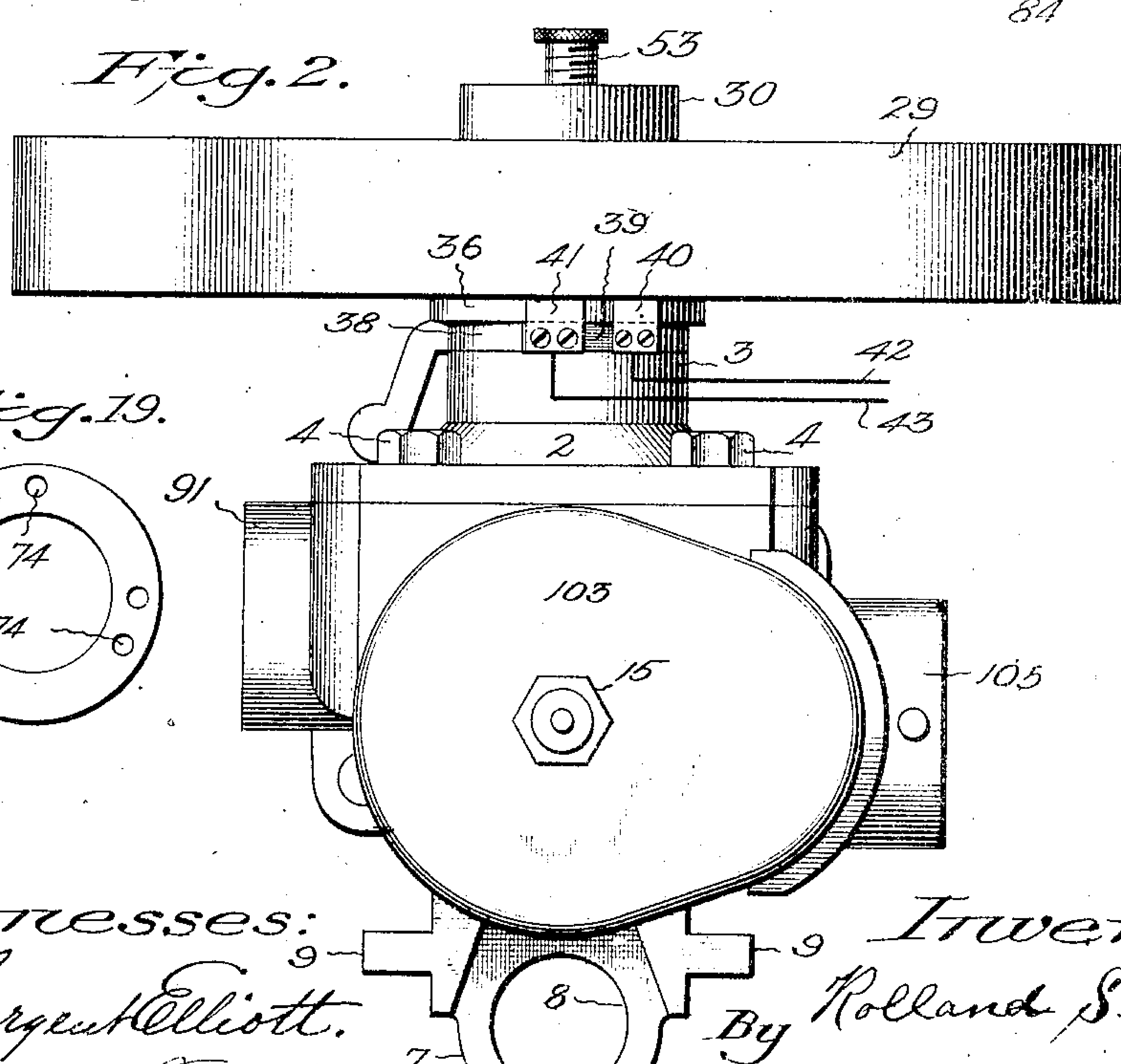
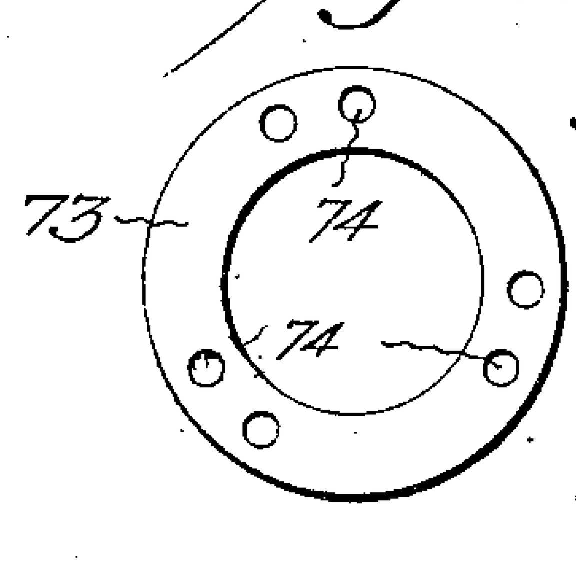


Fig. 19.



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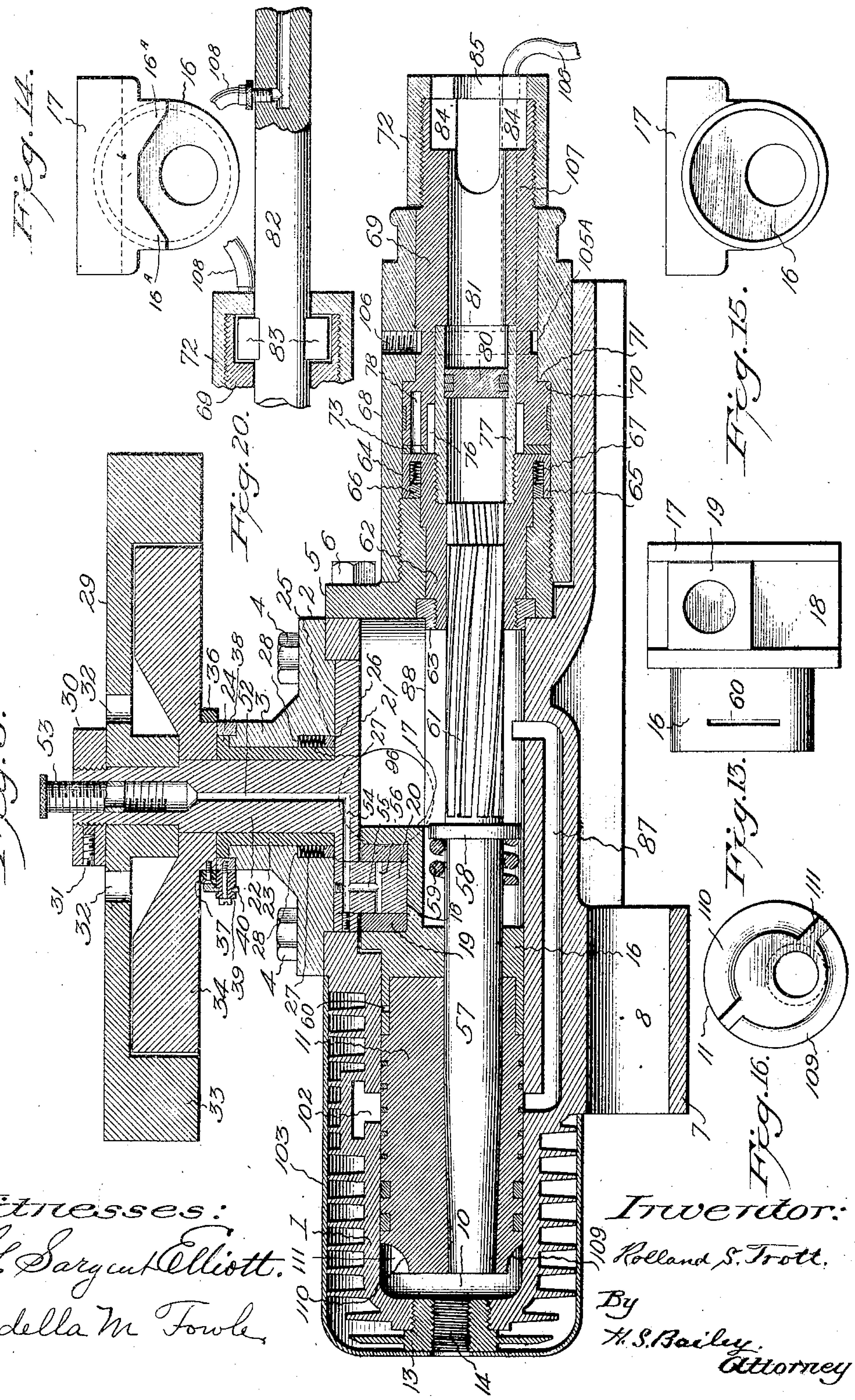
4 SHEETS—SHEET 2.



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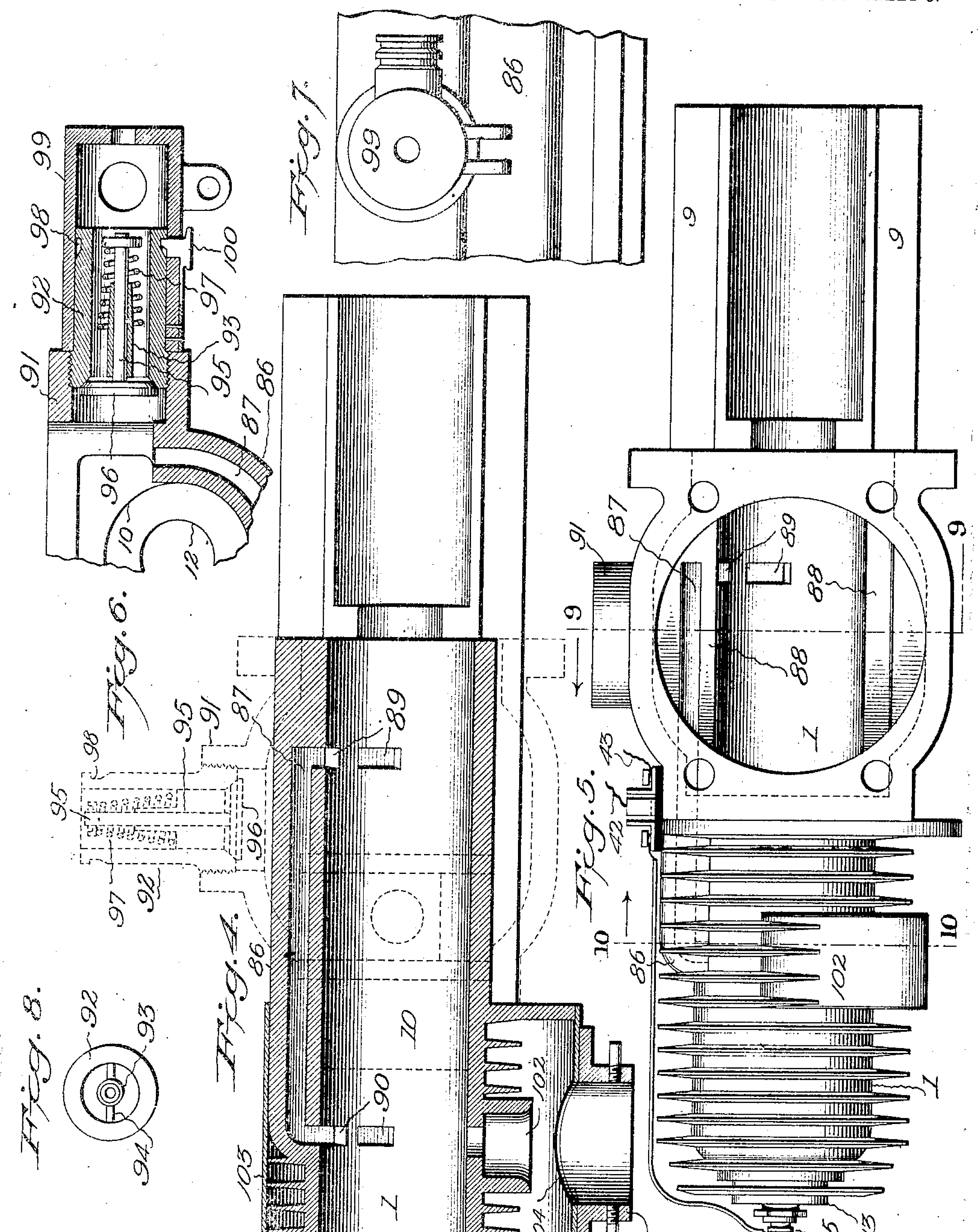
4 SHEETS—SHEET 3.



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4 SHEETS—SHEET 4.

Fig. 9.

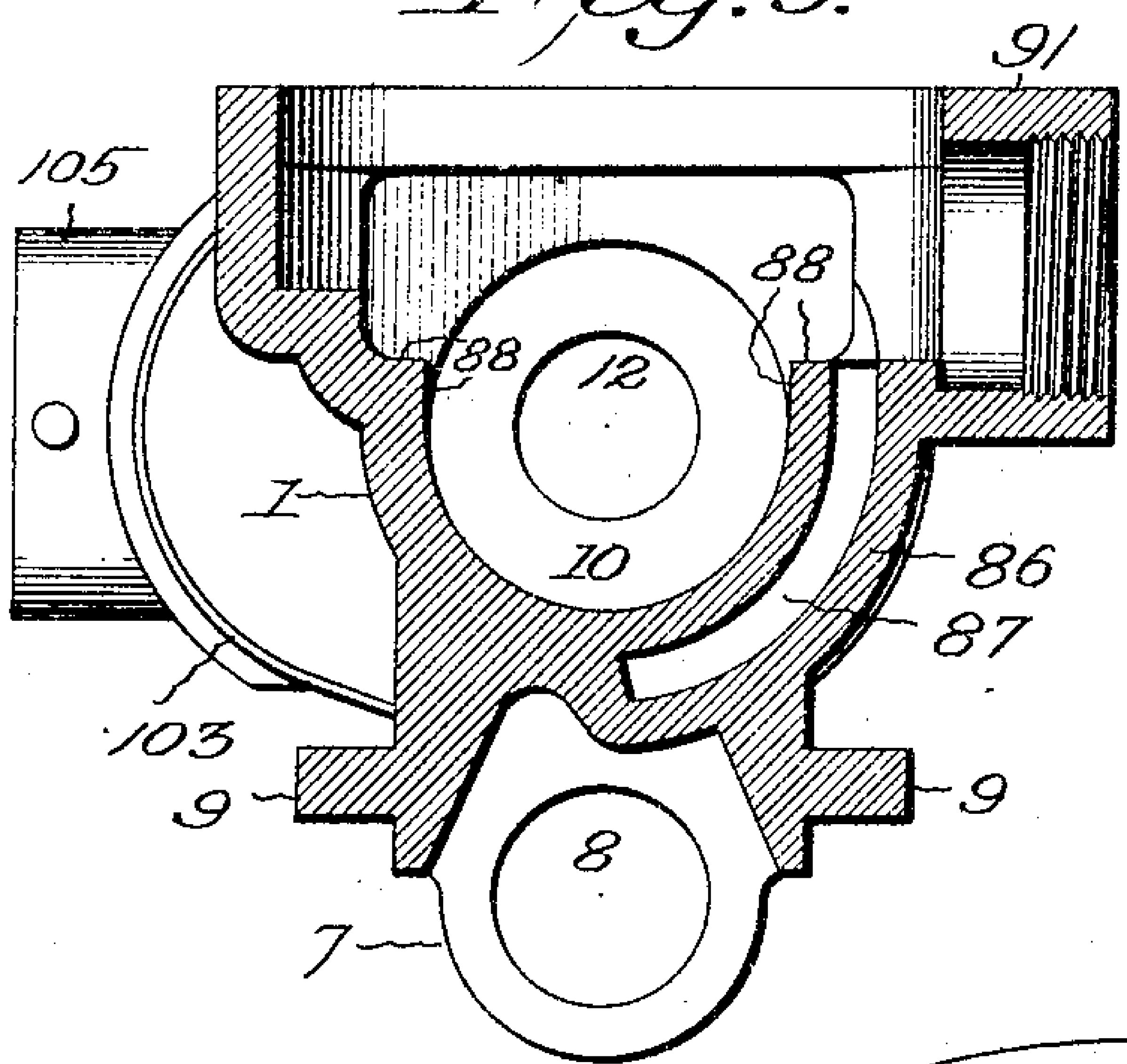


Fig. 10.

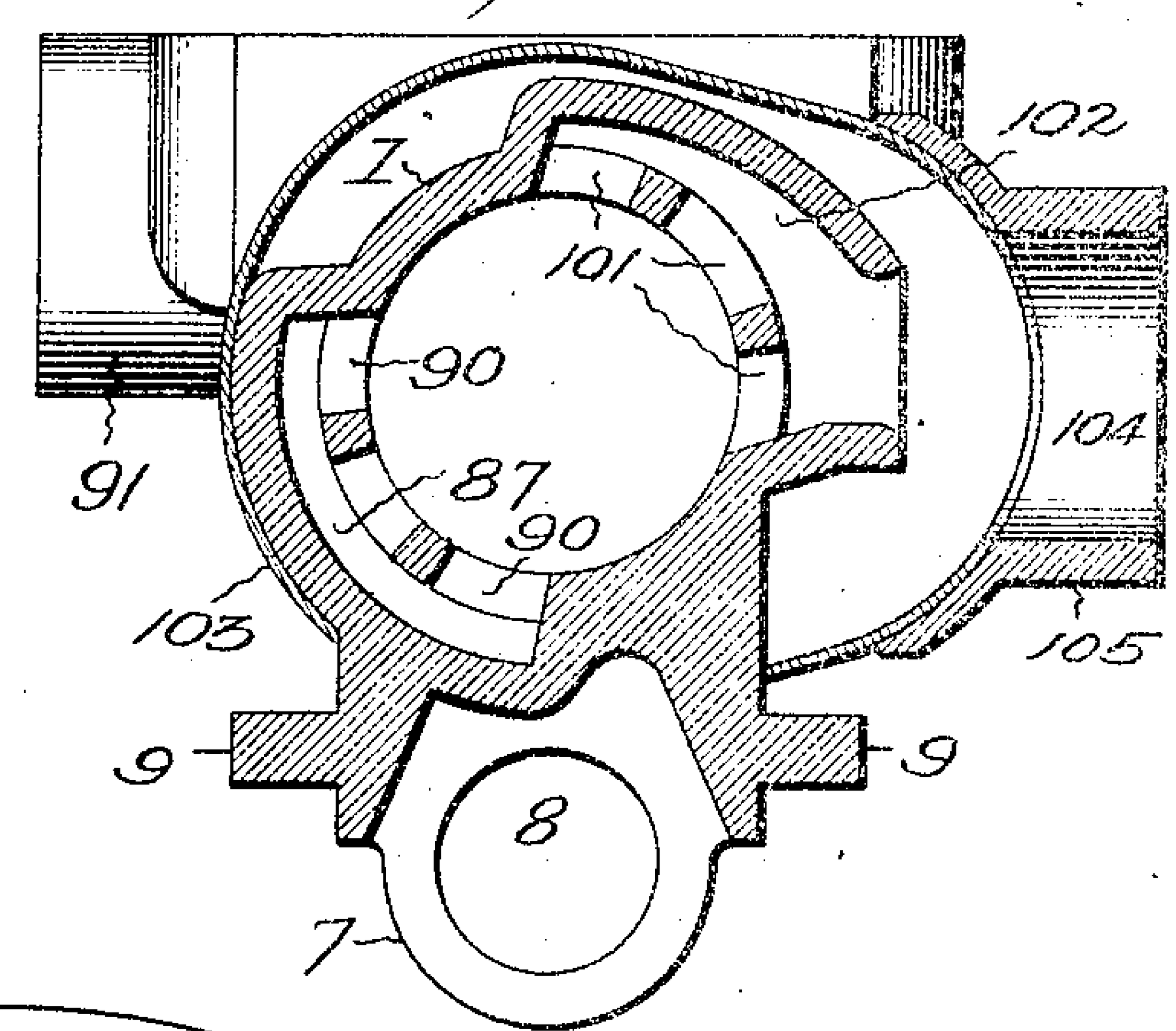


Fig. 11.

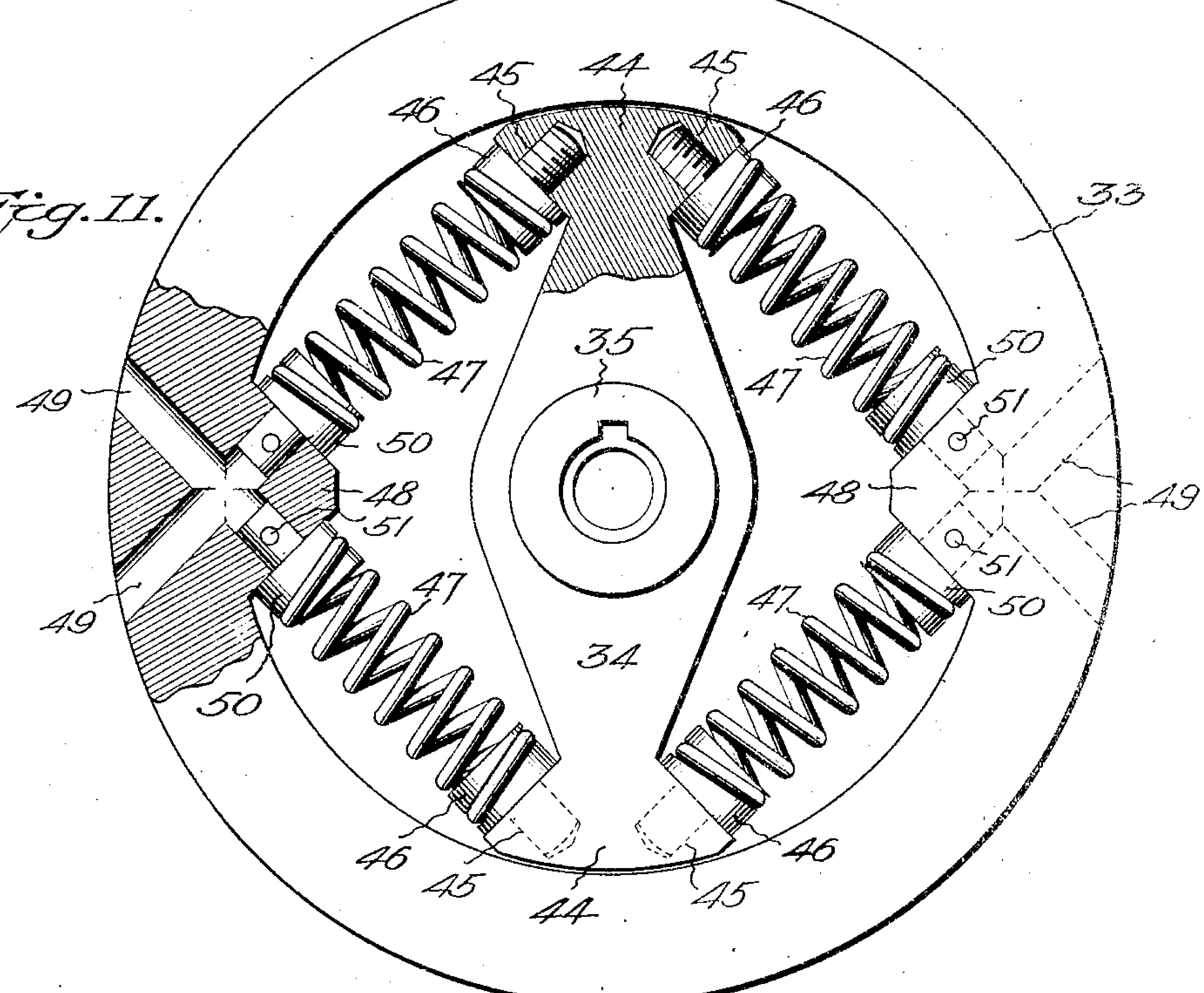
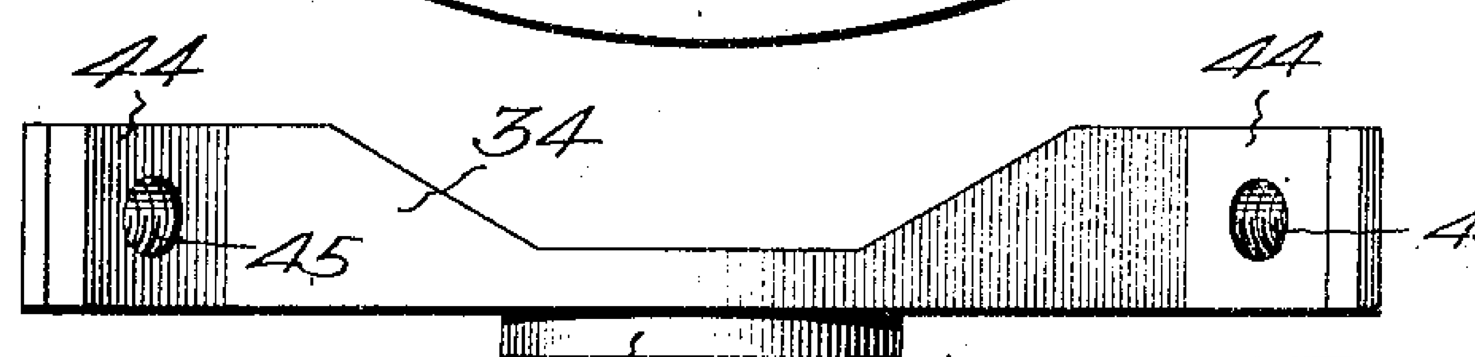


Fig. 12.



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UNITED STATES PATENT OFFICE.

ROLLAND S. TROTT, OF DENVER, COLORADO.

GAS-OPERATED ROCK-DRILLING ENGINE.

No. 896,777. Specification of Letters Patent. Patented Aug. 25, 1908.

Application filed December 26, 1906, Serial No. 349,386. Renewed February 15, 1908. Serial No. 416,110.

To all whom it may concern:

Be it known that I, ROLLAND S. TROTT, a citizen of the United States of America, residing in the city and county of Denver and State of Colorado, have invented a new and useful Gas-Operated Rock-Drilling Engine, of which the following is a specification.

My invention relates to improvements in gasolene operated rock drilling engines, and the objects of my invention are: to provide a simple, light weight, durable gasolene operated rock drilling engine, that embodies various new and practical features which are fully described in the accompanying specification, and which are fully illustrated in the accompanying drawings, in which:

Figure 1, is a front end elevation of my improved rock drilling engine, the supporting shell being omitted. Fig. 2, is a rear end elevation of the same. Fig. 3, is a vertical, longitudinal, sectional view through the engine. Fig. 4, is a horizontal, sectional view through the cylinder casing on the line 4—4 of Fig. 1. Fig. 5, is a plan view of the cylinder casing, the crank casing being removed. Fig. 6, is a transverse, vertical, sectional view, through a fragment of the cylinder showing the gas inlet, and valve for controlling the same, a coupler being shown in connection therewith, to which a suitable carbureter may be attached. Fig. 7, is a front view of Fig. 6. Fig. 8, is a front view of the valve nipple which screws into the gas inlet. Fig. 9, is a transverse, vertical, sectional view through the cylinder casing, on the line 9—9 of Fig. 5. Fig. 10, is a transverse, vertical, sectional view on the line 10—10 of Fig. 5. Fig. 11, is a plan view partially in section, of the fly wheel, actuating arm and buffer springs interposed between the ends of the arm, and projecting lugs on the rim of the wheel, the view being taken from the under side. Fig. 12, is a side view of the wheel-actuating arm shown in Fig. 11. Fig. 13, is a top plan view of the cushioning cap, which is mounted on the forward end of the piston. Fig. 14, is a front elevation of the same. Fig. 15, is a rear elevation of the same. Fig. 16, is a rear view of the piston. Figs. 17 and 18 are respectively front and rear views of the drill chuck, the ratchet sleeve being shown in connection with the latter view. Fig. 19, is an elevation of the pawl ring. And Fig. 20, is a view showing the hose connection between the drill bit and the water channel of the drill.

Similar letters of reference refer to similar parts throughout the several views.

Referring to the accompanying drawings, the numeral 1, designates the cylinder casing of my improved drill; 2, the crank shaft casing, which is provided with a hub 3. This crank shaft casing is secured by cap screws 4 above an opening formed in the top of the cylinder casing.

5, desigates the front cylinder head, which is bolted to the front end of the cylinder casing by bolts 6. The cylinder shell is provided with a depending lug portion 7, having a central bore 8, in which is secured the usual threaded sleeve, through which the operating feed screw passes, but the sleeve, feed screw and supporting shell, in which the drilling engine slides, are omitted, as they are of the type in general use, and form no part of my present invention. The bottom of the cylinder casing is provided with slideway lugs 9, which move in the guideways formed in the sides of a supporting shell, and the drilling engine is moved forward or backward in the shell, by turning the feed screw, as is fully understood.

The cylinder casing is provided with a cylinder bore 10, in which a piston 11 is reciprocally fitted, and which is provided at intervals with packing rings as shown, which are adapted to prevent the explosive mixture which enters the cylinder and crank chamber on the back stroke of the piston, from flowing past the piston into the rear end of the cylinder, also to prevent the exploded gas from escaping around the piston to the forward end of the cylinder. The rear end of the cylinder casing forms the explosion chamber of the cylinder, and the peripheral surface of this end of the casing is formed into fluted or ribbed surfaces, or thin projecting circumferential flanges, that form heat radiating surfaces, and a threaded aperture 12 is formed through the axial center of the rear end of the cylinder, which receives a plug 13, having a threaded bore 14, into which a spark plug 15 of the usual type is screwed. The aperture 12 is large enough to receive a finishing tool, such as would be required in finishing the interior surface of the cylinder, and the plug 13 forms a reducer, to receive the spark plug.

The front end of the piston 11 is provided with a cap 16, which extends over the end of the piston for a short distance. This cap is provided with a forward projection 17. in the upper side of which a slideway 18 is formed, in which a box 19 of bronze or brass or other suitable metal is fitted. This box is adapted to receive a crank pin 20, which is secured to a disk 21, formed on the inner end of a shaft 22, which is rotatably mounted in an anti-friction journal bushing 23, in the hub of the crank casing. This journal lining is provided at its outer end with a flange 24, which bears against the end of the hub of the crank casing, and in the inner end of the crank casing a circumferential recess 25 is formed, which surrounds the end of the lining, and in this recess I place a packing ring 26, which is held against the adjacent face of the disk by coiled springs 27, which are inserted in holes 28, drilled into the casing from the bottom of the resess in which the packing ring is placed. This packing ring is pinned or otherwise held against axial movement, and is adapted to bear against the crank disk and prevent the gas in the cylinder from escaping out through the crank shaft bearing to the atmosphere.

The shaft 22 extends beyond the end of the hub portion of the casing, and terminates in a reduced shouldered portion, upon which a fly wheel 29 is rotatably mounted so as to rest upon the shoulder. This reduced end of the shaft extends through the fly wheel and is threaded, and a nut 30 is screwed upon the end of the shaft against the fly wheel, and holds it in place. A set screw 31 is screwed into the nut, and is adapted to bear against a piece of lead, which contacts with the threaded portion of the shaft to lock the nut thereon against accidental displacement. Through the fly wheel adjacent to the nut, apertures 32 are formed, to receive a suitable spanner wrench, which is used to rotate the fly wheel and crank shaft to start the piston and cause an explosion in the cylinder. The under side of the fly wheel is recessed, thereby forming a depending marginal rim 33, around the wheel, within which is located a fly wheel actuating arm 34, which is keyed or otherwise secured to the shaft between the fly wheel and the flanged end of the shaft bushing 23. A short hub 35 is formed on the under side of the arm adjacent to the bushing, upon which an insulating ring 36 is secured, and a contact strip 37 is secured to the insulated ring by screws as shown. An axially movable ring 38, is mounted on the flange of the bushing 23, and on a reduced shouldered portion formed on the end of the hub of the crank casing, and an insulating plate 39 of suitable substance is secured to this ring, upon which a pair of brushes 40 and 41 are secured, in position to engage the contact strip on the insulated ring 36, of the arm 34, as the shaft revolves. A circuit wire 42 is connected to the brush 40, and a circuit wire 43 is connected to the brush 41, and these wires extend to a terminal coupler, secured upon a convenient portion of the cylinder casing, which also connects with a wire leading to the spark plug, and with a battery and spark coil (not shown), so that a circuit is formed, and a spark produced when the strip 37 contacts with the brushes 40 and 41. The actuating arm 34, extends on each side of the shaft, to within a short distance of the wheel rim 33, and upon its ends are formed heads 44, having faces which incline toward the arm at an angle of forty-five degrees. Each head has two faces, as shown, and a threaded aperture 45 is formed in each face, in which is screwed a stud 46. The outer ends of these studs are formed into short spiral thread portions, that are adapted to receive the ends of cushioning springs 47, the coils of which are arranged to screw upon the threaded ends of the studs. Upon diametrically opposite sides of the inner periphery of the wheel rim 33, and on a line at right angles to the heads 44, of the actuating arm, are inwardly projecting lugs 48, which are V-shaped and are arranged so that each of their faces will stand parallel with the opposing face of one of the heads 44 of the actuating arm. Apertures 49 extend from the faces of the lugs through the rim of the wheel, the apertures in each lug crossing each other at right angles as shown; and in each of these apertures I place a stud 50, which studs are secured therein by pins 51, which extend through the lugs and through the shanks of the studs. The outer ends of these studs are formed with spirally arranged threads adapted to receive the opposite ends of the spring 47; consequently the actuating arm when inoperative stands at right angles to the lugs 48, as shown in Fig. 11, and when rotated by the rotary motion of the shaft it rotates the fly wheel through the medium of the four cushioning springs 47. The fly wheel and actuating arm act as a resilient compensating device for the variable reciprocal movement of the piston when it reverses the direction of its forward stroke and starts on its backward stroke relative to the fixed rotative movement of the crank pin in the box, of the piston, as will be fully explained hereinafter.

Through the axial center of the shaft, I form an oil passage 52, the upper portion of which is enlarged to form a grease cup, and is also threaded to receive a removable cap 53. An oil passage 54 is formed through the crank disk from its periphery to its center, where it intersects the oil passage in the shaft, and a vertical oil passage 55 is formed partially through the crank pin intersecting the oil hole passage of the crank disk, and being intersected by a horizontal oil passage 56, at its lower end. Consequently the oil or grease can work from the grease or oil cup through the shaft and crank disk to the out-side of the crank pin, and thus lubricate the sliding box 19, and the slideway 18 of the piston cap 16. The piston is provided with a hammer bar 57, which passes through an aperture in the cap 16, and is secured in a bore formed in the piston slightly below its axial center, when the drilling engine is standing in its normal horizontal position, as illustrated in Fig. 3. This hammer-bar is provided with a collar 58, which is flush with the outer end of the slideway projection 17 of the cap 16, and between this collar and the cap I place on the hammer bar a coiled spring 59. The inner end of the cap is in the form of a short sleeve, which fits over the reduced forward end of the piston, so as to have a short sliding movement thereon, and an air inlet slot 60 is formed through this sleeve about midway of its length, which permits the gasolene air mixture to flow into the space between the cap and the end of the piston, in a manner and for a purpose which I will presently describe.

The surface of the hammer bar beyond the collar 58, is rifled or provided with spirally arranged teeth 61, as shown in Fig. 3, and this rifled end of the hammer bar extends into a rifled nut 62, which is rotatably mounted in the cylinder head 5. An annular recess is formed in the cylinder head, surrounding the inner end of the rifled nut 62, and this end of the nut is reduced and threaded, and a buffer ring 63 is screwed upon this reduced end of this riffle nut and fits loosely in the annular recess formed in the cylinder head. The opposite end of this rifled nut is larger in diameter than the cylinder and fits in an enlarged shouldered counterbore formed in the cylinder head, and beyond this enlarged portion it is formed with an enlarged collar portion 64, that extends beyond the end of the cylinder head and bears against it, and the face of this collar portion which is adjacent to the end of the cylinder head is provided with a circumferential recess 65, in which a packing ring 66 is placed, which is pinned or otherwise held against rotation in the collar, and in the bottom of this recess a number of apertures are drilled, in which coiled expansion springs 67 are placed, which are arranged to hold the packing ring under resilient pressure against the end of the cylinder head, and prevent the escape of the explosive gas between the rifled nut and the cylinder head. The projecting hub portion of the cylinder head is exteriorly threaded, and a sleeve 68 is threaded to it; which projects loosely over and beyond the rifled nut, and a drill bit holding chuck 69 is rotatably mounted within it. The axial bore of the sleeve is formed in two diameters, the larger of which surrounds the adjacent end of the rifled nut. This enlarged diameter of the bore of the sleeve surrounds an enlarged end portion of the drill chuck, and the smaller bore of the sleeve surrounds a reduced portion on the drill chuck, a shoulder 70 being formed at the junction of the two diameters of the drill chuck, which fits against a corresponding shoulder 71 formed at the junction of the two bores of the sleeve. The drill chuck extends through and beyond the sleeve a short distance, and this projecting end portion is reduced in diameter, and is exteriorly threaded, and a cap 72 is threaded to it. The drill chuck has an axial hole through it, of the same diameter as the smaller bore of the rifle nut and in alinement with it. Between the opposing ends of the rifled nut and of the chuck, a pawl supporting ring 73 is placed. This pawl supporting ring is secured by pins to the adjacent end of the drill chuck, and is provided with three apertures 74, which extend through it and are adapted to receive the trunnions of three ratchet pawls 75. The body portions of the pawls lie in recesses formed in the adjacent end of the drill chuck, and engage ratchet teeth 76, formed on a sleeve 77, one end of which is threaded and screws into a threaded counterbore formed in the forward end of the rifled nut, while its opposite end fits rotatably in a counterbore formed in the drill chuck. The trunnions of the pawls also extend pivotally into bearing apertures 78, formed in drill chuck, which are arranged opposite to the apertures in the pawl ring. Expansion springs 79 hold the pawls in engagement with the ratchet teeth 76.

The sleeve 77 has an axial bore of two diameters arranged in axial alinement with the rifled nut and hammer-bar. The smaller bore of this sleeve is made large enough to permit the rifled end of the hammer bar to reciprocate loosely in it, while the larger bore extends into the sleeve from its forward end and terminates in a shoulder at its junction with the smaller bore, and a striking block 80 is loosely mounted in this enlarged bore in the path of the hammer-bar, and is prevented from being driven forward out of the sleeve by a shoulder 81, at the forward end of the sleeve, formed by the smaller bore of the drill chuck, the block being free to move in the bore in the sleeve. The axial bore in the drill chuck is adapted to receive the shank end of a drill bit 82, which is provided with projecting lugs 83 that are adapted to fit into oppositely arranged concentric recesses 84, formed in opposite sides of the forward end of the drill chuck. These recesses are enough larger than the lugs to receive them loosely, and they extend concentrically around the axial bore of the drill chuck far enough to permit the lugs to be turned to one side against the end of the recess, and as the drill bit is turned by the chuck in the opposite direction from the direction in which it is turned when it is inserted in the chuck it naturally remains against the ends of the recesses, and is prevented from working out of these recesses by the end of the cap 72, which has an opening 85 large enough to receive the shank and lugs of the drill bit, the drill bit being turned when inserted in the chuck so that the lugs will be out of line with the opening 85; consequently when the drill bit is inserted through the cap into the chuck, and its lugs are turned to one side against the ends of the recesses 84, it can not be withdrawn or accidentally work out, as the lugs are covered by the end portion of the cap.

The cylinder casing has formed on one side an enlargement 86, concentric with the axis of the casing, which extends from the forward end of the casing about two-thirds of its length. This enlargement begins substantially at a point determined by a line drawn vertically through the axial center of the casing, and extends around and terminates slightly above a point determined by a line drawn horizontally through the axial center of the casing. A port 87 is formed in the enlargement 86, which extends from a point substantially coincident with limit of forward movement of the forward end of the piston cap, to a point substantially coincident with the limit of forward movement of the rear end of the piston. The upper half of the forward portion of the cylinder is enlarged, as shown in Figs. 5 and 9 to accommodate the slideway projection 17 on the piston cap 16, and slideways 88 having vertical and horizontal faces, are formed on each side of this enlarged portion of the cylinder, upon the horizontal faces of which slide the ends of the projection 17, as the piston reciprocates, while depending guide lugs 16^A fit between the vertical faces of the slideways. The port 87 opens into the enlarged end of the cylinder through one of these slideways, but beyond the end of the projection 17, so as not to be obstructed thereby, and this enlargement of the upper half of the cylinder is extended far enough rearward to accommodate the slideway projection 17, when the piston is at the limit of its rearward movement. At the forward end of the port there are openings 89, extending from the port through the shell of the cylinder, and the port opens into the rear end of the cylinder by means of similar openings 90.

Centrally of the forward or enlarged portion of the cylinder, and on that side upon which enlargement 86 is formed, is located an interiorly threaded hub 91, into which is screwed one end of a valve nipple 92, the inner end of which is formed with a valve seat. A guide tube 93 is formed within the nipple, being connected to the nipple by integral webs 94, as shown in Fig. 8, and through this tube extends the stem 95 of a valve 96, which normally rests against the seat in the end of the valve nipple. A disk is secured upon the outer end of the stem, and a coil spring 97 is interposed between the disk and the webs 94, to hold the valve against its seat.

The outer end of the valve sleeve has a circumferential groove 98, and a sleeve 99 is mounted on the nipple, so as to rotate freely thereon, being held upon the nipple by a spring dog 100, which projects through an opening in the sleeve, and into the circumferential groove of the nipple. To this sleeve is connected a carbureter and gasolene tank, the arrangement and construction of which are neither illustrated nor described in this application, as it is fully set forth in an application for gasolene operated rock drilling engines, filed by me on the 4th day of September, 1906, and again more fully set forth in an application for detachable carbureter for gas operated rock drilling engines, filed by me on the 15th day of October, 1906, Serial No. 333,279, the arrangement of the tank and carbureter forming no part of my present invention.

At a point diametrically opposite to where the port 87 enters the rear end of the cylinder, are exhaust ports 101, which open into a flue 102, formed integral with the cylinder casing. The forward edges of these ports are in line while the exhaust port extends slightly farther to the rearward. A hood 103 surrounds this end of the casing, and is provided with an outlet 104, in line with the flue 102, and to a hub 105 surrounding this outlet, may be coupled a suitable hose (not shown) by which the exhaust may be conveyed away from the cylinder to any desired point.

A circumferential groove or channel 105^A is formed in the chuck 69, and a threaded aperture 106 is formed in the sleeve 68, which aperture opens into the channel 105^A. A passage 107 extends from the channel to the forward end of the chuck, and through the cap 72. Water is admitted through the aperture 106, to the channel 105^A, whence it passes out through the passage 107. The drill bit is hollow from its cutting end, to a point which will be adjacent to the end of the chuck, when the drill is inserted in the chuck, and an aperture is formed in the side of the drill, communicating with the hollow bore. A short section of hose 108 connects the chuck passage 107 with the aperture in the side of the drill, being attached to the drill by any suitable style of coupler, and thus water is admitted to the drill. The hose can not become twisted, as it moves with the chuck and drill.

The operation of the improved drilling engine is as follows: The fly wheel is first turned manually to give the initial movement to the piston, and as the piston recedes, gas from a suitable carbureter is drawn into the forward end of the cylinder, through the valve nipple 92, and is forced into the rear end of the cylinder through the port 87, by the forward stroke of the piston; as the piston moves rearward again the gas behind it is compressed, and as the piston reaches the limit of its rearward movement the contact strip 37 on the fly wheel actuating arm contacts with the brushes 40 and 41, completing a circuit between a battery, spark coil, cylinder, and the spark plug 15, causing a spark, which explodes the gas and throws the piston and hammer bar forward. This movement of the piston will be transmitted to the fly wheel, through the medium of the cushioning cap 16, having the slideway 18 in which the crank pin box 19 moves, which carries the crank pin with it, thus turning the shaft 22, and actuating arm 34, which turns the fly wheel through the medium of the springs 47. As the hammer bar nears the end of its stroke, it will strike the block 80, located in the ratchet sleeve, through which its blow will be communicated to the end of the drill bit. It will be noted that this block is provided with suitable packing rings, to prevent the escape of gas from the cylinder. Should the hammer bar and block strike the drill before the crank pin reaches the dead center line, the piston will be brought to a stand still, but the crank pin will continue around carrying with it the cushioning cap 16, which will be moved away from the end of the piston. Its sleeve end however, will not become disconnected from the piston, and when the slot 60 in the sleeve passes the end of the piston, the gas in the forward end of the cylinder will be drawn through the said slot into the space between the front end of the piston and the cap, and as the momentum imparted to the wheel by the explosion carries the crank pin past the dead center line, the cap 16 will slide back again on the end of the piston, but the gas between the piston and cap will cushion the return stroke of the crank pin and the contact of the cap with the end of the piston, thus reducing the strain and jar upon the crank pin, shaft, and fly wheel, to a minimum, the springs 47 connecting the actuating arm and fly wheel also contributing to this result. The spring 59 on the hammer bar, will cushion excessive forward movement of the cap 16, as in case of a missed explosion at full speed or when gas is shut off suddenly, and should the drill strike a "fault" and permit the piston to be thrown to the limit of its stroke, the fly wheel will then take the shock of the return movement of the crank and thus prevent injury or breaking of the parts. The gas passing into the explosion end of the cylinder, will be deflected toward its rear end by a deflecting surface 109, formed on the end of the piston, as shown in Fig. 16, and the exploded gas is deflected toward the exhaust port 101 by a similar deflecting surface 110, and these two surfaces are separated by a bridge 111. The rifled nut 62 turns the ratchet sleeve 77, the teeth of which engage the chuck pawls on the rearward movement of the piston, to rotate the drill, and slip the pawls on its forward movement, as will be fully understood.

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

1. In an explosion operated rock-drilling engine, a cylinder, a piston in said cylinder, a gas explosive chamber in which said piston reciprocates, an electric spark igniting apparatus operatively connected to said cylinder, there being a valve controlled explosive gas inlet port extending along the central portion of said cylinder to the opposite end portions of said cylinder, a rock-cutting drill-bit arranged in said cylinder in striking relation to said piston, means including a crank shaft, and a fly wheel arranged with a resilient oscillating movement independent of said crank shaft for moving said piston on its rearward strokes.

2. In a gasolene gas explosion rock-drilling engine, a gasolene gas explosion cylinder, a piston reciprocally mounted in said cylinder, there being a valve controlled gas inlet port leading into said cylinder in front of said piston and connected to a supply of gasolene air-gas, and a port in said cylinder leading from its front portion to the rear end portion of said cylinder, a crank shaft arranged to be driven by said piston on said piston's forward stroke and adapted to drive said piston on its rear stroke, a fly wheel and means whereby said fly wheel is connected to said crank shaft in such a manner as to have a short predetermined resilient independent movement on said crank shaft.

3. In a gasolene gas explosion rock-drilling engine, a gas explosion cylinder, a piston reciprocally mounted in said cylinder, a rock-cutting drill-bit mounted in said cylinder in the reciprocal path of said piston, a striking block arranged between said drill-bit and said piston adapted to be struck by it, and to impart its blow to said drill-bit, there being a port connected to a supply of gasolene air-gas, and extending to the opposite ends of said cylinder, a rotative crank-pin and shaft mounted in said cylinder and arranged to operate said piston on its rearward stroke, and an electrical spark gas igniting apparatus operatively connected to said cylinder and said crank, and arranged to ignite a supply of gas in said cylinder at a predetermined point of said piston's movement.

4. In a gasolene gas-explosion operated rock-drilling engine, a gas explosion cylinder, a drill-bit striking piston-hammer reciprocally mounted in said cylinder, a rock-cutting drill-bit supported by said cylinder in the reciprocal path of said piston, there being a gas inlet port extending to the opposite end portions of said cylinder and arranged to be

controlled by the reciprocal movements of said piston, a crank shaft and crank pin arranged in said cylinder to operate said piston in one direction of its movement, an arm connected to said shaft, a fly wheel mounted loosely on said shaft and means for resiliently connecting the fly-wheel with said arm, and an electrical spark device in circuit with said gas explosion cylinder and arm.

5. In a gas explosion operated rock-drilling engine, the combination of a gas explosive cylinder and a drill-bit striking hammer piston reciprocal in said cylinder, a rotative drill-bit supported in said cylinder in the striking path of said piston, a striking block between said drill-bit and piston, there being ports arranged to be controlled by the reciprocative strokes of said piston for admitting a supply of gas to said cylinder, and an electrical spark producing apparatus for igniting the gas in said cylinder at a predetermined point of the rear stroke of the piston.

6. In a gas explosion operated rock-drilling engine, the combination of a cylinder, a reciprocating piston, a rotative drill-bit, and a striking block between said drill-bit and piston, with a rotative fly-wheel arm, crank shaft, crank pin, and a fly wheel mounted on said shaft, springs arranged to connect said arm and fly wheel, an electrical gap spark apparatus, and means for rotating said drill-bit.

7. In a gas explosion operated rock-drilling engine, the combination of a gas explosion cylinder arranged to receive gas from a source of supply, a drill-bit-striking hammer piston reciprocally mounted in said cylinder, there being ports in said cylinder for leading said explosive gas in front of said piston whence it is driven to the rear end of the cylinder by the forward stroke of the piston, means including an electrical intermittent spark-producing device for igniting said gas at a predetermined point of said piston's reciprocative movement to drive said piston against said drill-bit, and means connected with and actuated by said piston including a crank shaft, a crank pin, a fly wheel and operating arm, and a cushioning device on the end of said piston, for operating it on its rearward or inoperative stroke.

8. In a gas explosion operated rock-drilling engine, a cylinder provided with a gas explosion and a gas compressing end, and having a port extending adjacent to the said ends, connected with a valve controlled inlet, a hammer piston reciprocally mounted in said cylinder, which draws gas into the forward end of the cylinder on its rearward stroke, and forces it into the rear end of the cylinder on its forward stroke, means for igniting said gas at a predetermined point of the stroke of said piston, a sliding buffer cap on the forward end of said piston, having an inlet to admit air between said cap and the end of the piston, when the cap is moved forward, and means including a rotating crank pin arranged to engage said cap for moving said piston on its rearward reciprocal strokes.

9. In a gas explosion operated rock-drilling engine, the combination of a cylinder and a piston, of a crank casing connected to said cylinder, a crank shaft rotatably mounted in said casing, a crank-pin on the inner end of said crank shaft, a sliding cap on the front end of said piston having a sleeve thereon provided with an aperture arranged to admit the explosive gas between said cap and the front end of said piston, whereby to form a cushion between the two, a slideway in said sleeve arranged transversely to its movement, a journal box slidably mounted in said slideway and journaled to said crank pin, a drill-bit driving hammer bar connected to said piston below its axial center and extending through said cap, a collar on said hammer bar a short distance from the front end of said sleeve, a coiled spring on said hammer bar between said collar and said sleeve, and a fly wheel mounted on said crank shaft.

10. In a gas explosion rock-drilling engine, the combination with a cylinder, of a piston reciprocally mounted therein, the forward movement of which is accomplished by an explosion of gas, a reciprocating cap mounted on the forward end of said piston having an inlet therein adapted to admit the explosive fluid of said cylinder between said cap and the front end of said piston, a sliding journal box mounted in said cap, means including a crank shaft connected to said journal box for moving said piston throughout its rearward stroke, a drill-bit driving hammer bar extending forward from said piston and extending through said cap, an abutment on said hammer bar and a resilient member between said abutment and said cap.

11. In a gas explosion operated rock-drilling engine, a cylinder, a piston in said cylinder, a sliding cushioning cap on the front end of said cylinder, a sliding journal box in said cap, a crank shaft and pin connected to said sliding journal box, a fly wheel resiliently connected to a driving arm mounted on said crank shaft, a drill driving hammer bar connected to said piston and projecting through said sleeve, an abutment on said hammer bar, a coiled spring between said abutment and said sleeve, a rifled surface on said hammer bar, a pawl and ratchet controlled rifled nut rotatably mounted in said cylinder, a rock-cutting drill-bit supported by said cylinder, and connected with said pawl and ratchet mechanism, and a striking block between said drill-bit and said hammer bar.

12. In a gas explosion rock-drilling engine, the combination of a cylinder having a gas explosion chamber, a drill-bit striking ham-

mer piston reciprocally mounted in said cylinder, said cylinder having a port controlled by said piston, through which gas is forced by said piston to the rear end of said cylinder, an electric spark device and apparatus arranged to ignite said explosive gas to operate said piston on the forward strokes of its reciprocal movement, a fly-wheel crank shaft rotatably mounted in said cylinder in the path of the forward stroke of said piston and arranged and adapted through the medium of its rotative momentum to move said piston on its rearward or backward stroke, a rotative rock-cutting drill-bit supported in the reciprocal path of said piston, and a striking block between said drill-bit and said hammer piston.

13. In a gas explosion operated rock-drilling engine, the combination with a cylinder having a crank chamber, and a piston, provided with a cushioning reciprocating cap, a sliding box in said cap, a hammer bar and a spring between said hammer bar and said cap, of a crank shaft in said crank chamber, a fly-wheel on the outer end of said shaft, a crank disk on the inner end of said crank shaft in said crank chamber, and the crank pin rotatably secured to the sliding box of the cap.

14. In a gas explosion rock-drilling engine, a gas explosion cylinder, comprising a cylindrical portion having a drill-bit holding chuck at one end, a rock-cutting drill-bit rotatably mounted in said chuck, a rifled sleeve rotatably mounted in said cylinder adjacent to said chuck, a hammer piston reciprocally mounted in said cylinder to strike said drill-bit, a crank shaft and crank pin operated by the forward stroke of the piston for moving said piston rearward, means including a reciprocating cap connected to said piston for cushioning the rearward movement of said crank pin, means connected with said piston and rifled sleeve and chuck for rotating said drill-bit step by step, said cylinder having an explosion chamber at its rear end provided with a corrugated peripheral surface and having a port connecting its forward and rear ends, and connected with a valve controlled inlet, said piston acting to draw gas into the forward end of the cylinder on its rear stroke, and force it through said port to the rear end of the cylinder, on its forward stroke, and means for igniting said gas at a predetermined point of said piston's stroke.

15. In a gas explosion operated rock-drilling engine, the combination with a cylinder and a piston, said cylinder having a gas inlet leading into it, in front of said piston, of a nipple threaded to said inlet, having a valve seat, a valve disk arranged to fit said valve seat, a valve stem on said valve disk, a support for said valve stem in said nipple, a spring arranged between said support and the end of said valve stem to normally hold said valve disk in engagement with said valve seat, said valve and its spring being arranged to open and admit explosive gas to the front end of said cylinder by the suction action of the rearward stroke of said piston, there being a gas port extending from the front end portion of said cylinder to its rear end portion, packing rings around said piston for preventing the escape of gas around said piston on either stroke, means including an electrical sparking device for igniting said gas at a predetermined part of the reciprocal stroke of said piston to drive it on its forward stroke, a reciprocating air cushioning cap on the front end of said piston provided with a reciprocating journal box, and means including a fly-wheel crank and crank pin coöperatively connected to said piston cap journal box for moving said piston on its backward stroke, a rotative rock-cutting drill-bit arranged in said cylinder in the reciprocal path of said piston, and a striking block between said drill-bit and said piston.

16. In a gas explosion operated rock-drilling engine, the combination of the cylinder having a gas inlet port, a valve in said port, a piston reciprocating in said cylinder and arranged to control said port and to open said valve by the suction of its rearward stroke, a reciprocative cap on said piston, a journal box in said cap, a crank shaft and crank pin arranged to be in operative engagement with said journal box, an arm secured to said crank shaft, a fly wheel mounted on said crank shaft and arranged to surround said arm, and coiled springs on the opposite sides of the opposite ends of said arm and positioned between said arm and said fly wheel, and arranged to connect said fly wheel with resilient connections to the opposite sides of each end of said arm.

17. In a rock-drilling engine of the character described, the combination of a cylinder and a piston, a cushioning cap on said piston, and a sliding box in said cap, with a crank pin in engagement with said box, a crank shaft, an arm secured to said crank shaft, and a fly wheel resiliently connected to said arm.

18. In a gasolene operated rock-drilling engine, the combination of the cylinder and the crank shaft, having an arm secured thereto, a fly wheel mounted loosely on said crank shaft provided with a peripheral rim arranged to surround the opposite ends of said arm, threaded plugs connected to the opposite sides of both ends of said arm, abutments on the inner peripheral rim of said fly wheel, threaded plugs connected to said abutments and arranged opposite to the threaded abutments on said arm, and coiled springs threaded at one end to the threaded ends of said plugs of both sides of the opposite ends

of said arm and threaded at their opposite ends to the threaded ends of the threaded plugs of said fly wheel, and means for securing said threaded plugs to said fly wheel and to said arm.

19. In a rock-drilling engine of the character described, the combination with a cylinder of a reciprocating hammer piston having a sliding cap on its forward end, connected with the pin of a crank shaft, and a fly wheel resiliently attached to said shaft, an air cushion being formed between the cap and the end of the piston when the cap is moved so as to form a space between it and the end of the piston.

20. In a rock-drilling engine of the character described, the combination with a cylinder of a reciprocating piston having a hammer bar fitted in an aperture therein; a cap having a sliding movement on the end of the piston and provided with an air inlet; a crank shaft having a fly wheel mounted resiliently thereon, and a crank pin on said shaft connected with said cap, which slides said cap on the end of the piston on its forward movement, thereby admitting air between the cap and the end of the piston, which forms a cushion when the cap is returned by the return movement of the crank pin.

21. In a rock drilling engine of the character described, the combination with a cylinder having an explosion chamber at one end, a reciprocating hammer piston in said cylinder, and a cushioning device upon the forward end of said hammer piston, of a shaft mounted in said cylinder at right angles to said piston, a fly wheel on the outer end of said crank shaft, a crank disk at the inner end of said shaft, a crank pin on said crank disk which engages said cushioning device, said piston being thrown forward by an explosion of gas, thereby rotating the shaft and its disk and pin and fly wheel, which returns the piston on its rearward stroke.

22. In a rock-drilling engine of the character described, a cylinder having a valve controlled inlet connecting with a port which communicates with the cylinder adjacent to its ends; a hammer piston in said cylinder having an air cushion cap on its forward end; a crank shaft having a crank pin engaging said cushion cap; a fly wheel resiliently mounted on said shaft, and a spark device connecting said wheel and cylinder.

In testimony whereof I affix my signature in presence of two witnesses.

ROLLAND S. TROTT.

Witnesses:
G. Sargent Elliott,
Adella M. Fowle.