S. H. IVERY.

ROTARY EXPLOSIVE ENGINE.

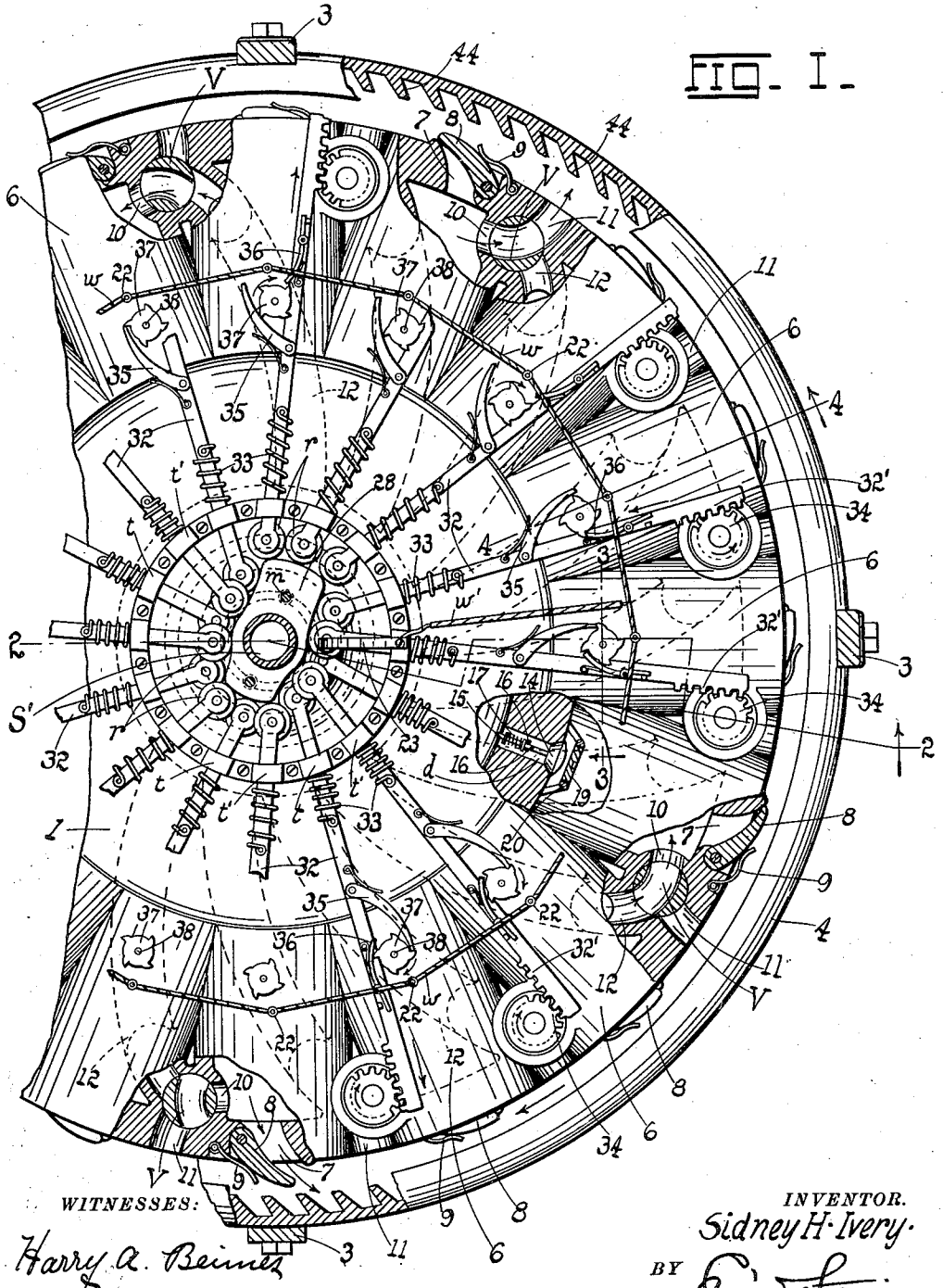
APPLICATION FILED NOV. 17, 1911.

1,047,232.

Patented Dec. 17, 1912.

3 SHEETS—SHEET 1.

FIG. I.



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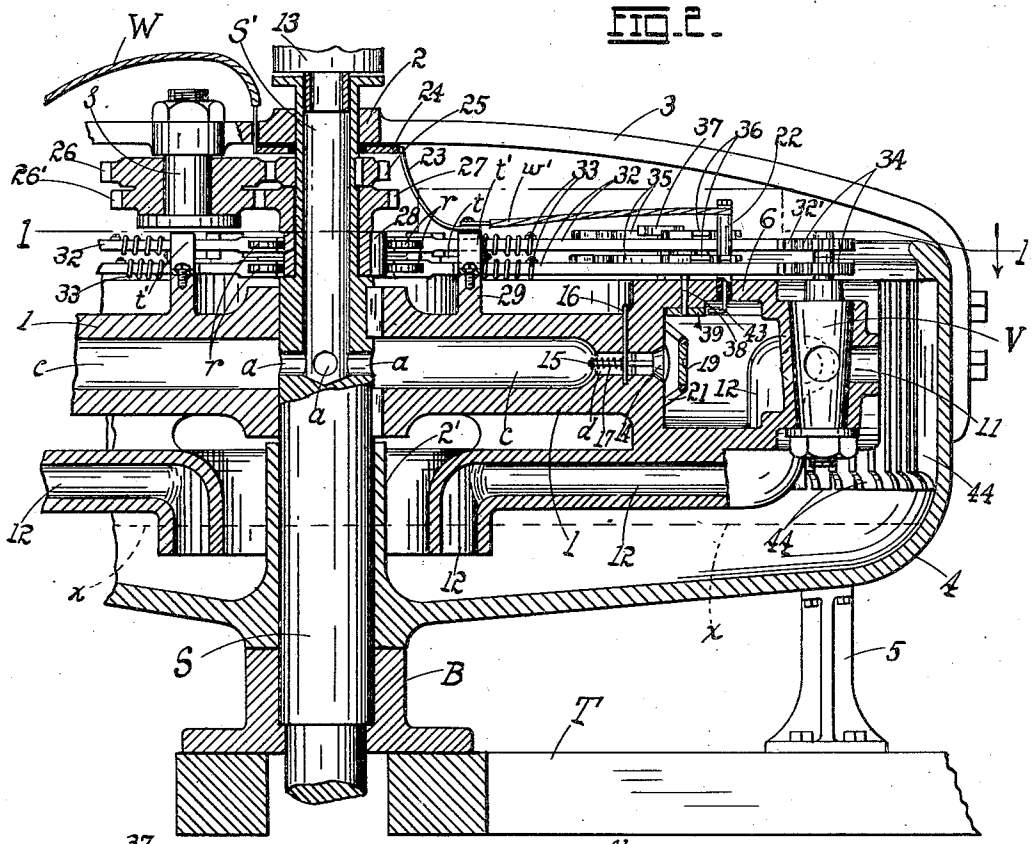
3 SHEETS—SHEET 2.

FIG. 2.



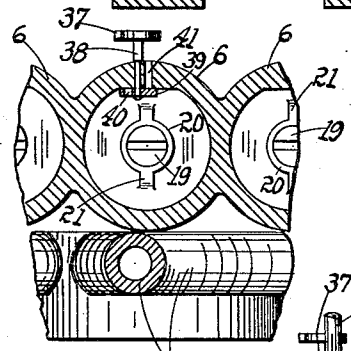


FIG. 3.

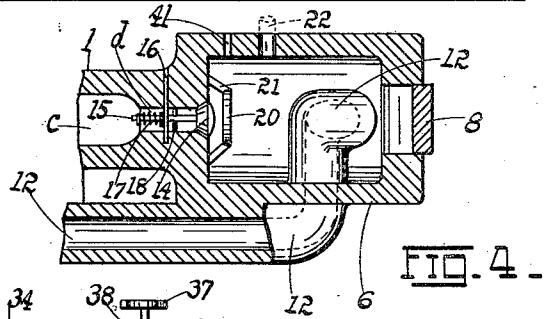


FIG. 4.

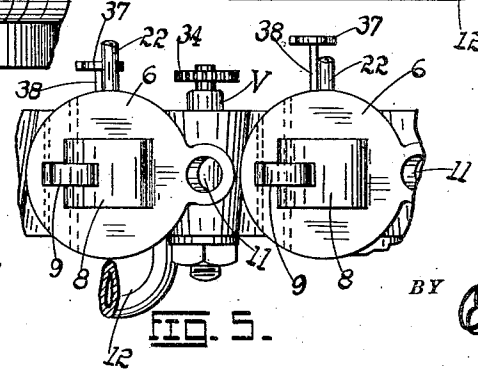


FIG. 5.

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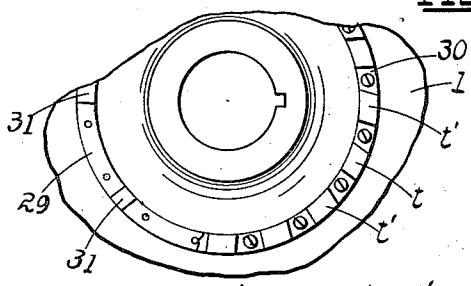
3 SHEETS—SHEET 3.

FIG. 6.



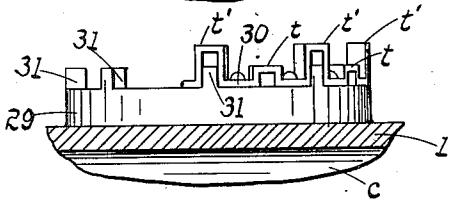


FIG. 7.

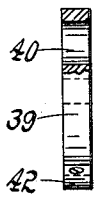


FIG. 8.

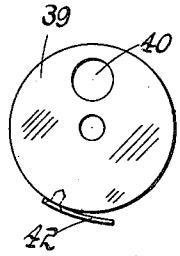


FIG. 9.

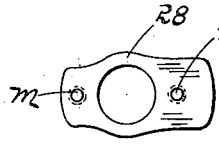


FIG. 10.

FIG. 11.

FIG. 12.

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UNITED STATES PATENT OFFICE.

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ROTARY EXPLOSIVE-ENGINE.

1,047,232. Specification of Letters Patent. Patented Dec. 17, 1912.

Application filed November 17, 1911. Serial No. 660,837.

To all whom it may concern:

Be it known that I, SIDNEY H. IVERY, citizen of the United States, residing at St. Louis, State of Missouri, have invented certain new and useful Improvements in Rotary Explosive-Engines, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part hereof.

My invention has relation to improvements in rotary explosive engines; and it consists in the novel details of construction more fully set forth in the specification and pointed out in the claims.

In the drawings, Figure 1 is a combined top plan, and horizontal section of the engine on the line 1—1 of Fig. 2; Fig. 2 is a vertical section on the line 2—2 of Fig. 1; Fig. 3 is a vertical sectional detail on the line 3—3 of Fig. 1 taken through the exhaust valve of the cylinder; Fig. 4 is a vertical section on the radial line 4—4 Fig. 1, (certain parts being omitted); Fig. 5 is an outer end view of two of the revolving cylinders; Fig. 6 is a top plan of a portion of the ring or flange for guiding the valve-controlling bars; Fig. 7 is an elevation of Fig. 6, with wall below the ring in section; Fig. 8 is an edge and sectional view of the exhaust-valve and wiper carried thereby; Fig. 9 is a plan of the exhaust valve; Fig. 10 is a plan of the cam traversed by the valve-controlling bars; Fig. 11 is a side view of the cam with part in section; and Fig. 12 is a diagrammatic view showing the successive positions of the exhaust-valve relatively to the spark-plug for a single revolution of the cylinder around the cam.

The object of my invention is to construct a rotary explosive engine employing the turbine principle of propulsion, water or other liquid being utilized in conjunction with the explosive mixture to effect the rotation.

The employment of water or other liquid dispenses with the necessity of employing mechanical pistons, thereby not only reducing the cost of construction, but at the same time serving as a means of keeping the working parts cool or at least preventing the overheating thereof.

A further object is to construct an engine with a minimum number of parts; one in which the several parts work positively and with certainty, maintaining a perfect control over the cycles on which a given impulse imparted to the engine depends.

The invention presents further and other features of construction better apparent from a detailed description thereof, which is as follows:—

Referring to the drawings, S represents a vertical rotatable shaft mounted in a step-bearing B, resting on timbers T, the upper end of the shaft terminating in a hollow portion S′ from the base of which radiate the ports *a*, *a*, said ports being in communication with the chamber *c* of a hollow casting or member 1 keyed to, and rotating with the shaft. The upper terminal of the shaft has its bearing in the hub 2 of a spider 3 the outer ends of whose arms are bolted to the outside of the vertical walls of a liquid container or pan 4 loosely surrounding the shaft, the latter passing freely through the bottom hub 2′ of the pan as shown (Fig. 2). The pan rests on the bearing B and is in addition secured fixedly by standards 5 bolted to the timbers T. Cast integrally with the casting or rotatable member 1 are a series of cylinders 6, whose several axes radiate from the axis of the shaft S as shown. The outer head of each cylinder is provided with a liquid discharge port 7 controlled by a hinge-valve 8 which is normally held closed by a flexed spring 9 (Fig. 1). Located at the outer end of the side of each cylinder is a port 10 controlled by a two-way rotatable valve V, the same valve likewise controlling the outer liquid discharge or waste port 11 located between each pair of cylinders and in addition controlling the discharges from the upper end or goose-neck of the curved conduit 12 cast with the member 1, the intake end of each conduit dipping into the liquid in the pan 4 at a point near the axis of the shaft (or axis of rotation of the member 1) the level of the liquid being indicated by the dotted line X—X (Fig. 2). The conduits 12 are so cast that they curve in a horizontal plane from their intake to the discharge end, the raised discharge or goose-neck end then rising between two cylinders and coming opposite the port of the two-way valve V.

Communicating with the upper hollow portion S′ of the shaft S is the base of any conventional carbureter 13 for supplying the explosive mixture to the chamber *c* of the rotatable member 1, the gas being admitted

into the cylinders 6 by a check-valve 14 the stem 15 of which is guided between two rods 16, 16, which at the same time serve as an abutment for one end of the controlling spring 17, the opposite end being secured to the stem. The latter is guided in the passage-way *d* provided for it, by a cross-pin 18 which bears against the walls of the passage-way. To limit the inward movement of the valve 14 (that is to say a movement toward the cylinder) I provide a shield or guard in the form of a disk 19 which is screwed into the center ring or hub 20 of a spider whose arms 21 are secured in any mechanical manner to the inner head of the cylinder.

Carried by each cylinder is a spark-plug 22 of conventional design, the several plugs being connected by a conducting wire *w*, a common feed wire *w'* supplying the current, the inner end of the wire *w'* being in electric connection with a wiper 23 whose free end traverses a collector disk 24 loosely enveloping the shaft S' and properly insulated, the current being supplied to the collector by the line wire W leading from any source of electrical energy. The wiring is not here claimed nor dwelt upon as that is within the skill of the mechanic. Keyed to the shaft S' below the collector disk 24 is a gear wheel 25 which meshes with the larger section 26 of a double gear mounted about a stud *s* carried by the spider frame 3, (Fig. 2), the smaller gear section 26' in turn meshing with a gear 27 passed loosely about the shaft S' (so as to turn independent thereof), the gear 27 being larger than the gear 25, so that a slower rate of rotation will be participated in by the gear 27 than is imparted to the gear 25 keyed to the shaft. We may for convenience assume that the gear 25 makes thirty revolutions to twenty-nine (or fewer) imparted to the gear 27, the reducing gear shown being availed of for a purpose presently to appear. The body of the loose gear 27 is provided with sockets for the reception of the pins *m*, *m*, (Fig. 11) of a cam 28 passed loosely over the shaft section S' and shouldered on the solid section S (Fig. 2), the cam necessarily participating in the rotations imparted to the gear 27. Cast with the member 1 and surrounding the cam is a flange or rim 29 the top of which is surmounted by a circular band or ring 30 provided with alternately low and high inverted U-shaped bends *t*, *t'*, respectively, the higher bends *t'* spanning the projections or lugs 31 distributed along the top of the flange 29. The respective loops *t*, *t'* form guides for the radially disposed valve-controlling bars 32, whose inner converging terminals are provided with rollers *r* playing over or traversing the sinuous face of the cam 28. Owing to the large number of these bars (32) they could not conveniently be disposed in the same plane, so for convenience they are disposed in pairs, the lower bar of each pair passing through a guide-loop *t* and resting on the upper edge of the flange or ring 29, the other bar resting on the projection 31 and passing through the loop *t'* as quite obvious from the drawing. For the same reason the height of the cam surface is sufficient to accommodate the rollers *r* necessarily disposed in superposed planes. Each bar 32 is provided with a coiled spring 33 one end of which bears against the bar guide or band 30, the opposite end of the spring being secured to the bar (Fig. 1). The free outer end of each bar 32 is provided with a rack-section 32' which engages a pinion 34 (partially toothed) carried by the stem of the rock-valve V, (the stems of the successive valves V being long and short owing to the disposition of the bars 32 as previously explained), the said bar being additionally provided with spring-controlled pawls 35, 36 adapted with successive strokes of the bar to engage a tooth and impart a partial rotation to the outer terminal ratchet disk 37 carried at the outer end of the stem 38 (the stems being alternately long and short to reach the successive bars for reasons previously explained) of the rotatable exhaust disk-valve 39, the latter being provided with an opening 40 to register at the proper time with the gas-exhaust port 41 from the cylinder. The edge of the valve 39 carries a wiper 42 which at the proper time wipes against the finger 43 leading from the spark-plug 22, thus drawing a spark and exploding the gas mixture in the cylinder. The contents expelled by the explosion discharges through the port 7 more or less tangentially, impinging against a series of ribbed abutments 44 cast at the proper angle along the inner face of the vertical wall of the pan or container 4, the contents so discharged against the abutments flowing back into the container 4, the member and shaft S rotating in the direction as shown by the curved peripheral arrow (Fig. 1), the shaft S at points beyond the bearing B, being adapted to be coupled to any suitable machinery intended to be driven.

The operation of the engine is substantially as follows:—Since the cam 28 has a relatively slower rotation than the shaft S and the member 1, we may for purposes of explaining the operation, assume that the cam is at rest. Let us assume for convenience (taking any cylinder 6 of the series as any example, since they all act alike) that a cylinder has reached a position where it has brought its particular bar 32 to that portion of the cam surface where the bar had turned the valve V to a position so as to establish communication between the conduit 12 and the port 10 (Fig. 1). The cen-

trifugal action of the moving mass (the part 1, cylinders 6, and conduits 12 rotating as a unit) drafts the water (or other liquid) from the container 4 through the conduit 12 the liquid discharging into the cylinder through the passage-way of the valve V. The liquid thus entering compresses the charge of gas previously admitted (as subsequently to be explained) and as the mass continues to rotate, the bar 32 will gradually ride "up" the cam, forcing the bar outwardly so as now to close the valve V altogether (bottom Fig. 1). In this outward pushing of the bar 32, the pawl 35 thereof has rotated the valve 39 to closed position (bottom of diagrammatic view Fig. 12) and caused the wiper 42 to rub the finger 43 of the spark-plug, thus exploding the gas, the explosion expelling the liquid (and some of the spent gases) through the port 7 past the gate-valve 8, against the fixed abutments 44, (and against the vertical wall of the pan 4 which likewise serves as an abutment), the expulsion of the water and gases as described driving the mass as indicated by the curved arrow in Fig. 1, causing the cylinder 6 to thus revolve about the axis of the shaft S. The expulsion can continue while the roller end of the bar 32 is traversing the lower concentric curvature of the cam (Fig. 1), after which the bar will "drop" (or advance toward the axis of the shaft as clearly obvious from the shape of the cam in Fig. 1) and again rock the valve V to open communication between the conduit 12 and cylinder, the valve 8 having by this time closed, and the valve 39 having been turned by the pawl 36 (the pawls 35, 36, acting alternately but always rotating or advancing the gas-exhaust valve 39 in the same direction) to open position as shown at the left in Fig. 12 where the ports 40 and 41 are in register. The liquid is now again free to enter the cylinder under centrifugal action of the rotating mass, the spent gases from the previous explosion being free to escape through the open port 41. This continues while the bar 32 is traversing the left-hand concentric portion of the cam (Fig. 1) after which the bar suddenly "rises" and rocks the valve V to the position shown at the right hand upper end in Fig. 1, thereby establishing communication between the cylinder and the waste port 11, thus allowing the water (or other liquid) to be expelled from the cylinder back into the pan 4; and as the liquid is thus expelled into the pan 4 from the cylinder 6 (in which expulsion centrifugal force plays an important part), the mixture of gas flows into the cylinder to take the place of the expelled liquid, the gas flowing into the cylinder from the passage-way of the shaft-section S′ through the ports a, a, into the chamber c, thence through passage d, past the check-valve 14 (which is unseated) as obvious from the drawings.

As the mass revolves the valve V remains in the last position referred to while the bar 32 is traversing the upper concentric portion of the cam (Fig. 1) after which it again suddenly "drops" rocking the valve V to the first position described, that is to say opening communication between the cylinder 6 and conduit 12, when liquid is again free to enter the cylinder and compress the gas charge ready for the next explosion, thus completing the cycle. For a given cycle, the bar 32 makes two strokes inward and two outward, the pawls 35, 36 taking turns in imparting a rotary advance to the exhaust valve 39, said valve uncovering the port 41 once only for each cycle, and that is to allow the spent gases to escape to make room for the liquid, as best shown in diagram in Fig. 12, in which the relative positions of the ports 40, 41, for a given cycle may be followed. The liquid entering the cylinder thus acts as a piston of a four-cycle engine, the liquid first entering the cylinder (expelling the spent gases), then being expelled from the cylinder to admit a fresh charge of gas, then entering the cylinder to compress this charge, then being expelled from the cylinder upon the sparking and explosion, the explosion imparting rotation to the mass (or revolution to the several cylinders) about the axis of the shaft S. Of course, each valve-controlling bar 32 is actuated outwardly by the cam 28, and inwardly by the spring 33 which causes the roller end of the bar to constantly hug the cam surface. It is obvious that, barring evaporation, the same liquid may be used over and over, and as a liquid it has the advantage in that it keeps the parts cool.

By having a large number of cylinders, we may secure a corresponding number of impulses; and by properly regulating the differential in the number of rotations in a unit of time between the shaft S and the cam 28, the frequency of the cycles and impulses may be regulated. The reducing gear (25, 26, 26′, 27) may be changed to suit working conditions, and hence any desired speed may be imparted to the shaft S, depending on the reduction in speed assigned to the cam. Obviously it is by reason of the gain in speed by the member 1 over that of the cam 28 which permits the bars 32 to traverse the cam and control the valves V and 39.

Having described my invention what I claim is:—

1. In combination with a cylinder revolving about a fixed axis, a source of liquid supply, means for conducting the liquid by centrifugal action from said supply source into the cylinder during a portion of the revolution of the cylinder, means for con-

ducting an explosive mixture into the cylinder behind the liquid admitted thereinto, the explosion of the mixture driving the liquid out of the cylinder at a proper angle to impart a revolution to the cylinder about the fixed axis aforesaid.

2. In combination with a cylinder revolving about a fixed axis, a source of liquid supply, a valve-controlled conduit for conveying the liquid by centrifugal action from a point removed from the axis to a point in the cylinder beyond the intake of said conduit, an exhaust for the cylinder, a liquid-discharge valve on the cylinder, a source of gas supply communicating with the cylinder, a spark-plug, means on the exhaust valve for drawing the spark from the plug and exploding the gas admitted into the cylinder, the explosion driving out the liquid through the discharge-valve and imparting revolution to the cylinder.

3. In combination with a cylinder revolving about a fixed axis, a source of liquid supply, a source of gas supply, an exhaust valve on the cylinder, a liquid-discharge valve on the cylinder, a cam disposed about the axis of revolution of the cylinder, a spring-controlled member playing over the cam surface and coöperating with the aforesaid valves to effect proper control thereover, a spark plug on the cylinder, a wiper on the exhaust valve to draw the spark from the plug and explode the gas admitted into the cylinder, the explosion driving the liquid out of the cylinder through the discharge valve and thereby imparting a revolution to the cylinder, and means for conducting the liquid so expelled back to the original source of supply thereof.

4. In combination with a fixed vertical shaft rotating about its axis, a hollow rotatable member carried thereby and provided with a series of cylinders disposed radially about said axis, a stationary frame for the support of said shaft, a cam loosely mounted about the shaft, reducing gears interposed between the shaft and cam for effecting a differential speed of rotation between the rotatable member and the cam, a liquid pan or container surrounding the shaft, radially disposed conduits having intakes dipping into the liquid at points adjacent the shaft and discharging into the outer ends of the cylinders, rotatable valves at the discharge ends of the conduits, rotatable exhaust valves on the several cylinders, a source of gas supply, means for conducting said gas through the shaft into the chamber of the rotatable member, said chamber communicating with the inner ends of the several cylinders, check-valves for the gas, spring-controlled bars radiating from the shaft along the several cylinders and playing with their ends over the cam surface, means on said bars for actuating the liquid-control and exhaust-valves, spark-plugs on the cylinders, wipers on the exhaust valves for drawing the spark from the plugs for exploding the gas in the cylinders, whereby the liquid is expelled against the abutment and the hollow member is rotated about the axis of the shaft, and liquid discharge-valves on the several cylinders, the parts operating substantially as and for the purpose set forth.

5. In combination with a cylinder revolving about a fixed vertical axis, a cam disposed about said axis, a liquid pan surrounding said axis, a conduit leading from the pan from a point near the axis and discharging through the outer end of the cylinder, a rotatable valve controlling the discharge of the liquid into the cylinder, a pinion carried by the valve on the outside of the cylinder, a rotatable exhaust valve on the cylinder, a ratchet disk on said valve, a bar radiating from the cam and having its inner end traversing the cam surface, a rack on the bar engaging the teeth of the pinion of the liquid control-valve, a pawl on the bar controlling the ratchet disk on the exhaust valve, a spark plug on the cylinder, a wiper on the exhaust valve cooperating with the spark-plug, a guide for the bar, a spring encircling the bar and having one end engaging the bar and the opposite end engaging the guide, means for admitting an explosive mixture into the cylinder from a point leading from the axis of the shaft, and a check-valve at the gas intake end of the cylinder, substantially as set forth.

6. In combination with a cylinder revolving about a fixed axis, a cam disposed about said axis, the cylinder being provided with a liquid-intake port and a waste port, and with a gas-exhaust port, a valve adapted to establish communication between the intake port and the interior of the cylinder, and between the cylinder and the waste port respectively, and a member traversing the cam and coöperatively connected to the valves aforesaid, for actuating the same with the revolution of the cylinder about the cam.

7. In combination with a cylinder revolving about a fixed axis, a cam disposed about, and revolving independently about said axis at a different rate of speed, the cylinder being provided with a liquid-intake port, a waste port, a liquid discharge port, and a gas-exhaust port, a rotary valve controlling communication between the cylinder and the intake and waste ports, an independent valve controlling the liquid exhaust port, a rotary valve controlling the gas-exhaust port, a bar coöperatively connected to the rotary valves, extending across the cylinder and having one end engaging the cam, said end traversing the cam surface with a revolution of the cylinder about the axis afore-

said, the difference in the speeds of rotation between the cam and cylinder causing the bar to reciprocate to and from the axis of the cam, in which reciprocations the rotary valves are actuated.

8. In combination with a cylinder revolving in a horizontal plane about a fixed vertical axis, a liquid supply source disposed about said axis, and conduits leading from said liquid and in coöperative connection with the cylinder for drawing the liquid into the cylinder by centrifugal action resulting from the revolution.

9. In combination with a cylinder revolving about a fixed axis, a liquid supply surrounding said axis, and conduits having intake ends dipping beneath the surface of the liquid and having discharge ends leading into the cylinder for drawing the liquid into the cylinder by centrifugal action resulting from the revolution.

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

SIDNEY H. IVERY.

Witnesses:
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