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W. G. MACOMBER.

ROTARY ENGINE.

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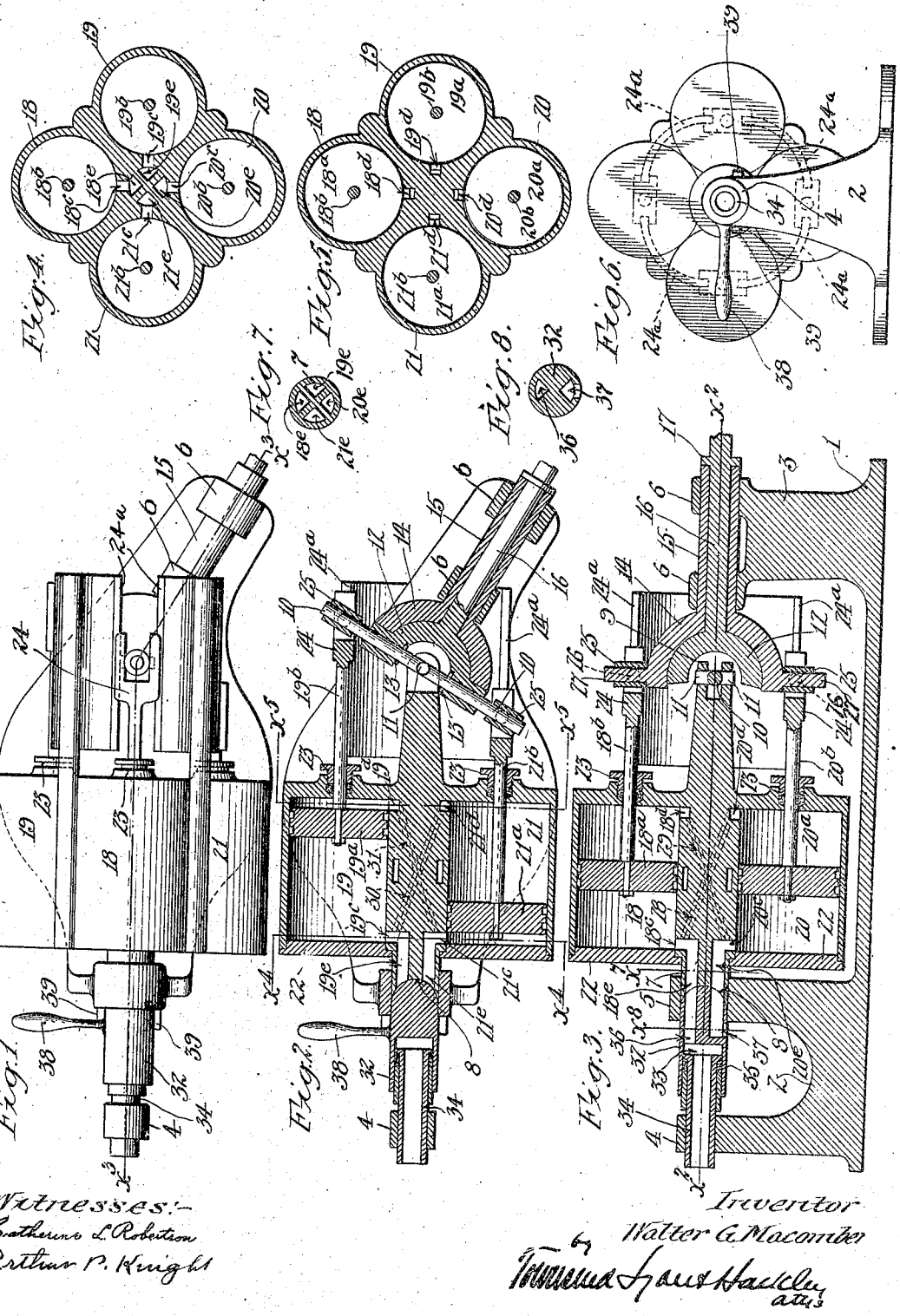

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ROTARY ENGINE.

No. 893,181. Specification of Letters Patent. Patented July 14, 1908.

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To all whom it may concern:

Be it known that I, WALTER G. MACOMBER, a citizen of the United States, residing at Johannesburg, county of Kern, State of California, have invented a new and useful Rotary Engine or Pump, of which the following is a specification.

This invention relates to a rotary engine or pump in which a cylinder having a reciprocating piston is employed, and the object of the invention is to employ a plurality of cylinders with their pistons and cause a rotary bodily movement of the cylinders in a plane at right angles to the direction of piston travel. The power from the reciprocating pistons is applied to a rotating element which rotates in a plane at an angle to the rotation of the cylinders, and a further object is to equalize the pressure of one piston against said element by an opposing pressure produced by another piston at the opposite side of said element, thereby avoiding end thrust and vibration. In this engine no fly-wheel is required, as the cylinders partake of bodily rotation and their weight is sufficient to cause them to perform the service of a fly-wheel. Each piston, in this embodiment, is propelled by the motive fluid, for example, steam or air, in both directions. In other words, each piston is double acting, and a further very important object of the invention is to dispense with movable valves and their necessary attendant mechanism for operating them, such as eccentrics, cams, and the like, and to effect the admission and exhaust of the cylinders by the bodily rotating movement of the cylinders.

A further object is to provide a manually controlled valve for reversing the sequence of admission and exhaust and thus provide for operating the engine in either direction.

From the foregoing it will be seen that the engine may be of exceedingly simple construction and that the only movable parts thereof are the cylinders, their pistons, the angularly disposed rotating element and the connections between said element and the pistons.

Other objects and advantages will be brought out in the following description.

The accompanying drawings illustrate the invention, and referring thereto:—Figure 1 is a plan view of the engine constructed with four cylinders. Fig. 2 is a horizontal section through the engine on line x^2—x^2 Fig. 3. Fig. 3 is a vertical section through the engine on line x^3—x^3 Fig. 1. Fig. 4 is a section on line x^4—x^4 of Fig. 2. Fig. 5 is a section on line x^5—x^5 of Fig. 2. Fig. 6 is an end elevation of the head end of the engine. Fig. 7 is a cross section through the cylinder shaft on line x^7—x^7 Fig. 3. Fig. 8 is a cross section through the reversing valve on line x^8—x^8 Fig. 3.

The engine is provided with a base 1 having at one end a standard 2 and at the other end a standard 3. The standard 2 is formed with a support 4 and journal bearing 5 axially in line with each other and the standard 3 is provided with journal bearings 6 axially in line with each other, but at an angle to the axis of bearings 4 and 5, as clearly shown in Figs. 1 and 2.

7 designates the cylinder shaft which has a hemispherical concave recess 8 in its head end, which end is journaled in the bearing 5 and terminates therein. The other end of the cylinder shaft 7 is preferably tapered, as shown, and has a fork 9 through which passes a cross rod 10, the cross rod 10 having trunnions 11 which pivot the cross rod to the fork 9 thereby forming a universal joint between the cylinder shaft and cross rod. The cross rod 10 extends diametrically through a hollow hemispherical bowl, hereinafter termed the inner bowl 12, and pins 13 hold the cross rod 10 from slipping endwise in the inner bowl. The inner bowl 12 is nested within a similarly shaped outer bowl 14. The outer bowl 14 is carried on the end of a sleeve 15 journaled in bearings 6 and the inner bowl 12 is carried on a shaft 16 which is journaled in sleeve 15, the shaft 16 having a collar 17 which bears against the end of sleeve 15 to prevent relative longitudinal movement between the sleeve and shaft.

Mounted on the cylinder shaft 7 and preferably cast integrally therewith are four cylinders 18, 19, 20 and 21, each cylinder having a removable head 22. Mounted to reciprocate within the respective cylinders 18, 19, 20 and 21 are pistons 18^a, 19^a, 20^a and 21^a, which pistons are provided respectively with piston rods 18^b, 19^b, 20^b and 21^b, each piston rod passing through a gland 23 in the end of its cylinder. The four piston rods all have forked ends 24 which slide on ways 24^a projecting from the cylinders, and in each forked end 24 is a sleeve 25 having trunnions 26 which are journaled in the forked end so that

the sleeve 25 can swing therein. The ends of cross rod 10 are mounted in sleeves 25 of the piston rods 19^b and 21^b. Projecting from the outer bowl 14, from diametrically opposite points, are two trunnions 27, which trunnions project into sleeves 25 connected with piston rods 18^b and 20^b. Thus, pistons 18^a and 20^a are connected with the outer bowl 14 and the pistons 19^a and 21^a are connected with the inner bowl 12.

The cross rod 10 which is carried by the inner bowl 12 is free from engagement with the outer bowl 14 and lies at right angles to the trunnions 27 of the outer bowl, but this relative angular position is not maintained absolutely, for as will be hereinafter pointed out, there is a slight relative movement between bowls 12 and 14 which causes a certain amount of change in the relative angular positions of cross rod 10 and trunnions 27. However, at all times the cross rod 10 may be said to be substantially at right angles with the trunnions 27, as the relative movement with respect thereto is slight. The cylinder 18 is provided at each end, respectively, with port 18^c and 18^d; cylinder 19 is provided with similar ports 19^c and 19^d; cylinder 20 with similar ports 20^c and 20^d; and cylinder 21 with similar ports 21^c and 21^d. A passage 28 formed in cylinder shaft 7 connects ports 18^c and port 20^d, and a passage 29 connects port 20^c with port 18^d, as shown by dotted lines in Fig. 3; the said two passages do not communicate with each other. A passage 30 connects port 19^c with port 21^d, and a passage 31 connects port 21^c with port 19^d as shown by dotted lines, Fig. 2, and these latter passages do not communicate with each other. The cylinder shaft 7 at the head end is provided with four longitudinal passages 18^e, 19^e, 20^e and 21^e which respectively communicate with ports 18^c, 19^c, 20^c and 21^c, and the said passages all open at the concave end 8 of the shaft 7. A reversing valve 32 is arranged at the concave end of shaft 7 and has a rounded nose which fits the concave face 8. The other end of the reversing valve is formed with a socket providing a chamber 33. Projecting part way into the chamber 33 is a stationary shaft 34 upon which the reversing valve 32 is revolubly mounted. The shaft 34 is hollow to form an inlet for the admission of the motive fluid to the chamber 33, and an annular gland 35 is arranged between the reversing valve 32 and shaft 34 to prevent leakage. The reversing valve 32 is provided with passages 36 and 37, both passages opening at the round end of the reversing valve and the passage 36 communicating directly with chamber 33, while the passage 37 does not communicate with passage 33 but is open to the atmosphere.

A reversing lever 38 is provided on the reversing valve 32 for operating the valve, and stops 39 limit the movement of the reversing valve to an arc of half a circle. When the valve stands in the position shown in Fig. 2, motive fluid enters through hollow shaft 34 to chamber 33 and while in chamber 33 exerts end pressure against the reversing valve, tending to hold its round nose firmly seated in the concave end of shaft 7, and as this joint is a ground joint leakage is prevented. Motive fluid passes from chamber 33 into passage 36 and from passage 36 it enters through port 18^c into the cylinder 18 at the left side of piston 18^a. An equal amount of motive fluid is also admitted through passage 28 and through port 20^d into cylinder 20 at the right hand side of piston 20^a, and thus piston 18^a is moved to the right and piston 20^a moves to the left. During this movement of the pistons the motive fluid on the right hand side of piston 18^a passes out through port 18^d and through passage 29 to passage 20^e where it mingles with motive fluid at the left of piston 20^a, and the combined motive fluid passes along passage 20^e into passage 37 of the reversing valve and exhausts into the atmosphere. The combined pushing effect of piston rod 18^b against the associated trunnion of outer bowl 14 and the pulling effect of piston rod 20^b upon its associated trunnion of the outer bowl 14 imparts rotation to the outer bowl on account of the angular thrust and pull of the said two piston rods on the bowl which causes the outer bowl to rotate, and as the bowl is thus caused to rotate, it in turn imparts through piston rods 18^b and 20^b rotation to the cylinders; and as all of the cylinders are mounted as one piece they are all caused to revolve together, and for that reason at this time the inner bowl 12 is also given rotation through the medium of the other pair of piston rods connected therewith. When the piston 18^a arrives at port 18^d and piston 20^a arrives at port 20^c, the cylinder shaft 7 has been turned one quarter of a revolution, which brings passage 21^e into register with inlet passage 36 and brings inlet passage 19^e into register with exhaust passage 37, whereupon the piston in cylinders 21 and 19 are moved in opposite directions by the introduction and exhaust of motive fluid thereto in a manner similar to that described in connection with cylinders 18 and 20, and during this movement of pistons 19^b and 21^b a combined push and pull is exerted through the cross rod 10 upon the inner bowl 12, which in turn transfers rotation to the cylinders and to the shaft 16 and sleeve 15 through the second quarter of revolution. Upon the completion of the second quarter of revolution the passage 20^e is in register with inlet passage 36 and passage 18^e is in register with exhaust passage 37, and piston 20^a is moved to the right and piston 18^a moved to the left, again acting upon the outer bowl, and through the parts connected therewith imparting rotation as

before to the cylinders and shaft 16 and sleeve 15, and during the last quarter of the revolution pistons 19^a and 21^a of cylinders 19 and 20 are acted on in the same manner. It will thus be seen that the four ports 18^e, 19^e, 20^e and 21^e are successively brought into communication with inlet passage 36 and in sequence are brought into register with outlet passage 37. Thus, the cylinder shaft 7 in its revolution acts as a valve to permit intake and exhaust according to the position of these four passages. It is obvious that by operating the lever 38, the reversing valve 32 may be turned through half a circle which will bring the exhaust passage 37 at the top and intake passage 36 at the bottom, and from Fig. 3 it will be seen that exhaust passage 37 is then in communication with passage 18^e, while intake passage 36 is in communication with passage 20^e, whereupon motive fluid will be introduced through passage 36 into passage 20^e and through port 20^e at the left of cylinder 20, while fluid will exhaust from the left side of cylinder 18 through passage 18^e to exhaust passage 37, fluid being admitted to the right of cylinder 18 through passage 29 which communicates with passage 20^e. This will result in imparting reverse movement to the motor.

A careful consideration of the principles of construction will show that the end of each piston rod has a path of travel through a circle, viewed in a direction along the stroke of the piston rod, but as the inner and outer bowls are also circular and rotate at an angle the points of contact of the forked ends of the piston rods will vary on the trunnions as the trunnions move in an ellipse when viewed along the line of piston travel. On account of this the sliding connection between the trunnions and piston rod ends is provided. From this it will be seen that a slight differential movement occurs between the two bowls, first one bowl slightly leading and then the other leading, according to the changing radius from centers of bowls to the contacting points on the trunnions, and it is thus necessary to provide for a certain amount of relative movement between the two bowls 12 and 14, which relative movement is provided as was before pointed out in the specification. Power can be taken off either from the sleeve 15 or shaft 7.

Obviously the machine may be driven to act as a pump in which the circuit of fluid will be the same as when the machine operates as an engine. More or less cylinders may be employed as will be evident.

What I claim is:—

1. A rotary machine comprising a plurality of cylinders mounted to rotate bodily transversely to their bores, reciprocating pistons in the cylinders, a device mounted to rotate in a plane angular to that of the cylinder rotation, two pistons being connected to said device at points not diametrically opposite with means providing relative movement between said points of connection.

2. A rotary machine comprising a plurality of sets of cylinders mounted to rotate bodily transversely to their bores, reciprocating pistons in the cylinders, a device mounted to rotate in a plane angular to that of the cylinder rotation, the cylinders being mounted 90° apart and their pistons being connected to said device at points substantially 90° apart with means providing relative movement between the points of connection of one set of pistons and the other set of pistons.

3. A rotary machine comprising a plurality of cylinders mounted to rotate bodily transversely to their bores, reciprocating pistons in the cylinders, a device mounted to rotate in a plane angular to that of the cylinder rotation and consisting of two members capable of relative movement, the piston of one cylinder being connected to one of said members, and another piston being connected to the other member.

4. A rotary machine comprising a plurality of sets of cylinders mounted to rotate bodily transversely to their bores, reciprocating pistons in the cylinders, a device mounted to rotate in a plane angular to that of the cylinder rotation and consisting of two members capable of relative movement, the pistons of one set of cylinders being connected to diametrically opposite points of one of said members, and the other pistons being connected at diametrically opposite points of the other member.

5. A rotary machine comprising a plurality of cylinders mounted to rotate bodily transversely of their bores, reciprocating pistons in the cylinders, a pair of nested bowls mounted to rotate angularly to the cylinder rotation, a piston connected to one bowl, and another piston connected to the other bowl, said bowls being capable of relative movement.

6. A rotary machine comprising a plurality of cylinders mounted to rotate bodily transversely to their bores, reciprocating pistons in the cylinders, a pair of nested bowls capable of relative movement and mounted to rotate angularly to the cylinder rotation, trunnions on the outer bowl, a cross rod on the inner bowl forming trunnions, piston rods on the pistons and having forked ends, sleeves journaled on said trunnions, and trunnions on each sleeve journaled in the forked end of its associated piston rod.

7. A rotary machine comprising a plurality of cylinders mounted to rotate bodily transversely to their bores, reciprocating pistons in the cylinders, a pair of nested bowls capable of relative movement and mounted to rotate angularly to the cylinder rotation, trunnions on the outer bowl, a cross rod on

the inner bowl forming trunnions, piston rods on the pistons and having forked ends, sleeves journaled on said trunnions, trunnions on each sleeve journaled in the forked end of its associated piston rod, a shaft supporting the inner bowl, a sleeve loose on said shaft and supporting the outer bowl, and journal bearings in which the sleeve and shaft are mounted.

8. A rotary machine comprising a cylinder shaft, cylinders thereon, the shaft having passages near its end, each cylinder having a port at each end, the respective ports at one end being connected with the respective passages, the ports at the other end being connected by offset passages with the first named passages whereby the two ports of each cylinder are in communication with diametrically opposite first passages, a device rotating angularly to the cylinders, said pistons being connected to said device with means providing relative movement between the device and certain pistons, and means allowing admission and exhaust to the first named passages in sequence as the cylinder shaft revolves.

9. A rotary machine comprising a cylinder shaft, cylinders thereon, the shaft having passages near its end, each cylinder having a port at each end, the respective ports at one end being connected with the respective passages, the ports of the other end being connected by offset passages with the first named passages whereby the two ports of each cylinder are in communication with diametrically opposite first passages, a device rotating angularly to the cylinders, said pistons being connected to said device, a reversing valve fitting against the end of the cylinder shaft and having a chamber, said valve having an inlet passage extending from the chamber to the end of the cylinder shaft, and having an exhaust passage opening through the side and extending to the end of the cylinder shaft.

10. A rotary machine comprising a cylinder shaft, cylinders thereon, the shaft having passages near its end, each cylinder having a port at each end, the respective ports at one end being connected with the respective passages, the ports of the other end being connected by offset passages with the first named passages whereby the two ports of each cylinder are in communication with diametrically opposite first passages, a device rotating angularly to the cylinders, said pistons being connected to said device, a reversing valve fitting against the end of the cylinder shaft and having a chamber, said valve having an inlet passage extending from the chamber to the end of the cylinder shaft, and having an exhaust passage opening through the side and extending to the end of the cylinder shaft, a hollow stationary shaft extending into said chamber and a stuffing box between the hollow shaft and walls of the reversing valve.

11. A rotary machine comprising a cylinder shaft, cylinders thereon, the shaft having passages near its end, each cylinder having a port at each end, the respective ports at one end being connected with the respective passages, the ports of the other end being connected by offset passages with the first named passages whereby the two ports of each cylinder are in communication with diametrically opposite first passages, a device rotating angularly to the cylinders, said pistons being connected to said device, a reversing valve fitting against the end of the cylinder shaft and having a chamber, said valve having an inlet passage extending from the chamber to the end of the cylinder shaft, and having an exhaust passage opening through the side and extending to the end of the cylinder shaft, the end of the cylinder shaft having a concave face and the end of the reversing valve having a convex face fitting in the concave face of the cylinder shaft.

12. A rotary machine comprising a cylinder shaft, cylinders thereon, the shaft having passages near its end, each cylinder having a port at each end, the respective ports at one end being connected with the respective passages, the ports of the other end being connected by offset passages with the first named passages whereby the two ports of each cylinder are in communication with diametrically opposite first passages, a device rotating angularly to the cylinders, said pistons being connected to said device, a reversing valve fitting against the end of the cylinder shaft and having a chamber, said valve having an inlet passage extending from the chamber to the end of the cylinder shaft and having an exhaust passage opening through the side and extending to the end of the cylinder shaft, a hand lever on the reversing valve for operating it and a stop for limiting the throw of the reversing valve.

13. A rotary machine comprising a cylinder shaft, a plurality of cylinders arranged longitudinally on said shaft, reciprocating pistons in the cylinders, a pair of nested bowls capable of relative movement and mounted to rotate angularly to the cylinder shaft, trunnions on the outer bowl, a cross rod on the inner bowl, a universal joint between said cross rod and the adjacent end of the cylinder shaft, and piston rods on the pistons connected to the trunnions of the outer bowl, and other piston rods connected to the ends of the cross rod.

14. A rotary machine comprising a plurality of cylinders mounted to rotate bodily transversely to their bores, reciprocating pistons in the cylinders, a pair of nested bowls capable of relative movement and mounted to rotate angularly to the cylinder rotation, trunnions on the outer bowl, a cross

rod on the inner bowl forming trunnions, piston rods on the pistons and having forked ends, sleeves journaled on said trunnions, trunnions on each sleeve journaled in the forked end of its associated piston rod, and guides projecting from the cylinders on which said forked ends travel.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 24th day of September 1907.

WALTER G. MACOMBER.

In presence of—
GEORGE T. HACKLEY,
FRANK L. A. GRAHAM.