

Aug. 23, 1966

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3,267,675

ROTARY APPARATUS FOR ACTING MECHANICALLY ON FLUIDS

Filed Feb. 13, 1964

3 Sheets-Sheet 1

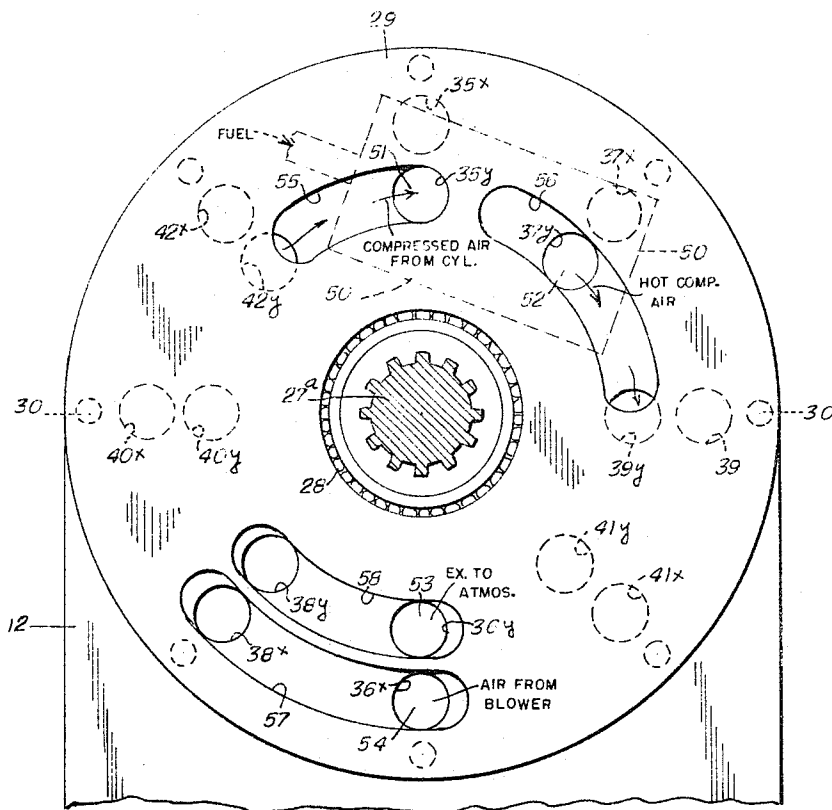
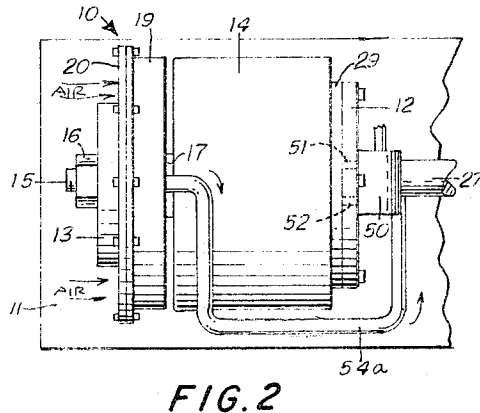
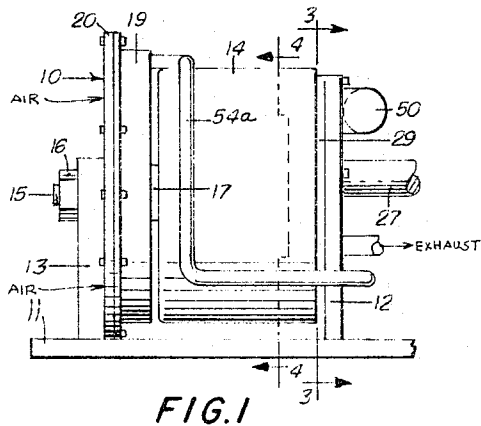


FIG. 3

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3 Sheets-Sheet 2

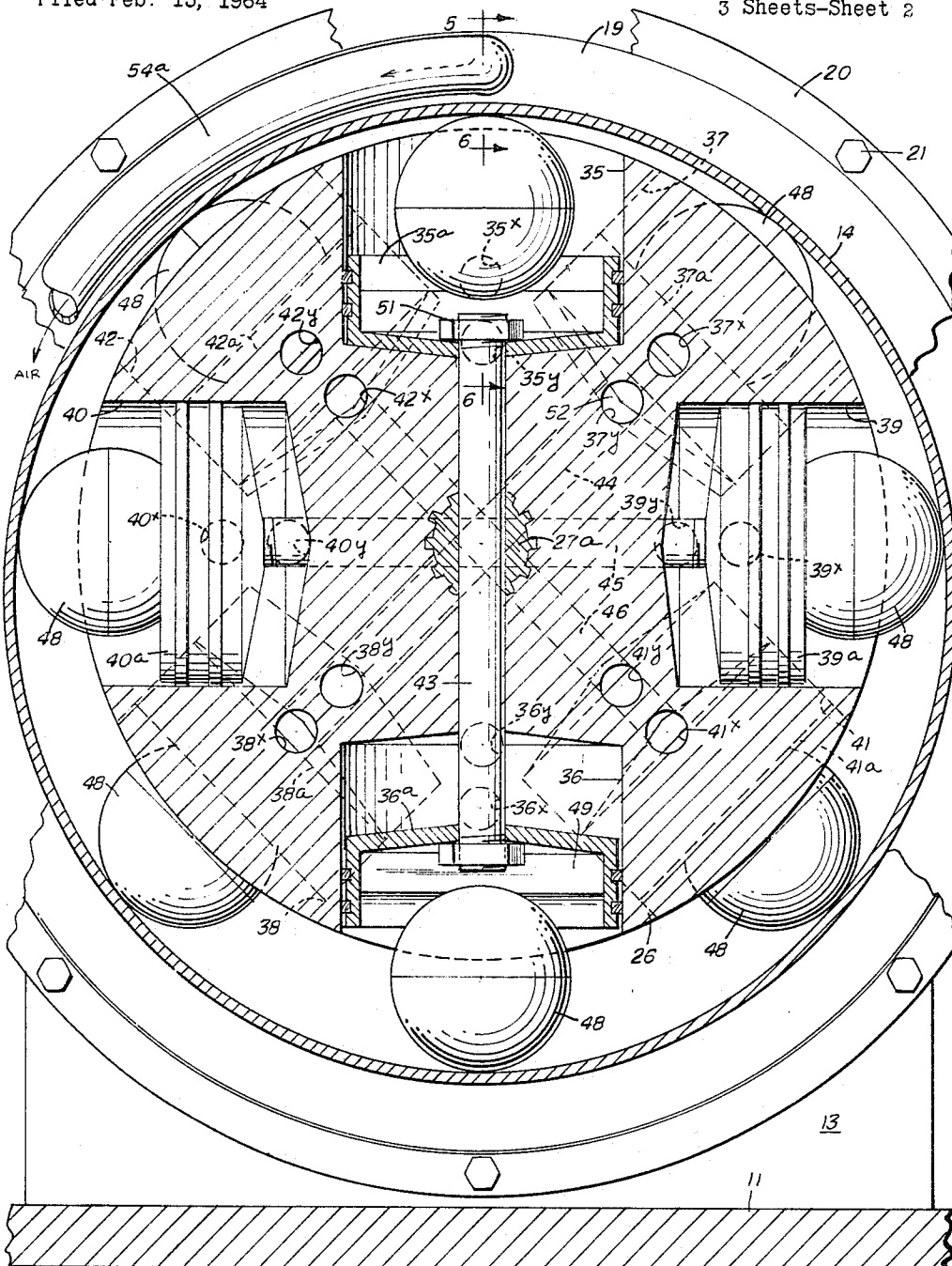


FIG. 4

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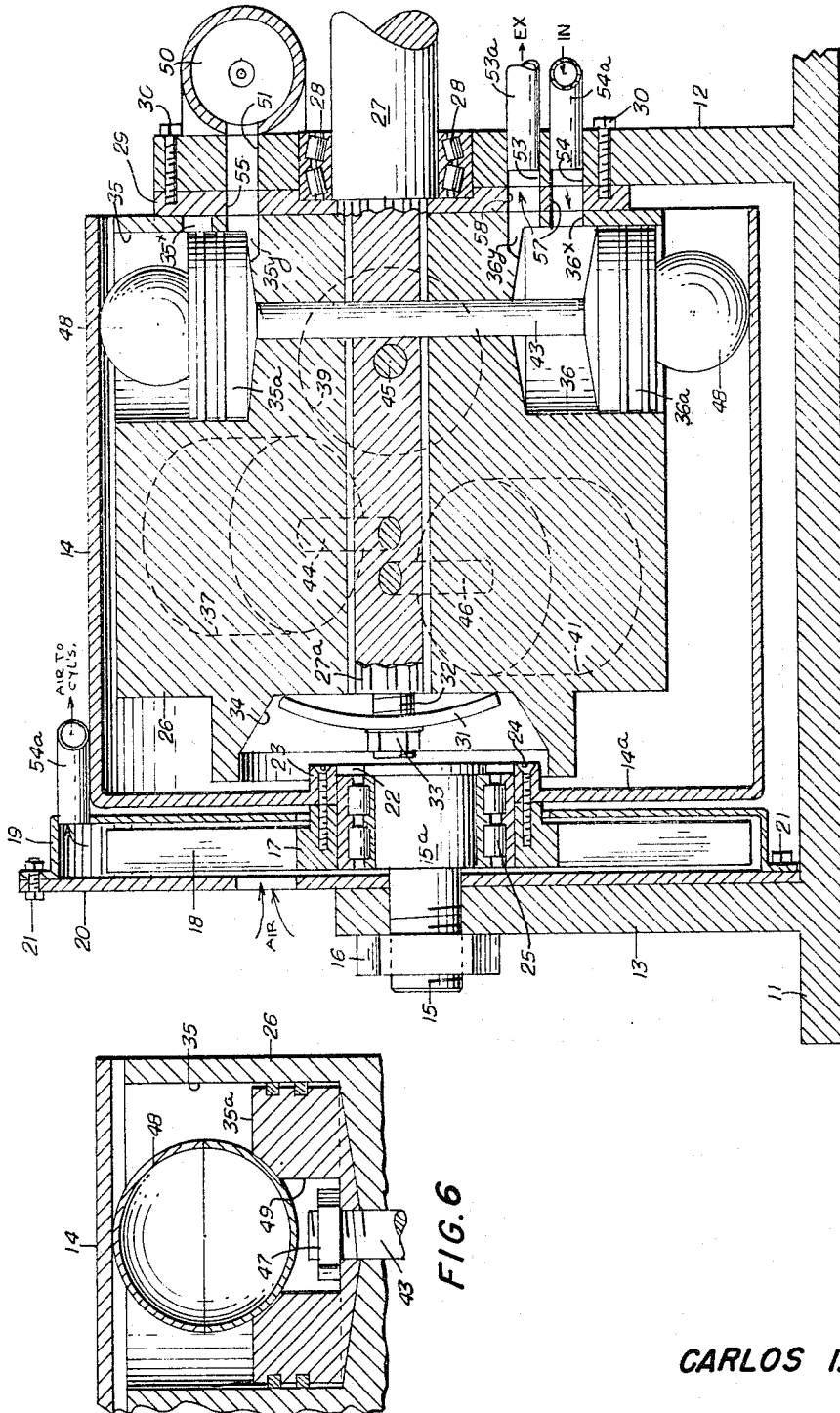


FIG. 5

FIG. 6

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1

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3,267,675 ROTARY APPARATUS FOR ACTING MECHANICALLY ON FLUIDS

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1 Claim. (Cl. 60—39.61)

The present invention relates to rotary apparatus for acting mechanically upon fluids and may be used as a pump for liquids and gases or as a compressor or expander or both for gases or vapors for either the production of power, for refrigeration or heating.

In the prior art, and specially in rotary apparatus as per my Patent No. 3,104,527, or my co-pending, allowed application Serial No. 208,893, rotary apparatus with radially disposed, open on the outside end cylinders, with free moving pistons therein, have been disclosed in which the centrifugal forces drive out the piston therewith enlarging the respective working chambers for the fluids, and by the action of an eccentrically rotatable pressure receiving gear, these pistons are forced back thereby reducing again the volume of these chambers and increasing the pressure of the enclosed fluid.

In these apparatus, the centrifugal forces of the pistons and pressure transmitting means at conventional speeds acquire tremendously high figures which make it necessary to employ expensive, heavy and bulky machinery having only a low mechanical efficiency because of the excessive pressures on the rubbing parts, which cause a great deal of friction and wear.

One object of this invention is therefore to reduce these objections by mechanically joining the opposing pistons to one another by some suitable rod whereby the centrifugal force of one piston is set off by the similar but opposing force of the opposing piston.

In apparatus of this type embodying freely reciprocal pistons, difficulty arises in the proper guiding of the pistons, since the conventional ratio of diameter to length is not suitable for this type of engine which requires a very large diameter in relation to length.

It is therefore the primary object of the present invention to overcome the difficulties noted in connection with my previous apparatus and to provide means to properly guide and control the movement of the pistons within the cylinders.

Another object of the invention is to provide in a rotary apparatus of this character, means for positively connecting radially opposite pairs of pistons so that the effect of centrifugal force on the controlling and guiding of the pistons is minimized.

Another object of the invention is to provide connecting rods between radially opposed pairs of pistons, with the connecting rods extending through the rotor and laterally offset with respect to one another to avoid interference.

A further object of the invention is to provide a rotary power developing apparatus of this character which is more compact than previous apparatus of this type, and thereby considerably less expensive to construct.

With the above and other objects in view which will appear as the description proceeds, the invention consists in the novel features herein set forth, illustrated in the accompanying drawings and more particularly pointed out in the appended claim.

Referring to the drawings, which illustrate an internal combustion engine as one of the many possible applications, in which numerals of like character designate similar parts throughout the several views:

FIG. 1 is a view in side elevation, more or less diagrammatically illustrating an apparatus of the present invention;

FIG. 2 is a top plan view thereof;

FIG. 3 is an enlarged sectional view taken on line 3—3 of FIG. 1, illustrating the face of the valve plate;

FIG. 4 is a sectional view taken on line 4—4 of FIG. 1;

FIG. 5 is a slightly reduced, longitudinal sectional view taken on line 5—5 of FIG. 4; and

FIG. 6 is a fragmentary sectional view taken on line 6—6 of FIG. 4, illustrating the anti-friction means associated with the pistons.

Referring first to FIGS. 1 and 2, the power developing apparatus is generally indicated by the numeral 10, and comprises a base 11 having two upright standards 12 and 13, longitudinally spaced to provide suitable supports for the working parts of the apparatus. A cylindrical housing 14 is supported at one end on a stud 15, the outer threaded end of which extends through the upright 13 and is secured thereto by a nut 16.

As best seen in FIG. 5, the inner end of the stud 15 is enlarged as at 15a where it extends concentrically through and supports the hub 17 of a blower fan 18, arranged in the blower assembly casing 19. The blower casing 19 is bolted to a supporting plate 20 and is secured in fixed relation to the upright 13 by bolts 21.

Adjacent the blower casing 19, the housing 14 is provided with an end wall 14a, the central portion of which is provided with an opening 22 bounded by an annular boss 23. The boss 23 is secured to the hub 17 through an opening in the housing 19, by means of screws or bolts 24, and roller bearings 25 within the boss 23, rotatably support the housing 14 on the enlarged end 15a of the stud 15.

The opposite end of the housing 14 is open and within the housing is a rotor 26 which is smaller in diameter than the interior of the housing 14 and supported eccentrically therein on the splined end 27a of a power shaft 27. The shaft 27 is rotatably supported in eccentric relation to the stud 15 by roller-thrust bearings 28, mounted in an opening in the upright 12. Interposed between the upright 12 and the adjacent end of the rotor 26 is a valve plate 29 which is held in fixed relation to the upright by means of bolts 30, and the end of the rotor is maintained in close sliding engagement with the opposed face of the valve plate 29, by means of a leaf spring 31 carried transversely on the reduced and threaded end 32 of the splined extension 27a, said spring being held in place by means of a bolt 33 on the threaded member 32. This leaf spring arrangement is preferably located in a central recess 34 in the end of the rotor 26, as best seen in FIG. 5.

The rotor 26 is preferably formed of a mass of any suitable material, such as metal or plastic, in cylindrical form, and its periphery is drilled to provide a series of radially disposed cylinders open at the periphery of the rotor and arranged in diametrically opposite pairs. As will later appear, in view of the compact arrangement of the cylinders, it is necessary that the respective pairs be relatively offset longitudinally of the rotor in order that the latter may accommodate a sufficient number of cylinders. Thus, cylinders 35 and 36 are diametrically opposite, cylinders 37 and 38 are opposite, cylinders 39 and 40 are opposite, and cylinders 41 and 42 are opposite, each pair being offset with respect to the adjacent pair, as shown in FIGS. 4 and 5.

In each of the cylinders, a piston is reciprocally mounted, and the respective opposite pistons of each pair of cylinders are axially connected by connecting rods which extend through suitable bores in the body of the rotor 26. Thus, the piston 35a in cylinder 35 is connected by rod 43 to piston 36a in cylinder 36, piston 37a is connected by rod 44 to piston 38a, piston 39a is connected by rod 45 to piston 40a, and piston 41a is connected by rod 46 to piston 42a. As seen in FIG. 5, each of these connecting rods is offset longitudinally of the rotor 26, with respect to the next rod, and their immediate portions all extend

through the splined end 27a of the power shaft 27, which, of course, rotates with the rotor. Any suitable means may be employed to provide a gas-tight seal between the connecting rods and bores. A longitudinal bore or hole greater in diameter than the piston rods 43, 44, 45, 46 along the center of the shaft 27 communicates with a lubricating oil supply under pressure (not shown) and lubricates these rods and their corresponding cylinders and furnishes, at the same time, an air tight seal for the rods within the rotor 26.

In FIG. 6, which shows an enlarged detail through cylinder 35, for example, it will be seen that the connecting rod 43 extends through the base of the piston 35a, and its threaded end receives a nut 47 which secures the piston in place on the rod. The connecting nut 47 is located in a recess 49 which extends partially across the upper face of the piston 35a with its upper longitudinal edges bevelled outwardly to provide a guide trough for an anti-friction ball 48. Each of the pistons is provided with one of these balls which is interposed between the trough formed by the recess 49 and the inner periphery of the cylindrical housing 41. It will be apparent that these balls function in a manner similar to the anti-friction rollers in my said former patent.

Fixed to the outer face of the upright 12 adjacent its upper end is a combustion chamber 50, generally similar in structure and function to the combustion chamber shown in my former patent, suitable means (not shown) being provided to inject fuel and to cause ignition.

As in said former patent, the combustion chamber 50 is provided with a compressed air inlet passage 51 and a hot compressed gas discharge passage 52. In FIGS. 2 and 3, the relative locations of these inlet and discharge passages will be seen, and in FIG. 3, the combustion chamber is shown in phantom lines as it is located on the opposite side of the valve plate 29. It will be apparent that these passages extend through the stationary upright 12 and are controlled by the rotation of the rotor with respect to the fixed valve plate 29, as will later appear. The valve plate 29 may be formed as an integral part of the upright 12, instead of separately bolted thereto.

Also extending through the upright 12 adjacent its lower end are an exhaust passageway 53 and an air intake passageway 54, best seen in FIGS. 3 and 5, the exhaust passageway 53 being provided with an exhaust conduit 53a leading to atmosphere and the inlet passageway 54 being connected by a conduit 54a to the blower assembly 19.

Each of the cylinders is provided with a pair of passageways which extend from the respective cylinders to the end face of the rotor 26 where they open adjacent the opposed face of the valve plate 29. For purposes of simplicity of illustration, FIG. 5 shows only passageways 35x and 35y for cylinder 35 and passageway 36x and 36y for cylinder 36, it being understood that similar passageways are provided for each of the other six cylinders, as best seen in FIG. 4, where cylinder 37 has passageways 37x and 37y; cylinder 38 has passageways 38x and 38y; cylinder 39 has passageways 39x and 39y; cylinder 40 has passageways 40x and 40y; cylinder 41 has passageways 41x and 41y; and cylinder 42 has passageways 42x and 42y, all, as before stated, leading to and opening at the end face of the rotor 26.

The fixed valve plate 29 adjacent the end of the rotor 26 is provided with an arcuate compressed air channel 55, arranged in line for successive registry with the passageways 35y, 37y, 39y, etc. of respective rotating cylinders and terminating at one end in fixed registry with the inlet passageway 51 of the combustion chamber 50. A similar arcuate channel 56, posterior to channel 55, is in permanent registry with the discharge passageway 52 leading from the combustion chamber 50, as seen in FIG. 3, and this channel 56 is arranged for successive registry with said passageway 35y, 37y, 39y, etc., as the respective cylinders rotate past said channel, and preferably, both

channels 55 and 56 are of sufficient length to at least partially overlap the preceding and succeeding cylinder passageways to cause continuity of flow through the combustion chamber.

The lower portion of the valve plate 29 is provided with two radially spaced arcuate channels 57 and 58, adjacent leading ends of which are respectively in permanent registry with passageways 54 and 53, leading to the air intake and exhaust conduits 54a and 53a (FIGS. 3 and 5). The opposite ends of these channels are arranged for successive registry with the respective pairs of ports in the rotating cylinders.

The operation of this apparatus is substantially the same as that described in my former patent. Briefly, however, it is as follows: The apparatus is started by a starter motor (not shown) of the nature referred to in the former patent, or preferably by compressed air injected right into the combustion chamber, and when the desired speed of rotation has been reached, the cycle commences. At the lower end of valve plate 29, air supply from the blower assembly 19 and conduit 54a enters the cyclically adjacent cylinder, in this instance, cylinder 36, through passageway 54 and cylinder port 36x, and a portion thereof enters cylinder 38 through port 38x, due to the communication between the two ports by means of channel 57. At this point, the pistons in these respective cylinders are projected radially outwardly, leaving a maximum of air receiving space in the cylinders, as seen in FIG. 4. Simultaneously, the opposite cylinder 35 is positioned at the upper part of valve plate 29 where, because of the eccentric arrangement of the rotor 26 and the housing 14, the air in that cylinder has reached a maximum of compression in the cylinder, due to the camming action of housing 14 on the piston 35a through its anti-friction ball 48. This highly compressed air is discharged through port 35y, channel 55 and inlet passage 51, into the combustion chamber 50 where combustion and expansion take place. From the combustion chamber, the hot compressed gases pass through discharge passage 52 and port 37y into the next cylinder 37, immediately in advance of cylinder 35, and through the arcuate channel 56, a portion of such gases enters the cylinder 39 next in advance, through port 39y.

It is believed unnecessary to recite the complete cycle of operation, as this is substantially the same as that just described in the former patent, and the present invention is primarily directed to the arrangement of the pistons in connected pairs. Suffice it to say that as the cycle continues, each rotating cylinder arrives in register with the respective valve channels, and as each cylinder reaches the exhaust port, a scavenging of the gases therein takes place through exhaust passageway 53 which leads to atmosphere through conduit 53a, the arcuate channel 58 permitting a completion of the scavenging from two adjacent cylinders by the overlapping of the channel 58 with the discharge ports of the cylinders. Thus, as seen in FIG. 3, ports 36y and 38y communicate through channel 58 and discharge through passage 53.

As this rotation continues, the access passage of each cylinder is closed, and the work gases expand the expandable chambers formed by the cylinders and pistons, and a tangential component of force develops at each cylinder to cause rotation of the rotary members 26 and 14, as described in my said former patent.

In the course of this cyclic operation, it will be apparent that the connected pairs of pistons in opposed cylinders operate simultaneously, and their action is controlled by the connecting rods between the pistons of each pair, thus minimizing the effect of centrifugal force on the reciprocating pistons.

When utilizing this apparatus as a heat pump, the combustion chamber is preferably replaced by a heat exchanger, through which the compressed air, heated by the compression, is flown and cooled to nearly ambient temperature by a branch of the air coming from the blower

5

while this second mentioned air is warmed up in counter-current flow at ambient pressure and conducted to the place of use. When leaving the heat exchanger, the compressed and cooled air is introduced into the cylinders for expansion and further cooling and conduction to the place to be cooled.

This rotary apparatus may also be utilized as a steam engine by taking off the combustion chamber and the blower, and providing in the valve plate a nozzle to inject in the cylinders in the first part of the expansion stroke, a suitable amount of live steam. In this case, the cylinder ports remain preferably open during the entire stroke wherein the working chambers in the cylinders are getting smaller.

To utilize this rotary apparatus as a pump for liquids, the blower and combustion chamber are eliminated and the arcuate channel 56 is used as an inlet to cover slightly less than the whole expansion side and the arcuate channel 58 as outlet to cover slightly less than the whole compression side.

From the foregoing, it is believed that the invention may be readily understood by those skilled in the art without further description, it being borne in mind that numerous changes may be made in the details disclosed without departing from the spirit of the invention as set forth in the following claim.

I claim:

A multiple cylinder and piston engine, comprising a block rotatable about a first axis, a series of radially disposed cylinders in said block, opening externally of the latter and connected in opposed pairs by bores extending through said block, pistons in said cylinders connected in

6

opposed pairs by rods snugly slidable with a gas tight fit in respective bores, the cross-section of said bores and rods being substantially less than that of said cylinders and pistons, to thereby provide expansible chambers in said cylinders at the inner ends of respective pistons, a cylindrical housing enveloping said block, rotatable about a second axis parallel to but displaced from said first axis, the inner surface of said housing forming an uninterrupted cylindrical pressure backup means for said pistons, and spherical pressure transmitting means coacting with said pistons adjacent the open ends of respective cylinders, in engagement with the outer ends of respective pistons and said backup pressure surface, thereby permitting substantially frictionless tangential reciprocating changes of speed of the movement engendered within the circular motion of the pistons and cylinders with relation to said pressure backup means, by the distance separating said first and second axes, simultaneously and cyclically accelerating certain of said pistons and decelerating respectively opposed cylinders in their circular movement.

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