ABSTRACT OF THE DISCLOSURE

An opposed rotary engine or pump embodying four oval gears controlling the opposed pistons through two-to-one gearing, and a power shaft driven by the two oval gears placed in the gear train most remote from the pistons.

The invention herein disclosed is a rotary piston machine adapted to operate as a power source or as a work producer.

In the first category, the invention may be embodied, for example, in the form of a steam engine, compressed air or hydraulic engine and in the second class the invention may be incorporated in various pump structures for handling different kinds of liquids and gases.

The objects of the invention generally have been to provide a simple, substantial, compact machine having few, smoothly operating parts, controlled effectively to accomplish the desired cycles of operation.

Special objects of the invention have been to utilize full displacement possibilities and gain maximum efficiency in a compact machine structure and to avoid sealing difficulties such as sometimes encountered in rotary machines.

Briefly the invention may be considered as embodying a casing having a circular chamber with walls defining an annular working channel of constant cross section and provided with at least one inlet and one outlet, shafts journalled on the axis of said chamber, opposing pistons carried by said shafts, conforming to the cross section of said annular channel and gearing connected with said shafts for effecting approach and separation of the pistons to vary the contained volume between the pistons at predetermined definite stages in rotation of the pistons in the chamber and in respect to the inlet and outlet of the casing.

Other novel features of the invention and desirable objects accomplished are set forth or will appear in the course of the following specification.

The drawings accompanying and forming part of the specification illustrate certain present practical embodiments of the invention. Structure and operation, however, may be modified and changed as regards the immediate disclosure, all within the true intent and scope of the invention, as hereinafter defined and claimed.

FIG. 1 is a perspective view of the pistons for a two piston machine and with the shafts carrying the pistons arranged to extend out one side of the machine housing, the latter not shown.

FIG. 2 is a similar view showing how the shafts carrying the pistons may be arranged to extend out opposite sides of the casing, the latter not shown.

FIG. 3 is a longitudinal sectional view of a pump with the pistons of FIG. 1 incorporated therein and eccentric oval gearing provided for operating the pistons in desired relation, this view being taken on substantially the plane of line 3—3 of FIG. 4.

FIG. 4 is a cross sectional view as on substantially line 4—4 of FIG. 3.

FIGS. 5 and 6 are similar cross sectional views illustrating successive phases of movement of the synchronized opposed pistons.

FIG. 7 is a perspective view of a four piston embodiment of the invention with diametrically opposite pistons connected in pairs.

FIG. 8 is a broken longitudinal sectional view of a rotary piston engine embodiment of the invention with pistons controlled by differential gearing, this view taken on substantially the plane of line 8—8 of FIG. 9.

FIG. 9 is a cross sectional view on substantially the plane of line 9—9 of FIG. 8.

FIGS. 10 and 11 are cross sectional views illustrating successive phases of movement of the pistons.

FIG. 12 is a perspective view of a four piston engine arrangement controlled by oval gearing.

FIG. 13 is a longitudinal sectional view of the component parts of such an engine.

FIG. 1 illustrates the basic concept, of two pistons 1, 1 shaped to fit the annular working channel of a circular casing, on part circular hubs 3, 4 in end-to-end relation, forming the inner circular wall of the annular channel and mounted on shafts 5 and 6, rotating on a common axis 2.

In this view, both shafts project in the same direction and so may be extended out through one side of the housing.

The construction shown in FIG. 2 differs from the first in that the shaft supported lobes 1, 1 extend in opposite directions and so may project through opposite sides of the housing.

FIGS. 3 to 6 illustrate the invention developed as a pump, with the pistons operating in a circular cylindrical housing 9, provided with a cover 10, with the walls of the circular chambered housing, cover and hubs forming an annular channel 11 in which the pistons rotate.

A tubular extension 9' on the back of the housing provides a beaming support for the shafts 5 and 6.

The free ends 5' and 6' of the shafts extend out of the housing and are connected with separate outputs of a transmission gearing, designated as a whole as 12, FIG. 3.

By this transmission, the pistons are positively controlled in their rotary movement in the annular channel in the direction of arrow 13, FIG. 4, to effect approach at a predetermined point 14, FIG. 5, so that upon each full revolution, the piston shown at the left will reach a maximum distance from the piston moving in front of it and at the same time provide maximum distance between the opposite faces of the pistons at position 15, diametrically opposite the point 14.

In FIG. 5, the piston at the left has reached the point of closest relation to the piston at the right, which may be practically in contact and piston at the right has its forward surface at a point 15, the furthest separation from the piston in front of it, the left piston.

Symmetrically related to the point 14 of the annular channel 11, the housing 9 is provided with an inlet 16, and an outlet 17.

The transmission gearing 12 includes a drive shaft 18, FIG. 3, carrying oval gears 19, 20, displaced 180° apart and in mesh respectively with corresponding oval gears 21 and 22 on shafts 6 and 5 carrying the pistons.

The gears 21 and 22 are fixed on shafts 6 and 5, in position to effect the relative approach and separation of the rotating pistons as described, the shafts of these gears each representing a gearing output for such purposes.

The pistons in the present disclosure are slidingly guided on the walls of the housing by surface contact and the angular or circumferential extension of these pistons as shown provides efficient surface seal with the walls of the annular channel.

For practical purposes, the pistons may be of plastic having good sliding characteristics.
In FIG. 4, the working space 23 between the front of the upper piston and the back of the lower piston is in communication with the inlet 16, and at the same time, the working space 24 between the front of the lower piston and the back of the upper piston is in communication with the outlet 17.

The oval gears are placed to cause each piston to move faster in the lower region of its rotation than in the upper region, so that in the illustration, the right hand working space 23 is increased upon further movement, while the left hand working space 24 is rapidly reduced in size.

Therefore, the fluid worked in the pump is drawn in through inlet 16, while fluid already taken in is pressured or compressed and ejected through outlet 17.

In FIG. 5, the circumferentially extended portion of the piston at the right has closed the inlet 16, while the other piston has closed outlet 17.

The pistons in this position have reached the point of minimum separation or maximum approach, with fluid drawn into the working space 23, then at a maximum, contained in the lower portion of the annular channel, here shown as shut off from both inlet and outlet.

On further movement to the FIG. 6 position, the working space 23 is carried into communication with outlet 17 and the working space 24 is open to inlet 16. Thus fluid in space 23 is compressed or subjected to pressure and discharged through outlet 17, while fresh fluid is being taken in through inlet 16.

The exact operation of the pump enables it to be used as a dosaging pump in processing packages and is suited for use for circulating or many other purposes.

In the four piston machine illustrated in FIG. 7, there are two diametrically opposed pistons 25, and a second pair of diametrically opposite pistons 26, on part circular hubs 27, and 28, fixed on concentric shafts 29 and 30 respectively.

The inner shaft 29 is shown controlled by an irreversible clutch 31, permitting rotation in only one direction and similarly the outer, tubular shaft 30 is shown controlled by a non-reverse clutch 31', permitting rotation in only one direction.

The shafts 29 and 30 are connected with separate outputs of the transmission gearing 32, controlling the piston movement as above described.

The transmission 32, FIG. 7, may be the oval gearing illustrated or differential gearing or a hydraulic transmission.

The internal combustion engine form of the invention shown in FIGS. 8 to 11 embodies the paired piston structure with one fixed pair of diametrically opposite pistons 25, opposed to similar diametrically opposite pistons 26, 26, operating in a circular cylinder housing 33, with cover 34 providing an annular channel 35.

The housing has tubular bearing extension 36 for the piston shafts 30, and these shafts are shown connected with separate outputs of a differential gearing 36, FIG. 8, controlling the piston movement.

Shafts 29 and 30 are shown connected with reverse checks 37 and 38, which may be in the nature of bicycle coaster brakes and permitting rotation in only one direction.

The differential gearing 36 may be similar to an automotive differential with bevel gears 39 and 40 on shafts 29 and 30 in mesh with planetary gears 41, on a spur gear 42, in mesh with a pinion 43, on a drive shaft 44.

In the rotary piston machine of FIGS. 8 to 11, the rotary motion of the pistons is controlled so that each full revolution is divided into two sections of equal size or volume and each piston during each half of revolution, at given points 45 and 46, FIG. 9, approaches the minimum distance from the piston preceding it and moves away from the preceding piston to maximum distance away from the preceding piston.

By the two pairs of pistons 25 and 26, four working spaces 49, 50, 51, and 52 are defined in the annular channel 35.

Upon each complete revolution, the volume of each of these four working spaces is reduced twice to a minimum and increased twice to a maximum. Accordingly, in each of the working spaces 49, 50, 51, 52, upon a complete revolution of the pistons, a complete four-stroke cycle is effected, the housing having suitable inlet 53 and outlet 54 at the bottom.

At the top, the housing 33 is shown as enlarged at 55, into a chamber for a spark plug 56, fuel injection nozzle or the like.

FIG. 9 shows the working space 51, between the lower opposed pistions in communication with inlet 53, and the working space 49 at the top in communication with the recess 55.

With direction of rotation in the sense of arrows 57, the movement of the pistons is controlled so that they move more slowly in the upper and lower regions of the annular channel 55, and more rapidly in the lateral regions.

In FIG. 9, the compressed combustible mixture in working space 49 is ignited by spark plug 56, forcing these pistons apart with movement controlled by differential gearing 36, in combination with nonreverse checks 37 and 38, effecting forward rotation.

At this same time, the diametrically opposite working space 51 is increased in size to draw fresh fuel mixture in through the inlet 53.

In the working space 52, the mixture is compressed and sent gases in working space 50 are discharged through outlet 54.

Thus as shown in FIGS. 9, 10 and 11, a suction stroke is being effected in working space 51, compression in space 52, expansion with performance of work after ignition in working space 49, and exhaust of gases in space 50.

During a complete revolution of the pistons, there takes place once in each working space 49, 50, 51, 52, each of the four working strokes, suction, compression, expansion and exhaust.

The differential gearing 36 transmits the energy developed to the driven shaft 44.

The construction illustrated in FIGS. 12 and 13 is generally similar to that last described, except that the oval gearing designated 58 is employed instead of differential gearing.

The piston shafts 29 and 30 are shown as carrying like gears 59 and 60, in mesh with pinions 61, and 62, forming step-up gearing.

Pinion 61 is connected with an oval gear 63, by a shaft 64, and pinion 62 is connected with a reversely disposed oval gear 65 by a concentrically journaled shaft 66.

Oval gear 63 meshes with a reversely disposed oval gear 67 and oval gear 65 meshes with a reversely disposed oval gear 68.

Both the final oval gears 67 and 68 are fixed 180° apart on a common driven power shaft 69.

This machine operates in the same manner as described in respect to FIGS. 9, 10 and 11, but with the advantage however, that it may be developed either as an engine or as a working machine. In the latter case, the shaft 69 would be driven by a motor and instead of the place for the spark plug, there would be provided usually an outlet and an inlet, so that upon a full revolution of the pistons, two operating cycles would be created with the machine operating for instance, as a compressor.

The invention is not limited to the examples given. Depending on the purpose of use and on operating speed, the seal between the pistons and walls of the annular channel may be provided by close engagement of the companion surfaces or surface packing may be provided and in some cases, a slight clearance may be provided
between opposing surfaces, leaving a slit seal and pistons rotating without contact, the slits being so slight that equalization of pressure between working spaces will not take place. Also spring loaded pressure seals may be used. The annular channel may be developed in the form of a torus and have a circular cross-section with correspondingly circular rotary pistons. In the latter case, piston rings may be used to assure proper seal.

Rotary piston machines embodying the invention may be developed as compressors or internal combustion engines of Diesel or spark plug type, or as steam or compressed air engines.

The simple circular shape of the working chamber and the simple rotary movement of the pistons provide smooth operation, effective sealing and low cost manufacture, operation and servicing.

Provision for heating or cooling, if found desirable, may be readily applied to the circular casing of the machine and sealing and lubrication of the control gearing may be effected by enclosing the same in a casing connected or associated with the main housing.

The angular, arcuate extent of the pistons may be varied to suit the action and purposes of the machine and to utilize the maximum displacement which the invention provides.

The machine is adapted for low or high speed operation and the different forms of transmission gearing may be used as best suited to such operation. The eccentric, oval or elliptical form of gearing may be preferred for many purposes because of simplicity and study character.

In the engine form of the invention illustrated, the power impulse created between adjoining pistons at the moment of near or closest approach imparts forward motion to the leading piston, while the following piston is slowing to an approach to rest, while supported by the compression force exerted on the back of it.

What is claimed is:

1. A rotary piston machine comprising the combination of a housing having a cylindrical working chamber, concentric shafts journaled centrally in said chamber, a pair of diametrically opposite pistons on each of said shafts, both pistons of the two pairs in alternating order and in cooperative relation with the walls of said cylindrical chamber, with the pistons on each shaft in opposed relation to the pistons on the other shaft, concentric countershafts journaled parallel to said concentric piston carrying shafts, a power shaft journaled parallel to said countershafts, two to one gearing between said concentric countershafts and said concentric piston carrying shafts for maintaining two to one ratio of rotation of said countershafts and piston carrying shafts, oval gears fixed in diametrically opposite extended balanced relation on said power shaft, corresponding oval gears on said countershafts in mesh with said gears on the power shaft with maximum and minimum radiants of the same phased to effect approach and separation of leading and following pistons twice to each revolution of the same in said cylindrical chamber, and said chamber having an intake port controlled by said pistons and positioned at a point in line with the separating movement of a pair of leading and following pistons and an exhaust port controlled by said pistons at a point in line with a position of approaching movement of leading and following pistons.

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