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DUAL NUTATING DISC APPARATUS

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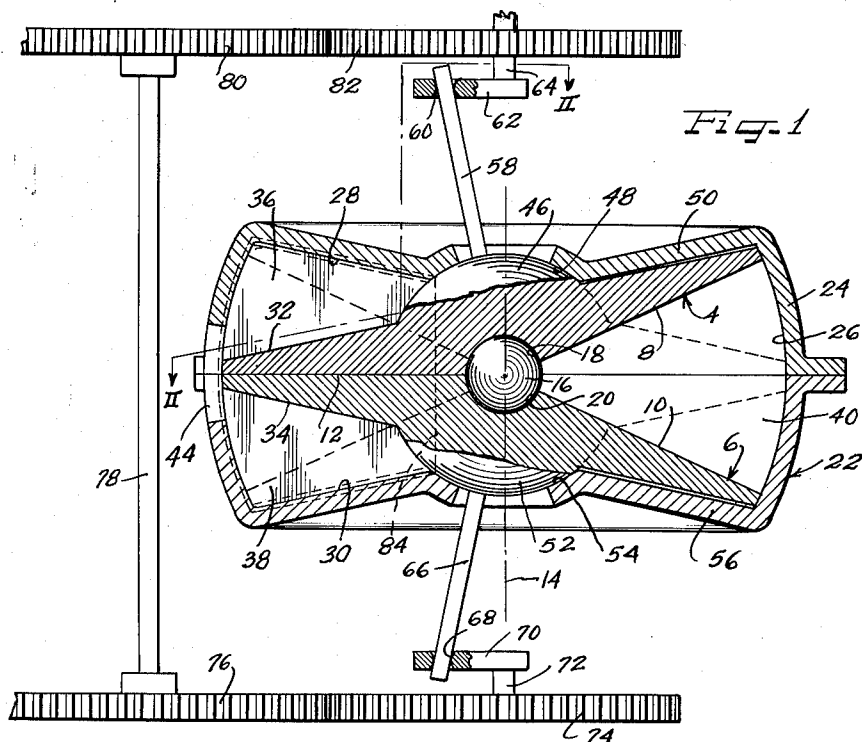


Fig. 1

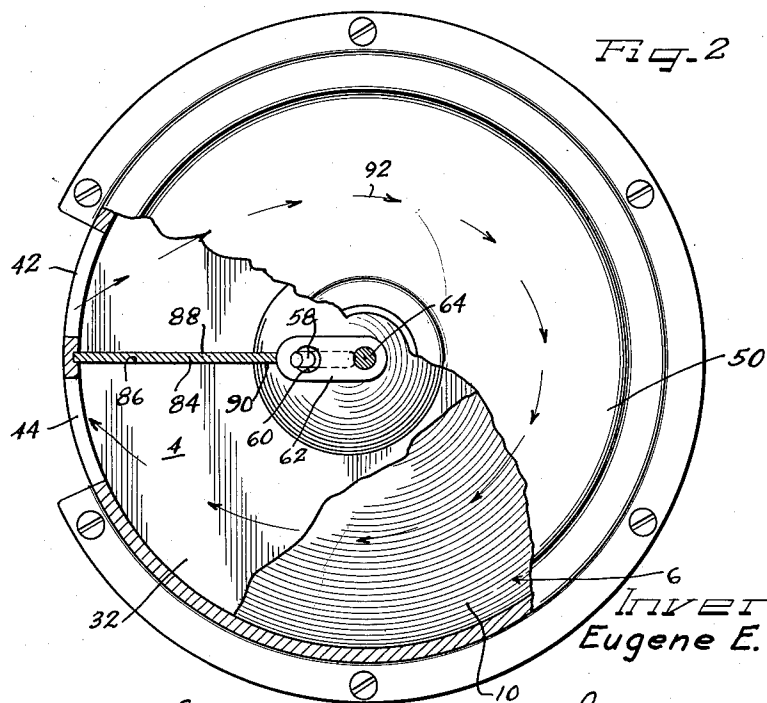


Fig. 2

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## DUAL NUTATING DISC APPARATUS

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The present invention relates to improvements in mechanisms employing a nutating disc for the conversion of power between mechanical movement and fluid displacement, such as is used in a nutating disc motor, compressor, or pump.

More specifically, the present invention relates, as illustrated in the preferred form of the invention, to an assembly wherein a pair of nutating discs are positioned in opposed coaxial juxtaposed oppositely nutating relationship. The nutating discs or plates are preferably circular in shape and have conically shaped opposing surfaces which meet in straight line engagement to separate the chamber defined between the plates. The plates are supported by a free spherical ball positioned between them and located in semi-spherical sockets at the apex of the conically shaped surfaces. The plates are enclosed in a housing have a rounded or bulged outer wall for free nutating movement of the plates and to define chambers within the housing above the upper plate and below the lower plate. The upper and lower walls of the housing have conically shaped surfaces to meet the upper and lower plates in straight line engagement to divide the chambers for relative movement of fluids with nutating movement of the plates. The plates are locked to each other for simultaneous opposed nutating movement by eccentric pins projecting from the plates and connected to drive cranks which are mechanically connected by interlinking gearing. The housing is separated by a radial partition extending on one side of the housing and having a low pressure side and a high pressure side with a low pressure fluid conduit communicating with the low pressure side and a high pressure fluid conduit communicating with the high pressure side, and with each of the conduits opening into the three chambers formed above and below and between the plates. The construction may be operated as a motor with pressurized gases delivered through the high pressure conduit, or as a compressor or pump with intake gas or liquid supplied through the low pressure conduit and with the plates driven in nutating motion.

Accordingly, an object of the invention is to provide an improved nutating disc mechanism which may be used as a motor, compressor or pump, and wherein opposed discs are utilized defining a chamber between them for accommodating the flow of fluid.

Another object of the invention is to provide a fluid flow conversion apparatus employing a nutating disc principle and obtaining increased power conversion without a corresponding increase in space requirements.

Another object of the invention is to provide a nutating disc motor or compressor which obtains double the capacity of compressors or motors of the type heretofore used without an increase in space requirements.

Another important object of the invention is to provide a nutating disc mechanism for use as a motor, compressor or pump which is pressure balanced and inertia balanced to reduce stresses and vibration during operation.

Another object of the invention is to provide a nutating disc apparatus wherein the same fluid conduits supply a

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plurality of pressure chambers related to the plurality of nutating discs.

Other objects and advantages will become more apparent with the disclosure of the principles of the invention in connection with the description and showing thereof in the specification, claims and drawings, in which:

Figure 1 is a vertical sectional view taken through a nutating disc apparatus embodying the principles of the present invention; and,

Figure 2 is a sectional view taken along line II—II of Figure 1.

As shown in the drawings:

The nutating disc apparatus is illustrated in Figures 1 and 2 as having a pair of opposed plates or discs 4 and 6 with the first upper plate 4 being concentric with, and located above in juxtaposed relationship to the second lower plate 6.

The upper plate 4 has a downwardly facing lower conically shaped surface 8. The second lower plate 6 has a mating, corresponding, upwardly facing, conically shaped surface 10. The two conically shaped surfaces 8 and 10 meet in substantially straight line engagement along a line 12 extending radially outwardly from the center of the plates, which is indicated by the axis line 14 extending vertically through the apparatus, as illustrated in Figure 1.

The opposed nutating discs 4 and 6 are separated and supported by a free ball 16, which is located between them on their axial center, and which is received by each of the discs in a semi-spherical socket with the socket for the disc being shown at 18, and the socket for the disc 6 being shown at 20.

The opposed discs 4 and 6 are enclosed in a housing 22. The housing is shown as having a circular outer wall 24 which is bulged outwardly to provide a curved inner surface 26 to permit nutating motion of the disc. The top and bottom of the housing are shaped with the internal surfaces 28 and 30 being of conical shape so as to meet the upper flat faces 32 and 34 of the plates 4 and 6 in substantially straight line engagement. This engagement divides the chambers 36 and 38 formed above the upper plate 4 and below the lower plate 6. An intermediate chamber 40 is formed between the plates.

Thus, pressurized operating fluid will drive the plates with simultaneous nutating movement. The chambers 36, 38 and 40 are supplied with pressurized fluid and exhausted through the common inlet port 42 and a common outlet exhaust port 44. The plates 4 and 6 are shown in one position of their nutating movement in Figure 1, wherein pressurized fluid is flowing in the chambers 36 and 38 above the upper plate 4 and below the lower plate 6. In the dotted line position of the plates, as shown in Figure 1, pressurized fluid is flowing into the chamber 40 between the plates to act on the lower surface 8 of the upper plate and the upper surface 10 of the lower plate. To insure that the plates will nutate together, and to simultaneously take power from the moving plates, they are mechanically linked together.

For guiding the plates in their nutating movement, the upper plate has projecting from its upper surface 32 a fragmentary spherical surface 46. This surface fits into a fragmentary spherical socket 48 formed in the center of the conical surface 28 in the upper wall 50 of the housing.

The lower plate 6 has projecting from its lower surface 34 a fragmentary spherical surface 52, which is received in a fragmentary spherical socket 54 in the center of the conical surface 30 of the lower wall 56 of the housing.

Projecting from the axial center of the upper disc 4 and extending from the center of the fragmentary spherical projection 46 is a crank pin 58. The crank pin is

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received in a slot 60 formed in a crank arm 62 secured to a power shaft 64. As the disc or plate 4 nutates, the crank pin 58 will oscillate about the axial center 14 of the mechanism, and drive the crank and the power shaft 64 in rotation.

Rotation of the power shaft 64 is also obtained from movement of the lower plate 6, which is mechanically connected to the upper plate for transmission of power and to maintain the plates in timed positional relationship.

Projecting from the lower plate 6 and extending from the center of the fragmentary spherical surface 52 is a crank pin 66. The crank pin is received in a slot 68 in a crank 70. The crank 70 is carried on a shaft 72 which is suitably supported for rotation and which carries a gear 74. The gear 74 is in mesh with another driven gear 76 mounted on an interconnecting shaft 78. The interconnecting shaft carries a gear 80 on its other end which is in mesh with a gear 82 mounted on the power shaft 64. Thus, through the gear and shaft linkage, power is taken from the lower nutating plate 6 and also transmitted to the power shaft 64.

The interior of the housing 24 is divided by a vertical radially extending partition 84. The partition projects through radially extending slots, shown generally at 86, in the plates 4 and 6. The partition 84, Figure 2, divides the interior of the housing, and has a high pressure side 88 and a low pressure side 90.

Communicating with the high pressure side 88 of the partition 84 is the pressurized fluid inlet port 48. This port will be supplied with a driving fluid, such as a pressurized gas or the like through a connecting conduit. The flow of gas will follow the arrowed lines 92, flowing through each of the chambers above, below and between the plates, as shown at 36, 38 and 40, to be exhausted through the outlet port 44.

In some instances it may be desirable to use the afore-described construction as a compressor or a pump. In this instance the flow of fluid will be reversed, and the nutating plates 4 and 6 will be mechanically driven. With the apparatus shown, the drive shaft or power shaft 64 will be driven in rotation, and the plates 4 and 6 will, therefore, be driven in nutation. A supply of fluid to be pumped or compressed will be furnished to the port 44 and will fill the chambers 36, 38 and 40 above, below and between the plates, and be discharged out through the port 42. It will be recognized, of course, that if the discs are driven mechanically and in the same direction as they operate when the mechanism is used as a motor, the flow will be in the same direction as the gas, as indicated by the arrowed lines 92 and the direction of flow of gas or fluid is not material.

Although the operation of the mechanism will be clear from the description of the structure and function of the individual parts, a description of the overall operation will be helpful in understanding the objectives and attainments of the invention. In operating as a motor, a pressurized fluid such as a gas or product of combustion is directed to the inlet port 42, and flows into the chambers 36 and 38 above the upper plate 4 and below the lower plate 6, to cause nutating movement of the plates. As the plates begin to nutate, the chamber 40 will be exposed to the inlet port, and gas will flow into the chamber between the plates. The plates will automatically continue their nutating motion, and the gas will be discharged out through the outlet port 44, flowing in the direction indicated by the arrowed lines 92. The nutating plates continue to move in unison and are mechanically interconnected by gearing, connected to the interconnected shaft 78, and power is delivered to the power drive shaft 64.

In the event the mechanism is to be used as a compressor, the power shaft 64 is mechanically driven in either direction, and if in the same direction as previously described for use as a motor, gas will flow into

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the inlet 42 and will be compressed and will be discharged in a pressurized condition through an outlet port 44. The mechanism may also be used as a pump for non-compressible fluids, and control of the compression operation is obtained by a design of the size of the inlet and outlet ports 42 and 44.

Thus, it will be seen that I have provided an improved nutating disc apparatus which may be used as a motor or compressor, and which meets the objectives and advantages hereinbefore set forth. The mechanism is capable of operation in a compact space, and substantially double the capacity of mechanisms heretofore used is obtained in substantially the same space.

It is a significant advantage that balance is achieved, both from a pressure and an inertia standpoint, in that the discs are always acting in opposition in their nutating movement. The unbalanced forces tend to squeeze the discs or plates together, and this will aid in improved starting of the mechanism.

The mechanism may be adapted for use as a combustion engine. In this case, the inlet and output ports will be connected with combustible gas conduits, and spark plugs or other ignition means will be provided in the chambers in the housing. With this construction a powerful, efficient motor can be achieved using a mechanism which has relatively few moving parts, and is simple in construction.

I have, in the drawings and specification, presented a detailed disclosure of the preferred embodiments of my invention, and it is to be understood that I do not intend to limit the invention to the specific form disclosed, but intend to cover all modifications, changes and alternative constructions and methods falling within the scope of the principles taught by my invention.

I claim as my invention:

1. A nutating disc apparatus having a pressure balanced and an inertia balanced operation comprising in combination a first circular nutating disc having an upper surface and a lower surface, a second circular nutating disc having an upper surface and a lower surface positioned coaxial with the first with respect to their nutating axes and in juxtaposition thereto, the lower surface on the first disc being conically shaped, the conically shaped upper surface on the second disc facing the lower surface of the first disc and meeting said surface in straight line contact to divide the chamber defined between the discs, a housing for enclosing said discs having a chamber with a circular outer wall which is curvedly expanded toward the center portion with the curvature of the wall swung from a central location between said two discs, an upper inner conical surface within said housing chamber facing the upper surface of said first disc, a conically shaped lower inner surface within said housing chamber facing the lower surface of said second disc, said conical surfaces of the housing engaging said discs in line contact to divide the chambers formed between the discs and the housing, a spherical surface projecting from the upper surface of said first disc, a socket centrally located within the upper portion of the housing to receive said spherical surface for supporting the first disc, a spherical surface projecting from the lower surface of said second disc, a socket in the lower portion of the housing for supporting the spherical surface of the second disc, opposed semi-spherical sockets at the axial center of the facing conical surfaces of said first and second discs, a spherical ball between said discs mounted in said socket to separate said first and second discs, openings extending through the center of the housing at the top and bottom thereof, eccentric drive pins connected respectively to said first and second discs and extending through said openings, cranks connected to said drive pins and extending to rotate about the nutating axis of said discs to move with nutating movement of said discs, mechanical linkage means connecting said shafts to insure movement of the discs in unison, a fixed vertical

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radially extending partition in one side of said housing extending through slots provided in each of said discs and extending from the upper conical surface to the lower conical surface of the housing and from the circular outer wall of the housing to the spherical surfaces of the discs and defining a low pressure side and a high pressure side on opposing faces of said partition, a pressure conduit communicating with the chambers within said housing on the high pressure side of said partition, and a low pressure conduit communicating with the chambers in said housing on the low pressure side of said partition whereby a continual flow of gases will occur with simultaneous nutating movement of said discs.

2. A nutating disc apparatus having a pressure balanced and an inertia balanced construction comprising in combination a pair of opposed aligned oppositely tilting nutating plates, said plates having conically shaped inner surfaces facing each other to meet in substantially a straight line contact to divide the chamber defined between them and each having outer surfaces, a housing for enclosing said plates having a chamber with curved side walls to accommodate tilting movement of the plates therein and having upper and lower wall surfaces to define chambers above and below said plates, one of said surfaces between the lower wall of said housing and the lower plate and one of said surfaces between the upper wall of said housing and the upper plate being conical and meeting its opposing surface in line contact, said plates having a periphery shaped to conform to the side walls of the housing, eccentric drive pins projecting through openings provided in said housing from each of the nutating plates, a mechanical connecting means operatively connected to the drive pins for power transmission therebetween whereby said plates will nutate in opposed unison, a radially extending partition passing through slots provided in each of said plates and fixed in the housing extending radially across the housing chamber at one side of said housing from the upper to the lower wall surfaces and to the curved side wall of the chamber and defining a low pressure zone on one side of the partition and a high pressure zone on the other side, a low pressure fluid conduit extending through an opening in the housing and communicating on the low pressure side of said partition with the chambers above and below said plates and between said plates, and a high pressure fluid conduit extending through the wall of said housing on the high pressure side of said partition and communicating with the chambers above and below said plates and between said plates whereby a continual gas flow can occur with nutating movement of said plates between the high and low pressure conduits.

3. A nutating disc motor having a pressure balanced and an inertia balanced operation comprising a first circular nutating disc having an inner and an outer face, a first support means for supporting the disc for a nutating movement about its center, a second circular nutating disc having an inner and an outer face, the inner faces of said discs being substantially conical meeting in straight line contact, a second support means for the second disc supporting the disc for nutating movement about its center and positioned to locate the disc adjacent the first disc in alignment and facing free engagement therewith, a housing for said discs having a circular chamber substantially the diameter of the discs with conically shaped facing opposed inner surfaces adjacent the outer faces of the discs to meet the discs in line contact, said discs having a periphery to conform to the size and shape of the housing, a fixed partition extending radially completely across said chamber on one radial side of the housing and passing through slots in said discs to divide the chamber into a high pressure zone and a low pressure zone on opposed sides of the partition, a pressure inlet port in said housing opening into the space between said inner surfaces of said discs in said high pressure zone, an exhaust port in said housing opening from said low

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pressure zone from the space between said inner surfaces, and driven means connected to both of said discs and driven by nutating movement thereof.

4. A nutating disc motor having a pressure balanced and an inertia balanced operation comprising a first plate adapted for movement in a nutating motion having an inner and an outer surface, a first support means for supporting the plate for a nutating movement about its center, a second plate having an inner and an outer surface and adapted for movement in a nutating motion and being positioned in alignment with and free engagement with the first plate and adjacent thereto, a second support means for the second plate supporting the plate for nutating movement about its center and positioned to locate the plate adjacent the first plate, the inner faces of said plates having substantially conical surfaces meeting in straight line contact, a housing for said plates having a chamber therein with an outer peripheral wall and upper and lower walls shaped to confine the plates and define substantially closed chambers above and below said first and second plates and between said first and second plates, said plates having a periphery to conform to the size and shape of the housing, a fixed partition extending radially completely across said chambers in the housing from the upper to the lower wall and radially to the outer wall and passing through slots in said plates to divide the chambers into a high pressure zone and a low pressure zone on opposed sides of the partition, a pressure inlet port in said housing opening into the spaces between and above and below said plates in said high pressure zone, an exhaust port in said housing opening into the spaces between and above and below said plates from said low pressure zone, and driven means connected to both of said plates and driven by nutating movement thereof.

5. A device adapted for operation with a pressurized fluid comprising a first nutating plate having inner and outer surfaces, a second nutating plate having inner and outer surfaces, the inner surfaces of said plates having substantially conical surfaces meeting in straight line contact, means supporting each of said plates for nutating movement and in facing aligned free engagement, housing means enclosing said plates and defining pressure chambers in which said plates move with a nutating motion and shaped to meet said first and second plates on their outer surfaces in straight line contact, said plates having a periphery to conform to the size and shape of the housing, fixed partition means extending completely across one radial side of said housing dividing said chambers into high and low pressure zones, a common pressurized fluid conduit leading into the spaces between the plates and above and below the plates in the high pressure zone, a common low pressure fluid conduit leading into the spaces between the plates and above and below the plates in the low pressure zone, and means mechanically connecting said plates for simultaneous transmission of driving power.

6. A device adapted for operation with a pressurized fluid comprising a first nutating plate having inner and outer surfaces, a second nutating plate having inner and outer surfaces, the inner surfaces of said plates having facing substantially conical surfaces meeting in straight line contact, means supporting each of said plates for nutating movement and locating said plates in adjacent facing position to define a fluid pressure chamber therebetween, a housing for said plates having an interior chamber shaped with a peripheral wall and with upper and lower walls to confine the plates meeting the outer surface of the plates in line contact and to define substantially closed chambers above and below said first and second plates and between said first and second plates, said plates having a periphery to conform to the size and shape of the peripheral wall of the housing, a fixed partition extending radially outwardly to the outer wall and from the upper to the lower wall completely across one

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radial side of said housing and through a radial slot provided in each of said plates and dividing the housing into a low pressure zone and a high pressure zone on the opposing sides of the partition, a common pressurized conduit leading to said high pressure zone and communicating with both sides of both of the plates, a common low pressure conduit leading to said low pressure zone and communicating with both sides of said plates, and means mechanically connecting said plates for simultaneous transmission of driving power.

7. A device adapted for operation with a pressurized fluid comprising a plurality of stacked plates each having upper and lower surfaces and peripheral edges, the facing surfaces between the plates being conical to engage in line contact dividing the chambers formed between the plates, a housing enclosing the plates and forming a chamber with upper and lower and peripheral walls and shaped and being of a size to form closed chambers between the plates and meeting the upper and lower surfaces of the upper and lower of said stacked plates in line contact, the peripheral edges of said plates conforming to the size and shape of the peripheral wall of said housing, a fixed partition extending radially outwardly completely across one radial side of said housing chamber to the peripheral wall and from the upper to the lower wall of the housing chamber and through a radial slot provided in each of said plates and dividing the housing chamber into a low pressure zone and a high pressure zone on the opposing sides of the partition, a pressure conduit communicating with the high pressure side of the partition and with both sides of each of the plates, a low pressure conduit communicating with the low pressure side of the partition and with both sides of each of the plates, and means mechanically connecting said plates for simultaneous transmission of driving power.

8. A nutating disc compressor having a pressure balanced and an inertia balanced operation comprising a first circular disc having an inner and an outer surface, a first support means for supporting the disc for a nutating movement about its center, a second circular disc having an inner and an outer surface, the inner surfaces

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of said discs being conical and meeting in straight line contact, a second support means for the second disc supporting the disc for nutating movement about its center and positioned to locate the disc adjacent the first disc in aligned facing free engagement therewith, a housing for said discs having a circular chamber with upper and lower conical walls and a peripheral wall substantially the diameter of the discs with the upper and lower chamber walls adjacent the outer surfaces of the discs meeting the outer surfaces in line contact, said discs having a periphery to conform to the size and shape of the housing, a fixed partition extending radially to the peripheral wall and from the upper to the lower wall in the housing completely across one radial side of the housing and passing through slots in said discs to divide the chamber into a high pressure zone and a low pressure zone on opposed sides of the partition, a gas intake port in said housing opening from said low pressure zone on both sides of said discs, a pressure discharge port in said high pressure zone opening from both sides of said discs, and power means connected to simultaneously drive said discs in nutating motion for operation as a gas compressor.

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