Nov. 5, 1940. R. E. GREY 2,220,095

ROTARY FLUID MOTOR AND THE LIKE

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FIG. 1

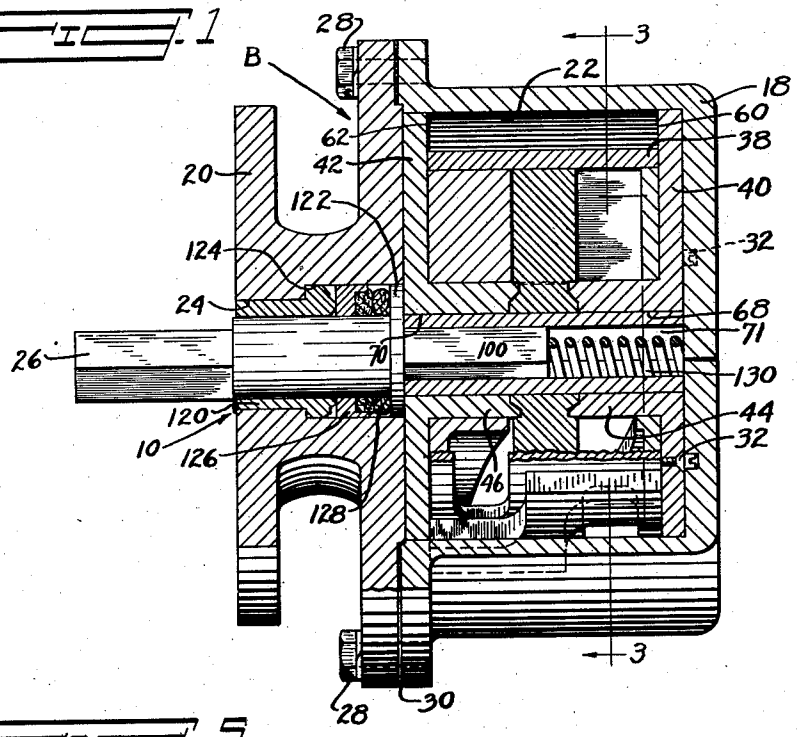
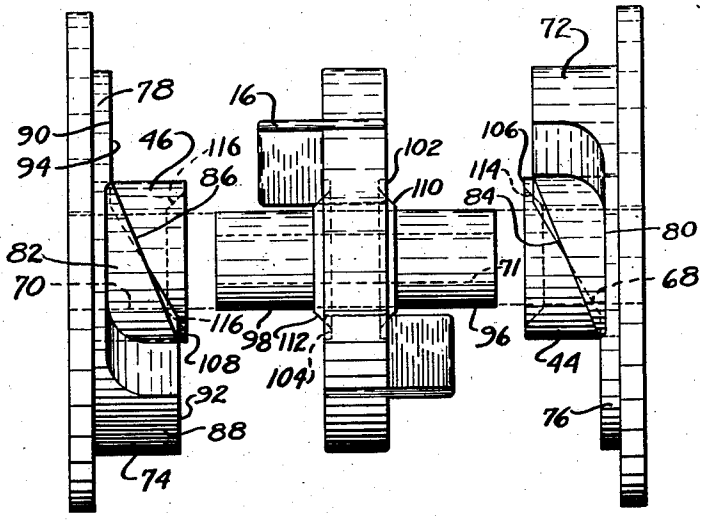


FIG. 5



INVENTOR
RALPH E. GREY
By John J. Hogan and Clarke Toomey
ATTORNEYS

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FIG. 2

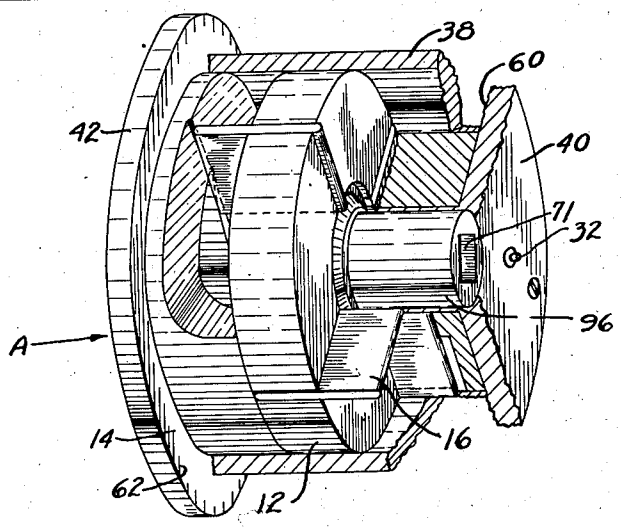


FIG. 4

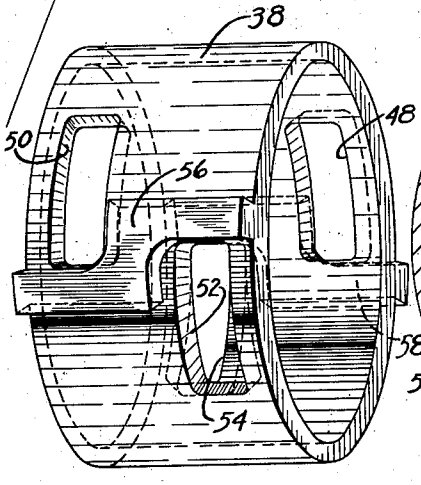
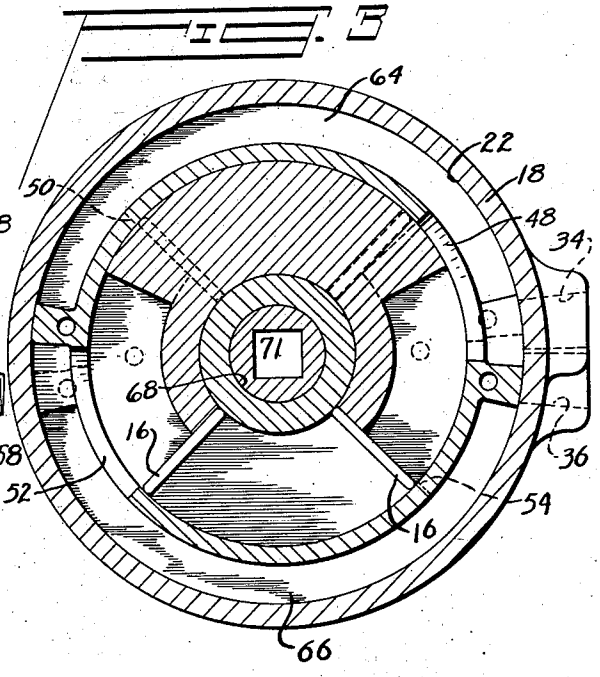


FIG. 3



INVENTOR
RALPH E. GREY
By John J. Hogan and Wade Kooney
ATTORNEYS

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UNITED STATES PATENT OFFICE

2,220,095

ROTARY FLUID MOTOR AND THE LIKE

Ralph E. Grey, Osborn, Ohio

Application April 28, 1938, Serial No. 204,768

3 Claims. (Cl. 103—139)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to improvements in rotary engines, pumps or the like.

It is an object of my invention to make provision, in a reciprocating vane type rotary engine or pump in which the vanes are relatively stationary during the effective working stroke thereof, for the equalization of the fluid pressure on opposite sides of the reciprocating vanes during practically the entire period of reciprocation thereof to decrease the resistance to reciprocating movement of said vanes and thereby increase the power output in the case of the motor and decrease the power required in the case of the pump.

It is a further object of my invention to provide, in a reciprocating vane type motor or pump, a working chamber in which the area of the parasitic or non-working movable parts is reduced to a minimum.

A further object of my invention is to provide in a reciprocating vane type engine of this character, or pump, a novel arrangement of casing, stator and rotor, in which the rotor is supported by and journalled in the stator.

A further object of my invention is to provide in a reciprocating vane type engine or pump of this character a novel thrust bearing arrangement for the rotor so as to reduce to a minimum the coupling forces acting on said bearings.

Other and further objects of my invention will appear from the following detailed description of my invention.

In the drawings:

Figure 1 is a view of an engine embodying my invention showing a motor assembly and the housing therefor in quarter section and with parts broken away;

Figure 2 is a perspective view of the motor assembly shown in Figure 1 with parts broken away;

Figure 3 is a sectional view taken on the line 3—3 of Figure 1;

Figure 4 is a perspective detail view; and

Figure 5 is an exploded detail view.

The engine 10, shown in the drawings and which is illustrative of my invention, is of the four vane type and comprises a motor assembly A and a mount and casing assembly B; the motor assembly comprising a rotor 12, a stator 14, and reciprocating vanes 16; and said mount and casing assembly serving as a support for the engine and providing with the stator input and output manifolds or chambers.

The casing is preferably formed in two sections, the section 18 being formed with an internal cylinder 22 that is closed at one end and open on the other, and section 20 constituting a closure for the open end of section 18 and having a central opening 24 to receive a power driving or driven shaft 26 for driving connection with the rotor of the motor assembly. These two sections are suitably connected together by means of bolts 28 and a gasket 30, the stator of the motor assembly being connected in fixed relation to said casing in any suitable manner as by shrinking or by means of dowel pin connections 32. The section 18 is provided, as best shown in Figure 3, with an intake opening 34 and an exit or discharge opening 36.

The stator of the motor assembly comprises an outer cylinder 38, a pair of end plates 40, 42, and a pair of inwardly presenting cylinders or cylindrical portions 44, 46 that are preferably made integral with said end plates, the inner cylinders being arranged in coaxial alignment with each other and in concentric relation with said outer cylinder.

The outer cylinder is provided with a pair of inlet openings 48, 50 and a pair of outlet openings 52, 54. The inlet openings are arranged on opposite ends of the cylinder and preferably mainly but partly on the same side of a plane passing through the cylinder and normal to the axis thereof, and likewise the outlet openings are arranged on opposite ends of the cylinder and mainly on the same side of a plane passing through the cylinder and normal to the axis thereof, each inlet and its corresponding outlet being diametrically oppositely disposed and lying in the same plane. If desired, said inlets and outlets, respectively, may be arranged so as to lie on one side only of said cylinder. On opposite sides of the cylinder and on the outer surface thereof there are provided Z-shaped partitions 56, 58 that isolate the inlet openings 48, 50 from the outlet openings 52, 54 and provide, with the flanged portions 60, 62 of the end plates 40, 42 and with the outer cylinder and casing 12, chambers 64, 66, chamber 64 being in communication with the casing inlet 34 and the cylinder inlets 48, 50, and chamber 66 being in communication with the casing outlet 36 and cylinder outlets 52, 54. By utilizing the entire width of the cylinder as one wall of the chambers 64 and 66 respectively, the overall size of the engine is reduced with ample capacity for fluid supply to

each pair of inlet and outlet openings, and with a consequent reduction in weight and economy in construction.

The inner cylinders or cylindrical portions are respectively preferably made integral with the inner side of a corresponding cylinder head or end plate 40, 42 and are formed with coaxial openings 68, 70 that extend through the end plates and constitute bearings for the rotor.

The inner sides of the cylinder heads or end plates are provided with inwardly presenting abutments 72, 74 which are preferably formed on separate circular discs 76, 78 that are provided with openings through which the inner cylinders extend in close fitting relation and are fixedly connected to the end plates by means of the threaded pins 32. Each abutment is formed with two segmental-shaped portions 80, 82 having cam surfaces 84, 86 respectively and a pair of equi-angularly spaced sector portions 88, 90 having flat exterior vane guiding surfaces 92, 94 respectively that extend through an angle slightly greater than 90 degrees. The cam surfaces extend in opposite directions through an angle slightly less than 90 degrees from the radial extending edges of the flat interior vane guiding surface 92 to the flat outer vane guiding surface 94, which, likewise, extends over an angle slightly greater than 90 degrees. The discs 76, 78 and their respective abutments are so arranged on the piston heads when the motor is assembled that the exterior and interior flat segmental vane guiding surfaces of one cylinder will be respectively directly opposite the interior and exterior segmental vane guiding surfaces of the other cylinder head and constitute walls of the working chambers hereinafter described. With this angular arrangement of the cam surface segments and the guiding surface segments the pitch or cam angle of the camming surfaces for a four vane type engine of this character is a minimum consistent with obtaining optimum length of work stroke and minimum camming load on the vane during reciprocation thereof.

In order to provide for a minimum resistance to fluid flow through the motor, the cam segments are struck upon an arc of less radius than the guiding surface segments, thus providing on opposite sides of the vane bearing segments and in the projected area of the cylinder inlet and outlet openings under-cut portions. It will thus be seen that with this construction and arrangement of the cam segments there is not only a considerable reduction in power losses due to friction between the vanes and the cam surfaces, but also there is considerable reduction in friction and resistance losses otherwise set up by restrictions to fluid flow into the space between the reciprocating vanes and the camming surfaces. It will further be seen that by providing these undercut portions, ready access of the fluid to opposite sides of the vanes is made possible as soon as the vanes engage the camming surfaces, with the result that equal pressure on opposite sides of the reciprocating vane is instantaneously established. This has the effect of minimizing sliding friction of the vanes in the rotor and of obtaining maximum torque during a greater part of the vane operating stroke.

The rotor 12 may be formed of any suitable material and is provided with a hollow central hub portion having a pair of laterally extending trunnions 96, 98 that are adapted to be received in close running relation within the bearing openings 68, 70 of the inner cylinders for rotatably supporting the rotor in concentric relation with the outer cylinder. These trunnions have a polygonal axial opening 71 extending therethrough and each trunnion preferably extends throughout the length of its corresponding bearing opening. The hollow of said hub portion is preferably made polygonal to receive, in driving relation, a similarly shaped inner end 100 of the driving or driven shaft 26. The rotor is formed on opposite sides thereof with annular central recesses 102, 104 to receive the inner projecting edges 106, 108 of the inner cylinders, and with conical bearing surfaces 110, 112 for complemental engagement with conical bores 114, 116 formed in the walls at the inner cylinder edges 106, 108. By seating and rotatably supporting the rotor on the inner cylinders in this manner, a good seal against excessive leakage is provided and binding due to slight misalignment of parts due to inability to adhere to strict allowable manufacturing tolerances is avoided. Also, binding in the rotor bearing due to impact or back pressures acting normal to and on opposite ends of the axis of rotation of the rotor is practically eliminated.

The rotor is provided with four slots 118 that are arranged 90 degrees apart to receive a corresponding number of vanes 16. These slots extend into the hub portion and below the normal operating position of the vanes to provide undercut passages, to permit slight seepage of fluid from one side of the rotor to the other, to prevent building up of unequal pressures and consequently reduce the coupling forces on opposite sides of the rotor. The rotor, as already noted, is drivingly connected with the shaft 26 which is rotatably mounted in a bushing 120 seated in the central opening of casing section 20. This shaft is provided with a flange 122 that is disposed within a counter bore 124 and provides therewith and with a gland packing element 126 a gland housing for one or more packing rings 178, preferably made of synthetic rubber such as "Duprene." The gland packing element is seated against the inner tapered edge of the bushing. The flange 122 yieldingly compresses the packing by means of a spring 130 that is disposed within the axial opening 71 and seated at one end against the inner end of the shaft and at the other end against the inner wall of casing section 18.

In the operation of the device, as a fluid motor or engine, fluid under pressure is allowed to enter through the casing inlet port 34 filling the chamber 64 and passing through the inlet ports 48, 50 into the spaces above the corresponding cam portions and corresponding working chambers, where it impinges upon the vanes that are individually cyclically projected into the diametrically opposed working chambers in the opposite ends of the cylinder respectively by the cam surfaces 84, 86 of the abutments as the rotor is forcibly rotated by the pressure applied to the vanes. As each vane arrives at and between the low or inner point of one cam surface and the coincident high or outer point of another corresponding cam surface, the supply of fluid pressure is shut off by such vane to a preceding vane, while said preceding vane is still in the working chamber but at the end of its working stroke. This is due to the fact that the space angle of the vanes is less than the angle of the guiding surface segments, which results in the prevention of leakage through the working chambers which would take place if such angles were equal, for

then the two vanes at opposite ends of each working chamber would be riding the cam surfaces at the same time, forming a passage through which the fluid could escape without doing work. After each vane has passed through a work chamber, it is forced by the cam surfaces through the rotor to the opposite end of the cylinder and during this period of the cycle, the fluid pressure which has propelled same is exhausted through one of the cylinder outlets. At the same time, fluid pressure entering through the other cylinder inlet impinges upon the traversing exhausting vane propelling it again until it has reached the other cylinder outlet where the operation began, thus the vanes are each alternately acted upon by the fluid pressure entering the cylinder inlets, and simultaneously and alternately discharging the propelling fluid through the cylinder outlets 52, 54 into the discharge chamber 66 and thence through the casing outlet 36.

It will be seen that when the device is used as a pump, the rotor is rotated by a suitable power drive connected with the drive shaft 26, causing the vanes to be reciprocated in the slots of the rotor by the cam surfaces as described above, and the fluid will be drawn into the working chambers through the input chamber and cylinder inlets on one side of the cylinder and expelled through the cylinder outlets and discharge chamber on the opposite side of the cylinder and thence through outlet 36. The flow of fluid into and exit of fluid from the cylinder takes place simultaneously and each vane operates alternately to suck in and discharge fluid on opposite ends of the cylinder.

It will be seen that various changes may be made by those skilled in the art without departing from the spirit of my invention, and that, while one illustrative embodiment has been described in detail, it is not my intention to limit the scope of the invention other than by the appended claims.

What I claim is:

1. A rotary engine or pump comprising, in combination, a casing having an inlet and an outlet, a rotor and stator assembly disposed within said casing, said assembly providing two working chambers and having vanes operating therein, said stator being connected in fixed relation with said casing and being provided with a cylinder constructed to provide with said casing oppositely arranged inlet and outlet fluid compartments respectively in communication with the inlet and outlet of said casing, one of said compartments having a pair of inlets and the other having a pair of outlets and a pair of side members for closing said chambers and compartments, each member having a central inner cylindrical portion, a pair of substantially equiangularly spaced inwardly presenting sector portions, each sector portion having parallel inner and outer flat surfaces at opposite ends of said cylindrical portion constituting walls of said chambers respectively, and only one pair of oppositely disposed sector cam elements serving to guide said vanes and being arranged intermediate said first mentioned sector portions adjacent the inner edge portions thereof and in radially spaced relation to said cylinder to provide with the corresponding inlet and outlet of said cylinder a relatively unrestricted fluid path to the corresponding working chamber and having camming surfaces inclined from one flat surface to the other, said members being arranged so that the inner flat surface of one side member is opposite to the outer flat surface of the other and said rotor being rotatably supported between said side members and having said vanes in contact with said surfaces for intermittently reciprocating the same through said rotor during rotation thereof.

2. A rotary high pressure engine or pump of the class described, comprising, in combination, a casing having an inlet and an outlet, a rotor rotatably supported within said casing and having a plurality of equally spaced vanes respectively reciprocally movable therethrough, a stator disposed within and fixedly connected to said casing, said stator including a cylinder and a pair of side members for closing said cylinder, said cylinder being constructed to provide with said casing oppositely arranged inlet and outlet fluid compartments, respectively, in communication with the inlet and outlet of said casing, one of said compartments having a pair of inlets and the other having a pair of outlets, said pairs of inlets and outlets, respectively, being disposed at opposite ends of said cylinder, with said pair of inlets substantially diametrically opposed to said pair of outlets, each of said side members having a pair of angularly and axially spaced inwardly presenting sector portions providing parallel inner and outer flat surfaces, and only one pair of cam elements serving to guide said vanes during rotation thereof and having cam surfaces respectively inclined from one flat surface to the other, each of said cam elements having its outer peripheral surface spaced from the inner surface of said cylinder and its inner peripheral surface in substantial continuation of the inner surfaces of said sector portions, said members and said cylinder being arranged so that the inner flat surface of one is opposite to the outer flat surface of the other and so that said pairs of inlets and outlets provide with the spaces between said cam elements and said cylinder relatively unrestricted paths in substantially the direction of rotation of said rotor.

3. In a rotary motor or pump of the class described, a stator, a rotor disposed within and forming with said stator a pair of work chambers, said stator including a cylinder and side plates, said cylinder having at each end thereof a pair of substantially, diametrically opposed inlet and outlet openings and said plates having inwardly presenting cam abutments, each abutment being formed with a pair of radially arranged and axially and angularly spaced segmental portions provided with inwardly presenting inner and outer flat surfaces and only one pair of sector cam elements serving to guide said vanes during rotation thereof and having vertically arranged camming surfaces inclined from one flat surface to the other, said cam elements being disposed in the projected area of said inlet and outlet openings and spaced therefrom substantially throughout their peripheral lengths for a distance corresponding to a major portion of the radial extent of said segmental portions to provide with said inlet and outlet relatively unrestricted fluid paths to and from said work chambers.

RALPH E. GREY.