Jan. 26, 1960 M. C. HANKEL ET AL 2,922,376

VARIABLE CAPACITY PUMP

Filed Sept. 7, 1956 3 Sheets-Sheet 1

Fig 1

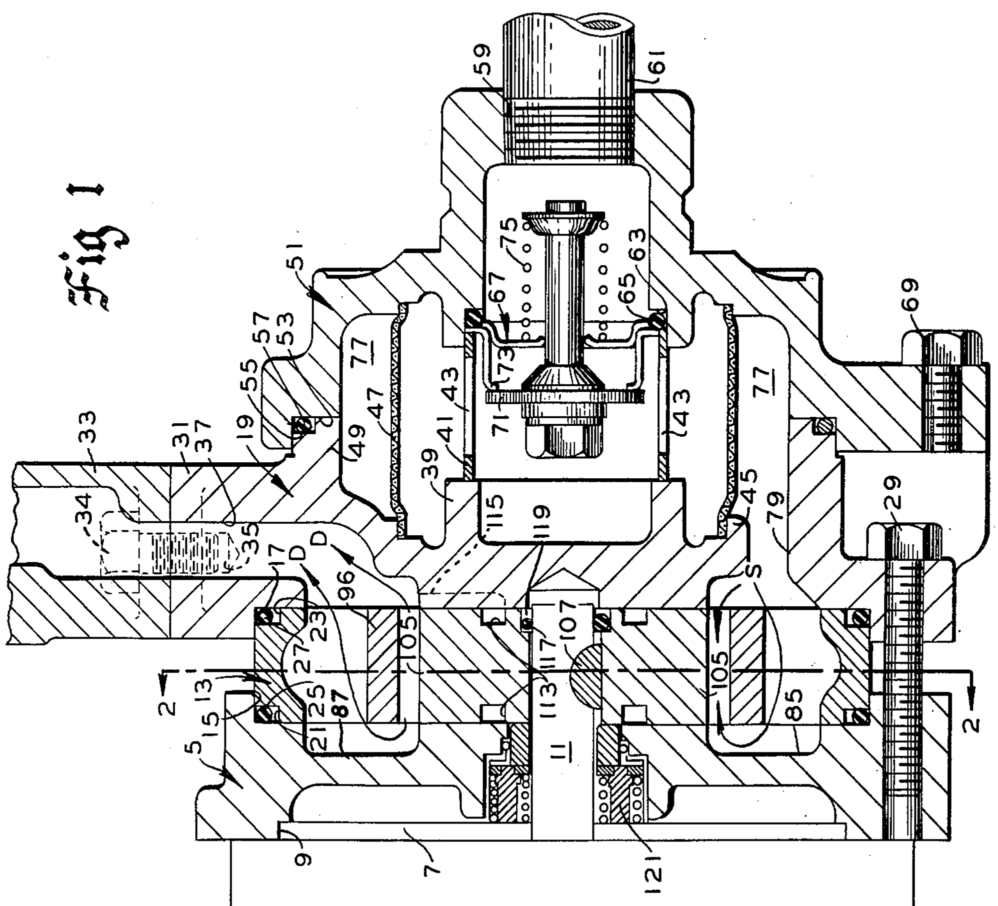

Fig 5

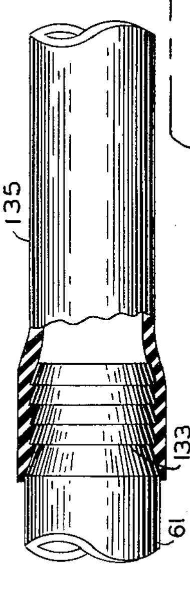

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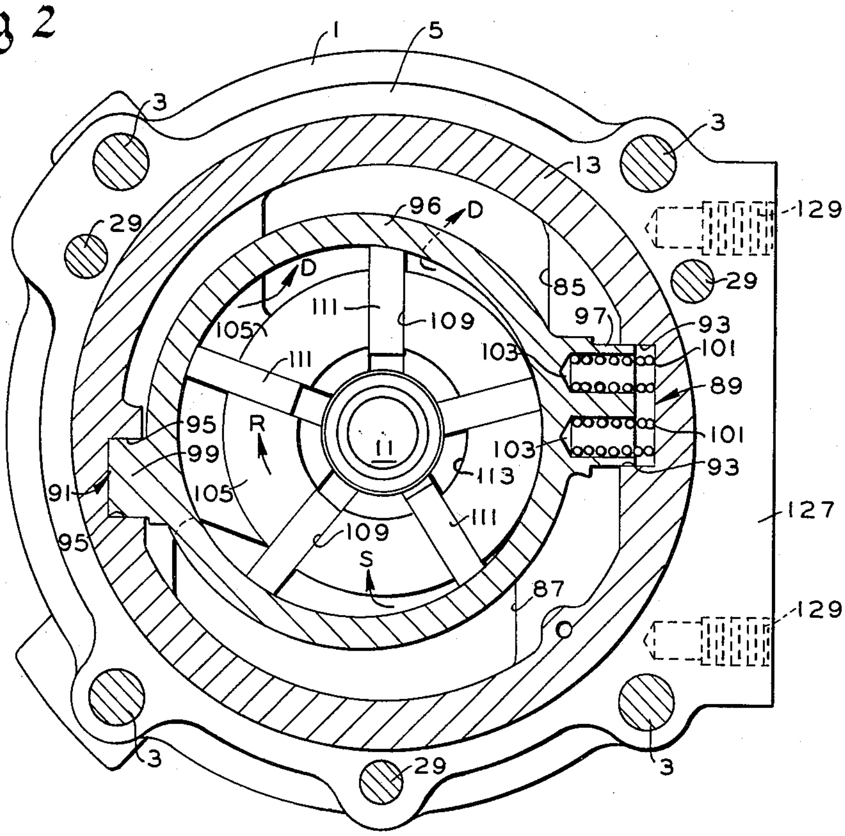
Fig 2



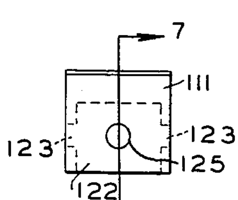


Fig 6

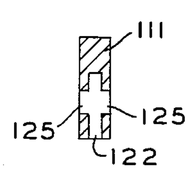


Fig 7

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VARIABLE CAPACITY PUMP

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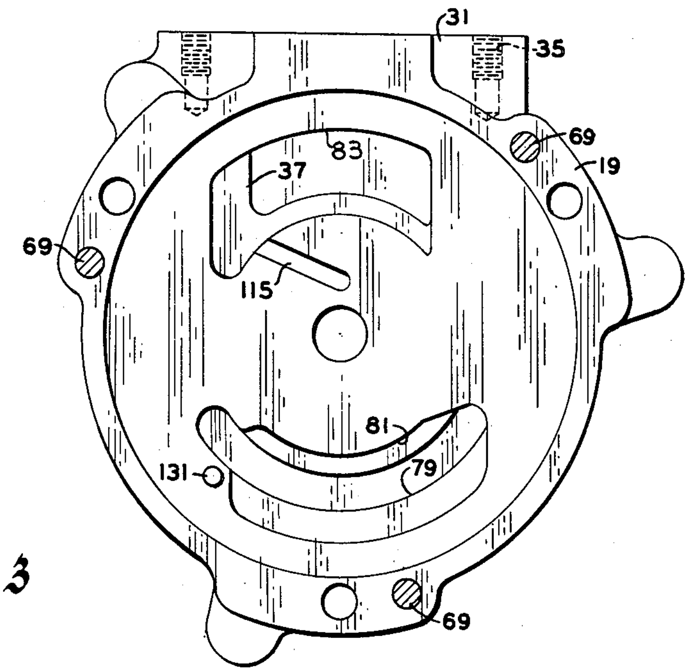

Fig. 3

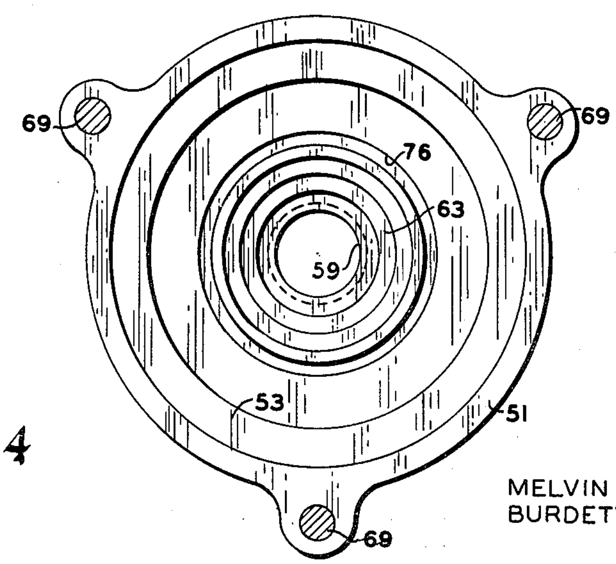

Fig. 4

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United States Patent Office

2,922,376

Patented Jan. 26, 1960

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2,922,376

VARIABLE CAPACITY PUMP

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Application September 7, 1956, Serial No. 608,503

13 Claims. (Cl. 103—120)

This invention relates to a variable capacity pump. More specifically it relates to a pump in which a bladed rotor operates within a shiftable ring which is mounted so that as the discharge pressure increases, the ring will shift toward a concentric relation with respect to the rotor to reduce the pump capacity and vice versa.

It is an object of the invention to provide the pump with a built-in inlet check valve.

Another object of the invention is to provide the pump with a built in strainer.

A further object of the invention is to provide means for mounting the check valve and strainer so that they can be removed readily.

Still another object of the invention is to provide a pumping unit which comprises a pump, a motor directly connected to the pump rotor and a readily removable inlet check valve and strainer.

Yet another object of the invention is to provide blades of a plastic material which are weighted with metal to improve the seal attained by the blades.

These and other objects will become apparent from a study of the specification and the drawings which are attached hereto, made a part hereof and in which:

Figure 1 is a vertical sectional view of the pump, strainer, check valve and other parts.

Figure 2 is a sectional view taken substantially on line 2—2 of Figure 1 but rotated 90 degrees.

Figure 3 is an elevation of the ported pump head.

Figure 4 is an elevation of the valve housing.

Figure 5 is an elevation, partly in section, of the suction hose and connection.

Figure 6 is an elevation of a pump blade.

Figure 7 is a sectional view of a blade taken substantially on line 7—7 of Figure 6.

Referring first to Figure 1, the numeral **1** represents an electric motor to which is attached, by means of four screws 3 (Fig. 2), a pump head **5**. The motor has a pilot boss **7** which is received in a recess **9** in the head to hold the latter centered with respect to the motor shaft **11**.

The pump body **13** is mounted in recesses **15** and **17** in the head **5** and the ported head **19** respectively. The body is grooved at **21** and **23** to receive the O-ring gaskets **25** and **27**. Thus the body is both centered with respect to the heads and is sealed between them.

Head **19** is held on body **5** by means of three suitable cap screws **29** (Fig. 1). It is also provided with a suitable outlet boss **31** to which any suitable outlet fitting **33** may be attached, by means of cap screws **34** or other fasteners which enter holes **35** (Fig. 3). The boss also defines the discharge channel **37**.

The head **19** is also provided with a central, axially tending boss **39**. The latter supports on its end, one end of a cylindrical sleeve **41** which is provided with ports **43**. The boss is circumscribed by an axially extending flange **45** which receives one end of a substantially cylindrical strainer **47**.

A second axially extending flange **49** surrounds and extends beyond the end of flange **45** to serve as a pilot for the valve housing **51** which is recessed at **53** to receive the flange **49**. The latter is provided with a shoulder **55** between which and the wall of the recess **53** is confined an O-ring gasket **57**.

The valve housing is provided with a central, threaded axial bore **59** which receives the inlet or suction nipple **61** and with a counterbore **63** which receives another O-ring gasket **65** upon which is mounted a check valve body **67** which is held in place on the gasket by the other end of the sleeve **41**.

The valve housing **51** is held in place on the head **31** by means of cap screws **69** (Fig. 3) which enter tapped holes in the head **19**. These screws also serve to compress the gaskets **57** and **65** to establish the required seals.

A poppet valve **71** is mounted in the body **67** and is urged toward its seat **73** by the spring **75**. A recess **76** is also provided in housing **51** to receive the other end of screen **47**.

From Figure 1 it will be seen that the head **19** and housing **51** define a cavity **77** which communicates with the body **13** through a passage **79** which terminates in an inlet port **81** (Fig. 3). The discharge channel **37** also terminates adjacent the body **13** in a discharge port **83**. The head **5** is also provided with cavities **85** and **87** which have an outline of substantially the same size and shape as the inlet and discharge ports.

As will be seen from Figure 2, the body **13** is provided with two rectangular guide ways **89** and **91** which extend for the full width of the body and have parallel walls **93**, **95**. The ways are offset above and below the horizontal diameter of the body.

A pumping ring **96**, having substantially the same width as the body **13**, has projections **97**, **99** which are fitted to reciprocate in the guide ways **89** and **91** respectively. Springs **101** are received in holes **103** formed in projection **97** to urge the ring toward its fartherest left-hand position as shown in Figure 2 so that it will normally have a maximum eccentricity with respect to the motor shaft **11**. The springs are short, that is, they have an axial length which is only a few times the external diameter. It is a well known fact that the resistance to compression of such springs increases more rapidly for a given increment of displacement than would a longer spring having the same specifications.

A rotor **105** is mounted on the shaft and is driven by the shaft through a key **107**. The rotor is provided with a number of radial, blade receiving slots **109**, here shown to be five in number, in which are mounted the blades **111**. The blades fit the slots closely but reciprocate therein.

The rotor is provided with a concentric groove **113** at each end which intersects the slots **109** near their inner ends. The groove intersects a channel **115** which communicates with the discharge passage **37** so that the discharge pressure assists in holding the blades in contact with the ring.

A counterbore **119** is formed in the end of the rotor adjacent head **19** to receive an O-ring seal **117** to prevent the travel of liquid along the shaft **11**. A rotary seal **121** of any desired design is provided between the rotor and the other head.

The blades **111** are wide enough to establish a seal with each of the heads **5** and **19** and thick enough to seal the slots in the rotor. They are, of course, slidable in the slots and to insure that they retain sealing contact with the ring **96** under the centrifugal force resulting from the speed of the rotor, they are constructed as shown in Figures 6 and 7.

A weight **122** which is preferably of lead or other heavy material is formed accurately and is provided with projections 123 at each end and 125 on each face. The body of the blade is of any suitable hardened plastic material and is molded around the weight in a suitable mold.

A thermosetting, phenol formaldehyde plastic has been found satisfactory for the blades. The projections on the weight assist in centering the weight in the mold so that it will be properly encased and centered in the plastic material and also prevent the parting of the plastic material from the weight.

A boss 127 (Fig. 2) may be formed on the head 5 and provided with tapped holes 129 to receive screws which support a switch (not shown) for controlling the motor.

As shown particularly in Figure 3, a pin 131 is set in the head 19 and is adapted to enter the body 13 so as to position the guide ways 89, 91 properly with respect to the ports 81, 83, 85, 87.

As shown in Figure 5, the nipple 61 preferably has its free end formed with a series of sharp edged flanges 133 which receive a suction hose 135 and serve to hold the hose in place on the nipple.

Operation

When the pump is not in operation, the ring 96 will be forced to assume the position shown in Figure 2 by the springs 101. The motor, when running will rotate the rotor 105 in the direction indicated by arrow R.

It will also be seen from Figure 2 that the ring 96 and its projections 97, 99 divide the body 13 into upper and lower portions which communicate with the discharge and inlet ports respectively. The volume of the space defined by the rotor, blades, heads and ring at the lower side of the pump is expanding under the described rotation and this space is also in communication with the inlet ports as shown in Figures 1 and 2. Liquid thus moves through the suction hose 135, nipple 61, valve 71, ports 43, strainer 47 into chamber 77 from which it passes as shown by arrows S through passages 79 and 85 into the space which is expanding, from both ends thereof so as to fill the space as it expands in volume.

At the same time the spaces defined by the heads, ring, rotor and blades at the top of the pump are contracting in volume and, being in communication with the discharge ports, liquid will be forced from these spaces, as shown by arrows D out the discharge passage 37.

An inspection of Figure 2 will show that the exterior of that portion of the ring 96 above the projections 97, 99 is subjected to discharge pressure while that below the projections is subjected to suction pressure and that there is a considerable exterior area of the ring extending from immediately above the projection 99 to the nearest edge of port 85 which is exposed to discharge or high pressure externally and suction or low pressure internally while the pressures on the interior and exterior of the rest of the ring are substantially balanced.

The effect of the pressure difference is to urge the ring to the right against the action of springs 101. Thus as the discharge pressure increases, as when a discharge valve is throttled, the ring tends to move to the right, toward concentricity with the rotor 105. As this occurs the effective displacement of the pump is reduced so that the work done by the pump is reduced and this results in a reduction in the load on the motor. When the discharge from the pump is entirely closed, the ring will move into concentric relation with respect to the rotor and no liquid will be pumped so that the motor load is minimized. When the discharge is again opened the reduction in discharge pressure will permit the springs 101 to move the ring to the left to increase the displacement proportionally.

It should also be understood that the weighting of the blades produces an effect in addition to that of insuring a proper seal with the ring.

It will be noted that as the blades move out of the rotor slots the radius of gyration of the weights increases and vice versa. This increase occurs on the side of the rotor remote from the location of the ring shifting spring means so that the net or resultant centrifugal force of the weighted blades on the opposite sides of the rotor will aid the spring means to move and hold the ring in a position of maximum eccentricity.

However, as the discharge pressure increases sufficiently to overcome both the spring means and the resultant centrifugal force and moves the ring toward concentricity with the rotor, the value of the resultant centrifugal force diminishes rather rapidly because the radius of gyration of the extended blades is not only reduced but that of the retracted blades is increased because they are not fully retracted under such conditions. Of course when the ring and rotor are concentric, the net effect of the centrifugal forces is zero.

Accordingly, it will be seen that when the pump is operating at its maximum capacity, the ring is stabilized by the centrifugal force and will not yield to ordinary pulsations. However, when the outlet pressure rises to a value which requires relief and the ring starts to move, it will move readily and quickly to a new equilibrium condition providing the required relief. Thus the weighted blades produce both a stabilizing effect at full capacity and a sensitive, rapid adjustment in response to the existing discharge pressure.

Thus the pump will adjust its displacement to the discharge pressure and there is no need to provide a by-pass line and valve between the suction and discharge sides of the pump. Such valves are often unsatisfactory because they do not follow the demand requirements closely and are often noisy.

The strainer, of course, prevents harmful material from entering the pump and the check valve prevents back flow from the discharge to the suction when the pump is idle.

The valve and strainer are rendered readily accessible for inspection, cleaning or replacement by the removal of the three bolts 69 and the housing 51. Since the suction line 135 is a hose, no pipe joints need be broken in the process.

The weighting of the blades assisted by discharge pressure applied to their inner ends insures that the blades will at all times be in contact with the ring so that the efficiency of the pump will not be impaired because of failure of the blades to establish the required seal.

The seal 119 prevents leakage of liquid along the shaft 11 whence it might escape through the rotary seal 121 and the latter prevents the escape of liquid through head 5 from the periphery of the seal.

It is obvious that various changes may be made in the form, structure and arrangement of parts of the specific embodiments of the invention disclosed herein for purposes of illustration, without departing from the spirit of the invention. Accordingly, applicants do not desire to be limited to such specific embodiments but desire protection falling fairly within the scope of the appended claims.

We claim:

1. In a variable capacity pump, a pair of heads having substantially parallel surfaces, a body mounted on said heads in sealing relation with said surfaces, a cylindrical ring, means for mounting said ring with its ends in sealing relation with said surfaces and for reciprocation diametrically of said body, a rotor mounted substantially concentrically in said body and in sealing relation with said surfaces, a number of blades reciprocably mounted in said rotor and having sealing relation with said rotor, the interior of the ring and with said surfaces to define fluid chambers, yieldable means for urging the ring to a position eccentric with the rotor, said heads each defining inlet and discharge ports each communicating with both the interior and exterior of the ring at the ends thereof, said ring and mounting means forming a barrier between the inlet and outlet ports, said barrier being disposed so that as the

discharge pressure increases it will urge the ring toward concentricity with the rotor in opposition to said yieldable means so as to decrease the effective volumetric capacity of said fluid chambers, the improvement in the ring mounting means which comprises means defining a pair of recesses each having a pair of planar guide surfaces disposed parallel to a diametral plane of the body which includes the central axes of said ring and rotor, said pair of recesses being disposed on opposite sides of said plane, said ring having projections disposed to enter and be guided in said recesses.

2. The structure defined by claim 1 wherein said yieldable means comprises a helical compression spring and wherein one of said projections defines a recess for receiving and supporting said spring with one end in contact with said body.

3. The structure defined by claim 1 wherein said heads are each provided with a recess for receiving one end of the body, said body is provided with a recess at each end which, with the recess of the adjacent head, defines a closed annular channel, O-ring gaskets are mounted, one in each channel and means are provided to draw said heads together against the body to compress said gaskets.

4. In a rotary pump the combination of a pair of heads, a body sealingly mounted between the heads to form a chamber, a displacement mechanism mounted in the chamber, one of said heads defining an outlet passage, a housing mounted on the exterior of said one head to form a chamber therewith, an inlet conduit mounted on the housing, said chamber having a passage communicating with said conduit and a normally closed, check valve mechanism, said housing defining a seat surrounding said inlet passage, a gasket on the seat upon which said valve mechanism is supported, said valve being disposed so as to open with the flow of fluid from said conduit to said chamber, and a perforated sleeve disposed for engagement with said valve mechanism at one end and with said one head at its other end and being arranged to support said valve mechanism and gasket so that said gasket will be compressed as said housing is mounted on said one head.

5. The structure defined by claim 4 wherein a substantially cylindrical strainer is disposed around and substantially concentrically with said sleeve and wherein seating means are provided on said one head and on said housing to receive and support the ends of the strainer as said housing is mounted on said one head.

6. In a variable capacity pump, a pair of heads having substantially parallel surfaces, a body mounted on said heads in sealing relation with said surfaces, a cylindrical ring, means for mounting said ring with its ends in sealing relation with said surfaces and for reciprocation diametrically of said body, a rotor mounted substantially concentrically in said body and in sealing relation with said surfaces, a number of blades reciprocably mounted in said rotor and having sealing relation with said rotor, the interior of the ring and with said surfaces to define fluid chambers, short, helical compression spring means for urging the ring to a position eccentric with the rotor, said heads defining inlet and discharge ports positioned for successive communication with said chambers, said ring and mounting means forming a barrier between the inlet and outlet ports, said barrier being disposed so that the resultant of the pressures acting on the ring will urge the ring toward concentricity with the rotor in opposition to

said yieldable means, said blades including weighting means to increase the centrifugal forces acting on the blades during rotation of the rotor, the resultant of the centrifugal forces of all of the blades acting in a direction to oppose said action of said discharge pressure.

7. The structure defined by claim 6 wherein said blades comprise a core of heavy material substantially enclose in a lighter material.

8. The structure defined by claim 6 wherein said blades comprise a core of heavy material substantially enclosed in a thermosetting plastic material.

9. The structure defined by claim 6 wherein said blades comprise a core of rigid, heavy material substantially sheathed by a relatively light plastic material, said core having projections adapted for embedding in said plastic material to prevent relative shifting of the core and sheath.

10. The structure defined by claim 9 wherein said core is made of lead and the plastic material is of the thermosetting type.

11. In a variable capacity pump, a body means defining a substantially cylindrical chamber, a rotor having a diameter which is substantially less than that of said chamber mounted coaxially therein, a ring having an external diameter less than that of said chamber and an internal diameter greater than that of said rotor, mounted in said chamber for movement, substantially along a diameter of the ring, to and from a position concentric with said rotor, short helical compression spring means for urging said ring from concentric position, said rotor defining slots directed toward said ring, weighted blades mounted in said slots so as to ride on the ring, said body means defining axially directed inlet and outlet ports disposed on opposite sides of said diameter of movement, first and second ring guiding means on said ring and body means and disposed therebetween, said first means being disposed between said inlet port and said diameter of movement and second means being disposed between said outlet port and said diameter of movement and on the opposite side of said ring from said first means.

12. The structure defined by claim 11 which includes means for urging said ring from concentric position with respect to said rotor, said second guiding means being disposed adjacent said yieldable means.

13. The structure defined by claim 12 wherein said blades comprise a core of heavy metal substantially enveloped in a plastic material.

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