

[54] **ROTOR FOR REACTION ROTARY OIL FILTER**

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[58] **Field of Search**..... 233/1 R, 1 A, 1 C,
233/11, 8, 23 R, 23 A, 24, 27, 28, 46, 47 R

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[57]

ABSTRACT

A rotor consisting of an upper casing and a lower casing, the skirts of said both casings being joined in lapped relation and curled up together convolutely to securely unite them, said rotor having provided at the upper and lower positions on its center axis the upper and lower annular bearings the inner diameters of which are selected to satisfy the relation:

$$d_2 = \sqrt{(4W/\pi P) + d_1^2} (1 \pm K)$$

where:

d_1 is inner diameter of the upper annular bearing;

d_2 is inner diameter of the lower annular bearing;

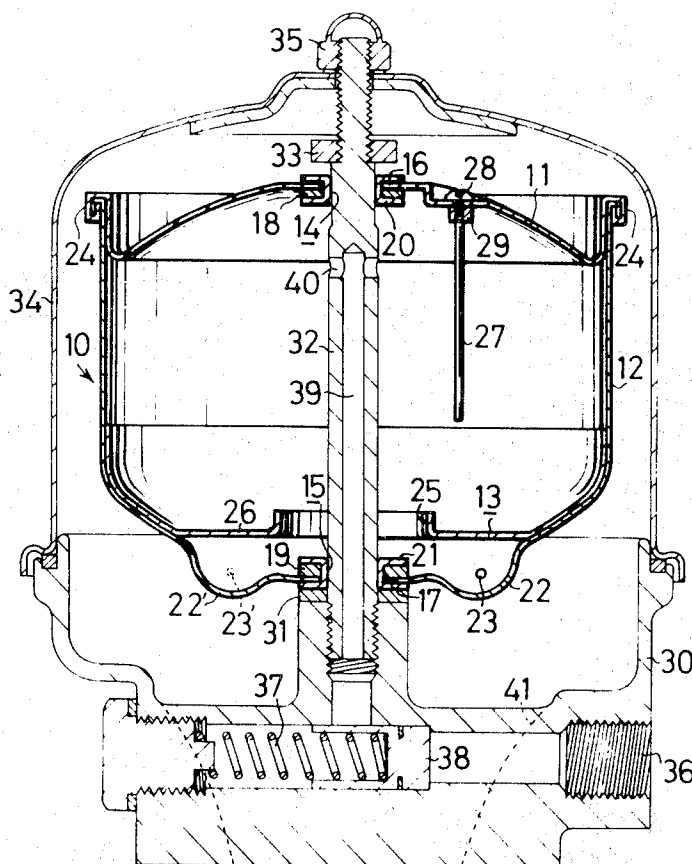
P is oil pressure in the rotor;

W is sum of empty weight of the rotor and weight of oil in said rotor;

K is correction value defined within the range of $-0.08 < K < +0.08$

said rotor also having detachably provided therein a gauge whereby one can readily know when to replace the rotor.

3 Claims, 3 Drawing Figures



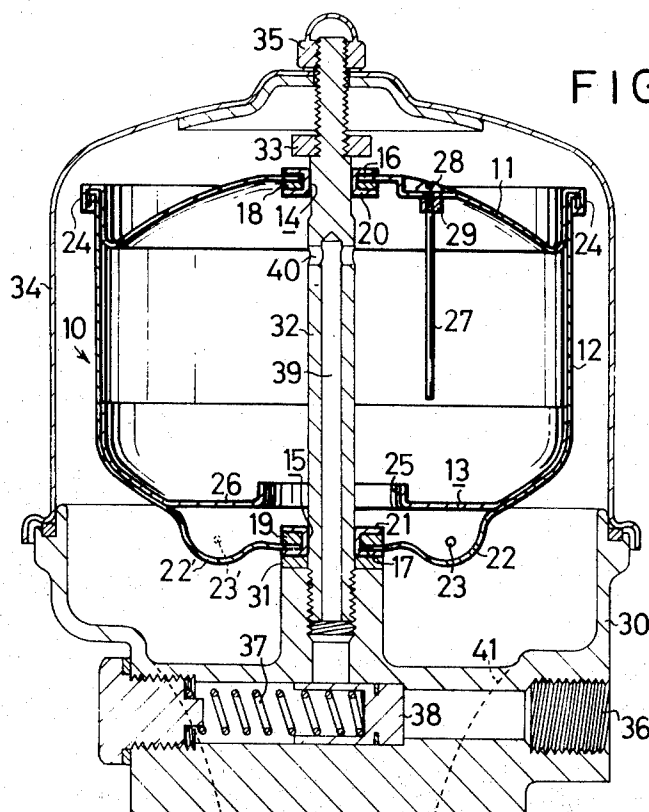


FIG. 1

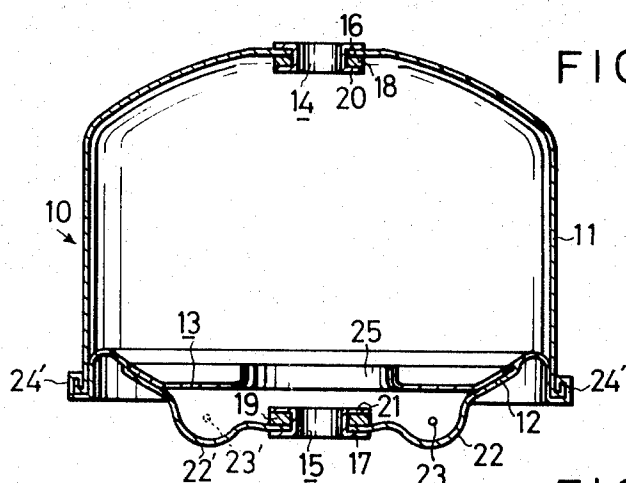


FIG. 2

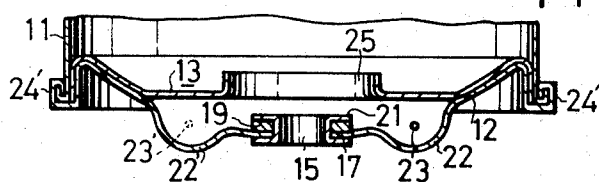


FIG. 3

ROTOR FOR REACTION ROTARY OIL FILTER

This invention relates to a rotary reaction oil filter for cleaning lubricating oil in internal combustion engines or other oils used for other purposes, and more particularly it relates to the improvements in such oil filters in which high speed rotation of the rotor about its axis is performed by utilizing the reaction of oil jet issued from the interior of the rotor and in which when the sludge in the oil has been accumulated to a considerable amount on the inner wall face of the rotor owing to the centrifugal force, such can be readily known by a gauge means and the rotor is replaced with new one, the used rotor being discarded.

The rotor used in this type of reaction rotary oil filters, as compared with other types where the rotor is positively rotated from the outside, is more subject to the influence of frictional resistance in bearing sections because such frictional resistance gives a delicate influence to the rotational frequency of the rotor and may affect the centrifugal filtering efficiency. Nevertheless, the conventional rotors were of a construction in which the rotor is rotated with the end face of its lower bearing being kept in contact with the rotational frequency of the rotor would be reduced due to frictional resistance in said part, resulting in lowered centrifugal separating effect. Also, such conventional rotors were relatively complicated in construction and hence rather costly for use as an expendable rotor. Further, it depended on the sixth sense and experience of the operator to judge the extent of accumulation of sludges on the rotor interior so as to decide whether the rotor should be replaced or not.

In view of the above, the present invention has for its object to provide an improved rotor device of the type referred to, which is simple in construction and non-expensive for use as an expendable type centrifugal rotor and in which when the rotor is being rotated the underside face of the lower bearing thereof stays slightly apart from the pressure receiving face of the filter body to minimize frictional resistance so as to expedite high speed rotation.

It is another object of the present invention to provide means whereby the condition of deposition of sludges can be readily known so that one can determine when to replace the rotor, such means being easily incorporatable in the rotor mechanism.

According to the present invention the rotor is provided with an upper bearing and a lower bearing, both of annular form, which are disposed at the predetermined upper and lower positions, respectively, on the center axis of the rotor. The inner diameter of the lower annular bearing is selected such as to satisfy the following relation:

$$d_2 = \sqrt{(4 W/\pi P) + d_1^2} (1 \pm K)$$

where:

d_1 is inner diameter of the upper annular bearing;

d_2 is inner diameter of the lower annular bearing;

P is oil pressure in the rotor;

W is the sum of empty weight of the rotor and weight of oil in the rotor;

K is a correction value defined within the range of $-0.08 < K < +0.08$.

More specifically, in a rotor whose upper, center and lower portions are all of a fixed diameter D , if the inner diameter d_1 of the upper annular bearing is smaller than the inner diameter d_2 of the lower annular bearing, the

difference in area between the upper and lower faces of the rotor where oil pressure P is loaded will be:

$$[\pi/4 (D^2 - d_2^2) - \pi/4 (D^2 - d_1^2)]$$

or

$$[\pi/4 (d_2^2 - d_1^2)]$$

Therefore, an upward force equal to oil pressure P multiplied by the above area difference is applied to the rotor body. On the other hand, a pressure equal to the sum W of empty weight of the rotor body and weight of oil in the rotor is applied as a downward force to the rotor body. Balancing these upward and downward force, the following formula is obtained:

$$\pi/4 (d_2^2 - d_1^2) P = W$$

From this formula, d_2 is given as follows:

$$d_2 = \sqrt{(4 W/\pi P) + d_1^2} \quad (1)$$

Since the inner diameter d_1 of the upper annular bearing can be determined from the strength of the material while W and P can also be predetermined, the inner diameter d_2 of the lower annular bearing can be calculated from the above formula (1).

Actually, however, the oil ejection holes formed in the rotor body are not always disposed horizontally; in some cases such apertures may be formed with a certain angle such that they will be directed aslant upwardly or downwardly. In case the ejection angle directs downwardly, the rotor body receives an upward component, so that the inner diameter d_2 must be made smaller than that calculated from the formula (1). While, in case the ejection angle directs upwardly, the rotor body receives a downward component and hence the inner diameter d_2 must be made larger than that calculated from said formula (1). Therefore, if a correction value K is introduced, d_2 is given by the following formula:

$$d_2 = \sqrt{(4 W/\pi P) + d_1^2} (1 \pm K) \quad (2)$$

As induced from many experimental results, this correction value K never exceeds the range of ± 0.08 .

The rotor in accordance with the present invention is provided with a detachable gauge disposed parallel to the axis of rotation of the rotor, whereby the operator can readily know whether it needs to replace the rotor according to the hardness or resistance felt in pulling out the gauge.

The other objects and features of the present invention will become apparent from reviewing the following description of some preferred embodiments of the present invention when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a sectional view of a rotary reaction oil filter in accordance with the present invention;

FIG. 2 is a sectional view showing the construction of a rotor according to another embodiment of the present invention; and

FIG. 3 is a sectional view showing the principal parts of a rotor according to still another embodiment of the present invention.

Referring first to FIG. 1, there is shown a rotor unit, generally designated by reference numeral 10, consisting of an upper casing 11, a lower casing 12 and a sludge receiver 13. This rotor unit 10 is made from iron sheet pressings and hence economical for use as an expendable rotor. On the upper and lower positions on the center axis of said rotor unit 10 are provided annular bearings 14 and 15, respectively. Said annular bearings 14, 15 comprise rings 18, 19 of a suitable thickness

which are placed along the edges 16, 17 of the central openings in the upper and lower casings 11, 12, and metal plates 20, 21 made of brass or other metals which are bent in U-shape so as to externally fit over said respective rings and opening edges to integrally caulk the bearings. This arrangement of each said bearing can accommodate a comparatively wide breadth longitudinally, is highly resistive against wear and offers strong reinforcement for the central opening edges to make it possible to well withstand high speed rotations of the rotor.

Assuming that the inner diameter d_1 of the upper annular bearing 14 is 11 mm ϕ , oil pressure P is 3 kg/cm ^{2} , empty weight of rotor 10 is 0.7 kg, weight of oil in rotor 10 is 0.8 kg and K is 0.022, then the inner diameter d_2 of the lower annular bearing 15 can be determined from the aforementioned formula (2) as follows:

$$d_2 = \sqrt{4/3 \cdot 14 \times 1.5/3 \times 1.1^2 (1 + 0.022)} \\ \approx 1.4 \text{ cm}\phi$$

The lower casing 12 is formed at its bottom with two outwardly projected portions 22, 22' which are disposed at diametrically opposite points radially displaced from the axis of rotation of the rotor. In each of the downwardly projected portions is formed an oil ejection hole 23, 23' so disposed that the jet of liquid issuing from it will have a substantial tangential component with respect to a circle having the axis of rotation of the rotor for centre. The ejection hole 23 is visible in the accompanying drawings in full line while the position of the hole 23', which is not visible in the drawings, is indicated in dotted line. The skirt of the upper casing 11 is substantially vertically raised up so as to join with the top edge of the lower casing 12, and the ends of these joined portions are curled up together to form a convolute joint 24. The sludge receiver 13 is formed with a central opening 25 and saucer-like recession 26 therearound and has its outer peripheral edge secured to the inner face of the lower casing 12 so as to receive sludges which may flow down, when rotor rotation is stopped, from the interior wall surface of the rotor 10 on which they were deposited, so as to prevent clogging of the ejection holes 23, 23'. It also serves as a guide for preventing the oil fed into the rotor 10 from immediately escaping from the ejection holes 23, 23'.

The position of the above-said convolute joint 24 and the manner of mounting the sludge receiver 13 may be varied suitably. In the embodiment of FIG. 2, the upper casing 11 is an inverted cup-shaped structure formed by deep drawing work, and the convolute joint between the upper and lower casings 11 and 12 is formed at the lower peripheral edge of the rotor 10 as indicated by reference numeral 24'. The sludge receiver 13 is securely fitted to the lower casing 12. In the embodiment shown in FIG. 3, the joined edges of the upper casing 11, lower casing 12 and sludge receiver 13 are curled up together to constitute a convolute joint. Either of these convolute joints can well withstand the internal pressure produced by high speed rotation of the rotor 10.

It is to be also noted that a gauge 27 formed from a single elongated bolt is inserted into the rotor unit through a hole 28 formed in the upper casing 11 and is threadedly secured in position by a nut 29 secured to the inner face of the upper casing 11 concentrically with said hole 28. such gauge is therefore easily detachable when so desired.

The rotor 10, of which the structural arrangement has been described above, is incorporated in an oil filter in the following manner.

First, the rotor unit is fixed on a shaft 32 planted vertically on the filter body 30 such that the bottom end face of the lower annular bearing 15 of the rotor 10 will rest on the top face of the boss portion 31 of the filter body 30, and then a nut 33 is threadedly engaged with the shaft to secure the unit. Then a cover 34 is mounted over the unit and the entire assembly is secured by a check nut 35 from atop the assembly as shown. It will be noticed that a suitable space is formed between the underside of the nut 33 and the top face of the upper annular bearing 14 of the rotor 10.

The soiled oil is supplied from a supply hole 36, causing a cylinder valve 38 to move back against the force of a spring 37 placed in said hole, whereby oil enters a hollow 39 in the shaft 32 and flows out from a lateral opening 40 into the rotor unit 10. Oil in the rotor unit 10 passes through the central opening 25 in the sludge receiver 13 and is ejected from the ejection holes 23, 23' and discharged through an outlet 41 in the filter body. The rotor 10 is caused to rotate at high speed by the reaction produced when oil is issued out from the ejection holes 23, 23'. Since sludges in oil are gathered on the inner wall face of the rotor 10 by dint of the centrifugal force that is produced by high speed rotation of the rotor, the cleaned oil alone is ejected from the ejection holes 23, 23'.

Thus, the rotor 10 is rotated at high speed by the reaction of the oil jet from the ejection holes 23, 23'. Since the inner diameters d_1 and d_2 of the upper and lower annular bearings 14 and 15 are different from each other as aforementioned, said both bearings are equilibrated at a position where the underside of the lower bearing 15 stays slightly apart from the top face of the boss 31 of the filter body 30. Consequently, the top face of the upper bearing 14 of the rotor 10 approaches the nut 33 but they are never contacted with each other. With frictional resistance being minimized in this manner, the rotor unit 10 is rotated at high speed of from 4,000 to 6,000 r.p.m. by oil pressure to perform filtering operation at high efficiency.

The gauge 27 disposed parallel to the center axis of the rotor unit 10 may be pulled out with little resistance if the amount of sludges accumulated on the inner wall surface of the rotor unit is small because the gauge remains uncontacted with such sludges. However, if the sludges are accumulated to such an extent that the gauge 27 is buried therein, it becomes hard to pull out the gauge owing to resistance of the sludges therearound. Therefore, it is possible to easily determine whether the rotor 10 should be replaced or not by merely noticing the resistance felt in pulling out the gauge 27.

What is claimed is:

1. A rotor for a rotary reaction oil filter comprising an upper casing having an upper annular bearing at an axial portion of said rotor and an upper skirt, a lower casing having a lower annular bearing at an axial portion of said rotor, downwardly projected portions at the bottom thereof, and a lower skirt, said lower casing having two oil ejection holes disposed above said downwardly projected portions and a sludge receiver formed with a central opening communicating with said holes and a saucer-like recession, said sludge receiver being securely fixed to an inner face of said lower casing

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above said ejection holes, said upper skirt and said lower skirt being joined in curled up lapped relation and fastened together, said lower annular bearing being larger in inner diameter than said upper annular bearing to satisfy the formula:

$$d_2 = \sqrt{4W/\pi P} + d_1^1 (1 \pm K)$$

wherein:

- d_1 is inner diameter of the upper annular bearing,
- d_2 is inner diameter of the lower annular bearing,
- P is oil pressure in the rotor,
- W is a sum of weight of the rotor and oil in the rotor,
- K is correction value defined within the range of $-0.08 K + 0.08$,

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said upper and lower casings having central openings, said annular bearings disposed in said central openings and comprise annular rings with U-shaped plates covering said rings caulking said central openings of said upper and lower casings.

2. A rotor for a rotary reaction oil filter as claimed in claim 1, wherein said rotor also has a gauge removably mounted in said rotor.

3. A rotor in a rotary reaction oil filter as claimed in claim 2, wherein said gauge is elongated and rod-like and is removably mounted in said upper casing, said gauge extending parallel to the axis of said rotor.

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