

June 3, 1941.

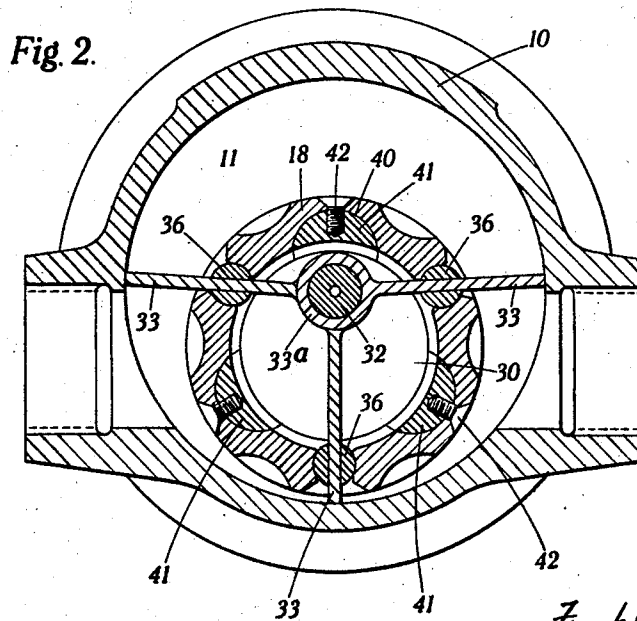
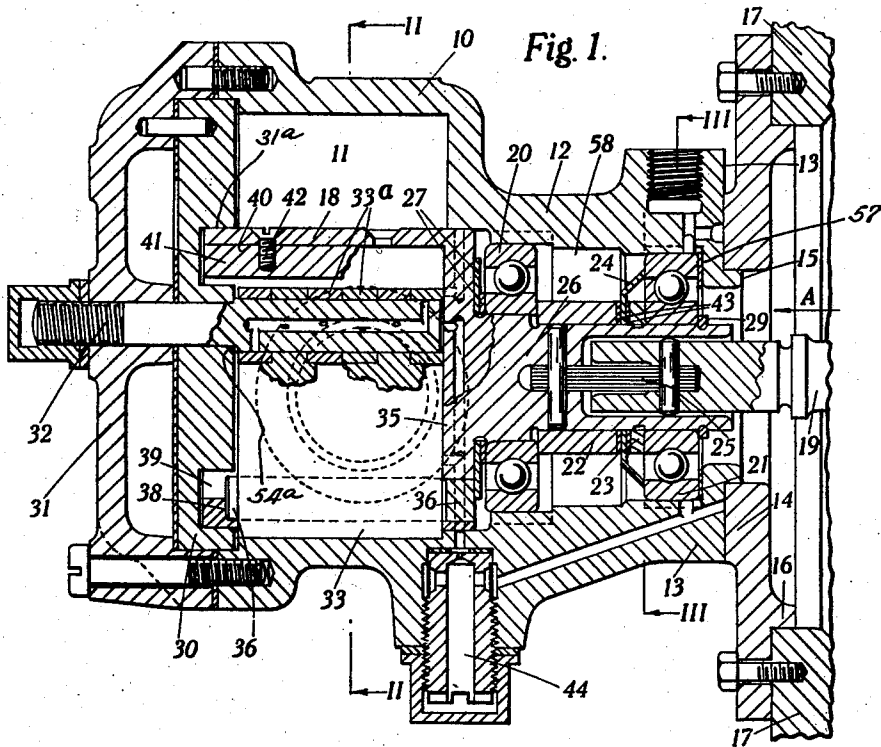
F. C. FULCHER

2,243,899

ROTARY PUMP AND THE LIKE

Filed May 24, 1939

3 Sheets-Sheet 1



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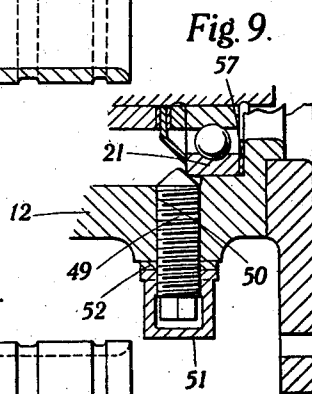
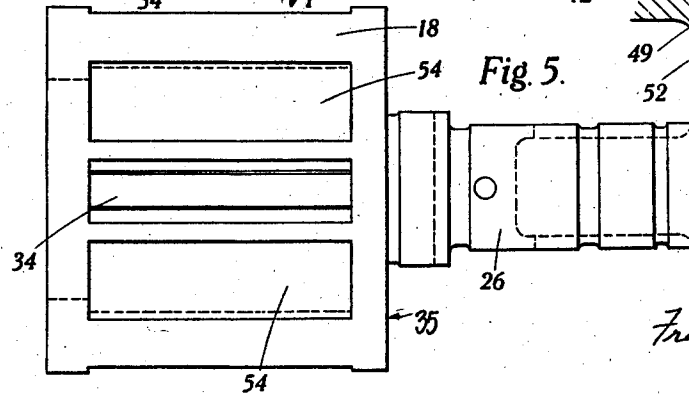
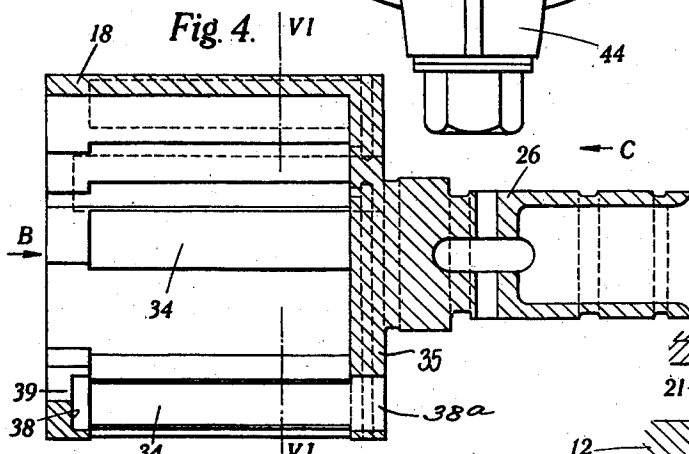
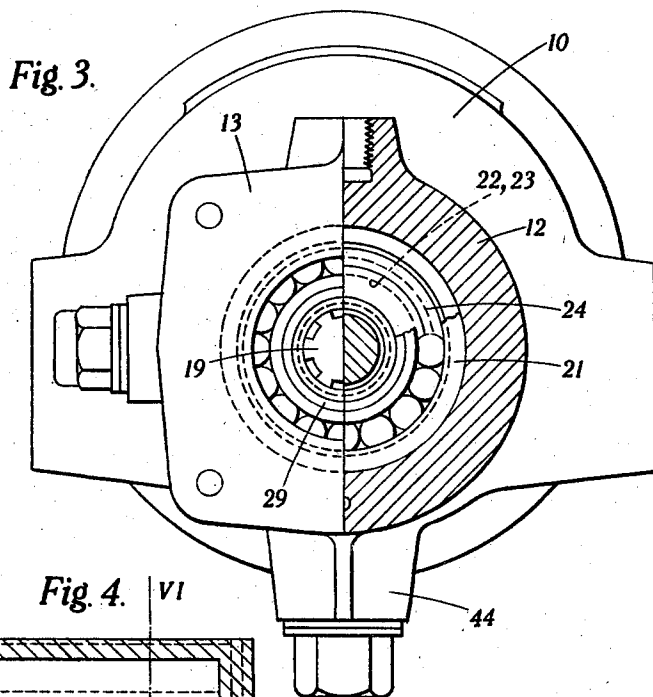
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ROTARY PUMP AND THE LIKE

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3 Sheets-Sheet 2



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Fig. 6.

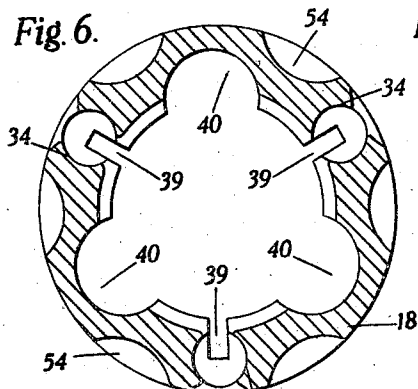


Fig. 7.

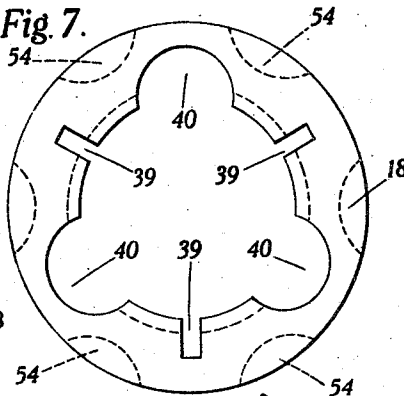


Fig. 10.

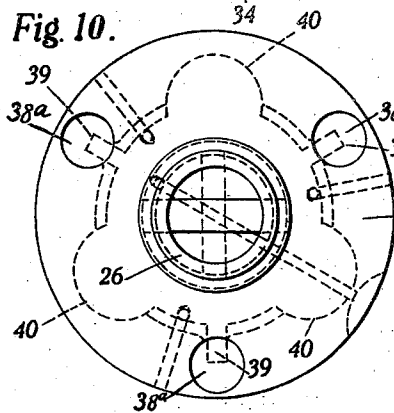
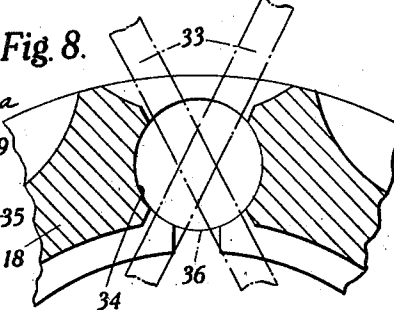


Fig. 8.



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UNITED STATES PATENT OFFICE

2,243,899

ROTARY PUMP AND THE LIKE

Frank Christian Fulcher, Purley, England

Application May 24, 1939, Serial No. 275,454

In Great Britain October 12, 1938

5 Claims. (Cl. 230-157)

The present invention relates to rotary vane pumps or the like of the kind in which the vanes are mounted to rotate within a chamber and pass through slotted or divided (hereinafter termed slotted) bearing members which are rotatably mounted in slots in the wall of a barrel portion of a rotor, which portion is open at one end and also rotates within the chamber upon an axis eccentric to that about which the vanes rotate, so that in the rotation of the vanes and the rotor a relative sliding movement between the vanes and the rotor is produced and the ends of the vanes are carried round the peripheral wall of the working chamber, the vanes being longer radially than the internal diameter of the barrel and extending between the centre and the inner periphery of the working chamber and their inner ends being provided with hinge portions which are rotatably mounted upon a common spindle. The outer extremities of the vanes or blades may have a clearance from the inner surface of the working chamber. The invention is particularly designed for duty as a so-called vacuum pump for the operation of various instruments, gauges and de-icer equipment on aircraft.

The main object of the present invention is to avoid slotting the barrel to the open end thereof and thus weakening that end of the barrel and also to facilitate assemblage of the vanes in the rotor barrel or the detachment of the vanes therefrom. According to the invention the barrel wall is provided between peripherally continuous end portions with closed ended axial slots in which are mounted the bearing members in which the vanes are slidably arranged, the slots in the bearing members being endwise accessible from the open end of the barrel and the latter having axially extending grooves opposite to the slots so as to allow the vanes to be inserted into the end of the barrel and slid along the barrel, with the outer end of the vane guided by the slot and the inner end received in the axial groove, up to a position in which the vane can be passed diametrically through the slot.

In a pump so characterized, it is practicable rotatably to mount the rotor barrel cantilever fashion in a bearing or bearings at one end only of the rotor, a shouldered down axial extension of the rotor being journaled in bearings in the pump casing, while the rotor barrel per se may rotate without contact with a bearing. For example, the reduced driving end of the rotor may be journaled in axially spaced ball bearings in the neck of the pump casing, while the rotor extends into the pumping chamber without bearing contact therein.

The free end of the rotor preferably runs in an annular recess of an end plate or cover.

Conveniently and advantageously the open end of the rotor is provided with internal grooves

in endwise alignment with the slots in the bearing members and of a width sufficient to give passage to the vanes.

It may be of advantage, in some cases, to provide plugs or fillets of appropriate cross-sectional shape for insertion in the aforesaid axially extending grooves which receive the inner ends of the vanes during the assembly thereof, thereby restoring the inner cylindrical surface of the rotor.

In use as a vacuum pump on aircraft, the rotor will generally be driven by means of a spring coupling which mates with the accessory drive of the engine or a gear box driven therefrom.

Other objects and features of the invention will become apparent from the constructional forms of the invention embodied, by way of example, in a rotary vane pump of the kind above referred to, as hereinafter described with reference to the accompanying drawings in which Fig. 1 is a sectional, side elevation of a rotary vane pump according to the present invention as particularly constructed for duty as a vacuum pump on aircraft for the operation of suction-driven flight instruments and gyropilots and to provide ample discharge pressure for the operation of de-icer equipment.

Fig. 2 is a cross-sectional view taken on line II-II of Fig. 1.

Fig. 3 is an end view of the pump looking in the direction of the arrow A (Fig. 1), the left-hand portion of the view being an external view, and the right-hand portion thereof being taken on line III-III of Fig. 1.

Fig. 4 is a sectional elevation of the rotor barrel.

Fig. 5 is an external side elevation of the rotor barrel.

Fig. 6 shows a cross-section taken on line VI-VI of Fig. 4.

Fig. 7 is an end view looking in the direction of arrow B (Fig. 4).

Fig. 8 is a sectional detail view of the oscillating guide for the rotor vanes.

Fig. 9 is a detail view showing means for retaining the rotor barrel from inadvertent axial displacement, and

Fig. 10 is an end view of the rotor barrel in the direction of arrow C (Fig. 4).

Referring to the drawings, the pump structure comprises a cylindrical casing 10, containing a pumping chamber 11 and extending at one end into a neck 12 which has a mounting flange 13 at its outer extremity. The flange 13 has a spigot 15 for engagement with an annular flanged adaptor plate 14 which in turn is formed with a spigot 16 which makes a push fit in an opening in, for example, the engine accessory pad 17 of an engine crankcase upon which the pump is adapted to be mounted.

The end of casing 10 which is remote from its neck 12, is open for the reception of the pump rotor which is journaled at one end only in bearings in the casing neck so as to project axially in cantilever fashion into the pumping chamber 11. The pump rotor (Figs. 1, 4, 5, 6 and 7) comprises a cylindrical barrel 18 closed at one end and open at the other, the closed end thereof having a co-axial outwardly projecting hollow extension 26 forming an axle for mounting the rotor cantilever fashion.

A ring type ball bearing 20 is mounted upon the axle 26 adjacent the end wall of the barrel from which the bearing is spaced by packing washers 27. The outer portion of axle 26 is somewhat reduced in diameter and near its free end receives a second ring type ball bearing 21 of smaller diameter than that of bearing 20. The inner races of bearings 20, 21 make a tight driving fit with the stepped peripheral surfaces of axle 26 and are spaced apart by a spacing sleeve 22 and spacing washer 23 both of which embrace the barrel axle 26. The outer end of the sleeve 22 abuts the inner race of bearing 20, and the outer face of washer 23 abuts the inner race of bearing 21, while the inner face of washer 23 and outer end face of sleeve 22 clamp therebetween a dished sealing washer device 24.

A spring ring 29 engages an annular groove in the outer peripheral surface of axle 26 to retain the bearings 20 and 21 and associated spacer members 22, 23 in position on the axle.

The axle 26 and bearings 20 and 21 therefore are mounted in the casing neck 12, the inner peripheral surface of the latter being formed with stepped peripheral recesses with which the outer faces of the bearings 20, 21 make a close fit and against a shimmed shoulder face 57 of the neck 12 the outer race of the spaced bearing 21 is tightly pressed so as axially to position the rotor and seal such outer race against such face. One or both of the peripheral recesses which receive the bearings 20, 21, particularly the recess which receives the latter bearing, may be bushed.

The open end of the rotor barrel 18 enters an annular groove formed in the inner face of a ported insert plate 30, and the open flanged end of casing 10 is sealed with the aid of a jointing shim of the desired thickness by a flanged sealing plate 31 which serves also to lock the ported insert plate 30 in operative position. The construction and function of the sealing plate 31 and insert plate 30 is fully disclosed in my co-pending U. S. patent application lodged on May 24, 1939, under Serial No. 275,455.

A bearing spindle 32, secured at one end in a bossed hole set co-axially in the sealing plate 31, serves by its shoulder 54a to clamp the insert plate 30 against the cover plate 31 and besides forming a fluid tight joint between them with the aid of a jointing shim of the desired thickness, it further serves to space the inner face of the insert plate 30 away from the corresponding edges of the vanes 33 and the bottom of the recess 31a away from the end of the rotor 18. The spindle 32 projects inwards, cantilever fashion, so as to lie within the rotor barrel 18 in parallelism with, but eccentric to, the axis of rotation of the barrel 18. The spindle 32 rotatably mounts three hinged flap-like vanes 33 (Figs. 1 and 2) which pass through guide slots provided in the wall of the rotor barrel 18. The vane flaps 33 each have a pair of butts 33a axially spaced apart to receive therebetween the butts of the adjacent flaps so that the butts of the flaps are interleaved.

As shown more clearly in Figs. 2, 4, 5 and 6, the body of the rotor barrel is cylindrical, the wall of the body being formed with three axially extending slots 34 which extend from the outer face of the end wall 35 (Figs. 4 and 14) of the rotor barrel and terminate before reaching the peripherally continuous end portion of the open end of the barrel, so that the peripheral wall of the barrel at its open end is unbroken. The walls of the slots 34 are arcuate so as to form bearing surfaces for forked pins diametrically slotted oscillating pins or equivalent divided bearings 36, of circular cross-section, for the passage of the vanes 33. The pins 36 exceed in length that of the vanes 33, so as to project from either end of the latter into bearing recesses 38 and bearing apertures 38a respectively formed in the peripherally continuous opposite end portions of the barrel wall in endwise alignment with the slots 34, the pins being retained in position by the retaining washers 27.

From Figs. 1 and 2 it will be clearly seen that the overall radial length of each vane 33 exceeds the internal diameter of the rotor barrel. Accordingly, as shown in Figs. 1, 3, 5, 6 and 7, for enabling the vanes to be readily assembled and disassembled by a straight endwise movement through the open end of the rotor followed or preceded by movement of the vanes diametrically of the rotor to a position in which they project through the rotor wall or are free to slide along such grooves, the rotor wall is internally provided, diametrically opposite the slots 34, with axially extending grooves 40 and, where necessary, in addition, the open end of the rotor, as shown, may be provided with internal grooves 39 in endwise alignment with the axial slots 34 in the barrel wall and of a width sufficient to give passage to the vanes 33. The grooves 40 may conveniently be of part circular shape.

The grooves 39 and 40 have a length sufficient to enable the vanes to be registered with the slots 34 and the grooves 40 may be normally occupied in some cases, by fillets 41 secured in a readily releasable manner such as by countersunk set screws 42.

The outer portion of each longitudinal wall of each slot 34 in the rotor barrel 18 is shaped e. g., backed away, so as not only to give the necessary clearance for the vanes as these oscillate with the rotor pins 36 in the manner shown in Fig. 8, in the operative rotation of the rotor barrel, but also to permit the vanes to turn during assembly or disassembly so as partly to intrude into the axially extending grooves of the rotor. The portion of the barrel wall adjacent the open end is made thicker than the remaining part of the barrel wall. Consequently the requisite strength at the open end of the barrel is obtained while more space is provided in the barrel for manoeuvring the vanes to permit one vane to be moved as far as possible out of the way of another vane which is subsequently assembled.

Preferably the rotor barrel 18 is axially grooved as at 54 (Fig. 6) upon its outer peripheral surface to reduce the weight of the rotor as far as is practically possible.

If during the working of the pump there should arise a tendency for the ball bearings axially to creep due to wear such as between the outer races and the pump body, the motor would tend to exert an axial thrust against the cover. As indicated by the detail shown in Fig. 9, these tendencies may be resisted by a locating screw 49 which enters a tapped bossed hole 50 in the

casing neck 12 and passes therethrough so that its inner conical extremity engages the inner peripheral edge of the outer ball race of bearing 21. The outer end of the screw 49, which is provided with flats for engagement with a spanner, is left projecting outwards from the hole 50 and is covered by a cap nut 51 which engages the outer threaded portion of the screw 49 and beds upon a packing washer 52.

By screwing up the screw 49 the outer race of the ball bearing 21 is driven against a shimmed shoulder 57 and in addition to restraining the rotor barrel from axial displacement assists in preventing the ball bearing from rotating.

The axle 26 of rotor barrel 18 is coupled to a driving link 19 by means of a flexible coupling 25 which is constructed and arranged as described in my co-pending United States application filed on May 24, 1939, under Serial No. 275,456. The driving link 19 projects through the adaptor plate 14 and engine accessory pad 17 for engagement with driving means not shown.

I claim:

1. A rotary pump or the like, comprising a working chamber, a plurality of vanes rotatable therein, a rotor having a barrel portion rotatable in said chamber about an axis eccentric to the axis of rotation of said vanes, said rotor barrel having an open end and having peripherally continuous end portions, axially extending apertures in said barrel between said end portions, bearing members rotatably mounted in said apertures, said bearing members having axially extending slots, a spindle centrally of said chamber, said vanes passing through said slots and each including a hinged end mounted to rotate about said spindle, said vanes being of greater radial length than the internal diameter of said barrel, the internal wall of said barrel having a plurality of axially extending grooves opening into the open end of the rotor and said open end providing an aperture which permits the vanes to be inserted therethrough with the inner end of the vane in one of said grooves and the outer end of the vane guided by the slot in the bearing member opposite such groove to enable the vane to be guided in sliding movement during assembly along the rotor into a position in which it can be passed diametrically through the slot.

2. A rotary pump or the like, comprising a working chamber, a plurality of vanes rotatable therein, a rotor having a barrel portion rotatable in said chamber about an axis eccentric to the axis of rotation of said vanes, said rotor barrel having an open end and having peripherally continuous end portions, axially extending apertures in said barrel between said end portions, bearing members rotatably mounted in said apertures, said bearing members having axially extending slots, a spindle centrally of said chamber, said vanes passing through said slots and each including a hinged end mounted to rotate about said spindle, said vanes being of greater radial length than the internal diameter of said barrel, the internal wall of said barrel having a plurality of axially extending grooves opening into the open end of the rotor and said open end providing an aperture which permits the vanes to be inserted therethrough with the inner end of the vane in one of said grooves and the outer end of the vane guided by the slot in the bearing member opposite such groove to enable the vane to be guided in sliding movement during assembly along the rotor into a position in which it can be passed diametrically through the slot.

ing member opposite such groove to enable the vane to be guided in sliding movement during assembly along the rotor into a position in which it can be passed diametrically through the slot, the longitudinal wall of each of said apertures comprising opposed part-circular portions which rotatably support the bearing member and outer portions diverging to the periphery of the barrel wall to such an extent in relation to the thickness of the vane that the hinge portion of the vane can be turned about said part circular portions during assembly or disassembly to lie against the inner wall of the barrel between the aperture supporting said vane and the axially extending groove opposite said aperture so as to facilitate the subsequent insertion or removal of another of the vanes.

3. A rotary pump as claimed in claim 2, in which the wall of the barrel comprises a portion at the open end which is internally thickened thereby to strengthen this end of the barrel, the remaining portion of greater internal diameter extending over a distance at least equal to the axial length of the vane to facilitate manoeuvring an assembled vane inside the barrel out of the way of another during the subsequent assemblage or disassembly of the latter.

4. A rotary pump as in claim 2, in which the outer portion of the longitudinal walls of each aperture diverge to the periphery of the rotor barrel to such an extent in relation to the thickness of the vanes as to allow the hinge portion of the vane to be swung into an adjacent axially extending groove.

5. A rotary pump or the like, comprising a working chamber, a plurality of vanes rotatable therein, a rotor having a barrel portion rotatable in said chamber about an axis eccentric to the axis of rotation of said vanes, said rotor barrel having an open end and having peripherally continuous end portions, axially extending apertures in said barrel between said end portions, bearing members rotatably mounted in said apertures, said bearing members having axially extending slots, a spindle centrally of said chamber, said vanes passing through said slots and including hinged portions at their inner end mounted to rotate about said spindle, said vanes being of greater radial length than the internal diameter of said barrel, the end portion of the barrel at the open end thereof being arranged to close an adjacent open end of the slot in each bearing member but said end portion having radial grooves each opening at the inner periphery of such end portion and adapted each to register with an inner portion of the slot in the corresponding bearing member, said barrel having a plurality of grooves extending axially to such open end, one opposite to each radial groove, said radial groove serving to guide the outer portion of the vane in sliding movement along the rotor during assembly whilst the vane is moving up to the exposed portion of the end of the slot in the bearing member and the inner hinge carrying end of the vane is moving in the opposite axial groove, said vane being then further slidable along the barrel with one end guided by the slot in the bearing member and the other end continuing to move along the opposed axial groove.

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