April 24, 1951 A. N. ALLEN, JR 2,550,180

SEALING MEANS FOR THE WORK CHAMBERS IN OSCILLATING VANE TYPE FLUID MOTORS

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Fig. 1.

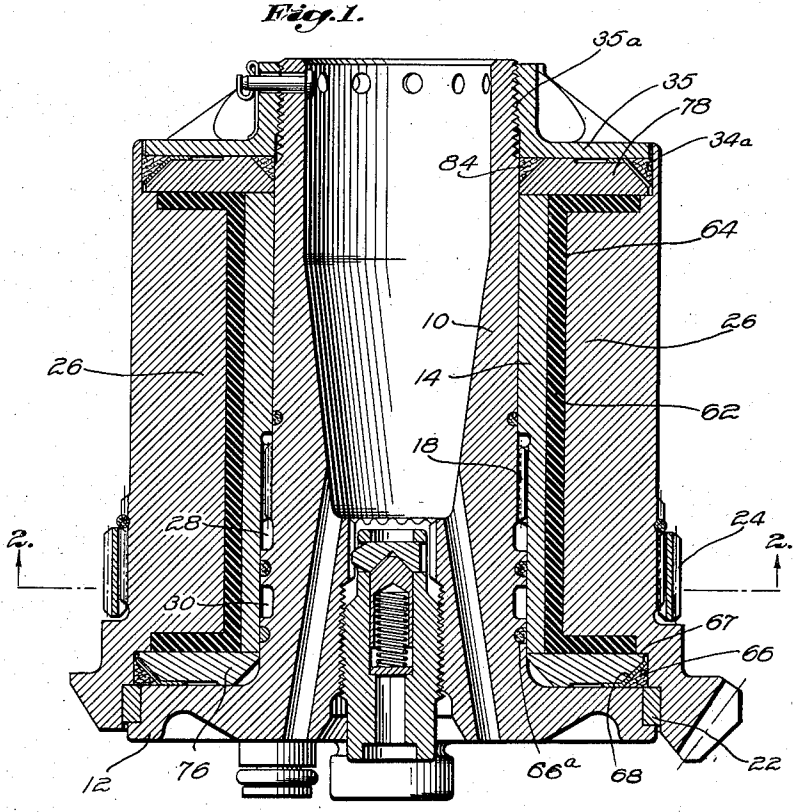

Fig. 2.

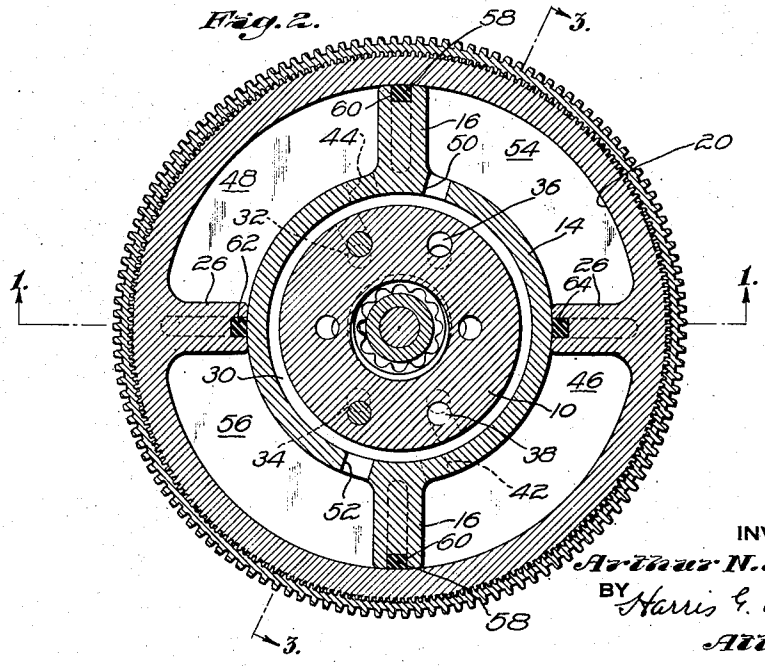

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Fig. 3.

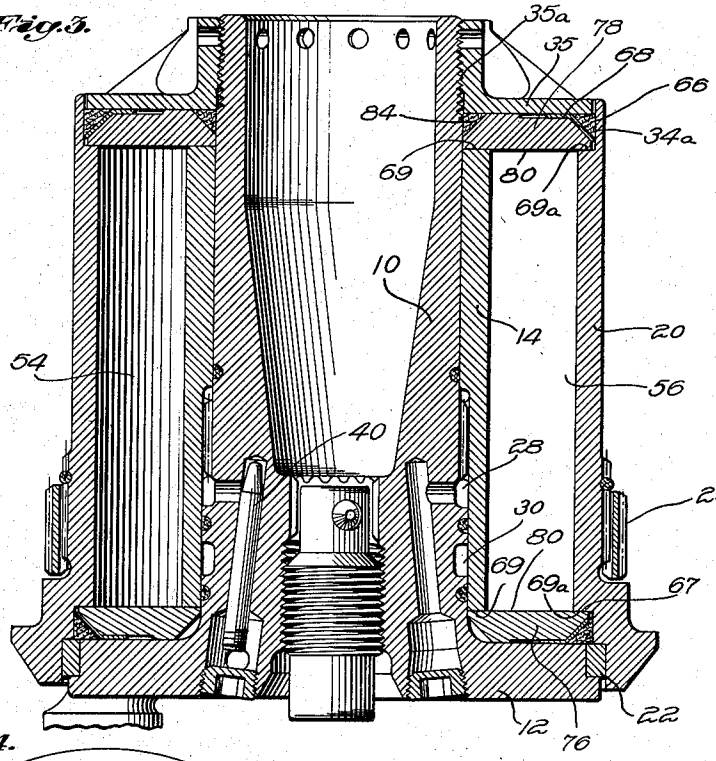


Fig. 4.

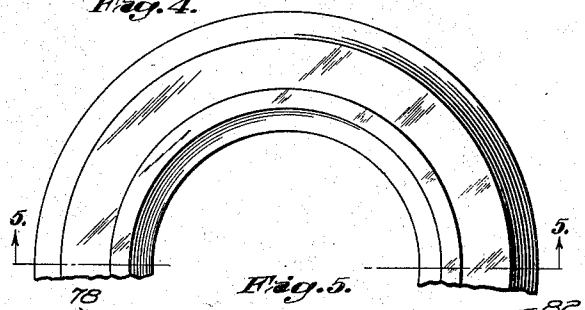
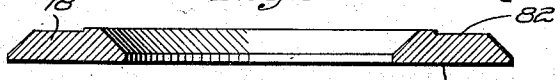


Fig. 5.



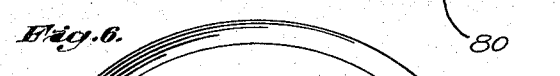


Fig. 6.

Fig. 7.

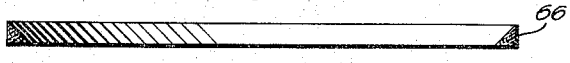


Fig. 8.

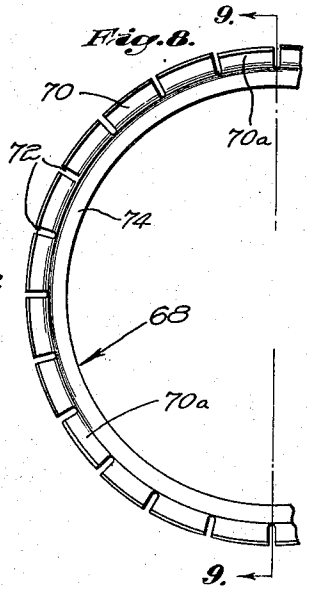
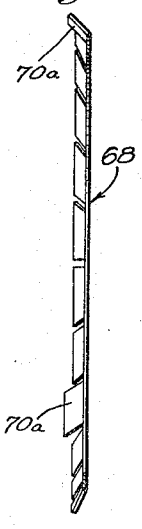


Fig. 9.



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2,550,180

UNITED STATES PATENT OFFICE

2,550,180

SEALING MEANS FOR THE WORK CHAMBERS IN OSCILLATING VANE TYPE FLUID MOTORS

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Application June 19, 1946, Serial No. 677,678

9 Claims. (Cl. 121—38)

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This application relates to improvements in fluid motor means, especially of the type disclosed in the application of John E. Anderson and Arthur N. Allen, Jr., Serial No. 621,224, filed October 9, 1945, and assigned to the assignee of this application. This application is a continuation-in-part of the above-identified joint application of John E. Anderson and Arthur N. Allen, Jr.

The invention relates to sealing means for hydraulic vane motors of the type used in the hubs of variable pitch aircraft propellers.

These motors are usually of the oscillating vane type having an inner cylindrical member provided with outwardly projecting vanes and an outer cylindrical member surrounding the center member and having vanes which project inwardly into the spaces between the stationary vanes. Either the inner or outer member may be fixed and the other movable. This arrangement of vanes is such as to provide a plurality of peripherally arranged chambers between adjacent fixed and movable vanes so that by admitting high pressure fluid into the chamber on one side of each movable vane and venting the chamber on the other side of these movable vanes, rotation of the movable member is effected. The fluid pressures used are very high and as a result great difficulty is experienced in preventing leakage of the actuating fluid past the ends of the movable vanes.

It is an object of this invention to provide improved means for sealing the vane ends in a vane motor of this type. More specifically it is an object of this invention to provide a sealing member at opposite ends of the movable vanes and to provide means for urging these members against the ends of the motor vanes by a fluid pressure which is substantially equal to the actuating pressure in the vane motor chambers.

A further object of the invention is to provide sealing means between the supporting members for the fixed and movable vanes for providing a sealed chamber at each end of the motor, and to provide an annular member in each of these chambers which is acted upon by the hydraulic actuating pressure of the motor in a direction to constantly bear against the ends of the motor vanes.

A further object of the invention is generally to improve the construction and operation of hydraulic vane type motors.

These and other objects and advantages of the invention will be hereinafter more fully pointed out in connection with the accompanying drawings in which one embodiment of the invention is shown for purposes of illustration.

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In these drawings,

Fig. 1 is a longitudinal sectional view taken through the center of the vane motor on the line 1—1 of Fig. 2;

Fig. 2 is a cross sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is a longitudinal sectional view taken on line 3—3 of Fig. 2;

Fig. 4 is a plan view of the sealing member, part of the member being broken away to facilitate illustration;

Fig. 5 is a cross sectional view taken on line 5—5 of Fig. 4;

Fig. 6 is a plan view of an oil seal ring;

Fig. 7 is a cross sectional view taken on line 7—7 of Fig. 6;

Fig. 8 is a plan view of an annular seal spring; and

Fig. 9 is a transverse sectional view taken on line 9—9 of Fig. 8.

As herein shown, a central cylindrical member 10 which constitutes the vane motor center post is seated, with its axis extending radially, on the propeller hub and includes a bottom flange 12. Surrounding and concentric with the member 10 is a generally tubular member 14 having outwardly projecting vanes 16 (Fig. 2). In the motor shown two diametrical vanes 16 are provided, and since the member 14 is attached to the post 10 by splines 18 the vanes 16 constitute the fixed vanes, or hydraulic abutments, of the motor.

The outer rotatable member, or vane barrel, 20 of the motor is journalled at one end, the inner end when mounted on the propeller hub, on the flange 12 in a bearing 22 and is rotatably attached to the interior of the propeller blade shank by vertical splines 24. The barrel 20 has inwardly projecting vanes 26 which are diametrically opposed and extend between and rotate circumferentially with respect to the fixed vanes 16, depending on the flow of oil into or out of annular chambers 28 and 30, through suitable conduits including conduits 32 and 34, under control of the pilot or an automatic governor. The vane barrel 20 also has a recessed end, 34a, the outer end when mounted on the hub, to receive an annular cover member 35 which is screw-threaded at 35a to the post 10, thus forming a cover for the inter-vane chambers of the motor.

Conduits 36 and 38, similar to conduits 32 and 34, are also provided so that by plugging one or the other set of conduits the motor can be used

with left or right rotating propellers. Herein the conduits 32 and 34 are closed by plugs, one of which is shown in elevation at 40 in Fig. 3. The motor shown is therefore adapted to operate a right hand rotating propeller.

The annular chamber 28 communicates through passages 42 and 44 in cylindrical member 14 with the diametrically opposite motor chambers 46 and 48 respectively. The annular chamber 30 communicates through passages 50 and 52 with the diametrically opposed chambers 54 and 56 respectively of the vane motor.

It will be evident that if high pressure fluid is admitted from the annular chamber 30 through passages 50 and 52 into chambers 54 and 56, this pressure fluid acting between the fixed abutments 16 and the movable vanes 26 will result in a rotation of the vane barrel 20 in a clockwise direction as viewed in Fig. 2. During this movement any fluid which may occupy the chamber 46 and 48 will be vented through passages 42 and 44, upper annular chamber 28 and the connecting conduits into the propeller hub. Admission of high pressure fluid through passages 42, 44 to chambers 46, 48 and the venting of chambers 54, 56 will result in a reverse operation of the motor, all in a well-known manner in this art.

The stationary vanes 16 are provided with packings 58 which extend along the outer periphery of the vane and provide a fluid tight seal between the latter and the cylindrical member 20. Packings 58 may be strips of leather or may be moulded or cut from sheets of fabricated material such as rubber or plastics. As shown most clearly in Fig. 2 the seal 58 which is received in an edge recess 60 in the vane, is extended continuously from the outer periphery along the ends of the vane in parallel extensions of recess 60. Movable vanes 26 are similarly provided with packing 62 received in peripheral recesses 64 in the vane.

Many devices have been tried to prevent leakage of the high pressure actuating fluid from the high pressure chambers to the adjacent lower pressure chambers around the ends of the vanes. The fluid pressures used in propeller blade adjusting motors are very high (3000 p. s. i.) and the parts are subject to constant use in service and it has proved difficult to obtain and maintain a seal at this point which will be reliable over a long period of service.

In accordance with the present invention an oil seal ring 66 of triangular cross section is provided between the barrel 20 and the relatively fixed flange 12 to provide a fluid tight seal therebetween. This packing ring is received in an annular recess 67 in the barrel 20 and an annular resilient washer 68 is provided having resilient ears 70 formed by radially inwardly directed slits 72 which bear on the inner oblique surface of the ring 66, certain of these ears 70a being deflected out of the plane of the washer at peripherally spaced points for a purpose later to be explained. The washer 68 has an angularly related flange 74 which overlies the flange 12 of the post member 10. A similar packing ring 66 and annular spring member 68 is provided between the barrel 20 and the annular cover 35.

It will be noted that the vanes 16 and 26 terminate somewhat short of the flange 12 which comprises the bottom of the vane chambers and the cover 35 which forms the top thereof and also that the cylindrical member 14, which is the same length as the vanes, has annular right angled shoulders 69 which lie in the same planes as shoulders 69a formed by recesses 67 and 34a.

In accordance with this invention an annular washer-like plate member 76 is provided over the motor vanes in the annular space between flange 12 and shoulders 69, 69a and a similar annular member 78 is provided over these vanes in the annular space between cover 35 and shoulders 69, 69a at the other end of the vanes. The plates 76, 78 have flat confronting faces 80 which are seated at their inner peripheries on the shoulders 69 at opposite ends of cylindrical member 14 and at their outer peripheries on shoulders 69a formed by recesses 34a and 67 in the barrel 20. End plate 76 and, in turn, members 14 and 78 rest on flange 12 of the center port 10 and are clamped between flange 12 and screw threaded cover 35.

On their remote sides the plates 76 and 78 have annular cut-away portions 82 which receive the flanges 74 of spring members 68. These plates 76, 78 also have oblique inner and outer marginal surfaces, of which the outer oblique surfaces overlie the tabs 70 of the spring members 68 and, by reason of their engagement with tabs 70a, urge the plates 68 against the sealing rings 66. The plates 76 and 78 are thus well supported at their inner and outer peripheries and distribute pressures applied at diametrical points to the ends of all the vanes of the motor. The inner oblique surface of the plate 78 has a packing ring 84 in engagement therewith forming a seal between the post 10 and the cover at the threaded connection 35a.

Pressure in chambers 46 and 48 or 54 and 56 will tend to stretch center post 10 and relieve the clamping action of cover 35 on plates 76 and 78. Thus pressure in chambers 54 and 56, Fig. 2, for example, will deflect plate 76 away from shoulder 69a and, if the center post has been stretched enough by the operating pressure to relieve the clamping action on plates 76 and 78, away from shoulder 69 as well. This will permit fluid to seep past the ends of the vanes 16 and 26 and past the inner and outer oblique peripheries of the plates 76 and 78. This leakage oil is prevented from escaping from the chambers containing the plates 76 and 78 by packing rings 66 and in the case of the plate 76 by the packing ring 66a and in the case of plate 78 by the packing ring 84. As a result, a pressure builds up on the remote sides of these plates which is substantially equal to the actuating pressure in the chambers 54, 56. The segments of the plates 76, 78 which are adjacent the arcuate chambers 54, 56 will accordingly have substantially the same pressures acting on the outer and inner surfaces thereof; but those segments of the plates which cover the arcuate chambers 46, 48 will have substantially no pressure inside and full line pressure outside acting to urge the plates into engagement with the shoulders 69 at the ends of cylinder 14 and the shoulders 69a on barrel 20, as well as against the packing at the ends of the vanes 16 and 26, thus effecting a seal between the several chambers 54, 56, 46 and 48 at the ends of the vanes. It will be noted that there are always two diametrically opposite chambers in which the resultant pressure on the remote side of the plates are acting to urge the plates into sealing engagement, and the forces exerted against the remote sides of these plates at these diametrically opposite segments causes these plates to deflect inwardly and clamps them to the drain chambers 46 and 48, thereby eliminating any inter-chamber

leakage. Hence, it can be seen that each plate is deflected to a rippled or wave form with two high and two low points for providing sources of pressure and sealing surfaces respectively.

It will also be evident that when the motor is reversed and the chambers 54, 56 become the low pressure chambers and chambers 46, 48 become the high pressure chambers the oil pressure on the remote sides of the plates will be maintained in a continuous manner without further seepage past the end of the vanes.

As a result of this invention particularly simple and effective means have been provided for sealing the ends of the motor vanes by which the former objectionable loss of pressure fluid is eliminated at these points. Further, it will be evident that since the sealing function of the sealing member is obtained through the action of the very pressure which operates the motor, this seal is obtained without the danger, which is always present with adjustable packings, of creating friction to such a degree that the motor is unable to operate at the pressure available.

While a single embodiment of the invention has been described herein and illustrated in the accompanying drawings, it will be evident that various changes may be made in the construction and arrangement of the parts without exceeding the scope of the appended claims.

What it is desired to secure by Letters Patent is:

1. A seal for the end of a vane motor comprising a member overlying the inter-vane spaces and the end of a vane, and mechanism for maintaining fluid pressure on the side of said member remote from said vane end substantially equal to the van moving pressure in the vane motor, means including said member providing leak passages for fluid flow from said inter-vane spaces to said remote side, said means and said member forming a closure rendered effective by the pressure on said remote side for blocking fluid flow from said remote side to an inter-vane space.

2. A seal for the ends of an oscillating vane motor having inter-vane spaces at opposite sides of a vane and oscillatable by application of fluid pressure to the inter-vane space at one side of said vane and venting of the inter-vane space at the opposite side of said vane and then application of fluid pressure to the inter-vane space at said opposite side of said vane and venting of the inter-vane space at said one side of said vane comprising, a member overlying said inter-vane spaces and the end of said vane and means for maintaining fluid pressure on the side of said member remote from said vane end substantially equal to the actuating fluid pressure in any inter-vane space of the vane motor, including means cooperating with said member to provide leak passages between the inter-vane spaces and the side of said member remote from said vane end and rendered effective by a preponderance of pressure on said remote side of said member over the pressure in a vented inter-vane space to block the leak passage between said vented space and said remote side of said member.

3. A seal for the ends of the vanes of a vane motor having sets of alternately arranged fixed and movable vanes, said seal comprising a plate overlying the inter-vane spaces and the ends of the several vanes, said plate being movable by motor actuating fluid pressure so that fluid pressure may leak around said plate from the inter-

vane space under pressure to the remote side of said plate to subject the side of said plate which is remote from said vane ends to a pressure substantially equal to the vane moving pressure in the vane motor.

4. A seal for the ends of the vanes of an oscillating vane motor having sets of alternately arranged fixed and movable vanes, a fluid tight chamber at the end of the motor communicating directly with the inter-vane spaces, whereby fluid pressure in said chamber is maintained substantially equal to the vane moving pressure in the inter-vane spaces in said vane motor, a plate disposed in said chamber and having a plane vane end engaging surface and means cooperating with said plate, when the pressure on the remote side of said plate from said vane ends exceeds the pressure in an inter-vane space, to seal said last mentioned inter-vane space from said chamber and prevent bleeding of fluid from said chamber to said last mentioned inter-vane space.

5. In a vane motor, an inner member having outwardly extending vanes, an outer member having inwardly extending vanes, said inwardly and outwardly extending vanes being alternately arranged, a seal for the ends of said vanes comprising a plate overlying the ends of said vanes, abutment means on said inner and outer members forming seals for the inner and outer peripheries of said plate in the plane of said vane ends, vane moving pressure in an inter-vane space of said motor leaking past said plate to the back of said plate so that fluid pressure back of said plate in maintained substantially equal to the vane moving pressure in said motor for urging said plate against said abutments and said vane ends to render the seals effective with respect to an inter-vane space having a pressure less than the vane moving pressure.

6. In a vane motor, an inner member having a set of outwardly projecting vanes, an outer member having a set of vanes projecting inwardly, the vanes of said sets being alternately arranged and one of said members being fixed and the other relatively movable by motor actuating fluid pressure, a closure member for one end of said motor which is spaced apart from the adjacent ends of said vanes, sealing means disposed in the space between said closure member and the ends of said vanes having a confronting surface subjected to the vane moving pressure in some inter-vane spaces and drain pressure in other inter-vane spaces and supported on said inner and outer members in position to engage and seal the adjacent inter-vane chambers against fluid intercommunication at said vane ends, said sealing means being movable to render said seal ineffective over the inter-vane spaces having vane moving pressure therein for maintaining fluid pressure back of said sealing means substantially equal to the vane moving pressure in said vane motor while maintaining said seal effective over the inter-vane spaces containing drain pressure.

7. In a vane motor, an inner member having a set of outwardly projecting vanes, an outer member having a set of vanes projecting inwardly, the vanes of said sets being alternately arranged and one of said members being fixed and the other relatively movable by a fluid pressure difference on opposite sides of the vanes thereof, outer and inner closure members for said motor which are spaced apart from the ends of said vanes, annular plates extending over the

entire ends of said motor having confronting surfaces supported on abutments on said inner and outer members which lie in the same planes as the ends of said vanes, said plates being flexible and flexed by said pressure difference applied on opposite sides thereof so that fluid under pressure may leak around the circumference of said plates from the pressure chamber of said vane motor to the remote sides of said plates whereby fluid pressure is maintained on the entire remote sides of said plates substantially equal to the vane moving pressure in said vane motor.

8. In a vane motor, an inner member having a set of outwardly projecting vanes, an outer member having a set of vanes projecting inwardly, the vanes of said sets being alternately arranged and one of said members being fixed and the other relatively movable by a fluid pressure difference on opposite sides of the vanes thereof, outer and inner closure members for the inter-vane spaces of said motor which are spaced apart from the ends of said vanes, and deformable washer-like members in the spaces between said closure members and the ends of said vanes, supported on said inner and outer members in position to engage the ends of both said fixed and movable vanes, and deformable by said pressure difference applied on opposite sides thereof, and means including said washer-like member for draining fluid from inter-vane spaces under vane moving pressure for maintaining fluid pressure on the opposite sides of said members from said vane ends substantially equal to the vane moving pressure in the vane motor.

9. In a device having oscillating vanes, an inner cylindrical member having a set of outwardly

projecting vanes, an outer cylindrical member having a set of vanes projecting inwardly, the vanes of said sets being alternately arranged and defining inter-vane spaces, one of said members being fixed and the other relatively movable by a fluid pressure difference comprising a motor actuating fluid pressure on one side and a lower fluid pressure on the other side of the vanes of said movable member, a closure member for the inter-vane spaces at one end of said motor, said closure member being spaced from the ends of said vanes to provide an annular chamber at said end, seats on said inner and outer members in the plane of said vane ends, a combined seal and valve member controlling the flow of fluid between said inter-vane spaces and said chamber comprising a flexible plate seating at its inner and outer peripheries on said seats and flexing under said pressure difference to permit flow of motor actuating fluid pressure from an inter-vane space to said chamber but sealing inter-vane spaces having a lower fluid pressure from flow from said chamber or from an adjacent space having motor actuating fluid pressure.

ARTHUR N. ALLEN, JR.

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