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VANE MOTOR CENTER POST LOADING DEVICE

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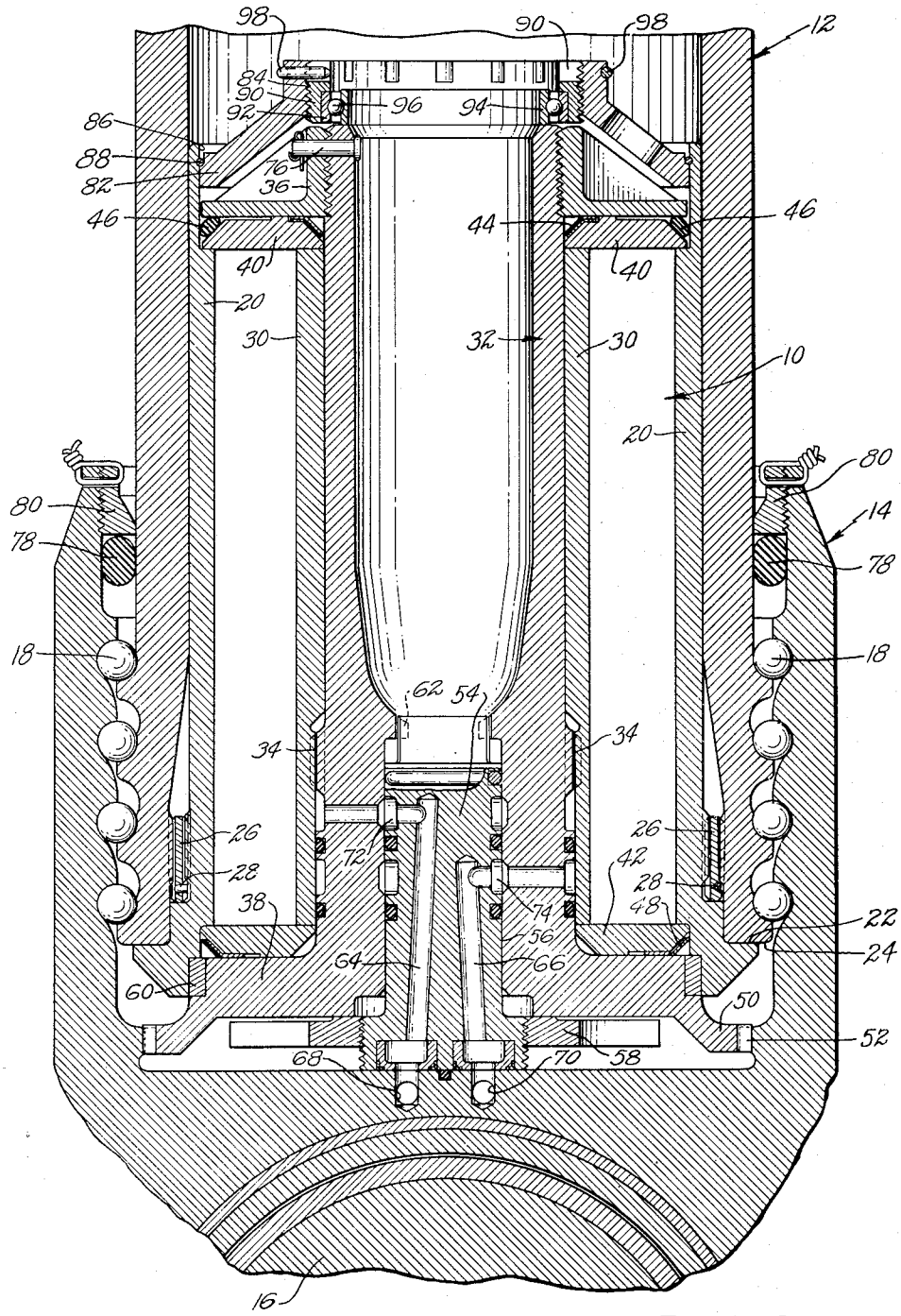

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VANE MOTOR CENTER POST LOADING DEVICE

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This invention relates to the construction of vane motors of the type used in the hubs of variable pitch aircraft propellers having radially extending blades and particularly to a construction for preventing distortion of the centerpost flange of the vane motor.

These vane motors are usually of the oscillating vane type having a stationary 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. The inner cylindrical member is usually secured against rotation onto a centerpost which, in turn, is splined or otherwise secured against rotation to the propeller hub. The outer cylindrical member is usually received in the hollow end of, and secured to, the propeller blade with the longitudinal axis of said cylindrical member extending parallel to the longitudinal axis of the propeller blade.

This arrangement of vanes is such as to provide 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 outer member with respect to the inner 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. This trouble is aggravated by the action of centrifugal force tending to force the motor and the centerpost out of the hub, the centerpost and a portion of the motor being retained in the hub by a flange on the end of the centerpost through which the centrifugal forces are transmitted indirectly to the hub. This causes distortion of the flange overlying the ends of the movable vanes and thus aggravates the leakage conditions.

It is an object of this invention to improve the construction of the vane motor and particularly the support for the vane motor centerpost.

A further object is to prevent distortion of the sealing end plates overlying the vane ends to thereby reduce leakage.

A still further object is to provide an auxiliary support loading means for the vane motor centerpost by which the centerpost is initially preloaded so that centrifugal force acting on the centerpost incident to rotation of the propeller is transmitted to the propeller blade and the hub without passing through the centerpost flange.

These and other objects and advantages of the

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invention will be hereinafter pointed out in connection with the accompanying drawings in which one embodiment of the invention is shown for purposes of illustration.

In the drawings the single figure is a longitudinal sectional view taken through the center of the vane motor and showing it installed in a propeller blade on a hub.

As herein shown, the vane motor indicated generally at 10 is supported in the hollow shank of a propeller blade 12 which blade, in turn, is supported in a hub 14. Hub 14 is mounted in a well-known manner, on a shaft 16 which is driven by an aeronautical engine not shown. Propeller blade 12 is supported in hub 14 by means of ball bearings 18 to provide for rotation of the propeller blades about their longitudinal axis to effect pitch change of the propeller blades. These ball bearings also hold the propeller blade in the hub against the action of centrifugal force produced by rotation of the propeller with the shaft 16. As shown, the shank of the propeller blade 12 is hollow and receives the vane motor 10. The outer cylindrical member 20 of the vane motor has an outstanding flange or shoulder 22 which seats against the inboard end 24 of the propeller blade and holds member 20 against outward movement under the action of centrifugal force. Member 20 is secured against relative rotation with respect to blade 12 by a splined ring 26 which has external splines mating with internal splines on the propeller blade and has internal splines mating with external splines on member 20. A snap ring 28 received in a groove in ring 26 secures the ring in position against the action of centrifugal force. The inner cylindrical member 30 which carries the outwardly directed vanes is arranged concentric with and inside of member 20 and is supported on a centerpost 32. Intermeshing splines 34 prevent relative rotation of the centerpost and member 30.

Centerpost 32 serves as a through-bolt for holding the various parts of the vane motor in assembled relation and comprises a hollow cylindrical center portion threaded at the outer end to receive a retaining flange 36 and an outwardly directed flanged portion at the inboard end to form retaining flange 38. Retaining flanges 36 and 38 overlie members 20 and 30 the ends of the vanes carried thereby and the sealing plates 40 and 42 located between the flanges and the vane ends. The construction, purpose and operation of the sealing rings is more specifically described in the application of Arthur N. Allen, Jr., Serial No. 677,678, filed June 19, 1946, now

Patent No. 2,550,180, to which reference may be made for further more detailed explanation.

Packing of any suitable material indicated at 44, 46 and 48 serves to prevent the escape of the pressure operating fluid from between the vanes to the outside of the motor and to retain pressure between the sealing rings and the flanges 36 and 38 to hold the sealing rings onto, and in sealing relation with, the vane ends.

An extension 50 on the flange 38 carries splines 52 which mesh with mating splines in the hub 14 to hold the centerpost 32 against relative rotation with respect to the hub.

A plug 54 received in a longitudinal bore 56 in the centerpost 32 is threaded at its inboard end to receive a nut 58. Nut 58 acting against the inboard end of centerpost 32 forces plug 54 inwardly toward hub 14 to force the centerpost outwardly as the nut is threaded onto the plug 54. A bearing ring 60 acts as an abutment to rotatively connect centerpost 32 with outer cylindrical member 20 and prevent outward movement of centerpost 32 with respect to outer cylindrical member 20, and transmit the centrifugal force of the centerpost 32 from the flange 38 to the flange 22 of outer cylindrical member 20 thence to the inboard end of the blade 12 and thence through the ball bearing 18 to the hub 14. The plug 54 is splined at its outer end to engage mating splines 62 in the interior of the centerpost 32 to prevent relative rotation of the plug 54 and the centerpost 32 especially while nut 58 is being tightened and to the position the plug with respect to the centerpost. Plug 54 is drilled to provide passages 64 and 66 leading to adjacent chambers in the vane motor. Passages 64 and 66 connect with passages 68 and 70 in the propeller hub which, in turn, connect with control mechanism, not shown, which may be either a manual control or an automatic control such as would be provided by a governor for controlling the propeller speed by varying the propeller pitch. Suitable packings are provided to render the joint between the plug 54 and the hub 12 fluidtight. Passages 64 and 66 lead to annular recesses 72 and 74 respectively from which leads are taken through the centerpost 32 and the inner cylindrical member 30 to adjacent chambers in the vane motor.

The flanged member 36 which is threaded onto the outboard end of centerpost 32 provides a flange for holding the inner and outer cylindrical members 30 and 20 and the sealing end plates 40 and 42 onto the centerpost 32. Flange member 36 is threaded onto the centerpost until the vane motor elements are all snugly held together. A pin 76 passing through both the centerpost 32 and flange member 36 holds flange 36 in position.

Suitable packing 78 retained by a nut 80 suitably locked in position serves to prevent leakage of lubricating or other fluid from the interior of the hub barrel past the propeller blade.

The structure thus far described is the vane motor construction on which the improvement of this application is to be applied. In the vane motor thus far described all the centrifugal force produced by rotation of the centerpost 32 and the parts supported thereby has to be transmitted to the hub barrel through flange 38. This force has been found to be great enough to cause deflection of the flange 38 sufficient to cause distortion of the sealing end plate 42 and displacement of sealing end plate 40 and hence cause leakage past these sealing end plates. This force has also caused wear of the rotative abutment of bearing ring 60 and cylindrical member 20 sufficient to cause axial misalignment of parts and resulting in leakage.

In order to prevent this deflection and wear and its resultant leakage, applicant invented the structure about to be described. A cylindrical member 82 having a threaded axially extending bore 84 extending therethrough has its outer periphery fitted to a cylindrical surface 86 provided on the inner surface of an outboard extension of the cylindrical outer member 20. A snap ring 88 seated in a groove in surface 86 prevents outward movement of cylindrical member 82. A castellated threaded ring 90, threaded on the outside to mate with threaded bore 84, carries on its inner surface a ball bearing comprising outer race 92, inner race 94 and ball bearing 96, the outer race 92 being received in a groove in member 90.

When the vane motor is assembled on the centerpost and members 30, 32, and the threaded ring 90 are also assembled, the inner race 94 is arranged in axial alignment with the outer end of centerpost 32, so that threading the member 90 inwardly towards the centerpost will cause inner race 94 to contact the end of centerpost 32, forcing it inwardly and preloading the centerpost. After centerpost 32 has been sufficiently preloaded, members 82 and 90 are locked against relative rotation by snap ring 98. The resulting outward thrust of member 82 is transmitted through the outer cylindrical member 20 and its vanes to the sealing end plate 40, to member 36, and through threads to centerpost 32. When the vane motor is assembled in the blade 12, and the blade into hub 14 by means of ball bearings 18, preloading plug 54 is forced inwardly by means of nut 58, thus exerting an outward force on vane motor centerpost 32. When the propeller is rotating, the combination of the centrifugal force of the centerpost 32 and the outwardly directed force exerted by nut 58 is transmitted to the inner race 94 thru member 82 and ring 88 to cylindrical member 20 then through flange 22, to the blade 12, ball bearing 18 and eventually to the hub 14. The combination of the centrifugal force and outwardly directed force exerted by nut 58 applied on inner race 94 replaces the original preload developed by screwing in member 90 and thus relieves the force between the vanes of member 20 and the seal end plate 40 and replaces this force with one carried through member 20, flange 22, blade 12, ball bearings 18 to hub 14. Thus if the original preload developed by tightening member 90 is equal to the combination of centerpost centrifugal force and outwardly directed force exerted by nut 58, this combination will completely relieve the original preload force between the vanes of the outer cylindrical member 20 and sealing end plate 40 and no force will be carried by bearing ring 60 against the flange 22 of outer cylindrical member 40. All centrifugal force will then be carried through bearing inner race 94 to blades 12 and thence to hub 14. Thus the centrifugal force will not distort flange 38 and seal end plate 42 and the fluid sealing in this region will be improved. Since the force on ring 60 is relieved, wear at the contact surface between ring 60 and flange 22 of outer cylindrical member 20 will be greatly reduced thus maintaining the axial relationship of centerpost 32 and the inner and outer cylindrical members 30 and 20 respectively (including their vanes) thereby

greatly improving the sealing of pressure fluid at the vane ends.

In other words, by use of the member 82 the outer cylindrical member 20 is placed under tension while the centerpost 32 will have a force acting inboard imposed thereupon. This inboard force on centerpost 32 is somewhat opposed by the preloading force which is applied by the blade preload nut 58. Hence any centrifugal force created during propeller rotation will tend to add to this compression resulting in transmitting such loads to the blade shank and hub directly through the outer cylindrical member 20.

As a result of this invention particularly simple and effective means have been provided for improving the sealing of the ends of the motor vanes by preventing distortion and bearing wear resulting from the action of centrifugal force on the centerpost thus preventing an objectionable loss of pressure fluid which at some times occurred under some operating conditions of the propeller.

While a simple 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 specific 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. In combination, in a propeller rotatable about an axis including a hub having variable pitch blades carried thereby, a vane motor having its longitudinal axis extending radially of the axis of rotation of said propeller and carried by each of said blades, a centerpost for said vane motor having a flanged supporting member on the inboard end thereof operatively engaging said blade to limit outward radial movement thereof relative to said blade, means at the outboard end of said centerpost connecting said centerpost with the propeller blade independent of said flanged supporting member and including adjustable means operatively engaging said blade for forcing said centerpost in an inboard direction and transmitting centrifugal force from said centerpost to said blade independent of said flanged supporting member.

2. In combination, in a propeller rotatable about an axis including a hub having variable pitch blades carried thereby, a vane motor extending along the axis of each of the propeller blades including relatively movable members, one of said members being fixed for pitch changing movements with the propeller blade and the other of said members being fixed against movement about the blade axis relative to said hub, said one member being fixed against outer radial movement relative to said blade, said other member having a flanged supporting element on the inboard end thereof in sealing engagement with said one member, and means at the outboard end of said other member including a bearing connection for transmitting centrifugal loads in said other member to said blade independently of said flanged supporting element.

3. In combination, in a propeller rotatable about an axis including a hub having variable pitch blades carried thereby, a vane motor extending along the axis of each of the propeller blades including relatively movable members, one of said members being fixed for pitch changing movements with the propeller blade and the other of said members being fixed against movement about the blade axis relative to said hub, said one member being fixed against outward radial movement relative to said blade, said other member having a flanged supporting element on the inboard end thereof in sealing engagement with said one member, and means at the outboard end of said other member including a bearing connection for transmitting centrifugal loads in said other member to said blade independently of said flanged supporting element and screw mechanism for axially adjusting said bearing means.

4. In combination, in a propeller rotatable about an axis including a hub having variable pitch blades carried thereby, a vane motor extending along the axis of each of the propeller blades including relatively movable members, one of said members being fixed for pitch changing movements with the propeller blade and the other of said members being fixed against movement about the blade axis relative to said hub, said one member being fixed against outward radial movement relative to said blade, said other member having a flanged supporting element on the inboard end thereof in sealing engagement with said one member, and means at the outboard end of said other member providing a connection between said members whereby said members are fixed against relative movements axially of said blades and free for relative movement about said blade axis including bearing means for transmitting centrifugal loads from said other member to said blades and hub independently of said flanged supporting element.

5. In combination, in a propeller rotatable about an axis including a hub having variable pitch blades carried thereby, a vane motor extending along the axis of each of the propeller blades including relatively movable members, one of said members being fixed for pitch changing movements with the propeller blade and the other of said members being fixed against movement about the blade axis relative to said hub, said one member being fixed against outward radial movement relative to said blade, said other member having a flanged supporting element on the inboard end thereof in sealing engagement with said one member, and means for maintaining said flanged element in undeflected and in continued sealing engagement with said other member when centrifugal loads are imposed upon said members including means interconnecting said members at their outboard ends for maintaining them fixed against relative movement along the blade axis.

6. A combination according to claim 5 wherein said interconnecting means includes bearing means for permitting substantially free relative motion between said members about said blade axis.

7. In combination, in a propeller rotatable about an axis including a hub having variable pitch blades carried thereby, a vane motor extending along the axis of each of the blades including coaxial spaced relatively movable members, one of said members being fixed for pitch changing movements with the propeller blade and being fixed against outward radial movement relative to said blade, the other of said members having a flanged supporting element on the inboard end thereof in sealing engagement with said one element and a flanged adjustable element on the outboard end thereof in sealing engagement with said one member for closing the space between said members, cooperating means responsive to fluid under pressure for relatively rotating said members, fluid passage means

in said other member for directing fluid to said space including cooperating passages in said hub, and means at the outboard end of said members providing a connection between said members whereby said members are fixed against relative movement along their axes and are free for relative movement about their axes including bearing means for transmitting centrifugal loads from said other member to said blades and hub independently of said flanged elements and means for adjusting said connecting means.

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