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PROPELLER TORQUE UNIT CONSTRUCTION

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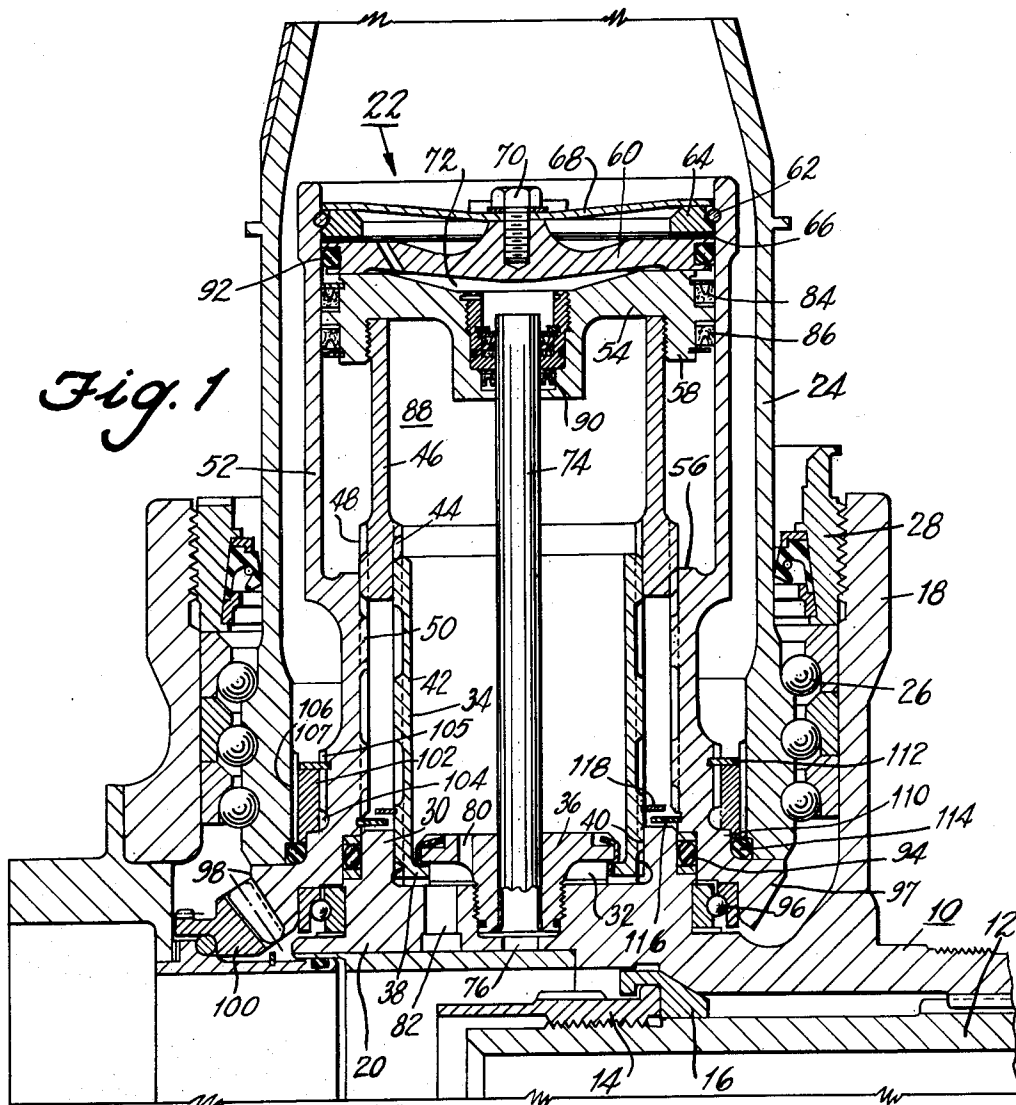


Fig. 1

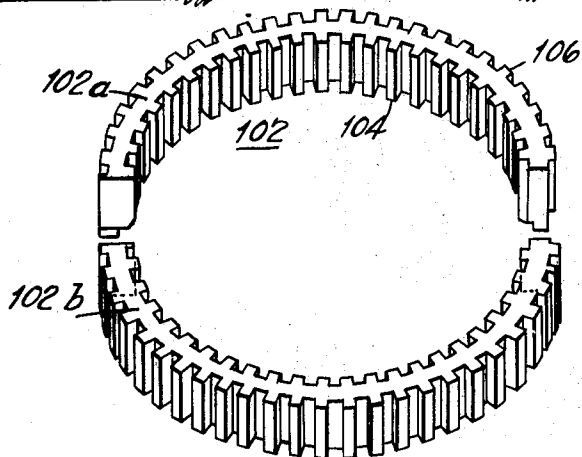


Fig. 2

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PROPELLER TORQUE UNIT CONSTRUCTION

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The present invention pertains to fluid pressure operated motors, and more particularly to servo-motors for adjusting the pitch position of a propeller blade.

Heretofore it has been a difficult and tedious task to adjust the stroke of the piston within the cylinder of a torque unit construction as disclosed in Patent No. 2,307,101, Blanchard et al. Moreover, it has become apparent that some means must be provided for increasing the piston area to enable the use of lower pressure potentials for actuating the servo-motor. Accordingly, among my objects are the provision of a servo-motor including means for adjusting the stroke of the piston; and the further provision of a servo-motor including means for increasing the effective area of the piston so as to reduce the pressure potentials required to actuate the servo-motor.

The foregoing and other objects are accomplished in the present invention by providing a cylinder having a stepped bore, the smaller diameter portion of which is operatively connected to the hollow shank portion of a propeller blade by means of a split indexing ring. Specifically, the servo-motor includes a reciprocable piston disposed in the larger diameter portion of the cylinder, the piston being operatively connected through helical splines to a fixed portion of a propeller hub. The piston is also operatively connected to the cylinder by means of helical splines, the construction and arrangement being such that linear movement of the piston will impart rotation to the cylinder. Rotary cylinder movement is, in turn, transferred to an enclosing blade by means of the split indexing ring, the blade being rotatably supported within a radially extending socket of the hub. The angular relationship between the blade and the hub is controlled by the selected matching of the helical working splines in the servo-motor, and the straight splines of the indexing ring. With this construction it is possible to accomplish predetermined blade angle settings within fairly small fractions of a degree.

Mechanical stops are incorporated in the servo-motor for limiting the travel of the piston within the larger diameter portion of the cylinder. The present invention contemplates the use of an adjustable head assembly for the larger diameter portion of the cylinder to enable the stroke of the piston to be adjusted without necessitating the disassembly of the entire servo-motor. The use of the split indexing ring facilitates the provision of a larger diameter cylinder portion which is traversed by the piston and thereby enables the use of lower pressure potentials to sustain the twisting moments on the blade which tend to move the blade to a predetermined pitch position. It is to be understood that the exterior dimensions of the cylinder are limited by the size of the enclosing propeller blade, and by employing a torque unit of the instant design in a propeller blade of a given size, it has been discovered that the requisite pressure potentials can be reduced as much as 30%.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred embodiment of the present invention is clearly shown.

In the drawing:

Fig. 1 is a longitudinal sectional view of a propeller

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hub and the fluid pressure motor means for actuating a blade rotatably mounted within the support.

Fig. 2 is a perspective view of an indexing ring used in the construction.

With particular reference to the drawing, a propeller hub 10 is shown mounted on a hollow propeller shaft 12 by means of a spline connection, the hub being retained on the shaft by means of a nut 14 and a wedge ring 16. The hub 10 includes a plurality of radially extending blade sockets 18, the blade sockets being concentric with a boss 20, only one socket being depicted in Fig. 1. A reversible fluid pressure operated servo-motor 22 is disposed within the hub socket. The servo-motor 22 is enclosed by the hollow shank portion of a propeller blade which is supported by bearings 26 within the socket 18, the bearings 26 being retained by a ring nut 28. The boss 20 is located at the bottom of the socket 18 and terminates in an annular flange 30 concentric with the socket. The annular flange 30 forms a cup-like recess 32 within which a fixed sleeve 34 is retained by means of a screw device 36, which threadably engages the boss and forces a flange 38 of the fixed sleeve 34 against the bottom of the recess. The inside of the flange 30 and the outside of the sleeve 34 are complementarily straight splined as at 40 to prevent rotation of the sleeve 34 relative to the boss 20. The exterior of the sleeve 34 is provided with helical splines 42 that engage interior helical splines 44 of a piston skirt 46 which also has exterior helical splines 48 engageable with interior helical splines 50 on the inside of a step bored cylinder sleeve 52.

The length of the larger bore of the cylinder sleeve 52 is traversed by a piston head 54 secured to the skirt 46. One stop or limit of such movement, the inboard limit, is provided by an annular shoulder 56 at the step of the cylinder bore which is engaged by the end of flange 58 depending from the piston head 54. The other stop or limit of the piston movement, the outboard limit, is determined by a cylinder head 60 supported within the outboard end of the cylinder 52 by a snap ring 62. A spacer 64, seating against the snap ring 62, and a selective number of shims 66, disposed between the ring 64 and the outer edge of the cylinder head 60, are employed to position cylinder head 60. A star spring 68 engages the snap ring 62 and is held in place with respect to the cylinder head 60 by a cap screw 70.

Though the piston head 54 may engage the head 60 as an outboard stop, chamber 72 is always in communication with a transfer tube 74. The piston head 54 slides along tube 74 toward and from the screw 36 which secures one end of the transfer tube to the boss 20. The tube 74 communicates with a fluid channel 76 leading to apparatus, not shown, for controlling the flow of fluid into and out of the chamber 72. The inboard chamber 88 of the torque unit is connected by openings 80 in the screw 36 that communicate with another fluid passage 82 provided by the support 10 and thence connected to the same control apparatus. Fluid under pressure may also penetrate the spline connections 40, 42, 44, 48, 50 to be applied on the under side of the piston head.

Fluid seal assemblies 84, 86 carried by the piston head 54 prevent cross flow of fluid pressure between the outboard chamber 72 and the inboard chamber 88. The piston head 54 also carries a seal assembly 90 to prevent fluid flow between the chambers around the outside of transfer tube 74. A high pressure seal 92 carried by the cylinder head 60 prevents leakage at the outboard end of the cylinder 52 while a seal assembly 94 prevents leakage at the inboard end of the cylinder, which is supported for rotation about the boss 20 by a bearing 96. The cylinder sleeve 52 includes a flange 97 having a tooth segment 98 that meshes with a master gear 100 that meshes in like relation with other blade gears of the hub, not shown.

The coupling connection between the cylinder 52 and blade 24 is accomplished by a split indexing ring 102 that has a splined connection with the outside of a cylinder 52 at 104, 105 and a splined connection with the inside of the blade 24 at 106, 107. Indexing ring 102 is split into two sections 102a and 102b thereby facilitating assembly of the torque unit, inasmuch as the indexing ring has a diameter smaller than that of the larger diameter portion of cylinder 52. This construction permits the use of a larger diameter piston thereby reducing the unit area pressures required to effect reciprocable movement of the piston for a given size blade. The indexing ring also permits adjustable angular relations between the blade and cylinder by having a different number of splines engaging the cylinder from the number engaging the blade. One spline relation found to be satisfactory includes 88 splines on the inner series 104 as compared with 101 on the outer series 106. The spline sections 102a and 102b are retained against movement axially of the assembly by means of a shoulder 110 at the bottom of the sleeve 52 and by means of snap ring 112 seated across the top end of splines 105. This connection affords retention of the indexing ring when the blade 24 is pulled from the socket after removing the nut 28. A seal ring 114 is disposed between the index ring 102 and flange 97 of the cylinder. At the same time dislodgment of the cylinder 52 from its preload bearing 96 is prevented by an internal snap ring 116 at the end of the cylinder splines 50 that underlie a snap ring 118 on the exterior of the fixed sleeve 34.

Usually, a suitable amount of adjustment for indexing of the blade can be accomplished by setting the ring 102 in an advanced or retarded position between the cylinder 52 and the blade 24. Primarily, the initial indexing, or orientation as it may be called is satisfactorily accomplished by selection of the matings of the splines 42, 44 and 48, 50, according to the procedure taught by Martin 2,500,692. That is accomplished by removal of the cylinder head 60 which gives access to the piston head for making the selective engagement of the splines. Thus, the low pitch angle and the high pitch angle between which the blade 24 may move is determined by the working splines 42, 44 and 48, 50 algebraically added to the indexing splines 104, 105 and 106, 107. By advancing one spline engagement and retarding one or more of the other spline engagements, very small changes in the two limit angles may be accomplished. In so doing the entire range of blade angle change is shifted a small amount, by which the limit stops are both shifted one way or another at the same time.

With the range of movement remaining the same the step position at one end of the range, namely, the feather regime, may be altered by changing the spacing between the cylinder head 60 and the retaining ring 62. Selection of shims of different thickness at the point 66 will alter the position of the outboard stop, and hence change the critical setting for the relation between the blade 24 and the support 10. That adjustment will shorten or lengthen the range of movement between the low angle and the high angle. When the adjustment has been made and the retaining means replaced the blade 24 is then telescoped over the fluid pressure unit 22 and rotated around the same to engage the indexing ring 102 for the angle setting desired. That angle setting is selected by shifting the ring 102 in an advance or retard direction with respect to the respective splined teeth of the cylinder or blade or both. On the other hand that setting may involve advance with relation to one and retard with relation to the other. As an example, by advancing the ring 102 through seven teeth of the splines 104—105 and retarding through eight teeth of the spline 106, 107 will give a total change of plus .118 part of a degree.

During operation of the servo-motor the piston sleeve 46 reacts against the fixed spline sleeve 34 to produce a rotary motion of the stepped sleeve 52, which by its

coupling through ring 102 imparts rotary movement to the blade 24. This result is achieved by reason of the engaged helical splines of the skirt 46 and the sleeves 34 and 52. The range of piston movement is shortened or lengthened with respect to shoulder 56 by means of the spacer 64 and shim 66. After the sleeves 52, 34 have been indexed, the split ring 102 translates all the movement in the piston to rotation of the blade 24. The finite position of the blade due to the outward movement of the piston 54 can be altered by adding or subtracting one or more of the shims 66.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In a blade pitch changing device for aircraft, a support providing a socket, a blade rotatably supported in said socket for angular movement to and from a definite position critical to the operation of the aircraft, means providing a cup-like boss concentric with said socket, reversible fluid pressure motor means reacting against said boss for rotating the blade relative to the socket, said motor means comprising a sleeve mounted within the cup-like boss, a cylinder of stepped bore mounted for rotation about said boss and thereby concentrically spaced from said sleeve, a fluid pressure operated piston movable within said stepped cylinder and having a skirt portion telescopically movable in said concentric spacing, helical spline connections coupling said piston skirt with said sleeve and said cylinder whereby lineal movement of the piston effects rotary motion of said stepped cylinder, a removable cylinder head within the open end of said cylinder, a snap ring and spacer cooperating with the stepped cylinder for maintaining the cylinder head in position, inboard stop means provided by the stepped cylinder and piston head for marking one end of the range of blade movement, an outboard stop provided by said cylinder head and piston head for marking the definite position of said blade, and means for adjusting the definite position to the critical value including shims disposed between the cylinder head and spacer ring, said stepped cylinder having a set of locating splines exterior thereof, and means coupling said stepped cylinder in driving relation with the blade including a split ring having interior and exterior splines selectively engageable with the exterior splines of said stepped cylinder and interior splines provided by said blade.

2. In combination with a propeller blade having a hollow root portion rotatably supported within a propeller hub, a torque unit for effecting rotation of the blade relative to the hub comprising a cylinder having disposed therein a reciprocable piston, means supporting said cylinder for rotation relative to said hubs, means interconnecting said piston and said cylinder whereby piston reciprocation will effect rotation of said cylinder, and coupling means connecting the cylinder and the blade including indexing means having selective splined engagement with the outside of said cylinder and the inside of said blade root portion, said indexing means comprising a split ring, said ring having different numbers of teeth engaging the cylinder and the blade root portion.

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