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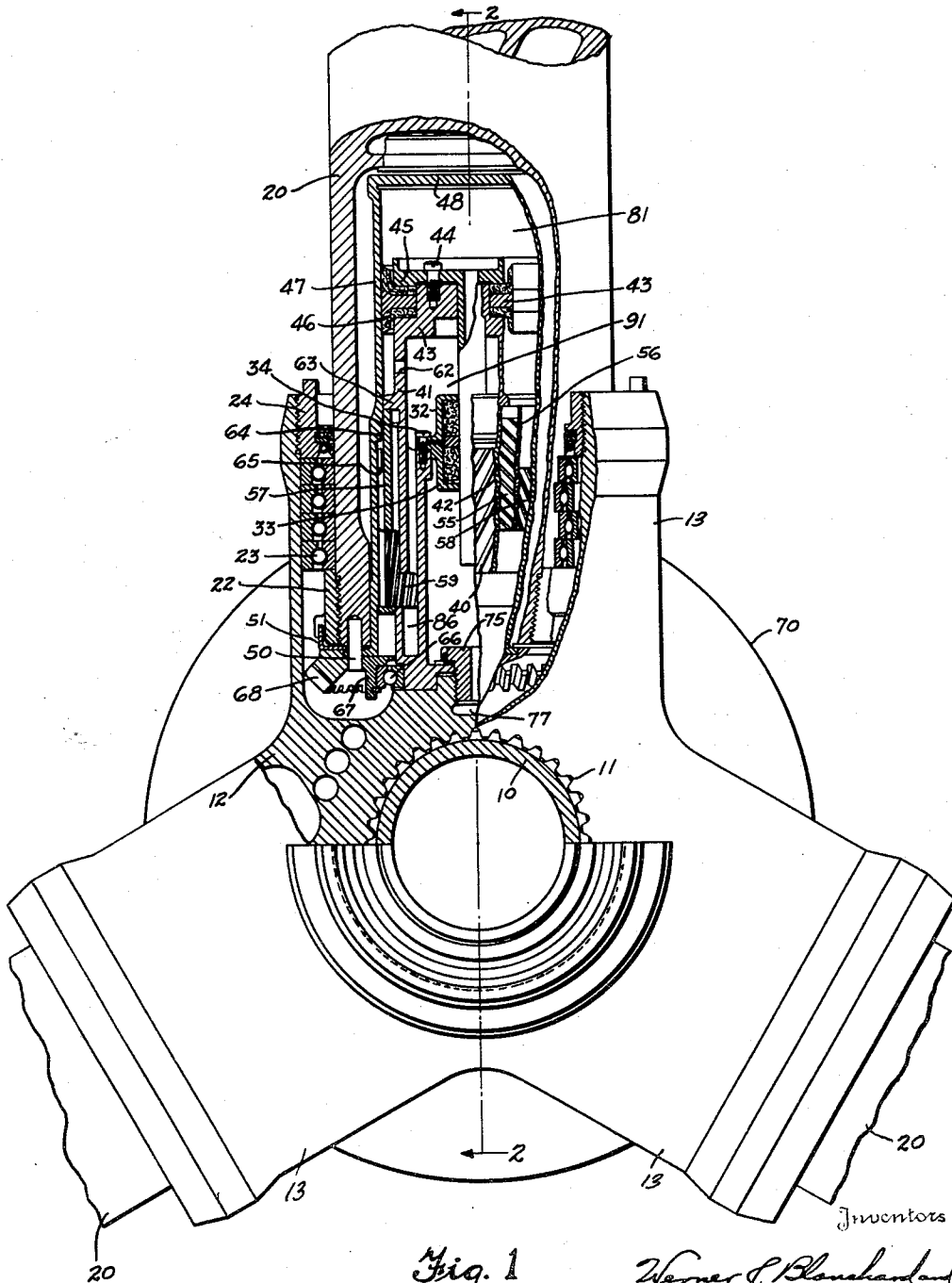
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2,307,101

PROPELLER MECHANISM

Filed June 16, 1939

3 Sheets-Sheet 1



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PROPELLER MECHANISM

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3 Sheets-Sheet 2

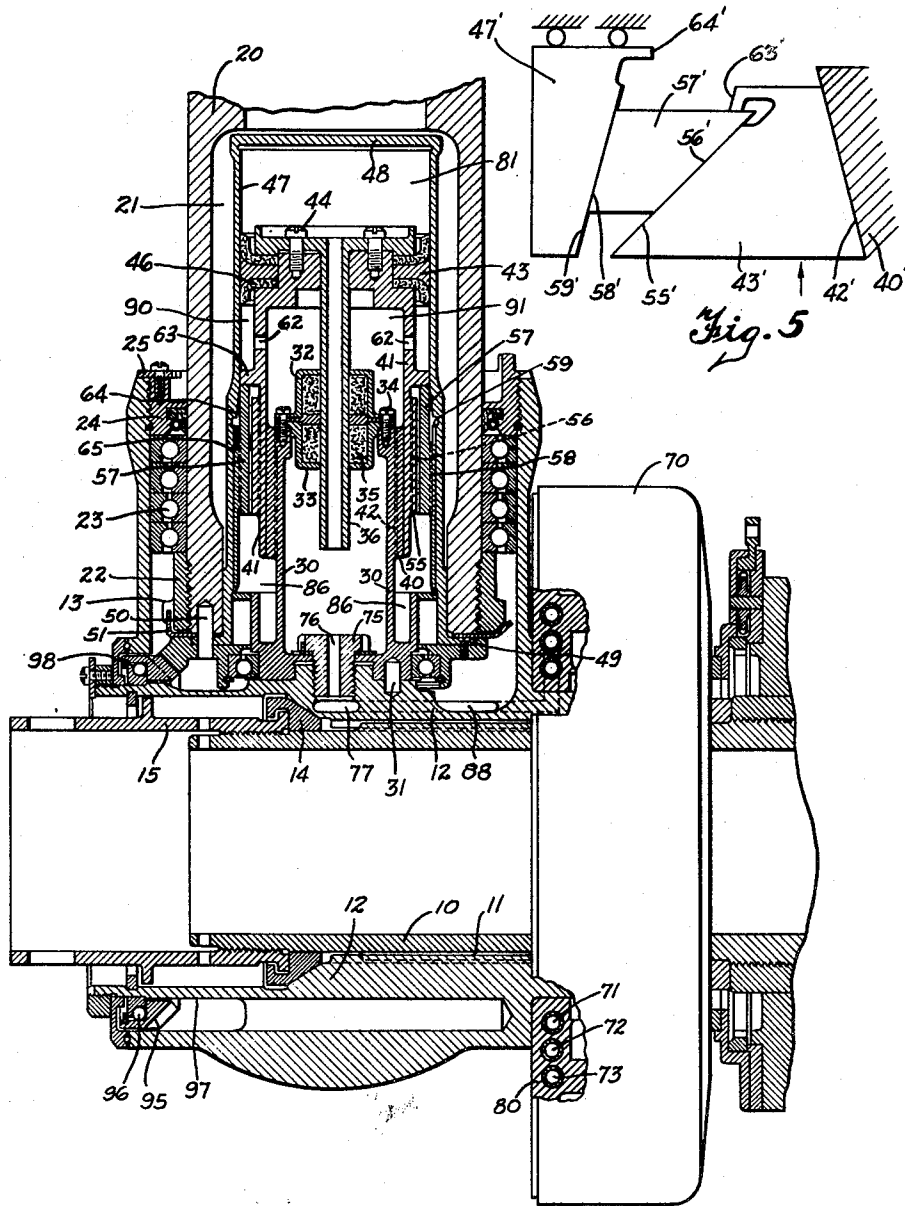


Fig. 2

Fig. 5

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3 Sheets-Sheet 3

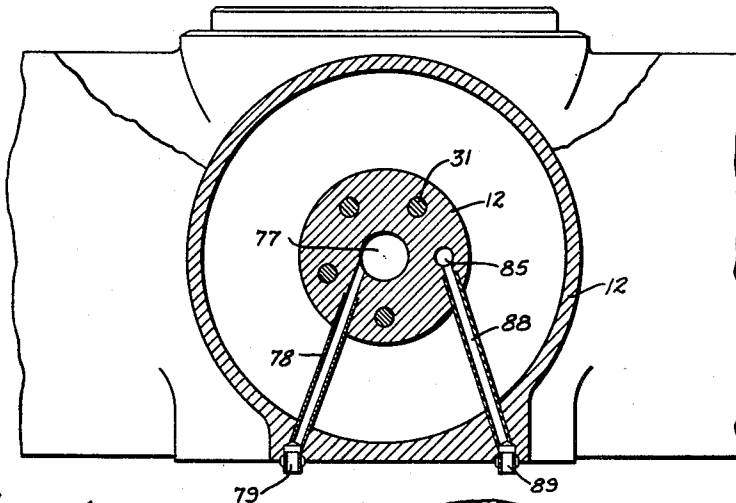


Fig. 4

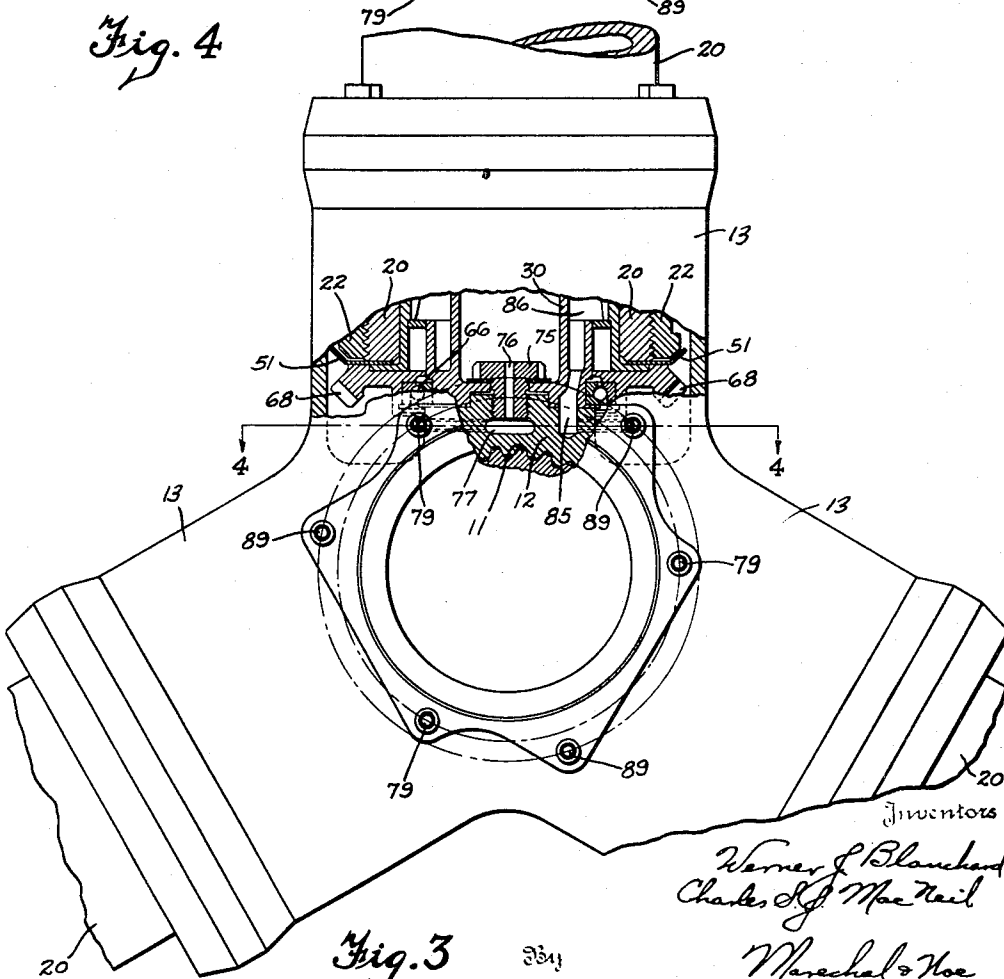


Fig. 3

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UNITED STATES PATENT OFFICE

2,307,101

PROPELLER MECHANISM

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Application June 16, 1939, Serial No. 279,530

18 Claims. (Cl. 170—163)

This invention relates to propellers and more particularly to propellers having hydraulically adjustable blades.

It is a principal object of the invention to provide a propeller having hydraulically adjustable blades which is simple in construction and in which the blades are adjustable both rapidly and accurately over a wide range of positionings, such as from a negative pitch position to a feathered position.

It is a further object to provide a propeller of this character in which the blades are held in a predetermined operating position through the normal range of flight positions against the action of the centrifugal forces to which the propeller is subjected, and are actuated in both pitch-increasing and pitch-decreasing directions by selectively applied hydraulic pressure.

It is a still further object to provide a propeller of this character in which the mass of the operating parts and forces encountered in use are distributed around the periphery of the blade to avoid excessive localized loads and unbalanced centrifugal forces.

It is a further object to provide an adjustable propeller blade which is relatively slowly and accurately adjustable as to its angular positioning over the normal working range of the blade and which is more rapidly movable from the working range into a feathered position to provide for securing rapid and accurate overall adjustment.

It is also an object to provide such a propeller in which the actuating mechanism is located within the propeller hub out of alignment with the driveshaft, leaving the driveshaft clear for the purpose of firing projectiles or the like there-through.

Other objects and advantages will be apparent from the following description, the accompanying drawings, and the appended claims.

In the drawings—

Fig. 1 is an end elevational view of a propeller hub constructed in accordance with the present invention, certain of the parts being broken away to more clearly show the construction;

Fig. 2 is a vertical sectional view through the axis of one of the blades on the line 2—2 of Fig. 1;

Fig. 3 is a broken end elevational view of the hub with parts broken away and showing the opposite end from that shown in Fig. 1;

Fig. 4 is a horizontal section through the blade socket on the line 4—4 of Fig. 3 showing the connection; and

Fig. 5 is a diagrammatic view illustrating the

combined rapid and slow speed adjustment for the angular positioning of the blades.

Referring to the drawings which show a preferred embodiment of the invention, a hollow driveshaft is shown at 10 and is provided with the usual spline 11 for receiving and driving the main hub 12, which has a cooperating spline connection. The hub is formed integrally with the blade sockets 13 in the number desired, illustrated in the drawings as comprising three such sockets. The hub is retained in proper position upon the shaft by means of a wedge ring 14 and a locking nut 15 threadedly received upon the end of the shaft.

The blades are shown at 20, and as illustrated in Fig. 2 comprise a hollow root portion 21. The inner ends of the blades are received within the sockets 13, and retained therein in rotatably adjustable position against the outward centrifugal force. The means for so retaining the blades comprises a clamping ring 22 threadedly received upon the shank of the blade 20 and having bearing engagement upon a series of ball bearings 23 surrounding the blade, and in turn retained in position within the blade sockets by means of a retaining nut 24 threaded into the socket. Provision is made for adjusting and for fastening the nut in predetermined position in the usual way through the use of a locking member 25 fastened to the retaining nut and cooperating with one of a series of notches formed in the outer periphery of the blade socket. This construction provides for retaining the blade in the socket while providing for the angular movement and adjustment thereof with respect to the socket.

In order to effect rotation of the blades in their sockets to adjust the pitch angle thereof, each blade in the hollow root portion 21 thereof is provided with hydraulic actuating mechanism. This mechanism as shown comprises a stationary cylindrical member 30 which is pinned fast to the hub 12 centrally of the blade by means of dowel pins 31, and extends radially outwardly thereof into hollow portion 21. At its outer end this sleeve carries a pair of clamping rings 32 and 33 which are bolted at 34 to the end of the sleeve, and which are provided with packing material 35 therebetween. The clamping rings 32 and 33 are provided with coaxial passages for receiving a tubular piston rod 36 which extends there-through, the construction thus described providing for the movement of the piston rod through the clamping means in fluid sealed relation with respect thereto.

Member 30 is provided on its outer periphery with spirally arranged spline teeth 40 having a relatively small angle of lead. Operatively engaged therewith is a piston skirt or sleeve member 41 having cooperating spline teeth 42 upon its inner periphery, having the same helix angle as teeth 40 to provide for intermeshing engagement therebetween. The skirt member 41 is formed integrally with and as an extension of the weighted piston head 43. The piston rod 36 is bolted to the piston head by means of bolts 44 passing through an outwardly projecting flange 45 formed integrally with the piston rod. Suitable flexible members or cups 46 are likewise carried by the piston for sealing engagement with the wall of the cylinder 47.

The cylinder 47 also received within the hollow blade root is closed at its outer end by means of wall 48, and at its inner end is provided with an outwardly turned flange 49 which engages over the end of the blade root 20, being pinned thereto by means of pins 50 so that the cylinder 48 is caused to rotate along with the blade. Suitable fluid sealing means 51 is provided to prevent loss of fluid pressure from the interior of the cylinder.

In order to effect rotation of the cylinder 47 in response to movement of piston 43 radially of the propeller axis, and to secure both rapid and accurate positioning of the blade, use is made of an interconnecting means effective between the piston and the cylinder to give the desired degree and accuracy of control. As already described, the skirt 41 of the piston is provided with helical spline teeth 42 upon its inner periphery for engagement with helical spline teeth 40 formed upon the stationary member 30. The outer periphery of the skirt 41 is likewise provided with helical spline teeth 55 which operatively engage with helical spline teeth 56 formed upon the inner periphery of a floating spline member 57. The helix angle of teeth 55 and 56 is the same, but is preferably of a greater angle of lead than that of teeth 40 and 42, the purpose of which will be described hereafter. Floating spline member 57 likewise has helical spline teeth 58 formed upon its outer periphery which engage with helical spline teeth 59 formed upon the inner periphery of the cylinder 47. Teeth 58 and 59 have the same angle of lead, which is preferably smaller than that of teeth 55, 56, and comparable with that of teeth 40, 42. As an example of said construction, the angle of lead of teeth 40, 42, 58, and 59, is made 20°, while that of teeth 55, 56 may be 45°.

Skirt 41 is provided with a series of passages 62 through the wall thereof outwardly of the several spline constructions as described, and is likewise formed with an outwardly projecting finger 63 which is adapted to engage the end of floating spline member 57 in order to cause positive movement thereof. Cylinder 47 is likewise provided with an inwardly projecting extension 64 which is adapted to have engagement with the outwardly projecting nose 65 of the floating spline member 57 in order to limit the outward movement thereof.

To guide the blade in its rotational movements the base of member 30 is provided with a roller bearing 66, the outer race being carried in the flange 67 of a bevel gear 68, which is pinned to the blade root by pins 50.

Means are provided for supplying actuating fluid under pressure to effect adjustment in the setting of the blades. In the particular arrange-

ment shown provision is made for selectively applying fluid in order to effect both increase and decrease in the pitch angle setting of the blades. Control of the supply of such pressure actuating fluid is provided through the use of a regulator device where it is desired to have a constant speed of rotation of the propeller. A preferred regulator for this purpose is that disclosed in co-pending application Serial No. 279,531, filed currently herewith, in which the regulator comprises a self-contained unit and is rotatable with the propeller hub, thereby avoiding the necessity for transmitting fluid from a stationary to a rotating part, with elimination of the necessity for packed glands and the like. In addition to this preferred form of regulator, other control means for selectively supplying the actuating fluid may be utilized as desired.

As illustrated in Fig. 2, the regulator 70 is carried by the driveshaft 10 so as to be rotatable therewith and standing directly adjacent the rear face of the hub 12 and the several blade sockets 13. With such regulator there are provided concentric passages 71 and 72 at different radial spacings, preferably extending around the entire periphery. Pressure fluid is pumped from a reservoir formed by the outer casing into an outer passage 73 from which it is automatically and selectively supplied to one or the other of passages 71 and 72 in accordance with the functioning of the regulator mechanism, and as determined by the conditions of propeller speed, pressure being supplied into one of said conduits (71) upon a drop in speed, and to the other (72) upon an increase in speed.

Means are provided in the hub for introducing fluid from each of the passages selectively into the root portion of each of the propeller blades, to effect change in the pitch angle setting of the blades in a manner corresponding to the supply of pressure fluid thereto, and to maintain a desired speed condition of the blade. This means comprises a nut 75 which is threaded into the hub through the base of cylindrical member 30 and provided with an axial bore 76 establishing communication between the interior of cylindrical member 30 and a central recess 77 formed in the hub 12. A tube 78 leads from recess 77 to the rear face of the socket 13 where it communicates with a connecting tube 79 projecting from the face of the socket and having such radial positioning from the propeller axis as to be in line with the passage 71 of the regulator device. Connection 79 extends through the wall 80 of the regulator device and thus establishes direct communication for the passage of fluid from the passage 71 into the interior of member 30. It will be observed by reference to Fig. 3 that each of the several blade sockets is provided with a similar such connecting device 79, all of said devices being located on the same radius so that each one of them has direct and individual communication with passage 71.

Upon application of fluid pressure to passage 71, it is directly supplied into each of the cylindrical members 30 in each of the several blade sockets, and from there it flows through the respective piston rods 36 into the space 81 formed outwardly of the piston member 43. Thus in response to such pressure application each piston is caused to move radially inwardly.

In order to effect the application of pressure on the opposite side of the piston to cause outward movement thereof, a passage 85 (shown in Fig. 4) is formed in the inner wall of member

30 leading into the annular space 86 between member 30 and cylinder 47. This passage extends downwardly, in substantially the location of one of the dowel pins 31 which it replaces, to a plane substantially the same as that containing tube 78. A similar tube 88 leads from the passage 85, through the hub, and to the outer rear face of the socket, emerging therefrom with a connecting tube 89 at a different and greater radial distance from the propeller axis than tube 79. Each of the tubes 89 is thus brought out to communicate through the wall 80 of the regulator with the passage 72 so that fluid is supplied therethrough into each of the propeller root portions, and into the chambers 86 as described above.

The several spline teeth which occupy space 86 are formed with sufficient clearance between adjacent teeth to provide for passage of the fluid through and over the splined surfaces, thereby providing a source of lubrication under pressure for such working surfaces. The fluid is then transmitted above the splined teeth into the annular space 90, from which it passes through apertures 62 into the space 91 formed beneath the piston and above the fixed end of member 30. Consequently when pressure is applied through passage 72, that pressure is communicated to and is simultaneously made effective upon the inside of each piston 43 to effect outward movement thereof, it being understood that when fluid pressure is applied upon one side of the piston 43 the pressure is released upon the other to permit of back flow of fluid therefrom.

In the operation of the device constructed in accordance with this invention, and assuming it is desired to increase the pitch angle of the blades, either from a small positive or from a negative angle position, fluid pressure is applied through the passage 72 and made effective upon the inner face of piston 43 in the manner just described. As a result of this pressure, piston 43 moves outwardly with respect to the member 30 and cylinder 47. As the sleeve 41 is thus moved outwardly, spline teeth 40 and 42 cause a twisting or rotation to occur in the piston and piston extension relative to the fixed member 30. However this outward movement of sleeve 41 also tends to effect relative movement between spline teeth 55, 56 and between teeth 58, 59. Because the pitch angle of spline teeth 58, 59 is less than that of teeth 55, 56, there is less resistance to the relative sliding as between teeth 58 and 59 than as between teeth 55 and 56. Therefore the initial movement all takes place between teeth 58, 59, teeth 55, 56 remaining locked together. The cylinder 47 is thus caused to rotate with a movement which is the sum of that caused by spline teeth 40, 42 and 58, 59, in the direction from left to right as shown in Fig. 2. This movement is relatively slow, so that a rather extended travel of the piston during this initial portion of the blade rotation results in adjustment of the blade within substantially the normal working range of the blade. Thus for example with the arrangement shown a movement of the piston 43 of two inches at the beginning of its outward travel is made to effect an angular adjustment of the blade position of approximately 50°. This is generally sufficient to cover the normal working range of positions of the blade, even beginning with a negative blade position of as much as -12°, and can be increased if desired. Since the extent of travel of piston 43 is subject to accurate

control, the pitch angle of the blade is also determined with a high degree of accuracy and the speed is maintained within narrow limits such that objectionable noise and vibrations are overcome.

When the normal range of operative positions of the blade in which considerable accuracy of setting and fineness of adjustment are desired, has been covered, provision is made for rapidly moving the blade into its fully feathered position, with a relatively reduced amount of additional piston travel. In accordance with the present construction this is provided by the use of the floating spline construction as above described. As the piston 43 continues to move outwardly carrying the floating spline along with it, the nose 65 of the floating spline advances outwardly to a position where it contacts with the overhanging projection 64 of the cylinder. Thereafter the floating spline is prevented from further outward movement. Upon continued application of hydraulic pressure upon the inner face of the piston, the piston is caused to move outwardly against the now stationary spline member 57. As a result of this action, and because of the greater angle of lead of spline teeth 55, 56, additional outward movements of piston 43 result in proportionately greater turning of the cylinder 47 and with it of the blade. It will be noted that under these conditions the rotary movement of cylinder 47 becomes the sum of that produced by spline teeth 40, 42 and 55, 56 and the blade is thus moved rapidly into higher pitch positions and if desired finally into a fully feathered position.

In order to effect the restoring of the blade to a lower pitch position, substantially the reverse operation takes place. That is to say, with the blade in a fully feathered position, pressure is supplied through passage 71, tube 78, passage 76 and through tubular piston rod 36 into the passage 81 above piston 43. Piston 43 is thus caused to move radially inwardly effecting rotation thereof in the reverse direction by reason of spline teeth 40, 42. Also because of the greater angle of lead of spline teeth 55, 56, initial piston movement results in relative movement occurring therebetween, teeth 58, 59 meanwhile remaining locked. Hence the blade is quickly returned from its fully feathered position into a high pitch setting within its operative range. In order to further reduce the pitch and to do so more slowly and under more accurate control, the application of further fluid pressure above the piston causes the nose 63 of the sleeve 41 to contact the floating spline and to thereafter effect relative rotation as between spline teeth 57 and 58 as well as between teeth 40 and 42.

The operations as described above are illustrated diagrammatically in Fig. 5 where the piston 43' is shown as traveling in the direction of the arrow, and in such manner as to produce a resultant rotational movement of the blade, illustrated as a lateral movement of member 47' to left or right. This movement corresponds to the sum of the leads of surfaces 40', 42' and 58', 59'. Because surfaces 55' and 56' have a greater angle, no relative movement takes place initially therebetween. However as the movement of the piston continues, floating member 57' strikes nose 64' of cylinder 47' and further movement is terminated; thereafter relative movement between surfaces 55' and 56' takes place, resulting in a correspondingly greater lateral displacement,

Upon reverse movement of the piston, initial movement occurs between surfaces 55' and 56' until nose 53' returns into engagement with member 57', thereby causing relative movement between surfaces 58' and 59'.

Each of the several blades is preferably provided with actuating mechanism of this character, and the constants are preferably chosen so as to substantially balance the forces of blade torque at a suitable point in the operative range. Thus the centrifugal blade torque acts upon the blade to tend to reduce it to a lower pitch position. Opposed to this force is the centrifugal force which is effective upon the piston, the piston skirt, and associated parts. While the weight of these parts may be varied to secure a balancing of the oppositely acting forces at different blade positions, a satisfactory arrangement is to provide such weight in the piston 43 that it will be in substantially balanced relation with the centrifugal blade torque at a blade angle of about 40°. With the splined construction as shown the forces acting to cause rotation of the blade are uniformly distributed around the entire periphery of the operating parts and hence a well balanced condition is maintained, avoiding excessive loads in localized areas and stresses resulting from unbalanced centrifugal forces. With the forces resulting from the weight of the piston, centrifugal blade torque, etc., substantially balanced in the operative range, the blade will have a static position so that it will retain such setting in the absence of any application of fluid actuating pressure. And by reason of the frictional forces opposing a shifting of the spline members relative to each other in either direction, the actual range over which the blade has a static condition is relatively wide, and in practice may readily be such as to cover substantially the normal operating range of blade angle positions. As a result therefore a highly satisfactory construction is provided in which, with the blade in a normal operating position, it is necessary only to effect the application of fluid pressure to one side of the piston or the other to secure a change in the setting of the blade, and thereafter it is no longer necessary to maintain pressure upon the piston, the blade being frictionally retained in the desired adjusting position.

By suitably changing the constants of the weight of the piston in relation to the factors which produce centrifugal blade torque, the blade can be overbalanced or underbalanced as desired, to such extent as to utilize such forces for the shifting of the blade in one direction, and making use of the fluid pressure application to only one side of the piston under the control of the regulator for effecting change in the opposite direction.

In order to provide for synchronizing the adjusting movements of all of the blades, the teeth of each bevel gear 68 are adapted to engage with the beveled teeth of a ring gear 95 which is rotatably journaled upon ball bearings 96 carried upon an extended sleeve portion 97 of the hub 12. Suitable retaining and clamp devices 98 provide for retaining the bearings and the ring gear in position, the ring gear thus engaging the ring sectors on each of the several blades so as to assure of their operation and rotation in coordinated and synchronized movements.

The invention therefore provides a highly satisfactory adjustable blade propeller which is simple in construction and in which the blades are

adjustable rapidly and accurately over a wide range of positionings, which if desired may extend from a position of negative pitch to a position where the blade is fully feathered. And with the combined slow and rapid rate of adjustment, provision is made for securing highly accurate adjustment of the blade setting in the normal operating range so as to provide for maintaining a predetermined speed condition with accuracy, while simultaneously providing for shifting the blade more rapidly into a feathered position. The mechanism is well balanced kinetically, and provides for retaining a desired condition of blade setting without the necessity for the continuous application of fluid pressure thereto so that within the operating range the blade position will be held even in the event of failure of the fluid pressure system. Likewise the blade actuating mechanism and the supply of pressure control fluid is such that the hollow driveshaft is left completely clear so that it is adapted for such use as may be desired, for example, the firing of projectiles therethrough.

While the form of apparatus herein described constitutes a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise form of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. An hydraulically adjustable propeller of the character described which comprises a hub, a blade socket formed in said hub, a blade having a hollow root portion extending into said socket, means for mounting said blade in said socket for rotation with respect thereto to vary the pitch of the blade, fluid pressure actuated means within said hollow root portion, means mechanically interconnecting said fluid pressure means with said blade for effecting controlled positive rotation of the blade in both directions, the weight and mass distribution of the blade and of said fluid pressure means being correlated such that the forces tending to effect increase in the pitch of the blade are substantially in balance with those tending to effect decrease thereof in a predetermined blade position within the normal operating range and means for supplying fluid selectively to said fluid pressure actuating means to cause positive operation thereof in both directions to effect both pitch increasing and pitch decreasing adjustment of the blade.

2. An hydraulically adjustable propeller of the character described which comprises a hub, a blade socket formed in said hub, a blade having a hollow root portion extending into said socket, means for mounting said blade in said socket for rotation with respect thereto to vary the pitch of the blade, fluid pressure actuating means for effecting rotation of the blade in opposite directions including a cylinder within said hollow root and directly connected to said blade, a piston movable radially within said cylinder, a skirt movable with said piston, and means interconnecting said cylinder and said skirt providing for rotating said blade relatively slowly over the normal working range of blade positions and relatively rapidly into a feathered position.

3. An adjustable propeller of the character described having its operating mechanism located entirely clear of the propeller axis which comprises a hub, a blade socket formed in said hub, a blade having a hollow root portion extending into said socket, means for mounting said blade

in said socket for rotation with respect thereto to vary the pitch of the blade, means movable radially of the blade within said hollow root portion over a predetermined range of movement, means interconnecting the blade and said movable means and operable over one portion of the movement of the latter for causing a relatively slow rotational movement of the blade and operable over another portion of the range of movement thereof for causing more rapid rotational movement of the blade, and controllable fluid pressure actuating means for effecting movement of said radially movable means.

4. An hydraulically adjustable propeller of the character described which comprises a hub, a blade socket formed in said hub, a blade having a hollow root portion extending into said socket, means for mounting said blade in said socket for rotation with respect thereto to vary the pitch of the blade, fluid operated actuating means having a movement substantially radially of the propeller shaft for effecting rotation of the blade, means interconnecting said blade and said fluid operated actuating means for effecting slow movement of the blade in one portion of the radial movement of said fluid actuating means, and additional means operable in a predetermined portion of the radial movement of the fluid actuating means for effecting rapid movement of the blade.

5. An adjustable propeller of the character described having its operating mechanism located entirely clear of the propeller axis which comprises a hub, a blade socket formed in said hub, a blade having a hollow root portion extending into said socket, means for rotatably retaining said blade in said socket providing for adjustment of the pitch angle thereof, a cylinder fixed in said blade root, a piston radially movable in said cylinder, a stationary member fixed to the hub and extending into said hollow root portion, means connecting said piston with said stationary member to cause said piston to occupy a predetermined angular positioning throughout its radial movement, a helical spline connection for effecting direct rotational movement of said cylinder in response to radial movement of said piston, and a conduit for the supply of fluid pressure to said piston to effect operation thereof, the path of fluid supply to said piston including said helical spline connection to provide for forced lubrication thereof.

6. An hydraulically adjustable propeller of the character described which comprises a hub, a blade socket formed in said hub, a blade having a hollow root portion extending into said socket, means for mounting said blade in said socket for rotation with respect thereto to vary the pitch of the blade, fluid pressure actuating means for effecting rotation of the blade including a cylinder positioned within said hollow root portion, a piston radially movable within said cylinder, a floating spline member having helical spline teeth engaging upon opposite sides thereof respectively with said cylinder and with said piston, said spline teeth having different angles of lead to provide for producing different corresponding rotational movements of said cylinder upon movement of said piston, and means for controlling the movement of said floating spline member to provide for predetermined adjusting movement of said blade.

7. An hydraulically adjustable propeller of the character described which comprises a hub, a blade socket formed in said hub, a blade having a

hollow root portion extending into said socket, means for mounting said blade in said socket for rotation with respect thereto to vary the pitch of the blade, fluid pressure actuating means for effecting rotation of the blade including a cylinder positioned within said hollow root portion, a piston radially movable within said cylinder, a floating spline member having helical spline teeth engaging upon opposite sides thereof respectively with said cylinder and with said piston, said spline teeth having different angles of lead to provide for producing different corresponding rotational movements of said cylinder upon movement of said piston, and means for controlling the relative movement between said piston and said floating spline, and between said cylinder and said floating spline to secure selective relative rotation of said cylinder and said blade.

8. An hydraulically adjustable propeller of the character described which comprises a hub, a blade socket formed in said hub, a blade having a hollow root portion extending into said socket, means for mounting said blade in said socket for rotation with respect thereto to vary the pitch of the blade, fluid pressure actuating means for effecting rotation of the blade including a cylinder positioned within said hollow root portion, a piston radially movable within said cylinder, a floating spline member having helical spline teeth engaging upon opposite sides thereof respectively with said cylinder and with said piston, said helical teeth upon the opposite sides of said floating spline member having different angles of lead, and cooperating parts formed on said cylinder and said piston providing for forcing relative movement between said teeth having the greater angle of lead following initial movement between teeth having the lesser angle of lead.

9. An adjustable propeller of the character described which comprises a hub, a blade socket formed in said hub, a blade having a hollow root portion extending into said socket, means for mounting said blade in said socket for rotation with respect thereto to vary the pitch of the blade, actuating means for effecting rotation of the blade including a cylinder positioned within said hollow root portion, a piston movable in said cylinder axially thereof, a stationary cylindrical member extending into said hollow root and fixed to said hub, a skirt carried by said piston having a spline connection upon the inner and outer faces thereof, said cylindrical member having spline teeth for engaging said skirt to provide for maintaining the piston in a predetermined angular positioning throughout its axial movement, and a floating spline having engagement with the outer spline teeth on said skirt and with inner spline teeth on said cylinder, and providing for interconnecting said parts to cause adjustment of the pitch of the blade in response to axial movement of said piston, the direction of lead of all of said spline teeth being the same to cumulate the rotational effect thereof upon outward movement of said piston.

10. An hydraulically adjustable propeller of the character described which comprises a hub, a blade socket formed in said hub, a blade having a hollow root portion extending into said socket, means for mounting said blade in said socket for rotation with respect thereto to vary the pitch of the blade, fluid pressure actuating means located within said hollow root portion for effecting rotation of the blade in opposite directions including a cylinder positioned within said hollow root and connected with said blade, a piston

radially movable within said cylinder and having a skirt and a tubular piston rod attached thereto, a stationary member within said hollow root and fixed to said hub, means for interconnecting said piston and said stationary member providing for relative movement therebetween a fluid sealed connection in said stationary member for slidably receiving said piston rod therethrough, means for introducing a fluid actuating medium under pressure interiorly of said stationary member to be supplied through said hollow piston rod to the outer face of said piston in order to cause movement thereof radially inward, additional means for supplying fluid actuating medium under pressure outwardly of said stationary member to be effective upon the inner side of said piston to cause movement thereof radially outwardly, said skirt being apertured to provide for passage of said fluid to the inner side of said piston and a helical spline connection between said piston and said cylinder for effecting rotation of the latter in response to said movement of the piston, said spline connection being within the path of said pressure fluid and adapted to be lubricated thereby.

11. An hydraulically adjustable propeller of the character described which comprises a hub, a blade socket formed in said hub, a blade having a hollow root portion extending into said socket, means for mounting said blade in said socket for rotation with respect thereto to vary the pitch of the blade, a cylinder within said hollow root portion, a piston member operating in said cylinder and having a predetermined weight directly subject to centrifugal force upon rotation of said hub, said piston member being movable outwardly with respect to said hub, means for interconnecting said piston member and said blade to provide for pitch increasing adjustment of said blade upon outward movement of said piston member and for pitch decreasing adjustment of said blade upon inward movement of said piston member, the weight of said piston member and the forces tending to effect pitch increasing adjustment being coordinated with the centrifugal blade torque and the other forces tending to effect pitch decreasing adjustment so that said forces tending to effect pitch increasing adjustment are not predominately greater than those tending to effect pitch decreasing adjustment in the normal operating position of the blade, and controllable means for introducing fluid pressure to said piston to effect positive controlled movements of said piston member with corresponding pitch increasing and pitch decreasing adjusting movement of said blade.

12. An hydraulically adjustable propeller of the character described which comprises a hub, a blade socket formed in said hub, a blade having a hollow root portion extending into said socket, means for mounting said blade in said socket for rotation with respect thereto to vary the pitch of the blade, a cylinder within said hollow root portion, a piston operating in said cylinder, a weighted member associated therewith and subject to centrifugal force upon rotation of said hub, said weighted member being movable outwardly with respect to said hub, means for interconnecting said weighted member and said blade to provide for pitch increasing adjustment of said blade upon outward movement of said weighted member and for pitch decreasing adjustment of said blade upon inward movement of said weighted member, the weight of said weighted member and the forces tending to effect pitch

increasing adjustment being coordinated with the centrifugal blade torque and the other forces tending to effect pitch decreasing adjustment so that said pitch increasing forces are less than those required to effect pitch increasing adjustment in the normal operating position of the blade and in the absence of fluid pressure application, and controllable means for selectively introducing fluid pressure to each side of said piston to effect positive controlled movement of said weighted member in each direction with corresponding adjusting movement of said blade.

13. An hydraulically adjustable propeller of the character described which comprises a hub, a blade socket formed in the hub, a blade having a hollow root portion extending into said socket, means for mounting said blade in said socket for rotation with respect thereto to vary the pitch of the blade, a cylinder within said hollow root portion, a piston member operating in said cylinder subject to centrifugal force upon rotation of said hub and being movable outwardly with respect to said hub within said hollow root portion, means for interconnecting said piston member and said blade to provide for pitch increasing adjustment of said blade upon outward movement of said piston member and for pitch decreasing adjustment of said blade upon inward movement thereof, the weight of said piston member and the forces tending to effect pitch increasing adjustment being predetermined with respect to the centrifugal blade torque to be opposed to and not effectively greater than such centrifugal blade torque and the other forces tending to effect pitch decreasing adjustment, and controllable means for introducing fluid pressure to the inner side of said piston to force the same outwardly under positive pressure application for increasing the pitch of said blade.

14. An hydraulically adjustable propeller of the character described which comprises a hub, a blade socket formed in said hub, a blade having a hollow root portion extending into said socket, means for mounting said blade in said socket for rotation with respect thereto to vary the pitch of the blade, fluid pressure actuated means including a weighted member mounted within said hollow root portion and movable with respect to said hub for effecting rotation of the blade in both directions and subject to centrifugal force, means for interconnecting said blade and said weighted member to provide for the effect of centrifugal force on the latter acting in a direction to tend to increase the pitch of the blade, the weight of said member being such that the effect of centrifugal force acting thereon substantially reduces but does not exceed the effect of centrifugal blade torque in a position falling within the normal operative range of blade positions, and means for supplying fluid selectively to said fluid pressure actuated means to cause positive operation thereof in both directions to effect pitch increasing and pitch decreasing adjustment of the blade.

15. An hydraulically adjustable propeller of the character described which comprises a hub, a blade socket formed in said hub, a blade having a hollow root portion extending into said socket, means for mounting said blade in said socket for rotation with respect thereto to vary the pitch of the blade, fluid pressure actuated means including a weighted member located in said hollow root portion and subject to centrifugal force for effecting rotation of the blade, means interconnecting said weighted member and

said blade to effect rotation of the latter in direct response to movement of said fluid pressure actuated means, said interconnecting means requiring application of an actuating force in excess of a predetermined value to cause movement of said fluid pressure actuated means, the weight of said member and the centrifugal blade torque acting upon the blade being such that the resultant of the forces tending respectively to cause increase and decrease of the pitch of the blade in blade positions within the normal operative range is less than said predetermined value to provide for retaining the blades in a predetermined adjusted position within such normal operating range, and means for selectively applying fluid pressure to said fluid pressure actuated means to produce a force in excess of said predetermined value with resulting pitch increasing or pitch decreasing adjustment of the blade.

16. An hydraulically adjustable propeller of the character described which comprises a hub, a blade socket formed in said hub, a blade having a hollow root portion extending into said socket, means for mounting said blade in said socket for rotation with respect thereto to vary the pitch of the blade, fluid pressure actuated means including a piston located in said hollow root portion and directly subject to centrifugal force, means interconnecting said fluid pressure actuated means and said blade to effect rotation of the latter, the centrifugal force effective upon said piston acting in opposition to the effect of centrifugal blade torque, said interconnecting means having substantial frictional force such as to provide for retaining the blades in predetermined adjusted position within the normal operating range against the tendency of said opposing forces to cause change in the pitch thereof, and means for supplying fluid to said fluid pressure actuated means under positive pressure sufficient to overcome said frictional force and to effect adjustment of the pitch of the blade in both directions.

17. An hydraulically adjustable propeller of the character described which comprises a hub, a blade socket formed in said hub, a blade having a hollow root portion extending into said socket, means for mounting said blade in said socket for rotation with respect thereto to vary the pitch of the blade, said blade being subject to centrifugal blade torque tending to reduce the pitch thereof in operation, fluid pressure actuated

means located in said hollow root portion for effecting rotation of the blade in both directions including a weighted member subject to centrifugal force, means interconnecting said fluid pressure actuated means, said weighted member and said blade to effect rotation of the latter, the action of centrifugal force on said weighted member acting through said interconnecting means in a direction to tend to increase the pitch of said blade, said interconnecting means having substantial retarding force to provide for retaining the blade in a predetermined adjusted position within the normal operating range and opposing the tendency of the forces acting thereon to rotate said blade, and means for supplying fluid pressure selectively to said fluid pressure actuated means under positive pressure sufficient to overcome said retarding forces and to adjust the position of the blade in both directions to effect controlled pitch increasing and pitch decreasing adjustment of the blade.

18. An hydraulically adjustable propeller of the character described which comprises a hub, a blade socket formed in said hub, a blade having a hollow root portion extending into said socket, means for mounting said blade in said socket for rotation with respect thereto to vary the pitch of the blade, fluid pressure actuated means for effecting rotation of the blade including a cylinder element positioned within said hollow root portion, a piston element axially movable in said cylinder, an abutment fixed with respect to said hub and extending into said hollow root portion, said abutment, said piston, said cylinder and said blade socket all being located coaxially, annular spline means having teeth arranged around the periphery thereof and directly connecting said piston and said cylinder to maintain the rotating forces distributed around the periphery thereof, one of said piston and cylinder elements being operatively connected to said blade, and annular spline means having teeth arranged around the periphery thereof for connecting the other of said piston and cylinder elements to said abutment, at least one of said spline means being spiral to provide for developing a rotational force upon said blade socket on relative movement between said cylinder and said piston while maintaining all the rotating forces in annularly distributed relation.

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