Nov. 22, 1949 M. M. SENSENICH ET AL 2,488,686

CONTROLLABLE PITCH PROPELLER

Filed May 29, 1945 4 Sheets-Sheet 1

Fig. 1.

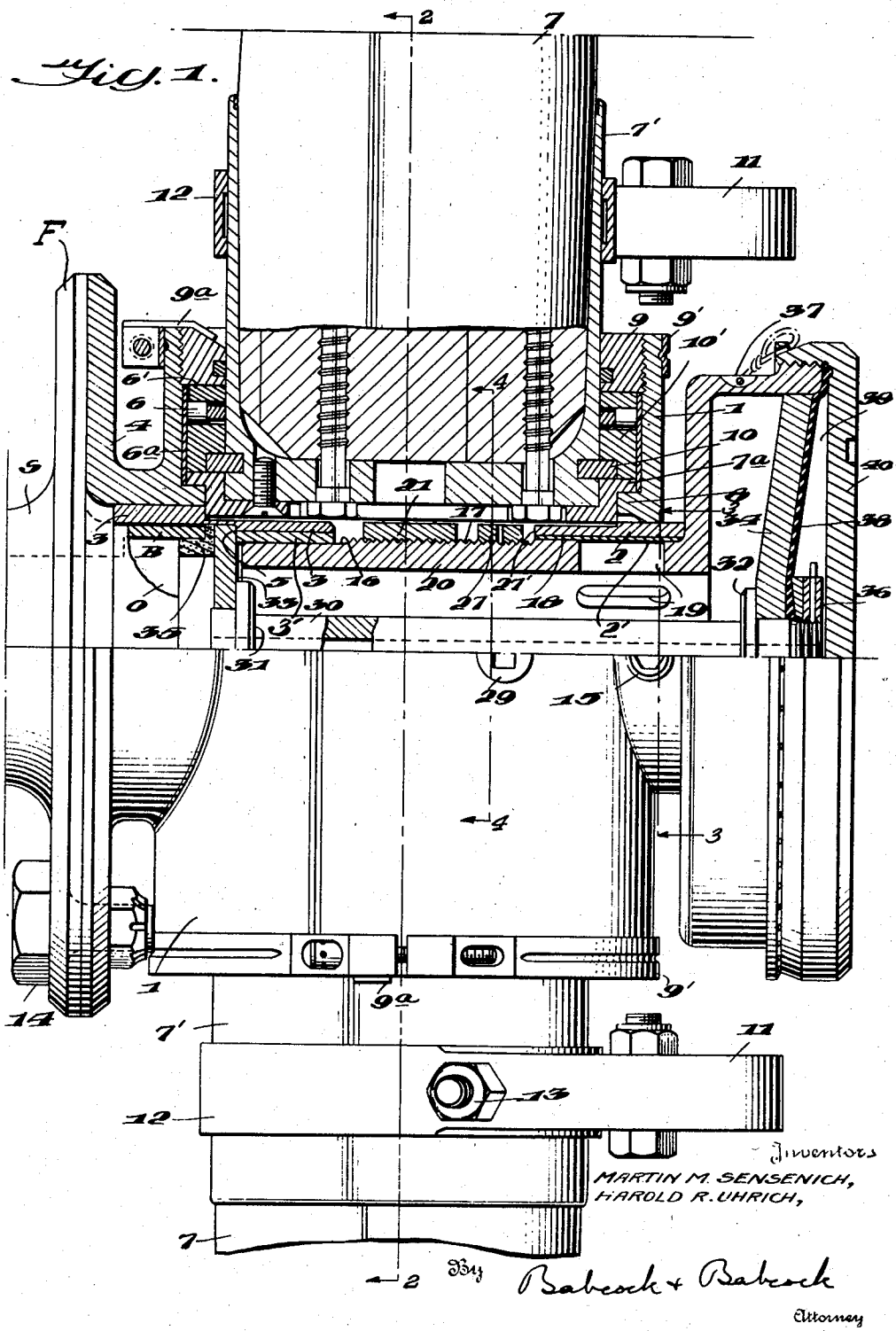


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Fig. 2.

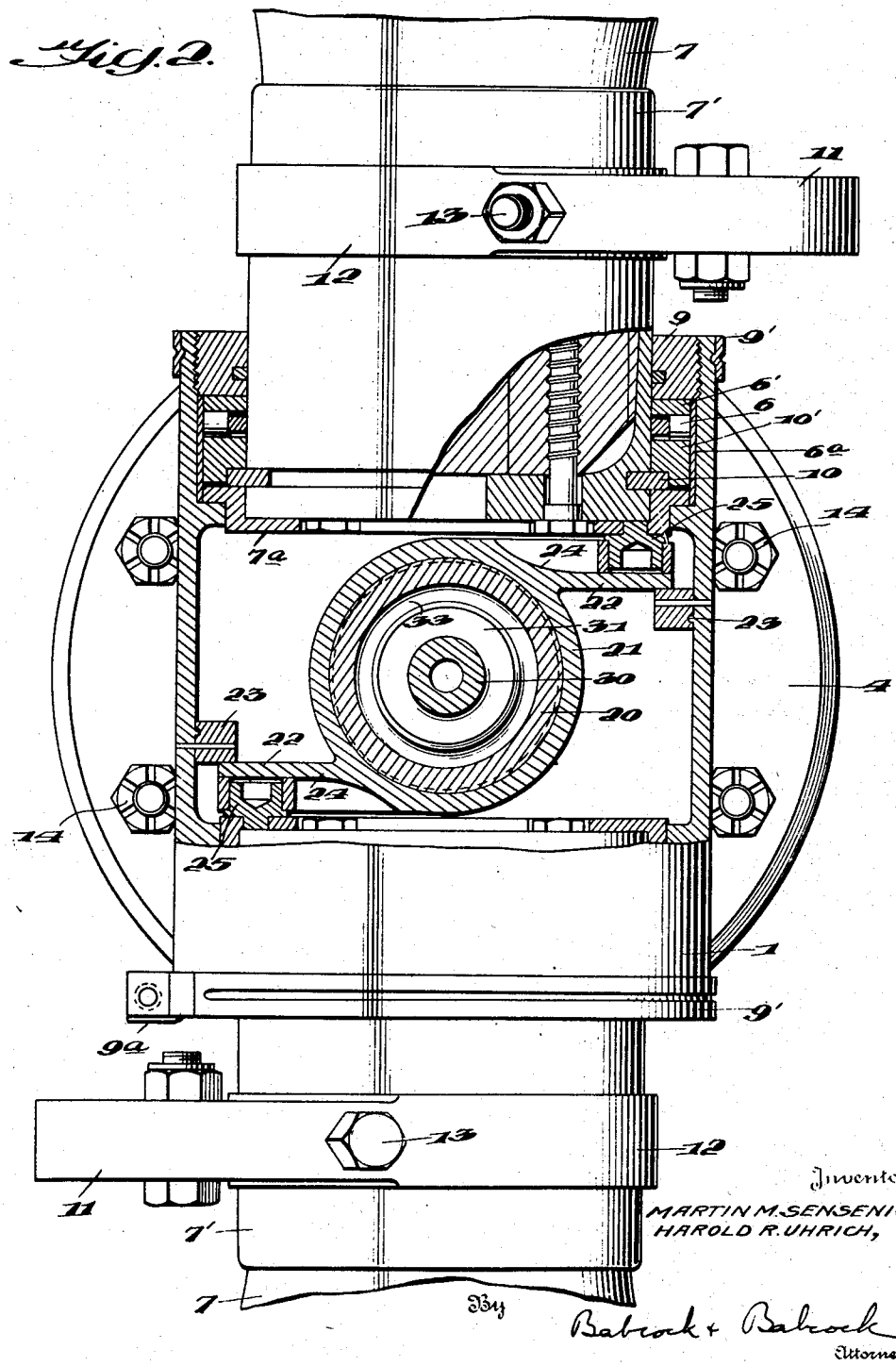


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Fig. 3.

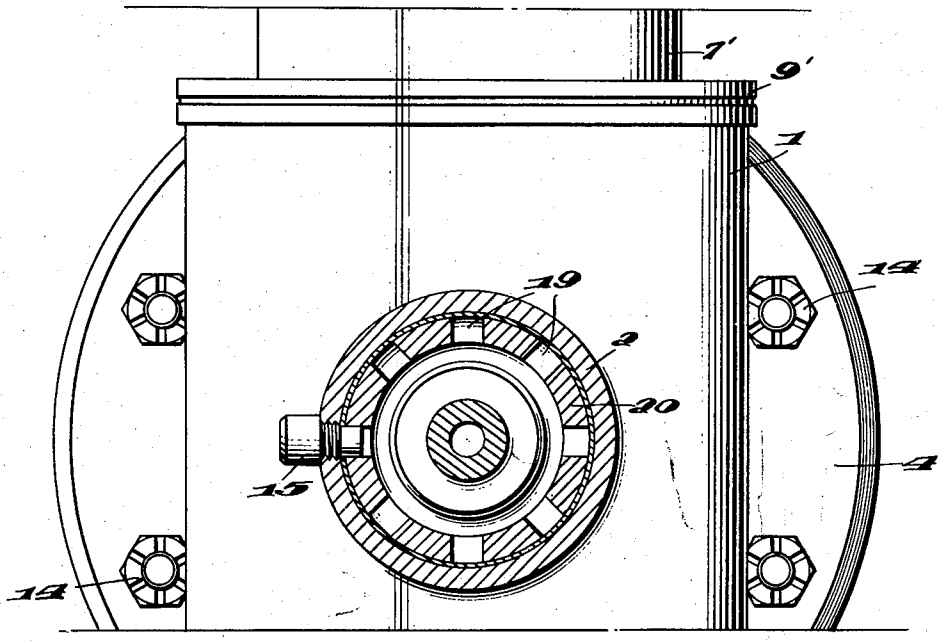
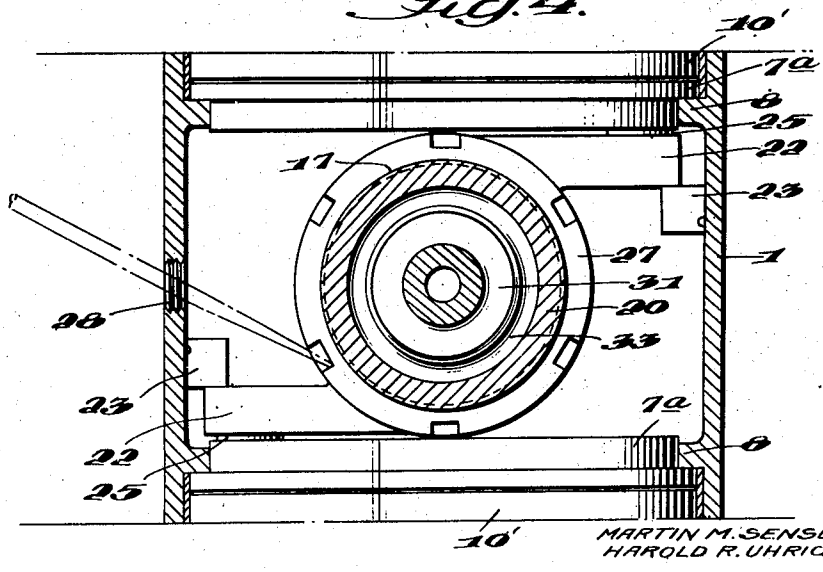



Fig. 4.

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Filed May 29, 1945 4 Sheets-Sheet 4

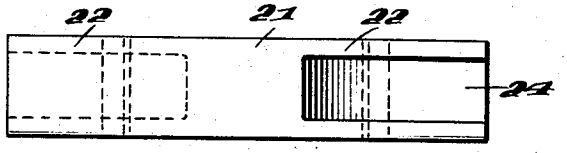



Fig. 5.

Fig. 6.

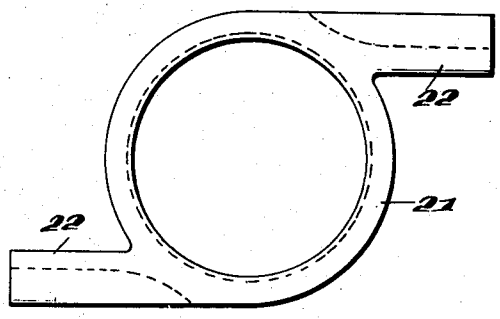



Fig. 7.

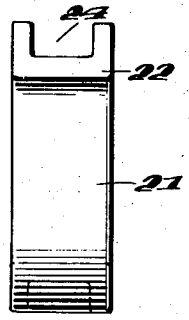



Fig. 8.

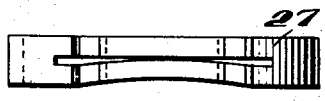



Fig. 10.

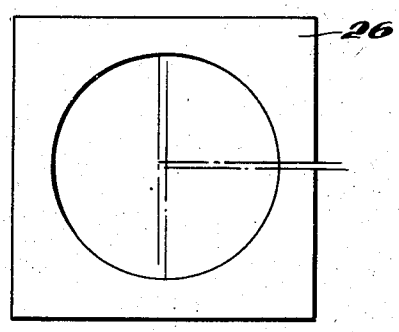



Fig. 9.

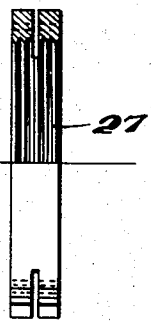
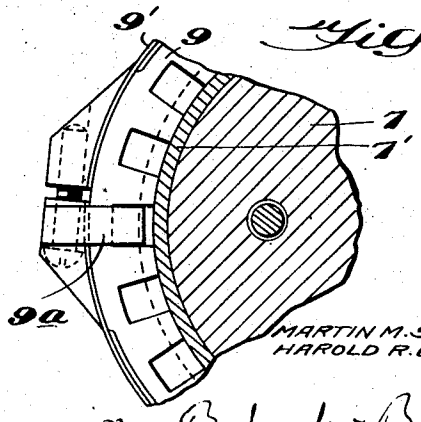



Fig. 11.

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Patented Nov. 22, 1949 2,488,686

# UNITED STATES PATENT OFFICE

2,488,686

## CONTROLLABLE PITCH PROPELLER

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Application May 29, 1945, Serial No. 596,442

13 Claims. (Cl. 170—160.32)

1

This invention relates to controllable propellers or propellers in which the pitch of the propeller blades may be adjusted and controlled during flight or during rotation of the propeller, such adjustment in the embodiment illustrated being from a fixed high pitch position to a fixed low pitch position, or vice versa.

The propeller of the present invention is of the so-called hydraulic control type and its blades are to be moved or rotated about their axes from one of their operative positions to the other by a suitable fluid, most usually oil under pressure, which may be oil diverted from the engine lubricating system under pressure, said blades being moved or rotated in the reverse direction by the action of weights secured in suitable manner to the blades, usually to their stems or roots, or by the centrifugal action of the mass of the blades and aerodynamic forces acting to move the blades toward their low pitch or neutral positions when free of the hydraulic control. In order to supply the operative fluid, such as oil from the engine lubricating system, to the propeller hub to operate the actuating parts thereof, the engine shaft S is formed with an axial passage or bore O in accordance with known construction, which bore O or passage is in communication with the interior of the hub tube **30**, and suitable tubing or ducts may be provided in conjunction with a suitable control plug or cock preferably disposed on or adjacent to the panel or instrument board in the plane cabin whereby when the plug or cock is turned to one position the oil under pressure will flow from a pump or pressure tank or body of oil under suitable pressure into and through the central longitudinal or axial bore O of the shaft S and from there through the tube **30**, and whereby when the plug or cock is turned to another position it closes communication between the bore O and the oil supply and opens communication between the bore O and the engine crank case or a sump so that the oil may flow or escape from the hub when the blades move back to their initial positions under the action of the weights or by the action of centrifugal force and aerodynamic forces when they are freed of the influence or thrust of the hydraulic system or fluid pressure, in accordance with such hydraulic or oil pressure systems as shown in any one of the patents as follows: German Patent 301,635, Lorenzen, April 7, 1920; 1,565,100, Nutt, Dec. 5, 1925; or 2,032,255, Caldwell, Feb. 25, 1936, or my invention may be embodied in that type of propeller which has its own independent supply or fluid together with means for supplying some of such fluid to the hub with such force or pressure as will suffice to properly actuate the parts and result in moving the blades about their axes from one pitch position to another together with means permitting the fluid to escape from

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the operative cylinder of the hub, and preferably back to the main body of fluid, when the pressure is released and the blades move back to their initial pitch positions as above mentioned.

Since the source of supply of the fluid under pressure and the means of control are old and well known and form no part of this invention, there is believed to be no need for further description, or for illustration thereof and therefore the remainder of this specification, and the drawings, are confined to the propeller per se and the operative parts thereof.

The primary objects of the present invention are: to provide a propeller of the type mentioned in which all parts operative to adjust the pitch setting, the extent of the pitch movement of the blades, and the entire range of pitch movement are enclosed and yet which is quickly adjustable in the assembled operative condition of the propeller without need to remove a blade or section of the hub, it being sufficient to remove simply an access opening plug or closure and to release or partially screw out a locking means or bolt or pin; to simplify the construction and assembly and increase the ease of accessibility to the parts of such propellers and their application to the drive shaft of the airplane or vehicle; to provide for the adjustment of the initial pitch of the propeller blades to suit the characteristics of any given engine developing maximum power and speed within the general engine power and speed range for which a given size of propeller is designed so that a single standard model propeller may be produced in large quantities and secured to the shaft of, and used with, any given engine of a large number of different types and makes of engines often having many different characteristics as to their speeds of rotation of their power shafts in relation to their most efficient development of power and by a suitable and simple adjustment of the propeller obtain the greatest degree of efficiency of operation from said engine; to provide simple and efficient means for adjusting the range of pitch movement as a whole; to provide simple and efficient means for adjusting the extent of the range of angular adjustment between the high and low pitch positions of the propeller blades to best suit the characteristics of a given engine; and to provide simple and positive means for securing the parts in any given adjusted position.

In the accompanying drawings:

Figure 1 represents a view partly in side elevation and partly in section of the hub and root portions of the blades of a dual blade propeller embodying my invention, the adjacent end portion of the engine shaft S to which it is bolted or on which it is otherwise suitably mounted being indicated by light dot and dash lines and having its boss B snugly fitted in the rear end

of the bore of the hub sectioned to show the oil bore or passage O;

Figure 2, a sectional view on the line 2—2 of Fig. 1, looking in the direction of the arrows and with the outer portions of the blade roots shown in side elevation and broken away;

Figure 3, a sectional view on the line 3—3 of Fig. 1, looking in the direction of the arrows;

Figure 4, a fragmentary sectional view on the line 4—4 of Fig. 1, looking in the direction of the arrows;

Figure 5, a top plan view of the adjustable position pitch adjusting or actuating traveler, spider or cross-head 21;

Figure 6, a front elevation thereof;

Figure 7, a side elevation thereof;

Figure 8, a top plan view of the adjusting nut 27;

Figure 9, a view partly in section and partly in elevation of said nut 27;

Figure 10, a top plan view of one of the blocks 26; and

Figure 11, a detail view showing the manner of locking the blade retaining collars or nuts 9 against turning movement in the blade sockets of the hub.

The drawings illustrate a two blade or dual blade embodiment of our invention, though of course our invention is not restricted to a dual blade propeller but may be embodied in propellers having three or more blades or only one blade, in any such case the hub of course to be modified correspondingly as also the spider or cross-head 21 to receive and cooperate with all of the blades of a given propeller of a given type.

The propeller of our invention may be said to be comprised of three main groups of elements, as follows: the blades 7 with their roots, ferules, end caps, split lock rings, bearings, races, retaining collars or nuts, locking means for the latter, all in general of conventional construction and design, their pitch bosses or pins and their weights where the latter are employed; the hub per se; and the hydraulic or fluid pressure control mechanism. In turn, such hydraulic mechanism may be said to be comprised of two main sub-groups of elements, the same being a composite sleeve and cylinder or chamber, with closure plate or cap unit and a piston and diaphragm with piston rod or thrust tube and oil or hydraulic fluid supply duct or communication duct unit hereinafter referred to as the piston unit or assembly or assemblage.

The cross-head, or spider 21 adjustable axially of the sleeve portion 20 of the composite sleeve and cylinder unit serves to operatively connect the hydraulic mechanism to the blades to adjust the pitch of the latter, and the nut 27 engaging the exterior screw-threads of sleeve portion 20 cooperates with an abutment face or portion of the hub per se to either, together with cross-head or spider 21, adjust the position as a whole of the range of the pitch adjustment, or to adjust the extent of the range of pitch movement.

The hydraulic or fluid pressure control mechanism is easily and quickly removable as a unit and replaceable by a similar identic construction unit, all without need for demounting or disassembling any other elements or parts of the propeller, and the piston unit or assemblage by the simple removal of the cylinder head or cover or plate 40 is removable and reinsertible or replaceable by a similar duplicate piston assemblage without need for demounting or disassembling any other elements or parts of the propeller,



both of these features facilitating greatly the ease and rapidity of servicing and reconditioning or repairing, and the original assembly, of the propellers and both being considered important features of our invention.

Referring now in detail to the drawings, S designates the engine shaft having a flange F to which is bolted the flange 4 of the propeller hub and a boss B fitting in the rear end of the bore of the hub and being hollow or formed with an oil or hydraulic fluid duct or bore O.

1 designates the cylindrical, or preferably cylindrical body of the hub having its end portions internally screw-threaded to receive the externally threaded retaining rings, collars or nuts 9 and formed with internal annular flanges 8 respectively spaced from the respectively internally screw-threaded portions sufficiently to accommodate between the inner faces of the respective retaining rings, collars or nuts 9 and the outer faces of the respective flanges 8 the respective blade root mounting assemblages.

The body 1 is formed with a central bore or opening extending at right angles to the axis of said body 1 and a centering support or guide bush or bearing 2 is brazed, welded or otherwise suitably secured or formed in the front wall of said opening in axial alignment with a similar bush or bearing 3 similarly secured or formed in the rear wall of said opening and said bushes or bearings 2 and 3 may be provided with suitable bearing linings 2' and 3' respectively as illustrated, in any suitable manner, and the propeller mounting flange 4 is secured to the rear end of the bush or bearing 3 and to the adjacent portions of the body 1 at all points about the bush or bearing 3 by welding or brazing or in any other suitable manner, and preferably said flange 4 is formed with bolt holes to receive cooperating bolts 14 also received by similar bolt holes in the flange of the engine shaft S, nuts being turned on said bolts to secure the propeller to said shaft.

The bush 3 preferably is formed with a radial inner shoulder 5, that portion of its inner face on the front side of said shoulder being of smaller diameter than the front bearing 2 to snugly receive, support and guide the reduced rear end of the sleeve 20 and being of larger diameter rearwardly of said shoulder 5 to receive and support in proper centered position the abutment plate or disc 33, which is held in place by the pressure of the engine shaft boss B and a suitable fluid sealing gasket 35 of any suitable preferably compressible material interposed between the annular end face of said boss B and the radially outer portion of the opposed face of disc 33.

There will be, of course, a blade 7 for each blade socket of the hub 1, there being two sockets and hence two blades in the embodiment illustrated, and such blades 7 will be mounted and retained in their sockets by any suitable conventional mounting and bearing means. In the embodiment illustrated such conventional means employs for each blade a ferule 7' having an annular groove adjacent its inner end, an end plate or caps 7a secured to the extreme end of the blade root and making a snug fit inside of the flange 8 of the blade socket with an upper flange resting on the outer face of said flange 8, a split locking ring 10 composed of two semi-circular metal pieces retained in position in said groove by the retaining element or ring 10' with its inner portion or flange extending axially of the blade to flush with the inner faces of the members of the locking ring 10 and engag-

ing or adjacent to the outer face of the cap 7a, the outer face of retaining ring 10' functioning as the inner roller race, an outer roller race 6', a roller bearing assembly 6 interposed between the race 6' and retaining ring 10', an externally screw-threaded retaining ring, collar or nut 9 engaging the internal threads in the outer end portion of the corresponding blade socket of the hub 1 and pressing against the outer face of the outer race 6', a ring form antifriction micarta lining 6a for the socket, and, preferably, some suitable means for locking the collar or nut 9 against turning, such as a band 9' having a portion fitting in an external annular groove of the corresponding blade socket and having a lock finger or tongue 9a fitting into anyone of a series of recesses or notches in the axially outer face of the collar or nut 9.

A pitch adjusting lug or stud 25 is secured to the end of the root of each blade to extend axially of the blade at a point remote from the axis of the blade, preferably as remote therefrom as practical to obtain the benefit of as much leverage as possible, and said lug or stud 25 may be either formed as an integral part of the cap 7a, or it may be formed separately with a stem pressed or driven into a corresponding hole or drilled bore in said cap with a tight fit and thereafter welded or brazed to said cap as illustrated.

Weights 11 may be secured to the respective blades 7 in such angular positions as to tend to turn said blades to and maintain them in their high pitch position during the rotation of the propeller unless and until counteracted by the positive action of the hydraulic mechanism acting to forcibly turn them to, and hold them in, their low pitch positions while the oil or other fluid is supplied under pressure, or maintained under pressure, to said hydraulic mechanism. To this end each weight 11 is connected to a band 12 to encircle the stem or ferule of a blade 7 and is provided with a nut and bolt 13 or other suitable means for drawing said band into tight binding and locking engagement with said stem or ferule 7a, preferably the ferule, to hold the said weight 11 in any selected angular position of adjustment thereon against movement relative thereto. Said weights may be of any suitable construction and may be of such construction that their effective weight can be varied as desired by employing anyone of a series of supplemental weights, this being old and well known in the art.

The sleeve 20 is preferably integral with the enlarged cylindrical cup or cylinder 37 at its forward or front end, and is formed with three external cylindrical portions, being an extreme rear end reduced diameter bearing portion 16 making a snug sliding fit in the rear bush or bearing 3 for reciprocatory movement therein, an intermediate externally screw-threaded portion 17, and a large diameter bearing portion 18 making a snug sliding fit in the front bush or bearing 2 for reciprocatory movement therein, and is formed in said front portion 18 with a plurality of equi-distantly spaced locking slots 19 arranged in a circular series and extending entirely through the wall of the sleeve 20, at least it is preferred that they be arranged in a circular series and that they extend entirely through the wall of the sleeve 20, though neither of these attributes is essential so long as they be so formed and so arranged as to meet the needs for locking the sleeve 20 against rotary movement while permitting it to have such extent of reciprocatory movement in any position of adjustment of the parts as will permit it to function as required.



The threads of the externally threaded portion 17 engage the threads of the internally screw-threaded pitch adjusting or actuating traveler, spider or cross-head 21 to, by the rotation of the sleeve 20, adjust the former axially of the sleeve 20 to any position of adjustment for the initial position of the blades, or to such initial angular adjustment of the blades as may be called for by the characteristics of a given engine, the range of pitch movement of the blades starting from such initial position of angular adjustment.

The adjusting nut 27 for, in association with said spider or cross-head 21, adjusting the range of pitch movement as a whole without varying the extent or degree or length of such pitch movement, or of varying the extent of such pitch movement independent of the spider or cross-head 21, is mounted on the sleeve 20 in advance of the spider or cross-head 21 with its internal screw-threads in engagement with the screw-threads of the screw-threaded external portion 17 of said sleeve 20, and by engagement with, or abutment against, the rear end or abutment face 27' of the bush or bearing 2, serves or functions to limit the forward reciprocatory sliding movement of the sleeve 20.

While the screw-threaded portion 17 is of greater external diameter than the rear end bearing portion 16 to permit the adjusting nut 27 and spider or cross-head 21 to be slipped over the portion 16 and engage with the threads of portion 17 to be thereby moved into and held in adjusted position axially of the sleeve 20, the said screw-threaded portion 17 is preferably of slightly less diameter, at its extreme greatest external diameter, than the external diameter of the forward bearing portion 18 to the end that the screw-threaded portion 17 may be easily inserted through the bush or bearing 2 and the forward bearing portion 18 makes a snug free sliding fit in said bush or bearing 2 for reciprocatory movement therein.

A lock stud or pin 15 having a screw-threaded portion engaging the threads of an internally screw-threaded bore or hole through the wall of bush or bearing 2 and a preferably smooth uniform diameter tip or toe to fit in anyone of said slots 19 of said series of locking slots functions to lock said sleeve against any turning movement or any substantial turning or rotary or partial rotary movement, so that once the initial position of angular adjustment of the blades 7 has been made by causing the movement of the spider or cross-head 21 axial of the sleeve 20 by turning the sleeve 20 through the spider or cross-head 21, the lock stud or pin 15 having first been removed to permit such turning of the sleeve 20, the parts may be locked in such adjusted relationship by replacing the lock stud or pin 15 and turning it home in its bore or hole with its smooth toe or tip portion in one of the slots 19. Preferably the diameter of the tip or toe of the pin 15 will be just slightly less than the width of anyone of the uniform width slots 19 so as to be snugly received between the opposing axial walls thereof.

While, when the locking pin or stud 15 is removed, the sleeve 20 may be turned, and the adjusting nut 27 will turn with it unless held against turning as by a suitable tool or instrument inserted through access hole or opening 28, the spider or cross-head 21 will be held against turning with the sleeve 20 by the stop blocks or lugs

23 suitably secured to the interior face of or integral with the hub body 1 in such positions respectively as to be slidably engaged by the inner faces of the extreme end portions of the respective arms 22 of the spider or cross-head 21, whereby said stops or lugs 23 will support, and permit axial movement of, the arms 22 of said spider or cross-head 21 while preventing rotary movement of the said spider or cross-head 21.

The outer faces of the arms 22, that is the faces presented toward the respective caps or cap plates 7a of the blades 7 are respectively formed with guide-ways 24 to slidably receive the eccentric or slightly off-center bored compensating guide blocks 26, which respectively snugly receive in their respective bores the pitch adjusting lugs or studs 25 respectively extending or projecting from the respective caps 7a of the respective blades 7, which studs or lugs 25 will be arranged respectively at such angular positions with relation to the axes of their respective blades as to maintain the proper relationship between the blades of the propeller in all angular positions of the respective blades throughout the range of pitch movement thereof including their positions of high and low pitch.

From the foregoing it follows that any movement of the spider or cross-head 21 in a direction axially of the sleeve 20, whether with the sleeve 20 or relative to the sleeve 20 will result in some pitch movement of the blades 7 about their respective axes and in equal degree and proper relationship, and similarly that any axial movement of the sleeve 20 will result in movement of the spider or cross-head 21 in a direction axial of the sleeve 20.

The adjusting nut 27 will preferably be slotted perpendicularly to its axis and will have one portion on one side of the slot mashed or deformed or pressed toward the other such portion, and this may be repeated at a diametrically opposite portion of the nut, so as to distort the thread of the nut, which is of a suitable springy or resilient material, such construction being for the purpose of holding the nut 27 on the sleeve in any position axially thereof to which it may be adjusted while permitting the nut to be held against turning while the sleeve 20 is turned to thereby cause axial movement of the nut 27 on the sleeve 20 to a new axial position of adjustment thereon. The nut 27 may be held against turning by any suitable tool or instrument inserted through the access opening of bore 28 and for this purpose the outer periphery of the nut 27 is formed with a plurality of preferably equi-distantly spaced notches. While the above construction of the nut 27 is preferred, it may be formed in any manner or shape suitable to the purpose and such as will serve the functions mentioned.

By holding the nut 27 against turning and removing the locking pin 15, the spider or cross-head 21 and the nut 27 may be simultaneously adjusted axially of the sleeve 20 to adjust the range of pitch adjustment as a whole without varying the extent of such range, or the extent of the range of such pitch movement may be varied by leaving the pin 15 in place to lock the sleeve 20 against turning and simply turning the nut 27 on the sleeve 20 by means of a suitable tool operated through the access opening 28.

The compensating block 26 is square so that it may be inserted in the slot or guideway 24 of its corresponding arm 22 in any one of four positions to obtain a fine adjustment of the initial pitch position or to compensate for wear of the parts.



A thrust or piston rod 30 having a rear end nipple snugly slidably removably fitting in and preferably through the central opening of the abutment plate or disc 33 extends lengthwise through the sleeve 20 and nearly to the cylinder head or front or cover plate 40, having an externally screw-threaded nipple extending through a dished form piston 34 and a flexible diaphragm 38 of any suitable material, such for instance as molded neoprene, a nut 36 turning on the extreme front end portion of said threaded front end nipple extending forward beyond said diaphragm to tightly clamp said piston 34 and diaphragm 38 between said nut 36 and an annular flange or shoulder 32 integral with or rigidly secured to the forward end portion of said thrust or piston rod 30. The rear end portion of the thrust or piston rod 30 is formed with an annular flange or shoulder 31 integral with said thrust or piston rod 30 or rigidly secured thereto and exerts a thrust against the abutment plate or disc 33.

The thrust or piston rod 30 is held in proper centered relation to the sleeve 20 and cylinder 37 by the abutment plate or disc 33 at its rear end and the piston at its front end making a snug sliding fit in the internal cylindrical space of the cylinder 37.

The diaphragm 38 is preferably formed with a peripheral bead presented forwardly toward the removable cylinder head or cover plate 40, which is provided with a preferably integral internally screw-threaded rearwardly presented flange engaging an externally screw-threaded portion of the forward end of the cylinder 37 and formed in its rear face with a groove in line with the front face of edge of the cylinder 37 to receive the peripheral bead of said diaphragm 38 and to tightly clamp the peripheral edge portion of the said diaphragm between the cylinder 37 and the cylinder head or cover plate 40 to thus seal the joint between the cylinder 37 and the cylinder head or cover plate 40 at all points against the escape of fluid, the joint between the piston 34 and the diaphragm and thrust or piston rod 30 being similarly sealed at all points by the nut 36 clamping the diaphragm 38 and piston tightly against the flange 32, such construction resulting in the provision of a fluid tight chamber 39 in the cylinder 37 and defined by the rear face of the cylinder head or cover plate 40 and the diaphragm and varying in size according to the variations in position of the cylinder 37 and sleeve 20 according to the oil pressure or absence thereof in the chamber 39.

After the cylinder head or cover plate 40 has been turned up tight it may be locked against unscrewing by any suitable means, for instance by tie wires passing through any number of a series of small holes in the radially outer rear portion of the rearwardly presented flange of the cylinder head 40 and corresponding holes in any of a plurality of webs or ribs formed in the outer peripheral wall of the cylinder 37 as shown.

Similarly, the nut 36 is locked to the end of the thrust or piston rod in any suitable manner, as by cotter pins passing through holes drilled through said nut 36 perpendicularly to its axis and fitting in slots extending axially of the screw-threaded front end nipple of said thrust or piston rod 30.

The said thrust or piston rod 30 is hollow or tubular in form with both ends open to constitute an oil duct with its rear end in communication with the oil duct or bore O of the engine shaft S and with its front end in communication with

the interior of the chamber 39, so that on oil being admitted under pressure to the oil duct or bore O it will flow through the thrust or piston rod 30 into the chamber 39 and shove the cylinder 37 and the sleeve 20 integral therewith together with the spider or cross-head 21 forward against the opposing force of the weights, overcoming the force of the latter and moving the sleeve 20 forward until the nut 27 abuts or engages the abutment face 27' of the front bush or bearing 2 and moving the blades 7 about their axes from high pitch to low pitch for take off and climbing. When the supply of oil under pressure is shut off and the oil return or drain is opened, the weights 11 will act, as the propeller rotates to turn the blades about their axes toward high pitch and as said blades thus turn their pitch pins will shove the spider or cross-head 21, together with the sleeve 20, cylinder 37 and cylinder head or cover plate 40 rearward, thus expelling the oil in the chamber 39 through the thrust or piston rod 30, oil duct or bore B and suitable drain tubing or piping, not shown, to the engine crank-case or a sump, not shown, from which it will eventually be returned to the oil pump or source of oil under pressure, or, in the case of a self-contained oil pressure system within the propeller as an operative unit, from the chamber 39 through the thrust or piston rod to the rear of the abutment plate or disc 33 and from there back to the fluid system of the hydraulic mechanism to be held in a suitable reservoir or other storage means to be again used as the occasion may require.

While I prefer to supplement the piston 34 by the diaphragm 38 to provide a more efficient liquid sealing off of the expansion chamber of the cylinder, the use of such a diaphragm is not essential and it may be dispensed with.

Also, while I have shown and described a propeller in which the blades are moved to low pitch by the hydraulic mechanism, that is, by the admission of oil under pressure to the chamber 39, and are moved back to high pitch position by the weights 11, the arrangement might equally well be exactly the reverse, the hydraulic mechanism in such case moving the blades to high pitch and holding them in high pitch during straight away flying and the weights 11 tending to move the blades to low pitch, in this supplementing the normal inherent action of the blades masses, or the weights in such case might be entirely eliminated and reliance placed altogether on the centrifugal action of the blade masses to return the blades to low pitch position.

From the foregoing description it will be seen that when the cylinder head or cover plate 40 has been removed the piston assembly can be easily and quickly removed as a unit, simply by pulling forward on the front nipple of the thrust or piston rod 30 or on the diaphragm 38; and also that the hydraulic system may be removed as a unit simply by removing the lock pin 15 and then turning the sleeve 20 to screw it forward until it is free of the spider or cross-head 21 and the adjusting nut 27.

The access opening 28 will be of such size or diameter, preferably from a fourth to three eighths of an inch in diameter, to permit the insertion and manipulation as necessary of a suitable tool or instrument to either hold the nut 27 stationary or to manipulate it to turn it to move it in either axial direction with relation to the sleeve 20, and said opening will preferably be closed by any suitable removable and replaceable closure means, preferably a screw-plug 29.

Engagement between the rear face of the cylinder 37 and the front end of the bushing or bearing 2 functions to limit the rearward reciprocatory movement of the sleeve 20 in the bearings 2 and 3 of the hub 1, preventing such rearward movement of the sleeve 20 beyond its position shown in Figure 1.

We claim:

1. A controllable pitch propeller comprising a hub, propeller blades mounted in said hub, and pitch pins respectively extending from said blades, in combination with a sleeve slidably mounted for reciprocation in said hub and having a medial externally screw-threaded portion, hydraulic mechanism for forcing said sleeve in one direction axially thereof, releasable means for locking said sleeve against rotary movement relative to said hub while permitting its axial movement therein, a spider having screw-thread engagement with the screw-threaded portion of said sleeve and carrying means engaging said pitch pins to cause said blades, spider and sleeve to move together in either axial direction of movement of said sleeve, and an adjustable pitch movement limiting nut having screw-thread engagement with the screw-threaded portion of said sleeve and normally turning therewith and limiting the extent of the power thrust movement thereof by engaging a relatively fixed part carried by said hub, and means for holding said spider against substantial partial rotation with said sleeve, said hub being formed with a closable access opening to permit adjustment of said nut axially of the sleeve in the assembled operative condition of the propeller either independently of, or simultaneously and to the same extent with, said spider, said spider being adjustable to different positions axially of the sleeve independently of said nut.

2. A controllable pitch propeller comprising a hub, propeller blades mounted in said hub, and pitch pins respectively extending from said blades, in combination with a sleeve slidably mounted for reciprocation in said hub and having an externally screw-threaded portion, hydraulic mechanism for forcing said sleeve in one direction axially thereof, releasable means for locking said sleeve against rotary movement relative to said hub while permitting its axial movement therein, a spider having screw-thread engagement with the screw-threaded portion of said sleeve and carrying means engaging said pitch pins to cause said blades, spider and sleeve to move together in either axial direction of movement of said sleeve, and an adjustable pitch movement limiting nut having screw-thread engagement with the screw-threaded portion of said sleeve and normally turning therewith and limiting the extent of the power thrust movement of said sleeve by engaging a relatively fixed part carried by said hub, said spider being adjustable to different positions axially of the sleeve independently of said nut by rotation of said sleeve relative to said hub.

3. A controllable pitch propeller comprising a hub, propeller blades mounted in said hub, and pitch pins respectively extending from said blades, in combination with a sleeve slidably mounted for reciprocation in said hub and having an externally screw-threaded portion, hydraulic mechanism for forcing said sleeve in one direction axially thereof, releasable means for holding said sleeve against rotary movement rel-

ative to said hub while permitting its axial movement therein, a spider having screw-thread engagement with said sleeve and carrying means engaging said pitch pins to cause said blades, spider and sleeve to move together in either axial direction movement of said sleeve, and a nut having screw-thread engagement with said sleeve and normally turning therewith and limiting the extent of the power thrust movement of said sleeve by engaging a relatively fixed part carried by said hub, said nut being adjustable to different positions axially of the sleeve independently of said spider in the assembled operative condition of the propeller.

4. A controllable pitch propeller comprising a hub, and propeller blades mounted in said hub, in combination with a sleeve slidably mounted for reciprocation in said hub and having an externally screw-threaded portion, hydraulic mechanism for forcing said sleeve in one direction axially thereof, releasable means for locking said sleeve against rotary movement relative to said hub while permitting its axial movement therein, a spider having screw-thread engagement with said sleeve, means for preventing substantial rotary movement of said spider relative to said hub and for so connecting said spider and blades that said blades, spider and sleeve move together in either axial direction movement of said sleeve, and a nut having screw-thread engagement with said sleeve and normally turning therewith and limiting the extent of the power thrust movement of said sleeve by engaging a relatively fixed part carried by said hub, said spider and nut being adjustable to different positions axially of the sleeve independently of each other.

5. A controllable pitch propeller comprising a hub, and propeller blades mounted in said hub, in combination with an element slidably mounted for reciprocation in said hub and having an externally screw-threaded portion, hydraulic mechanism for forcing said element in one direction axially thereof, releasable means for holding said element against rotary movement relative to said hub while permitting its axial movement therein, a spider having screw-thread engagement with said element, means for so connecting said spider and blades that said blades, spider and element move together in either axial direction movement of said element, and a nut having screw-thread engagement with said element and normally turning therewith and limiting the extent of the power thrust movement of said element by engaging a relatively fixed part carried by said hub, said spider being adjustable to different positions axially of said element independently of said nut, said nut being adjustable to different positions axially of said element independently of said spider, and said spider and nut being simultaneously adjustable to different positions and to the same extent axially of said element by rotating said element with relation to both said spider and nut.

6. A controllable pitch propeller comprising a hub, propeller blades mounted in said hub, a spider disposed in said hub for movement in the direction of the axis thereof, said spider being internally screw-threaded, means for preventing rotary movement of said spider relative to said hub and for so connecting said spider and blades that said blades will move about their axes simultaneously with, and in proportion to the extent of, an axial movement of said spider, and an abutment having a smooth bore extending axially of the hub and sealing off at all other points a space to the rear of said abutment, in combination with hydraulic control means for forcing said spider axially of said hub in one direction and permitting its reverse axial movement, means for limiting the extent of the axial movement of said spider, and releasable means for locking said hydraulic control means in the hub, said hydraulic control means comprising an externally screw-threaded sleeve fitting within and having screw-thread engagement with said spider and being slidably mounted in said hub, a cylinder carried by said sleeve, a tube fitting within the bore of said abutment and exerting a thrust against the latter and removable from said bore by a straight forward movement and establishing communication between the space behind said abutment and said cylinder, and means connected to said tube and disposed within said cylinder for causing the axially forward movement of said sleeve, said hydraulic control means being removable from, and replaceable in, said hub as a single unit and while all other parts of the propeller remain in normal operative assembled condition.

7. A controllable pitch propeller comprising a hub, propeller blades mounted in said hub, a spider disposed in said hub for movement in the direction of the axis thereof, said spider being internally screw-threaded, means for preventing rotary movement of said spider relative to said hub and for so connecting said spider and blades that said blades will move about their axes simultaneously with, and in proportion to the extent of, an axial movement of said spider, and an abutment having a smooth bore extending axially of the hub and sealing off at all other points a space to the rear of said abutment, in combination with hydraulic control means for forcing said spider axially of said hub in one direction and permitting its reverse axial movement, and releasable means for holding said hydraulic control means in the hub, said hydraulic control means comprising an externally screw-threaded sleeve fitting within and having screw-thread engagement with said spider and being slidably mounted in said hub, a tube fitting within the bore of said abutment and exerting a thrust against the latter and removable from said bore by a straight forward movement and establishing communication between the space behind said abutment and the interior of said hydraulic control mechanism, said hydraulic control means being removable from, and replaceable in, said hub as a single unit, and while all other parts of the propeller remain in normal operative assembled condition.

8. A controllable pitch propeller comprising a hub, propeller blades mounted in said hub, a spider disposed in said hub for movement axially thereof, said spider being internally screw-threaded, means for preventing rotary movement of said spider relative to said hub and for so connecting said spider and blades that said blades will move about their axes simultaneously with, and in proportion to the extent of, an axial movement of said spider, and an abutment having a bore extending axially of the hub, in combination with hydraulic control means for forcing said spider axially of said hub in one direction and permitting its reverse axial movement, and means for limiting the extent of the axial movement in one direction of said spider, said hydraulic control means comprising an externally screw-threaded element fitting within and having screw-thread engagement with said spider and being

slidably mounted in said hub, a tube fitting within the bore of said abutment and exerting force thereon and removable from said bore in a direction of the axis of said hub, said hydraulic control means being removable from, and replaceable in, said hub as a single unit.

9. A controllable pitch propeller comprising a hub, propeller blades mounted in said hub, a sleeve slidably reciprocally mounted in said hub, means so connecting said sleeve and blades that said blades will move about their axes simultaneously with, and in proportion to the extent of, an axial movement of said sleeve, a cylinder carried by the front end portion of said sleeve, and a cylinder head removably secured to said cylinder, in combination with a piston making a working sliding fit in said cylinder and having a central bore, a flexible diaphragm having its peripheral portion clamped between said cylinder and cylinder head and its central portion secured against said piston at all points about the bore thereof, an abutment plate having a smooth central bore concentric with said sleeve and cylinder and rigidly mounted in said hub, a tubular piston rod making a snug endwise sliding removable fit in the bore of said abutment plate and exerting a thrust against the same and having its front end portion rigidly secured to said piston and establishing communication between the space to the rear of said abutment plate and the space between said diaphragm and said cylinder head, said piston, piston rod and diaphragm being removable and replaceable as a unit by a simple axial pull or push when the cylinder head has been removed.

10. A controllable propeller comprising an integral one-piece hub, propeller blades mounted in said hub, a spider disposed in said hub for movement in the direction of the axis thereof, means for preventing rotary movement of said spider relative to said hub and for so connecting said spider and blades that said blades will move about their axes simultaneously with, and in proportion to the extent of, an axial movement of the spider, in combination with hydraulic control means connected with said spider for causing movement of said spider in one direction axially of said hub, means for limiting the extent of movement of said spider in said direction, and releasable means for locking said hydraulic control means in said hub, said control means being operable to adjust said spider to different positions axially of said hub, and said hydraulic control means being removable from and replaceable in said hub as a single operative unit.

11. In a controllable pitch propeller comprising a hub and blades mounted for pitch movement relative to said hub and to turn with said hub, an externally screw-threaded sleeve slidably mounted in the hub of the propeller for reciprocation axially of the hub, an internally screw-threaded spider having screw-thread engagement with the external screw-threads of said sleeve, means connecting said spider and the blades of the propeller to cause pitch movement of said blades by movement of said spider in one direction axially of the propeller hub, and releasable means for holding the sleeve against rotation relative to said hub and spider, said spider being



adjustable in position axially of the sleeve by rotating the sleeve within said spider.

12. In a controllable pitch propeller comprising a hub and blades mounted for pitch movement relative to said hub and to turn with said hub, an externally screw-threaded sleeve slidably mounted in the hub of the propeller for reciprocation axially thereof, an internally screw-threaded spider having screw-thread engagement with the external screw-threads of said sleeve, means for preventing rotation of said spider relative to said hub and for connecting said spider and the blades of the propeller to cause pitch movement of said blades by movement of said spider in one axial direction, a nut engaging the threads of said sleeve and normally turning therewith and limiting axial movement of said spider in said direction by engaging a relatively fixed part carried by said hub, and releasable means for holding said sleeve against rotation, said nut being adjustable axially of the sleeve independently of said spider.

13. In a controllable pitch propeller comprising a hub and blades mounted for pitch movement relative to said hub and to turn with said hub, an externally screw-threaded element slidably mounted in the hub of the propeller for reciprocation axially thereof, an internally screw-threaded spider receiving and engaging the threads of said element, means for preventing rotation of said spider relative to said hub and element and for connecting said spider and the blades of the propeller to cause pitch movement of said blades by movement of said spider in an axial direction, mechanism mounted in said hub and operative at will to cause an axial movement of said element and said spider connected thereto, said spider being adjustable in position axially of said element by turning the latter in said spider, and said mechanism and element being removable from and replaceable in said hub as a unit.

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