

Nov. 1, 1938.

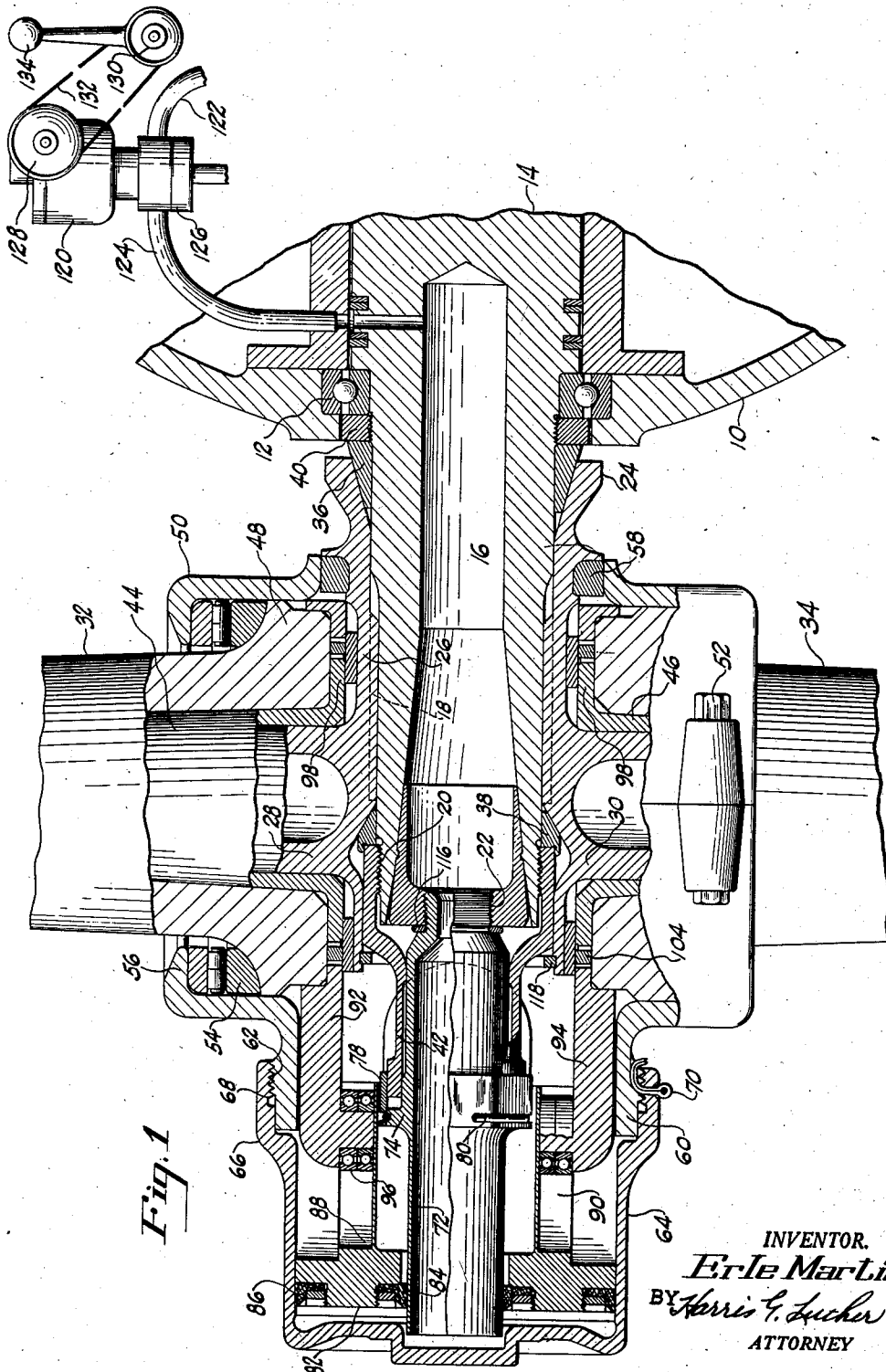
E. MARTIN

2,135,190

AERONAUTICAL PROPELLER

Filed March 26, 1936

5 Sheets-Sheet 1



Nov. 1, 1938.

E. MARTIN

2,135,190

AERONAUTICAL PROPELLER

Filed March 26, 1936

5 Sheets-Sheet 2

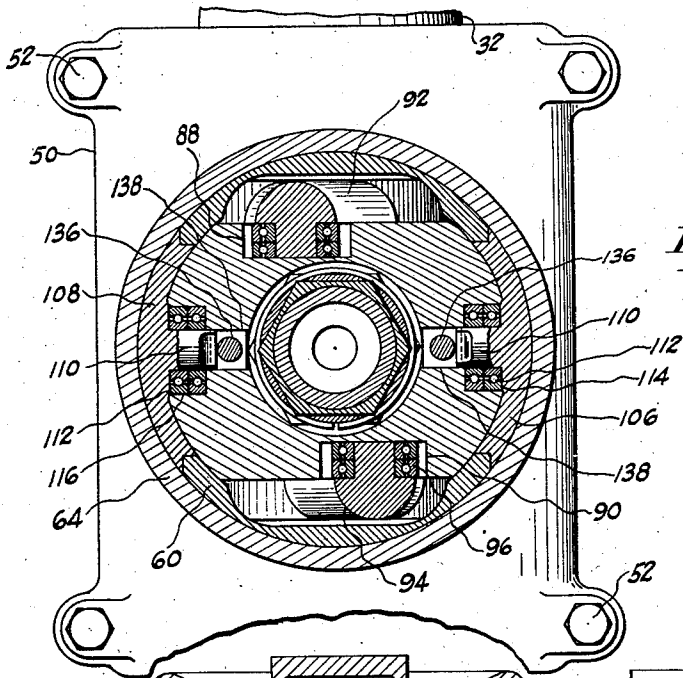


Fig. 2

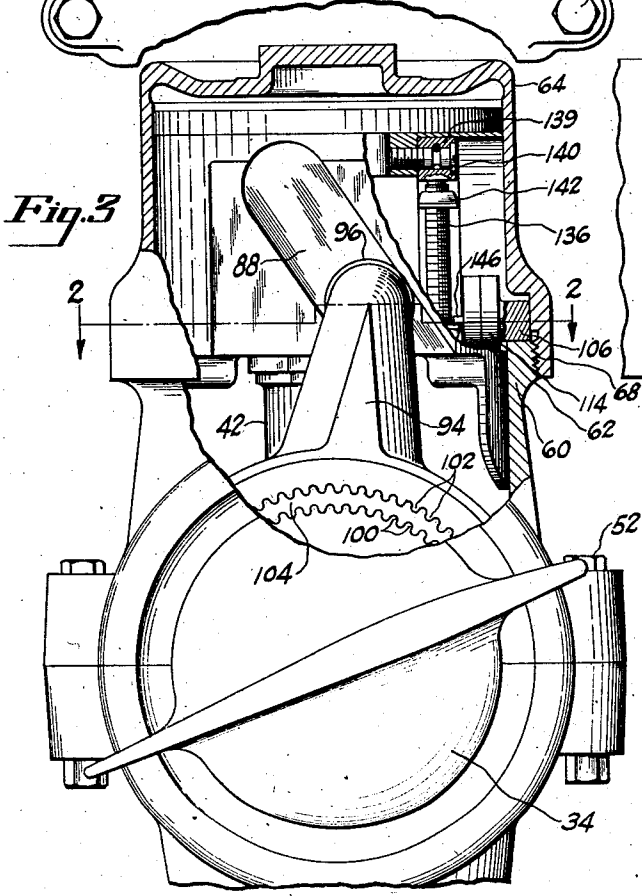


Fig. 3

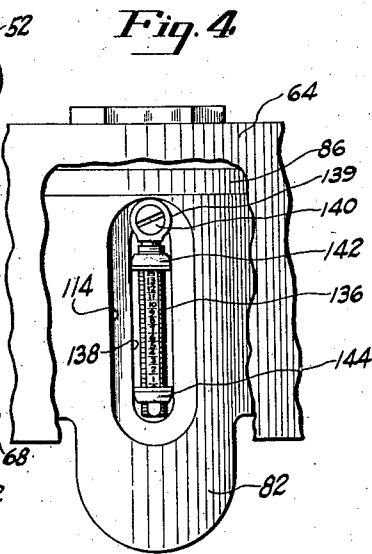


Fig. 4

INVENTOR.
Erle Martin
BY *Harris G. Lucher*
ATTORNEY

Nov. 1, 1938.

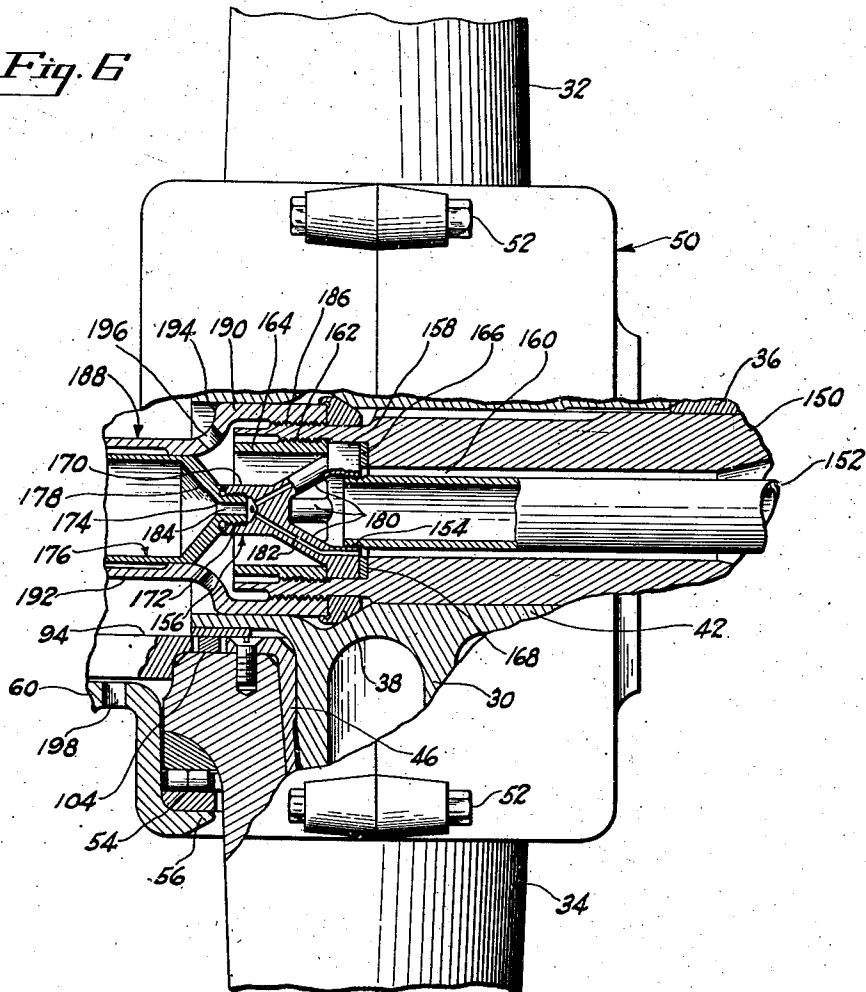
E. MARTIN
AERONAUTICAL PROPELLER

2,135,190

Filed March 26, 1936

5 Sheets-Sheet 4

Fig. 6



INVENTOR.
Erle Martin
BY *Harris G. Luther*
ATTORNEY

Nov. 1, 1938.

E. MARTIN

2,135,190

AERONAUTICAL PROPELLER

Filed March 26, 1936

5 Sheets-Sheet 5

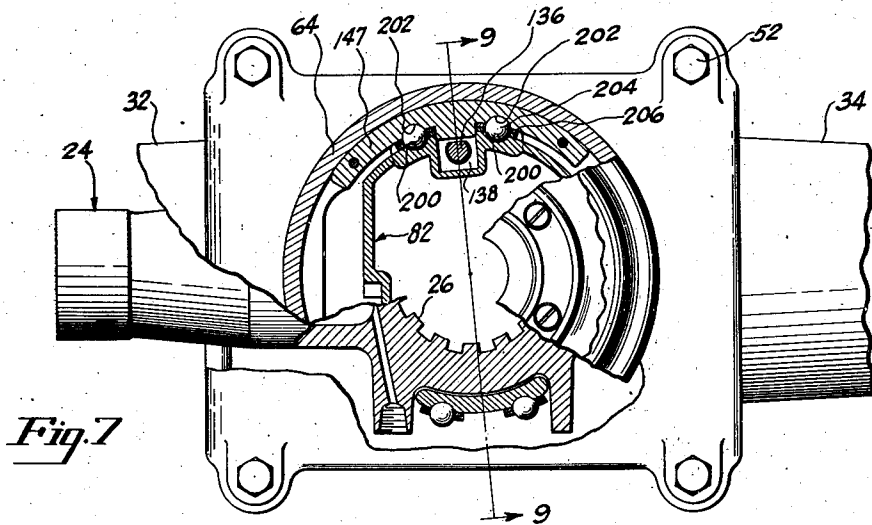


Fig. 7

Fig. 8

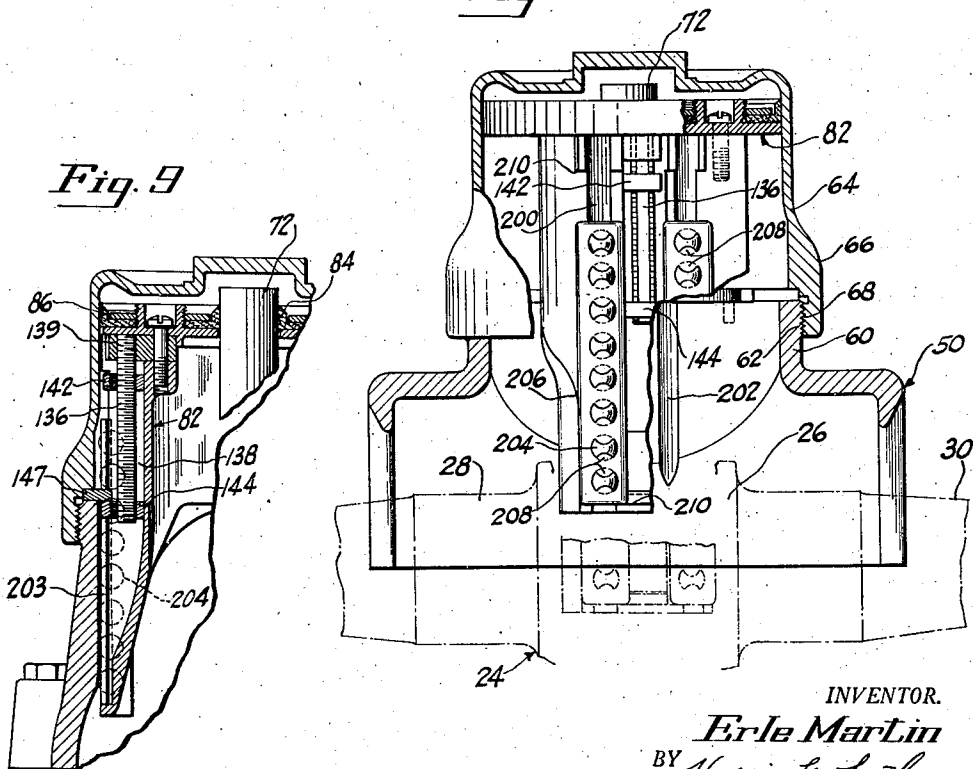
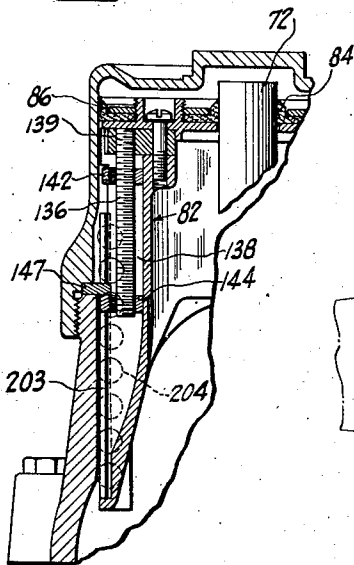


Fig. 9



INVENTOR.
Erle Martin
 BY *Harris G. Luther*
 ATTORNEY

UNITED STATES PATENT OFFICE

2,135,190

AERONAUTICAL PROPELLER

Erle Martin, West Hartford, Conn., assignor to
United Aircraft Corporation, East Hartford,
Conn., a corporation of Delaware

Application March 26, 1936, Serial No. 70,975

11 Claims. (Cl. 170-163)

This invention relates to 'improvements in aeronautical propellers and particularly to aeronautical propellers having rotatable blades and means for controlling the pitch angle thereof.

One of the objects of this invention lies in the provision in a propeller of the class described of an improved and simplified controlling means for the propeller blades. A further object resides in the provision of a blade controlling mechanism which is completely housed within a hollow casing sealed to the propeller hub.

Other objects and advantages will be apparent as the description proceeds.

In the accompanying drawings in which like reference numerals are used to designate similar parts throughout, there is illustrated a suitable mechanical embodiment of what is now considered to be the preferred form of the invention, and one somewhat modified form thereof. The drawings, however, are for the purpose of illustration only and are not to be taken as limiting the invention, the scope of which is to be measured entirely by the scope of the appended claims.

In the drawings:

Fig. 1 is an elevational view of a propeller hub and control mechanism constructed according to the idea of this invention, certain portions thereof being broken away and shown in section to better illustrate the construction and arrangement of the various parts making up the improved device.

Fig. 2 is a vertical sectional view on the line 2-2 of Fig. 1.

Fig. 3 is a plan view of the propeller hub and the controlling mechanism, portions thereof being broken away and shown in section to better illustrate the shape and arrangement of the various parts.

Fig. 4 is an elevational view of a fragmentary portion of the piston illustrated in Fig. 3 showing the piston stop mechanism illustrated in the upper right hand portion of Fig. 3.

Fig. 5 is an exploded view showing in perspective the various elements comprising a controllable pitch propeller constructed according to the idea of the invention.

Fig. 6 is a sectional view similar to Fig. 1 showing a somewhat modified form of the device of the invention.

Fig. 7 is a view similar to Fig. 2 showing a further modification of the idea of the invention.

Fig. 8 is a side elevational view of the controllable pitch propeller mechanism illustrated in Fig. 7, certain portions being broken away and

shown in section to better illustrate the construction thereof.

Fig. 9 is a sectional view of a fragmentary portion of the controllable pitch propeller mechanism rotated 90 degrees from the position illustrated in Fig. 8.

Referring to the drawings in detail, the numeral 10 indicates the front plate of a suitable engine upon which a propeller constructed according to the idea of this invention may be mounted. The front or nose plate 10 is provided with an aperture within which is disposed an annular bearing 12 and through the bearing 12 a power shaft 14 extends to provide a mounting for the propeller. The shaft 14 is tubular as indicated at 16 and is provided with longitudinal external splines 18 and with external and internal screw threads 20 and 22 respectively at its outward end. The propeller blades are secured upon the projecting end of the shaft 14 by means of a spider generally indicated at 24 which has an apertured cylindrical central portion 26 provided with internal splines which cooperate with the splines 18 to restrain the spider against rotation relative to the shaft 14, and with radially projecting arms 28 and 30 which extend within the interiors of the hollow ends of the propeller blades 32 and 34. The spider is rigidly retained in fixed position upon the projecting end of the shaft 14 by means of a pair of wedging conical shaped washers 36 and 38 which are disposed at the opposite ends of the spider and urged toward each other into wedging relation by means of the bearing retaining nut 40 against which the thick end of the washer 36 abuts and the screw threaded nut 42 which bears against the thick end of the washer 38 and is screw threaded upon the external screw threads 20 at the outer end of the shaft 14. A flanged sleeve as indicated at 44 and 46 is disposed between the inner wall of each hollow propeller blade 32 and 34 and the respective arm 28 or 30 of the spider 24. The arms 28 and 30 have a circular cross section throughout their length to provide outer bearing surfaces which cooperate with the similar inner bearing surfaces of the sleeves 44 and 46 to provide bearing surfaces between the sleeves and the arms so that the propeller blades may be rotated about the axes of the arms of the spider, the blades being shrunk upon the sleeves to provide a rigid connection between each propeller blade and its included sleeve. While a two bladed propeller is illustrated, it is to be understood that the invention applies as well to a propeller having three or more blades.

Each of the propeller blades is provided at its root end with an outwardly extending flange as indicated at 48 and the blades are retained in position upon the spider by means of a barrel 5 generally indicated at 50 which is formed in two similar parts clamped together by suitable means such as clamp bolts 52. A bearing member as indicated at 54 is disposed between the flange of each propeller blade and the adjacent intumed end 56 of the barrel 50 to provide a suitable bearing surface to carry the load between the flange 48 and the barrel 50 caused by the action of centrifugal force when the propeller is rotating at high speeds. Preferably, though not necessarily, a ring 58 of some slightly resilient material such as micarta is disposed between the bearing surface of the barrel 50 and the spider 24.

The side of the barrel 50 remote from the engine front plate 10 is provided with an enlarged circular aperture surrounded by an outwardly projecting flange 60 having external screw threads 62 thereon. A hollow cup shaped cylinder 64 having at its open end a flare 66 provided with internal screw threads 68 is screw threaded upon the flange 60 to provide at the forward end of the barrel the cylinder of a hydraulic device for controlling the pitch angle of the blades 32 and 34 of the propeller, the cylindrical member 64 being locked against rotation with respect to the barrel 50 by suitable locking means such as the bent-over cotter key 70.

A tubular member 72 is secured to the outer end of the shaft 14 by means of the internal screw threads 22 and forms a forward projection of the shaft terminating a slight distance short of the inner wall of the end of the cylindrical member 64 to provide a continuous passage for hydraulic fluid through the tubular shaft to a position adjacent to the outer end of the cylinder. This member 72 is provided intermediate its length with a flange 74 having a hexagonal circumference. The nut 42 terminates in a hexagonal portion 76 which lies adjacent to the hexagonal flange 74 when the members 42 and 72 are in their assembled relation. Preferably the members 42 and 72 rotate in opposite directions when being screw threaded upon the end of shaft 14 and are rigidly locked in assembled relation with the shaft by means of a hexagonal collar 78 which overlies both of the hexagonal members 74 and 76 and is retained in operative position by suitable locking means such as the binding wire 80. An apertured piston generally indicated at 82 is disposed within the cylindrical member 64 surrounding the tubular member 72 and is provided with fluid seals 84 and 86 in the form of leather rings cooperating with the walls of the cylindrical member 64 and the tubular member 62 respectively to prevent the passage of hydraulic fluid between the piston and the cylinder and tubular member.

From the construction so far described, it will be observed that fluid under pressure forced through the tubular shaft 14 and the tubular extension 72 will be led into the space between the forward wall of the cylinder 64 and the forward end of the piston 82 and will cause the piston to move rearwardly or in a direction toward the axis of the propeller blades 32 and 34. In order to convert this rectilinear movement of the piston into a rotary movement of the propeller blades to adjustably control the pitch angle of the blades the following mechanism is provided. The piston is provided with a plurality of spirally extending elongated cam slots as indicated at 88

and 90, there being one such cam slot for each blade of the propeller. Each of the propeller blades is provided with an outwardly extending arm as indicated at 92 and 94 and each arm carries a roller in the form of an anti-friction bearing as indicated at 96 which lies within the corresponding cam slot 88 or 90 to provide a cam follower so that the side walls of the spiral cams will impose a lateral thrust upon the arms 92 and 94 to rotate the arms about the axes of the respective propeller blades to which they are secured. The cam slots 88 and 90 are sloped at an angle such that the blades will be turned by a predetermined force applied to the piston. Each of the arms 92 and 94 has formed there-with an annular ring which surrounds the outwardly flanged base portion 98 of the sleeve 44 or 46. The base portions of the sleeves and the ring portions of the arms are provided with teeth 100 and 102 respectively as particularly illustrated in Fig. 3, the outer circumference of the base portion of the sleeve and the inner circumference of the ring portion of the arm being spaced apart to provide space for a ring 104 provided upon both sides thereof with teeth cooperating with the teeth 100 and 102 to non-rotatably secure the arm to its respective sleeve. The number of teeth 100 is less than the number of inter-meshing teeth on the ring member 104 and the number of teeth on the outer surface of the ring 104 is less than the number of teeth 102, so that by suitably selecting the number of teeth, a vernier adjustment of an angle less than the space of one tooth may be obtained between the arm and the sleeve, thus the arm may be adjusted to provide a desired pitch angle of the propeller within a tolerance of one tenth of one degree if desired. If now the piston 82 be moved in the cylinder 64, a reactive force will be exerted between the sides of the cam slots 88 and 90 and the respective arms 92 and 94 to move the arms to rotate the propeller blades 32 and 34 and rotate the piston 82 in the opposite direction. Suitable mechanism to restrain the piston against rotation relative to the cylinder 64 to insure that the force transmitted to the piston will be in turn transmitted to the arms for rotation of the propeller blades is particularly illustrated in Fig. 2, and a somewhat modified form thereof is illustrated in Figs. 7, 8, and 9 to be later described. The form of mechanism particularly illustrated in Fig. 2 comprises a plurality of partly cylindrical base members as indicated at 106 and 108 set in indentations provided in the outer end of the flange 60 on the forward half of the barrel 24. Each of the base members 106 and 108 carries an inwardly projecting pin as indicated at 110, and upon each of these pins is rotatably mounted a hardened anti-friction roller 112 which rollers fit within longitudinally extending cam slots 114 and 116 provided in the sides of the piston 82 and preferably located opposite to each other and at some convenient angle from the spiral cam slots 88 and 90. While the cam slots 114 and 116 are illustrated as straight grooves it is within the scope of the invention to provide these cam slots with a curvature opposite to the curvature of the slots 88 and 90 to rotate the piston 82 in a direction to increase the lateral movement of the arms 92 and 94. With this construction the reactive force tending to rotate the piston 82 when the piston is forced outwardly to increase the angle of the propeller blades, is transmitted by the rollers 112 and base portions 106 and 108 to the fixed barrel

member and thus the movements of the piston caused by the introduction of pressure fluid into the space between the piston and the forward end of the cylinder are transmitted in full force to the arms 92 and 94 and thence to the respective propeller blades 32 and 34.

The piston 82 is single acting, that is, the pressure of the hydraulic fluid will urge it in one direction of movement only and in order to obtain reciprocation of the piston in the opposite direction some force outside of the hydraulic mechanism must be relied upon.

This force is the natural tendency of the propeller blades to assume their lowest pitch position, which tendency is caused by the action of centrifugal force which sets up turning moments in the blades upon opposite sides of the longitudinal axes, such moments acting in opposite directions to exert a rotational couple tending to bring the major axis of the blade section into the plane of rotation of the blade. Thus there are two forces, the force of the pressure fluid acting on the blade in one direction and the rotational moments of the blades acting in the opposite direction, acting to rotate the blades to control the pitch angles thereof. If it is desired to increase the pitch angle of the blade pressure fluid is admitted behind the piston 82 to force the piston backwardly and thereby forceably rotate the blades to a higher pitch position by the reaction of the spiral cam slots 88 and 90 upon the respective cam followers. When it is desired to adjust the blades to a low pitch position, or when the speed responsive device controlling the adjustment of the propeller acts under the influence of decreasing rotational speed to adjust the blades to a lower pitch angle, hydraulic fluid is allowed to drain out of the space between the piston 82 and the cylinder 64, whereupon the centrifugal forces acting upon the blades to produce the turning moments described above will cause the blades to rotate toward a lower pitch angle position and will at the same time move the piston toward the closed end of the cylinder 64. In going from a low pitch to a high pitch position the blade angle may be stopped by the speed responsive device or a manual control connected therewith at any desired angle by simply shutting off the supply of pressure fluid to the piston 82 and the propeller may be held in such position by maintaining the pressure fluid line blocked so that no fluid can enter or leave the space between the piston 82 and the cylinder 64. In passing from a high pitch position, the pressure fluid is drained out of the space between the piston and the cylinder and the mechanism may be stopped at any position of pitch angle adjustment of the propeller blades by blocking the pressure fluid line to stop the piston 82 at the proper or desired pitch angle of the propeller blades.

The joint between the end of the shaft 14 and the cooperating end of the tubular member 72 is preferably sealed against leakage of hydraulic fluid by means of a suitable gasket 116. A snap ring 118 is disposed in the outer end of the cylindrical portion of the spider 24 so that the spider may be withdrawn from the shaft 14 by unscrewing the nut 42.

The introduction of pressure fluid to the space between the piston 82 and the cylinder 64 is preferably controlled by a speed responsive device such as the engine driven governor generally indicated at 120. This governor has a connection 122 with a source of fluid under pressure such as a lubricating system of the engine or an auxiliary

fluid pressure pump and has a second connection 124 leading to the interior of the tubular shaft 14. Between the connections 122 and 124 there is a governor controlled valve within the casing 126. The action of the governor may be controlled by a manually actuatable mechanism including the pulleys 128 and 130, the cable 132 and the hand lever 134; however, as the specific governor and its manual control do not form a definite part of the invention it is believed that a detailed description thereof is not necessary for the purpose of this disclosure.

In order to confine the adjustment of the pitch angle of the propeller blades within certain predetermined limits, there is provided a suitable adjustable stop mechanism particularly illustrated in Figs. 3, 4, and 5. This mechanism includes screw threaded shanks 136 disposed in elongated depressions 138 let into the piston 82 within the cam slots 114 and 116 or between the cam grooves in the modified form of bearing shown in Figs. 7, 8, and 9. The shanks 136 are securely anchored at one end by suitable means such as the shank heads 139 fitted into suitable bores provided in the piston and held in place by set screws, as indicated at 140. Each shank carries thereon a pair of spaced apart nuts as indicated at 142 and 144 in Figs. 3, 4, 5, 8, and 9, and each of the roller carrying pins 110 is provided with a flattened extension as indicated at 146 which cooperates with the nuts 142 and 144 to limit the travel of the piston and consequently, the action of the spiral cam slots 88 and 90 on the respective arms 92 and 94. In the modified bearing construction the cylinder is provided with a detent 147 which engages with the nuts 142 and 144 in the manner described above.

In the modification of the invention illustrated in Fig. 6, the power shaft 150 is provided interiorly thereof with an axially disposed breather tube 152 leading from the interior of the engine crank case and venting the crank case to the surrounding atmosphere. The outer end of the breather tube 154 terminates somewhat short of the end of the power shaft 150 and is provided at this end with exterior screw threads 154 upon which is screw threaded a member generally indicated at 156. The member 156 comprises an annular ring portion 158 provided interiorly thereof with screw threads cooperating with the screw threads 154 upon the end of the breather tube 152. The ring portion 158 fits into an enlargement at the end of the bore of the power shaft and serves to maintain the breather tube 152 in concentric relation to the power shaft so that an annular space 160 is provided between the exterior of the breather tube and the wall of the power shaft bore. Within the enlarged portion adjacent to the end thereof, the power shaft is provided with interior screw threads 162 into which is screw threaded the tubular member 164, bearing at its inner end upon the outer surface of the ring portion 158 to firmly secure member 156 in the outer end of the power shaft. A gasket 166 is disposed between the inner surface of the ring portion 158 and the shoulder 168 defining the inner end of the enlarged portion of the power shaft bore to provide a fluid seal between the member 156 and the power shaft. The member 156 further comprises a cylindrical portion 170, concentric with the ring portion 158 and spaced therefrom in a forward direction when the member 156 is assembled in the power shaft. This cylindrical portion 170 is provided with a screw threaded well 172 into which is screw threaded the reduced end 174 of the tubular

member generally indicated at 176, the walls of the tubular member being connected with the reduced portion 174 by a conical end portion 178. The cylindrical portion 170 of the member 156 is connected to the ring portion 158 by a plurality of diverging integral tubular members indicated at 180, each tubular member being provided with an interior channel as indicated at 182 leading from the space between the breather tube and the bore of the power shaft to the bottom of the well 172 in the cylindrical portion 170. A channel 184 extends through the reduced portion 174 of the member 176 and connects the ends of the channels 182 with the interior of the tubular member 176 so that fluid flowing through the space between the breather tube 152 and the bore of the power shaft 150 may flow through the channels 182 in the member 156 and through the channel 184 to the interior of the tubular member 176.

At its outer end, the power shaft 150 is provided with external screw threads 186 substantially opposite the screw threads 162 and an outer tubular member 188 has its expanded end portion 190 threaded upon the screw threads 186. This member 190 at its inner, or rearward, end bears against a tapered washer 38, which serves to maintain the spider 24 upon the power shaft 150. Beyond the expanded end portion 190, the outer tubular member 188 is provided with a cylindrical portion 192 which fits closely about the exterior of the cylindrical portion of the tubular member 176. The cylindrical portion 192 of the member 188 is connected with the expanded end portion 190 by a curved fillet portion 194 provided with a plurality of apertures 196 which provide a fluid passage from the end of the power shaft to the interior of the propeller barrel 50. The propeller barrel may be provided with apertures as indicated at 198 preferably located in the forwardly directed flange 60 thereof to provide a fluid passage from the interior of the barrel to the surrounding atmosphere.

From the above description, it will be observed that a fluid passage is provided from the end of the breather tube 152 between the tubular portion 180 of the member 156 to the interior of the member 188 and thence through the apertures 196 to the interior of the barrel 50, and from the interior of the barrel 50 through the apertures 198 to the surrounding atmosphere so that breathing of the engine through the breather tube 152 is not interfered with by the application thereto of the controlling mechanism for the controllable pitch propeller.

The outer tubular member 188 is locked against relative rotation with respect to the inner tubular member 176 by a suitable lock connection such as that illustrated at 74, 76, 78, and 80 of Fig. 1 of the drawings. From this lock connection, the inner tubular member 176 extends forwardly through the hydraulic piston 82 to provide a passage way for hydraulic fluid from the interior of the engine to the propeller operating mechanism. In other respects, the propeller and the propeller operating mechanism may be the same as that illustrated in Figs. 1 to 5 inclusive.

In the further modified form of the invention illustrated in Figs. 7, 8, and 9, a bearing capable of supporting both radial and tangential loads is utilized instead of the bearing 114 described above.

In the modified form of construction the piston 82 is provided exteriorly thereof with a plurality of relatively shallow longitudinally extending

grooves 200 of partly circular cross section. These grooves are preferably arranged in pairs and the pairs are suitably spaced around the circumference of the piston so as to provide a pair of grooves on each side of the piston between the diagonal cam slots 88 and 90, or between each two adjacent cam slots where more than two cam slots are provided as would be necessary in case of a propeller having three or more blades. For convenience and compactness of construction the stop member 136 is located between the grooves of one pair.

The cylinder 64 is provided interiorly thereof with a plurality of similar grooves 202 corresponding to and overlying the respective grooves 200 to provide bores or wells of circular cross section between the piston and cylinder as is clearly illustrated in Fig. 7. These grooves 202 also extend along the interior of the flange portion 60 of the barrel member 50 as clearly illustrated at 203 in Fig. 9 since the flange portion 60 is utilized as a part of the cylinder the remainder of which is provided by the relatively short cylindrical cap 64.

Ball bearings 204 are retained in these grooves 200 and 202 by suitable retaining plates or cages 206. The cages are provided with suitable aligned apertures within which the balls are permanently secured by suitable means such as the bent over lugs or lips 208. For convenience in manufacture, the ball retaining cages may be made of two coincident plates, welded or otherwise suitably secured together.

The bearings, each comprising a retaining plate or cage and its associated bearing balls, are made shorter than the length of the grooves 200 and 202 so that the cage may move relatively to both the piston and the cylinder and the balls may roll therebetween as the piston moves in the cylinder. The cages are also made sufficiently rigid so that they will not be buckled or otherwise distorted if they should strike one of the piston carried stops 210 at one limit of travel before the piston had reached its limit of travel in the same direction.

With this modified form of bearing relative rotational movement between the piston and cylinder will be resisted by the bearing balls in shear, a change in shape of the barrel and cap under centrifugal stress of the rotating propeller blades with a resulting tendency to bind the piston will be resisted by the bearing balls in compression. Any tendency of the piston to tilt or cock in the cylinder and barrel will also be resisted by the bearing balls in compression.

While there has been illustrated and described a particular mechanical embodiment of the idea of the invention and two somewhat modified forms thereof, it is to be understood that the invention is not limited to the particular embodiments so illustrated and described, but that such changes in the size, shape, and arrangement of parts may be resorted to as come within the scope of the sub-joined claims.

Having now described the invention so that others skilled in the art may clearly understand the same, what it is desired to secure by Letters Patent is as follows:

1. In a controllable pitch propeller, a hub, a plurality of blades rotatably mounted on said hub said blades having centrifugal moments of inertia tending to rotate the blades in one direction of pitch angle adjustment upon rotation of said propeller, a cylinder fixed to said hub, a piston having a plurality of straight cam slots

and a plurality of diagonal cam slots therein reciprocable in said cylinder to rotate said blades in a direction opposite to that induced by said moments of inertia, an arm on each propeller blade extending within said cylinder, a cam follower on each of said arms, said cam followers cooperating with respective diagonal cam slots to convert rectilinear movements of said piston into rotational pitch adjusting movements of said blades and rotational movements of said blades into rectilinear movements of said piston, members fixed to said hub, and cam followers on said fixed members cooperating with respective straight cam slots in said piston to restrain said piston against rotation in said cylinder.

2. In a controllable pitch propeller, a hub, a plurality of blades rotatably mounted on said hub, a cylinder fixed to said hub, a piston having a plurality of cam slots therein reciprocable in said cylinder, an arm on each propeller blade extending within said cylinder, a cam follower on each of said arms, said cam followers cooperating with respective cam slots to convert rectilinear movements of said piston into rotational pitch adjusting movements of said blades, and adjustable means for limiting the extent of movement of said propeller blades comprising, a screw threaded shank fixed on said piston, a pair of spaced apart nuts on said shank and a fixed projection on said hub cooperating with said nuts to limit the movements of said piston.

3. In combination with a tubular power shaft and a controllable pitch propeller driven by said shaft, a propeller hub non-rotatably mounted upon said shaft, a plurality of blades rotatably mounted on said hub, and means for controlling the pitch angle of said blades comprising, a cylinder fixed to said hub, an apertured piston reciprocable in said cylinder, a nut on the end of said shaft for maintaining said hub in assembled relation thereon, a tubular extension screw threaded onto the end of said shaft adjacent to said nut and projecting through the aperture in said piston, said nut and said extension having opposite screw threads adjacent polygonal portions on said nut and said extension, a polygonal ring overlying said portions to restrain said nut and said extension against rotation relative to each other or to said shaft, means for forcing fluid under pressure through said shaft and said extension to the space between said piston and cylinder, and means within said cylinder operatively connecting said blades with said piston to convert rectilinear movements of said piston in said cylinder into rotational movements of said blades.

4. In the combination of a controllable pitch propeller and an engine drive shaft for supporting and driving said propellers, a spider secured on said drive shaft and provided with radially extending arms, propeller blades mounted upon said arms and driven thereby, a barrel including said spider and the ends of said blades for supporting said blades against the action of centrifugal force, a cylinder on said barrel, a piston in said cylinder, a cam and follower connection between said piston and said blades for imparting rotational movement to said blades upon axial movement of said piston with respect to said cylinder, means for introducing hydraulic fluid under pressure through said drive shaft to the space between said piston and said cylinder to change the pitch of said blades, said cam and follower connection being disposed entirely within said cylinder, and means also included within

said cylinder for resisting the rotational force imparted to said piston by the reaction of said cam and follower connection.

5. In a controllable pitch propeller having a plurality of movable blades, a cylinder and piston device for changing the pitch of said propeller blades, adjustable stops located between said cylinder and said piston in a recess in said piston, and a fixed member secured on said cylinder co-acting with said stops to limit the maximum travel of said piston to determine the positive high and low pitch settings of said propeller blades.

6. In a controllable pitch propeller, a hub spider, a plurality of blades rotatably mounted on said spider, said blades having centrifugal moments tending to rotate them to low-pitch position upon rotation of said propeller, a hub barrel retaining said blades on said spider, and means for controlling the pitch angle of said blades comprising, a cylinder fixed on said hub barrel, a piston provided with two sets of cam slots in which respective cam slots of said two sets are disposed at an angle to each other, hydraulic means for moving said piston in said cylinder in a direction to turn said blades to high-pitch position, cam followers within said cylinder but outside of said spider cooperating with respective cam slots of one of said sets and connected with said propeller blades within said barrel to convert rectilinear movements of said piston in said cylinder into rotational movements of said blades, and means cooperating with the cam slots of the other of said sets to control the rotation of said piston relative to said cylinder.

7. In a controllable pitch propeller, a hub spider, a plurality of blades rotatably mounted on said spider, a hub barrel for retaining said blades on said spider, and means for controlling the pitch angle of said blades comprising, a cylinder fixed to said hub barrel at one side thereof, a piston having a plurality of diagonal cam slots movable in said cylinder, hydraulic means for moving said piston, a cam follower attached to each propeller blade within said barrel and cooperating with the respective diagonal cam slot within said barrel to convert rectilinear movements of said piston into rotational movement of said blades, and means within said cylinder acting between said cylinder and said piston for resisting the rotational force imparted to said piston by the reaction between said diagonal cam slots and said cam followers.

8. In a controllable pitch propeller, a hub having a spider portion and a barrel portion in which said spider portion is adapted to be mounted on a propeller drive shaft and is provided with a plurality of integral radially extending blade carrying arms and said barrel portion substantially encloses said spider portion, a blade mounted for pitch changing movement on each radially extending arm, and means associated with said barrel portion for retaining said blades on said arms, a cylinder assembled on said barrel portion to one side of said spider portion, a piston in said cylinder, and a cam and cam follower connection between said piston and said blades disposed between said cylinder and barrel portion assembly and said spider portion for converting movements of said piston in said cylinder into pitch changing movements of said blades.

9. In a controllable pitch propeller, a hub including a spider portion and a barrel portion substantially surrounding said spider portion, a

plurality of blades carried by said spider portion and retained thereon for pitch changing movements by said barrel portion, a cylinder carried by said barrel portion outside of said spider portion, a hydraulically actuated piston in said cylinder, and a cam and cam follower mechanism within said cylinder and said barrel portion but outside of said spider portion operatively associated with said piston and said blades for converting movements of said piston in said cylinder into pitch changing movements of said blades.

10. In a controllable pitch propeller, a hub having a spider portion and a barrel portion in which said spider portion is adapted to be rigidly mounted on a propeller drive shaft and is provided with a plurality of integral radially extending blade carrying arms and said barrel portion substantially encloses said spider portion, a blade mounted for pitch changing movements on each radially extending arm, and means associated with said barrel portion for retaining said blades on said arms; a cylinder assembled on said barrel portion to one side of said spider portion, a piston in said cylinder, a cam and cam follower connection between said piston and said blades disposed between said cylinder and barrel portion assembly and said spider portion for converting movements of said piston in said cylinder into pitch changing movements of said

blades, and means supported by said barrel portion for opposing the reaction to the blade turning efforts of said cam and cam follower connection.

11. In a controllable pitch propeller, a hub having a spider portion and a barrel portion in which said spider portion is adapted to be rigidly mounted on a propeller drive shaft and is provided with a plurality of integral radially extending blade carrying arms and said barrel portion substantially encloses said spider portion, a blade mounted for pitch changing movement on each radially extending arm, and means associated with said barrel portion for retaining said blades on said arms; a cylinder assembled on said barrel portion to one side of said spider portion, a piston in said cylinder, a cam and cam follower connection between said piston and said blades disposed between said cylinder and barrel portion assembly and said spider portion for converting movements of said piston in said cylinder into pitch changing movements of said blades, and a relatively fixed cam and cam follower mechanism supported by said hub for opposing the reaction to the blade turning force exerted by said piston on said first mentioned cam and cam follower connection.

ERLE MARTIN.