

Nov. 28, 1933.

L. J. KOZUB

1,936,677

SELECTIVE PITCH PROPELLER

Filed Jan. 16, 1930

2 Sheets-Sheet 1

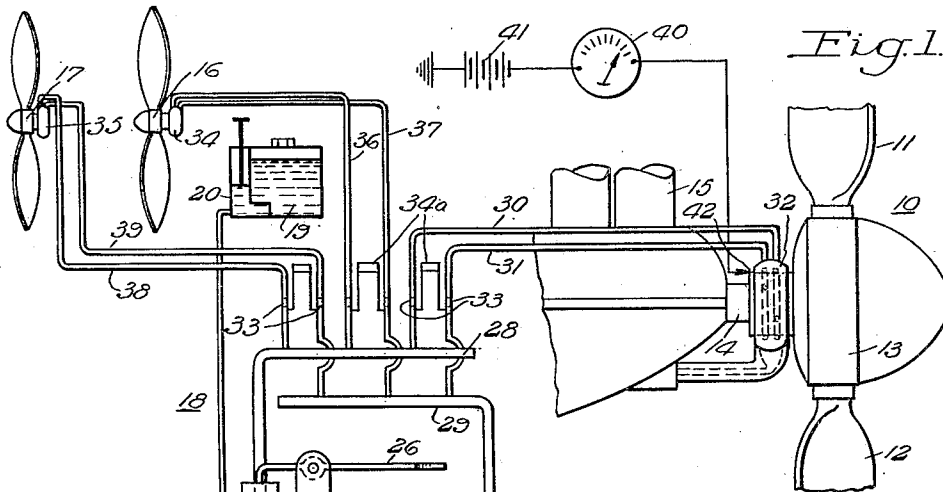


Fig. 1.

Fig. 3.

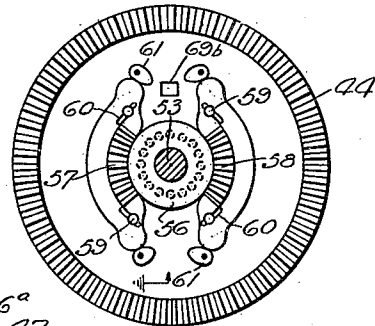
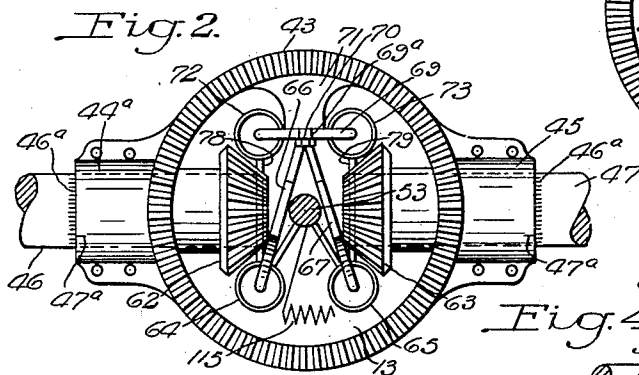


Fig. 2.

Fig. 4.

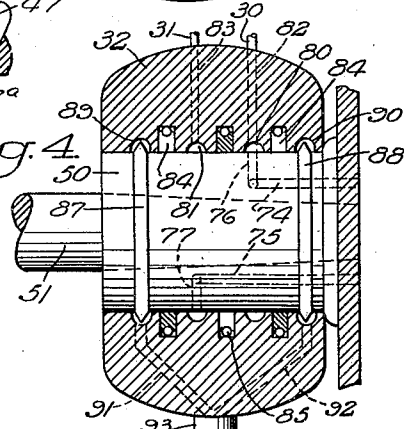


Fig. 5.

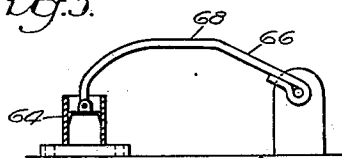
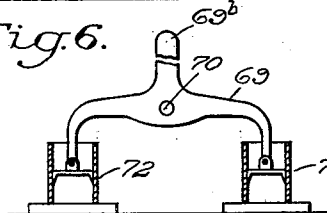


Fig. 6.



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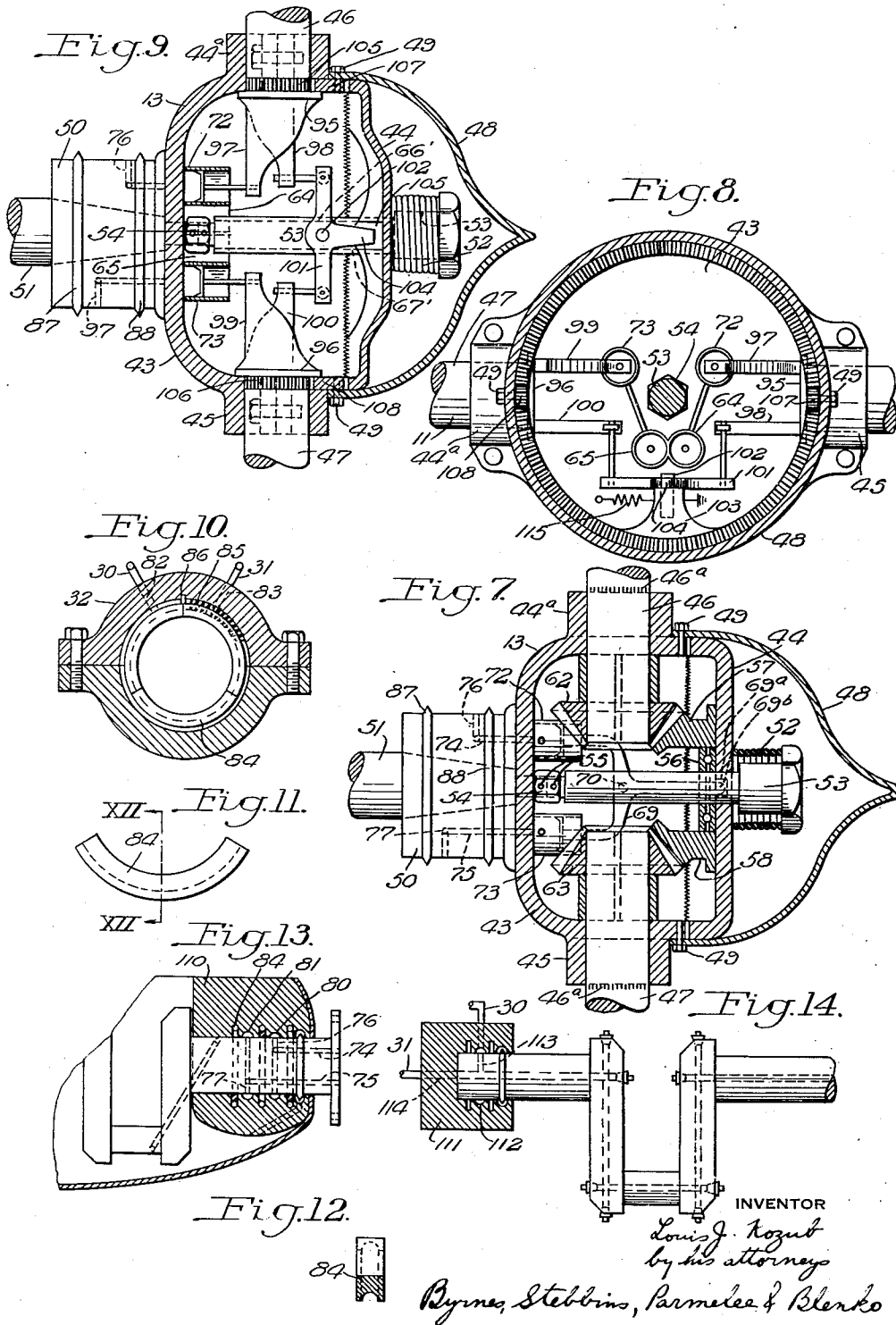
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

1,936,677

SELECTIVE PITCH PROPELLER

Louis J. Kozub, Pittsburgh, Pa.

Application January 16, 1930. Serial No. 421,138

19 Claims. (Cl. 170-163)

My invention relates to a mechanism for shifting the angular position of the blades of a screw propeller and, particularly, to a hydromechanical device for controlling the pitch of airplane propeller blades.

It has been recognized for some time that the provision of some means to effect changes in the angular positions of airplane propeller blades while the propeller is revolving would be a great step forward in airplane transportation. Several modifications of devices for accomplishing this object have been put forth but none of them, so far as I am aware, is without serious disadvantages. In one such modification, a hydraulic system is employed, the actuating medium comprising a circulating oil stream. This modification, however, is applicable only to chain driven propellers, since no means is provided for introducing the fluid between the propeller hub which carries the operating mechanism and the crank shaft of the propeller motor. This disadvantage is very serious, since modern practice in airplane construction requires that the propeller be mounted directly on the motor crank shaft. This modification is also handicapped by the circulating fluid stream and the fact that the system is always under pressure when in use.

Other modifications include mechanical systems or combined hydraulic and mechanical systems. One of these is a system having a mechanical linkage adapted to be actuated by hydraulic pistons on a stationary frame. Because of the complexity of the mechanical linkage, the results obtained in practice from this modification are not promising.

I have obviated the difficulties met with heretofore in attempts to provide means for shifting the angular position of the propeller blades by the use of a novel arrangement of the mechanical connections and the hydraulic operating system. According to the invention, the blades of the propeller are swivelled in a hub which is mounted directly on the shaft of the driving motor. The hub contains remotely controlled blade shifting means. The propeller blades are normally locked in adjusted position by means of a positive mechanical clutch. I provide a normally static fluid column having pilot control means for applying opposing pressures to the ends thereof, and means for the transmission of such pressures through this column to the blade shifting mechanism which is carried within the propeller hub. This fluid pressure is also utilized to release the clutch to permit adjustment of the blade position and, after the

adjustment has been effected, the release of the pressure permits the clutch to re-engage the blades in their adjusted position.

By the use of the invention, it is possible to adjust simultaneously a plurality of propellers or to effect an individual adjustment of each of the propellers of a multi-motored airplane. Since the operating fluid pressures are transmitted through the revolving shaft, the invention is applicable to propellers which are mounted directly on the motor shaft. The invention is not limited to two-bladed propellers but is applicable to a propeller having any number of blades. The means for transmitting the fluid pressure through the rotating shaft include a stationary member having annular grooves therein cooperating with radial holes or channels in the motor shaft or the propeller hub secured thereto. The grooves are separated by spring contracted, stationary, non-friction oil rings. The radial holes or channels connect with axial holes which transmit the actuating fluid pressure directly to the operating mechanism within the propeller hub.

In addition to providing for the desired adjustment of the propeller blades while the propeller is revolving, I also provide means for effecting an initial adjustment of the blades to insure that both blades will be given the same movement. I also provide means for preventing fluttering of the blades while the propeller is revolving. These means take the form of auxiliary locking means which grip the swivelled blades firmly to hold them in the adjusted position.

Indicating means are provided to inform the operator of the extent of the change in the angular position of the blades. It is thus possible to know at all times in what direction, and to what extent, the blades should be shifted to accommodate the exigencies of any particular situation.

I have illustrated in the accompanying drawings a present preferred embodiment of the invention with certain modifications thereof. It is to be understood, of course, that the illustrated embodiments in nowise limit the scope of the invention, as it may be otherwise practiced within the scope of the broader claims.

In the drawings,

Figure 1 is a diagrammatic view of the system for shifting the position of propeller blades,

Figure 2 is a side elevation of the propeller hub which contains the operating mechanism, the cover of the hub being removed,

Figure 3 is a plan view of the cover which cooperates with the hub shown in Figure 2,

Figure 4 is a sectional view through the axis of

the motor shaft, showing the details of the means for supplying fluid under pressure to the revolving propeller hub,

Figures 5 and 6 illustrate details of the structure shown in Figure 2,

Figure 7 is a sectional view showing the arrangement of the modification illustrated in Figures 2 and 3,

Figure 8 is a view similar to Figure 2 of a modified form of blade shifting means,

Figure 9 is a sectional view of the modification of Figure 8,

Figures 10, 11 and 12 illustrate details of the structure shown in Figure 4.

Figure 13 illustrates a modified form of the apparatus shown in Figure 4, and

Figure 14 represents a further modification of the structure of Figure 4.

Referring in detail to the drawings, and particularly to Figure 1, an airplane propeller 10 comprises blades 11 and 12 rotatably mounted in a hub 13. The hub 13 is secured to the shaft 14 of a vertical motor 15. Additional propellers 16 and 17 may be mounted on the same airplane and are identical in arrangement with that shown at 10.

In order to shift the blades of the propellers 10, 16 and 17 to the desired position, I provide a hydraulic pilot control system indicated generally at 18, which, in cooperation with remotely controlled means operated by hydraulic pressure contained within the hubs of the propellers, effects the desired adjustment of the blade position. The hydraulic pilot control system 18 includes a reservoir 19 having a priming pump 20. A pair of cylinders 21 and 22 having reciprocable pistons therein are connected to the reservoir 19 by a pipe 23 and the connections to the cylinders are provided with check valves 24 and 25. Operating handles 26 and 27 are pivoted in suitable supports for reciprocating the pistons within the cylinders 21 and 22 to apply the required pressure to the operating fluid column.

The pressure applied to the pistons within the cylinders 21 and 22 is transmitted through a pair of headers 28 and 29. Pipes 30 and 31 lead from the headers 28 and 29 to a stationary bearing collar 32 on the hub of the propeller 10. This collar affords a means for introducing fluid under pressure to the blade shifting mechanism within the hub, although the latter revolves with respect to the source of fluid pressure. The details of this device will be described more fully later.

The pipes 30 and 31 include cut-off valves 33 adapted to be simultaneously operated by the handle 34a. The propellers 16 and 17 are also provided with bearing collars 34 and 35, similar to that shown at 32, and pipe lines 36, 37 and 38, 39, transmit fluid pressure from the headers 28 and 29 to the bearing collars 34 and 35.

The valves 33 in the pipe lines 30, 31, 36, 37 and 38, 39 permit individual control of the propellers 10, 16 and 17. By closing all the valves 33 except that in the pipe line to the propeller it is desired to control, any one of the propellers may be adjusted without affecting the pitch adjustment of the other propellers.

An indicating device 40, which preferably takes the form of a current meter, is connected in series with a current source such as a battery 41 and a control device within the propeller hub to be later described, through a rotating connection, such as a slip ring 42.

The control levers 26 and 27, the valves 33, and the indicators 40 of which one is provided

for each propeller, are preferably mounted within easy reach of the airplane pilot. It will thus be possible for him to readily bring about any desired adjustment of the propellers regardless of their location.

Referring now to Figures 2, 3 and 7, the hub 13 of the propeller 10 comprises a body 43 and a cover plate 44 which serves as a clutch member. Bearing sleeves 44a and 45 are formed integral with the body 43 for receiving the shanks 46 and 47 of the blades 11 and 12. A shield 48 covers the front of the hub and is secured to the body thereof by the screws 49. The body 43 of the hub is provided with a rearwardly projecting sleeve 50 integral therewith, which is adapted to receive the end 51 of the motor shaft 14.

The clutch member 44 has a splined connection with the forward edge of the body 43 of the hub 13 and is maintained in engagement therewith by means of a coil spring 52 which fits under the head of a pin 53. The pin 53 passes through a central hole in the member 44 and is secured to the shaft 51 by means of a nut 54 cooperating with the threaded reduced ends of the shaft and pin. The threaded connection between these members is supplemented by cotter pins 55 passing through the nut 54. The splined or toothed connection between the clutch member and body of the hub is such that relative rotation of these members is prevented as long as the clutch member engages the hub. When the clutch member is spaced from the hub slightly, for example, by a gap of $\frac{1}{8}$ of an inch, it may be rotated in either direction on the hub. The inner face of the member 44 is provided with a thrust bearing 56, the purpose of which will become apparent hereinafter.

Arcuate rack bars 57 and 58 are secured to the inner face of the clutch member 44, by means of screws 59. The screws 59 pass through slots 60 adjacent the ends of the rack bars to permit adjustment of the latter. This adjustment is effected by means of adjusting screws 61 having eccentrically shaped heads. The rack bars 57 and 58 are adapted to cooperate with bevel gears 62 and 63 keyed to the shanks 46 and 47 of the propeller blades 11 and 12. By means of the adjusting screws and slots, the blades 11 and 12 may be given corresponding initial positions, so that any subsequent adjustment will cause equal changes in the position of both blades. The ratio of the gear connection including the rack bars and pinions is preferably one to one, although it may be either greater or less. It is generally desirable that a given movement of the clutch member 44 and rack bars effect a lesser movement of the blades, so that a comparatively fine adjustment is possible. For this reason, I prefer to make the ratio one to one or less.

In order to facilitate the initial adjustment of the blades heretofore referred to, I provide graduations 46a on the blade shanks adapted to cooperate with an index 47a on the bearing sleeves 44a and 45. The blades may thus be axially set to the same angular position, with respect to the hub 43 by adjusting one rack bar until the index on both sleeves lies opposite the same graduation on the shanks.

It will be apparent from the description which has preceded, that the blades 11 and 12 are normally locked relative to the hub 13, by reason of the toothed or splined engagement of the clutch member with the hub, the rack bars on

the clutch member determining the position of the blades.

In order to prevent fluttering of the blades when the propeller is revolving, the rack bars 57 and 58 may be shimmed up, so that the tips of the teeth of the rack bars "bottom" on the roots of the teeth of the gears and vice versa when the clutch member 44 engages the hub 43. All movement of the blade shanks relative to the rack bars is thus prevented but when the clutch member 44 is shifted away from the bevel gears, it may be rotated to cause adjustment of the blades.

In order to disengage the cover or clutch member 44 from the face of the body 43 of the hub, I provide a pair of cylinders 64 and 65. Pistons reciprocate within these cylinders, as shown in Figure 5, and actuate pivoted clutch throwout links 66 and 67. The links 66 and 67 have flattened midportions 68 which engage the thrust bearing 56 on opposite sides of the pin 53. The pistons are controlled by the fluid pressure applied by the hydraulic pilot control system 18 of Figure 1, in a manner which will be set forth in greater detail later.

The rotation of the clutch member 44 which effects the desired adjustment of the blades 11 and 12, is accomplished through the medium of a yoke member 69 pivoted centrally thereof, as at 70, on a boss 71 formed within the body 43 of the hub 13. The yoke member 69 is connected to pistons reciprocating in a pair of cylinders 72 and 73 mounted within the hub 13. Fluid under pressure is supplied to these pistons and to the pistons 64 and 65 through axial holes or channels 74 and 75 in the hub 50 which connect with radial channels 76 and 77. The cylinders 72 and 73 are connected to the cylinders 74 and 75 by the conduits 78 and 79 within the hub 13.

The yoke member 69 is provided with a forward extension 69b which enters an off-center opening 69a in the clutch member 44. The member 44 is adapted to be rotated about the pin 53 by means of the yoke member 69, after it has been spaced from the hub 13. This spacing of the member 44 and its rotation about the pin 53 is accomplished by applying pressure to the fluid contained in the cylinders 64, 65, 72 and 73. The application of pressure to the fluid in the cylinders 64 and 65 disengages the clutch member or cover plate 44 from the hub 13 through the medium of the throw-out links 66 and 67. After the disengagement of the clutch member has been effected, it may be rotated by increasing the pressure applied to one or the other of the cylinders 71, 73. If excess pressure is applied to the cylinder 72, for example, the yoke member 69 will swing about its pivot point 70 in a clockwise direction. The downward movement of the forward projection 69b of the yoke member 69, which enters the opening 69a in the member 44, imparts a similar movement to the latter, and its movement causes the desired adjustment of the blades 11 and 12 through the rack members 57 and 58 and the bevel pinions 62 and 63. When the desired adjustment has been effected, the pressure applied to the cylinders is released and the spring 52 causes the member 44 to re-engage the hub 13, so that the blades are locked and firmly held in their adjusted position. The means for supplying fluid pressure to the cylinders within the propeller hub, while the latter is revolving, is one of the

important features of the invention and will now be described in detail.

As best shown in Figure 4, the conduit defined by the axial channel 74 and the radial channel 76 communicates with an annular groove 80 formed in the bore of the bearing collar 32 which is clamped about the sleeve 50. The conduit including the channels 75 and 77 likewise communicates with a similar annulus 81. The pipe lines 30 and 31 are connected to the annuli 80 and 81 by means of the radial holes 82 and 83 in the collar 32. The annuli 80 and 81 are provided with non-friction oil rings 84 on each side thereof. These rings are made up of three 120° segments and have an external groove for receiving a contractile spring 85, as best shown in Figures 10 through 12. A key 86 locks the non-friction rings to the bearing collar 32 to prevent their rotation with the sleeve 50.

Shedder rings 87 and 88 are formed on the sleeve 50 and cooperate with grooves 89 and 90 in the collar 32 to return any fluid that might leak past the non-friction rings 84 to a sump through holes 91 and 92 in the collar 32 and a conduit 93 connected thereto.

From the foregoing, it will be obvious that by shifting the levers 26 and 27 to apply pressure to the headers 28 and 29, it will be possible to release the engagement of the clutch member 44 with the hub 43 and to effect the desired adjustment of the blades 11 and 12, after which release of the pressure applied to the hydraulic system permits the re-engagement of the clutch member to prevent further movement of the blades in the hub. One of the advantages of the invention is that no pressure is applied to the hydraulic system, except during the brief intervals when an adjustment is actually being made. This advantage is an important one, since it relieves the hydraulic system of the wear and deterioration resulting from continuous circulation of the fluid.

It also minimizes the effect of slight leakages in the hydraulic system, since the pressure is applied for a short period only, and even though slight leaks in the system develop, any oil lost may be replaced from the storage tank 19, so that continuous operability is ensured.

The embodiment just described is readily adaptable for use on propellers having more than two blades. It is only necessary to provide additional rack bars on the clutch member 44 similar to those shown at 57 and 58, for cooperation with the extra blades which, of course, like the blades 11 and 12, will be swivelled in the hub and provided with bevel pinions for engaging the rack bars.

Figures 8 and 9 illustrate a modification of the clutch releasing and blade shifting mechanism described above with reference to Figures 2, 3 and 7. The means and method for supplying actuating fluid is the same in both cases and the only difference lies in the mechanical connections between the fluid pressure cylinders and the blade shanks. Referring to Figures 8 and 9, in which the same reference numerals applied to Figures 2, 3 and 7, are employed to identify corresponding elements, the blade shanks 46 and 47 are swivelled within the sleeves 44a and 45 of the body 43 of the hub 13. The shanks 46 and 47 are provided with terminal forks 95 and 96. The fork 95 has spaced arms 97 and 98, and the fork 96 has similar arms 99 and 100. The cylinders 72 and 73 carry reciprocable pistons which are connected directly to the arms 150

97 and 99 of the brackets 95 and 96. The arms 98 and 100 of these brackets are connected to a link 101 pivoted at its center 102 to a boss 103 projecting from within the hub 43. The link 101 has a forward projection 104 which is adapted to be received within an off-center recess 105 in the clutch member 44. The latter is adapted to be disengaged from the hub 43 by the pistons reciprocating in the cylinders 64 and 65, as previously explained. These pistons have rods 66' and 67' connecting them directly to the clutch member 44, which take the place of the links 66 and 67.

In order to lock the blades to the hub by means independent of the clutch member 44, I provide the blade shanks 46 and 47 with knurled or splined portions 105 and 106. These portions are adapted to be engaged by slidable blocks 107 and 108 having cooperating splined or toothed surfaces. The blocks 107 and 108 have slots therein so that they can slide on the screws 49. The blocks are forced into engagement with the splined portions 105 and 106 by the movement of the member 44 which bears directly on the forward face of the blocks. The blocks afford a duplicate locking means for the blades 11 and 12 to prevent any whipping or fluttering thereof due to a possible looseness in the mechanical connection between the cylinders and the blades, although the clutch member 44 will substantially eliminate all such fluttering.

The operation of the modification of Figures 8 and 9 is similar to that of the modification previously described. Pressure is first applied to both ends of the fluid column traversing the clutch releasing and blade shifting cylinders, so that the member 44 is separated from the toothed surface of the hub 43. An increased pressure applied to one of the cylinders 72 and 73 will then cause a slight rotation of the blades 11 and 12. The movement of the blades is effective through the link 101 to shift the clutch member 44, so that when the adjustment has been completed and the pressure released, the reengagement of the member 44 with the hub 43 will lock the blades in adjusted position. The reengagement of the member 44 forces the blocks 107 and 108 into engagement with the splined portions 105 and 106 of the shanks 46 and 47 to further lock the blades against movement.

Figure 13 illustrates a possible modification of the structure shown in Figure 4. In Figure 13 I have illustrated the annuli 80 and 81 formed in a main bearing 110 of the motor crank shaft. The annuli are separated by non-friction rings 84, as in the structure of Figure 4, and the axial and radial channels 74, 75, 76 and 77 are formed in the crank shaft itself instead of in the rearward extension of the propeller hub, as shown in Figure 4. The operation of the two modifications is the same and both provide means for supplying a hydraulic pressure from a stationary source to a rotating operating mechanism.

The invention as described so far has been explained with reference to an internal combustion engine of the vertical type. It is also readily adaptable to engines of the radial type having a crank shaft of the character illustrated in Figure 14. In order to apply the invention to this type of engine, it is merely necessary to provide suitable conduits in the shaft by drilling and plugging in the known manner. Fluid pressure is supplied to the conduits thus formed in the crank shaft through a bearing such as that shown at 111. This bearing has an annulus 112 cooper-

ating with a radial hole 113 connected to one of the conduits through the crank shaft. The other conduit which preferably traverses the center of the shaft cooperates with a hole 114 in the bearing. The fluid supply pipes 30 and 31 may be connected to the groove 112 and to the hole 114. Non-friction oil rings and shedder rings are employed as in the modification shown at Figures 4 and 13. The means shown in Figure 14 for introducing fluid pressure has the advantage over those previously described that one leakage path is eliminated, although the means first described may be employed with radial or vertical motors.

The indicating means illustrated at 40 in Figure 1 may be controlled by any suitable device, but I preferably employ a rheostat 115 (Figures 2 and 8), the resistor element of which is carried within the hub 43. A moving contact is carried by and grounded on the cover plate or clutch member 44 (Figure 3). As the clutch member is shifted to cause an adjustment of the blade position, the rheostat contact is likewise moved to vary the resistance in the circuit including the meter 40. The indication of the latter is thus altered to afford the operator exact information concerning the blade adjustment.

As previously explained, the invention involves the principles of static hydraulic pressures applied from a stationary source to a rotating operating mechanism. The advantages of such system have been partially enumerated hereinbefore. In addition to these advantages, the invention provides simple and easily controlled actuating means for causing the desired adjustment of propeller blades either of a plurality of screws simultaneously or of each screw individually, and also locks the blades in adjusted position to prevent any accidental movement thereof. It is possible to vary the propeller blade position to any desired extent for forward movement, or the blades may even be slightly reversed to slow down an airplane in case of an attempt to land in a short distance. The advantages of the selective pitch propeller in taking off, climbing and cruising are so fully realized that enumeration thereof is not necessary. The invention may be used on propellers having two or more blades.

The structures described provide means for supplying controlling pressures from a stationary source to the rotating propeller mounted directly on a motor crank shaft and revolving at a high rate of speed. The blade shifting means contained within the propeller hub are thus controlled without the use of complicated mechanical means for transmitting actuating impulses from a stationary point to the rotating propeller. The propeller hub and blade shifting means are an integral part of the motor shaft for all practical purposes and the described method for introducing the hydraulic pressure is such that it does not interfere with the normal operation of the motor and can be applied to substantially any type of airplane motor now in use.

Although the invention has been described with reference to airplanes and airscrews, the same principles may be employed in controlling the pitch of other types of screws, such as those employed for the propulsion of watercraft.

Although I have illustrated and described but a few modifications of the invention and its details, it will be apparent that numerous changes therein may be made without departing from the spirit of the invention. It is possible, instead of utilizing two opposing fluid pressures to em-

ploy a single fluid pressure opposed by a mechanical force such as that exerted by a compression spring. It is also obvious that motor driven pumps with suitably controlled valves may be substituted for the pressure applying means 26 and 27. Any such changes may be made within the scope of the appended claims which constitute the sole limits upon the breadth of the invention.

10 I claim:

1. The combination with an airscrew having a variable pitch, of means for indicating the angular position of the screw blades, comprising pitch-varying means and a rheostat operated thereby.

2. An electric indicator for a selective pitch screw including a circuit having a current source, a current meter, and a rheostat actuated by the movement of the screw blades.

3. The combination with a motor, a propeller including a hub on the shaft of said motor and blades swivelled in the hub, of a clutch member in said hub, means for locking the member to the hub to prevent rotary movement thereof, hydraulic means in the hub for disengaging the member from the hub and rotating it thereon, and a connection between said member and said blades whereby movement of the member changes the pitch of the blades.

4. Means for controlling an adjustable revolving propeller mounted directly on the crank shaft of a driving motor by a stationary source of hydraulic pressure, including radial and axial channels in the rotating mechanism, and stationary chambers for conducting fluid thereto.

5. The combination, in a multi-screw craft, with a plurality of selective pitch screws each comprising a hub on a shaft and blades swivelled in the hub, of pilot control means for said blades within said hubs, and a common remote control means for simultaneously selecting the desired pitch for the blades of one or more of said screws.

6. In a selective pitch screw having blades swivelled to a hub, mechanical means for locking the blades to the hub to prevent relative rotation thereof, means for rendering said means ineffective, means for effecting a shift in the setting of the blades, and a common actuating medium for said two last-mentioned means.

7. The combination with a propeller hub having blades swiveled thereto, of blade adjusting and locking means comprising a cover for said hub, means on said cover and hub for preventing relative rotation thereof, a spring for forcing said cover against said hub, means within the hub for starting the cover from the hub against the force of said spring and for turning the cover relative to the hub, and means on said cover and blades for causing swiveling movement of the blades on rotation of said cover.

8. In a propeller hub having blades swiveled thereto, releasable means for mechanically locking the blades against swiveling movement in the hub, hydraulic means in the hub for releasing and moving said locking means, and connections between said locking means and the blades for swiveling the blades on movement of the locking means.

9. In a propeller, a hub, blades swiveled therein, releasable means in the hub for mechanically locking the blades against swiveling movement in the hub, means for releasing said locking means including a hydraulic column, means for applying pressure to said column, and means for shifting said column to rotate said locking means,

and means on said locking means for causing the swiveling movement of the blades.

10. In a propeller, a hub having blades swiveled therein, releasable means in the hub and rotating therewith for locking said blades relative to the hub, pressure actuated means for releasing said locking means, pressure operated means for rotating said locking means, and means including a fluid-pressure line extending to and from said hub for applying pressure to said releasing means and for selectively operating said rotating means.

11. A propeller having a hub, blades swiveled therein, pinions on said blades, a cover for said hub having releasable locking relation thereto, rack bars on said cover for engaging said pinions, means for releasing the cover from the hub, and means for rotating said blades.

12. Apparatus for adjusting blades swiveled in a propeller hub, comprising blade-locking means and blade-shifting means, a substantially static hydraulic column extending to and from said hub, means actuated by the pressure sustained by said column for releasing said locking means, and means actuated by a slight movement of said column to actuate said blade-shifting means.

13. In a multi-motored aircraft having propellers with shiftable blades, means for selectively effecting equal adjustments of the pitch of the blades of one or more of said propellers, comprising a static hydraulic column, blade-shifting means in the propeller connected to said column, and means for applying pressure to said column.

14. In a propeller having blades swivelled to a rotatable hub mounted on a shaft, the combination with blade-shifting and blade-locking means in said hub, of hydraulic means in the hub and rotating therewith for operating said blade-shifting and blade-locking means, and means for applying variable pressures to a fluid column extending to said operating means, for releasing the blade-locking means and actuating the blade-shifting means.

15. In a screw, a hub, blades pivotally mounted therein, releasable means in the hub for locking said blades in adjusted position, blade-adjusting means in the hub and rotating therewith, a fluid column connected to said blade-locking and blade-adjusting means, means for applying equal and opposite pressures to the column for releasing the blade-locking means, said blade-adjusting means being operated upon an excess pressure at one end of the column over that at the other.

16. In a screw, a hub, blades swivelled in the hub, releasable mechanical means in the hub for retaining the screw blades in a fixed position, and hydraulic means in the hub and rotating therewith for releasing said mechanical means and shifting said blades.

17. A propeller comprising blades swivelled in a rotatable hub mounted on a motor shaft, a clutch member in said hub, interlocking projections on the member and hub, hydraulic means in the hub and rotating therewith for disengaging the member from the hub and rotating it thereon, and means in the hub actuated by the rotation of the member for changing the pitch of the blades.

18. The combination with an air screw directly mounted on a shaft of a driving motor and having a hub with blades adjustably carried therein, blade-shifting means and blade-locking means in the hub, means for introducing a fluid column to the rotating system comprising said screw and shaft between the screw and the motor, and

means for applying pressure to the fluid column to release the blade-locking means, and for moving the column to operate the blade-shifting means.

- 5 19. The combination with a variable pitch screw propeller mounted directly on a driving motor shaft, means for normally locking the propeller blades, hydraulic means for releasing said blade-locking means, and hydraulic means for

adjusting said blades, of means for conducting a fluid column to said releasing and shifting means, means for applying pressure to said column to actuate said releasing means, said pressure-applying means being operable on further movement, to move said column to operate said blade-shifting means.

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CERTIFICATE OF CORRECTION.

Patent No. 1,936,677.

November 28, 1933.

LOUIS J. KOZUB.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 5, lines 79 and 80, claim 10, strike out the words "in the hub and rotating therewith" and insert the same after "means" in line 81; and line 103, claim 13, strike out the syllable "pro-"; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 9th day of January, A. D. 1934.

F. M. Hopkins

(Seal)

Acting Commissioner of Patents.

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