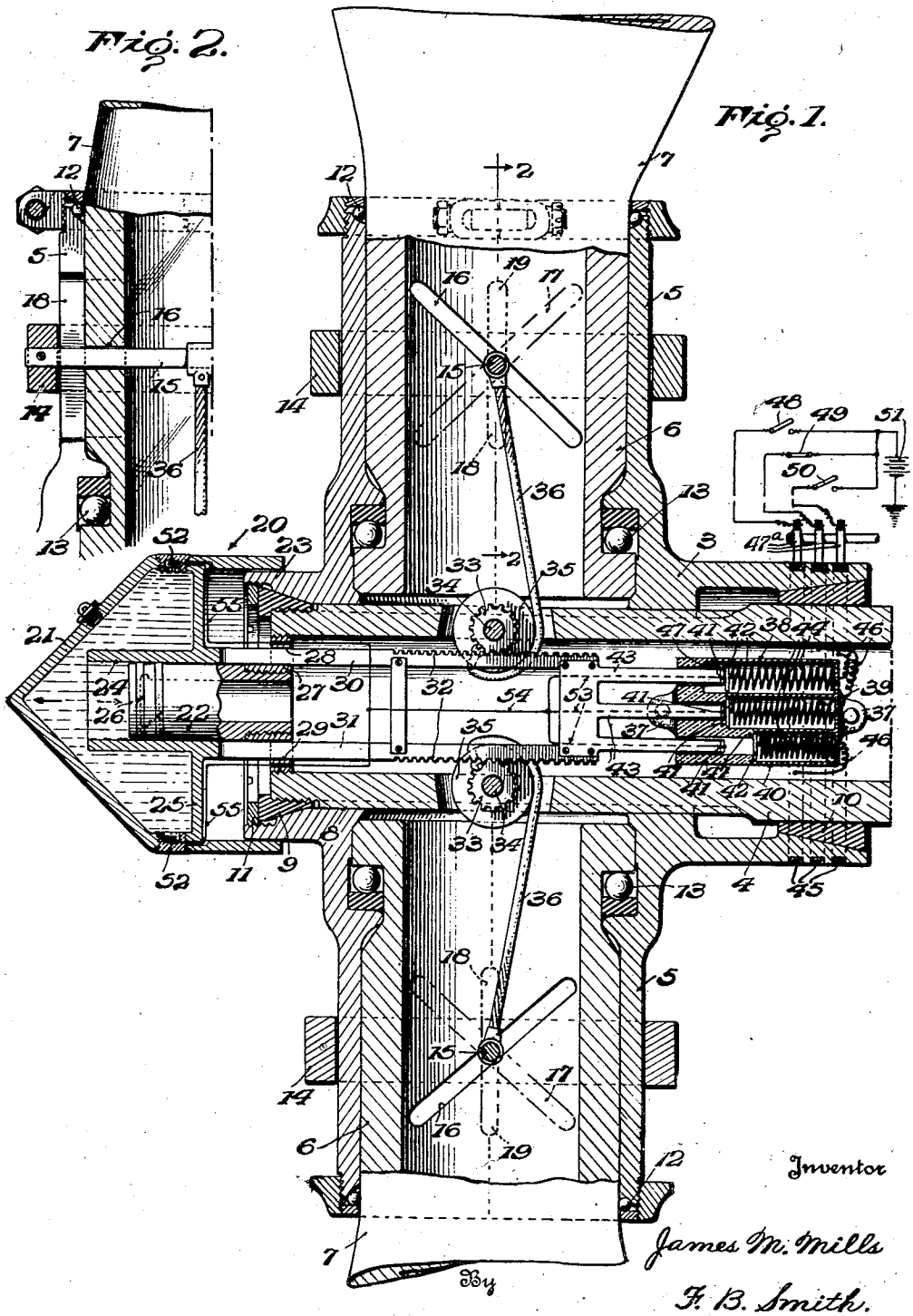
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PROPELLER

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Fig. 2.

Fig. 1.



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PROPELLER

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This invention relates to propellers and more particularly to variable pitch propellers which may be particularly adaptable for use on aircraft.

One of the objects of the present invention is to provide novel means and mechanism for varying the pitch or angularity of the blades of a propeller while the latter is in operation, whereby the propeller may be operated at maximum efficiency under varying conditions.

Another object of the invention is to provide in a variable pitch propeller, novel means responsive to fluid pressure for varying the pitch of the blades.

Another object is to provide in a variable pitch propeller, novel means responsive to centrifugal force for varying the pitch of the blades together with a selectively operable mechanism for determining the extent of operation of the pitch varying means whereby the pitch of the blades may be easily and quickly changed to the desired value.

Still another object is to provide in a propeller of the above character wherein centrifugally-responsive means are employed for securing an increased pitch of the blades, novel means for reducing or reversing the pitch.

A further object is to provide in a propeller of the above type, thermal-responsive means for varying the pitch of the blades together with mechanism whereby the supply of energy thereto may be readily regulated.

A still further object is to provide in a variable pitch propeller embodying centrifugally-responsive members for increasing the pitch of the blades, mechanism actuated by the expansion of a fluid in response to heat supplied thereto, for controlling the operation of the members together with a novel arrangement for controlling the amount of heat supplied the fluid, thereby permitting the blades to be moved to assume various pitch angles.

The above and other objects of the invention will appear more fully hereinafter from the following detailed description when taken in connection with the accompanying drawing wherein there is illustrated one embodiment of the invention. It is to be expressly understood, however, that the drawing is for the purpose of illustration only and is not designed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawing, wherein similar reference numerals refer to similar parts throughout the several views:

Fig. 1 is an axial section of a propeller constructed in accordance with the present invention; and

Fig. 2 is a fragmentary view in section of certain of the parts illustrated in Fig. 1.

Referring more particularly to Fig. 1, a variable pitch propeller embodying the principles of the present invention is illustrated therein as embodying a hub 3 adapted to be driven by a rotatable shaft 4, which may be the crankshaft or an extension thereof of an internal combustion engine, the said hub being provided with a plurality of radially extending sockets 5 within each of which the root end 6 of a blade 7 is rotatably mounted. Only a portion of the blades 7 is illustrated in order that a large scale drawing may be employed.

In order to drivably connect the hub 3 to the shaft 4, the latter is provided with a plurality of keys or splines 8 which are adapted to cooperate with similar splines formed on the hub. Preferably, the hub cooperates with split front and rear cones 9 and 10 respectively, interposed between the drive shaft and hub for properly positioning the latter. As illustrated, the cone 9 may be threaded upon the outer end of the shaft and suitably locked thereon as by means of a threaded ring 11. As heretofore stated, the roots 6 of the blades are rotatably mounted in the hub sockets, and as shown, such mounting may be effected by bearings 12 and 13, the latter serving also as a thrust bearing.

Means are provided for varying the pitch of the blades, and preferably such means include members responsive to the centrifugal force developed therein during operation of the propeller. As shown, such means is constituted by a member 14 which may be a weighted ring or collar surrounding the socket 5. For the purpose of operatively associating the member 14 with the propeller blades in order that longitudinal movement of the former may produce rotation of the latter about their longitudinal axes, a shaft 15 connected to diametrically opposed portions of the ring 14 extends through the socket 5 and through the blade root 6 by reason of the provision of diagonally extending slots 16 and 17 disposed on opposite sides of the blade root. The shaft 15 also extends through slots 18 and 19 provided in either side of the hub socket, and these slots preferably extend longitudinally of the axis of the blades. From the above it will readily be apparent that during longitudinal movement of the members 14, the shafts 15 will cooperate with the diagonally extending slots 16 and 17 to ro-

tate the blades about their axes and thus vary the pitch thereof, it being borne in mind that the members 14 are prevented from rotating by reason of the co-operation between the shafts 15 and the longitudinally extending slots 18 and 19.

Outward movement of members 14 causes the shafts 15 and grooves 16, 17 and 19 to effect an increase in the pitch of the blades.

In order to secure lower pitch settings of the propeller blades, fluid pressure means are provided, which in operation serve to control the effect of the above described centrifugally-responsive means. Preferably, such fluid pressure means is constituted by a confined body of liquid which is thermally-responsive in such a manner that the volume thereof varies in response to heat supplied thereto to cause relative movement between the hub and centrifugally-responsive means. As shown, such means is constituted by a fluid operated device 20 having relatively movable cylinder and piston portions 21 and 22 respectively, the former being guided in its axial movement by a flange 23 on the hub 3, and preferably having its exterior contour so formed as to increase the aerodynamic efficiency thereof. The cylinder 21 is provided interiorly with a bore 24, supported by a diaphragm 25 which latter, together with the head 26 of the piston 22 within the bore and rigidly connected with the drive shaft 4, serve to confine within the cylinder, a suitable thermal-responsive liquid such as, for example, mercury. As illustrated, the piston 22 is rigidly connected to the drive shaft 4 by means of a nut member 27, there being provided a pair of oppositely disposed openings 28 and 29 in said member for receiving a pair of axially extending arms 30 and 31 respectively, which may be formed integrally with the cylinder 21. It will thus be observed from the above that relative movement between the cylinder portion 21 and the piston portion 22 will effect axial movement of both of the arms 30 and 31.

In order to operatively connect the arms 30 and 31 with the centrifugally-responsive members 14 so that longitudinal movement of the former will effect a control of the position of the latter and hence a variation of the pitch of the blades, the inner portion of each of said arms is formed with teeth 32 which are adapted to mesh with a pinion 33 rotatably mounted in the drive shaft 4, in any suitable manner, as by means of a shaft 34 to which the pinion is drivably connected. Drivably secured to the shaft 34 is a pulley 35 to which one end of a suitable cable or chain 36 is secured, the other end thereof being attached to the shaft 15. From this construction, it will be apparent that movement of arms 30 and 31 to the right, as viewed in Fig. 1, will permit the members 14 to be moved outwardly in response to centrifugal force to increase the pitch of the blades, while movement of the rods to the left will move the members 14 inwardly by reason of the cable 36 winding on the pulley 35, to decrease the pitch of the blades.

Means are provided for supplying heat to the body of fluid confined within the device 20 and for thus controlling the operation of the latter, and preferably such means is constituted in such a manner as to include a plurality of electrical circuits which may be selectively actuated to secure various adjustments of the pitch of the blades. As shown, such means embodies a switch casing 37 preferably formed of insulating material suitably secured to the shaft 4 and provided with three portions 38, 39, and 40 adapted to form switch housings for relatively movable contacts 41 and 42. The contacts 41 are carried by each of the inner ends of a plurality of arms 43, secured to the arms 30 and 31 in any suitable manner, while the contacts 42 are each electrically connected to conducting resilient members or springs 44. Each of the latter is connected to a slip ring 45 by means of a conductor 46, each of the slip rings being carried by the hub 3 and suitably insulated therefrom. It will be observed that each of the switch housings 38, 39, and 40 is provided internally with a plurality of stops 47 of variable length which cooperate with contacts 42 carried by the ends of members 44 to limit expansion of the latter for a purpose which will appear more fully hereinafter. In order to supply energy to each of the slip rings 45, the latter are connected through brushes 47a and remotely located independently controlled switches 48, 49, and 50 to one terminal of a battery 51, the other terminal thereof being preferably grounded. Each of the contacts 41 may be electrically connected with one terminal of a plurality of removably mounted electrical resistance units 52 by wires 53, 54, and 55, and the other terminals of said units may be grounded to the cylinder 21.

The parts as illustrated in Fig. 1, wherein switch 49 is closed, illustrate a low pitch position of the blades while the propeller is in operation. With switches 48, 49, and 50 open and the propeller in operation, the centrifugally-responsive members 14 will move radially outwardly and the shafts 15 carried thereby will cooperate with the diagonally arranged slots 16 and 17, as heretofore described, to rotate the blades in their sockets to a position of maximum pitch. It is to be particularly noted that during this operation, each of the pinions 33 will rotate and move the cylinder 21, arms 30 and 31 and arms 43 toward the right, as viewed in Fig. 1, whereby all the contacts 41 and 42 will be brought into operative engagement and resilient members 44 placed under compression. If it be now desired to reduce the pitch of the propeller blades to a low position, switch 49 may be closed to establish a circuit to the heating elements 52 from the battery 51 through switch 49 and associated brush 47a, slip ring 45, lead 46, the centrally located resilient member 44, engaged contacts 42 and 41 and conductors 53, 54, and 55, whereby the fluid within the device 20 will be heated.

Upon the application of heat to the fluid, the latter will expand and effect relative movement between the cylinder 21 and piston 22 to move the arms 30 and 31 toward the left, as viewed in Fig. 1, such movement resulting in rotation of the pinions 33, whereby the cable 36 will draw the centrifugally-responsive members 14 inwardly, and such movement of the latter will reduce the pitch of the blades by reason of the cooperation between the shaft 15 and the slots 16 and 17. It will also be observed that the arms 43 will also be moved toward the left, the contacts 41 and 42, however, remaining in operative relation until the latter reaches the stop 47 whereupon further movement thereof to the left is positively arrested. Continued movement of the cylinder assembly and arms 43, toward the left, due to the expansion of the fluid within the device 20, will interrupt the operative relation between contacts 41 and 42 and thus disconnect the supply of energy to the heating elements 52. The fluid within the device 20 will then contract due to the cooling effect of the air passing

over the cylinder 21, and the centrifugally-operable members will be effective to again move the cylinder assembly to the right, as viewed in Fig. 1, to bring contact 41 into engagement with contact 42 to reestablish the supply of current to the heating elements. The above described reciprocatory movement of the cylinder assembly will be extremely slight, the net result being that the pitch of the blades will remain substantially constant at the low value.

Should it be desired to secure an intermediate pitch setting of the blades, the switches 49 and 50 being opened, the switch 48 is closed to complete a circuit to the heating elements 52 through the lower resilient member 44, it being pointed out that the contacts 41 and 42 will have been closed due to the outward movement of the members 14. As above described, in connection with the operation of the mechanism for securing a low pitch of the blades, the cylinder assembly will be maintained in such a position that the engagement between the contacts 41 and 42 will be alternately made and broken at a position corresponding to the location of the stops 47 associated with the lower switch housing 40, and the pitch of the blades will be substantially constant at an intermediate value.

In the event that it is desired to completely reverse the pitch of the blades, the switch 50 is closed to energize the elements within the switch housing 38 and to thus supply current to the heating devices 52. In this instance, the cylinder assembly will be maintained in an extreme position toward the left and the shaft 15 will cooperate with the lower portions of the slots 16 and 17 to reverse the pitch of the blades.

There is thus provided by the present invention a novel variable pitch propeller embodying centrifugally operated members for securing a variation in the pitch of the blades. The provision of the fluid pressure operated control mechanism whereby the effect of the centrifugally-responsive members may be readily regulated, enables the pitch changing operation to be effected in a simple and efficient manner. The use of the electrical means for regulating or controlling the operation of the fluid pressure operated mechanism and embodying selectively operable switches renders it possible to predetermine the pitch to which the blades are to be adjusted.

Though there has been illustrated and described only one embodiment of the invention, it is to be understood that the same may be capable of expression in various forms, as will now be understood by those skilled in the art, without departing from the spirit thereof. Reference will therefore be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. A variable pitch propeller comprising a plurality of blades, means for rotating said blades, means responsive to centrifugal force for varying the pitch of said blades, means operable in accordance with the expansion of a fluid for controlling the operation of said centrifugally-responsive means, and means for controlling the expansion of said fluid, said last-named means including a heating element, and means for supplying electrical energy to said element.

2. A variable pitch propeller having a plurality of blades, a rotatable shaft, means for drivably connecting said shaft and blades, means for rotating said blades about their longitudinal axes to increase the pitch, said means comprising centrifugally-responsive members, and means, including a fluid pressure operated switch, for variably controlling said centrifugally-responsive members.

3. In combination, a rotatable shaft, a plurality of propeller blades, a hub for drivably connecting said blades and shaft, said blades being rotatably mounted in said hub, and means for varying the pitch of said blades, said means including centrifugally-responsive members completely surrounding said blades and movable axially thereof, and control means for said members including a fluid pressure operated switch.

4. In combination, a rotatable shaft, a plurality of propeller blades, a hub for drivably connecting said blades and shaft, said blades being rotatably mounted in said hub, means for varying the pitch of said blades, said means including centrifugally-responsive members completely surrounding said blades and movable axially thereof, control means for said members comprising a thermally-responsive mechanism, together with a fluid pressure operated switch.

5. In combination, a rotatable shaft, a plurality of propeller blades, a hub for drivably connecting said blades and shaft, said blades being rotatably mounted in said hub, means for varying the pitch of said blades, said means including centrifugally-responsive members completely surrounding said blades and movable axially thereof, and a thermally-responsive control mechanism for controlling the operation of said centrifugally-responsive members, said mechanism including a fluid pressure operated switch.

6. In a variable pitch propeller having a plurality of blades, means for varying the pitch of said blades while the propeller is in operation, said means including centrifugally-responsive members completely surrounding said blades and movable axially thereof, expansible means for controlling the operation of said members, and selectively operable control mechanism including a fluid pressure operated switch for predetermining the extent of operation of said expansible means.

7. In a variable pitch propeller having a plurality of blades, means including expansible and contractible means for varying the pitch of said blades, and means for selectively applying heat to said expansible and contractible means including relatively movable switch contacts, one of said contacts being carried by a part of said pitch-varying means and movable therewith.

8. A variable pitch propeller comprising a rotatable shaft, a hub drivably connected therewith, a plurality of propeller blades rotatably mounted in the hub, and means for rotating said blades in the hub to vary the pitch, said means including a fluid operated device, and an electrical circuit for controlling the operation of said device, said circuit including a pair of relatively movable contact members, one of said members being carried by a movable portion of said device.

9. In a variable pitch propeller having a plurality of blades, a hub having socket portions adapted to receive said blades, means for varying the pitch of said blades, said means including a centrifugally-responsive member surrounding each socket and operatively connected to the blade associated therewith, and fluid operated means for controlling the operation of said member.

10. A device of the character disclosed comprising in combination a drive shaft; a hub mounted upon said shaft; a plurality of propeller

blades mounted upon said hub; said propeller blades being relatively rotatable about an axis transverse to the axis of the said drive shaft; means for preventing axial movement of said blades including collars carried by said hub and coacting with said blades; means for changing the effective pitch of said propeller blades; said means including members completely surrounding said blades and movable axially thereof in response to centrifugal force to counteract the tendency of the propeller blades to move to a different pitch angle while in motion, and means including a fluid pressure operated switch for variably controlling said members.

11. A device of the character disclosed comprising in combination a drive shaft; a hub mounted upon said shaft; a plurality of propeller blades mounted upon said hub; a plurality of collars carried by said hub and coacting with said blades to prevent axial movement of said blades; said blades when rotated tending to twist in one direction; means for relatively rotating said blades about an axis transverse to the axis of said drive shaft; and means movable axially of said blades to neutralize the force tending to twist said blades.

12. In a propeller structure, the combination of a shaft for rotating said propeller; a hub structure having extensions and carried by said shaft; adjustable blades mounted in said hub extensions; means for adjusting said blades while the propeller is in motion; said means including means movable axially of said shaft, means movable axially of said extensions and operating connections therebetween, and means on the exterior of said hub to positively position said blades with respect to said hub.

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