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CHANGEABLE PITCH PROPELLER UNIT

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[Diagram with labeled parts]

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This invention relates to airplane propellers of the changeable pitch type, and one important object is to provide a changeable pitch propeller wherein the pivotal axes of the propeller blades are extended along or forwardly of the leading edges of the blades, thereby facilitating the automatic turning of the blades respectively to the speed of the motor and preventing or lessening vibration in the blades.

By this offset mounting of the blades, as the R. P. M. of the motor is reduced, due to the pull of the propeller, the air pressure is increased against the delivery side of the propeller. In other words the air pressure the motor is pulling against has a leverage on the off-set blades to automatically turn them to corresponding pitch position.

Another object is to provide a changeable pitch propeller adapted for use upon a twin motored or multiple motored plane, wherein the propeller blades are so designed and freely mounted for rotation on their axes, that the blades will automatically "feather" against the wind, in case one motor dies, thereby reducing air resistance.

Another object is to provide a changeable pitch propeller the blades of which are set under spring tension, with an independent motor control governing the spring tension and therefore the pitch of the blades.

Still another object is to provide an airplane propeller having rotatably journaled blades designed to automatically set themselves at a pitch best adapted to the speed of the motor, the airstream and the load carried, the blades being linked however to spring or resilient tension elements, and these elements being in turn motor controlled to increase or diminish the tension on the springs or tension elements, to change the pitch of the blades contrary to the normal automatic action of the blades in flight.

With the stated objects in view together with such other advantages as may appear from the specification, certain preferred embodiments of the invention and the several structural features thereof are shown in the drawing, wherein:

Figure 1 is a plan view of the elements of one form of the invention as assembled, including the outer end of the propeller drive shaft and the inner ends or shanks of the propeller blades in section.

Figure 2 is a plan view of a modified form of the invention and wherein certain elements shown in Figure 1 are omitted or modified.

Figures 3, 4, and 5 are plan views of three variant forms of "offset" propeller blades.

In practicing this invention, and as illustrated in Figures 1 and 2, the engine drive shaft 5 has rigidly secured at the forward end thereof a cylindrical housing 6 which is formed with a central socket or sleeve 8a for engaging the threaded forward end of the shaft. This end of the shaft is passed snugly through the sleeve and a heavy nut 7 is turned onto the threaded end of the shaft, and laterally overlaps the margins, whereby firmly locking the housing 6 to the shaft 5. An integrally formed ring 9a extended from the housing 6 encircles the nut 7 inside the housing, and a beveled gear 8 having a hub 8b is rotatably journaled by said hub upon the ring 6b of the housing, the ring 8b of beveled gear teeth being disposed adjacent the cylindrical rim of the housing. A number of adjustment screws 3 are passed threadedly through the rear side of the housing adjacent the gear 8, the inner ends of these screws having a bearing against the gear plate 9 and whereby the latter may be pressed inwardly of the housing, for a purpose later pointed out.

A pair of diametrically aligned hub holes 6c are formed through the cylindrical rim of the housing 6, and a pair of diametrically aligned metallic hub sleeves 11 are rigidly seated therein to protrude these hub-holes and protruded radially outwardly. A pair of flat propeller blades 12 are rotatably and slidably journaled by their rounded metallic shanks 12a through said sleeves. The sleeves 11 are formed with accurately spaced and rearwardly turned cam slots 11a adapted to slidably engage adjustment or blade turning pins or studs 12b seated in the shanks 12a, the purpose of which arrangement will be later pointed out. The inner ends of the shanks 12c are reduced and threaded to provide threaded spindles 12c for engaging bored and tapped nuts 13 designed to function as pitch regulators for the blades 12. The nuts or regulators 13 are formed with laterally extended spring seats 13a and with shaft bores 13b centrally through their closed ends, the walls of said bores being grooved or fluted as at 13e in regular spaced relation.

Bolts 14 are extended axially into the ends of the spindles 13a in exact alignment with the shaft bores 13b of the regulator nuts 13, said bores 13b being sufficiently greater in diameter than the bores of the nuts 13 to rotatably and slidably engage splined stub shafts 15 passed axially through the fluted bores 13b of the nuts 13, the splines 18a of the shafts engaging the flutes 12c so as to rotate the nuts with the shafts, but being rotatable within the larger bores 13.
of the spindles. A pair of shaft supporting webs or brackets 16 are rigidly anchored at 17 centrally to the inner face of the frontal side of the housing 6, in spaced relation and with their inner webs 16a extended in spaced and parallel relation. The inner webs within 16a are formed with shaft bosses 16c aligned and dimensioned with the bosses 13b of the nuts 13. The inner ends of the shafts 15 are journeed through the bosses 16c of the brackets 16, the splines 16b being stripped at the journals, and bevel gears 17 are rigidly anchored to 18 on the inner ends of the shafts 15, inwardly of the brackets 16.

A reversible electric motor 19 is bolted at 20 centrally to the outer face of the frontal side of the housing 6, with its extended shaft 21 journeed at 22 through this side of the housing, and a small pinion bevel gear 23 is rigidly keyed to the inner end of the shaft and placed in mesh with the gears 17 at each side. Bevel gear rings 30 are slidably splined at 31 to the shanks 12a inside the cylindrical rim of the housing 6. Bevel teeth 30a are carried by these rings, the same being meshed with the mating teeth 32b of the gear 8. Ball thrust bearings 32 are journeed on the shanks 12a between the inside of the cylindrical rim of the housing 6 and the bevel gear rings 30. The shanks 12a are grooved or fluted longitudinally as at 12d and teeth 32b are formed around the inner margins of the rings 30 and slidably engage the grooves 12d of the shanks. Coil springs 34 encircle the shanks 12a and are braced at their ends between the seats 12c of the regulating nuts 13 and the outer ring 30.

An important feature of the invention lies in the manner of mounting the propeller blades 12, in that the axes indicated at 12a, on which the blades turn or rotate, extend through the leading edges 1/2 of the blades, as shown in Figures 3, 4, 5. It is thought that this feature is novel, and by virtue thereof the blades will automatically turn and "feather" against the wind in case a motor should fail or go "dead," thus reducing resistance and enabling the other motors to function more efficiently. By this design and mounting of the propeller blades, the harder the air pressure against them, tending to slow the motor down, the more the blades turn edgewise in cutting the air-stream, to a lower pitch angle, thus allowing the motor to hold a constant speed. This offset or "leading edge" method of mounting the blades also prevents or reduces danger of vibration in the blades.

The blade control motor 19 is wired for the control of the pilot by wires 40 extended from the motor to rings 41 on the sleeve 6a, the rings slidably contacting brushes (not shown) on the motor housing and from which are extended wires to control switch (not shown) of the pilot.

In the operation of the assembly as shown and described and with the drive shaft 5 and motor 19 inert, the springs 34 being braced between the gear ring 30 and the spring seats 12a of the nuts 13, will urge these elements asunder, pressing the gear ring 30 against or onto the thrust bearing 32, and pressing the nuts 13 inwardly. The nuts 13 being in rotatable threaded engagement with the splindles 12c of the propeller blades 12, these blades will be drawn inwardly to their limit, the blade studs 12b will move to the inner ends of the cam slots 11a of the sleeves 11, and the flat blades 12 will be turned edgewise towards or into a common plane passing through them edgewise, the blades being now in their idle or starting position. As the shaft 5 is energized and the blades 12 begin to rotate, centrifugal force will urge them outwardly with the shanks 12a sliding slightly through the sleeves 11. In turn the blade studs 12b will travel outwardly through the arcuate cam slots 11a, this action resulting in partially rotating the blades 12 outwardly from a common plane and impinging the air at a more oblique angle, thus drawing the airplane (not shown) forward. As the shaft 5 picks up speed from the source of power (not shown), the studs 12b move further outwardly through the slots 11a, turning the blades out more sharply, and this action continues until an equilibrium is established between the speed of the propeller blades, the resistance offered by the air and the load carried.

However, if it is found desirable by the pilot in any situation to disturb such automatic equilibrium, and to increase or decrease the pitch of the blades irrespective of their normal pitch at any given speed of rotation, this may be done by energizing the electric motor 19. Such operation rotates the gears 11, the splined shafts 15 and the regulator nuts 13. The latter then turn either further onto the threaded splindles 12c, or the reverse, according to the direction of rotation of the motor shaft 21. If the nuts 13 are turned further onto the splindles the propeller blades are drawn inwardly under the increased pressure of the springs 34, and the blades are consequently turned more edgewise to the air, or more towards a common plane. The reverse rotation of the motor shaft and nuts pushes the blades outwardly and turns them more obliquely to the air stream, both movements being due to the stated outward and rearward movement of the studs 12b through the slots 11a. Should the source of power of the airplane fail, the blades 12 will under the wind pressure, automatically "feather" to the air-stream as above pointed out.

The gear plate 5 may be forced inwardly by the screws 8, thus urging the meshing of the teeth 30b with the teeth of the bolts 30b of the gear rings 30. Such intermeshing ensures the simultaneous and equal rotation of the propeller blades, and is auxiliary to the action of the motor pinion gear 28 to the same end.

Obviously, the above described method of mounting the propeller blades, to rotate upon axes extended through or in advance of their leading edges, may be applied to any conventional form of changeable pitch propellers.

The description given of the operation of the device is as applied to a propeller rotating counterclockwise as viewed from the pilot's seat, with the propeller blades turning downward and rearward for increasing their pitch against the air stream.

If desired, the independent motor control for altering the normal blade pitch, may of course be omitted, and the device limited to the normal automatic elements described and as illustrated in Figure 2. The nuts 13 could then be adjusted and locked by hand to place the springs 34 under the desired tension.

In this assembly is shown a spider and gear unit 45, anchored medially to the frontal wall of the housing 6, and arranged to turn the blades in unison. This unit includes a pair of bevel gears 46 mounted in opposite parallel relation on splined stub shafts passed slidably into
tubular and interiorly fluted blade spindles 12a, and bevel pinion gears 48 mounted and journaled on a shaft extended through the spider 32, and placed in mesh with the gears 46. The bevel gears 3 and rings 32 are also omitted in the assembly of Figure 2. The springs 34 are just strong enough to sustain the blades to their inmost retracted positions when hanging down vertically.

While I have here shown and described certain embodiments of my invention and certain structural features thereof, the same may be changed within the scope of the claims.

I claim:

1. In an airplane propeller assembly of the changeable pitch type and including a drive shaft and cylindrical housing axially anchored to the forward end of the shaft, and including propeller blades with shanks oppositely, radially, rotatably and slidably journaled through the cylindrical rim of the housing, the inner ends of the shanks being screw-threaded and axially bored, blade regulator nuts on the inner threaded ends of the shanks, said nuts being formed with laterally disposed spring seats and with shaft bores centrally through their ends; the walls of said bores being fluted axially, splined stub-shafts passed slidable through the fluted bores of the nuts and rotatably and slidably into the aligned bored ends of the blade shanks, annular ball-bearing units freely embracing the blade shanks inside the rim of the housing, coil springs embracing the inner ends of the blade shanks and braced between the spring seats of the regulator nuts and the outer ball bearing units for normally urging the propeller blades inwardly, an electric motor anchored centrally at the front of the housing with its extended shaft journaled therethrough, electrical leads and connections extended from the motor to the control of the pilot, and gear connections between the motor shaft and the said regulator nuts of the blade shanks, whereby the nuts and the slidably associated splined stub-shafts may be rotated for compressing or releasing the springs of the blade shanks to positively urge the propeller blades inwardly as against centrifugal force or permit them to move outwardly under such force.

2. In a device as defined in claim 1, means for automatically varying the pitch of the propeller blades as they move outwardly or inwardly.

3. In an airplane propeller assembly of the changeable pitch type, and including a drive shaft having a cylindrical housing axially anchored at its forward end, and including propeller blades with shanks oppositely, radially, rotatably and slidably journaled, laterally through the cylindrical rim of the housing, coil springs embracing the blade-shanks and braced at their ends between settings to normally press the blades inwardly, means for increasing the pitch of the blades as they are projected outwardly by centrifugal force under rotation of the housing, an electric motor on an outer end of the housing the shaft thereof being extended and journaled centrally into the housing, controls for the motor, and means connecting the motor shaft with the spring-settings of the blade shanks for varying the tension of those spring-settings through the operation of the motor, portions of said spring-settings being movable for such purpose.

4. In a device of the kind and described including a housing with a pair of propeller blades having their shanks diametrically oppositely, rotatably and slidably journaled through the opposite walls of the housing, means for partially rotating the shafts in unison for changing the pitch of the blades, the peripheries of the shank ends being screw-threaded, complementally threaded press elements on the threaded shanks, coil springs embracing the shanks and braced between the walls of the housing and said press elements, an electric motor on the housing having its shaft journaled therewith, controls for the motor, and connections between the motor shaft and the threaded press elements on the shanks for rotating the press elements in unison for retracting the blades against centrifugal force, or the reverse.

5. In a device according to claim 4, means for automatically varying the pitch of the propeller blades as they move outwardly or inwardly.

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