

April 21, 1931.

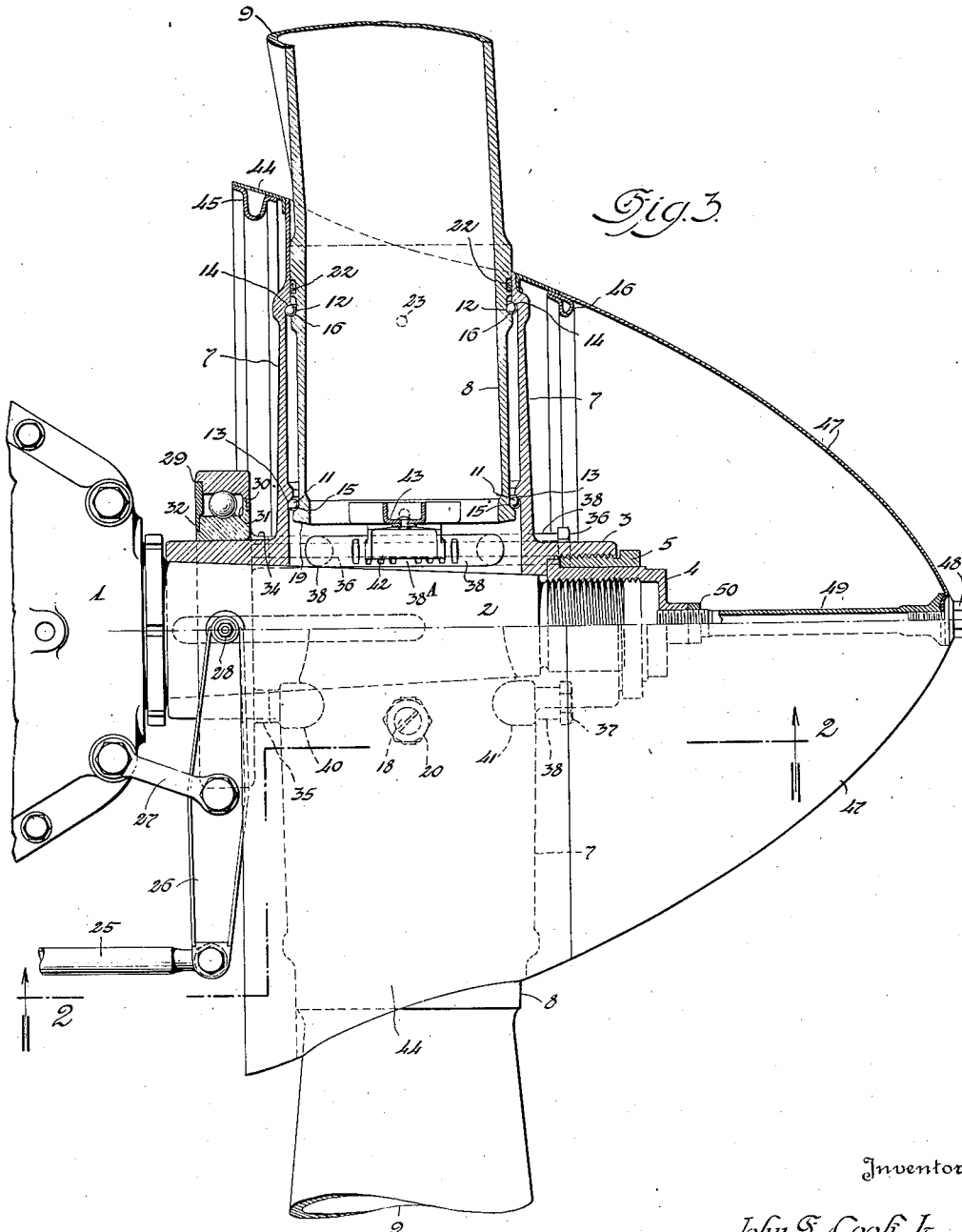
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1,801,725

AERIAL PROPELLER

Filed July 12, 1926

3 Sheets-Sheet 2



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AERIAL PROPELLER

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3 Sheets-Sheet 1

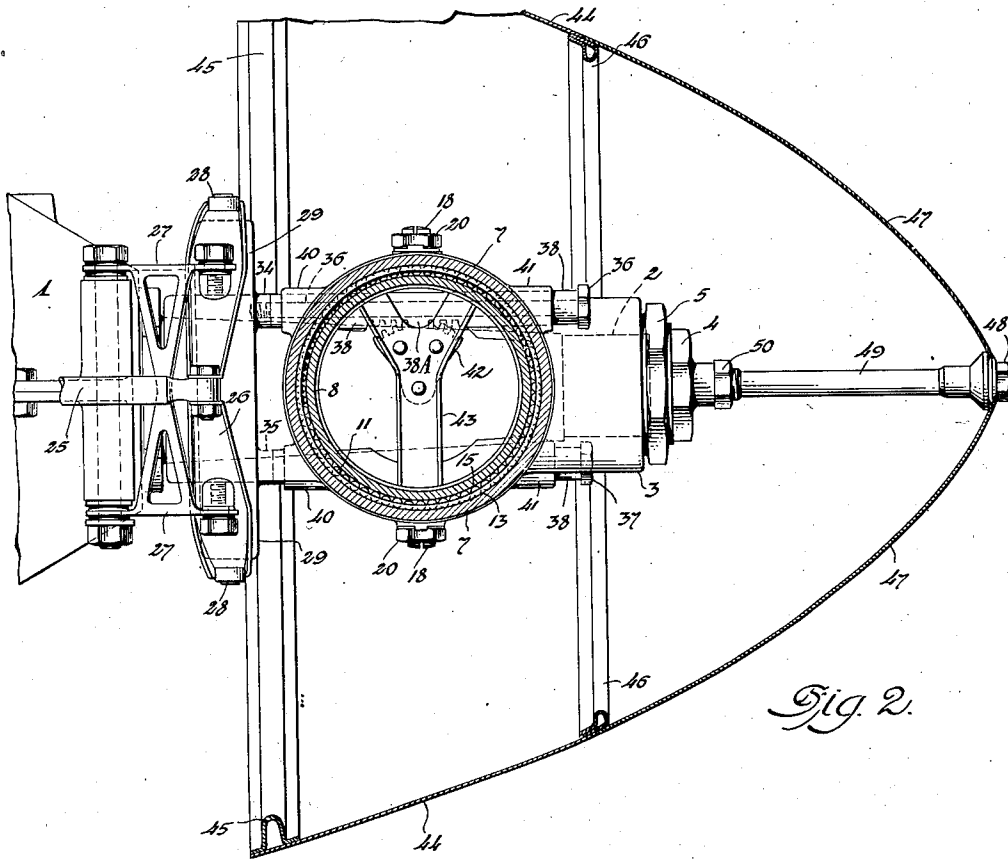


Fig. 2.

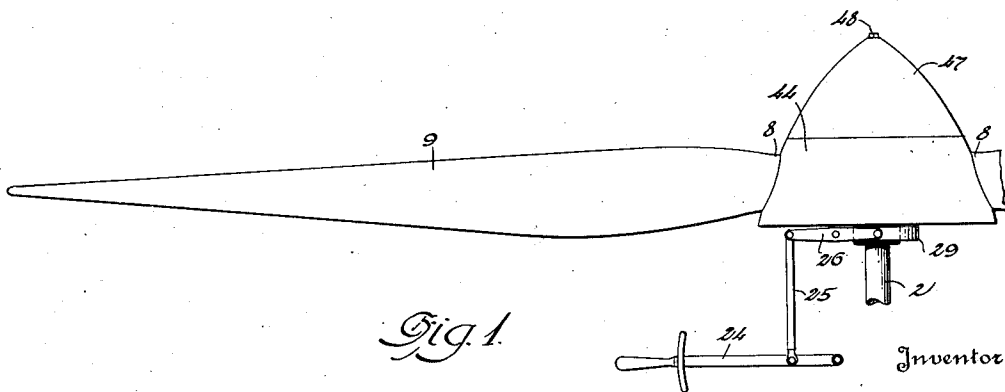
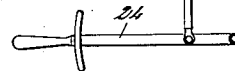


Fig. 1.



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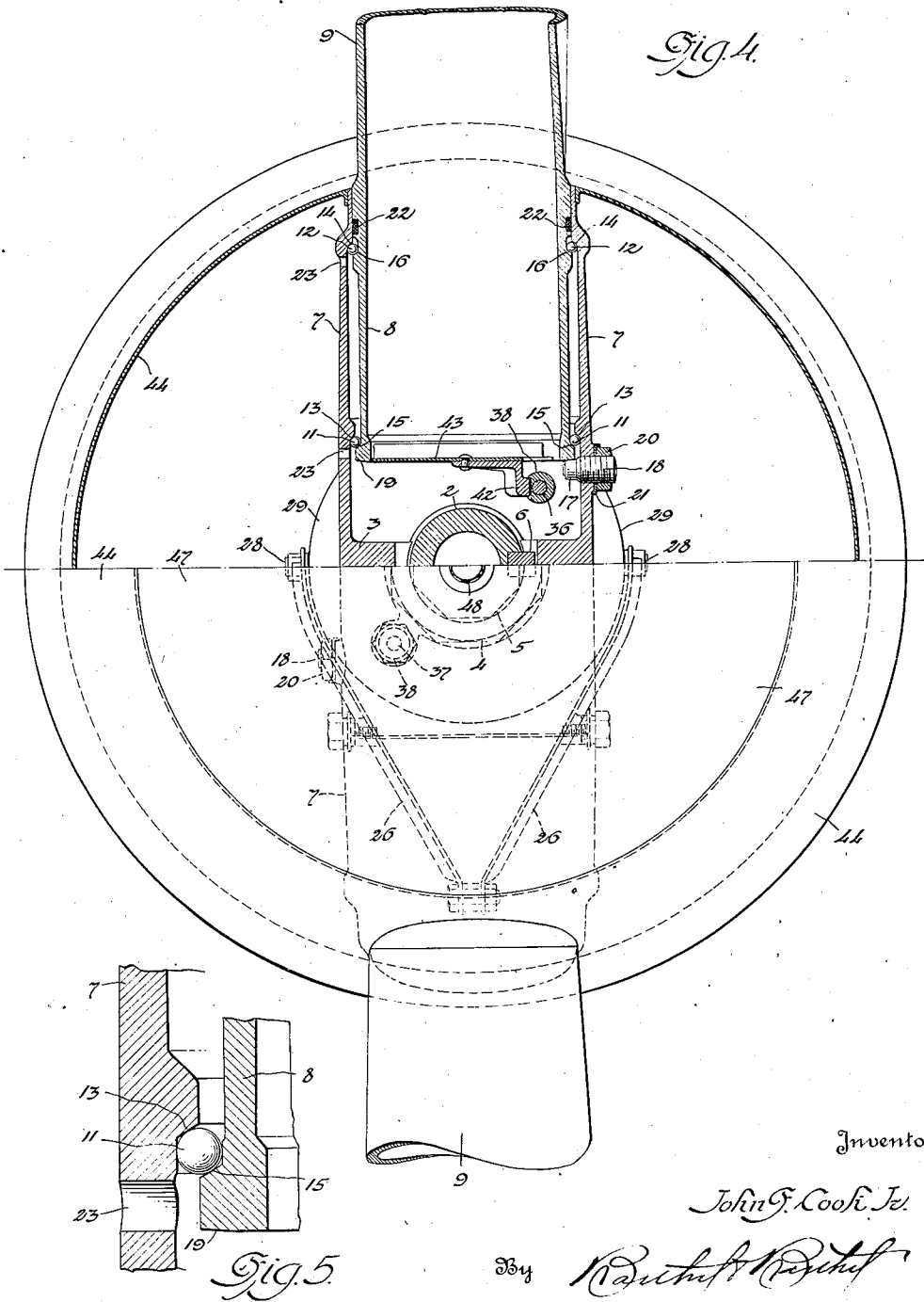
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AERIAL PROPELLER

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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AERIAL PROPELLER

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This invention relates to aerial propellers and more particularly to adjustable and reversible propellers.

In airplanes and the like, it is extremely desirable that the pitch or angle of the propeller blades should be capable of being changed to any desired angle under the instant control of the aviator, while the propeller is running.

The object of my invention therefore, is to provide a propeller construction in which the blades can be manually adjusted to a relatively low pitch angle for quick take-off and fast climb, and adjusted to a high pitch angle for high speed, and also, to be reversed to reverse the direction of thrust so as to act as a brake to reduce the landing run of the airplane.

A further object is to provide a propeller of metal construction having a one-piece hub and one-piece blades, and provided with a spinner to reduce head resistance and to protect the mechanism of the propeller.

A still further object of the invention is to provide an improved construction by which the propeller blades are journaled within the hub, whereby the blades will be firmly held therein so as to effectively withstand the powerful centrifugal force developed when the propeller is revolving at great speed, at the same time permitting the free movement of the blades about their axis in varying the pitch thereof.

Referring to the drawings,

Figure 1 is a side elevation of a propeller illustrative of the invention and showing an operating lever connected thereto;

Fig. 2 is a vertical cross section through one of the barrels of the propeller hub substantially upon the line 2—2 of Fig. 3; and a vertical axial section through the hub spinner or casing, the propeller being shown in operative position upon the forward end of an engine;

Fig. 3 is a sectional elevation of the propeller in operative position, the upper half being shown in vertical section and the lower half in side elevation;

Fig. 4 is a sectional elevation, showing the upper half in transverse section on the axis

of the blades and the lower half in end elevation;

Fig. 5 is a sectional detail showing the construction of ball bearings which journal the blades within the hub.

It will be understood in this description, that the propeller hub is that part of the propeller which is fixed to the crank shaft of the motor, and that the hub barrels are tubular portions of the hub extending laterally therefrom to receive the cylindrical roots or shanks of the blades.

Referring more specifically to the drawings, 1 indicates the crank case of any suitable motor, 2 the shaft of such motor to which shaft the propeller hub 3 is secured by means of the nuts 4, 5 and key 6 in the usual manner.

The hub, as shown in Figs. 2, 3 and 4 comprises the hub proper, having a longitudinal bore within which the projecting end of the engine crank shaft is secured, as described, and a pair of oppositely disposed like tubular barrels 7 extending laterally from the hub proper with their longitudinal axes at right angles to the longitudinal axis of the bore in which the shaft is secured and in which barrels the cylindrical end portions 8 of the blades 9 are each journaled by means of the ball bearings 11 and 12. These bearings or rows of balls have outer races 13 and 14 respectively, formed by internal annular ribs formed integral with the barrel, and inner ball races 15 and 16 respectively, made integral with or formed upon the root or tubular inner end portion 8 of each blade by providing annular ribs on said end portion or shank of each blade. The adjustment of these ball bearings 11 and 12 is effected by means of a tapered roller 17, (see Fig. 4) which is journaled on the inner end or pilot of a screw 18 to engage an annular inclined or tapered surface 19 on the inner end of the blade shank 8, said screw being inserted through a screwthreaded opening in the inner end of the barrel wall and locked by means of nut 20 and washer 21 in adjusted position with the roller 17 bearing against the annular end surface of the shank to prevent movement of the blade inwardly in the barrel and hold the blade

shank adjusted outwardly with its inner ball races 15 and 16 in proper contact with the balls. These ball bearings 11 and 12 act as both radial and thrust bearings, making a simple and effective means for securing the blades to the hub with the barrels forming sockets within which the blade shanks turn freely by reason of the interposed balls, and a felt or cork ring 22 which is inserted in an annular groove in each blade shank, is for the purpose of sealing the joint between the shank and barrel.

To assemble the blades in the hub, the hub is turned so that holes 23 formed in the wall of each hub inwardly a short distance from the races 13 and 14, (see Figs. 4 and 5), will be on the top side of the barrel, and the balls are then inserted through these holes, the blade shank being first inserted in the barrel with its races 15 and 16 inwardly of these holes. In this position the shank of the blade is held centrally in the barrel by the straight portion of the shank which is a slip fit in the outer end of the barrel 7 with the ball races 15 and 16 of the blade in the proper relation to the holes 23 to allow the balls to drop freely into their races through these holes until the races are full. The blade is then moved outwardly and the tapered roller 17 is adjusted into engagement with its annular track or seat 19 on the end of the blade shank so that there will be no end play to the blade.

The roller 17 is then locked in its adjusted position by nut 20 and washer 21.

To rotate the blades in their sockets or barrels 7 and change their pitch angles, a lever 24 is mounted in convenient reach of the aviator, and to this lever is attached a rod 25, the opposite end of which is attached to a yoke lever 26 pivotally connected to the crank case 1 by a link 27. The arms of the yoke 26 are attached to pins 28 on the outer ball race of the radial thrust bearing 29 surrounding the inner end of the hub 3, thus holding this outer race against turning, and a flange 30 on the outer race at one side thereof overlaps a flange 31 on the inner race with a small clearance between them, and a flange ring 32 which is pressed into an annular notch in the outer race at the other side thereof has clearance between it and the inner race, thus permitting the outer race to remain stationary while the inner race turns, and at the same time making the bearing dust-proof. A rocking movement of the yoke 26 will therefore cause a longitudinal movement of the bearing 29 on the inner end of the hub 3.

On the inner race of the bearing 29 are bosses 34 and 35 which are tapped to receive long screws 36 and 37. These screws extend through tubular gear racks 38 and attach these gear racks to the inner race way to move longitudinally with the movement imparted to the thrust bearing by the lever 24. These gear racks have a free longitudinal

movement through bearings 40 and 41 provided on the barrels 7 and the gear racks will therefore cause the inner race of the thrust bearing 29 to rotate with the propeller hub.

Each gear rack 38 is in mesh with a sector gear 42 which is secured to a Y-shaped member 43, welded within and flush with the inner end of the blade shank 8. A movement of lever 24 will therefore cause a movement of the bearing 29 longitudinally of the hub and an endwise movement of the gear racks 38, which movement of the racks by reason of their engagement with the sectors 42, will cause a simultaneous but opposite rotation of the blade shanks in their barrels or sockets, effecting an adjustment of the blades 9 relatively to change the pitch angle of the propeller.

The longitudinal movement of bearing 29 is limited in one direction by the inner race coming in contact with the bearing bosses 40 and in the other direction it is limited by the heads of screws 36 and 37 coming in contact with bearing bosses 41. This movement is sufficient to adjust the blades from the maximum reverse pitch to the maximum forward pitch.

The hub 3 of the propeller is provided with a spinner or casing surrounding and rotating with the hub and which spinner has a configuration suitable to form the nose of the fuselage or nacelle in which the motors are usually installed, thus reducing the head resistance of the fuselage or nacelle, and at the same time increasing the efficiency of the propeller.

The rear half or ring member 44 of this spinner or casing is preferably made of sheet metal and of truncated conical shape to form a continuation of the stream line of the fuselage, and is provided with holes through which the outer ends of the barrels 8 project, the edges of the metal surrounding the holes being turned inward over the outer ends of the hub barrels 7 and welded thereto to securely and rigidly attach this casing ring member 44 to the propeller hub, and the rear edge of said member 44 is reinforced and stiffened by a sheet metal ring 45 welded within the member along said rear edge, the front edge of this member 44 being stiffened by a sheet metal ring 46, the cross section of which ring 46 is in the form of a loop with its two edges parallel and spot welded to the inner surface of member 44 and with the greater part of the loop extending forwardly beyond the edge of said member for the purpose of stiffening the forward edge of the member 44 and supporting the rear edge of the nose part 47 of the spinner which is detachable and continues the curved surface of the spinner. This nose portion is firmly and detachably held in position by means of a cap screw 48 extending through an opening at the center of the forward point or end of the nose mem-

ber and screwed into the outer end of a tubular member 49, the inner end of which member is screwed into a screwthreaded opening in the propeller nut 4 and locked by means of the jam nut 50 in position to force the nose portion 47 toward the fixed portion 44 with the necessary pressure to firmly hold the nose detachably in place, thereby making the mechanism of the propeller accessible by a removal of the nose portion of the spinner.

The propeller blades are preferably made of alloy steel tubing having the same chemical analysis as the hub, the tubes being reduced in thickness from the root to the tip to correspond with the stresses at the different diameters of the propeller and as is the usual practice, the blades are made up of a series of aerofoil sections, and in the present construction it is necessary to select a tube with a circumference sufficient to form the aerofoil section at the maximum width of the blade. From the maximum width of the blade the tube is tapered to the root of the blade and the maximum ordinance of the first aerofoil section next to the hub, is slightly less than the root diameter of the blade, and as this section is on the tapered part of the tube, it will then be necessary to flatten the tube. This will make a more efficient section at this point than would be obtained with a tube having a uniform diameter throughout its length. The blades are seamless from the root to the maximum width but from there to the tip the leading and trailing edges are edge-welded where the excess metal is removed in reducing the blade in width toward the tip, thereby making a one-piece blade that is hollow and tapered in wall thickness from the root to the tip.

By selecting the proper alloy steel for the hub and blades, the heat treatment will give these members unusual toughness and strength, but as the ball races are an integral part of the blade shank and require a much harder surface, this is effected by carbonizing the surface of the ball races before heat-treatment of the members, which will then give the required hardness to the ball races.

The gear rack 38 is preferably formed with a central tooth 38A of double thickness and the gear sector 42 is made with a double space to correspond with the double tooth on the rack for the purpose of assisting in the assembly of the blades, insuring the proper angular position of the blades by the proper meshing of the racks and sectors. As the two blades are identical, they are interchangeable.

No ball retainers are employed in the bearings 11 and 12 and the balls are therefore in contact with each other as shown in Figure 2, utilizing the maximum number of balls and giving the maximum possible carrying capacity to the bearings. Additional bearings or rows of retaining balls may be provided if found desirable, but such additional

bearings will be required in very rare cases only, as the load carrying capacity of these bearings is very great. Further, the present construction is not limited to a two-blade propeller, as shown in the drawings, but is applicable to propellers with any number of blades desired.

The advantages of the adjustable propeller may be more clearly brought out by a description of its operation during flight. The angle of attack of the blades should remain approximately the same throughout the speed range of the airplane. Greater efficiency is obtained for take-off, with a relatively small pitch. This increased efficiency makes available a greater amount of power for take-off and climbing, gives faster climbing speed, and with maximum pitch, permits throttling down the motor to obtain a more economical cruising speed, hence increasing the radius of flight and the time that the airplane may remain aloft for a given amount of fuel consumed. When landing the airplane, the propeller blades may be rotated to neutral position, and at the instant the wheels touch the ground or in the case of machines that have a tendency to float, when close to the ground, the pitch may be instantly reversed, thus serving as a brake to check the forward speed of the machine and reduce the roll along the ground. The greater efficiency of the variable pitch propeller will also be of value in increasing climbing ability at high altitudes, thus making it possible to reach greater heights with a given machine. The manner of mounting the blades in the hub also insures easy operation thereof at all times to change their pitch angle and also insures against the blades becoming detached through the action of centrifugal force. The construction also makes for simplicity in construction and manufacture, and lightness in weight.

Obviously changes may be made in the construction and arrangement of parts, within the scope of the appended claims, without departing from the spirit of the invention, and I do not, therefore limit myself to the construction shown.

Having thus fully described my invention, what I claim is:—

1. An aircraft propeller including a hub provided with sockets, blades having end portions engaged within said sockets, the walls of said sockets being formed with integral internal annular ribs forming one side of raceways and with openings adjacent and inwardly of said sockets from said raceways, said end portions of said blades being also formed with integral external ribs to oppose said ribs on said sides and form the raceways, balls inserted through said openings in said sockets into said raceways, means for holding said blades against endwise inward movement in their sockets.

2. An aircraft propeller including a hollow hub formed with radial sockets, blades having shank portions engaging said sockets, rows of retaining anti-friction members inserted between said blade shanks and the walls of said sockets in direct contact therewith and forming the sole means for retaining said shanks in said sockets and to permit free rotation thereof in said sockets, a member to engage the inner end of each shank and hold the same against inward movement in its socket, and means within said hollow hub for imparting turning movement to said blades in their sockets during rotation of the propeller.

3. An aircraft propeller including a hub formed with radial tubular sockets each having a pair of internal continuous annular ribs, one adjacent the outer end of said socket and the other adjacent the inner end thereof, each of said sockets being also formed with openings through the wall thereof, one opening located inwardly toward the inner end of said socket from each rib, blades having cylindrical end shanks each formed with a pair of external continuous annular ribs to oppose said pair of internal ribs on the wall of each socket, said ribs on said blade shanks being of lesser external diameter than the internal diameter of said ribs on said socket walls to permit the insertion of said shanks endwise into said sockets past said ribs on said socket walls, balls inserted through said openings and engaged between said opposed ribs on said shanks and walls, and means extending through the wall of each socket into engagement with the inner end of each blade shank to prevent inward movement of said shank and separation of said opposed ribs.

In testimony whereof I affix my signature.
JOHN F. COOK, JR.

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