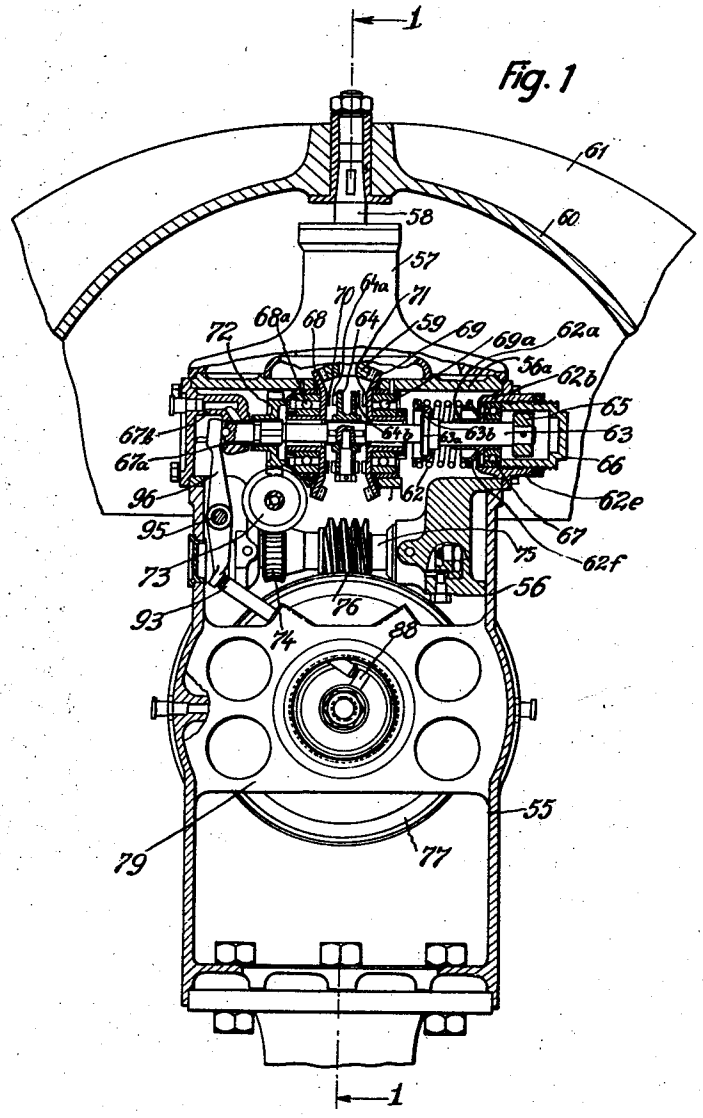
Aug. 5, 1941. H. REISSNER ET AL 2,251,602

REGULATABLE PROPELLER HAVING ADJUSTABLE BLADES

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Fig. 1



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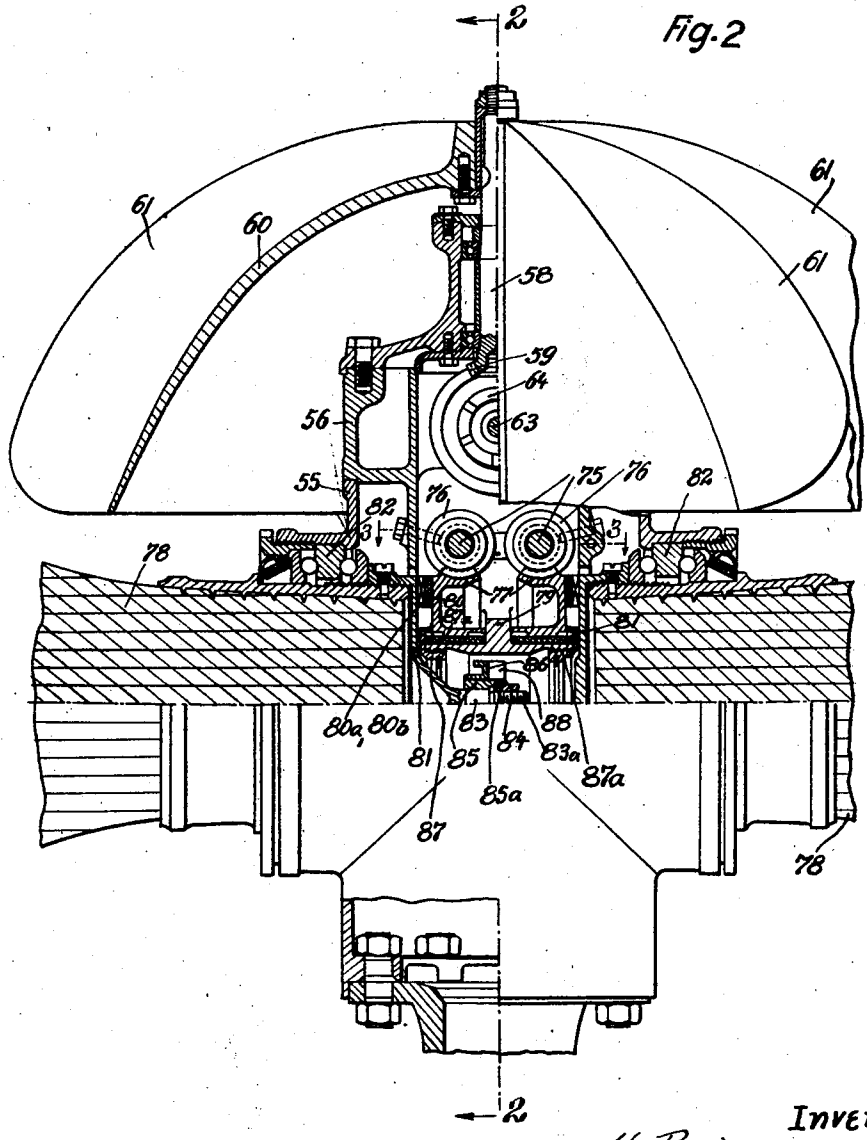
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REGULATABLE PROPELLER HAVING ADJUSTABLE BLADES

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Fig. 2



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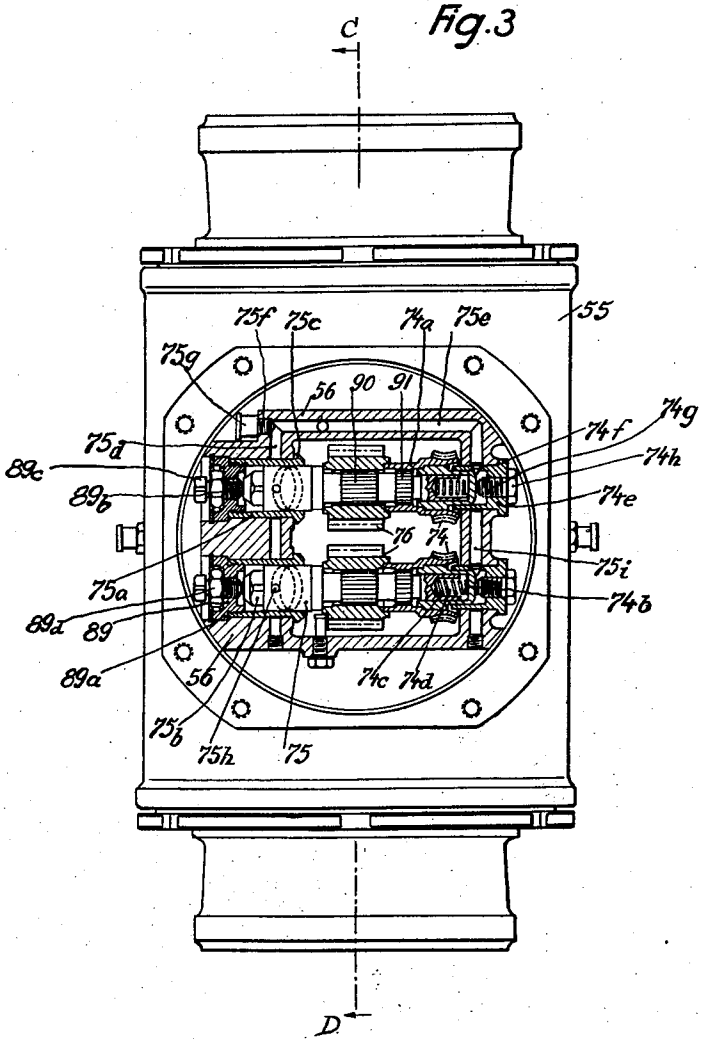
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REGULATABLE PROPELLER HAVING ADJUSTABLE BLADES

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Fig. 3



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REGULATABLE PROPELLER HAVING ADJUSTABLE BLADES

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Fig.4

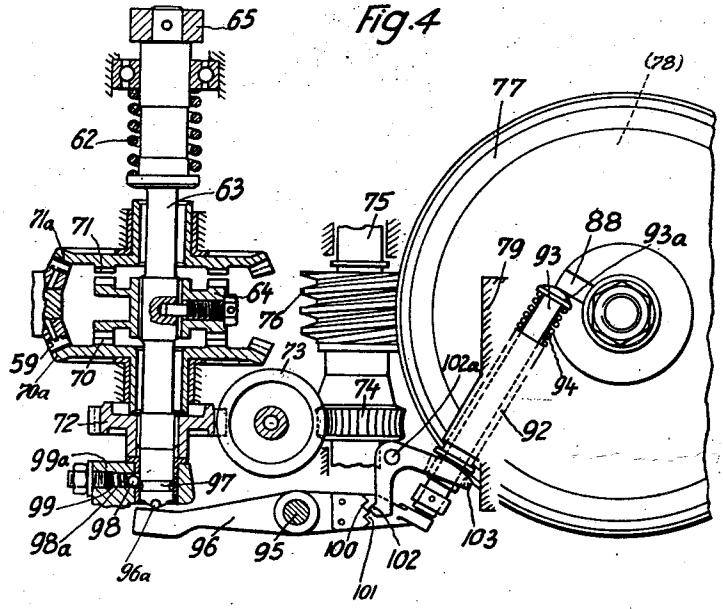


Fig.6

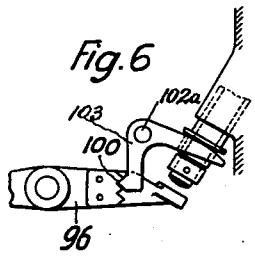
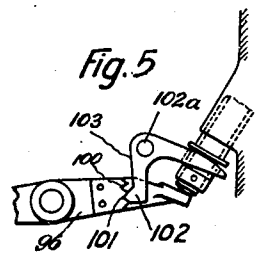


Fig.5



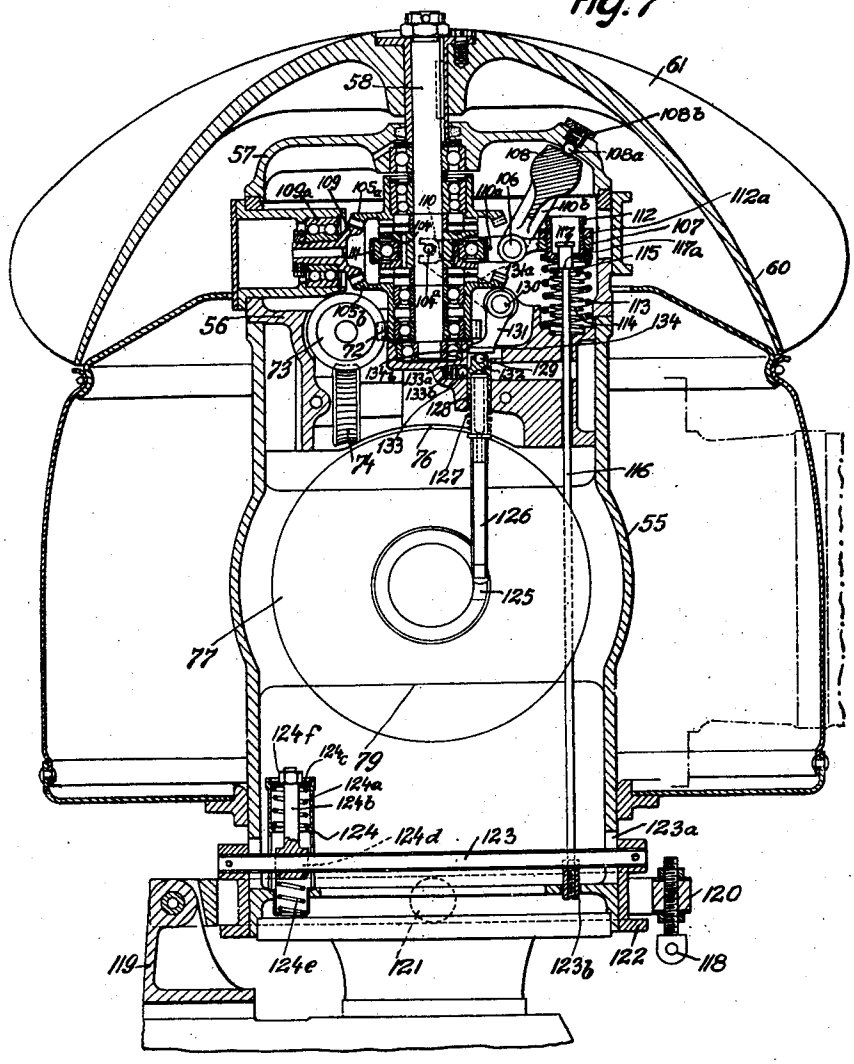
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REGULATABLE PROPELLER HAVING ADJUSTABLE BLADES

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Fig. 7



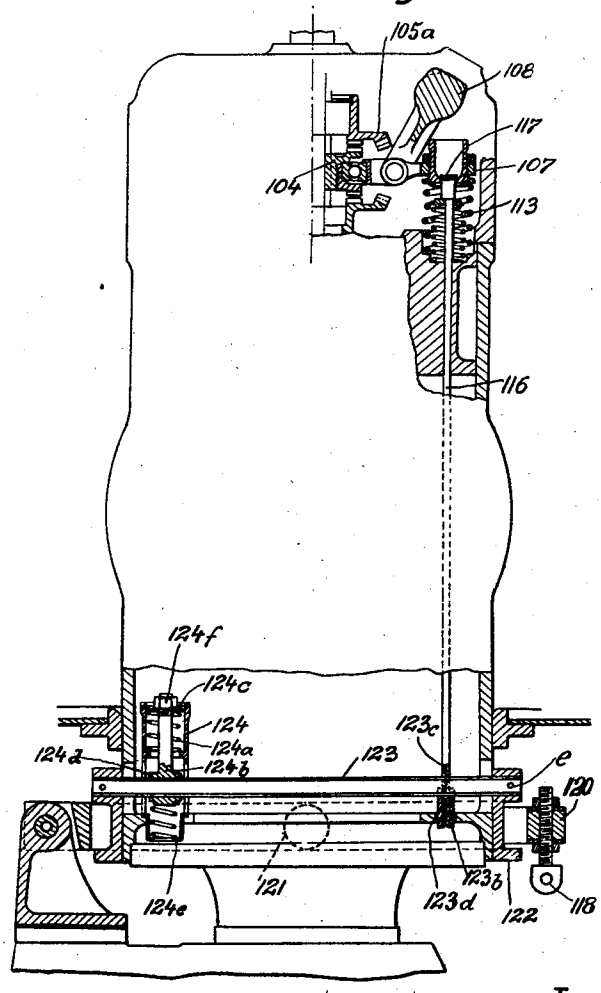
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REGULATABLE PROPELLER HAVING ADJUSTABLE BLADES

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Fig. 8.



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REGULATABLE PROPELLER HAVING ADJUSTABLE BLADES

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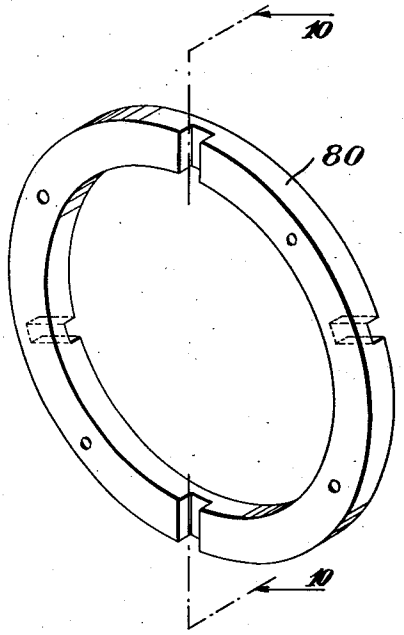
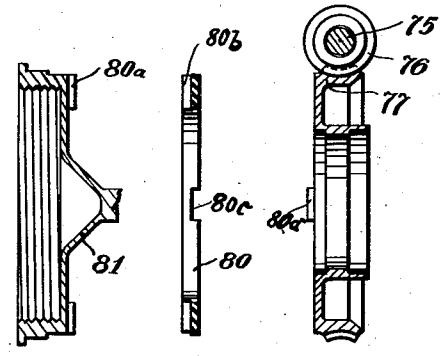


Fig. 9

Fig. 10



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UNITED STATES PATENT OFFICE

2,251,602

REGULATABLE PROPELLER HAVING ADJUSTABLE BLADES

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Application April 25, 1938, Serial No. 204,208
In Germany August 21, 1936

8 Claims. (Cl. 170—163)

The present invention relates to a variable pitch propeller and more particularly to a variable pitch propeller for aircraft of the kind in which a pair of gears is arranged between a mechanism supplying the power for adjusting the propeller blades and a mechanism actuating the blades and in which coupling members are provided for connecting and disconnecting one of the pair of gears and said mechanisms and governors for controlling the coupling members, which governors are responsive to the number of shaft revolutions.

It is one object of this invention to adapt the driving engine to the various conditions of flight, particularly starting, climbing, fast flight, diving and so forth.

It is a further object of the invention to positively adjust the governor for various predetermined speed settings.

It is a further object of the invention to prevent an undesired and excessive rotative movement of the blades, which might result in the so-called negative thrust of the propeller when throttling the engine.

It is a further object of the invention to positively interfere with the operation of the governor to adjust the propeller blades when the engine is not working in such manner that the same cause a minimum of air resistance and that practically no torque is exerted upon the engine.

It is a further object to improve the operation of the pitch changing mechanism by the provision of means for supplying the power for the adjustment of the propeller blades when the engine does not drive the propeller.

A further object of the invention consists in the provision of direct mechanical means for positively establishing certain predetermined speed settings of the governor.

A further object of the invention consists in the provision of means which positively shift the coupling member into and hold it in a disconnected middle position.

It is a further object of the invention to modify the operation of the means for adjusting the members of the governor in such manner that besides the automatic adjustment of the governor a positive adjustment may be effected of the same when the driving engine is not operated.

The invention is illustrated by way of example in the annexed drawings, of which:

Fig. 1 shows a longitudinal section through the propeller hub including the blade adjusting device on line 2—2 of Fig. 2;

Fig. 2 shows a longitudinal section on line 1—1 of Fig. 1;

Fig. 3 shows a cross-section on line 3—3 of Fig. 2;

Fig. 4 shows an enlarged view of the stopping means for disconnecting the coupling member and the means for holding same in a disconnected middle position;

Figs. 5 and 6 show certain operating positions of the stopping means and a control lever illustrated in Fig. 4;

Fig. 7 shows a longitudinal section through a second modification of the propeller hub. In this modification the axis of the impeller blade wheel arranged in front of the hub coincides with the axis of the reversing gear;

Fig. 8 shows an elevation partially in longitudinal section showing parts of the hub and the reversing gear illustrated in Fig. 7;

Fig. 9 shows on an enlarged scale a perspective view of the coupling disc between the blade roots and the blade adjusting means; and

Fig. 10 shows vertical sections of the blade root, of said coupling disc and a worm gear cooperating with the propeller blade adjusting means.

According to Figs. 1 to 6, hub casing **55** is provided with a front portion **56**; the hub casing encloses the gear which adjusts the propeller blades. The front end of casing **56** is closed by cover **57** which supports shaft **58**, Figs. 1 and 2. A bevel gear **59** is keyed upon this shaft. The end of shaft **58** projects from the casing; it carries a cowl **60** on which impeller blades **61** of an impeller blade wheel are mounted; these blades are inclined towards the direction of flight. The inclination of the impeller blades **61** is preferably opposite to that of the propeller blades and chosen in such manner that when diving the impeller blade wheel does not assume an excessive speed and yet causes a speedy adjustment of the blades and furnishes sufficient power for its adjustment.

In the casing portion **56** a shaft **63** is journalled which extends in a vertical direction to the axis of the hub; it may be displaced against the action of a spring **62**. A collar **63***b* bears against a flange **63***a* on the shaft **63**; one end of the coiled spring **62** bears against collar **63***b* and the other end bears by means of a collar **62***f* against a flange **62***a* slidably arranged upon the shaft **63**. The flange **62***a* in turn bears aaginst a ball bearing **67** which is slidably arranged in a portion **62***b* of the hub casing. A threaded screw cap **66**, is screwed into the portion **62***b* of the hub casing and engages with its edge the ball bearing **67**.

By means of the screw cap 66 the tension of the spring 62 may be positively adjusted and the action of the centrifugal weight 65 mounted upon the end of the shaft 63 may be varied accordingly.

A sleeve coupling member 64 is keyed to the shaft 63. This coupling member 64 is provided with disc-like members having claw-like projections 64*a* and 64*b*; these projections are located opposite to a pair of bevel gears 68 and 69 which are provided with corresponding coupling claws 70 and 71. The claws 70 are provided on bevel gear 68 and the claws 71 on bevel gear 69.

The bevel gears 68 and 69 are coaxially arranged with the shaft 63 carrying the centrifugal governor; they bear by means of the ball bearings 68*a* and 69*a* against the wall 56*a* of the casing portion 56. The two bevel gears 68 and 69 are in constant engagement with each other by means of bevel gear 59 mounted upon shaft 58, the axis of which extends vertically to the axis of shaft 63 and bevel gears 68, 69. Therefore, the two bevel gears 68, 69 can only rotate in opposite direction to each other.

Shaft 63 is rotatably supported by suitable bearings; one of these bearings is the ball bearing 67, which receives the pressure of the spring 62 and prevents twisting of the latter; a second bearing is formed as a bearing sleeve 67*a* mounted in a projecting portion 67*b* of the hub casing portion 56.

In conformity with the position of the coupling member 64, the cams 64*a*, 64*b* engage the corresponding claws 70 or 71 of the pair of gears 68, 69. The shaft 63 is accordingly rotated either in the one or in the opposite sense; the power for effecting this rotation is transmitted from the impeller blade wheel 60, 61 by means of the bevel gears of the reversing gear and the coupling claws.

The end of the shaft 63 opposite to that carrying the centrifugal weight 65 carries a worm 72, which drives a worm wheel 73. Two other worms not shown in the drawings are mounted upon the shaft of the worm wheel 73. These worms drive two worm wheels 74 one of which only is shown in Figs. 1–3. These worm wheels 74 drive worms 76, on shaft 75, which worms drive worm gears 77, Fig. 2, which are arranged coaxially with the rotating axis of the propeller blades 78 upon a stationary plate 79 of the hub casing 55, Fig. 1; these worm gears act upon the roots of the propeller blades.

Next to worm wheels 77 facing the propeller blades cross-disc couplings, Figs. 4 and 9, are provided. These couplings consist of discs 80 provided with cross-wise arranged notches 80*b*, 80*c*; caps 81 of the roots of the propeller blades engage by means of ribs 80*a* and without play from the one side grooves 80*b* of the discs; from the other side worm wheel discs 77 engage by means of similar ribs 80*d* grooves 80*c*; the transmission of vibrations of blades 78 to worm wheels 77 is hereby prevented.

The blades are rotatably supported in casing 55 of the propeller hub by means of ball bearings 82. The plate 81 of the blade root, shown at the left hand side in Fig. 2, carries a conical bolt 83 projecting towards the root of the opposite blade. Conical sleeves 85 encase this bolt 83; they are surrounded by an annular member 86. By means of a threaded nut 84 screwed upon the threaded portion of conical bolt 83 the sleeves may be pressed against the outer annular member 86 if the conical sleeves 85 are axially shifted towards the left by nut 84. At the same time sleeves 85 tend to move outwardly upon the conical portion of bolt 83 and are thereby firmly pressed against annular member 86.

The annular member 86 carries a stop 88 which at predetermined positions of the propeller blades disengages coupling member 64, Fig. 1, by means of a special gear shown in Figs. 1, 4–6 and described later on.

Stop 88 may be adjusted relatively to the position of the propeller blades by turning annular member 86 upon the sleeves 85 and thereupon locking said member by means of nut 84.

At the side of the sleeves 85 facing the nut 84 a flange is provided having a recess 85*a* and projecting inwardly towards the nut. This flange fits over a corresponding flange of the nut 84; the sleeves 85 are hereby held together with the nut 84 so as to prevent axial movement. Due to the divided construction of the two sleeves 85 the same may be placed upon the nut with their flanges interengaging before they are mounted upon the conical bolt.

Worm wheels 77 are rotatable with regard to the hub portion 79; but they are prevented from axial displacement by means of nut 87 having a thread 87*a*, Fig. 2.

Shafts 75 of worms 76, Figs. 2 and 3, may be axially shifted in sleeves 75*a*, Fig. 3, by means of nut 89*a* screwed into sleeve 75*a*. Sleeves 75*a* are located in hub member 56 and bear against the same by means of flange 75*c*. A screw bolt 89*b* is screwed in the nut 89*a*. This bolt carries a head 89*c*; a nut 89*d* acting as a counter nut holds bolt 89*b* in a fixed position.

The free end of bolt 89*b* is rounded off and bears against the adjacent end of shaft 75. Shaft 75 at this end carries a many-sided head 75*b* by means of which it may be turned with the aid of a wrench inserted into sleeve 75*a*.

75*d* and 75*e* are oil channels. The oil may for instance be introduced by an opening 75*f* which may be closed by a threaded plug 75*g*; the outer end of the plug is formed as a grip or handle. The channels are connected with bores 75*h* and lead to the upper surface of the shafts 75. Between the portions used for journalling the shafts 75 a relatively long tooth wheel 90 and spaced therefrom a shorter tooth wheel 91 are provided. A worm 76 is mounted upon tooth wheel 90 (Fig. 3). A worm wheel 74 is located by means of a sleeve-like projection 74*a* on tooth wheel 91.

The tooth wheel 90 permits the worm 76 and the worm wheel 74 to be shifted into certain positions with regard to shaft 75; it is provided with notches to positively hold members 74, 76 in their adjusted position.

A cap 74*b* is provided at the end of shaft 75 which fits over the end of the same. This end of shaft 75 has a recess 74*d* and in this recess a resilient coil 74*c* is located bearing with its one end against the bottom of the recess and with its other end against the bottom of the sleeve 74*b*. A cap 74*b* is located in sleeve 74*e* the latter being located in casing portion 56 of the hub; it may be held in the latter against axial displacements. The portion of sleeve 74*e* located outside casing portion 56 is provided with a flange 74*f* by means of which it bears against casing portion 56. Screwed into sleeve 74*e* is a screw bolt 74*g* the end of which projects from the casing; this end carries a hexagon head 74*h* by means of which this bolt may be adjusted.

The free inner end of bolt 74*g* is rounded off and against this end bears the outer face of the bottom of cap 74*b*. An oil channel 75*i* supplies oil for reducing the friction at the sleeve 74*b*.

In Figs. 4–6 the device for disengaging the coupling 64 by means of a stop 88 is shown on an enlarged scale.

A sleeve 92 is shiftably journalled in the plate 79 of the hub casing 55. In the sleeve 92 a rod 93 is axially displaceable. The one end of rod 93 is rounded off and cooperates with stop 88. At this end of the rod 93 a spring 94 is provided which acts as a storage spring; the spring surrounds the rod 93 and is located between a flange 93*a* of the rod 93 and the front edge of the sleeve 92 facing the flange 93*a*. One end of the rod 93 cooperates with the shorter arm of the double-armed lever 96 pivotally carried on bolt 95 which is mounted in the casing 55, Fig. 1. The other long arm of the double-armed lever 96 cooperates by way of a ball 96*a* with the one end of the shaft 63 of the centrifugal governor 65. Fixed upon shaft 63 is the coupling member 64 for the reversing gear 70*a*, 71*a*, 59, see also Fig. 1.

The end of shaft 63 facing the lever 96 is provided with an annular groove 97 which in the middle position of the coupling 64 is entered by ball 98; which is actuated by a spring 98*a* and is guided in a bore 99 of bearing part 99*a* connected with shaft 63. This arrangement serves to prevent permanent axial reciprocating movements of the coupling member 64 due particularly to the alternating actions of the centrifugal weight 65 and the counter-spring 62. Such reciprocating movements of the coupling members 64 are not desired, as they may cause incomplete engagements of the claws to be coupled, undue wear of the latter and inaccurate operation of the stop 88.

In order to further prevent undesired reciprocating movements of the gear members 92 to 96 a special device is provided shown in Figs. 4–6. The short arm of the lever 96 is provided with notches 100, 101. Nose 102 of a bell-crank lever 103 which is rotatably mounted upon a pivot 102*a* engages these notches. The nose 102 is provided at the one arm of the bell-crank lever 103 the other arm of which bears against the sleeve 92.

The operation of the embodiment of the invention shown in Figs. 3–6 is, as follows:

Before the stop 88 provided at the root of the blade engages the rounded-off end of the rod 93 the claws of the coupling member 64 are in engagement with the claws 70 of the bevel gear 68. In this position the reducing gearing 72 to 77 is, by means of the impeller blade cowl 60, 61, actuated in such manner that the blade 78 is adjusted to a lower pitch and is rotated in a counterclockwise direction.

The lever 96 and the bell-crank lever 103 hereby occupy the positions shown in Fig. 5 the nose 102 engaging the notch 101. The longer arm of the lever 96 is swung into a position where the claws of the coupling member 64 engage the claws 70 of the bevel gear 70*a*.

If now the adjustable stop 88 presses against the rounded-off end of the rod 93 the other end of the rod presses upon the end of the control lever 96. The lever 96 is thereby turned in a clockwise direction and simultaneously the end of its longer arm presses by way of the ball 96*a* upon the adjacent end of the shaft 63. On a further displacement of the rod 93 and rotation of lever 96 the claws of the coupling member 64 are moved out of engagement with claws 70 of bevel gear 70*a*, so that the mutual engagement is interrupted. In this position the gear for adjusting the propeller blade is disconnected. Consequently, the rotation of stop 88 is interrupted and it does not exert further pressure upon rod 93 and lever 96.

When the stop 88 presses against rod 93 the latter is pushed through the sleeve 92 whereby the storage spring 94 is compressed. Simultaneously nose 102 of the bell-crank lever 103 is lifted out of engagement with notch 101, Fig. 6. When the nose 102 is out of engagement with notch 101 spring 94 presses by means of the displaceable sleeve 92, upon the adjacent end of the bell-crank lever 103 so that the latter is turned and nose 102 is pressed into notch 100.

Lever 103 may also perform its above described function if stop 88 is not forced to press upon rod 93. Under these conditions rod 93 would not be displaced and the danger arises that lever 96 might come to a standstill in an undesired intermediate position.

In this case however, compression spring 94 acts as a protecting storage spring and a secure position of lever 96 is attained in spite of rod 93 not being moved by means of said spring which turns bellcrank lever 103 in a clockwise direction whereby nose 102 is pressed into notch 100, Fig. 4.

In this position coupling member 64 is disengaged from bevel gear 70. Simultaneously, the ball 98 engages the annular notch 97 in the shaft 63 of the governor and holds the latter in such a position that the coupling member 64 occupies its middle position between the two bevel gears 70 and 71.

If now, due to the centrifugal force of the weight 65 and a faster rotation of the hub of the propeller the coupling member 64 is connected to the bevel gear 71*a* the adjusting gear 72 to 77 is driven in a sense opposite to that in which it was driven previously so that the stop 88 also is rotated in the opposite direction, i. e. in a clockwise direction whereby the rounded-off end of the rod 93 is released. Consequently, the spring 94 is slackened or released, and the sleeve 92 may be returned; simultaneously, due to the slackened or released spring 94 and its reduced pressure upon sleeve 92 bell-crank lever 103 is also released so that nose 102 may leave notch 100, Fig. 6 and engage notch 101, Fig. 5, i. e. if the lever 96, due to a preponderating centrifugal force of its longer arm, is turned in a counterclockwise direction.

By disconnecting the adjusting gear by means of stop 88 the pitch of the propeller blade may be prevented from being reduced too much by the impeller blade cowl 61 if the driving engine is throttled for a long duration of time. Accordingly the thrust of the propeller blades is not decreased in an undesired manner during flight or even becomes negative and, if full gas is given the blades are not adjusted to a too low pitch, so that running-away of the engine is prevented.

Another form of the invention is shown in Figs. 7 and 8. In this case the shaft 58 is carrying the impeller blade wheel 60—61 and is provided with a sleeve coupling 104 movable in the longitudinal direction of the shaft but prevented from rotating with regard thereto. A ball bearing 111 is arranged coaxially to this coupling 104. Connected with the ball bearing 111 are bolts 104*a* which extend at an angle of 90 degrees to the shaft 58; they are engaged by a fork 110 rigidly connected by means of an intermediate member 110*a* to the supporting member 110*b*

of a centrifugal weight 108. Intermediate member 110a and supporting member 110b form bell-crank lever which is pivoted about a bolt 106. Consequently, the fork 110 arranged at lever arm 110a may be rotated about bolt 106, mounted in hub casing 56 in such a manner that its rotation causes an axial displacement of the coupling member 104 upon its shaft 58 whereby the same is shifted into engagement with and a cooperation with the bevel gear 105a or bevel gear 105b of the reversing gear. These bevel gears 105a, 105b are rotatably mounted upon shaft 58 but are prevented from axial movement.

The movement of the centrifugal weight 108 causes rotation of the lever arm 110a and the fork 110 connected therewith fixed thereto about the bolt 106. The fork 110 then displaces the bolts 104a of the coupling member 104 or of the ball-bearing 111 connected thereto in such a manner that with an increased speed and outward swinging of the centrifugal weight 108 the coupling member 104 is brought into engagement with the coupling claws of the bevel gear 105a.

Between the bevel gears 105a and 105b another bevel gear 109 is rotatably located in a ball bearing 109a mounted in the casing 55. The axis of bevel gear 109 extends at an angle of 90° to the common axis of the other two bevel gears 105a, 105b. Bevel gear 109 therefore transmits movements to bevel gears 105a and 105b respectively in such a manner that those two bevel gears 105a and 105b may rotate in opposite directions to each other only.

A worm 72 is connected with bevel gear 105b. This worm 72 engages a worm wheel 73 which transmits the movements required for adjusting the blades of the propeller to such intermediate gears as are shown in Figs. 1–3. In this manner, the rotary movements are transmitted to worm wheels 74 and 75 by worms 76 and worm wheels 77, Fig. 1, upon the root of the propeller blade.

The construction shown in Fig. 7 has the advantage that bevel gears 105a and 105b are not permanently rotated as is the case in the construction according to Figs. 1 and 2 but are rotated only if they are coupled.

Bevel gears 105a, 105b and 109 are located on shaft 58 of the impeller wheel by means of ball-bearings.

The lever arm or supporting member 110b of the centrifugal weight 108 is rigidly connected to a lever arm 107 which is pivotally mounted upon bolt 106 in same manner as supporting member 110b. The free end of lever arm 107 has a bore in which a threaded sleeve 112 is mounted which may be adjusted by means of a counter nut 112a.

Lever arm 107 bears against one end of spring 113 and the other end of said spring bears against casing 56. A spring 114 is located inside of spring 113. The spring 113 alone or both springs 113 and 114 together counteract the centrifugal force of centrifugal weight 108 as they tend to so displace sleeve 112 that lever arm 107 is rotated about bolt 106 in a counterclockwise direction. At greater speed, however, the centrifugal weight tends to rotate lever arm 107 in a clockwise direction.

Springs 113 and 114 are located parallel to the axis of the propeller. Spring 114 may be engaged or disengaged by a stop 115 bearing against its end facing the sleeve 112 and a rod 116 acting upon stop 115. If rod 116 occupying the position shown in Fig. 7 is drawn downwardly a collar 117a provided thereon presses against stop 115 and moves the spring 114 out of the position in which it cooperates with the sleeve 112 so that the latter remains under the action of the spring 113 only. If rod 116 is moved in opposite direction so far that its collar 117a lies flush with the outer bottom of the sleeve 112 then the stop 115 presses against the bottom of this sleeve; thereby the latter is again actuated by the common action of the two springs 113 and 114.

The engagement and disengagement of the spring 114 allows adjustment of the centrifugal governor into two different middle positions which correspond to two different nominal speeds of the propeller.

Besides the collar 117a acting upon the springs the rod 116 carries at its free end a flange 117 which may bear against the inner bottom of the sleeve 112.

The coupling member 104 may by rod 116, its flange 117, sleeve 112 and lever 107 as well as by the lever arm 110a, the fork 110 and the fork bolts 104 be so moved as to be positively coupled to the bevel gear 105a.

A spring-loaded ball 108a acting upon centrifugal weight 108 is provided at that part of casing 57 in front of which weight 108 performs its rocking movements. The spring may be adjusted from the exterior by means of a screw cap 100b. Spring-loaded ball 108a engages a recess provided in the centrifugal weight 108, so that the latter is fixed in a predetermined position (middle position) and leaves this position only if a predetermined centrifugal force is exceeded.

Rod 116 is actuated from the pilot's seat by way of a leverage connected to the bolt 118 and not shown in the drawings. Bolt 118 is mounted on yoke 120 pivoted to bracket 119, which may be connected with the engine block. The yoke 120 surrounds the hub of the propeller in the manner of a collar. By means of two rollers 121 yoke 120 engages a ring 122 axially shiftable upon the hub of the propeller which may assume two different axial positions. One of these positions corresponds to the disengaged middle position of the coupling member 104 and in the other position spring 114 lifted from lever 107 by means of rod 116 is fixed in its position. Connected with ring 122 is a rod 123 which extends across the axis of the hub of the propeller and through slots 123a of the hub casing 55. Adjustably connected to rod 123 is rod 116 by means of an adjustable nut 123b, Fig. 8. In order to obtain this end the corresponding end of the rod 116 carries a thread upon which nut 123b is screwed which together with a bolt engages into a slot 123d of hub casing 55 (Fig. 8).

To compensate an unilateral pull exerted by springs 113, 114 upon rod 123 a special device is arranged substantially symmetrically to the axis of the hub of the propeller. This device includes a spring 124a arranged in a cylinder 124. Spring 124a acts upon bolt 124b one end of which bears by means of a stop 124c against the spring and the other end of which is formed as an ear 124d through which extends the rod 123. This ear-like end of the bolt 124b bears against a further spring 124c also mounted in the cylinder 124 and bearing against the latter. By means of a hexagon nut 124f screwed upon a thread provided at the free end of bolt 124b and resting upon stop 124c the bolt may be adjusted with regard to the springs. The spring 124f exerts a pressure upon the ear of the bolt 124b, whereas the spring 124a exerts a pull on the ear by way of displaceable stop 124c and bolt 124b. Both

springs, therefore, act upon a rod 123 in the same direction as rod 116.

Bolt 118 is connected to the centrifugal governor by the rotatable yoke 120; roller 121 and ring 122 are displaceable upon the hub by means of cross rod 123 connected to said ring and by means of control rod 116 connected to said cross rod.

As with the previously described form of the invention an adjustable stop 125 is provided at the root of the propeller blade. Stop 125 cooperates with a rod 126 displaceably mounted in sleeve 128. A storage spring 127 is provided between a flange of rod 126 and the edge of sleeve 128 facing rod 126. The rod, the sleeve and the spring extend parallel to the axis of the propeller. Sleeve 128 is displaceable in casing 56 and its edge opposite the spring carries a ball 192 which cooperates with a bell-crank lever 131, 131*a* pivotally arranged upon bolt 130. The arm 131*a* is connected to bolt 104*a* of coupling member 104 in such a manner that when lever 130, 131*a* is swung in a clockwise direction coupling member 104 is positively disconnected from coupling member 105*b* and moved into the middle position.

The portion of sleeve 128 adjacent to ball 129 carries a rounded-off projection 132 cooperating with ball 133 located in a box 133*a* of casing 55. Ball 133 bears against spring 133*b*.

The operation of the form of the invention shown in Figs. 7 and 8 is as follows:

It may be assumed that the propeller is moved by the engine at a speed corresponding to the nominal speed of the centrifugal governor. In this position coupling member 104 is disengaged and occupies the middle position between the two bevel gears 105 and 105*b*.

If now the speed of the propeller increases centrifugal weight 108 is swung outwardly against the action of spring 113 or against the action of both springs 114, 113. Centrifugal weight 108 rotates bell-crank lever 110*b*, 110*a* in a clockwise direction whereby fork 110 axially displaces coupling member 104 towards bevel gear 105*a* coupling same together. The propeller blades are rotated by bevel gear 109, bevel gear 105*b* and gears 72 and 77 in such manner that the pitch is increased until a predetermined speed is obtained.

The above described connection to the bevel gear 105*a* is effected at two different speeds depending upon whether by a corresponding displacement of rod 116 spring 114 is caused to act upon lever 107 or is disconnected from the same.

If now due to the increase of the pitch the speed decreases then the pressure of spring 113 or of the combined springs 113, 114 overcomes at a certain speed the centrifugal force of centrifugal weight 108 and coupling member 104 is disconnected from the bevel gear 105*a* and at first brought into the middle position.

The notch device 108*a*, 108*b* acting upon the centrifugal weight holds the coupling member in its middle position. If the speed further decreases the action of the spring exceeds that of the centrifugal weight to such extent that the locking action of notch 108*a*, 108*b* is also overcome and coupling member 104 is coupled to bevel gear 105*b*. This bevel gear rotates in a direction opposite to that of the bevel gear 105*a* and therefore causes an adjustment of the propeller blades to a lower pitch.

It is now assumed that the engine is to be stopped. Before this state is obtained coupling member 104 has been connected to bevel gear 105*b* by means of spring 113 or both springs 113, 114 overcoming the lessened force of centrifugal weight 108. As has been already mentioned this causes the blades of the propeller to be adjusted to a lower pitch. Such position of the blades, however, is undesired if the motor is stopped because it causes a great air resistance.

It is therefore desirable to move the blades into highest pitch, i. e. in the feathering position for the purpose of reducing the resistance to flight.

Rod 116 serves this purpose. If this rod is pulled downwardly, Fig. 7, it first disconnects, by means of its collar 117*a* spring 114 from lever 107. On further return movement of rod 116 collar 117 bears against the inner bottom of screw cap 112. Hereby a position of rod 116 is obtained at which immediate disengagement of the coupling members 104 from the claws of the coupling member 105*b* may be obtained. In fact, if rod 116 is returned still further it withdraws due to flange 117 bearing against the bottom of sleeve 112*a* the latter against the action of springs 113 and 114, whereby lever 107 is positively turned about the pivot 106 and, therefore, forked lever 110, 110*a* is rotated in the same sense, so that bolts 104*a* of the coupling member acted upon by the forked lever disconnect the coupling member from bevel gear 105*b*.

On further return movement of rod 116, coupling member 104 is moved beyond the middle position at which temporarily, a notch, not shown in the drawings, and provided between the ring 122 and the throat of the hub becomes operative. The coupling member 104 is hereby coupled to bevel gear 105*a*. Consequently, the blades of the propeller are in the above described manner adjusted to a higher pitch until the feathering position is reached.

If now the engine is to be started again and a change to normal conditions of flight is to be effected springs 113 and 114 must be completely disconnected from collar 117 and 117*a* of rod 116, so that the governor by means of releasing springs 113 or 113 and 114 disconnects coupling member 104 from bevel gear 105*a*, moves the coupling member 104 beyond the middle position and connects it to bevel gear 105*b* with the result that the blades of the propeller are again moved into a position of lower pitch. As soon as a definite position of low pitch of the blades has been reached the air current acting upon the blades causes starting of the engine.

The operation of rod 116 and the notches, not shown in the drawings, and provided between the ring 122 and the throat of the hub is, as follows:

After the coupling member 104 has been moved into its middle position, one of the two notches, provided between ring 122 and the throat of the hub, comes into action at once. In consequence of the notch action, springs 114 and 114, bearing against the collars of rod 116 are prevented from shifting the coupling member 104 beyond its middle position in which said coupling member is held by the rod 116 with the aid of lever 107 and forked lever 110*a*.

If by means of springs 113 and 114 the coupling member 104 is to be moved beyond its middle position and into engagement with bevel gear 105*b* then the rod 116 is from the pilot's seat, positively shifted upwardly whereby first, due to the lifting of the collar 117 from the bottom of the sleeve 112, the spring 113 is rendered effective.

To secure this position in which the spring 113 alone acts the second notch is arranged between

the throat of the hub and ring 122 which holds rod 116 in a position in which the spring 114 is disconnected.

If now spring 114 also is to be caused to act upon lever 107 and therefore upon coupling member 104 then rod 116 after overcoming the action of the second notch is shifted still further forwardly in the sense of the direction of flight until collar 117a of rod 116 is lifted from stop 115 of spring 114.

To allow movement of rod 116 beyond the positions determined by the notches a ring may be provided by the displacement of which the notches may be rendered ineffective.

On a corresponding forward shifting of rod 116 springs 113 and 114 are completely rendered effective and may, at a correspondingly weak counter action of the centrifugal weight 108, connect coupling member 104 to bevel gear 105b. Hereby, the blades of the propeller are adjusted to a lower pitch.

To prevent undesired adjustment of the blades to a lower pitch and to avoid pitches causing the undesired negative thrust the disconnecting device described above in connection with Fig. 7 becomes operative. Here, stop 125 arranged at the root of the blade of the propeller presses against rod 126. The latter compresses spring 127 until the ball 133 still bearing against rounded off projection 132 of the sleeve 128 is forced away laterally from the rounded off projection. Thereupon sleeve 128 is quickly projected under the action of the storage spring 127 and presses the lever 131 forward in a clockwise direction. Lever arm 131a rigidly connected to lever 131 and acting upon lateral bolt 104a of coupling member 104, axially shifts the coupling member in such a manner that it is disengaged from the toothed gear 105b. After lever 131a and lever 131 have been moved for a certain distance the front nose 134 of lever 131 meets a stop 134b of the casing 56, (Fig. 7), so that the movement of the levers 131, 131a is stopped and, therefore, the coupling member 104 may be arrested in the disconnected middle position.

What we claim is:

1. In a variable pitch aircraft propeller a freely rotatable impeller blade wheel arranged in front of said propeller and supplying the power for the adjustment of the propeller blades, roots for said propeller blades, a pair of gears driven in opposite direction by said impeller blade wheel, a worm gear actuating said propeller blades, a gear train operatively inserted between said worm gear and said pair of gears, a mechanically operated coupling member for connecting said gear train with one of said pair of gears and for disconnecting the same, a speed controlled governor actuating said coupling member, mechanical means for directly controlling said governor and for positively establishing certain predetermined speed settings in accordance with the various working conditions of flight, adjustable stopping means connected with said propeller roots for disconnecting said coupling member at a predetermined position of the propeller blades and mechanical means between said stopping means and said coupling member to shift said coupling member into and to hold the same in its disconnected middle position.

2. In a variable pitch aircraft propeller a freely rotatable impeller blade wheel arranged in front of said propeller and supplying the power for the adjustment of the propeller blades, roots for said propeller blades, a pair of gears driven in opposite direction by said impeller blade wheel, a worm gear actuating said propeller blades, a gear train operatively inserted between said worm gear and said pair of gears, a mechanically operated coupling member for connecting said gear train with one of said pair of gears and for disconnecting the same, a speed controlled governor actuating said coupling member, mechanical means for directly controlling said governor and for positively establishing certain predetermined speed settings in accordance with the various working conditions of flight, adjustable stopping means connected with said propeller roots for disconnecting said coupling member at a predetermined position of the propeller blades and mechanical means between said adjustable stopping means and said coupling member to shift the same into and to hold it in its disconnected middle position, the constantly running blades of said impeller blade wheel being shaped and inclined with regard to the plane of rotation in a manner to supply sufficient power for adjusting the propeller blades during flight when the driving engine is stopped.

3. In a variable pitch aircraft propeller a freely rotatable impeller blade wheel arranged in front of said propeller and supplying the power for the adjustment of the propeller blades, roots for said propeller blades, a pair of gears driven in opposite direction by said impeller blade wheel, a worm gear actuating said propeller blades, a gear train operatively inserted between said worm gear and said pair of gears, a mechanically operated coupling member for connecting said gear train with one of said pair of gears and for disconnecting the same, a speed controlled governor actuating said coupling member, mechanical means for directly controlling said governor and for positively establishing certain predetermined speed settings in accordance with the various working conditions of flight, said means being connected to a ring coaxially located relative to the axis of the propeller shaft, rotating with the same and acted upon by a non-rotating member circumferentially slidable upon the hub of said propeller, adjustable stopping means connected with said rotatable propeller roots for disconnecting said coupling member at a predetermined position of the propeller blades and mechanical means between said adjustable stopping means and said coupling member to shift the same into and to hold it in its disconnected middle position.

4. In a variable pitch aircraft propeller a freely rotatable impeller blade wheel arranged in front of said propeller and supplying the power for the adjustment of the propeller blades, roots for said propeller blades, a pair of gears driven in opposite direction by said impeller blade wheel, a worm gear actuating said propeller blades, a gear train operatively inserted between said worm gear and said pair of gears, a mechanically operated coupling member for connecting said gear train with one of said pair of gears and for disconnecting the same, a shaft carrying said coupling member and a bearing sleeve supporting said shaft, a speed controlled governor actuating said coupling member, mechanical means for directly controlling said governor and for positively establishing certain predetermined speed settings in accordance with the various working conditions of flight, adjustable stopping means connected with said rotatable propeller roots for disconnecting said coupling member at a predetermined position of the propeller blades, an an-

nular groove in said bearing sleeve and a spring loaded ball coacting therewith to resiliently hold the coupling member in its disconnected middle position.

5. In a variable pitch aircraft propeller a freely rotatable impeller blade wheel arranged in front of said propeller and supplying the power for the adjustment of the propeller blades, roots for said propeller blades, a pair of gears driven in opposite direction by said impeller blade wheel, a worm gear actuating said propeller blades, a gear train operatively inserted between said worm gear and said pair of gears, a mechanically operated coupling member for connecting said gear train with one of said pair of gears and for disconnecting the same, said coupling member and said pair of gears being located inside of the propeller hub and being constructed as a self-locking gear, a speed controlled governor actuating said coupling member, mechanical means for directly controlling said governor and for positively establishing certain predetermined speed settings in accordance with the various working conditions of flight, adustable stopping means connected with said rotatable propeller roots for disconnecting said coupling member at a predetermined position of the propeller blades and mechanical means between said adjustable stopping means and said coupling member to shift the same into and to hold it in its disconnected middle position.

6. In a variable pitch aircraft propeller a freely rotatable impeller blade wheel arranged in front of said propeller and supplying the power for the adjustment of the propeller blades, roots for said propeller blades, a pair of gears driven in opposite direction by said impeller blade wheel, a worm gear actuating said propeller blades, a gear train operatively inserted between said worm gear and said pair of gears, a mechanically operated coupling member for connecting said gear train with one of said pair of gears and for disconnecting the same, a speed controlled governor actuating said coupling member, mechanical means for directly controlling said governor and for positively establishing certain predetermined speed settings in accordance with the various working conditions of flight, stopping means for disconnecting said coupling member at a predetermined position of the propeller blades and limiting the change of pitch within said speed settings, mechanical means between said stopping means and said coupling member transmitting the action of said stopping means to said coupling member and a coupling inserted between the root of the propeller blades and the blade adjusting means, said coupling comprising a disc with crosswise located notches, said notches coacting with ribs of said blade root and said blade adjusting means.

7. In a variable pitch aircraft propeller a freely rotatable impeller blade wheel arranged in front of said propeller and supplying the power for the adjusting of the propeller blades, roots for said propeller blades, a pair of gears driven in opposite direction by said impeller blade wheel, a worm gear actuating said propeller blades, a gear train operatively inserted between said worm gear and said pair of gears, a mechanically operated coupling member for connecting said gear train with one of said pair of gears and for disconnecting the same, a speed controlled governor actuating said coupling member, mechanical means for directly controlling said governor and for positively establishing certain predetermined speed settings in accordance with the various working conditions of the flight, stopping means for disconnecting said coupling member at a predetermined position of the propeller blades and limiting the change of pitch within said speed settings, mechanical means between said stopping means and said coupling member transmitting the action of said stopping means to said coupling member and control members coacting with said stopping means, said control members comprising a control lever directly acting upon said coupling member and notches provided on said lever, a displaceable sleeve, a rod displaceable in said sleeve, said rod cooperating with said control lever and said stopping means, a spring bearing against said rod and said sleeve and a bell-crank lever having a nose and cooperating with said sleeve and with said notches.

8. In a variable pitch aircraft propeller a freely rotatable impeller blade wheel arranged in front of said propeller and supplying the power for the adjustment of the propeller blades, roots for said propeller blades, a pair of gears driven in opposite direction by said impeller blade wheel, a worm gear actuating said propeller blades, a gear train operatively inserted between said worm gear and said pair of gears, a mechanically operated coupling member for connecting said gear train with one of said pair of gears and for disconnecting the same, a speed controlled governor actuating said coupling member, mechanical means for directly controlling said governor and for positively establishing certain predetermined speed settings in accordance with the various working conditions of the flight, stopping means for disconnecting said coupling member at a predetermined position of the propeller blades and limiting the change of pitch within said speed settings, mechanical means between said stopping means and said coupling member to transmit the action of the stopping means to said coupling member, said means including a shaft carrying said coupling member, said shaft being displaceable in a bearing sleeve against the action of a spring, a pivotable control lever being acted upon by said shaft, said shaft having a rounded-off end and carrying a ball engaging said control lever.

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