

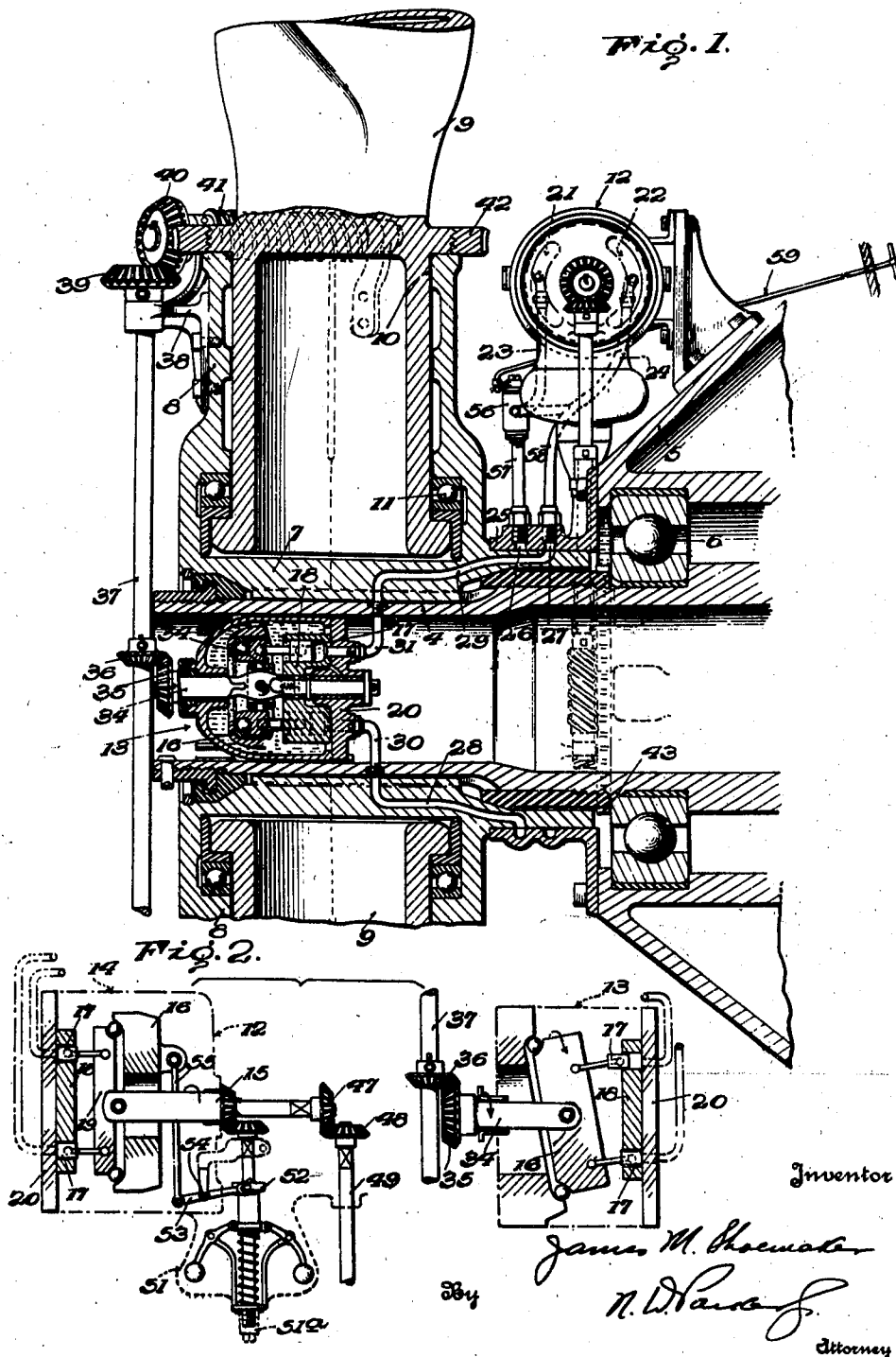
July 6, 1937.

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2 Sheets-Sheet 1



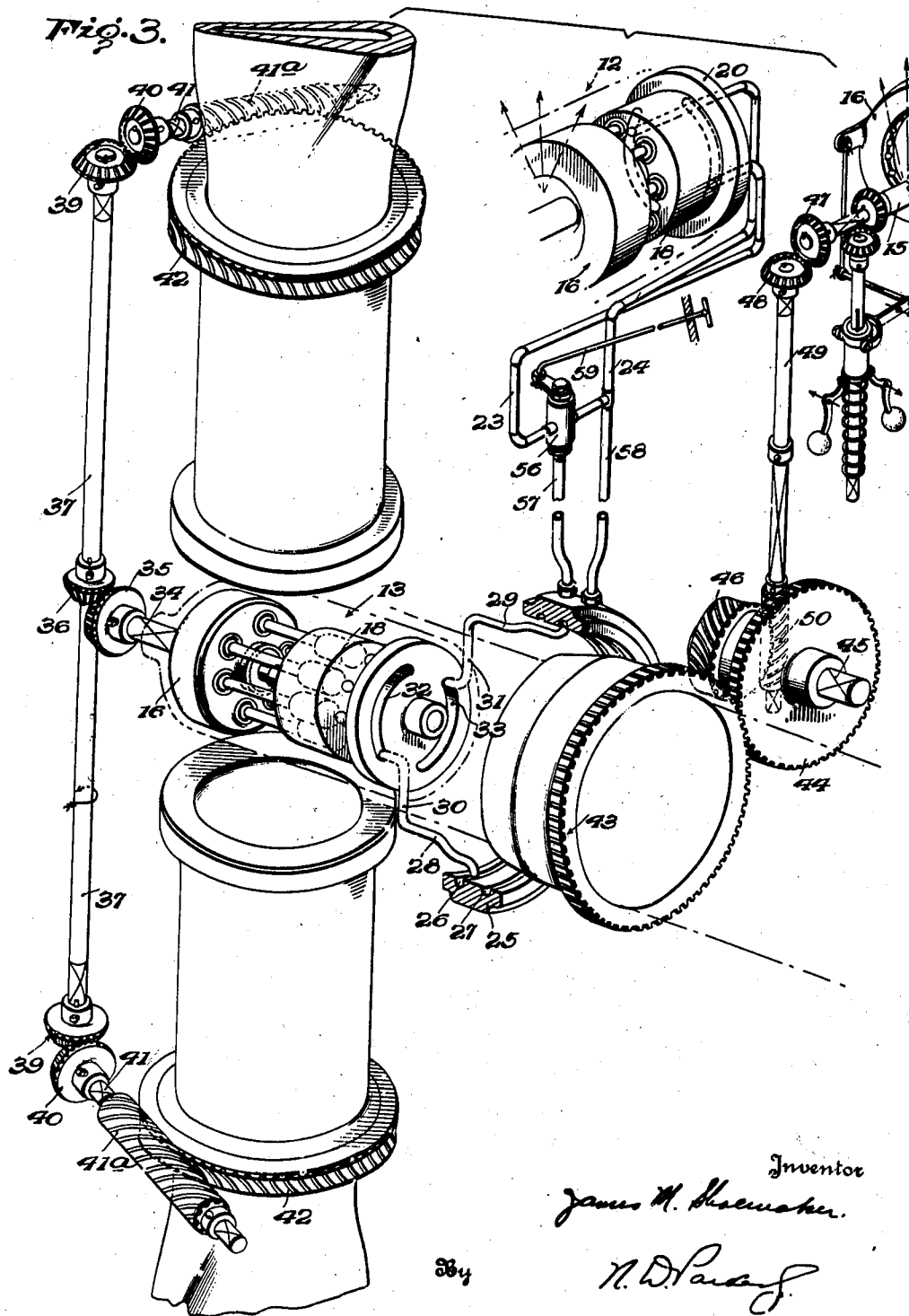
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UNITED STATES PATENT OFFICE

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VARIABLE PITCH PROPELLER

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5 Claims. (Cl. 170-163)

This invention relates to propellers and more particularly to propellers of the type provided with mechanism for varying the pitch of the blades.

5 One of the objects of the present invention is to provide a novel variable pitch propeller.

Another object of the invention is to provide a variable pitch propeller having a plurality of blades together with a novel governor-controlled mechanism for varying the pitch of the blades in accordance with the speed of rotation of the engine driving the propeller whereby the propeller and engine may be operated at maximum efficiency.

15 Still another object is to provide novel control mechanism in a variable pitch propeller of the governor-controlled type enabling the ready discontinuance of the pitch-varying apparatus at the will of the operator.

20 A further object is to provide in a variable pitch propeller of the automatic type, a novel arrangement of parts permitting the blades to be locked in position at the will of the operator, thus enabling the propeller to be operated efficiently during low engine throttle conditions.

25 A still further object is to provide a novel and compact arrangement of parts which shall not only be light in weight but also capable of efficient and positive operation, which features are especially desirable in instances of installations on aircraft.

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

In the drawings wherein similar reference characters refer to similar parts throughout the several views:

45 Fig. 1 is a vertical section of a propeller embodying the present invention;

Fig. 2 is a diagrammatic view partly in section of a portion of the mechanism for varying the pitch of the propeller blades; and

50 Fig. 3 is a perspective view of certain parts illustrated in Fig. 1.

Referring more particularly to Fig. 1, a propeller constructed in accordance with the present invention is illustrated therein as being constituted by a hollow engine-driven shaft 4 rotat-

ably mounted with respect to the engine crank case, a portion of which is indicated at 5, by means of ball bearings 6, and carrying at its outer end portion, a propeller hub 7 formed with a plurality of radially-extending sockets 8 for receiving the root ends of propeller blades 9. Each of these blades is rotatably mounted in its respective socket as by means of a journal bearing 10 and a ball thrust bearing 11, and means are provided for automatically rotating the said blades in their sockets to vary the pitch thereof during operation, which means will be referred to more specifically hereinafter.

15 Preferably, the means for varying the pitch of the propeller blades during rotation of the propeller is automatic in operation and is controlled by a device responsive to the speed of the engine shaft. By this construction, the propeller will serve to effect a governing action upon the engine in order to control the rate of revolutions thereof when operated under full-throttle conditions. As shown, such means is constituted by an hydraulic mechanism having an engine-driven pump 12 and a motor 13 adapted to be controlled in its operation by means of the pump 12 and being drivably connected to each propeller blade for varying the pitch of the latter. Inasmuch as the pump 12 and the motor 13 are of the same form as the Waterbury transmission and therefore are well known in the art, a detailed description thereof is not thought to be necessary. Moreover, since the elements constituting both of these devices are substantially identical, one only will be briefly described.

As shown diagrammatically in Fig. 2, the pump 12 is constituted by a fluid filled casing 14 having rotatably mounted therein a driving shaft 15. A plurality of longitudinally-extending pistons 17, arranged concentrically with respect to the shaft 15 and cooperating with a rotatable cylinder plate 18, are adapted to be rotated by said shaft through a thrust plate 19 to which said pistons are pivotally connected. Cooperating with the cylinder plate 18 and within the casing is a non-rotatable valve plate 20 having a pair of arcuate ports 21 and 22 therein, Fig. 1, which serve alternately as intake and exhaust ports depending upon the direction of flow of the fluid. Suitable pipes or conduits 23 and 24 communicate with the ports 21 and 22 and serve to conduct the fluid from the pump 12 to the motor 13. A tilting box 16 is pivotally mounted in the casing 14 in any suitable manner, and when in the position shown in Fig. 2, imparts no throw to the pistons 17. When the parts are in this position, it will be

understood that no fluid is transmitted from the pump to the motor notwithstanding the fact that shaft 15 is constantly rotating. When, however, the tilting box is tilted in one direction or the other, the pistons 17 will cooperate with the cylinder plate 18 to pump fluid through one of the conduits 23 or 24 to the motor 13, the tilting box 16 of which will be rotated by means of the cylinder plate 18 and pistons 17, the fluid being returned to the pump by the other conduit. If, however, the tilting box of the pump be tilted in the reverse direction, fluid will be pumped to the motor in a reverse direction and the direction of rotation of the tilting box therein will be consequently reversed.

Preferably, the motor 13 is housed within the rotating hollow shaft 4, and since the pump 12 is stationarily mounted on the casing 5, means are provided for interconnecting the conduits 22 and 23 common to each. As shown, such means comprise a stationary ring 25, Fig. 3, which may be split for ease in assembly, the said ring being provided with a pair of annular grooves 26 and 27, the first-named groove communicating with a duct 28 while the groove 27 communicates with a duct 29, both of said ducts being formed in the propeller hub 7. Each of the ducts 28 and 29 communicates respectively through conduits 30 and 31 with arcuate openings 32 and 33 formed in the valve plate 20 of the motor 13, such openings being preferably provided with suitable covers in order to prevent leakage of fluid.

In order to transmit movement from the motor 13 to each of the propeller blades to vary the pitch of the latter, when fluid under pressure is conducted from the pump to said motor, the latter is provided with a shaft 34, drivably connected with the rotatable tilting box 16 and suitably rotatably mounted in the casing of the motor, the said shaft carrying upon its outer end a bevel pinion 35 adapted to mesh with a corresponding bevel pinion 36 secured upon a shaft 37 extending perpendicularly to the axis of shaft 34. The shaft 37, adjacent its outer extremities, is suitably journaled in brackets 38 secured to the hub, and the extreme ends of the shaft carry bevel pinions 39 meshing with corresponding bevel pinions 40. These last-named pinions are secured upon worm shafts 41 carrying self-locking worms 41^a which are in constant meshing engagement with the teeth of worm gears 42 secured to the root ends of each blade exteriorly of the hub sockets, see Fig. 1. From the above construction, it will be readily apparent that upon rotation of shaft 34 and consequent rotation of shaft 37, the blades will be rotated in their respective sockets to either increase or decrease the pitch thereof simultaneously, dependent upon the direction of rotation of shaft 34.

In order to drivably connect the pump 12 and the engine shaft 4, the latter is adapted to drive a concentric gear 43, Fig. 3, which is adapted to mesh with a gear 44 mounted upon a suitably journaled lay shaft 45 to which shaft a worm wheel 46 is secured. The shaft 15, suitably rotatably mounted in a stationary portion of the engine casing, carries a bevel pinion 47 meshing with a corresponding bevel pinion 48 on a shaft 49, the other end of said shaft having secured thereon, a suitable reversible worm 50 for co-operation with worm wheel 46.

As heretofore stated, the angularity of the tilting box 16 of the fluid motor 12 will determine the throw of the pistons 17 and hence the degree of pressure of the fluid transmitted to the

motor 13. It will readily be appreciated that with variations in this pressure, the speed of shaft 34 will vary accordingly and hence the rapidity with which the pitch-changing operation occurs. In order to automatically control the position or angularity of the tilting box 16 in accordance with the speed of rotation of the engine shaft 4, a centrifugally-operated governing mechanism 51 is employed, such mechanism being of the well-known fly-ball type, drivably connected with the shaft 15 of the pump. The governing mechanism is provided with a slidable collar 52, the position of which is at all times a measure of the engine speed, and this collar is operatively connected to the tilting box 16 by means of a lever 53, having a stationary pivot 54, and link 55. Preferably an adjustment nut 51^a is provided in order to adjust the initial position of the tilting box 16 for the purpose of maintaining the latter in a substantially vertical inoperative position at the desired engine speed.

Inasmuch as the above described construction would cause operation of the pump at all times during rotation of the engine shaft, it may be desirable in certain instances, as for example, when it is desired to land an aeroplane equipped with the present invention, or to maneuver at low-throttle conditions, to render the pitch-varying mechanism inoperative, and preferably such action should be under the control of the pilot. For this purpose, Fig. 3, a by-pass valve 56 is associated with conduits 23, 24 and 57 and 58 conducting fluid from the pump 12 to the motor 13, and such valve is arranged to be manually operated by a connection 59 positioned in such a manner as to be readily accessible to the pilot to effect a disconnection between conduits 23 and 57, and establish communication between conduits 23 and 24, thus interrupting the continuous flow of fluid between the pump and motor and by-passing the fluid from the outlet to the inlet of the pump. When, therefore, the manually operable connection 59 is operated to render inoperative the pitch-changing mechanism, the blades will remain fixed in the position last assumed by reason of the self-locking nature of the worms 41^a.

When installing the above-described structure, the position of the weights of the governing mechanism is so adjusted by means of the adjusting nut 51^a that the said mechanism will maintain the tilting box in a substantially vertical position, as viewed in Figs. 1 and 2 at the engine speed it is desired to maintain. Under these conditions, if the engine speed does not exceed or fall below this value, the pitch-changing mechanism will be inoperative. However, in the event the engine speed exceeds the predetermined value the governing mechanism will actuate the tilting box 16 in such a direction as to cause a flow of fluid from the pump 12 to the motor 13 to cause rotation of shaft 34 and consequent rotation of shaft 37, gears 39 and 40 and worm wheel 42 to effect an increase in the pitch of the blades. This increase in pitch will effect a reduction in the speed of the engine, due to the increased load offered by the propeller, which will in turn affect the governing mechanism in such a manner as to cause a tilting of the member 16 in the opposite direction thus reversing the direction of flow of fluid through the motor 13 and effecting a reduction in pitch until the speed of the engine is restored to its normal value and the governing mechanism has returned the tilting box 16 to its vertical or inoperative position.

in the operation of aeroplanes equipped with the present invention, it is highly desirable to land with the pitch of the propeller fixed at a predetermined value. This is accomplished by the present invention by operation of the manually-operated connection 59 prior to landing, whereupon the pitch of the blades will remain fixed even though the engine be operating at less than full throttle. When cruising at full-throttle, it is desirable to vary the pitch of the blades automatically whereupon it is merely necessary to release the control member 59 whereupon the pitch of the blades will be automatically varied in a manner set forth above. It will also be readily observed that during take-off, the pitch of the blades will be automatically varied by the governing mechanism from a low value to a higher value due to increase in air speed and the tendency of the speed of the engine to increase.

There has thus been provided by the present invention a novel automatic variable pitch propeller mechanism so constructed and arranged as to be readily manually controlled to render the automatic feature inoperative. At such time the blades will automatically remain in position due to the employment of the self-locking members in the pitch-varying transmission, it being thus possible to easily and readily dispense with the automatic operation of the pitch-varying mechanism, a feature especially desirable when operating an aeroplane under conditions other than full-throttle. The device herein provided therefore enables maximum propeller and engine efficiency to be obtained during full-throttle operation, when the governing mechanism is in operation, as well as during part throttle open conditions, represented by discontinuance of the operation of governing mechanism and consequent functioning of the propeller with a fixed pitch.

While there has been shown and described one embodiment of the invention only, it is to be understood that the same is not limited thereto but may be embodied in various forms. Reference will therefore be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. In combination with a rotatable shaft having a propeller hub drivably connected thereto, a plurality of blades rotatably mounted in said hub, self-locking mechanism operable to rotate the blades in the hub to vary their pitch, hydraulic means for operating said mechanism to positively increase and decrease the pitch of the blades, said means including a pump and a motor, said motor being rotatable with said shaft, centrifugally operated mechanism for controlling said pump, conduits for interconnecting said pump and motor, and a manually controlled by-pass valve located in one of said conduits for by-passing fluid from the outlet of the pump to the inlet thereof whereby the motor will be rendered inoperative and the pitch of the blades will remain fixed in the last adjusted position.

2. In combination with a rotatable shaft having a propeller hub, a plurality of blades rotatably

carried by said hub, transmission mechanism including self-locking members operable to rotate the blades in the hub to vary their pitch, hydraulic means for operating said mechanism to positively increase and decrease the pitch, said means including a pump and a motor, said motor being rotatable with said shaft, centrifugally-operated means for governing the action of said pump, conduits for interconnecting said pump and motor, and a manually controlled by-pass valve located in one of said conduits for rendering said motor inoperative at will whereby the pitch of the blades will remain fixed in the last adjusted position.

3. In combination with a rotatable shaft having a propeller hub, a plurality of blades rotatably mounted in said hub, mechanism including self-locking members operable to rotate the blades in the hub to vary the pitch, hydraulic means including a pump and a motor for operating said mechanism to positively increase and decrease the pitch, said pump having a tiltable member for control of the operation thereof, centrifugally-operated means responsive to the speed of said shaft for controlling said tiltable member, and means for rendering said pump inoperative to affect the motor at the will of the operator whereby the pitch of the blades will remain fixed in the last adjusted position.

4. In a variable pitch propeller having a rotatable shaft, a hub drivably connected with said shaft, a plurality of propeller blades rotatably mounted in said hub, self-locking mechanism cooperating with each blade, a fluid-operated motor carried by said shaft and interconnected with said mechanism, a pump for supplying fluid under pressure to said motor to operate the latter to positively increase and decrease the pitch of said blades through said mechanism, means responsive to the speed of rotation of the shaft for controlling the pump, and means for rendering said pump inoperative at will, said means comprising a manually-operable by-pass between said pump and said motor whereby upon operation of said by-pass, the pitch of the blades will remain fixed in the last adjusted position.

5. In a variable pitch propeller having a hollow, rotatable shaft, a plurality of propeller blades rotatably mounted on said shaft, a fluid-operated motor disposed within said hollow shaft and rotatable therewith for positively increasing and decreasing the pitch of said blades, transmission mechanism interconnecting said motor and the blades, said mechanism including self-locking members, a relatively stationarily mounted pump for supplying fluid under pressure to said motor, said pump having an inlet and an outlet, centrifugally-operated means responsive to the rotative speed of said shaft for controlling the operation of said pump in order to vary the output thereof, and manually operable means for by-passing the fluid from the inlet to the outlet of the pump for effecting a discontinuance in the operation of the motor, said self-locking members maintaining the pitch of the blades fixed.

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