Nov. 5, 1935. C. H. HAVILL 2,019,965

PROPELLER

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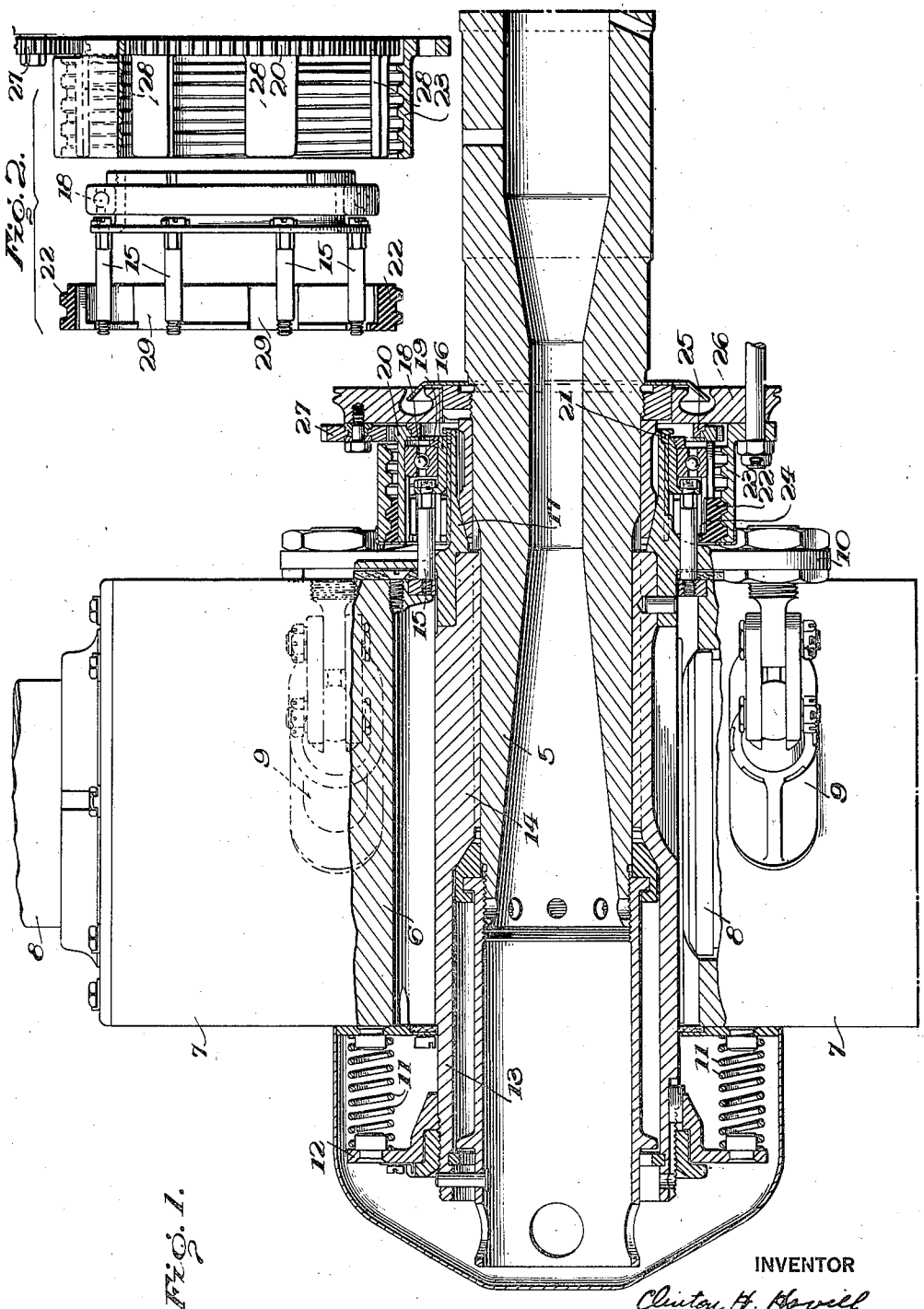

Fig. 1.

Fig. 2.

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Fig. 3.

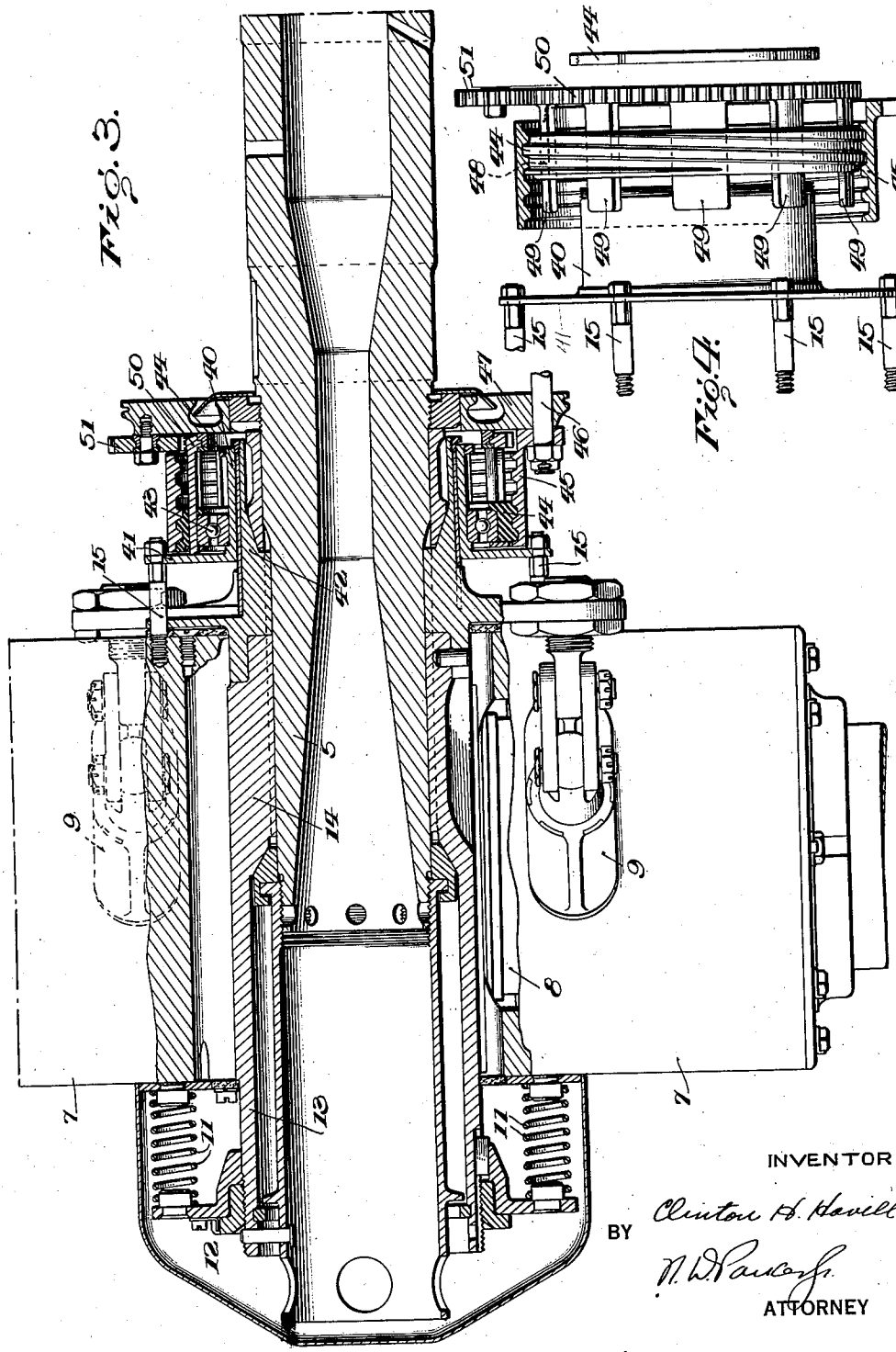

Fig. 4.

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PROPELLER

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16 Claims. (Cl. 170—162)

This invention relates to propellers and more particularly to propellers of the type having a plurality of blades, the angularity or pitch of which may be varied during operation.

One of the objects of the present invention is to provide, in a variable pitch propeller, a novel pitch-limiting mechanism so constituted as to be adjustable to various positions during operation of the propeller, whereby the pitch limits of the latter may be readily adjusted to compensate for variable conditions encountered during flight of an aircraft equipped with the invention.

Another object of the invention is to provide, in a construction of the above character, a novel mechanism permitting a ready variation of the lower pitch limit of the propeller blades to the end that the rate of revolutions of the propeller may be varied to meet different operating conditions and thus realize a maximum engine and propeller efficiency at all times.

Still another object is to provide a propeller having a plurality of blades, the pitch of which is automatically varied during operation in accordance with the thrust of the blades, in combination with a manually-adjustable mechanism effective during operation of the propeller to positively limit the pitch attainable by the blades.

A further object is to provide, in a variable pitch propeller of the automatic type, a novel construction including a manually-adjustable stop mechanism for limiting the pitch of the blades.

A still further object is to provide, in a propeller of the type embodying a hub movable axially of the drive shaft for changing the pitch of the blades, a novel manually-operable mechanism cooperable with a device carried by the propeller for positively arresting relative movement of the propeller hub with respect to the propeller shaft in order to positively limit the reduction in the pitch of the blades during operation of the propeller.

A still further object is to provide a novel variable pitch propeller and pitch-limiting mechanism embodying relatively few parts, so arranged as to obtain a light-weight, compact and positively operable structure capable of ready adaptation to existing types of aircraft engines.

The above and 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 similar reference characters refer to similar parts throughout the several views. 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,

Fig. 1 is a side view, partly in section, of a propeller illustrating one embodiment of the present invention;

Fig. 2 is an enlarged side view, partly in section, of certain of the parts constituting the pitch-limiting mechanism shown in Fig. 1;

Fig. 3 is a side view, partly in section, of a propeller illustrating a slightly different form of the invention, and

Fig. 4 is an enlarged side view, partly in section, of certain of the parts constituting the pitch-limiting mechanism shown in Fig. 3.

Referring more particularly to Figs. 1 and 2, a variable pitch propeller embodying the principles of the present invention is illustrated therein as being constituted by a rotatable engine shaft or extension thereof 5 and a hub 6 drivably connected thereto in any suitable manner but relatively movable longitudinally thereof in response to the thrust exerted by the blades. The hub is provided with a plurality of radially-extending sockets 7 adapted to rotatably receive the inner or root ends of propeller blades 8, there being also provided suitable link mechanisms 9 interconnecting the blades with a plate member 10 fixedly secured to the propeller shaft, these last named mechanisms being effective to vary the pitch of the blades during the aforesaid thrust-responsive movement of the hub relative to the shaft.

In order to yieldingly oppose forward axial movement of the hub with respect to the shaft for the purpose of arresting such movement at certain positions along the shaft in accordance with the degree of thrust exerted by the blades under the existing conditions of operation, there is preferably provided a plurality of resilient members such as for example, coil springs 11, arranged in a circle concentric with respect to the shaft and interposed between the hub 6 and a plate 12 secured in any suitable manner to a forward extension 13 of driving block 14, this latter element being suitably splined to the shaft 5 and forming a portion of the driving connection between said shaft and the propeller hub. It is to be noted that when the parts are in the position shown in Fig. 1, the pitch of the blades is a maximum, the pitch being gradually reduced during forward movement of the hub relative to the shaft in response to the thrust of the blades, the above

mentioned resilient members 11, however, serving to yieldably oppose such movement and to arrest the hub in such a position relative to the shaft that the pitch assumed by the blades will be substantially proportional to the thrust thereof and such as to yield a substantially maximum propeller efficiency for the conditions of thrust imposed.

One of the features of the present invention resides in the provision of means for predetermining the variation in the pitch of the blades and more particularly to provide means whereby one of the pitch limits may be readily varied during operation of the propeller. In the form shown, such means include a plurality of pins or studs 15 secured to the propeller hub 6 and carrying a sleeve 16 surrounding the propeller shaft and slidable along a member 17 secured to said shaft, during axial movement of the hub. The inner race of ball bearing 18 is secured to the sleeve 16 by any suitable means including a threaded ring 19, the outer race of such bearing being freely slidable with respect to a manually-operable member 20. An abutment 21 secured to the sleeve 17 forms a stop mechanism for limiting movement of the sleeve 16 in one direction with respect to the shaft.

For the purpose of limiting movement of the sleeve 16 in the opposite direction with respect to the shaft, an exteriorly-threaded nut 22 cooperable with a stationary interiorly-threaded sleeve 23 is provided and has formed thereon an abutment flange 24 constituting a stop mechanism for limiting movement of the sleeve 16 to the left as viewed in Fig. 1, through engagement of the outer race of bearing 18 therewith. In this manner, movement of the hub to the left as viewed in Fig. 1, in the direction to reduce the pitch of the blades, is arrested upon engagement of the flange 24 of the nut 22 with the outer race of the bearing 17 carried by the sleeve 16 movable with the hub during change in pitch.

In order that the position of the abutment 24 may be varied during operation of the propeller to the end that the reduction in pitch may be predetermined to secure maximum efficiency during various conditions of operation, manually-operable means are provided for rotating the nut 22 with respect to the threaded sleeve 23 to move the former with respect to the latter. As shown, such means include the manually-operable member 20 which, as shown, is rotatably mounted upon a ring 25 secured to a stationary portion 26 of the engine casing, the said member having gear teeth formed on the periphery thereof in constant engagement with gear 27, which latter may be controlled in any suitable manner by the operator. The member 20 is also provided with a plurality of fingers 28 extending parallel to the propeller shaft and adapted to engage corresponding slots 29 formed in the inner surface of the nut 22, such arrangement permitting ready rotation of the latter in order to move the same longitudinally with respect to the stationary nut 23, thus effecting a variation in the position of the flange 24 with regard to the bearing 18 and hence effecting an efficient mechanism for limiting the movement of the hub with respect to the propeller shaft.

Referring more particularly to Figs. 3 and 4, wherein a slightly modified form of the pitch-limiting mechanism is disclosed, the pins or studs 15 are secured to a sleeve 40 through a laterally-extending flange 41, the said sleeve being slidable along sleeve 42 during movement of the hub with respect to the propeller shaft. In this form of the invention, the inner race of ball bearing 43 is freely slidable with respect to sleeve 40, the latter carrying an abutment or suitable stop mechanism, preferably formed as a nut 44 which is engageable with the inner race of the bearing to limit movement of the hub with respect to the shaft toward the left as viewed in Fig. 3. The outer race of bearing 43 is suitably secured to the exteriorly-threaded nut 44 which, as in the first form of the invention, cooperates with an interiorly-threaded sleeve 45 suitably secured as by means of stud 46 to a stationary portion 47 of the engine crank case. The nut 44 is provided with suitable interiorly-disposed slots 48 for reception of fingers 49 formed integrally with the manually-adjustable member 50 which is suitably rotatably mounted on the crank case member 47 and may be rotated with respect thereto as by means of gear 51 suitably connected to any operator-controlled means for remote manipulation.

In the operation of this form of the invention, rotation of gear 51 will effect relative movement between nut 44 and threaded sleeve 45 through the manually-operable member 50 and and thus position bearing 43 in any desired location with respect to the sleeve 40. Movement of the hub to the left as shown in Fig. 3, to effect a reduction in the pitch of the blades, will be arrested as soon as the nut 44 carried by sleeve 40 engages the adjacent face of the inner race of bearing 43. In this manner, the lower pitch limit of the blades may be readily predetermined and adjusted during operation of the propeller.

There is thus provided by the present invention a variable pitch propeller of the type wherein the pitch of the blades is automatically varied during operation and embodying a construction wherein the pitch is varied between predetermined limits. The provision of the manually-adjustable pitch-limiting stop mechanism enables the lower pitch limit to be readily varied during operation of the propeller to the end that the maximum rate of revolutions of the engine may be predetermined thus permitting operation of the engine and propeller at maximum efficiency under all conditions.

While two embodiments of the invention have been shown and described herein, it is to be understood that the invention is not limited thereto but may be embodied in other forms, as well understood by those skilled in the art. Reference will, therefore, be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. A variable pitch propeller comprising a rotatable shaft, a hub drivably connected to and longitudinally movable along said shaft, a plurality of blades rotatably mounted in said hub, connections between said shaft and blades for changing the angularity of the blades in response to movement of the hub longitudinally of the shaft, stop means for limiting such movement of the hub, and manually-operable means for adjusting said stop means during operation of the propeller independently of said movement of the hub.

2. A variable pitch propeller comprising a rotatable shaft, a hub drivably connected to and longitudinally movable along said shaft, a plurality of blades rotatably mounted in said hub, connections between said shaft and blades for changing the angularity of the blades in response to movement of the hub longitudinally of the shaft, means for positively limiting movement of the hub along the shaft in one direction, and manually-operable control means for adjusting said limiting means during operation of the propeller independently of said movement of the hub.

3. A variable pitch propeller comprising a rotatable shaft, a hub drivably connected to and longitudinally movable along said shaft a predetermined extent, a plurality of blades rotatably mounted in said hub, connections between said shaft and blades for changing the angularity of the blades in response to movement of the hub longitudinally of the shaft, and manually-operable means effective during operation of the propeller for varying said predetermined extent independently of said movement of the hub.

4. In a variable pitch propeller having a hub and a plurality of blades rotatable about their longitudinal axes for changing the pitch thereof, means including said hub for effecting pitch-changing rotation of said blades, means for limiting operation of said pitch-changing means during a decrease in the pitch of the blades, and manually-operable means directly cooperating with said limiting means for adjusting the latter during operation of the propeller.

5. In a variable pitch propeller having a hub and a plurality of blades rotatable about their longitudinal axes for changing the pitch thereof, means including said hub for effecting pitch-changing rotation of said blades, means including a stop mechanism for positively limiting operation of said pitch-changing means during a decrease in the pitch of the blades, and manually-adjustable means directly cooperating with said stop mechanism for varying the position of the latter during operation of the propeller in order to change the lower pitch limit of the blades.

6. In a variable pitch propeller of the type having a hub movable along a propeller shaft in accordance with the thrust of the propeller blades, the combination with said propeller, of means operable to vary the pitch of the propeller blades during such movement of the hub, and means manually operable independently of said movement of the hub for positively variably limiting the movement of said hub along said shaft during rotation of the propeller.

7. In a variable pitch propeller of the type having a hub movable along a propeller shaft in accordance with the thrust of the propeller blades, the combination with said propeller, of means operable to vary the pitch of the propeller blades during such movement of the hub, and means manually operable during rotation of the propeller for positively variably limiting the movement of said hub along said shaft, said last named means including a pair of relatively-rotatable members.

8. In a variable pitch propeller having a hub and a plurality of blades rotatable about their longitudinal axes for changing the pitch thereof, means including said hub for effecting pitch-changing rotation of said blades, means including a pair of relatively-movable members for limiting operation of said pitch-changing means during a decrease in the pitch of the blades, and manually-operable means directly cooperating with one of said members for moving the latter with respect to the other of said members during operation of the propeller.

9. In a propeller having a plurality of blades, means actuated by the thrust of the blades for automatically varying the pitch thereof, means for predetermining the extent of operation of said pitch-varying means within predetermined limits, and means manually operable during rotation of the propeller and including a pair of relatively-rotatable members for varying one of said limits.

10. In a propeller having a plurality of blades, means actuated by the thrust of the blades for automatically varying the pitch thereof, means for predetermining the extent of operation of said pitch-varying means within predetermined limits, and means manually operable during rotation of the propeller for varying one of said limits, said last named means including relatively-movable threaded members and gear means for rotating one of said members.

11. A variable pitch propeller comprising a rotatable shaft, a hub drivably connected to and movable axially of said shaft, a plurality of blades rotatably carried by said hub, means responsive to axial movement of said hub for varying the pitch of the blades, a stop mechanism positioned exteriorly of the hub, means carried by the hub and movable therewith into engagement with said stop mechanism during axial movement of the hub with respect to the shaft in order to limit such movement, and means manually operable during rotation of the propeller for variably adjusting the position of said stop mechanism independently of said movement of the hub.

12. A variable pitch propeller comprising a rotatable shaft, a hub drivably connected to and movable axially of said shaft, a plurality of blades rotatably carried by said hub, means responsive to axial movement of said hub for varying the pitch of the blades, a stop mechanism positioned exteriorly of the hub and concentrically arranged with respect to the shaft, means carried by the hub and movable therewith into engagement with said stop mechanism during axial movement of the hub with respect to the shaft in order to limit such movement of the hub in the direction to effect a reduction in the pitch, and means manually operable during rotation of the propeller for variably adjusting the position of said stop mechanism, said manually-operable means including a pair of cooperating relatively-movable members.

13. In a variable pitch propeller of the type having a hub movable along a propeller shaft in accordance with a variable condition of operation of the propeller, the combination with said propeller, of means operable to vary the pitch of the propeller during such movement of the hub, means to predetermine the extent of such movement and hence the limit of change in pitch of the propeller, and means manually operable during rotation of the propeller to vary the position of said second named means independently of said movement of the hub.

14. In a propeller having pitch-variable blades, means for limiting the reduction in pitch of the blades, and means including a screw and nut mechanism and operable during rotation of the propeller for varying the position of said limiting means.

15. In a mechanism for limiting the change in pitch of a propeller of the type having a member movable during change in pitch, a stationary threaded member, a nut cooperating with said threaded member, means to rotate said nut during operation of the propeller to variably position the same with respect to the threaded member, and means cooperating with said nut and forming a stop engageable with said movable member during change in pitch.

16. In a variable pitch propeller of the type having a hub movable along a propeller shaft in accordance with a variable condition of operation of the propeller, the combination with said

propeller, of means operable to vary the pitch of the propeller during such movement of the hub, means to predetermine the extent of such movement and hence the limit of the change in pitch of the propeller comprising a sleeve connected with the hub and slidable along said shaft, a stop member carried by said sleeve, a stationary interiorly-threaded sleeve around said first named sleeve and member, an exteriorly-threaded nut cooperating with said threaded sleeve, an abutment associated with said nut and positioned to be engaged by said stop member during movement of the hub along the shaft to limit the change in pitch of the propeller, and means manually operable during rotation of the propeller for rotating said nut and abutment whereby said abutment will be variably positioned with respect to said stop member.

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