Oct. 26, 1943. L. G. FAIRHURST ET AL 2,332,786

VARIABLE-PITCH AIRSCREW

Filed Feb. 17, 1942

Fig. 1.

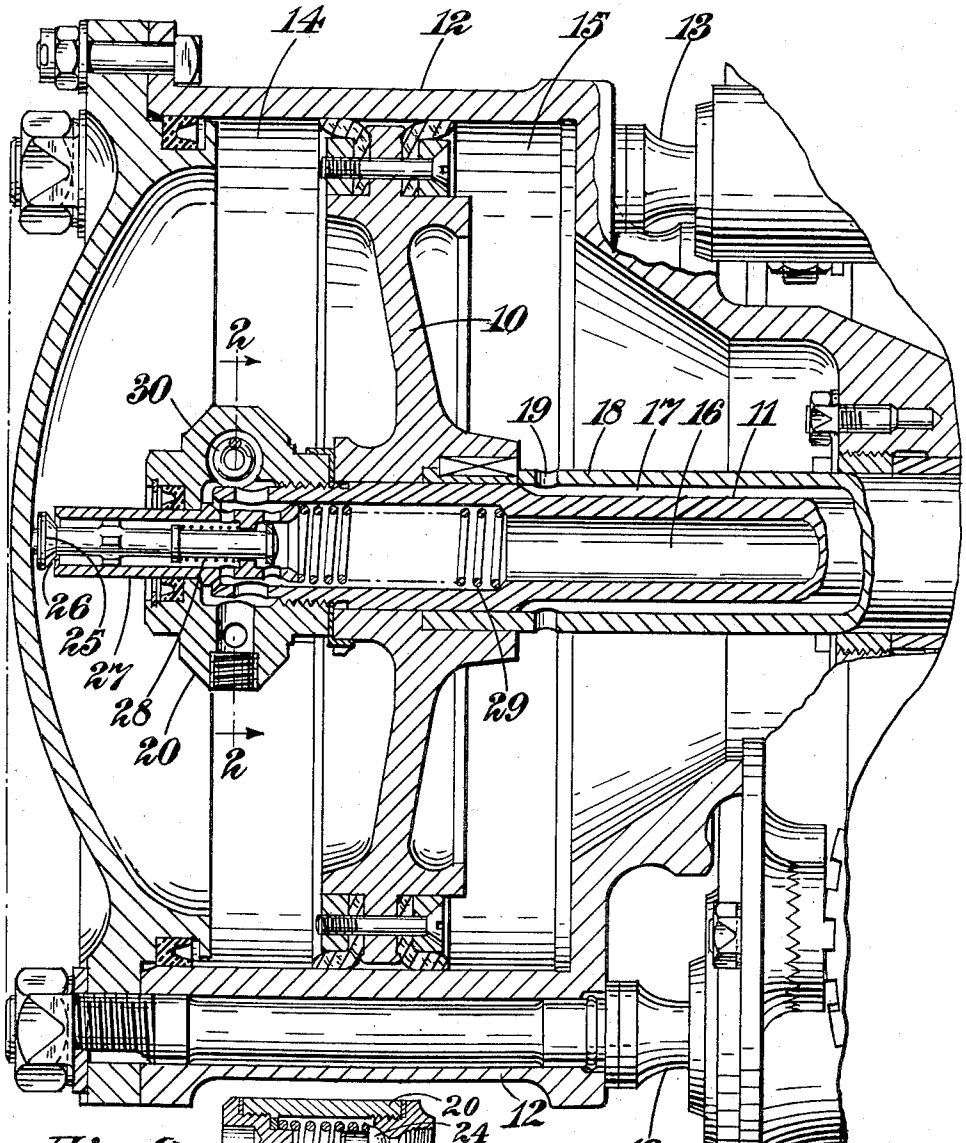
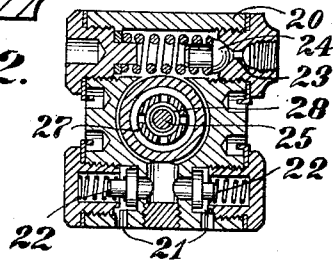


Fig. 2.



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VARIABLE-PITCH AIRSCREW

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In Great Britain September 20, 1940

1 Claim. (Cl. 170—163)

This invention is concerned with variable-pitch airscrews of the type in which an hydraulic ram is used to adjust the pitch of the blades under the control of a governor unit controlling the supply of the pressure-fluid to the ram.

Unless an adjustable blade in an airscrew is controlled, it tends to set itself into a fine-pitch position under the centrifugal and aerodynamic forces acting on it; this is undesirable as if the control is lost it leads to excessive engine-speed and to the necessity of reducing the engine-power; the control may be lost temporarily by the engine "cutting-out" in some abnormal condition of flight, as when flying inverted or on going into a very steep dive, and also a permanent loss of control may arise from accident or damage from enemy action, and in this case it is still more important that the blades should be prevented from automatically assuming a fine-pitch position.

In an hydraulically controlled airscrew of the type above-described, the ram-cylinder is normally filled with a working fluid on both sides of the ram and when pressure-fluid is admitted to one side to effect an adjustment of pitch, fluid is forced out from the other side by the movement of the ram in its cylinder and it will, therefore, be appreciated that in the circumstances mentioned above, when the pilot's control of the airscrew is lost, the automatic or self-adjustment of a blade to its fine-pitch position, causes the working fluid to be discharged from one side of the ram-chamber, the pressure available to effect this being derived from the forces acting upon the blade.

According to this invention, there is provided in a variable-pitch airscrew of the type described, the combination with the chamber from which liquid is delivered by the self-adjusting movement aforesaid of the blade, of means for admitting fluid under pressure to said chamber, and an outlet valve from said chamber, which outlet valve is loaded to a pressure greater than can be exerted on the fluid by the self-adjusting movements of the blade, but less than the working pressure used for effecting adjustment of the blade in normal working.

The supply of working fluid to this chamber is preferably effected by means of another port controlled by a simple non-return valve which permits entry of the fluid but completely prevents delivery from the chamber.

In order to permit rapid adjustment of the blade, and to provide for setting the blade at a suitable pitch in the event of the pitch-control being lost, there is provided, according to another feature of this invention, an additional port giving communication to and from the chamber, and a valve controlling said port and means whereby the valve which is normally open is moved to its closed position when the blade reaches a predetermined position in its movement towards a fine-pitch setting.

In the accompanying drawing which illustrates the application of this invention to a Rotol (registered trade-mark) hydraulic constant-speed variable-pitch airscrew,

Figure 1 is a central longitudinal section of the hydraulic ram and cylinder, and

Figure 2 is a detail, being a section on the line II—II of Figure 1.

The hydraulic apparatus comprises a ram 10 carried on a stationary hollow shaft 11 coaxial with the airscrew-blade, and a cylinder 12 which is mounted to move relatively to the ram 10 is coupled by rods 13 to the blades of the airscrew to adjust their pitch. Movement of the cylinder towards the left in Figure 1 adjusts the blades towards a coarser-pitch position, and movement towards the right adjusts them towards a finer-pitch position.

The ram 10 divides the cylinder into two chambers 14, 15 respectively and the working liquid is supplied to and from the chamber 14 through a central bore 16 in the shaft 11; the chamber 15 has the liquid supplied to and from it through the annular space 17 between a hollow shaft 18 and the shaft 11 aforesaid, this annular space 17 opening into the chamber 15 by means of ports 19. When liquid is supplied under pressure to either of the chambers 14, 15 to move the cylinder, a corresponding quantity of liquid is forced out form the other chamber through the appropriate conduit.

This invention is concerned with the construction and arrangement of valves controlling communication between the conduit 16 aforesaid and the chamber 14, since this is the chamber from which liquid is forced out by the self-adjusting movement of the blades when the pitch-control is lost, and it is desirable to prevent or limit such self-adjusting movement.

A valve housing indicated generally by the reference 20 is secured on the end of the shaft 11 and serves to retain the ram 10 thereon. The hollow interior of this casing which is in free communication with the passage 16 is provided with ports 21 (Figure 2) controlled by non-return valves 22, which are lightly spring-loaded on to their seats the arrangement being such

that liquid supplied through the conduits 16 under pressure opens the valves 22 and delivers the liquid into the chamber 14.

There is also provided a restricted port 23 (Figure 2) which opens from the chamber 14 to the interior of the casing 20 under the control of a valve 24 which is loaded by a spring 30 to a high pressure, greater than can be exerted on the liquid in the chamber 14 by the self-adjusting movement of the blades towards their fine-pitch setting. This loading however is less than the working pressure of the fluid for normal operation. By way of example, the normal working pressure of the liquid may be 350 lbs. per square inch, the loading of the valve 24 may be 150–175 lbs. per square inch and the loading of the valves 22 may be about 10 lbs. per square inch.

When liquid under pressure is supplied to the chamber 15 to move the cylinder 12 to the right, the liquid in the chamber 14 has to be discharged therefrom, and as so far described the only path of discharge is by way of the loaded valve 24, but this single outlet slows the effective operating pressure in 15 and in order to increase the rate of evacuation in 14 for all normal operations, there is provided an additional valve 25 controlling a port 26 which provides communication from the chamber 14 through a tube 27 to the conduit 16. This valve is held in its open position by a light spring 28 and is so positioned that when the cylinder 12 moves towards the right, it engages the valve 25 and moves it to close the port 26 and thereby shut off this communication. The parts are so proportioned that this closing of the valve takes place when the blades are in a medium pitch setting suitable for use when the pitch-control is lost as mentioned above, being for example 15° away from the finest pitch setting. In order to permit the possibility of adjustment to the finest pitch position, the tube 27 with the valve 25 is movable towards the right against the action of the spring 29. It will be appreciated that during this part of the movement the liquid is delivered from the chamber 14 by way of the port 23. When the blades are turned toward decreased pitch by the centrifugal torsion on them the valve 25—26 at first is open, allowing fluid to go from 14 through 16, and 12 to be moved inward. After a predetermined amount of such movement the outer plate 14 strikes 25 and closes this valve, thus preventing the blades from reaching an undesired low pitch. However, if a still lower pitch is desired the pressure in 15 is increased until the pressure in 14 becomes sufficient to open valve 24.

Whilst a particular construction and arrangement of valves has been described in connection with the above it will be undesrstood that various other types and arrangements can be used to operate in the same manner. It will be seen that with the arrangement above described there are two inlet valves 21, and two outlet valves 24, 25 respectively so that there is little likelihood of the whole device being rendered inoperative by the sticking of a valve.

We claim:

In a hydraulically-operated variable-pitch airscrew, the combination of blades rotatable each about its longitudinal axis to vary its pitch, a double-acting hydraulic ram coupled to said blades, means for admitting pressure-fluid through a non-return valve to one chamber of the ram to move the blades in a direction opposite to that in which they move under centrifugal and aerodynamic forces if unconstrained, an outlet valve from said chamber, a spring-loading for said outlet valve which is greater than the pressure that can be exerted on the fluid by the self-adjusting movements of the blades but less than the working pressure used for effecting adjustment of the blades in the opposite direction, means for admitting fluid to and discharging it from the other chamber of said ram at will, an additional port communicating with said first chamber, a valve controlling said port, and means adapted to be engaged by a movable part of said ram to close said valve when the blades reach a predetermined position in their movement towards a fine-pitch setting.

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