Nov. 4, 1952 J. RZECZYCKI 2,616,510

ROTOR BLADE DAMPER

Filed Nov. 7, 1947 3 Sheets-Sheet 1

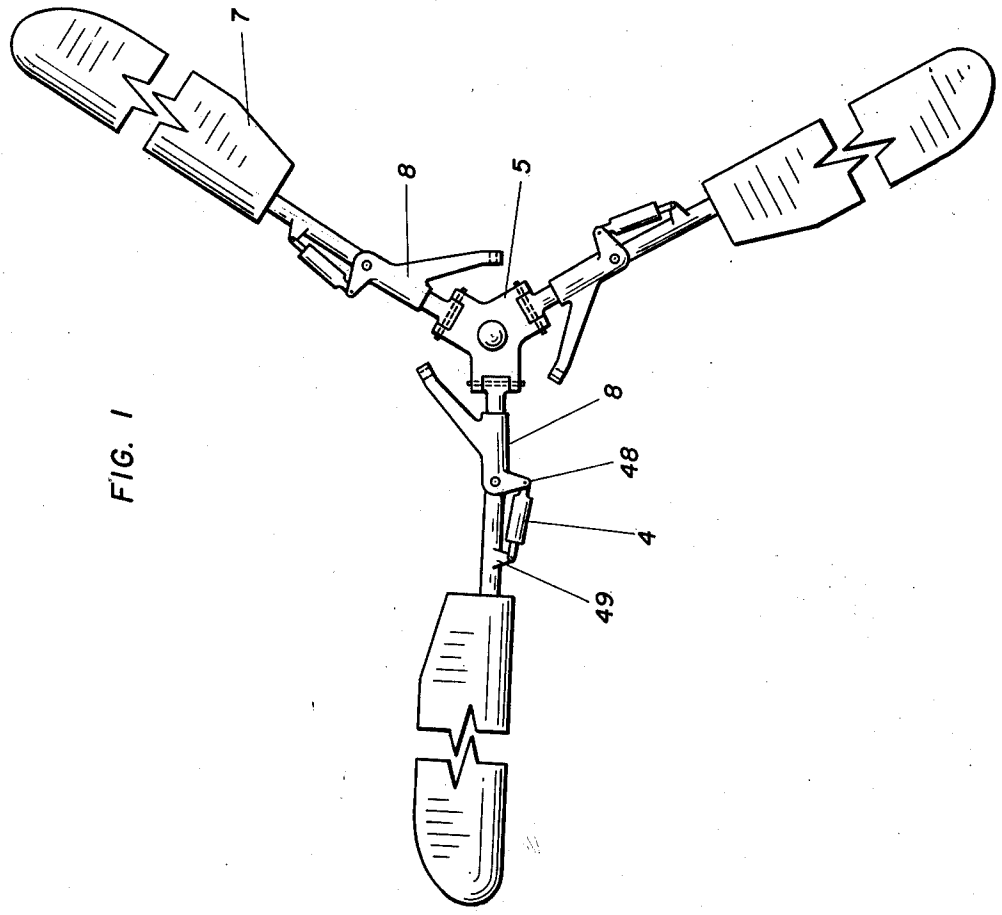



FIG. 1

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ROTOR BLADE DAMPER

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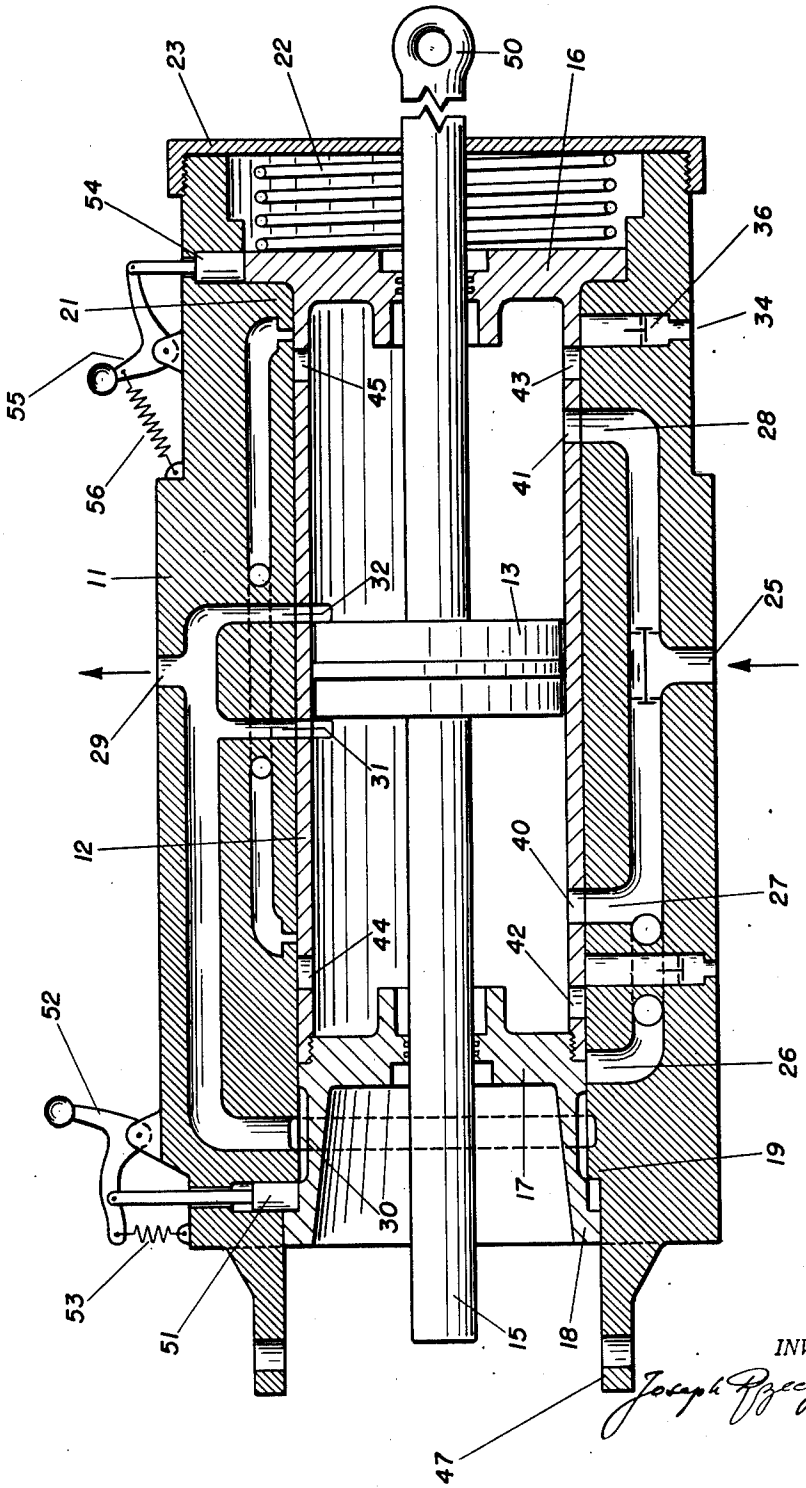



FIG. 2

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ROTOR BLADE DAMPER

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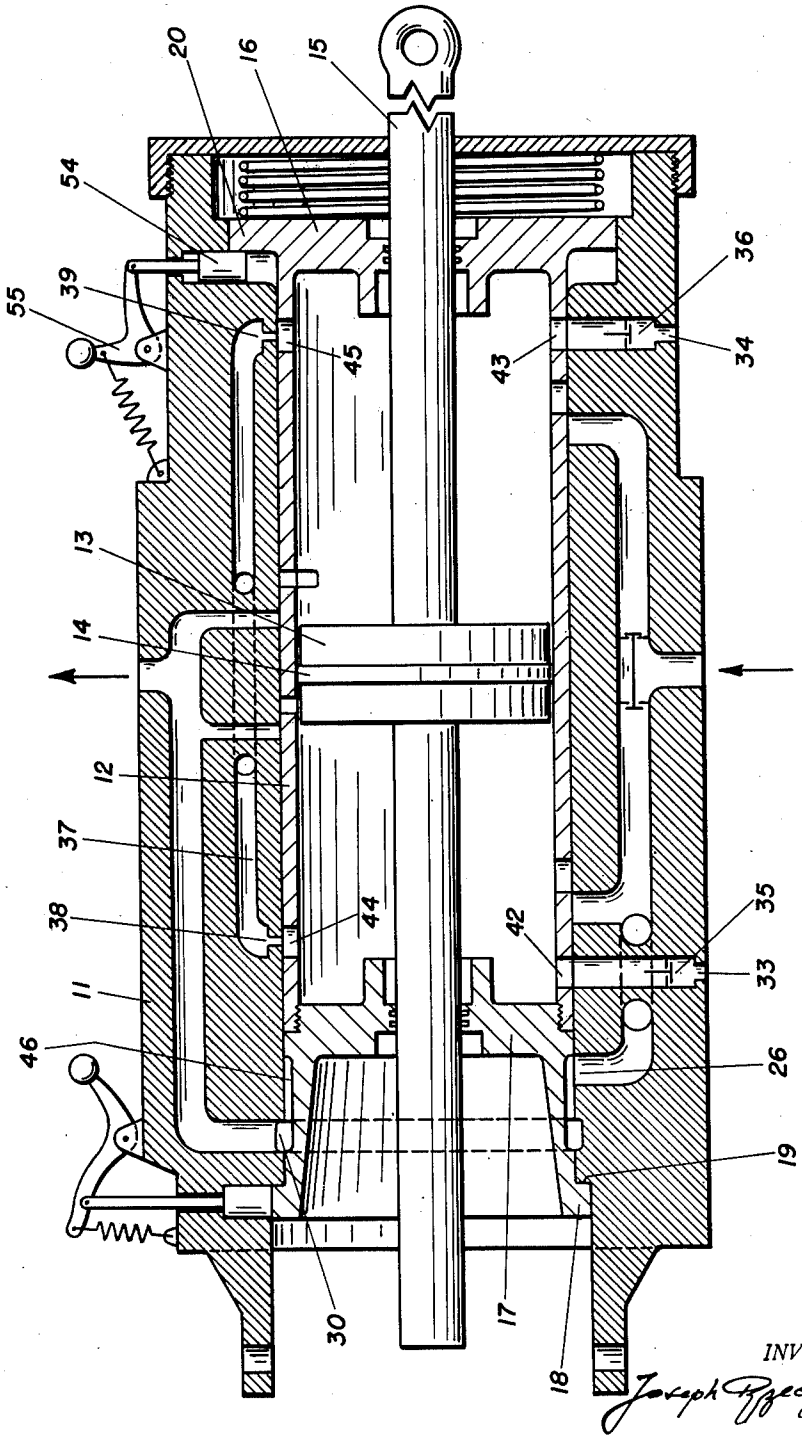



FIG. 3

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Patented Nov. 4, 1952 2,616,510

# UNITED STATES PATENT OFFICE

2,616,510

## ROTOR BLADE DAMPER

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5 Claims. (Cl. 170—160.55)

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This invention relates to rotary wing aircraft and more specifically to devices used to dampen oscillations of rotor blades about their vertical pivots.

In the operation of rotary wing aircraft employing articulated rotors it is common practice to use hydraulic dampers to prevent violent oscillation of the rotor blades in their plane of rotation. This violent oscillation usually occurs when the rotors are being stopped or started and the rotor speed is somewhere over one third of the normal rpm of the rotor.

I have found that during the period of time after the rotor is first started and until it reaches approximately one third of its normal speed, that the type of damper now employed will allow the blades to lag back about the vertical hinge, placing high loads on the control system, as the centrifugal force generated at these low speeds is not great enough to maintain the blades in their normal radial position. This condition also presents itself again when the rotor is being stopped, except in the latter condition the blade swings ahead of its normal position. This oscillation of the blades about the vertical pin is especially dangerous when the craft is setting down on the deck of a floating vessel rolling and pitching in rough seas.

Rotary wing aircraft operating under the aforedescribed conditions should, in order to avoid danger to its rotor blades, have some means to prevent the rotor blades from oscillating about their vertical pivots when the rotor is being started or stopped. This means should, however, become inactive when the blades have reached the rotative speed where the centrifugal force is great enough to maintain the blades in their correct radial position. It is, therefore, the principal object of this invention to provide such a device.

Another object of this invention is to provide means that will prevent any motion of the blades about their vertical pivots during the period in which the rotor is turning too slowly to allow the centrifugal force to maintain the blades in their correct radial position, said device being also provided with means to convert the locking mechanism into a damper for use at higher rotor speeds.

Another object of this invention is to provide a damper for rotor blades which includes automatic means for locking out the damping action of the device when the speed of the rotor is less than one third of its normal rotative speed.

Other objects and advantages will become apparent in the following specification when read in conjunction with the drawings forming a part of this specification.

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In Figure 1 of the drawings there is shown a rotor comprised of a hub, to which are hinged in a conventional manner the blades. The blades are hinged to the hub so that as they rotate with the hub, the blades are free to oscillate about their vertical and horizontal hinges in response to forces acting on the blades. The blade links 8 are further provided with pitch bearings so that the blades may be adjusted about their pitching axis.

Figure 2 is a detailed view of my invention shown in cross-section. The arrangement of the parts in this view are such that the device is acting to prevent motion of the blade about its vertical pivot.

Figure 3 is a similar view except that the parts are shown in position wherein the device acts as a blade damper.

Referring more particularly to the drawings in which like numerals indicate like parts the preferred embodiment of the invention is shown as comprised of a housing 11 of general tubular shape, the walls of which are provided with several oil passages. The housing 11 is machined to receive a sleeve or cylinder 12 adapted to move longitudinally therein. The sleeve 12 forms a cylinder in which is carried a piston 13, the piston 13 is fixed to a piston rod 15 and provided with a suitable packing ring 14. A cylinder head 16 is formed as an integral part of the outer end of the sleeve 12 and is provided with central opening through which the piston rod 15 slides. The inner end of the sleeve 12 is closed by a member 17 threaded into the sleeve 12, said member 17 being provided with a central opening through which the inner end of the piston rod 15 passes. The member 17 is also provided with an enlarged portion 18 which abuts against the shoulder 19 formed by counterboring the inner end of the housing 11 when the sleeve is in its outer most position, as shown in Figure 3. The cylinder head 16 of sleeve 12 is provided with an enlarged portion 20 which acts to limit the inward movement of the sleeve 12 when it abuts the shoulder 21 formed by counter-boring the outer end of the housing 11 as shown in Figure 2. The sleeve 12 is urged inwardly by action of the spring 22 abutting against the cylinder head 16 and held in place by a retaining member 23 threaded on the outer end of the housing 11.

The housing 11 is provided with an oil inlet passage 25 said passage leading to several ports

26, 27 and 28 opening into the inside of the housing 11. An oil outlet passage 29 is provided on the opposite side of the housing 11, said passage being provided with ports 30, 31 and 32. The housing 11 is also provided with two high pressure relief passages 33 and 34 containing high pressure relief valves 35 and 36. A damping conduit 37 is provided in the housing 11 said conduit having at each end thereof metering openings 38 and 39.

The sleeve 12 is provided with two inlet ports 40 and 41 spaced longitudinally so as to be in registry with the ports 27 and 28 when the damper is in locking position, as shown in Figure 2. The sleeve 12 is provided with two high pressure relief ports 42 and 43 spaced so as to be in registry with the relief passages 33 and 34 when the damper is in damping position, as shown in Figure 3. The sleeve 12 is also provided with damping ports 44 and 45 which are located so as to be opposite of the metering openings 38 and 39 when the damper is in damping position as shown in Figure 3. The member 17 has an annular recess 46 machined thereon to provide an oil passage connecting the port 26 with the port 30.

The inner end of the housing 11 is provided with a fork 47 for attachment to the bracket 48 formed on the pitch housing of the rotor blade link 8. The other end of the damper is connected to the bracket 49 formed on the inner portion of the blade by means of a pin extending through the eye 50 formed on the outer end of the piston rod 15.

The inner end of the housing 11 is drilled to receive a stop pin 51 which is moved from "in" and "out" positions by a centrifugally operated member 52 and by a spring 53 suitably carried on top of the housing 11. The outer end of the housing 11 is similarly drilled to receive a stop pin 54 which is also moved from "in" to "out" positions by a centrifugally operated member 55 and by a spring 56 carried on top of the housing 11. Fluid under pressure is supplied to the inlet passage 25 from any suitable pressure source in any suitable manner such as shown in Patents 2,183,119 and 2,264,943 to Agnew E. Larsen or Patent 2,247,034 to H. F. Pitcairn.

*Operation*

In operation the combination damping and locking device 4 is installed as shown in Figure 1, the outer end of the unit being connected to the blade spar and the inner end being connected to the blade link.

Oil is supplied by a suitable pump, to the inlet passage 25 and returned to the pump by a suitable conduit, not shown, connected to the outlet passage 29.

When the rotor is not rotating or operating at a low R. P. M., the spring 22 forces the sleeve 12 to take the position shown in Figure 2. The sleeve 12 is locked in this position by the pin 51 which is urged downwardly by the spring 53. The spring 56 acts to withdraw the stop pin 54 to allow the sleeve 12 to locate itself in an inward position.

With the sleeve 12 in the position as shown in Figure 2 oil entering the passage 25 will be allowed to flow through the ports 40 and 41 and enter the cylinder, moving the piston into a centrally balanced position whereupon the oil will exhaust out through the ports 31 and 32 into the passage 29 returning to the pump, not shown. Should the blade tend to lag about its vertical pivot it will move the piston outwardly causing a partial closure of the exhaust port 32. This will



cause the oil pressure to build up on that side of the piston returning the piston to its central position. Motion of the blade in an opposite direction will be resisted in a similar manner as any partial closure of the port 31 will cause an unbalance of the oil pressure acting on the piston to return it to its central or balanced position.

When the rotor speed has been increased sufficiently to prevent excessive oscillation of the blades about their vertical pins the centrifugal force acting on the element 52 will be high enough to overcome the force of the spring 53, at which time the element 52 will move the stop pin 51 upwardly allowing the centrifugal force acting on sleeve 12 to move it outwardly to the position shown in Figure 3 in which position it will be locked by the centrifugal force acting on the element 55 causing the lock pin 54 to move downwardly to the position shown in Figure 3. When the sleeve 12 is moved outwardly to the aforedescribed position it will be noted that the oil from the pump is shut off from the cylinder and by-passed around the sleeve 12 through the conduit 46 and out through the passage 29 and returned to the pump. The high pressure oil trapped at either side of the piston 13 is allowed to circulate from one side of the piston to the other through metering ports 38 and 39 located at the ends of the passage 37. This circulation of oil through the metering ports 38 and 39 allows the blade to oscillate slowly around its vertical pivot, said oscillation being damped. Any excessive high pressure generated by the motion of the piston in the cylinder is relieved by pressure relief valves 35 and 36.

From the foregoing description it will be readily understood that this invention provides a means to lock the blades in a radial position when the rotor is turning too slowly to generate enough centrifugal force on the blades to hold them in their correct radial positions. If this is not done, the blades swing from an extreme advanced position to an extreme lagging position, causing violent action of the blades about the pitch bearings, as the weight of the blades in either of these extreme positions acts to move the pitch bearing housing about its axis. In using a damper in combination with a blade locking means, an appreciable weight saving is gained over the use of two separate devices ordinarily required to accomplish the functions of this invention.

It is to be understood that while the foregoing is a description of the preferred embodiment of my invention as shown in the accompanying drawings, certain changes and modifications can be made without departing from the spirit and scope of this invention.

I claim:

1. In combination, an articulated sustaining rotor, a rotor blade damping and locking device comprised of a housing, the inner end of said housing having connecting means for attachment to the rotor hub a fluid containing cylinder carried by the housing for longitudinal movement therein, a piston slidably mounted in said cylinder, a shaft extending through said cylinder and fixed to the piston for reciprocation therewith, the outer end of said shaft being provided with fastening means for attachment to a rotor blade, a spring interposed between the outer end of the cylinder and a cap secured to the outer end of the housing, said spring acting to force the cylinder inwardly against a stop formed in the housing, said housing being provided with an inlet oil passage leading to ports provided in the

cylinder at opposite ends thereof, in registry therewith when the cylinder is in its inward position, said cylinder being provided with outlet ports spaced at each side of the piston when it is centrally located in the cylinder, said housing being provided with an outlet duct in registry with the outlet ports provided in the cylinder when the cylinder is in its inward position, said housing also being provided with a transfer duct opening into ports in registry therewith when the cylinder is in its outward position, provided near the ends of said cylinder, said device also being provided with centrifugally and spring actuated means to lock the cylinder in its inward position when the centrifugal forces are low or nonexistent and in its outward position when the centrifugal forces acting on the device are high.

2. In combination, a rotor comprised of a hub, a blade attached to said hub to permit the blade to oscillate in the plane of rotation, hydraulic means to move said rotor blade into a radial position with reference to the vertical axis of the rotor and hold it in such a position when the centrifugal forces acting on the blade are not high enough to maintain such a radial position, said hydraulic means comprising a piston connected with said blade, a cylinder containing the piston, said cylinder being secured to the rotor hub, said cylinder being supplied at each end thereof with fluid under pressure, said cylinder having outlet ports centrally spaced therein in such relationship that if the piston is not centrally located it will act to cover one or the other of the outlet ports so that the fluid pressure acting on the piston will be unbalanced, said unbalance of pressure acting to move the piston to a central position where the fluid outlets will be opened to balance the pressure on each side of the piston and maintain it in said central position.

3. In combination, an aircraft sustaining rotor comprising a hub, a blade hinged to the hub to permit relative oscillation, hydraulic damper means comprising a cylinder and normally centralized piston having a rod, said cylinder and rod being connected between the hub and blade,



passages to deliver pressure fluid to opposite ends of the cylinder, two discharge ports in said cylinder both uncovered only when the piston is centralized and alternatively covered when the piston is displaced in either direction from its central position, a by-pass connecting opposite ends of the cylinder and having fluid flow restricting means therein, and a second by-pass communicating with said passages to directly waste pressure fluid, valve means normally biased to open said delivery passages and said discharge ports and close said first and second by-passes, said valve means being positioned and mounted to move by centrifugal force against said bias to open said by-passes and close said delivery passages and discharge ports.

4. The device of claim 3 in which biased lock means is provided to hold the valve in biased position and means responsive to centrifugal force effective at rotor speeds above the order of 30 percent of maximum to release said lock means whereby the valve may move by centrifugal force.

5. The device of claim 4 in which second lock means is provided to hold the valve in by-pass opening position, means biasing the second lock to open position and centrifugal force responsive means to close said second lock when the rotor speed exceeds the order of 30 percent of maximum.

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