Jan. 17, 1950 J. E. ANDERSON 2,494,606

HYDRAULIC PUMP FOR PROPELLER PITCH CHANGING MECHANISMS

Original Filed April 8, 1943 3 Sheets-Sheet 1

Fig. 1.

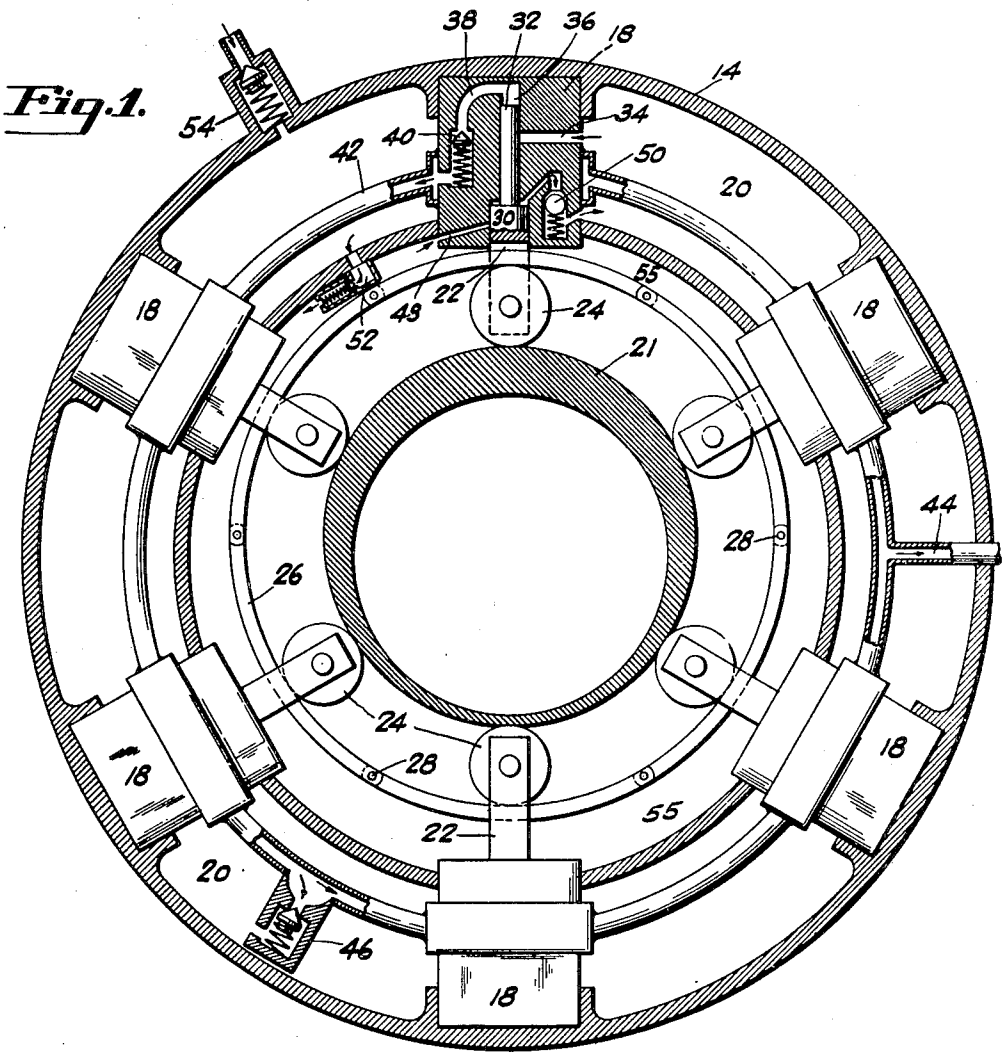
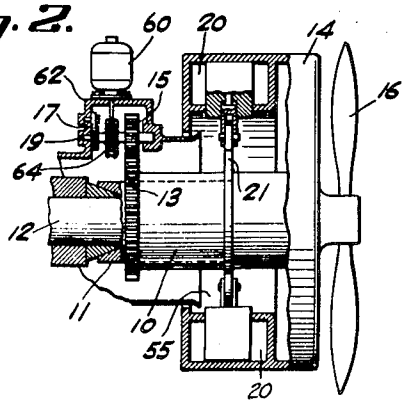


Fig. 2.



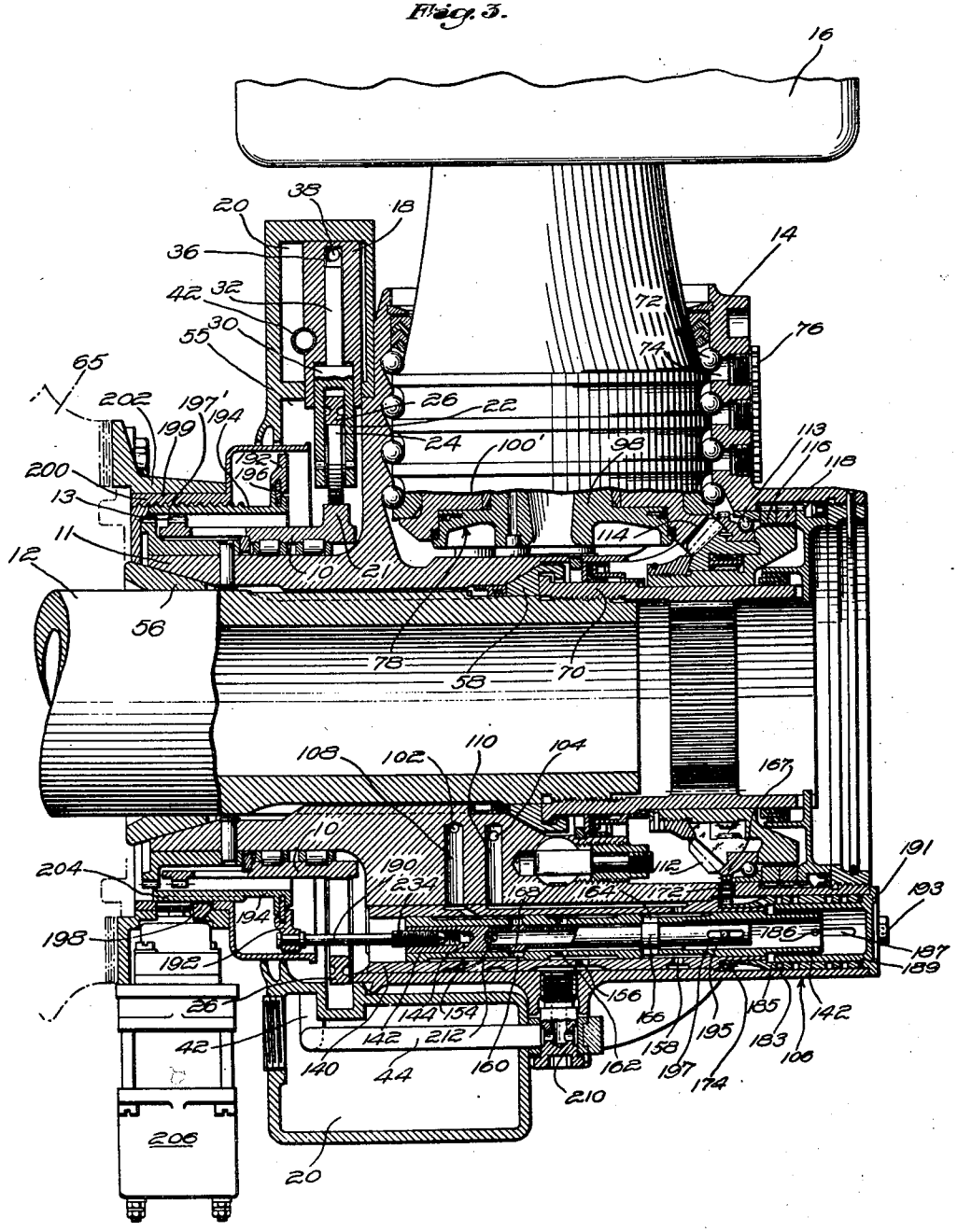
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Fig. 3.



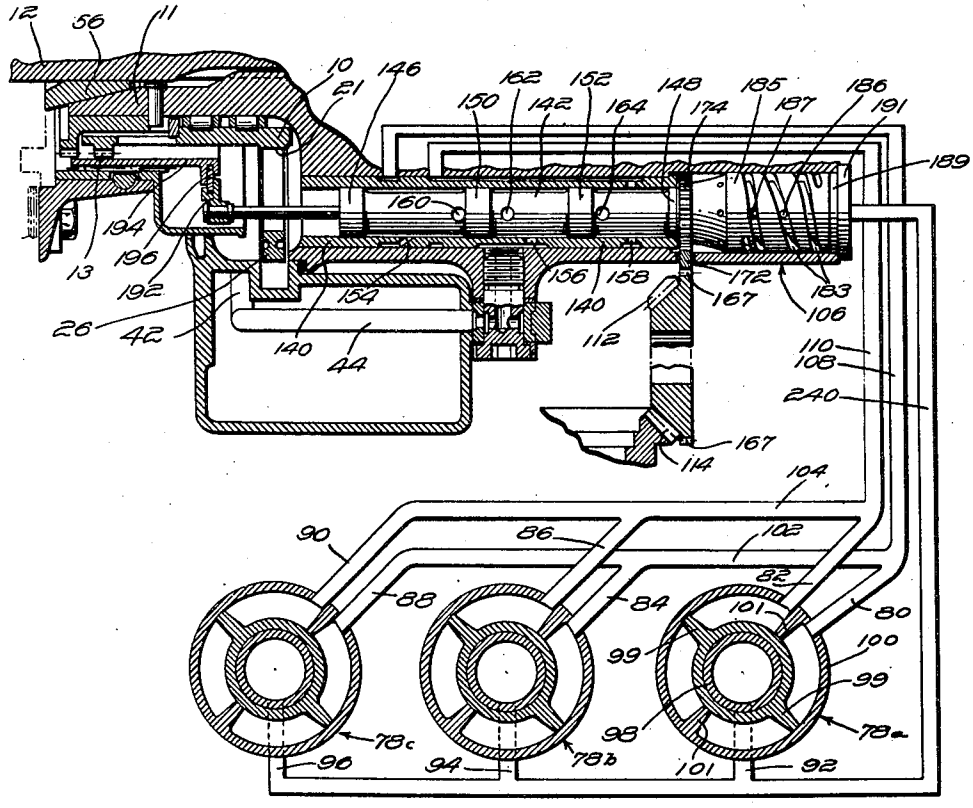
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Fig. 4.



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HYDRAULIC PUMP FOR PROPELLER PITCH CHANGING MECHANISMS

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8 Claims. (Cl. 170—160.33)

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This application is a division of United States application Serial No. 482,264, filed April 8, 1943, by John E. Anderson, for "Pumps for hydraulic pitch changing mechanisms," which matured into Patent No. 2,462,931 on March 1, 1949.

An object of this invention is to provide a pump construction and arrangement especially adapted for use on hydraulically controlled aircraft propellers.

The invention comprises a multi-cylinder pump having cylinders and pistons circumferentially arranged around a common center, and operated by suitable means such as the engine driving the propeller.

The cylinders are supported in an annular supply manifold or sump rotatable with the propeller hub.

Each cylinder has a radially movable piston, all pistons being reciprocated by a central cam.

Another object of the invention is the provision of improved means for unfeathering the propeller when the engine is not operating.

The individual pumps discharge into an annular manifold which, for convenience, may be supported within the supply manifold.

Other objects and advantages will be apparent from the specification and claims and from the accompanying drawing which illustrates what is now considered to be a preferred form of the invention.

In the drawing, Fig. 1 is largely a diagrammatic cross section of the pump in a plane perpendicular to the axis in rotation, and

Fig. 2 is a reduced scale of a diagrammatic side view of the invention installed on an aircraft.

Fig. 3 is a longitudinal sectional view of the pumps and associated mechanism assembled on a propeller.

Fig. 4 is a schematic view partially in section showing the propeller pitch changing mechanism, the sump, the control valve and the connections therebetween.

The cylindrical pump actuating member 10 is rotatably mounted by means of roller bearings on the rear end 11 of the propeller hub 14. The propeller 16 and hub 14 are driven from the engine 65 by the drive shaft 12.

Gear teeth 13 on member 10 engage gear 15 which is prevented from being rotated in one direction only by the engine by latch 17 which engages with the teeth of gear 19. Thus, when the engine is rotating the propeller and hub, pump operating member 10 is stationary.

The member 10 is provided with an eccentric cam in the form of flange 21. The propeller hub

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14 rotates with propeller 16 and supports the six individual pump units 18 and the reservoir manifold 20 from which the units draw their supply of oil.

Each piston 22 has a roller 24 bearing on the outer surface of eccentric 21, and a ring 26 keeps the rollers in contact with the cam against the suction pull of the pistons and against centrifugal force. For assembly purposes, ring 26 may be made in sections joined as at 28. Each pump piston has two different diameters, a comparatively large diameter 30 for low pressure, and a comparatively small diameter 32 for high pressure.

When the high pressure piston 32 moves radially inwardly sufficiently to uncover inlet passage 34 in pump body 18, oil will flow from sump 20 through passage 34 into high pressure cylinder 36, and on the out stroke the oil will be forced through passage 38 and check valve 40 into discharge manifold 42 from which it will pass through passage 44 to the control valves of the propeller.

A safety valve 46, discharging into sump 20, maintains a comparatively high pressure in manifold 42, for instance 3,000 pounds per square inch.

The large diameter part 30 of each pump piston serves to scavenge the lubricating oil and all leakage that may collect within the pump trough 55, drawing the oil through inlet 48 and forcing it into sump 20 past check valve 50. This pump has capacity enough to pump air if necessary. The pressure in sump 20 may be relieved through safety valve 52 at comparatively low pressure, for instance twenty-five pounds per square inch.

Lubricating oil which is under pressure from the propeller hub returns to sump 20 through check valve 54, which may be set at about thirty-five pounds per square inch.

Only one pump unit has been described, but it will be understood that the other units work in similar manner all drawing oil from sump 20 and discharging through manifold 42.

Thus, it will be seen that when the engine is driving the propeller, the pumps 18 will rotate about the stationary eccentric 21 to provide high pressure oil through passage 44 for feathering and unfeathering the propeller.

The propeller comprises a hub 14 having an internally splined bore into which the externally splined end of the propeller shaft 12 is fitted. The hub is secured on shaft 12, adjacent the engine 65 by conical rings 56 and 58 and nut 70, in a well known manner. The blades are retained in their sockets by thrust bearings comprising

circular grooves filled with steel balls 72, the balls being inserted through holes 74 in the wall of the sockets while the blades are in loading position with the end of vane motor 78 against hub 14, after which the holes are closed by plugs 76 and the blades are moved outwardly to their operative positions.

The pitch changing vane motor 78 is located within the shank of each blade, and is particularly illustrated and described in United States application Serial No. 474,638 filed February 4, 1943, by John E. Anderson and Arthur N. Allen, Jr., for Propellers. The three vane motors for a three bladed propeller are schematically shown at 78*a*, 78*b* and 78*c* in Fig. 4.

Each motor has fluid conduits, as indicated at 80—82, 84—86, and 88—90 (Fig. 4). Each conduit is, in reality, also connected by passages, not shown, to the chamber diametrically opposite the chamber to which it is shown to be connected in the drawing. Each motor comprises a fixed inner member 98 having a pair of abutments 99, and an outer member 100 having a pair of vanes 101 and rotatable about inner member 98 to change the pitch of the blades. The fluid connections to the motors lead from manifolds 102 and 104 (Figs. 3 and 4) extending around the propeller hub, and these manifolds are connected with the control valve generally indicated at 106, by channels 108 and 110. The passages 92, 94 and 96 take care of leakage from the vane motors.

The blades are interconnected for simultaneous and coextensive movements by a three piece adjustable bevel gear 112 (Fig. 3), rotatably supported on a bearing 113 mounted in hub 14 coaxial with shaft 12 and meshing with gear sectors secured to the shank ends of the blades, the sector for blade 16 being indicated at 114 (Fig. 3). Limiting positions of the propeller blades in their pitch changing movements are determined by stop rings 116 and 118 (Fig. 3) cooperating with a member rotatable with gear 112.

Fluid for operating the motors is supplied by a pump generally indicated at 18. Valve 106 (Figs. 3 and 4) comprises three concentric members, the fixed outer bushing 140, the slidable intermediate follow-up sleeve valve 142 and the slidable inner control valve 144. Bushing 100 is fixed in the propeller hub parallel to the axis of shaft 12. Follow-up valve 142 is in the form of a sleeve provided with end lands 146 and 148 and intermediate lands 150 and 152, the adjacent lands being separated by annular spaces in the sleeve, which overlie ports 154, 156 and 158 in bushing 140, connecting with the above annular spaces. Follow-up valve 142 is provided with ports 160, 162 and 164 leading from the interior to the exterior thereof, and control valve 144 is provided with spaced lands 166 and 168 which serve to control ports 160 and 164 in a manner to be presently described.

Sleeve valve 142 is moved in accordance with the pitch changing movements of the propeller blade through connection with blade synchronizing gear 112. To gear 112 is secured a spur gear 167 which, through an idler pinion 172, drives pinion 174 formed at one end of sleeve 185 (Figs. 3 and 4) in which are two helical cam grooves 183, 180 degrees apart. Sleeve 185 rotates around an inner sleeve 189 which is provided with diametrically opposed longitudinal slots 187 (Figs. 3 and 4). A pin 186, through the end of valve 142 passes through slots 187 with each end of the pin in one of the cam grooves 183. Sleeve 189 and its slots 187 are nonrotatable with respect to the hub, being integral with cap 191 which is secured to the hub by screws 193. With the above structure in mind, it will be realized that rotation of gear 174 will rotate cam 185. Cam grooves 183 engage the ends of pin 186 and therefore move the pin longitudinally along slots 187, and the pin will move valve 142 with it. Thus is established the control of follow-up valve 142 from gear 112, through gear 174 and pin 186.

Control valve 144 is connected through a screw threaded rod 190 with a ring 192 which is connected to an axially movable but nonrotatable member 194 by a flat slip ring 196 engaging aligned grooves in ring 192 and member 194. A pin 195 (Fig. 2) extending through a longitudinal slot 197 in control valve 144, and secured at its ends in follow-up sleeve 142 limits the extent of longitudinal movement of valve 144 relative to the sleeve. Pin 195 is also used for adjusting the position of the control valve through threaded rod 190. The pin is kept from rotating by engaging holes in follow-up sleeve 142, which in turn is prevented from rotating by pin 186 in slots 187. To adjust the position of the control valve screws 193 are removed, sleeve 189 is rotated a proper amount, and screws 193 are replaced.

Member 194 is movable by a pitch control mechanism, not illustrated, but which may be of the character illustrated and described in United States application Serial No. 422,252, filed December 9, 1941, by Perin and Richmond, for Propeller control means, (now abandoned in favor of continuation application Serial No. 77,644, filed February 21, 1949), and assigned to the assignee of this application. In such an arrangement a servo-motor operated rack 198 imparts a slight rotational movement to member 194 to cause a relative movement between external spiral splines 197' provided on member 194 and corresponding internal spiral splines 199 in an annular member 200 rigidly secured, by annular bracket 202, to the front end of the casing of engine 65.

Because of the spiral arrangement of splines 197' and 199 the slight rotational movement of member 194 will cause a longitudinal movement of this member proportional to the movement of straight-toothed rack 198 which engages teeth 204 provided on a portion of member 194. For the number of straight teeth in 194 plus the necessary rotational travel, the spiral teeth in fixed member 200 are removed. Movement of rack 198 may also be utilized to turn the rotor of a generator 206 of a Selsyn pitch indicating apparatus.

The pump pressure manifold 42 is connected (Figs. 1, 3 and 4) through pipe 44 and plug 210 (Fig. 2) with port 156 in tube 140, while channel 108 leading to manifold 102 is connected with port 154, and channel 110 leading to manifold 104 is connected with port 158. With this arrangement, fluid under pressure from the pump is supplied through port 156 in tube 140 and port 162 in follow-up valve 142 to the annular space within the valve between lands 166 and 168 of control valve 144. Flow of fluid from this space to either manifold 102 or 104 is controlled by movement of control valve 144. When that valve is moved to the left as viewed in Figs. 3 and 4, fluid will flow from the space within valve 142 between lands 166 and 168 of valve 144 through port 160 in valve 142, and port 154 in tube 140, and thence through channel 108 to manifold 102 to supply hydraulic fluid to one side of each pitch changing motor. At the same time, exhaust fluid from the opposite sides of the motors will flow

from manifold 104 through channel 110, port 158 and port 164 to the interior of valve 142 and thence through channels 199 in sleeve 195 to the interior of the propeller hub.

When valve 144 is moved to the right as viewed in Figs. 3 and 4, fluid will be supplied from 210 through ports 156, 162, 164, 158 and channel 110 to manifold 104, while the exhaust fluid from the opposite side of the motors will flow from manifold 102 through channels 108 and 154, through ports 160 and holes 212, into valve 144, and thus through the front end of sleeve 142 into the propeller hub, as described above.

When valve 144 has been moved a certain distance corresponding to a speed change demand of the governor control apparatus, one side of each motor will be connected with the fluid from the pump pressure manifold 42 in the manner described above and the opposite sides of the motors will be vented to the sump 20. The rotatable portions of the motors will thereupon start to rotate turning the propeller blades to change the propeller pitch. As the blades are rotated gear 112 is also rotated, and it rotates member 185 causing pin 186 to track through cam slot 183 thereby moving follow-up valve 142 in the same direction in which the control valve 144 was moved. When the blades have changed their pitch an amount corresponding to the movement of valve 144, sleeve 142 will have reached a position in which ports 160 and 164 are again centered relative to lands 166 and 168 of control valve 144 and movement of the motors will thereupon cease. When valve 142 is in the above position relative to plunger 144, lands 166 and 168 have negative lap i. e., they fail to entirely cover ports 160 and 164 but provide bleeder openings through the ports and surplus output of the pump can flow through control valve 142 to drain. Thus the valves act to unload the pump when the pitch changing motors are not operating and also maintains an equal pressure on both sides of the pitch changing motors. As soon, however, as control valve 144 moves with respect to follow-up valve 142 negative lap will be eliminated and the output of the motor will be directed to one side or the other of the pitch changing motors, depending upon the direction of movement of valve 144, and the opposite sides of the motors will be connected with drain in the manner described above. The position of valve 144 may be adjusted relative to ring 192 by the adjustable screw thread connection 234 to obtain the proper position of this valve relative to follow-up valve 142.

High pressure and low pressure relief valves 46, 54 respectively are included in the pitch changing hydraulic system to supplement the operation of control valve 106. The high pressure relief or blow-off valve 46 is provided to vent the pump outlet at a predetermined safe maximum pressure in the event the control valve 106 should, for some reason, fail to entirely dispose of the pump output. The low pressure control or exhaust pressure valve, interposed between the space within the propeller hub and the sump 20 is provided mainly to insure that the hub remains full of fluid for lubricating purposes. The space within the hub which hydraulically connects valves 106 and 54 is diagrammatically indicated by the channel 240 in Fig. 4.

It is also desired to provide means for unfeathering the propeller in the event the engine is inoperative. This is accomplished by means of electric motor 60 which is mounted on bracket 62 fixed to the engine nose. The motor 60 may

be energized to rotate pump actuating member 10 through worm drive 64 and gears 15 and 13, and hence cause eccentric 21 to rotate relatively to the now stationary pumps 18 and provide high pressure oil for unfeathering the propeller. The number of pumps, the location of their inlets, and the quantity of oil in the sump are selected to insure a supply of oil to at least one of the pumps in every stationary position of the propeller.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described, but may be used in other ways without departure from its spirit as defined by the following claims.

I claim:

1. A device for feathering airplane propellers comprising in combination, a cam, an annular manifold surrounding said cam, pump units supported by said manifold and surrounding and in operative engagement with said cam, a propeller including pitch control mechanism, a propeller drive shaft, said manifold, pumps, and propeller being rotated about said cam by said drive shaft to operate said pump, and means for rotating said cam and operating said pump to withdraw fluid from said manifold and deliver fluid to said propeller pitch control mechanism when said drive shaft is stationary.

2. In combination with an airplane propeller having hydraulically actuated pitch changing means including means for feathering said propeller, pump means carried by and rotatable with said propeller for supplying hydraulic fluid under pressure to said pitch changing means, a substantially constant volume sump for storing hydraulic fluid also carried by and rotatable with said propeller, a plurality of pump inlets connected with said pump means, said inlets including a plurality of inlet openings in said sump said inlet openings being spaced around said sump so as to be submerged in fluid held against the outer walls of said sump by centrifugal force when said propeller is rotating and spaced so that at least one of said inlet openings is always submerged in fluid held against a wall of said sump by gravity when the propeller is not rotating, and means for actuating said pump means both when the propeller is rotating and when the propeller is not rotating.

3. In combination with an airplane propeller, having hydraulically actuated pitch changing means including means for unfeathering said propeller, pump means carried by and rotatable with said propeller for supplying liquid under pressure to said pitch changing means, a substantially constant volume sump for storing liquid also carried by and rotatable with said propeller, a plurality of pump inlets connected with said pump means, said inlets including a plurality of inlet openings in said sump, said inlet openings being spaced around said sump so as to be submerged in liquid held against the outer walls of said sump by centrifugal force when said propeller is rotating, and spaced so that at least one of said inlet openings is always submerged in liquid held against a wall of said sump by gravity when the propeller is not rotating and means for actuating said pump means when the propeller is not rotating to pump liquid from said sump, through an opening submerged when the propeller is not rotating, to said pitch changing means to unfeather the propeller.

4. In combination with an airplane propeller mounted on a propeller drive shaft, and having hydraulically actuated pitch changing means in-

cluding means for unfeathering said propeller, pump means carried by and rotatable with said propeller for supplying liquid under pressure to said pitch changing means, an annular substantially constant volume sump carried by and rotatable with said propeller and substantially concentric with said drive shaft for storing liquid, a plurality of pump inlets connected with said pump means, said inlets including a plurality of inlet openings in said sump, said inlet openings being substantially equally spaced around the periphery of the interior of said sump so as to be submerged in liquid held against said periphery by centrifugal force when said propeller is rotating, and spaced so that at least one of said inlet openings is always submerged in liquid held against said periphery by gravity when the propeller is not rotating, and means for actuating said pump means both when the propeller is rotating and when the propeller is not rotating.

5. A device for unfeathering non-rotating airplane propellers comprising in combination, a propeller including pitch control mechanism, a propeller drive shaft, a sump carried by said propeller, a plurality of pump units for supplying unfeathering fluid to said propeller stitch control mechanism arranged around said drive shaft and carried by and operatively connected with said sump, each pump unit comprising one part rotatable with said propeller and another part held against rotation said pump being operated to pump fluid by relative rotation of said parts and means for rotating said other part and supplying unfeathering fluid to said propeller pitch control mechanism from said sump when said propeller is not rotating.

6. A device for unfeathering non-rotating airplane propellers comprising in combination, a propeller including pitch control mechanism, a propeller drive shaft, an annular sump substantially concentric with and arranged around said drive shaft, a plurality of pump units located in and connected with said sump and substantially equally spaced around said drive shaft each pump unit comprising one part connected with said sump for rotation therewith and another part held against rotation, said pump being operated to pump fluid by relative rotation of said parts, and means for rotating said other part and supplying unfeathering fluid to said propeller pitch control mechanism from said sump when said propeller is not rotating.

7. A device for unfeathering airplane propellers comprising in combination, a propeller, a propeller drive shaft, an annular substantially constant volume sump secured to and rotatable with said propeller for storing a supply of pitch changing fluid, a plurality of pumps carried by said sump and rotatable therewith, each pump having an individual intake submerged in said fluid when said propeller is rotating at least one of which pumps will have its intake submerged in said fluid when the propeller is not rotating, and means for operating said pumps both when the propeller is rotating and when it is not rotating.

8. A device for unfeathering a non-rotating airplane propeller having hydraulically actuated pitch changing mechanism carried by said propeller, comprising in combination, a substantially constant volume sump carried by said propeller for storing a supply of pitch changing liquid, a plurality of pump units carried by said propeller adjacent said sump, each pump unit having a separate individual inlet in said sump adjacent the respective pump, traveling through an orbit by rotation of said propeller, and located near the bottom of said sump when said respective inlet is at the bottom of its orbit, and means for operating said pump units when the propeller is not rotating to pump liquid through the inlet located near the bottom of said sump to said pitch changing mechanism to unfeather said propeller.

JOHN E. ANDERSON.

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