Sept. 29, 1953 J. E. ANDERSON 2,653,668

HUB MOUNTED CONTROL

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Fig. 2.

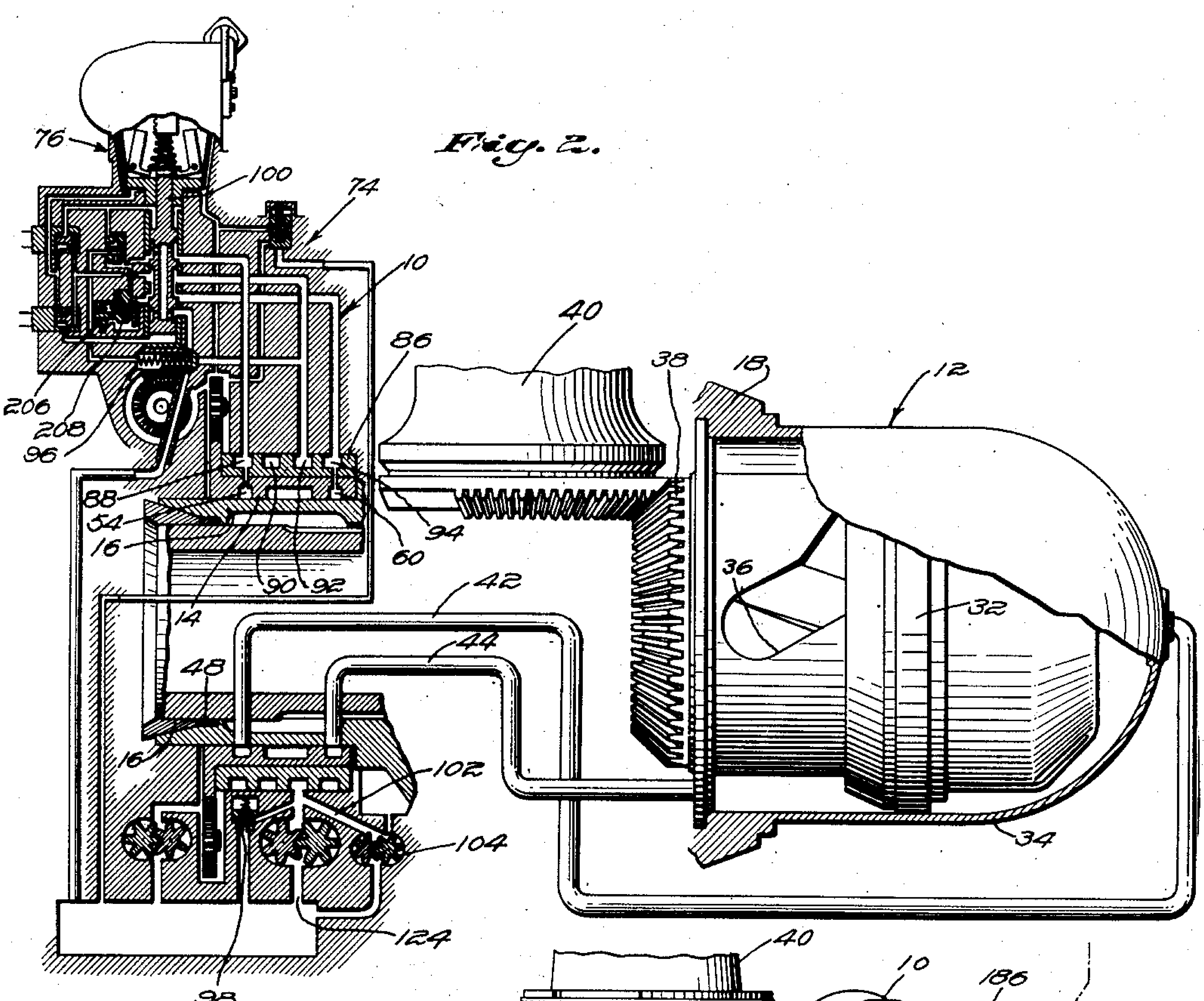

Fig. 1.

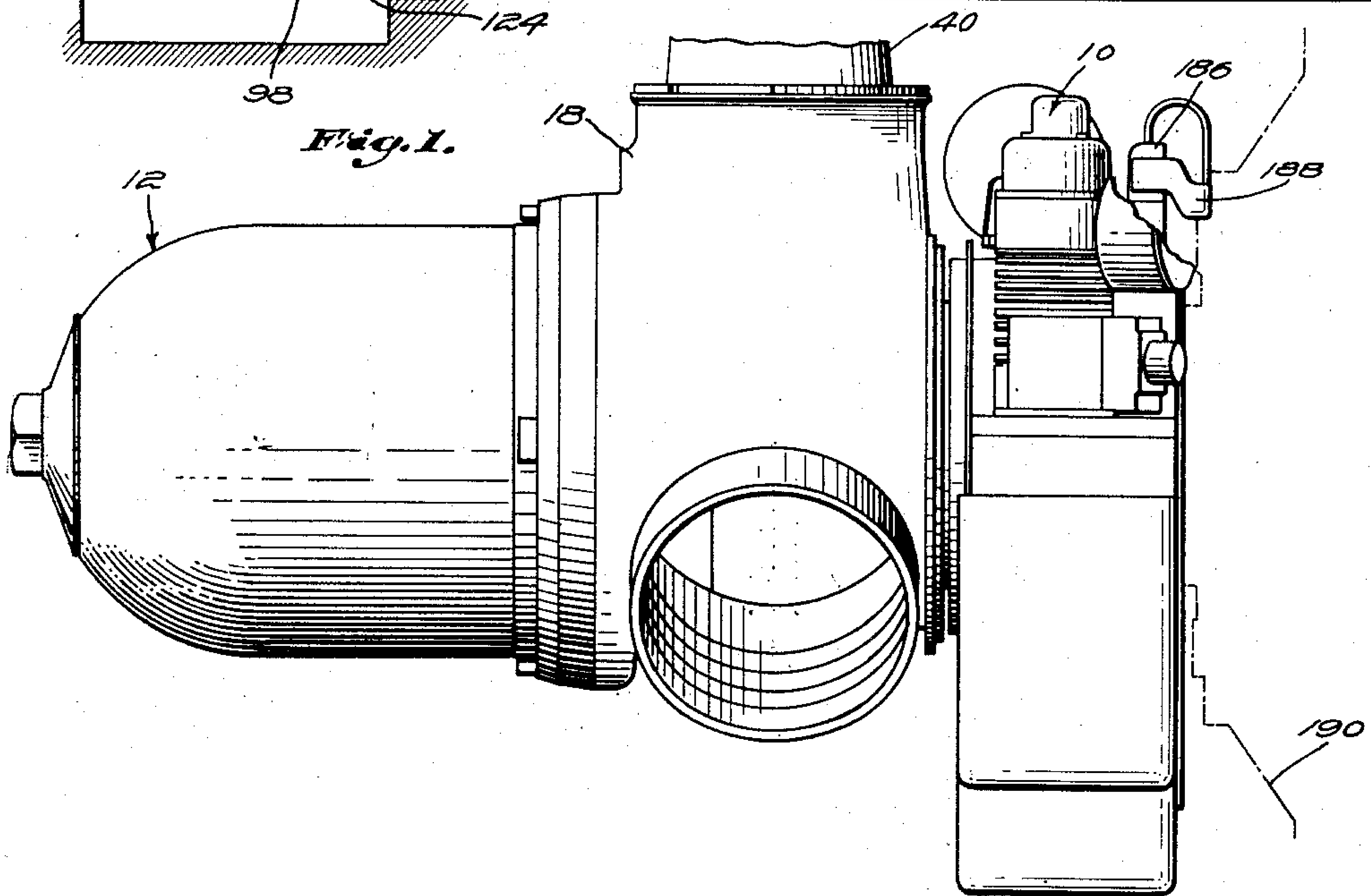

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Fig. 3.

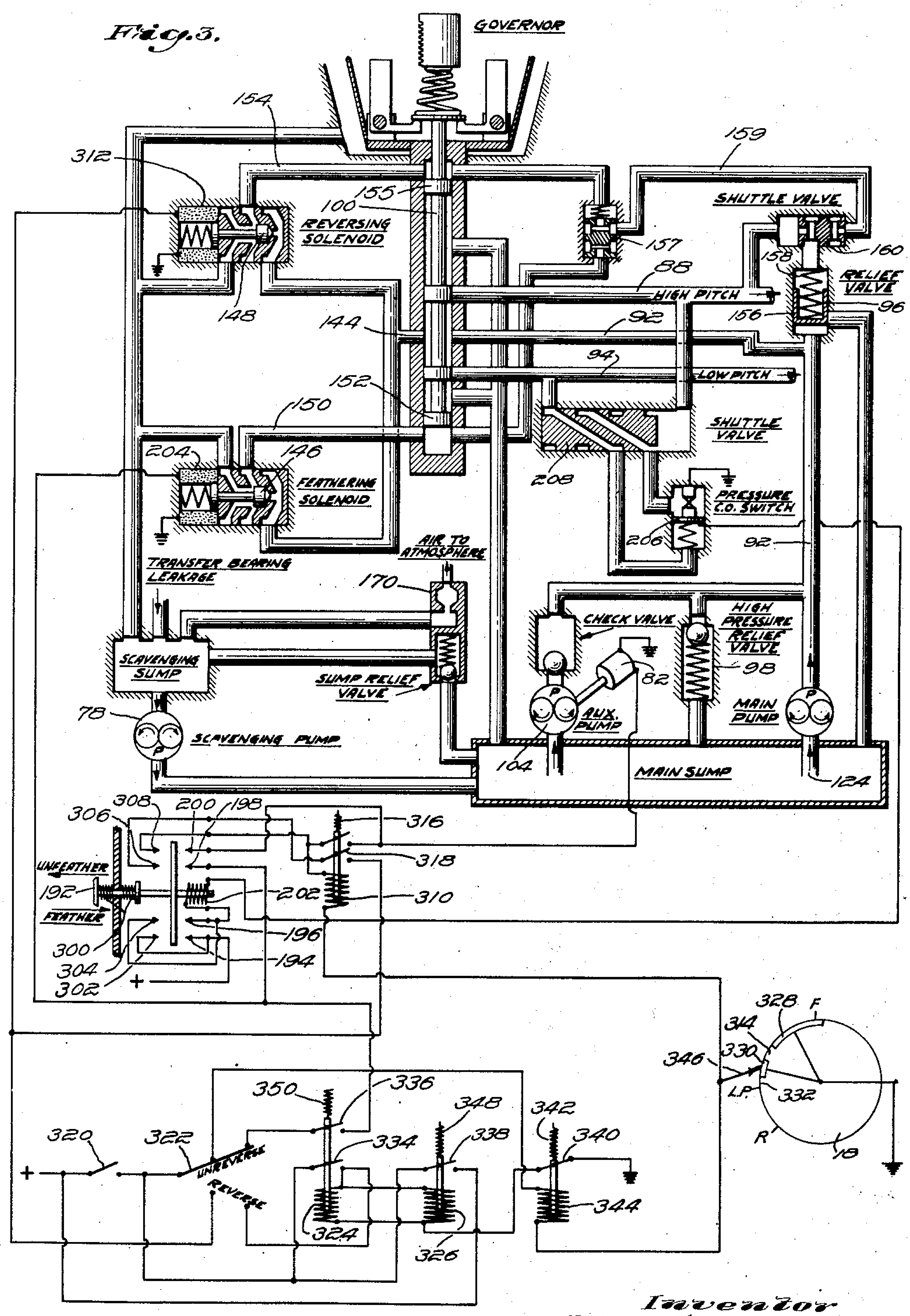

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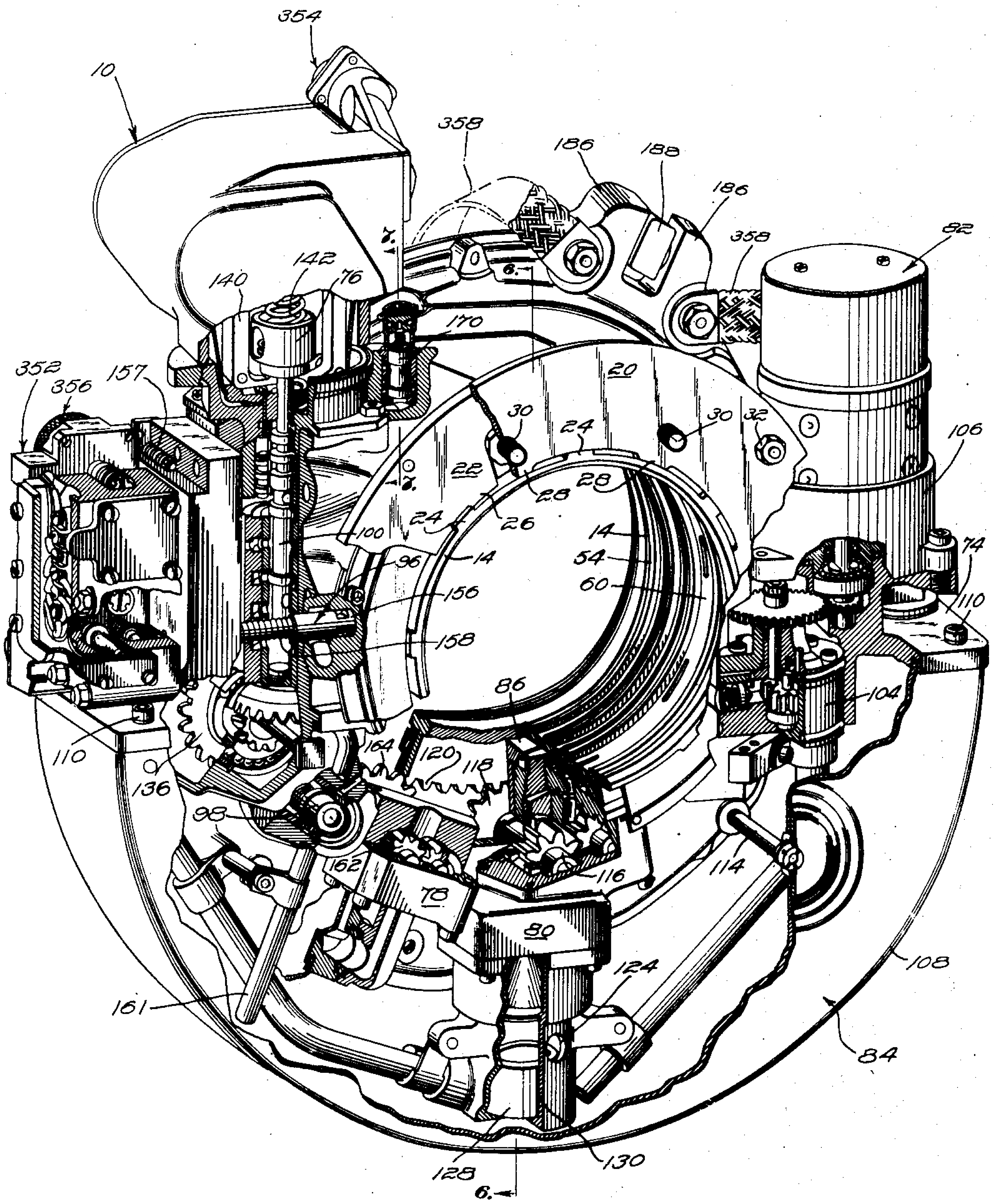
Fig. 4.



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HUB MOUNTED CONTROL

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Fig. 5.

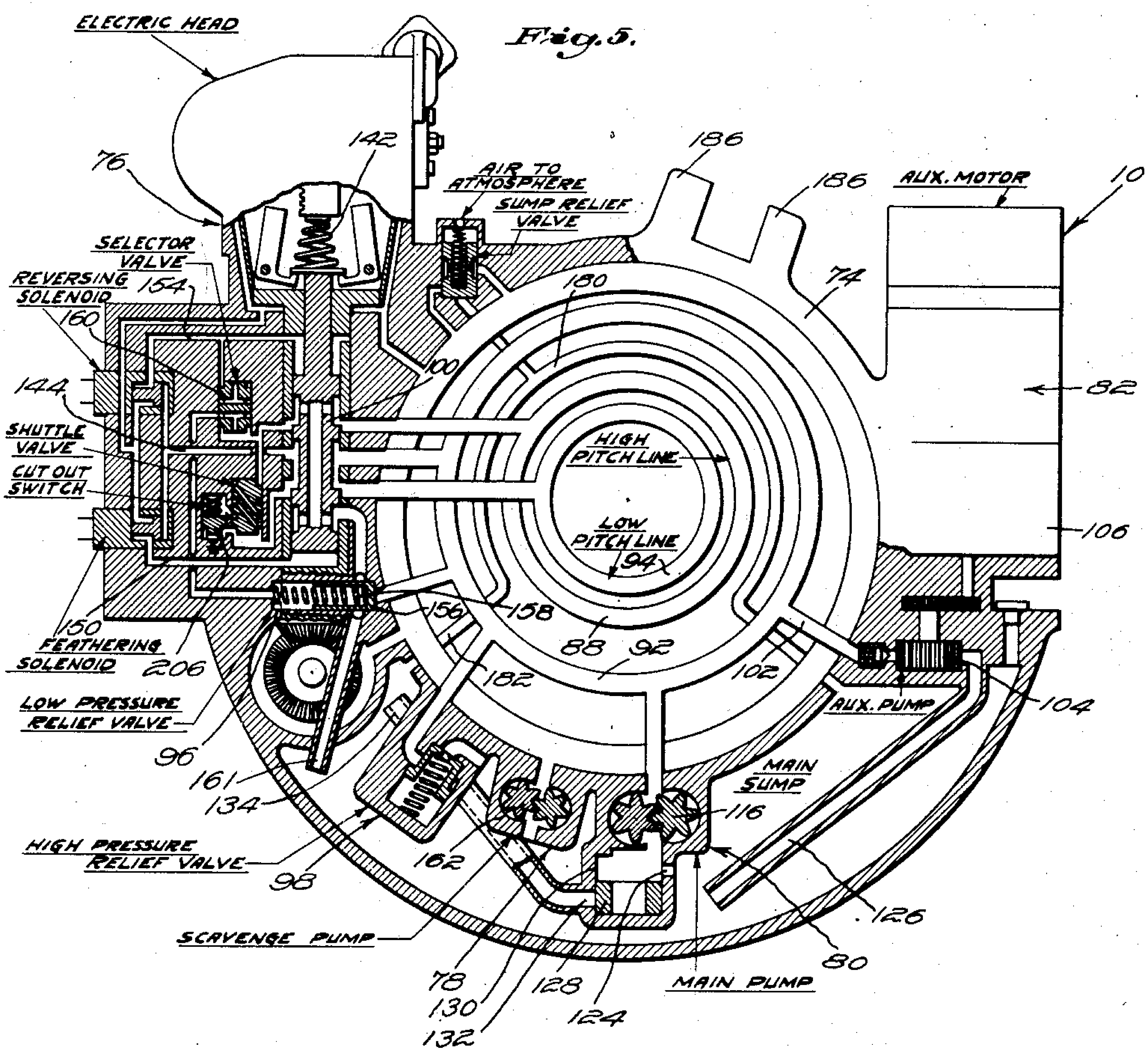

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Fig. 6.

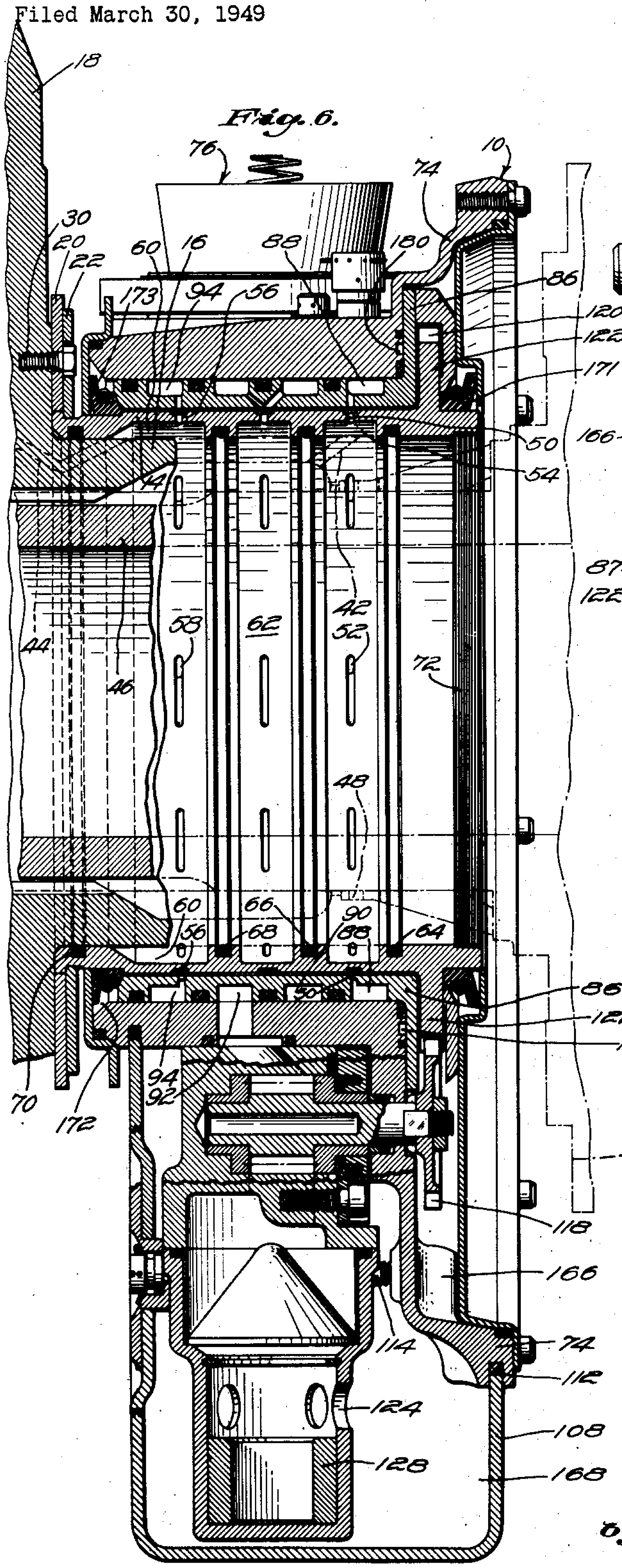
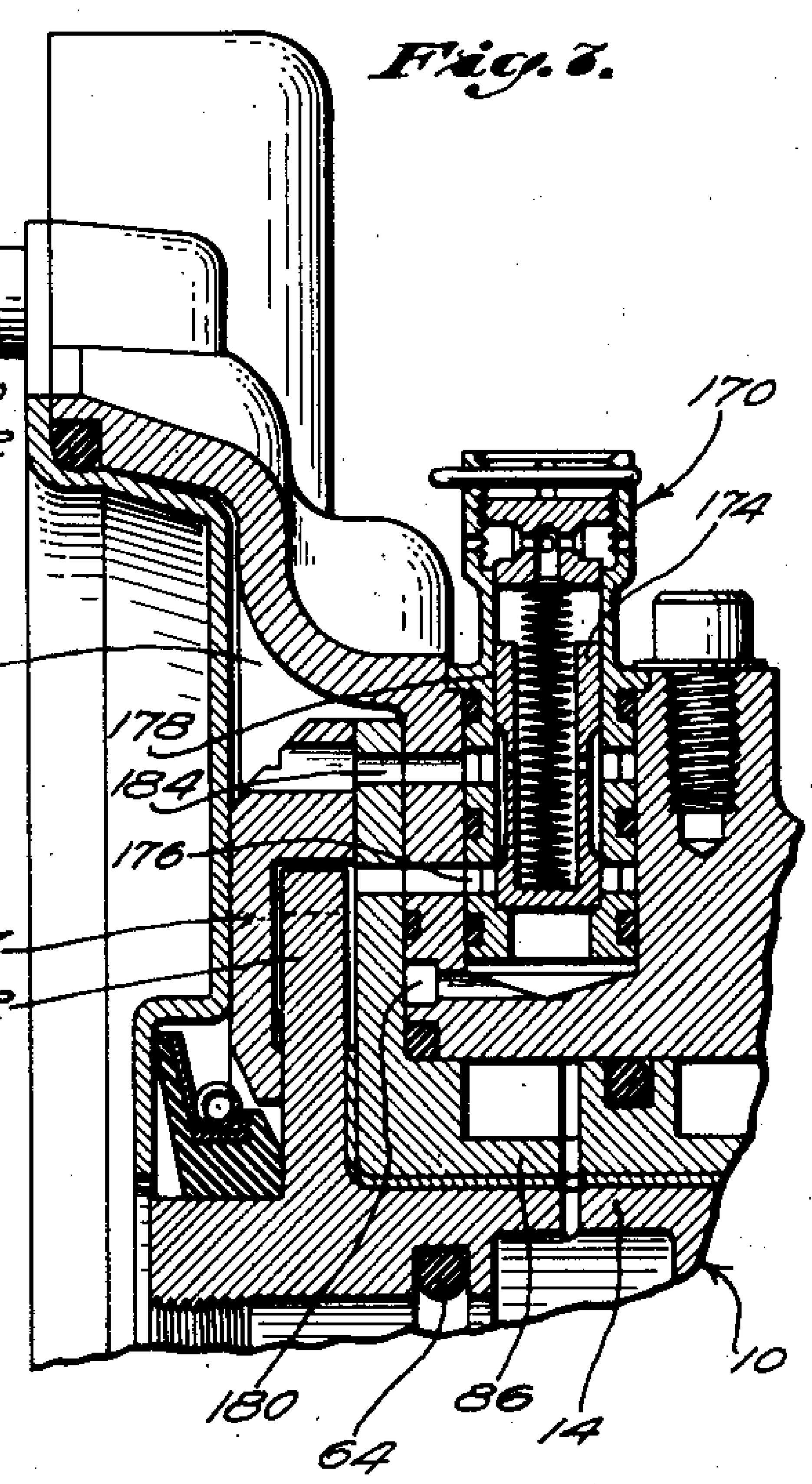


Fig. 7.



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UNITED STATES PATENT OFFICE

2,653,668

HUB MOUNTED CONTROL

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Application March 30, 1949, Serial No. 84,305

18 Claims. (Cl. 170—160.2)

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This invention relates to an improved propeller construction and particularly to an improved self contained propeller having a stationary control system and an oil supply, for the propeller and controls, independent of the engine lubricating system.

An object of this invention is a propeller-control unit with a non-rotating control system for supplying pressure fluid to rotating propeller pitch changing mechanism.

A further object is a propeller-control unit having a propeller-carried non-rotating control system, including a fluid supply independent of the engine lubricating system, for supplying pressure fluid to rotating propeller pitch changing mechanism.

A still further object is a propeller-control unit having a propeller-carried non-rotating control system including means for controlling the same to effect constant speed control, feathering and reversing.

A still further object is a non-rotating control in a propeller-control unit with provisions for inverted flight.

A still further object is to provide a self contained propeller-control unit which may be completely assembled before being secured on the propeller shaft and which delivers oil from the control unit to the propeller but does not require a special or modified propeller shaft.

A still further object is an improved propeller hydraulic control system.

Other objects and advantages will be apparent from the specification and claims, and from the accompanying drawings which illustrate what is now considered to be the preferred embodiment of the invention.

Figure 1 is a side view, with one blade removed, of the propeller-control unit of this application.

Figure 2 is a schematic side view showing the hydraulic control system and the pitch changing mechanism.

Figure 3 is a schematic diagram of the electrical and hydraulic circuits of the control.

Figure 4 is a perspective view, with portions broken away, of the control unit, removed from the propeller, looking at the control unit from the propeller side.

Figure 5 is a somewhat schematic diagram showing, in an end view, the hydraulic control circuit and the arrangement of parts.

Figure 6 is a section through the control unit taken on line 6—6 of Figure 4 showing the control mounted on the propeller hub.

Figure 7 is a detailed sectional view taken on line 7—7 of Figure 4 showing the air relief valve.

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Various attempts have been made to construct a propeller having the advantages of a self-contained propeller and also the advantages of hydraulic actuation of the propeller pitch changing mechanism while at the same time providing a structure which would not require modification of the propeller shaft or engine nose mechanism to provide oil passages therein. One of the objectives is a complete propeller which can be removed and replaced as a unit with a minimum of adjustment and connections to be made upon installation or removal. Some such attempts have required that the propeller controls be bolted to the engine nose and the propeller placed separately on the propeller shaft which requires considerable adjustment when the propeller is assembled on the propeller shaft and connected with the controls. Other such attempts have required that the controls and oil reservoir rotate with the propeller. Applicant has invented a hydraulically controlled propeller in which the oil reservoir and controls are stationary and are rotatably supported on bearings on the propeller and the oil connections between the controls and the propeller are made through the propeller hub so that no modification of the propeller shaft is required to provide the necessary oil passages. By this construction applicant is able to utilize oil of any desired characteristic for operating the propeller and no longer has to rely on the lubricating oil of the engine as propeller operating oil. Such a propeller constitutes a unitary structure which may be completely adjusted on the bench prior to assembly on the propeller shaft and then assembled on the propeller shaft without further adjustment. The hydraulic control system remains stationary and is electrically controlled from a convenient control station to provide, in addition to constant speed control, means for feathering, unfeathering, reversing, and unreversing the propeller. This is all accomplished in a unitary mechanism in which the oil reservoir and all the control elements are arranged in a non-rotating unit and act to control the flow of hydraulic fluid to and from the hydraulic pitch changing mechanism in the propeller without the use of any external oil connections.

In the drawings which illustrate a mechanical construction which is now considered the preferred form of the invention, the control unit is indicated generally at 10 and is shown as rotatably supported on bearings on the propeller unit, generally indicated at 12. The control unit 10 includes a bearing sleeve 14 which is telescoped with and supported on an axial projection 16 on the hub 18 of the propeller 12. The sleeve 14 is secured in position on the hub and held against axial or rotational movement thereon by notched rings 20 and 22. Sleeve 14 is provided adjacent the propeller hub with upstanding lugs 24. Ring 22 is provided with depending lugs 26. The ring 22 has a diameter at the inner side of the depending lugs 26 substantially equal to the diameter of the outside of sleeve 14 for a length substantially equal to the open space between the upstanding lugs 24 so that ring 22 with its depending lugs 26 may be assembled onto sleeve 14 and rotated so as to engage the rear of upstanding lugs 24.

Ring 20 has depending lugs 28 and an inside diameter equal to the outside diameter of sleeve 14 so that ring 20 may be placed over sleeve 14 and in the plane of upstanding lugs 24.

As shown in Figs. 4 and 6, ring 20 may be fastened by means of cap screws 30 to the hub 18. Rings 20 and 22 may then be secured together by means of cap screws 32 threaded into ring 22. When thus assembled, ring 22 will axially position sleeve 14 and the control unit relative to the propeller hub and ring 20 will prevent relative rotational movement of the hub 18 and the sleeve 14. Relative rotational movement of sleeve 14 and hub 18 would be prevented by contact of the lugs 24 and 28.

The propeller may be of any type utilizing hydraulic fluid for pitch changing and preferably having the propeller pitch changing motor carried by and rotating with the propeller. In the preferred form, the pitch changing motor comprises a piston mounted in a cylinder 34 and by means of cam slots 36 and cam rollers, not shown, turns a connecting gear 38 geared to the propeller blades 40 to thereby change the propeller blade pitch. Oil may be selectively directed to either side of the pitch changing mechanism by means of conduits 42 and 44. The propeller is secured to a propeller or engine shaft 46 supported in the usual manner by bearings in the engine or engine nose. For further details of these propeller constructions, reference may be made to Patent No. 2,477,868 of George W. Forman, filed April 17, 1946 and issued August 2, 1949. Reference may also be made to Patent No. 2,371,873 of Erle Martin, issued March 20, 1945, for a further disclosure of a suitable type of propeller for use with the control of this application. As this type of propeller is now well known, further detailed description thereof is believed to be unnecessary.

Hydraulic fluid is led from the control mechanism to the propeller through the conduits 42 and 44 in the propeller hub. Conduit 42 leading into the hub outside of propeller shaft 46 and through suitable connections such as shown in Patent No. 2,477,868, is led to the forward side of piston 32. Fluid may also be led through conduit 44 in the hub to the interior of the propeller hub and the space to the rear or inboard side of piston 32. Suitable means such as a gasket 48 prevents flow of oil inboard along the propeller shaft, the propeller surrounding the outboard end of the propeller shaft closes the outboard end against the loss of oil in the outboard direction. Oil from the control mechanism is directed into a groove 50 in the outer surface sleeve 14 which is connected by suitable passages 52 with a groove 54 on the inside of sleeve 14, which when assembled on hub projection 16, is in hydraulic communication with conduit 42. Oil may also be led from the control unit into groove 56 in the exterior of bearing sleeve 14 which is connected by suitable passages 58 with groove 60 formed in the interior of bearing sleeve 14. Groove 60, when assembled on the hub projection 16, is in hydraulic communication with the conduit 44. A groove 62 located between groove 54 and 60 is not utilized for any special function in the structure shown in this application. A series of O ring seals 64, 66, 68 and 70, located between the sleeve 14 and hub projection 16, define these grooves and serve to prevent oil leakage therefrom. The threaded portion 72 located at the inboard interior of sleeve 14 is provided to assist in removing the sleeve and the control unit from its assembled position on the hub projection 16.

The control unit 10 comprises a main casting 74 which supports all of the various control elements including the governor valve indicated generally at 76, the scavenge pump, indicated generally at 78, main pump and its connections, indicated generally at 80, the auxiliary pump and motor, indicated generally at 82, the various valves and their controls, to which reference will be made hereinafter, and the oil reservoir, indicated generally at 84. The various control elements are preferably separate units bolted or otherwise removably seured to the main casting. A bearing sleeve 86 is secured in main casting 74 and serves to rotatably support the entire control system on the bearing sleeve 14 which is secured as previously described on the hub projection 16. Bearing sleeve 86 is provided with a bearing metal such as babbitt on its inner diameter and inboard face which provides a bearing surface cooperating with the outer surface of bearing sleeve 14 to provide a suitable running joint and oil seal between the stationary control unit and the rotating propeller unit. As shown in Figs. 6 and 7 upstanding flange 122 of sleeve 14 projects between one end of bearing sleeve 86 and a thrust plate 87. Suitable fastening means such as screws, not shown, secure both the thrust plate 87 and sleeve 86 to main control casing 74. Flange 122 being positioned between bearing sleeve 86 and thrust plate 87 positions the entire control mechanism with respect to sleeve 14. Sleeve 14, as previously described, being positioned with respect to hub 18, therefore serves to locate the control mechanism with respect to the propeller and maintain them in assembled relation.

Four grooves 88, 90, 92, and 94 are provided in the outer surface of bearing sleeve 86 and, like the grooves in the interior of sleeve 14, are prevented from leaking by means of suitable O ring gaskets. Suitable passages lead from groove 94 through sleeve 86 to groove 56 in sleeve 14 and other passages lead from groove 88 through sleeve 86 to groove 50 in sleeve 14. Groove 90 is not utilized for any special function in the structure shown in this application and the passages leading from groove 92 to groove 62 are not utilized for any special function. Suitable passages led from grooves 88 and 94 to the governor valve which being thus connected with the propeller pitch changing mechanism controls the flow of oil to and from the pitch changing mechanism. Groove 92 is connected with the output of the main pump. Various passages in the main casting connect with groove 92 to deliver the output of the main pump to the low pressure relief valve, indicated generally at 96, high pressure relief valve, indicated generally at 98, and to the governor valve 100. A passage 102 connects an auxiliary pump 104, driven by auxiliary motor 106 with passage 92. As will be explained later, this auxiliary pump and motor are used to provide pressure fluid when the propeller is not rotating and the main pump is consequently idle.

A main sump or reservoir is formed at one side of the main casting 74 of the control unit which is the lower side when the control unit is in its normal upright position, by means of a curved, trough-like cover 108 secured to the lower portion of main casting 74 by cap screws 110 and sealed by suitable gaskets 112. Bolts 114 are utilized to prevent expansion of the cover by the pressure usually carried in the reservoir. The main pump 80 is enclosed by the cover 108 and comprises a gear pump 116 driven through gear 118 by a gear 120 formed on an upstanding flange 122 on the inboard side of sleeve 14 secured to rotate with the propeller. Pump 116 has an inlet 124 located near the bottom of the reservoir. This inlet, however, is spaced from the bottom of the reservoir a greater distance than inlet 126 leading to auxiliary pump 104 so that in the event of failure of the propeller to change pitch due to lack of oil it may still be possible to feather the propeller by means of the auxiliary motor which can still pump oil if the lack of oil is caused by the level falling just below the inlet to the main pump.

Provision is also made for supplying oil to the main pump during inverted flight. A gravity actuated ring 128, slideable in a cylinder 130 is normally held by gravity in the position shown in Figs. 4 and 5 so as to close orifice 132 and leave inlet 124 unobstructed. When the control unit is inverted as in inverted flight, ring 128 will be moved under the influence of gravity to a position closer to the gear pump 116 to thereby close inlet 124 and open orifice 132 which is connected by a conduit to an inlet 134 located near the top of the oil reservoir which, of course, would be the bottom of the oil reservoir in inverted flight. It should be noted that both the oil and ring 128 are positioned by the same force, normally gravity, so that other forces such as acceleration which might displace the oil would also displace the ring.

As stated above, oil from main pump 116 is led to passage 92 and thence to the governor valve 100 from where it is directed in the usual manner by the governor to the proper side of the pitch changing motor to maintain constant propeller speed by varying the propeller pitch. The governor is driven from gear 120 by gear 136 and a pair of bevel gears as shown in Fig. 4. The governor comprises the usual flyweights 140 opposed by a speeder spring whose tension may be adjusted in a well known manner by an electric motor, not shown, which in turn may be connected to controls from the pilot's cockpit. Pressure oil is also led through passage 144 to solenoid actuated feathering valve 146 and solenoid actuated reversing valve 148 which are normally closed. Actuation of the feathering valve will direct pressure fluid through conduit 150 to the underside piston 152 on the lower governor valve 100 to thereby raise the governor valve 100 and connect pressure fluid with groove 88 and the pitch increasing side of the piston 32 of the pitch changing motor.

Actuation of the reversing valve will direct pressure fluid from the passage 144 to passage 154 leading to a piston 155 on the top of the governor valve 100 thereby forcing the pilot valve down to direct pressure fluid from groove 92 into groove 94 and thence to the pitch reducing side of the piston 32 in the pitch changing motor.

Pressure oil is also led from the passage 92 to the front face of plunger 156 of relief valve 96 which is urged into closed position by spring 158. The relief setting of relief valve 96 is normally determined by the capacity of spring 158 but may be increased by leading oil under pressure to the backside of plunger 156. This is accomplished by a shuttle valve 160, one side of which is connected with the reversing valve 148 and the upper side of piston 155 on the governor valve 100 and the other side of which is connected with the groove 88 leading to the pitch increasing side of the pitch changing motor. Hence, whenever the reversing valve is opened or whenever pressure fluid is being led to the pitch increasing side of the pitch changing motor, the capacity of the relief valve 96 is increased to thereby increase the pressure output of the main pump. Shuttle valve 160 moves under the predominant pressure acting thereon to connect that predominant pressure with the rear of the plunger 156.

Under certain conditions which will be described later, it may be desirable to increase the pressure applied to the underside of piston 152 over that which is produced by the pumps when their pressure is determined by the normal setting of relief valve 96. In order to provide for this contingency a shuttle valve 157 may be connected into line 159 leading to shuttle valve 160. Shuttle valve 157 is connected between the line leading from the upper side of piston 155 and the line leading from the lower side of piston 152 so that when pressure is applied to the lower side of piston 152 shuttle valve 157 will be operated to direct pressure fluid from piston 152 to line 159 to move shuttle valve 160 and apply that pressure to back up plunger 156 of relief valve 96. Pressure applied to the upper side of piston 155 will move shuttle valve 157 and connect piston 155 with line 159 to back up plunger 156 in the same manner as described above without reference to shuttle valve 157. This is an added feature that may be required only on some installations and is, therefore, shown only in Figures 3 and 4. This shuttle valve 157 being omitted from Figures 2 and 5 for the purpose of simplicity.

Groove 92 is also connected with a high pressure relief valve 98 which serves to limit the ultimate pressure attainable by the main pump. Both relief valve 96 and 98 discharge directly into the main sump or reservoir, relief valve 96 discharging through conduit 161.

Gears 162 of scavenge pump 78 are driven through gear 164 by gear 120 and serve to remove oil that may collect in the drainage area 166 and force it into the reservoir 168 to keep the drainage area free from an accumulation of oil and maintain reservoir 168 under a pressure determined by the reservoir relief valve indicated generally at 170. Pump 78 may pump both oil and air to maintain the reservoir pressure.

Oil leakage from the ends of the bearing sleeve 86 will collect in drainage areas 166 and 172 which are sealed by suitable gaskets, two of which are lip type gaskets 171, 173 forming a running seal between the propeller and control units. These gaskets 171, 173 are arranged so that air may leak inward past them if the outside pressure is the greater, thus tending to reduce oil leakage. Drainage area 172 is connected with drainage area 166 by holes, not shown, in the main casting 74. These drainage areas are maintained under atmospheric pressure by being vented to atmosphere through the valve 170. The relief and vent valve 170 shown in Figures 4, 5 and 7 comprises a spring pressed plunger 174 normally closing a port 176 in a cylindrical bore 178. The underside of plunger 174 is subjected to the pressure maintained in reservoir 168, being connected therewith through a passage 180 and drilled holes shown diagrammatically at 182. When the pressure in the reservoir 168 is sufficient to lift plunger 174 the sump will discharge through port 176 to the area surrounding gear 120 and upstanding flange 122 and thus be conducted around the inside of thrust plate 87 lubricating the gears on the way and down back to the drainage area 166. Drainage area 166 is continuously connected with the outside atmosphere through a passage 184 and ports in the plunger 174 and its casing. The drilled passages 182 connect, as shown in Figure 5, with the upper portion of the sump so that in the normal upright position the relief valve serves to vent excess air from the reservoir to the drainage area and as passage 184 is at the top of the drainage area air is vented from the drainage area to the outside atmosphere.

The main casting 74 has projections 186 extending from one side thereof and forming a slot between them. A lug 188 fixed on engine nose 190 extends to a position between said projections and acts to prevent rotation of the control unit with the propeller while permitting it to move axially and radially with the propeller.

In normal constant speed operation the governor 76 operating valve 100 controls the flow of oil through passages 42, 88, 44 and 94 to maintain constant propeller speed by varying the propeller pitch. Shuttle valve 160 is maintained in the position shown in Figure 3 to apply pressure back of relief valve plunger 156 whenever pressure oil is introduced to the pitch increasing side of the pitch changing motor, scavenging pump 162 serving to keep drainage area 166 free from the accumulation of oil and to maintain a predetermined pressure in reservoir 168.

When it is desired to feather the propeller, feather button 192 in the control compartment of the airplane is pushed to close contacts 194, 196, 198, 200 to thereby energize holding coil 202, feathering solenoid 204 and auxiliary pump motor 82 to thereby hold feather button 192 depressed, open feathering valve 146 and operate auxiliary pump 104 to supply fluid in addition to that being supplied by the main pump and to, if necessary, continue to supply fluid after the main pump has ceased operation due to stopping of the propeller. Holding coil 202 is in series with a cut-out switch 206 which is actuated by the pressure fluid changing the propeller pitch. Opening of feathering valve 146 allows pressure fluid from grooves 92 and passage 144 to enter conduit 150 and act on the underside of piston 152 to lift governor valve 100 which will direct fluid from the groove 92 to groove 88 and the pitch increasing side of the pitch changing motor. Pressure oil in groove 88 will move shuttle valve 160 to the position shown in Figure 3 to put pressure oil back of plunger 156 of relief valve 96 and will move shuttle valve 208 to the position shown in Figure 3 to thereby connect the pressure cut-out switch with the pitch increasing side of the pitch changing motor. When the pitch changing motor has reached its limit of movement determined by stops, not shown, the pressure at the pitch increasing side of the pitch changing motor will increase creating a pressure surge which will open the pressure cut-out switch releasing the holding coil 202 and permitting springs 300 to return the feather button 192 to its off position as shown in Figure 3.

In the event that shuttle valve 157 is utilized pressure fluid acting on the underside of piston 152 will move shuttle valve 157 to direct fluid into line 159, move shuttle valve 160 so as to conduct pressure fluid to the back side of plunger 156. This will increase the pressure output of both the main pump and the auxiliary pump to thereby insure sufficient pressure to lift the governor valve 100 against the action of the speeder spring. After valve 100 has been lifted then the predominate pressure in line 88 or 159 will be the pressure which will move the shuttle valve 160 and back up plunger 158.

To unfeather the propeller from its non-rotating feathered position button 192 is pulled to the left as viewed in Figure 3 closing contacts 302, 304, 306 and 308 to thereby energize holding coil 310 and consequently auxiliary pump motor 82 and reversing solenoid 312 thus opening reversing valve 148. Operation of auxiliary pump motor 82 will supply auxiliary fluid in the same manner as described for feathering, except that it must supply all the fluid at the beginning of the operation as the main pump 116 then does not operate and it will assist the main pump after the propeller starts to rotate. Opening of reversing valve 148 will allow pressure fluid from groove 92 and passage 144 to enter passage 154 and act on the upper surface of piston 155 to thereby force the governor valve 100 down and admit pressure fluid from groove 92 to 94 and hence to the pitch decreasing side of the pitch changing motor. Pressure fluid in passage 154 will move shuttle valve 160 to apply pressure fluid back of plunger 156 of relief valve 96 to thereby increase the available pressure. Pressure in groove 94 will move shuttle valve 208 to the right as viewed in Figure 3 thereby connecting the pitch decreasing side of the pitch changing motor with the pressure cut-out switch 206. The pressure cut-out switch, however, is not utilized to stop the unfeathering operation as this is accomplished by electrical contacts on the propeller blade shank. When the propeller blade has reached a predetermined position in its pitch reducing movement the current in holding coil 310 is broken by an insulating segment 314 thus releasing holding coil 310 allowing spring 316 to return switch 318 to an off or neutral position thus breaking the current to reversing solenoid 312 and auxiliary motor 82. The plunger which cooperates with holding coil 202 is so far out of the holding coil when button 192 is in unfeather position that holding coil 202 has no effect. Button 192 is held out manually for unreversing and may be released by any time after the propeller starts windmilling. If, however, it is not released by the time the propeller has reduced its pitch well into the operating range the reversing solenoid and the auxiliary motor will be deenergized by the breaking of the circuit of the holding coil 310 by insulating segment 314 at which time the governor will take over control. As in the feathering operation the switch is returned to its neutral position by springs 300 after it is released. Reference may be had to application Serial No. 32,244 of Martin and McCarthy, filed June 10, 1948, for a more complete description of the construction and operation of the insulating and conducting segments on the blade 18. It will be sufficient to state here that by means of a brush, insulated from, and held in fixed position on the propeller hub an electric circuit may be completed by being conducted to ground through conducting segments 328 and 330 and the propeller blade and hub. The brush and segments are arranged so that the brush will be approximately at the position indicated by F when the propeller is feathered at the position indicated by L. P. when the propeller is at its low pitch stops and at R when the propeller is in its reversed pitch position. It will thus be apparent that even if switch knob 192 is held in the unfeather position until conducting segment 320 contacts the brush, the circuit will again be broken by insulating segment 332 before the propelled reaches its low pitch stop. This will prevent the propeller from going into reverse pitch while unfeathering because the pressure level maintained by relief valve 26 alone, when not backed up by pressure from reversing valve 148, is not sufficient to overcome the low pitch stops.

In order to reverse the propeller pitch, switch 320 is first closed and then reverse-unreverse switch 322 is moved into the reverse position which is the lower position as viewed in Figure 3. Closing of these switches will energize reversing solenoid 312 and holding coils 324 and 326. Energizing holding coil 324 will close switch 334 and 336. Closing switch 334 will in effect short circuit switch 322 so as to maintain holding coils 324 and 326 energized independent of the position of switch 322. Energizing holding coil 326 will close switch 338 which will in effect short circuit switch 320 so as to maintain holding coil 324, 326 energized independent of the position of switch 320. The closing of switch 336 has no immediate effect, but prepares the circuit for unreversing which will be described later. After passing through switches 320, 322 and holding coils 324, 326 the current passes through switch 340 to ground. Switch 340 is normally held closed by spring 342. Energizing the reversing solenoid 312 will produce the same hydraulic action as in unfeathering except that the auxiliary motor is not energized for reversing as the propeller is being continuously engine driven the main pump will supply all of the fluid necessary for pitch changing. As in unfeathering governor valve 100 is forced down so as to connect groove 92 with groove 94 and direct fluid to the pitch reducing side of the pitch changing motor. It is to be understood that as is usual in this double acting type of control, each time pressure fluid is conducted to one side of the pitch changing motor the opposite side of the motor is connected to drain or the reservoir to permit fluid to flow from one side of the motor as it is introduced to the other side. Switches 320 and 322 remain in the closed position just described as long as it is desired to have the propeller remain in the reversed pitch position and the propeller is maintained in that position by the fluid from the main pump being continuously directed to the pitch reducing side of the pitch changing motor thereby forcing the propeller against the reverse pitch or pitch limiting stops not shown.

To unreverse the propeller and bring it back into the constant speed range, switch 322 is first changed from its reversed to its unreversed position, the position shown in Figure 3, which will deenergize solenoid 312 and close valve 148. In the unreversed position of switch 322 the current will be conducted through switch 336 which is still maintained closed by holding coil 324 and will energize feathering solenoid or increase pitch solenoid 204. Switch 320 is then opened, but as it is short circuited by switch 338, it has no immediate effect. Placing switch 322 in the unreverse position will also close a circuit to prepare holding coil 344 for action when the circuit is completed through contact 330. Energizing increase pitch solenoid 204 will cause actuation of the governor valve 100 in the same manner as was described in the feathering operation except that the auxiliary pump is not used for unreversing. The governor valve 100 is moved to connect groove 92 with groove 88 and apply pressure fluid to the pitch increasing side of the pitch changing motor and thus move the blades 18 from reverse pitch through zero pitch to increased pitch position. After the blade pitch has been increased to a pitch somewhat above the pitch defined by the low pitch stops, brush 346 will make contact with conducting segment 330, which will energize holding coil 344 to thereby open switch 340. Opening switch 340 will break the ground connection of holding coils 324 and 326 thus deenergizing them. Springs 348 and 350 will now open switches 334 and 338 and deenergize increase pitch solenoid 204, closing valve 146 and thus returning the governor valve 100 to governor control.

From the above description it will be apparent that applicant has invented a unitary self-contained hydraulically actuated propeller construction which may be assembled on or removed from a standard propeller shaft as a unit and which requires no modification of the propeller shaft or of the engine in order to accommodate the propeller. The lug 188 being the only element attached to the engine may be a separate piece secured by bolts to the engine nose. The increase and decrease pitch solenoids and the pressure cutout switch may be carried in a housing indicated generally at 352 and the electrical connections from the switches at the control station in the airplane may be made to housing 352, the electric controls for the governor 10, and the auxiliary motor 82 by means of separable electrical plug connections or any other suitable type of connection shown generally at 354 and 356. These plug-in connections 354, 356 and ground connections 358 are the only propeller control connections that are necessary in removing one propeller and assembling another on the propeller shaft. The propeller contains its own oil supply and all of its own oil conduits and connections.

The propeller has been described in connection with a pressure cut-out switch 206 but if desired a suitable timing mechanism may be substituted for the cut-out switch which mechanism instead of operation on a pressure surge, will operate to disconnect the auxiliary motor after a predetermined elapsed time.

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 propeller comprising a hub, blades mounted in said hub for pitch changing movement, hydraulic pitch changing mechanism operatively connected with said blades and carried by said hub, control mechanism for said pitch changing mechanism comprising a housing rotatably mounted on said hub, and means for restraining said housing against rotation with said hub, said housing including an oil reservoir, a speed governor and pumps and means for actuating said governor and pumps incident to relative rotation of said housing and hub, an auxiliary motor and

pump supported by said stationary housing for supplying oil from said reservoir to said hub when the propeller is not rotating, means restraining said housing against axial movement relative to said hub, the rotatable mounting of said housing on said hub including a plurality of fluid passages connecting said governor valve with said pitch changing mechanism.

2. A propeller-control unit adapted for assembly on a propeller shaft as a unit comprising a hub having a shaft connecting portion, pitch changing mechanism carried by said hub for rotation therewith, a control unit rotatably mounted on said hub, means for holding said control unit against rotation, said control unit comprising an oil reservoir, a governor carried by said control unit and means connecting said hub and said control unit and energized by relative rotation of said hub and control unit for operating said governor and supplying fluid under pressure to said governor, and conduits connecting said non-rotating governor with said rotating pitch changing means.

3. In combination, a propeller having a hub and an hydraulically operated pitch changing mechanism rotatable with the propeller, a non-rotating hydraulic reservoir, control mechanism supported on said reservoir, rotatable bearing means supporting said non-rotating reservoir and said control mechanism on said hub, means restraining said reservoir against rotation, said bearing means including transfer bearings directing fluid from said control mechanism to said pitch changing mechanism.

4. In a unitary propeller-control unit, a propeller including a hub, blades mounted for pitch changing movement in said hub and hydraulic pitch changing mechanism carried by said hub and connected with said blades, said hub having an axial projection with conduits therein leading to said pitch changing mechanism, a stationary control unit comprising a housing, control mechanism, a reservoir and means for supplying fluid under pressure to said control mechanism, and bearing means rotatably supporting said control unit on said projection, said control unit having conduits leading from said control mechanism and connecting with the conduits in said projection.

5. In combination a propeller hub having blades rotatably mounted therein and carrying pitch changing mechanism, an axial projection on said hub, bearing means supported on said projection, a separate control unit supported on said bearing means, means for restraining said unit against rotation with said hub, said rotating projection and said non-rotating unit having mating conduits for conducting fluid from said non-rotating control unit to said rotating pitch changing mechanism.

6. A hydraulic control unit for a controllable pitch propeller having a hub, said unit comprising bearing means rotatably supporting said unit on said hub, means for restraining said unit against rotation with said hub, a liquid reservoir carried by said unit, pumps carried by said unit and actuated by relative rotation of said hub and said unit for withdrawing liquid from said reservoir and providing liquid under pressure, a governor carried by said unit and actuated by relative rotation of said hub and said unit, a governor valve, means directing said liquid under pressure to said valve, and from said valve to said propeller hub.

7. A hydraulic control unit for a controllable pitch propeller having a hub, said unit comprising bearing means rotatably supporting said unit on said hub, means for restraining said unit against rotation with said hub, a liquid reservoir, a pump carried by said unit and actuated by relative rotation of said hub and said unit for withdrawing liquid from said reservoir and providing liquid under pressure, a governor carried by said unit and actuated by relative rotation of said hub and said unit, a governor valve, means directing said liquid under pressure from said pump to said valve, and from said valve to said propeller hub, said pump having an intake adjacent the bottom of said reservoir in normal upright position, a gravity actuated valve automatically closing said intake and opening another intake at the opposite side of said reservoir when the forces acting on said valve are reversed.

8. In a propeller having a hydraulically actuated propeller-carried, separate, removable, hydraulic, control unit, removable as a unit from said propeller, a sleeve, said control unit being rotatably mounted on said sleeve, a hub having a projection adapted to telescope with said sleeve, means securing said sleeve on said projection, and means cooperating with said sleeve and projection forming separate fluid channels connecting said hub and control unit.

9. In a hydraulically actuated propeller having a propeller-carried, separate, removable, hydraulic, control unit, removable as a unit from said propeller, a sleeve, said control unit being rotatably mounted on said sleeve, a hub having a projection adapted to telescope with said sleeve, means securing said sleeve on said projection, and means cooperating with said sleeve and projection forming a hydraulic control connection between said control unit and said hub.

10. In a hydraulic control for a controllable pitch propeller having pitch changing mechanism, a governor valve, a source of fluid pressure, a relief valve for regulating said pressure, means leading pressure fluid to the rear of said relief valve to increase the relief setting thereof, conduits leading from said governor valve to said propeller, one to the pitch increasing, and one to the pitch decreasing side of the pitch changing mechanism, a fluid motor connected with said governor valve, a reversing valve for directing said pressure fluid to said motor to move said valve to direct said pressure fluid to the pitch decreasing side of said pitch changing mechanism to reverse the propeller pitch, a shuttle valve having one end connected with said conduit leading to said pitch increasing side and the other end connected to said motor, said shuttle valve being operable by the predominant pressure thereon to direct said predominant pressure to said means leading to the rear of said relief valve to thereby increase the pressure of said source whenever the propeller pitch is being increased or reversed.

11. In a non-rotating propeller control unit adapted to be assembled with a rotatable propeller and form part of a unitary propeller-control assembly, a reservoir, a sump, a pump for pumping fluid from said sump to said reservoir, a running joint forming a bearing between said non-rotating control unit and said rotatable propeller, fluid passages in said running joint forming a fluid passage from said unit to said propeller, said sump surrounding the ends of said joint to collect any leakage from said joint.

12. In a non-rotating propeller control unit

adapted to be assembled with a rotatable propeller and form part of a unitary propeller-control assembly, a main casing, a reservoir, a pump supported on said casing in said reservoir for maintaining pressure in said reservoir, a second pump supported on said casing in said reservoir for pumping fluid from said reservoir to control mechanism in said control unit, said reservoir being formed by a curved trough removably secured to said casing and enclosing said pumps.

13. In a non-rotating hydraulic propeller control unit adapted to be assembled with a rotatable propeller and form part of a unitary propeller-control assembly, a non-rotating main casing, control units supported on said casing, and a curved trough separately removably secured to said casing, enclosing said control units and forming with said casing a reservoir for hydraulic fluid for said control units.

14. A non-rotating control unit for controlling the flow of hydraulic fluid to hydraulic pitch changing mechanism of a propeller, comprising a casing, hydraulic control mechanism supported on said casing, a reservoir for hydraulic fluid, a bearing in said casing for rotatably supporting said casing on said propeller, said casing surrounding said bearing and having drainage space at the end of said bearing, said bearing including means for transferring hydraulic fluid from said control mechanism to said propeller, said drainage space arranged to collect leakage from said bearing.

15. A non-rotating unit for controlling the flow of hydraulic fluid to hydraulic pitch changing mechanism of a propeller, comprising a casing, hydraulic control mechanism supported on said casing, a reservoir for hydraulic fluid, a bearing in said casing for rotatably supporting said casing on said propeller, said casing surrounding said bearing and having drainage space at the end of said bearing, said bearing including means for transferring hydraulic fluid from said control mechanism to said propeller, said drainage space arranged to collect leakage from said bearing, a scavenge pump carried by said casing having an inlet connected with said drainage space and an outlet in said reservoir.

16. A non-rotating control unit for controlling the flow of hydraulic fluid to hydraulic pitch changing mechanism of a propeller, comprising a casing, hydraulic control mechanism supported on said casing, a reservoir for hydraulic fluid, a bearing in said casing for rotatably supporting said casing on said propeller, said casing surrounding said bearing and having drainage space at the end of said bearing, said bearing including means for transferring hydraulic fluid from said control mechanism to said propeller, said drainage space arranged to collect leakage from said bearing, a vent for said drainage space and a pressure regulating valve for said reservoir.

17. A non-rotating control unit for controlling the flow of hydraulic fluid to hydraulic pitch changing mechanism of a propeller, comprising a casing, hydraulic control mechanism supported on said casing, a reservoir for hydraulic fluid, a bearing in said casing for rotatably supporting said casing on said propeller, said casing surrounding said bearing and having drainage space at the end of said bearing, said drainage space having one wall defined by a rotating seal, said bearing including means for transferring hydraulic fluid from said control mechanism to said propeller, said drainage space arranged to collect leakage from said bearing.

18. In a non-rotating control unit for a hydraulically controlled propeller, a non-rotating casing, a reservoir for hydraulic actuating fluid carried by said casing, drainage spaces in said casing for collecting leakage within said casing, a relief valve for said reservoir, an inlet for said relief valve in an air space adjacent the top of said reservoir, a discharge for said relief valve into said drainage space at a point spaced from the top of said drainage space, and a vent for said drainage space adjacent the top of said drainage space, a scavenge pump having an inlet adjacent the bottom of said drainage space and a discharge into said reservoir, whereby the drainage area is emptied of oil, and air is vented from both the reservoir and the drainage area.

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