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CONTROLLING DEVICE FOR PUMPS

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FIG.-1.

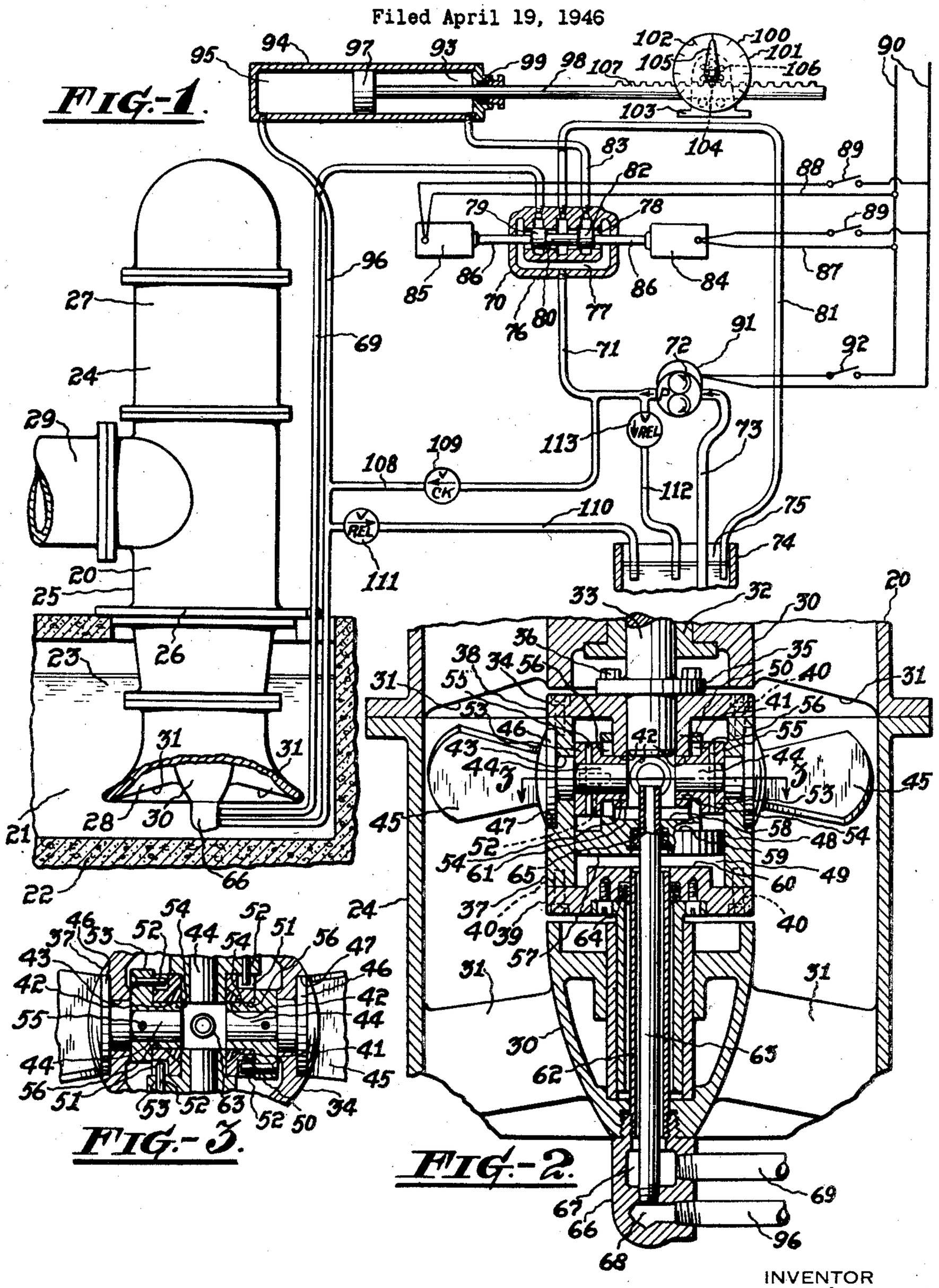

FIG.-3.

FIG.-2.

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CONTROLLING DEVICE FOR PUMPS

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6 Claims. (Cl. 103—89)

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This invention relates to pumps, and more particularly to a controlling device for changing the angular relationship of the pump vanes with respect to the direction of fluid flow through the pump.

One object of the invention is to selectively vary the impelling effect of the pump in accordance with immediate requirements or conditions of operation.

Another object is to enable the impelling effect of the pump to be thus varied at a point remote from the pump impeller and with a minimum of manual effort.

A more specific object is to avoid the overloading of the motor driving the pump when operating at reduced capacity.

Other objects will be in part obvious and in part pointed out hereinafter.

In the drawings accompanying this specification and in which similar reference numerals refer to similar parts:

Figure 1 is an elevation of a centrifugal pump equipped with a controlling device constructed in accordance with the practice of the invention,

Figure 2 is an elevation, partly in section, showing an enlarged view of a portion of the pump, and

Figure 3 is a transverse view taken through Figure 2 on the line 3—3.

Referring more particularly to the drawings, the pump designated, in general, by 20 is shown extending into a pit 21 defined by a foundation 22 for removing liquid 23.

The pump casing 24 is formed in sections some of which lie within the pit 21 and one section, designated 25, has a flange 26 to seat on the foundation 22 and supports a motor only the casing 27 of which is shown. The pump is of the vertical type and the lowermost end of the casing 24 is flared outwardly to define an inlet opening 28 for the passage of liquid from the pit 21 into the casing 24. The outlet conduit 29 for the pump is shown as leading from the casing section 25.

Within the casing 24 is a series of support members 30 which are connected to the casing by ribs 31, and the uppermost support member 30, of those shown, contains a bearing 32 for a pump shaft 33 that may be secured in any suitable manner to the shaft of the driving motor. The shaft 33 terminates between the support members 30 and extends at its lower end into a hub 34 that is secured to a flange 35 on the shaft by bolts 36.

The hub 34 comprises a casing 37 of generally

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cylindrical shape that is closed at its upper and lower ends, respectively, by cover plates 38 and 39 fastened to the casing 37 by screws 40. On the cover plate 38 is a depending skirt 41 having apertures 42 that are axially aligned with similar apertures 43 in the casing 37 to serve as bearings for trunnions 44 of the pump vanes 45, and between each trunnion 44 and its vane is a collar 46 that lies in a recess 47 in the outer surface of the casing 37 to prevent movement of the vanes in the direction of the axis of the pump.

The trunnions 44 are rotatable in the apertures 42—43 to change the pitch of the vanes, and such movement is effected by a fluid actuated piston 48 reciprocable in a piston chamber 49 in the casing 37 and operatively connected to the vanes in such wise that all the vanes will be rotated about their axes in unison and in equal degree. To this end, the piston is provided on its upper surface with an extension 50 that is slidable on the skirt 41 and has slots 51 in its outer surface to receive the ends of crank pins 52 seated in collars 53 on the trunnions 44.

Each collar 53 bears against the inner surface of the casing 37 and has an annular sleeve portion 54 that encircles the trunnion to serve as a renewable wearing surface therefor. The collars are secured to the trunnions by pins 55, and the sleeve portions 54 extend through the apertures 56 in the extension 50 for engagement with the skirt 41. The apertures 56 are of oblong shape to permit of endwise movement of the extension 50 with respect to the skirt 41 and their vertical side surfaces have a slide fit on the sleeve portions 54 so that the piston will rotate with the shaft.

The piston 48 is located in the lower portion of the casing 37, below the trunnions 44, and its lowermost pressure surface 57 and an elevated portion 58 of its upper pressure surface 59 cooperate, respectively, with a seating surface 60 on the cover plate 39 and a seating surface 61 at the lower end of the extension 41 to limit the stroke of the piston 48.

The motive fluid serving to actuate the piston 48 is conveyed into the piston chamber 49 by a pair of tubes 62 and 63 extending through the lowermost support member 30. The tube 62 opens into the lower end of the piston chamber 49, and sealing material 64 in the cover plate 39 encircles the tube 62 to prevent the leakage of fluid along its exterior. The tube 63 is arranged within the tube 62 and is of sufficiently smaller diameter than the tube 62 to permit the ready flow of fluid through the latter. The tube 63, moreover,

extends through the piston 48 and opens into the piston chamber 49 above the piston 48 which carries a sealing member 65 to prevent the leakage of fluid along the cooperating surfaces of the tubes and the piston.

The tubes 62 and 63 are threaded at their lower ends into a fitting 66 on the support member 30 and communicate, respectively, with recesses 67 and 68 in said fitting. Motive fluid for moving the piston 48 upwardly is conveyed to the recess 67 by a conduit 69 connected to a control valve mechanism 70 to which motive fluid is delivered by the discharge conduit 71 of a pump 72 the inlet pipe 73 of which extends into a reservoir 74 containing a liquid 75, oil for example.

The valve mechanism 70 comprises a chest 76 having a passage 77 in constant communication with the conduit 71 and with the opposed ends of a valve chamber 78, and motive fluid flows through an end portion of the valve chamber to the conduit 69. Communication between the said end of the passage 77 and the conduit 69 is controlled by a flange 79 of a reciprocatory valve 80 and said flange also controls communication between the conduit 69 and a conduit 81 leading from the intermediate portion of the valve chamber 78 to the reservoir 74. The valve 80 also controls the motive fluid serving to cause movement of the piston 48 in a downwardly direction and accordingly has a second flange 82 to valve fluid from the passage 77 through the other end of the valve chamber 78 to a conduit 83 and to control communication between the conduit 83 and the conduit 81.

The valve is shifted to its controlling position by solenoids 84 and 85 the armatures of which are not shown but may be connected to stems 86 on the valve projecting through the end walls of the valve chest 76. The solenoids 84 and 85 are, respectively, provided with electric circuits 87 and 88 each having a switch 89 to control the flow of current to the solenoids from a circuit 90 for the motor 91 which drives the pump 72. The circuit 90 also has a switch 92 for controlling the operation of the motor.

The conduit 83 controlled by the valve head 82 leads from the valve chest 76 to an end 93 of a cylinder 94 which is of a volume equal to the amount of fluid displaced by the piston 48 during its full upward stroke in the piston chamber 49. The opposite end 95 of the cylinder 94 is in constant communication with the recess 68, and thus with the upper portion of the piston chamber 49, through a conduit 96.

Within the cylinder 94 is a plunger, or piston, 97 having a rod 98 extending slidably through a stuffing box 99 in the end of the cylinder 94 to actuate an indicating device designated, in general, by 100 and serving to indicate the pitch of the vanes 45. The indicating device 100, and which may be of any suitable type, comprises a dial 101 having markings 102 thereon to indicate different angular positions in which the vanes may be placed for varying their impelling effect. The dial 101 is mounted upon a bracket 103, and a shaft 104 journaled in the bracket extends axially through the dial 101 and carries a pointer 105 for cooperation with the markings 102. The shaft 104 also carries a pinion 106 that meshes with the teeth of a rack 107 on the rod 98 for rotating the pointer 105.

The valve mechanism 70 controls the flow of motive fluid only to and from one end of the piston chamber 49 and of the cylinder 94, and in the conduit 96 and the other ends of the piston

chamber and the cylinder 94 is a constant volume or body, of oil to transmit movement from the piston 48 to the plunger 97 and, conversely, to transmit movement from the plunger to the piston. Such oil is delivered to these chambers by a conduit 108 leading from the conduit 71 to the conduit 96 and a check valve 109 in the conduit 108 is biased to pass oil only in the direction of the conduit 96 and to open for that purpose only at a pressure somewhat higher than that supplied to the piston chamber 49 and the cylinder 94 through the valve mechanism 70.

In order to avoid the introduction of oil into the conduit 96 and the associated chambers at pressures in excess of that through which the check valve 109 is set, the conduit 96 is provided with a discharge conduit 110 having a relief valve 111, of any suitable type, that operates at the pressure at which the check valve 109 opens to permit the escape of oil from the conduit 96 to the reservoir. Preferably, the discharge conduit 71 is also provided with a branch 112 that leads to the reservoir 74 and has a relief valve 113 therein adapted to open at a pressure somewhat in excess of the maximum pressure of the fluid required for rotating the vanes to avoid subjecting the fluid conducting system to unnecessarily high pressures.

The operation of the device is as follows: Whenever it is intended to decrease the pitch of the vanes 45, and with the pump 72 in operation, the circuit 87 is closed, by means of its switch 89, and the solenoid 84 will then pull the valve 80 toward the right to communicate the left-hand end of the passage 77 with the conduit 69. Motive fluid then flows through the end of the valve chamber and the tube 62 into the lower end of the piston chamber 49 and moves the piston 48 upwardly, thereby rotating the vanes 45.

During such movement of the piston 48, the fluid passes from the upper portion of the casing 37 through the tube 63 and the conduit 96 into the end 95 of the cylinder 94 and shifts the plunger 97 to rotate the pointer 105 and to expel fluid from the end 93 of the cylinder 94 through the conduit 83, the valve chest 76 and the conduit 81 to the reservoir 74. When the pointer reaches a marking 102 corresponding to the desired pitch of the vanes the switch 89 is opened and the solenoid 84 is thereby deenergized. The armature of the solenoid 84 and valve 80 will then return to neutral positions and cut off the flow of fluid from the pump through the valve mechanism 70.

Whenever it is desired to increase the impelling effect of the vanes 45, the switch 89 of the circuit 88 will be closed to cause the armature of the solenoid 85 to shift the valve 80 leftward and uncover the conduit 83. Fluid will then flow from the passage 77 through the right-hand end of the valve chamber 78 and the conduit into the end 93 of the cylinder 94. The plunger 97 is moved thereby in the direction of the end 95 and the fluid thus expelled from the cylinder 94 passes through the conduit 96 and the tube 63 into the piston chamber 49, above the piston 48, and forces the latter downwardly to tilt the vanes 45 to a steeper pitch.

During such downward movement of the piston 48 the fluid it displaces passes through the tube 62 and the conduit 69 and through the valve chamber between the flanges 79 and 82, thence through the conduit 81 to the reservoir 74. When the vanes 45 have been rotated to the desired

position, as indicated by the pointer 105 on the dial 101, the switch 89 is opened to deenergize the solenoid 85. The valve 80 will then again return to a neutral position and cut off the further flow of fluid through the valve mechanism.

As will be readily appreciated, owing to the heavy pressure required for rotating the vanes, some of the fluid pushed back and forth by the piston 48 and the plunger 97 may escape along their surfaces so that its volume is reduced. The driven piston will then short-stroke and the position indicated by the pointer 105 will not be a true indication of the pitch of the vanes. In order, therefore, to minimize the chances of error incident to such leakage the pump 72 is continued in operation after the flow of fluid through the valve mechanism 70 has been cut off, and when the discharge pressure exceeds the value for which the valves 109 and 111 have been set make-up fluid will flow through the conduit 96 and cause the driven piston to complete its stroke.

If, on the other hand, the body of fluid between the pistons should become increased through linkage along the driving piston, and in consequence of which the driven piston completes its full stroke ahead of the driving piston, the latter is actuated to the end of its stroke by the continued application of driving fluid thereto and the fluid in excess of normal requirements will thereby be ejected from the conduit 96 through the relief valve 111 and the conduit 110 to the reservoir 74.

From the foregoing description it will be readily apparent that, irrespective of the nature of any variations in the volume of the fluid between the pistons, both pistons may be conveniently brought to definitely known positions prior to each blade-tilting operation, and a subsequent setting of the vanes may then be effected with little or no error between their actual position and that indicated by the pointer on the dial 101.

I claim:

1. In a controlling device, the combination of a pump casing and a rotary shaft therein, vanes on and rotatable with respect to the shaft, a piston for rotating the vanes having opposed pressure surfaces, indicating means for indicating the pitch of the vanes, a plunger operatively connected to the indicating means and having opposed pressure surfaces, means for communicating one pressure surface of piston and of the plunger, means for maintaining a constant volume of liquid between the last said surfaces for transmitting movement from the piston to the plunger and vice versa, and means for selectively subjecting another pressure surface of the piston and of the plunger to motive liquid for rotating the vanes.

2. In a controlling device, the combination of a pump casing and a rotary shaft therein, vanes on and rotatable with respect to the shaft, a piston chamber having a piston therein for rotating the vanes, indicating means for indicating the pitch of the vanes, a cylinder of the same volume as the piston chamber, a plunger in the cylinder for effecting operation of the indicating means, a conduit to afford constant communication between one end of the piston chamber and one end of the cylinder, means for maintaining a constant volume of liquid in the conduit and in said one end of the piston chamber and the cylinder for transmitting movement from the piston to the plunger and vice versa, and means for selectively subjecting another pressure surface

of the piston and of the plunger to motive liquid for rotating the vanes.

3. In a controlling device, the combination of a pump casing and a rotary shaft in the casing, vanes on and rotatable with respect to the shaft, means on the shaft to provide a piston chamber, a reciprocatory piston in the piston chamber to rotate the vanes, indicating means located at a point remote from the vanes for indicating the pitch of the vanes, a cylinder of the same volume as the piston chamber, a plunger in the cylinder for effecting operation of the indicating means, a conduit to afford constant communication between one end of the piston chamber and of the cylinder, a predetermined volume of liquid in the conduit and in the said one end of the piston chamber and the cylinder for transmitting movement from the piston to the plunger and vice versa, means for replenishing such volume of liquid to compensate for leakage of liquid from said one end of the piston chamber and the cylinder, and means for selectively subjecting another pressure surface of the piston and of the plunger to motive liquid for rotating the vanes.

4. In a controlling device, the combination of a pump casing and a vertical rotary shaft therein, vanes on and rotatable with respect to the shaft, means at the lower end of the shaft having a piston chamber therein, a reciprocatory piston in the piston chamber for rotating the vanes, conduits entering into the lower end of the casing and communicating the opposed end portions of the piston chamber with a source of liquid under pressure, a valve in said conduits for controlling the direction of flow of motive liquid through the conduits, a cylinder in one of said conduits, a plunger in the cylinder, a constant volume of liquid between the ends of the piston and plunger communicated by one of said conduits, and means actuated by said plunger for indicating the pitch of the vanes.

5. In a controlling device, the combination of a pump casing and a rotary shaft therein, vanes on and rotatable with respect to the shaft, means on the shaft for defining a piston chamber, a reciprocative piston in the piston chamber for rotating the vanes and having opposed pressure surfaces, indicating means for indicating the pitch of said vanes, a pump, valve means for directing the flow of liquid from said pump, a pair of conduits communicating said surfaces with said valve means, a cylinder in one of said conduits, a plunger in the cylinder connected to said indicating means, a conduit connected between one of the first said conduits and the discharge side of said pump, a check valve in the last said conduit, a conduit connected between the intake side of said pump and one of the first said conduits, and a relief valve in the last said conduit.

6. In a controlling device, the combination of a pump casing and a rotary shaft therein, vanes on and rotatable with respect to the shaft, means on the shaft defining a piston chamber, a reciprocative piston in the piston chamber for rotating the vanes and having opposed pressure surfaces, indicating means for indicating the pitch of said vanes, a pump, valve means for directing the flow of liquid from said pump, a pair of conduits communicating said surfaces with said valve means, a cylinder in one of said conduits, a plunger in the cylinder connected to said indicating means, a conduit communicating the discharge side of said pump with one of the first said conduits, a check valve in the last said conduit biased to

pass liquid from the pump whenever the pressure on the downstream side of said check valve exceeds the value of the pressure required to actuate said piston, a conduit communicating the intake side of said pump with one of the first said conduits, and a relief valve in the last said conduit biased to pass liquid to said inlet side at the operating pressure of said check valve.

ALEXEY J. STEPANOFF.

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