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CONTROL FOR FLUID PUMP BYPASS

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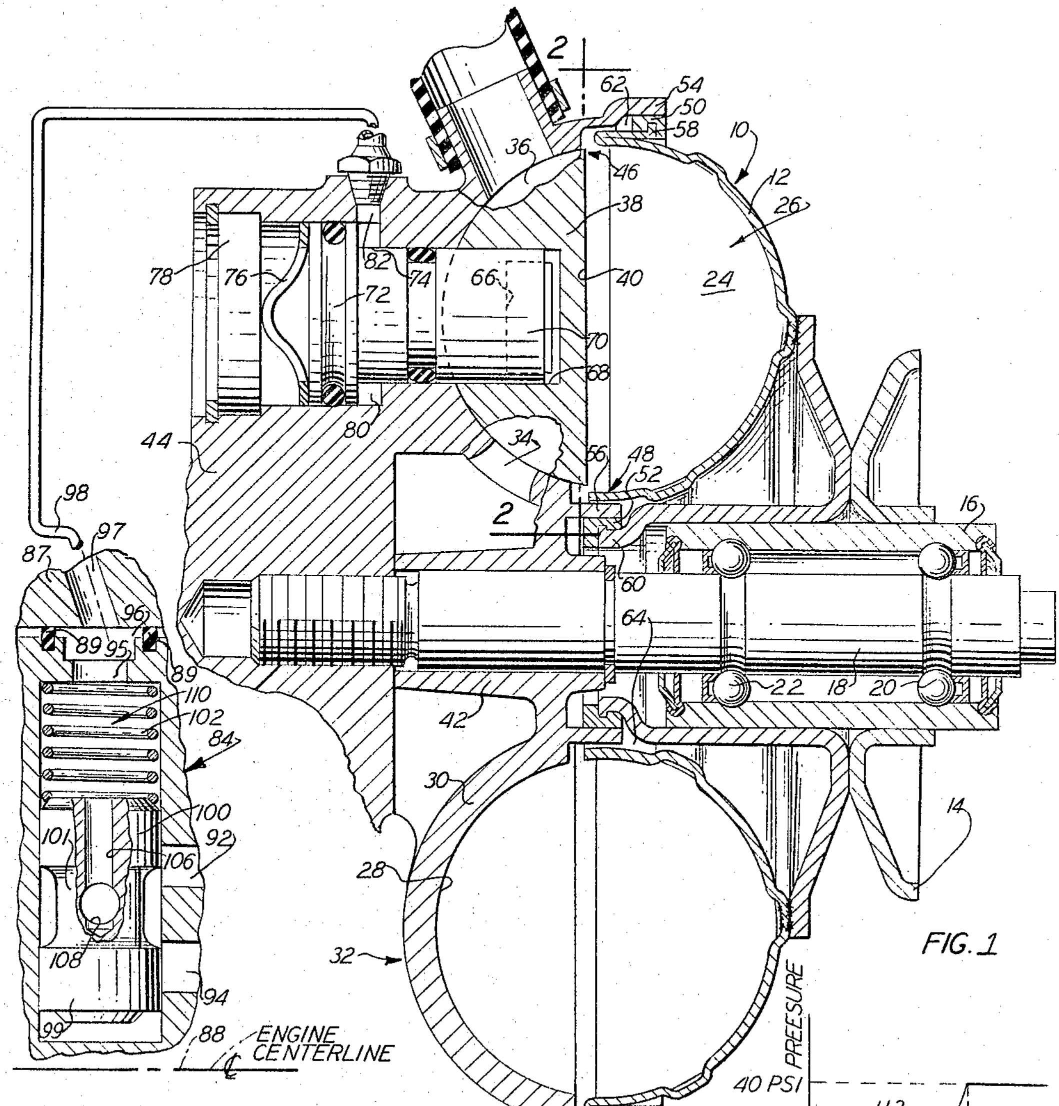

FIG. 1

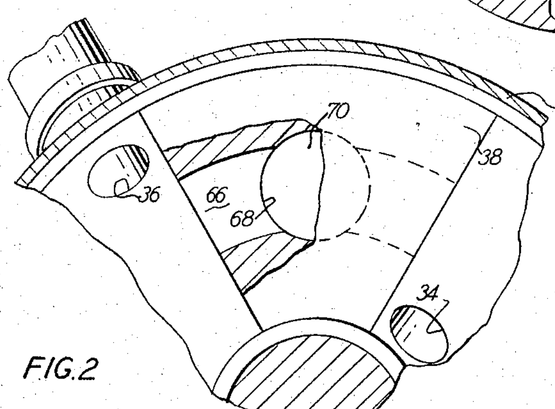

FIG. 2

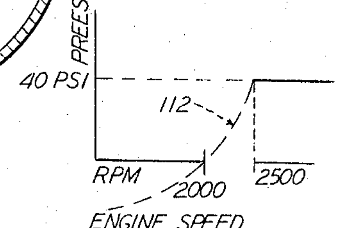

FIG. 3

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CONTROL FOR FLUID PUMP BYPASS

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9 Claims. (Cl. 103—97)

ABSTRACT OF THE DISCLOSURE

An air turbine type pump having a bladed rotor cooperating with a bladeless stator containing an air dam deflecting the pressurized air from the circuit. The dam contains a slidable piston valve that is spring biased to close an air bypass opening in the dam and is progressively opened by a predetermined fluid pressure level of fluid from a speed responsive valve.

This application is a continuation-in-part of our S.N. 517,729, filed Dec. 30, 1965.

This invention relates, in general, to a fluid pump control. More particularly, it relates to a compressor of the centrifugal type having means to bypass high pressure discharge fluid back to the pump inlet above a predetermined pump speed.

Present day motor vehicles are being equipped with engine secondary air injection manifolds or similar devices to supply additional air to the engine exhaust system so that any unburned hydrocarbons and other harmful elements that exist in the exhaust gases can be converted to less harmful forms before entering the atmosphere. This secondary source of air generally is supplied independently of the primary air intake system, and by a belt driven air compressor that usually is mounted on the engine as an accessory.

In substantially all cases, the air pump is rotated continuously, and therefore consumes a considerable amount of useful engine output horsepower at high engine speeds when the pump output provides more air than is needed. It is a primary purpose of the invention, therefore, to provide a control for an air pump that is effective at the higher engine speeds to bypass air from the high pressure outlet side of the pump back to the low pressure inlet side, to reduce the load on the pump and the horsepower required to drive it. This results in a saving of useful horsepower and a greater engine operating efficiency.

One of the objects of the invention, therefore, is to provide a fluid pump control that at times permits a bypass of fluid from the high pressure to the low pressure side of the pump.

Another object of the invention is to provide a centrifugal air pump having cooperating bladed rotor and bladeless stator members, the stator member having an air inlet and outlet and a control normally blocking communications therebetween in one direction of flow, the control being operable at times to permit a flow of air from the high to the low pressure side of the pump.

A further object of the invention is to provide an air compressor or pump with a fluid bypass that is operable at higher pump speeds to reduce the load on the pump and the horsepower required to drive the pump.

A still further object of the invention is to provide a

centrifugal air pump with an air bypass control consisting of a piston stem movable into and out of a bore in the stator member block seal or fluid abutment to control flow through a passage connecting the high and low pressure side; the piston being movable by a fluid pressure force that increases as a function of the increase in engine or pump speed and is controlled by a centrifugally responsive valve regulating the flow and pressure of oil to the piston from the engine oil pump.

Another object of the invention is to provide an air pump bypass control of the type described that effects a gradual bypass of the air as the pump speed increases, and a gradual return of the pump to its normal operation when the speed decreases.

Other objects, features and advantages of the invention will become apparent upon reference to the succeeding, detailed description thereof, and to the drawings illustrating the preferred embodiment thereof; wherein,

FIGURE 1 shows, schematically, a cross-sectional view of a fluid pump and a bypass control embodying the invention;

FIGURE 2 is a cross-sectional view taken on a plane indicated by and viewed in the direction of the arrows 2—2 of FIGURE 1; and

FIGURE 3 is a graph illustrating the change in fluid pressure with changes in speed.

FIGURE 1 shows an air pump or compressor **10** of the centrifugal type. It includes a semi-toroidal driving shell or casing **12** that is formed integral with or otherwise secured to a V-type drive pulley **14**. The pulley is driven at say three times engine crankshaft speed, for example, by a suitable belt drive type connection (not shown). The pulley is fixed on a sleeve **16** that is rotatably mounted on a stationary shaft **18** by a pair of spaced annular ball bearing units **20** and **22**. The ends of the sleeve are suitably sealed as shown.

Shell **12** supports a number of circumferentially spaced impeller or pump blades **24** to define a rotor member **26**. Blades **24** are substantially dish-shaped in cross section, and cooperate with and face a semi-toroidal shaped cavity **28** defined by a stationary casing **30**. The casing constitutes a stator member **32**, and is hollow and bladeless. The stator has an air inlet opening **34** and a fluid discharge outlet **36** located on opposite circumferential sides of a block seal or fluid abutment **38**. The block seal normally prevents direct communication between the air inlet and outlet as blades **24** pass over the face seal portion **40** in a known manner. Stator **32** has a hub **42** fixedly secured to shaft **18**, the shaft being threaded or otherwise secured in a stationary housing portion **44**.

The axial spaces **46** and **48** between the outer and inner radial portions of the pump and stator casings are sealed by a pair of elastomeric rings **50** and **52**. These rings are cemented or bonded in a suitable manner to extensions **54** and **56**, respectively, of stator **32**. They cooperate with external annular flanges or lips **58** and **60** provided, respectively, on the radially outward portion of impeller shell **12** and the inner hub portion of pulley **14**. During initial rotation of impeller shell **12**, each lip **58** and **60** will cut its own path into the respective elastomeric ring **50** and **52** to form an effective seal against leakage. Labyrinthian passages **62** and **64** formed by the shell extensions also minimize circumferential leakage.

In operation, as thus far described, rotation of rotor **26** by pulley **14** causes air to be drawn in through inlet

34 into the spaces (not shown) between blades 24. The air is then centrifuged outwardly and forwardly into the stator cavity 28, where it is redirected back into the rotor blade cavities to impart additional energy to the blades. This continuing cycling imparts a helical spiral motion to the air, causing it to flow clockwise (FIGURE 2) around the toroidal circuit until it reaches the block seal member 38, at which point it is diverted into the outlet 36 under pressure.

Turning to the invention, the block seal member 38 is shown as having a circumferentially extending through port or passage 66, which in this case is shown as being rectangular, although it will be clear that it could be of other suitable shapes. Passage 66 is intersected by a bore 68 that slidably and sealingly receives the stem 70 of a piston 72. The piston is movable in a stepped diameter bore 74 in the stationary housing. It is biased against the end of the bore to the bypass blocking position by a spring 76 seated between the piston and a backing disc 78. The piston is moved to the left to withdraw stem 70 from passage 66 by admission of fluid under pressure to the annular space 80 through port 82.

Flow of fluid to port 82 is controlled by a centrifugal governor-like valve unit 84. This latter unit consists of a valve body 86 that is rotatably and sealingly (annular seals 89) mounted within a stationary portion 87 of part of the engine block (not shown). In this case valve body 86 is shown located at right angles to the engine crankshaft (indicated generally by center line 88) and is rotatable with it at all times. It will be clear, of course, that, if desired, the valve body could be rotatable with the pulley 14. Valve body 86 slidably contains a spool valve 90 that controls flow of fluid under pressure from a line 92 alternately to a drain line 94 connected to a sump (not shown) or through a port 95 and an annulus 96 in body 86, to a port 97 in portion 87 and a line 98 connecting port 97 to port 82. Line 92 in this case is a branch of the conventional engine oil pump discharge line, and, therefore, eliminates the need for an additional fluid pump. It will be clear of course that a separate supply pump could be provided if desired.

Spool valve 90 consists of a pair of spaced lands 99 and 100 interconnected by a reduced diameter neck portion 101. The valve is biased by a spring 102 to its lower inoperative position blocking supply line 92 and connecting the annular chamber 104 to the drain line 94. The valve has a central bore 106 connected at all times to chamber 104 by a crossbore 108.

In operation, the mass of valve 90 is chosen so as to be subject to the effect of centrifugal force as it rotates with the crankshaft, and is of a volume such that below an engine speed of, say, 2,000 r.p.m., for example, the valve spring 102 will maintain the valve in the inoperative position. Above 2,000 r.p.m., centrifugal force acting on the valve mass moves it upwardly to crack open the annular chamber 104 to the fluid under pressure in line 92, thus filling the spring chamber 110, line 98, and chamber 80 to the right of piston 72. As the engine speed continues to increase, the fluid under pressure acting in spring chamber 110 increases as the valve moves upwardly due to centrifugal force. The fluid pressure force thus increases in the manner shown in FIGURE 3 to gradually increase the pressure acting in piston chamber 80 against the force of spring 76. The fluid pressure then gradually begins to move the piston stem to the left and out of the stator bypass port 66.

At approximately 2,500 r.p.m., the centrifugal force on the valve will be sufficient to open wide the supply line 92 and therefore provide a maximum pressure of say 40 p.s.i., for example, in chamber 80 acting against piston 72. The pressure at this time will be sufficient to fully move piston 72 to the left against the force of spring 76 so that the stem 70 is fully withdrawn from the through port 66. As a result, the high pressure discharge side of the pump is now connected through port 66 to the low pressure side, and the air now flows easily therebetween at reduced pressures. Accordingly, the load on the pump decreases and the horsepower required to drive the pump is reduced considerably. This results in a savings of useful engine horsepower and a greater engine operating efficiency.

It will be clear that with a gradual decrease in engine speed, the fluid pressure signal force against the piston will decrease gradually in the manner indicated by the curve 112 in FIGURE 3, thereby gradually returning the stem 70 into the through port 66 and therefore gradually again closing the bypass port 66.

It will be seen, therefore, that the invention provides a simple means for bypassing air from the high to the low pressure side of the pump at the higher engine speeds, and that the bypass control is effected in a simplified manner by a centrifugal governor-type valve unit controlling the flow of engine oil pump lubricant in accordance with a predetermined rotation either of the engine crankshaft or the pump rotor.

While the invention has been illustrated in its preferred embodiment in the figures, it will be clear to those skilled in the arts to which the invention pertains that many changes and modifications may be made thereto without departing from the scope of the invention.

What is claimed is:

1. A centrifugal pump having a bladed rotor member, a hollow stator member cooperating therewith to define an annular fluid flow chamber therebetween, said stator member having a fluid inlet and outlet to said chamber, a source of fluid connected to said inlet, fluid blocking means movable into and out of said chamber between positions blocking or unblocking flow between said inlet and outlet in one direction, and control means for controlling the movement of said fluid blocking means, said latter means including means biasing said blocking means to its blocking position, and speed responsive means for moving said fluid blocking means to its fluid flow unblocking position, said control means including a second source of fluid under pressure, and conduit means operatively connecting said second source to said blocking means to act thereon to move said control means to its blocking position.

2. A pump as in claim 1, said speed responsive means including means for controlling flow through said conduit means.

3. A pump as in claim 1, said second source being rotatable as a function of the speed of said rotor.

4. A pump as in claim 2, said blocking means comprising a piston member movable into and out of said chamber.

5. A pump as in claim 2, said means for controlling flow comprising a valve in said conduit means operably rotatable in timed relation with said rotor and movable in respone to centrifugal force acting thereon to increase the fluid pressure in said conduit means.

6. A pump as in claim 2, said means for controlling flow comprising a valve operably rotatable in timed relation with said rotor and variably movable in response to centrifugal force acting thereon from a position blocking said conduit means to a position unblocking said conduit means, and thereby increasing the pressure in said conduit means from a minimum to a maximum, and means biasing said valve to a conduit blocking position.

7. A pump as in claim 4, said piston member being movable to its blocking position upon attainment of a predetermined second source fluid pressure thereagainst.

8. A pump as in claim 6, said valve having means thereon acted upon by the fluid pressure in said conduit means to resist movement of said valve by centrifugal force.

9. A pump as in claim 7, said means for controlling flow comprising a valve operably rotatable in timed relation with said rotor and variably movable in response to centrifugal force acting thereon from a position in blocking said conduit means to a position unblocking said

conduit means, and thereby increasing the pressure in said conduit means from a minimum to a maximum, and means biasing said valve to a conduit blocking position.

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