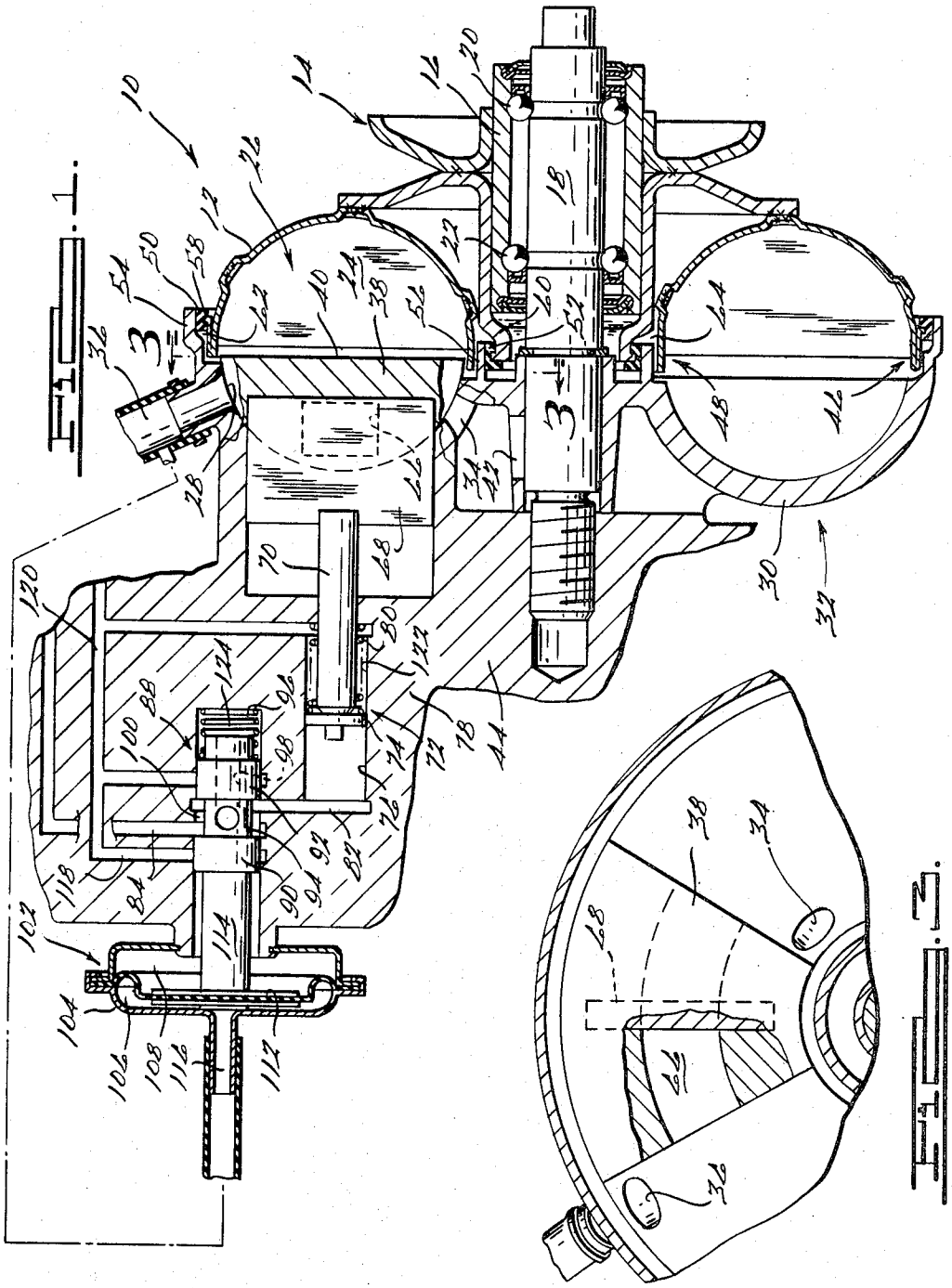
Dec. 5, 1967 J. KNOWLES ET AL 3,356,034

FLUID PUMP FLOW BYPASS CONTROL

Filed Dec. 28, 1965 2 Sheets-Sheet 1



INVENTORS.
James Knowles,
Richard D. Moan
BY John R. Faulkner
Robert E. McCollum

Dec. 5, 1967 J. KNOWLES ET AL 3,356,034

FLUID PUMP FLOW BYPASS CONTROL

Filed Dec. 28, 1965 2 Sheets-Sheet 2

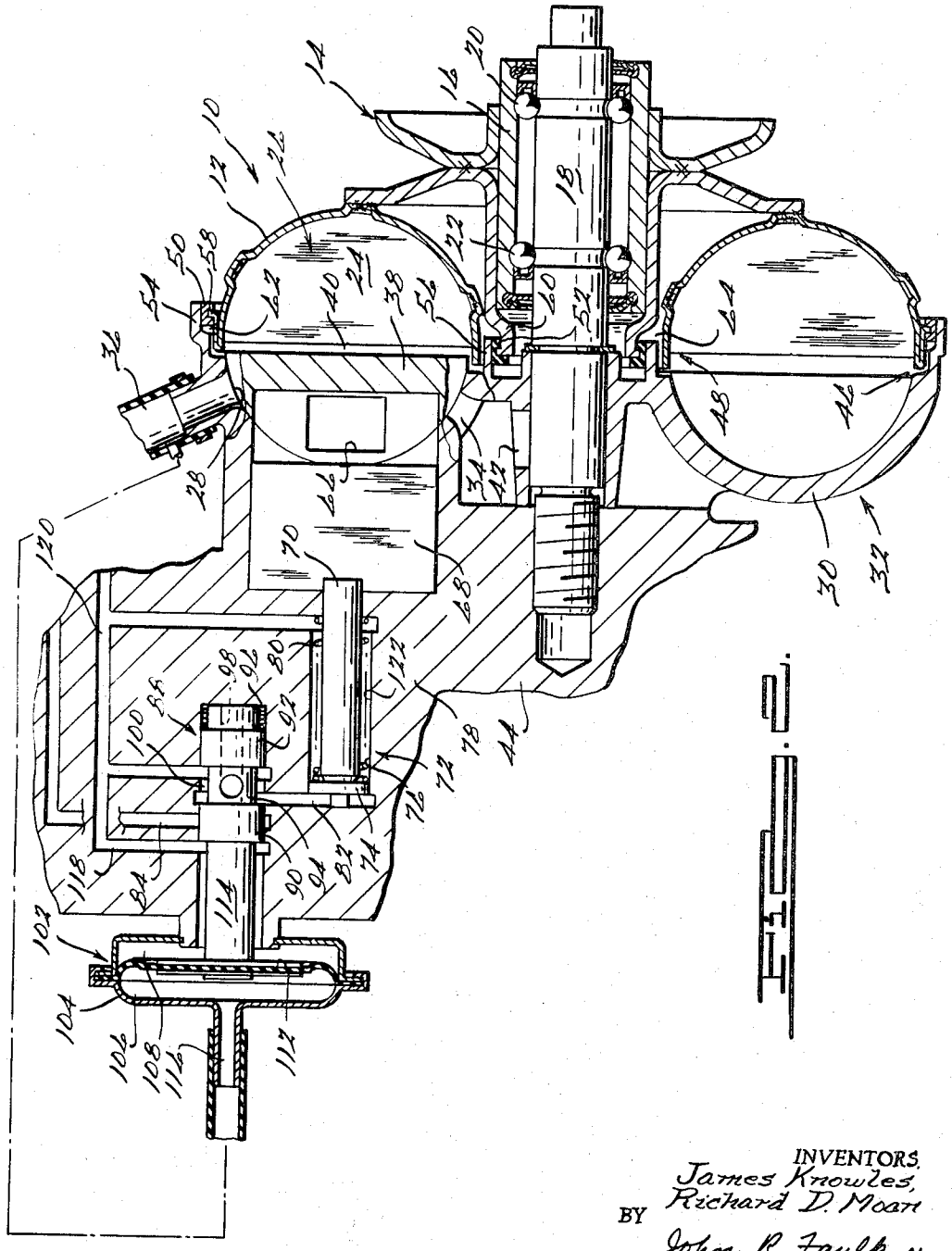


Fig. 2

INVENTORS.
James Knowles,
Richard D. Moan
BY John R. Faulkner
Robert E. McCollum

United States Patent Office

3,356,034

Patented Dec. 5, 1967

3,356,034

FLUID PUMP FLOW BYPASS CONTROL

James Knowles, Bloomfield Hills, and Richard D. Moan, Dearborn Heights, Mich., assignors to Ford Motor Company, Dearborn, Mich., a corporation of Delaware

Filed Dec. 28, 1965, Ser. No. 516,998
10 Claims. (Cl. 103—97)

ABSTRACT OF THE DISCLOSURE

An air turbine pump having a bladed rotor cooperating with a bladeless stator containing an air dam that deflects the pressurized air into an outlet. The dam contains an air bypass opening that is closed by a gate that is spring biased to an open position and movable to a closed position by an engine oil pressure actuated servo. An air output pressure controlled diaphragm controlled supply and vent of oil pressure to the servo.

This invention relates, in general, to a fluid pump control. More particularly, it relates to an air compressor of the centrifugal type having means to bypass the high pressure discharge air 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 at all engine speeds 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 is generally supplied independently of the primary air intake system, and by an air compressor that generally is mounted on the engine as an accessory and driven at from two to three times engine crankshaft speed.

In substantially all cases, the air pump is rotated at all engine speeds, and therefore consumes a considerable amount of useful engine output horsepower at the higher engine speeds when there is less need for additional air. It is a primary purpose of the invention, therefore, to provide a control for an air pump that is effective at higher engine speeds to bypass air from the outlet of the pump back to the inlet, and thereby reduce considerably the load on the pump and the horsepower required to drive the pump. This results in a substantial 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 bypasses fluid from the high pressure side of the pump to the low pressure side.

Another object of the invention is to provide a centrifugal air pump having cooperating rotor and stator members, the stator member having a fluid inlet and outlet and a control normally blocking communication 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 therefore 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 gate movable into and out of the stator chamber of the pump to control communication between the high and low pressure sides of the pump; the gate being movable in response to movement of a valve that is differentially controlled by engine oil pressure and pump air discharge pressure operatively acting on opposite ends in a

manner such that at a predetermined air pressure, the gate will be withdrawn to permit a bypass of air, and the gate will remain withdrawn until the pump outlet pressure has dropped to a low value.

Another object of the invention is to provide an air pump bypass control of the type described that effects a quick bypass of the air when called for, and delays a return of the pump to its normal operation until the pump outlet pressure has decayed to a fairly low value.

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,

FIGURES 1 and 2 show, schematically, cross-sectional views of a fluid pump and a bypass control embodying the invention; and

FIGURE 3 is a cross-sectional view taken on a plane indicated by and viewed in the direction of arrows 3—3 of FIGURE 1.

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 welded or otherwise secured to one side of a V-type drive pulley **14**. The pulley would have a speed-up belt drive type connection (not shown) to the engine crankshaft, and is fixed on a sleeve **16**. The sleeve 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 narrow 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**, at say three times crankshaft speed, for example, 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 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. Flow of fluid or air from outlet **36** back to inlet **34** through passage **66** is controlled by a

slide gate **68** that is movable in a direction substantially at right angles to passage **66**. The movement of the gate is controlled by a fluid pressure actuated mechanism indicated schematically to the left of pump **10** in FIGURE 1.

More specifically, gate **68** is fixed to the shaft **70** of an actuator **72** having an enlarged end **74** slidably and sealingly mounted in the bore **76** of a valve body **78**. The actuator is biased against one end of the bore by a spring **80** to withdraw gate **68** from passage **66**. Gate **68** is moved across passage **66** upon admission of fluid under pressure to the end of the bore **76** through a line **82**. Line **82** is connected alternately to a source of fluid under pressure in a line **84**, or to a sump (not shown) through a drain line **86**. The line **84** in this instance is connected to the conventional engine oil pump discharge line, and, therefore, contains oil normally at a pressure that will vary between 35 and 55 p.s.i., for example.

The flow of fluid to or drain from line **82** is controlled by the movement of a spool valve **88** having spaced lands **90** and **92** interconnected by a reduced neck portion **94**. The valve is slidably mounted in the valve body **78**, and is movable between the positions shown in FIGURES 1 and 2. The valve is biased to the FIGURE 1 position by a spring **96**, and has a central bore **98** connecting the annular fluid chamber **100** to the end of the valve. In the FIGURE 1 position, engine oil pressure acts behind the valve to aid spring **96** in maintaining the valve in the position shown so that oil under pressure can flow through line **82** to act on the gate actuator **72** and move the gate **68** to the position shown blocking passage **66**.

The valve is moved to the FIGURE 2 position upon a rise in the pump discharge pressure sufficient to move a diaphragm type servo **102** connected to the valve. The servo consists of a housing **104** divided into fluid chambers **106** and **108** by an annular diaphragm **110**. The diaphragm extends between the housing and an annular flange **112** fixed to a stem **114** on valve **88**. Chamber **106** is connected to a branch line **116** of air pump outlet **36**, and chamber **108** is vented to exhaust through a drain line **118**. The common drain passage **120** is also connected to the gate actuator spring chamber **122**.

In operation, when the engine that drives the air pump is rotating at low speeds, the pump output pressure in line **116** will be insufficient to overcome the force of spring **96**, and the control system parts will be as shown in FIGURE 1. Engine oil pressure will flow through the valve central bore **98** into the chamber **124** containing spring **96** to maintain the valve in this position. The oil will also flow into line **82** and against the gate actuator **72** to move it against the force of spring **80** and position the gate **68** as shown to block flow through pump block seal passage **66**.

Assume now the engine speed increases, which causes a corresponding increase in the pump outlet pressure. When this pressure reaches a predetermined level of say, 5 p.s.i., for example, indicating a pump speed of say, 6000 r.p.m., for example, the air pressure is sufficient to move the valve **88** to the right against the force of spring **96** and the engine oil pressure to the FIGURE 2 position. This immediately cracks open the chamber **100** to drain line **86**, and the oil pressure begins to drop. A resultant quick rightward movement of the valve occurs, and the oil pressure in line **82** drops to zero. Spring **80** now quickly strokes the gate actuator **72** to the left and thus moves gate **68** out of passage **66** to permit a bypass of air from the high pressure outlet side **36** of pump **10** to the low pressure inlet side **34**. The air pressure, therefore, immediately decays and unloads the pump so that considerably less horsepower now is required to drive it.

Since the only force acting on valve **88** to oppose the air pressure is the spring **96**, the air pressure will continue to drop until it reaches a low value, such as, for example, .5 p.s.i. This pressure point will be determined, of course, by the value of the spring chosen. At the moment the spring force becomes greater than the air pressure, the valve again will move to the left to the FIGURE 1 position and permit engine oil pressure to act behind the valve to maintain the valve in the FIGURE 1 position. Simultaneously oil under pressure is supplied to the gate actuator **72** to move it again against the force of its spring **80** to the FIGURE 1 position, blocking the pump passage **66**.

From the foregoing, therefore, it will be seen that the invention provides a bypass control for a centrifugal air pump that is responsive to engine or pump speed to bypass the output of the pump back to its inlet above a predetermined speed; and, that the control is actuated by fluid from the conventional engine oil pump, thereby eliminating the need for an additional source of fluid under pressure. It will thus be seen that the horsepower normally lost due to driving the air pump at high engine speeds is saved, and, therefore, results in a greater engine operating efficiency.

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. For example, while a block seal member is shown between the inlet and outlet, it will be clear that it could be eliminated if desired without departing from the scope of the invention, since the gate would serve substantially the same function by extending across the width of the stator cavity.

We claim:

1. A centrifugal pump having a bladed rotor member, a 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, first conduit means connecting said inlet and outlet, fluid bypass control means movable into said conduit means to block flow from said outlet to said inlet while permitting flow from said inlet to said outlet and movable out of said conduit means to a bypass position permitting flow from said inlet to said outlet and back to said inlet, and means for controlling the movement of said bypass control means, said latter means including means biasing said control means to a fluid bypass permitting position essentially out of said conduit means, a second source of fluid under pressure, second conduit means operatively connecting said second source to said control means to act thereon to move said control means to a bypass blocking position into said first named conduit means, and means for controlling flow through said second conduit means.

2. A fluid pump as in claim **1**, said last-mentioned means comprising a valve movable in a second conduit closing direction by fluid outlet pressure operatively acting thereon, and further means biasing said valve in the opposite second conduit flow permitting direction.

3. A fluid pump as in claim **1**, said second source being operatively rotatable with said rotor member and varying in pressure as a function of the speed of said rotor member.

4. A fluid pump as in claim **1**, said bypass control means including a gate movable across said stator member chamber portion circumferentially between said inlet and outlet.

5. A fluid pump as in claim **1**, said stator member having a fluid abutment between said inlet and outlet, said first conduit means comprising a passage through said abutment, said bypass control including a gate slidable in said abutment across said passage.

6. A fluid pump as in claim **2**, said second source varying in pressure as a function of the speed of said rotor member, said further means including means connecting fluid under pressure from said second source to act on said valve.

7. A fluid pump as in claim **2**, said further means including means connecting fluid under pressure from said second source to act on said valve.

8. A fluid pump as in claim **2**, including a diaphragm

operatively connected to said valve and acted upon by the fluid at said outlet to move said valve in said second conduit closing direction.

9. A fluid pump as in claim **3**, said valve being movable from a first position blocking the connection between said source and said control means while connecting the fluid acting on said control means to a vent line to a second position blocking said vent line and connecting said source and control means.

10. A fluid pump as in claim **9**, said valve having means connecting the fluid at said control means at all times to one end of said valve for biasing said valve at times to its second position, said valve when moved to its first position connecting said latter means to said drain line.

References Cited

UNITED STATES PATENTS

2,317,723	4/1943	Becht	230—114
2,455,552	12/1948	Bower	103—97
2,786,420	3/1957	Kenney	103—97
2,863,601	12/1958	Torell	230—114
3,095,820	7/1963	Sanborn et al.	103—96
3,257,955	6/1966	Worst	103—96

DONLEY J. STOCKING, *Primary Examiner.*

HENRY F. RADUAZO, *Examiner.*