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TURBINE DRIVEN PUMP INDUCER

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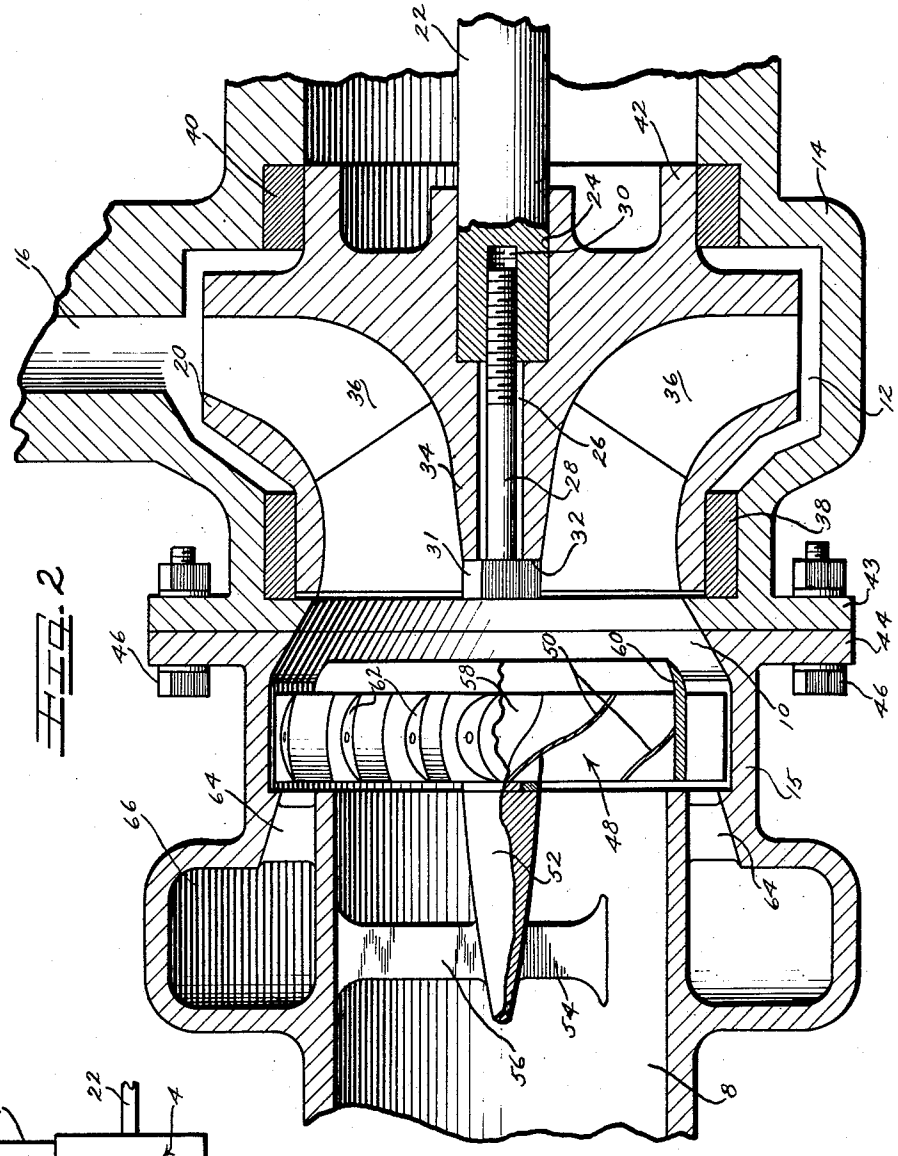

FIG. 2

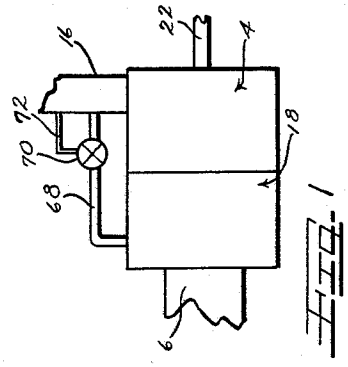

FIG. 1

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TURBINE DRIVEN PUMP INDUCER

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The present invention relates to improvements in pump assemblies, and especially those provided with an inducer for preventing cavitation.

In pump operating conditions where cavitation is likely to occur, such as where the intake of the pump is connected to a high lift, or where a high temperature or volatile fluid is being pumped, means have been provided heretofore for reducing cavitation, such as by providing an inducer on the intake of the pump which maintains a slight pressure on the pump intake side. In a pump which has a variable output, it is not necessary that the inducer run at full capacity for small outputs, since this will result in a waste of power, and will merely create turbulence at these low flow conditions. With the use of a rotary or centrifugal pump, a simple inducer has been provided heretofore which consists of another small rotary pump mounted on the same shaft as the main pump. However, at low flow conditions, the inducer will continue to be driven at high speed and will consume a substantial amount of power, which is wasted.

Accordingly, it is an important object of the invention to provide an inducer for a pump which operates to prevent cavitation and will operate efficiently and satisfactorily at varying pump outputs, and will not consume an unwarranted amount of power at low pump outputs.

Another object of the invention is to provide an inducer for a pump wherein the output of the inducer will vary in accordance with the output of the pump, thereby eliminating the waste of power which will normally occur at low output of the pump.

Another object of the invention is to provide an improved flow inducer for a pump which is driven by fluid, and more specifically is driven by fluid by-passed from the pump output.

Another object of the invention is to provide an improved pump assembly, such as that which employs a centrifugal pump wherein a rotary pump inducer is provided on the input side of the pump to reduce cavitation, and wherein the impeller is driven by a fluid turbine operated by fluid by-passed from the pump output, and wherein the turbine operating fluid flow is controlled in accordance with the flow output of the pump.

Other objects and advantages will become more apparent in connection with the disclosure and teaching of the principles of the invention in the description and illustration of the preferred embodiments thereof, in the specification, claims and drawings, in which:

FIGURE 1 is a somewhat diagrammatic view shown in elevation of the pump assembly; and

FIGURE 2 is a vertical sectional view taken through the pump assembly and showing the details of construction thereof.

As shown in the drawings:

The pump assembly is illustrated in FIGURE 1 with a pumping unit 4 provided with an inlet line 6 defining an inlet passageway 8, as shown in FIGURE 2, which leads to an inlet chamber 10 adjacent a pump chamber 12.

The pump chamber 12 is enclosed in a pump housing 14 which is provided with a pump discharge passageway 16. The entire pump assembly includes the pump housing 14 and a housing 15 which encloses the inlet passageway 8, and the inlet chamber, and also the inducer mechanism which is indicated generally by location at 18 in FIGURE 1.

Within the pump housing 14, and within the pump chamber 12, is a rotary centrifugal pump impeller 20. The impeller is driven by a power-driven rotary shaft 22 upon which the rotary impeller 20 is mounted. For mounting the impeller, it is provided with a shaft receiving bore 24 which leads to a smaller bore 26 for the passage of a bolt 28. The bolt 28 is threaded into a threaded opening 30 in the power-driven shaft 22 and draws the shaft tightly into the bore 24 with a head 31 of the bolt resting on the upper shoulder 32 of a central hub 34 of the impeller.

The impeller is provided with the usual openings 36 which extend axially from the intake end of the impeller and curve out to open radially into the pump chamber 12. The chamber 12 will normally be volute shaped and lead into the discharge passageway 16.

The pump housing 14 is provided with a first annular seal 38 extending around the intake end of the pump rotor, and a second annular seal 40 surrounding a flange 42 at the back end of the rotor.

The pump housing 14 may be manufactured by being cast in parts in such a manner so that it may be assembled with the impeller 20 therein, as shown in FIGURE 2. The sections 14 and 15 of the housing assembly are held together by having annular flanges 43 and 44 respectively, through which pass bolts 46, which clamp the sections together.

An inducer 48 is provided to supply fluid to the intake chamber 10 to flow into the passageways of a pump impeller at a slight pressure to avoid cavitation. These problems of cavitation occur with high speed pumps, and are especially troublesome when high lifts are encountered, and when high temperature or volatile materials are pumped. This is frequently true with pumping high temperature fuels or the like, and in a fuel pump the pump frequently operates continually to maintain pressure in the discharge passageway 16. The discharge flow varies over a wide range, and may vary from zero delivery to maximum delivery of the pump.

The inducer 48 is of the nature of a rotary pump having fluid impeller blades 50. When the inducer is driven in rotation, a pressurized flow of fluid will be driven forward through the intake passageway of the pump and through the intake chamber 10. The rotary inducer is mounted for rotation on a shaft 52 which is supported within the intake passageway 8 on arms 54 and 56 of a spider.

The inducer blades 50 are mounted on a central hub 58 at their inner ends, and are secured at their outer ends to an annular band 60. Carried on the outer surface of the annular band are a plurality of turbine blades 62. The band 60 thus separates the inducer blades 50 from the turbine blades 62.

Operating fluid for driving the turbine which is comprised of the turbine blades 62 mounted on the band 60, is received from slots 64 leading from an annular turbine fluid supply chamber 66.

In accordance with the principles of the present invention, fluid is by-passed from the output of the pump and this fluid is transformed to useful power for driving an inducer mechanism. As will be seen from the description of the operative elements, the flow of by-pass fluid is controlled so that the inducer will have an output in accordance with the output delivery flow of the pump.

In the present embodiment of the invention, the inducer is in the form of a rotary fluid impeller driven by a turbine which derives its operating fluid through a by-pass line 68, FIGURE 1, which leads into the supply chamber 66, FIGURE 2, for the turbine. The by-pass line 68 connects directly to the discharge passageway 16 of the pump and may be relatively small as compared to the output passageway, since a relatively small quantity of fluid is required for driving the inducer.

In the form illustrated, a control valve 70 is provided to control the amount of fluid flowing through the by-pass line to drive the inducer. Thus, the inducer may be driven only at a speed sufficient to deliver fluid to the intake of the pump to prevent cavitation. These circumstances may vary with the pump characteristic, the fluid pumped, the height of fluid, and the temperature of the fluid, and other variable factors.

The fluid delivered by the inducer 48 may also be varied in accordance with the output of the pump. This may be achieved by selecting valve 70 to be a flow-responsive valve which will control the flow through the by-pass line 68 in accordance with the flow through the pump discharge line 16. In one form, the flow control valve 70 may have a small control sensing line 72, FIGURE 1, which connects directly to the line 16, and which senses the flow of fluid therethrough. Inasmuch as there will be a pressure variation with flow variation, in some circumstances the flow sensing valve 70 may operate responsive to pressure in the output line 16 so that when the output flow through the line 16 is reduced, the flow through the by-pass line 68 is similarly reduced, thus reducing the power required to drive the inducer. As will be appreciated by those skilled in the art, in a first type of fluid system where the output of a constant speed pump is connected to a line with a variable demand, when the demand increases the output pressure of the pump will drop and when the demand decreases the output pressure will increase. Also in a second type of system the pump may be used in an arrangement where the pump rotor is driven at a variable speed, and to meet increased demands the speed of the pump is increased, thus increasing the output pressure. In both systems the increased output of the pump rotor is accompanied by an increased by-pass to increase the output of the inducer. In order to operate according to flow variation, as above described, in the first system the flow sensing valve 70 opens as a function of the decrease in pressure in the output line 16. In the second system the flow sensing valve opens as a function of the increase in pressure in the output line 16.

At minimum flow conditions, the operation of the inducer 48 can be reduced to a minimum, or in some instances stopped. This will reduce the turbulence which will be created in instances where an inducer is mounted directly on the pump shaft. In these installations, a considerable waste of power occurs at low output, since the power consumption of the inducer will be relatively high.

With the structure of the present invention, however, the power consumption of the inducer is maintained at a minimum and only the power needed is used. The fluid which is by-passed to drive the inducer is delivered back into the flow stream, passing into intake chamber 10, and again flowing through the pump impeller 20.

In operation of the pump, the shaft 22 will be power driven to rotate the impeller 20, and fluid will flow through the intake passageway 8, and the intake chamber 10 to flow out through the discharge passageway 16. A portion of fluid from the discharge passageway is by-passed through the by-pass line 68 and this fluid reacts against the turbine blades 62 to drive the coaxial impeller 48 and deliver fluid under a slight pressure to the intake of the pump thereby reducing cavitation. The control valve 70 in the by-pass line controls the amount of fluid flowing to the turbine so that at reduced or minimum flow output of the pump, a minimum amount of by-pass fluid is used to drive the inducer.

Thus it will be seen that I have provided an improved pump assembly which provides an inducer consuming a minimum of power for efficient and satisfactory operation. The power consumption of the inducer is maintained at a minimum throughout the entire range of output of the pump, and at a minimum output, the power consumption of the inducer may even be reduced to zero.

Thus, a condition such as which occurs when an inducer is mounted directly on a pump shaft, wherein a large amount of power is consumed by the inducer at low outputs of the pump and turbulence occurs, is completely eliminated.

I have, in the drawings and specification, presented a detailed disclosure of the preferred embodiments of my invention, and it is to be understood that I do not intend to limit the invention to the specific form disclosed, but intend to cover all modifications, changes and alternative constructions and methods falling within the scope of the principles taught by my invention.

I claim as my invention:

1. A pumping unit adapted to operate under high speed and high lift or high temperature conditions with an absence of cavitation comprising in combination a rotary power-driven pump centrifugal impeller unit, a housing surrounding the impeller unit and having a pump discharge passageway and a pump intake chamber, a rotary inducer impeller mounted in said intake chamber in close proximity to the impeller unit, a supporting shaft carrying said inducer impeller, an annular band surrounding said inducer impeller, a series of fluid-driven turbine blades mounted outside of said band, a turbine housing surrounding said blades outside of said pump intake chamber and operative to deliver pressurized fluid to said turbine blades to drive the blades and the inducer impeller whereby fluid delivered to the intake chamber to the centrifugal pump is pressurized fluid to prevent cavitation, a by-pass fluid flow passageway connected between the turbine housing and the pump discharge passageway whereby pressurized fluid delivered by the centrifugal pump impeller will flow to the turbine impeller and drive the turbine and inducer impeller at a speed to deliver pressurized fluid to the centrifugal pump impeller and prevent the occurrence of cavitation, and a fluid flow control by-pass valve in said by-pass line to determine the amount of fluid which will be by-passed and the power used for driving the turbine, said valve being pressure responsive and connected to the discharge passageway and operative to reduce the flow path for fluid through the by-pass line to decrease the speed of operation of the turbine and the speed of the inducer impeller at high pressures and low flow outputs of the centrifugal pump impeller.

2. A cavitation preventing pump assembly for pumping high temperature fluids or high suction lifts comprising in combination a pump enclosed in a housing having an inlet passageway and a discharge passageway for the flow of pumped fluid, a rotary fluid impeller having impeller blades connected to deliver fluid to said pump intake passageway, a fluid driven rotary motor having reaction elements radially spaced outwardly from the impeller blades and mounted for corotation with the fluid impeller and driving the impeller in rotation, an inwardly tapered guide surface leading from the discharge of said rotary motor to said inlet passageway for said pump guiding the path of fluid discharge from the reaction elements inwardly to the inlet passageway, and a fluid flow by-pass passageway connected to bleed fluid from the pump discharge passageway and deliver the fluid to drive the rotary motor in accordance with the output of the pump.

3. A cavitation preventing pump assembly for pumping high temperature fluids or high suction lifts comprising in combination a main pump enclosed in a housing having an inlet passageway and a discharge passageway for the flow of pumped fluid, an inducer connected to said inlet passageway and operative to deliver fluid to said pump thereby reducing cavitation, fluid powered driving means connected to drive said inducer, a by-pass conduit connected between the pump discharge passageway and said driving means to drive said driving means in accordance with the output of said pump, a flow control valve in said by-pass conduit whereby the amount of fluid oper-

ating the driving means may be regulated with varying pumping conditions, and a flow responsive valve control connected to operate said flow control valve and connected to said pump discharge passageway and operative to reduce the size of the flow path through the valve corresponding to decreased output of said pump so that the inducer output is reduced to a low quantity.

4. A cavitation preventing pump assembly comprising in combination a pump having a rotor with an axial intake enclosed in a housing having an axial inlet passageway and a discharge passageway for the flow of pumped fluid, a rotary fluid flow inducer positioned in the intake passageway of the pump coaxial with said pump rotor and in close proximity thereto to deliver fluid to said pump, a rotary fluid driven motor positioned coaxially with said flow inducer and coaxially with said pump rotor and connected to drive the inducer, a fluid flow by-pass passageway connected to bleed fluid from the pump discharge passageway and deliver the fluid to drive the rotary motor in accordance with the output of the pump, and an annular discharge passageway for said rotary motor coaxial with said pump rotor communicating with said pump intake passageway in an annular flow path so that the fluid for operating the motor will again pass through the pump.

5. A cavitation preventing pump assembly comprising in combination a pump having a rotor with an axial intake enclosed in a housing having an axial inlet passageway and a discharge passageway for the flow of pumped fluid, a rotary flow inducer positioned in the intake passageway of the pump having an axial flow rotor coaxial with said pump rotor to deliver fluid to said pump, a rotary fluid driven motor for said inducer including vanes annularly arranged on the periphery of said inducer rotor so as to be coaxial with said pump rotor and in close proximity thereto and so that fluid passing therethrough will be discharged in an annular path around said inducer rotor coaxial with the pump rotor, and a fluid flow by-pass passageway connected to bleed fluid from the pump discharge passageway and deliver the fluid to said vanes to drive the motor in accordance with the output of the pump with said bled fluid passing coaxially through the pump rotor after operating said motor.

6. A cavitation preventing pump assembly for pumping high temperature fluids or high suction lifts comprising in combination a pump enclosed in a housing having an inlet passageway and a discharge passageway for the flow of pumped fluid, the pressure in the discharge passageway varying as a function of the rate of flow through the passageway, an inducer connected to said inlet passageway and operative to deliver fluid to said pump thereby reducing cavitation, fluid powered driving means connected to drive said inducer, a by-pass conduit connected between the pump discharge passageway and said driving means to drive said driving means in accordance with the output of said pump, a flow control valve in said by-pass conduit whereby the amount of fluid operating the driving means may be regulated, and pressure responsive means connected to said pump discharge passageway and connected to said flow control valve to open said valve in response to change in discharge pressure occurring with an increase in the discharge of the pump and to close said valve in response to change in discharge pressure occurring with a decrease in discharge of the pump so that the flow path of the by-pass conduit will be varied with pump output and fluid will be by-passed as an increasing function of increase in delivery of the pump.

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