

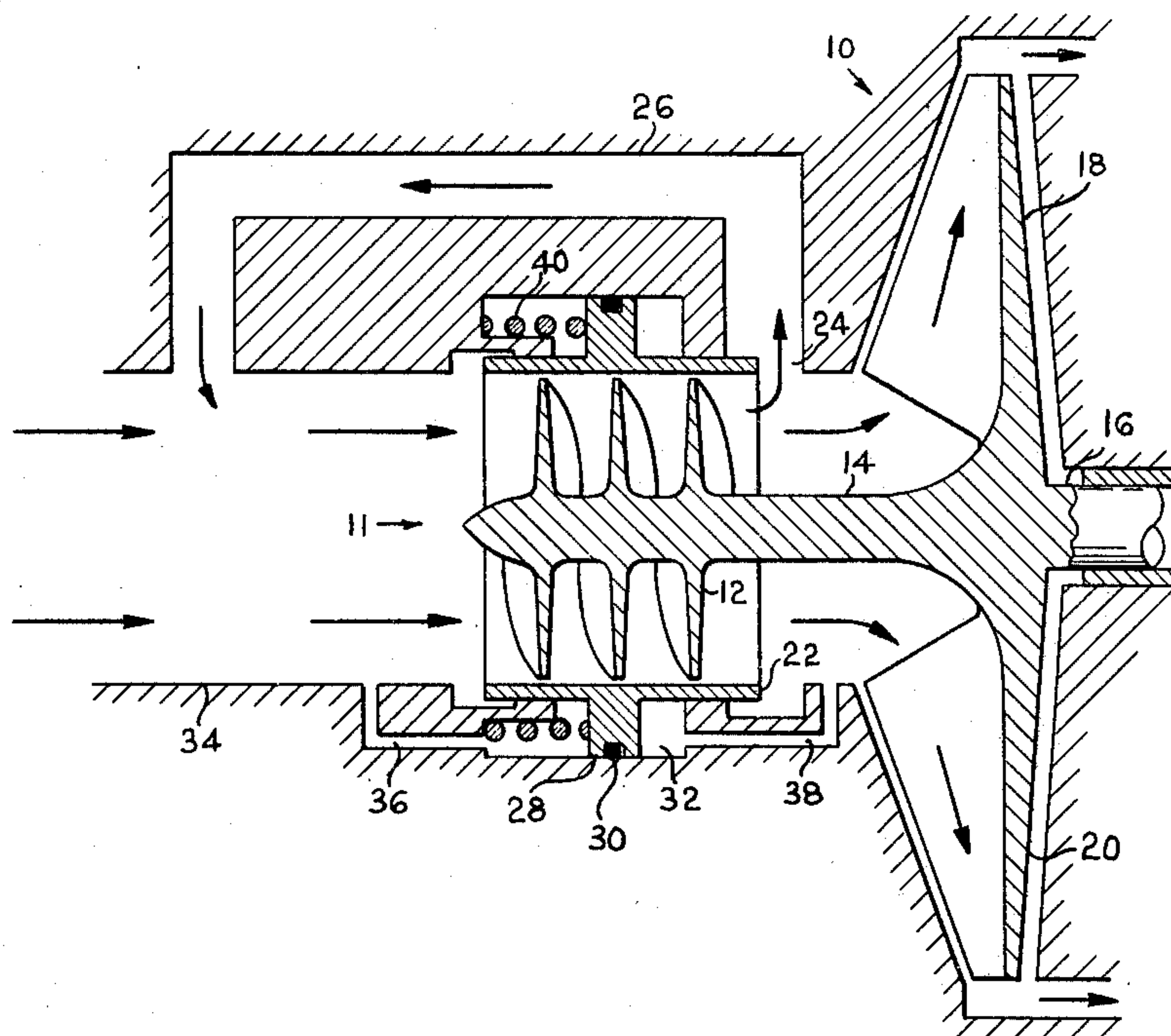
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WIDE RANGE INDUCER

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WIDE RANGE INDUCER

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10 Claims

ABSTRACT OF THE DISCLOSURE

An inducer for use in conjunction with high speed fluid pumps required to operate over a wide flow range at high suction specific speeds. By placing pressure sensing passages upstream and downstream of the inducer, a pressure gradient can be determined and when pressure downstream becomes high, indicating reduced flow from the pump, this high pressure can operate to open a fluid return passage so that fluid may be recirculated from the downstream side of the inducer to the upstream side of the inducer.

BRIEF SUMMARY OF THE INVENTION

In high speed pumps which employ roto-dynamic effects to accomplish pumping and which are required to operate over a wide range of flows at low inlet pressures and/or high temperatures, it is often necessary to employ inducers to provide fluid to the impeller of the pump at sufficient pressure to overcome the vapor pressure of the fluid.

An inducer which is required to function over a wide flow range at high speed can develop a condition of cyclic flow instability at low flow rates. This is caused by prerotation of the fluid upstream of the inducer entry plane which may cause a cylindrical core of vapor to appear in the inducer entry passage. This cavity can go into forced radial oscillation at frequency dependent upon the system configuration. The pressure pulses produced at the pump discharge can be violent enough to destroy the system, unless the pump speed is reduced or the flow rate is increased to regain a stable operating condition.

This is especially true in applications where inducer rotational speed is proportional to or equal to main pump rotational speed as is the case in aircraft after burner applications where independent rotation of the inducer would cause an increase in weight and/or a decrease in available power. It is, therefore, an object of this invention to provide an inducer capable of stable operation over a wide range of flow rates and which does not require an independent driving source.

This invention discloses a method of automatically varying flow rate through the inducer in such a way that pump output is not affected. It, therefore, is an object of this invention to provide an inducer capable of stable operation over a wide range of pump output flow conditions. It is also an object of this invention to provide a novel means of recirculating pump flow. It is a further object of this invention to provide an automatic means for a high-speed fluid pump of by-passing fluid back to the upstream side of the inducer, whenever the downstream pressure conditions indicate approaching instability in the operating conditions of the pump. Other and further objects and advantages of the present invention will be obvious to the man skilled in the art from the included drawing and the appended claims.

BRIEF DESCRIPTION OF THE DRAWING

The drawing shows, in schematic section, a preferred embodiment of an inducer and pump made according to the present invention with the control valve in a partially-open condition.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The drawing shows a high speed centrifugal pump indicated generally by 10. The inducer section, indicated generally by 11, consists of a helical inducer blade or blades 12 formed on a shaft 14 which is a part of the main pump shaft 16. Centrifugal impeller blades 18 and 20 radiate from the main pump shaft 16. Surrounding the blade 12 is slidable valve or sleeve 22 which moves to open or close the port 24 of by-pass or recirculating passage 26. Passage 26 communicates with the main fluid passage 34 upstream of the inducer blade 12.

The sleeve 22 includes a flange 28 and seal 30 received in annular recess 32. Fluid passage 36 extends from the recess 32 and communicates with the main fluid passage 34. Fluid passage 38 extends from the recess 32 and communicates with the main fluid passage 34 downstream of the inducer blade 12. Spring 40 is shown biasing the sleeve 22 to close the opening 24.

OPERATION

The flow characteristic of inducers is such that the pressure of fluid at the downstream side of the inducer is greater than the pressure at the upstream side of the inducer and the pressure at the downstream side is also inversely proportional to the flow through the inducer.

The passages 36 and 38 serve to establish the pressure rise across the impeller blade 12 and the spring 40 provides sufficient bias pressure against the flange 28 to keep the sleeve valve 22 closed until the downstream pressure rises to a sufficient degree to indicate that the flow has approached the desired minimum for the inducer. At this point, the pressure in passage 38 will begin to move the flange 28 and sleeve 22 against the bias of the spring 40 and the port 24 will begin to open.

As the port 24 begins to open, static pressure on the downstream side of the inducer blade 12 will cause fluid to enter the port 24 and flow through the passage 26 to be discharged back into the main fluid stream 34 upstream of the inducer 11. Once the valve 22 begins to open, flow through the inducer 11 will remain substantially constant as pump output continues to decrease. For a given inducer and pump combination, the point at which the recirculating begins can be selected to give the best compromise between inducer power consumption and fluid temperature rise due to recirculation.

The present invention accomplishes its stated objectives, but the description of the preferred embodiment should not be taken as limiting the scope of the invention, inasmuch as the man skilled in the art could alter the preferred embodiment without departing from the spirit of the invention as contained in the claims which follow.

I claim:

1. In the combination comprising an inducer and a high speed downstream pump wherein said combination is required to pump a fluid capable of becoming a two-phase fluid, the improvement in the inducer comprising:
 - a main fluid passage operative to communicate a fluid to be pumped to the inlet of the downstream high speed pump; said inducer comprising
 - a helically bladed axial flow impeller rotatably located in said main fluid passage;
 - recirculatory passage means having an inlet port downstream from said impeller and an outlet port upstream from said impeller, operative to increase total flow through said impeller;
 - sensing means communicating with said main fluid passage downstream of said impeller and upstream of said high speed pump operative to sense fluid flow through said impeller; and
 - valve means in co-operative association with said re-

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circulatory passage means and operatively coupled to said sensing means to control fluid flow through said recirculatory passage means.

2. The device claimed in claim 1 wherein said sensing means sense fluid flow by comparing fluid pressure upstream and downstream from said impeller.

3. The device claimed in claim 1 wherein said valving means comprise a normally-closed valve means located in proximity to the inlet ports of said passage means.

4. The device as claimed in claim 1 where said sensing means comprise mechanical positioning means connected to said valve means, means for sensing and comparing fluid pressure upstream and downstream of said impeller and means for applying the resultant pressure to said mechanical positioning means.

5. An inducer for a high speed pump having a main fluid passage comprising: a helical axial flow impeller located in said passage; fluid by-pass means connected to said passage and operable when open to circulate fluid from the downstream side of the impeller to the upstream side of the impeller; and flow control means in cooperative association with said fluid by-pass to control flow therethrough operative to increase flow therethrough, as the fluid output from said pump decreases below a predetermined minimum wherein said flow control means comprise in combination:

first and second pressure sensing passages;
a pressure comparison chamber;
one end of each of said pressure sensing passages connected to opposed portions of said chamber, the other end of said first pressure sensing passage connected to said main fluid passage upstream of said impeller, the other end of said second pressure passage connected to said main fluid passage downstream of said impeller;
said pressure comparison chamber divided by a slidable partition to isolate each of said pressure sensing passages from the other;
said partition positionable in response to differential pressure in said pressure sensing passages; and
valve control means connected to said partition to control valve position in response to partition position.

6. An inducer for a fluid pump having a main fluid passage comprising:

an impeller rotatably mounted in said passage;
a slidable sleeve having a flange surrounding said impeller and in frictional contact with the wall defining said fluid input passage;
a spring retained within said passage;
said sleeve slidable from a first position to a second position and yieldably biased toward said first position by said spring;
said flange slidable in a recess in said wall and said spring contained in said recess acting against said flange;
at least one recirculating passage having inlet and outlet passages in said main fluid passage, said inlet being downstream of said impeller and said outlet being upstream of said impeller;

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said inlet being defined by the first and second positions of the downstream edge of said sleeve such that when said sleeve is in said first position, said inlet is closed;

a first passage communicating said fluid input passage upstream of said impeller and said recess;

a second passage communicating said fluid input passage downstream of said impeller and said recess; and

said second passage operative to apply fluid pressure to said flange in opposition to said spring to position said flange in said passage and control said inlet.

7. A device comprising in combination:

a high speed centrifugal pump having a fluid inlet passage;

an axial flow inducer located in said inlet passage;

said inducer including a helically bladed rotatable impeller;

recirculatory passages means having inlet and outlet ports in said inlet passage and forming a by-pass around said inducer;

sensing means in communication with said inlet passage operative to sense fluid flow through said inducer; and

valve means in cooperative association with said recirculatory passage means and operatively coupled to said sensing means to control fluid flow through said recirculatory passage means to maintain flow through the inlet passage above a predetermined minimum.

8. The device as claimed in claim 7 wherein said impeller has an operational speed proportional to the operational speed of said pump.

9. The device as claimed in claim 7 wherein said impeller is drivably connected to said pump.

10. The device as claimed in claim 7 wherein said valve means comprise normally closed sleeve valve means.

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