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INLET PIECE FOR A CENTRIFUGAL PUMP

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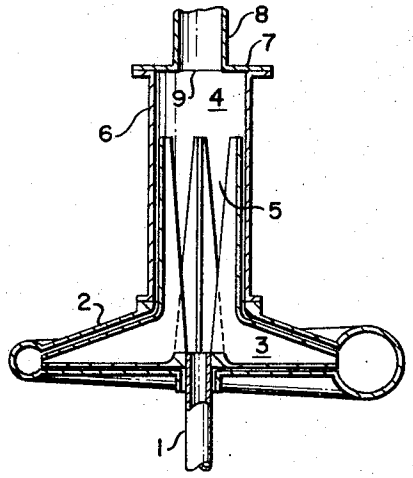

FIG. 1

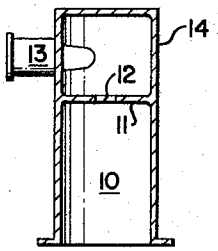

FIG. 2

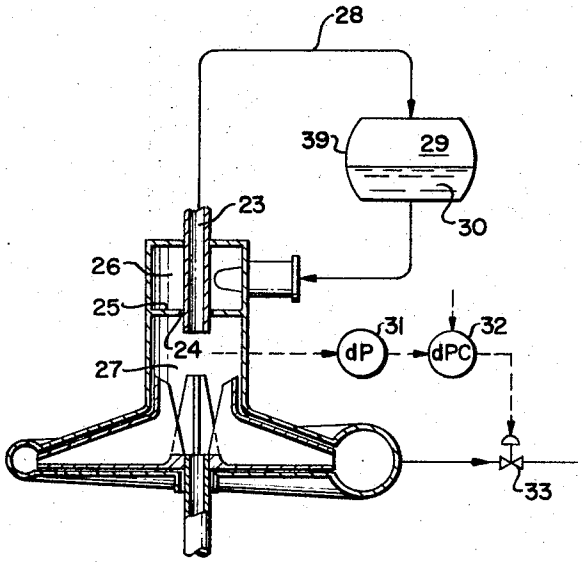

FIG. 4

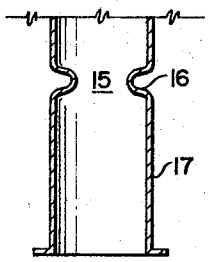

FIG. 3

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INLET PIECE FOR A CENTRIFUGAL PUMP

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This invention relates to an inlet piece for a centrifugal pump for liquids and particularly to a centrifugal pump designed to provide its own suction head.

Centrifugal pumps are used extensively for pumping liquids. In a centrifugal pump the pressure at the delivery side is obtained by imparting a centrifugal acceleration to the liquid means of an impeller. In the inlet opening of the pump, which is located in the center of the impeller, the liquid consequently experiences a pressure drop.

When the liquid enters the impeller the pressure of the liquid must be sufficiently large to prevent the formation of gas or vapor bubbles. If such bubbles are formed, they will implode in regions where a higher pressure exists, causing caviation, which may result in mechanical damage to the impeller. In addition, cavitation greatly reduces the capacity of the pump. The required difference in pressure between the hydrostatic pressure at the inlet opening and the pressure at which gas bubbles are formed is generally termed NPSH (net positive suction head).

The NPSH can be obtained by a variety of methods. A method often applied is one in which the vessel from which liquid is drawn is placed at a sufficiently high level. However, this solution is often uneconomical, particularly when the vapor pressure of the liquid is high. Another solution is the use of a separate pump at the inlet side of the centrifugal pump. However, this solution is expensive since it requires an additional pump and the power to operate it.

It has also been suggested that a centrifugal pump could be provided with impeller blades that have been axially lengthened towards the inlet side. Thus, the separate pump for producing the required NPSH is attached to and driven by the centrifugal pump. In the space where the extensions of the impeller blades are located a rotary motion will be imparted to the liquid which may be sufficient to prevent cavitation.

This construction has several disadvantages. For instance, as a result of the rotary motion of the liquid in the space above the pump, pressure will be exerted on the wall enclosing that space. As a result, the liquid is supplied to the pump inlet opening and still has to be under pressure. Furthermore, this pump cannot be used for pumping liquid whose volume rate of flow varies, because the liquid to be supplied is regulated in dependence on the quantity of liquid that is rotating. At a small supply of liquid the pump or the greater part of it will become dry.

This invention solves the above problems by providing a centrifugal pump having impeller blades extending into an inlet piece which inlet piece consists of a cylindrical rotation chamber positioned coaxial with the pump shaft and having a closed lateral surface. The diameter of the chamber is approximately the same diameter as the inlet opening of the pump housing. The chamber is also provided with a liquid supply line having an outlet located coaxially in the end wall of the chamber. The cross-sectional area of the supply line is smaller than the area of the inlet opening of the pump housing.

The above advantages of this invention will be more easily understood from the following description when taken in conjunction with the attached drawings in which:

FIGURE 1 is a vertical section of a centrifugal pump showing one embodiment of this invention;

FIGURE 2 is a vertical section of a centrifugal pump inlet piece showing a second embodiment of the invention;

FIGURE 3 is a vertical section of a centrifugal pump inlet piece showing a third embodiment of this invention; and

FIGURE 4 is a vertical section of a centrifugal pump inlet piece showing an embodiment of this invention incorporating a gas discharge outlet and a control system therefor.

Referring to FIGURE 1, there is shown an embodiment of the inlet piece 4 constructed according to this invention. The inlet piece consists of a cylindrical chamber 6 having a diameter at least equal to the diameter of the inlet opening 5 of the pump housing 2. The pump shown is provided with a shaft 1 journaled in the pump housing 2. The impeller 3 is secured to the shaft 1 and disposed within the housing 2. The cylindrical chamber 6 is connected to the inlet opening 5 in the pump housing 2 and that has the same diameter as the cylindrical chamber 6. A liquid supply pipe 8 communicates with the center of the closed end piece 7 of the cylinder 6. The cylinder 6 and supply pipe 8 are disposed coaxially with respect to the axis of rotation 1 of the centrifugal pump impeller 3. An inlet piece of this type may for instance consist of two pipe sections differing in diameter, which are welded or coupled together, the liquid being supplied through the smaller pipe.

The rotary motion of the liquid in the inlet piece creates a pressure in the liquid with the pressure being directed radially outwards. The pressure is a highest adjacent the wall of the cylinder 6 and lowest at the center of the cylinder 6. The outlet of the liquid supply device 8 is located centrally in the end piece 7 of the inlet piece 4, hence the entering liquid encounters little or no counter-pressure. It is thus possible for the lateral wall of the cylinder 6 to be designed with sufficient strength to resist the pressure created. The liquid under pressure cannot be forced upward because the area of the outlet of the liquid supply device is smaller than the area of the inlet opening of the pump housing. By making the opening of the inlet piece of the pump as large as possible, for example, equal to the inlet opening of the pump housing, the highest possible pressure will be created. In addition, the outlet of the liquid supply device should be as small as possible and still supply the required quantity of liquid to the pump. It is possible for the inlet piece to form an integral part of the pump housing or as a separate piece fastened to the pump housing.

Referring now to FIGURE 2, there is shown a second embodiment of this invention which consists of a cylindrical chamber 10 with a diameter at least equal to the diameter of the inlet opening of the pump housing. The cylindrical chamber is formed by a cylinder 14 that is closed at one end and fitted with a partition 11 perpendicular to the center line of the cylinder. In the center of the partition 11 there is located an opening 12 that forms the outlet of the liquid supply pipe 13. The cylinder 14 on the upstream side of the partition 11 communicates with the liquid supply pipe 13.

The simplest case of the embodiment shown in FIGURE 2 would consist of a wide inlet pipe in which there is located a transverse partition with a central aperture.

A modification of this embodiment is shown in FIGURE 3 where an inlet pipe 17 is provided with a diameter equal to the diameter of the inlet opening of the pump. The inlet pipe 17 is provided with a constriction 16 having a small central opening 15. The opening 15 should be similar in size to the openings 9 and 12 in FIGURES 1 and 2.

The embodiments shown in FIGURES 1, 2 and 3 all improve the NPSH of the centrifugal pump by causing the liquid in the cylindrical chamber to rotate. The rotation of the liquid can be increased by placing the liquid inlet to the cylindrical chamber tangential to the wall of the chamber as shown in FIGURE 2. The cost of the modifications required of the conventional centrifugal pump is small. Further, while the embodiments shown in FIGURES 1, 2 and 3 utilize a pump having a vertical shaft, the invention can also be incorporated into pumps having a horizontal shaft.

In many cases, as a result of the characteristics of the liquid, it is impossible to prevent the liberation of gas that is entrained in the liquid, for example, boiling liquid. If, under the conditions prevailing in the inlet piece, the gas is non-condensable, for instance, air, a core of gas will form in the center of the cylindrical chamber. This gas cannot enter the impeller of the pump but must be removed from the pump inlet.

One method for removing the gas from the pump inlet is to provide a discharge pipe that extends into the gas core at the pump inlet. The discharge pipe may extend outside the supply line for the pump. In some cases it may be desirable to extend the discharge pipe to the storage tank to obtain a pressure equilibrium between the pump and the storage tank.

Generally, centrifugal pumps for liquids are used in systems having a sufficient supply of the liquid. That is to say, as long as the pump is running, any limitation on the rate at which the liquid is pumped is caused by the pump or by the liquid discharge, not by a reduction in the liquid supply. Liquids whose volume rate of flow varies—and whose flow may even be temporarily stopped—cannot be properly pumped with a centrifugal pump without special equipment. In cases where the liquid supply is interrupted, the impeller, or part of the impeller, may run dry or vapor bubbles may be liberated. Consequently, there is a risk of damage to the impeller.

FIGURE 4 shows a gas discharge pipe **23**, which protrudes through the outlet **24** in the partition **25** between the liquid supply chamber **26** and the cylindrical rotation chamber **27**. By means of a line **28** the pipe **23** is connected to the space **29** over the liquid **30** in a storage vessel **39**. Gauge **31** is a differential pressure gauge which measures the difference in pressure between the liquid present near the wall and the liquid being present closer to the center line of the chamber **27**. The signal from gauge **31** passes to controller **32** which compares this signal with a set value and generates an output signal. The output signal is supplied to a valve **33** in the discharge line of the pump. The controller **32** controls the valve **33** to maintain the differential pressure measured by the gauge **31** within present limits. The preset limits are chosen to insure that the impeller of the pump remains filled with liquid.

The invention thus provides for a control system to be applied to a pump provided with an inlet piece according to the invention, by which the pump may successfully pump liquids whose volume rate of flow varies. For this purpose the discharge line of the pump contains a control device that is positioned by the output of a controller. The controller input is connected to a differential pressure gauge that measures the liquid pressure at the aperture of the impeller.

The flow control device, for instance, may be a valve in the discharge line that will be closed when the measured liquid pressure or the measured pressure difference in the liquid becomes too low as compared with the set value of the controller. This set value is selected to ensure there always remains sufficient liquid in the chamber **27** for the NPSH in the cylindrical rotation chamber when the liquid supply is insufficient and even when the supply stops altogether. In the latter case the valve referred to will be fully closed. When the liquid supply is resumed this liquid is pumped immediately, since the pump is in operation.

I claim as my invention:

1. A centrifugal pump for liquids comprising:

a pump chamber having inlet and outlet openings;

an impeller, said impeller being mounted on a shaft and disposed for rotation in said pump chamber, the blades of said impeller in addition extending into the inlet opening of said pump chamber;

a cylindrical rotation chamber, said rotation chamber having a lateral partition formed therein and disposed normal to the center line of the chamber, said partition having a central opening, said rotation chamber having approximately the same diameter as the inlet opening of said pump chamber, said rotation chamber in addition being connected to the inlet opening of said pump chamber;

a gas discharge tube, said tube being disposed on the center line of the impeller and extending through said partition, the diameter of said tube being less than the diameter of the opening in the partition;

a liquid supply conduit, said conduit leaving an outlet connected to said rotation chamber upstream of said partition.

2. A pump according to claim **1** wherein the supply line of the pump is connected tangentially to the wall of the rotation chamber upstream of said partition, the direction of said tangential connection being such that the direction of the motion of the liquid leaving the tangential connection is the same as that of the impeller of the pump.

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