

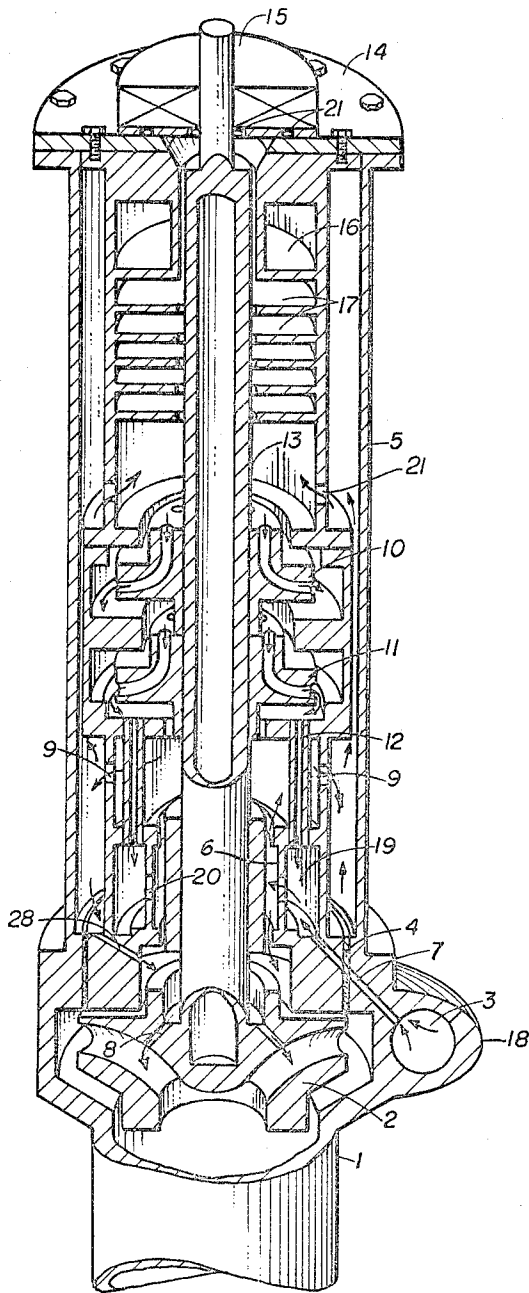
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CENTRIFUGAL PUMP OF THE FREE SURFACE TYPE

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CENTRIFUGAL PUMP OF THE FREE  
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3 Claims

## ABSTRACT OF THE DISCLOSURE

A centrifugal pump of a free-surfaced type is described wherein a portion of the fluid flow recirculates within the pump in the presence of a covering gas. A pair of auxiliary impellers are utilized to control the liquid level within the pump while also preventing flooding of the pump and providing the recirculating fluid therein, for maintaining fluid pressure at a pressurized bearing.

## Background of the invention

The invention relates to a centrifugal pump and more particularly relates to such a pump of the free-surface type. This invention arose in the course of or under Contract AT(11-1)-GEN-8.

Centrifugal pumps are known in the art. One such type of pump is frequently referred to as the free surface type. Such free-surface pumps are frequently used in the nuclear reactor art for pumping liquid metal coolant. Such free-surface type pumps are characterized by the fact that they have no internal seal separating the impeller from the other component parts within the pump casing. Accordingly, in such a vertically oriented pump the fluid rises vertically beyond the level of the impeller; therefore the prior art pumps include a means which is necessary for controlling the level of the fluid in the pump as well as for removing this fluid. Usually an overflow line and internal drains are provided for returning the fluid back to the inlet of the pump. The design of such pumps necessitates certain limitations on the use of the pump as to its position in the fluid system which not only requires additional components but also limits the usefulness and efficiency of the pump. Since oxygen must normally be excluded from any system having liquid metal such as sodium, an inert covering gas, usually of nitrogen or argon, is used in liquid metal pumps.

## Summary of the invention

An object of the invention is to provide an improved free-surface type pump wherein overflow lines are eliminated.

It is an object of this invention to provide a free-surface type pump capable of being used at low points in the piping system whereby large suction pressure is available at the pump.

It is another object of the invention to provide a free-surface type pump capable of operating at high shaft speeds with less danger of cavitation.

A further object of this invention is to provide a free-surface type pump wherein flooding of the pump is prevented by the use of auxiliary impellers to create a pressure greater than the pressure created by the main impeller and of sufficient size to provide a fluid flow greater than the leakage in the pump.

Another object is to provide a pump having a pressurized bearing wherein the fluid to the pressurized bearing is supplied as leakage from the main impeller and is recirculated within the pump casing by the use of auxiliary impellers creating a pressure greater than the pressure of the main impeller to return this fluid to the system.

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The invention provides a centrifugal pump of the free-surface type wherein fluid is permitted to leak beyond the main impeller into the main pump casing. A pressurized bearing region is provided in the casing to absorb radial loads. Leakage fluid builds up or fills a substantial part of the pump casing including the pressure bearing. Auxiliary impellers provide a back pressure on the fluid within the pump casing at a pressure greater than that of the main impeller to recirculate fluid throughout the pump bearing.

## Description of the drawing

The figure shows the cross-section elevational view of a preferred embodiment of the invention.

## Description of the invention

In the figure the operation of the pump is as follows: The incoming pump fluid is admitted to the inlet nozzle 1. The fluid is pumped by means of the centrifugal force created by rotation of the impeller 2 and the fluid exits into the volute or diffuser 3 for supplying a nuclear reactor system (not shown). The impeller is attached to shaft 13 for rotation therewith from an external motor or other driving source. A significant feature of this free-surface type pump is that essentially there is no permanent or complete seal between the main impeller and the other components of the pump; accordingly, the fluid at the inlet is permitted to rise within the pump casing 5 to a level dependent upon the pump and gas pressure and other factors such as the overflow lines in the prior art pumps.

The discharge fluid in the volute 3 is at the discharge pressure created by the main impeller 2 and this fluid passes out the discharge nozzle to the nuclear reactor or heat exchanger as the case may be. A portion of this high pressure fluid leaks through the labyrinth seal 4 which forms the alignment fit between the pump casing and its internal component parts. The leakage fluid from seal 4 collects in the pump casing 5 along with any other leakage fluid existing because of the absence of any permanent seal between the impeller housing 18 and pump casing 5.

High pressure fluid is delivered to the pressurized bearing 6 through the bearing supply line 7 formed in the impeller housing. Recirculatory flow ports 8 serve to return a part of the effluent from the pressurized bearing 6 to inlet side of the impeller; the balance of the leakage from the high pressure bearing passes out the bearing flow port 9 and collects in the pump casing 5 causing the fluid to rise in level within the casing. The fluid rises in the casing and along the rotor shaft until the fluid level reaches the inlet to the upper side of the top auxiliary impeller 10.

The liquid is pumped by the top and bottom auxiliary impellers 10 and 11 respectively to the chamber 19 supplying fluid to the pressurized bearing through the collected fluid return lines 12. Since these auxiliary impellers 10 and 11 pump only liquid rather than gas against the pump discharge pressure, there is no danger of driving gas into the pressurized bearing.

It should be noted that the pressurized chamber 19 receives high pressure liquid flow from both the main and auxiliary impellers. The fluid passes through opening 20 into the bearing along the shaft and the pump casing to the top of the auxiliary impellers.

It is understood in the liquid metal art, that when sodium is in contact with oxygen or air, a violent reaction usually occurs; accordingly, such sodium pump systems usually use a cover gas within the pump casing in the form of nitrogen or inert gas such as argon to prevent such accidents. Such a gas is usually present in the upper half of the pump casing, that is above the auxiliary impellers.

The auxiliary impellers 10 and 11 in this invention are sized and function to deliver slightly more fluid than can

be supplied by the leakage from the labyrinth seal 4 and the pressurized bearing; and they operate in series to deliver a back pressure at the pressure bearing greater than that produced by the pump's main impeller 2. These impellers receive most of their fluid through the supply ports 21.

The pump shaft 13 is supported at the floor plate 14 by a thrust bearing and gas seal assembly 15; thermal protection for this upper pump region is provided by the thermal heat barrier cavity 16 which may include air or conventional insulation and the radiation heat barrier 17.

Drain ports 28 are provided for removing the liquid from the pump casing, when the pump is to be cleaned and aid in reducing the amount of fluid to be pumped by auxiliary impellers 10 and 11.

The significant improvement in this invention is that it eliminates the overflow lines required for prior art free-surface type pumps and it is also possible to discard the gas-vent lines in such prior art pumps. It is, therefore, possible to place this pump at the lowest surface in a piping system since the level of the free liquid surface is determined by the position of the top auxiliary impeller. Furthermore, by maintaining the proper gas pressure in the pump casing it is possible to protect the pump against flooding.

The advantages of this pump are clearly indicated by the fact that this pump can be placed at the lowest point or at a low point in a fluid piping system such that the amount of net positive suction pressure available to the pump inlet is maximized. This condition permits operating the pump at higher shaft speeds with less danger of cavitation and will also permit using a smaller and less costly unit.

The use of the auxiliary impellers to handle the leakage within the pump is certainly an important aspect of this invention such that they control the level of the liquid surface in the pump. In addition, the auxiliary impellers are designed to create a back pressure on the liquid greater than that created by the main impeller to provide a recirculating back flow of liquid to the pressure bearing to exceed the leakage into the main pump body from the main impeller; thus, it is clearly seen that these auxiliary impellers provide an important function in this invention. While we have shown one preferred embodiment of the invention as required, it will be obvious that there are numerous modifications of the individual components of this invention; accordingly, the scope of the invention is defined in the following claims.

I claim:

1. A centrifugal pump of the free surface type comprising a pump casing defining a fluid discharge port, an impeller mounted for rotation within said casing, said impeller and casing providing a leakage flow path therebetween for providing a free-surface liquid level within the pump casing, a pressurized bearing associated with said impeller and adapted for receiving a portion of said leak-

age flow, a bearing supply line connected between said fluid discharge port and said pressurized bearing, means including two auxiliary impellers within said casing and means including a fluid flow port for connecting the pressurized bearing to said auxiliary impeller means for creating a recirculating fluid flow therein for supplying said pressurized bearing with liquid metal flow, and fluid return mains connected for returning fluid from auxiliary impellers to the pressurized bearing.

2. Apparatus as in claim 1 and further including an internal drain means connecting the fluid port means to the main impeller.

3. A centrifugal pump of the free-surface type comprising

an elongated pump casing,  
a pump housing attached to one end of said casing and including an inlet and outlet ports,  
a rotatable shaft extending through said casing,  
an impeller within said housing adapted to pump fluid from the inlet to the outlet when rotated by said shaft,  
a pressurized bearing cooperating with the shaft,  
an annular pressurized chamber formed between the bearing and casing, said chamber adapted to supply liquid to the bearing surface with the shaft,  
a bearing supply line connected between the output port and one end of said chamber for supplying high pressure fluid from the pump housing,  
an auxiliary impeller affixed to the shaft within the casing adapted for pumping fluid accumulated within the casing at a pressure greater than the pressure at the output port,  
a fluid line communicating with the other end of the pressure chamber for returning fluid to the pressure chamber under high pressure created by the auxiliary impeller,  
a drain port connected for returning fluid from the casing to the pump housing,  
and a recirculatory flow port connected for returning fluid from within the casing to the inlet port of the pump whereby bidirectional fluid flow paths are provided between the casing and pump housing and recirculation of fluid with the casing and the pressurized bearing is provided.

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