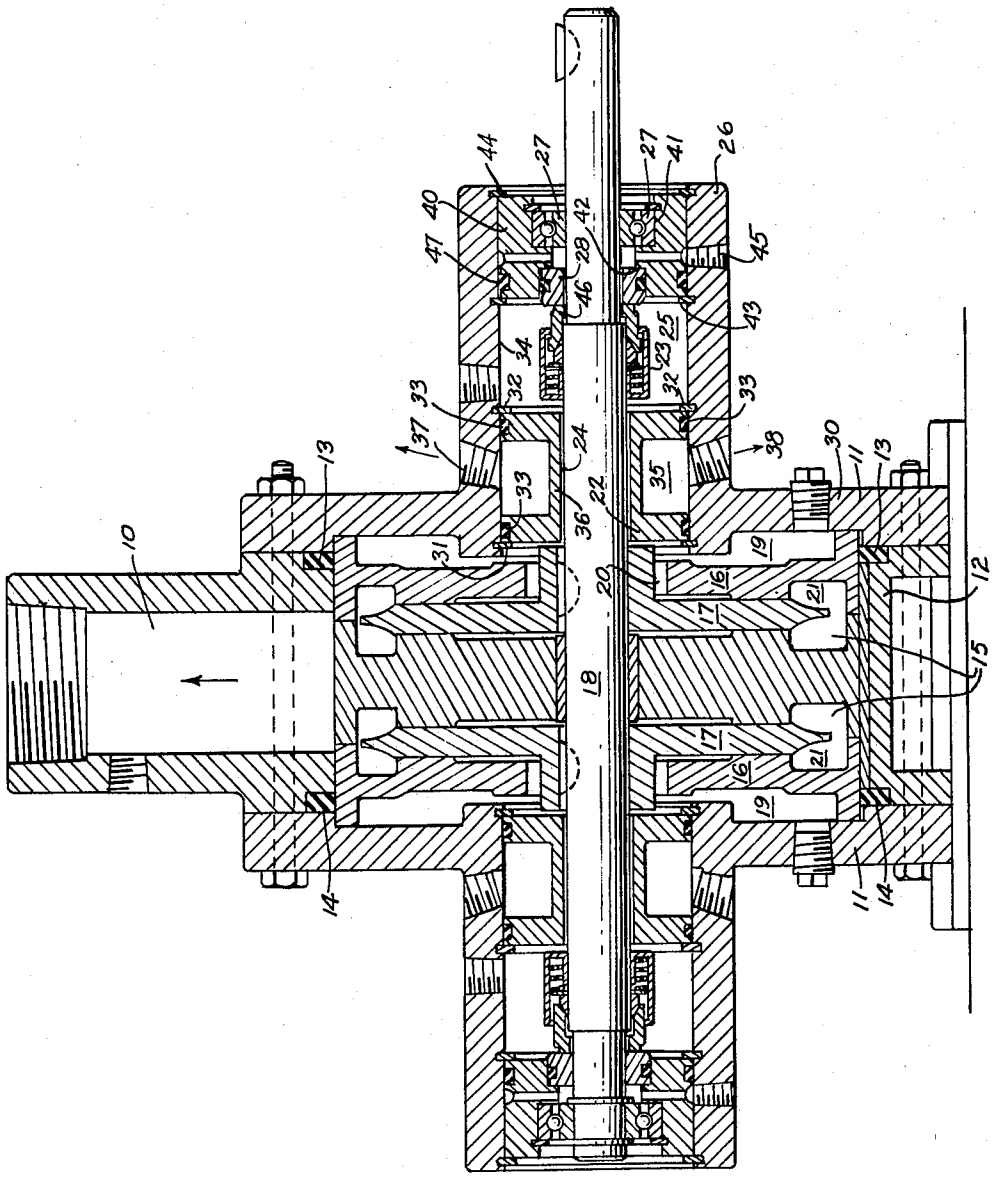
Dec. 16, 1958 J. T. CULLETON 2,864,314

HIGH PRESSURE, HIGH TEMPERATURE PUMP

Filed May 11, 1955



INVENTOR.
JOHN T. CULLETON
BY
ATTORNEY.

United States Patent Office 2,864,314
Patented Dec. 16, 1958

2,864,314

HIGH PRESSURE, HIGH TEMPERATURE PUMP

John T. Culleton, Hayward, Calif., assignor to Pacific Pumping Company, Oakland, Calif., a corporation of California

Application May 11, 1955, Serial No. 507,601
2 Claims. (Cl. 103—96)

This invention relates to improvements in fluid pumps and particularly to pumps adapted for pumping liquids at high temperature and under high pressure.

The pumping of liquids when close to their flash point, such as in the condensate return system in a steam heating plant for drying plywood, has proved particularly troublesome because in such a case the optimum condition is to return the condensate to the boiler with the minimum possible heat loss. The rotating pump shaft must be sealed against loss of fluid and pressure along the shaft. The heat generated by the shaft seal is often enough to raise the temperature of the liquid back to its flash point, thereby robbing the shaft seal of the lubricating effect the fluid has when in liquid form.

It is therefore an object of the present invention to provide a pump construction which will assure the retention of the fluid in liquid form in the housing adjacent the bearings and yet will leave the fluid in the pumping zone of the pump housing at an elevated temperature on one side or the other of its flash point.

Another object of the invention is to effect heat savings in lower fuel costs and less maintenance on the boiler because by maintaining the fluid condensate in the pumping zone at as high a temperature as possible there is less work for the boiler to do in lifting this condensate to its vapor phase.

Another object of the invention is to reduce the amount of "make-up water" needed in operating a boiler, thereby saving in water treatment costs.

Another object of the invention is to eliminate the extra parts usually needed in the fluid system where there is a substantial drop in temperature of the condensate, such parts being the traps, steamers, checks, valves and fittings.

Another object of the invention is to reduce the back pressure on the device in which the steam is being used, for example in a plywood dryer, and thereby achieve a greater steam flow, increase the capacity of the dryer and use practically no energy from the steam to move the condensate.

Another object of the invention is to reduce the horsepower needed in the pump for returning the liquid to the boiler, the extra horsepower being saved because the condensate is returned to the boiler at a temperature and pressure only slightly below that in the boiler.

These and other objects will be apparent from the following description of a preferred embodiment of the invention, given to explain its principle and functioning so that those skilled in the art may practice it upon the expiration of this patent. In thus complying with the statute, it is not the inventor's intention to limit the invention to this one form, as its principles may be practiced in other forms.

The single figure of the drawings is a cross-sectional view in elevation of a fluid pump in which is incorporated the structure of the invention.

The invention is especially adaptable to use in any pump where the fluid being pumped is at an elevated temperature close to its flash point and where it is desirable, for reasons already stated, that this temperature should be maintained in the pumping chamber, but where the circulation of the fluid at that temperature near the

pump shaft seal will cause it to flash into its vapor phase and thereby deprive the pump of the lubricating effect the fluid has while in its liquid phase. The alternative heretofore has been to cool the fluid being pumped so that the friction of the pump shaft seal would not generate enough heat to raise the fluid to its flash point.

For purposes of illustration I have shown a twin impeller pump of a well-known type, which I have altered in the areas on each side of the pump housing proper where my invention is placed. To shorten this description only one half of the device in the drawing will be referred to in detail as it is a duplicate of the other half.

The pumping zone proper may be any satisfactory construction having provision for entry of the fluid (not shown) and an outlet **10** connected to the line leading back to the boiler (not shown). The pump end housings **11** are suitably secured to the central housing member **12**, with O ring sealing members **13**, **14** effecting a leak tight fit to form a pumping zone **15**, inside of which are fitted the usual replaceable pump liners **16** in close proximity to the pump impellers **17**. The latter are keyed to the pump shaft **18**. Suitable passageways in the pump housing (not shown) conduct the fluid from the inlet to the outlet **10**. Some of these are shown at **19**, **20** and **21**.

As stated, my invention is employed adjacent the pumping zone where it is desired to maintain some of the fluid being pumped at a lower temperature than the fluid in the pumping zone. This is accomplished by means of a partition **22** between the shaft seal **23** and the pumping zone **15**, with the partition having sufficient openings or a clearance **24** to admit a small flow of fluid into the seal chamber **25**, and having means for cooling the condensate that flows past it from the pumping zone **15** into the seal chamber **25**. To have room for the cooling partition or sleeve **22** in the end housing **11** of an existing pump, new end housings were made having an extended tubular member **26** to carry the shaft bearings **27**, the shaft seals **23** and the cooling partitions or sleeves **22**. It also was necessary to make the shaft **18** longer.

Detail on the form of pump used to describe my invention shows the end housing **11** having the radial end wall **30**, with the cylindrical tubular member **26**. Inside the latter is assembled the annular cooling sleeve **22**, held in place by spring lock rings **31** and **32** with O rings **33** sealing the sleeve **22** against the bore wall **34**. The cooling sleeve **22** is U-shaped in cross-section so that its open side forms, with the bore wall **34**, an annular jacket **35** in which cooling water is circulated. It has a thin wall at **36** where the heat is to be drawn out of the condensate as it flows into the seal chamber **25**. Suitable ports **37** and **38** are provided in the end housing **11** to get the cooling water into and out of the annular jacket **35**. The inside diameter of the bore forming the annular wall **36** will be slightly larger than the diameter of the shaft **18** to form a gap or passageway **24** between the pumping zone **15** and the sealing chamber **25**. The size of this gap will be determined by the temperature drop desired between the fluid in the pumping zone and in the sealing chamber, and the relative effectiveness of the cooling chamber **35**. In a pump used on a condensate return line where the cooling water was introduced at 50° F., where the wall **36** was ⅛" thick, and where the pump shaft **18** was ⅞" in diameter, I obtained satisfactory operating results with a 1/64" clearance at **24** between the shaft and the wall **36**.

At the outer end of the sleeve **26** and spaced from the annular cooling member **22** is the shaft bearing **27** and the shaft seal member **28**. Both of the latter are shown mounted in a ring **40** having an annular recess **41** to receive the outer race of the bearing **27** and a recess **42**

to receive the stationary sealing face 28 of the shaft seal. The ring 40 is held in by the lock rings 43 and 44 with an O ring 47 to seal the ring 40 in the sleeve 26. A bearing lubricating port is provided at 45. The movable portion 23 of the shaft seal is secured on the shaft 18 with a press-tight fit so the matched sealing face 46 bears against the stationary sealing face 28. It is the friction generated by these sealing faces which in the past has caused the condensate adjacent them to flash into a vapor phase thereby depriving them of the lubricating effect of the condensate when in its liquid plane.

I have discovered that by fencing off the sealing chamber from the pumping zone with only a small passageway for the condensate to go from one to the other, and by cooling the condensate that does flow into the sealing chamber, I can cool the small amount of condensate in the sealing chamber so it does not flash back to a vapor phase and I can preserve the condensate in the pumping zone at a temperature very close to its flash point so that when it gets back to the boiler, very little heat is required to turn it into steam.

Sample temperatures taken on an experimental device showed that in the pumping zone the condensate under pressure was from 350 to 400 degrees F.; the condensate that passed along the passageway 24 into the sealing chamber 25 was from 85 to 90 degrees F.; and the cooling water circulating in the cooling jacket 35 was from 40 to 70 degrees. The result was the life of the shaft seal was many times greater than ever before in this type device; the boiler had less work to do; and the pump was shut down for repairs very infrequently compared to earlier devices.

Thus this invention brings a new principle of operation into pumps for fluids, where the fluids are being pumped at temperatures close to their flash point. The concept of the organization is new and the results obtained solve a long standing problem in this art. Prior to this invention, the inventor and others in the art have tried with liquid cooled jackets to lower the temperature of the fluid at the shaft seals to add life to the seals, but these efforts have failed. They failed for several reasons, one being that in the case where condensate is being pumped back to the boiler, the heat generated by friction of the shaft seal parts is enough to flash the condensate from a liquid to a gaseous state. This deprived the seal parts of the necessary lubricating effect of the liquid and resulted in scored shafts and prematurely worn seal parts. On the other hand, when the cooling jacket around the shaft seals was made more effective to prevent the liquid from flashing to a vapor phase, the temperature of the condensate was lowered so much as to require the boiler to do extra work in heating it up. This cost extra fuel and time.

There are several ways the structure which produces the new principle of the present invention might be described. One would be to view it as means for dividing the pump into separate zones, so that the pumping area is in one zone and the shaft sealing device or devices is in its own sealing zone. These zones are separated by a liquid jacketed means extending in close to the shaft but spaced from it just far enough to permit some of the fluid being pumped to flow into the shaft seal zone. This has the practical effect, first, of cooling the condensate well below its flash point as it goes by the liquid jacketed cooling means into the sealing zone; second, of confining in the shaft sealing zone this cooled condensate so it does not mix particularly with or cool the condensate being handled in the pumping zone, and third, of assuring the presence of a liquid in the shaft sealing area to serve as a lubricant.

One practical effect has been to lengthen the life of the shaft seals from 18 days to several months. Another practical effect has been to reduce the fuel bills for firing the boiler. One installation on which experimental use of the device was made effected a saving of about $1000 a month in fuel, primarily because the condensate was returned to the boiler at a temperature so high, it took very little heat to raise it to a vapor phase.

To those skilled in the art to which this invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the spirit and scope of the invention. The disclosures and the description herein are purely illustrative and are not intended to be in any sense limiting.

I claim:

1. A pump for hot fluids, including in combination a housing with inlet and outlet ports; a shaft mounted for rotation in said housing; a pump impeller mounted rigidly on said shaft; a face-type shaft-sealing assembly having a first face-seal member rotatably mounted on said shaft, a second stationary face-seal member mounted on said housing, and spring means urging a face of said first member into sealing contact with a face of said second member; and partition means between said impeller and said shaft-sealing assembly, forming part of said housing, dividing the interior of said housing into a pumping zone and a sealed chamber, and providing relatively narrow clearance around said shaft, sufficient to allow restricted entry of fluid from said pumping zone into said sealed chamber, said partition being provided with passage isolated from both said pumping zone and said chamber for circulating a coolant therethrough to cool the fluid passing through said clearance, whereby a cooled small fraction of the fluid being pumped lubricates the faces of said face-type shaft sealing member so as to protect them against wear during their relative rotation against each other with their sealing action, said cooling preventing vaporization of the fluid and resultant loss of its lubricity from the heat of friction caused by relative rotation of said seal faces against each other.

2. A pump for liquid close to its boiling point, and under high pressures, including in combination a housing with inlet and outlet ports leading into and from an interior; bearings secured in said housing; a shaft mounted for rotation on said bearings; a pump impeller mounted rigidly on said shaft; a face seal having a first member rotatably mounted on said shaft, a second member mounted stationary on said housing, and spring means urging a face of said first member into sealing contact with a face of said second member, said face seal separating the interior of said housing and the liquid therein from said bearings; and partition means between said impeller and said face-seal, forming part of said housing, dividing the interior of said housing into a pumping zone and a sealed chamber, and providing relatively narrow clearance around said shaft, sufficient to allow restricted entry of liquid from said pumping zone into said sealed chamber, said partition being provided with a passage isolated from the interior of said housing for circulating a coolant therethrough to cool the liquid passing through said clearance, whereby a cooled small fraction of the liquid being pumped lubricates said faces of said face-seal so as to protect them against wear due to their rotating relatively while sealing against each other, the cooling of the liquid preventing vaporization of the liquid and resultant loss of its lubricity from the heat of friction caused by relative rotation of said seal faces against each other.

References Cited in the file of this patent

UNITED STATES PATENTS

2,203,525	Dupree	June 4, 1940
2,427,656	Blum	Sept. 21, 1947
2,493,602	Sterrett	Jan. 3, 1950
2,555,492	Kidney	June 5, 1951

FOREIGN PATENTS

114,725	Austria	Oct. 25, 1929
651,299	Great Britain	Mar. 14, 1951