Oct. 26, 1965 S. A. CARSWELL 3,213,798

SEALING AND COOLING DEVICE FOR A PUMP SHAFT

Filed March 16, 1964 3 Sheets-Sheet 1

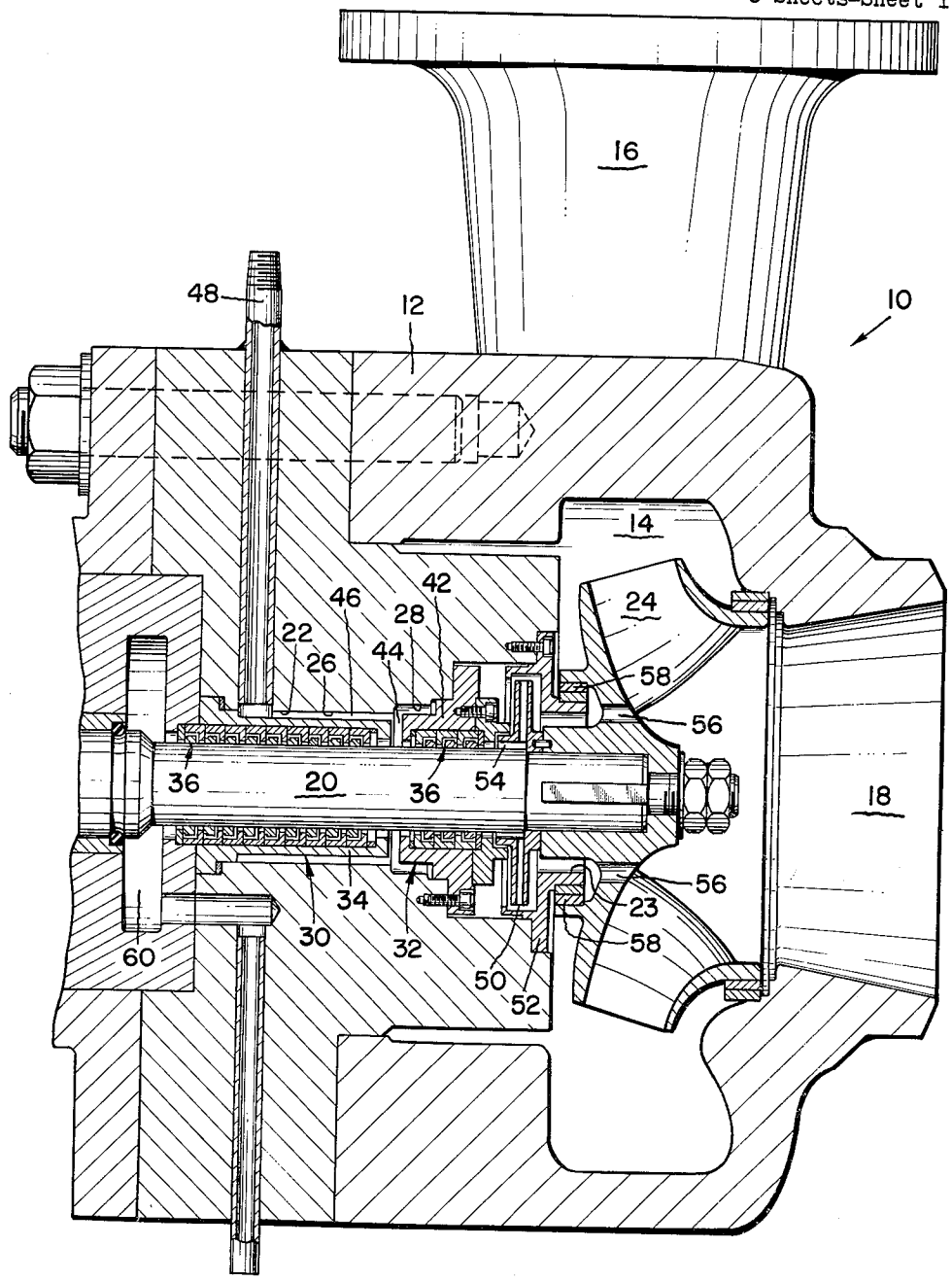

FIG. 1

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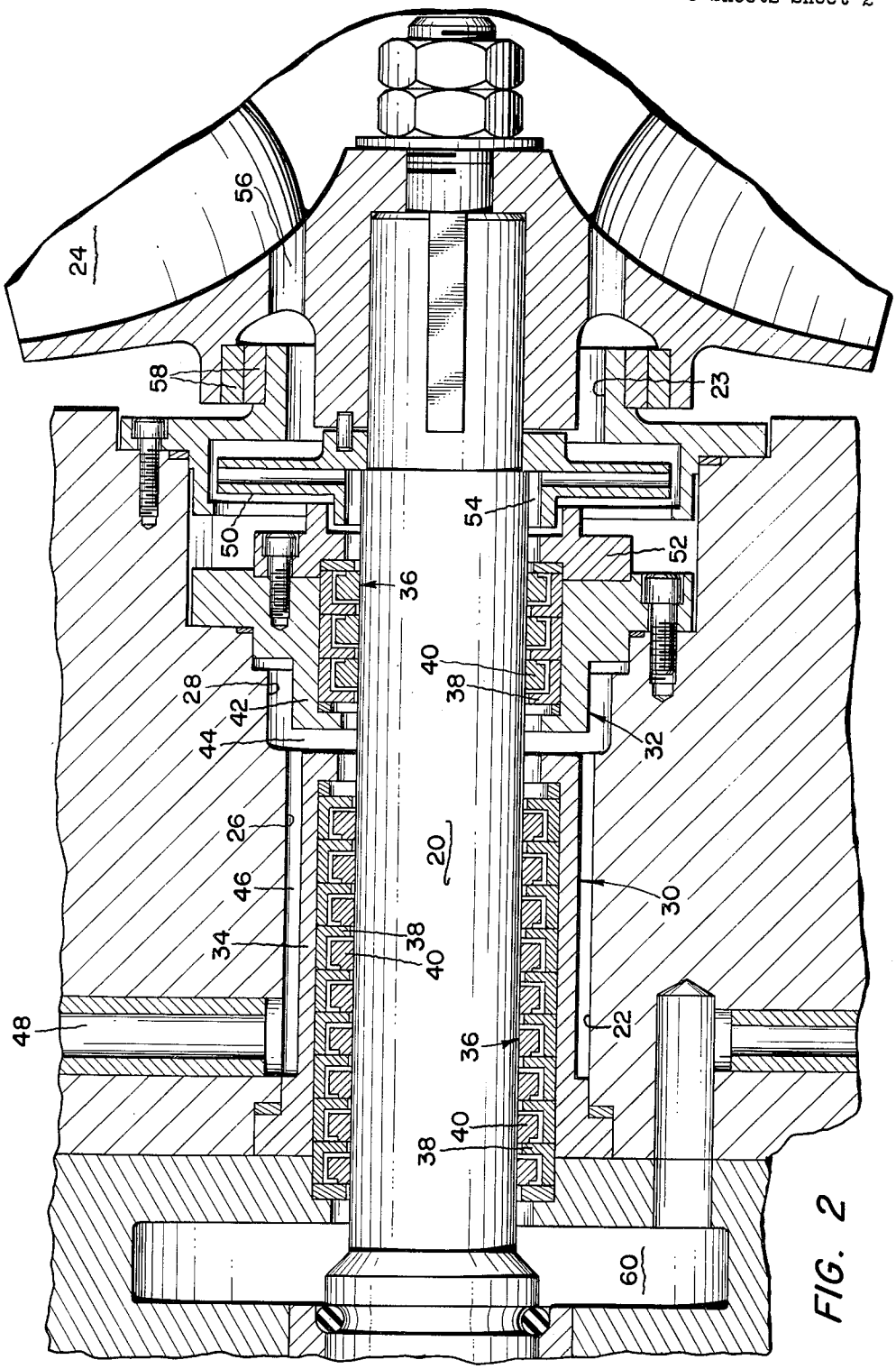

FIG. 2

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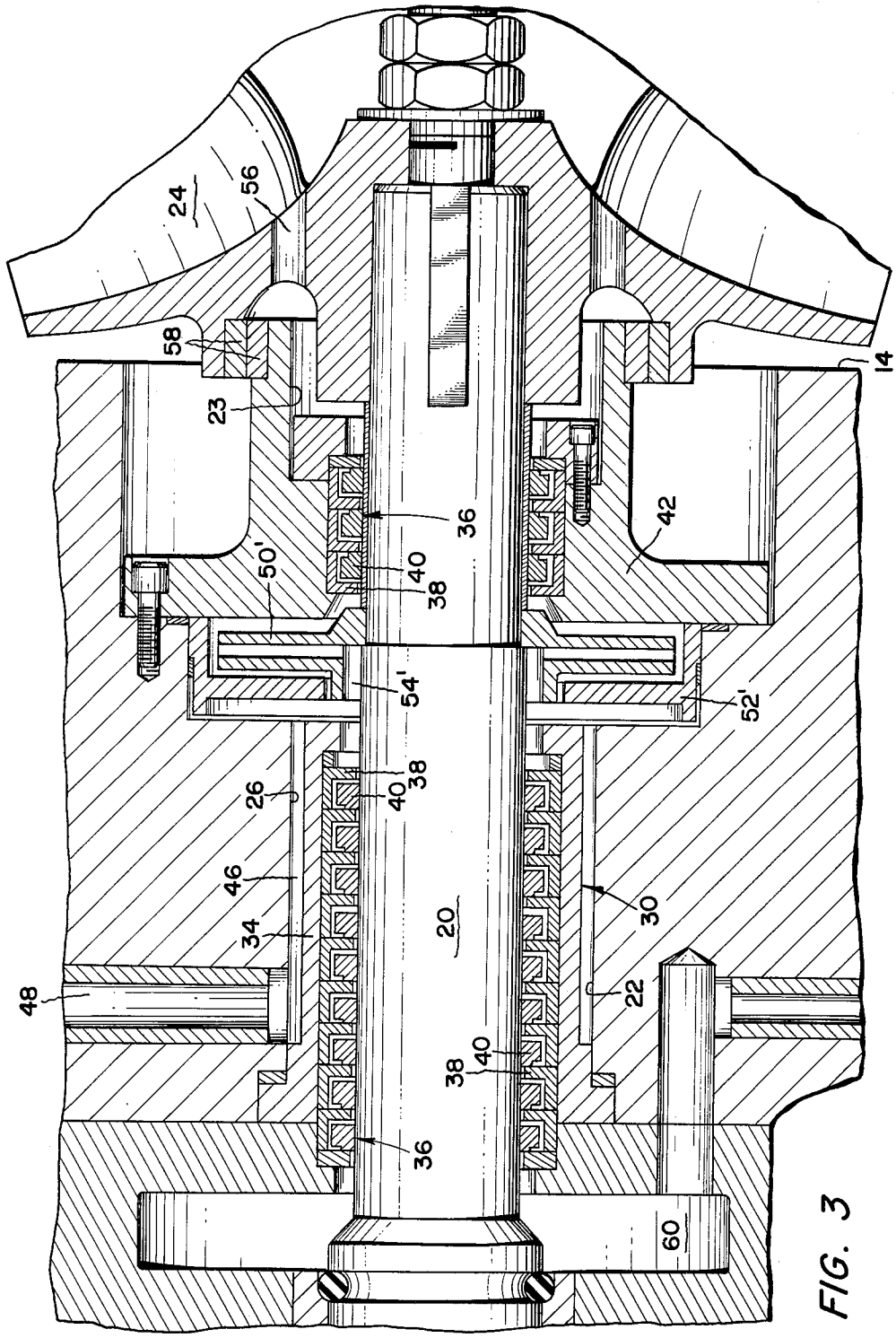

FIG. 3

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SEALING AND COOLING DEVICE FOR A PUMP SHAFT

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This invention relates in general to seals for rotary shafts and more in particular to a sealing and cooling arrangement for a shaft of a rotary pump.

For many rotary pump uses, particularly those for boiler feed and boiler circulation requiring pumping of water of high pressure and high temperature, it is important that the fluid being pumped is prevented from leaking out of the pumping or impeller chamber along the shaft and into the adjacent seal chamber for the shaft of the pump. This causes overheating of the shaft and associated components, or, when leaking along the shaft to atmosphere, causes the water to flash into steam.

In present type boiler circulating pumps in which a commonly known sealing arrangement in the seal chamber of the pump is used, such as shown in FIGURE 1 but without the auxiliary impeller, injection water at low temperature and at a pressure higher than the circulating pump pressure is usually taken from the boiler feed pump and introduced into the stuffing box or seal chamber formed in the pump casing. The injection water is conducted to flow along the shaft into the pumping or impeller chamber of the pump for purposes of cooling the shaft and preventing the high temperature water present in the impeller chamber of the pump to leak therefrom along the shaft and into the adjacent seal chamber. However, under certain conditions, and in particular at low boiler loads when the boiler feed pump operates at variable speeds, the pressure of the injection water decreases to equal to or even lower than the suction pressure of the circulating pump. This results in either stagnation of the injection water in the seal chamber of the pump casing, or back flow of the high temperature high pressure water from the impeller chamber along the shaft and into the seal chamber causing overheating of the the shaft and flashing of the water into steam when the water leaks off to atmosphere.

In order to avoid these objectionable results, the pump is provided with an auxiliary impeller and auxiliary impeller housing positioned adjacent the main impeller chamber to create a constant pressure drop at the eye of the auxiliary impeller relative to the pressure of the injection fluid. In this manner the injection fluid flows constantly to the auxiliary impeller from where it is pumped into the main impeller chamber independent of the pressure of the injection fluid, thereby insuring prevention of escape of the high pressure high temperature water from the main impeller chamber along the pump shaft and into the seal chamber.

According to the invention, the pump includes an impeller chamber and a seal chamber through which the pump shaft extends. In the seal chamber is provided a sealing means adapted to permit a limited flow of cooling fluid introduced into the seal chamber to flow through the clearance between the sealing means and the shaft, and, an auxiliary impeller mounted on the pump shaft to rotate therewith to cause the cooling fluid to flow constantly along the shaft from the seal chamber into the impeller chamber to prevent the fluid in the impeller chamber to flow therefrom into the seal chamber.

An object of this invention is to provide an effective cooling and sealing arrangement for the shaft of a boiler feed pump.

Another object of this invention is to provide a simple and reliable cooling and sealing arrangement for the shaft of a boiler feed pump.

Yet another object of this invention is to provide for increased pump life and pump efficiency.

Other objects and advantages of the invention will be apparent from the following description taken in conjunction with the accompanying drawings wherein like reference numerals refer to like parts, and in which:

FIGURE 1 is a longitudinal section through a part of a centrifugal pump showing the preferred embodiment of the invention,

FIG. 2 is an enlarged sectional view of the part of FIG. 1 showing the preferred embodiment of the invention, and

FIG. 3 is a longitudinal section through a part of a centrifugal pump showing an alternate structure of the invention.

Referring to the drawings, **10** designates a centrifugal type pump having a pump casing **12** within which is formed an impeller chamber **14** and a discharge **16** for the impeller chamber. The impeller chamber **14** is provided with an axial inlet **18** for admittance of fluid to be pumped. A rotating shaft **20** driven and supported by suitable means (not shown) is received in a bore **22** of the pump casing, one end of the shaft **20** extending through a bore **23** in the wall of the impeller chamber and into the impeller chamber **14** to carry an impeller **24** in a commonly known manner.

Bore **22** forms a seal chamber including a rear chamber **26** and a forward chamber **28**, each chamber having therein disposed a commonly known floating ring type sealing arrangement **30** and **32**, respectively. The floating ring type seals **30** and **32** are of the type wherein there is no contact between the sealing elements and the shaft but where the seal is obtained by maintaining a close clearance between the shaft and the sealing elements and providing for a limited flow of fluid through the clearance and along the shaft. Sealing arrangement **30** includes an elongated sleeve-like retainer **34** carrying a plurality of ring shaped sealing elements **36**, each sealing element being formed by a washer **38** and a sealing ring **40**. The sealing elements are adapted to cooperate with each other, with the inner periphery of the retainer, and with the shaft to permit a limited flow of fluid along the shaft through the clearances between the shaft and the sealing rings **40**. Sealing arrangement **32** includes a relatively short sleeve-like sealing element retainer **42** carrying the same type sealing elements but fewer than carried by retainer **34**.

The opposing ends of retainers **34** and **42** are spaced from each other to form a passage **44** into which injection fluid is conducted from a passage **46** formed between the periphery of bore **22** and retainer **34** and from conduit **48**. The injection fluid introduced into conduit **48** is usually provided by the boiler feed pump, however, it can be taken from any other suitable source of supply.

In order to provide for a constant flow of the injection fluid along the shaft and into the main impeller chamber **14** to prevent the fluid in the main impeller chamber **14** from flowing therefrom and along the shaft into the shaft housing, an auxiliary impeller **50** and corresponding housing **52** are provided and mounted intermediate the wall of main impeller chamber **14** and retainer **42**. Auxiliary impeller **50** is preferably mounted on shaft **20** and connected to impeller **24** to rotate therewith. The eye **54** of auxiliary impeller **50** is in communication with the interior of retainer **42**, while the discharge of auxiliary impeller **50** is conducted through the auxiliary impeller housing **52**, bore **23**, passages **56** formed in the back shroud of impeller **24**, and into the flow path of the fluid flowing from the eye of impeller **24** into main im-

peller chamber **14**. It is to be noted that the location of passages **56** through the back shroud of main impeller **24** is chosen in a low pressure area close to the inlet of the main impeller relative to the high pressure area at the discharge of the main impeller to provide for a relatively low dicharge pressure of the auxiliary impeller.

A commonly known sealing arrangement formed by back rings **58** is provided to prevent the flow of the high pressure discharge fluid of main impeller **24** into the flow path of the low pressure discharge fluid of the auxiliary impeller **50**.

During operation of pump **10**, injection water supplied by the boiler feed pump at lower temperature than the temperature of the water being pumped through main impeller chamber **14** is conducted through conduit **48** and passage **46** to passage **44**. As auxiliary impeller **50** is rotating with main impeller **24**, an under pressure relative to the pressure of the injection water is created at the eye **54** of the auxiliary impeller **50**, urging a portion of the injection water in passage **44** to flow through the clearance formed between the sealing elements in retainer **42** and the associated portion of shaft **20** into the the auxiliary impeller **50**. The auxiliary impeller then pumps the injection water through the auxiliary impeller housing **52**, bore **23**, and passages **56** of main impeller **24** into the flow path of the water being pumped by main impeller **24**. The other portion of the injection water flowing through passage **44** is conducted to flow through the clearance formed between the sealing elements in retainer **34** and the associated portion of the shaft **20** into a chamber **60** formed downstream of the flow of injection water through sealing arrangement **30** from where it is discharged in any suitable manner.

An alternate structure of the invention is shown in FIG. 3. In this structure the auxiliary impeller **50'** and corresponding housing **52'** are positioned between the sealing arrangements **30** and **32**, auxiliary impeller **50'** being mounted on shaft **20** in any suitable manner to rotate therewith. With this arrangement a portion of the injection water supplied through conduit **48** and passage **46** is drawn into the eye **54'** of the rotating auxiliary impeller **50'** and pumped thereby through the clearance formed between the sealing elements in retainer **42** and the associated portion of shaft **20** into bore **23**, passages **56** of main impeller **24** and into the flow path of the water being pumped by main impeller **24**. The other portion of the injection water flowing from conduit **48** and passage **46** is conducted to flow through the clearance formed between the sealing elements in retainer **34** and the associated portion of shaft **20** into chamber **60** from where it is discharged in any suitable manner.

It will be understood that the invention is not intended to be limited to the specific construction or arrangement of parts shown, but that they may be widely modified within the invention defined by the claims.

I claim:

1. A sealing and cooling device for a shaft of a rotary pump which is adapted for pumping fluid of relatively high temperature, said device comprising:

a casing having an impeller chamber and a seal chamber in communication with each other through an axial passage in a common wall between said chambers;

a rotatable shaft extending through said seal chamber and having an end extending with clearance through said axial passage into said impeller chamber;

a primary impeller carried by said shaft within said impeller chamber for rotation therein;

a plurality of axially spaced groups of annular seals surrounding said shaft in spaced relationship thereto within said seal chamber for permitting a restricted flow of fluid along said shaft intermediate said annular seals and said shaft;

means for introducing cooling fluid into said seal chamber intermediate said groups of annular seals such that portions of said cooling fluid flow continuously between each of said groups of annular seals and said shaft towards the opposing ends of said shaft; and

an auxiliary impeller upon said shaft within said seal chamber for rotation therein for directing the portion of said cooling fluid that flows towards said impeller chamber through said axial passage in said wall into said impeller chamber.

2. A cooling and sealing device according to claim **1** wherein said auxiliary impeller is disposed within said seal chamber adjacent said common wall between said seal chamber and said impeller chamber.

3. A cooling and sealing device according to claim **1** wherein said auxiliary impeller is disposed within said seal chamber intermediate said axially spaced groups of annular seals.

4. A cooling and sealing device according to claim **1** wherein said casing includes fluid carrying means adjacent the end of said rotatable shaft opposite to that carrying said primary impeller for carrying cooling fluid directed towards said former mentioned end of said rotatable shaft from said rotatable shaft.

References Cited by the Examiner

UNITED STATES PATENTS

2,708,126	5/55	McLachlan et al.	103—111
3,128,713	4/64	Nichine	103—111
3,162,135	12/64	Nichols et al.	103—111

FOREIGN PATENTS

378,091	7/23	Germany.
592,327	2/34	Germany.
652,168	10/37	Germany.
881,400	11/62	Great Britain.
422,115	1/47	Italy.

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