United States Patent [19]
Magni

[11] 3,744,935
[45] July 10, 1973

[54] **COOLING SYSTEMS FOR MOTOR DRIVEN PUMPS AND THE LIKE**

[75] Inventor: **Reinald G. Magni**, Croydon, Pa.

[73] Assignee: **Crane Co.**, New York, N.Y.

[22] Filed: **Oct. 7, 1971**

[21] Appl. No.: **187,361**

[52] **U.S. Cl.** **417/370**, 417/84, 417/366, 417/901

[51] **Int. Cl.** **F04b 39/02**, F04b 39/06

[58] **Field of Search** 417/366, 368, 369, 417/370, 371, 901, 84; 62/505, 45, 55; 60/260

[56] **References Cited**

UNITED STATES PATENTS

3,241,331	3/1966	Endress et al.	62/505 X
2,292,617	8/1942	Dana	417/901 X
1,736,002	11/1929	Frickey et al.	417/366
3,561,217	2/1971	Hall	60/39.46 X

Primary Examiner—Carlton R. Croyle
Assistant Examiner—R. J. Sher
Attorney—George S. Schwind

[57] **ABSTRACT**

Cooling systems for motor driven pumps and the like are disclosed which include the use of a sub cooler applied to motor driven pumps and the like that impel low boiling fluids and include provisions for bleeding a small portion of the pumped fluid, flashing the fluid for cooling, using the vapor to cool the pumped fluid and/or circulating the vapor around the pump to cool the bearing and other critical areas susceptible to excessive heating.

6 Claims, 6 Drawing Figures

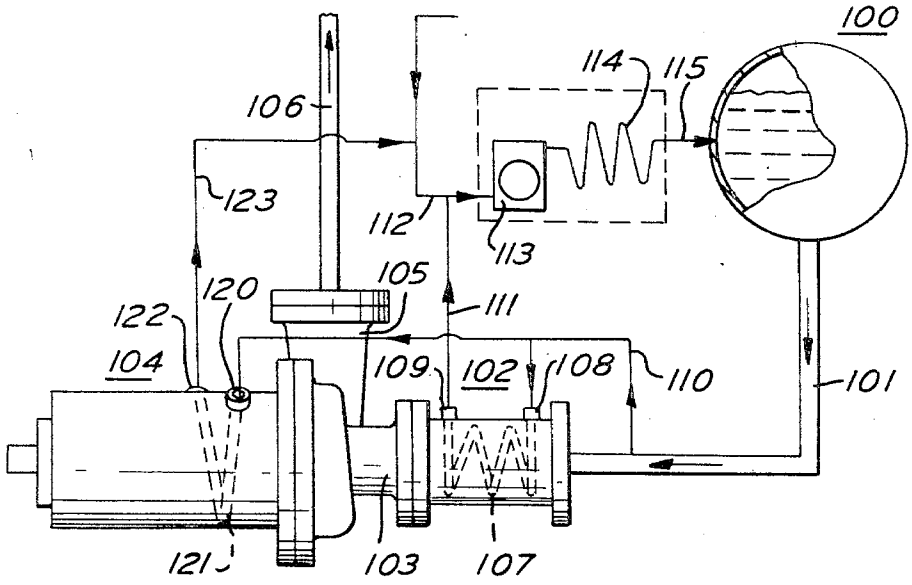
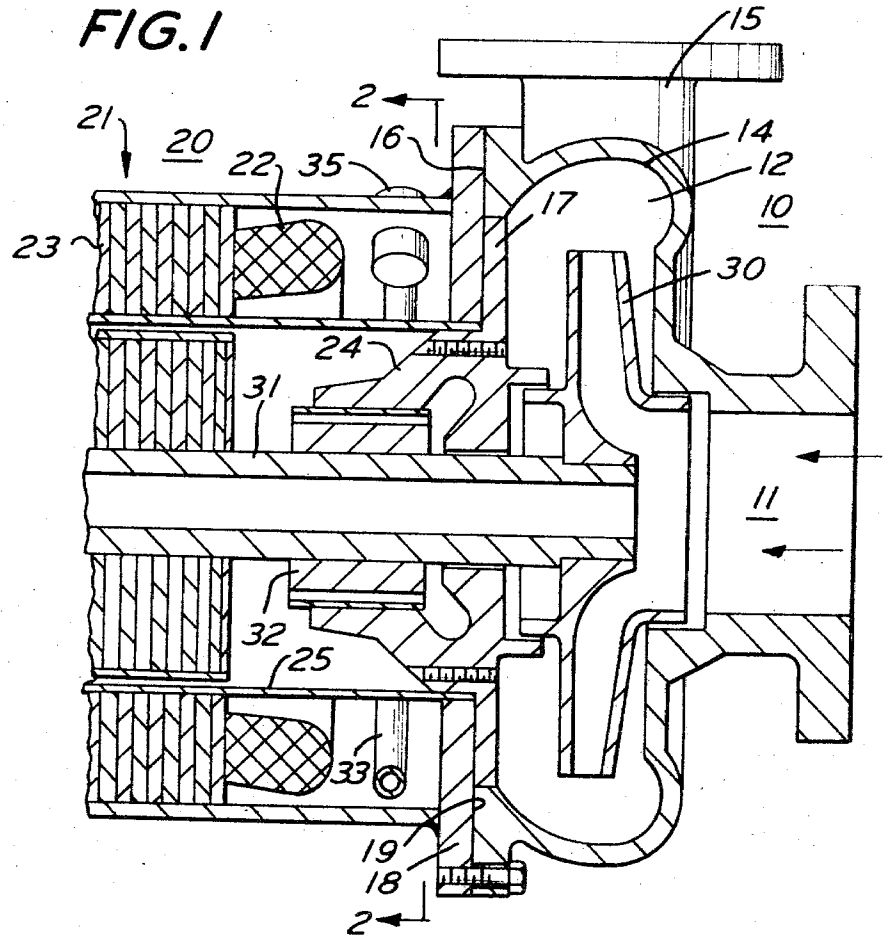


FIG. 1


15
2
21
20
16
14
22
35
12
17
10
23
30
24
31
11
32
25
33
19
18
2

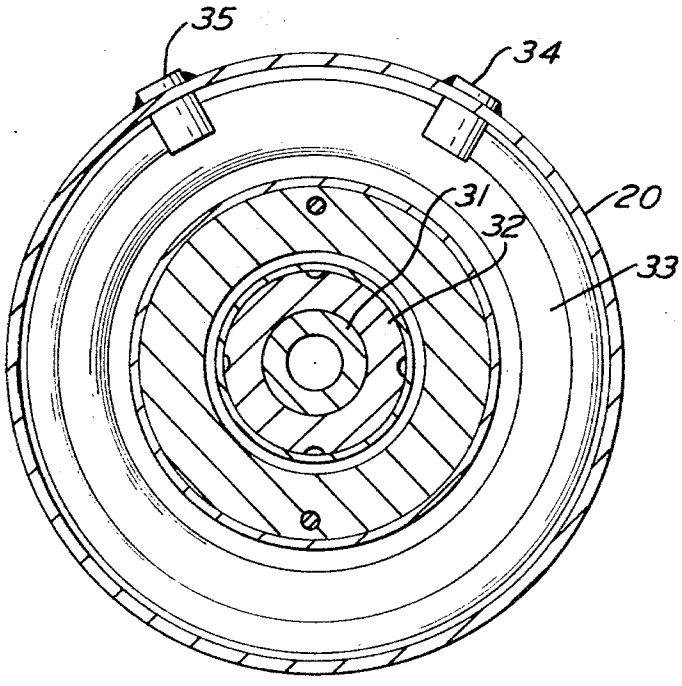

35
34
31
20
32
33

FIG. 2

FIG. 3

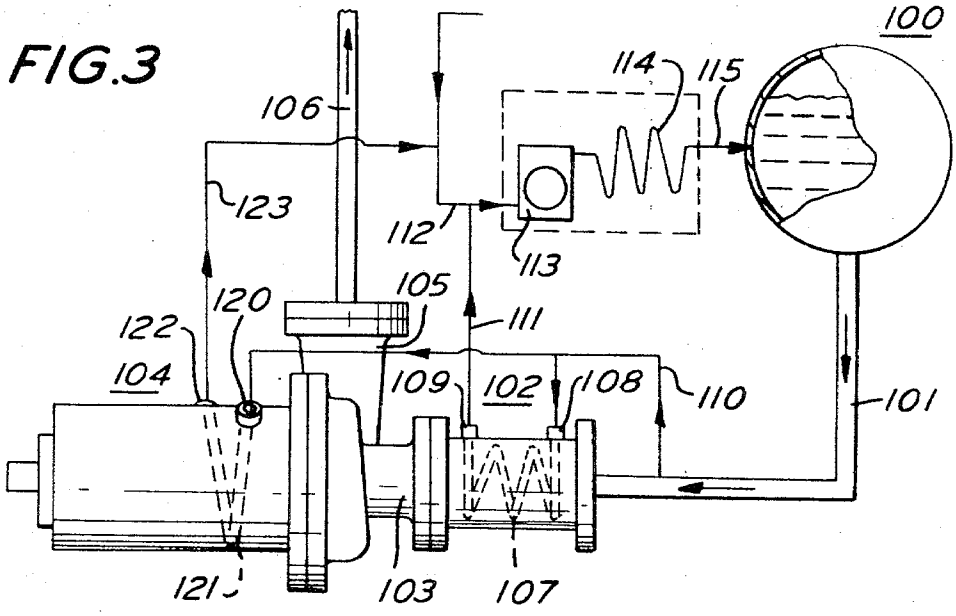

100
114
115
106
123
112
113
105
120
111
122
104
109
102
108
110
101
121
103
107

FIG. 4

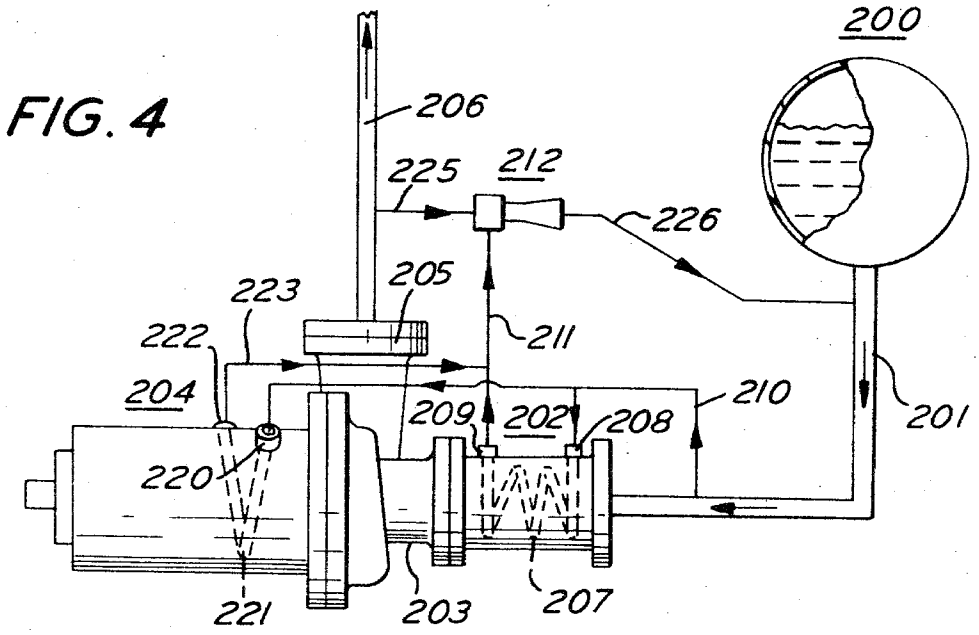
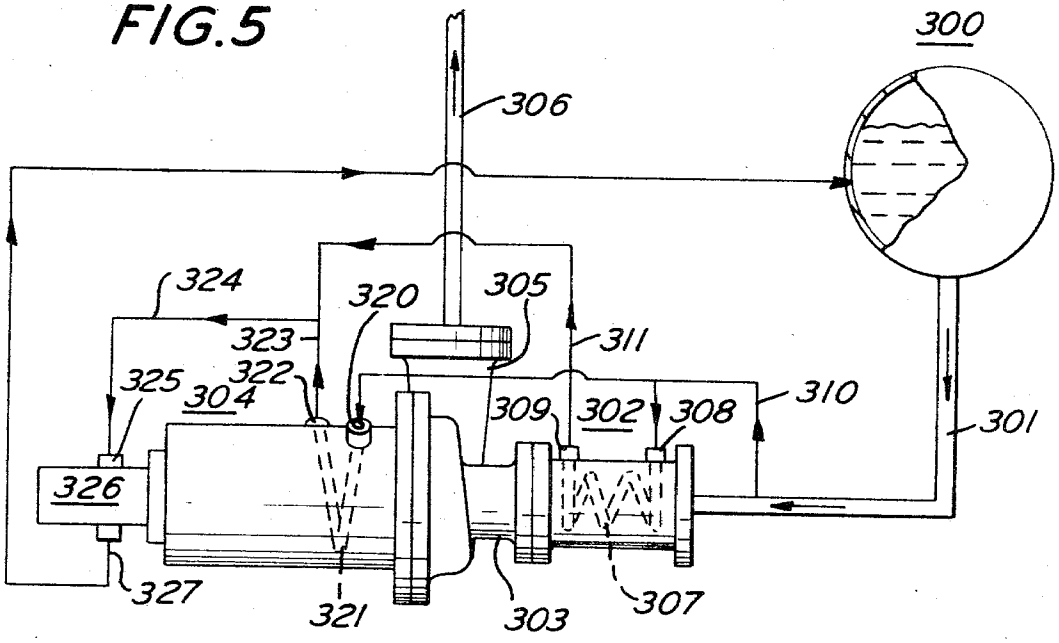

200
206
225
212
226
223
205
222
211
204
210
209
202
208
201
220
221
203
207

FIG.5


300
306
324
320
305
323
311
322
325
304
309
302
308
310
301
326
327
321
303
307

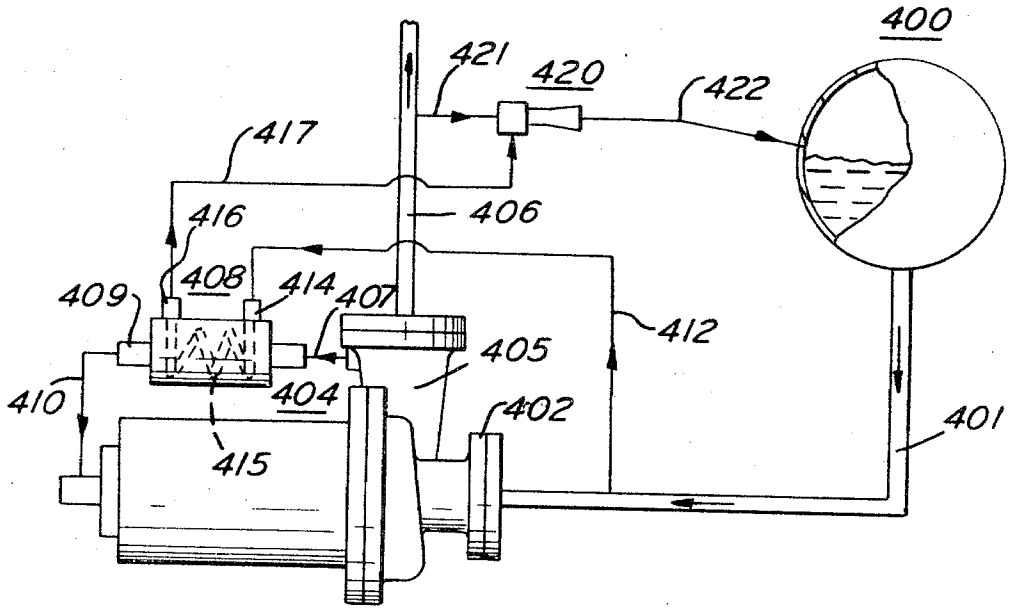

400
421
420
422
417
406
416
408
414
407
409
412
405
410
404
402
401
415

FIG.6

COOLING SYSTEMS FOR MOTOR DRIVEN PUMPS AND THE LIKE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a cooling system for motor driven pumps and the like wherein a portion of the pumped fluid is flashed and circulated to cool the pumped fluid, and/or portions of the pump subject to excessive heating.

2. Description of the Prior Art

It has heretofore been proposed to cool motor driven pumps for liquids and the like and which have a motor stator isolated from the motor rotor by an interposed sleeve by circulating a portion of the liquid being pumped in the interior of the sleeve and in contact with the motor rotor and also to utilize part or all of that portion of the liquid for lubricating and cooling the motor bearings. See, for example U.S. Pat. No. 3,280,750.

It has also been proposed to apply cooling coils to the exterior of the motor housing and circulating liquid therethrough for cooling. One example is shown in U.S. Pat. No. 3,127,530.

Low boiling point fluids such as fluorinated hydrocarbons, chlorine, ethane, and liquid nitrogen that vaporize at low temperatures and at high pressures are extremely difficult to handle in pumps. Unless a high static column of a low boiling point fluid is maintained on the suction side of the pump, the pumped fluid may flash off to a vapor causing cavitation and loss of liquid film in the bearing journals which can result in severe damage to the pump.

Various structures have heretofore been proposed as a solution to this problem such as increasing the suction forces on the lubricating fluid or the volume used for cooling but none have proven wholly satisfactory. The present invention utilizes a sub cooler to cool the pumped fluid before it enters the pump and provides for cooling the critical areas of the pump so as to maintain the temperature at a level to avoid flashing of the fluid in the bearings and in other pump areas where such flashing would be undesirable.

SUMMARY OF THE INVENTION

In accordance with the present invention cooling systems are provided for motor driven pumps and the like which pump low boiling point liquids, the systems having a sub cooler to reduce the temperature of part or all of the liquid being pumped and to provide cooling at selected locations or critical pump locations such as the motor bearings to prevent the lubricating fluid from flashing in the bearing journals with resulting loss of fluid lubricating film in the bearings.

The principal object of the invention is to provide cooling systems for motor driven pumps and the like which pump low boiling point fluids by using the expansion heat absorbing characteristics of the pumped fluid to cool the pumped fluid and locations susceptible to excessive heating.

A further object of the invention is to provide cooling systems for motor driven pumps and the like which circulate low boiling point fluids and which is easily applied to various types of pumps.

A further object of the invention is to provide a cooling system for pumps for low boiling point fluids that is inexpensive to construct but reliable in operation.

Other objects and advantageous features of the invention will be apparent from the description and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The nature and characteristic features of the invention will be more readily understood from the following description taken in connection with the accompanying drawings forming part thereof, in which:

FIG. 1 is a fragmentary central sectional view of a portion of a typical motor driven pump with the apparatus of the invention applied thereto;

FIG. 2 is a vertical sectional view taken approximately on the line 2—2 of FIG. 1;

FIG. 3 is a diagrammatic view of a cooling system in accordance with the invention;

FIG. 4 is a diagrammatic view of another cooling system in accordance with the invention;

FIG. 5 is a diagrammatic view of another cooling system in accordance with the invention; and

FIG. 6 is a diagrammatic view of still another cooling system in accordance with the invention.

It should, of course, be understood that the description and drawings herein are illustrative merely and that various modifications and changes can be made in the structure disclosed without departing from the spirit of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now more particularly to the drawings and FIGS. 1 and 2 thereof, a typical motor driven pump such as is shown in U.S. Pat. No. 3,280,750 is illustrated and includes an impeller housing 10 with a fluid inlet or intake connection 11 and an impeller chamber 12. The impeller chamber 12 is enclosed within a scroll 14 of well known type. The impeller housing 10 has a fluid delivery connection 15 formed thereon and communicating with the scroll 14. The housing 10 has an end face 16 with a liner plate 17 aligned therewith and which plate 17 is secured to a motor housing end plate 18. The plate 18 has an inner face 19 in meeting relation to the end face 16 of the housing 10.

The end plate 18 is part of a motor housing 20 which contains a motor stator 21 with windings 22 and stator laminations 23.

The liner plate 18 has a motor stator isolating sleeve 25 secured thereto in fluid tight relation. An inwardly extending boss 24 secured to the plate 18 extends within the sleeve 25.

A fluid impeller 30 is disposed within the scroll 14 and is carried on a hollow shaft 31 journaled in bearings 32 mounted in the boss 24.

A cooling tube 33 is provided outside of the sleeve 25 and inside of the motor housing 20 to cool the windings 22 and the bearings 32. The tube 33 has an intake orifice 34 and an outlet connection 35.

Referring now to FIG. 3 one embodiment of the invention is there shown which includes a source 100 of low boiling point fluid, such as fluorinated hydrocarbon, chlorine, ethane, liquid nitrogen and the like to be pumped which source has a pipe 101 connected thereto and to a sub cooler assembly 102. The sub cooler assembly 102 is directly connected to the inlet side 103 of a motor driven pump 104 of well known type and as previously described. The motor driven pump 104 has an outlet connection 105 with a pipe 106

connected thereto for delivery of the fluid being pumped.

The sub cooler **102** includes a cooling tube **107** which is spirally wound about the interior of the cooler **102** for cooling contact therewith of fluid supplied to the pump inlet **103**. The cooler **102** is provided with an intake expansion orifice **108** and an outlet connection **109**.

A pipe **110** is connected to pipe **101** to divert a small portion of the fluid in pipe **101** to the orifice **108**. The outlet connection **109** has a pipe **111** connected to it and to a pipe **112** which is connected to a condensing compressor **113** of a type commonly used in refrigeration and cooling systems and then to a condensing coil **114**. The coil **114** has a pipe **115** connected to it and to the fluid source **100**.

The pipe **110** extends to an expansion orifice **120** within a cooling tube **121** which extends around the interior of a pump **104** as shown in FIGS. **1** and **2** and with an outlet connection **122** having a pipe **123** connected to it and to pipe **112**.

In operation, a portion of the fluid being pumped in pipe **101** is diverted by pipe **110** to expansion orifice **108** where it flashes to vapor in tube **107** and absorbs heat from the fluid which passes through sub cooler **102** and is in contact with the tube **107**. The vapor in tube **107** is exhausted through outlet **109**, through pipe **111** to pipe **112** and to condensing compressor **113** and condensing coil **114** where it is returned to a liquid state and is then returned through pipe **115** to source **100**.

A portion of the fluid in pipe **110** flows through orifice **120** where it flashes to vapor in the tube **121** absorbing heat from pump **104** and the vapor is exhausted through outlet **122** and to pipe **123** to pipe **112** and to condensing compressor **113** and condensing coil **114** to supply **100**.

Referring now to FIG. **4** in the embodiment there shown a fluid supply source **200** has a pipe **201** connected thereto and through a sub cooler assembly **202**. The sub cooler assembly **202** is connected to the fluid inlet side **203** of a motor driven pump **204** as previously described. The pump **204** has an outlet connection **205** with a fluid delivery pipe **206** connected thereto for delivery of pumped fluid as desired.

The sub cooler **202** has a cooling tube **207** therein spirally wound therearound with an intake expansion orifice **208** and an outlet connection **209**. A pipe **210** is connected to a pipe **201** and to orifice **208** to divert a small amount of fluid to the expansion orifice **208**.

The outlet connection **209** has a pipe **211** connected thereto and to an eductor **212** of well known type. The pipe **210** extends to an expansion orifice **220** at the inlet of a cooling tube **221** which extends around the interior of the housing of the motor driven pump **204** as shown in FIGS. **1** and **2**. A vapor exhaust connection **222** is connected to the tube **221** and by the pipe **223** to the pipe **211**. The pipe **206** has a small pipe **225** connecJed thereto and to the nozzle (not shown) of the eductor **212** for tapping off higher pressure fluid to mix with and carry the vapor from the pipe **211** into pipe **201** through pipe **226**.

The cooling operation proceeds as previously described with the high pressure fluid at the nozzle of the eductor **212** from pipe **225** evacuating the low pressure vapor delivered thereto by pipe **211** and carrying it back to pipe **201** through pipe **226**.

Referring now to FIG. **5** another embodiment of the invention is illustrated which includes a fluid supply source **300** with a pipe **301** connected thereto and to a sub cooler assembly **302**. The sub cooler assembly **302** is connected to the inlet side **303** of a motor driven pump **304**. The motor driven pump **304** has an outlet connection **305** with a fluid delivery pipe **306** connected thereto for delivery of pumped fluid as desired. The sub cooler **302** has a cooling tube **307** therein spirally wound around the interior with an intake expansion orifice **308** and an outlet connection **309**.

A pipe **310** is connected to pipe **301** and to orifice **308** to divert a small amount of fluid to the orifice **308**. The outlet connection **309** has a pipe **311** connected thereto. The pipe **310** extends to an expansion orifice **320** at the inlet end of cooling tube **321**. The cooling tube **321** extends around the interior of the housing of the pump **304** as previously described. A vapor exhaust connection **322** is connected to the tube **321** and by a pipe **323** to the pipe **311**. A pipe **324** is connected to pipe **311** and to the intake **325** of a positive displacement condensing compressor **326** of well known type connected to and driven by the motor driven pump **304**. A pipe **327** is connected to the outlet from compressor **326** and carries the liquid from the compressor back to the source **300**.

The operation of this system is similar to that previously described for FIG. **3** except that the vapor is condensed by compressor **326** driven by the motor driven pump **304** and does not therefore require an outside coil system for vapor condensation.

Referring now to FIG. **6** another embodiment of the invention is shown in which a fluid supply source **400** has a pipe **401** connected thereto and directly to the inlet **402** of a motor driven pump **404**, the motor driven pump **404** being the same as is shown in FIGS. **1** and **2**. The motor driven pump **404** has an outlet connection **405** with a fluid delivery pipe **406** connected thereto for delivery of pumped fluid as desired.

The outlet **405** has a small pipe **407** connected thereto and to the intake side of a heat exchanger or evaporator **408** of well known type. The outlet **409** from the exchanger **408** has a pipe **410** connected thereto and to the pump **404** at the left to supply cooled fluid for use as a lubricant and for cooling the pump **404**.

The pipe **401** has a pipe **412** connected thereto and to an expansion orifice **414** of the heat exchanger **408**. The heat exchanger **408** has a cooling tube **415** therein spirally wound around in contact with the fluid from pipe **407**. An exhaust outlet connection **416** is provided for tube **415** with pipe **417** connected thereto and to an eductor **420** of well known type.

The eductor **420** has a pipe **421** connected to its nozzle (not shown) from pipe **406** for tappling off higher pressure fluid to deliver fluid in the pipe **417** back to the source **400**.

In operation a portion of the fluid from the pump outlet **405** in pipe **407** passes through the heat exchanger **408** where it is cooled as a result of the action of the fluid flashing in orifice **414** and absorbing heat as it flows through tube **415** and to the outlet **416**. The cooled fluid from the heat exchanger **408** is carried through pipe **410** to the hollow shaft of the motor driven pump **404** where it cools the pump bearings and other areas susceptible to heating and is mixed with the fluid at the fluid inlet **11** as shown in FIGS. **1** and **2**.

The vapor from heat exchanger 408 passes through outlet 416 and through pipe 417 to eductor 420 and then through pipe 422 to the supply 400.

The vapor pressure of the vaporized fluid can be held about 10 to 12 psig below the suction pressure of the motor driven pump and the temperature of the vapor will be of the order of 12° to 16° F. below the process fluid temperature. Since the heat of vaporization of these fluids is from 120 to 150 times the specific heat of the liquid a relatively small cooling system is capable of high heat rate removal.

It will thus be seen that apparatus has been provided with which the objects of the invention are attained and which utilized the vaporization of a part of the fluid being pumped to effect cooling at desired locations.

I claim:

1. Cooling apparatus for motor driven pumps and the like for low boiling point liquids which comprises
a source of low boiling point liquid to be pumped,
a motor driven pump having inlet and delivery connections and having the inlet connection connected to said source for the introduction of said liquid to the inlet connection and pump,
means for diverting a portion of the liquid from said source and vaporizing said diverted portion in predetermined cooling relation to said pump,
fluid delivery means returning the vaporized liquid in liquid form to said source, and
said diverting and vaporizing means includes heat exhange means interposed between the source and the pump inlet connection for cooling the liquid delivered to the pump inlet connection.

2. Cooling apparatus as defined in claim 1 in which said fluid delivery means includes a compressor

3. Cooling apparatus as defined in claim 2 in which said compressor is connected in driven relation to the motor of said motor driven pump.

4. Cooling apparatus as defined in claim 2 in which said fluid delivery means also includes separate cooling means.

5. Cooling apparatus as defined in claim 1 in which said diverting and vaporizing means includes an expansion orifice, and
a heat exchanger into which fluid is expanded through said orifice.

6. Cooling apparatus for motor driven pumps and the like for low boiling point fluids which comprises
a source of low boiling point fluid to be pumped,
a motor driven pump having inlet and delivery connections and having the inlet connection connected to said source,
means for diverting a portion of the fluid from said source and vaporizing said diverted portion in predetermined cooling relation to said pump,
fluid delivery means returning the vaporized fluid in liquid form to said source, and
a fluid connection is provided from the delivery connection of the pump to the inlet connection of the pump, and
said diverting and vaporizing means includes heat exchange means cooling the fluid in said fluid connection.

* * * * *