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Koons et al.

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[54] PRESSURE BALANCING OIL SYSTEM FOR STERN TUBES OF SHIPS

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[52] **U.S. Cl.** ..... **114/0.5 R**, 115/0.5 R, 184/1 R, 277/3, 277/15

[51] **Int. Cl.** **B63b 35/00, F16j 15/40**

[58] **Field of Search** ..... 184/7, 1 R, 6.1; 277/3, 15; 115/0.5 R, 34 R; 308/36.3

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[57] **ABSTRACT**

The oil in the stern tube is normally maintained at a predetermined pressure. A conduit leading from a source of compressed air has an outlet in the region of the center line of the tail shaft, the air in said conduit being at a pressure to normally bleed air from the outlet, and there being valve means in said conduit between the source of compressed air and the outlet which is responsive to changes in the air pressure in the conduit, caused by changes in the draft of the ship, for varying the oil pressure in the oil chamber to maintain it at a predetermined value above sea pressure. In one form of the invention the air pressure in the conduit serves as a medium to transmit changes in the draft of the ship to the oil in a closed head tank. In another form of the invention the air pressure in the conduit acts to control the flow of oil from an elevated head tank to thereby control the pressure in the stern tube, and in another form of the invention the air pressure in the conduit acts to control the effective pressure of the oil being delivered to the stern tube by a pressure pump.

11 Claims, 3 Drawing Figures

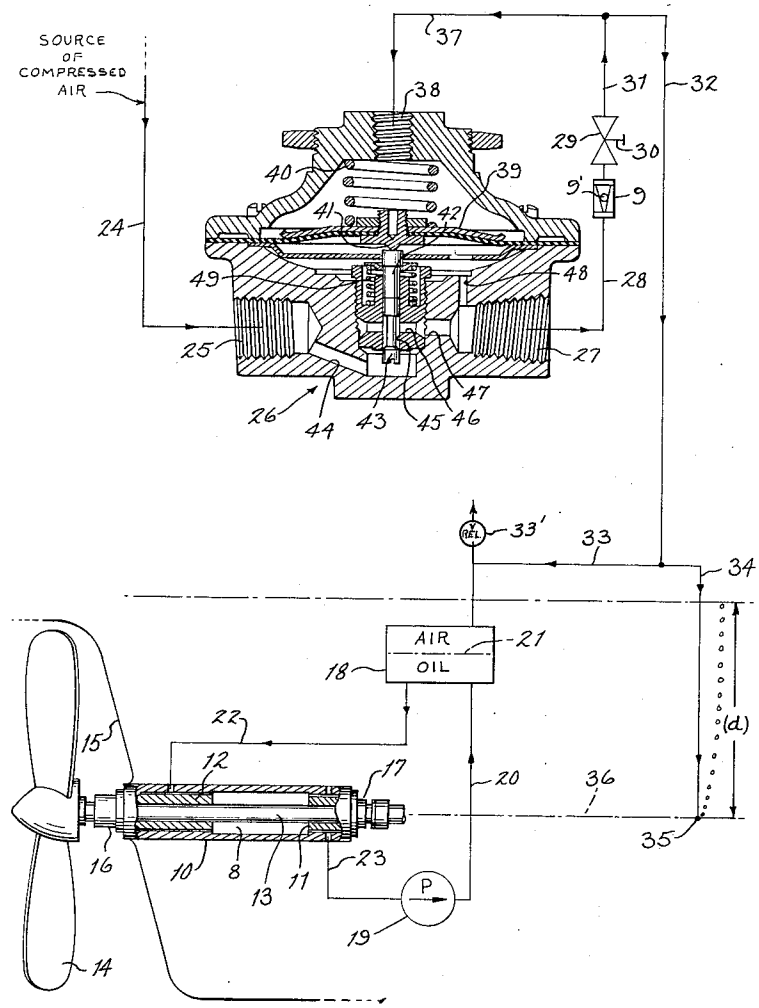
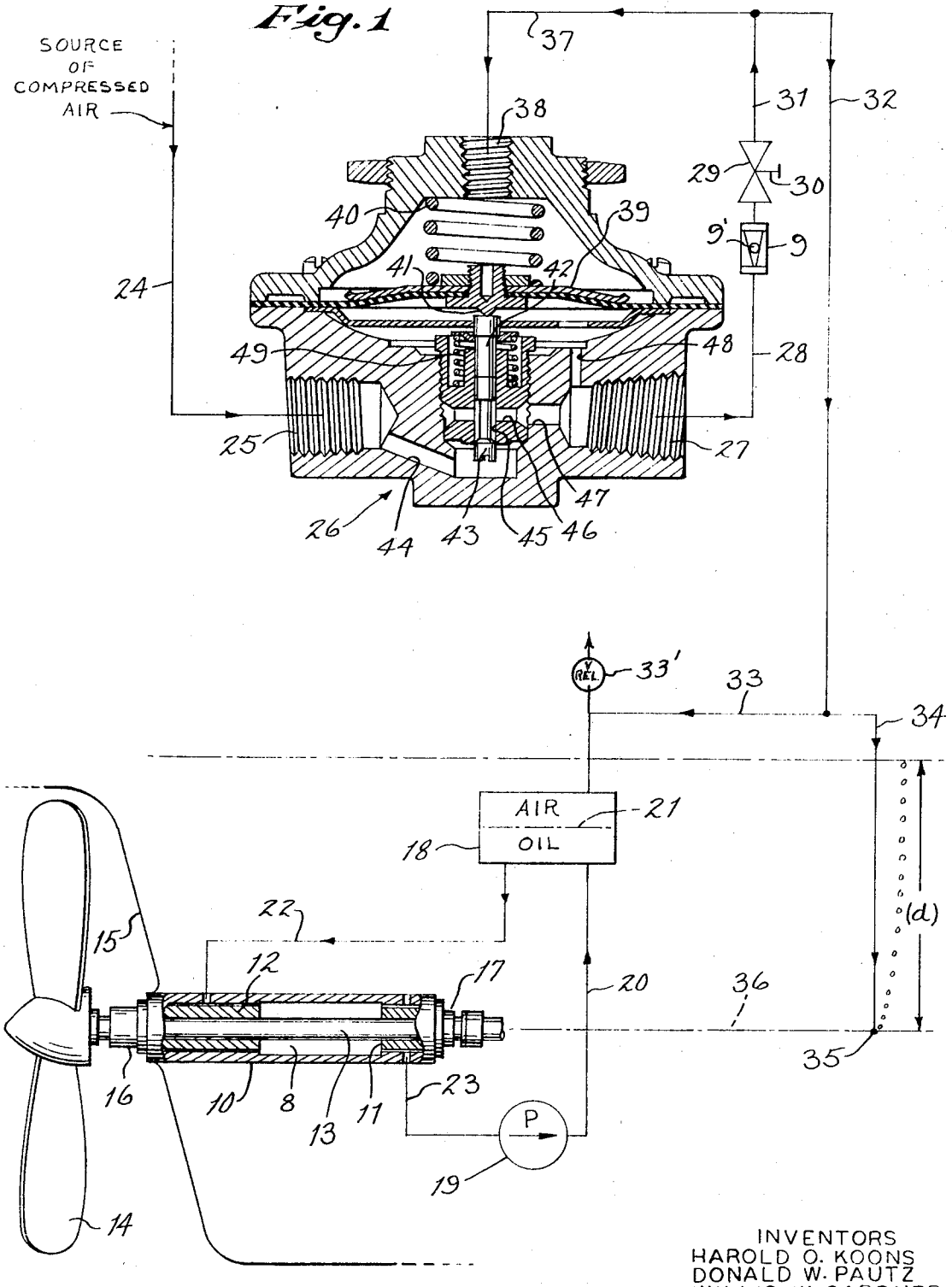


Fig. 1



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Fig. 2

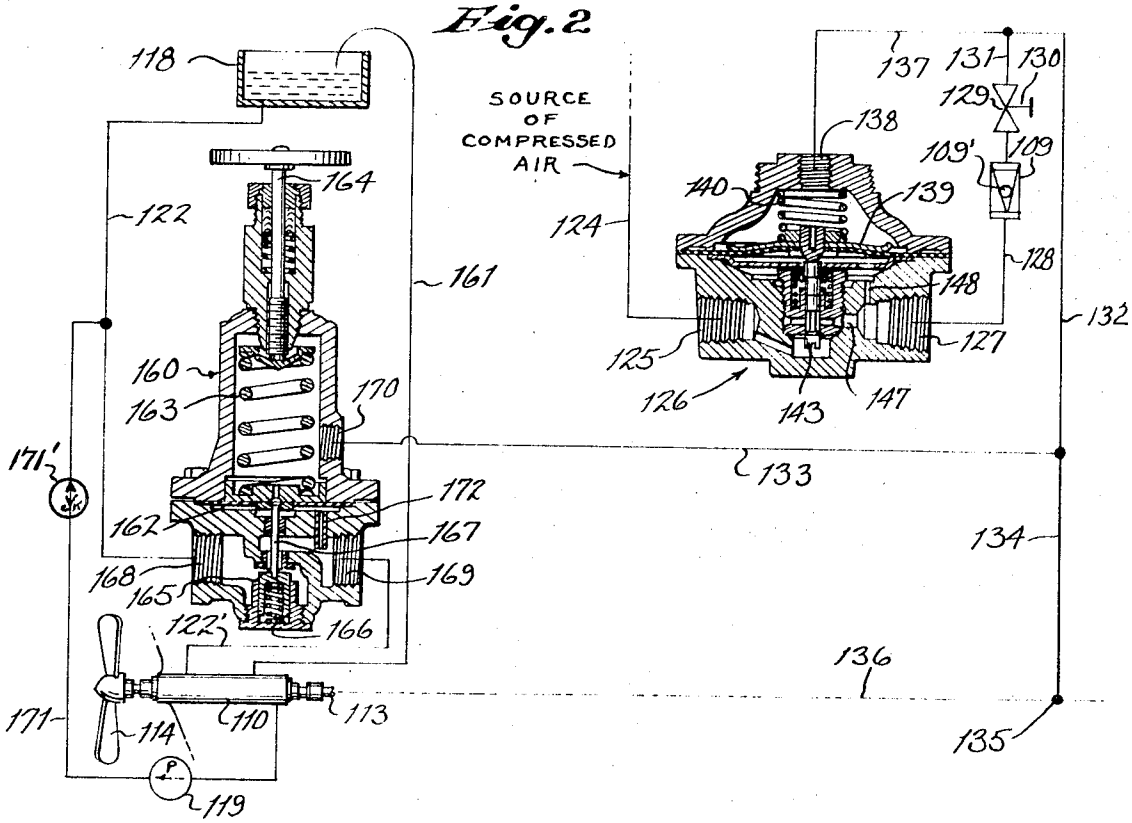
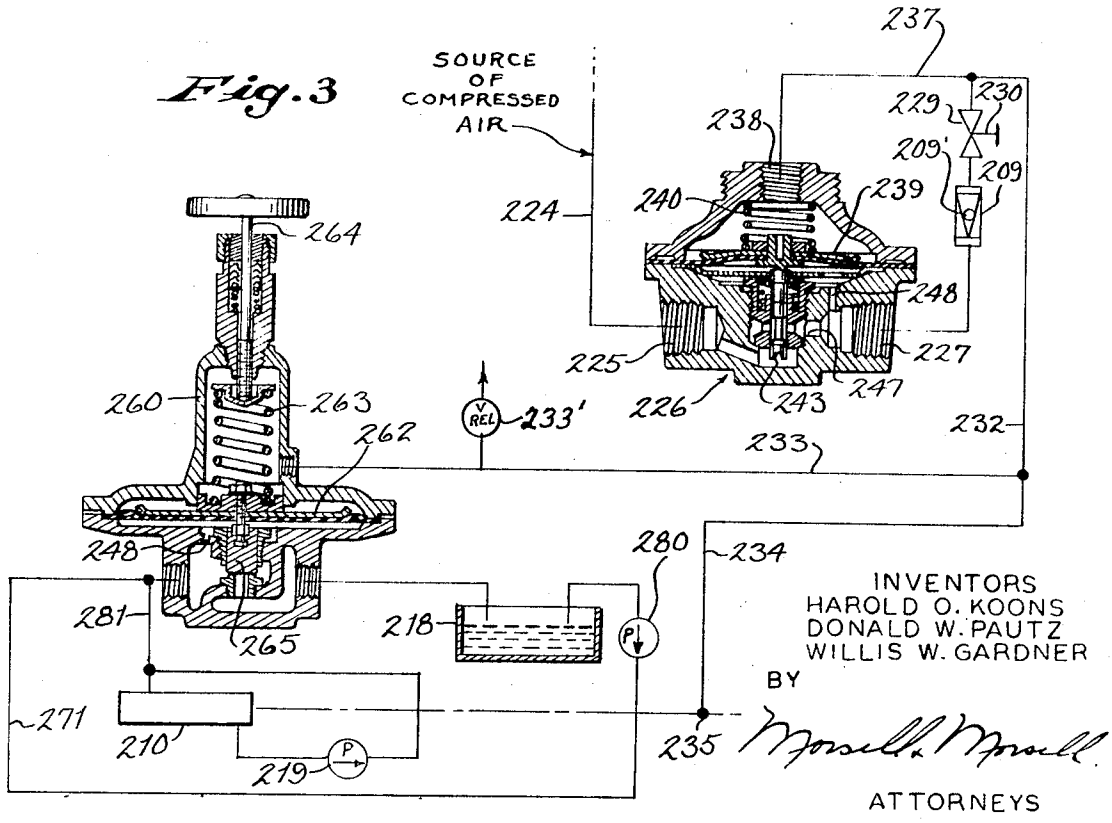

118
SOURCE OF COMPRESSED AIR
137
131
130
129
138
109'
109
140
139
124
128
148
132
122
164
161
160
163
170
125
127
126
143
147
171'
133
172
162
167
134
168
165
169
122'
166
136
171
114
110
113
135
119

Fig. 3


237
SOURCE OF COMPRESSED AIR
229
230
238
209'
209
224
240
239
248
225
227
226
243
247
233'
232
233
264
260
263
262
280
234
248
281
218
265
271
210
219
235
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PRESSURE BALANCING OIL SYSTEM FOR STERN TUBES OF SHIPS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention is particularly adapted for use in connection with the stern tube of ships, and particularly large ships such as large tankers where there can be large changes in draft.

Where there are large changes in the draft of a ship it is possible for the lubricating oil pressure in the stern tube to have a value so much in excess of the sea water pressure that there is danger of damaging the aft seals so that they do not operate properly. These seals are preferably of the radial lip type and there is a maximum pressure difference which can be handled by a sealing element of this type. If this pressure differential is exceeded, deformation of the flexible sealing elements can result. This may cause enlarged contact areas between the sealing lip and the rotating shaft. These large contact areas generate increased amounts of heat, raise the seal operating temperature, and eventually result in deterioration of the elastomer of which the seals are made. When this occurs, leakage and general seal failure result. Also, while it is customary to maintain the stern tube oil pressure at a sufficient value above sea water pressure to prevent the sea water from entering through the seals, nevertheless, due to draft changes, this may be reduced to the point where sea water can undesirably enter the stern tube.

Description of the Prior Art

In pending application of Gardner and Rafferty, Ser. No. 5,560, filed Jan. 26, 1970, there is means responsive to changes in the draft of the ship for varying the oil level in a standpipe, this level establishing the pressure in the stern tube, and there being an elevated reservoir for adding or subtracting oil from the system to thereby vary the level in the standpipe.

SUMMARY OF THE INVENTION

It is a general object of the present invention to provide a system wherein compressed air acts as a medium for transmitting sea water pressure to control valve means, and to utilize air pressure under control of said valve means for automatically maintaining the oil pressure in the stern tube at a constant value above sea pressure at the level of the stern tube.

A further object of the invention is to provide a system as above described wherein a conduit leading from a source of compressed air has an outlet in the region of the tail shaft center line from which air normally bleeds, and in which there is valve means between said source of compressed air and outlet responsive to changes in the air pressure in said conduit caused by changes in the draft of the ship for varying the oil pressure in the oil chamber of the stern tube to maintain it at a predetermined value.

A further object of the invention is to provide, in one form of the invention, a system wherein there is a head tank as a source of pressure for the oil in the stern tube, together with valve means in compressed air conduits whereby the air under pressure is a medium for transmitting changes in sea pressure to the oil in the head tank so that the oil pressure in the stern tube is responsive to changes in draft of the ship. Thus the oil pressure in the stern tube is maintained at a desired value above the water pressure at the level of the stern tube.

A further object of the invention is to provide, as another form of the invention, a system wherein air under pressure acts as a medium for transmitting sea water pressure to valve means, with the latter controlling the flow of oil by gravity from the head tank to the stern tube to thereby control the pressure in the stern tube circulating system in accordance with changes in the draft of the ship.

A further object of the invention is to provide a system wherein a pressure pump is used in lieu of a head tank, and wherein air under pressure acts as a medium to transmit sea water pressure to valve means in the system whereby the effective pressure in the stern tube from the pressure pump is controlled in a manner responsive to changes in the draft of the ship.

With the above and other objects in view the invention consists of the improved pressure balancing oil system for stern tubes of ships, and all of its parts and combinations, as set forth in the claims, and all equivalents thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings, wherein the same reference numerals designate the same parts in all of the views:

FIG. 1 is a partially diagrammatic view showing the improved system, part of the stern tube being broken away and shown in longitudinal section, and the diaphragm valve being shown in vertical section;

FIG. 2 is a similar view showing a modification wherein there are two control valves, the stern tube being shown diagrammatically; and

FIG. 3 is a similar view showing another modification.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring more particularly to FIG. 1 of the drawing, the numeral **10** designates a stern tube having an oil chamber **8** and having a forward bearing **11** and an aft bearing **12** through which the tail shaft **13** is journalled, the tail shaft carrying the usual propeller **14** for a ship **15**. Between the aft bearing **12** and the propeller **14** is the housing **16** for the aft sealing assembly, which assembly includes seals of any conventional type but which are preferably of the radial lip type of elastomeric material and are designed to retain the oil within the stern tube and to resist entrance of sea water into the stern tube. Forwardly of the forward bearing **11** is the housing **17** for a forward seal assembly. This assembly may include seals of any conventional type, but preferably are radial lip type seals of elastomeric material.

Lubricating oil from a head tank **18** is adapted to be circulated by a pump **19** through a conduit **20** leading to the head tank **18**, there being a liquid level **21** in the head tank. Oil is delivered from the head tank to an aft portion of the stern tube through a conduit **22**. A return line **23** for oil leads from a forward portion of the stern tube to the pump.

Referring now to the upper portion of FIG. **1**, a compressed air line **24** leads from the ship's supply of air under pressure to an inlet opening **25** in a constant flow regulator **26**. An outlet port **27** of said regulator is connected by a conduit **28** with one side of a variable orifice device **29**, there preferably being a visual flow rate indicator **9** upstream of the orifice device **29** of the type having a ball **9'** which shows when there is flow, the orifice device including a needle valve **30** for regulating the size of the orifice. The pressure upstream of the needle valve **30** is always greater than the downstream pressure, e.g. approximately 3 psi greater. The other side of the orifice device is connected by a line **31** with a compressed air line **32**. The latter has two branches, one branch **33** connecting with the top of the head tank **18** to create pressure within the head tank, and the other branch **34** from the compressed air conduit **32** extending downwardly to an outlet **35** which is a predetermined distance below sea level. In the present instance this is located at the center line **36** of the tail shaft. A relief valve **33'** leading from line **33** to atmosphere is desirable to insure against overpressuring the seals should the air outlet **35** become blocked.

The compressed air line **32** also communicates through line **37** with a port **38** above the diaphragm **39** of the regulator **26**.

A spring **40** normally urges the diaphragm downwardly. The diaphragm has a force-supplying element **41** in the center of its underside which is engageable with the upper end of a valve stem **42**. The lower end of the valve stem carries a valve element **43** which controls flow of compressed air from duct **44** into valve openings **45** and **46**, the latter communicating through duct **47** with the outlet port **27** and also with a port **48** leading to the valve chamber below the diaphragm **39**.

In use of this form of the invention the air pressure in the line **32** will normally cause a small but constant flow of air to bubble from the opening **35**, and this establishes air pressure in the line **32** which is equal to sea pressure. If, however, the draft (*d*) of the ship increases, this tends to increase the sea pressure acting at the outlet opening **35** of the compressed air line and will either prevent or reduce bubbling of air from the opening **35**. However, whenever this occurs the pressure in the lines **32** and **33** increases. Through the air line **37** this increase in pressure acts downwardly on the diaphragm **39** and causes the valve **43** to open somewhat against spring **49**. This allows a greater amount of the air pressure from the ship's air supply to flow through the valve into the port **27** to raise the pressure on the lower side of the orifice device **29** and bring the pressure differential back to normal (there normally being a slightly greater pressure upstream of the orifice device **29** than downstream in the line **31**). This increased pressure also acts through the bypass port **48** on the lower side of the diaphragm **39** to reduce the deflection caused by pressure on the top side from the line **37**. Thus there is now a tendency to move the valve **43** farther toward closed position. The regulator **26** therefore serves to maintain a constant pressure differential across the variable orifice device **29** thus providing a constant flow rate of air out of the line **32** regardless of variations in the draft (*d*) of the ship. The pressure from the line **32** into line **33**, plus the head pressure in the head tank **18**, creates the desired value above sea pressure within the stern tube **10** to maintain proper sealing conditions.

If the draft of the ship should be reduced then there is a lowering of the pressure acting at the outlet end **35** of the compressed air line **34**. This reduces the pressure from the line **37** acting on top of the diaphragm **39** and tends to let the diaphragm raise, thus permitting further closing of the valve **43**. This in turn reduces the air pressure from the ship's air supply which reaches the ports **47** and **27** of the regulator valve thus maintaining the pressure differential across the orifice device **29** substantially constant.

It is apparent from the above that in this system the air pressure in the lines **32**, **34** and **37** acts as a medium for transmitting sea pressure to the regulating valve **26**, and the air pressure which is maintained in the lines **32** and **33** is applied directly over the oil in the head tank **18** without going through any intermediate valves and it is unnecessary to use any draft-sensing device other than the outlet of the compressed air line **34**.

In the form of the invention illustrated in FIG. **2** the construction of the stern tube is the same as that illustrated more completely in FIG. **1** and the same reference numerals are used in FIG. **2** preceded by the digit "1." Also the construction of the constant flow regulator valve **126** of FIG. **2** is the same as the construction of the valve **26** of FIG. **1** and all parts in FIG. **2** which correspond to parts in FIG. **1** use the same reference numerals preceded by the digit "1." These parts will therefore not again be explained.

In the construction of FIG. **2** the head tank **118**, which corresponds to the head tank **18** of FIG. **1**, is mounted high enough that the maximum oil pressure from the head tank **118** is higher (e.g. 10 psi) than the maximum sea water pressure at the shaft center line **136**. Because of this height it is unnecessary to apply pressure to a closed air chamber such as done in the head tank **18** of FIG. **1**. In this form of the invention the flow line **122** for oil from the head tank connects with a differential-pressure-regulating valve **160** so that oil flows through said valve before entering the aft end of the stern tube through line **122'**. There is also a vent pipe **161** leading from the forward portion of the stern tube to the top of the head tank **118**.

The differential-pressure-regulating valve **160** includes a diaphragm **162** acted on by a spring **163**. A manually-operable screw **164** is operable to effect a predetermined adjustment on the diaphragm to give the required differential between the sea pressure and the oil pressure. A valve member **165**, which is normally urged by a spring **166** into valve-closing position, is adapted to be urged to open position by a valve stem **167** when the diaphragm acts in a downward direction on said valve stem. This controls the flow of oil which enters the valve at **168** from the head tank and which leaves the valve through line **122'** from valve port **169**. The air line **133** provides communication between the air line **134** and a port **170** of the valve **160** above the diaphragm. Oil conduit **171** preferably has a check valve **171'** therein to prevent full head tank pressure from being applied in case the pump **119** is shut off.

During operation the circulating pump **119** for the stern tube oil system is in operation at all times, as is the valve **160**, the pump communicating through oil conduit **171** with the line **122** from the head tank. If the draft of the ship increases there will be a reduction in the bubbling of air from the opening **135** and the pressure in the lines **134**, **132** and **133** will increase. This will act above the diaphragm **162** of the valve **160** to further open the valve **165** and reduce the pressure drop through the valve. This will increase the pressure in the circulating system in an amount required to compensate for the increase in the draft of the ship. Whenever this occurs this increased pressure is sensed in the sensing tube **172** of the valve **160** and acts on the lower side of the diaphragm **162** to tend to close the valve **165** to reestablish proper pressure differential.

Also when an increase in the draft of the ship occurs the pressure in line **137** will increase, tending to open the valve **143** and allowing a greater amount of air pressure from the ship's air supply to flow through the valve **126** to raise the pressure on the lower side of the orifice device **129** and bring the pressure differential back to normal. This increased pressure also acts through the bypass port **148** on the lower side of the diaphragm **139** to reduce the deflection caused by pressure on the top side of the diaphragm from the line **137**. Thus there is now a tendency to move the valve **143** farther toward closed position. As a result a constant flow rate of air out of line **132** is maintained and pressure equal to sea pressure is maintained in line **133** acting on the top of the diaphragm **162** in valve **160**. Thus the desired value above sea pressure is maintained within the stern tube **110** to maintain proper sealing conditions.

When the draft of the ship decreases the pressure lowers in line **133** tending to allow the valve **165** to close to create a greater pressure drop across the valve **165**. This will decrease the pressure in the stern tube circulating system in an amount to make up for the decrease in the draft of the ship.

Also when the draft of the ship decreases, then there is a lowering of the pressure in line **137** tending to let the diaphragm **139** raise, thus permitting further closing of the valve **143**. This in turn reduces the air pressure from the ship's air supply which reaches the port **127**, thus maintaining the pressure differential across the orifice device **129** substantially constant and providing a constant flow rate of air out of the line **134** which controls the pressure from line **133** which acts on the upper side of the diaphragm of the valve **160**.

The form of the invention illustrated in FIG. **3** is very similar to the form of the invention illustrated in FIG. **2**. Wherever a "100"series reference numeral is used in FIG. **2** the same numeral in a "200" series is employed in FIG. **3** for the same part. The description of these common parts will therefore not be repeated.

In FIG. **3**, instead of having a head tank **118**, the oil reservoir **218** is at the general level of the stern tube rather than elevated. Also a pump **280** is used as a pressure source. Here, in lieu of the valve **160** of FIG. **2**, there is a differential pressure relief valve **260** having a diaphragm **262** acted on by a spring **263**, there being an adjustment screw **264** acting on the spring. The valve member **265** is normally urged to a closed position. The pressure from the pressure pump **280** not only serves as a pressure source but also, when there is a loss of oil, to deliver oil through the line **271**.

When the draft of the ship increases there is a reduced bubbling action from the opening **235** at the lower end of the line **234**. This causes an increase in the pressure of the air in the lines **234**, **233** and **237**. The increase in pressure in the line

233 causes downward movement of the diaphragm 262 in the valve 260 and movement of the valve toward closed position. Thus the pressure in line 271 increases, which acts through the port 248 on the lower side of the diaphragm 262 to reestablish the pressure differential. Also when there is an increase in the draft of the ship, the pressure in line 237 will increase, tending to open the valve 243 and allowing a greater amount of air pressure from the ship's air supply to flow from line 224 through the valve 226 to raise the pressure on the lower side of the orifice device 229 and bringing the pressure differential back to normal. The increased pressure also acts through the bypass port 248 on the lower side of the diaphragm 239 to reduce the deflection caused by pressure on the top side of the diaphragm from the line 237. Thus there is now a tendency to move the valve 243 farther toward closed position. As a result, a constant flow rate of air out of line 232 is maintained and pressure equal to sea pressure is maintained in the line 233 acting on top of the diaphragm 262 in the valve 260. Thus the desired value above sea pressure is maintained within the stern tube 210 to maintain proper sealing conditions.

When the draft of the ship decreases, the pressure in the lines 234, 233 and 237 decreases. This then permits upward movement of the diaphragm 262 to tend to open the valve 265 to reestablish the pressure differential. Also when the draft of the ship decreases then there is a lowering of the pressure in the line 237 tending to let the diaphragm 239 of valve 226 raise, and thus permitting further closing of the valve 243. This in turn reduces the air pressure from the ship's air supply through line 224 which reaches the port 227 thus maintaining the pressure differential across the orifice device 229 substantially constant. This causes a constant flow rate of air out of the line 232, thus controlling the pressure in line 233 which acts on the upper side of the diaphragm valve 260. Thus, in the form of the invention of FIG. 3, the variation in pressure in the air system acts to vary the pressure which is applied by the pump 280 to the stern tube, with the pressure being sensed upstream. In the form of the invention of FIG. 2 the mechanism senses downstream pressure to vary the pressure applied by the head tank to the stern tube. While the mechanism of FIG. 3 requires two pumps 280 and 219, it does not require an excessively elevated reservoir as in FIG. 2, nor a closed head tank which can withstand air pressure as in the form of the invention of FIG. 1.

It is believed clear that in all forms of the invention there is valve means between the source of compressed air and the outlet of the bleed line to the sea which is responsive to changes in the air pressure in the bleed conduit caused by changes in the draft of the ship for varying the oil pressure in the oil chamber 8 of the stern tube. It is also clear that in all forms of the invention there is an external flow line leading to the stern tube oil chamber which has means in communication, through lines 33, 133 or 233, with the bleed conduit so that the air pressure in the bleed conduit acts on said means to vary the oil pressure in the oil chamber and maintain it at a predetermined value above sea pressure. In the form of the invention of FIG. 1, this means is the closed oil tank 18 which is acted on by pressure in the line 33. In the other forms of the invention the means is the valve 160 or 260 which has a closed chamber above the diaphragm acted on by the pressure from the line 133 or 233 just as the closed chamber above the oil in the closed tank 18 is acted on by the pressure 33.

It is to be understood that I do not desire to be limited to the exact details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

What we claim is:

1. In a ship having a stern tube with an oil chamber therein, means for normally maintaining pressure on the oil in said chamber, a source of compressed air, a bleed conduit leading from said source and having an outlet to the sea in the region of the stern tube, the air in said conduit being at a pressure to normally bleed from said outlet, and valve means between said source of compressed air and outlet responsive to changes in the air pressure in said bleed conduit caused by changes in the draft of the ship for varying the oil pressure in said oil chamber to maintain it at a predetermined value.

2. A combination in a ship as defined in claim 1 in which the means for normally maintaining pressure on the oil in the stern tube chamber includes a closed head tank for oil, and in which there is communication downstream of the valve means between the bleed conduit and the closed head tank so that the air pressure in said bleed conduit acts on the oil in the head tank.

3. A combination in a ship as claimed in claim 1 in which the means for normally maintaining pressure on the oil in the stern tube chamber includes an oil reservoir, and in which the valve means includes a differential pressure valve in the conduit between the oil reservoir and the stern tube controlling the oil pressure in the latter.

4. A combination in a ship as claimed in claim 3 in which the oil reservoir is at such an elevation as to normally maintain pressure in the stern tube, and in which said differential pressure valve is located in a gravity line leading from the head tank to the stern tube.

5. A combination in a ship as claimed in claim 4 in which the valve is a differential pressure regulating valve.

6. A combination in a ship as claimed in claim 1 in which the means for normally maintaining pressure on the oil in the chamber is a pressure pump, and in which the valve means includes a differential pressure relief valve in the circuit between said pump and reservoir for varying the effective pressure from said pump on the oil in the stern tube.

7. A combination in a ship as claimed in claim 1 in which the valve means between the source of compressed air and the outlet includes a differential regulator providing a constant flow rate for the compressed air in said conduit.

8. A combination in a ship as claimed in claim 7 in which there is a bypass line between the outlet of said differential regulator and the compressed air conduit upstream of the differential regulator, and in which there is a variable orifice in said bypass line.

9. A combination in a ship as claimed in claim 3 in which the valve means includes a constant flow differential regulator between the source of compressed air and the outlet, and in which there is communication between said bleed conduit downstream of said differential regulator and said differential pressure valve.

10. A combination in a ship as claimed in claim 6 in which the valve means includes a constant flow differential regulator between the source of compressed air and the outlet, and in which there is communication between said bleed conduit downstream of said differential regulator communicating with said differential pressure relief valve for controlling the latter.

11. A combination in a ship as claimed in claim 1 in which the means for normally maintaining pressure on the oil in the stern tube chamber includes an external flow line leading to the chamber, and in which there is means in said external flow line in communication downstream of the valve means with the bleed conduit whereby air pressure in said bleed conduit acts on said means to vary the oil pressure in said oil chamber and maintain it at a predetermined value.

* * * * *