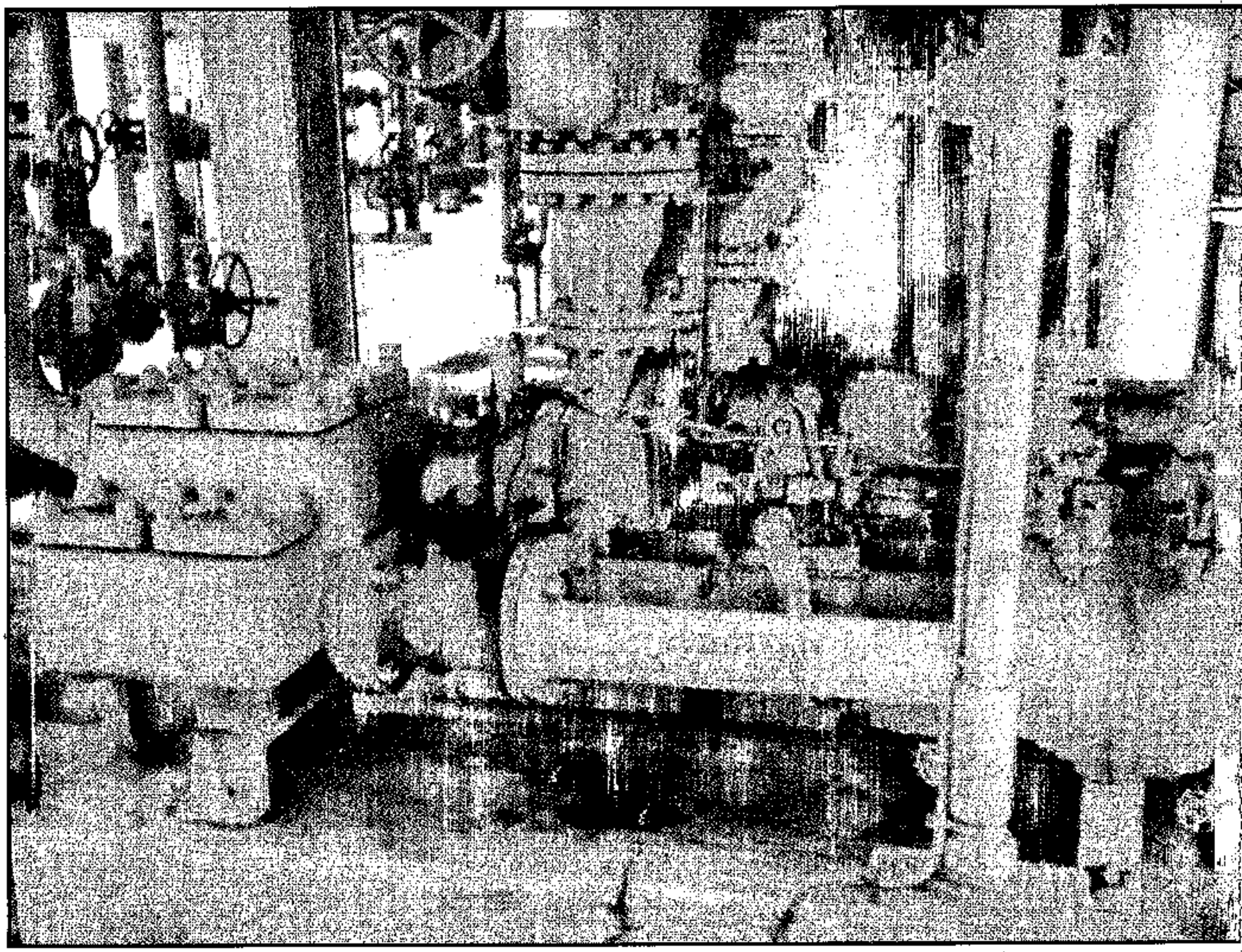
1072WB2

10

PROFIT AND PILOT SERIES PUBLICATION

Positive Displacement Pumps



HOWELL TRAINING

Program developed for API by: Howell Training Company
5201 Langfield Road
Houston, Texas 77040-6694

Programers: Shirley Ball
Lyn Sandow
Kurt Simons

Editor: David Sprey

Artist: Robert Culp

Production Editor: Paul Stadtherr

Content Specialists for API: Guy Tanner
Humble Oil and Refining Co.
B. W. Pitchford
Humble Oil and Refining Co.

Content Consultants: C. A. Champion
R. M. Robinson
R. Renn Rothrock
Wendell L. Zachary

Validation provided through the cooperation of: Humble Oil and Refining Co.
Mobil Oil Corp.
Sun Oil Co.

This text has been validated by the Committee on Training, Division of Refining, American Petroleum Institute, 1969.

Special Acknowledgement

For the general encouragement and support given the PROFIT programed learning series by the API Executive Committee on Training and Development;: J. P. Malott, Continental Oil Co., Chairman; H. D. Aggers, Thums Long Beach Co., Chairman, Committee on Vocational Training; Howard Swaim, Continental Oil Co., Chairman, API Sub-committee on Programed Learning, and members of the subcommittee.

PILOT PROFIT

Seventh Printing
April 1987

POSITIVE DISPLACEMENT PUMPS

POSITIVE DISPLACEMENT PUMPS

Section 3

Construction Details

Positive displacement pumps are reciprocating and rotary pumps that move liquid by the positive displacement of liquid volume.

In Section 1 of *Positive Displacement Pumps* you learned the operating principles of these pumps; what determines their capacity, pressure, horsepower and efficiency; how NPSH is calculated; and the performance characteristics of positive displacement pumps.

In Section 2, you learned the basic types of reciprocating and rotary pumps, including piston pumps, plunger pumps, diaphragm pumps, direct-acting steam and air pumps, and rotary lobe, vane, gear, and screw pumps. You learned how these pumps differ from each other in design and performance.

In Section 3, you will learn the construction and operation of pump valves, pulsation dampeners and suction stabilizers, variable displacement devices, bypasses and relief valves. You will learn about packing, lubrication, and cooling systems.

In Section 4, you will learn startup and shutdown procedures; how to recognize and solve common pumping problems; and proper operating maintenance.

INSTRUCTIONS

This is a programed learning course.

Programed learning gives information in a series of steps called *frames*. Each frame gives some information and asks you to make use of it.

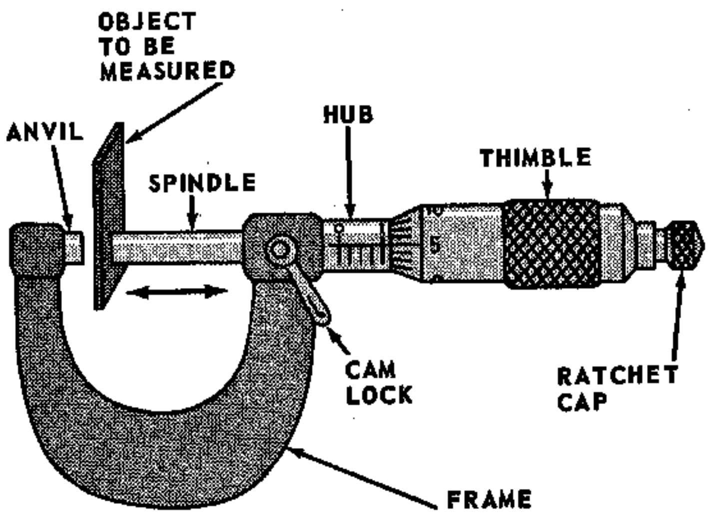
Here is how it works. First, cover the response column at the right with a mask.

Read this frame and use the information it gives to fill in the blank.

> A micrometer is an instrument designed to measure in thousandths of an inch.
>
> A micrometer is a good tool for measuring very ________ differences in size. — small

Move the mask down to uncover the word at the right of the frame. If you have filled the blank with that word or a word that means the same, you are ready to go ahead to the next frame.

The drawing of a micrometer provides information that will help you fill in the next blanks.



Seven major parts are shown in the drawing, but only the ________ and the ________ contact the object to be measured. — anvil; spindle

The next frame calls for a choice. Circle or underline the appropriate word.

> Of the two parts that contact the object, only the (anvil/ spindle) moves.

spindle

A program is a series of frames that work like the ones you have just done:

> Read the frame.
>
> Use the information to fill in the blanks or make a choice.
>
> Move the mask down and check the response column.
>
> Go on to the next frame.

Remember to cover the response column with a mask before you begin each page.

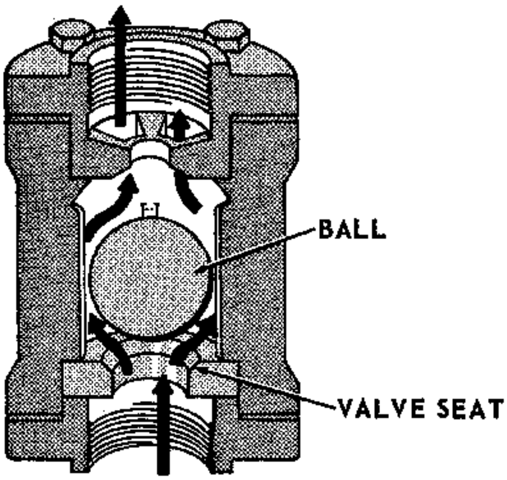
Notice that the left-hand pages from here on are printed upside down. The program is designed so that you will go through all the right-hand pages first, and then turn the book upside down and go through the other pages.

SECTION 3

CONSTRUCTION DETAILS

CYLINDER VALVES

1. This is a commonly-used pump valve.



The part that moves during opening and closing of the valve is a metal ____________.

ball

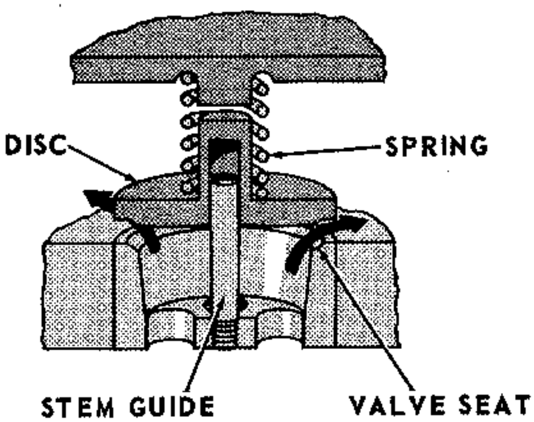
2. To close the valve, the ball must fit closely into the valve ____________.

seat

3. To open the valve, liquid pressure below the seat must be more than (the pressure of the weight of the ball/ total pressure above the seat).

total pressure above the seat

4. This is another commonly-used pump valve.



In this case, the part that moves during opening and closing of the valve is a flat, metal ____________.

disc

5. The disc is fitted with a spring.

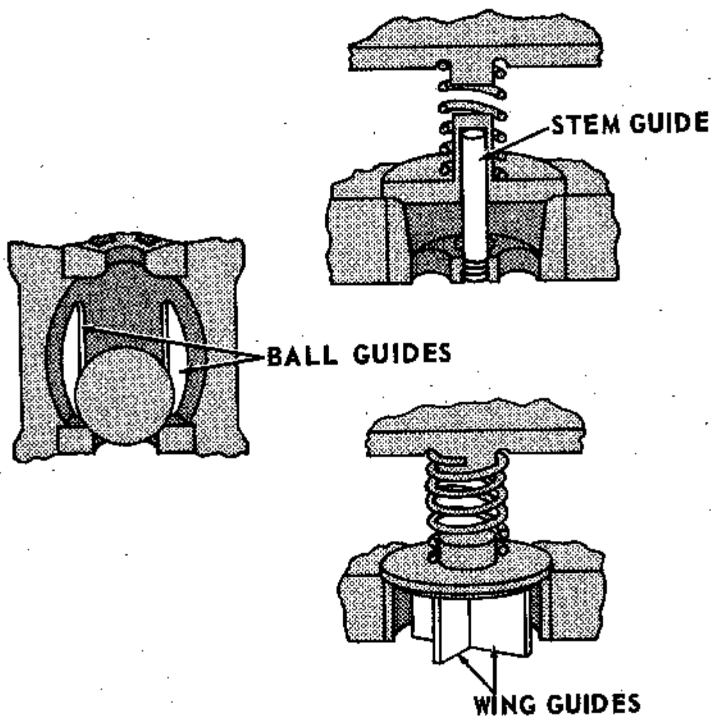
The spring provides some of the force that causes the disc to ____________ when suction pressure drops.

seat, or close

6. The tension of the spring also increases the suction pressure required to ____________ the valve.

open, or unseat

7. Every valve must be constructed so that the ball or disc can make a complete seal across the valve seat every time.



In the ball valve, the ball is guided into the seat by the walls of a ____________ surrounding the ball.

cage

8. In the disc valve, the disc must be guided into the seat by some sort of ____________ or ____________.

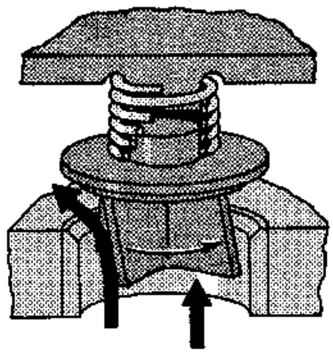
stem; wings

9. Stem-guided valves are satisfactory for service involving relatively low pressures.

The wing guide is sturdier in construction, so it can be used where the pressures are moderately ____________.

high

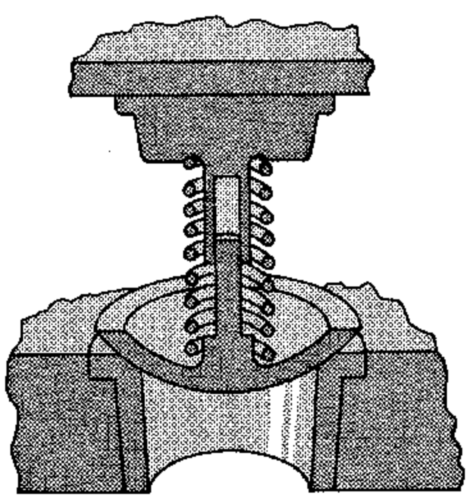
10. For very high-pressure service, a wing guide may be *beveled.*



The beveled surface causes the guide to ________ slightly as the liquid flows through it. | turn, or rotate

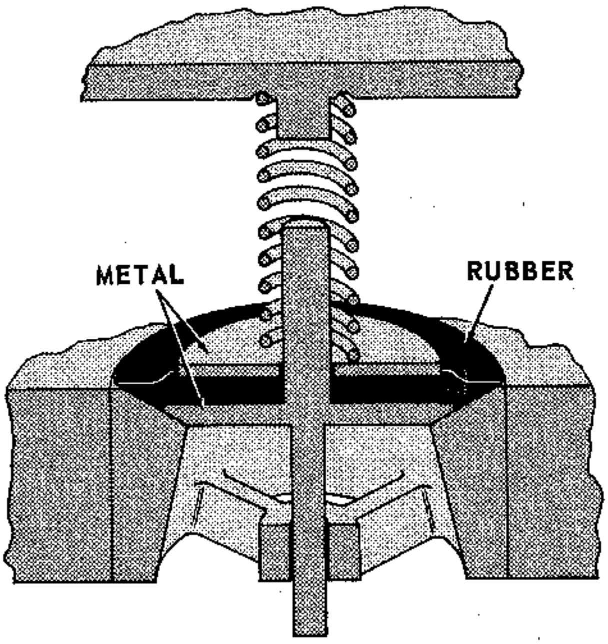
11. This turning action evens out the ________ on the valve. | wear

12. A *bowl* valve is almost like a disc valve.



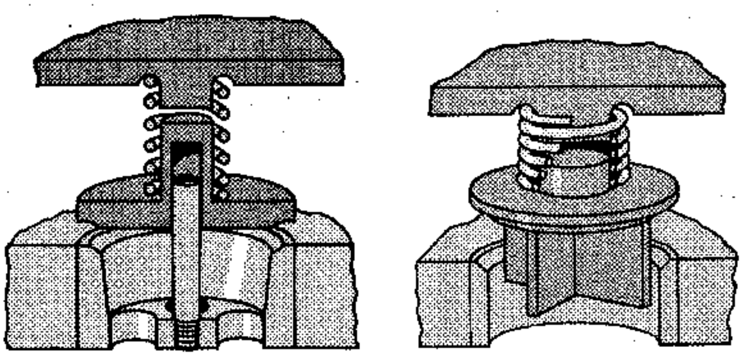
The bowl shape helps the valve make a tight ________ against the valve seat. | seat, or seal, or fit

13. Some valves are *dual*-seated. One part of this valve seats metal-to-metal.



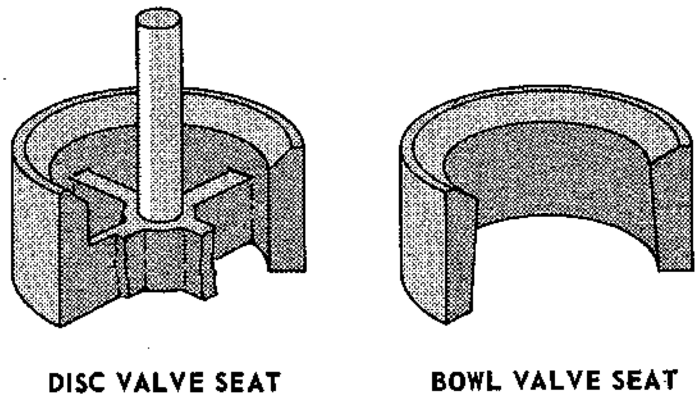
The other part seats metal-to-__________. rubber

14. Here are two valves designed for use in pumping thick liquids.



Valve A is used where the pressure is low. Valve B, because it has wing guides, can be used where pressure is __________. high

15. These views show the seat area of both a disc valve and a bowl valve.



In this case, the seat of the (disc/bowl) valve offers less obstruction to flow. — bowl

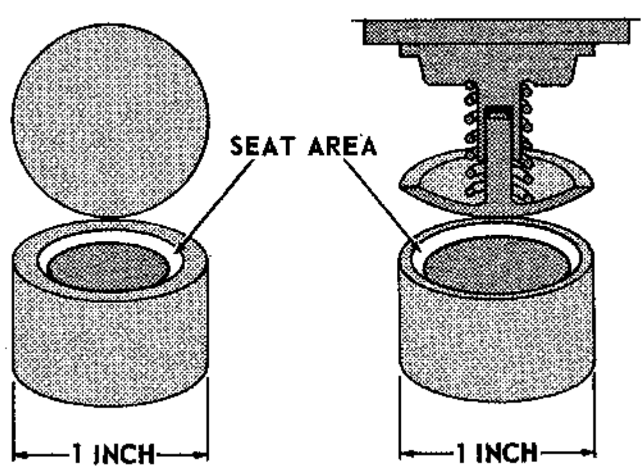
16. Suppose a highly viscous liquid is to be pumped.

Based on the difference in seat area, the (disc/bowl) valve just shown would be a better choice. — bowl

17. Suppose the liquid is abrasive.

The seat with (more/less) obstruction to flow would be better. — less

18. The seats of the ball and bowl valves have the freest openings.



Of these two valves, the (ball/bowl) valve has a greater seat area. — bowl

19. Of the two, the (ball/bowl) valve is simpler in construction. ball

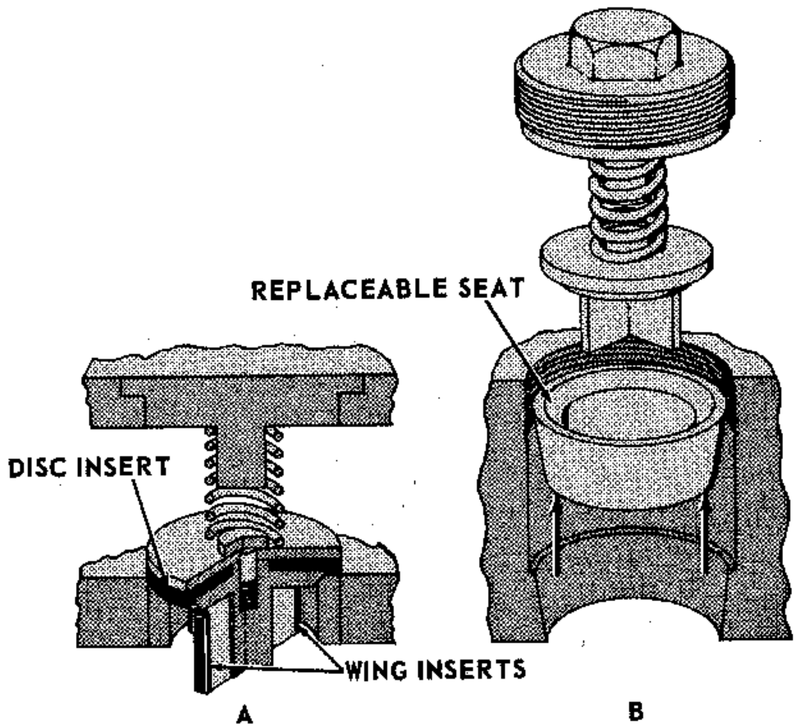
20. Because of the spring, the action of the bowl valve is (smoother than/not as smooth as) the ball valve. smoother than

21. When clear flow is required but smooth valve action is not essential, the ________ valve is a better choice for easy maintenance. ball

22. Suppose a pump must handle a thick, gritty liquid.

You would expect wear on the valve parts to be (rapid/no different from other service). rapid

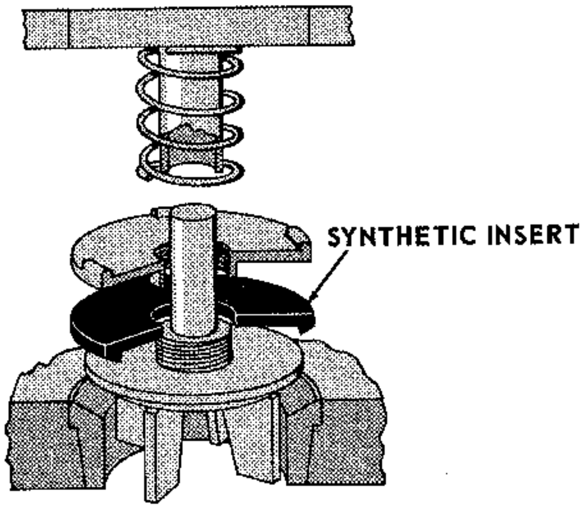
23. These two valves show one way of compensating for such severe service conditions.



Valve A has renewable rubber inserts for the ________ and part of the ________. wings disc

24. Valve B is designed so the ________ of the valve can be replaced. seat

25. This dual seat valve has a synthetic insert in the disc.



The synthetic insert is used for all ordinary services.

The construction is such that the insert could be replaced (easily/only with difficulty) with a special corrosion or abrasion-resistant insert for severe service. — easily

26. Usually, the same kind of valve is used for both the suction and the discharge of a given pump.

However, a pump's discharge pressure may be (the same as/greater than/equal to) the suction pressure. — greater than

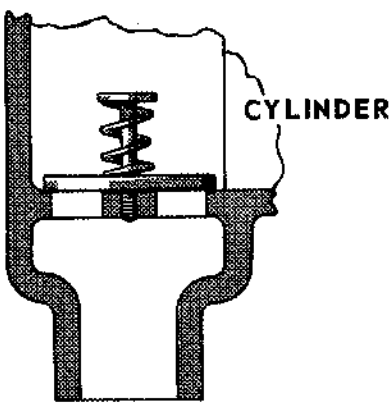
27. Therefore, if there is a difference between suction and discharge valves, it is likely that the (suction/discharge) springs are heavier. — discharge

28. The major difference between suction and discharge valves is the way the valves are installed.

Suction valves open into the (line/cylinder). — cylinder

29. Discharge valves open into the ____________. — line, or discharge

30. Look at the setting of this valve.

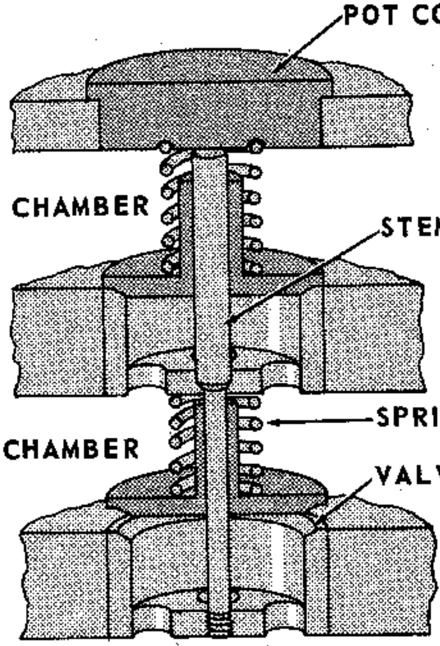


It is installed as a (suction/discharge) valve. — suction

31. Although pumps vary, suction valves are usually installed near the bottom of a pump.

Discharge valves are usually installed near the ________ of the pump. — top

32. This is called a *turret* assembly.



The suction valve is mounted (on top of/beneath) the discharge valve. — beneath

33. The two valves share the same ____________. — stem, or guide

34. Access to both valves for inspection or adjustment is through the pot cover.

The discharge valve (must be removable/need not be removable). — must be removable

Summary

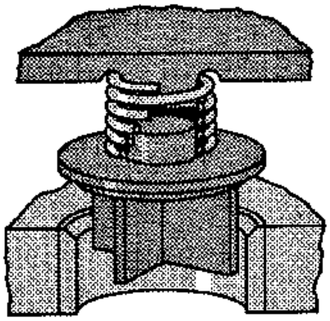
35. Pump valves work as check valves by allowing fluid flow in (only one direction/two directions). — only one direction

36. In order for the valve to operate, there (must be/need not be) a pressure difference across the valve. — must be

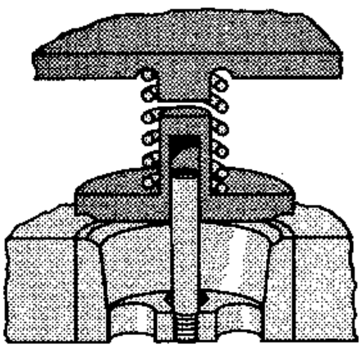
37. Springs are put into many valves to (increase/decrease) the speed of seating and also to increase the amount of pressure required to ____________ the valve. — increase; open

38. The type of guide used depends in part on (pump speed/the pressure difference across the valve). — the pressure difference across the valve

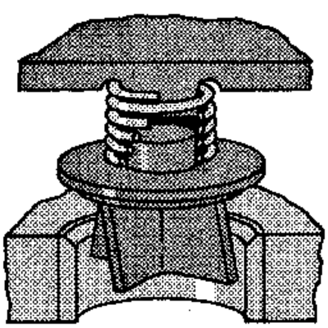
39. Identify these three kinds of valve guides.



A. __________ guide. wing

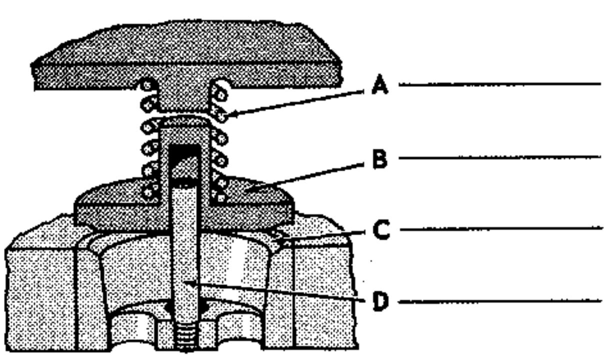


B. __________ guide. stem



C. __________ __________ guide. beveled wing

40. Name the lettered parts of this valve.



A. spring
B. disc, or valve
C. valve seat
D. stem, or valve guide

41. The valve shown in frame 40 is a ____________-guided ____________ valve.

stem
disc

42. It would be used for pumping at moderately (high/low) speeds through moderately low pressures.

high

43. It would be used when the pumping liquid (is/is not) highly viscous, corrosive, or abrasive.

is not

PULSATION DAMPENERS AND SUCTION STABILIZERS

44. The flow of liquid from a reciprocating pump is (continuous/pulsating).

pulsating

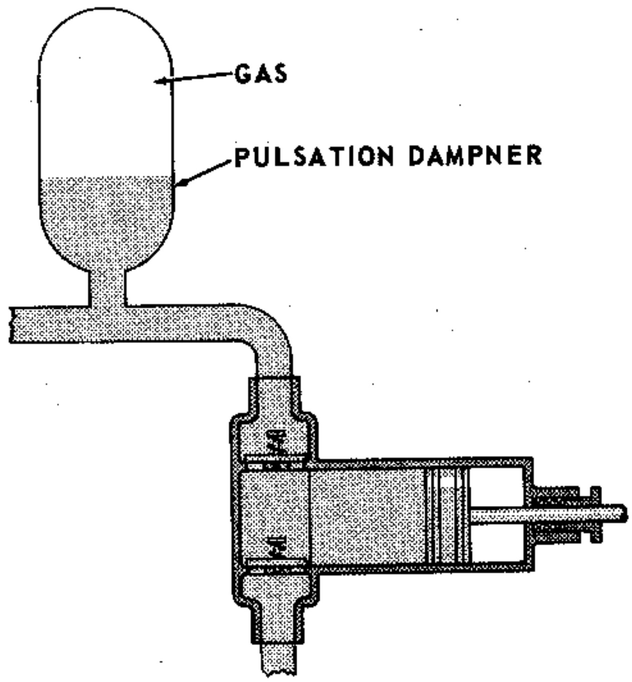
45. The flow is more even from a (single-acting/double-acting) pump.

double-acting

46. Flow is also more even if the pump is (simplex/multiplex).

multiplex

47. A *pulsation dampener* evens out the flow from a reciprocating pump.



The pulsation dampener is a sealed chamber containing ____________.

gas

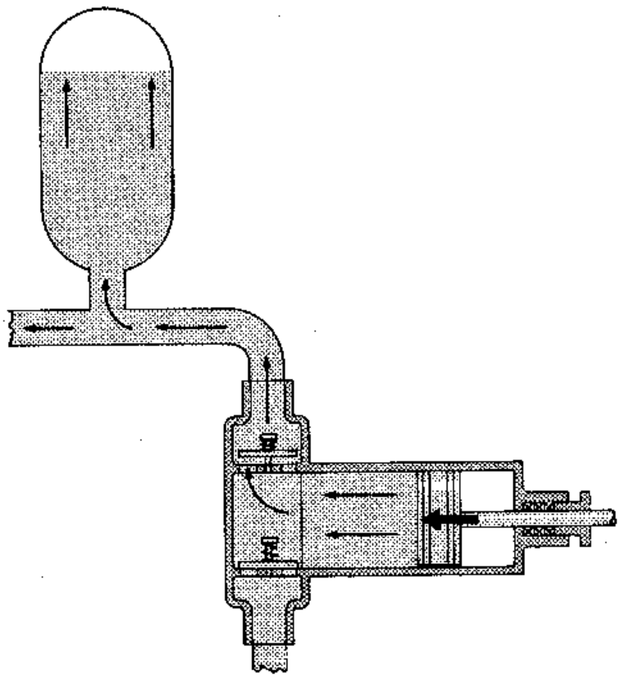
48. The gas used may be air or nitrogen.

Since hydrocarbons mixed with air can ignite and burn, (air/nitrogen) is preferred when hydrocarbons are being pumped.

nitrogen

49. For pumping water, the pulsation dampener would normally be filled with __________. — air

50. The pulsation dampener is connected to the pump's discharge line.



While the pump is discharging, liquid is forced (into/out of) the dampener chamber. — into

51. The liquid compresses the __________ in the chamber. — gas, or air

52. As the piston moves back, the gas expands against the liquid.

Now the __________ forces __________ into the discharge line. — gas; liquid

53. Because the gas in the chamber compresses, the dampener can minimize any sudden (increase/decrease) in discharge line pressure. — increase

54. Because the gas once compressed can provide enough pressure to force liquid out of the chamber, the dampener can minimize any sudden __________ in discharge line pressure. — decrease

55. The pulsation dampener functions to minimize the effect of sudden changes in flowline __________. — pressure

56. The dampener helps to maintain a more even ________ of liquid through the line. flow

57. Pumps with smoother discharges require proportionately smaller gas chambers.

A single-acting simplex pump in low-pressure service requires a gas chamber that is *twice* as large as the pump's displacement.

A duplex or a double-acting pump may have a gas chamber that is equal in volume to the pump's ________. displacement

58. Liquids under pressure absorb gas.

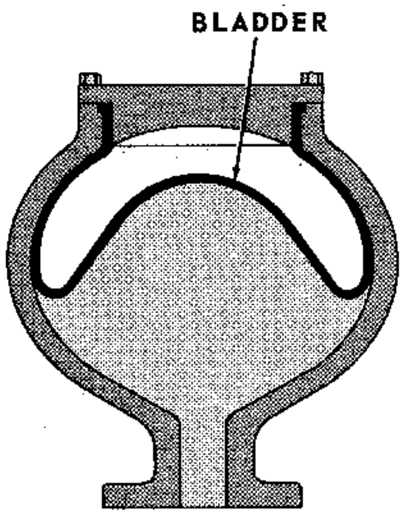
The greater the pressure, the (faster/slower) the liquid absorbs the gas. faster

59. Pumps in high-pressure service require proportionately larger ________ ________. pulsation dampeners, or gas chambers

60. For a high-pressure pump, the gas in the chamber may be kept at a higher level of compression than for low-pressure service.

Increasing the compression of the gas ________ the size of chamber that is required for the pump. reduces

61. Sometimes a *bladder* is used in the chamber to seal off the gas from the liquid.



When a bladder is used, the gas (can be/cannot be) absorbed by the liquid. cannot be

62. When there is *no* bladder, the gas in the chamber is gradually absorbed by the ____________. liquid

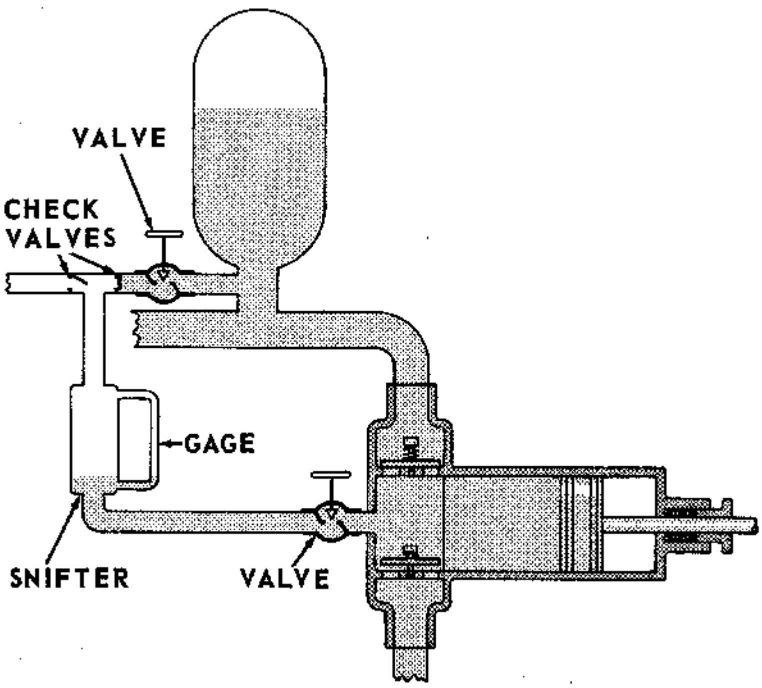
63. When a bladder is not used, some means must be supplied to periodically replenish the supply of __________. gas

64. If air at atmospheric pressure is used, the chamber may be replenished by isolating the chamber and opening a drain valve at the bottom.

Opening the valve drains the chamber of ____________ and admits fresh ____________ into the chamber. liquid / air

65. Or, the chamber may be replenished by forcing compressed ____________ into the top of the chamber. gas, or air

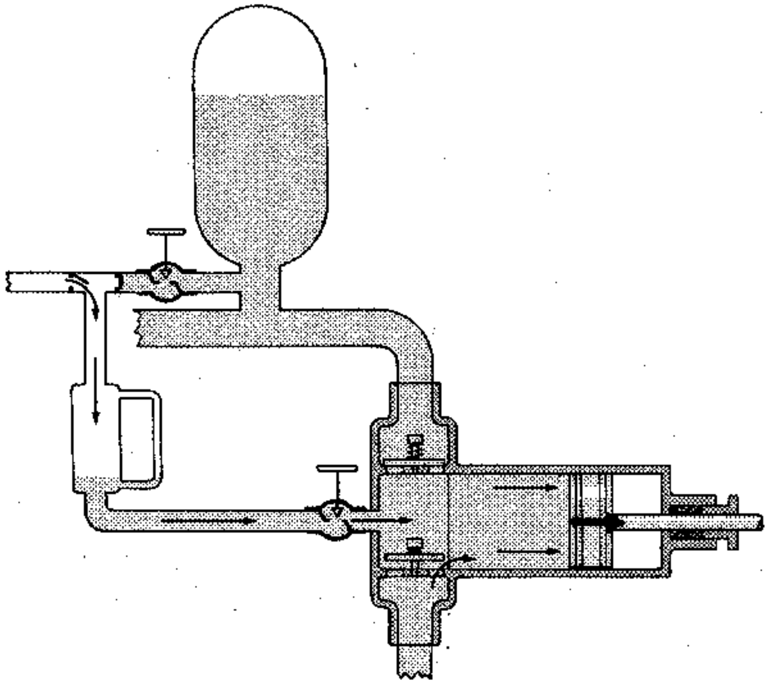
66. In low-pressure pumps, a *snifter* may be used to automatically recharge the air chamber.



The snifter is a partially-filled liquid cylinder that is connected between the air chamber and the wall of the ____________. pump, or cylinder

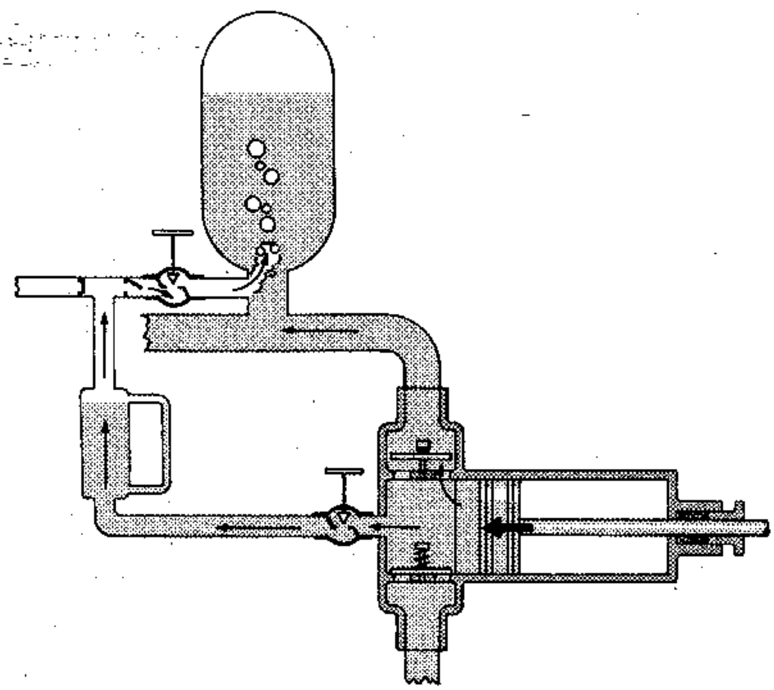
67. Two check valves above the snifter allow flow from the snifter and the atmosphere (into the air chamber only/ both into and out of the air chamber). into the air chamber only

68. On the backstroke, the pump draws some liquid from the snifter.



The snifter in turn draws air from the ______________. atmosphere

69. On the forward stroke, the pump forces liquid into the snifter.



The rising level in the snifter closes the check valve from the atmosphere, forcing ______________ into the chamber. air

70. The liquid in the snifter acts as a piston to draw in air from the ________.

atmosphere

71. After drawing it in, the liquid forces the air from the ________ ________.

air chamber,
or pulsation dampener

72. For proper operation, the snifter cylinder should never be completely empty of liquid.

When the system is properly adjusted, the liquid level in the snifter sight gage should rise and fall practically the full length of the glass, in time with the strokes of the ________.

pump, or piston

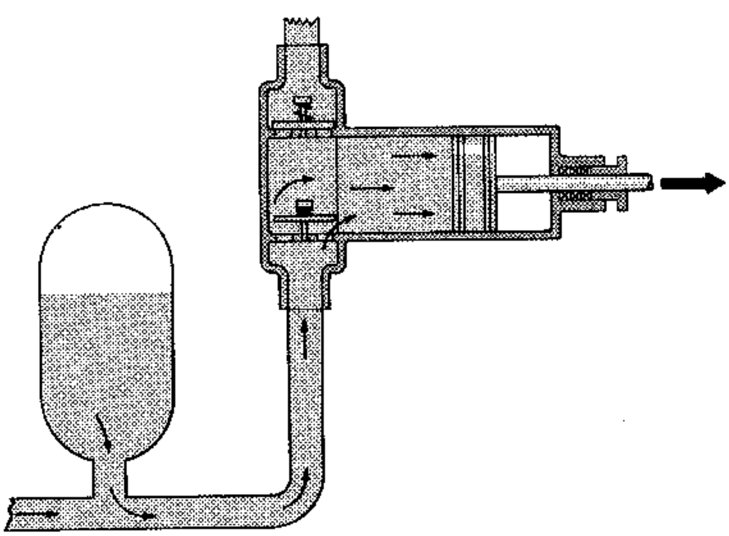
73. The operator does not need to drain and replenish the air chamber if a properly operating ________ is installed.

snifter

74. But snifters can be used only for (high-pressure/low-pressure) pumps.

low-pressure

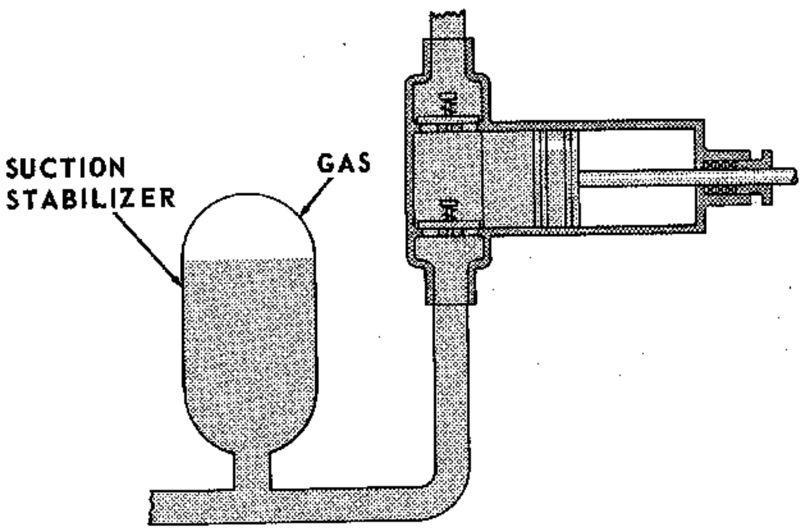
75. A suction stabilizer works like a pulsation dampener in reverse.



The stabilizer is connected to the pump's ________ line.

suction

76. This drawing shows the suction stroke.



While the pump is drawing liquid, liquid flows (into/out of) the stabilizer. — out of

77. When the suction valve closes, liquid flows from the suction line into the ______________. — stabilizer

78. This prevents the suction liquid from hammering at the cylinder valve and piping.

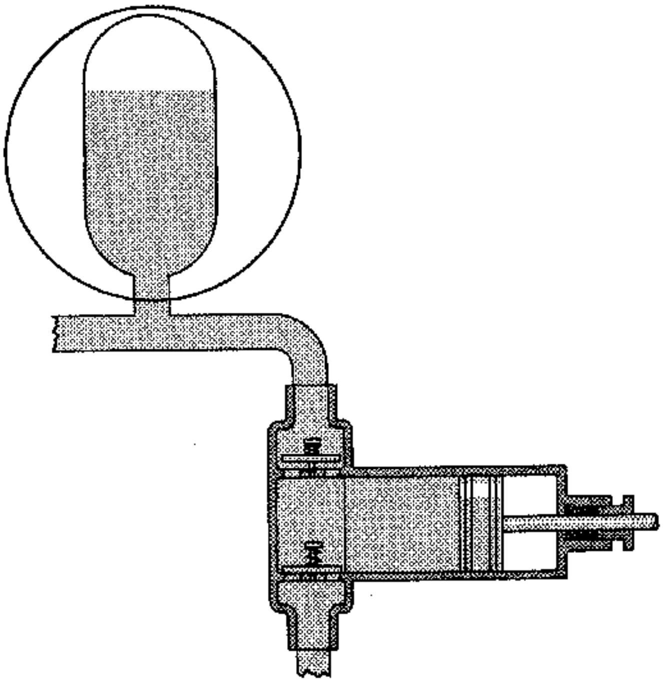
Then, on the suction stroke, liquid is again drawn from the stabilizer into the ______________ line. — suction

79. Suction stabilizers are especially needed on high-pressure or high-speed pumps, where the suction liquid could develop a strong hammer when it is not being drawn into the pump.

The stabilizer should be large enough to hold a volume of liquid at least equal to the pump's ______________. — displacement

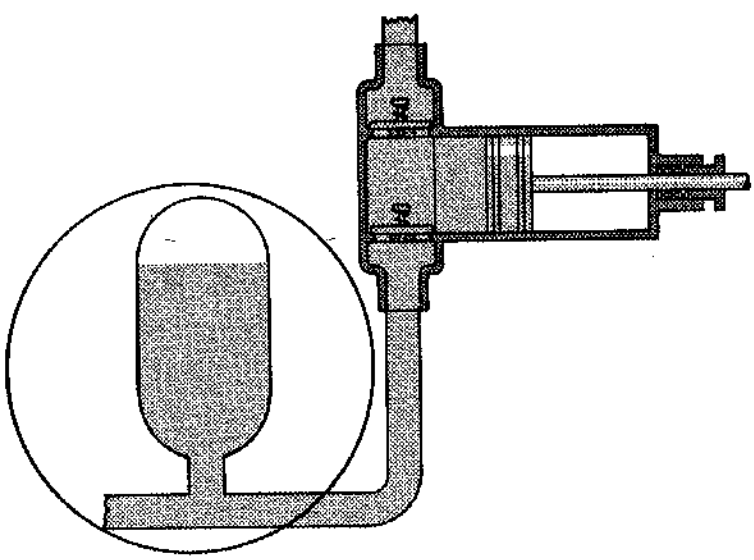
Summary

80. Identify the equipment circled in the drawing.



A. ______ ______.

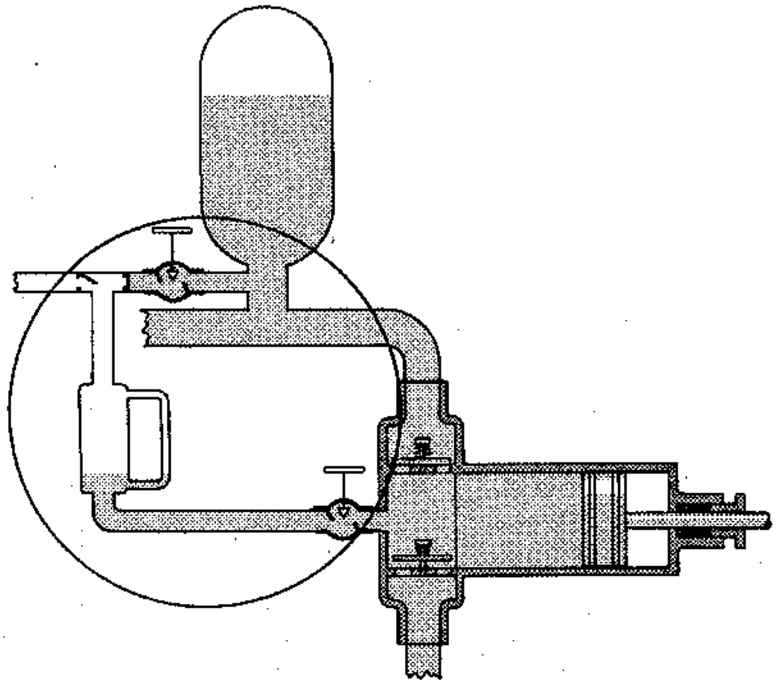
pulsation dampener, or gas chamber



B. ______ ______.

suction stabilizer

80. (cont.)



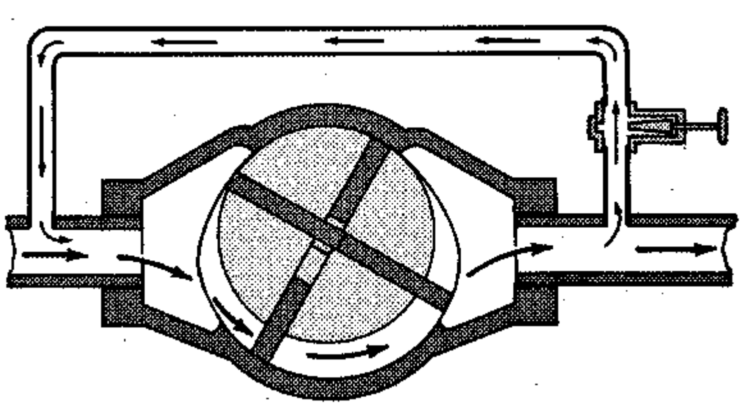
C. ________. snifter

81. A snifter is used to replenish the supply of ________ in an ________ ________. air; air chamber, or pulsation chamber

82. The pulsation dampener and suction stabilizer act as shock absorbers to prevent the ________ from hammering at the pump or piping. liquid

BYPASSES AND RELIEF VALVES

83. This pump is equipped with a discharge-to-suction *by-pass.*



Opening the bypass sends liquid from the discharge line back to the ________ line. suction

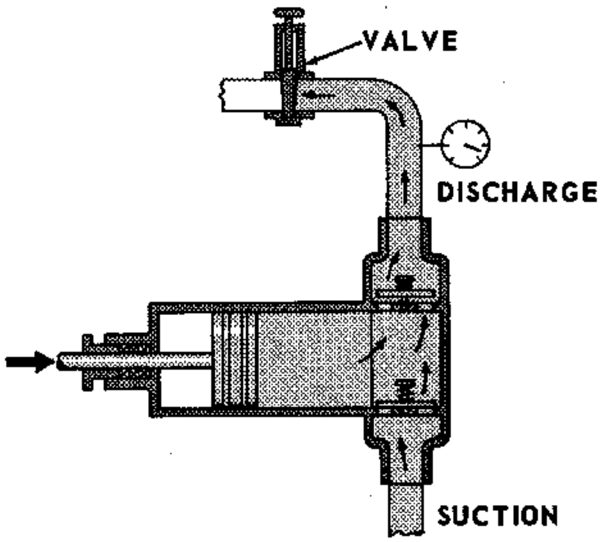
84. Engines and turbines must be started with no load.

A bypass (can/cannot) remove the load from the pump during startup. — can

85. If less liquid is needed for a process, the bypass can ________ the volume of liquid flowing through the discharge line. — decrease, or reduce

86. The bypass valve can be installed to be operated manually or ________. — automatically

87. A positive displacement pump *must* discharge liquid in order to complete its pumping cycle.



Here, a valve in the discharge line is accidentally closed. The pump (can/cannot) discharge. — cannot

88. The piston (can/cannot) displace the liquid down the flowline. — cannot

89. As the piston continues to transmit force, liquid pressure ________. — increases, or rises

90. If the pump is direct-acting, the pistons will ________. — stall, or stop

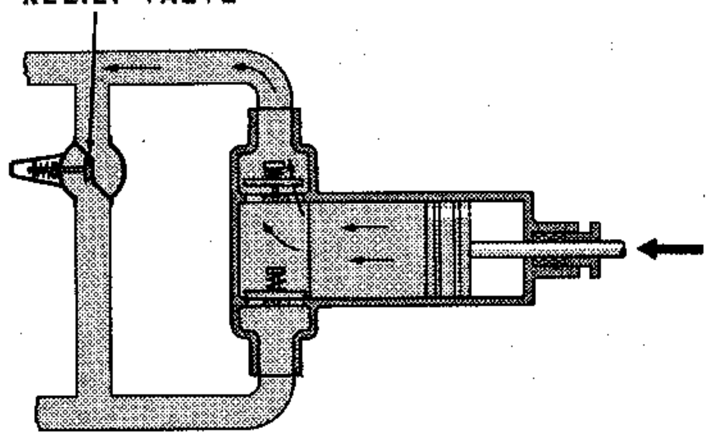
91. If the pump is a power pump, a pressure relief valve must open.

Otherwise, the prime mover will overload or some part of the pump or piping will ________. — break, or rupture

92. A (power/direct-acting) pump will be damaged if it cannot discharge liquid. — power

Summary

93. This pump is equipped with a safety relief valve.



The relief valve is installed in the discharge-to-suction __________.

bypass

94. As long as discharge pressure is normal, the relief valve is closed.

If discharge pressure gets too high, the relief valve __________.

opens

95. With the relief valve open, liquid is bypassed into the __________ line.

suction

96. The relief valve is a safety device that protects against excessive discharge pressure or a __________ discharge line.

blocked, or plugged, or closed

97. With a discharge line blockage, a direct-acting pump is more likely to (stall/rupture).

stall

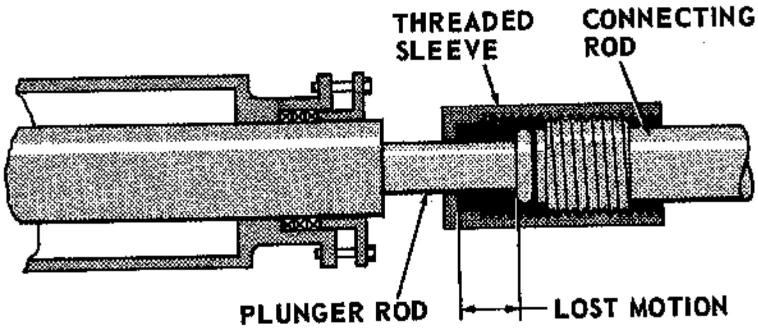
98. A power pump (will/will not) develop dangerously high pressure with a discharge line blockage.

will

99. For safety, any positive displacement pump should have a pressure __________ __________ between the pump discharge valves or port and the first block valve in the discharge line.

relief valve

100. Here is a portion of a plunger pump.



The plunger rod is coupled to a connecting rod by a threaded ______. sleeve

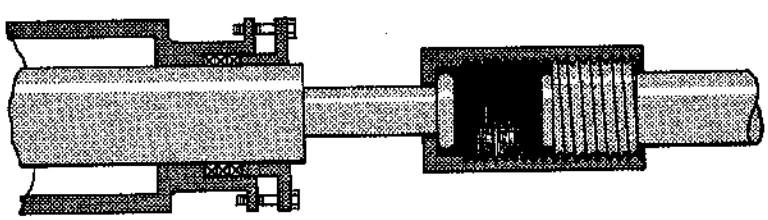
101. As shown above, the plunger rod is almost touching the connecting rod.

Suppose the connecting rod moves to the right. For some distance the plunger rod (will also move/will not move). will not move

102. Depending on the setting of the threaded sleeve, a certain amount of the connecting rod travel is lost motion.

In this arrangement, the lost motion is (always the same/variable). variable

103. Look at the positions of the plunger and connecting rods here.



If the connecting rod moves to the left, there will be (lost motion/no lost motion). lost motion

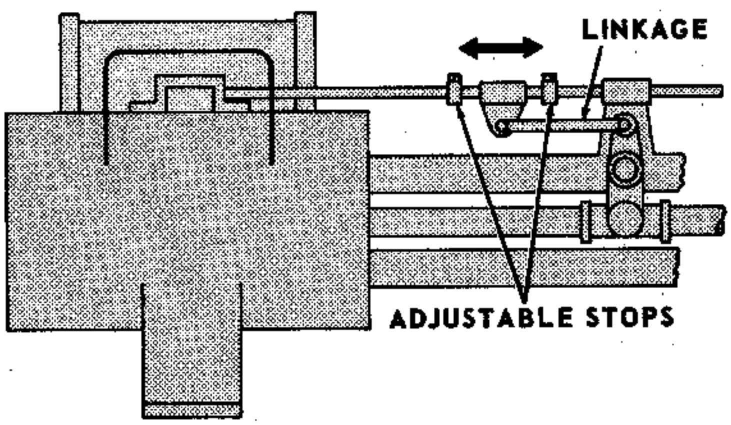
104. Changing the lost motion distance (changes/does not change) the length of stroke of the plunger. changes

105. Changing the length of stroke of the plunger changes the volume of liquid that is ____________ by the pump. — displaced

106. If the stroke is increased for a given speed, the pump moves (more/less) liquid. — more

107. In order to increase the stroke of the plunger pump by a lost motion device, the lost motion must be (increased/decreased). — decreased

108. Direct-acting pumps also have lost motion mechanisms.



To provide lost motion, one part of a linkage assembly slides back and forth between two ____________ stops. — adjustable

109. In this case, the lost motion effect is opposite to that in the plunger pump.

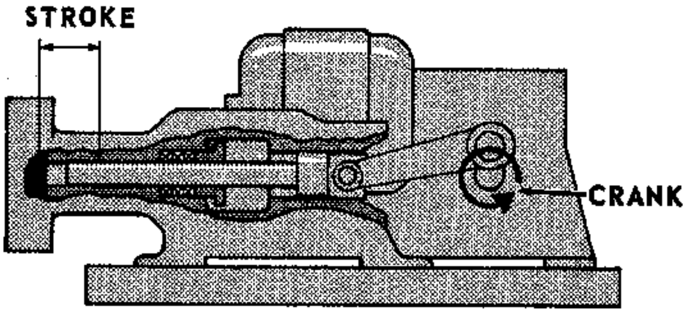
As lost motion decreases, the piston stroke (also decreases/increases). — also decreases

110. Whether the pump is power or direct-acting, plunger or piston, decreasing the stroke for a given speed causes (more/less) liquid to be displaced. — less

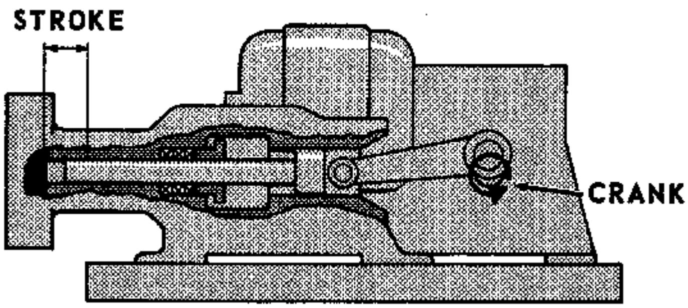
111. For plunger pumps, another way to change displacement is to change the size of the plunger.

The pump displaces more liquid with a (larger/smaller) plunger. — larger

112. Changing the crank length affects displacement. Compare these two cranks.



A



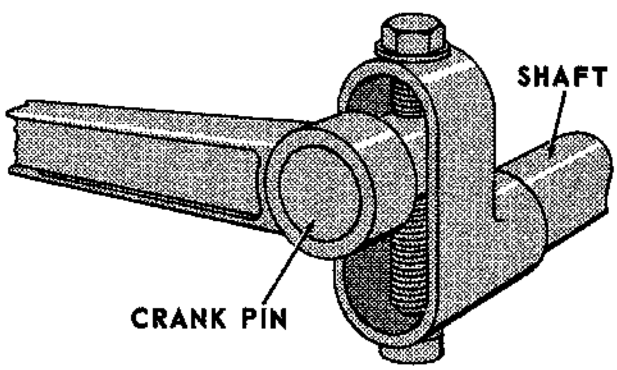
B

Crank (A/B) is longer. — **A**

113. Pump (A/B) has the longer stroke. — **A**

114. Increasing the length of the crank ____________ the pump's displacement. — **increases**

115. The crank for this pump is slotted.



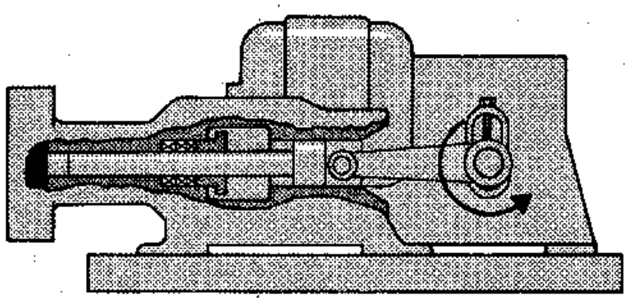
The connecting rod is attached to the crank through a ____________ ____________. — **crank pin**

116. The crank pin can be moved in the slot.

Moving the crank pin toward the shaft has the effect of (lengthening/shortening) the crank. — shortening

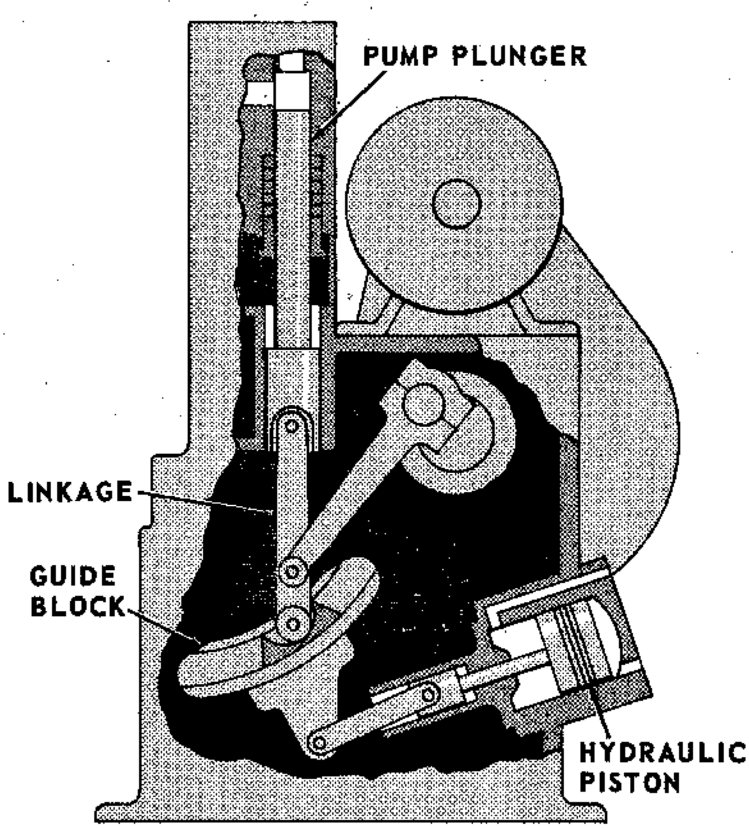
117. The pump's displacement increases as the crank pin is moved (toward/away from) the shaft. — away from

118. This crank pin can be centered with the shaft.



With the crank pin in the center position, the pump's displacement is (maximum/zero). — zero

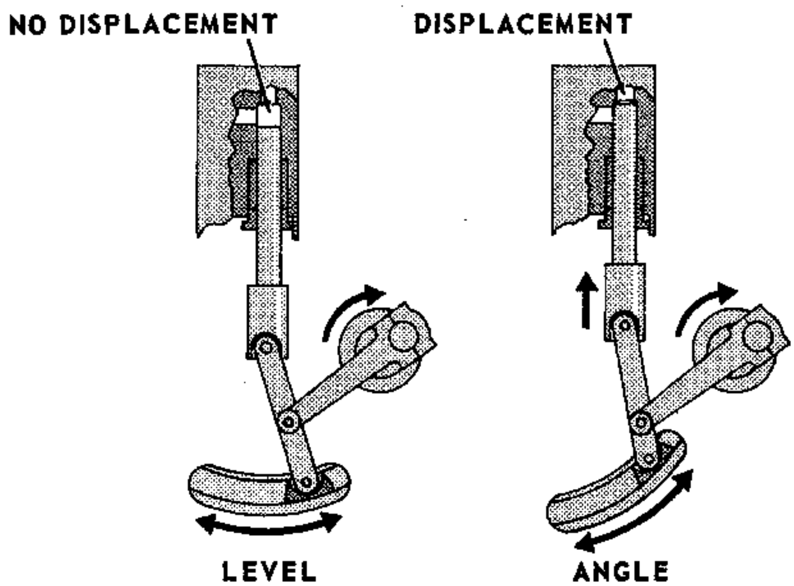
119. This device is called a *stroke transformer*.



The connecting rod is replaced by a two-part mechanical ________. — linkage

120. The linkage pivots on a track in the ____________ ____________. guide block

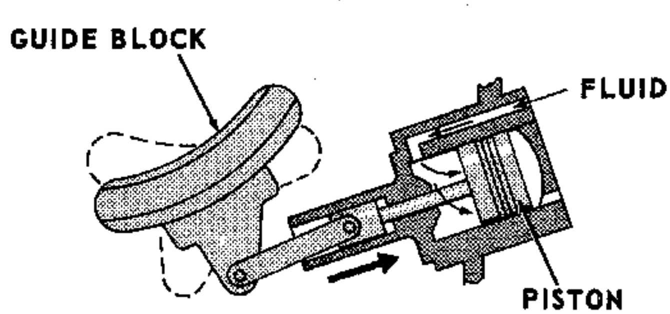
121. When the guide block is level, there is no displacement at the pump.



The rods move when the guide block is (level/at an angle). at an angle

122. The stroke length is controlled by controlling the ____________ of the guide block. angle, or position

123. The guide block may be controlled by a hydraulic piston.



Hydraulic fluid fed *under* this piston (increases/decreases) the angle of the guide block. increases

124. Fluid fed in *above* the piston (increases/decreases) the angle at the stroke transformer. decreases

125. The hydraulic piston can be controlled by pump discharge pressure.

This arrangement varies the displacement of the pump to adjust to changes in the __________ of the liquid in the discharge line. — pressure

126. A reciprocating variable displacement pump may be matched to the stroke of some other pump in a process.

Both pumps then make the same number of __________ per minute. — strokes

127. A pump used this way is usually called a *proportioning* pump.

The volume of flow from one pump is *proportioned* to the __________ of flow from the other pump. — volume

128. Suppose one pump is moving water and another pump is moving chemicals to treat the water.

The flow of chemical may be __________ to the flow of water. — proportioned, or adjusted

129. Variable displacement and proportioning pumps permit fine control of pump capacity without changing pump __________. — RPM, or speed

Summary

130. From time to time, the capacity of a pump may need to be changed.

One way to change capacity is to change the operating __________. — speed, or RPM

131. Another way to change capacity is to __________ the displacement of the pump. — vary, or change

132. Variable displacement pumps are built to permit changes in __________ without changing operating speed. — capacity, or displacement

133. For a plunger pump, displacement can be varied by changing the setting of the connecting __________ in an adjustable __________. — rod / sleeve

134. For a direct-acting pump, the travel of a linkage can be changed.

In both cases, changing the amount of lost motion (changes/does not change) the stroke. — changes

135. Where an adjustable sleeve is used, increasing the lost motion (increases/decreases) the stroke. — decreases

136. Where the linkage to a steam valve is used, increasing the lost motion __________ the stroke. — increases

137. Where a guide block is used, the adjustment in stroke is made by changing the ____________ of the guide block.

angle

138. If one pump is being matched or related to the stroke of another, the pump is usually called a ____________ pump.

proportioning

PACKING

139. Some clearance space is required between stationary and moving pump parts.

If a pump were not packed, liquid could ____________ through pump clearances.

leak

140. Besides being used to control leakage, packing is used to reduce ____________ between stationary and moving pump parts.

wear

141. To reduce wear, packing must be made of low-friction material.

It also must be flexible enough to provide a tight ____________.

seal, or fit

142. Some materials soften and break at high temperatures; others swell and become too tight.

Packing is chosen for the nature and ____________ of the pumping liquid.

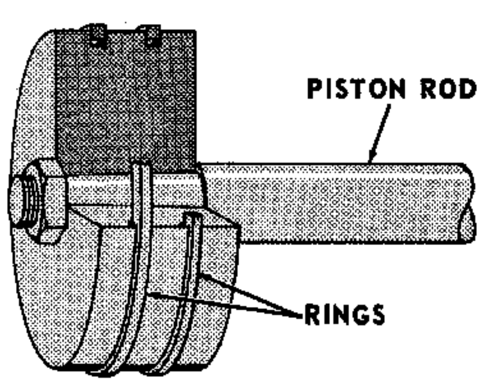
temperature

143. In piston pumps, some packing is carried on the piston.

That is, the packing is on and moves with the ________ itself.

piston

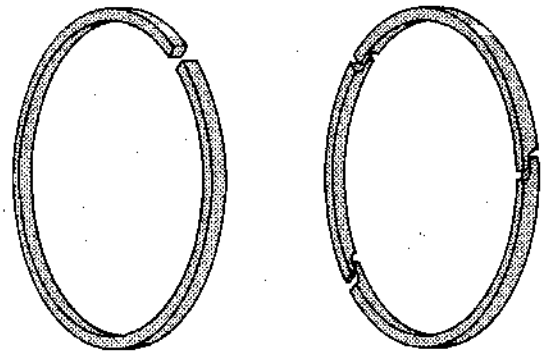
144. This drawing shows one form of piston packing.



The packing is actually a set of rings fitted into grooves on the ____________.

piston

145. Piston packing rings are usually made of cast iron, with gaps for expansion.



The rings may be made in one piece or in ______ pieces, or segments. — three

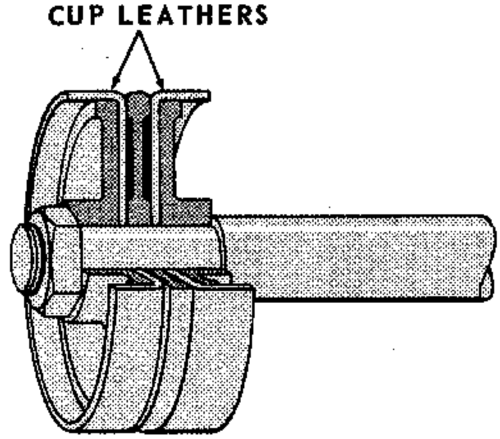
146. The gaps allow the rings to ______ against the cylinder as the pump reaches operating temperatures. — expand, or swell

147. A set of metal rings is installed so that the gaps (line up/do not line up) with each other. — do not line up

148. Metal rings are corroded or abraded easily.

Where corrosive or abrasive liquids are being pumped, it is probably (desirable/undesirable) to use metal piston rings. — undesirable

149. This piston is also packed, but is fitted with cup leathers instead of rings.

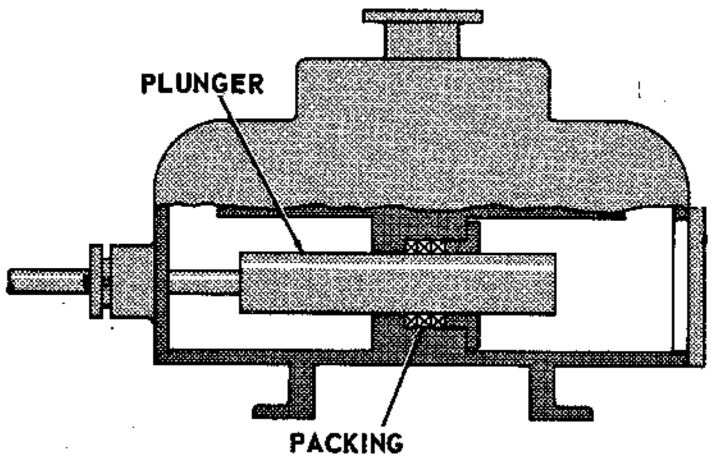


Contact with the pumping liquid causes the cup leathers to swell out against the wall or lining of the ______ — cylinder

Now turn the page,
turn the book over, and go on.

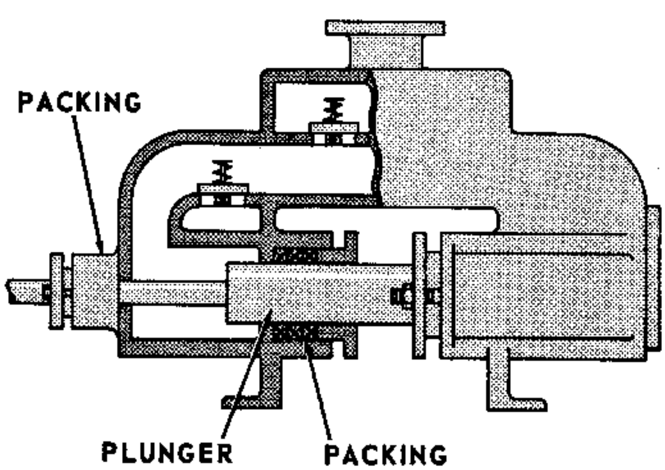
150. Instead of cup leathers, hard rubber or fiber rings may be used for pumping liquids that are ______ or abrasive. corrosive

151. All piston pumps are *inside* packed.



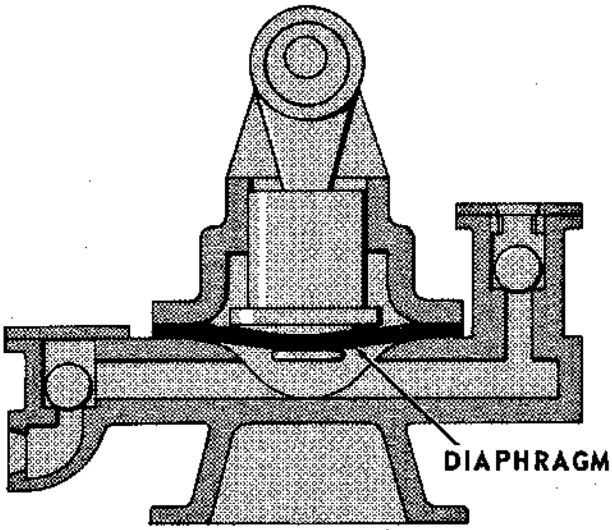
Notice the location of the plunger packing in this *plunger* pump. It is (also inside packed/not inside packed). also inside packed

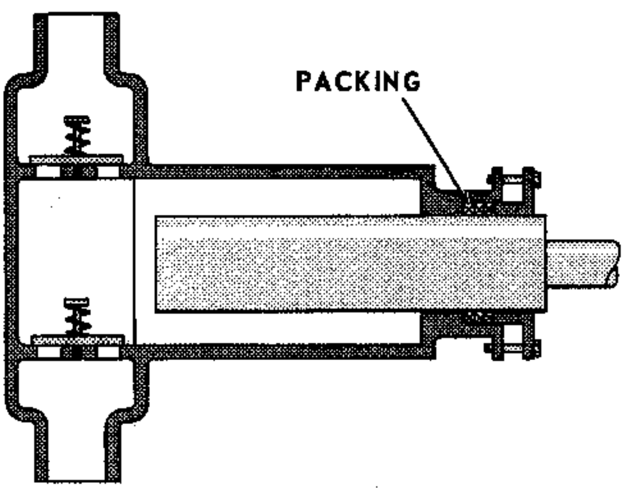
152. In most plunger and rotary pumps, however, the packing is usually located *outside* or at one end of the cylinder.



Although the plunger packing here is in the center of the entire pump unit, each packing gland is located (outside/inside) of the cylinders. outside

153. Look at these two pumps.





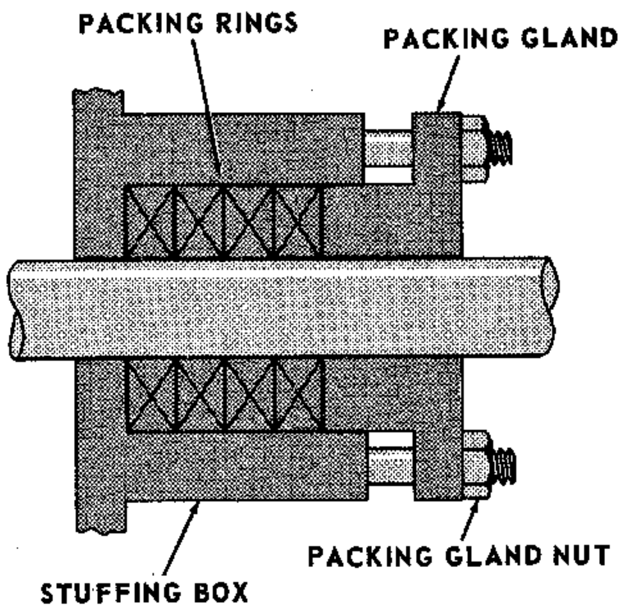
On the outside-packed plunger pump, the plunger's stationary __________ prevents leakage from the cylinder.

packing

154. On the diaphragm pump, the diaphragm acts as a seal between the pumping liquid and the rods, (so no packing is needed/but packing is still needed).

so no packing is needed

155. The packing used on rotary and plunger pumps is contained in a packing box.



The packing itself is usually soft packing or a set of metal or fiber ________ ________. packing rings

156. The packing can be tightened or loosened by adjusting each ________ on the packing gland. nut

157. If the packing is too tight, there is too much friction and the rings ________ too quickly. wear

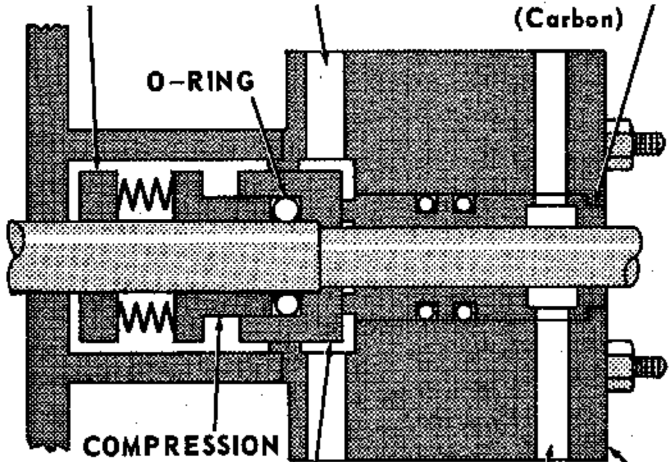
158. If the packing is too loose, there is too much ________ of the pumping liquid. leakage

159. On most pumps, some leakage is permitted for lubrication of the packing.

But if the liquid is corrosive or abrasive, then it is (desirable/undesirable) to allow leakage for lubrication. undesirable

160. When corrosive or abrasive liquids are being pumped, an outside source may be used to ________ the packing. lubricate

161. Instead of a packing box, a rotary pump may have a *mechanical seal.*



The stationary seal ring is held by the ________________ ________________. — seal flange

162. The rotating seal ring ____________ with the shaft. — rotates, or turns

163. The compression ring is forced into the rotating seal ring by a ____________. — spring

164. The compression ring compresses a flexible O-ring.

The O-ring prevents ____________ around the shaft. — leakage

165. A thin film of seal oil lubricates and cools the rings.

The seal oil also helps to ____________ the space between the rings. — seal, or fill

166. Mechanical seals may be used for pumping liquids at temperatures below 500°F.

They provide sealing with very little ____________ of the pumping liquid. — leakage, or loss

Summary

167. Packing does two things in a pump:

it seals spaces between moving parts to keep ____________ to a minimum; leakage

it also provides a low-friction surface to reduce ____________. wear

168. Piston pumps are always (inside/outside) packed. inside

169. In a few cases, the packing of a plunger pump is inside, but in most cases, plunger and rotary pumps are ____________ packed. outside

170. A certain amount of leakage past the packing can be allowed to provide ____________ for other parts of a pump. lubrication

LUBRICATION

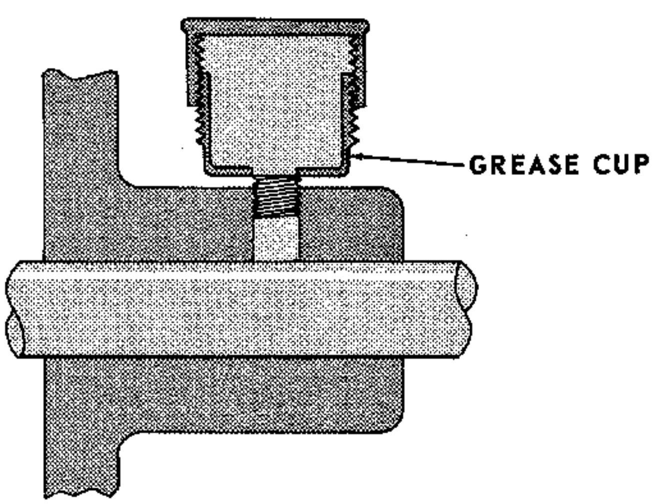
171. Many moving pump parts are lubricated by the pumping liquid.

However, some parts never come in contact with the ____________ being pumped. liquid

172. Oil and grease are used to ____________ these parts. lubricate

173. Even the packing may be lubricated from an outside source if the pumping ____________ has poor lubricating qualities. liquid

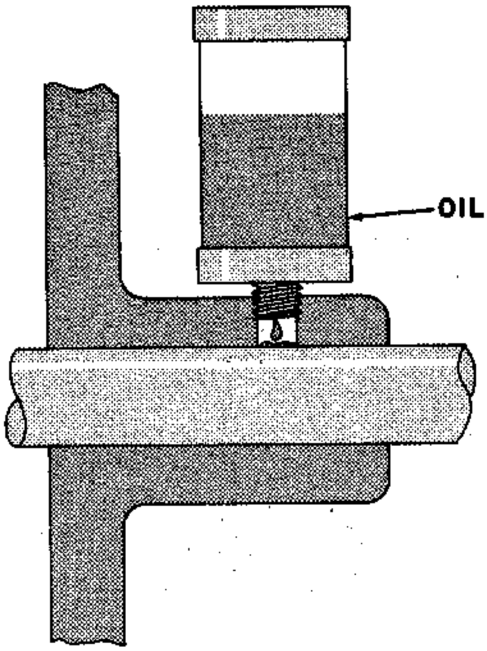
174. This drawing shows a grease cup.



As the shaft rotates under the cup, it picks up ____________. grease

175. The cap must be periodically turned down, and the cup must be ______________ with grease as needed. filled

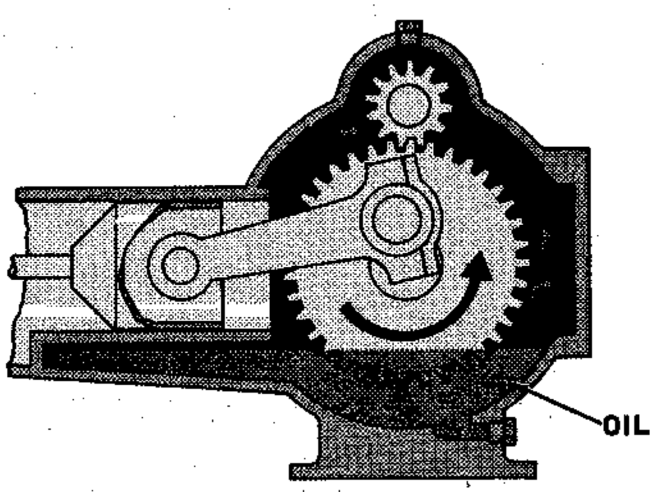
176. This is a drip oil lubricator.



It supplies oil (in a steady stream/a drop at a time). a drop at a time

177. Like the grease cup, the drip lubricator must be periodically ______________. filled

178. This drawing shows a splash system of lubrication.



There is a reservoir of lubricating oil at the bottom of the ______________. crankcase, or casing

179. The gears pick up the oil and ______________ it on the bearings, gears, and crankshaft. splash, or carry

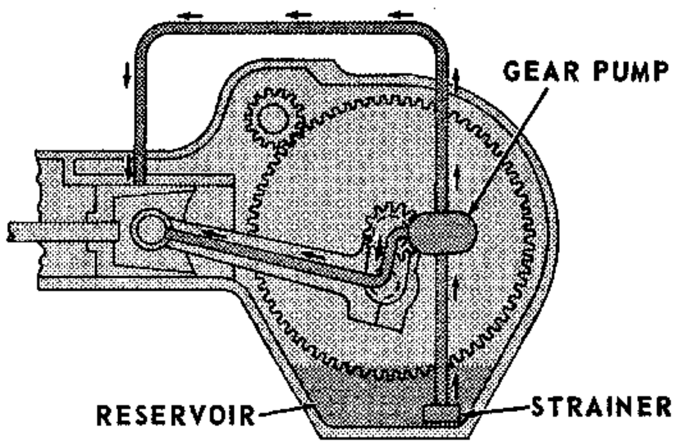
180. Then the oil drips down into the __________ again.

reservoir, or crankcase, or casing

181. The level of oil in the crankcase must be __________ periodically.

checked

182. In large or slow speed pumps, a forced lubrication system is used.



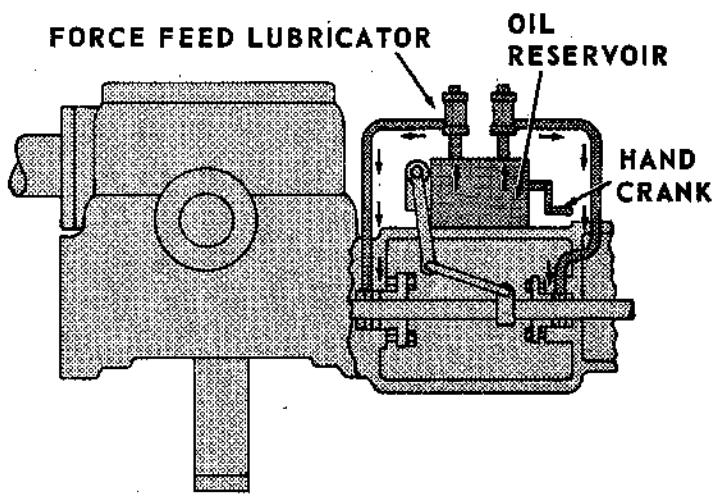
Oil is forced from the crankcase to the bearings by a small __________.

pump

183. The oil from the reservoir flows through a __________ before it enters the oil pump.

strainer

184. This force-feed lubricator uses a small plunger pump.



The lubricator is powered by a linkage to the pump __________.

rod, or shaft

185. The forced-feed lubricator does not begin operating until the pump is started.

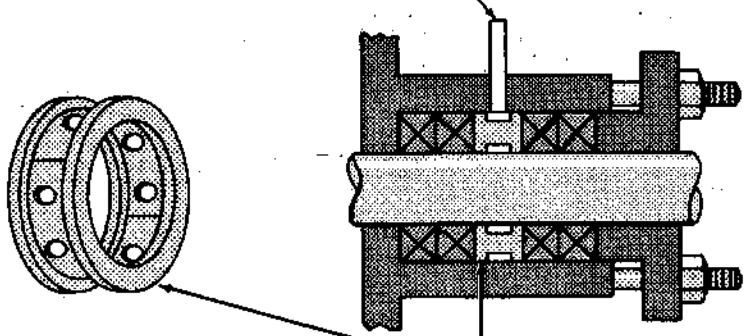
A hand crank may be used to operate the forced-feed lubricator (before/after) the pump is started.

before

186. The oil flow from a forced-feed system is usually observed through a drip glass.

Proper lubrication is maintained only when the oil is ________ through the system. flowing

187. A lantern ring is a metal cage about the size of a packing ring.



It fits near the center of the ________ ________. packing box, or packing rings

188. The lantern ring makes a space between the packing rings.

This space is used to provide lubricating or seal ________ to the packing. oil

189. The lubricant may be the pumping liquid or another liquid.

When corrosive liquids are being pumped, liquid from (the pump/another source) is used to lubricate the lantern ring. another source

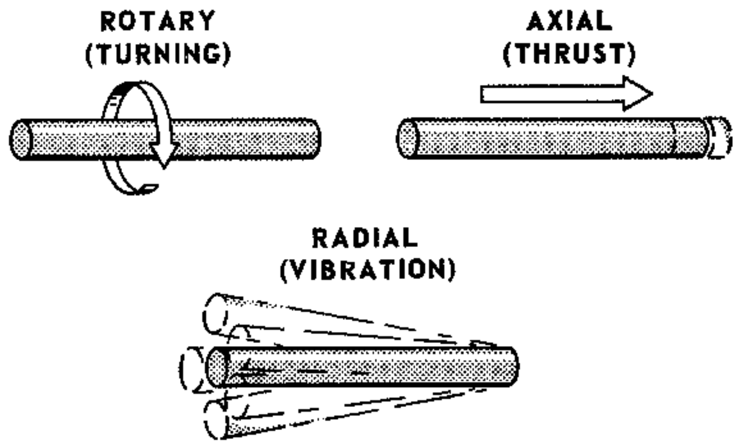
190. When the pumping liquid is *not* used, lantern ring lubrication must be pumped in at a *higher* pressure than the pressure in the pump.

This higher pressure prevents pumping liquid from entering the ________ ________. packing box

191. Lantern rings are also used when the pump is operating under vacuum.

To keep air from entering a vacuum pump, the sealing oil or other sealant at the lantern ring must be kept at a pressure that is (higher/lower) than atmospheric pressure. higher

192. The shaft of a rotary pump may tend to move in three different ways.



Thrust, or movement in a straight-line direction, is ____________ movement. — axial

193. A long, unsupported shaft can also vibrate up and down.

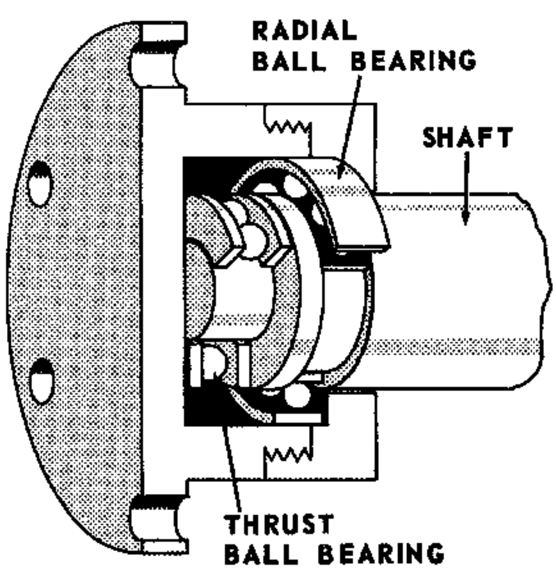
This is (axial/radial) movement. — radial

194. Bearings are used to control axial and radial movement in shafts.

A thrust bearing limits the amount of (axial/radial) movement. — axial

195. A radial (journal) bearing controls ____________ movement. — radial

196. This rotary pump uses ball bearings.



The ball bearings control (axial/radial/both axial and radial) motion. — both axial and radial

197. The ball bearings turn freely as the shaft rotates.

The bearing lubricant provides a fluid film that reduces ______________ between the bearing and the shaft. friction, or wear

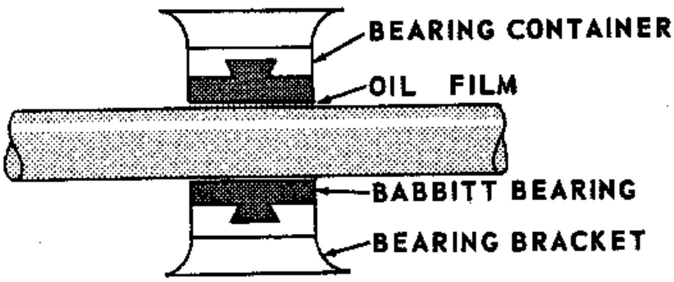
198. Ball bearings may be grease- or oil-lubricated.

Where the load on the bearing is great and considerable heat is generated, oil is used as the lubricant because it can also ______________ the shaft and bearing. cool

199. Grease-packed bearings can be over-greased.

Overgreasing causes the bearing to ______________. overheat, or fail

200. Some pumps use sleeve bearings instead of ball bearings.

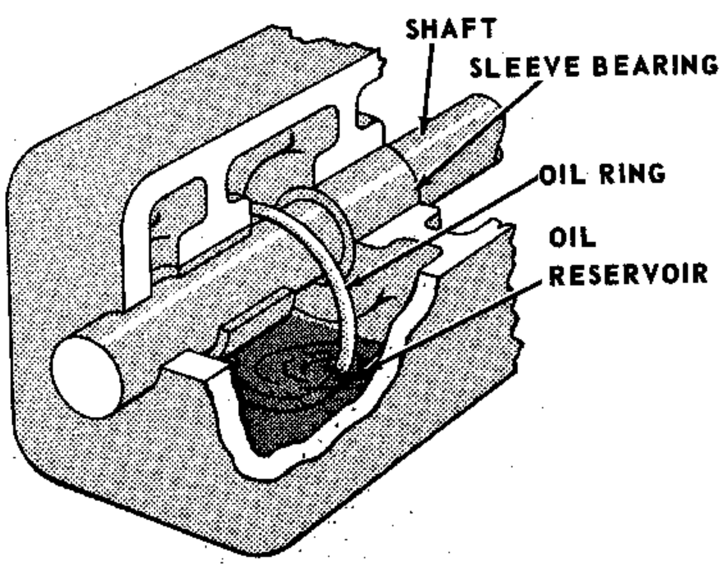


Sleeve bearings control (axial/radial) movement. radial

201. There is no contact between the shaft and bearing.

The shaft rotates on a film of ______________. oil

202. The oil is supplied through grooves on the bearing surface.



An oil ring picks up oil from a ______________ and carries it up to the bearing. reservoir

203. Pump couplings may be lubricated with heavy oil or grease.

Before the pump is started and during operation, the couplings should be checked for ____________. leakage, or lubrication

204. The operating manual or the supervisor specifies the ____________ and amount of oil to be used for lubricating the coupling. grade, or type

205. Oil must be free of dirt and water.

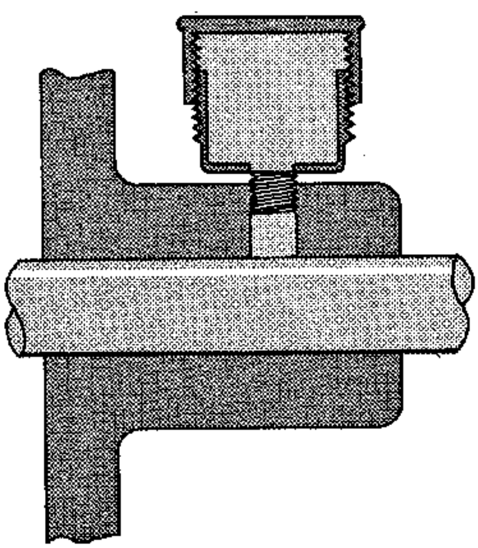
Water breaks down the film between the shaft and bearing, and ____________ is abrasive. dirt

Summary

206. The main purpose of lubrication is to prevent ____________ between moving parts. contact, or wear

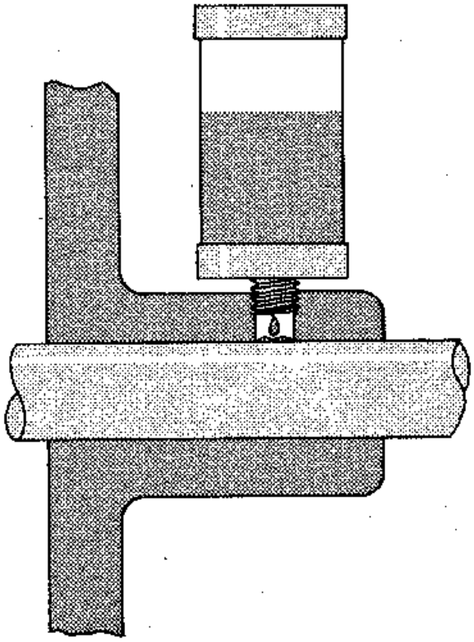
207. If the liquid being pumped cannot provide lubrication, outside sources of ____________ and ____________ are used. oil; grease

208. The drawing shows one device for lubricating moving parts.



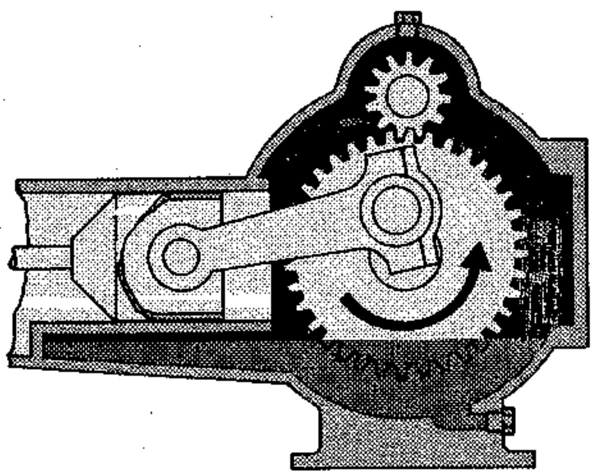
This is a grease ____________. Grease is forced in by tightening the ____________. cup
cap

209. This device supplies oil.



This is a ______________ oil lubricator. drip

210. This arrangement also supplies oil.



This is a ______________ system. splash

211. If a splash system is not adequate, oil can be brought to the desired points by way of a gear or plunger ______________. pump

212. A lantern ring is designed to provide space between packing rings so that lubricating __________ can reach moving parts. — oil

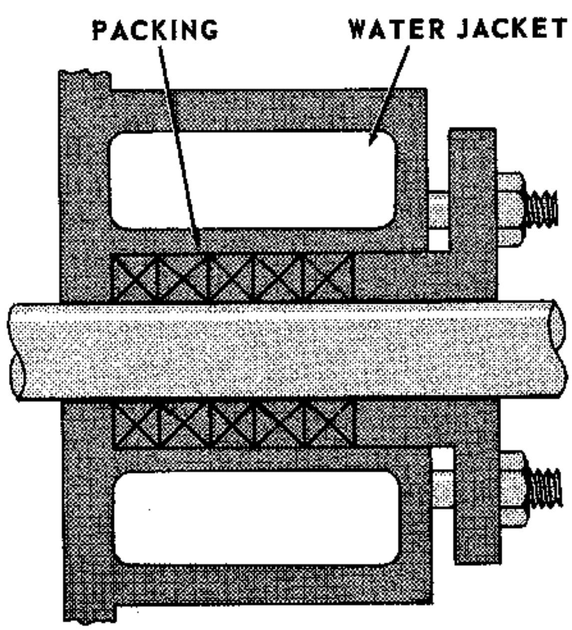
213. Bearings provide low friction contact points.

Regardless of type, bearings normally (should/should not) be lubricated. — should

COOLING

214. When the temperature is not too high, the heat at the packing box can be carried away by the surrounding __________. — air, or atmosphere

215. Sometimes air cooling is not enough.



This packing box is cooled by water circulating through a __________ __________. — water jacket

216. The water __________ the packing and rod or shaft. — cools

217. When the bearing must be cooled, the bearing and reservoirs may be surrounded with __________ __________. — water jackets

218. High-temperature pumps usually have water-jacketed bases (pedestals).

The more heat the pump has to handle, the more thoroughly it is __________-__________. — water-jacketed, or water-cooled

Section 4

Operation

SECTION 4

OPERATION

PRESTART

1. Before startup, be sure the pump and its driver are ready for operation.

   Check the crankcase and other ____________ systems and fill with oil or lubricants if necessary. — lubrication

2. Bearings and fittings are usually greased on a regular schedule, rather than before every startup.

   Overgreasing may cause a bearing to ____________ and fail during operation. — overheat

3. Steam cylinders are usually lubricated with a quill.

   The quill is used to inject a spray of ____________ into the steam supply line. — oil

4. If the pump or its driver has a cooling system, fill with ____________ and begin circulation. — water, or coolant

5. If a pump is put under load when it is cold, some of the parts heat up faster than other parts.

   When parts heat up unevenly, they expand at (equal/unequal) rates. — unequal

6. Expansion at unequal rates can cause the parts to seize and ____________ the entire pump unit. — stop, or damage

7. When the pump is not running, heating the parts unevenly is (likely/not likely) to cause damage. — not likely

8. If hot liquid is circulated through the cylinders or casing for a long enough time, (all/only some) of the pump will come up to the same temperature. — all

9. Circulate the hot liquid long enough before the pump is started so the pump is at a safe operating ____________ when you start it up. — temperature

10. A spare pump in hot service is usually kept warm by a circulating line from the operating pump's discharge line.

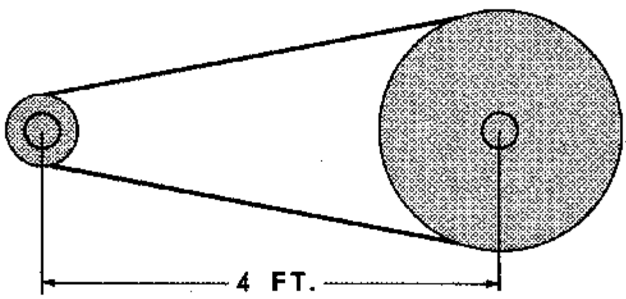
    The circulating line moves ____________ through the spare pump and back into the suction line. — liquid

11. If electrical work has been done on a motor-driven pump, check to be sure the ____________ of the pump and the motor shaft is in the proper direction. — rotation

12. Drain any condensate or liquid water in steam engine cylinders.

Condensate is not compressible and may ____________ cylinder heads. — damage

13. Check the condition and tension of V-belts.



The *span* of this V-belt drive is ____________ feet. — 4

14. Generally, a V-belt is properly adjusted when it gives its own thickness or width for every 4 feet of span.

A ½-inch belt should give ____________ inch for every 4 feet of span. — ½

15. Tighten any slack belts and replace ____________ belts. — worn

16. In a piston pump, replace worn piston ____________ or cylinder liners. — rings

17. Check the packing box for leaks, and ____________ as needed. — tighten, or adjust, or repack

18. Check to make sure that valve covers are in place and that all bolts are ____________ enough. — tight

19. Relief valves should be routinely checked and ____________ so that they operate properly. — set, or adjusted

20. There are block valves in the piping leading to and from the pump.

Before startup, the suction and discharge line valves must be (open/closed). — open

21. Double-check the discharge line valves.

Trying to start a pump with a closed discharge line valve can stall the driver or ____________ the pump or piping. — rupture, or break, or damage

22. Before startup, fill the suction line completely with liquid, so that there is a liquid seal at the suction ____________ or port. — valve

23. Bleed or vent vapor pockets in the suction liquid ____________ they reach the pump. — before

24. Because vapors rise, vapor pockets are likely to occur at ____________ points in the suction line.

high

25. Bleeder valves are set at high points in the line to vent off vapor or gas before it reaches the ____________.

pump

26. If the vapor from the pumping liquid is valuable or hazardous, the vapor is vented into (the atmosphere/a disposal system).

a disposal system

27. On a reciprocating pump, the pulsation dampener must be filled with ____________ before startup.

gas

28. Fill the suction stabilizer with liquid.

If vapor pockets have formed in the stabilizer, these pockets must be ____________ off.

bled

29. With vapor bled from the stabilizer, suction or flowline pressure will fill it with ____________.

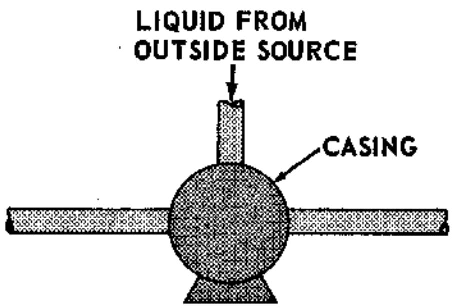
liquid

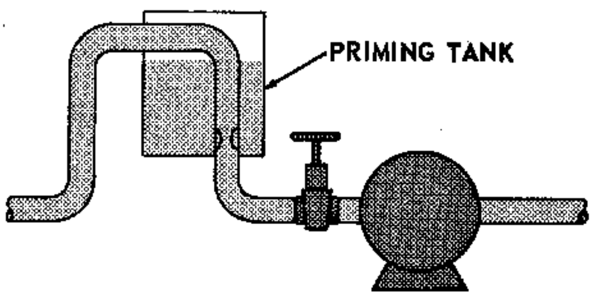
30. Most rotary pump manufacturers recommend priming or bleeding the pump before startup.

Filling the pump with liquid reduces ____________ between the close-fitting parts of the pump.

wear, or friction

31. This drawing shows two types of priming systems.





The pump may be primed by admitting liquid directly into the ____________.

casing, or pump

32. Or, a priming tank may be used to force liquid into the pump through the ____________ line.

suction

33. Some drivers can be damaged by low-speed operation at full load.

Before startup, the operator must make sure that the pump will not put too great a __________ on the prime mover. — load, or strain

34. The bypass connects the discharge line to the suction line.

With the discharge block or check valve closed and the bypass open, the pump takes in liquid from the __________ line and discharges it back at essentially (the same/a different) pressure. — suction; the same

35. Opening the __________ valve removes most of the load from the prime mover. — bypass

36. Internal combustion engines generate intense heat in their cylinders as soon as they start.

Just after a cold engine has been started, the different parts will be at (equal/unequal) temperatures. — unequal

37. Just after a cold start, the parts of the engine have expanded (equally/unequally). — unequally

38. With unequal expansion, it is likely that operating conditions (are correct/are not correct). — are not correct

39. Under these circumstances, running a cold engine under full load may cause __________ to the parts. — damage

40. Internal combustion engines, therefore, should be started under no load.

Full load can be applied safely to the engine (as soon as it is running/only when operating temperature has been reached). — only when operating temperature has been reached

41. Electric motors, on the other hand, heat up equally throughout the parts.

Expansion of motor parts is, therefore, (equal/unequal). — equal

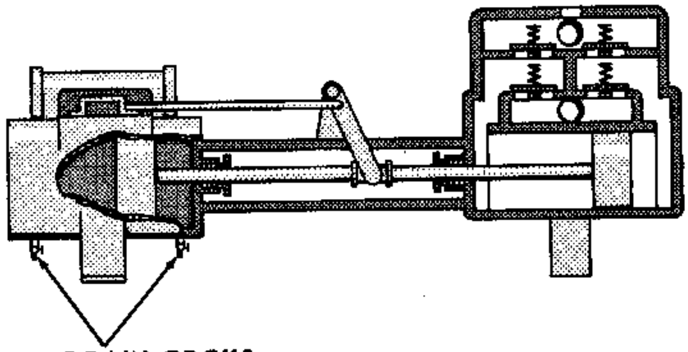
42. To apply full load to a motor just after it has reached running speed is (likely/not likely) to cause damage. — not likely

43. Electric motors (require/do not require) a long warmup period after starting. — do not require

44. A pump powered by an (electric motor/internal combustion engine) requires a longer warm up. — internal combustion engine

45. When the prime mover has reached full operating temperature and speed, the bypass valve can be ________ again as the discharge block valve is ________. — closed / opened

46. This is a direct-acting steam pump.



The steam cylinder has been prepared during prestart by draining out ________. — water, or condensate

47. To start, open the exhaust line and crack open the high-pressure ________ valve. — steam

48. Allow time for ________-________. — warm-up, or heating-up

49. Close the ________ drain valves. — condensate, or cylinder

50. If the pump is moving hot liquid, the pump itself should have a chance to ________ up. — warm, or heat

51. Prime the pump if possible and bleed off ________ from the suction piping. — vapor, or gas

52. Open steam to the ________, and adjust for proper pumping rate. — cylinder

53. Once the pump is operating, it should be checked for ________ in the casing, packing, or piping. — leaks

54. Packing should be checked for temperature as well as for leakage.

Excessive temperature may mean that the packing is too ________. — tight

55. Loose packing must be tightened.

To permit the amount of leakage desired for lubrication, packing that is too tight should be __________. — loosened

56. Continue to check the pump during operation.

If unusual noises develop, determine the source and probable cause.

The pump should be ________ ________ to correct the trouble. — shut down

SHUTDOWN

57. A power pump is shut down by shutting down the ________ ________. — prime mover, or pump driver

58. An electric motor is simply switched off.

An internal combustion engine should be run at low load or no load for 10 to 15 minutes to allow the engine to ________ before it is shut down. — cool

59. After the prime mover is shut down, close all the pump ________. — valves

60. In a direct-acting steam pump, the power is supplied by steam.

To shut this pump down, the (steam inlet/exhaust valves) should be closed first. — steam inlet

61. The next steps are to close the exhaust valves, then drain the steam cylinder to remove ________. — condensate, or water

62. If freezing is likely, drain water from the pump's ________ system. — cooling

63. Vent the pump if there is any possibility that heat will cause excess ________ to build up. — pressure, or gas, or vapor

64. If a pump is to be taken out of service, shut down the driver and lock it out to be sure that it is not ________ by accident. — started

65. When a pump is shut down to work on it, either in place or in the shop, close off the process lines by installing ________. — blinds, or blanks

66. To take the pump to the shop, purge or flush it out and disconnect it from its base (before/after) installing the blinds. — after

67. To remove hazardous vapor or liquid, purge the pump with steam or wash it with ________. — water

68. If a pump is going to be set as an operating spare, leave the cooling systems operating and the suction and discharge valves open in the line.

With this done, the pump is ready to ________. — start, or operate

69. Usually, a check valve in the discharge line prevents liquid in the line from backing up through the spare ________. — pump

70. During shutdown, the check valve should close automatically.

If liquid should leak back through the spare, the pumping system loses ________. — capacity, or pressure, or efficiency

Summary

71. The pump has been checked through prestart and is ready to start when:

all valves in the suction and discharge lines are ________ and the lines are ________ of obstructions; — open; free, or clear

all bleeders, vents, and drains are ________; — closed

all cooling and lubrication systems are ________; — checked, or filled

rotary pumps are ________ with liquid, and there is a liquid seal in the ________ line; and — filled, or primed; suction

relief valves are ________ properly. — set, or operating

72. To start a pump:

first unload the pump by setting the bypass valve (open/closed); — open

start the driver and, if it is an internal combustion engine, let it idle under (no load/full load); — no load

load the engine only after it is up to ________ temperature. — operating

73. To start when the driver is an electric motor, be concerned about reaching (operating temperature/running speed.) — running speed

74. For a power driver, after speed and/or temperature are at the desired levels, (leave the bypass valve open/close the bypass valve). — close the bypass valve

At the same time, open the ________ block valve. — discharge

75. To start a direct-acting steam pump:

set the exhaust line (open/closed);	open
crack the high-pressure ________ valve;	steam
let the unit ________ ________;	warm up
set the cylinder drain valves (open/closed);	closed
prime the pump and bleed off ________;	vapor
let steam into the ________, and adjust the ________ of pumping.	cylinder rate

76. To shut down a power pump:

if an electric motor, (switch if off/let it idle under no load);	switch it off
if an internal combustion engine, run it for 10 or 15 minutes at low or no load to allow it to ________.	cool

77. To shut down a direct-acting steam pump, set the:

live steam valve (off/on);	off
exhaust steam valve (off/on);	off
steam cylinder drains (open/closed);	open
pump suction valve (open/closed);	closed
pump discharge valve (open/closed);	closed
cooling water (off/on).	off

COMMON PUMPING PROBLEMS

Gradual Loss of Capacity

78. Wear and leakage in the pump cause a gradual loss of ________.	capacity
79. Pump packing should be replaced or renewed when it no longer prevents excessive ________.	leakage
80. Dirt, coke, or grit in the liquid can clog or wear cylinder valves. Clogged valves should be ________.	cleaned
81. Worn or broken valves must be repaired or replaced. Failure of cylinder valves to ________ properly is a common cause of loss of capacity.	seat, or operate, or close

82. A leaking valve in the bypass line can also cause a loss of capacity.

For operation at full capacity, the bypass valve should be tightly ______. closed

83. At a constant steam or air pressure, the capacity of a direct-acting pump changes when liquid pressures change.

Loss of capacity in direct-acting pumps may mean a rising pressure in the ______ line. discharge

Loss of Suction

84. Loss of suction pressure may prevent the pump from filling properly with liquid.

If suction pressure falls below the required NPSH, the pump loses ______ rapidly. capacity, or suction

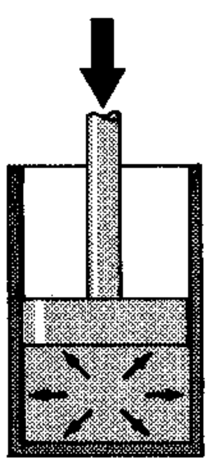
85. An increase in suction lift or a decrease in suction head causes a ______ of suction pressure. loss, or decrease

86. Obstructions or excessive pressure loss in the suction piping can also cause the pump to lose ______. suction

87. If a pump is losing suction, check the liquid level or pressure at the suction and the condition of the suction ______. piping, or line

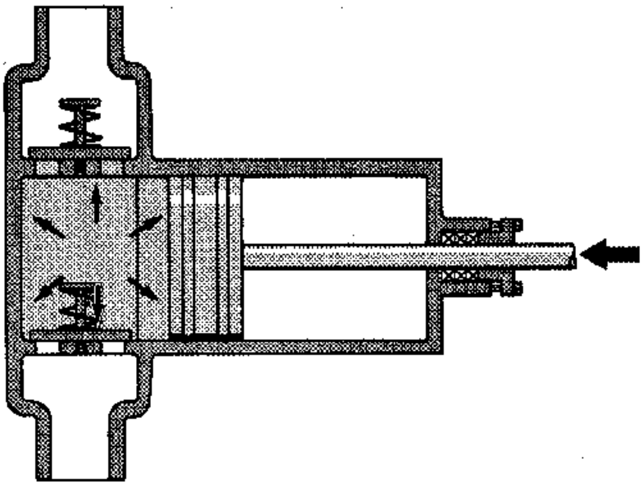
Vapor-Locking

88. Gases are *compressible.*



When force is applied to a gas, the gas is squeezed into a smaller ______. volume, or space

89. This piston pump is filled with high-pressure gas.



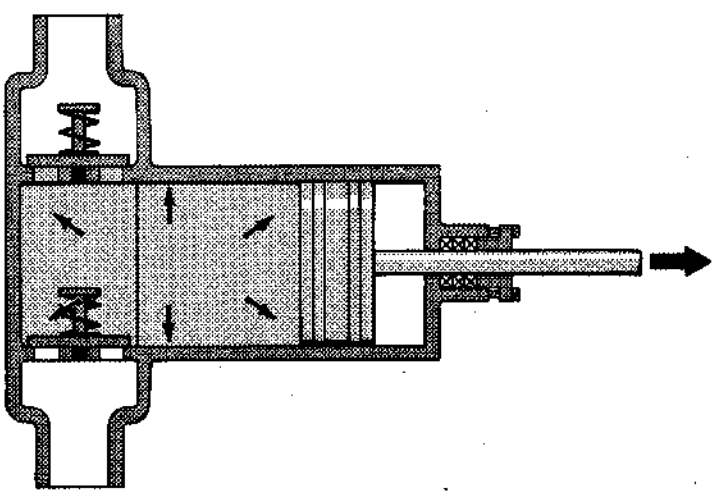
As the piston moves forward, it ____________ the gas into a smaller volume. — compresses

90. The pressure of the gas in the cylinder may not rise as high as discharge line pressure.

Then the discharge valve does not ____________ on the forward stroke. — open

91. When the discharge valve does not open, no __________ leaves the cylinder. — liquid, or vapor, or gas

92. As the piston moves back, the compressed gas expands in the cylinder.



The pressure of the gas in the cylinder prevents the ____________ valve from opening. — suction

93. As a result, liquid (can/cannot) enter the cylinder on the backstroke.

cannot

94. Although the piston continues to move back and forth, nothing enters or leaves the cylinder.

The valves cannot operate because of the pressure of the ____________ in the cylinder.

gas, or vapors

95. When this happens, the pump is *vapor-locked.*

A vapor-locked pump moves (some/no) liquid.

no

96. Vapor-locking may be indicated if the pump fails to ____________.

discharge, or pump

97. A vapor-locked pump is noisy, and the pump housing may vibrate.

Noisy operation, together with greatly reduced or zero capacity, may indicate a pump that is ____________-locked.

vapor

98. Air may enter the pump through leaks in the (suction/discharge) line.

suction

99. Air may also enter the pump through loose ____________ around the shaft or rod.

packing

100. Air or gas may enter through a suction pipe that is too near the ____________ of the liquid.

surface, or top

101. Evaporation of the pumping liquid can also cause vapor-lock and loss of suction.

To prevent vaporization, NPSH available must be equal to or ____________ than NPSH required.

more, or greater

102. NPSH can be increased by either:

(increasing/decreasing) the suction pressure, or by

increasing

(increasing/decreasing) the temperature of the suction liquid.

decreasing

103. If there is not enough NPSH available, pump speed must be (increased/decreased) to obtain proper operation.

decreased

104. A vapor-locked pump must be bled of vapors by closing the discharge block valve and ____________ the pump to the atmosphere or to a low-pressure system.

venting, or bleeding

105. The suction source must be checked to correct the cause of vapor-locking.

Or, the pumping rate may be (increased/decreased) to increase the NPSH at the pump.

decreased

Sudden Loss of Capacity

106. A blocked discharge line prevents the pump from ____________ liquid.	discharging, or pumping
107. In the direct-acting steam pump, the steam engine will ____________ if the discharge is blocked.	stall, or stop
108. A blocked discharge will overload the prime mover or driver of a power pump and cause the pump to ____________.	fail, or stop, or stall
109. If the prime mover does not stall or fail, a blocked discharge without a relief valve will rupture gaskets, piping, or some part of the pump. When the discharge is blocked, pump capacity is suddenly reduced to ____________.	zero, or no capacity
110. Excessive friction in the piping can cause high discharge pressures. If the piping is too small or too long, the effect is similar to that caused by a ____________ in the discharge line.	block, or plug
111. Excessive discharge pressures will cause a sudden (increase/decrease) in pump capacity.	decrease
112. Loss of suction also causes the pump to suddenly ____________ discharging liquid.	stop

Overloading

113. Suppose the packing of a pump is too tight. Packing that is too tight can set up excessive ____________ or rubbing.	friction
114. Suppose there is not enough lubrication at several points. This condition (sets up excessive/does not affect) friction.	sets up excessive
115. Improper alignment (can/cannot) set up excessive friction.	can
116. Excessive friction (increases/does not affect) the chance that the driver will overload or stall.	increases
117. Suppose the discharge line is blocked. Discharge pressure then (goes up/drops).	goes up

118. If the discharge pressure gets too high, the driver will ________. — overload, or stall

119. Suppose there is an increase in the viscosity or density of the liquid being pumped.

Power requirements go (up/down). — up

120. If the load increases for any of these reasons — friction, blockage, or higher viscosity — the driver is (more likely/less likely) to overload or stall. — more likely

Overspeeding

121. Overload leads to somewhat the same results in either direct-acting or power pumps.

Loss of load effects both kinds of units (the same way/differently). — differently

122. Suppose an AC motor is running under load at its rated speed.

If the load is removed, the motor will (speed up/slow down/continue at rated speed). — continue at rated speed

123. Suppose the driver is an internal combustion engine.

Removing load causes the engine to speed up (more and more/up to the limit of the throttle setting). — up to the limit of the throttle setting

124. If the load is removed from a *direct-acting* unit, the driver speeds up (more and more/up to a given limit). — more and more

125. Low intake of fluid is (like/not like) removing load. — like

126. Given a low intake of fluid, the power pump is (likely/not likely) to overspeed; the direct-acting pump is (likely/not likely) to overspeed. — not likely; likely

Short-Stroking

127. Jerky, short strokes may be caused by a piston rod packing that is too ________. — tight

128. On direct-acting pumps equipped with cushion valves, long- or short-stroking may call for an adjustment of these valves.

Too much cushion causes short-stroking.

Too little cushion may permit the piston to ________ the end of the cylinder. — strike, or hit

129. In some situations, a lost-motion adjustment may be necessary to produce the correct ______. | stroke

130. Loss of power in a direct-acting pump sometimes indicates valve trouble.

Incorrectly set or worn steam valves slow the pump down or even cause it to ______. | stop, or stall

Noise and Vibration

131. Excessive noise and vibration are signs of faulty operation.

Vapor-locking can cause excessive ______ at a pump. | noise, or vibration

132. Improper alignment can also cause excessive ______. | noise, or vibration

133. Any improperly balanced rotating assembly can cause excessive vibration.

A loud pounding or rattling noise may mean that a bearing has become so worn that it is loose enough to ______ around. | move

134. A piston nut could have worked loose and the ______ could be slipping back and forth on the rod. | piston

135. Almost any worn part can produce noise. Weak or broken valve springs lead to pounding of the valves.

Operating at a lower speed reduces the noise until the faulty springs can be ______. | replaced, or repaired

136. Operating at too-high speed is another cause of excessive ______. | noise, or vibration

137. Or, excessive vibration may indicate that the pump or its driver is not bolted securely enough to its ______. | foundation, or base

138. Discharge piping may be poorly designed and may amplify ______. | vibration, or noise

139. Sometimes the pressure surges will cause the discharge line to vibrate.

This may indicate that the discharge piping is too ______ in diameter. | small

140. Or, the pulsation dampener may be filled with liquid and need to be refilled with ______. | gas

141. Improper lubrication can also cause pump parts to grab and seize.

Faulty __________ can cause noise and vibration. — lubrication

142. A direct-acting steam pump gets noisy when steam enters the cylinder too *late* to cushion the piston enough at the ends of the stroke.

To give more cushioning, the cylinder steam inlet valves must be timed to open (sooner/later.) — sooner

143. A crackling noise indicates water in the cylinders.

When this occurs, the cylinder __________ should be partly opened to let out the water, and kept open until the noise stops. — drains

144. If the noise comes back after the drains are closed again, water is probably coming into the cylinders from the steam line.

Water in the steam line indicates that the boiler is making very wet steam, or that the steam traps are not removing the __________. — water, or condensate

145. Periodic checking should assure that operation stays smooth and continuous.

If unusual noises develop, the __________ should be determined. — cause

146. It may be necessary to correct pumping conditions.

If the trouble is mechanical, the pump (need not be/should be) shut down. — should be

OPERATING MAINTENANCE

147. A pump must be checked periodically to keep it operating __________. — efficiently, or properly

148. Oil levels are checked to be sure that there is enough oil to reach all lubrication points.

The flow of the oil is checked periodically to assure that moving parts are properly __________. — lubricated

149. Proper lubrication prevents __________ and overheating. — friction, or wear

150. Cooling jacket temperatures show how well the pump is being cooled.

These temperatures should be checked frequently to see that the pump bearings or packings are not getting too __________. — hot

151. To best assure continuous operation without malfunctions, the operator should make the checks recommended by his supervisor.

Logging pump speed, flow, pressures, and temperatures helps to show what ________ take place in pump performance. — changes

152. Water level in a cooling system and ________ levels in the oil reservoirs need to be checked daily. — oil

153. All lines in the system should be checked at least once every day to make sure there are no losses of fuel, oil, water, or air as a result of ________ in the lines. — leaks, or holes, or obstructions

154. Unless pure water is used, or rust and scale inhibitors are added to the cooling water, rust and scale form quickly in an engine's water jacket.

When no inhibitors are used, the engine water jackets should be checked for ________ and ________ formation at least once a month. — rust; scale

155. Pump packing gland leakage should be observed during regular inspection rounds.

Worn packing should be tightened or ________. — replaced

156. Operating manuals from manufacturers usually outline general maintenance guides for their pumps.

These general maintenance guides should be combined with the procedures of your company for efficient ________ of each pump. — maintenance, or operation

THE END

HOWELL TRAINING COMPANY
5201 LANGFIELD ROAD • HOUSTON, TEXAS 77040-6694 • (713) 460-4460