UNIT 1

EQUIPPING A WELL FOR FLOW

SURFACE EQUIPMENT

The Well Head

1. Suppose an oil well were just a "hole in the ground," with no protection.

   During drilling, soft earth or high formation pressures would probably make the well-bore ______________ ______________.

2. And a well completed and produced without protection would be very wasteful.

   Oil and other reservoir fluids would ______________ from the well-bore into the other formations.

3. *Casing strings* are used to protect the well-bore during drilling.

   After the well is completed, the casing strings continue to prevent cave-ins and ______________ from the well-bore.

4. Casing is steel pipe ranging from less than 4½ inches OD to more than 20 inches OD.

   Casing pipe put together with leakproof connections is called a casing ______________.

5. During drilling, more than one casing string may be set in the well-bore.

   Drilling continues (inside/around) each casing string after it is set.

6. Or, the first casing string installed during drilling has the (largest/smallest) OD.

7. The casing string that completes the well-bore to a producing formation is called the *production casing.*

   The production casing has the (largest/smallest) OD of any casing string in the well-bore.

8. If the well is completed with only one casing string, that string is the ____________ casing.

9. Usually, the first string installed is the *surface casing.*

   Then the surface casing is the casing with the (largest/smallest) OD.

10. Sometimes a conductor casing is set before the surface casing.

    The first casing string installed is always the (longest/shortest) casing string in the well-bore.

11. If no conductor casing is set, the shortest casing string in the well-bore is the ____________ casing.

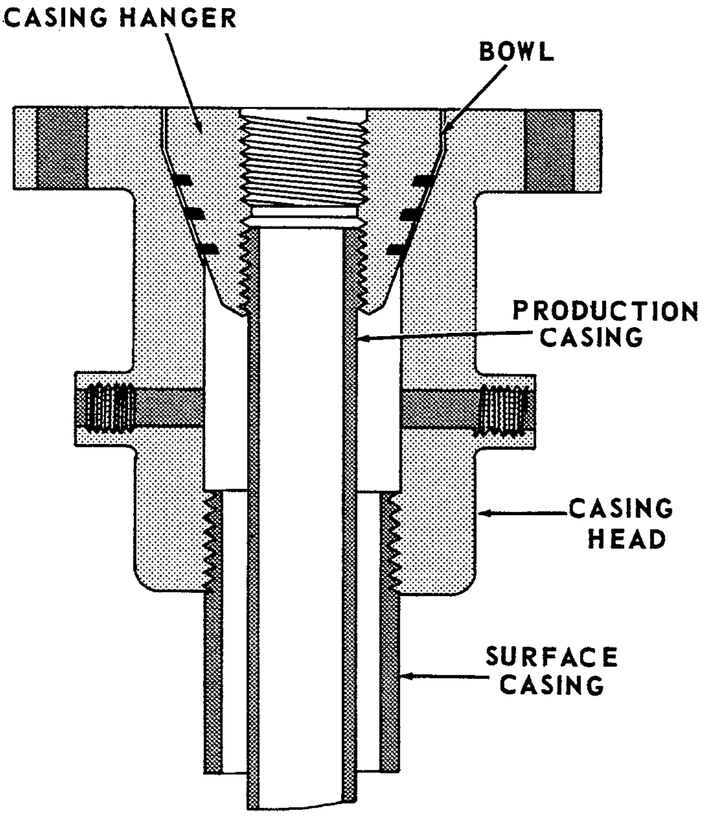
12. The first string of casing installed during drilling is held in place with cement.

    If only one string of casing is used to complete the well, the production casing is held by ____________ all the way to the producing formation.

13. Usually, it is the (production/surface) casing that is completely cemented in.

14. In a two casing-string completion the production casing is run (inside/outside) the surface casing.

15. To support the production casing from the surface, a *casing head* is used.



The casing head has a ____________ which supports the casing ____________.

16. This casing hanger supports the ____________ ____________.

17. The casing head screws into or is welded onto the top of the ____________ ____________.

18. Or, at the well head, the weight of the production casing is actually supported by the ____________ ____________.

19. At the bottom of the string, the production casing, like the surface casing, is ____________ in place.

20. Some wells are completed with three casing strings.

An *intermediate* casing string may be set inside the ____________ casing.

21. Then the production casing is set inside the ____________ casing.

22. The intermediate casing is longer than the ____________ casing but shorter than the ____________ casing.

23. It is used when formation pressures and drilling depths make (one/two/three) casing strings necessary.

24. When an intermediate casing string is used, it is supported at the top by a casing ____________ set on the surface casing.

25. Then, to support the production casing from the surface, a second ____________ ____________ is used.

26. A well completed with three casing strings has two casing heads.

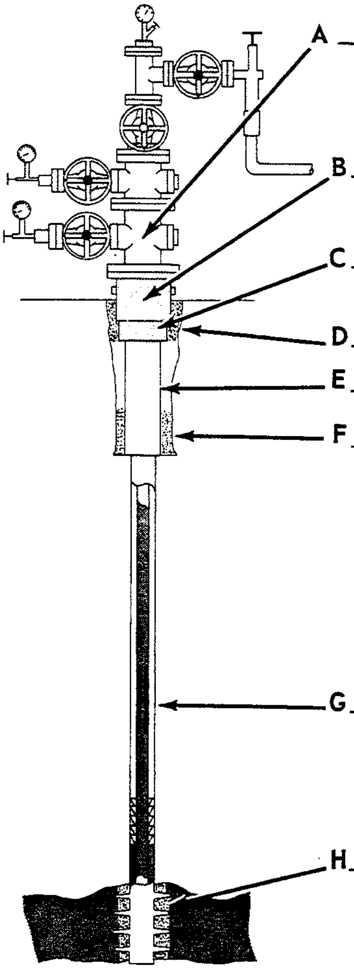
The uppermost casing head supports the ____________ casing.

The lowermost casing head sits on the surface casing and supports the ____________ casing in a well completed with three casing strings.

27. The surface casing is usually:

____ supported by a casing head.
____ cemented in place.

28. See if you can name these casing strings and supports.



A ______________________

B ______________________

C ______________________

D ______________________

E ______________________

F ______________________

G ______________________

H ______________________

29. You can calculate the number of casing strings in the well-bore by counting the casing heads.

There is always (one more/one less) casing head than there are casing strings in the well-bore.

30. Before production begins, perforations, or holes, must be shot through the ____________ ____________ and ____________.

31. The production casing is usually too wide for efficient flow.

A few wells are produced directly through the production casing.

These are wells with an extremely (large/small) casing ID.

32. In these tubingless completions, the casing may be exposed to very high pressures during flow.

If the casing begins to leak, it (can/cannot) be pulled to the surface for repairs.

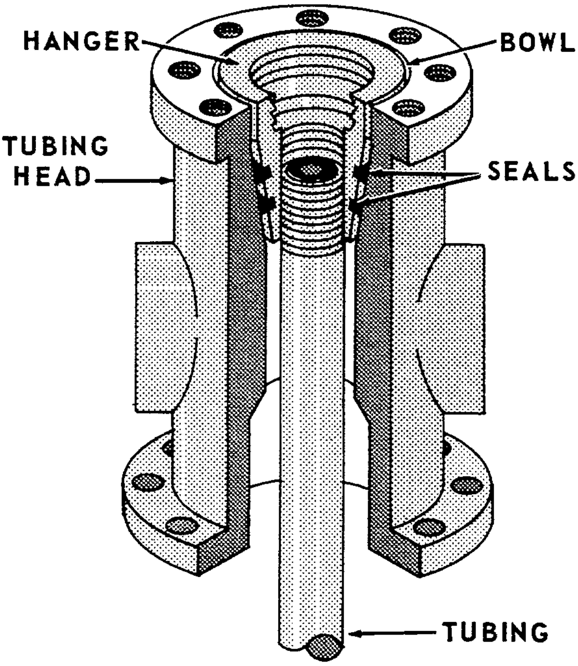
33. Stuck equipment may ____________ a well that is being produced through a casing string.

34. *Tubing* is steel pipe usually from 1½" to 4" OD that can be run (inside/outside) the production casing.

35. Most wells are produced through a string of ____________ run inside the production casing.

36. So that it can be pulled for repairs, the tubing string (is/is not) cemented in place.

37. At the surface of the well, the tubing string is supported by a *tubing head.*



The tubing head is flanged, studded, or threaded onto the uppermost ____________ ____________.

38. A *bowl* in the tubing head contains a ____________ which supports the ____________.

39. Leakage up around the tubing is prevented by a set of ____________ on the hanger.

40. The space between two strings of pipe may be called an annulus.

In a well with tubing, there is space between the tubing and the ____________ ____________.

41. This space is often called the ____________.

42. The outlets at the sides of the tubing head are outlets from the (tubing/annulus).

43. There may also be outlets at the sides of the *casing* heads.

These outlets are for the annular spaces between the ____________.

44. In a well with three casing strings, the outlet on the lowermost casing head would connect to the space between the ____________ casing and the ____________ casing.

45. Usually, the outlets in the tubing head are equipped with pressure gages.

These gages register the pressure in the annulus, or the space between the ____________ casing and the ____________.

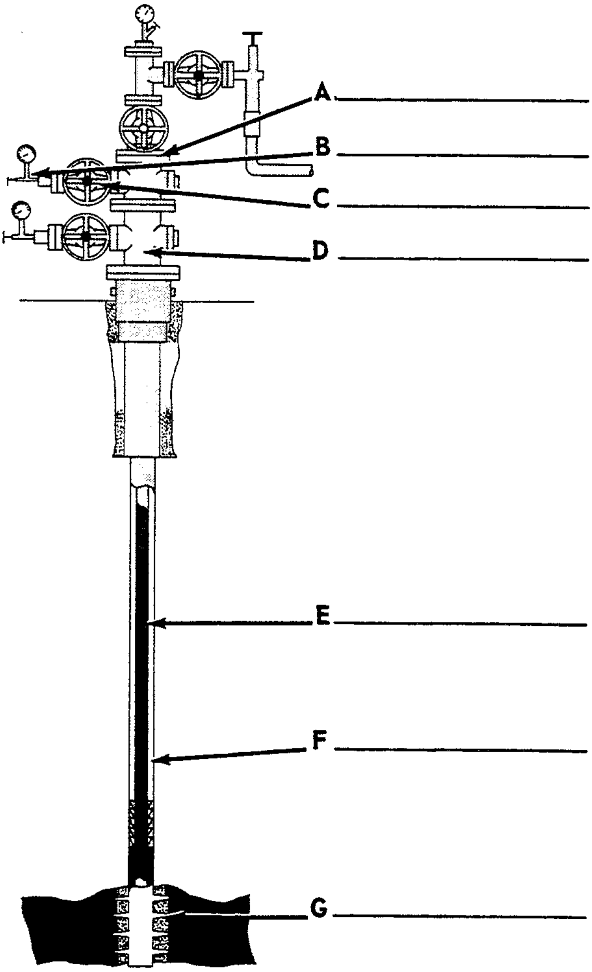
46. Even though the casing head outlets may also have pressure gages, the gage at the tubing head is usually called *the* casing pressure gage.

In production work, the term "casing pressure" usually means the pressure (inside/outside) the production casing, and (inside/outside) the tubing.

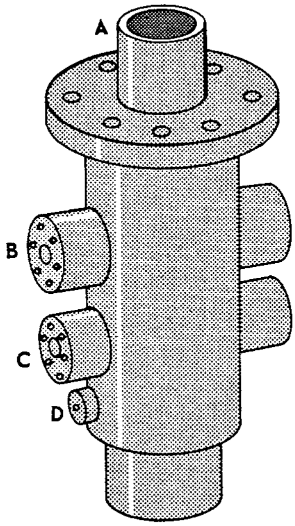
47. The *casing pressure gage* measures the pressure in the (tubing/annulus).

The casing pressure gage is set at (the tubing head/ a casing head).

48. Now name these parts of a flowing well.



49. In some wells, the casing heads and tubing head are all in one piece of equipment.



In this compact head, the tubing outlet is at (A/B/C/D).

50. The outlet from the annulus is at ____________.

51. The uppermost casing head outlet is at ____________ and the lowermost casing head outlet is at ____________.

52. Compact well heads have fewer connections than assembled well heads and are (more likely/less likely) to leak.

But salvage value is better with a (compact/assembled) well head.

53. All well-head equipment must be marked with a maximum operating pressure and tested by the manufacturer before it is ____________.

54. Here is a table of the standard operating and test pressures for flowing well heads.

Maximum operating pressure, PSI	Test pressure, PSI
1,000	2,000
2,000	4,000
3,000	6,000
5,000	10,000
10,000	15,000
15,000	22,500

The equipment must test out at much (higher/lower) pressures than its maximum operating pressure rating.

55. Operating pressures given are for temperatures under 250°F.

As fluid temperatures increase, fluid pressures (also increase/decrease/remain the same).

56. At flow-line temperatures above 250°F, the equipment used at the well head needs a (higher/lower) maximum operating pressure rating.

57. Normally, flanged well-head equipment has a higher operating pressure than threaded equipment.

On high-pressure wells, well-head equipment is more likely to be (threaded/flanged).

The Christmas Tree

58. Until a well is allowed to flow, a *back-pressure valve* may be set in the tubing head to keep the well shut in.

The well is not opened to flow until the surface equipment that is used to ____________ flow is installed.

59. The equipment on a flowing well head that is used to control flow is called "the Christmas tree."

The Christmas tree is set above the ____________ head.

60. Usually, the bottom of the Christmas tree and the top of the tubing head have different dimensions.

An *adapter* is a piece of equipment used to join two parts with different dimensions.

The Christmas tree is joined to the tubing head through a tubing-head ____________.

61. A Christmas tree needs a master ____________ to open and shut in the well.

62. It also needs outlets to the surface ____________ lines.

63. To control flow to the surface lines, the master valve is set (upstream/downstream) from the outlets to the surface lines.

64. The Christmas tree may have one flow outlet (a tee) or two flow outlets (a cross).

The master valve is installed (above/below) the flow tee or cross.

65. Sometimes, tools and measuring instruments are run into the tubing on a *wire line* while the well is flowing.

Equipment run through the Christmas tree will go straight through the ____________ valve.

66. A *full-opening* valve is a valve that opens as wide as the tubing.

Master valves (must/need not) be full-opening valves.

67. Or, when the master valve is open, its ID should be at least as large as the ID of the ____________.

68. After the Christmas tree is installed, the back-pressure valve is removed from the tubing head.

Then the well is opened or shut in by the ____________ valve.

69. During operation, there (is/is not) a valve upstream from the master valve.

70. Suppose the master valve is damaged and needs replacing.

Before the master valve can be replaced, flow must be blocked by a plug or valve (upstream/downstream) from the master valve.

71. Or, to replace a master valve, the (surface flow lines/tubing) must be plugged.

72. A tubing plug may be run into the tubing on a wire line if the master valve needs ____________.

73. A tubing plug is a piece of equipment designed to ____________ flow from the tubing.

74. Or, a back-pressure valve may be reset in the ____________ head to stop flow.

75. But, it is better to prevent ____________ on the master valve in the first place.

76. A valve is under greatest pressure when it is first opened or closed.

If the master valve is closed against the full-flowing force of the well, it ____________ out very quickly.

77. Suppose the master valve is left open while a valve downstream from the master valve is closed.

More of the wear is taken by (the master valve/ the downstream valve).

78. The valves on the flow tee or cross are called *wing valves.*

A wing valve is (upstream/downstream) from the master valve.

79. When the wing valves are closed, flow through the Christmas tree ____________.

80. If the wing valve is closed first, more of the wear is taken by the (wing valve/master valve).

81. Then the master valve can be closed after flow has ____________.

When fluid is not flowing as the valve closes, there is less ____________ on the valve.

82. After the master valve is closed, the wing valve (can/ cannot) be removed for repairs, if necessary.

83. It is more convenient to replace a worn (wing valve/ master valve).

84. For this reason, most wells are shut in by first closing the ____________ valve.

85. Because it is not in line with the tubing, a wing valve does not need to be full-opening.

Equipment run through the top of the Christmas tree (passes/does not pass) through the wing valve.

86. Some high-pressure wells have two master valves.

Then the lower master valve is usually left ___________ to prevent it from wearing.

87. If the upper master valve needs repair, the well can be shut in by closing the ___________ master valve.

88. Most Christmas trees have one or two *surface chokes.*

A choke is used to (increase/decrease) the rate of flow from the well.

89. An *orifice,* or restriction in the choke, slows the rate and (increases/decreases) pressure upstream from the choke.

90. Changing the size of the orifice ID changes the rate of flow.

Installing a wider orifice in the choke (increases/decreases) the rate.

91. Installing a smaller ID orifice ___________ the rate.

92. In some chokes, the orifice can be adjusted while the well is flowing; in others, the well must be shut in to change the ___________ size.

93. Flow must be stopped to change a *positive* choke.

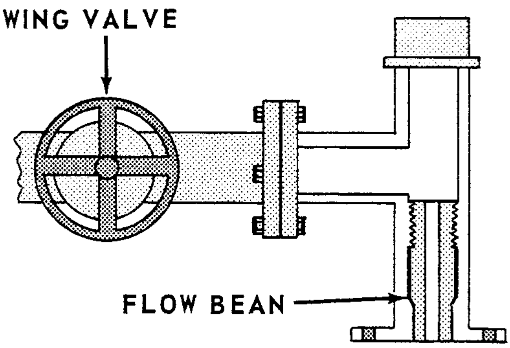
(A positive/An adjustable) choke can be adjusted while the well is flowing.

94. When any surface choke is being repaired or replaced, flow through it must be ___________.

95. To decrease wear on the master valve, flow through the choke is usually stopped by closing the ___________ valve.

96. Surface chokes are usually located (upstream/ downstream) from the wing valve.

97. Here is a drawing of a *positive* choke.



The orifice in a positive choke is called a flow ____________.

98. This choke is installed in a ____________ in the line.

99. The flow bean is mounted (upstream/downstream) from the tee.

100. There are several reasons for mounting a choke with its orifice downstream from the tee.

The tee itself is a restriction in the flow line.

Back pressure builds up (upstream/downstream) from the tee.

101. The edge of the bean that the fluid enters, or the leading edge, wears less when the (tee/choke) is upstream.

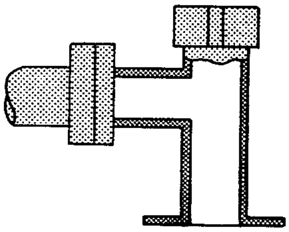
102. Mounting a positive choke with the flow bean *downstream* from the tee is also a safer mounting.

Suppose the choke is plugged and an operator removes the bean from an upstream-mounted choke.

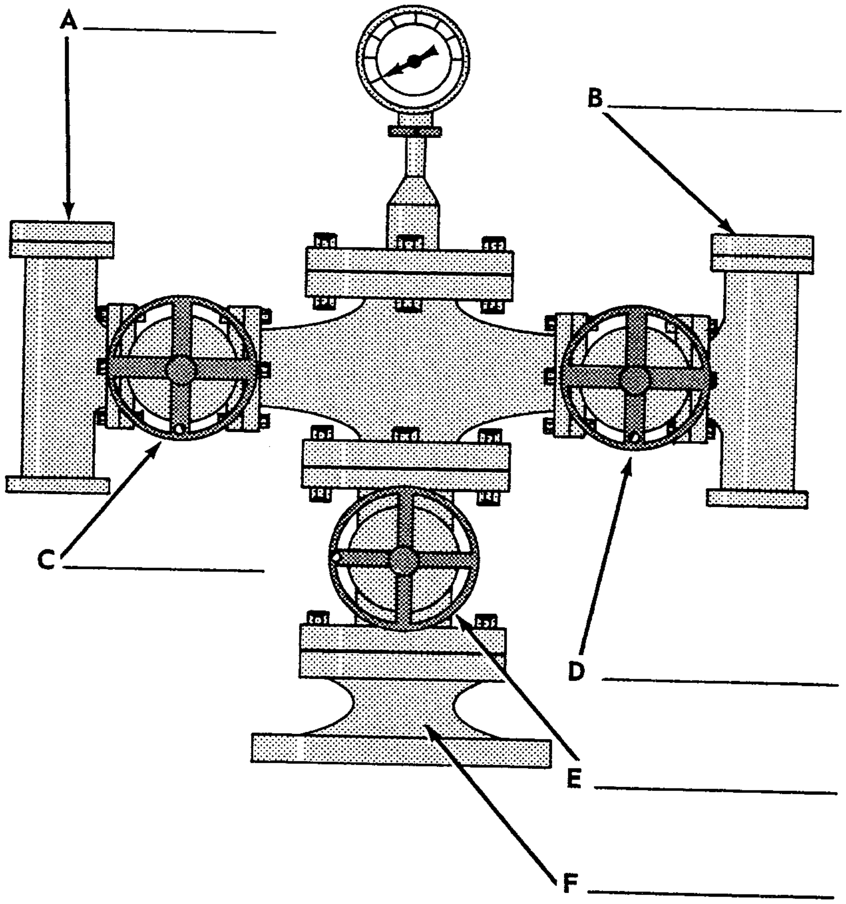
Pressure build-up behind the choke may force the ____________ out of the tee.

103. With the bean mounted downstream from the tee, opening the end of the tee releases the ____________ without moving the bean.

104. Put an X on this drawing to show where the bean should be installed.



105. See if you can label these parts of the Christmas tree.



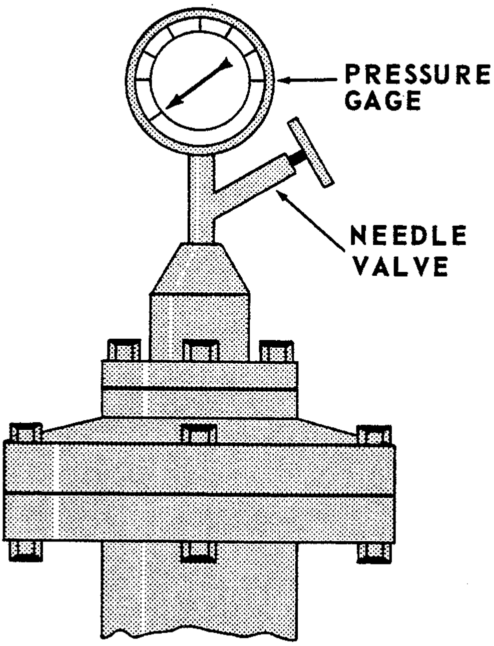
106. A surface safety valve may be installed between the wing valve and the choke.

The safety valve, like the master valve and the wing valve, is always either completely __________ or completely __________.

107. Some wells have no wing valves.

In these wells, a surface safety valve may be used to ____________ in the well while a choke is being worked on.

108. Here is the top of the Christmas tree.



The pressure gage registers the pressure in the (tubing/annulus).

109. To protect the gage, the line below can be shut off with a gage valve, usually a ____________ valve.

110. Since the treetop and the flow cross or tee may have different dimensions, there may also be a treetop ____________ below the needle valve.

111. When instruments and equipment are run down through the Christmas tree into the tubing, the ____________ ____________ and the ____________ ____________ are first removed from the tree.

112. Then a lubricator is installed above the ____________ adapter.

113. Equipment or solvents are run into the tubing through the ____________ on the treetop adapter.

114. Solvents or test instruments are run into the *annulus* through the outlets in the (treetop adapter/tubing head/ casing heads).

115. In some units the flow cross or tee, wing valve, choke, and the tubing pressure gage and its valve, are all machined as one piece of equipment, called a *flow control.*

A flow control includes everything on the Christmas tree above the ____________ ____________.

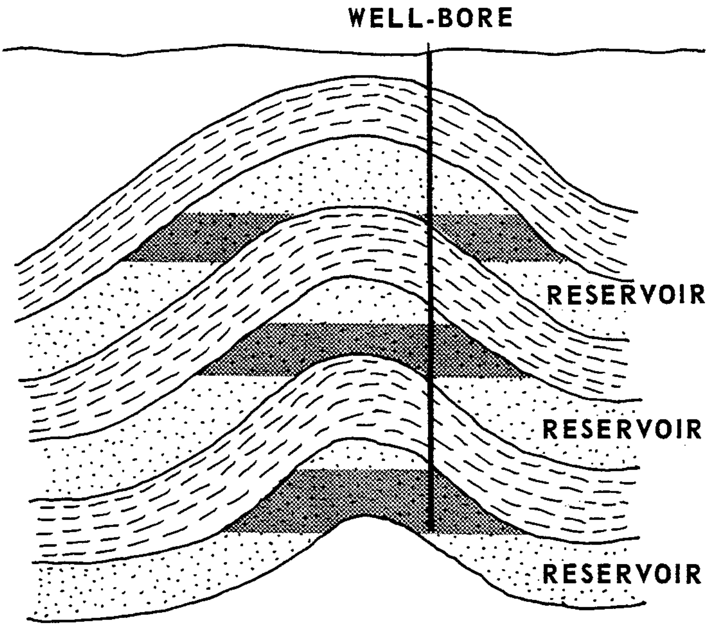
116. A flow control unit is more compact than an assembled ____________ ____________.

117. But, like an assembled well head, the (flow control/ flanged or threaded tree) has better salvage value.

118. And valves and parts are more readily changed or replaced with an ____________ Christmas tree.

Multiple Completions

119. Sometimes oil-bearing formations occur in several layers in the ground.



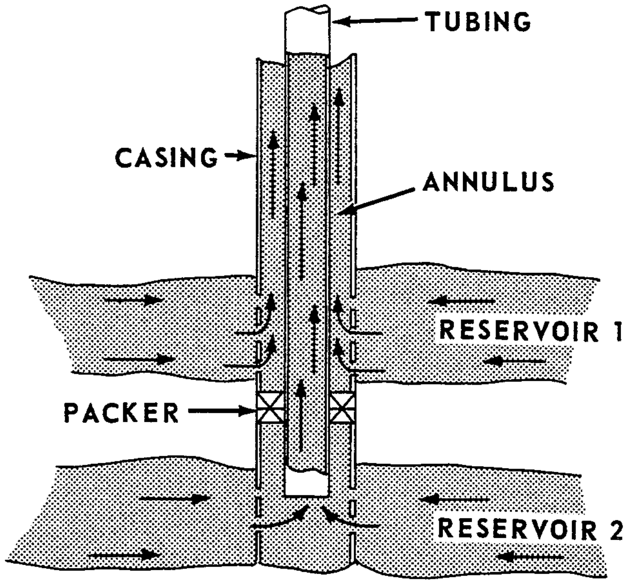
Then the same well-bore cuts through more than one ____________.

120. If several of these formations are productive, more than one reservoir may be produced through the same ____________-____________.

121. One way of producing such a well is to deplete one ____________ and then recomplete to produce the second.

122. Another way is to produce from more than one reservoir at the same ____________.

123. In a *multiple completion,* the production casing is completed in two or more reservoirs at the same time.



At one time, a multiple-completion well produces from (only one/more than one) formation.

124. One reservoir may be produced through the tubing while another reservoir is produced through the ____________.

125. Then there (is one tubing string/are two tubing strings) inside the production casing.

126. But there must be ____________ flow lines, ____________ chokes, and at least ____________ valves at the surface of the well.

127. When one reservoir is produced through the annulus, the flow line for that reservoir is connected to the outlet in the ____________ head.

128. A pressure gage at the tubing head, or the (tubing pressure gage/casing pressure gage) records the well-head pressure for that reservoir.

129. A choke in the surface line coming out of the tubing head controls flow from the ____________.

130. There is also a ____________ at the tubing-head outlet to open or shut in that line.

131. Suppose *three* reservoirs are being produced at the same time.

Then the well may be produced through the annulus and two strings of ____________.

132. The hanger in the tubing head must then support ____________ tubing strings.

133. And the Christmas tree must have two ____________ lines, at least two ____________ (to control flow), two ____________ valves, and two ____________ valves.

134. On such a tree, there are ____________ pressure gages, ____________ needle valves, and ____________ treetop adapters.

135. You can tell the number of tubing strings in a well by counting the flow lines, master valves, and pressure gages at the ____________ ____________.

136. You *cannot* always tell the number of reservoirs being produced by knowing the number of ____________ strings in the well-bore.

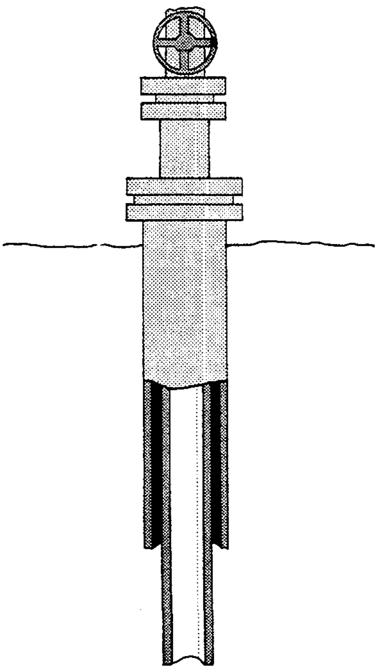
One reservoir may be produced through the ____________.

137. Some states have laws against production through the casing.

In these states, the number of tubing strings probably (does/does not) indicate the number of formations being produced.

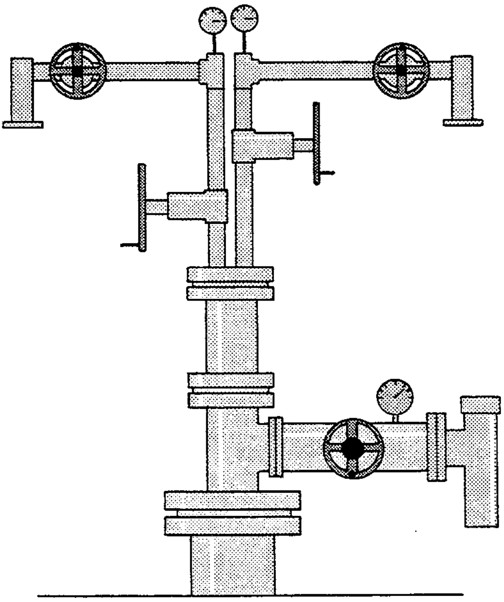
Review

138. How many casing strings are installed in this well-bore?



(1 / 2 / 3 / 4)

139. How many tubing strings are in this well?



(1 / 2 / 3 / 4)

140. This well probably (is/is not) being produced through the annulus.

141. Or, there are probably (1 / 2 / 3 / 4) producing formations at this well-bore.