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COMPACT CASING HEAD AND HANGER

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Fig. 1.

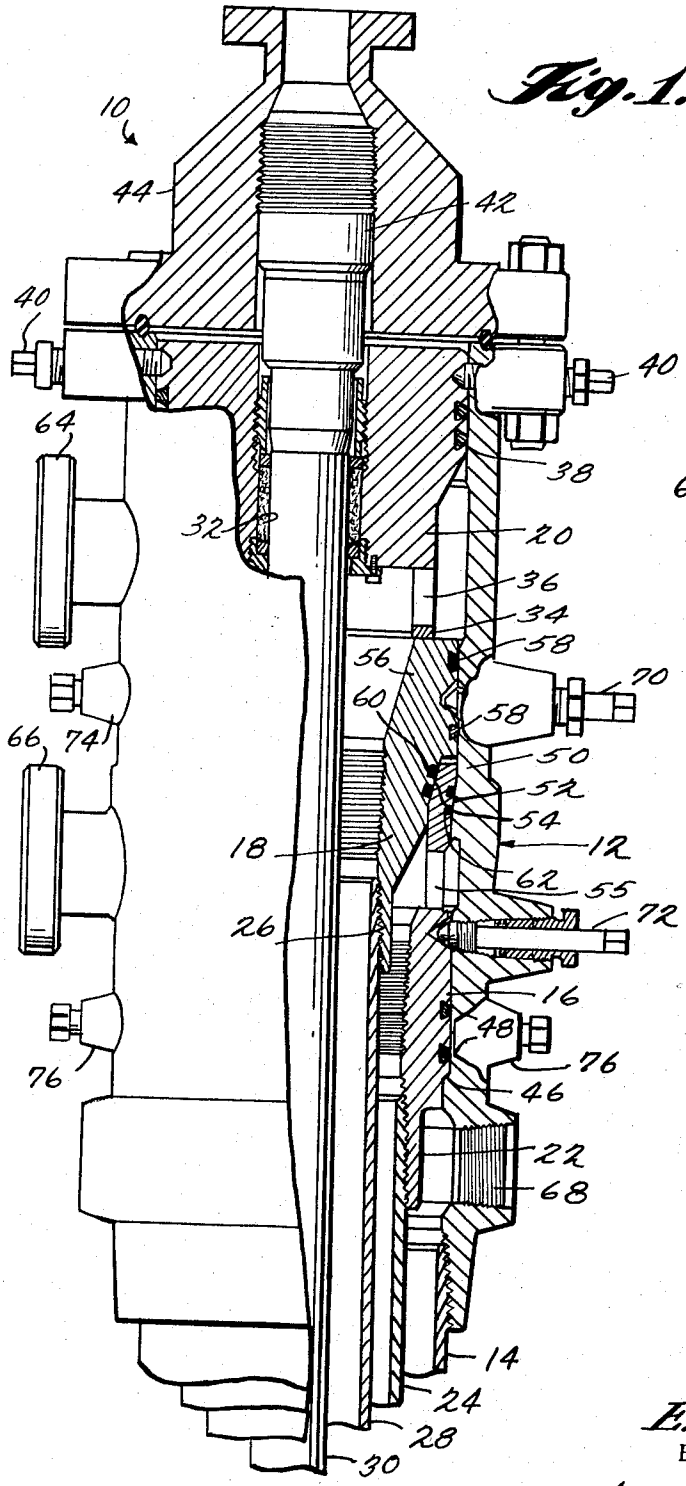
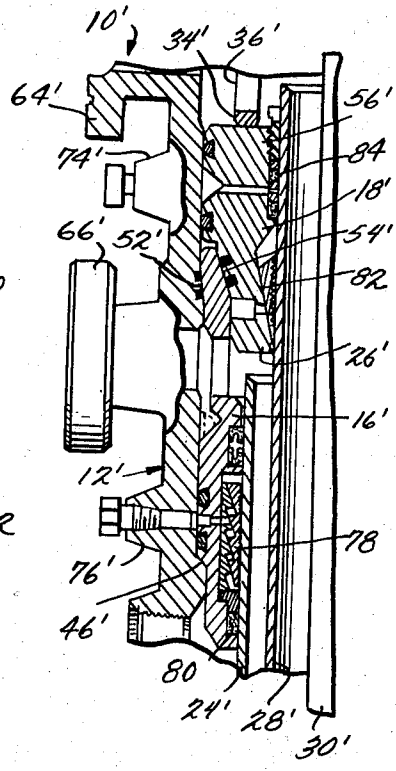


Fig. 2.



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COMPACT CASING HEAD AND HANGER

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This invention relates to well heads for suspending tubing and/or casing and in particular to heads which are relatively compact in size.

In drilling oil and gas wells it is customary to case or line the hole with several different sizes of casing, starting at the top with a relatively large casing and employing smaller sizes in a telescopic manner until reaching the proper depth, each size being cemented off at its lower end and suspended from its upper end by a hanger and casing head arrangement. Usually a separate hanger and casing head is provided for each string of casing and for the tubing, the first hanger and head being mounted on the outer or surface casing, the second hanger and head being mounted on the first head by means of releasable clamps or bolted flanges and other hangers and heads being mounted in sequence in a similar manner.

Under some circumstances unitary head arrangements are provided which are adapted to suspend two or more strings of casing together with tubing within a single, unitary head structure. The internal arrangement and construction of these head structures is such as to provide a single head which may be used in place of the plurality of heads normally employed in completing a well head assembly. In one type of arrangement the hanger structures for the later positioned casing strings are more or less nested within the hanger structures for the earlier positioned strings so that a compact assembly of reduced height is achieved. In another type of unitary head arrangement the head is provided internally with a single deep bowl presenting a single tapered surface upon which the several hangers seat one above another.

The initial installation of a unitary head on the surface casing or the like effects substantial savings in subsequent rig time because blowout preventers mounted on the compact head may be left in place until the Christmas tree is to be installed. In addition, the unitary head eliminates time spent in installing additional hangers and heads and reduces the number of connections which must be made and consequently reduces the hazard of leaks. These savings in time and in the number of manipulations steps are of great importance in conducting remote operations such as encountered in underwater work.

Unitary head assemblies of the nesting type are, however, susceptible of improvement because in prior assemblies it has been conventional to provide a single hanger and a single hanger seat which support all of the strings of casing and in some instances the tubing also. That is, the hanger for the first-suspended string rests on the single seat and the later-suspended strings are seated on top of or inside the first hanger so that high stresses and consequent bearing failure may occur at the single hanger seat. This problem can be alleviated by increasing the size of the seat, but this solution detracts from the compactness of the head.

In the deep-bowl type of unitary head each hanger is supported directly from the single large deep bowl. This arrangement, of course, requires a continually increasing head diameter as well as considerable head height and therefore is not actually a compact arrangement.

It is the primary object of the present invention to provide a hanger and head arrangement which has both compact size and a reduced liability to bearing failure along the seating surfaces between the head and the suspended structures.

It is a further object to provide a hanger and head arrangement in which a first-installed hanger receives the load from later-installed hangers and transmits the greater part of it laterally to the head at a location above the seat for the first-installed hanger.

It is a still further object to provide a hanger for an arrangement of the above type in which the hanger is provided above its primary seating surface, with an upwardly projecting expandable extension having an outer downwardly facing tapered shoulder for engagement with a complementary seat in a head and an inner, upwardly facing tapered shoulder for receiving a second hanger.

The invention will be further understood from the following detailed description taken with the drawing in which:

FIGURE 1 is an elevational view, partly in section, of a well head assembly embodying the principles of the present invention; and

FIGURE 2 is a fragmentary elevational view, partly in section, of a modification of the well head assemby of FIGURE 1.

Referring to FIGURE 1 there is shown a well head assembly **10** which includes, as primary components, a unitary compact casing and tubing head **12** mounted on top of a casing **14**, for example 13⅜ inch casing, and containing in ascending order a first casing hanger **16**, a second casing hanger **18** and a tubing hanger **20**. The lower casing hanger **16** is provided with a downwardly projecting, interiorly threaded extension **22** spaced inwardly from the wall of the casing and tubing head **12** by which a first string of casing **24**, for example 9⅝ inch casing, is suspended. The upper casing hanger **18** has a lower interiorly threaded extension **26** spaced inwardly from the lower hanger **16** from which a second string of casing **28**, for example 7 inch casing, is suspended. The tubing hanger **20** suspends a single tubing string **30**, for example 3½ inch tubing, and is itself supported on top of the upper casing hanger **18**.

The tubing hanger **20** is of the stuffing box type in which an annular seal **32** grips the exterior of the tubing string **30**. A bottom extension **34** on the tubing hanger **20** is spaced inwardly from the head **12** and is provided with a plurality of lateral circulation ports **36** communicating with the annulus between the tubing **30** and the extension **34** and with the annulus between the extension **34** and the head **12**. The upper portion of the tubing hanger **20** is provided with annular sealing rings **38** and an annular groove for receiving hold-down screws **40** which extend through the head **12**. Above the top of the head **12** the tubing **30** connects with a threaded plug bushing **42** which is retained in a flanged cap member **44** bolted to the top of the head **12**. In practice suitable valving and a production line will be connected to the top of the cap member **44** for receiving the flow from the tubing **30**.

According to the principles of the invention the unitary compact head **12** and the upper and lower hangers **18** and **16** are designed to have the smallest possible pressure area yet avoid danger of bearing failure along the supporting surfaces. To achieve these advantages the upper casing hanger **18** is arranged to nest partly within and be supported by the lower casing hanger **16** and the latter is provided with two vertically spaced seats which transmit the load to the head **12** in a predetermined manner.

The lower hanger **16** is supported by the head **12** primarily along an exterior, downwardly facing tapered shoulder **46** which is located on a cylindrical center portion of the hanger **16** below a pair of spaced sealing rings **48** and which rests on a complementary seat within the head **12**. Integral with the center portion of the lower hanger **16** is an upwardly projecting annular extension **50** having an exterior sealing surface **52** which is tapered

slightly inwardly and downwardly for engagement with a complementary seat within the head **12**. This seat has, of course, a minimum diameter of sufficient size to permit the body portion of the hanger **16** to pass by during the landing of the casing string **24**. The inner surface of the extension **50** is tapered inwardly and downwardly at **54** to a greater extent than the surface **52** so as to form a seat for the upper hanger **18**. A plurality of circulation ports **55**, extend through the extension **50** below the tapered surfaces.

The upper hanger **18** includes, in addition to its lower extension **26**, an upper cylindrical portion **56** which engages the bore of the head **12** above the lower hanger **16**. Intermediate the extension **26** and the upper portion **56** the upper hanger **18** is provided with an exterior tapered surface which engages the seat **54** in the lower hanger **16**. Suitable sealing rings **58**, **60** and **62** are provided between the upper hanger portion **56** and the bore of the head **12** and at the seats **54** and **52**, respectively.

The unitary compact head is provided with the usual outlets, hanger hold-down screws and test ports. As shown, flanged lateral outlet **64** communicates with the annulus between the tubing string **30** and the casing string **28**, another flanged outlet **66** communicates with the annulus between the casing strings **28** and **24** and an interiorly threaded port **68** communicates with the annulus between the casing string **24** and the supporting casing **14**. The upper and lower casing hangers **18** and **16** are locked in place by hold-down screws **70** and **72**, respectively, which engage annular exterior grooves in the upper portions of the hangers. Two test ports **74** are provided in the wall of the head **12** between the sealing rings **58** associated with the upper hanger **18** and two more test ports **76** are provided between the sealing rings **48** associated with the lower hanger **16**.

FIGURE 2, in which primed reference numerals identify elements already described, illustrates a well head assembly **10'** in which the principles of the invention are applied to slip-type hangers. As shown a lower casing hanger **16'** is carried in a unitary compact head **12'** primarily on a lower seat **46'** and secondarily on an upper seat **52'**. A string of casing **24'** is suspended by the lower hanger by means of slips **78**. A sealing ring **80** below the slips **78** is expanded into tight engagement with the casing **24'** and the hanger **16'** by the weight of the casing **24'**. An upper casing hanger **18'** is carried by the lower casing hanger **16'** in generally nesting relationship at a tapered seat **54'** formed on the inner bore of an extension on the lower hanger **16'**. An inner casing string **28'** is suspended from the upper hanger **18'** by conventional slips **82** and seals **84**. A string of tubing **30'** is suspended from a tubing hanger having a lower extension **34**, which rests on top of the upper casing hanger **18'**.

The well head assemblies **10** and **10'** are assembled by generally conventional procedures which will not be described in detail except to the extent that they affect or are affected by the novel design of the casing hangers and the interior configuration of the unitary compact head **12**. Since the assemblies **10** and **10'** differ only in the use of slips in place of a threaded connection between the casing hangers and their casing strings, a description of the procedures associated with one of the assemblies will suffice. Referring to FIGURE 1 the lower casing hanger **16** and its casing string **24** is landed in the head **12** in the usual manner after the well has been drilled and the supporting casing **14** and head have been installed. This may be accomplished, for example, by threading the lower end of a drill pipe into the inner bore of the hanger **16** and lowering it along with its casing string **24** through the head **12** by means of a draw works. The hanger **16** is so designed and constructed that as it descends its upper extension **50** seals against the tapered surface **52** and then the lower shoulder lands on the seat **46**, the extension **50** actually deflecting inwardly to a slight degree as landing occurs. The hanger **16** is thus supported at **52** and **46**.

After the well hole has been drilled further, the upper casing head **18** with its casing string **28** attached is lowered through the head **12** to engage its exterior tapered surface with the interior seat **54** on the lower casing head **16**. The load of the upper hanger **18** is thereby transmitted to the head **12** principally in a lateral direction through the seat **52**, only a small portion being transmitted to the seat **46**. It will be appreciated that the extent to which this load is transmitted laterally rather than downwardly depends on the relationship among the tapers of the seats, **46**, **52** and **54**. To effect lateral transmission of the load, the taper of the seats **52** and **54** on the extension of the lower hanger are, of course, less than the taper of the lower seat **46**. As shown, the taper of the seat **54** is greater than the taper of the seat **52**, but the precise relationship of these tapers is not critical. It will be appreciated also that the extension on the lower hanger **16** should preferably be constructed so as to be laterally deflectable by the forces exerted on the seats. This will assure that the weight of the upper hanger **18** and its casing string **28** will be transmitted to the head **12**, primarily in a lateral direction at the seat **52**, rather than in a downward direction at the seat **46**.

When the well hole has been drilled further the tubing **30** is run in and suspended by means of the tubing hanger **20** on the top of the upper casing head **18**. The upper surface of the casing hanger **18** and the lower surface of the lower extension **34** on the tubing hanger **20** are machined flat to assure even distribution of the load. The load is transmitted downwardly through the hanger **18** to the seat **54** and then primarily laterally to the head **12** through the seat **52**. Completion of the well head assembly is then effected in a conventional manner employing the usual procedures.

A further advantage associated with the head and hanger arrangement of the invention is that one size control equipment may be utilized during construction of the well once the supporting casing **14** has been cemented in place and the head **12** attached thereto.

From the above description it will be appreciated that the hanger and head assembly of the invention provides a unitary assembly which maintains a very small pressure area for suspending the hangers and which suspends the successive casing strings within a short vertical space. The assembly is therefore not only compact, but by virtue of the double tapered extension **50** on the lower hanger it avoids the possibility of bearing failure by transmitting some of the load laterally to the head above the lowermost hanger seat. While a specific embodiment of the invention has been described and illustrated, it is not intended that the details thereof be limiting except as they appear in the appended claims.

What is claimed is:

1. In a well head assembly: a compact unitary head for receiving hangers and associated strings of pipe, said head including a unitary body member having a vertical bore therethrough, said bore defining an upper annular tapered seat and a lower annular tapered seat concentric with and disposed below said upper seat, said upper seat facing more toward the vertical than said lower seat; a hanger member in engagement with and supported on said upper and lower seats, said hanger member including a unitary tubular body having a lower portion, an upwardly extending annular extension and means associated with said lower portion for suspending a string of casing therefrom, said extension having a downwardly facing annular shoulder in mating engagement with said upper seat and said lower portion having a downwardly facing annular shoulder in mating engagement with said lower seat, the relative vertical distances between said shoulders and between said seats being such that the shoulder on said extension engages said upper seat before the shoulder on said lower portion engages said lower seat when said hanger member is lowered into said head, said extension being of radially deflectable construction relative to said

lower portion and, in the final position of said hanger member, being deflected radially inwardly from its undeflected position by engagement with said upper seat whereby the weight of a casing string suspended by said suspending means will be supported partially by said upper seat and partially by said lower seat.

2. Apparatus as in claim 1 including a second hanger member supported by said extension and means associated with said second hanger member for suspending a string of pipe therefrom, said second hanger member having a downwardly facing annular shoulder engaging an upwardly facing annular seat on said extension whereby the more nearly vertical taper at said upper seat in the bore of said head together with the radial deflectability of said extension will transmit downward forces generated by the weight of said second hanger member in a primarily lateral direction to said head through said upper seat.

3. Apparatus as in claim 1 wherein the bore of said extension has an upwardly facing annular tapered seat which faces more toward the vertical than said lower seat in said head, said apparatus further including a second hanger member supported on said seat in the bore of said extension and means associated with said second hanger member for suspending a string of casing therefrom whereby the more nearly vertical taper of said last-named seat and of said upper seat in said head together with the radial deflectability of said extension will transmit forces generated by the weight of said second hanger member in a primarily lateral direction to said head through said upper seat.

4. Apparatus as in claim 3 including a third hanger member and associated suspending means supported by said second hanger member.

5. Apparatus as in claim 3 wherein said hanger member which engages said seats in a bore of said head is provided with a radial port at a location between its upper and lower shoulders, and wherein said head is provided with a lateral outlet which communicates with said port.

6. Apparatus as in claim 1 wherein said deflectable extension on said hanger means is defined by a hollow, generally cylindrical wall extending upwardly from said lower portion of said hanger member, the thickness of said wall being less than the thickness of the wall which defines said lower portion.

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