Dec. 20, 1932. O. K. STEPHENS 1,891,508

CASING HANGER FOR SUSPENDING AND PACKING STRINGS OF CASING

Filed April 13, 1931

Fig. 1.

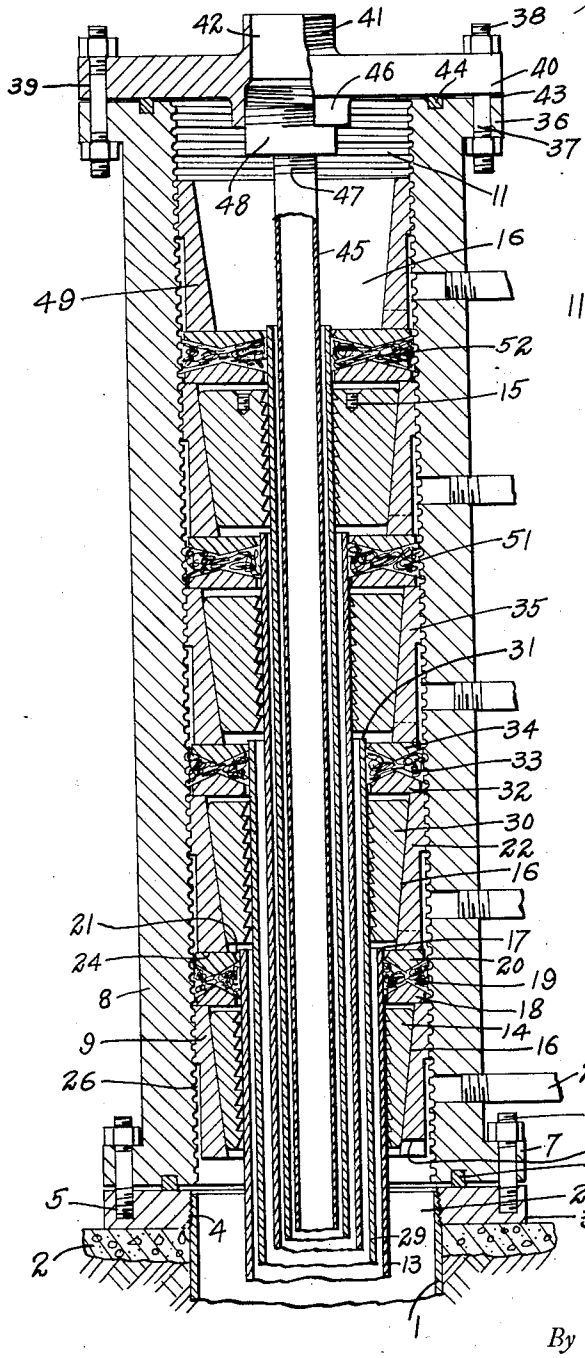
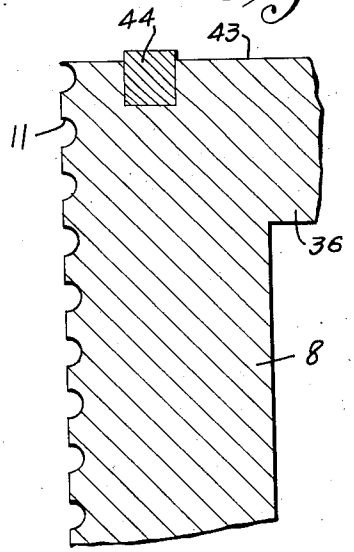


Fig. 3.



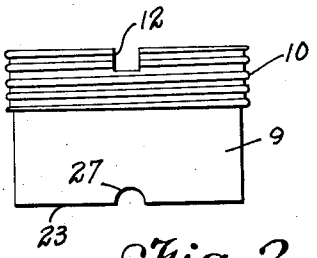


Fig. 2.

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UNITED STATES PATENT OFFICE

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CASING HANGER FOR SUSPENDING AND PACKING STRINGS OF CASING

Application filed April 13, 1931. Serial No. 529,782.

This invention relates to casing hangers. In drilling oil wells it is customary to case the well with several different sizes of pipe or casing, starting at the top with a relatively large size and employing smaller sizes in a telescopic manner until reaching the proper depth, each string of pipe being cemented off at its lower end.

As each string of casing must reach to the top of the well it will be readily seen that some means must be provided for suspending it.

During the process of drilling and subsequent production, heavy gas and fluid pressures are frequently encountered. The flow of this gas or fluid up through one or more of these strings of casing must be controlled at the mouth of the well.

Under the present system of suspending casing it is customary to provide a landing and packing head of such construction that it must not only withstand the bursting strain of a set of tapering slips suspending the string of casing but must also encounter the bursting power of the high pressure gas and fluid pressures coming from the well. These individual casing heads as a general thing have been provided with external flanges which are employed to secure the several heads together by means of bolts and depending on a circumferential ring of packing to effect a pressure resisting union between.

In case this union connection does not resist the extreme pressures within the well, the well operator has practically no chance to keep control of the well.

Some of the objects of my present invention are as follows: To provide a means of securing the heads together which will make it unnecessary for the heads themselves to withstand the double strain of gas pressure and casing suspension, also to provide a means of packing between the separate heads which will make possible a second line of defense in case of failure on the part of packing; also to provide a means of securing the separate heads together which does not depend on external bolted unions which are subject to failure. Also to provide means such as a valved port to each string of casing for the control of the pressures within by injecting or withdrawing gas or fluid under pressure, also to make it possible by the unique design of the assembly to have at all times a landing head properly placed and secured to receive and suspend a string of casing, immediately after it has been placed in the well or following the cementing process; and also to provide means for capping the well in case of an emergency blowout or for production purposes.

A further object of the invention is to improve the general construction of landing apparatus for casing heads.

Further objects of this invention, the utility of which will be apparent to the trained operator will appear hereinafter.

The invention consists of novel parts and combinations of parts to be described hereingafter, all of which contribute to produce an efficient casing hanger.

A preferred embodiment of the invention is described in the following specification, while the broad scope of the invention is pointed out in the appended claims.

Referring to the drawing:—

Figure 1 is an approximately central vertical section through the several strings of casing supported by slips in the casing heads, and supported by a cylinder in accordance with this invention.

Figure 2 is a side elevation of one of the landing heads.

Figure 3 is a fragmentary vertical section of a portion of a cylinder provided to support a plurality of casing heads and shows a type of thread that may be provided upon the inside wall of the cylinder on a larger scale.

In accordance with my invention, I provide a casing string hanger in the form of an upright body having a central bore and cooperating with this bore I provide a plurality of bushings which I call landing heads. In using the apparatus, these landing heads are inserted as may be necessary, and the landing heads and the said bore are provided with interlocking means preferably threads

which enable the landing heads to be supported on the hanger body.

In practicing my invention the first or surface string of casing, indicated by the numeral 1 is placed in the well and properly cemented for its full length and the concrete foundation 2 is placed around its upper end, the annular flange 3 being provided with an interior thread is screwed onto the upper end of pipe 1 and rests upon the concrete foundation body 2 that forms a shoulder to suspend the casing 1 and also operates as a base for supporting the casing hanger.

The flange 3 is in the form of an annular metal ring or collar being provided with a threaded central opening 4, to receive the threaded upper end of the casing 1 and also has a plurality of vertically drilled holes 5 to receive bolts 6 to which may be secured the flanged bottom 7 of the vertical casing hanger body, preferably in the form of a cylinder 8 which is provided with an inserted circumferential ring of packing 50, and is of a sufficient vertical length and inside diameter to accommodate in its bore several casing heads.

After mounting the base ring 3 on the first string of casing, drilling is then continued until the proper depth is reached, when it becomes necessary to install a casing head 9 in the lower portion of the body 8. This casing head 9 is provided with an external thread of square or semi-circular cross section which is received by a corresponding internal continuous thread 11, having a correspondingly formed groove in the wall of the body 8, and the head 9 may be set at the lower portion of the body 8. This may be accomplished by using a tool such as a fish tail bit, mounted upon a drill stem acting in effect as a large screw driver. This tool is contacted with the head 9 by the expedient of placing its lower edge in diametrically opposite driving notches 12, said notches having radially disposed and vertical walls to receive the torque of the above mentioned tool.

The threads 10 and 11 are a comparatively loose fit and this fact allows the head 9 to be easily rotated to the lower portion of the cylinder. The casing heads 9, 22, 35 and 49 are of uniform design and are provided with tapered central openings of the same diameter, that is they have inwardly and downwardly sloping faces to form conical seats 16 for pipe slips. After the casing 13 has been placed in the well it then becomes desirable to properly suspend or land it.

The upper end of this casing 13 will, of course, extend above the derrick floor as it is cemented, it being suspended upon the elevating apparatus with which all drilling wells are equipped, and to properly land the casing 13 the tapered slips 14 are dropped in so as to support the casing and they should have an outside diameter and degree of taper to fit the central opening of the casing head. The slips may be properly placed around the pipe 13 and inside the head 9 by means of long handles properly threaded on their lower ends to be received by threaded holes or sockets 15 in the upper portion of the slips 14. The slips 14 are of course, of a substantially tapering, vertical cross section and each set of slips is received on the corresponding or conical seat 16 of its corresponding landing head.

The weight of the casing 13 may then be slowly placed upon the slips 14 by the operation of slacking off on the elevating apparatus after which the slip handles may be removed.

The casing 13 may then be cut off at a point 17, several inches above the slips 14 and the short piece of casing removed, after which an annular metal collar 18 is dropped into place. This collar constitutes a packing seat, the cross section of which has a horizontal bottom line, vertical side lines and conical faces sloping inwardly and upwardly from the side lines to a point of intersection approximately equidistant from the vertical side faces, said point or line of intersection forming an annular apex to receive the lower face of an annular packing ring 19 of a compressible material having a suitable cross section to cooperate with packing rings. They may be oblong in cross-section, the longer sides being substantially horizontal, and the upper face of the above mentioned packing ring 19 which is of compressible material, receives the annular apex formed on the lower face of an upper annular metal follower 20, said annular metal follower having a cross section like that of ring 18, but inverted. These annular members 18, 19 and 20 have central openings to enable them to fit over the casing 13 and an outer diameter slightly less than the inside diameter of the body 8. They constitute the packing ring seat, packing and follower in what constitutes a stuffing box formed by the inner face of the body 8 and the upper face of the casing head 9 around the casing 13.

This having been accomplished the next operation is to take a second landing head 22 and just as with the head 9, insert it into the cylinder 8 and rotate it down through the cylinder 8 until it makes a contact on its lower face 23 with the upper face 24 of the disc 20 acting in effect as a packing nut and effecting a pressure upon the packing ring 19 of compressible material causing it to expand in a radial direction against the outer wall surface of the casing 13 and also against the internal face 11 of the body 8, effecting a seal in the space between the casing 13 and the body 8.

It should be explained at this point that the threaded internal face 11 of the body 8

makes an excellent seat for the disc of compressible material 19 as the threads 11 are comparatively shallow and preferably rounded as shown in Fig. 3.

It should also be explained at this point that as it is often desirable to bell or swage the top edge of the casing 13 at the point 17, this is made possible by providing the ring 20 with a conical counterbore, or sloping surface 21 at its central opening. This counterbore surface 21 makes it possible to use a tapered spud of the proper size to swage and expand the upper edge of the casing 13. This is sometimes done to facilitate the easy entrance of tools or pipe into the casing 13.

It will be readily seen that some means must be provided which will make it possible to control the fluid or gas between the casings 13 and 1. This is accomplished by providing threaded and valved pipe connections 25 at properly spaced positions through the cylinder wall 8. These connections 25 communicate through ports respectively with an annular chamber 26 formed by constructing the lower portion of the head 9 with a neck of smaller diameter than the inside diameter of the body 8, and the bottom face of each head such as the head 9 is provided with a notch or vent 27 making it possible for fluid or gas to pass through the port 25, and downwardly through the annular space 26 and thence through the depression 27 into the space 28, and of course if desired the operation might be reversed, thereby permitting a free but controlled passage of fluid or gas out of, or into, the well, and this flow of gas in or out may be controlled by remote control for the cooling of the entire casing hanger, if the well should be on fire.

After the head 22 has been properly tightened, drilling may proceed to the proper depth, at which another string of casing 29 may be placed in the well and properly cemented, after which, as the head 22 is already placed, the slips 30 may be properly set as were the slips 14, and the casing 29 may be cut off at the point 31 and the discs 32, 33 and 34 properly placed as were discs 18, 19 and 20, and after swaging the upper edge of the casing 29 at the point 31, another landing head 35 may be screwed down through the body 8 as were heads 9 and 22, thereby compressing the packing ring 33 just as the disc 19 was compressed.

It is obvious that in practicing my invention a landing head is always in position ready to receive a set of slips for the proper landing of another string of casing as that becomes necessary, and makes it possible to land the casing as soon as it is properly cemented; and the landing operation may be repeated as often as is necessary to arrive at the proper depth to reach the oil sands. The fact that each landing head such as the head 22 may be placed in position ready to receive the next string of casing such as 29, is made possible by the fact that the landing heads such as 9 and 22 and any others designed for the assembly have an inside diameter larger than the casing to be landed.

The difference in diameter of each casing such as 13 and 29 etc. is compensated for by a difference in thickness of the slips; in other words, the slips are progressively thicker from the lowest slip to the uppermost.

As has been stated before, it frequently happens that a well blows out so that high pressure gas or fluid in the well may flow uncontrolled from the well. In this emergency it is necessary to cap the well. For this purpose, the upper portion of the body 8 is provided with an integral, external circumferential flange 36, which is provided with a plurality of vertical holes 37 to receive bolts 38, carried in bolt holes 39 arranged circumferentially in a metal cap or plate 40. This cap 40 is provided with an externally threaded neck portion 41 located around a central opening 42 to receive a control gate. This cap 40, when properly fitted with the necessary control gates, may be secured to the flange 36 by means of the bolts 38 and will act as an effective cap in case of a blow out.

The upper face 43 of the body 8 is provided with an inserted circumferential packing ring 44 to insure a pressure resisting joint between the adjacent faces of the flange 36 and the cap 40.

When the oil sand has been reached it will be necessary to suspend a string of tubing 45 in the well. For this reason the cap 40 has been provided with an internally threaded, downwardly projecting, neck portion 46 located around a central opening 42 to receive the externally threaded upper end 47 of a string of tubing 45; the effecting of this connection is facilitated by employing an enlarging, or compensating bushing 48. The production may be controlled by means of a valve secured to the threaded neck portion 41.

In case it should be necessary to remove the tubing 45 from the well the uppermost landing head 49 may be used as the usual spider to receive slips for the holding of the tubing 45 as the different stands of tubing are removed from the main string.

It will be noted in the drawing that an inserted packing ring 50 has been provided between the adjacent faces of the flanges 3 and 7, making a pressure-tight connection at this point through the aid of the bolts 6. This fact makes it possible, in case of a failure on the part of the respective packings 19, 33, 51 or 52 to place and secure the cap 40 in position and as the lower end of the cylinder 8 is secured through the medium of the collar 3 to the upper end of the casing 1, this casing 1, being properly cemented in the well may be depended upon to hold the well pressure, thereby making its continued control possible

by employing the valved connections such as 25 to regulate the internal pressure.

It is understood that the embodiment of the invention described herein is only one of the many embodiments this invention may take, and I do not wish to be limited in the practice of my invention, nor in my claims, to the particular embodiment set forth.

What I claim is:—

1. In a casing head apparatus for deep wells, the combination of a bottom collar having means for securing the same to an outer well casing of relatively large diameter, said collar having a seat on its upper side, a casing hanger body resting on the said seat with means for securing the same, said body having a bore with a thread, a plurality of landing heads having threads and mounted in the threaded bore, and means cooperating with the landing heads for suspending casing strings of progressively smaller diameter.

2. In a device for the purpose set forth, the combination of a pipe string let into the well and having its outer end projecting above the earth's surface, a concrete foundation body disposed around the outer end of the pipe string, a metal base resting on the foundation, having a central opening to engage the pipe, other pipe strings of different diameters to be received one in the other and in the first mentioned pipe string, landing heads with slips seated within them and having external threads, and a casing hanger body having a threaded bore carrying the landing heads and seated on the said metal base.

3. In a device for the purpose set forth, the combination of a pipe string let into the well, and having its outer end projecting above the earth's surface, a concrete foundation body disposed around the outer end of the pipe string, a base ring resting on the foundation, having a central opening to engage the pipe string, other pipe strings of different diameters received one within the other and in the first named pipe string, a casing hanger-body resting on the base ring and having a threaded bore, a plurality of landing heads corresponding to the different pipe strings, having threaded engagement with said bore, slips corresponding to the different landing heads for engaging the corresponding pipe strings, each pipe string having its upper end projecting above the upper end of its corresponding landing head, and packing means located between the upper end of each pipe string and the wall of the hanger body and clamped between the upper and lower faces respectively of the adjacent landing heads.

4. In a device for the purpose set forth, the combination of a pipe string let into the well, and having its outer end projecting above the earth's surface, a concrete foundation body disposed around the outer end of the pipe string, a base ring resting on the foundation, having a central opening to engage the pipe string, other pipe strings of different diameters received one within the other and in the first named pipe string, a casing hanger-body resting on the base ring and having a threaded bore, a plurality of landing heads corresponding to the different pipe strings having threaded engagement with said bore, slips corresponding to the different landing heads for engaging the corresponding pipe strings, each pipe string having its upper end projecting above the upper end of its corresponding landing head, packing means located between the upper end of each pipe string and the wall of the hanger-body and clamped between the upper and lower faces respectively of the adjacent landing heads, said landing heads having reduced necks forming annular chambers, pipe connections in the wall of the body at said chambers, said landing heads having ports for opening communication between the interior of the pipe strings and the pipe connections.

5. In a device for the purpose set forth, the combination of a pipe string let into the well, and having its outer end projecting above the earth's surface, a concrete foundation body disposed around the outer end of the pipe string, a base ring resting on the foundation, having a central opening to engage the pipe string, other pipe strings of different diameters received one within the other and in the first named pipe string, a casing hanger-body resting on the base ring and having a threaded bore, a plurality of landing heads corresponding to the different pipe strings having threaded engagement with said bore, slips corresponding to the different landing heads for engaging the corresponding pipe strings, each pipe string having its upper end projecting above the upper end of its corresponding landing head, packing means located between the upper end of each pipe string and the wall of the hanger-body and clamped between the upper and lower faces respectively of the adjacent landing heads, said landing heads having reduced necks forming annular chambers, pipe connections in the wall of the hanger-body at said chambers, said landing heads having ports in the form of notches at their lower ends for opening communication between the interior of the pipe strings and pipe connections.

6. In a casing head apparatus for deep wells, the combination of a bottom collar having means for securing the same to an outer well casing of relatively large diameter, said collar having a seat on its upper side, a casing hanger-body resting on the said seat with means for securing the same, said body having a bore with a thread, a plurality of landing heads having threads and mounted in the

threaded bore, means cooperating with the landing heads for suspending casing strings of progressively smaller diameter, a cylinder head forming a cap resting on the upper end of the casing hanger-body with means for packing and clamping the same on the upper end of the hanger-body, and a flow-pipe passing up through the innermost pipe-string with means for connecting the same to the cap.

7. In a device for the purpose set forth, the combination of a pipe string let into the well, and having its outer end projecting above the earth's surface, a concrete foundation body disposed around the outer end of the pipe string, a base ring resting on the foundation, having a central opening to engage the pipe string, other pipe strings of different diameters received one within the other end in the first named pipe string, a casing hanger-body resting on the base ring and having a threaded bore, a plurality of landing heads corresponding to the different pipe strings having threaded engagement with said bore, slips corresponding to the different landing heads for engaging the corresponding pipe strings, each pipe string having its upper end projecting above the upper end of its corresponding landing head, packing means located between the upper end of each pipe string and the wall of the hanger-body and clamped between the upper and lower faces respectively of the adjacent landing heads, the said threaded bore having a thread in the form of a groove with a curved cross-section, and said packing means including a compressible ring for engaging in the threads of the bore in packing off the casing strings.

8. In a casing head apparatus for deep wells, the combination of a casing hanger-body with means for securing the same on the ground at the well, said body having a threaded bore, a plurality of landing heads having threaded engagement with the said bore, each landing head corresponding to a diameter of pipe string to be received within the same, and having a conical seat face, slips corresponding to the different landing heads resting on the conical seats to support their corresponding pipe strings, and packing means located between the adjacent landing heads for packing off the pipe strings.

9. In a casing head apparatus for deep wells, the combination of a casing hanger-body with means for securing the same on the ground at the well, said body having a threaded bore, a plurality of landing heads having threaded engagement with the said bore, each landing head corresponding to a diameter of pipe string to be received within the same, and having a conical seat face, slips corresponding to the different landing heads resting on the conical seats to support their corresponding pipe strings, packing means located between the adjacent landing heads for packing off the pipe strings, said landing heads operating to clamp the packing-means between the same, and having reduced necks at their lower portions to form annular chambers respectively around the landing heads within the hanger-body, each landing head having means for opening communication from the interior of a pipe string to its corresponding annular chamber, and pipe connections mounted in the wall of the casing hanger-body located at said annular chambers.

10. In a casing head apparatus for deep wells, the combination of a bottom collar having means for securing the same to an outer well casing of relatively large diameter, said collar having a seat on its upper side, a casing hanger-body resting on the said seat with means for securing the same, said body having a bore with a thread, a plurality of landing heads having threads and mounted in the threaded bore, and means cooperating with the landing heads for suspending casing strings of progressively smaller diameter, said landing heads having engaging means to cooperate with rotary drilling apparatus at the well for enabling the rotary apparatus to screw the landing heads down into the hanger-body.

11. In a casing head apparatus for deep wells, the combination of a bottom collar having means for securing the same to an outer well casing of relatively large diameter, said collar having a seat on its upper side, a casing hanger-body resting on the said seat with means for securing the same, said body having a bore with a thread, a plurality of landing heads having threads and mounted in the threaded bore, and means cooperating with the landing heads for suspending casing strings of progressively smaller diameter, said landing heads having notches in their upper ends to cooperate with rotary apparatus at the well to screw the landing heads down into the hanger-body.

12. In a device for the purpose set forth, the combination of a pipe string let into the well, and having its outer end projecting above the earth's surface, a concrete foundation body disposed around the outer end of the pipe string, a base ring resting on the foundation, having a central opening to engage the pipe string, other pipe strings of different diameters received one within the other and in the first named pipe string, a casing hanger-body resting on the base ring and having a threaded bore, a plurality of landing heads corresponding to the different pipe strings, having threaded engagement with said bore, slips corresponding to the different landing heads for engaging the corresponding pipe strings, each pipe string having its upper end projecting above the upper end of its corresponding landing head,

a bottom packing ring located above each landing head and supported thereon, a compressible packing ring resting on the same, and a follower packing ring resting above each corresponding compressible packing ring, said bottom ring and follower ring being clamped between the adjacent landing heads to pack the space between each pipe string and the wall of the hanger-body.

13. In a device for the purpose set forth, the combination of a pipe string let into the well, and having its outer end projecting above the earth's surface, a concrete foundation body disposed around the outer end of the pipe string, a base ring resting on the foundation, having a central opening to engage the pipe string, other pipe strings of different diameters received one within the other and in the first named pipe string, a casing hanger-body resting on the base ring, and having a threaded bore, a plurality of landing heads corresponding to the different pipe strings, having threaded engagement with said bore, slips corresponding to the different landing heads for engaging the corresponding pipe strings, each pipe string having its upper end projecting above the upper end of its corresponding landing head, a bottom packing ring located above each landing head and supported thereon, a compressible packing ring resting on the same, and a follower packing ring resting above each corresponding compressible packing ring, said bottom ring and follower ring being clamped between the adjacent landing heads to pack the space between each pipe string and the wall of the hanger-body, each bottom packing ring having an outer substantially conical face and an inner substantially conical face and each follower packing ring having an outer substantially conical face and an inner substantially conical face, the conical faces of each bottom packing ring and follower ring cooperating to compress the compressible packing ring to pack the same against a corresponding pipe string and the wall of the hanger-body.

14. In a casing head apparatus for deep wells, the combination of a bottom collar having means for securing the same to an outer well casing of relatively large diameter, and having a seat on its upper side, a casing hanger-body received on said seat and secured to the said bottom collar, said hanger-body having a bore extending through the same, a plurality of landing heads to be received in said bore at different levels, said landing heads and the face of said bore having interlocking means enabling the landing heads to be supported at different levels in the hanger-body, a plurality of pipe strings of progressively smaller diameter from the bottom upwards, received within said outer well casing and corresponding respectively to the said landing heads, slips corresponding to the different landing heads for gripping their corresponding pipe strings, each casing string extending at its upper end above its corresponding landing head, and packing means clamped between the landing heads for packing the space between each pipe string and the wall of the hanger-body.

15. In a device for the purpose set forth, the combination of a pipe string let into the well, and having its outer end projecting above the earth's surface, a concrete foundation body disposed around the outer end of the pipe string, a base ring resting on the foundation, having a central opening to engage the pipe string, other pipe strings of different diameters received one within the other and in the first named pipe string, a casing hanger-body resting on the base ring and having a threaded bore, a plurality of landing heads corresponding to the different pipe strings, having threaded engagement with said bore, and having tapered openings therein of the same diameter, slips corresponding to the different landing heads and having different thickness corresponding to the diameter of the pipe held in the landing head.

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