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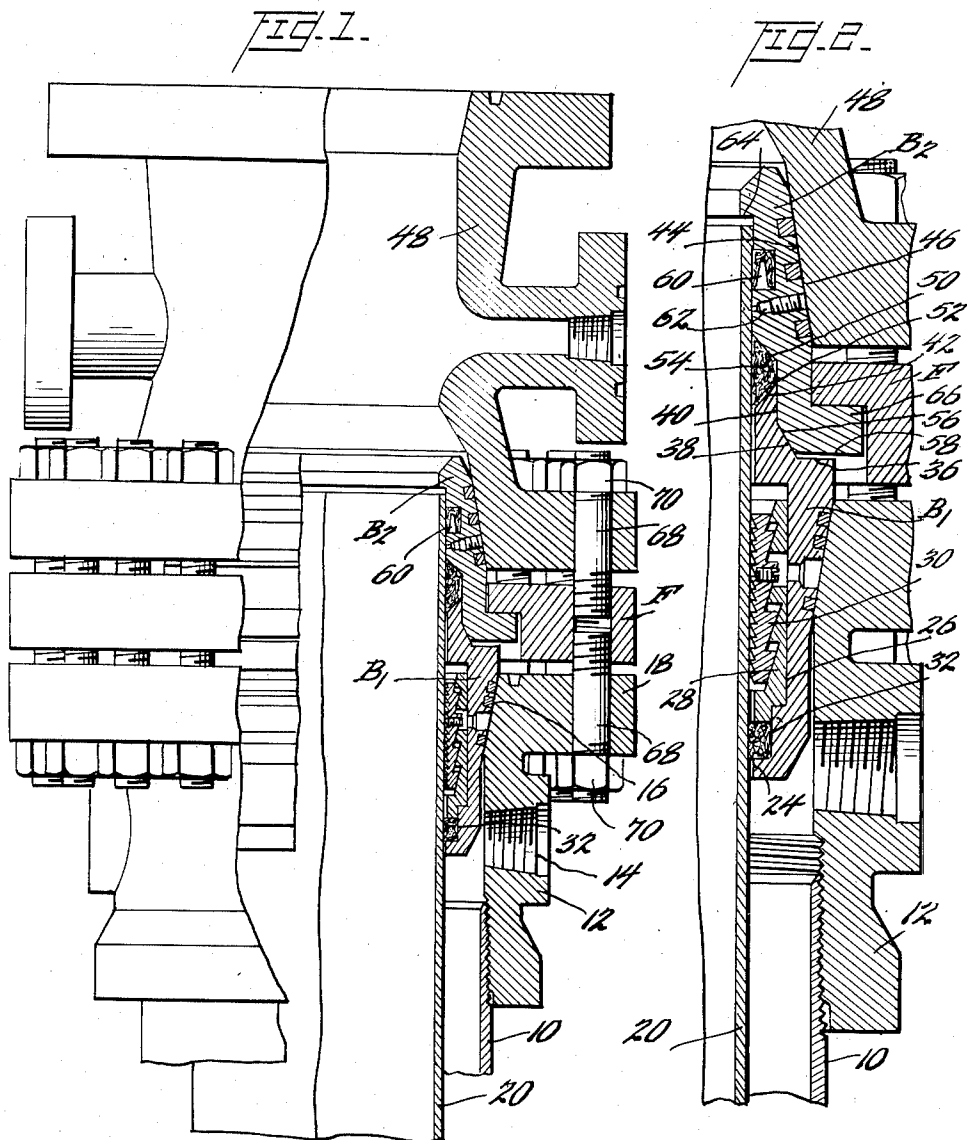
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CASING HANGER ASSEMBLY

Filed June 3, 1949

2 Sheets-Sheet 1



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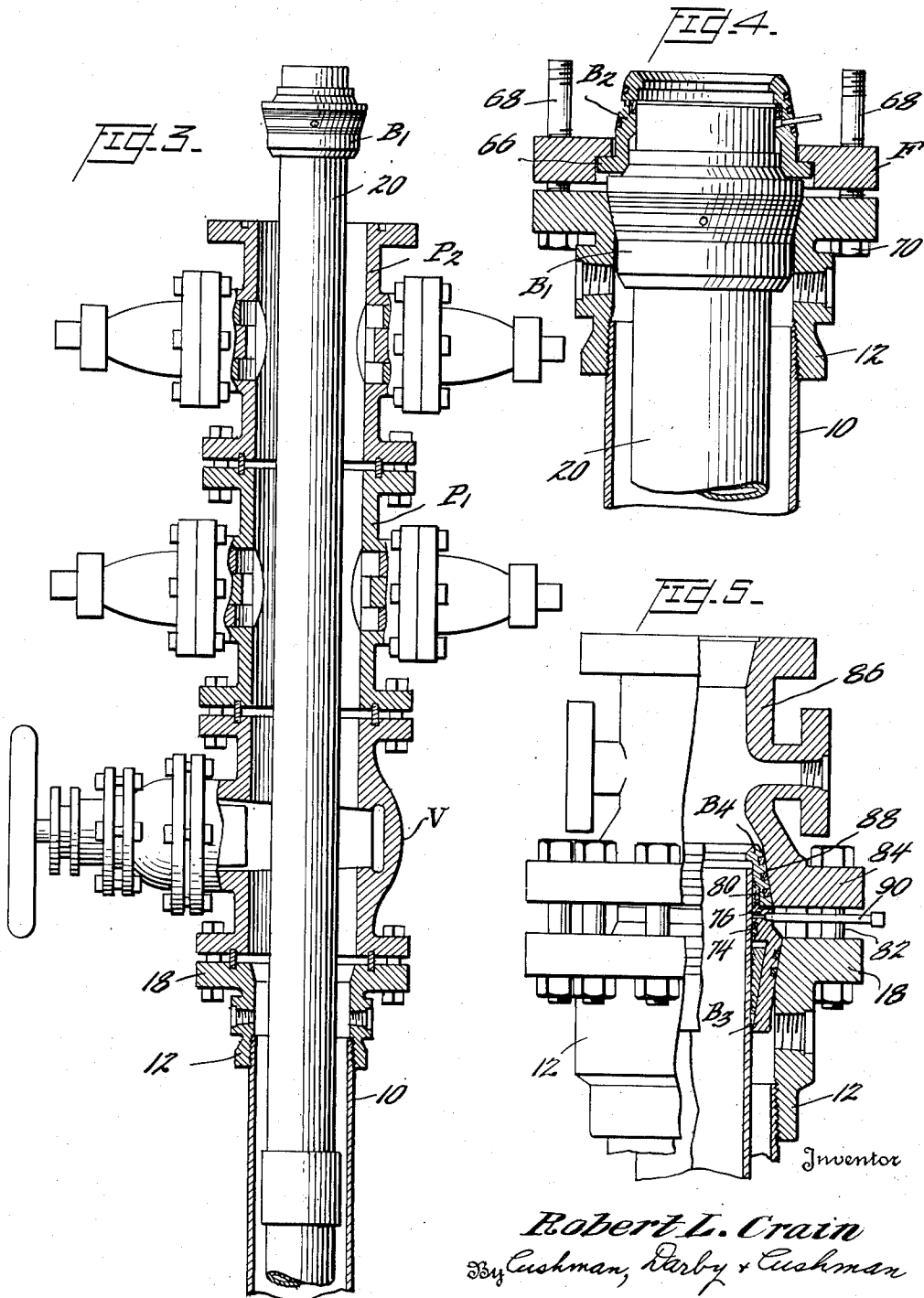
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UNITED STATES PATENT OFFICE

2,568,581

CASING HANGER ASSEMBLY

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13 Claims. (Cl. 285—22)

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The present invention relates to an oil well casing head and hanger assembly of the type which may be employed to permit the running and landing of successive strings of casing while maintaining effective control of the well.

The principal object of the invention is to provide a novel hanger and associated casing head assembly which will provide a permanent seal between the hanger and the casing head in which it is suspended and between the hanger and the casing which it suspends without the necessity of welding or using casing rolling practices as have been suggested and practiced. Ancillary to the object just mentioned, the invention is intended to provide such an assembly in which it is unnecessary to rely on temporary seals whose life is of short duration to provide control throughout the life of the well.

In order to accomplish the above, I have provided a novel form of casing hanger which has means to form a permanent seal in the casing head in which it is landed, said hanger being formed in two parts providing an adjustable packing chamber which is closed except on its inner side which is open toward the casing being suspended, whereby, upon adjustment of the two parts of the hanger toward one another, the packing in the chamber is positively compressed inwardly toward the casing to form an effective and permanent seal therewith. The assembly further provides means for positively closing the outer side of the packing chamber as mentioned above, and positive means for limiting the movement of the hanger sections toward one another, so that the exertion of excessive pressure against the wall of the casing is avoided, so that the possibility of collapsing the casing by this excessive inward pressure is eliminated.

The invention comprises a lower hanger section having means to engage and suspend the inner casing and which is of such diameter that it may be lowered through control equipment mounted on the outer casing head and landed in its seat to form a permanent seal therein, so that the control equipment may be removed. The hanger further comprises an upper section which is thereafter mounted on the casing and tightened against the lower section to form a permanent seal in the space between the inner wall of the hanger and the exterior of the casing which it suspends.

Two forms of the invention are illustrated in the drawings, it being understood that the invention may be practiced with apparatus of somewhat modified construction.

In the drawings:

Figure 1 is a side elevational view of a well head assembly for carrying out the invention, partly in section;

Figure 2 is an enlarged half sectional view, similar to Figure 1;

Figure 3 is a vertical sectional view through the well head, including the control equipment, illustrating the manner in which the equipment of the present invention may be used while maintaining mechanical control of the well;

Figure 4 is a vertical sectional view showing the condition of the equipment in an intermediate stage of installation after the control equipment is removed showing particularly the manner of mounting and securing the upper hanger bushing; and

Figure 5 is an elevational view, partly in section, showing a modified construction.

It will be understood that the present invention is particularly concerned with that type of double tapered casing hanger which is described in Patent No. 2,082,413, Mueller et al., June 1, 1937, which hanger is used in carrying out the methods of the patent to Mueller et al., No. 2,117,444, May 17, 1938. However, the hanger disclosed herein is of the slip suspension type, the general construction and use of which is described in detail in Patent No. 2,207,469, Royce, July 9, 1940. However, in the arrangement disclosed herein, a particular type of slip suspension is employed, including the use of a temporary seal associated with the slip suspension, as disclosed in a co-pending application of Mueller et al., Serial No. 680,334, filed June 28, 1946.

Referring to Figure 1, the outside well casing is shown at 10 and mounted thereon is the casing head of now well-known construction 12 having the usual side outlet 14, tapered hanger seat 16, and connecting flange 18. The inner casing is indicated by the numeral 20, and the hanger assembly is shown associated with a casing hanger and arranged to suspend same in the casing head 18 while providing mechanical control of the well.

The details of the hanger are better illustrated in Figure 2. The hanger comprises a lower bushing B₁ and an upper bushing B₂, said bushings having central bores therethrough, as shown, in order to closely embrace the inner casing 20. The bore of the lower hanger bushing at its lower end is only slightly greater than the exterior diameter of the casing, as indicated at 24. The central part of the lower hanger bushing is counterbored as at 26 to form a wider cylindrical

chamber to receive the slip assembly consisting of the slip cage 28 and the slip segments 30, the precise construction of this slip arrangement being described in detail in the said co-pending application, Serial No. 680,334. Between the lower end of the chamber 26 and the lower hanger bore 24, there is a short counter-bore chamber 32 of intermediate diameter. This chamber is of vertical dimension sufficient to receive several packing rings capable of expansion outwardly and inwardly upon the application of vertical pressure thereto to form a seal between the inner wall of the lower hanger bushing and the outer wall of the casing.

The lower hanger bushing tapers upwardly and outwardly to conform with the taper of the seat in the casing head 12, and in this tapered portion of the hanger, there are a plurality of rings of packing extending entirely around the hanger which make a permanent seal with the casing head when the hanger is suspended therein.

It will be understood that the lower hanger bushing is of maximum exterior diameter slightly less than the minimum interior diameter of the control equipment which is customarily mounted on the casing head 12, so that this lower hanger bushing may be landed through this control equipment in the manner well-known in the art while maintaining mechanical control of the well, as is discussed in detail in the patents and in the application referred to above. That is, the hanger bushing is of such diameter that it will pass through the control equipment now well-known in the art which is of rated size with relation to the casing 10 to which the casing head 12 is connected, this control equipment being attached to the flange 18 of the casing head 12 as illustrated in Figure 3.

Above its tapered portion, the upper end of the lower hanger bushing is formed with a flat ledge or shoulder 36, an upwardly tapered annular portion 38 surmounted by a short vertical cylindrical extension 40. The portion 40 terminates in a relatively sharp circular edge, formed by a downwardly tapered inside area 42 which forms the inside wall of the packing chamber referred to above and to be hereinafter described.

The upper hanger bushing has an outside tapered area 44 with packing rings therein, and it will be understood that this area is adapted to seal with the inside 46 of the casing head or tubing head 48 mounted above the hanger, whereby the area against which pressure from within the casing 20 may exert itself is substantially reduced.

The upper hanger bushing B₂ has a bore of diameter to closely embrace the casing 20, and the lower portion of this bore is flared outwardly as at 50 and then extends vertically as at 52, in order to telescope over the upper protruding end of the lower hanger bushing, forming a packing chamber of adjustable volume between the chambers which may be filled with a quantity of compressible packing material 54 of the permanent type such as well-known hydraulic packing.

It will be noted particularly that the packing chamber is closed at its upper end by the wall 50 and at its lower end by the wall 42 and at its outer side by the wall 52, and it will be observed that the walls 50 and 42 are so tapered as to urge the packing in sealing relationship toward the outer wall of the casing 20. The packing chamber is open only toward the casing 20, whereby, upon the application of substantial pressure to telescope the two bushings toward one another,

the packing will be compressed to form a permanent and protected seal around the casing 20.

Below the wall 52 of the upper bushing, there is an outwardly and downwardly flared surface 56 of shape conforming with the surface 38, and this flared surface 56 terminates in a downwardly presented flat face 58. Surfaces 38 and 56 may be properly ground to form a metal to metal seal and their tapers are such with respect to the arrangement of the packing 54 and the packing chamber, that they impose a limit on the downward movement of the upper hanger bushing so that the packing 54 cannot be subjected to such excessive pressure as would tend to collapse the casing 20.

The bore of the upper hanger bushing above the packing chamber referred to is provided with an annular cut-out 60 in which there is a packing of the lip type and with the lips downwardly presented as shown, and there is a suitable port 62 extending through the wall of this hanger bushing between its packing rings providing access to the bore of the bushing between the lip packing 60 and the packing chamber 54, so that pressure may be applied to the port in the well-known manner in order to test the effectiveness of the seal 54.

There is an inwardly projecting ledge 64 at the upper end of the bore of the hanger bushing B₂, providing a stop shoulder which would serve to prevent any undesired upward movement of the inner casing 20.

The manner of using this hanger assembly will be apparent from the above description and with further reference to Figures 3 and 4. With now conventional control equipment mounted on the casing head, such as the master drilling valve V and the blow-out preventers P₁ and P₂ as shown in Figure 3, the lower hanger bushing B₁ is positioned on the casing 20 and lowered through the control equipment until it reaches the seat in the casing head 12. When the lower hanger bushing reaches its seat, it takes the weight of the casing on the slips 30, and this weight is transmitted to the seat of the casing head 12, as will be clear from the teachings of the said patents and application referred to. Therefore, when the hanger is landed, the lower hanger bushing forms a permanent or primary seal closing off the upper end of the casing 10 by reason of the pressure transmitted to its tapered portion and against the tapered seat of the head 12 by the weight of the suspended pipe. Of course, the operation of the slips and the slip cage is such that the packing in the chamber 32 is likewise compressed to form a temporary seal around the casing 20.

With the seals thus provided upon the initial landing of the lower hanger bushing, the control equipment shown in Figure 3 may be removed with safety, and on cementing time, and the permanent seal around the casing 20 may then be made up by the application of the upper hanger bushing B₂ as will be apparent from the description of Figure 2. An appropriate quantity of packing is placed in the packing chamber and the bushing B₂ is forced downwardly toward the bushing B₁ to reduce the volume in the packing chamber 54 and form the permanent seal referred to.

The bushing B₂ is equipped with an exterior flange 66, and there is a double studded hold-down flange F which has a portion bearing against the upper face of the flange 66. The studs 68 extending from the hold-down flange carry suitable nuts 70 which are manipulated to

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positively pull the flange downwardly to force the bushing B₁ toward the bushing B₂ as illustrated in Figure 4.

After the permanent seal is thus formed against the casing 20, its effectiveness may be tested by means of the port 62 in a manner well-known in the art and as illustrated in Figure 4, after which the upper casing head 48 is mounted on and above the hanger bushing B₂ forming a seal against the tapered portion of that bushing and closing off the port 62 in a manner illustrated in Figure 2.

A modification of the apparatus just described is shown in Figure 5. In this modification, the separate hold-down ring F is eliminated. The lower hanger bushing B₃ may be of the same general construction as previously described or it may be the more simple slip arrangement shown, in which case it is provided with a packing chamber 74 above the slip chamber, and this packing chamber would have a lip packing therein with the lips directed upwardly. In this modification, the testing port is in the lower hanger bushing as at 76, just above the packing chamber 74.

The upper hanger bushing B₄ is of design similar to that previously described except that the test port and packing chamber 60 may be eliminated in this modification. The operations performed in forming the permanent seal by compressing the packing 80 between these bushings will be apparent from the description previously given. Downward pressure is applied to the upper hanger bushing by tightening the nuts on the bolts 82 which extend between the flange 18 of the lower casing head and the flange 84 of the upper casing head or tubing head 86. The head 86 has an inside tapered portion 88 which seals with the external taper on the upper bushing B₄ and exerts downward pressure thereon to compress the packing in the chamber 80. In this arrangement, the effectiveness of the permanent seal is tested after the upper casing head is mounted by means of a suitable conduit 90 which may be inserted between the bolts 82 and connected with the port 76.

It will be apparent that I have provided casing hanger assemblies wherein a complete seal is provided immediately upon landing of the lower hanger bushing. This seal consists of an outside permanent seal where the exterior tapered wall of the hanger bushing engages the tapered seat in the casing head and an inside seal against the outer wall of the casing of less permanent character. This latter seal is then augmented by the application of a permanent seal to the casing by mounting the upper hanger bushing thereon, and telescoping it toward the lower hanger bushing. A permanent seal is insured by reason of the formation of the engaging parts of the two bushings, which define a packing chamber of adjustable volume closed at its top, bottom and outer sides and being open only inwardly toward the outer wall of the casing.

It will be understood that while the ring F as used in the embodiment of Figure 1 is applied to the structure prior to the application of the casing head 40, in order that the seal 54 may be tested prior to application of the head 48 if desired, the ring F may be considered as a part of the upper casing head in the sense that said upper head consists of two parts ultimately attached together, and when so attached, the upper head not only exerts tension downwardly on the bushing B₂ to maintain the seal 54, but also

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maintains the sealing engagement against the outer tapered surface of the upper bushing B₂.
I claim:

1. A hanger assembly for suspending an inner casing within an outer casing comprising separate lower and upper hanger bushings having bores to closely embrace the inner casing, said lower bushing being of diameter adapting it for lowering through control equipment of size rated with the outer casing, and having means to grip and support the weight of the inner casing, said lower bushing having an exterior surface provided with means to form a permanent seal with a lower casing head by the weight of the inner casing when said lower bushing is landed in the lower casing head, said bushings having telescoping parts providing for relative vertical movement between said bushings and being formed to provide between them a packing chamber of adjustable volume closed at its upper, lower and outer sides but open at its inner side toward the inner casing, said upper bushing having an exterior surface for the application of a downwardly directed force to telescope said parts and compress packing in said chamber to thereby form a permanent seal against the exterior of the inner casing.

2. A construction in accordance with claim 1 wherein one of said bushings is provided with a temporary seal in its bore positioned in spaced relation with respect to said chamber to seal with the inner casing and with a test port extending laterally therethrough to test the seal formed by the packing in said chamber.

3. A hanger assembly for suspending an inner casing within an outer casing comprising separate lower and upper hanger bushings having bores to closely embrace the inner casing, said lower bushing being of diameter adapting it for lowering through control equipment of size rated with the outer casing, and having means to grip and support the weight of the inner casing, said lower bushing having means in its bore forming a temporary seal with the inner casing and an exterior surface provided with means to form a permanent seal with a lower casing head by the weight of the inner casing when said lower bushing is landed in the lower casing head, said bushings having telescoping parts providing for relative vertical movement between said bushings and being formed to provide between them a packing chamber of adjustable volume closed at its upper, lower and outer sides but open at its inner side toward the inner casing, said upper bushing having an exterior surface for the application of a downwardly directed force to telescope said parts and compress packing in said chamber to thereby form a permanent seal against the exterior of the inner casing.

4. A hanger assembly for suspending an inner casing within an outer casing comprising separate lower and upper hanger bushings having bores to closely embrace the inner casing, said lower bushing being of diameter adapting it for lowering through control equipment of size rated with the outer casing, and having means to grip and support the weight of the inner casing, said lower bushing having an exterior surface provided with means to form a permanent seal with a lower casing head by the weight of the inner casing when said lower bushing is landed in the lower casing head, said bushings having telescoping parts providing for relative vertical movement between said bushings and being formed to provide between them a packing cham-

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ber of adjustable volume closed at its upper, lower and outer sides but open at its inner side toward the inner casing, said upper bushing having an exterior surface provided with means to seal with an upper casing head.

5. A hanger assembly for suspending an inner casing within an outer casing comprising separate lower and upper hanger bushings having bores to closely embrace the inner casing, said lower bushing being of diameter adapting it for lowering through control equipment of size rated with the outer casing, and having means to grip and support the weight of the inner casing, said lower bushing having an exterior surface provided with means to form a permanent seal with a lower casing head by the weight of the inner casing when said lower bushing is landed in the lower casing head, said bushings having telescoping parts providing for relative vertical movement between said bushings and being formed to provide between them a packing chamber of adjustable volume closed at its upper, lower and outer sides but open at its inner side toward the inner casing, said upper bushing having an exterior flange thereon, a separate clamping ring adapted to engage said flange to apply a downward force thereto to telescope said parts and compress packing in said chamber to thereby form a permanent seal against the exterior of the inner casing, said ring being provided with bolts to engage the lower casing head to force said upper bushing downwardly.

6. A hanger assembly for suspending an inner casing within an outer casing comprising separate lower and upper hanger bushings having bores to closely embrace the inner casing, said lower bushing being of diameter adapting it for lowering through control equipment of size rated with the outer casing and having its bore enlarged to provide a slip chamber within said bushing, slips in said chamber to grip and support the weight of the inner casing, said lower bushing having a downwardly and inwardly tapered exterior surface with means to form a permanent seal in the lower casing head by the weight of the inner casing when said lower bushing is landed in the lower casing head, said bushings having engaging parts providing for relative vertical movement between said bushings and one of said parts being recessed to provide a packing chamber of adjustable volume which is open toward the engaging part of the other of said bushings and toward the inner casing, and a member adapted to be mounted on said upper bushing in contact therewith and having adjustable means for engaging the lower casing head to force said upper bushing downwardly toward said lower bushing.

7. A hanger assembly for suspending an inner casing within an outer casing comprising separate lower and upper hanger bushings having bores to closely embrace the inner casing, said lower bushing being of diameter adapting it for lowering through control equipment of size rated with the outer casing and having means to grip and support the weight of the inner casing, said lower bushing having a downwardly and inwardly tapered exterior surface with means thereon to form a permanent seal in the lower casing head by the weight of the inner casing when said lower bushing is landed therein, said bushings having opposed ends formed to receive and compress a quantity of packing between them and against the inner casing, said upper bushing having an upwardly and inwardly tapered exterior

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surface with means thereon to seal with an upper casing head mounted above.

8. An assembly for suspending an inner casing within an outer casing comprising a lower casing head having a hanger seat, a lower hanger bushing of diameter adapting it for lowering through control equipment of size rated with the outer casing and having a bore to surround the inner casing with means therein to grip and support the weight of the inner casing, said lower bushing having an exterior surface formed to effect a permanent seal with said lower casing head by the weight of the inner casing when said lower bushing is landed in said lower casing head, a separate upper hanger bushing having a bore to surround the inner casing, said bushings having opposed ends formed to receive and compress a quantity of packing between them and against the inner casing to effect a permanent seal against the latter, said upper bushing having an exterior surface to seal with an upper casing head, and an upper casing head adapted to be mounted above and in sealing engagement with said sealing surface of said upper bushing, said upper casing head having adjustable means connected with said lower casing head to force said upper bushing downwardly toward said lower bushing to compress the packing against the inner casing.

9. An assembly for suspending an inner casing within an outer casing comprising a lower casing head having a hanger seat, a lower hanger bushing of diameter adapting it for lowering through control equipment of size rated with the outer casing and having a bore to surround the inner casing, said bore having an enlarged slip chamber with slips therein entirely enclosed within the lower bushing body to grip and support the weight of the inner casing, said bore having means therein to form a temporary seal with the inner casing and said lower bushing having an exterior surface with means thereon to effect a permanent seal with said lower casing head by the weight of the inner casing when said lower bushing is landed in said lower casing head, a separate upper hanger bushing having a bore to surround the inner casing, said bushings having opposed ends formed to receive and compress a quantity of packing between them and against the inner casing to effect a permanent seal against the latter, said upper bushing having an exterior surface to seal with an upper casing head, and an upper casing head adapted to be mounted above and in sealing engagement with said sealing surface of said upper bushing, said upper casing head having adjustable means connected with said lower casing head to force said upper bushing downwardly toward said lower bushing to compress the packing against the inner casing.

10. A hanger comprising separate lower and upper bushings having bores to closely embrace an inner casing, said lower bushing being so formed and of diameter adapting it for lowering through control equipment of size rated with the outer casing and having an exterior surface with means thereon to form a permanent seal with a lower casing head, said upper bushing having an exterior surface with means thereon to form a seal with an upper casing head, said bushings having telescoping parts providing for relative vertical movement between said bushings and being formed to provide between them a chamber of adjustable volume for a quantity of compressible packing of the permanent type which is closed

at its upper outer and lower sides but open at its inner side toward the inner casing, one of the walls of said chamber having a tapered surface arranged to force said packing material toward the inner casing when said bushings are telescoped toward one another, and means in said hanger to grip and support the inner casing.

11. A hanger comprising separate lower and upper bushings having bores to closely embrace an inner casing, said lower bushing being so formed and of diameter adapting it for lowering through control equipment of size rated with the outer casing and having a lower exterior downwardly and inwardly tapering surface with a packing ring thereon to form a permanent seal with a lower casing head, said upper bushing having an exterior upwardly and inwardly tapered surface with a packing ring thereon to form a seal with an upper casing head, said bushings having telescoping parts providing for relative vertical movement between said bushings and being formed to provide between them a chamber of adjustable volume for a quantity of compressible packing of the permanent type which is closed at its upper, lower and outer sides but open at its inner side toward the inner casing, one of the walls of said chamber having a tapered surface arranged to force said packing material toward the inner casing when said bushings are telescoped toward one another, and means in said hanger to grip and support the inner casing.

12. An assembly for suspending an inner casing within an outer casing comprising a lower casing head having an upwardly presented hanger seat and an upper casing head having means for attaching same to said lower casing head and having a downwardly presented sealing surface, a hanger comprising separate lower and upper bushings having bores to closely embrace an inner casing, said lower bushing being formed and of diameter adapting it for lowering through control equipment of size rated with the outer casing and having a downwardly pre-

sented exterior sealing surface with means thereon to form a permanent seal with said upwardly presented hanger seat of said lower casing head, said upper bushing having an upwardly presented sealing surface with means thereon to form a seal with said downwardly presented sealing surface of said upper casing head, said bushings having telescoping parts providing for relative vertical movement between said bushings and being formed to provide between them a chamber of adjustable volume for a quantity of compressible packing of the permanent type which is closed at its upper, lower and outer sides but open at its inner side toward the inner casing, and means in said hanger to grip and support the inner casing.

13. Oil well completion equipment comprising a casing head having an inside seat, a lower casing hanger section for supporting a well pipe in said head, said lower section having an outside surface adapted to engage said seat and form a seal therewith, an annular sealing element supported by said lower casing hanger section, an upper casing hanger section supported in interfitting relationship by said lower section, whereby said sealing element is completely enclosed, and means for maintaining tension between said upper casing hanger section and said casing head, whereby said sealing element is forced into permanent sealing relationship between said well pipe and said casing hanger sections.

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