

April 8, 1941.

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2,237,683

METHOD AND APPARATUS FOR SUSPENDING WELL CASING

Filed April 24, 1939

4 Sheets-Sheet 1

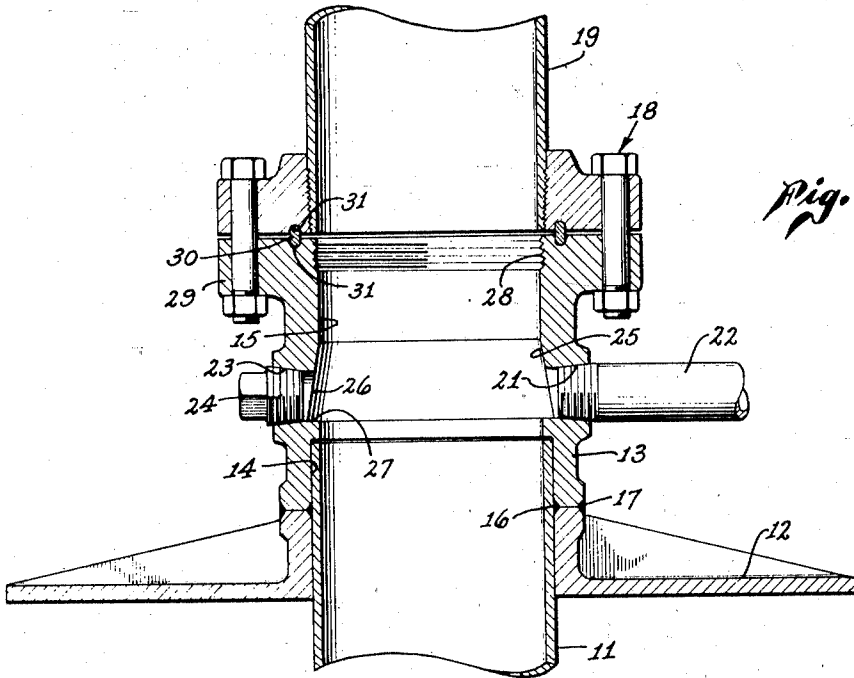


Fig. 1.

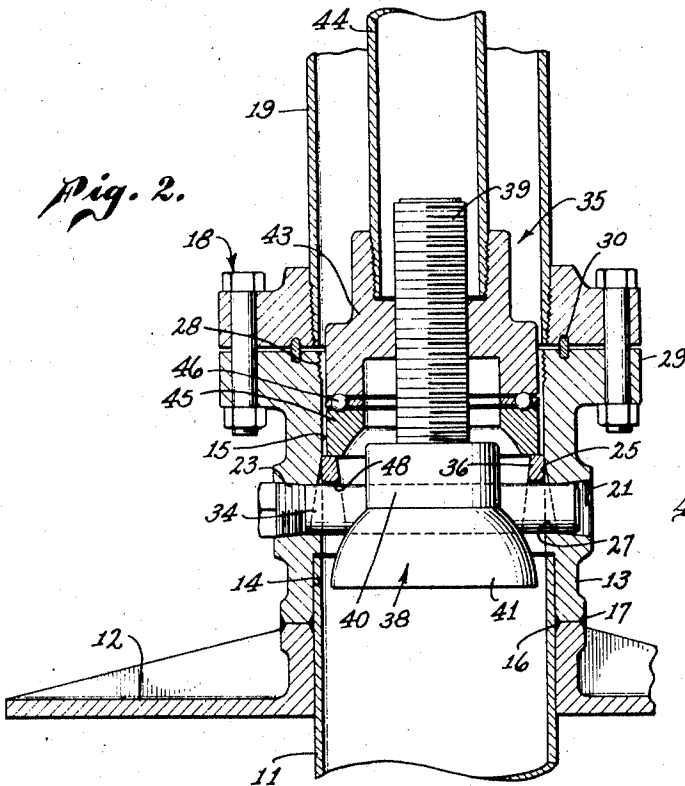


Fig. 2.

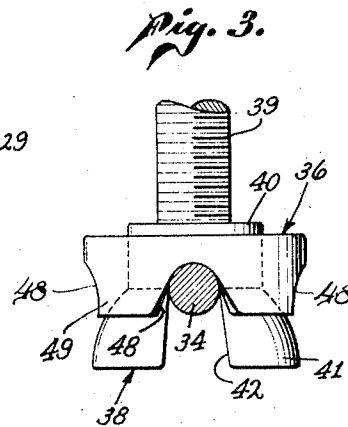


Fig. 3.

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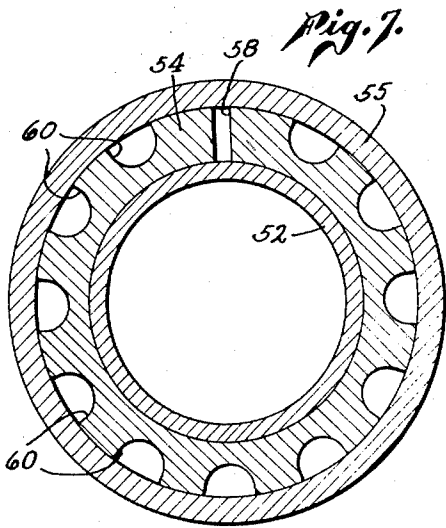
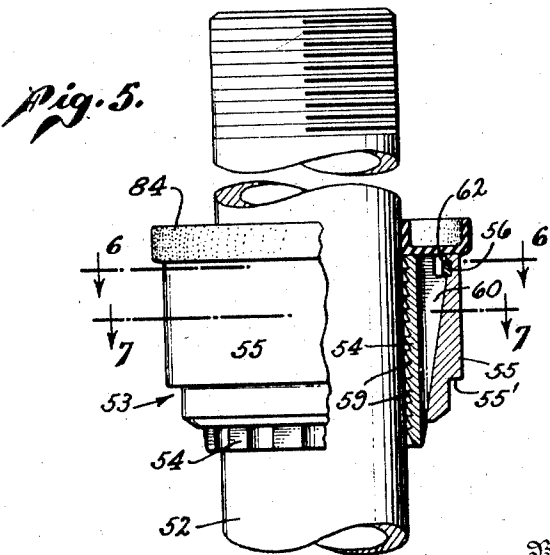
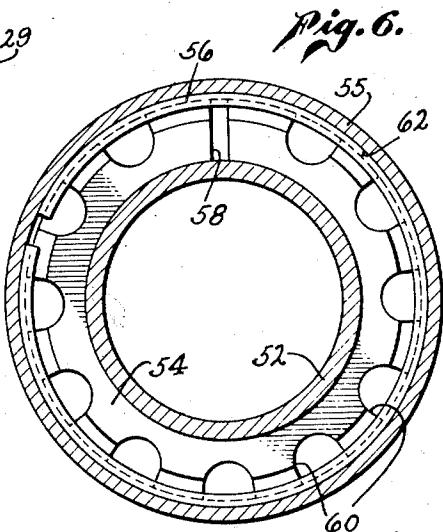
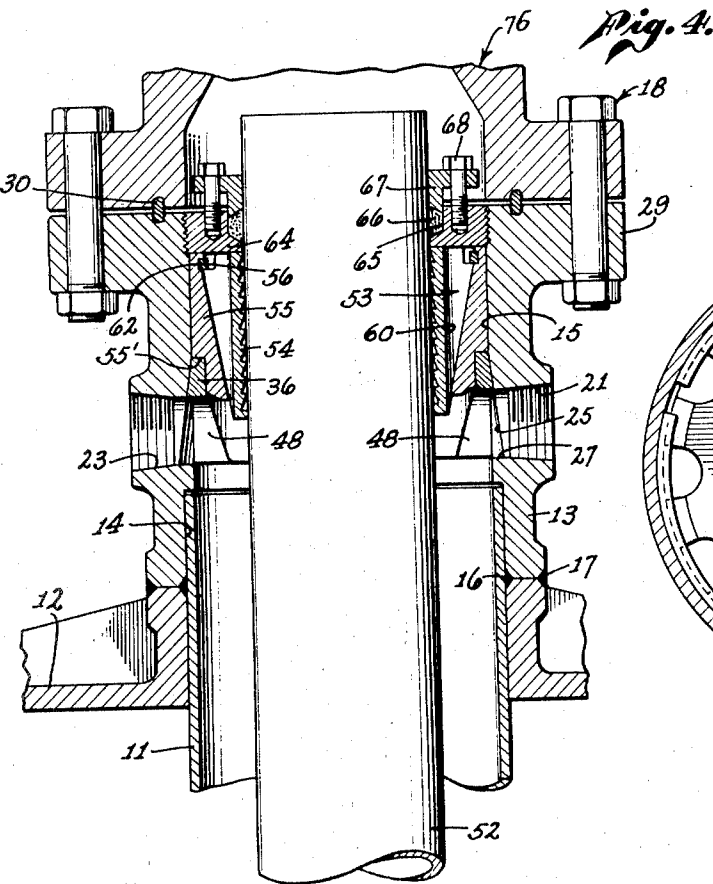
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METHOD AND APPARATUS FOR SUSPENDING WELL CASING

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4 Sheets-Sheet 2



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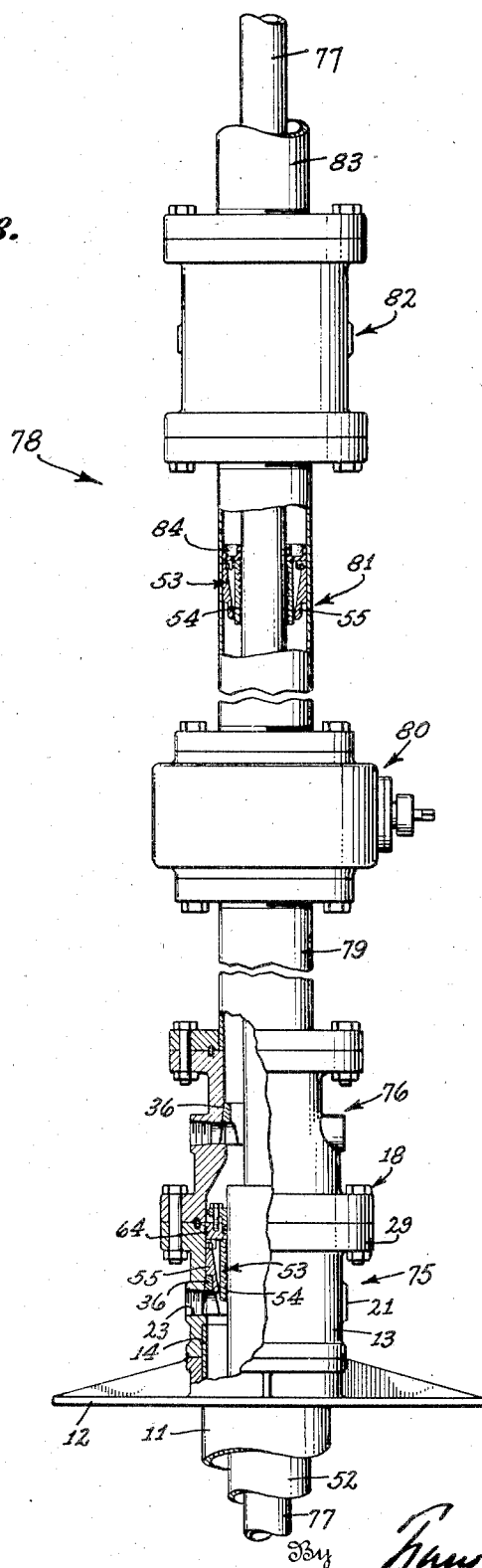
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METHOD AND APPARATUS FOR SUSPENDING WELL CASING

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4 Sheets-Sheet 3

Fig. 8.



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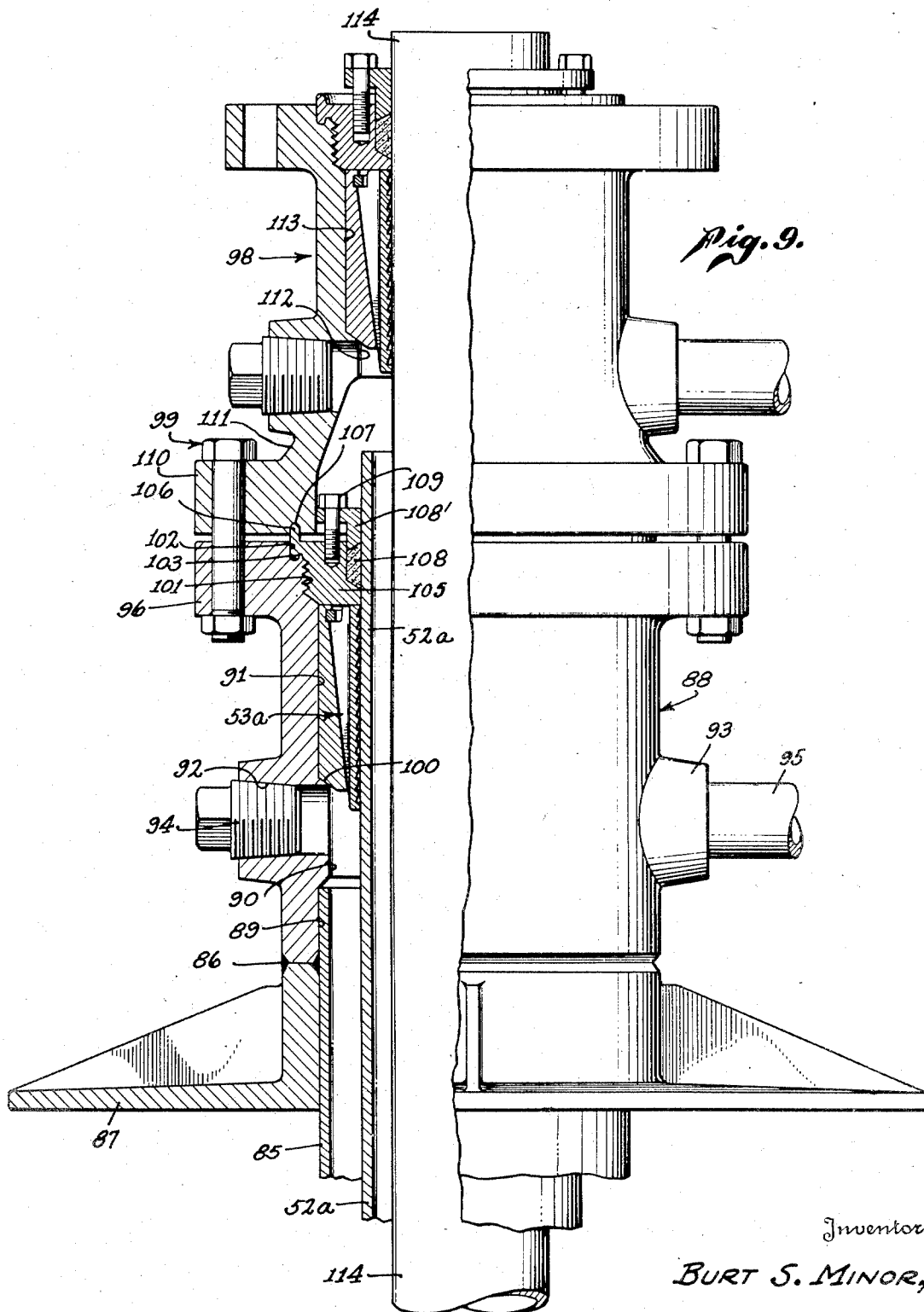
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2,237,683

METHOD AND APPARATUS FOR SUSPENDING WELL CASING

Filed April 24, 1939

4 Sheets-Sheet 4



UNITED STATES PATENT OFFICE

2,237,683

METHOD AND APPARATUS FOR SUSPENDING WELL CASING

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Application April 24, 1939, Serial No. 269,703

19 Claims. (Cl. 166—14)

This invention relates generally to casing head apparatus, particularly casing head apparatus used for suspending casing in oil wells and for controlling pressures in oil wells.

It is the usual practice in drilling oil wells and the like to employ casing head structures for the support and suspension of the casings concentrically one within the other and for providing means for controlling pressures which may be encountered. With the ordinary type of casing head apparatus it is necessary to part the drilling tree, that is the drilling nipple, blowout preventers, etc., which are mounted above the first casing head member on the first string of casing which has been set from the first casing head member, in order to insert slips in the casing head member for the suspension of the next string of casing to be landed. The disadvantage of this is apparent when it is considered that very high pressures are often encountered in drilling and the removal of the drilling tree with its blowout preventers, etc., leaves a period of time when the well is not under control.

It therefore is a primary object of this invention to provide a method and apparatus for landing casing through the drilling tree and suspending the casing in the casing head so that control of the well may be maintained at all times and there will be no possibility of a blowout of the well and destruction of the equipment. In this connection, it is a particular object of this invention to provide a method and apparatus for landing casing through a drilling tree where normal bore casing heads and normal bore drilling apparatus is used above the casing head so that the casing may be suspended within the casing head without removal of the drilling tree. It is also a particular object of this invention to provide for the landing and suspension of casing through the drilling tree where over-sized bore equipment is used.

In connection with the landing of casing through normal bore apparatus it is also an object of this invention to provide a method and apparatus for providing a supporting means forming a ledge or shoulder in a normal bore casing head member, that is, one having a bore approximately equal to the inner bore of the last casing landed, after drilling has been completed and prior to landing of another string of casing and without necessitating the removal of the drilling tree. In this connection it is a particular object of this invention to provide a supporting ring or ring insert member which is adapted to be expanded or deformed into a recess in the casing

head member to form a supporting means. It is also an object of this invention to provide an expanding means for the ring and to provide means for positioning the expanding apparatus and the ring member in proper position opposite the recess into which it is to be deformed.

It is a further object of this invention to provide a new and improved slip and spider apparatus for suspending casing. In this connection it is a particular object to provide a slip and spider apparatus that can be "set" or positioned on the casing prior to suspending the casing in the head and which will remain attached to the casing at the desired point.

It is a further object of this invention to provide a casing head member adaptable to accommodate either a slip apparatus or an abutment means such as an abutment coupling for suspending the casing within the casing head member.

It is a further object of this invention to provide a method of and apparatus for landing casing through a drilling tree whereby it is possible to run the casing in the well, provide a slip assembly on the casing which may be run into the drilling tree to some point above the casing head which is to support the casing, cement the casing, place the proper tension on the casing after the cement has set, and subsequently force the slip assembly down in the drilling tree to its point of support in the casing head by fluid pressure. To accomplish the last mentioned step it is a particular object of this invention to utilize an annular flexible cup member on the casing above the slip assembly against which fluid pressure can be exerted to move the slip assembly.

These and other objects will be apparent from the drawings and the following description thereof. Referring to the drawings which are for illustrative purposes only:

Fig. 1 is a sectional elevation of a part of the casing head structure of this invention as it appears prior to running of an inner string of casing;

Fig. 2 is a sectional elevation of the apparatus of Fig. 1 showing associated therewith the supporting ring and the expander apparatus for deforming the ring;

Fig. 3 is a detail elevation of the mandrel of the expander apparatus and the supporting ring and shows in section the positioning bolt extending therethrough;

Fig. 4 is a sectional elevation of the casing head apparatus after casing has been landed and suspended within the head;

Fig. 5 is a fragmentary elevation partly in sec-

tion of a portion of the inner casing of Fig. 4 and showing the slip mechanism mounted thereon;

Fig. 6 is a sectional plan view on line 6—6 of Fig. 5;

Fig. 7 is a sectional plan view on line 7—7 of Fig. 5; and

Fig. 8 is an elevation, partly in section, of two casing head members associated with parts of a drilling tree showing a slip assembly associated with a flexible cup for use in moving the slip assembly; and

Fig. 9 is an elevation partly in section of an over-size bore casing head apparatus for use in connection with over-size drilling equipment.

More particularly describing the invention, reference numeral 11 indicates the surface or water string of casing which may be considered as having been set and cemented in the ground after the first drilling operation. Welded to this is a landing base 12. Above the landing base and welded thereto is a casing head body member 13 which is provided with an enlarged bore 14 to accommodate the casing 11 and which has a smaller bore 15 which is substantially the same as the inner bore of the casing 11. The member 12 is welded to the casing 11 and member 13 welded to member 12 at welds 16 and 17 respectively. Above the member 13 there is mounted by means of the usual flange and bolt construction 18, a drilling nipple 19.

It is to be understood of course that above the portion of the drilling nipple shown there is the usual drilling tree consisting of the drilling nipple 19 and suitable control means such as blow-out preventers, gates and the like, and above these the rotary table.

The body member 13 of the casing head is provided with a suitable threaded opening 21 to accommodate a pipe 22. Opposite the opening 21 is another threaded opening 23 which has been shown closed by a plug 24. The purpose of the opening 23 will subsequently be pointed out. The body member 13 is provided with an inner annular recess 25 which has a downwardly and outwardly sloping wall 26 terminating in a shoulder or shelf 27 which is recessed with respect to the bore 15. The upper end of the bore 15 is threaded at 28 to accommodate a lock ring as will subsequently be described and is provided with a flange 29 so that other elements may be bolted to it as shown in the drawings and generally indicated by reference numeral 18. In the assembling of the units a ring 30 of deformable metal is utilized as a packing member and extends into grooves 31 in the flanges.

The casing head apparatus shown in Figs. 1, 2, 4, and 8 is what will be termed a normal bore casing head apparatus, that is, the bore 15 of the casing head member 13 is approximately the same diameter as the inner bore of the casing 11. With this type of apparatus normal size parts are used in the drilling tree above the casing head, that is, the bore of the members above the casing head is substantially the same as the bore 15.

Fig. 1 shows the casing head apparatus such as is used for drilling beyond the lower extremity of the casing 11 and prior to setting of an inner casing. After drilling through this member and the casing 11 the drilling tools are removed from the hole and it becomes desirable to land a casing in the newly bored hole. In order to do this, plug 24 is removed and a bolt 34 (see Fig. 2) is threadably mounted in the opening 23. The bolt extends across and partially into the opening 21.

This bolt is adapted to act as a stop or guide bolt for the positioning of the expanding apparatus generally indicated by reference numeral 35 and the associated supporting ring 36 in position opposite the recess 25 so that the supporting ring may be expanded into the recess to form a shoulder or supporting ledge of less diameter than the bore 15.

The bolt 34 also serves as a safety member to prevent the ring 36 or any portion of the expander 35 from dropping into the hole.

The expander apparatus 35 comprises a mandrel 38 having a threaded shank 39, a cylindrical portion 40 and terminating in a head 41. This head 41 is provided with a transversely extending slot 42 so that the expander may be lowered into position and fit over bolt 34. The shank 39 of the mandrel is adapted to be threadably mounted in a collar 43 which is mounted on the lower end of a string of pipe 44. When the expander is assembled the ring 36 is first put on the expander in the position in which it is shown in Figs. 2 and 3 and then a slip washer 45 is placed over it. Above the washer 45 and between it and the collar 43 is placed a suitable anti-friction thrust bearing 46, the mandrel being threadably mounted in the collar to bring the parts 43, 36, 45 and 46 into contact as assembled and shown in Fig. 2.

The supporting ring 36 is an annular member having cut-out portions 48 forming an interrupted lower end and forming teeth 49. The interruptions in the lower end of the ring serve to facilitate the expansion of the ring as will subsequently be described. Preferably the ring member is composed of deformable metal.

The expander 35 with ring mounted thereon is lowered into the position in which it is shown in Fig. 2 so that the expander rests on the bolt 34. In this position the ring member is so positioned as to permit of its expansion into the recess 25. Rotation of the string of pipe 44 with its attached collar 43 serves to draw the mandrel 38 through the ring and deform it into the recess so that it assumes the position in which it is shown in Fig. 4. The expander apparatus 35 is then removed from the casing head member and associated drilling tree. Expansion of the supporting ring 36 into the recess 25 provides a supporting shoulder or ledge within the bore 15 of the body member 13 upon which the inner casing may be suspended by means of means protruding therefrom.

Referring to Figs. 4 to 7 inclusive, there is shown a preferred form of means for suspending an inner casing 52 in the casing head. This means comprises a slip and spider assembly generally indicated by reference numeral 53 and comprising a single slip member 54, a spider member 55 and a retaining ring 56. The slip member 54 is a single piece element provided with a longitudinal slot 58. Internally the slip is provided with the ordinary serrations 59. Externally the slip is provided with longitudinal grooves 60 which are provided for the purpose of making the slip member yieldable to a certain degree. In this connection it should be pointed out that the slip member is designed to have an inner diameter slightly less than the outer diameter of the casing to be supported by it. With this construction it is possible to place the slip member about the casing, then place the spider 55 over the slip member and subsequently secure the two members together by means of the split ring 56 abutting against the upper end of the slip member and fitting into a groove 62 in the spider.

When the slip assembly 53 is thus mounted on a casing as is shown in Fig. 5 the assembly will remain in place on the casing at the desired point. In Fig. 5 there is also shown a flexible cup 84 which will be described subsequently and may be disregarded for the present. Therefore, it is possible with the apparatus shown to land the casing through the drilling tree and casing head and then raise it to the desired amount, fasten the slip assembly to the casing as in Fig. 5 and then lower the casing down into the casing head until the slip assembly rests upon and is supported by the supporting ring 36. Preferably the spider 55 is provided with a shoulder 55', which is adapted to seat upon the upper end of the supporting ring 36. After the casing 52 has been lowered into place as shown in Fig. 4 and supported in the casing head by means of the slip assembly 53, the drilling tree including the drilling nipple 19 may be removed from the casing head member 13 and a lock ring 64 threadably mounted in the upper end of the body member 13. This lock ring has an annular recess 65 which is adapted to accommodate packing 66. The packing is compressed into sealing engagement with the inner casing 52 by means of a packing compression ring 67 which is mounted in the lock ring by means of bolts 68. The casing 52 may then be cut off at the proper height and another casing head member mounted on the flange 29 of the casing head member 13. This casing head member has been partially shown in Fig. 4 and is indicated generally by reference numeral 76. It is also shown in Fig. 8. It is to be understood of course, that the operation may be repeated for as many strings of casing as it is desired to set so that when the well is completed there will be a series of casing head members mounted one upon the other supporting a series of casings one within the other.

It is to be understood of course that in place of the slip assembly 53 an abutment collar of any type may be mounted or secured to the inner casing 52 for supporting the casing upon the supporting ring 36.

It has been pointed out as an object of this invention to provide a method of landing casing through the drilling tree whereby it is possible to run the casing in the well and provide a slip assembly on the casing which may be run into a drilling tree to some indeterminate point above the casing head after which the casing may be cemented in place. After the cement has set the casing may be elevated to give it the proper tension and subsequently the slip assembly may be moved downwardly in the drilling tree into the casing head where it will be supported. Referring to Fig. 8 to illustrate this method and the apparatus for carrying it out, there is illustrated a lower casing head which is generally indicated by reference numeral 75 which is in all respects similar to the casing head heretofore described and most clearly illustrated in Fig. 4 and the parts of the head therefore bear the same reference numerals. Above this is mounted a second casing head 76 which is of less diameter than the first casing and is adapted to support a third string of casing 77. This casing head 76 is provided with a supporting ring 36 in the manner previously described and the third string of casing 77 is run through the drilling tree into the hole. This drilling tree has been generally indicated by reference numeral 78 and has been shown as comprising a drilling nipple 79, a ram gate valve 80 and another drilling nipple 81.

Above the drilling nipple 81 is mounted a blow-out preventer 82 and above this is a section of tubing 83 which may extend up to any desirable height to some point below the rotary table. It is to be understood that the drilling tree shown is merely for illustrative purposes and that the makeup of drilling trees varies greatly. In running the casing 77, after sufficient casing has been run to determine the approximate point at which it is desired to mount the slip assembly 53, the casing is raised and slip assembly mounted thereon. So that the slip assembly may be moved on the casing after the casing has been run into the hole to proper position for cementing and the slip assembly is at some point in the drilling tree above the ring 36 in head 76, an annular flexible seal or cup 84 is placed over the casing above the slip assembly. This cup is shown in Figures 5 and 8. The casing is then run into the hole into position for cementing and cemented into place by pumping cement down casing 77 in the ordinary manner. After the cement has set and it is desired to place the casing 77 under tension and suspend it from the casing head 76, this may be done by pumping fluid under pressure down inside of the members 82, 78, 81, 80, 79, thereby forcing the slip assembly down until it rests upon the supporting ring 36 in head 76. In this connection the cup 84 under the action of the pressure fluid seals off against the various members of the drilling tree and against the casing 77 and thereby acts as a piston under the action of pressure fluid forcing the slip assembly down into the casing head 76.

It is to be understood that the member 82 may be provided with suitable closure means such as a cementing head or the like provided with suitable ports so that pressure fluid may be introduced and maintained under pressure within member 82 and the other elements of the drilling tree.

After the slip assembly 53 has been forced down into the casing head 76, the drilling tree may be parted from that head and a lock ring, packing and compression spring secured in place as shown in Fig. 4 in connection with head 75. The casing 77 may then be cut off at the desired point. Subsequently other strings of casing may be landed in a similar manner by utilizing successively smaller size casing heads on top of casing head 76.

Referring to Fig. 9 there is shown a type of casing head construction for use where it is desired to use over-size equipment, that is, equipment having a bore larger than the bore of the outer casing or in the case of casing head members above the lowermost casing head member, a bore larger than the last casing landed. Welded to the outer casing 85 by means of welding 86 is a landing base 87. Welded, above the landing base and mounted on the upper end of casing 85 is a casing head member 88. Member 88 has a bore 89 adapted to accommodate the upper end of the casing 85. Above the bore 89 is an intermediate bore 90 of less diameter and above this bore is an enlarged bore or over-size bore 91 which is of greater diameter than the bore of the casing 85. In the region of the bore 90 are provided suitable threaded ports 92 and 93 which are shown as having a plug 94 and a pipe 95 mounted therein respectively. The upper end of the member 88 is provided with a flange 96 to accommodate another casing head member generally indicated by reference numeral 98 which

may be bolted to member 88 by means of the bolt assembly 99.

The lower end of the bore 91 of member 88 terminates in a downwardly and inwardly sloping shoulder 100 while the upper end of the bore terminates in a threaded portion 101. At the upper end of the threaded portion 101 there is another and larger bore 102. An annular lip 103 is located between portions 101 and 102.

After the first string of casing 85 has been landed and the casing head members 87 and 88 mounted thereon, the ordinary drilling tree is mounted upon the flange 96 of the member 88 and the hole is drilled deeper. Subsequently the casing 52a is landed through the drilling tree. A slip mechanism generally indicated by reference numeral 53a is used and mounted on inner casing. This slip assembly is in all respects the same as the slip assembly 53 heretofore described except that the spider has a different outward configuration in order to fit into the bore 91 and rest upon the shoulder 100. After the casing has been landed and suspended within the member 88 the drilling tree is removed and a lock ring 105 is threadably mounted in the upper end of the member 88. This lock ring has an annular double flange 106 which is adapted to extend into the recess 103 in the flange 96 and is adapted to extend into a groove 107 in the lower end of the casing head member 98 when the same is mounted on flange 86. Suitable packing 108 and a packing compression ring 108' are then mounted in connection with the lock ring 105 and secured thereto by the bolts 109. The casing may then be cut off at the proper height and the casing head member 98 mounted thereon.

The casing head member 98 is provided at its lower end with a flange 110 so that it may be mounted upon the member 88. From the flange 110 the walls of member 98 extend inwardly at 111 to an inner bore 112. Upwardly of the bore 112 is an enlarged bore 113 which bears the same relation to the casing 52a as bore 91 bears to casing 85. The upper end of the member 88 is the same as the upper end of member 78 except that it is of smaller size and therefore need not be described in detail. The slip assembly, lock ring and packing means for suspending an inner casing 114 is the same as the slip assembly, lock ring and packing means described in connection with the member 88 except that it is smaller in diameter and therefore need not be described in detail.

It is of course apparent that after member 98 has been mounted on the member 88 that the drilling tree may be mounted on the member 98 and drilling conducted in the ordinary manner prior to the setting of the casing 114. Other members 98 of reduced size may be mounted upon the member 98 for suspending successive inner casings as is the usual practice.

Although the invention has been particularly shown and described it is contemplated that various changes and modifications may be made without departing from the invention and it is intended to cover such changes and modifications as come within the scope of the claims.

I claim as my invention:

1. The method of providing supporting means in a casing head member having an inner annular recess therein which comprises providing an expander, placing a supporting ring on said expander, lowering said expander and ring into said casing head member to position said ring opposite said recess, and operating said expander

to position the lower part of said ring in said recess.

2. The method of providing supporting means in a casing head member having an inner annular recess therein which comprises providing an expander, placing a supporting ring on said expander, said ring being wider than said recess, lowering said expander and ring into said casing head member to position the lower end of said ring opposite the lower end of said recess, and operating said expander to deform the lower part of said ring into said recess.

3. The method of providing supporting means in a casing head member having an inner annular recess therein which comprises providing an expander, placing a supporting ring on said expander, said ring being wider than said recess, the annularity of said ring being interrupted at its lower end by cut-out portions thereby forming teeth, lowering said expander and ring into said casing head member to position the lower end of said ring opposite the lower end of said recess, and operating said expander to position said teeth and adjacent portions of said ring in said recess.

4. The method of providing supporting means in a casing head member having an annular recess therein and having means for the reception of a cross bolt in the region of said recess which comprises inserting a cross bolt in said casing head in the region of said recess, providing an expander, placing a supporting ring on said expander, lowering said expander and ring into said casing head to seat said expander on said cross bolt, said cross bolt being positioned so as to bring the lower end of said ring opposite the lower end of said recess when said expander is seated thereon, and operating said expander to position the lower part of said ring in said recess.

5. The method of suspending an inner casing within an outer casing which comprises mounting a casing head member on the upper end of said outer casing, said casing head member having an inner annular recess with a shoulder at its lower end, lowering a one-piece supporting ring in said head and deforming said ring into said recess whereby the lower end of said ring is free to seat on said shoulder and the upper end of said ring forms an inwardly extending annular ledge in said casing head member, mounting a supporting means on said inner casing, and lowering said inner casing in said casing head member until said supporting means rests on said ring.

6. The method of suspending an inner casing within an outer casing which comprises mounting a casing head member on the upper end of said outer casing, said casing head member having an inner annular recess terminating in a shelf at its lower end, lowering a one-piece supporting ring in said head and deforming said ring into said recess whereby the lower end of said ring is seated on said shelf and the upper end of said ring forms a supporting ledge in said casing head member, placing a split slip member on said inner casing, mounting a spider on said slip, said spider serving to hold said slip in place on said inner casing, and lowering said inner casing in said casing head member until said spider rests on said ring.

7. The method of suspending an inner casing within an outer casing which comprises mounting a casing head member having an internal annular recess terminating in a shelf at its lower

end on the upper end of said outer casing, providing a temporary stop member in said head member in the region of said recess, providing an expander, placing a supporting ring on said expander, lowering said expander and said ring into said casing head member until said expander engages said stop member thereby positioning said lower end of said ring opposite the shoulder of said recess, operating said expander to deform the lower part of said ring into said recess, removing said expander, removing said stop member, attaching a supporting means to said inner casing, and lowering said inner casing in said casing head until said supporting means rests on said ring.

8. The combination of, a hollow body member having an internal annular recessed shelf, and a unitary supporting ring having its lower end portion deformed to rest on said shelf and having its upper end portion projecting into the interior of said body forming an annular supporting ledge therein.

9. For use as described, the combination of a hollow casing head member having an internal annular recess, said recess having an annular shoulder at its lower end, and a supporting ring having an interrupted lower end forming a series of teeth, said teeth extending downwardly into said recess and having their lower ends resting on said shoulder.

10. For use as described, the combination of a well casing, a casing head member mounted on said casing, said casing head member having a large bore to accommodate said casing and a smaller bore substantially the same diameter as the inner bore of said casing, an annular recess in said smaller bore having an annular flat shoulder at its lower end, and a supporting ring having an interrupted lower end forming a series of teeth, said teeth extending downwardly and outwardly into said recess and having their lower ends supported on said shoulder, the upper end of said ring forming an annular ledge in said casing head member.

11. A casing head structure comprising an outer casing, a hollow casing head member mounted thereon, said member having an annular recessed shelf, a supporting ring in said casing head supported on said shelf at its lower end, an inner casing, a split slip member on said inner casing, a spider surrounding said slip member, and a split ring for securing said spider and slip member together, said spider being receivable in said casing head member and being adapted to be supported by said supporting ring.

12. A casing head structure comprising an outer casing, a hollow casing head member mounted thereon, said member having an annular recessed shelf, a supporting ring having an interrupted lower end forming a series of teeth, said teeth extending downwardly and outwardly and having their lower ends supported on said shelf, an inner casing, a split slip member on said inner casing, a spider surrounding said slip member, and a split ring for securing said spider and slip members together, said spider being receivable in said casing head member and being adapted to be supported by said supporting ring.

13. A slip assembly comprising a split annular slip member having a serrated inner surface and having a longitudinally grooved outer surface, a spider adapted to surround said slip member, said spider having an internal annular groove, a split ring mounted in said groove and

extending over the top of said slip member, said ring being adapted to hold said assembly together.

14. A slip assembly for supporting a casing comprising a split annular slip member having a normal internal diameter less than the outer diameter of the casing to be supported, a spider surrounding said slip member, and a lock ring securing together said slip and spider members.

15. A casing head structure comprising an outer casing, a hollow casing head member mounted thereon, said casing head member having a supporting ledge therein, an inner casing, a split slip member on said inner casing, a spider surrounding said slip member, and a split ring for securing said spider and slip members together, said spider being receivable in said casing head member and being adapted to seat on said supporting ledge.

16. The method of landing casing in a well through the drilling tree which comprises providing a casing head having a supporting ledge therein below said drilling tree, running said casing through the tree and associated casing head into the well, placing a supporting assembly on said casing at a point where it will be located in the drilling tree when the casing is positioned for cementing, placing a flexible annular cup on said casing above said supporting assembly, cementing said casing, suspending said casing under tension, and forcing said flexible cup and supporting assembly down in said tree to seat on the ledge in said casing head by forcing fluid under pressure into said tree above said cup.

17. For use as described, the combination of a drilling tree and a casing head associated therewith and therebelow, said casing head having a supporting ledge therein, an inner casing extending through said tree and head and into the well, a supporting assembly on said casing in said tree at a point above the ledge in said head, an annular flexible cup above said supporting assembly engageable with said inner casing and said tree, and means for admitting a pressure fluid to the interior of said tree above said cup for forcing said cup and supporting assembly downwardly into said head.

18. For use as described, the combination of a drilling tree and a casing head associated therewith and therebelow, said casing head having a supporting ledge therein, an inner casing extending through said tree and head and into the well, a split slip member on said casing, a spider surrounding said slip member, said slip and spider members being downwardly frictionally slidable on said casing as a unit, an annular flexible cup on said inner casing above said slip and spider members engageable with said casing and said tree, and means for admitting a pressure fluid to the interior of said tree above said cup for forcing said cup, slip and spider members downwardly into said head.

19. A slip member for use in combination with a pipe of a given diameter comprising a one-piece longitudinally split annular member having a serrated inner surface and having a plurality of longitudinal grooves in its outer surface, the normal inner diameter of said slip member being slightly less than the outer diameter of the pipe with which it is to be used in combination whereby said slip member will frictionally engage the pipe and maintain itself in position thereon.

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