Jan. 14, 1941. E. L. BARKER 2,228,555

MEANS FOR SECURING CASING IN A WELL

Filed March 10, 1938 3 Sheets-Sheet 1

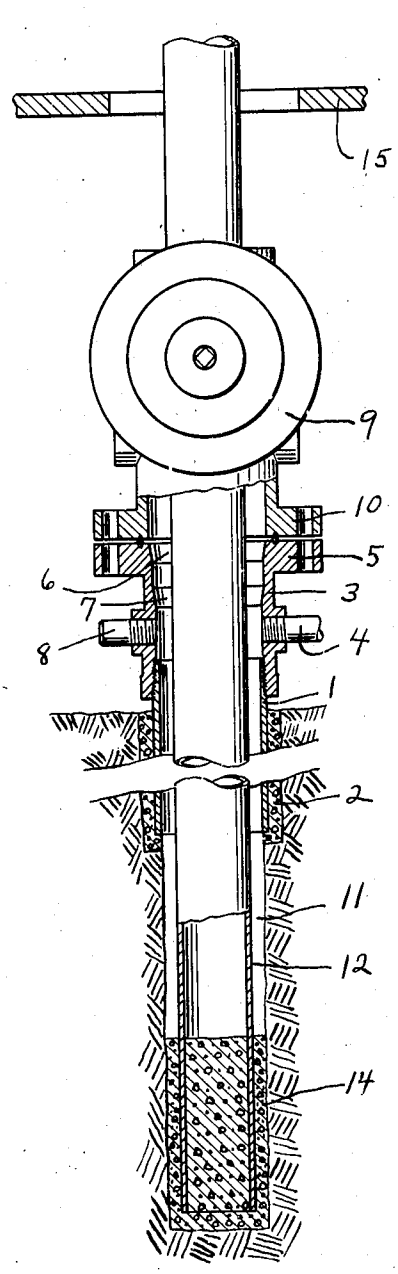


Fig. 1

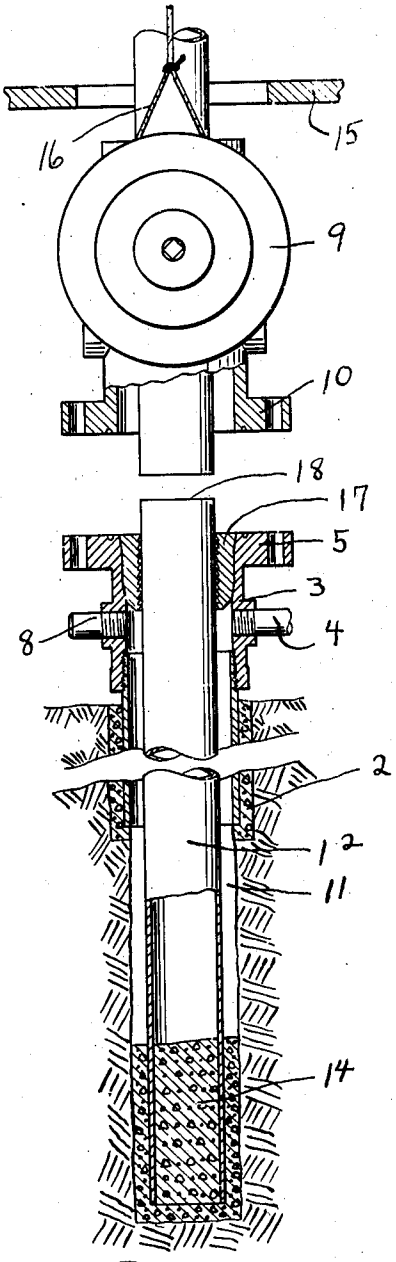


Fig 2.

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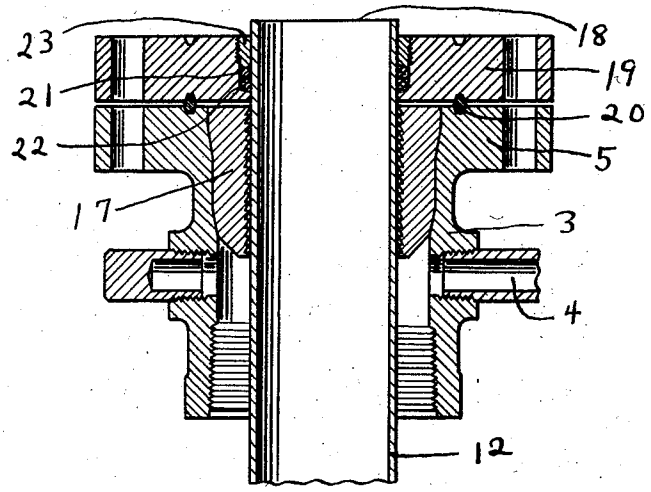


Fig. 3

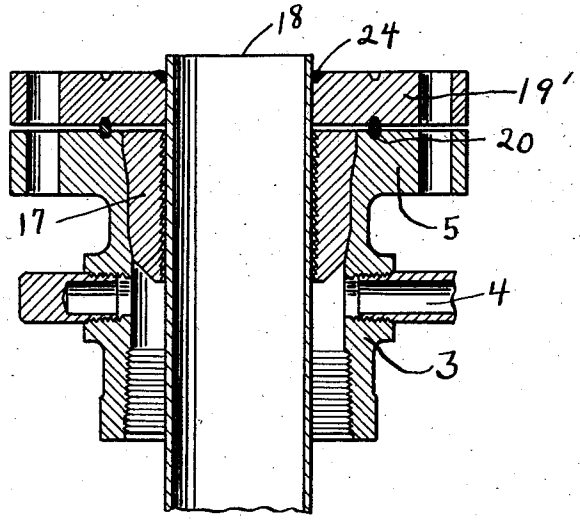


Fig. 4

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MEANS FOR SECURING CASING IN A WELL

Filed March 10, 1938 3 Sheets-Sheet 3

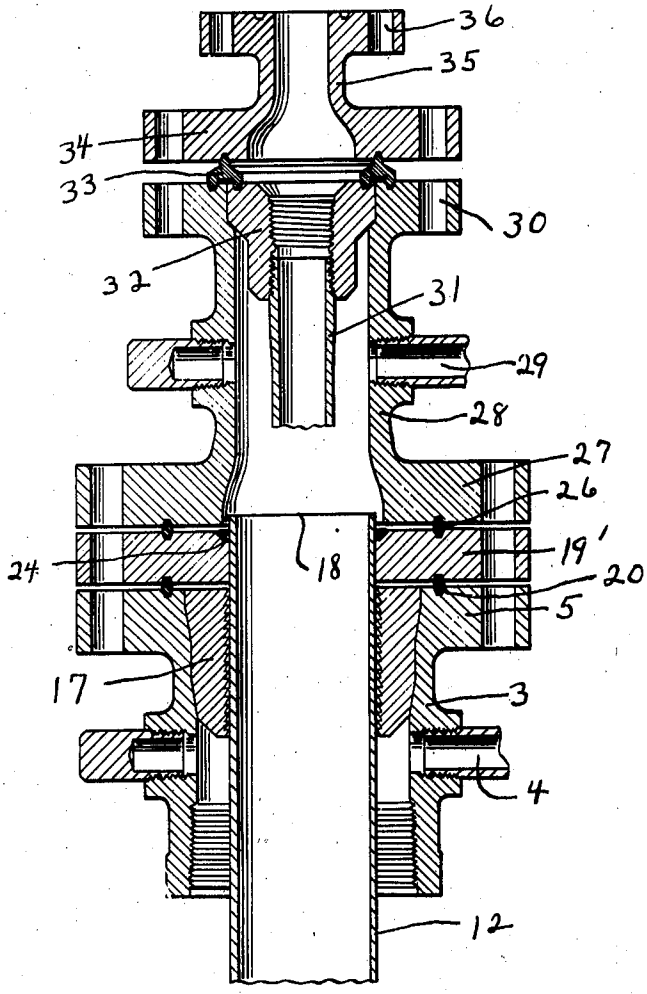


Fig. 5.

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UNITED STATES PATENT OFFICE

2,228,555

MEANS FOR SECURING CASING IN A WELL

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Application March 10, 1938, Serial No. 194,994

1 Claim. (Cl. 24—263)

This invention relates in general to a means for completing wells. It has particular reference to a method of securing a casing in place within a well and proceeding with the completion thereof and to a means for supporting the casing and sealing off the space outside the casing.

This invention has for its general object the provision of a means whereby the time required for setting casing and placing the well in condition for continuing with the completion thereof may be greatly reduced.

A further object of this invention is to provide a novel means for supporting a casing more rigidly and firmly than has been possible with structures of the prior art.

Another object of this invention is to provide a means for sealing the space between two strings of casing independently of flowing equipment mounted on the outer string and arranged to control flow through the inner string of casing.

In the past it has been customary to first drill a relatively shallow hole of large diameter and then to set therein a relatively large casing such as is ordinarily known as surface casing. Then the practice has been to drill down below the surface casing a somewhat smaller hole than that in which the surface casing is set. When a point is reached which is believed to be just above a producing formation, drilling is stopped and a second smaller string of casing is put in place. This smaller string of casing is lowered to a point just above the bottom of the hole and cement is forced down through the casing and up around the outside thereof so that when this cement hardens the casing will be firmly anchored and no flow will be permitted from formations above its lower end down around its lower end and into the casing. During the time that this casing is being cemented in place it is customarily supported by mans of the hoisting equipment connected with the derrick at the top of the ground and continues to be so supported until the cement has had time to set.

During the drilling of the well and the running of the casing as just described there is mounted in place on the upper end of the surface string of casing a blowout preventer and other similar equipment which when the casing has been cemented in place surrounds the casing. This equipment is usually placed below the derrick floor so that it cannot be lifted up through the derrick floor and removed from the upper end of the pipe. Furthermore, it could not be removed from the upper end of the pipe while the pipe is being supported in the derrick and in order to obtain a good cement seal the pipe must be supported by the hoisting equipment in the derrick or by some other means until the cement at the bottom of the well has set. There has thus been necessitated great delay because of a necessity for waiting until the cement has set before the blow-out preventer can be removed and the casing supported on the upper end of the surface casing.

It is necessary also that the upper end of the casing be positioned at the proper level to provide for the mounting of flow connections thereon when the well is completed and the space between the casing and the surface string must be sealed off to prevent by-passing of pressure from the casing to the interior of the surface string. Heretofore, the upper end of the casing has been brought to its proper position by first waiting a number of hours until the cement has set, then releasing the casing so that it is supported on the cement which is a very bad practice and removing the upper section thereof down to the first coupling within the surface string. The blow-out preventer used in drilling is then removed.

A nipple is then procured which is of a length to reach from said first coupling to substantially the proper level for making the flow connections. Inasmuch as the casing usually employed is of large diameter it is not feasible to provide for cutting and threading the same at the well and it is, therefore, necessary after one has waited for the cement to harden, and has removed the upper section of casing and the blow-out preventer to take considerable time to procure a special section of casing cut to length and threaded so as to bring the upper end of the casing to exactly the point desired.

All of the foregoing has caused considerable delay in completing wells and it is the avoidance of this delay that constitutes one of the major objects of this invention.

It is customary to support a string of pipe in a well by means of slips placed in the upper portion of a supporting head mounted on the surface string, which upper portion is usually tapered downwardly and inwardly so that the slips will be wedged between the tapered portion of the head and the pipe to be supported. These slips and the upper ends of these heads are customarily provided with single tapered surfaces. That is, they are provided with continuous or uninterrupted tapers from their upper to their lower ends. However, the lower or smaller diameter

of the tapered opening in the upper end of the head is limited by the internal diameter of the surface casing employed, whereas the upper or larger diameter of this taper is limited by the internal diameter of the blow-out preventer equipment available for given size of pipe. The difference in diameters between the upper and lower ends of the tapers is, therefore, limited, and the length of the tapered zone has been limited to give the taper sufficient pitch so that the slips would not "freeze" into the head when placed therein and the casing supported thereon. If it was found to be necessary to provide a longer gripping surface on the slips, these slips were extended beyond the end of the tapered surface in the head.

The structure just described has two defects, namely, that the expanding force exerted upon the head by the slips was concentrated into a relatively narrow zone, thus placing an excessive load on those portions of the head with which the slips contacted, and since the slips extended beyond the zones of their contact with the head, they were not backed up throughout their length and the force exerted by the slips on the casing was not uniform. The tapered zones could not be made longer because if they were, the pitch of the taper would be so slight that the slips would wedge in place and become "frozen" so that they could not be removed.

The foregoing is of great importance because during the production of oil or other liquid from a well the flow is not a smooth flow as might be supposed but is instead a pulsating flow which continually exerts various stresses on the tubing and casing of the well. If the zones of support between the slips and the head be, as above mentioned, then the vibration of the casing during production of the well will tend to rock the slips upon their seat within the head, thus not only loosening packing, et cetera, used for forming a seal between the inner casing and the casing head, but also tending to crystallize the material of these parts and result in an ultimate breakdown. It is important, therefore, that the support for the inner casing within the casing head be made such that it will not only support the weight of the casing, but also so that it will form a comparatively rigid support for the casing and tend to prevent the casing from vibrating with respect to the casing head.

It is, therefore, another object of this invention to overcome the difficulties above referred to and to provide a more rigid and sturdy support for a casing.

Another object of this invention is to provide a permanent and dependable seal between the inner and outer casings at their upper ends.

One other object of this invention is to provide a means for sealing the space between the inner and outer casings at their upper ends, which means will lend a substantial degree of rigidity to the casing support.

Another object of this invention is to provide a means for sealing the space between the inner and outer casings at their upper ends, which means will both form a permanent seal between these parts independent of equipment later to be placed on the well, and also serve to rigidly support the inner casing with respect to the outer casing.

In addition to the foregoing, it has been found desirable in many cases that the inner casing be not only supported against downward movement, but that it also be supported against upward movement because under some conditions there is a tendency for the upper end of the casing to move upwardly.

It is, therefore, an object of this invention to provide a means for supporting an inner casing against upward movement with respect to an outer casing.

Other objects and advantages of this invention will become apparent in the following description wherein like numerals indicate corresponding parts throughout.

In the drawings:

Fig. 1 is a vertical cross section showing a well in which the inner casing has just been cemented in place and before the blow-out preventer used in drillinng the well has been removed.

Fig. 2 is a view similar to Fig. 1 but showing the apparatus after the blow-out preventer has been lifted, the casing suspended on slips and severed.

Fig. 3 is an enlarged vertical cross section of the head and upper end of the casing shown in Figs. 1 and 2 together with one form of sealing means for forming a seal between the head and the upper end of the inner casing.

Fig. 4 is a view similar to Fig. 3 showing a slight modification.

Fig. 5 is a view similar to Fig. 4 showing the well after a portion of the flowing equipment has been put in place thereon.

Referring now more in detail to the drawings, the numeral 1 indicates a surface string of casing of relatively larger diameter which has been set in a well by means of a body of cement 2. Secured on the upper end of this surface casing is a casinghead 3 having a flow line 4 connected thereto and having a laterally extending flange 5 at its upper end. Within its upper end, this head is provided with vertically spaced tapered zones 6 and 7, respectively, and a plug 8 is provided for closing the side outlet from the casinghead on the opposite side from the flow line 4.

Mounted on the front end of the casinghead 3 is a blow-out preventer 9 of the usual type having a laterally extending flange 10 on its lower end adapted to cooperate with the laterally extending flange 5 on the casinghead and to be secured thereto by suitable bolts or the like.

After the surface string of casing just referred to has been set in place, the well hole itself is drilled down below the lower end thereof to substantially the depth which it is desired to have the well extend. There is then lowered into the well through the blow-out preventer 9 the inner casing 12 which is cemented in place by means of a body of cement indicated at 14. The numeral 15 indicates the derrick floor which is located above the blow-out preventer 9.

Just after the cement has been placed at 14 as indicated in Fig. 1, the inner casing 12 is being supported by the hoisting equipment in the derrick and this casing it must be remembered cannot be released until such time as the cement has had time to harden sufficiently to support the casing. In accordance with the present invention, the blow-out preventer 9 is at this time released from the casinghead 3 and is lifted by means of an auxiliary hoisting equipment for comparatively light loads, this equipment being known as a "cat-line" indicated at 16 in Fig. 2. It is to be remembered that this blow-out preventer cannot be raised through the derrick floor because it is larger than the hole in the derrick floor. With the blow-out preventer thus held by the "cat-line" 16 the slips 17 may be placed

in position around the inner casing 12 so as to support the same. It is now possible to release the hoisting equipment in the derrick from the inner casing because the same is positively supported by means of slips 17 in the head 3. However, it is still impossible to remove the blow-out preventer 9 because the inner casing 12 extends up through the derrick floor and the blow-out preventer cannot be passed over its upper end. The blow-out preventer 9 is, therefore, held in the position illustrated in Fig. 2 and by means of a cutting torch or the like and the inner casing 18 is severed at a point a short distance above the upper end of the head 3. The short section of casing which has been severed can then, of course, be removed and the blow-out preventer 9 taken away.

After the removal of the equipment just described from the upper end of the well, there is placed over the projecting end of the inner casing 12 a sealing ring 19 illustrated in Fig. 3. This sealing ring 19 is adapted to receive a metallic packing ring 20 for the purpose of forming a seal with the upper end of the casinghead 3 and is provided with a countersunk portion 21 adjacent its upper end adapted to receive the packing rings 22. The packing rings 22 are compressed by means of a glad nut 23 so as to form a seal between the ring 19 and the inner casing 12. If found preferable, a ring 19' may be substituted for the ring 19, and this ring 19' welded to the exterior of the casing as shown at 24. Except for the means of forming a seal between the ring and the casing, this ring 19' is the same as the previously described ring 19.

The upper end of the ring 19' is provided with a circular groove adapted to receive a second metallic sealing ring 26 for the purpose of forming a seal between the ring 19' and the flange 27 of a tubing head 28. This tubing head 28 is provided with a flow line 29 and at its upper end with a second laterally extending flange 30.

At this point, a drill is again lowered into the well through the inner casing and the cement plug at the bottom of the inner casing is drilled out, the drill traveling downwardly into the producing formation.

After the well has been drilled into the producing formation below the lower end of the casing, or after the well has otherwise been placed in condition for flow, the tubing 31 may be lowered into place through the head 28 and suspended upon a suitable tubing hanger 32. A special 3-point sealing ring 33 is then placed upon the flange 30 and the tubing hanger 32 in position to receive the lower flange 34 of a fitting 35. This fitting 35 has an upper flange 36 by which it may be connected to the usual flow lines for producing the well.

It will be seen from the foregoing that there has been provided a method of setting a casing within a well, which method makes it possible to proceed with the steps of hanging and sealing off the casing without having to wait a number of hours for the cement around the lower end of the casing to set to such an extent that it will support the very heavy casing. This method also eliminates the necessity for securing a casing nipple of special length for the purpose of bringing the upper end of the casing to exactly the point desired for hanging the same and sealing off the space between the inner and outer casings. As a matter of fact, it has been found by actual experience that by this method there may be saved more than eighteen hours of time in the completion of a single well, and when it is appreciated that the cost of maintaining a set of drilling equipment ranges from $300.00 per day upward for rigs capable of drilling deep wells, it will be seen that this saving in time is very important.

It will be seen also that by providing slips and a casinghead in which the cooperating tapered surface has been divided into two separate zones, the stresses exerted by the slips both upon the casinghead and upon the casing have been distributed over a greater portion of the length of those parts thereby reducing the unit stresses tending to distort the same. At the same time, the dividing of this taper into a plurality of separated tapered zones rather than making it in one short tapered zone has made it possible to provide a support for the casing over a much greater portion of its length, and thus to more firmly support the casing against movement from its vertical position under the vibratory influences exerted upon it during the flowing of the well. The slips will not stick or freeze within a casinghead because the pitch or angle of the tapered surfaces has not been changed from the customary pitch or angle used when the tapered surface is concentrated in one short tapered zone. Instead, this tapered surface is simply divided into two short tapered zones and these zones are located adjacent the upper and lower ends, respectively, of the elongated slips.

In the form of sealing device illustrated in Fig. 3, it will be appreciated that whereas in most of the prior art sealing devices it was necessary to remove the sealing device entirely before the packing which formed the seal could be replaced, it is possible in this sealing device to remove and replace the packing without distributing the plate or ring in which the packing is mounted. It is also to be noted that this plate or ring closely embraces the inner casing and thus serves to add rigidity to the relatively rigid support already provided by the slips disclosed.

In the form of sealing device illustrated in Fig. 4, the plate or ring 19' is actually made integral with the casing by means of welding. This forms a permanent seal which is an absolute seal and which will not deteriorate any more than the parts between which the seal is formed. In addition to this fact, this sealing device forms another rigid connection between the inner and outer casings and serves both to assist the slips in supporting the inner casing against downward movement and also serves to positively support the inner casing against upward movement such as might otherwise occur upon expansion of the casing due to temperature changes or upon the occurrence of other eventualities.

With respect to both forms of sealing device it is to be noted that the tubing head and flow equipment located thereabove may be removed and replaced whenever desired without in any manner disturbing the sealing means about the inner casing or the expansion of the inner casing. This is rather important in that it is highly desirable once the inner casing is set in place and a seal provided between the inner and outer casings, that the inner casing be not again disturbed except for the purpose of removing the same in the event that should become desirable. With the equipment illustrated in this application, it is possible to make any desired changes in the flowing equipment, or even to remove and replace the tubing and tubing head without in any way disturbing the seal or hanging means used in setting the inner casing.

It is to be understood that the specific embodiments of this invention set forth were all by way of example and illustration only and that this invention is to be limited in its scope only by the prior art and by the terms of the appended claim.

Having described my invention, I claim:

In a means for supporting a pipe, an annular support member having a plurality of vertically spaced tapered zones therein, slips for gripping said pipe and having spaced tapered zones thereon adapted to cooperate with said zones in said member to form vertically spaced zones of support for said pipe against downward and lateral movement, and means above said member for providing additional lateral support for said pipe.

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