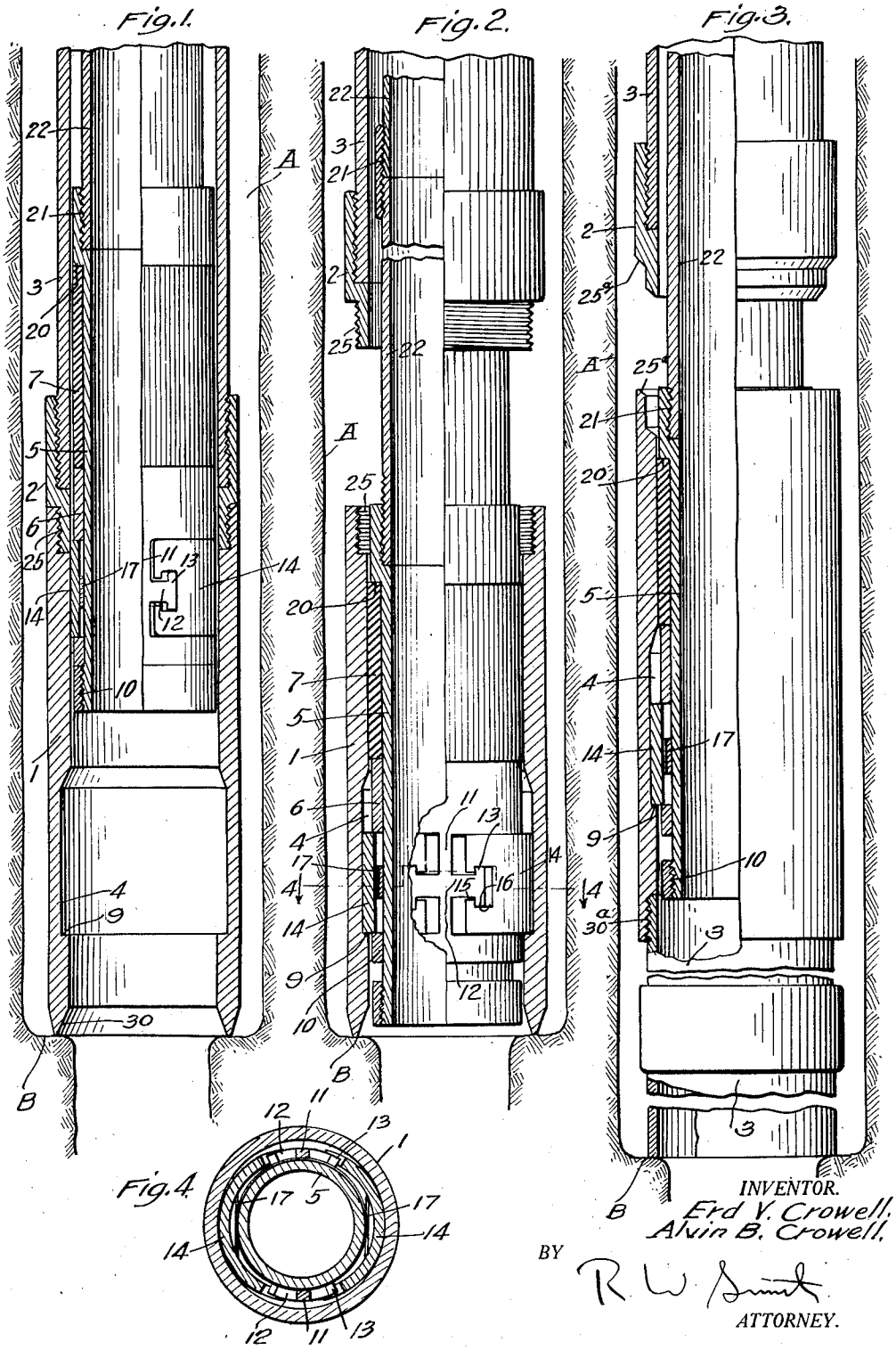
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METHOD AND APPARATUS FOR PROTECTING WELLS

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METHOD AND APPARATUS FOR PROTECTING WELLS.

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This invention relates to protection of oil walls and the like by the use of casing adapted to seat on the formation seat of a well bore, and it is the object of the invention to substitute a string of casing of smaller diameter for the string of casing which has been employed as the final "oil string" set next above the sand, the substitution being made after the final or "oil string" has been set, without interfering with the usual protection to the open well bore provided by the final or "oil string".

It is a further object of the invention to employ a final or "oil string" of casing which consists of upper and lower sections, and after seating this sectional string on the formation seat, to introduce a string of casing of smaller diameter through the upper section so as to engage and seal with the lower section, and subsequently withdraw the upper section without disturbing the protection to the well bore.

The invention thus provides for great economy and efficient results in the handling of wells, since it affords continuous protection against water or cavings while permitting material reduction in the cost of equipment by allowing pulling of all the casing except the last string and substituting a string of reduced casing. As a consequence, without disturbing the protection of the well, the larger casing which it is necessary to use during the drilling operation may be subsequently withdrawn and put to other use, and casing of reduced diameter such as will serve as well when the well is on production may be substituted and may be selected of the proper reduced diameter to utilize maximum energy of the gas pressure.

In the accompanying drawing we have illustrated a preferred embodiment of the invention in which:

Fig. 1 is an axial section through a well showing introduction of the apparatus for providing a water-tight seal at the formation seat.

Fig. 2 is a similar view showing substitution of a string of reduced casing without disturbing the protection afforded by the water-tight seal.

Fig. 3 is a view similar to Fig. 2 but showing a modified construction.

Fig. 4 is a transverse section on the line 4—4 of Fig. 2.

In the drawings we have shown a usual well bore A having a formation seat B at the production sand; and a lower shoe 1 is adapted for support upon the formation seat and engages an upper shoe 2 to which a usual string of well casing 3 is connected. The shoes 1 and 2 have unobstructed bores forming a continuation of the bore of the well casing so as not to hinder drilling or washing operations, and the bore of the lower shoe is provided with an annular recess 4 for reception of anchoring means on a reduction core 5 which is adapted to form a water tight seal between the core and the lower shoe.

The reduction core carries a slip cage 6 and a packing rubber 7 supported on the cage, the core and its associated parts being adapted for lowering through casing 3 and shoes 1 and 2 until the slip cage is in alinement with recess 4, whereupon the slips carried by the cage are expanded for seating on the shoulder 9 at the base of the recess to anchor the reduction core in the lower shoe.

As an instance of this arrangement a retaining nut 10 may be threaded on the lower end of core 5 with the slip cage supported on this nut. The slip cage is an elongated sleeve cut-away at each side medially of its length to form diametrically opposite ribs 11 connecting the respective ends of the sleeve, and medially of the length of these ribs they have transversely projecting opposite arcuate guides 12 terminating in heads 13. Diametrically opposite arcuate slips 14 are mounted in the cut-away portions of the cage sleeve between the opposite ribs 11, and these slips are recessed as shown at 15 to slidably engage guides 12, with enlargements 16 at the inner ends of the recesses received over heads 13 for limiting said sliding movement. The slidable mounting for the slips permits their retraction within the slip cage through their engagement by the wall of casing 3 and shoes 1 and 2 to permit free lowering of the reduction core as shown in Fig. 1, but springs 17 in back of the slips yieldably tend to project the same, so that when the reduction core is lowered until the slips are in alinement with recess 4 the slips are expanded into the recess and seat on shoulder 9 for anchoring the reduction core.

The slip cage 6 and the packing rubber 7 which is mounted thereon are both slidable on reduction core 5, and a shoulder 20 at the

upper end of the core engages the rubber so that when the core is being lowered and the slip cage rests upon nut 10 as shown in Fig. 1, the shoulder exerts no pressure against the rubber and consequently the latter remains in normal inoperative position permitting free lowering of the core, but when the slip cage is anchored and the reduction core continues its downward movement therethrough, the shoulder 20 presses against rubber 7 so as to expand the same for forming a water tight seal between the reduction core and lower shoe 1.

The upper end of the reduction core has a usual threaded connection 21 whereby a string of casing 22 of reduced diameter may be mounted thereon, and with such reduced casing connected to the reduction core and the latter packed off by rubber 7, the upper shoe 2 and the string of larger casing 3 may be withdrawn from the well, leaving the lower shoe and the reduced casing in position in the well without disturbing the protection of the well against entrance of water or cavings or the escape of gas from the sand.

To readily permit such withdrawal of upper shoe 2 and casing 3 without disturbing the seal formed by the lower shoe, the upper and lower shoes may have a left-hand threaded connection 25 as shown in Figs. 1 and 2, while the connections between the upper shoe and the lengths of the string of casing are standard right-hand threaded joints as shown at 21, thereby permitting the string of casing and shoe 2 to be readily disconnected from shoe 1 by turning the string of casing in the direction to tighten joints 21 but break the joint 25.

A modified construction is shown in Fig. 3, wherein the shoes 1 and 2 have a conical ground joint 25^a instead of the left-hand threaded connection 25, the weight of the string of casing 3 making the ground joint effective as long as the casing remains in position supported on the lower shoe, but permitting the ready removal of the string of casing and the upper shoe when the reduction core has been packed off in the lower shoe.

As shown in Fig. 1, the lower shoe 1 may rest directly on the formation seat B, for which purpose the shoe has a tapering seating end 30, while in the modified construction shown in Fig. 3 the shoe 1 preferably has a threaded connection 30^a at its lower end from which one or more lengths of casing 3 are suspended so as to rest upon the formation seat and serve as an anchor for centering the lower shoe in the well bore and extending it up past possible caves.

In operation the upper shoe with casing 3 attached may be either run into the well bore with shoe 1 suspended therefrom by the connection 25 as shown in Fig. 1, or if the ground joint connection 25^a of Fig. 3 is employed, the lower shoe may be run in by means of a suitable tool such as a dart bailer, and the upper shoe with the casing attached is then lowered onto the lower shoe. In either case the weight of the string of casing firmly anchors the lower shoe on the formation seat and the well is then completed in usual manner ready for production. Since the only future purpose of the casing is to protect the sand pocket and provide a conduit for the pumping equipment, the casing 3 of relatively large diameter is no longer necessary and casing of smaller diameter will serve as well. The reduction core 5 attached to reduced casing 22 is therefore lowered through casing 3 and the reduction core is anchored as previously described so that the packing rubber 7 provides a tight seal between the core and the lower shoe 1. The casing 3 and shoe 2 may then be removed without disturbing the protection of the well, since the shoe 1 remains firmly seated on the formation seat and the casing 22 is tightly packed off with relation to the seated lower shoe, this removal of the upper shoe and casing 3 being readily effected as a result of the use of left-hand threaded connection 25 or ground joint 25^a. The reduced casing 22 is thus employed during production of the well, thereby reducing the amount of casing and prolonging its life and service, and freeing the larger casing 3 for other use. The reduction in the diameter of the casing also provides for maximum production in flowing wells, since casing 22 may be of the proper reduced size to regulate the gas pressure so as to obtain maximum energy thereof for lifting the oil. The construction is also particularly advantageous in gas wells, since it affords a convenient and positive means for packing off the gas.

We claim:

1. The method of handling wells which consists of seating the lower end of a string of casing on the formation seat of a well, completing the drilling and cleaning of the well ready for production, and without disturbing that portion of the string of casing seating on the formation seat withdrawing the remainder of said string of casing which extends upwardly from the seated lower end of the string.

2. The method of handling wells which consists of seating the lower end of a string of casing on the formation seat of a well, completing the drilling and cleaning of the well ready for production, introducing a string of casing of reduced diameter into said seated string of casing, packing off between the reduced casing and that portion of the seated string of casing resting on the formation seat, and without disturbing that portion of the seated string of casing resting on the formation seat withdrawing the remainder of said string of casing which extends upwardly from the seated lower end of the string.

3. Apparatus of the character described comprising a lower shoe adapted for support on the formation seat of a well bore, an upper shoe adapted for suspension from a string of well casing so as to engage the lower shoe with said upper and lower shoes and the casing forming an uninterrupted substantially uniform bore, and a threaded connection between said shoes threaded in the direction opposite to that of the threaded connections between the upper shoe and the lengths of the string of casing whereby the said connection is adapted to form a tight joint or permit withdrawal of the upper shoe and string of casing without disturbing the lower shoe and without turning the upper shoe and the string of casing in the direction to break the joints between the lengths of the string of casing.

4. Apparatus of the character described comprising a lower shoe adapted for support on the formation seat of a well bore, an upper shoe adapted for suspension from a string of well casing, and a connection between said shoes adapted to form a tight joint or permit withdrawal of the upper shoe and string of casing without disturbing the lower shoe, a core adapted for lowering through the casing into the lower shoe, and means for packing off between the core and the lower shoe.

5. Apparatus of the character described comprising a lower shoe adapted for support on the formation seat of a well bore, an upper shoe adapted for suspension from a string of well casing, and a connection between said shoes adapted to form a tight joint or permit withdrawal of the upper shoe and string of casing without disturbing the lower shoe, a core adapted for lowering through the casing into the lower shoe, means for attaching a string of casing of reduced diameter to the core, and yieldable packing means adapted for expansion by the weight of said string of casing of reduced diameter to form a fluid tight connection between the core and the lower shoe.

6. Apparatus of the character described comprising a shoe adapted for insertion in a well bore and having an annular recess in its bore, a string of well casing, a core suspended from the string of well casing and adapted for lowering into the shoe, the core and the string of well casing having an unobstructed open bore, yieldably projected slips slidable on the core and retracted during lowering of the core through engagement by the wall of the shoe and adapted for projection into the annular recess to anchor the slips against further downward movement through the shoe, packing slidable on the core above the slips and adapted for expansion to pack off between the core and shoe by lowering of the core relative to the anchored slips.

7. Apparatus of the character described comprising a shoe adapted for insertion in a well bore and having an annular recess in its bore, a string of well casing, a core suspended from the string of well casing and adapted for lowering into the shoe, the core and the string of well casing having an unobstructed open bore, packing slidable on the core, a support for said packing slidable on the core and adapted for automatic anchoring in the shoe to prevent downward movement of the support relative to the shoe, and means for expanding the packing to pack off between the core and shoe by lowering the core relative to the anchored support.

8. The method of handling wells which consists of seating the lower end of a string of casing on the formation seat of a well, completing the drilling and cleaning of the well ready for production, introducing a string of casing of reduced diameter into said seated string of casing, anchoring the string of casing of reduced diameter to that portion of the seated string of casing resting on the formation seat, and without disturbing that portion of the seated string of casing resting on the formation seat, withdrawing the remainder of said string of casing which extends upwardly from the seated lower end of said string.

9. Apparatus of the character described comprising a lower shoe adapted for support on the formation seat of a well bore, an upper shoe adapted for suspension from a string of well casing, and a connection between said shoes adapted to form a tight joint or permit withdrawal of the upper shoe and string of casing without disturbing the lower shoe, a core adapted for lowering through the casing into the lower shoe, and means for anchoring the core in the lower shoe.

10. Apparatus of the character described comprising a lower shoe adapted for support on the formation seat of a well bore, an upper shoe adapted for suspension from a string of well casing, and a connection between said shoes adapted to form a tight joint or permit withdrawal of the upper shoe and string of casing without disturbing the lower shoe, a core adapted for lowering through the casing into the lower shoe, and yieldable packing means adapted to form a fluid tight connection between the core and the lower shoe.

11. Apparatus of the character described comprising a lower shoe adapted for support on the formation seat of a well bore, an upper shoe adapted for suspension from a string of well casing, and a connection between said shoes adapted to form a tight joint or permit withdrawal of the upper shoe and string of casing without disturbing the lower shoe, a core adapted for lowering through the casing into the lower shoe, means for anchoring the core in the lower shoe, and yieldable

packing means adapted to form a fluid tight connection between the anchored core and the lower shoe.

12. Apparatus of the character described comprising a lower shoe adapted for support on the formation seat of a well bore, an upper shoe adapted for suspension from a string of well casing, and a connection between said shoes adapted to form a tight joint or permit withdrawal of the upper shoe and string of casing without disturbing the lower shoe, the lower shoe having an annular recess therein, a core adapted for lowering into the recessed shoe, yieldably projected slips slidable on the core and retracted during lowering of the core through engagement by the wall of the shoe and adapted for projection into the annular recess to anchor the slips, packing slidable on the core above the slips and adapted for expansion to pack off between the core and recessed shoe by lowering of the core relative to the anchored slips.

13. Apparatus of the character described comprising a lower shoe adapted for support on the formation seat of a well bore, an upper shoe adapted for suspension from a string of well casing, and a connection between said shoes adapted to form a tight joint or permit withdrawal of the upper shoe and string of casing without disturbing the lower shoe, the lower shoe having an annular recess therein, a core adapted for lowering into the recessed shoe, packing slidable on the core, a support for said packing slidable on the core and adapted for automatic anchoring in the recessed shoe, and means for expanding the packing to pack off between the core and recessed shoe by lowering the core relative to the anchored support.

14. Apparatus of the character described comprising a shoe adapted for insertion in a well bore and having an annular recess in its bore, a string of well casing, a core suspended from the string of well casing and adapted for lowering into the shoe, the core and the string of well casing having an unobstructed open bore, arcuate slips on the core adapted for radial retraction and projection, and springs in back of the slips tending to radially project the same, said slips being retracted against the tension of their springs during lowering of the core through engagement of the slips by the wall of the shoe and adapted for projection by their springs into the annular recess of the shoe to anchor the slips.

15. Apparatus of the character described comprising a shoe adapted for insertion in a well bore and having an annular recess forming a supporting shoulder at its lower end, a string of well casing, a core suspended from the string of well casing and adapted for lowering into the shoe, the core and the string of well casing having an unobstructed open bore, arcuate slips adapted for radial retraction and projection on the core to permit lowering of the core into the shoe and projection of the arcuate slips into the annular recess of the shoe so as to seat on the supporting shoulder and thereby anchor the core.

16. Apparatus of the character described comprising a shoe adapted for insertion in a well bore and having an annular recess in its bore forming a supporting shoulder at its lower end and an inclined shoulder at its upper end, a string of well casing, a core suspended from the string of well casing and adapted for lowering into the shoe, the core and the string of well casing having an unobstructed open bore, and arcuate slips adapted for radial projection and retraction on the core to permit lowering of the core through the shoe and projection of the slips into the annular recess so as to seat on the supporting shoulder for anchoring the core, the said inclined shoulder being adapted to engage the projected slips and retract the same when the core is elevated relative to the shoe, in order to permit withdrawal of the core from the shoe.

17. Apparatus of the character described comprising a shoe adapted for insertion in a well bore and having an annular recess forming a supporting shoulder at its lower end, a string of well casing, a core suspended from the string of well casing and adapted for lowering into the shoe, the core and the string of well casing having an unobstructed open bore, arcuate slips slidable on the core and adapted for radial retraction and projection on the core to permit lowering of the core into the shoe and projection of the arcuate slips into the annular recess of the shoe so as to seat on the supporting shoulder for anchoring the slips, packing supported on the slips and slidable on the core, and means on the core for engaging the packing and axially compressing the same against the anchored slips so as to radially expand the packing to pack off between the core and the recessed shoe by lowering the core relative to the anchored slips.

18. The method of handling wells which consists of seating the lower end of a string of casing on the formation seat of a well, introducing a string of casing of reduced diameter into said seated string of casing, packing off between the reduced casing and that portion of the seated string of casing resting on the formation seat, and without disturbing that portion of the seated string of casing resting on the formation seat withdrawing the remainder of said string of casing which extends upwardly from the seated lower end of said string.

In testimony whereof we have affixed our signatures to this specification.

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