June 18, 1940. C. E. BURT 2,204,659

SLIP FOR OIL WELL TOOLS

Filed Dec. 23, 1939

Fig. 1.

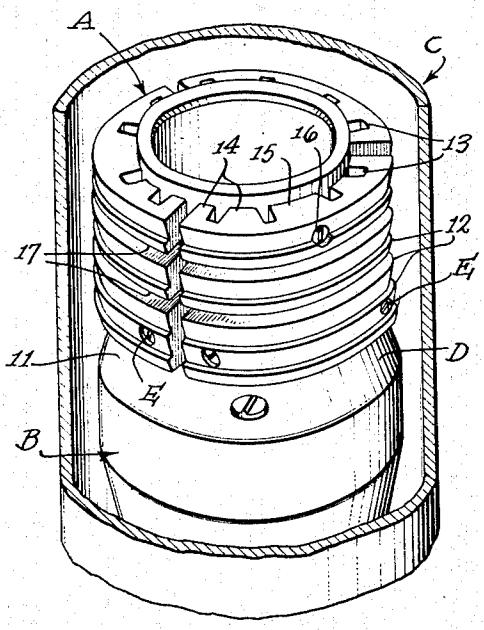
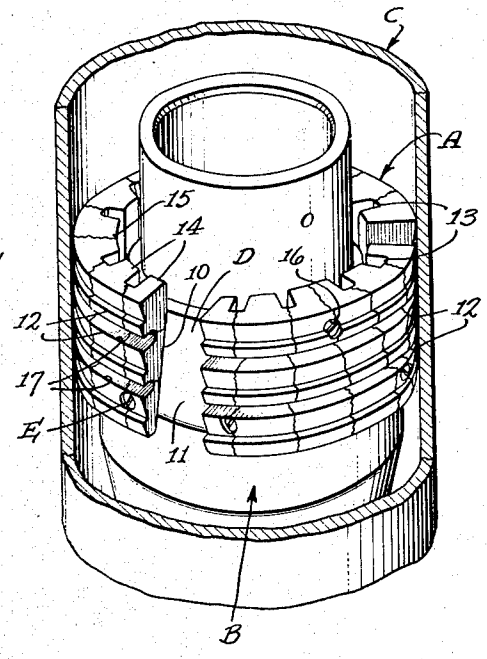


Fig. 2.



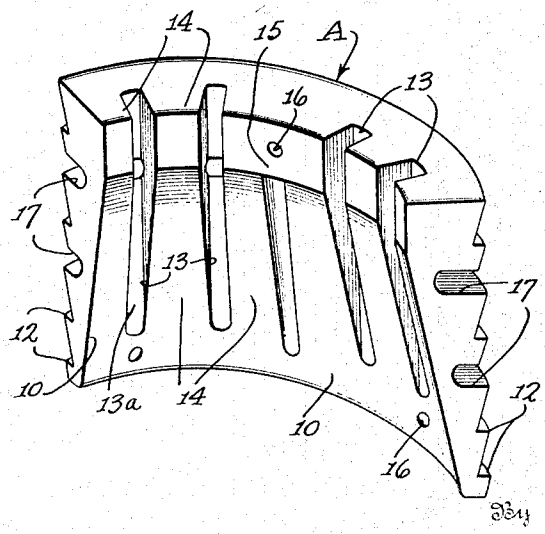


Fig. 3.

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SLIP FOR OIL WELL TOOLS

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9 Claims. (Cl. 166—12)

This invention relates to slips, being particularly concerned with slips designed for use as component parts of oil well tools.

Slips are usually provided with wickers or teeth which bite or dig into casing or tubing to couple or anchor oil well tools thereto. In some applications, the slips irretrievably anchor oil well tools to the casing, and if it is later desired to remove the tool, this is accomplished by drilling to break it into pieces, preferably small enough to be removed from the casing by the drilling fluid. Heretofore it has been difficult to drill up the slips because of their heavy section, despite the use of frangible material such as cast iron. The present invention is accordingly concerned with slip constructions capable of being broken up more readily by a drilling bit.

It is usual practice to form slips with a generally conical or frusto-conical surface, so that upon moving relatively to a companion conical or frusto-conical expander, they will be shifted radially into anchoring engagement with a cooperable member, as the walls of a casing. Because of the divergent surface of a cone or conoid its radius of curvature correspondingly increases. As a consequence, should the inner cone-contacting surface of a cooperable slip be formed with a radius of curvature equal to that of the smaller end of the cone, to provide a surface contact therebetween, upon being positioned at the larger end of the cone the surface contact will be lost due to the different radii of curvatures of the inner slip surface and the larger diameter cone surface. The slip will then have only a two-point or line contact with the cone. Should the inner surface of the casing have a larger radius of curvature than the wickers on the slips, the slips will only make point or longitudinal line contact with the casing, the anchoring effect being concentrated at the line contact region, and the other wicker portions remaining ineffective for anchoring purposes.

In my Patent No. 2,153,035, "Method of producing slips for oil well tools," the difficulty noted has been overcome to a certain extent by providing a weakened longitudinal section in each slip segment so that each initial segment will be broken into two sections by the wedging and clamping action of the cooperable cone and casing, and thereby engage both of these parts over a greater area and with greater security. While this arrangement offers advantages, each part of the slip is still of too great a size to be drilled up or removed with ease and rapidity. It is, therefore, a further object of this invention to provide a slip which will be broken up into relatively small pieces upon being expanded into engagement with a well casing, these pieces thereafter requiring very little if any action by the drilling bit to effect their removal from the casing by the drilling fluid.

This invention has other objects that will become apparent from a consideration of the embodiment shown in the drawing accompanying and forming part of the present specification. This form will now be described in detail, but it is to be understood that such detailed description is not to be taken in a limited sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawing:

Figure 1 is a perspective view of the slips mounted on a packer body, prior to their expansion into engagement with a well casing;

Figure 2 is a view similar to Figure 1 with the slips expanded into gripping engagement with the casings and

Figure 3 is an enlarged perspective view of one of the arcuate slip segments.

One specific slip A embodying the present invention is shown in the drawing as forming part of a well packer B adapted to be anchored to the casing C by the segmental slips A, which are initially secured to the conical expander D of the packer by shear screws E. The inner surface 10 of each slip is tapered to cooperate with the companion and opposed tapered surface 11 of the cone, so that upon relative movement occurring between the slips and cone the former will be urged radially outwardly until their wickers 12 are firmly embedded in the casing. By being wedged between the cone and casing, the slips serve to anchor the well packer in the desired position within the casing.

Each slip is formed with a plurality of longitudinal grooves 13 on its inner periphery, defined by the separating longitudinal ribs 14. These grooves extend substantially along the entire length of the slip, but are of variable depth due to the cone-contacting, tapered inner face 10 of the slip. That is, each groove 13 is deeper at the larger cross-sectional end of the slip, its bottom wall 13a merging into the inner peripheral surface 10 at the smaller end. In the instant case, this effect is produced by casting or otherwise forming its groove with its bottom 13a generally parallel to the outer face of the slips. At those points where the shear screws E initially secure the slips to the cone or body of the packer, the longitudinal ribs 14 are interconnected by

a bridge 15 through which a hole 16 for a screw is provided. This design is required by the necessity for producing a shearing action on the screws, for were the screws to extend through one of the grooves 13 it would be subjected to a bending action rather than a pure shearing action.

As aforementioned, upon sliding on the cone toward casing engaging position, the radius of curvature of any section of the inner surface 10 of each slip is less than that of the cone surface 11 with which it contacts. After contacting the casing, localized thrust loads will be imposed on each slip segment at the initial wedging points or lines of contact with the cone and casing, introducing lateral bending moments, whose attendant thrusts and leverages will break each slip at each section through the longitudinal grooves 13, not only producing a better and more uniform gripping or anchoring of the wickers 12 in the casing, but also providing a greater surface of contact between the slip pieces and the cone.

While the desirable smaller slip segments result from the longitudinal grooves 13, it has been found that these pieces are still too large, rendering it difficult to drill up or disintegrate the well packer after it has been set in the casing. It is accordingly proposed to provide additional weakened sections, such as result from spaced outer circumferential weakening grooves 17 on each slip, which can be either cast, machined, or otherwise formed therein. These grooves preferably do not diminish the number of wickers 12 on the slips, being defined between adjacent wickers and only necessitating the removal or omission of non-casing engaging wicker portions. It is to be noted further that the circumferential grooves are of varying depth, those at the thicker portion of the slip being deeper than those at the narrower portion. This is done to provide substantially the same weakening effect at different portions of the slips. Furthermore, the circumferential grooves 17 may or may not intersect the longitudinal grooves 13, depending solely on the depth to which they are carried. Should intersection of the grooves occur, no detrimental effects would result since the slip sections defining the circumferential grooves would still be connected through the agency of the ribs 14 defining the longitudinal grooves.

The cooperative weakening effects of the longitudinal and circumferential grooves cause each slip to be broken up into relatively small pieces upon being wedged between the casing and cone, these pieces remaining in wedged position and anchoring the well tool to the casing. Assuming that five longitudinal grooves 13 are formed in the inner face of the slip and two circumferential grooves on the outer face, each slip will be broken into eighteen pieces by being fractured through the groove sections. It is to be understood however that the numbers mentioned are solely for illustrative purposes and should not be construed as conferring any limitations upon the invention.

The small pieces are of such dimensions as to be removed upwardly by the drilling fluid away from the well packer B, and thereby do not impede the progress of the drilling bit in removing or disintegrating the packer. However, should each slip segment fail to fracture into the number of pieces defined by the weakening grooves, the action of the drilling bit will readily break the slip at least into such number of pieces, so that in any event and irrespective of the breaking action of the slips upon being set in the casing, removal of the slips under the action of the drilling bit will be expedited.

While the slip has been disclosed with the circumferential grooves 17 at right angles to the longitudinal grooves 13, the circumferential grooves or longitudinal grooves can be inclined somewhat if desired and still produce the same weakening effect. Furthermore, all of the grooves could be provided on only one slip face, if desired; or their positions interchanged from the specific example disclosed.

I claim:

1. A slip for well tools having wickers on one face thereof and a tapered surface on another of its faces, said tapered face being provided with a plurality of spaced generally longitudinal grooves, and said wickered face being provided with a plurality of spaced circumferential grooves of a depth greater than that of said wickers.

2. A slip for well tools having wickers on one face thereof and a tapered surface on an opposed face thereof, said tapered face being provided with at least one generally longitudinal groove, and said wickered face being provided with at least one circumferential groove of a depth greater than that of said wickers.

3. A slip for well tools having wickers on one face thereof and a tapered surface on an opposed face thereof, one of said faces being provided with at least one generally longitudinal groove, and the other face being provided with at least one circumferential groove in addition to the grooves defined by said wickers.

4. A slip for well tools having wickers on an outer face thereof and a tapered surface on an inner face thereof inclined to said outer face to define a longitudinal slip cross-section decreasing in width from one end to the other, one of said faces being provided with at least one generally longitudinal groove increasing in depth toward the wider slip section, and the other face being provided with at least one circumferential groove in addition to said grooves defined by said wickers.

5. A slip for well tools having wickers on an outer cylindrical face thereof and a frusto-conical surface on an inner face thereof, one of said faces being provided with at least one generally longitudinal groove increasing in depth toward a wider slip section, and the other face being provided with a plurality of spaced circumferential grooves, one of said circumferential grooves at a wider slip section being deeper than another circumferential groove at a narrower slip section.

6. A slip for well tools having wickers on an outer cylindrical face thereof and a frusto-conical surface on an inner face thereof, said inner face being provided with a plurality of spaced generally longitudinal grooves each increasing in depth toward a wider slip section, said other face being provided with a plurality of spaced circumferential grooves, one of said circumferential grooves at a wider slip section being deeper than an adjacent circumferential groove at a narrower slip section.

7. A slip for well tools having wickers on an outer cylindrical face thereof and a frusto-conical surface on an inner face thereof, said slip having a plurality of spaced generally longitudinal weakened sections and spaced circumferential weakened sections, to cause said slip to break into small pieces.

8. A slip for well tools having wickers on an outer cylindrical face thereof and a frusto-conical surface on an inner face thereof, said slip being

provided with a plurality of spaced grooves lying in generally parallel planes and another group of spaced grooves lying in generally parallel planes at an angle to said first-mentioned planes, said grooves being of a depth and extent to produce many weakened sections in said slip along which it may be broken into a large number of small pieces while in a well casing.

9. An annular slip segment for well tools whose wall increases in thickness in one direction of its axis, said wall having a plurality of spaced grooves lying in generally parallel planes and another group of spaced grooves lying in generally parallel planes at an angle to said first-mentioned planes, said grooves extending into said wall to an extent producing many weakened sections therein along which said slips can be readily broken into a large number of small pieces while in a well.

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