Oct. 6, 1970 C. D. CRICKMER 3,531,836

CONFORMABLE SLIP

Filed May 28, 1968

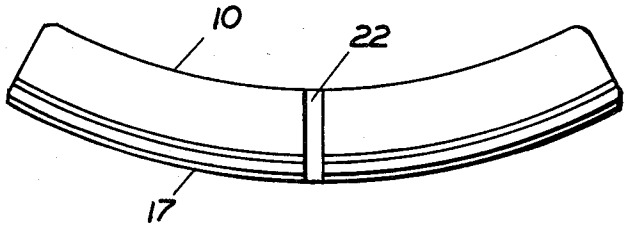


Fig. 3.

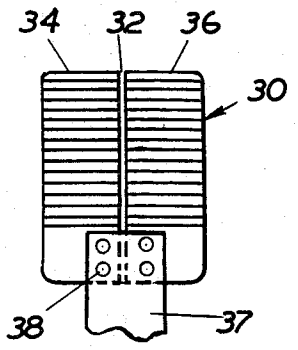


Fig. 4.

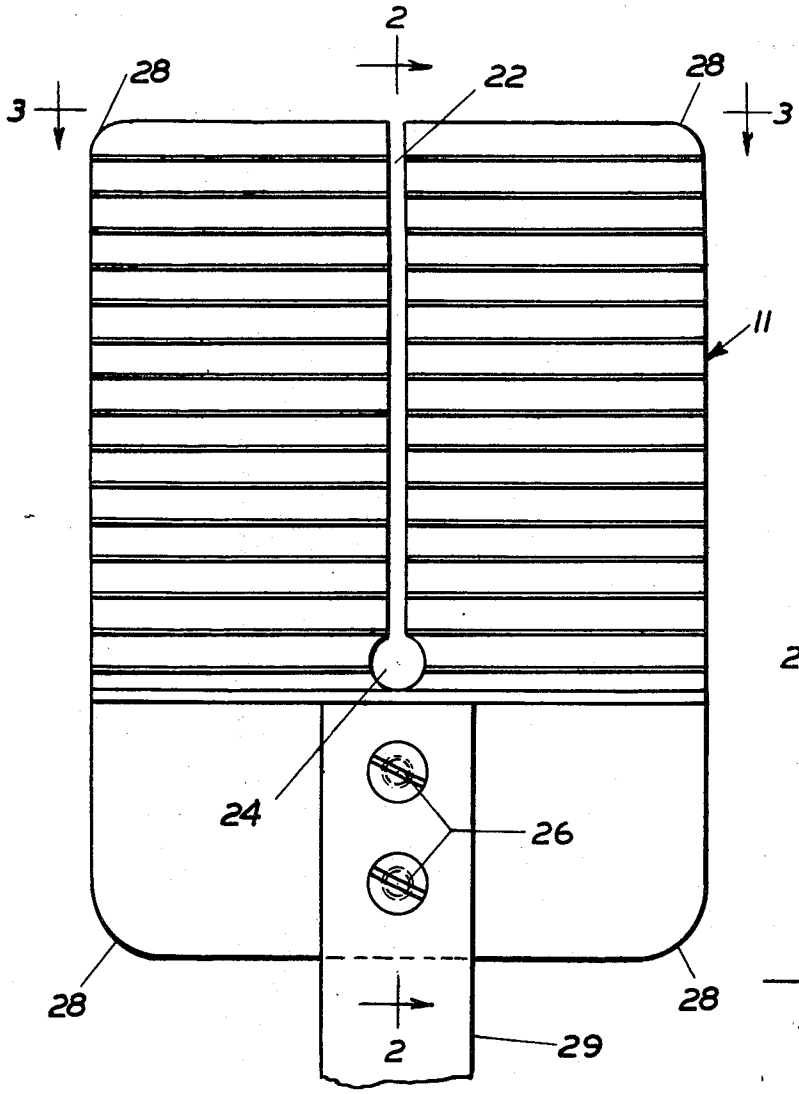


Fig. 1.

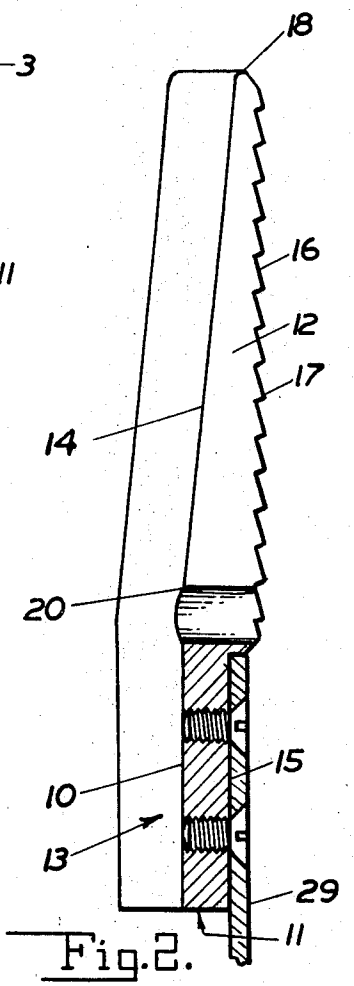


Fig. 2.

INVENTOR.
Charles D. Crickmer.

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CONFORMABLE SLIP

Charles D. Crickmer, 12923 Memorial Drive, Houston, Tex. 77024

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U.S. Cl. 24—263 8 Claims

ABSTRACT OF THE DISCLOSURE

A slip structure which self adjusts to increase the area of engagement with the surfaces of various diameter objects.

This invention relates to slips, particularly for use in well operations, where it is necessary to suspend oil and gas fuel tools from a well casing to plug, block, pack or perform similar functions at some point in the interior thereof, all as is well known in the art.

Heretofore, one commonly employed form of slip has comprised a one piece rigid body having the inner surface thereof radially symmetrical with the outside diameter of a cone and an outwardly extending portion of a constant radius having outwardly extending tooth or grip means on the outer surface thereof. Since casing and cone diameters vary such a rigid slip will not maintain a uniform bearing on the inside casing surfaces, therefore resulting in excessive point loading rather than a uniformly distributed stress for which the slip, cone and casings were designed. An excessive point loading condition has resulted in failure of the slip, casing or cone at axial loads less than the design loads.

In the present invention, the use of one or more slots in a slip structure, preferably with a stress relieving bore at the end thereof, allows the slip to conform to various casings inside diameters and cone outside diameters, thereby minimizing failures at less than the design load. Additionally, the slip of this invention reduces inventory and production overhead for a single slip will perform the function of several slips of the type presently used in the art.

The objects and advantages of this invention will become apparent to those skilled in the art upon reading the following detailed description.

Shown in the accompanying drawings are preferred embodiments of the invention in which:

FIG. 1 is a plan view of a slip structure constructed according to the principles of this invention;

FIG. 2 is a cross-sectional view of the slip structure taken on lines 2—2 of FIG. 1;

FIG. 3 is an end elevational view of the slip structure taken on lines 3—3 of FIG. 1;

FIG. 4 is a plan view of another embodiment of a slip structure constructed according to the principles of this invention.

One preferred embodiment of an elongated slip structure generally indicated as **11**, of the present invention comprises, with reference to FIGS. 1 and 2, an upper nose portion **12** and a lower heel portion **10** which extends axially downwardly therefrom.

As shown, upper nose portion **12** has an inner tapering arcuate surface **14** which diverges inwardly and axially downwardly from an upper end **18** thereof to a lower end **20** thereof, thereby forming a portion of the surface of the frustrum of a right circular cone. An outer surface **16** of portion **12** has a plurality of transverse arcuate axially downwardly directed teeth **17**. An open ended expansion slot **22** which extends axially downwardly from end **18** to a stress relieving bore **24**, located adjacently upward from end **20**, is provided along the chord centerline of portion **12** for a purpose hereinafter described.

The arcuate cross sectional shaped heel portion **10** extends axially downwardly from the lower end **20** of the upper nose portion **12** to a lower end **11** thereof. Portion **10** has an inner surface **13** thereof, the upper edge of which is coincident with the most downward portion of surface **14** and an outer surface **15** thereof slightly inward of surface **16**. Fastening bores **26** are provided in heel portion **10** for a purpose hereinafter described.

The four exterior corners **28** of the slip structure of this invention are preferably rounded to a radius sufficient to relieve excessive corner stress concentrations as is well known in the art.

In use, a plurality preferably three or more, of the conformable slips of this invention are wedged into a set position around the periphery of an activating cone (not shown), by any of a variety of methods well known in the art. The set position of the slip will result in the inner surface **14** of the nose portion **12** in full engagement with an outer surface portion of the cone and the radially outward tips of teeth **17** bearing on the inner surface of a well casing (not shown).

The expansion slot **22** allows the upper nose portion **12** to be angularly deflected with respect to the central longitudinal axis thereof, thus enabling the slip to conform to possible diametric variances of the cone and casing, thereby assuring more uniform bearing and contact surfaces. The stress relieving bore **24** relieves excessive edge stress concentrations which could result because of the self-adjusting movement of nose portion **12** permitted by slot **22**.

The lower heel portion **10** is fastened to downwardly extending reins on drag springs **29**, shown in part, at the fastening bores **26**. The reins hold the slip in the disengaged position as is well known in the art.

The degree of full engagement that the inner surface **14** and teeth **17** have with respect to the well cone and well casing respectively is inversely correlated to the chord length of upper nose portion **12** determined by the number of slots **22** contained therein. The illustrated embodiment of this invention teaches a single slot **22** in the upper nose portion **12**, however, a plurality of slots **22** can be provided in the upper nose portion **12** to reduce the effective chord length and to enable the slip to accommodate a wider range of diametric variances. Additionally, although the illustrated embodiment shows the slot **22** going through the slip, the slot **22** could comprise a groove on either one surface only or on both the inner and outer surfaces leaving a web therebetween of a geometry which will permit the slip to function in the manner hereinbefore described. In other words at least one elongated axially extending portion of reduced cross sectional area between different segments of the nose portion **12** of slip **11** allowing relative angular motion of segments with respect to each other is necessary for the application of the principles of this invention. Such a reduced area portion includes all of the above described slots and grooves as well as complete separation of the slip member into two segments as in a slip structure **30** hereinafter described.

FIG. 4 illustrates another embodiment of a slip structure constructed according to the principles of this invention comprising an elongated slip structure **30** having an axial through slot **32** along the entire length thereof which effectively separates the slip **30** into two distinct segments **34** and **36** each of which is independently affixed to a singular rein **37**, shown in part, at fastening bores **38** located at the lower end thereof. With the exception of the slot **32**, the geometry and operation of slip structure **30** performs the same function as slip structure **11** as hereinbefore described.

Although preferred embodiments of the structure of this invention have been described and illustrated herein

one skilled in the art can readily embody the principles of this invention in other structures to obtain the same operation and advantages.

What is claimed is:

1. A slip member having one axial end portion thereof adaptable for connection to mounting means and having inner and outer surfaces, one of said surfaces being a portion of a frusto conical surface and the other of said surfaces being toothed for engagement with a substantially cylindrical element, the improvement comprising: said surfaces circumscribing an arc of less than 120°; and at least one elongated axially extending slot dividing said slip member into segments angularly movable relative to each other, said slot extending from an open end thereof at the other axial end of said slip member to a closed end thereof upwardly adjacent said one axial end portion of said slip member.

2. A slip member as specified in claim 1 wherein said slot extends through said inner and outer surfaces.

3. A slip member as specified in claim 2 wherein said improvement further comprises a bore from said inner to said outer surface encompassing said closed end of said slot.

4. A slip member as specified in claim 3 wherein at least one slot extends along the axial centerline of said slip member with slot sides parallel to such centerline.

5. A slip member as specified in claim 4 wherein said improvement further comprises said one axial end portion of said slip incorporating two bores therethrough parallel to said slot and said first mentioned bore.

6. A slip member as specified in claim 5 wherein said two bores have axes in said axial centerline.

7. A slip member as specified in claim 1 wherein said frusto-conical surface is said inner surface and said toothed surface is said outer surface.

8. A slip member as specified in claim 1 wherein said angular movability is about the longitudinal central axis of said slot.

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DONALD A. GRIFFIN, Primary Examiner

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294—86.25