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(54) **Inflatable packer with inflatable packing element for use in subterranean wells**

Aufblasbarer Packer mit aufblasbarem Dichtelement für unterirdische Bohrlöcher

Packer gonflable avec élément d'étanchéité gonflable pour puits souterrains

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(56) References cited:  
**US-A- 4 403 660** **US-A- 4 544 165**  
**US-A- 4 979 570**

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## Description

### BACKGROUND OF THE INVENTION

#### 1. FIELD OF THE INVENTION:

The invention relates to the construction of an inflatable packing element for use in inflatable packers or bridge plugs employed in subterranean wells.

#### 2. SUMMARY OF THE PRIOR ART:

Inflatable packers (or bridge plugs) have long been utilized in subterranean wells. Such inflatable tools normally comprise an elastomeric sleeve element mounted in surrounding relationship to a tubular body portion. Pressured fluid is communicated from the surface of the well to the bore of the tubular body and then through radial passages to the interior of the elastomeric sleeve. To protect the elastomeric sleeve, it is customary to completely surround the elastomeric sleeve with a plurality of peripherally overlapping, resilient, reinforcing slats or ribs. The medial portions of the reinforcing ribs are surrounded by and may be bonded to an outer annular elastomeric packing element or cover of substantial wall thickness. Upper and lower securing assemblies respectively engage the ends of the elastomeric sleeve and the reinforcing ribs and is fixedly and sealably secured relative to a central tubular body. A lower securing assembly is secured to a sealing sub which is mounted for slidable and sealable movement on the exterior of the central tubular body, in response to the inflation forces. A structure of this general type is shown in U.S. patent number 3,160,211 to MALONE.

With inflatable packers of this type, very substantial tensile forces are exerted on the reinforcing slats or ribs during the inflation of the elastomeric sleeve. It has been customary to clamp the ends of the ribs to the upper and lower securing assemblies, but such clamping arrangements are subject to failure if the inflatable packer is repeatedly inflated for engagement with different portions of the well casing or conduit in which it is inserted.

More recently, the ends of the flexible ribs have been welded to an internal surface of a securing sleeve, in the manner indicated in Fig. 1 of the drawings. If the welding operation is properly accomplished, this provides a secure anchoring of the ends of the flexible ribs to the mounting sleeve, but those skilled in the art will recognize the difficulty of making consistently good welds within the relatively small bore of a mounting sleeve for the inflatable packing element of an inflatable packer. If one or more of the ribs is not properly welded, such ribs will break loose under the tensile forces imposed by the inflation of the elastomeric sleeve packer or element which is inserted within the ribs and, because there is thus created a weak area in the cylindrical cage of the reinforcing ribs, the substantial fluid pressure applied to the inflatable elastomeric sleeve can well push

such ribs out of alignment with the other ribs and thus produce a potential area of breakage of the inflatable elastomeric sleeve because it will follow the outward displacement of the unanchored rib and form a thin walled bubble.

There is a need therefore for an anchoring system for the peripherally stacked cage of flexible reinforcing ribs which normally surround the inflatable elastomeric sleeve of an inflatable packer or bridge plug which effects a reliable rigid connection of the ends of the ribs to the mounting sleeves for the expansible packing element.

U.S. Patent No. 4 043 660, to Coone discloses the welding metal reinforcing slats to an annular ring which is engaged by helical threads to another component of a compression-set packer.

US-A-3 160 211 represents the prior art as referred to in the pre-characterising portion of claim 1.

#### 20 SUMMARY OF THE INVENTION

The present invention is set forth in claim 1.

More particularly, the ends of a cylindrical cage of peripherally overlapped slats or ribs surrounding an inflatable elastomeric sleeve of an inflatable packing element are respectively welded to an external surface of a force transmitting sleeve. Such force transmitting sleeve is further provided with an external shoulder which is disposed in abutting relationship with an internal shoulder provided on the respective mounting sleeve for securing the entire inflatable assemblage to the body of the inflatable packer or bridge plug. Additionally, the location of the abutting shoulders is deliberately selected so as to provide an axial length of the circumferential array of resilient slats or ribs in frictional contact with the internal bore of the mounting sleeve. Such frictional forces, which are greatly increased through the application of the inflation pressures to the apparatus, significantly reduce the tensile forces applied to the welds, hence minimizing the opportunity for any individual rib to break at its weld.

Further advantages of the invention will be readily apparent to those skilled in the art from the following detailed description, taken in conjunction with the annexed sheets of drawings, on which is shown a preferred embodiment of the invention.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a combination perspective and sectional view illustrating a prior art method of welding the ends of the reinforcing ribs to the mounting sleeve of an inflatable packer.

Fig. 2 is a vertical quarter sectional view of the mounting sleeve portion of an inflatable packer wherein the reinforcing ribs are secured by utilization of the construction of this invention.

Fig. 3 is a view similar to Fig. 2 but illustrating the

effects of application of inflation pressures to the elastomeric sleeve of the mounting construction of Fig. 1.

Fig. 4 is an enlarged scale sectional view taken on the plane 4-4 of Fig. 2.

#### DESCRIPTION OF PREFERRED EMBODIMENT

Referring to Fig. 1, a prior art construction for securing the reinforcing ribs of an inflatable element for an inflatable packer or bridge plug is shown. The ends of each ribs is welded to an interior surface of a mounting sleeve. After the welding operation, a sleeve of elastomeric material (not shown) is inserted within the rib cage and the end secured in conventional fashion. It should be noted, however, that the welding has to be accomplished in a small internal bore surface and this is recognized to be a difficult procedure to consistently produce good welds for each of the multitude of reinforcing ribs.

Referring now to Fig. 2, only the upper securing portion of the inflatable element of an inflatable packer or bridge plug is shown. All other elements of the inflatable packer or bridge plug, including the valving apparatus for supplying inflation pressures are well known in the art, see for example, U.S. Patent No. 4,832,120; U.S. Patent No. 4,708,208; and U.S. Patent No. 4,805,699.

Inflatable element 10 comprises a cylindrical cage of peripherally overlapping flexible metal slats or ribs 12, the configuration of which is best shown in the enlarged sectional view of Fig. 4. The ends 12a of such ribs are welded to a force transmitting sleeve or end ring 14 by a weld W which is accomplished after the insertion of the ribs through a mounting sleeve or anchor sleeve 20. The force transmitting sleeve 14 is provided with an external shoulder 14a which cooperates with an internal shoulder 20a provided on a medial portion of mounting sleeve 20 for transmitting tensile forces exerted on the ribs 12 to the mounting sleeve 20.

An inflatable tube or sleeve 30 of elastomeric material is inserted within the bore of the rib cage 12 and passes through the bore 14b of the force transmitting sleeve 14. A tube retainer 11 is installed inside the mounting sleeve or anchor sleeve 20, radially forcing the inflatable tube or sleeve 30 of elastomeric material to extrude and engage in appropriate circumferential grooves 20c formed in mounting sleeve 20. Anchor body 1 is provided with external threads 1b for threadably engaging the upper end of the mounting sleeve 20. Such threads are sealed by an O-ring 1e.

A cover portion 35 of elastomeric material is bonded to the medial portions of the rib cage 12 to provide a sealing contact with the bore of a well or well conduit, as is customary.

As is customary in inflatable packers, the internal surface of anchor body 1 cooperates with an internal body tube 2 to define an annular passage 1c and radial ports 1d for application of fluid pressure to the interior of the elastomeric sleeve 30. The application and main-

tenance of fluid pressure on the interior of the elastomeric sleeve 30 is accomplished in a manner well known in the art and fully disclosed in the aforementioned patents, hence further description is deemed unnecessary.

Thus, when such fluid pressure is applied through the fluid passage 1c, the inflatable packing element 10 is expanded to assume the configuration illustrated in Fig. 3. The tensile forces developed in the ribs 12 by such expansion are transmitted by the welds W to the force transmitting sleeve or end ring 14 and by the peripheral shoulder 14a to the mounting sleeve 20 and the anchor body 1.

As best shown in Fig. 3, the location of the force transmitting sleeve 14 relative to the length of the mounting sleeve 20 is an important feature of this invention. The force transmitting sleeve is preferably located above the central or medial portion of the mounting sleeve 20 so that a substantial length of the ribs 12 are disposed in frictional engagement with the bore 20b of the mounting sleeve 20. These frictional forces are substantially increased by the fluid pressure forces illustrated by the arrows shown in Fig. 3 and result from the application of the inflation pressure.

It will be therefore be readily apparent to those skilled in the art that a very substantial frictional force may be developed to resist the tensile forces exerted on the reinforcing ribs 12 by the inflation of the elastomeric sleeve 30. Such frictional forces substantially diminish the tensile forces exerted on the welds W and thus provide further insurance against the separation of any of the welds W.

While only the mounting structure for one end of the inflatable packing element 10 has been shown, those skilled in the art will recognize that the other end of the element is of identical construction. Thus, the other ends of the reinforcing ribs 12 are secured by external welds W to a force transmitting sleeve which is identical to sleeve or ring 14 except that it will be disposed in a vertically reversed relationship.

The aforescribed construction resolves a troublesome structural defect of inflatable packers or bridge plugs through not only the substantial elimination of welding defects caused by performing rib welds in an internal bore, but also significantly reduces the tensile forces applied to the welds through the utilization of an extended longitudinal bore area of the mounting sleeve in frictional contact with the reinforcing ribs 12 when such ribs are expanded by inflation pressure.

Although the invention has been described in terms of specified embodiments which are set forth in detail, it should be understood that this is by illustration only and that the invention is not necessarily limited thereto, since alternative embodiments and operating techniques will become apparent to those skilled in the art in view of the disclosure.

**Claims**

1. An inflatable packer having an inflatable packing element (10) for use in a subterranean well, the packing element comprising:
  - a tubular elastomeric body (30);
  - elongated, peripherally adjacent reinforcing means (12) snugly surrounding at least the medial portion of said tubular elastomeric body (30);
  - characterised by at least one force transmitting sleeve (14) externally secured to a respective end of said reinforcing means (12) and defining a respective external force transmitting shoulder (14a); and
  - respective mounting means (20) for the or each said force transmitting sleeve (14), said mounting means (20) defining a respective internal shoulder (20a) abutable with said external force transmitting shoulder (14a) of the respective force transmitting sleeve (14), thereby unidirectionally transmitting to said mounting means (20) the tensile forces produced by said reinforcing means (12) by fluid pressure expansion of said tubular elastomeric body (30).
2. An inflatable packer according to claim 1, characterised in that said peripherally adjacent reinforcing means (12) comprises a plurality of elongated, peripherally adjacent, flexible metal ribs (12).
3. An inflatable packer according to claim 1 or 2:
  - characterised is that the or each said force transmitting sleeve (14) is externally welded to the respective ends of said metal ribs (12);
  - wherein the respective mounting means (20) comprises a respective anchor sleeve (20) for the respective force transmitting means (14), said anchor sleeve (20) defining said internal shoulder (20a).
4. An inflatable packer according to claim 3 dependent from claim 2, characterised in that said internal annular shoulder (20a) is respectively disposed in a medial location in the anchor sleeve (20), whereby a substantial length of the ends of said ribs (12) are respectively expanded by said tubular elastomeric body (30) into frictional engagement with the bores of said anchor sleeve (20), thereby absorbing a portion of said tensile forces.
5. An inflatable packer according to claim 1, characterised in that the respective mounting means (20) comprises a respective mounting sleeve or anchor sleeve (20) for the respective force transmitting means (14), said mounting sleeve or anchor sleeve

(20) defining said internal shoulder (20a),

wherein the or each said force transmitting sleeve (14) comprises a respective end ring (14) formed of a weldable material and insertable in said respective mounting sleeve or another sleeve (20), the respective force transmitting shoulder (14a) being formed on said ring (14);

wherein said elongated, peripherally adjacent reinforcing means (12) comprises a plurality of elongated flexible ribs (12) also formed of a weldable material, said ribs (12) being disposed in a cylindrical, overlapping array, with said ribs (12) having their ends respectively welded to the exterior of the or each said end ring (14); and

wherein said tubular elastomeric body (30) comprises a sleeve of elastomeric material inserted in said cylindrical array of ribs (12).

6. An inflatable packer according to claim 3, characterised in that said internal annular shoulders (20a) are respectively located in medial portions of said respective mounting sleeve or anchor sleeve (2) and the end portions of said ribs (12) are respectively frictionally engaged with a substantial portion of the interior surface of said respective mounting sleeve or another sleeve (20).

**Patentansprüche**

1. Aufblasbarer Packer, der ein aufblasbares Versatzelement (10) hat, zum Einsatz in einer unterirdischen Bohrung, wobei das Versatzelement folgende Komponenten aufweist:

- einen rohrförmigen elastomeren Körper (30);
- ein längliches, peripher angrenzendes Verstärkungsmittel (12), das zumindest den mittleren Abschnitt des rohrförmigen elastomeren Körpers (30) eng umschließt;

- gekennzeichnet durch wenigstens eine kraftübertragende Buchse (14), die außen an einem entsprechenden Ende des Verstärkungsmittels (12) befestigt ist und einen entsprechenden äußeren kraftübertragenden Absatz (14a) bildet; und

- entsprechende Befestigungsmittel (20) für die oder jede der kraftübertragenden Buchsen (14), wobei die Befestigungsmittel (20) einen entsprechenden inneren Absatz (20a) bilden, der an den äußeren kraftübertragenden Absatz (14a) der entsprechenden kraftübertragenden Buchse (14) anstoßen kann, um so die Zugkräfte, die durch das Verstärkungsmittel (12) durch Ausdehnung des rohrförmigen elastomeren Körpers (30) durch hy-

drostatischen Druck erzeugt werden, einseitig gerichtet auf die Befestigungsmittel (20) zu übertragen.

2. Aufblasbarer Packer nach Anspruch 1, dadurch gekennzeichnet, daß das peripher angrenzende Verstärkungsmittel (12) eine Vielzahl von länglichen, peripher angrenzenden, flexiblen Metall rippen (12) umfaßt.

3. Aufblasbarer Packer nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die oder jede der kraftübertragenden Buchsen (14) außen mit den entsprechenden Enden der Metall rippen (12) verschweißt ist;

bei welchem die entsprechenden Befestigungsmittel (20) eine entsprechende Ankerbuchse (20) für die entsprechenden kraftübertragenden Mittel (14) umfassen, wobei die Ankerbuchse (20) den inneren Absatz (20a) bildet.

4. Aufblasbarer Packer nach Anspruch 3 in Abhängigkeit von Anspruch 2, dadurch gekennzeichnet, daß der ringförmige innere Absatz (20a) entsprechend in einer mittleren Position in der Ankerbuchse (20) angeordnet ist, so daß eine wesentliche Länge der Enden der Rippen (12) durch den rohrförmigen elastomeren Körper (30) jeweils zum Reibungseingriff mit den Bohrungen der Ankerbuchse (20) ausgedehnt wird, um dadurch einen Teil der Zugkräfte zu absorbieren.

5. Aufblasbarer Packer nach Anspruch 1, dadurch gekennzeichnet, daß die entsprechenden Befestigungsmittel (20) eine entsprechende Befestigungsbuchse oder Ankerbuchse (20) für die entsprechenden kraftübertragenden Mittel (14) umfassen, wobei die Befestigungsbuchse oder Ankerbuchse (20) den inneren Absatz (20a) bildet,

bei welchem die oder jede der kraftübertragenden Buchsen (14) einen entsprechenden Endring (14) umfassen, der aus einem schweißbaren Material gebildet wird und in die entsprechende Befestigungsbuchse oder andere Buchse (20) eingesetzt werden kann, wobei der entsprechende kraftübertragende Absatz (14a) auf dem Ring (14) gebildet wird; bei welchem das längliche, peripher angrenzende Verstärkungsmittel (12) eine Vielzahl von länglichen, flexiblen Rippen (12) umfaßt, die ebenfalls aus einem schweißbaren Material gebildet werden, wobei die Rippen (12) in einem zylindrischen, sich überlagernden Schema angeordnet sind, wobei die Enden der Rippen (12) jeweils mit der Außenseite des oder jedes der Endringe (14) verschweißt werden; und

bei welchem der rohrförmige elastomere Körper (30) eine Buchse aus elastomerem Material umfaßt, die in das zylindrische Schema von Rippen (12) eingesetzt wird.

6. Aufblasbarer Packer nach Anspruch 3, dadurch gekennzeichnet, daß sich die ringförmigen inneren Absätze (20a) jeweils in den mittleren Abschnitten der entsprechenden Befestigungsbuchse oder Ankerbuchse (2) befinden und die Endabschnitte der Rippen (12) sich jeweils im Reibungseingriff mit einem wesentlichen Abschnitt der Innenfläche der entsprechenden Befestigungsbuchse oder anderen Buchse (20) befinden.

## Revendications

1. Obturateur gonflable comportant un élément d'obturation gonflable (10) destiné à être utilisé dans un puits souterrain, l'élément d'obturation comprenant:

un corps élastomère tubulaire (30);

un moyen de renforcement allongé périphériquement adjacent (12) entourant étroitement au moins la partie médiane dudit corps élastomère tubulaire (30);

caractérisé par au moins un manchon de transmission de force (14) fixé extérieurement à une extrémité respective dudit moyen de renforcement (12) et définissant un épaulement de transmission de force externe respectif (14a); et

un moyen de montage respectif (20) pour le ou chaque manchon de transmission de force (14), ledit moyen de montage (20) définissant un épaulement interne respectif (20a) pouvant buter contre ledit épaulement de transmission de force externe (14a) du manchon de transmission de force respectif (14), pour assurer ainsi une transmission unidirectionnelle vers ledit moyen de montage (20) des forces de traction produites par ledit moyen de renforcement (12) par suite de la dilatation de la pression de fluide dudit corps élastomère tubulaire (30).

2. Obturateur gonflable selon la revendication 1, caractérisé en ce que ledit moyen de renforcement périphériquement adjacent (12) comprend plusieurs nervures métalliques flexibles allongées, périphériquement adjacentes (12).

3. Obturateur gonflable selon les revendications 1 ou 2:

caractérisé en ce que le ou chaque manchon de transmission de force (14) est soudé extérieurement aux extrémités respectives desdites nervures métalliques (12);

le moyen de montage correspondant (20)

comprenant un manchon d'ancrage respectif (20) pour le moyen de transmission de force respectif (14), ledit manchon d'ancrage (20) définissant ledit épaulement interne (20a).

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4. Obturateur gonflable selon la revendication 3, dépendant de la revendication 2, caractérisé en ce que ledit épaulement interne (20a) est agencé respectivement dans un emplacement médian dans le manchon d'ancrage (20), une longueur substantielle des extrémités desdites nervures (12) étant ainsi respectivement dilatée par ledit corps élastomère tubulaire (30) pour s'engager par friction dans les alésages dudit manchon d'ancrage (20), pour absorber ainsi une partie desdites forces de traction.

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5. Obturateur gonflable selon la revendication 1, caractérisé en ce que le moyen de montage respectif (20) comprend un manchon de montage respectif ou un manchon d'ancrage (20) pour le moyen de transmission de force respectif (14), ledit manchon de montage ou ledit manchon d'ancrage (20) définissant ledit épaulement interne (20a),

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le ou chaque manchon de transmission de force (14) comprenant une bague d'extrémité respective (14) composée d'un matériau soudable et pouvant être insérée dans ledit manchon de montage respectif ou dans un autre manchon (20). l'épaulement de transmission de force respectif (14a) étant agencé sur ladite bague (14);

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ledit moyen de renforcement allongé périphériquement adjacent (12) comprenant plusieurs nervures allongées flexibles (12) composées également d'un matériau soudable, desdites nervures (12) étant agencées dans un agencement cylindrique à chevauchement, les extrémités desdites nervures (12) étant respectivement soudées à l'extérieur de la ou de chaque bague d'extrémité (14); et

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ledit corps élastomère tubulaire (30) comprenant un manchon de matériau élastomère inséré dans ledit agencement cylindrique de nervures (12).

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6. Obturateur gonflable selon la revendication 3, caractérisé en ce que lesdits épaulements annulaires internes (20a) sont respectivement agencés dans les parties médianes dudit manchon de montage respectif ou dudit manchon d'ancrage (2). les parties d'extrémité desdites nervures (12) étant respectivement engagées par friction dans une partie substantielle de la surface interne dudit manchon de montage respectif ou d'un autre manchon (20).

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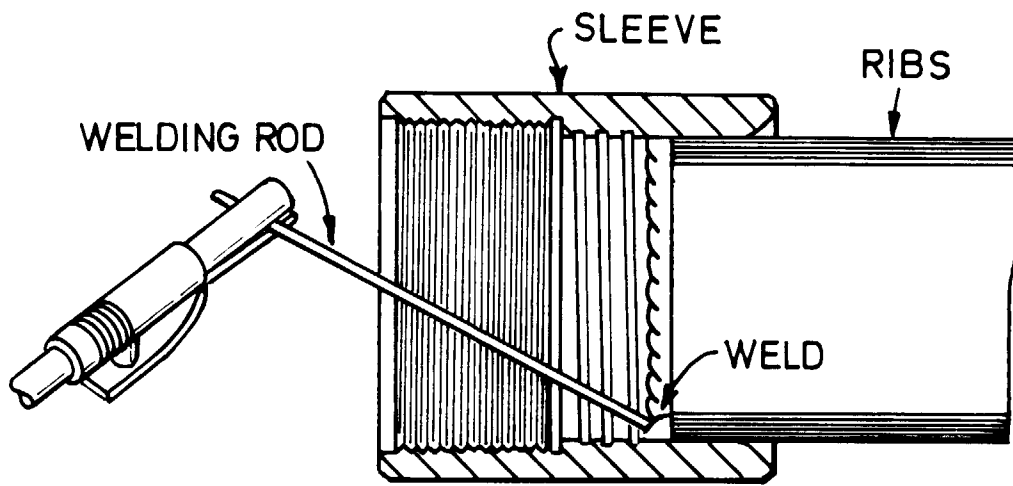


FIG. 1  
PRIOR ART

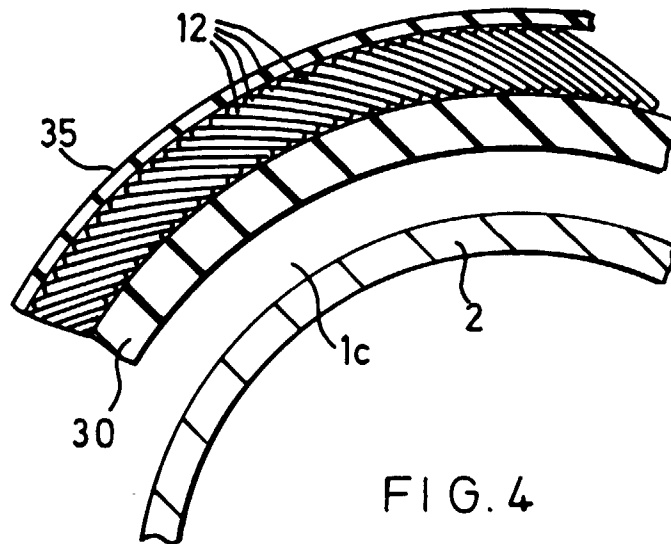


FIG. 4

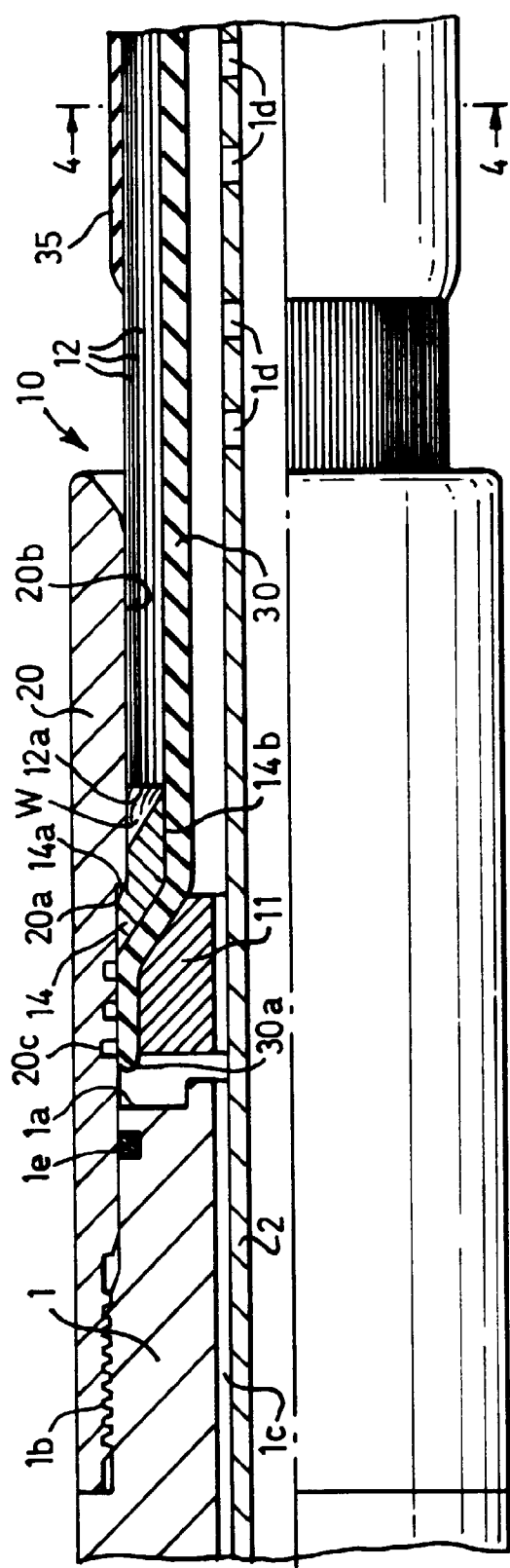


FIG. 2

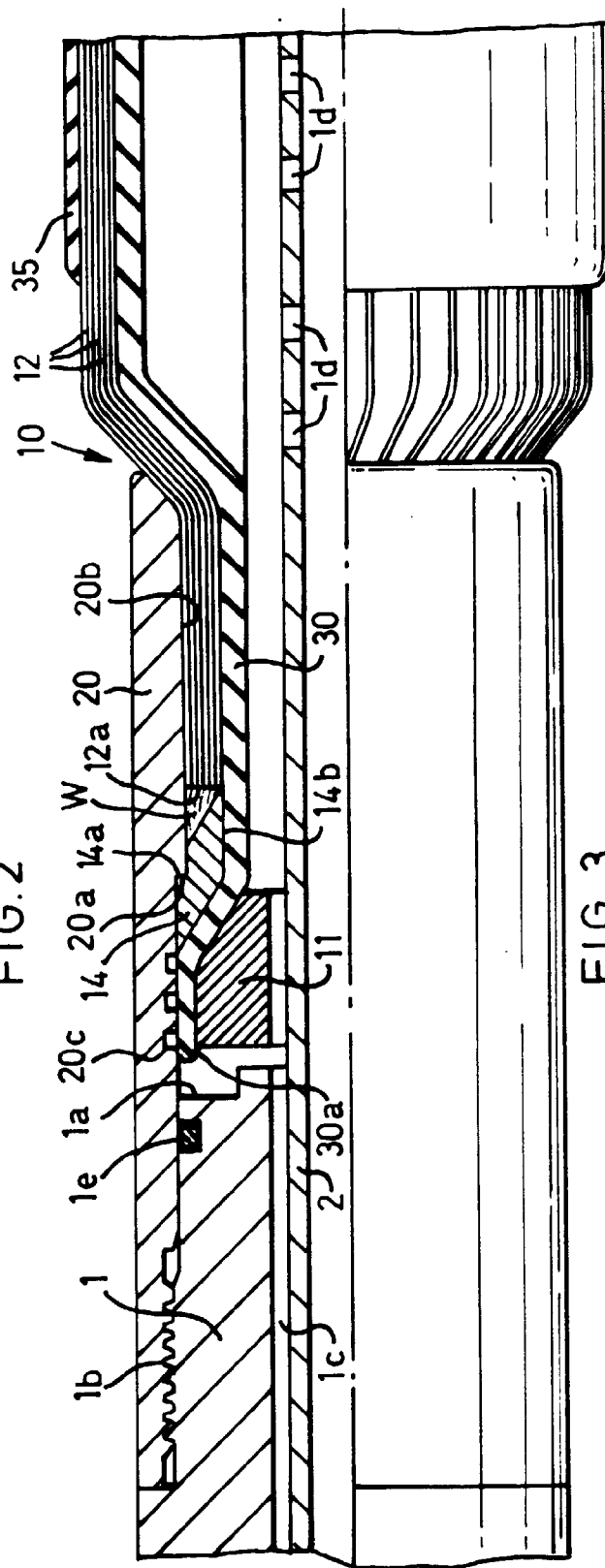


FIG. 3