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(54) Hand-held percussive tool incorporating apparatus for reducing vibration transmission to the user

Handgehaltenes Schlagwerkzeug mit vibrationsdämpfender Einrichtung

Outil de frappe porté à main avec dispositif pour réduire la transmission des vibrations aux utilisateurs

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(56) References cited:
EP-A- 0 336 261
CH-A- 669 142
NL-A- 109 403
US-A- 2 440 150
US-A- 3 788 404

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Description

This invention relates to a hand-held percussive tool incorporating apparatus for reducing vibration transmission to the user of the tool.

Previous attempts to reduce hand/arm vibration in a percussive tool have generally centred around either the isolation of the operator's grip by means of sprung handles or by employing a means of cutting power to the tool as the operator force increases.

One limitation of the springs solution is that a damper is required as well as the spring in order to obtain the optimum effect. Also, the mass of the sprung handles is relatively small compared with the mass of the tool and, since a coil spring usually functions linearly, high deflections are experienced. As a result, the option to reduce the power to help achieve the desired effect has been investigated. Power regulation of the tool has obvious disadvantages to efficiency, in that it reduces the blow frequency and intensity.

EP-A-336 261 discloses means for vibro-isolation of connections of structural units of pneumatic hand tools, the means including elastic guiding means.

According to the present invention, there is provided a hand-held percussive tool incorporating apparatus for reducing vibration transmission from a working tool portion of the tool to the user of the tool, the apparatus comprising first means interposed between a handle portion of the tool and the working tool portion and second means for reducing vibration transmission from the working tool portion to a casing of the tool, said second means being located adjacent the working tool portion and between the casing and the working tool portion, characterised in that said first means includes a floating, resilient ball arrangement.

The tool may be a percussive tool, such as a chipper, digger, needle gun, scaler, hammer drill or a demolition tool.

The tool may be air operated. The tool could also be electrically operated.

Preferably, the resilient ball arrangement of the first means comprises balls, preferably three, which can be of rubber, located between a male part on one of the portions and a female part on the other of the portions.

The male part can be a substantially frustoconical part joined to the handle portion and the female part can be a female bed joined to a working part of the tool or vice versa, the bed facing the frustoconical portion with the balls lying compressed on the bed and the external surface of the frustocone.

Oscillatory movement of the female bed parallel to the longitudinal axis of the frustocone causes the balls to roll on the male and female surfaces.

The balls can be located by pins or the like.

In the case of an air-operated tool, at least one and preferably each ball may be provided with a bore through which air under pressure can be transmitted from the frustoconical portion to the female bed and thence to the action of the working part of the tool.

The resilient ball arrangement of the second means can be in the form of a set of balls in a ring around the internal periphery of the casing and around the outer periphery of part of the working portion of the tool, thereby separating and isolating the two portions.

The set of balls can be linked together.

The balls can be located within shells which are curved to urge the balls towards their mean positions.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

Figure 1 is a sectional view of part of a hand-held percussive tool showing apparatus for reducing vibration transmission from a working portion thereof to the user thereof, the tool being illustrated at mid-stroke,

Figure 2 is a sectional view taken on the line II-II in Figure 1,

Figure 3 is an exploded perspective view of part of the apparatus and showing a modification,

Figure 4 is a sectional view of another part of the tool showing apparatus for reducing vibration transmission from the working portion to a casing of the tool, this view also being illustrated at mid-stroke,

Figure 5 is a section view taken on the line V-V in Figure 4,

Figure 6 is a sectional view similar to part of Figure 1 and showing a modification of that part, and

Figure 7 is a view similar to part of Figure 4 and showing a modification of that part.

Referring firstly to Figures 1 to 3, a D-handled, air-operated percussive tool is illustrated which incorporates apparatus for reducing vibration transmission from a working end portion 1 to a hand grip 2, thereby to reduce vibration transmission to the hand/arm of the user. Such apparatus will be briefly referred to hereafter as the "vibration isolator".

The vibration isolator in the form illustrated comprises a male, substantially frustoconical portion 3 whose tip is located facing a female bed 4. The base of the frustoconical part is attached to the handle grip 2, whilst the bed 4 is attached to the working end portion 1 of the tool.

Three substantially spherical rubber balls 5 are trapped between the portion 3 and bed 4, which is preferably of scalloped form, the number of scallops corresponding to the number of balls and each scallop serving to receive and locate its ball. The apparatus as depicted in Figure 1 is carrying a mean static load.

The balls can be located in their mean positions under compression by means of nylon tubes 6A and 6B located in bores 7 of the balls 5, the tubes having portions protruding from the surfaces of the balls so that these protruding portions are located in corresponding bores 8A and 8B in the portion 3 and bed 4, respectively. The tubes 6A and 6B in each bore 7 are spaced apart to give sufficient clearance for compression and expansion movement of the ball 5 in which the bore is located. The tubes 6A, 6B may be nylon inserts which are glued, bonded or simply press fits.

As illustrated in Figures 1 to 3, the bores can form an integral part of the compressed air supply to the working end portion of the tool from an air supply conduit 9 in the handle grip 2, into a conduit 9A passing down the centre of the tapered portion 3 and communicating with the bores 8A, 7 and 8B. The bores 8B lead on to a cycle valve illustrated generally at 10. Experiments have shown that for the operating range of the vibration isolator, the airways through the vibration isolator remain sufficiently consistent to allow the required air flow.

The portion 3 need not be pure frustoconical but can be given a gently curving taper and/or can incorporate an angular change in the direction of taper. The tubes 6A and 6B serve to locate the balls 5 on the taper, especially when the parts 1 and 2 are driven off-centre.

In the case where the tool is only electrically-operated, then the tubes 6A, 6B (or pins) simply serve as locating means.

The modification shown in Figure 3 takes the form of three radially-extending wings 11 on the portion 3 which run in slots 4A parallel to the longitudinal axis of the tool. These wings also act as anti-rotation means if the rotational stiffness of the balls is overcome, thereby acting as a travel limiter. Also, they act as a rebound stop or travel limiter in the axial direction.

In use, the percussive tool will oscillate at around ± 4mm at 25 Hz/sec. The acceleration levels experienced with the balls is very high and so the resilient material of the balls must be of a suitable hardness. The apparatus provides a high radial stiffness and a low (soft) axial stiffness with rising rate. In comparison, a normal coil spring would have a constant rate. The balls effectively provide a rising spring rate or stiffness. The rising rate can be varied by varying the degree of slope on the rolling surfaces.

The other end of the tool is diagrammatically illustrated in Figures 4 and 5, where a casing 12 is shown leading up to the handle end of the tool and obviously since the casing 12 is attached to the handle grip 2, it must not be allowed to short out the effect of the vibration isolator. Accordingly, another floating resilient ball arrangement 13 is provided between the working end portion 1 and the casing 12 in the region where the actual working tool 14 is located. This effectively forms another vibration isolator but in this case the balls are not provided with locating pins but are linked to the ring of balls and are located in outer and inner shells 15, 16, respectively. The balls may be moulded together or may be linked by other means.

In this case, the axial stiffness is intended to be lower, and with a constant rate, but the radial stiffness is intended to be higher than is the case with the vibrator isolator at the hand grip end of the tool. The shells 15 and 16 are curved to urge the bracelet of balls towards their mean positions. The balls are compressed and in this case, they have a shallow curve.

Such a construction at the end of the tool most adjacent the actual working tool 14 reduces the required length in that location as compared with prior art bearings and it is resistant to ingress of foreign material. To assist in this, a circular floating seal 17 is provided between the tool 14 and the ball arrangement 13.

Figure 6 shows a possible modification of the construction shown in Figures 1 to 3, in which the air line is not via the balls 5 but via a separate, flexible hose 18 connected between the hand grip 2 and the reciprocating portion 1. There are still three balls 5, each located in its own scalloped portion on the bed 4.

As with the embodiment shown in Figure 1, the male portion 3 can be provided with planar or substantially planar faces.

The reciprocating portion 1 is guided by three toughened pins 19 extending from the hand grip 2 parallel to the axis of the tool, each pin running as a loose fit in its own hardened bush 20. This construction provides guiding and anti-rotation means for the portion 1.

Figure 7 shows a possible modification of the construction shown in Figures 4 and 5, in which the bracelet of balls at the actual tool 14 end is replaced by a plain sliding bearing. This comprises a bed 21 of polymer fitted around the portion 1 and a part-spherical, radiussed bearing tip 22 which can be of hardened steel flash chromium plated. A slight clearance is provided to allow for "blow past", which provides self-cleaning and allows for expansion.

Another possibility, not illustrated, would be to provide a roller bearing running on flats on the portion 1 and provided with end stops. Yet another possibility would be to provide an air bearing.

Claims

1. A hand-held percussive tool incorporating apparatus for reducing vibration transmission from a working tool portion (1) of the tool to the user of the tool, the apparatus comprising first means interposed between a handle portion (2) of the tool and the working tool portion (1) and second means (13, 22) for reducing vibration transmission from the working tool portion to a casing (12) of the tool, said second means (13) being located adjacent the working tool portion (1) and between the casing (12) and the working tool portion (1), characterised in that said first means includes a floating, resilient ball arrangement (5).

2. A tool according to claim 1, wherein said resilient ball arrangement comprises three balls (5) located between a male part (3) on one of the portions and a female part (4) on the other of the portions.

3. A tool according to claim 2, wherein the balls (5) are of rubber.

4. A tool according to claim 2 or 3, wherein said male part is a substantially frustoconical part (3) joined to said handle portion (2) and the female part is a female bed (4) joined to a working part (10) coupled to the working tool.

5. A tool according to claim 2, 3 or 4, wherein the balls (5) are located by pins (6A, 6B).

6. A tool according to claim 4 or claims 4 and 5, wherein at least one of said balls (5) is provided with a bore (7) through which air under pressure can be transmitted from the frustoconical part (3) to the female bed (4) and thence to said working part (10).

7. A tool according to claim 4 or 5, wherein a flexible hose (18) is provided through which air under pressure can be transmitted from the handle portion (2) to said working part (10).

8. A tool according to any one of the preceding claims, wherein said second means includes a second, resilient ball arrangement (13).

9. A tool according to claim 8, wherein said second resilient ball arrangement is in the form of a set of balls (13) in a ring around the internal periphery of the casing (12) and around the outer periphery of part (1) of the working tool.

10. A tool according to claim 9, wherein the balls (13) in said set of balls are linked together.

11. A tool according to claim 9 or 10, wherein the balls (13) of the set of balls are located within shells (15) which are curved to urge those balls towards their mean positions.

12. A tool according to any one of claims 1 to 7, wherein second means comprises a sliding bearing (22).

13. A tool according to claim 12, wherein said sliding bearing (22) comprises a radiussed bearing tip running on a bearing bed.

14. A tool according to claim 13, wherein said bearing tip is of hardened steel and said bearing bed is of a polymer.

15. A tool according to any one of claims 2 to 14 and further comprising means (11, 19) to limit relative rotation between said male and female parts.

16. A tool according to claim 15, wherein said means to limit relative rotation comprises pins (19) extending parallel to the axis of the tool.

17. A tool according to any one of claims 2 to 16, and further comprising means (11) for acting as a rebound stop or travel limiter in an axial direction of relative movement of the male and female parts.

18. A tool according to any one of the preceding claims and being air operated.

19. A tool according to any one of claims 1 to 17 and being electrically operated.

20. A tool according to any one of the preceding claims and being in the form of a chipper, digger, needle gun, scaler, hammer drill or a demolition tool.

Patentansprüche

1. Handschlagwerkzeug mit einer Vorrichtung zum Reduzieren der Übertragung der Vibration von einem Arbeitswerkzeugabschnitt (1) des Werkzeugs auf den Verwender des Werkzeugs, wobei die Vorrichtung eine erste Einrichtung aufweist, die zwischen einem Handgriffabschnitt (2) des Werkzeugs und dem Arbeitswerkzeugabschnitt (1) angeordnet ist und eine zweite Einrichtung (13, 22) zum Reduzieren der Übertragung der Vibration von dem Arbeitswerkzeugabschnitt auf ein Gehäuse (12) des Werkzeugs aufweist, wobei die zweite Einrichtung (13) in der Nähe des Arbeitswerkzeugabschnitts (1) und zwischen dem Gehäuse (12) und dem Arbeitswerkzeugabschnitt (1) angeordnet ist, **dadurch gekennzeichnet,** daß die erste Einrichtung eine schwimmend gelagerte elastische Kugelanordnung (5) aufweist.

2. Werkzeug nach Anspruch 1, wobei die elastische Kugelanordnung drei Kugeln (5) aufweist, die zwischen einem männlichen Teil (3) eines der Abschnitte und einem weiblichen Teil (4) in dem anderen Abschnitt angeordnet sind.

3. Werkzeug nach Anspruch 2, wobei die Kugeln (5) aus Gummi sind.

4. Werkzeug nach Anspruch 2 oder 3, wobei der männliche Teil ein im wesentlichen kegelstumpfartiger Teil (3) ist, der mit dem Handgriffabschnitt (2) verbunden ist und der weibliche Teil ein weibliches Bett (4) ist, das mit einem Arbeitsbauteil (10) verbunden ist, das mit dem Arbeitswerkzeug gekoppelt ist.

5. Werkzeug nach Anspruch 2, 3 oder 4, wobei die Kugeln (5) durch Bolzen (6A, 6B) an Ort und Stelle gehalten werden.

6. Werkzeug nach Anspruch 4 oder den Ansprüchen 4 und 5, wobei wenigstens eine der Kugeln (5) mit einer Bohrung (7) versehen ist, durch die unter Druck Luft von dem kegelstumpfartigen Teil (3) zu dem weiblichen Bett (4) und dadurch zu dem Arbeitsabschnitt (10) geleitet werden kann.

7. Werkzeug nach Anspruch 4 oder 5, wobei ein flexibler Schlauch (18) vorgesehen ist, durch den Luft unter Druck vom Handgriffabschnitt (2) zum Arbeitsbauteil (10) geleitet werden kann.

8. Werkzeug nach einem der vorhergehenden Ansprüche, wobei die zweite Einrichtung eine zweite elastische Kugelanordnung (13) aufweist.

9. Werkzeug nach Anspruch 8, wobei die zweite elastische Kugelanordnung in Form eines Satzes von Kugeln (13) vorliegt, die in einem Ring um den inneren Umfang des Gehäuses (12) und um den äußeren Umfang des Bauteils (1) des Arbeitswerkzeugs angeordnet sind.

10. Werkzeug nach Anspruch 9, wobei die Kugeln (13) in dem Satz von Kugeln miteinander verbunden sind.

11. Werkzeug nach Anspruch 9 oder 10, wobei die Kugeln (13) des Satzes von Kugeln in Gehäusen (15) angeordnet sind, die gebogen sind, um die Kugeln in ihre Hauptstellungen zu drängen.

12. Werkzeug nach einem der Ansprüche 1 bis 7, wobei die zweite Einrichtung ein Gleitlager (22) aufweist.

13. Werkzeug nach Anspruch 12, wobei das Gleitlager (22) eine mit einem Radius versehene Lagerspitze aufweist, die auf einem Lagerbett läuft.

14. Werkzeug nach Anspruch 13, wobei die Lagerspitze aus gehärtetem Stahl besteht und das Lagerbett aus einem Polymer besteht.

15. Werkzeug nach einem der Ansprüche 2 bis 14, mit einer Einrichtung (11, 19), um eine Relativdrehung zwischen den männlichen und weiblichen Teilen zu begrenzen.

16. Werkzeug nach Anspruch 15, wobei die Einrichtung zum Begrenzen einer Relativdrehung Bolzen (19) aufweist, die sich parallel zur Achse des Werkzeugs erstrecken.

17. Werkzeug nach einem der Ansprüche 2 bis 16, mit einer Einrichtung (11) zur Wirkung als Rückprallanschlag oder Bewegungsbegrenzer in axialer Richtung einer Relativbewegung der männlichen und weiblichen Teile.

18. Werkzeug nach einem der vorhergehenden Ansprüche, das mit Luft betrieben wird.

19. Werkzeug nach einem der Ansprüche 1 bis 17, das elektrisch betrieben wird.

20. Werkzeug nach einem der vorhergehenden Ansprüche, in Form eines Schabers, eines Abtragwerkzeuges, eines Zündnadelgewehrs, eines Abklopfers, eines Bohrhammers oder eines Brechwerkzeuges.

Revendications

1. Outil de frappe porté à la main qui incorpore un dispositif pour réduire la transmission des vibrations depuis une partie active de l'outil (1) vers l'utilisateur de l'outil, l'appareil comprenant des premiers moyens interposés entre une partie de poignée (2) de l'outil et la partie active de l'outil (1), et des seconds moyens pour réduire la transmission de vibrations depuis la partie active de l'outil vers un boîtier (12) de l'outil, lesdits seconds moyens (13) étant situés en position adjacente à la partie active de l'outil (1) et entre le boîtier (12) et la partie active de l'outil (1), caractérisé en ce que lesdits premiers moyens comprennent un agencement flottant à billes élastiques (5).

2. Outil selon la revendication 1, dans lequel ledit agencement flottant à billes élastiques comprend trois billes (5) situées entre une partie mâle (3) de l'une des parties et une partie femelle (4) sur l'autre des parties.

3. Outil selon la revendication 2, dans lesquels les billes (5) sont en caoutchouc.

4. Outil selon l'une ou l'autre des revendications 2 et 3, dans lequel ladite partie mâle est une partie sensiblement tronconique (3) réunie à ladite partie de poignée (2), et ladite partie femelle est un appui femelle (4) réuni à une partie de travail (10) accouplée à l'outil de travail.

5. Outil selon l'une quelconque des revendications 2 à 4, dans lequel les billes (5) sont positionnées par des goupilles (6A, 6B).

6. Outil selon la revendication 4, ou selon les revendications 4 et 5, dans lequel l'une au moins desdites billes (5) est pourvue d'un perçage (7) à travers lequel on peut transmettre de l'air sous pression

depuis la partie tronconique (3) jusqu'à l'appui femelle (4) et ensuite à ladite partie active (10).

7. Outil selon l'une ou l'autre des revendications 4 et 5, dans lequel un tuyau flexible (18) est prévu, via lequel on peut transmettre de l'air sous pression depuis la partie de poignée (2) jusqu'à ladite partie active (10).

8. Outil selon l'une quelconque des revendications précédentes, dans lequel lesdits seconds moyens incluent un second agencement à billes élastiques (13).

9. Outil selon la revendication 8, dans lequel ledit second agencement à billes élastiques est sous la forme d'un jeu de billes (13) dans un anneau autour de la périphérie intérieure du boîtier (12) et autour de la périphérie extérieure d'une partie (1) de l'outil de travail.

10. Outil selon la revendication 9, dans lequel les billes (13) dans ledit jeu de billes sont reliées les unes aux autres.

11. Outil selon l'une ou l'autre des revendications 9 et 10, dans lequel les billes (13) du jeu de billes sont situées à l'intérieur de coquilles (15) qui sont incurvées pour repousser ces billes vers leur position moyenne.

12. Outil selon l'une quelconque des revendications 1 à 7, dans lequel lesdits seconds moyens comprennent un palier à coulissement (22).

13. Outil selon la revendication 12, dans lequel ledit palier à coulissement (22) comprend un embout de palier qui présente un rayon et qui circule sur une portée d'appui.

14. Outil selon la revendication 13, dans lequel ledit embout de palier est en acier durci, et ladite portée d'appui est en polymère.

15. Outil selon l'une quelconque des revendications 2 à 14, et comprenant en outre des moyens (11, 19) pour limiter la rotation relative entre lesdites parties mâle et femelle.

16. Outil selon la revendication 15, dans lequel lesdits moyens pour limiter la rotation relative comprennent des tiges (19) qui s'étendent parallèlement à l'axe de l'outil.

17. Outil selon l'une quelconque des revendications 2 à 16, et comprenant en outre des moyens (11) destinés à faire office d'arrêt à rebondissement ou de limiteur de course dans une direction axiale du mouvement relatif des parties mâle et femelle.

18. Outil selon l'une quelconque des revendications précédentes, actionné au moyen d'air.

19. Outil selon l'une quelconque des revendications 1 à 17, actionné par voie électrique.

20. Outil selon l'une quelconque des revendications précédentes, sous la forme d'un burin, d'un appareil à creuser, d'un percuteur à aiguille, d'une ébaucheuse, d'une perceuse à percussion, ou d'un outil de démolition.

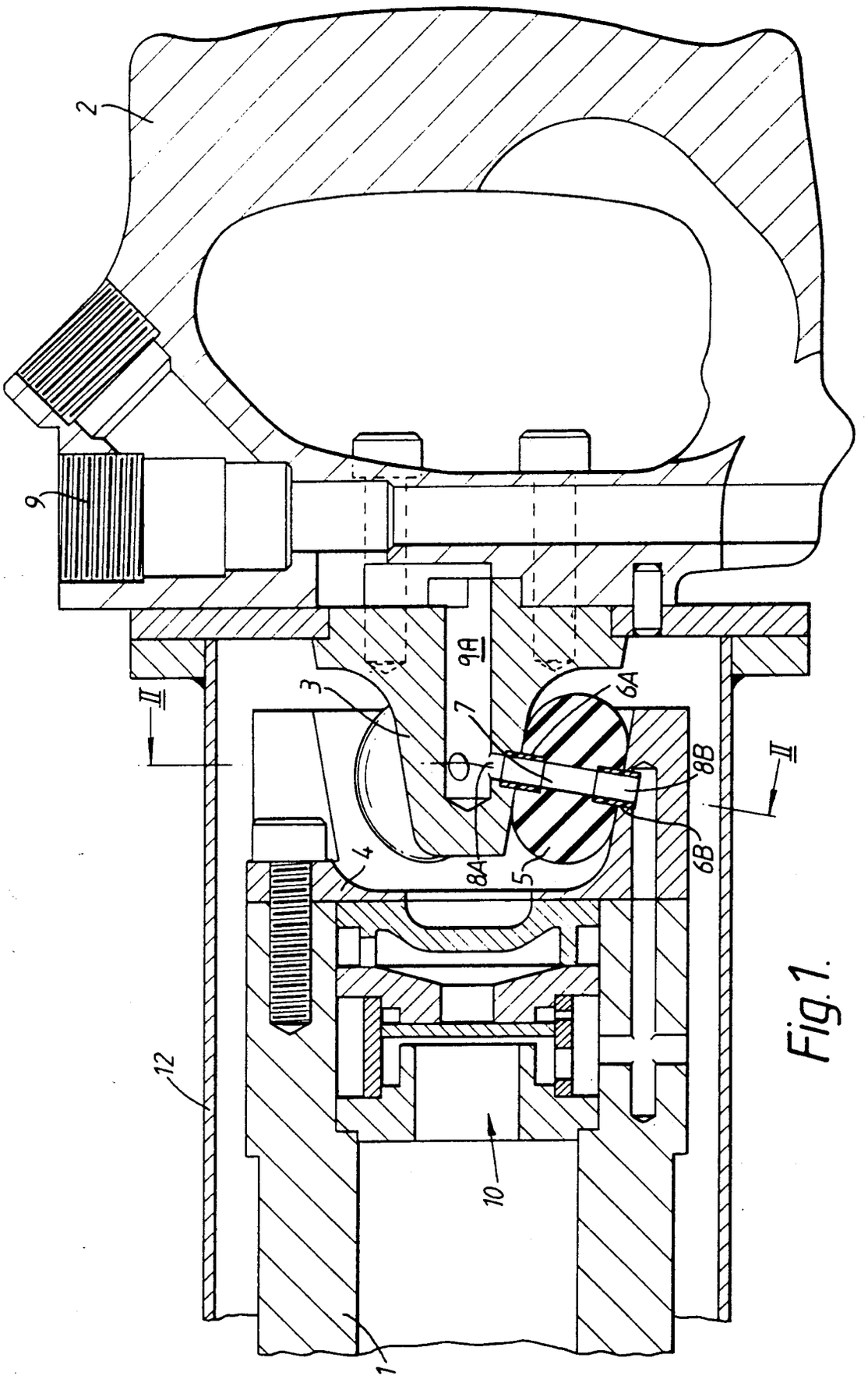

Fig. 1.

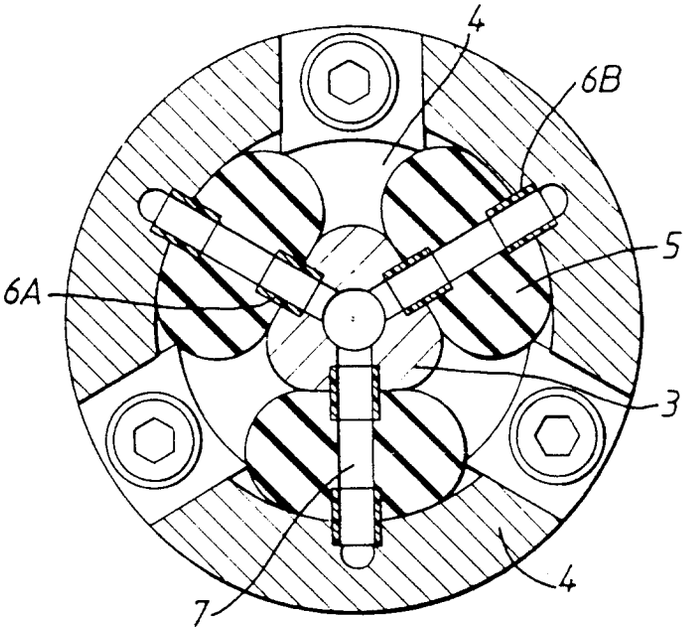

Fig.2.

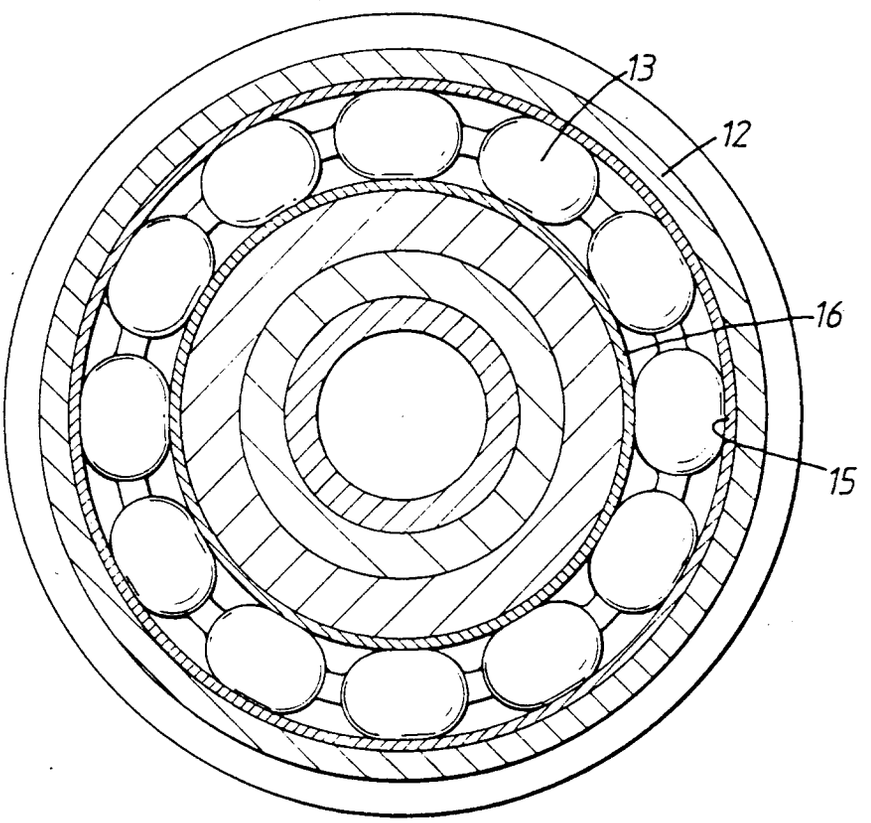

Fig.5.

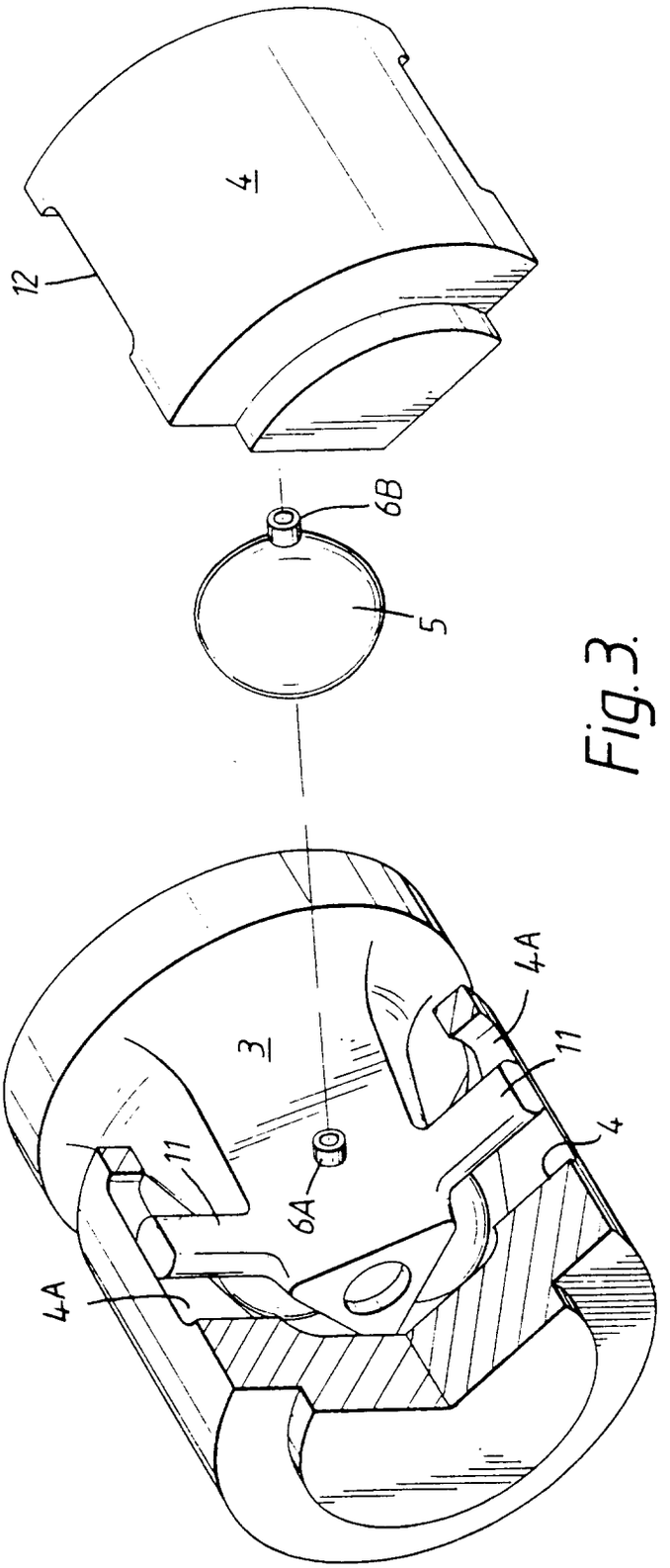

Fig.3.

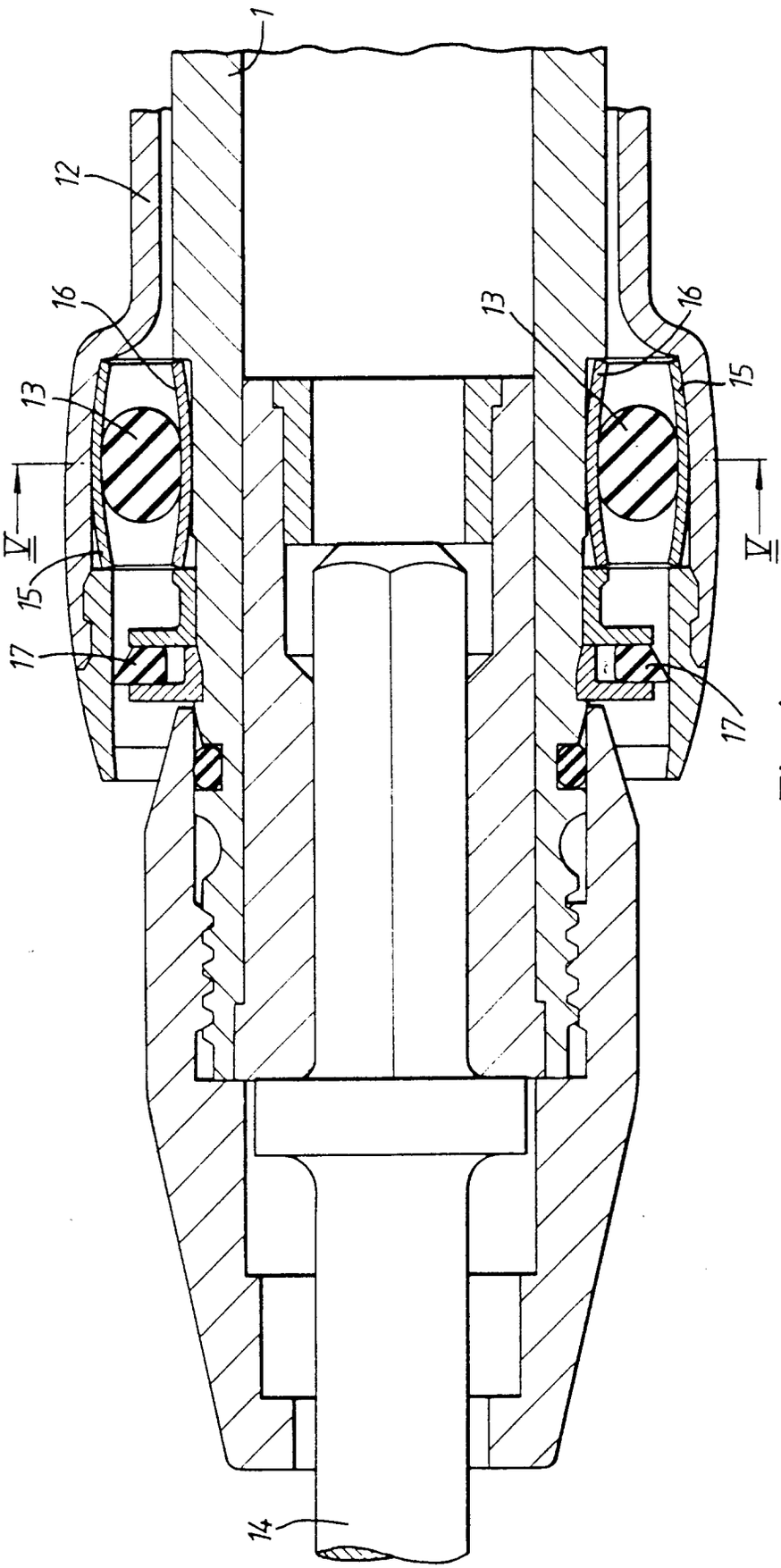

Fig.4.

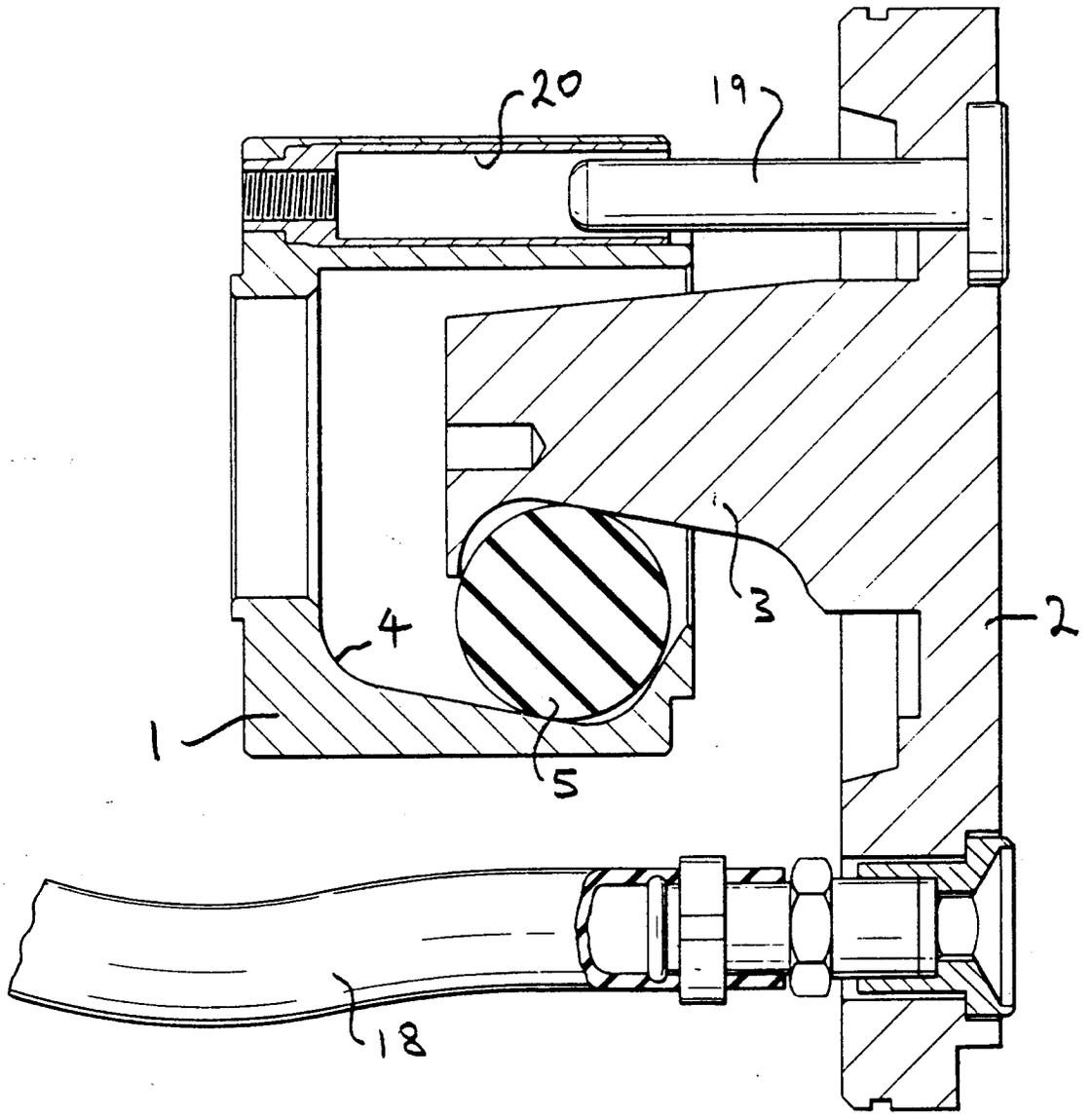

Fig.6.

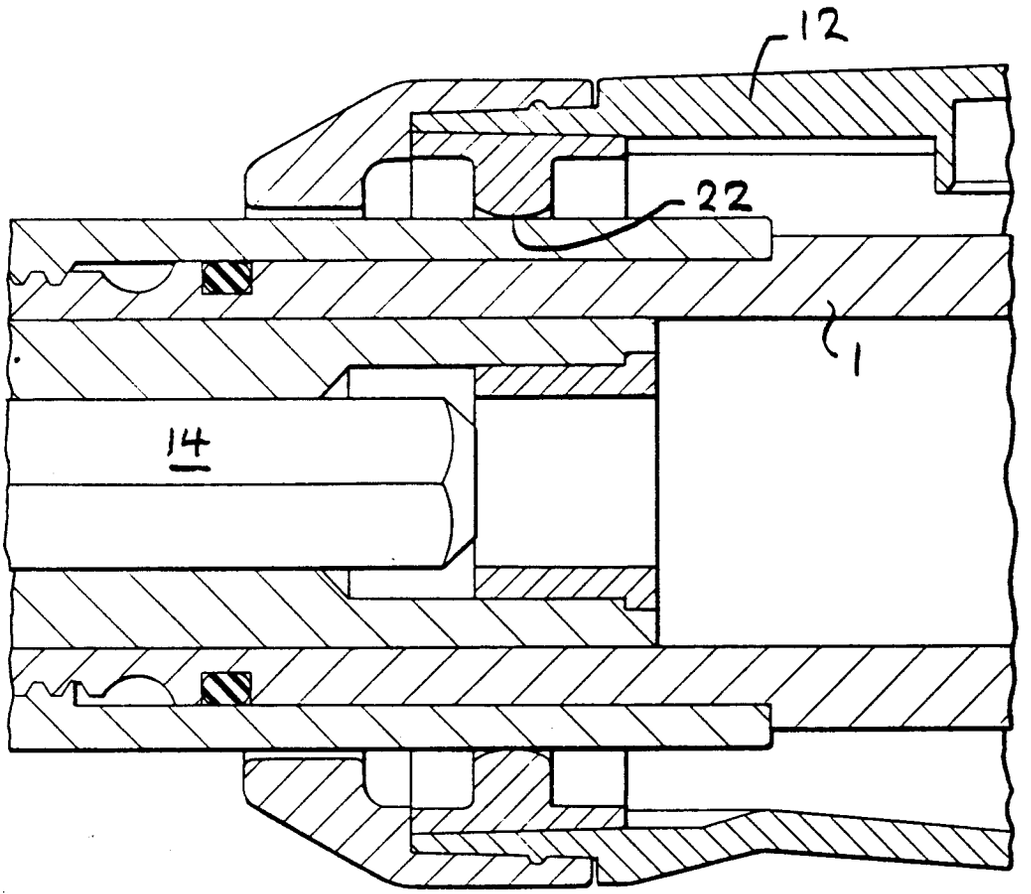

Fig.7.