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(54) Electrical conductor connector

(57) The invention relates to a connector for at least one electrical conductor end in the form of an electrical cable. The connector comprises a body with at least one port for the reception of a conductor end, a collet which fits around the conductor and clamping means which in one embodiment are threaded and engage with a threaded portion at the port opening. With the collet and conductor placed in the port, rotation of the clamping means moves the collet inwardly of the port, the internal walls of which are frustoconically shaped. The collet moves into the port until a location at which further movement of the clamping means causes at least a portion of the collet to move inwardly and exert a gripping force on the conductor and, in conjunction with the clamping means securing the conductor in the connector.

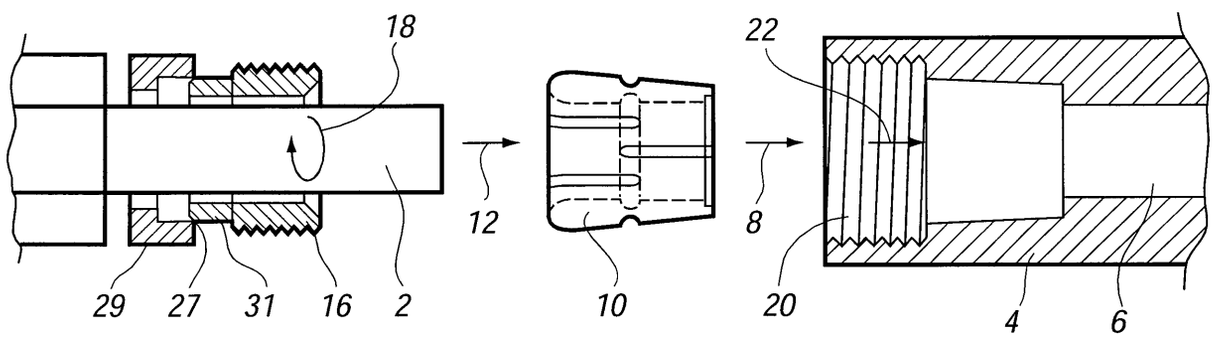

FIG. 2

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Description

[0001] The invention which is the subject of this application relates to a connector for use in the connection of electrical conductors such as for example the connection of respective ends of conductors, branch connections of conductors.

[0002] Use of mechanical connectors to join electrical conductors and allow the passing of electricity between said conductors through the connector is well known. The conventional manner of connecting said conductors is to provide a channel in which said conductor ends can be placed, the provision of covers to place onto the channels to enclose the conductors in the channels, a sleeve to go over the covers and clamping screws to secure the conductors in the connector and hence form the electrical connection. While this form of connector is used on a relatively large scale, there are several disadvantages with the same.

[0003] A first disadvantage is that the use of the clamping screws means that the length of the connector has to be such so as to accommodate the number of clamping screws which are required to be used and this can mean that the connector is in fact of a length determined mainly or solely by the number of clamping screws. The additional length of the connector means that the same can become bulky and, when one considers that the connector is typically required to be fitted in a confined space underground, and often in inclement conditions as, for example, the space may be flooded in wet weather, it will be appreciated that a bulky connector is not a desirable feature.

[0004] Another problem with the use of clamping screws is that although the mechanical connector tends to have an overall circular cross section, the channel and hence conductor, is not located along the central longitudinal axis of the same due to the need for a larger thickness of body portion to be provided where the clamping screw threads are to be formed. This means that when the connector is placed for in line connection of the conductor ends, the conductor ends are offset to one side of the longitudinal axis of the connector. This, in turn, can cause the fitter difficulty in insulating the same and/or applying insulating shrouds around the connector.

[0005] A further problem is that there are now a number of different forms of conductors being used in the industry which are of different cross sectional shape and, in many instances, the conventional mechanical conductors are not satisfactory in connecting certain conductor types such as, for example, a conductor with a substantially circular cross section.

[0006] The aim of the present invention is to provide a mechanical connector for use in the connection of electrical conductors to provide electrical connection between the same and to provide the connector in a form which can be of relatively short length, is easy to fit in confined areas and can be adapted to allow the connection of conductors of different shapes and/or sizes. Furthermore, it is an aim of the present invention to provide a mechanical connector for electrical conductors which can be provided in a manner to match any of the known forms of mechanical connectors in terms of arrangement of the respective conductors which are to be joined together and therefore provide a range of mechanical connectors which can be used in accordance with conventional requirements.

[0007] In accordance with a first aspect of the invention there is provided a connector for the connection of the ends of at least two electrical conductors in an end to end manner to allow electrical connection between the said conductors, said connector including at least one body portion, said body portion having at least one port at one end thereof for the reception of a conductor end therein, a collet arrangement for location around said conductor and location within said port with the conductor, and a clamping means, engageable with the body portion such that movement of the clamping means to exert a clamping force with respect to the body portion causes the clamping means to move inwardly of the port and exert a moving action on the collet and characterised in that the movement of the collet causes the same to move to a fixing position in the body portion port with respect to the conductor and/or connector body and causes the collet to exert a gripping action on the conductor and thereby secure the conductor in position within the connector.

[0008] Typically, the connector is used to connect a number of conductor ends together although the connection means used for respective conductors may vary and may be in a number of different arrangements. It should therefore be appreciated that the connection arrangement for each conductor may or may not be formed in accordance with the invention. For example, in one embodiment, the connector includes port openings at each end which extend into the length of the connector body, with a conductor end being introduced into each port opening and secured therein with respective collet and clamping means arrangements in accordance with the invention.

[0009] In one embodiment, the body portion includes one port passing along the length thereof with two openings, each receiving a conductor end and clamping arrangement. Alternatively, the connector body portion includes two ports, one extending inwardly from each of the body portion ends but not being linked.

[0010] In a yet further embodiment, the connector is formed by two connector body portions. Typically, each body portion is arranged with a port protruding inwardly from one end of each and, at the other end, an engagement formation is provided which, by connection of the mutual engagement formations allow the two body portions to be brought into contact and secured in contact to form the connector.

[0011] In a yet further embodiment, the connector has at a first end, a port or number of ports and at a second

end, a port or number of ports to allow the connection of more than two conductor ends.

[0012] In one embodiment, the collet is formed from one or more components, and, in use, the components are placed on the conductor and positioned in the port with the conductor. Typically, weakened lines and/or slots are provided at spaced locations on the collet to allow compression of the same during movement and the clamping of the collet on the conductor and connector within the connector body.

[0013] Typically, the walls of the port which receives the collet taper inwardly so as to form a substantially frustoconical shape as they depend inwardly of the connector from the port opening.

[0014] Typically, when the clamping means is first moved inwardly of the port, the collet is caused to move further inwardly of the port along the conductor but, at the same time, the typically frustoconical shaping of the walls of the port, cause the collet to move inwardly and onto the conductor as the collet moves along to exert greater contact with the conductor. After a period of movement, the collet comes to a position where it can no longer move further along or inwardly of the port and becomes fixed in position with respect to the conductor and port and exerts a gripping action on the conductor. At this point, in one embodiment, where no further lateral movement of the conductor or collet is possible, further movement of the clamping means inwardly of the port causes at least part of the collet to collapse inasmuch that the same moves inwardly towards the conductor and exerts a gripping action on the conductor.

[0015] The clamping means can be of any suitable form which allows the progressive movement of the same inwardly of the port of the connector body when it is required to clamp the conductor in position within the connector. In one embodiment, the clamping means is threaded and engages with a thread formed at the opening of the port such that rotation of the clamping means with respect to the connector body causes the same to progressively move inwardly of the port until the collet reaches a fixed position.

[0016] In use, it is important to ensure that the conductor is secured in the connector with the required tensile strength. In one embodiment a visual indication is provided on the connector to allow the fitter of the connector to be sure that the required tensile strength has been reached in securing the conductor in position. In an alternative and preferred embodiment, the clamping means are provided with a shearing feature such that when a predetermined selected clamping torque has been reached to cause the required tensile strength to be achieved, a portion of the clamping means shears thereby providing the visual indication required and, yet further, ensuring that the clamping means is not overly inserted into the container body. Furthermore the line of shear and shape of same can be such so as to leave the connector "clean lined" and available for the application of a shroud thereover and/or insulation via a heat-shrink material or moulded shroud without risk of the shroud being damaged by the line of shear.

[0017] In one embodiment the clamping means is provided with a shear line which shears when a predetermined clamping torque is exerted by the clamping means. Typically the clamping means comprises a main portion which is threaded for location with the connector body portion, a shear line and a detachable drive portion, which when the clamping means shears is detached from the clamping means. Preferably at the same time as, or after, the drive portion shears from the main portion of the clamping means, further detachment of the drive portion occurs to cause the same to split and hence be removable from the conductor. In one embodiment the shear line is formed so as to cause the splitting of the drive portion to occur or alternatively a separate shear line is included or, yet further, engagement means can be released to allow the drive portion to be detachable from the position round the conductor and hence leave only the main portion of the clamping means which is in contact with the connector body remaining.

[0018] Typically, when fitting the connector of the invention, the conductor ends are at least partially encapsulated in insulating material and, prior to the fitting of the connector, a portion of the insulating material at the conductor end is removed to allow the connector to be fitted thereon and bring about the electrical connection.

[0019] The collet, as previously stated, can be formed of one piece or formed from a number of components brought together around the conductor. The internal faces of the collet may be smooth or may be provided with protrusions thereon to improve the grip into the conductor. Yet further, the inner walls of the collet can be shaped to allow the receipt in a close fitting arrangement of the conductor. Thus, for example, if the conductor is of a circular cross section, then the inner walls of the collet will be curved in a similar manner so that a substantially circular passage is defined therein, or, if the conductor has a 90° or 120° sector shape, as is also possible in commercial use, the inner walls of the collet can be formed accordingly to receive the conductor in close fitting relationship. Alternatively, the inner walls of the collet and/or the body may be so formed as to be range taking inasmuch that they contact with a sufficient surface of the conductor to exert the gripping action thereon, regardless of the particular cross sectional shape of the conductor. Thus, it will be appreciated that the connector in accordance with the invention can be range taking and/or adaptable so as to take into account the dimensions and shapes of the conductors to be joined together.

[0020] Thus in the use of the connector in accordance with the invention, for each conductor end which is to be connected in the manner described, a clamping means and collet are inserted over and around the end of the conductor, said conductor and collet moved into a port in the connector and the clamping means engaged with and moved inwardly of the port, to move the

collet further inwardly of the frustoconically shaped port causing the collet to move onto the conductor as the collet moves along the port to exert greater contact with the conductor, and after a period of movement, the collet comes to a position where it can no longer move longitudinally of the port and further movement of the clamping means inwardly of the port causes at least part of the collet to collapse to exert a gripping action on the conductor.

[0021] Specific embodiments of the invention will now be described with reference to the accompanying drawings, wherein:-

Figure 1 illustrates the components of a connector in accordance with one embodiment of the invention.

Figure 2 illustrates in schematic fashion, cross sectional views of part of the connector and drive means along lines AA and CC respectively of Figure 1 required to form a connector for conductors in accordance with the invention;

Figures 3a and 3b illustrate a cross sectional view along line B-B of a collet in accordance with the invention, before and after use respectively in securing a conductor end;

Figure 4 illustrates the components of Figure 2 in position to secure a conductor end in the connector;

Figures 5a and 5b illustrate alternative embodiments of the collet arrangement in end elevation;

Figure 6 illustrates an elevation of the collet;

Figures 7a to 7e illustrate various embodiments of connector configurations in section, each configuration within the scope of the invention;

Figures 8 - 10 illustrate drawings of an embodiment of the connector body, collet and clamping means respectively;

Figures 11 and 12 illustrate the components of the Figures 8-10 in open and closed positions respectively, and

Figure 13 illustrates one form of clamping means drive portion.

[0022] Referring firstly to Figures 1 and 2, there are illustrated the components of one embodiment of the connector and in Figure 2 one end of the said connector.

[0023] There are illustrated conductor ends 2, 2' which are to be joined by the connector 4. The connector 4 is shown in section in Figure 2 and comprises a body with a port 6 defined at at least one end. The port is provided for the receipt of the conductor end 2 as indicated by arrow 8 and also receipt of a collet 10 which is placed onto the conductor as indicated by the arrow 12. With the collet and conductor end located in the port 6, the clamping means 16 which will already have been placed around the bared conductor end 2 can be rotated as indicated by arrow 18 so as to engage with a threaded section 20 in the port 6. As the clamping means is rotated, so it moves inwardly of the port as indicated by arrow 22 to a position as shown in Figure 4. Continued rotation of the clamping means 16 causes the collet to move along the frustoconically shaped walls of the port 6 and as it does so, the walls of the collet are forced inwardly towards each other so as to close the gap 25 as shown in Figure 3a and reach a point whereby the same can no longer move along the longitudinal axis of the port 6. At this point, continued rotation of the clamping means causes the portions 24A and 24B as shown in Figure 3a to partially collapse along the weakening sections 26 and by doing so, the same move onto the conductor and exert a gripping force on the same.

[0024] Figure 3A illustrates the formation of the collet before the tightening occurs and the position of the collet after the gripping effect is shown in Figure 3B.

[0025] The clamping means 16 is also preferably provided with a shear line 27, which, upon a predetermined and selected clamping torque being reached when the clamping means is turned, shears as illustrated in Figure 4. At this stage the connector collet is in the position and condition as shown in Figures 3b and Figure 4 to exert the required tensile and other clamping forces on the conductor so as to secure the same in the port. When the clamping means shears along the shear line 27 the drive portion 29 has sheared off and the fitter can be assured that the appropriate clamping torque has been reached. Typically the shear line 27 is defined by a weakened line with narrower cross section on the clamping means. The cross section size and shaping of the shear line 27 is predetermined with respect to the required clamping toque, the size of conductor, shape of the conductor, material used for the clamping means and indeed any relevant detail can be taken into account such that the drive portion 29 of the clamping means will shear off when the selected clamping torque on the collet and conductor is reached. This portion is therefore detachable from the connector leaving the main portion 31 in engagement with the connector and maintaining the clamping torque on the connector.

[0026] It should be appreciated that the process described with regard to Figures 1 to 4 can be repeated at the opposing end of the connector or, yet further, an alternative form of conductor fitting means may be provided for the other conductor end to be connected via the connector.

[0027] Figures 5a and 5b illustrate two forms of collet arrangement and Figure 5 illustrates that regardless of the internal shape of the collet, the external shape will be typically the same so as to allow the same to be acted

upon by the inwardly sloping walls of the port 6 in the connector which forces the walls of the collet together and onto the conductor. It should however be noted that the formations 24 need not always be of the same shape and equally, the cone shaped walls 30 of the collet portions equally need not be the same length at all times and, preferably, will be shortened as much as possible so as to allow the subsequent length of the connector to be shortened.

[0028] Figure 5a illustrates the collet in use to exert a clamping effect on a conductor 2 with a circular cross section. Figure 5b illustrates a collet with internal formations to accommodate a conductor 32 in the form of a sector cross section, in this case a 90° sector, conductor. Thus it will be appreciated that the internal area defined by the collet for the reception of the conductor can be formed to suit a particular conductor cross sectional shape. Although not shown, it is possible and in many cases may be preferable, for the internal surfaces of the collet which are to contact with the conductor, to be provided with ridges, teeth or other means which can move into the conductor material to improve the securing of the collet on the conductor during the clamping operation.

[0029] Figures 7a to 7e illustrate alternative embodiments of the connector in accordance with the invention. Figure 7a illustrates a connector body 34 in section with first and second ports 36, 38 which join onto each other and each is for the respective location of a conductor end therein in accordance with the invention. Figure 7b illustrates a connector body 40 with ports 42 and 44 which are not linked as shown. Figure 7c illustrates a connector body which is formed of two connector parts 46, 48, each connector part having a port 50, 52 respectively for the engagement of a conductor end in accordance with the invention and furthermore, each connector part is provided with an engagement formation 54, 56 which, when brought together as shown, allow the two connector parts to be joined together to form the connector body. Typically, a clamping means such as a clamping screw, not shown, is passed through the two formations 54, 56 to join the connector parts 46, 48 together. Figure 7e illustrates a branch connector body 57 with each of the ports 58, 60, 62 used to receive a conductor end. Figure 7d illustrates a terminal conductor body 63 in which the port 64 receives a conductor end which is secured therein in accordance with the invention, and a lug 66 is provided with means 68 to allow the same to be attached to apparatus to which the conductor end is used to supply electricity.

[0030] Figures 8-10 illustrate specific embodiments of a conductor body 100, collet 102 and clamping means 104 respectively.

[0031] Figure 11 illustrates the components of Figures 8 -10 in a fixing position for conductor ends (not shown) to be located in ports 106,106' respectively. Figure 12 illustrates how the clamping means 104 can be moved inwardly of the connector body 100 as indicated by arrows 105 to a closed or clamping position. At this stage, continued turning of the clamping means results in the drive portions 129 of the clamping means shearing along shear line 127 and additionally at the same time or thereafter along shear line 133 which is shown in Figure 13. The shear line 133 is provided to ensure that in addition to the drive portion shearing from the main portion 131 of the clamping means at the required clamping torque, the drive portion 129 splits in a manner to ensure that the split parts can be removed from the conductor completely and are not encircling the same. In one embodiment the shear lines 127 and 133 can be joined so as to form an integral shear line.

[0032] It should be noted that the form and path of the shear lines 27, 127 and 133 can take any suitable design form, the important requirement being that upon a selected clamping torque being reached, the drive portion shears from the main portion of the clamping means and shears in such as manner so that the drive portion is removable from the conductor.

[0033] Although not shown, it should be appreciated that the collet can be formed from more than one component, said components placed around the conductor to form the action required and herein described.

[0034] Thus it will be appreciated that the connector in accordance with the invention can be used for any conventional connection requirement but is provided in a form which represents significant advantages over the prior art.

Claims

1. A connector for the connection of the ends of at least two electrical conductors in an end to end manner to allow electrical connection between the said conductors, said connector including at least one body portion, said body portion having at least one port at one end thereof for the reception of a conductor end therein, a collet arrangement for location around said conductor and location within said port with the conductor and a clamping means engageable with the body portion such that movement of the clamping means to exert a clamping force with respect to the body portion causes the clamping means to move inwardly of the port and exert a moving action on the collet and **characterised in that** the movement of the collet causes the same to move to a fixing position in the body portion with respect to the conductor and/or connector body and causes the collet to exert a gripping action on the conductor and thereby secure the conductor in position within the connector.

2. A connector according to claim 1 **characterised in that** the connector is used to connect a number of conductor ends together, with port openings at each end which extend into the length of the connector

body, with a conductor end introduced into each port opening and secured therein with respective collet and clamping means arrangements.

3. A connector according to claim 1 **characterised in that** the body portion includes one port passing along the length thereof.

4. A connector according to claim 1 **characterised in that** the connector body portion includes two ports, one extending inwardly from each of the connector body ends.

5. A connector according to claim 1 **characterised in that** the connector is formed by two connector body portions which are arranged with a port protruding inwardly from one end of each and, at the other end, mutual engagement formations are provided which allow the two portions to be brought into contact and secured to form the connector.

6. A connector according to claim 1 **characterised in that** the connector comprises, at a first end, a port or number of ports and, at a second end, a port or number of ports to allow the connection of more than two conductor ends.

7. A connector according to claim 1 **characterised in that** the connector is provided with a port and clamping arrangement at one end and, at the other end, means for securing the connector to a terminal or other item of apparatus.

8. A connector according to claim 1 **characterised in that** the collet is formed from a number of components, and, in use, the components are placed on the conductor and positioned in the port with the conductor.

9. A connector according to claim 1 **characterised in that** the collet includes weakened lines and/or slots to allow compression of the same during the clamping of the same in position within the connector body.

10. A connector according to claim 1 **characterised in that** the collet is shaped so as to accommodate conductors of differing cross sectional shape and/or sizes within a known range of shapes and/or sizes.

11. A connector according to claim 1 **characterised in that** the clamping means is provided with a shear line which shears when a predetermine clamping torque is exerted by the clamping means.

12. A connector according to claim 11 **characterised in that** the clamping means comprises a main portion located with the body portion, a shear line and a drive portion, which when the clamping means shears is detached from the clamping means.

13. A connector according to claim 12 **characterised in that** upon shear the drive portion splits to be removable from the conductor.

14. A connector according to claim 12 **characterised in that** engagement means on the drive portion are releasable to allow the drive portion to be removed from the conductor.

15. A method of clamping a conductor end in a connector according to claim 1 **characterised in that** a clamping means and collet are inserted over and around the end of a conductor, said conductor and collet moved into a port in the connector and the clamping means engaged with and moved inwardly of the port, to move the collet further inwardly of the frustoconically shaped port causing the collet to move onto the conductor as the collet moves along to exert greater contact with the conductor, and after a period of movement, the collet comes to a position where it can no longer move longitudinally of the port and further movement of the clamping means inwardly of the port causes at least part of the collet to collapse to exert a gripping action on the conductor.

16. A method according to claim 15 **characterised in that** the clamping means is threaded and engages with a thread formed at the opening end of the port such that rotation of the clamping member with respect to the connector body causes the same to progressively move inwardly of the port until the collet reaches a fixed position.

17. A method according to claim 16 **characterised in that** the clamping means is provided with a shear line which is formed to shear upon a predetermined torque level being reached.

18. A method according to claim 17 **characterised in that** a portion of the clamping means shears off along the shear line when the predetermined torque level is reached.

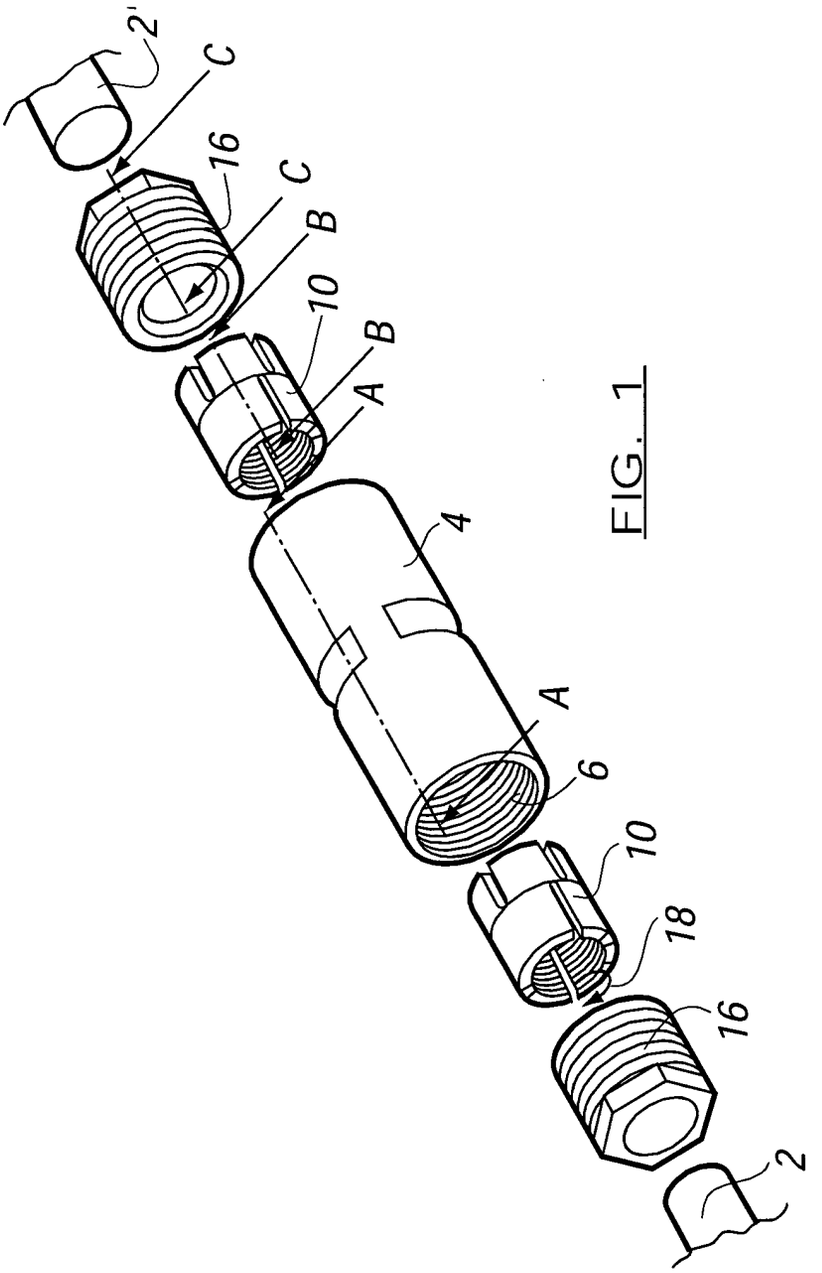


FIG. 1

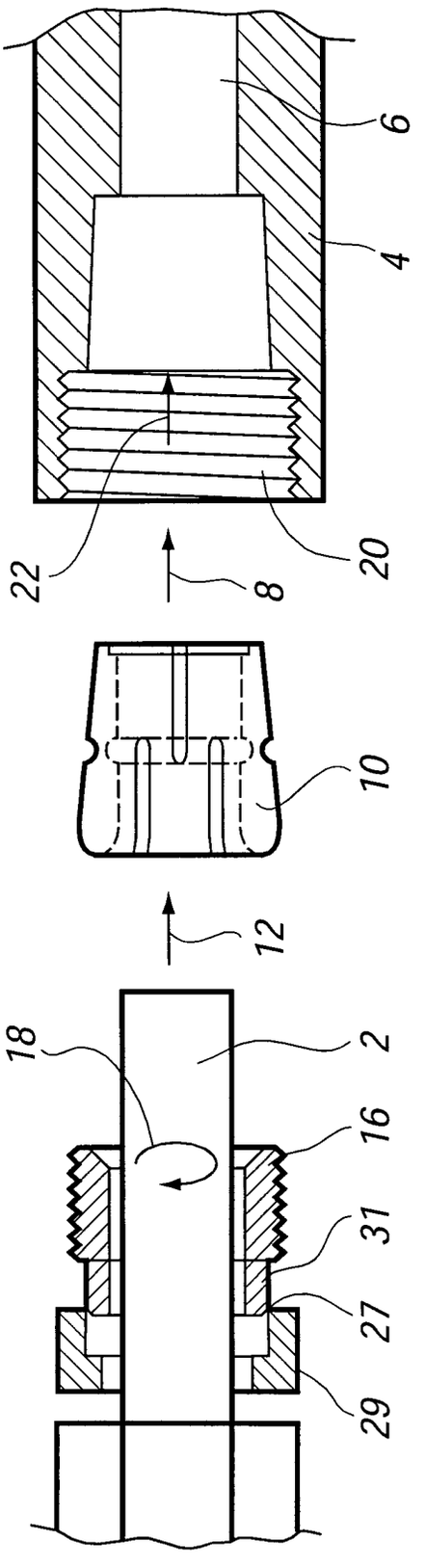


FIG. 2

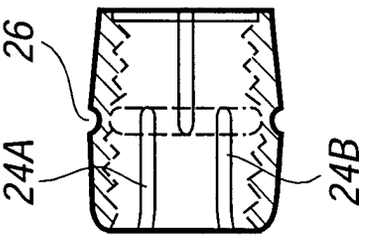


FIG. 3B

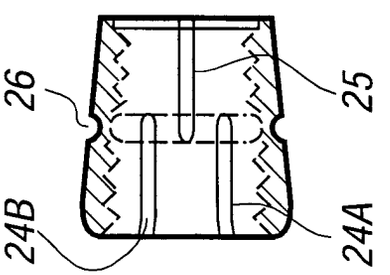


FIG. 3A

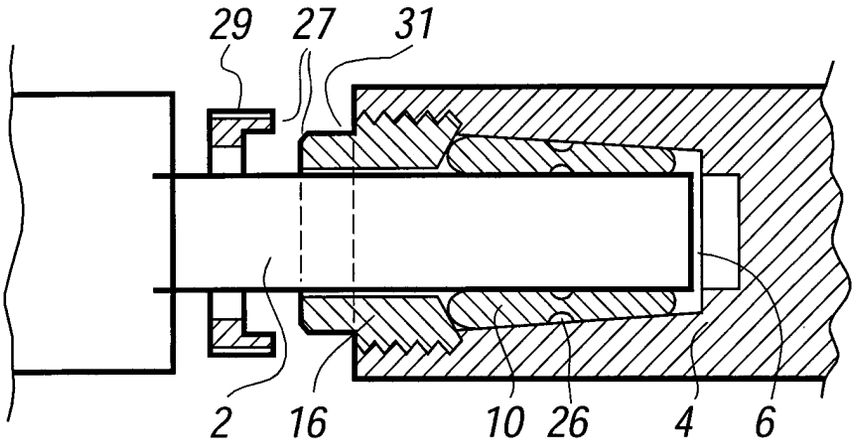


FIG. 4

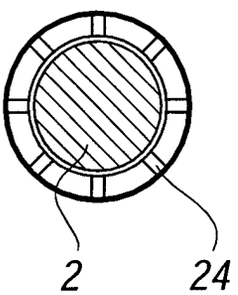


FIG. 5A

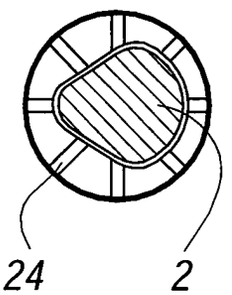


FIG. 5B

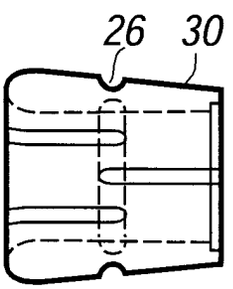


FIG. 6

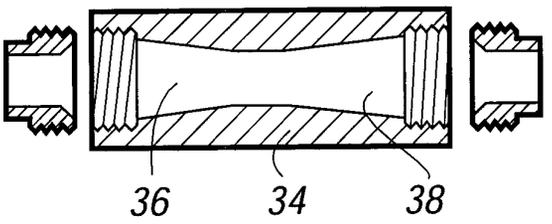


FIG. 7A

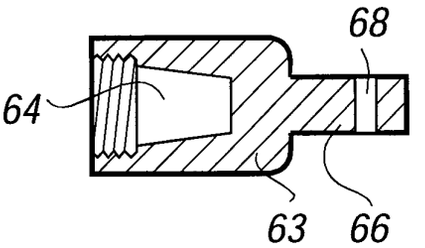


FIG. 7D

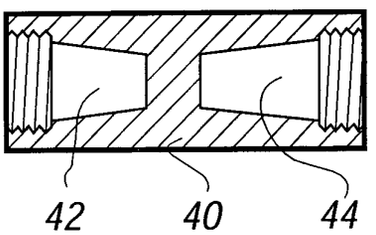


FIG. 7B

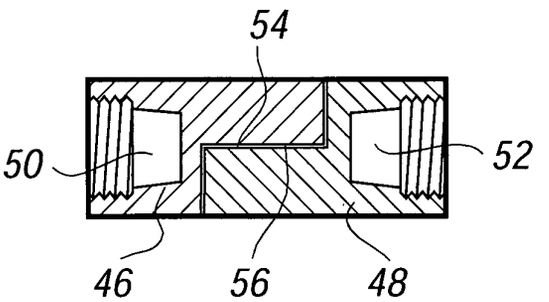


FIG. 7C

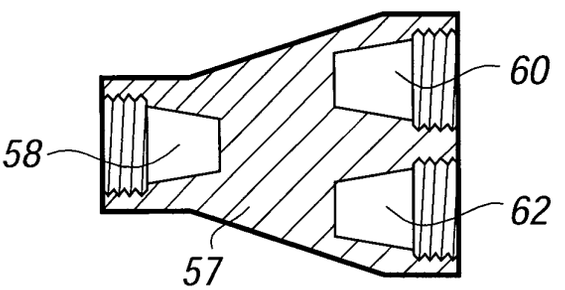
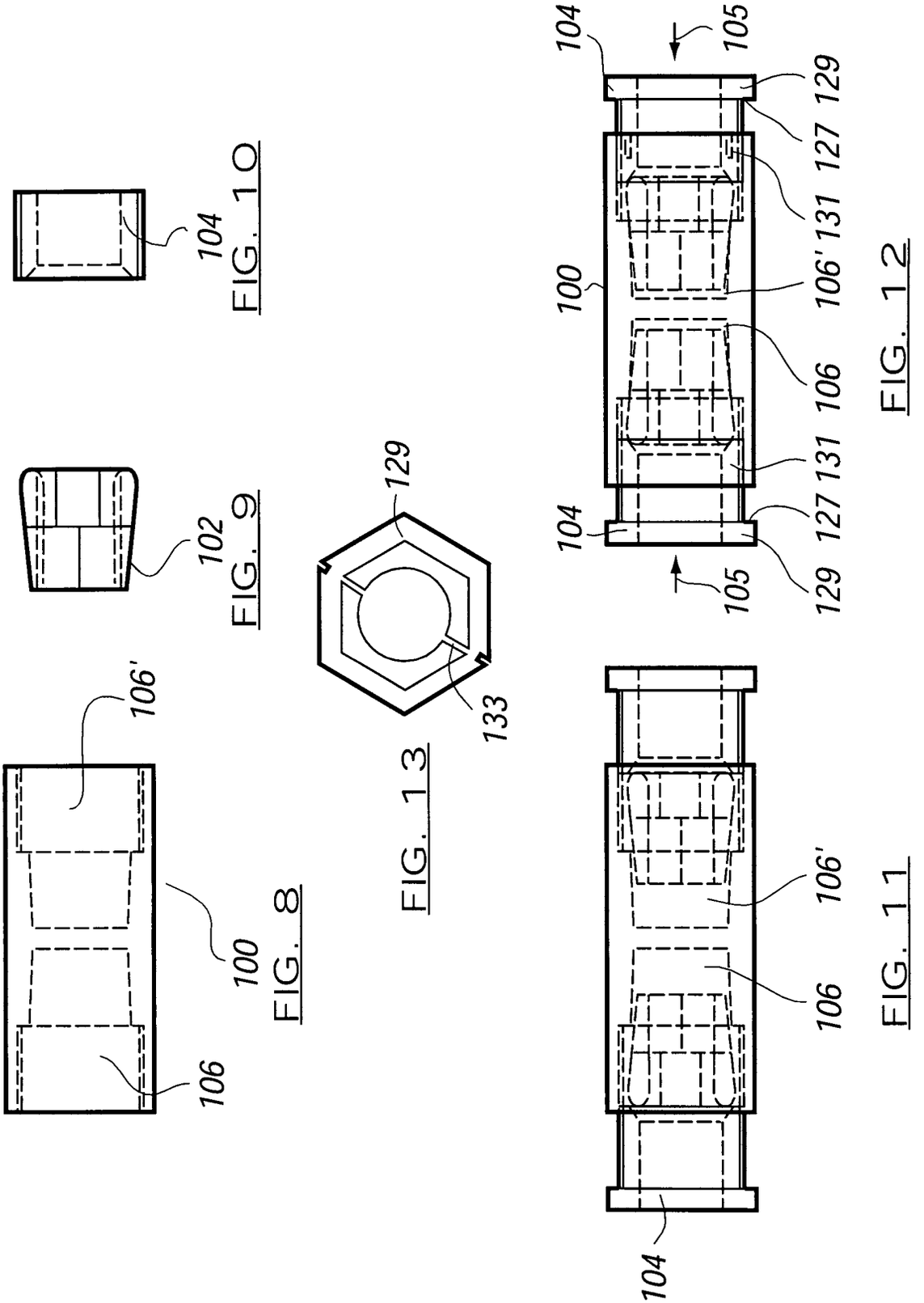


FIG. 7E


104
105
129
127
131
106'
106
100
104
105
129
127
131
106
106'
104
FIG. 12
FIG. 11
FIG. 10
FIG. 9
FIG. 8
FIG. 13
129
133
102
106'
100
106