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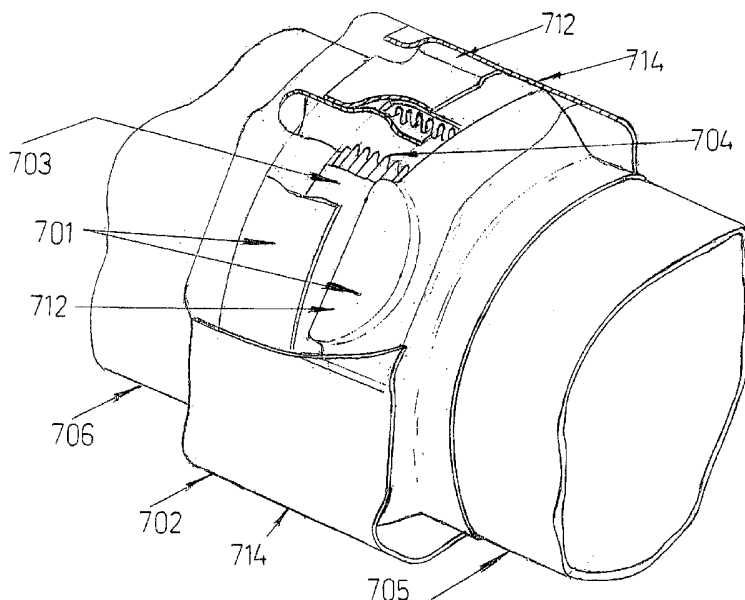
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(54) Title: JOINTS



(57) Abstract: A flexible joint (700) for joining two conduit parts (705,706) together to define a fluid conveying conduit. The flexible joint (700) comprises a tubular restraining sleeve (702), a first pair of diametrically opposed pivotable connections (708) between the restraining sleeve (702) and the first conduit part (705), and a second pair of diametrically opposed pivotable connections (708) between the restraining sleeve (702) and the second conduit part (706). The tubular restraining sleeve (702) is disposed radially outwardly over the conduit parts (705,706). Each of the pivotable connections (708) comprises a radially outward projection portion (712) formed on each respective conduit part (705,706,701), and a corresponding recess portion (714) defined in the restraining sleeve

(702) surface within which the radially outward projection portion (712) is engaged. An outer surface of the radially outward projection portion (712) defines a first bearing surface which slidingly abuts against a complimentary second bearing surface defined by the inner surface of the recess portion (714). In an alternative embodiment of a flexible joint (601, figures la-c) the restraining sleeve (600) is disposed radially inwardly inside the conduit parts (611,612), and the projection portion (604) projects radially inwardly and engages a depression (602) in the outside of the restraining sleeve (600). There is also disclosed a coupling (200-figures 4a-b) arrangement comprising inner and outer ring members (212,214) which are axially moved together by a worm arrangement (222) to clamp two conduit (202,204) ends together.



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-1-

JOINTS

5 This invention relates to a joint and a coupling for
a fluid conveying conduit.

10 Conventional flexible joints are used in conduits or
ducts for carrying fluids such as hot air, fuel and/or
water. In aircraft applications, these conduits are widely
used as to provide ducting for starting air to start the
engines and/or cabin air to convey pressurised air (or
15 other fluids) to and from the engines of the aircraft to
and around the air frame. The joints and associated ducting
are designed to withstand thermal expansion, loads
generated by internal pressures and vibrations caused by
engine vibrations, and provide a degree of flexibility and
movement.

20 Conventional joints comprise two main types, namely,
ball type joints or gimbal type joints.

 GB 1,603,914 describes a typical ball type joint
comprising a number (at least two) generally part spherical
annular sections or shells. A first annular segment is
25 structurally welded to one of the conduits with a second
then welded to the other conduit. The segments typically
slidingly overlap and fit over one another, or overlap and
fit over other further similar intermediate part spherical
segments, thereby connecting the ends of the conduits
30 together whilst allowing relative sliding about the part
spherical surfaces to provide some flexibility and movement
of the connection/joint. The overlapping of the segments
also provide the required fluid seal between the connected
conduits. In addition a bellows sleeve may be welded to
35 ends of the conduits to join the conduits and provide a

-2-

further fluid seal between the conduits.

Whist such an arrangement provides a flexible joint and connection between the conduits, the connection can be relatively stiff and difficult to articulate in particular
5 under load. This is due to the high friction developed between the overlapping surfaces of the segments. The connection can also be relatively difficult to assemble as well as requiring structural welding of the segments to the ends of the conduits which is difficult and requires
10 subsequent inspection.

In gimbal type joints a structural gimbal ring is located concentrically with the ends of the conduits. The gimbal rings supports and locates two pairs of gimbal pins about orthogonal diametric axes of the gimbal ring. The
15 gimbal ring may be internally or externally located from the conduits. The gimbal pins engage respective pairs of flanges structurally welded and joined to the respective ends of the respective ends of the conduits. This provides a flexible structural connection between the two ends of
20 the conduits through articulation of the gimbal pines, gimbal ring and flanges whilst holding the ends of the conduits together. A bellows sleeve is welded to ends of the conduits to join the conduits and provide a fluid seal between the conduits. The bellows however carries no
25 substantial structural load which is carried by the gimbal arrangement. Examples of such gimbal type joints are described in for example US 3915482, US 4508373, GB 2029537, GB 855384, and GB 875323.

Such gimbal joints are much more flexible than ball
30 joints. The joints however are assembled from multiple components and manufactured as a complete joint which is subsequently permanently attached to the engine and airframe by welding, brazing or soldering. The manufacture and subsequent assembly of the ducting and associated
35 joints in the airframe requires a large number of

-3-

manufacturing steps and inspection/testing steps which render the application of ducting and associated joints expensive in air frame manufacturing and maintenance. Gimbal arrangements also require a large number of small parts and structural welding of the gimbal elements, which carry the loads to the conduits. This increases complexity and manufacturing costs.

A variation of such gimbal arrangements is described in GB 1255480. This discloses a flexible joint for conduit parts which comprises a gimbal joint formed by a four armed cross-piece or spider positioned within a pair of diametrically opposed, axially extending curved lugs at one end of a conduit part and within a similar pair of lugs at another end of another conduit part, a clearance being present between the lugs to allow independent movement of the conduit parts relative to one another. The end faces of each arm of the cross-piece are connected by an integral pivot pin to one of the lugs respectively. This construction however has the further disadvantage that to form the joint, the end parts of the conduits must first be made in two halves, split longitudinally and then welded together after assembly of the spider. This is complicated, labour intensive and requires the use of tools (such as welding equipment) to form the joint. In addition, the spider forms an obstruction to the fluid conveyed through to the joint which results in large pressure losses over the joints which is undesirable.

Conventional couplings comprise a V-shaped clamp. GB854629, and GB 1104922 shows such a coupling. These couplings have the important disadvantage that they provide an uneven pressure around a V-flange which causes sealing, fitting and dismantling defects. In these V flange arrangements the ends of the conduits also overlap, with one end fitted inside the other, to provide a good seal between the conduits. This however makes assembly and

disassembly difficult. The V clamp, is also generally removed from the conduits when disconnected with the result that it may in use become misplaced.

5

The invention seeks to address the above described problems and/or to provide improvements to such arrangements generally.

10

According to a first aspect of the invention, there is provided a conduit joint as described in the accompanying claims.

15

According to a second aspect of the invention, there is provided a coupling as further described in the accompanying claims.

20

In an aspect of an embodiment of the invention, there is provided a flexible joint for joining fluid conveying conduit parts comprising bearing means provided in relation to the end portions of the respective conduit parts, the bearing means comprising, for each conduit part, diametrically opposed pivotable connections with the connections being angularly displaced by approximately 90 degrees from one conduit part relative to the other conduit part, the pivotable connections comprise first pivot members being provided on the conduit parts and corresponding second pivot members, wherein a restraining sleeve is provided over the bearing means, the second pivot members being provided on the sleeve.

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The restraining sleeve restrains the bearing means as the joint is subjected to an internal pressure by the fluid conveyed through the conduit parts. The configuration of the joint is such that the joint is of a compact configuration which significantly reduces the amount of

space required for the joint in comparison to conventional joints.

The first and second pivot members may each comprise a bearing surface. The bearing surfaces may be in contact
5 with one another to provide pivotal movement of the joint.

In this way, the joint provides free pivotal movement of the conduit parts relative to one another in any direction. This advantageously prevents stresses in the ducting caused by vibrations and other movements of the
10 conduit parts.

The joint is preferably configured in such a way that, upon expansion of the conduit parts, the configuration of the bearing surfaces and the resultant force on the restraining sleeve causes the sleeve to deflect whereby the
15 bearing surfaces remain in contact. This prevents the joints from disengaging in use due to the working pressures inside the joint. As the load inside the joint is restrained by the sleeve, the bearing surfaces remain in contact and secure the joint structure. In normal
20 operational conditions, the joint is configured in such a way that the sleeve only deflects within its elastic range, so that the sleeve can return to its original configuration as the pressure inside the joint is below a certain level. The restraining sleeve is deflected in an opposite
25 direction to its in use deflection to assemble the joint.

The joint may also comprise a sealing member, in particular a bellows member. The bellows member may be connected to the conduit parts to thereby seal the joint. The bellows are preferably located inside the sleeve. This
30 has the important advantage that the bellows are protected from external conditions which could otherwise cause puncturing or damage to the bellows. In addition, this arrangement is compact and thus reduces space and weight of the overall construction of the joint and associated
35 ducting.

-6-

The first pivot member may be connected to the conduit part by welding, brazing or soldering. Alternatively, the first pivot member may be integrally formed with the conduit part. The first pivot member may comprise an approximate part cylindrical shape. The second pivot member may comprise a complementary shape to allow pivotal engagement between the bearing surfaces of the first and second pivot members.

The second pivot member may be integrally formed with the restraining sleeve. Alternatively, the second pivot member may be connected to the restraining sleeve by appropriate members such as welding, brazing or soldering.

An internal support sleeve may be provided between the conduit parts. The internal support may be connected to the first pivot member of one of the conduit parts. Alternatively, the internal support may be integrally formed with the first pivot member of one of the conduit parts. The internal support provides additional sealing of the joint. The support sleeve may comprise a depression along its perimeter to reinforce the sleeve.

The first pivot member may comprise a sleeve which is connected to the conduit part. The conduit part comprises a projection for retaining the first pivot member on the conduit part. This facilitates assembly of the joint as it defines the location of the pivot member.

The joint thus comprises a limited number of parts.

To manufacture the joint, the conduit parts are each provided with a projection in the form of a shoulder around the end portion of the conduit part. A first pivot member is provided on each conduit part, the pivot member being formed to engage with the second pivot member on the sleeve. The first pivot members are each welded to the conduit parts. The bellows member is welded on the shoulders of the conduit parts. The second pivot member may be connected to the sleeve. During assembly, the sleeve is

-7-

deflected in a direction which is approximately opposite to its in-use deflected position to slide the sleeve over the first pivot member such that the first and second pivot member engage with their respective bearing surfaces. In
5 this way, the joint is assembled and is ready for use.

In a further aspect of an embodiment of the invention, there is provided a flexible joint for joining fluid conveying conduit parts. The conduit parts comprise
10 approximately part spherical end portions. The end portions of each conduit each comprise a pair of diametrically opposed first pivot members. The joint further comprises a restraining sleeve comprising two pairs of diametrically opposed second pivot members which are adapted to engage
15 with the first pivot members. The first pivot member comprises a bearing surface. The bearing surface may be of an approximate semi-cylindrical shape to allow pivotal movement in relation to the second pivot member. The bearing surfaces of the first and second pivot members are
20 preferably complimentary. Sealing members which may comprise a bellows member may be further provided to interconnect the conduit parts, the bellows member being provided inside the part spherical end portions of the conduit parts.

25 The first pivot member may be connected to the end of the conduit part by means of welding, soldering or brazing. The second pivotal member may be connected to the restraining sleeve by means of welding, soldering or brazing.

30 Preferably the part-spherical end portions overlap to provide additional sealing of the joint in addition to the sealing as provided by the bellows member.

In a yet further aspect of an embodiment of the

-8-

invention, there is provided a flexible joint for a fluid conveying conduit comprising a connection member adapted for insertion in the conduit to connect together two adjacent parts of the conduit. The joint comprises bearing means provided between end portions of the connection member and the respective parts of the conduit, the bearing means comprise, for each conduit part, diametrically opposed pivotable connections with the connections being angularly displaced by approximately 90° from one conduit part relative to the other conduit part, the pivotable connections comprising first pivot members being integrally formed by the end portions of the connection member and corresponding second pivot members provided on the conduit parts.

The pivot members may be shaped so as to enable insertion of the pivot members within the sleeve without the use of tools. This greatly simplifies the assembly of the joint and obviates the need for cutting, brazing, welding or soldering which may introduce additional failure modes in the joint and/or conduit construction.

Preferably the second pivot members may comprise diametrically opposed second depressions, the first pivot members comprising corresponding diametrically opposed first depressions for engaging with the second pivot members.

The depressions may be of an at least part circular or cylindrical shape to enable rotation or at least part rotation of the conduit parts around the pivotable connections. The second pivot member may be provided on one end part of the conduit part.

The connection member may also comprise a depression which protrudes from the surface of the connection member and which engages with similar protrusions on the end parts of the conduit parts to form a flexible gimbal joint.

The connection member may also comprise one or more reinforcement sleeves. The sleeves reinforce the connection member. The sleeve may be integrally moulded with the connection member and/or depressions.

5 A central continuous depression may be provided along the perimeter of the connection member. The central depression may further reinforce the connection member and provide additional stiffness to the connection member.

10 In a yet further aspect of an embodiment of the invention, there is provided a flexible joint for a fluid conduit comprising a tubular connection member adapted for insertion in the conduit to connect together two adjacent parts of the conduit, the joint comprising bearing means
15 provided between end portions of the connection member and the respective parts of the conduit, the bearing means comprising, for each conduit part, diametrically opposed pivotable connections with the connections being angularly displaced by approximately 90° from one conduit part
20 relative to the other conduit part, the pivotable connections comprising first pivot members being integrally formed by the end portions of the connection member and corresponding second pivot members provided on the conduit parts, the connection member allowing unobstructed passage
25 of the fluid through the member.

 The joint may also comprise a sealing member for sealing the joint. The sealing member may comprise a bellows member. The bellows member may be provided over and around the joint and connected to the conduit parts. The
30 sealing member may further comprise a pair of sleeve members which are provided over the bellows member to cover and protect the bellows member. The sleeve members may engage with one another, preferably by means of an overlap of the respective sleeve members. The bellows member forms

-10-

the primary seal of the joint. The sleeve members provide a secondary seal and control leakage in case the bellows member fails. The sleeve members also protect the bellows members from being damaged. The bellows or sleeve members
5 may be brazed or soldered or welded onto the adjacent conduit parts. The loads on the conduit parts are generally carried by the connection member.

In a yet further aspect of an embodiment of the
10 invention, there is provided a joint for a fluid conduit comprising a connection member adapted for insertion in the conduit to connect together two adjacent parts of the conduit, the joint comprising bearing means provided
15 between end portions of the connection member and the respective parts of the conduit, the bearing means comprising, for each part, diametrically opposed pivotable connections with the connection being angularly displaced by 90° from one part relative to the other part, the
20 pivotable connections being formed by integral pivot members on the end portion of each connection member and the conduit parts. Covers may be provided over the bellows member to protect this member.

In the above described aspects of embodiments of the
25 invention a joint is provided which has a minimal number of parts. This joint is therefore of a significantly less complicated construction and more cost efficient to produce than conventional joints. Also, the joint has a
30 significantly reduced number of failure modes present in the joint due to the absence of brazed, welded or soldered connections in the construction of the joint.

Conventional individual flexible joints are thus also improved eliminated by utilising the ends of ducts or pipes as part of the joint and introducing only a single

-11-

structural member capable of restraining the end load generated by the internal pressure, without load carrying welds, brazed or soldered joints.

5 The flexible joint described forms essentially a hybrid gimbal and ball joint combining the advantages, and reducing the disadvantages, of both types of joint. The ends of the ducts provide angulation over 360° based on Hooke's universal coupling principle of four pivots, equally spaced around the circumference of the end of the
10 ducts, which function as bearings between duct pivots and connection member pivots. Thus, the pressure end load generated from the effective diameter of the bellows provided over the joint is retained whilst allowing full 360 degree deflection. Juxtaposition of the connection
15 member in relation to the ducts allows the required angulation but prevents the connection member from deforming beyond the proof stress (recoverable deflection) when loaded by the internal pressure as caused by the fluid inside the joint.

20 The significant technical and commercial advantages of the flexible joint over conventional systems are that no structural welds are necessary which require subsequent verification as the joint is an integral part of the duct or pipe. The only welds present in the joint assembly are
25 welds for attaching the sealing member or bellows member or sleeve members over the joint. These members are of a non-structural nature as the loads on the conduit parts are generally carried by the connection member. Finally, the restraining structure for restraining the pressure end load
30 is of a simple construction. This results in a significant improvement in structural reliability.

Advantageously, the flexible joint only consists of four parts, a restraining sleeve/connection member, two ducts or conduit parts and a bellows member. In addition,

-12-

two additional sleeve members one part-overlapping the other may be provided over the bellows member to provide a further seal of the joint.

5 The flexible joint does not require any welding to assemble the joint. This results in a substantial reduction in manufacturing costs in comparison to conventional ducts. The ducts may be manufactured in complete lengths and then be adapted to form flexible joint sections by cutting the ducts and shaping the end portions to form the connectors.
10 The only additional structural member is the connection member which is fitted without welding. An advantageous property of the assembly is that full heat treatment may be undertaken before assembly.

15 The ducts as hereinbefore described provide flexibility in the ducting, by eliminating individual joints and integrating flexible sections as part of the duct thereby excluding all structural welds associated with attaching joints.

20 By providing the joints as hereinbefore described, the total manufacturing cost for manufacturing ducting is substantially reduced to less than 50% of current conventional ducts. The ducts can be manufactured as complete lengths or a reduced number of lengths from a present standard. The ducts can then subsequently be adapted for applications in flexible sections by parting
25 and shaping the sections to form the connectors.

30 An important advantage of the joint as hereinbefore described over conventional joints is that the joints are assembled without welding. This allows the ducting to be completely formed without any subsequent welding and allows the ducting to be fully heat treated, before assembly, in more convenient lengths than current conventional assemblies. Also, bellows fatigue life is not adversely affected by the manufacturing process of the ducting.

-13-

Welding of the ducting is reduced to an absolute minimum as the only welding present in the ducting is the seal weld of the bellows. In addition, tooling is significantly reduced in comparison to conventional manufacturing and assembly techniques, along with the absence of a number of manufacturing and assembly processes as used in present duct assemblies. This significantly reduces the overall cost of manufacturing the ducting and also allows the ducting to be produced more efficiently and cost effectively.

In addition, the joints provide damping. This avoids fretting (high frequency vibration wear at low pressures) of adjacent structural parts which is inherent in all conventional gimbal joints. Furthermore, the joints as hereinbefore described provide compression and angular stops, have minimum pressure drop, have no torque through the bellows and the bellows are externally protected with controlled leakage should bellows fail.

The weight of the flexible joint is lowered in comparison to conventional joints for similar operating conditions. Flexible sections can be provided with varying bending moments, from low bending moments (gimbal joints) to high bending moments (ball joints). The no-weld flexible joint has excellent structural integrity, whereas most individual joints have highly stressed welds, particularly internally restrained, with no satisfactory method of inspection.

There are thus provided joints for joining fluid conveying conduit parts as hereinbefore described.

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In a yet further aspect of the invention, there is provided, in an embodiment, a coupling for joining or coupling fluid conveying conduit parts, each conduit part comprising a projection, the joint comprising a sleeve

-14-

adapted to engage with the respective projections, wherein the sleeve comprises an inner ring for engaging with the first projection and an outer ring for engaging with a second projection, the joint comprising means for moving
5 the inner ring and the outer ring relative to one another whereby the inner ring is axially movable in relation to the outer ring to thereby clamp the conduit parts together.

The moving means may comprise a worm wheel rotatably mounted on the outer ring and the inner ring comprises
10 means for engaging with the worm wheel to move axially in relation to outer ring. In this way, the inner ring is effectively clamped against the outer ring thereby clamping the conduit parts together to provide adequate sealing of the joint.

15 The inner ring and the outer ring comprise inter-engaging surfaces. Preferably, the surfaces are in the shape of a tongue and groove, the tongue and groove being helical (the tongue and groove extending axially as well as tangentially along the inner perimeter of the inner and
20 outer rings) to allow clamping of the conduit parts as they are retained between the inner ring and the outer ring. As the worm is rotated, the inner ring is moved in relation to the outer ring thereby moving axially. This causes clamping of the conduit parts.

25 The first projection and/or second projection may comprise a member for sealing the joint. The sealing member may comprise a ring formed of an elastic material. The seal may be expandable under load to seal the joint.

The outer ring may be connected to the second
30 projection. The outer ring may be connected to the conduit part by means of welding, brazing or soldering.

The joint may be a fixed joint for securely interconnecting ducts. It is understood that this joint or coupling has a wide range of applications which are not

limited to aerospace applications.

The inventions as herein described are suitable for providing flexible joints in high temperature ducts or pipes, particularly bleed air systems in aircraft. The joints are adapted to overcome installation tolerances and withstand thermal expansion and vibration whilst conveying air or fluid under pressure with zero leakage.

The invention will now be described by way of example only and with reference to the accompanying drawings in which:

Figure 1a is a part cross sectioned side view of a flexible joint according to a first embodiment of the invention;

Figure 1b is an axial end view of flexible joint shown in figure 1a;

Figure 1c is an exploded perspective view of a duct end and connector member of the flexible joint shown in figures 1a and 1b;

Figure 2a is a part cross sectioned side view of a flexible joint according to a second embodiment of the invention;

Figure 2b is an axial end view of flexible joint shown in figure 2a;

Figure 2c is a perspective view of the flexible joint shown in figures 2a and 2b;

Figure 2d is a part cutaway perspective view of the flexible joint shown in figure 2c showing the internal elements;

Figure 3a is a part cutaway perspective view, similar to that of figure 2d and showing the internal elements, but of the flexible joint according to a third embodiment of

-16-

the invention;

Figure 3b is a part cross sectioned side view of a flexible joint shown in figure 3a;

Figure 3c is an exploded perspective view of the
5 connector flanges of the flexible joint shown in figures 3a and 3b;

Figure 4a is a perspective view of a coupling according to a further aspect of the invention;

Figure 4b is a part cross sectional view of the
10 coupling shown in figure 4a.

Figures 1a,b and c show a flexible joint 601 including an internally located connection member 600 in accordance
15 with a first embodiment of the invention. The connection member 600 comprising an internally located restraining sleeve comprises depressions 602 of approximate semi-circular shape. The depressions 602 engage with the semi-circular depressions 604 that are provided in the
20 corresponding conduit parts 611,612. The connection member 600 further comprises a central depression 603 along the perimeter of the connection member 600 to facilitate assembly of the flexible joint 601. A bellows 605 is fitted over the joint 601 to provide sealing of the joint 601. The
25 bellows 605 provides a primary seal to the joint 601. A bellows cover 606 is fitted over the joint 601. The bellows cover 606 forms the secondary seal, to protect the bellows 605 against damage and provide a controlled leakage should the bellows fail. The bellows cover 606 is in two
30 overlapping parts 608,610 with each part being sealed to a respective conduit part 611,612. The flexible joint 601 is assembled by placing the connector 600 and conduit parts 611,612 in their desired positions relative to one another. Subsequently, the corresponding depressions 604,602 are

-17-

provided in the conduit parts 611,612 and the connector 600 to form the joint 601.

Alternatively, the conduit parts 611,612 and the connector 600 are pre-manufactured. This obviates the need for any special equipment upon assembly of the flexible joint on site as the connection member 600 is directly inserted into the conduit parts 611,612 to assemble the joint 601.

After interconnecting the conduit parts 611,612, the bellows 605 is slid over the joint and is welded or brazed or otherwise adhered to the conduit parts 611 and 612. The bellows cover parts 608,610 are each brazed or soldered or otherwise adhered to the conduit parts 611,612. The joint 601 is then ready for use.

To manufacture and/or assemble the flexible joint 601, two inward facing indentations, depressions or dimples 604 are formed in each duct 611,612 and with the pair of dimples 604 of the two duct parts 611,612 being rotated over 90° relative to one another. The connection member 600 is formed to include the corresponding depressions or recesses 602 to accommodate the dimples 604 to provide 360 degrees rotational movement between each duct 611,612. The connection member 600 is pushed into the duct or conduit 611,612 and twisted to locate the dimples 604 in the and to interconnect the ducts 611,612. This is followed by the bellows member 605 being slid over the sub-assembly and attachment of the bellows member 605 to the outer surface of the ducts 611,612.

The joint 601 provides angulation of the conduit parts 611,612 over a range of $\pm 10^{\circ}$. The angulation prevents vibration induced wear and tear to the ducting. The joint 601 is sealed by means of the bellows 605. In addition, the bearing surfaces of the pivot members 604,602 provide additional sealing of the joint 601.

-18-

Figures 2a-d show a flexible joint 700 for joining fluid conveying conduit parts 705,706 in accordance with a second and preferred embodiment of the invention. The joint 700 comprises bearing means 710 which are provided in relation to the end portions of the respective conduit parts 705,706. The bearing means 710 comprise for each conduit part 705,706, diametrically opposed pairs of pivotable connections 708 with the pairs of connections being angularly displaced by approximately 90° from one conduit part 705 relative to the other conduit part 706.

The first pivot members 712 of the pivotable connections are integrally formed in connector flanges 701 which are provided on the conduit parts 705, 706. The connector flanges comprise part tubular/cylindrical elements having a generally part spherical shape and which are fitted over and located on the ends of the conduit part 705,706. It will however be appreciate that they could comprise similarly shaped integral parts of the conduit parts themselves. The pivotable connections 708 further comprise corresponding second pivot members 714 which engage with the first pivot members 712. The second pivot members 714 are provided on a tubular restraining sleeve 702 which is provided radially outwardly over the conduit parts 705,706 and over the joint 700. The second pivot members 714 are integrally formed with the restraining sleeve 702.

More specifically, and as shown the first pivot member 712 comprises a radially outward projection portion formed on connector flanges 701. This projecting portion is preferably press formed from the tubular cylindrical connector flanges 701. The second pivot member 714 comprises a recess portion defined in the restraining sleeve 702 surface within which the radially outward projecting portion is engaged, and generally corresponding

-19-

to the shape of the projecting portion. This recess portion is similarly preferably press formed in the restraining sleeve 702. An outer surface of the radially outward projection portion defines a first bearing surface which
5 slidingly abuts against a complimentary second bearing surface defined by the inner surface of the recess portion. This sliding engagement of the two bearing surfaces allows the joint to articulate. Preferably, and as shown the bearing surfaces comprise arcuate portions extending
10 radially and around which the connector flanges 701 pivot and articulate. In addition the bearing surfaces also comprise a further axially extending end surface of the projecting portion and axially extending inner surface of the restraining sleeve 702, which are perpendicular to the
15 arcuate bearing surfaces, and which by their abutment support and located the restraining sleeve 702. These additional bearing surfaces supporting the sleeve 702, whilst slightly increasing frictional resistance to articulation, reduced vibration in the joint. In addition
20 since the sleeve 702 is supported it does not have to be self supporting and only generally needs to carry an axial loading. As a result it can be of a lighter weight as compared to ring elements of conventional gimbal joints. In particular it can simply be fabricated and press formed
25 from sheet material. It should also be noted that the bearing surfaces provided by the projections and recess are significantly larger than the typical bearing surfaces provided by the associated pins or bearings in conventional gimbal type joints. Typically the bearing surfaces may be
30 two or three times as large. This again reduces vibration and wear problems. In particular the nominal diameter of the projecting portion is significantly greater than that of a typical pin bearing of a conventional gimbal joint.

The recess portion defined in the restraining sleeve

-20-

extends axially along the restraining sleeve 702 to open at one axial end of the restraining sleeve. In particular the recess portions associated with the first pair of pivotal connections open are open at one axial end of the
5 restraining sleeve 702 and the recess portions defined in the restraining sleeve 702 associated with the second pair of pivotal connections open are open at an opposite axial end of the restraining sleeve 702. This allows the projecting portions of the first pivotal members 712 to be
10 slid axially into the recess 714 through the respective ends during assembly, until they abut against the closed ends of the recess portions where they are located.

The conduit parts 705,706 each comprise a projection or shoulder rib 707 which is provided on the end part of
15 the conduit parts 705,706. The shoulder 707 helps to locate the connector flanges 701 during assembly of the joint 700 and they retain the pressure load through the end flanges 701. In addition, bellows 704 for sealing the joint and which are concentrically located on the conduit parts, are
20 connected to the shoulder 707. The bellows 704 are connected to the shoulder 707 by means of a weld, braze or seal bellows cuff (not shown).

The joint 700 further comprises an internal support 703 which is connected to the flange 701 of conduit part 705.
25 This internal support 703 provides further support to the joint structure 700. The internal support 703 provides an additional seal in the event that the bellows 704 may fail, and also protects the bellows 704. The internal support 703 is optional. In addition the internal support may be
30 joined to and comprise a part of either of the connector flanges 701. In particular as for example shown and described further below in figures 3a-c.

To manufacture and assemble the joint 700, flanges 701, conduit parts 705,706, bellows 704 and restraining sleeve

-21-

702 are formed. Each end flange 701 is located over the conduit parts 705,706 and the shoulders 701 are formed in each part 705,706 to retain the pressure load through the end flanges. The restraining sleeve 702 is located over the end flange 701 of conduit part 705 so that the second pivot members 714 of the sleeve 702 are located over the first pivot members 712 of the flange 701.

The bellows 704 are then connected to the conduit part 705 by welding or brazing or otherwise sealing of the bellows cuff and the internal support 703 is located over the bellows 704. The opposite end of the bellows 704 is then connected to the second conduit part 706 by welding or brazing or otherwise sealing of the bellows cuff. Finally, the end flanges 701 are slid along the conduit parts to the shoulders 707 and the restraining sleeve 702 is located over the pivot members 712 of the second conduit part 706 to form the joint. The restraining sleeve 702 when engaged by the pivotal conceptions 708 restrains and axially located the connector flanges 701 axially on the ends of the conduit parts 705,706 and abutting against the shoulders 707. This abutment of the inner diameters of the connector flanges 701 on the outside of the conduit parts 705,705, and against the shoulders provides a further seal and sealing of the joint 700.

The joint 700 is configured in such a way that, upon expansion of the conduit parts 705,706 in response to the internal pressure inside the joint, the configuration of the bearing surfaces 710 and the resultant force on the restraining sleeve 702 causes the sleeve 702 to deflect whereby the bearing surfaces 710 remain in contact. This prevents the joint 700 from disengaging in use due to the working pressures inside the joint 700. In normal operational conditions, the joint 700 is configured in such a way that the sleeve 702 only deflects within its elastic

-22-

range, so that the sleeve 702 returns to its original configuration if the pressure inside the joint 700 reduces.

Specifically a first pair of pivotal connections 708 associated with the first conduit part 705 are disposed, when the joint is assembled such that they bear and load against an axial position towards one axial end of the restraining sleeve 702 nearest to the first conduit part 705. The second pair of pivotal connections 708 associated with the second conduit part 706 are disposed, when the joint is assembled such that they bear and load against an axial position towards the other opposite axial end of the restraining sleeve 702 nearest to the second conduit part 706. The open ends of the respective recess portions then open put at the respective other ends of the restraining sleeve 702. The configuration of the joint 700 is thus such that as a load is applied to the joint 700, the bellows 704 and conduit parts 701 expand. As the restraining sleeve 702 effectively maintains the joint 700 in place, the sleeve 702 provides a resultant force inwards on the first pivot member 712. This causes the restraining sleeve 702 to deflect outwardly at the respective connections 708 causing the sleeve 702 to effectively pivot approximately around the bearing surfaces. As the deflection occurs on each axial side of the restraining sleeve 702, and spaced at the respective circumferential positions this causes the structure of the sleeve 702 to twist circumferentially and axially. This twisting of the sleeve is however in a direction such that the pivotal connections 712 are further retained within the recesses defined in the sleeve 702. During normal operation, the deflection or twist is within the elastic deformation range of the sleeve 702. This ensures that the sleeve 702 restrains the joint to prevent the joint 700 from becoming undone.

To disassemble the joint 700, the sleeve 702 is

-23-

deflected or twisted in an opposite direction. This causes the second pivot member 714 to disconnect from the surface of the first pivot member 712 thereby allowing dis-assembly of the sleeve 702 over the joint 700. Similarly, to
5 assemble the joint 700, the restraining sleeve 702 is deflected in an opposite direction to the in-use deflection. This allows the sleeve 702 to be located over the first pivot members 712 to secure the joint 700.

Figures 3a-c show a flexible joint 700' for joining
10 fluid conveying conduit parts 705', 706 in accordance with a third embodiment of the invention. This is generally similar to the embodiment shown and described in figures 2 a-d above. It will therefore not be described in detail. Like references for like parts, but denoted by an ' will
15 also be used. The main difference is in that the connector flanges 701' comprise inner 701b and outer 701a overlapping part spherical elements. Accordingly there is no inner support 703 as may be provided in the joint 700 of figure 2a-d. In addition the outer connector flange member 701a
20 includes cutouts 713 which are adapted to go around the first pivot member 712' of the inner connector flange 701a allowing the first pivot member 712' of the inner connector flange 701a to be engaged by and articulate within the second pivot member 714'.

25 The overlapping arrangement of the connector flanges 701a, 701b provides an improved secondary seal in addition to the bellows 704, and reduces the number of parts required, with the optional inner support 703 of the other embodiments now not required.

30

Figure 4a shows a perspective view of a coupling 200 and Figure 4b shows a cross-sectional view of part of coupling 200 for joining fluid conveying parts 202, 204. Each conduit part 202, 204 comprises a projection 206, 208.

-24-

The coupling 200 comprises a sleeve 210 which is adapted to engage with the respective projections 206, 208. The sleeve 210 comprises an inner ring 212 which engages with the first projection 206. The sleeve 210 further
5 comprises an outer ring 214 which engages with the second projection 208. The outer ring 214 comprises means 222 for moving the inner ring 212 relative to the outer ring 214.

The inner ring 212 and the outer ring 214 engage by means of a helical screw thread 216. The screw thread
10 arrangement 216 comprises a tongue 218 and a groove 220 on the inner ring 212 and corresponding tongues 218 and grooves 220 on the outer ring 214 which engage with one another. The tongue 218 and grooves 220 are arranged such that they form a helical channel which allows axial
15 movement of the inner ring 212 relative to the outer ring 214 as the moving means 222 are activated.

The moving means 222 comprise a worm wheel (not shown) which is provided on and activated by the screw 224. The sleeve 210 has a clip for retaining the worm in the outer
20 ring 214 and to provide a pressure face against which the worm is turned to release the sleeve 210. As the screw 224 is rotated, the inner ring 212 is moved along the channel formed by the tongue and groove arrangement 216 whereby the inner ring 212 moves axially relative to the outer ring 210
25 to seal the joint 200. The inner ring 212 forms a spigot location for the flange 206. The inner ring 212 and outer ring 214 can be permanently part of the duct or they can be retained by split rings.

In use, the outer ring 210 is provided over the first
30 conduit part 204. The inner ring 212 is provided over the second conduit part 202. The conduit parts are placed together and the inner ring 212 is located in contact with the outer ring 214. The screw 224 is rotated. This causes the inner ring 212 to move axially towards the outer ring

-25-

214 thereby clamping the conduit parts 202 and 204 together.

5 The worm configuration of the moving means 222 together with the profile of the rings 214,212 provides an effective and positive method of applying an equally distributed load around the flanges 206,208 for compressing the conduit parts 202,204 together.

10 An elastic or resilient seal or O ring 226 may be located and provided between the end faces of the conduit parts 202,204 , and preferably located within a suitable recess 220 in the end faces. As the coupling is tightened the seal 226 is compressed to provide a improved seal between the conduit parts 202,204.

15 As shown in figure 4b, the inner ring 202, preferably has an inner circumferential surface which extends axially beyond the end of the second conduit part 202 and abuts closely against the outer surface of both conduit parts 202,204 when the coupling is assembled. This provides a further seal of the interface between the conduit parts 202,204 and of the abutting faces of the conduit parts 202,204.

The coupling 200 has the advantage that the coupling 200 is releasable and mountable with a single tool to release and lock the coupling 200 over the conduit parts.

25 An important further advantage of the coupling 200 is that all parts of the coupling 200 are retained on the duct. Specifically once the inner ring 212 is unscrewed from the outer ring 214 to disconnect the two and open the coupling the inner and outer rings 212,214 are still retained on the ends of the conduit parts 202,204, by the flanges 206,208. As a result there is less likelihood of parts of the coupling 200 being misplaced during assembly/disassembly. This prevents parts of the coupling assembly from being lost. In addition, the overall size of

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-26-

the coupling 200 is more compact than conventional clamps/couplings. Also, the number of parts is low, which reduces manufacturing costs. The coupling 200 is easier to fit in comparison to conventional couplings or clamps. This significantly simplifies maintenance and assembly of the coupling thereby further reducing the overall cost of the coupling 200.

There is thus described a flexible joint as hereinbefore described and as shown in any of the accompanying drawings.

CLAIMS

1. A flexible joint for joining two conduit parts together to define a fluid conveying conduit, the flexible joint comprising a tubular restraining sleeve, a first pair of diametrically opposed pivotable connections between the restraining sleeve and the first conduit part, and a second pair of diametrically opposed pivotable connections between the restraining sleeve and the second conduit part, the second pair of pivotable connections being angularly displaced by approximately 90 degrees from first pair of pivotable connections;

wherein the tubular restraining sleeve is disposed radially outwardly over the conduit parts, and each of the pivotable connections comprises a radially outward projection portion formed on each respective conduit part, and a corresponding recess portion defined in the restraining sleeve surface within which the radially outward projection portion is engaged, an outer surface of the radially outward projection portion defining a first bearing surface which slidably abuts against a complementary second bearing surface defined by the inner surface of the recess portion.

2. A flexible joint as claimed in claim 1 wherein the recess portion defined in the restraining sleeve are open at an axial end of the restraining sleeve.

3. A flexible joint as claimed in claim 2 wherein the recess portions defined in the restraining sleeve associated with the first pair of pivotal connections open are open at one axial end of the restraining sleeve and the recess portions defined in the restraining sleeve associated with the second pair of pivotal connections open

-28-

are open at an opposite axial end of the restraining sleeve.

4. A flexible joint as claimed in claim 1 or 2 in
5 which the radially outward projection portion formed on
each respective conduit part has a part semi circular shape

5. A flexible joint as claimed in any preceding
claim in which the bearing surfaces have a part circular
10 shape.

6. A flexible joint as claimed in any preceding
claim wherein the projecting portion comprises a dimple
press formed in the conduit part.

15 7. A flexible joint as claimed in any preceding
claim wherein the recess portion comprises an indentation
press formed in the conduit part.

20 8. A flexible joint as claimed in any preceding
claim wherein first and second conduit parts comprise first
and second connector flanges each of which attach to
respective duct ends.

25 9. A flexible joint as claimed in claim 8 wherein
the connector flanges have a part spherical shape.

10. A flexible joint as claimed in any one of claims
8 to 9 wherein the connector flanges partially overlap.

30 11. A flexible joint as claimed in claim 8 or 9
further comprising an annular support element
concentrically located with respect to the connector
flanges and partially overlapping each connector flange.

-29-

12. A flexible joint as claimed in any one of claims 8 to 11 preceding claim wherein the connector flanges engage a shoulder rib formed around the circumference of the end of the duct to locate and retain the connector flanges on the ends of the ducts.

13. A flexible joint as claimed in any preceding claim wherein the first pair of pivotal connections are disposed towards one axial end of the restraining sleeve and the second pair of pivotal connections are disposed towards other opposite axial end of the restraining sleeve.

14. A flexible joint as claimed in any preceding claim further comprising an annular bellows member for sealing between the two conduit parts.

15. A flexible joint as claimed in claim 14 wherein the bellows member is concentrically disposed inside the conduit parts and restraining sleeve.

16. A flexible joint as claimed in any preceding claim wherein the restraining sleeve has an elastic range to allow, in use, the sleeve to be deflected and fitted over the projecting portions within its elastic range and return to its normal undeflected position.

17. A flexible joint as claimed in any preceding claim wherein the restraining sleeve is supported on the bearing surfaces of projecting portions of the conduit parts.

18. A flexible joint for joining two conduit parts together to define a fluid conveying conduit, the flexible joint comprising a tubular restraining sleeve, a first pair

-30-

of diametrically opposed pivotable connections between the restraining sleeve and the first conduit part, and a second pair of diametrically opposed pivotable connections between the restraining sleeve and the second conduit part, the
5 second pair of pivotable connections being angularly displaced by approximately 90 degrees from first pair of pivotable connections;

wherein the tubular restraining sleeve is disposed radially inwardly within the conduit parts, and
10 each of the pivotable connections comprises a radially inward projection portion formed on each respective conduit part, and a corresponding recess portion defined in the restraining sleeve surface within which the radially inward projection portion is engaged, an inner surface of the
15 radially outward projection portion defining a first bearing surface which slidably abuts against a complementary second bearing surface defined by the outer surface of the recess portion.

20 19. A coupling for joining or coupling fluid conveying conduit parts, each conduit part comprising a projection, the joint comprising a sleeve adapted to engage with the respective projections, wherein the sleeve comprises an inner ring for engaging with the first
25 projection and an outer ring for engaging with a second projection, the joint comprising means for moving the inner ring and the outer ring relative to one another whereby the inner ring is axially movable in relation to the outer ring to thereby clamp the conduit parts together.

30 20. A coupling as claimed in claim 19 wherein the moving means comprises a worm wheel rotatably mounted on the outer ring and the inner ring comprises means for engaging with the worm wheel such that as the worm wheel is

-31-

rotated the inner ring is moved axially in relation to outer ring.

21. A coupling as claimed in claim 19 or 20 wherein
5 the inner ring and the outer ring comprise inter-engaging surfaces.

22. A coupling as claimed in claim 21, wherein the
surfaces are in the shape of a helical screw thread
10 extending axially as well as tangentially along the inner
perimeter of the inner and outer rings to allow clamping of
the conduit parts as they are retained between the inner
ring and the outer ring.

23. A coupling as claimed in any one of claims 19
15 to 22 wherein the first projection and/or second projection
may comprise a member for sealing the joint.

24. A coupling as claimed in claim 23 wherein the
20 sealing member may comprise a ring formed of an elastic
material.

25. A coupling as claimed in claim 24 wherein the
seal may be expandable under load to seal the joint.

25

26. A coupling as claimed in any one of claims 19
to 25 wherein the ends of the conduit parts abut against
each other and the inner ring sealingly overlaps both
abutting ends of the conduit parts.

30

27. A coupling as claimed in any one of claims 19
to 26 wherein the outer ring may be connected to the second
projection.

-32-

28. A coupling as claimed in claim 27 wherein the outer ring may be connected to the conduit part by means of welding, brazing or soldering.

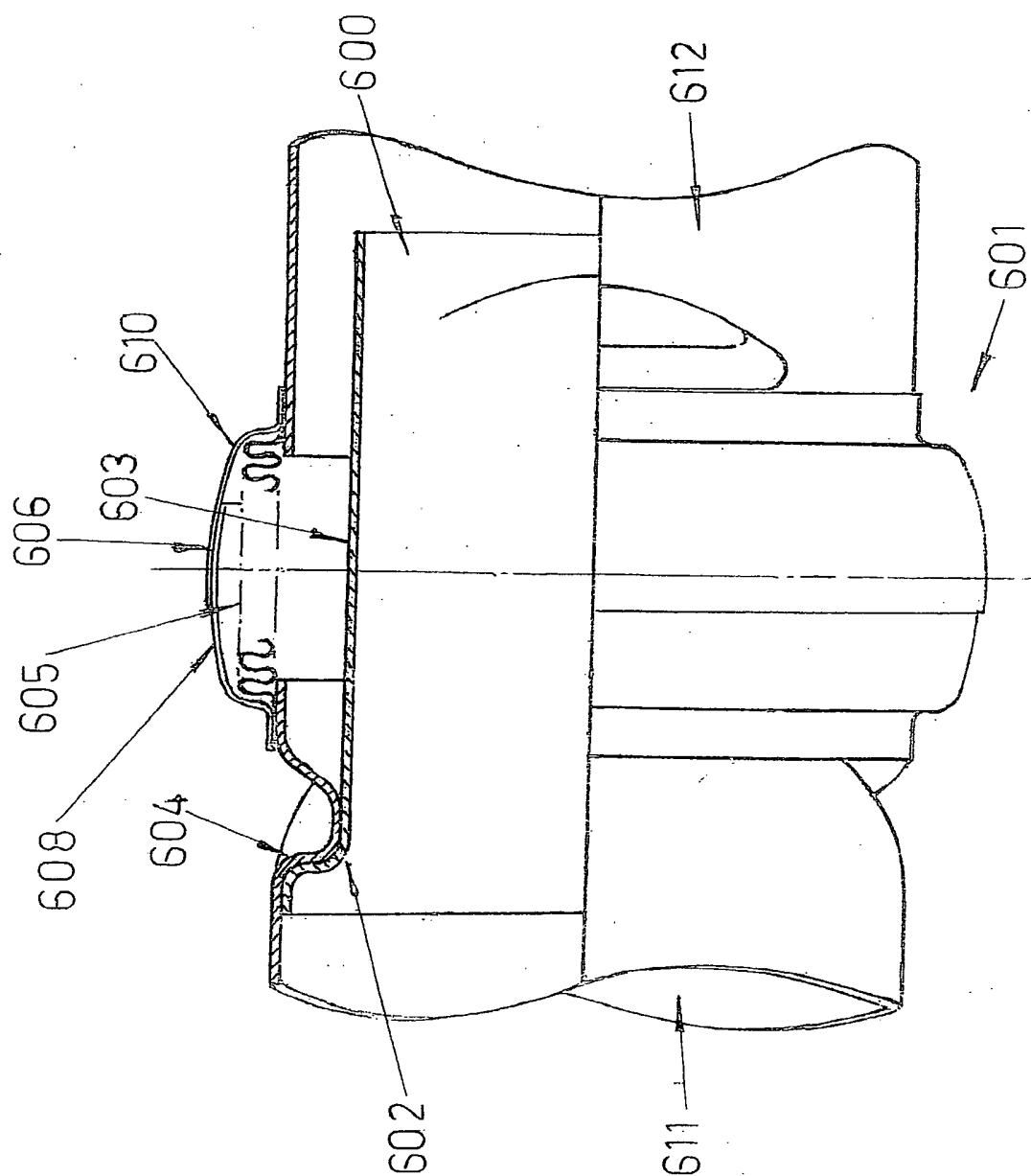


Fig 1a

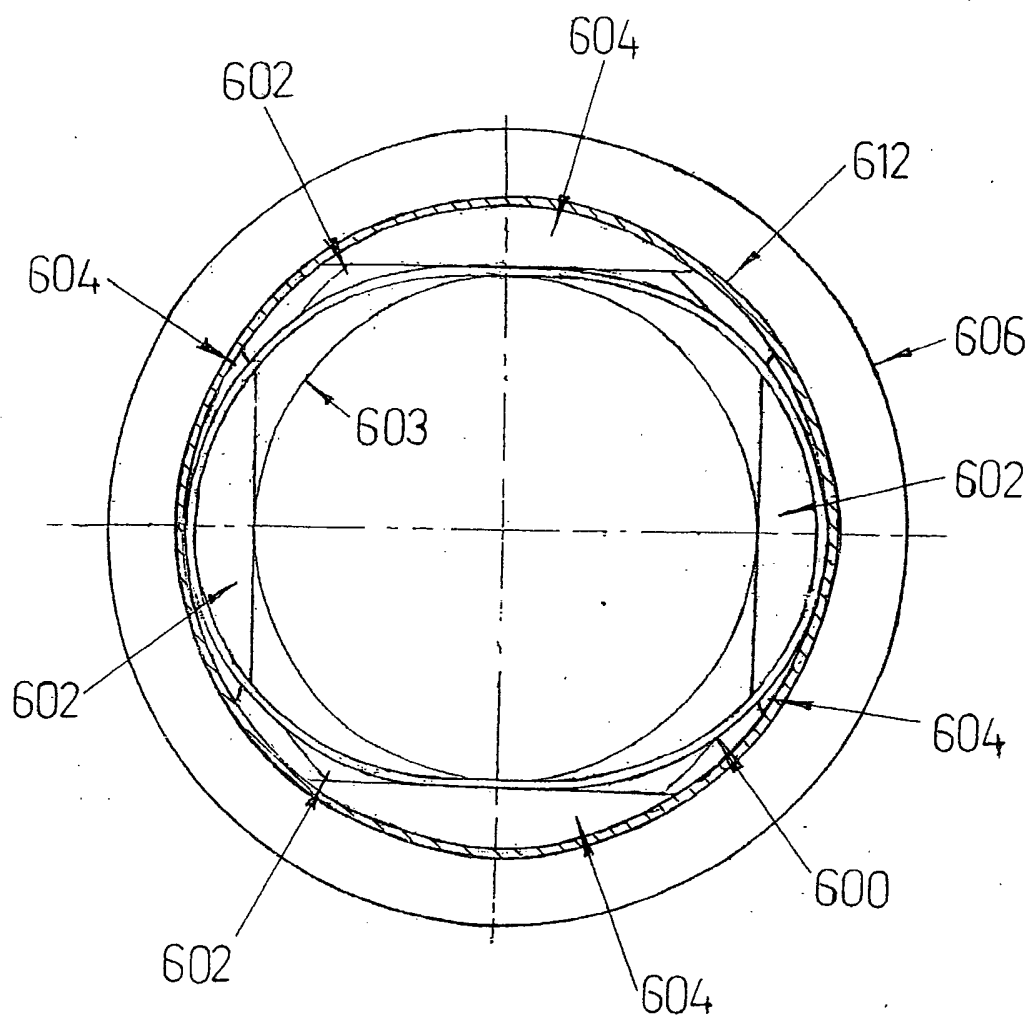


Fig 1b

3/10

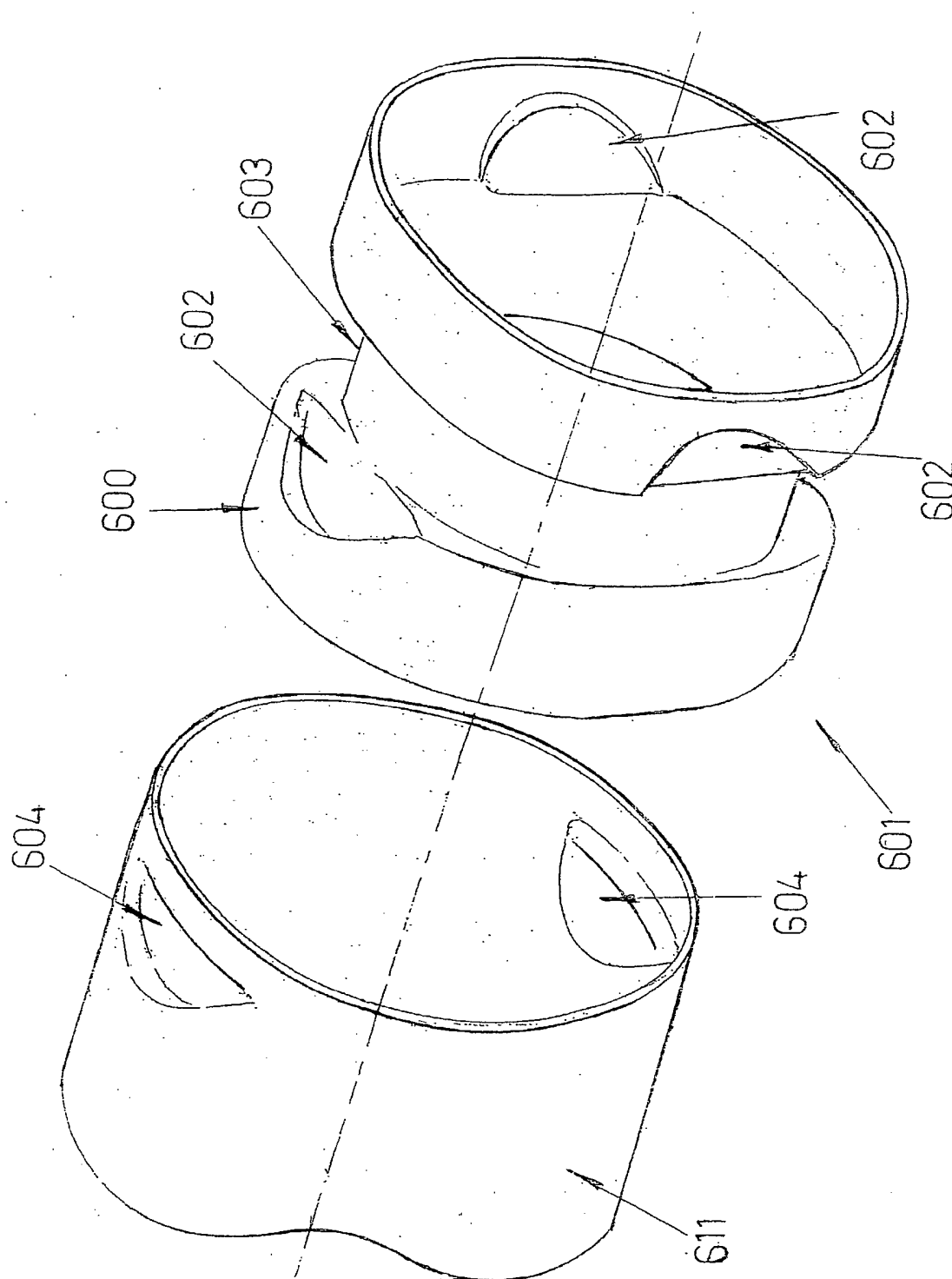


Fig 1c

4/10

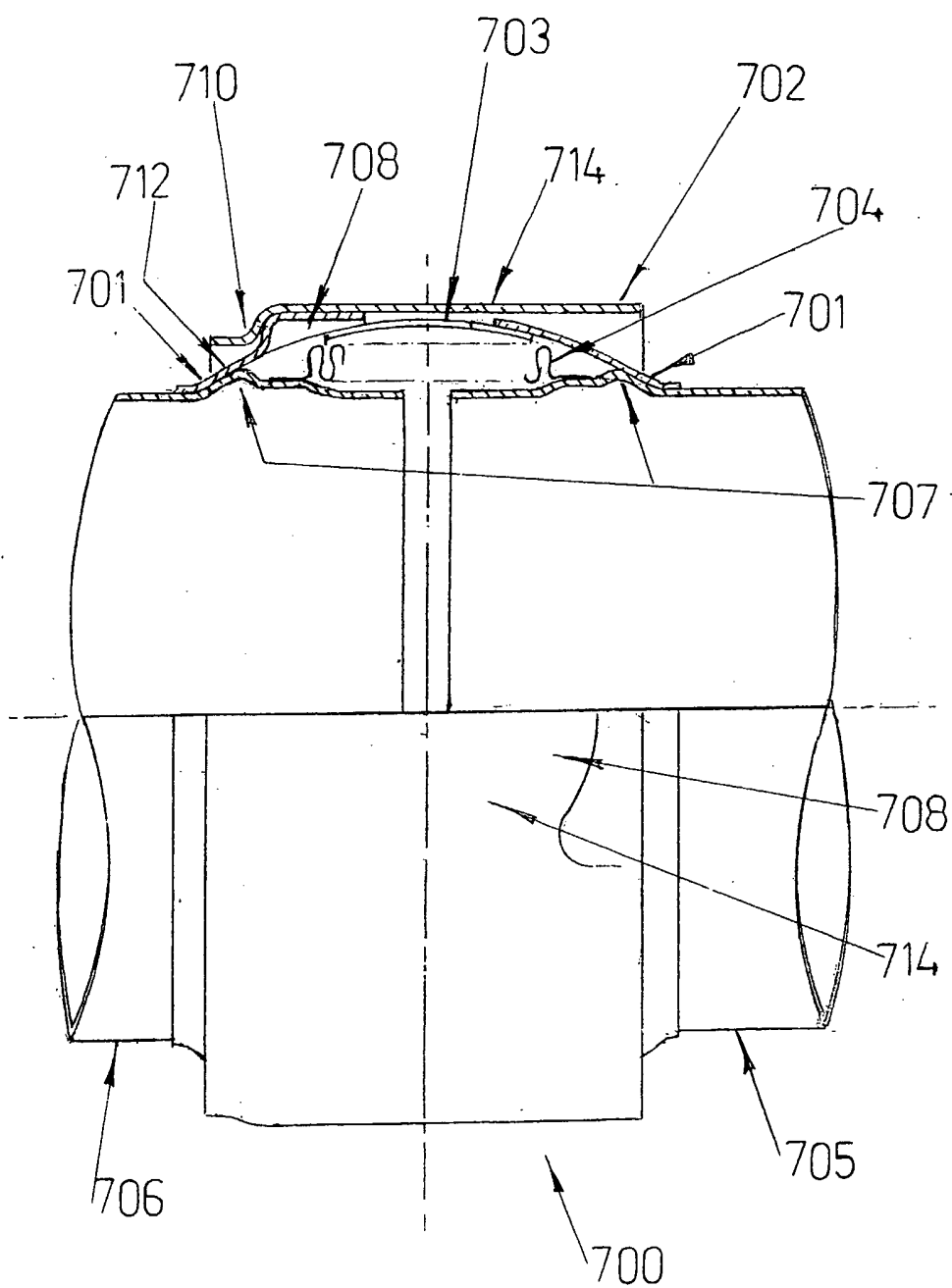


Fig 2a

5/10

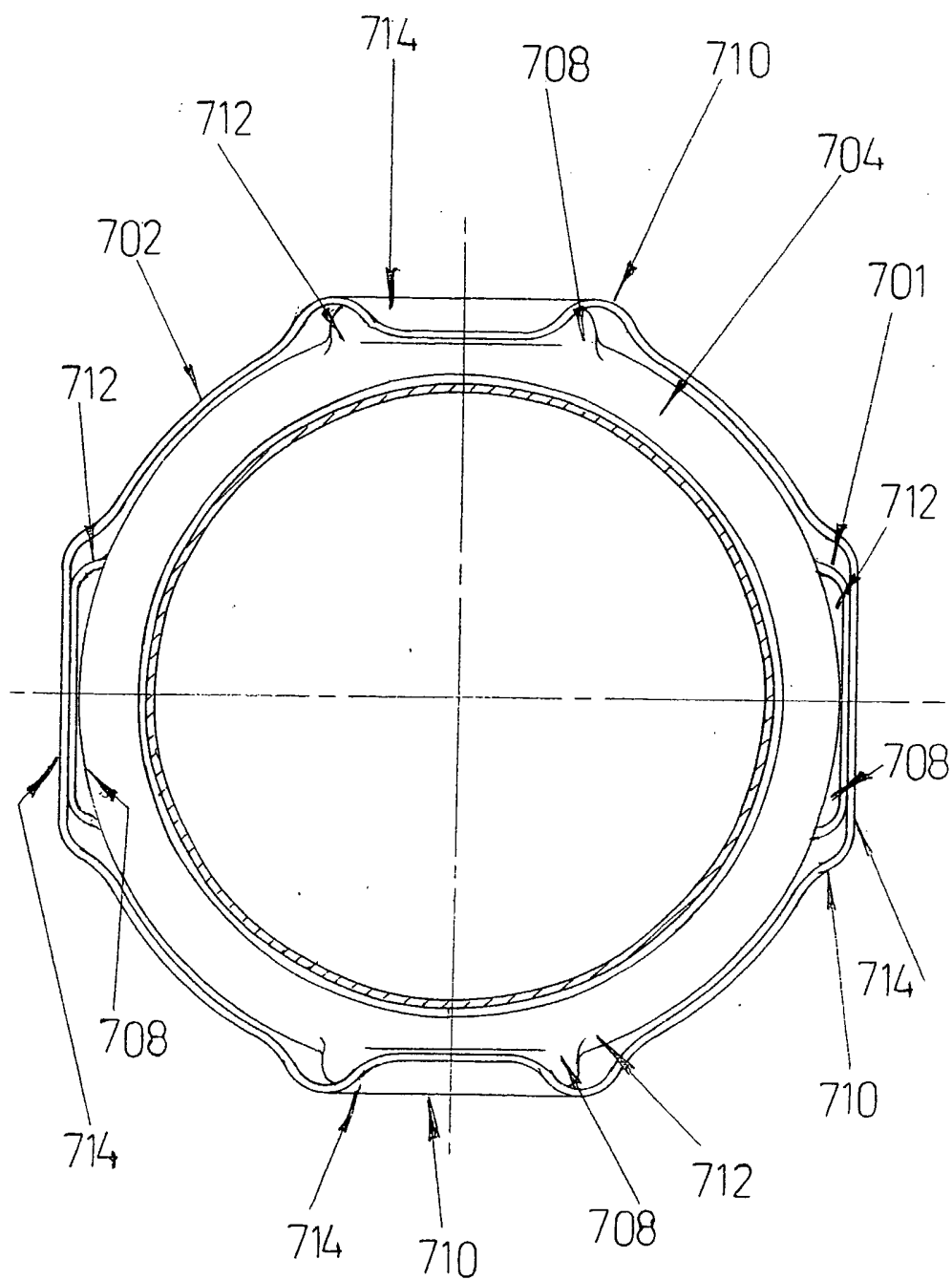


Fig 2b

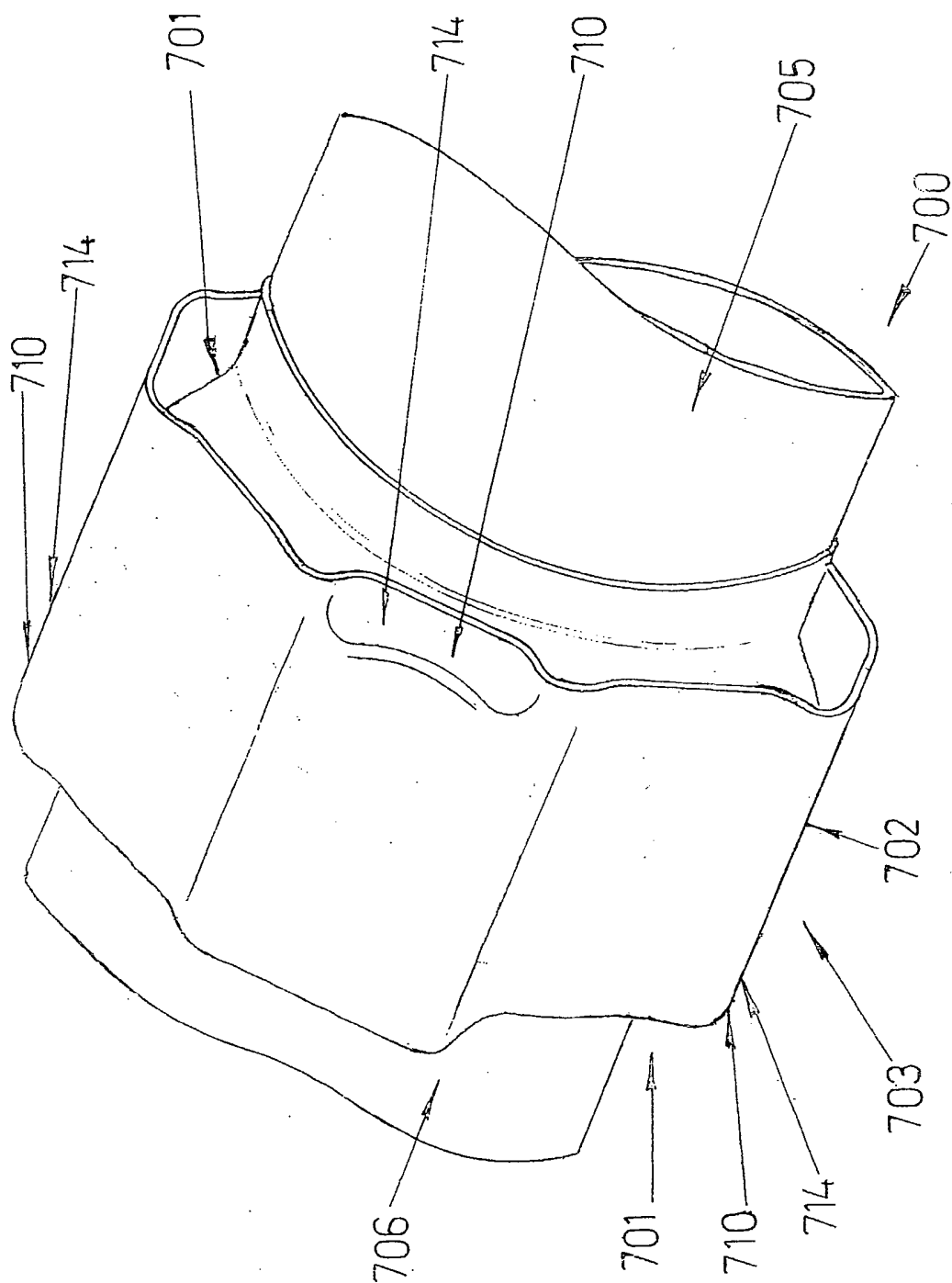


Fig 2c

7/10

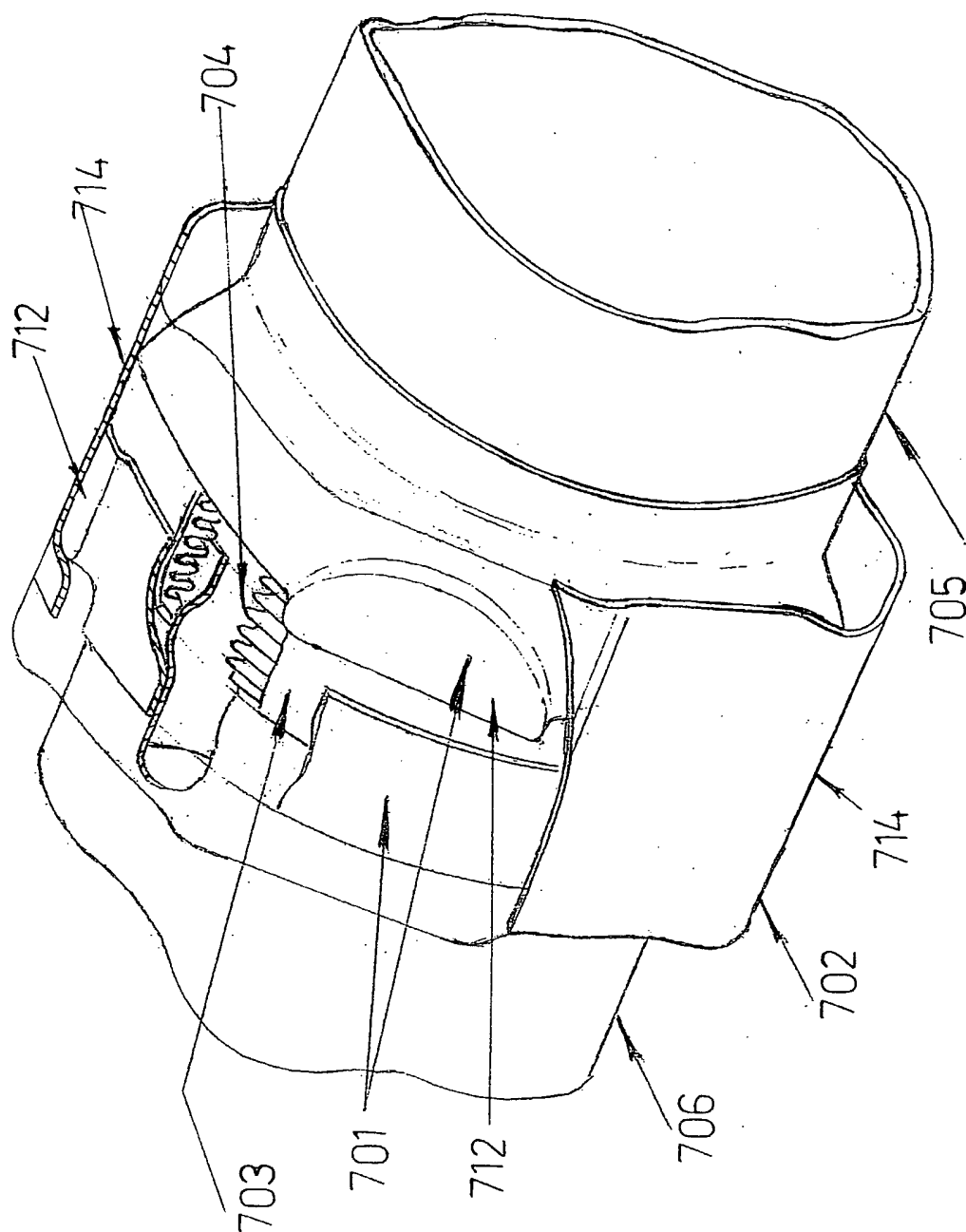


Fig 2d

8/10

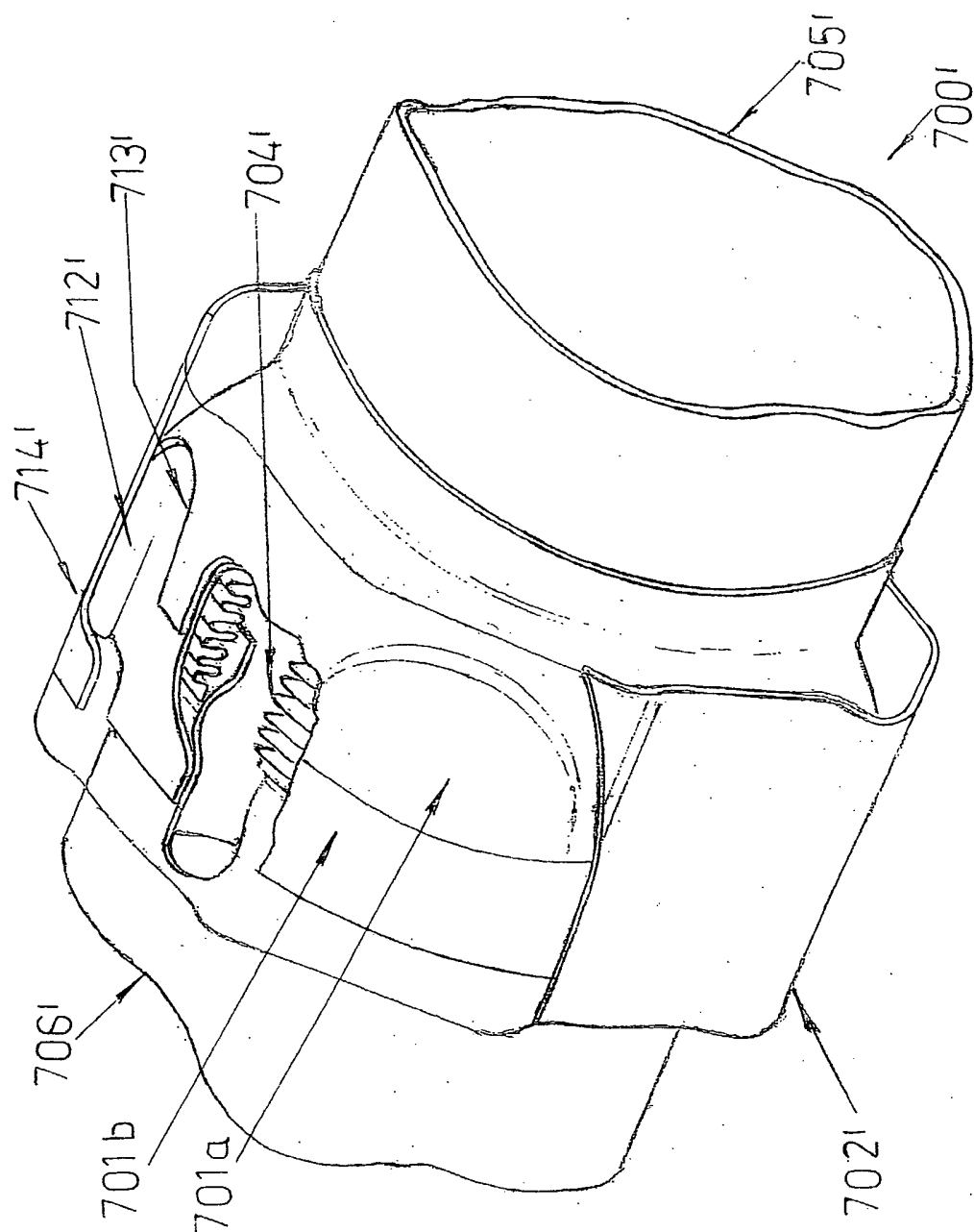


Fig 3a

9/10

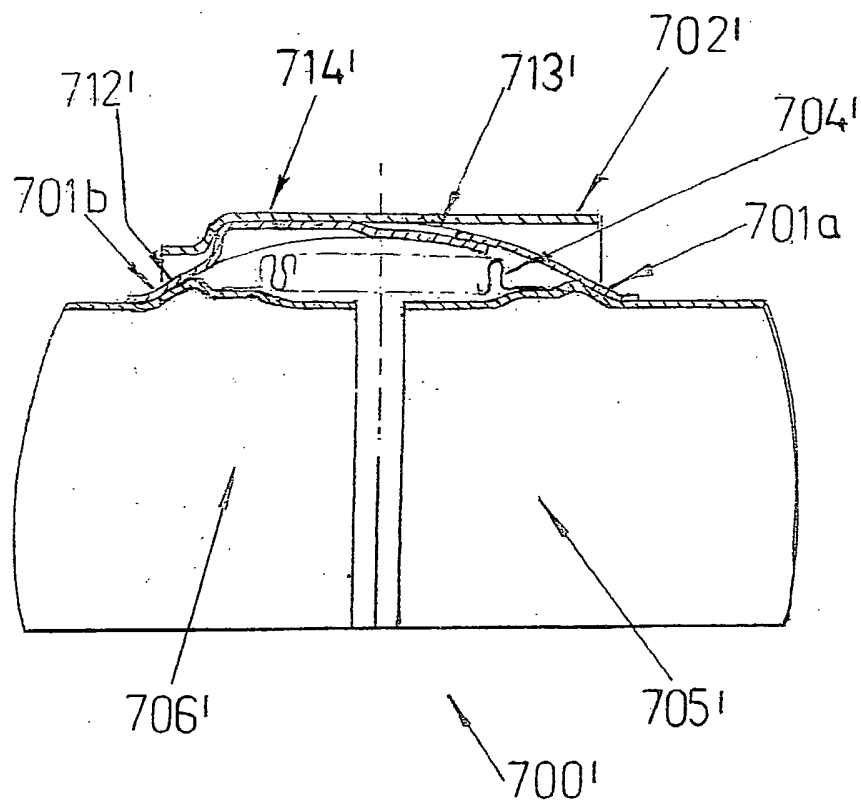


Fig 3b

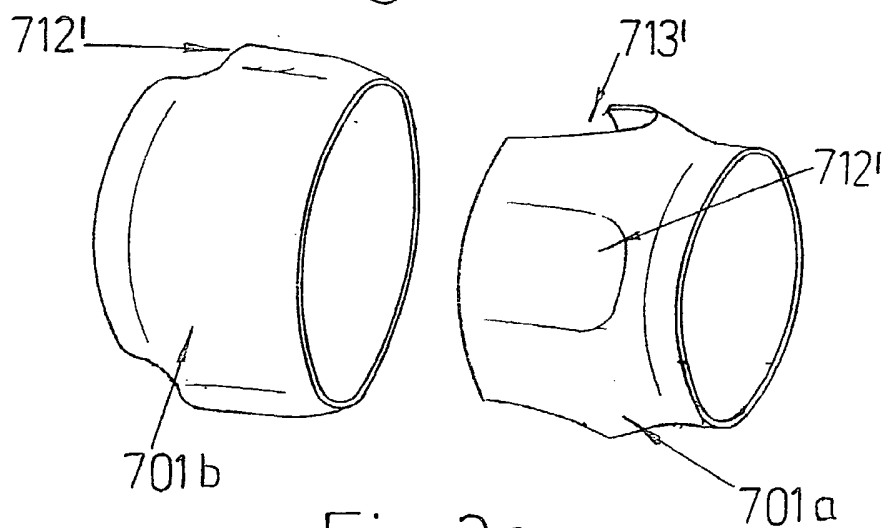


Fig 3c

10/10

