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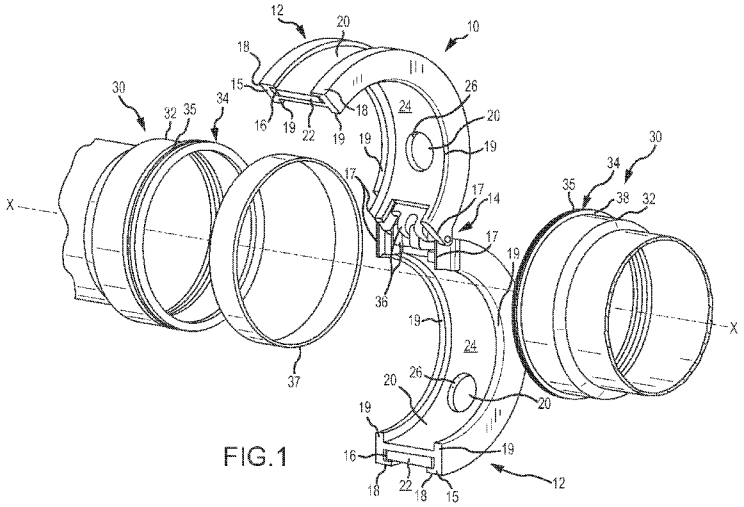

FIG.1

(57) Abstract: A concentric slide clamshell coupler 10 includes a pair of primary arcuate shaped coupling halves 12 joined at a hinge. Concentrically arranged secondary arcuate shaped coupling halves 20 are nested within the primary coupling halves 12. The primary and secondary coupling halves have respective hinges. When the hinges are aligned, the coupler may be opened. To close and lock the coupler about abutting ends of two fluid conveying members, the secondary coupling halves 20 are rotated within channels of the primary coupling halves 12, thereby separating the respective hinge elements from one another, and moving a portion of one of the secondary coupling halves 20 to span across distal facing surfaces of the primary coupling halves 12. In relation to a longitudinal axis of the connected fluid conveying members, the coupler when closed and locked creates a continuous ring around the ends of the fluid conveying members. The continuous ring locking features and hinge create redundant load carrying mechanisms.

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CONCENTRIC SLIDE CLAMSHELL COUPLER

FIELD OF THE INVENTION

The invention relates to couplers used for interconnecting fluid conveying conduits, and more particularly, to a coupling assembly for interconnecting two tubular fluid conveying members placed within the coupler, the coupler having redundant locking and carrying features to eliminate single points of failure.

BACKGROUND OF THE INVENTION

There is a large body of prior art for couplings or connectors that are used to interconnect various types of fluid conveying lines. The particular design of the connectors is typically driven by the special requirements associated with the type of fluid being conveyed, to include special safety requirements. For conveying non-volatile fluids such as water, a coupler may be afforded a more simple construction, since potential leakage in many applications may not introduce significant health or safety concerns. On the contrary, for lines that convey fuel or other volatile or hazardous liquids, the particular construction of couplers in these applications typically require redundant sealing features, as well as redundant locking or tamper-proof features.

Particularly for couplers that are used within environments that are subject to live loading conditions, such as couplers used within vehicles or aircraft, the construction of the couplers must be particularly robust to account for not only high fluid pressures within the conveying lines, but also the loading conditions that exist in the operation of the vehicles or aircraft. Additionally, particularly for aircraft, there is a considerable safety requirement in the design of fluid conveying lines and couplers to prevent the buildup of electrostatic charge. A stored electrostatic charge can give rise to an electrical spark hazard. A spark in the presence of vaporized fuel can result in a fire or explosion, which must be avoided at all costs. More specifically, creation of a spark by grounding, or by flexing of the coupling in a manner to bring metallic parts of the coupling into contact may cause instantaneous combustion of any vaporized fuel, which in turn can cause ignition of the fuel conveyed in the lines. Lightning strikes can also create a spark; therefore a coupling should also have the capability to dissipate a large dynamic electrical charge.

One known design for a coupler used to interconnect fuel conveying conduits within an aircraft is a "clamshell" coupler. An example of a US Patent reference that discloses such a design is disclosed in the US Patent No. 6,880,859. This reference more specifically discloses a coupler having a pair of coupling halves that are connected by a

hinge. A plurality of engagement members are mounted on the respective coupling halves for connecting and locking the coupling halves. Electrical conductivity is maintained across the coupling assembly by a bonding wire mounted on each of the coupling halves.

Another example of a patent reference that discloses a clamshell type coupler suitable for interconnecting fluid conveying lines of an aircraft is disclosed in US Patent No. 4,438,958. This reference more particularly discloses a clamshell coupler with coupling halves connected by a hinge, and a rotatable catch mechanism used to lock the coupling halves.

Yet another example of a patent that discloses a clamshell type coupler specifically designed for use within an aircraft is the US Patent No. 4,008,937. This reference also generally discloses a clamshell coupler with coupling halves connected by a hinge, a rotatable locking mechanism, and at least one electrically conductive spring metal jumper mounted exteriorly on the coupler to complete electrical bonding between the coupler and the fluid conveying members. The locking mechanism includes a retainer and toggle clamp that extends circumferentially around the coupler, and a safety lock incorporated on the mechanism to prevent inadvertent release of the toggle clamp.

Yet another example of a clamshell type coupler especially adapted for use within an aircraft is the US Patent No. 4,346,428. The clamshell coupler disclosed in this reference is characterized by a pair of coupling halves interconnected by a hinge. A resilient bonding jumper traverses a circumferential wall of the coupler to provide electrical continuity between the coupler and the interconnected fluid conveying members. The locking mechanism used for locking the coupling halves includes a clasp that is engageable with a notched lever member. The lever member is manipulated so that adjacent extremities of the coupling halves are drawn together through tension created by the lever member.

Yet another example of a clamshell type coupler especially adapted for use within an aircraft is disclosed in the US Patent No. 5,620,210. This reference discloses a coupling assembly for connecting adjacent ends of fluid conveying conduits, the coupling assembly also including a pair of coupling halves interconnected by a hinge. The coupler is characterized by laterally spaced locking tines that engage a mating channel for locking the coupling. The coupling assembly also includes a pivotal locking member for locking redundancy. The pivotal locking member has at least one fin received between locking tines, and the locking member snaps into locking position when the locking tines are engaged within the mating channel.

While the prior art references may be adequate for their intended purposes, traditional clamshell couplers have a number of inherent structural drawbacks. Clamshell couplers have relatively small hinges and latches that must be made from robust material such as stainless steel in order to withstand the high stresses and strains associated with use within an aircraft. Because of the number of couplers used within an aircraft, the stainless steel adds significant weight to the aircraft. Additionally, the fluid conveying lines are typically made from aluminum, resulting in the use of dissimilar metals which may create potential problems, not only with respect to proper grounding and isolation of electrostatic charges, but also with respect to galvanic corrosion that can take place over time between the dissimilar metals in contact with one another. Any moisture within the confines of the aircraft structure can act as an electrolyte to commence galvanic corrosion. Although aluminum and stainless steel may generally have excellent corrosion resistance characteristics, over long-term operation, use of the dissimilar metals may result in corrosion causing pitting or crevicing, thereby limiting the service life of the fluid conveying lines and associated couplers.

Another inherent drawback with respect to traditional clamshell couplers is that the relatively small hinges and latches/locks used make these components are more difficult to service because of their small size. For example, if the locking mechanism becomes jammed, or if the hinges become unserviceable, the user must use small tools with more precise force to successfully manipulate these components.

In general, the prior art can be characterized as not providing redundancy in locking and carrying features, and therefore single points of failure existed making the prior art couplers more prone to failure.

Therefore, there is a need to provide a clamshell type coupler that provides not only the required redundancy for locking, but also a more ergonomic design that makes locking and unlocking of the coupler an easier task for the user. It is also advantageous to provide a design that maintains simplicity without sacrificing functional requirements with respect to safety.

There is also a need to provide a clamshell type coupler that can still utilize traditional hinged connections between the coupling halves, but allows use of a coupler design to distribute loads induced upon the coupler, and specifically to reduce loads upon the hinge itself. This design may therefore allow use of weaker material such as aluminum, plastic, or composite components, which therefore also can ameliorate the problems associated with the use of dissimilar metals.

SUMMARY OF THE INVENTION

In accordance with the present invention, a concentric slide clamshell coupler apparatus is provided. According to the preferred embodiments, the coupler includes a pair of primary arcuate shaped coupling halves that are joined at a hinge, and are placed in a locking position to join confronting ends of two fluid conveying members. The coupler further includes a pair of concentrically arranged secondary arcuate shaped coupling halves that are nested in the primary coupling halves to form an integral coupler. The primary and secondary coupling halves each have their own respective hinge elements. When the hinge elements are aligned, the coupler may be opened like a traditional clamshell coupler. When it is desired to close and lock the coupler around the abutting fluid conveying members, the primary and secondary coupling halves are rotated with respect to one another. More specifically, the primary coupling halves include respective channels to receive the secondary coupling halves. To close and lock the coupler, the secondary coupling halves are slidable within the channels, thereby separating the respective hinge elements from one another, and moving a portion of one of the coupling halves to span across gap or plane separating the distal facing surfaces of the primary coupling halves. With relation to a longitudinal axis of the connected fluid conveying members, the coupler when placed in the closed and locked position creates a continuous ring around the abutting ends of the fluid conveying members.

Because the entire cross sectional area of one of the secondary coupling halves is used to span the gap/plane between the distal facing surfaces of the primary coupling halves, this results in a much greater volume of material available for locking the coupling over the fluid conveying members as compared to prior art locking features. This greater volume results in greater mass being made available for a more robust locking capability. Additionally, when the secondary coupling halves are slid within the channels, another portion of one of the coupling halves spans the location of the hinge elements of the primary coupling halves because the hinge elements of the secondary coupling halves are no longer aligned with the hinge elements of the primary coupling halves. This shifting of the secondary coupling halves also results in a much greater volume of material available for strengthening the point at which the primary coupling halves are connected to one another at the hinge. With these greater volumes of material, the coupler may therefore be made of weaker materials as compared to typical steel alloys that had to be used to accommodate the relatively small hinge and locking components of traditional clamshell couplers. Further, the specific hinge design associated with the primary and secondary

coupling halves can still be maintained in a relatively small cross-sectional profile, which therefore ensures that the coupler can be easily installed within the small spaces available for the fluid conveying lines.

Additional structural details of the coupler include the channels formed on the outer circumferential surface of the primary coupling halves. The channels extend continuously so that the secondary coupling halves may be freely slid through the channels in large circumferential angles, thereby simplifying locking of the coupler by ensuring the secondary coupling halves can be easily rotated to span continuously across both the facing distal surfaces of the primary coupling halves and across the hinged ends of the primary coupling halves located adjacent the hinge mounts. Different cross-sectional interfaces may be provided between primary and secondary coupling halves in embodiments of the invention. One example is a closed interface in which the laterally opposed sides of the secondary coupling halves are received within the channels of the primary coupling halves. Another example is an open interface in which the secondary coupling halves include annular flanges that are slidably engaged within corresponding annular grooves of the primary coupling halves. In yet another embodiment, the interface may be characterized by a connection between the inner and outer coupling halves by complementary dovetail shaped flanges and grooves.

The sliding of the secondary coupler halves can be prevented or allowed by several different types of locking features. In accordance with preferred embodiments of the invention, these features may include interfering pins or extensions to prevent slidable movement, or a latching mechanism to positively latch the secondary coupling halves at a stationary position.

Considering the foregoing features and advantages of the invention, in one aspect, the invention may therefore be further described as a coupler for releasably interconnecting first and second fluid conveying members, the coupler comprising: (i) first and second primary coupling halves pivotally joined at a first hinge, the primary coupling halves having an arcuate shape; (ii) first and second secondary coupling halves pivotally joined at a second hinge, the secondary coupling halves having an arcuate shape, each the secondary coupling half having a body with opposite lateral edges; (iii) the first and second secondary coupling halves being concentrically disposed and connected to the first and second primary coupling halves; and (iv) a locking mechanism secured to the primary and secondary coupling halves to prevent relative rotation between the primary and secondary coupling halves.

In connection with this first aspect, other aspects of the invention may include (i) the first and second primary coupling halves each include respective transverse webs and shoulders formed on an opposite transverse edges thereof, and a channel formed in each shoulder for receiving the lateral edges of the first and second secondary coupling halves; (ii) the transverse webs of the first and second primary coupling halves extend substantially parallel to a longitudinal axis of extension of the fluid conveying members and being substantially planar as extending along the longitudinal axis; (iii) the first and second secondary coupling halves extend substantially planar between the lateral edges thereof as extending along the longitudinal axis (iv) the first and second secondary coupling halves extend substantially parallel to the first and second primary coupling halves along the longitudinal axis (v) one or more sight openings formed in the primary and secondary coupling halves enabling a user to view alignment of the coupler as it is secured to the fluid conveying members (vi) the first and second hinges are aligned with one another when the coupler is in an open position, and the first and second hinges are misaligned with one another when the coupler is in a closed position (vii) the first and second secondary coupling halves have a rectangular cross-sectional shape (viii) the first and second secondary coupling halves have a t-shaped cross-sectional shape, and (ix) the first and second secondary coupling halves have a rectangular cross-sectional shape with dovetail-shaped tracks.

In another aspect of the invention, it may also be considered a combination in which features of a coupler are combined with fluid conveying members, the combination comprising (a) a coupler including: (i) first and second primary coupling halves pivotally joined at a first hinge, the primary coupling halves having an arcuate shape; (ii) first and second secondary coupling halves pivotally joined at a second hinge, the secondary coupling halves having an arcuate shape, each the secondary coupling half having a body with opposite lateral edges; (iii) the first and second secondary coupling halves being concentrically disposed and connected to the first and second primary coupling halves; (iv) a locking mechanism secured to the primary and secondary coupling halves to prevent relative rotation between the primary and secondary coupling halves; and (b) first and second fluid conveying members, the fluid conveying members each including distal ends with a flange, the flanges facing one another within the coupler when the coupler is closed over the distal ends of the fluid conveying members.

In connection with this combination, other features of the invention may include (i) a sleeve positioned between the facing flanges and placed within the coupler when the

coupler is closed over the distal ends of the fluid conveying members (ii) rotation of the secondary coupling halves with respect to the primary coupling halves so that the first and second hinges are misaligned with one another causes a plane between facing distal ends of the primary coupling halves to be spanned by a portion of the secondary coupling halves, thereby preventing the coupler from being opened, and (iii) wherein: the rotation creates a first locking feature to prevent opening of the coupler, and the locking mechanism creates a redundant second locking feature.

In yet another aspect of the invention, it can be considered a method for interconnecting fluid conveying members by a coupler, the method comprising: providing a coupler including (i) first and second primary coupling halves pivotally joined at a first hinge, (ii) first and second secondary coupling halves pivotally joined at a second hinge, the first and second secondary coupling halves being concentrically disposed and connected to the first and second primary coupling halves, (iii) a locking mechanism secured to the primary and secondary coupling halves to prevent relative rotation between the primary and secondary coupling halves; aligning the first and second hinges to place the coupler in an open position; placing portions of two fluid conveying members within the coupler to join the fluid conveying members; closing the coupler such that distal ends of the primary coupler halves are moved toward one another and face one another; rotating the secondary coupler halves with respect to the primary coupler halves such that the first and second hinges are misaligned with one another; and wherein the rotation causes a plane between the facing distal ends of the primary coupling halves to be spanned by a portion of the secondary coupling halves, thereby preventing the coupling from being opened.

In connection with this method, other aspects of the invention may include (i) wherein the first and second primary coupling halves each include respective transverse webs and shoulders formed on an opposite transverse edges thereof, and a channel formed in each shoulder for receiving lateral edges of the first and second secondary coupling halves; and further wherein rotation causes one of the secondary coupling halves to be rotated beyond the distal end of a corresponding primary coupling half in which it is nested, and inserted into the channel of the other primary coupling half, thereby preventing opening of the coupler (ii) wherein the rotating creates a first locking feature to prevent opening of the coupler, and the locking mechanism creates a redundant second locking feature

In yet another further aspect of the invention, it may include a coupler for releasably interconnecting first and second fluid conveying members, the coupler comprising (i) first and second primary coupling halves pivotally joined to one another; the primary coupling halves having an arcuate shape (ii) first and second secondary coupling halves pivotally joined to one another, the secondary coupling halves having an arcuate shape (iii) the first and second secondary coupling halves being concentrically disposed and connected to the first and second primary coupling halves, the first and second primary coupling halves each having a configuration for receiving the first and second secondary coupling halves and the secondary coupling halves being slidable within the configurations; and (iv) a locking mechanism secured to the primary and secondary coupling halves to prevent relative rotation between the primary and secondary coupling halves.

In connection with this further aspect, other feature of the invention may include (i) wherein the configurations include at least one of a channel, a dovetail connection, or groove, and (ii) the primary coupling halves are joined by a first hinge and the secondary coupling halves are joined by a second hinge, wherein the first and second hinges are aligned with one another when the coupler is in an open position, and the first and second hinges are misaligned with one another when the coupler is in a closed position by sliding the secondary coupling halves.

Additional features and advantages of the invention will become apparent from a review of the following detailed description, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of the concentric slide clamshell coupler of the present invention shown as positioned for interconnecting a pair of fluid conveying members;

Fig. 2 is a perspective view of the coupler placed in the closed position to thereby connect the fluid conveying members, and further wherein the respective hinge elements of the primary and secondary coupling halves are still aligned;

Fig. 3 is another perspective view of the coupler of Fig. 2 in the closed position, and further wherein the secondary coupling halves have been rotated with respect to the primary coupling halves, thereby separating the respective hinge elements, and moving a first portion of one of the secondary coupler halves to span the area adjacent the hinge elements of the primary coupler halves, as well as moving a second portion of the other

secondary coupler half to span the gap between distal facing surfaces of the primary coupler halves;

Fig. 4 is a cross-sectional view taken along line 4-4 of Fig. 2;

Fig. 5 is an elevation view illustrating the two fluid conveying members connected to one another within the clamshell coupler, and the coupler in the open position to expose the abutting ends of the fluid conveying members and a sleeve placed over the facing ends of the members;

Fig. 6 is a fragmentary cross-sectional view illustrating another preferred embodiment with respect to an interface between the primary and secondary coupling halves;

Fig. 7 is another fragmentary cross-sectional view illustrating another preferred embodiment with respect to the interface between the primary and secondary coupling halves;

Fig. 8 is a perspective view of one of the two primary coupling halves illustrating further structural details, to include structure used to catch and hold a locking mechanism to prevent slidable movement of the nested secondary coupling halves;

Fig. 9 is a perspective view of the other primary coupling half illustrating further structural details;

Fig. 10 is a perspective view of one of the two secondary coupling halves illustrating further structural details, to include a locking mechanism for preventing slidable movement of the secondary coupling half;

Fig. 11 is another perspective view of the other secondary coupling half illustrating further structural details;

Fig. 12 is a perspective view of the coupler illustrating the locking mechanism positioned in engagement with mounting structure on a primary coupling half, and a latch in an open position; and

Fig. 13 is another perspective view of the coupler of Fig. 12, with the latch in a locked position.

DETAILED DESCRIPTION OF THE DRAWINGS

Figs. 1-3 illustrate a preferred embodiment of the concentric slide clamshell coupler 10 of the present invention. As shown, the coupler, 10 can be generally characterized as including a pair of primary coupling halves 12 having arcuate shapes, and rotatable about a hinge assembly 14. The distal or free ends of the coupling halves 12 define surfaces 15 that when closed face one another. The outer circumferential portions of the primary coupling halves each include shoulders 18 formed on opposed lateral edges,

thereby forming respective channels 16. The interior circumferential portions of the primary coupling halves further include annular extensions 19 that are formed on the opposed lateral edges, and these extensions 19 capture the respective flanges 34 of the fluid conveying members 30. An arcuate web 24 defines the area between the shoulders 18 and between the lateral annular extensions 19 on each coupling half 12. Optionally, one or more sight openings 26 may be formed on the webs 24.

The secondary coupling halves 20 are nested within the corresponding channels 16 of the primary coupling halves 12. Also referring to Figs. 10 and 11, the secondary coupling halves have arcuate shapes. Each half includes an end incorporating interlocking knuckle portions 36 of the hinge assembly 14. The opposite ends of the secondary coupling halves are defined as the facing surfaces 22. When the coupler is placed in the closed position such as illustrated in Fig. 2, the surfaces 22 are placed in an abutting or facing relationship. Optionally, the secondary coupling halves may have one or more sight openings 28 (Fig. 2). Referring also to Fig. 3, the sight openings 26 and 28 may be aligned with one another between the respective primary and secondary coupling halves when the coupler is in the closed position enabling the user to determine whether the fluid conveying members are properly seated and joined by viewing the positioning of the sleeve 37 as installed, as well as to allow the user to view the concentric arrangement between the primary and secondary coupling halves.

Referring again to Fig. 1, a common configuration for connection of fluid conveying members 30 is illustrated in which each fluid conveying member 30 includes a fluid conveying tube 32 and a connecting flange 34 secured to the end of the tube 32. The flange 34 typically includes a circumferential groove/channel 35 that receives a compressible O-ring (not shown). A sleeve 37 is placed between the facing ends of the fluid conveying members 30. The sleeve 37 may have a particular design for an annular channel (not shown) formed on both sides thereof for receiving respective compressible O-rings (not shown). The O-rings are used to provide a leak-tight seal between the longitudinally aligned fluid conveying members as well as a leak-tight seal within the coupler by compression of the O-rings against the interior surfaces of the sleeve 37. Although a particular arrangement is shown with respect to how a pair of fluid conveying members may be connected, it shall be understood that the coupler of the present invention is not specifically limited to any particular configuration as to how the fluid conveying members are connected and sealed with respect to one another.

Referring to Fig. 2, the coupler is shown in the closed position in which the coupling halves are rotated such that the respective facing surfaces 15 face or abut one another. As also shown in Fig. 2, the secondary coupling halves are placed in a position such that the knuckle portions 36 of the secondary coupling halves align with the hinge mounts 40 which protrude from the shoulders 18 of the primary coupling halves. Accordingly, a continuous opening 42 is formed, which can be used to receive pins 44a, 44b, and 44c (Fig. 4). The hinge assemblies comprise the interlocking knuckle portions 36 of the secondary coupling halves 20, along with the exteriorly located hinge mounts 40 of the primary coupling halves 12. Although a particular arrangement is shown with respect to the hinge assembly 14, should be understood that other forms of hinges can be provided for connection of the coupling halves, such as hinges that do not protrude beyond the outer peripheral surfaces of the shoulders 18, "live" hinges, meaning those type of hinges that are made of flexible material capable of flexing or bending, thereby enabling opening and closing of the coupling halves, and snap hinges, meaning those type of hinges which involve an element that may slightly deflect or bend and therefore "snap" into place with another component that catches and holds the deflecting component.

Referring to Fig. 3, the coupler is illustrated in the closed and locked position in which the secondary coupling halves 20 have been rotated within the channels 16, and therefore positioned such that the knuckle portions 36 do not align with the hinge mounts 40. As the secondary coupling halves are rotated, the distal facing ends 15 of the primary coupling halves are spanned by distal portions of one of the secondary coupling halves that extend beyond the primary coupling half in which it is nested, and into the channel of the facing primary coupling half. Simultaneously, as the secondary coupling halves are rotated, another portion of the other secondary coupling half extends across or spans the area at the interface or connection between the hinged ends 17 of the primary coupling halves located adjacent the hinge mounts 40. This rotation of the secondary coupling halves results in a securing of the coupler so that it may not be opened. Because of the large cross-sectional volume/mass of the secondary coupling halves which span these planes, a very robust and secure locking feature is achieved. Redundancy in locking is achieved because none of the hinge elements are needed to carry load across the joint between the fluid conveying members.

Referring to Fig. 4, a cross section is illustrated showing additional details of the primary and secondary coupling halves, as well as the aligned pin opening 42 that may receive the pins 44a, 44b, and 44c. Pins 44a and 44c are received in the respective hinge

mounts 40 (Fig. 8), and pin 44b is received in the knuckle portions 36 (Fig. 10). As shown in Fig. 4, the lateral edges 27 of the secondary coupling half are secured within the channels 16. This capture of the lateral edges 27 within the channels 16 can be defined as a closed interface between the primary and secondary coupling halves. The shoulder 18 includes radially extending edges 25 that fully capture and hold the lateral edges 27 of the nested secondary coupling half 20. The cross sectional shape of the secondary coupling half is illustrated as rectangular. A sight opening 26 of the primary coupler half 12 is shown, but because the secondary coupling half 20 has not been rotated, the secondary coupling half is visible through sight opening 26.

Referring to Fig. 5, this figure illustrates how the fluid conveying members 30 are secured within the coupler. As shown, the sleeve 37 is captured between the facing ends of the flanges 34. The exterior edges 38 of the flanges 34 and sleeve 37 are captured by, and may contact the inner peripheral surfaces of the annular extensions 19. As mentioned, the present invention is not specifically limited to any particular configuration regarding how the fluid conveying members are connected and sealed with respect to one another, and this figure is therefore exemplary of one possible configuration of how fluid conveying members may be connected by the coupler.

Referring to Fig. 6, an alternative embodiment is illustrated in cross section with respect to the interface between the primary and secondary coupling halves. In this figure, the slidable relationship between the primary and secondary coupling halves is achieved by a dovetail type connection. More specifically, the primary coupling half 12 is illustrated as having a pair of laterally spaced interior tracks 51 having dovetail shapes. These tracks 51 extend radially inward. The secondary coupling half 20 is mounted over the protruding tracks 51, and the secondary coupling half 20 has a pair of corresponding dovetail shaped openings 52. It is also contemplated this dovetail connection could be provided in a reverse manner, namely, the primary coupling half 12 could incorporate dovetail shaped recesses, and the secondary coupling half 20 could incorporate dovetail shaped tracks or extensions received in the recesses. The cross sectional shape of the secondary coupling half can be generally described as rectangular with dovetail shaped tracks.

Referring to Fig. 7, this figure illustrates yet an additional alternative embodiment in cross section showing the interface between the primary and secondary coupling halves. In this figure, the slidable relationship between the primary and secondary coupling halves is achieved by a simple flange and groove connection. Therefore, since the secondary

coupling half is not fully enclosed within constraining portions of the primary coupling half, this interface can be defined as open. As shown, the outer coupling half 12 includes an annular slot or groove 54, which receives a complementary annular flange 56 that protrudes radially outward from the secondary coupling half 20. Movement between the primary and secondary coupling halves is achieved in the same manner for each of these alternatives embodiments. The secondary coupling halves are simply slid or shifted in a concentric manner, and then are locked in place as discussed further below. The cross sectional shape of the secondary coupling half is generally t-shaped as shown.

Figs. 8 and 9 are illustrated to further show basic structural details of the primary coupling halves 12. Fig. 8 also illustrates additional details with respect to components of a locking mechanism that are used to lock the rotational position of the primary and secondary coupling halves. More specifically, Fig. 8 illustrates a latch mount 74, respective pin openings 78, and tine anchors 80 more fully described below in Figs. 12 and 13.

Figs. 10 and 11 are also illustrated to further show basic structural details of the secondary coupling halves 20. Specifically, Fig.10 illustrates additional details with respect to components of the hinge, and a locking mechanism used to lock the rotational position of the primary and secondary coupling halves. Knuckle portions 36 are shown with a pin opening 39 for the hinge. Fig. 10 also shows a locking element 82 that is mounted to the exterior surface of the coupling half 20. The locking element 82 includes a plurality of resilient locking tines 84 and a catch surface 86.

Referring to Fig. 12, the coupler, 10 is illustrated with a locking mechanism 68 used to lock the rotational position of the primary and secondary coupling halves. As shown in this figure, the secondary coupling halves have been rotated such that one of the coupling halves spans the plane or gap between the distal facing ends 15 of the primary coupling halves, shown generally in Fig. 12 at plane/gap 88. Because of the considerable mass provided by the cross-sectional area of the secondary coupling half at this location, a very robust locking feature is provided. In order to prevent undesirable shifting between the primary and secondary coupling halves, which could conceivably result in shifting of the coupling halves back to a position such as shown in the Fig. 2, it is necessary to provide a locking mechanism. The locking mechanism 68 includes a latch 70 which is rotatably mounted to the opposing latch mounts 74. A pin (not shown) is placed through an aligned opening created between the aligned pin openings 78 of the latch mounts 74, and a pin opening (not shown) formed in the hinge portion 76 of the latch 70. The free

end of the latch 70 includes a distal catch 72. The secondary coupling halves are rotated such that the locking tines 84 are inserted between the tine anchors 80 as shown. The outer pair of locking tines 84 is slightly compressed inwardly during rotation and then open up when fully rotated catching the tine anchors 80, and the tines 84 are thereby held tightly within the gap between the tine anchors 80. In this position, the latch 70 can be rotated closed, as shown in Fig. 13. The latch 70 is rotated such that the distal catch 72 engages the catch surface 86 of the locking element 82, thereby securing the latch in the closed position and preventing any movement between the primary and secondary coupling halves. Additionally, the latch has a pair of protrusions 75 that align with the gaps between the tines 84. When the latch is closed, the protrusions 75 are frictionally inserted in the gaps that further prevent any opening or movement of the tines. As should be apparent, the two distinct locking actions of the rotated secondary coupling halves and the locking mechanism 68 provide locking redundancy.

Other forms of locking mechanisms are contemplated with respect to the present invention. For example, in lieu of the illustrated locking mechanism 68, it is also contemplated that locking can be achieved with a locking pin slid into aligned openings formed between a pair of mounts with openings formed on the primary coupling halves, and a pair of alignable mounts with openings formed on the secondary coupling halves. More specifically, a pair of mounts 74 with pin openings 78 such as shown in Fig. 12 can be provided, along with a pair of similarly constructed mounts and openings which are formed on the secondary coupling half. When these openings are aligned, a locking pin can be used to hold the coupling halves in position. Another manner in which to lock the primary and secondary coupling halves could include a push button lock in which interference would be created between surfaces of the primary and secondary coupling halves. For example, a resilient leaf spring with a protruding button mounted on one of the primary coupling halves could be aligned for engagement with an opening formed on the facing secondary coupling half, and the insertion of the button within the opening could achieve the locking function.

In accordance with another aspect of the invention, a method is provided for interconnecting fluid conveying members by a coupler. According to the method, a pair of primary coupling halves and a pair of secondary coupling halves are provided. The primary coupling halves have arcuate shapes, and form a clamshell configuration. The coupling halves are movable between open and closed positions. In the closed position, the coupling halves cover facing ends of the fluid conveying members for connecting the

members. To lock the coupling halves over the fluid conveying members, the secondary coupling halves are concentrically oriented with respect to the primary coupling halves, and are rotatable about a longitudinal axis X-X (Figs. 1 and 3) that defines the direction about which the coupling halves extend through the coupler. Upon rotation of the secondary coupling halves, the hinged ends of the primary coupling halves are spanned by a portion of one of the secondary coupling halves and the facing distal ends of the primary coupling halves are also spanned by another portion of the secondary coupling halves, thereby preventing the coupling from being opened. In order to prevent movement or translation between the primary and secondary coupling halves, a locking mechanism is provided to lock the position of the secondary coupling halves with respect to the primary coupling halves.

While illustrative embodiments have been described in detail herein, it is to be understood that the concepts may be otherwise variously embodied and employed, and that the appended claims are intended to be construed to include such variations, except as limited by the prior art.

What is claimed is:

1. A coupler for releasably interconnecting first and second fluid conveying members, said coupler comprising:

first and second primary coupling halves pivotally joined at a first hinge, said primary coupling halves having an arcuate shape;

first and second secondary coupling halves pivotally joined at a second hinge, said secondary coupling halves having an arcuate shape, each said secondary coupling half having a body with lateral edges on opposite sides thereof;

said first and second secondary coupling halves being concentrically disposed and connected to said first and second primary coupling halves; and

a locking mechanism secured to said primary and secondary coupling halves to prevent relative rotation between said primary and secondary coupling halves.

2. A coupler, as claimed in claim 1, wherein:

said first and second primary coupling halves each include respective transverse webs and shoulders formed on an opposite transverse edges thereof, and a channel formed in each shoulder for receiving said lateral edges of the first and second secondary coupling halves.

3. A coupler, as claimed in claim 2, wherein:

said transverse webs of said first and second primary coupling halves extend substantially parallel to a longitudinal axis of extension of said fluid conveying members and being substantially planar as extending along said longitudinal axis.

4. A coupler, as claimed in claim 3, wherein:

said first and second secondary coupling halves extend substantially planar between said lateral edges thereof as extending along said longitudinal axis.

5. A coupler, as claimed in claim 4, wherein:

said first and second secondary coupling halves extend substantially parallel to said first and second primary coupling halves along said longitudinal axis.

6. A coupler, as claimed in claim 1, further including:

one or more sight openings formed in said primary and secondary coupling halves enabling a user to view alignment of said coupler as it is secured to the fluid conveying members.

7. A coupler, as claimed in claim 1, wherein:

said first and second hinges are aligned with one another when said coupler is in an open position, and said first and second hinges are misaligned with one another when said coupler is in a closed position.

8. A coupler, as claimed in claim 1, wherein:

said first and second secondary coupling halves have a rectangular cross-sectional shape.

9. A coupler, as claimed in claim 1, wherein:

said first and second secondary coupling halves have a t-shaped cross-sectional shape.

10. A coupler, as claimed in claim 1, wherein:

said first and second secondary coupling halves have a rectangular cross-sectional shape with dovetail-shaped tracks.

11. In combination, a coupler for releasably interconnecting first and second fluid conveying members, said combination comprising:

(a) a coupler including:

(i) first and second primary coupling halves pivotally joined at a first hinge, said primary coupling halves having an arcuate shape;

(ii) first and second secondary coupling halves pivotally joined at a second hinge, said secondary coupling halves having an arcuate shape, each said secondary coupling half having a body with a lateral edge on opposite sides thereof;

(iii) said first and second secondary coupling halves being concentrically disposed and connected to said first and second primary coupling halves; and

(iv) a locking mechanism secured to said primary and secondary coupling halves to prevent relative rotation between said primary and secondary coupling halves.

(b) first and second fluid conveying members, said fluid conveying members each including distal ends with a flange, said flanges facing one another within said coupler when said coupler is closed over said distal ends of said fluid conveying members.

12. The combination, as claimed in claim 11, further including:

a sleeve positioned between said facing flanges and placed within said coupler when said coupler is closed over said distal ends of said fluid conveying members.

13. The combination, as claimed in claim 11, wherein:

rotation of the secondary coupling halves with respect to said primary coupling halves so that the first and second hinges are misaligned with one another causes a plane

between facing distal ends of the primary coupling halves to be spanned by a portion of the secondary coupling halves, thereby preventing the coupler from being opened.

14. The combination, as claimed in Claim 13, wherein: the rotation creates a first locking feature to prevent opening of the coupler, and the locking mechanism creates a redundant second locking feature.

15. A method for interconnecting fluid conveying members by a coupler, said method comprising:

providing a coupler including (i) first and second primary coupling halves pivotally joined at a first hinge, (ii) first and second secondary coupling halves pivotally joined at a second hinge, said first and second secondary coupling halves being concentrically disposed and connected to said first and second primary coupling halves, (iii) a locking mechanism secured to said primary and secondary coupling halves to prevent relative rotation between said primary and secondary coupling halves;

aligning said first and second hinges to place said coupler in an open position;

placing portions of two fluid conveying members within said coupler to join the fluid conveying members;

closing said coupler such that distal ends of the primary coupler halves are moved toward one another and face one another;

rotating the secondary coupler halves with respect to the primary coupler halves such that the first and second hinges are misaligned with one another; and

wherein said rotation causes a plane between said facing distal ends of the primary coupling halves to be spanned by a portion of the secondary coupling halves, thereby preventing the coupler from being opened.

16. A method, as claimed in claim 15, wherein:

said first and second primary coupling halves each include respective transverse webs and shoulders formed on an opposite transverse edges thereof, and a channel formed in each shoulder for receiving lateral edges of the first and second secondary coupling halves;

further wherein rotation causes one of the secondary coupling halves to be rotated beyond the distal end of a corresponding primary coupling half in which it is nested, and inserted into the channel of the other primary coupling half, thereby preventing opening of said coupler.

17. The method, as claimed in Claim 15, wherein: said rotating creates a first locking feature to prevent opening of the coupler, and the locking mechanism creates a redundant second locking feature.

18. A coupler for releasably interconnecting first and second fluid conveying members, said coupler comprising:

first and second primary coupling halves pivotally joined to one another; said primary coupling halves having an arcuate shape;

first and second secondary coupling halves pivotally joined to one another, said secondary coupling halves having an arcuate shape;

said first and second secondary coupling halves being concentrically disposed and connected to said first and second primary coupling halves, said first and second primary coupling halves each having a configuration for receiving said first and second secondary coupling halves and said secondary coupling halves being slidable within said configurations; and

a locking mechanism secured to said primary and secondary coupling halves to prevent relative rotation between said primary and secondary coupling halves.

19. A coupler, as claimed in Claim 18, wherein said configurations include at least one of a channel, a dovetail connection, or groove.

20. A coupler, as claimed in claim 18, wherein:

said primary coupling halves are joined by a first hinge and said secondary coupling halves are joined by a second hinge, wherein said first and second hinges are aligned with one another when said coupler is in an open position, and said first and second hinges are misaligned with one another when said coupler is in a closed position by sliding said secondary coupling halves.

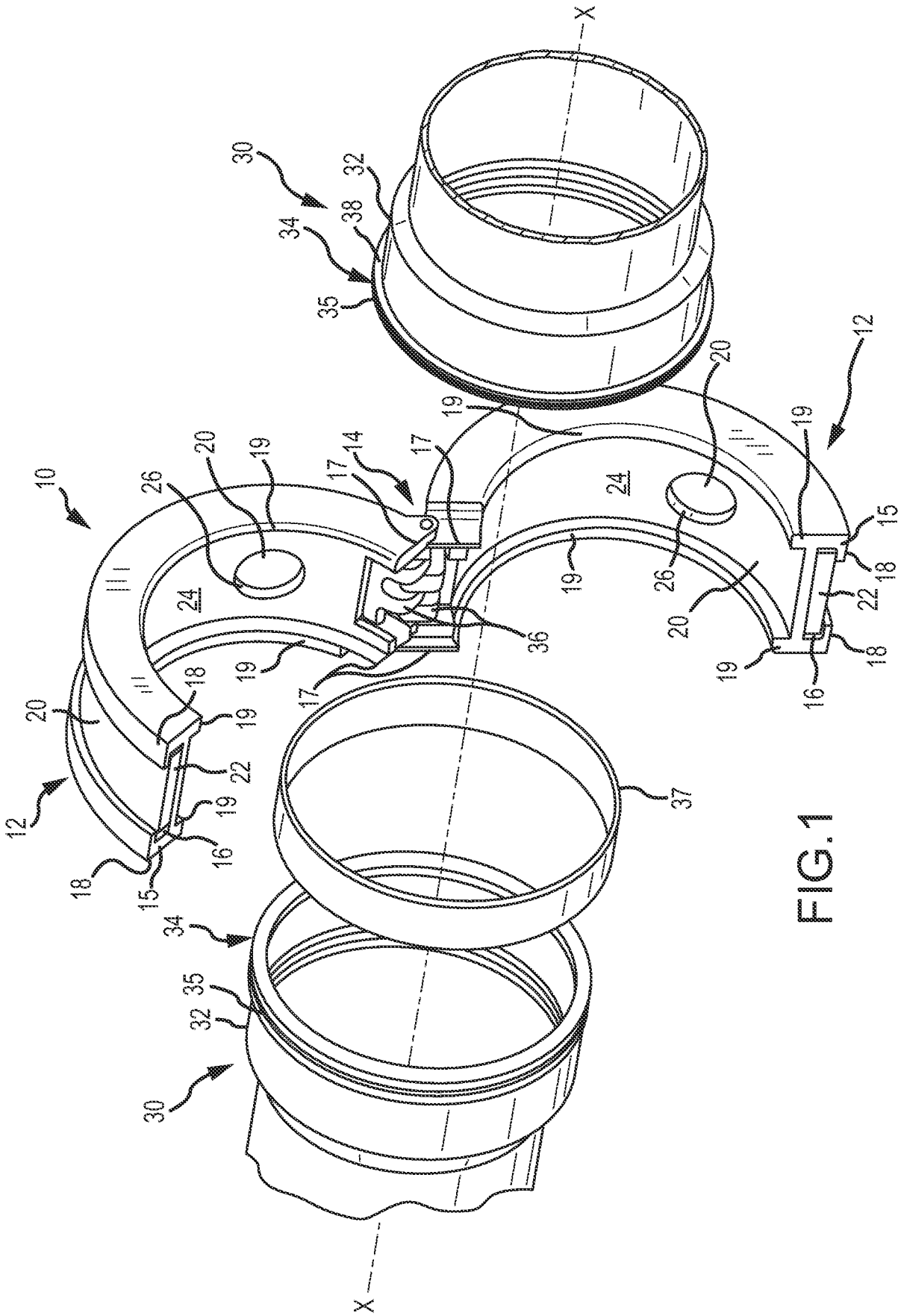

FIG. 1

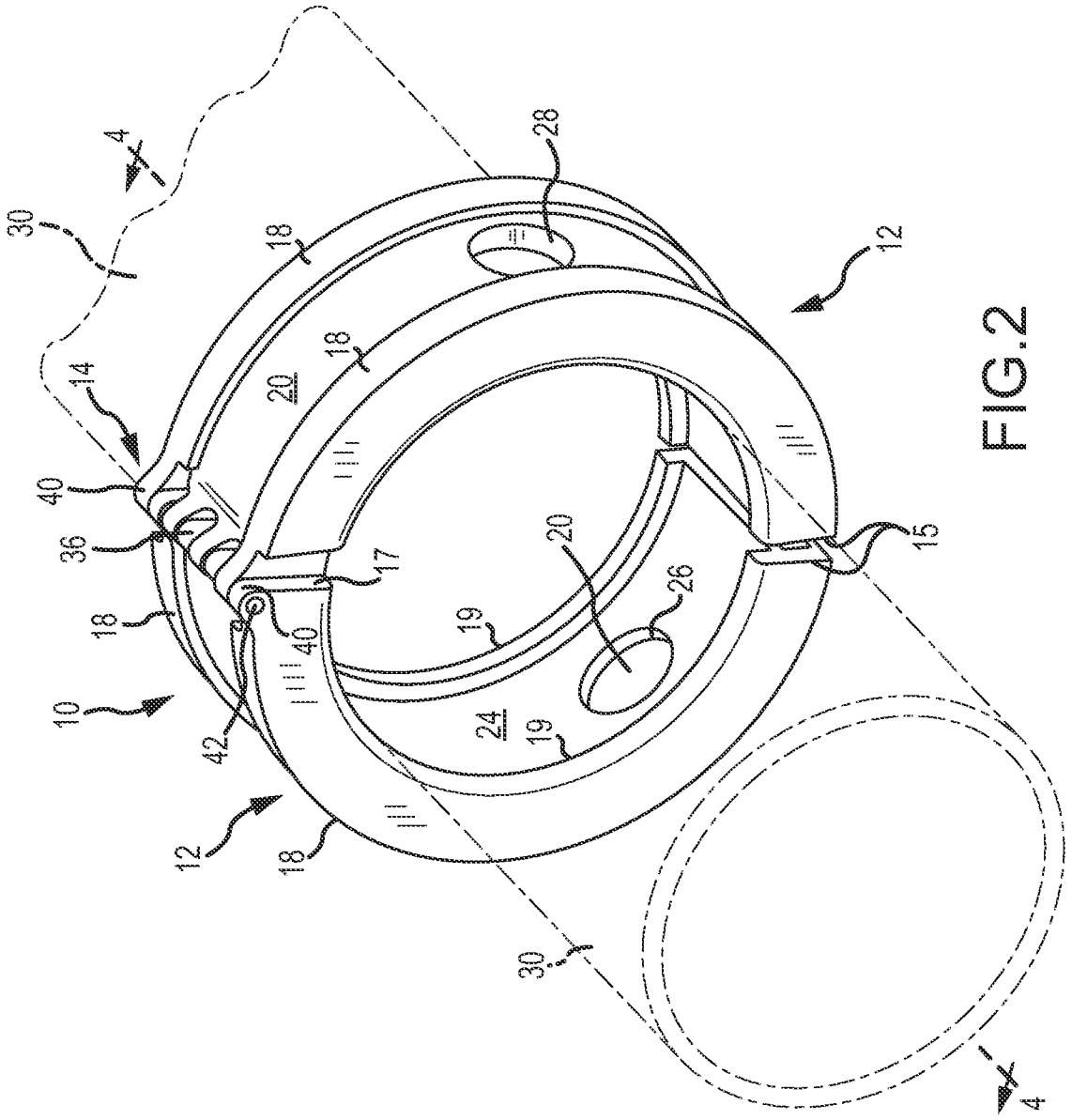

FIG.2

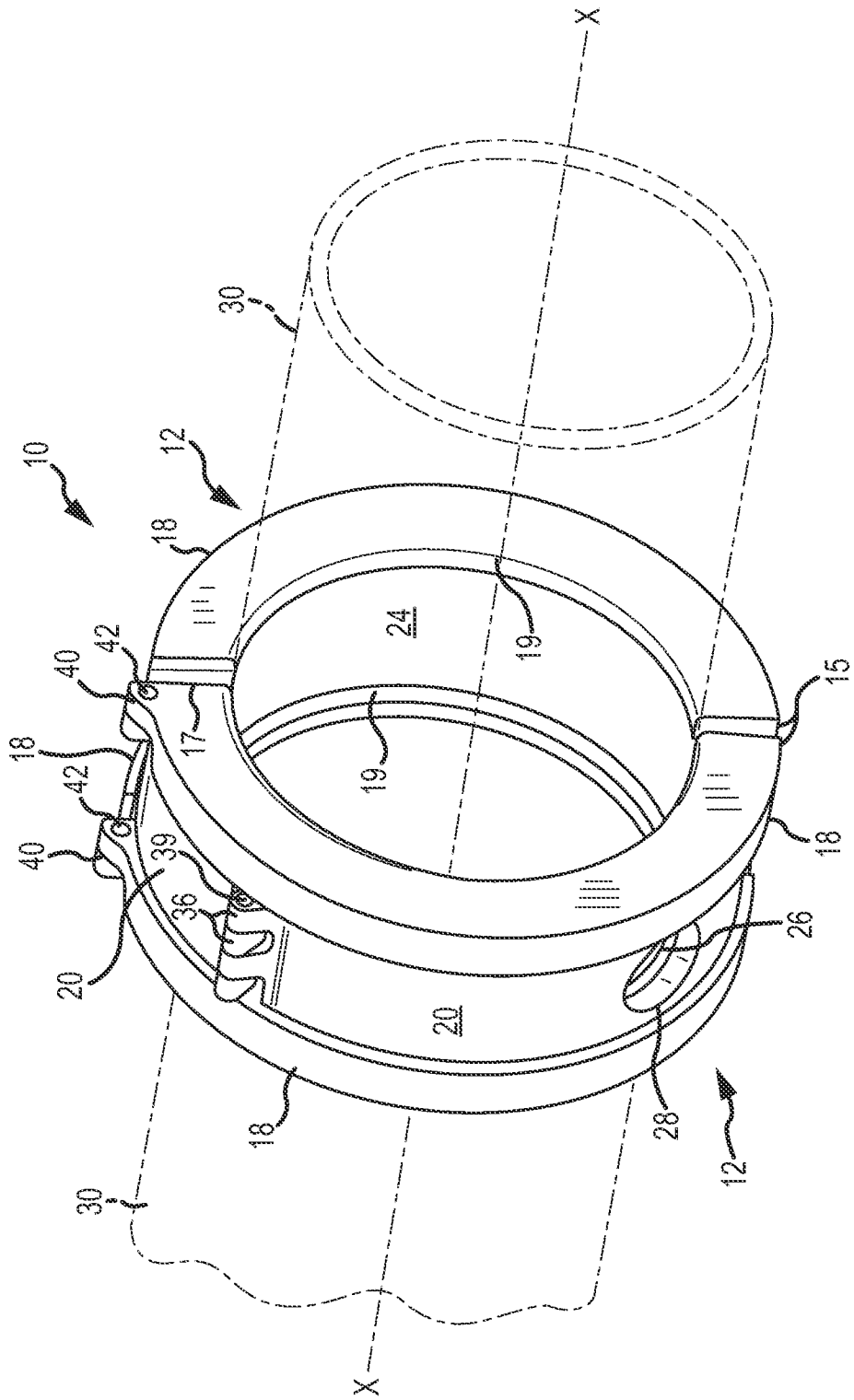

FIG.3

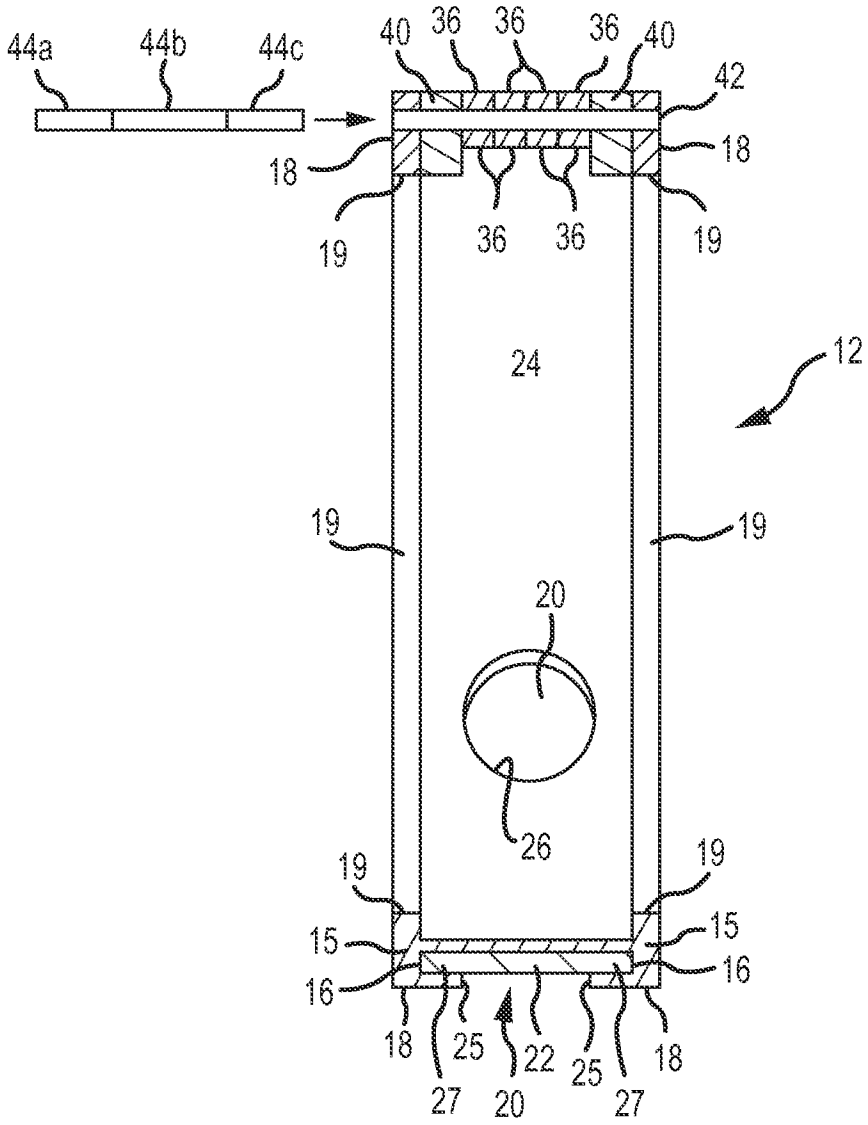
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FIG.4

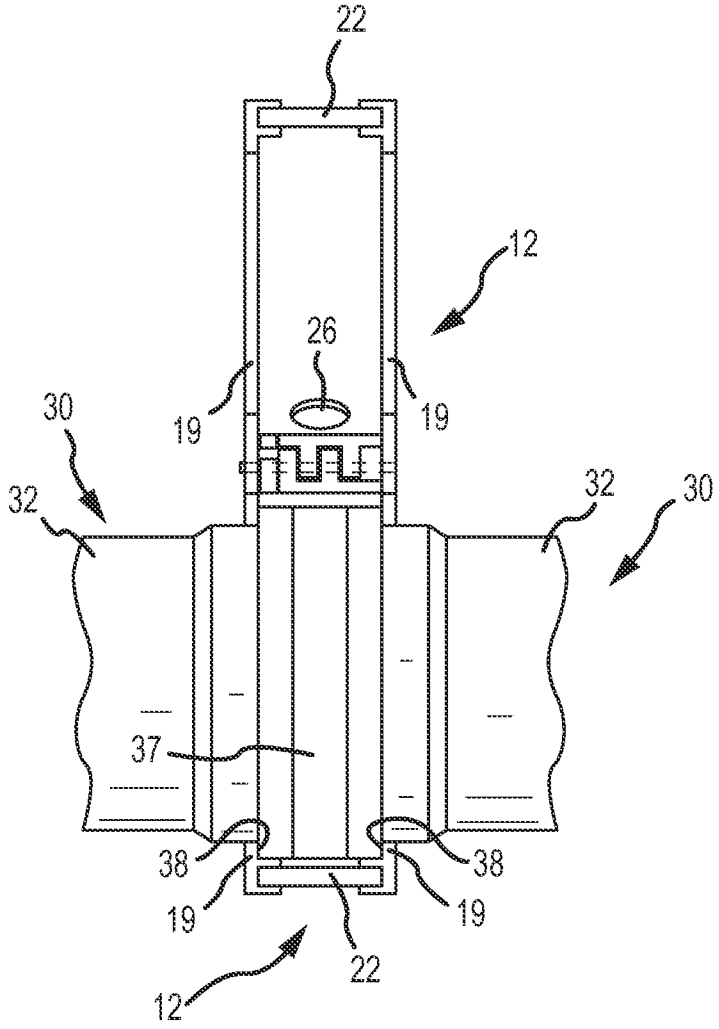

FIG.5

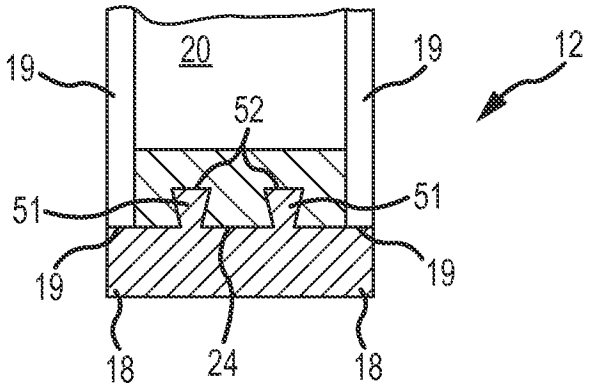
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FIG.6

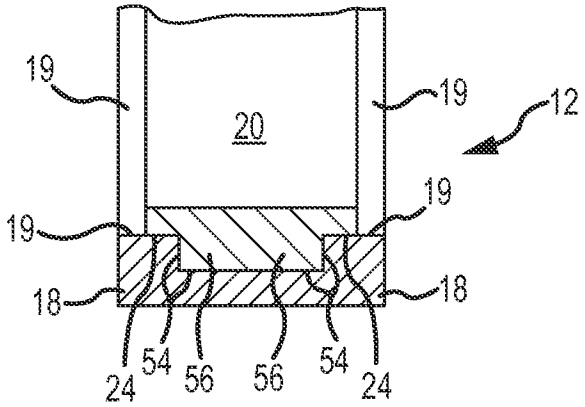
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FIG.7

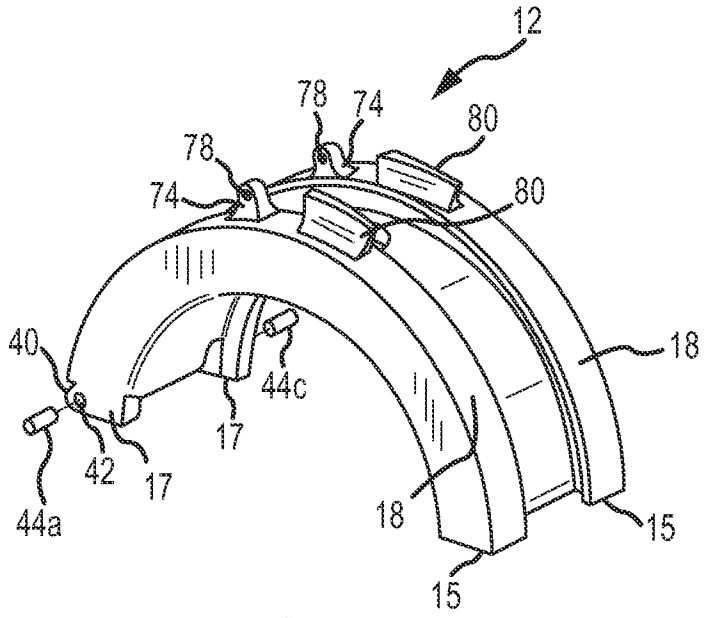
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FIG.8

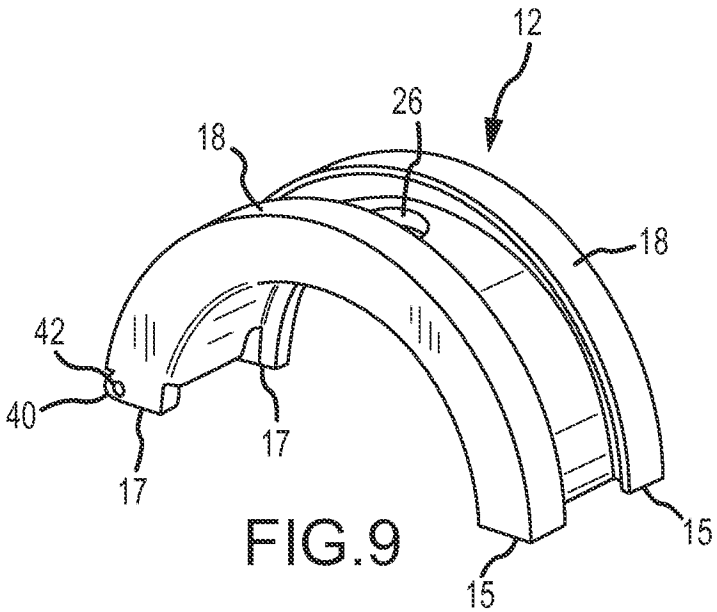
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FIG.9

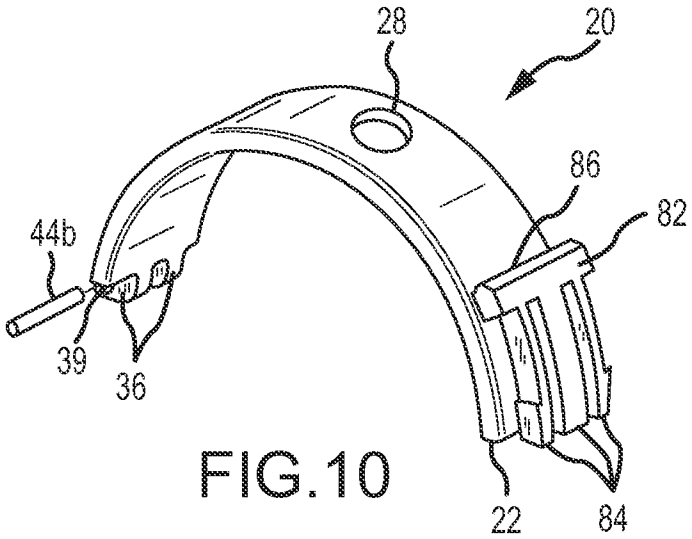

FIG.10

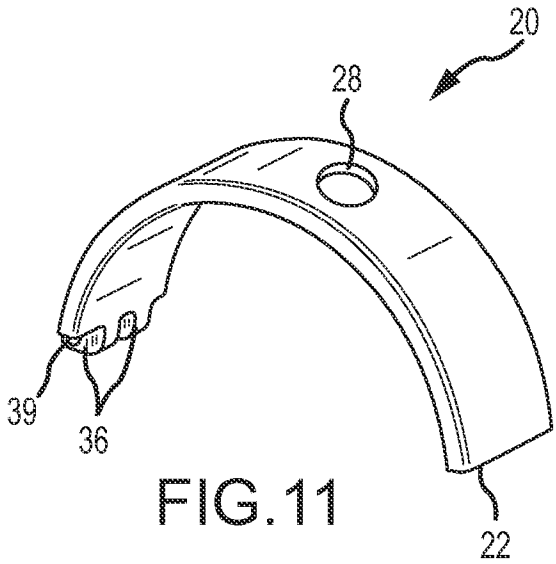

FIG.11

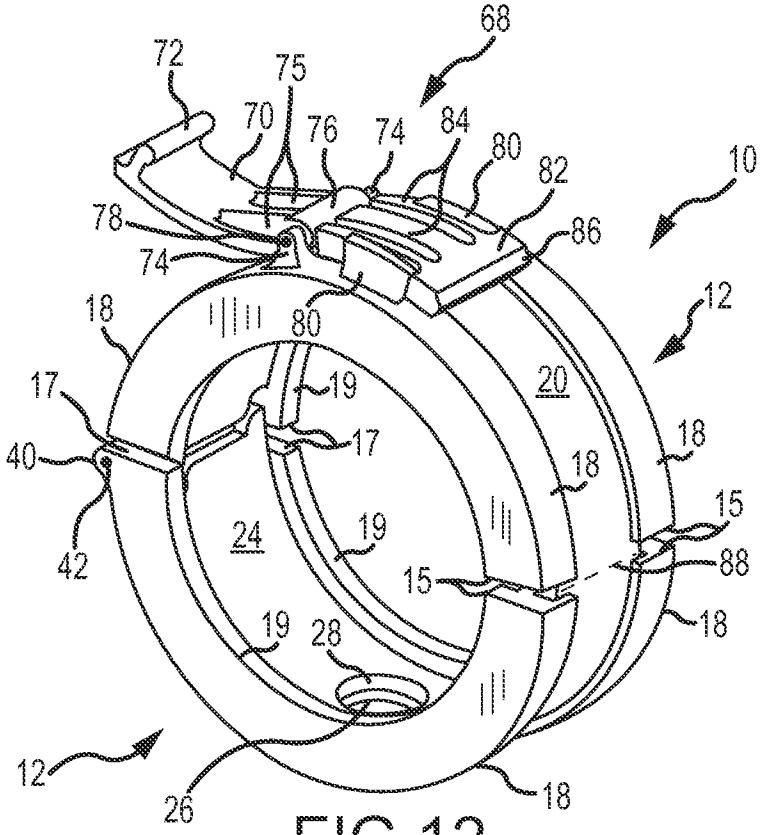
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FIG.12

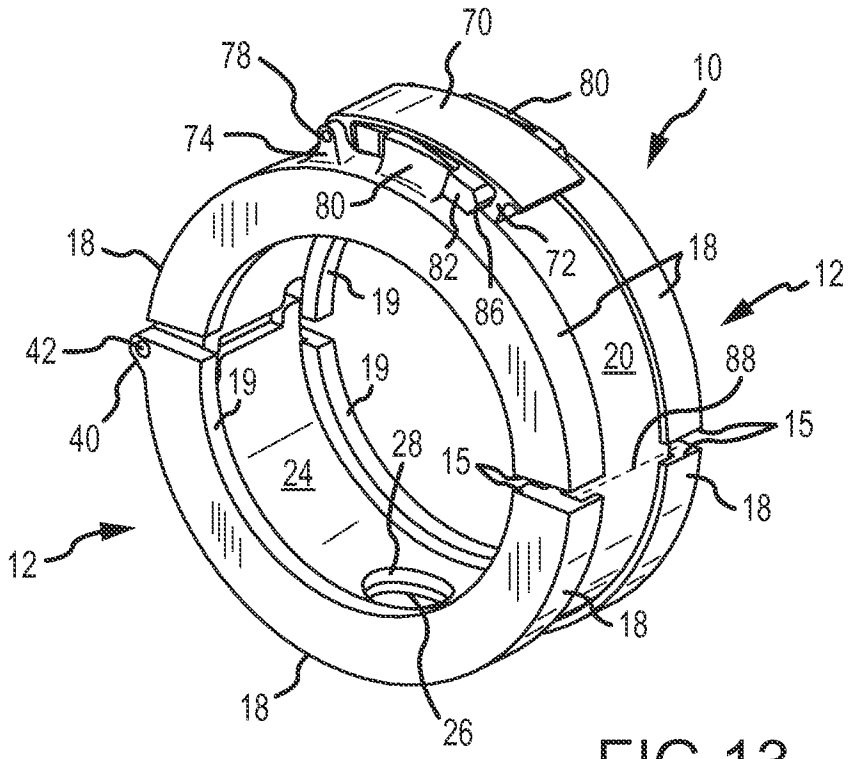
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FIG.13

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/016755

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16L23/04 F16L23/12
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16L B64D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 2004/207197 A1 (HOANG STEVE [US] ET AL) 21 October 2004 (2004-10-21) paragraphs [0002], [0043] - [0047], [0058]; figures 1-7	1-12,18, 19 13-17,20
X	US 2010/327576 A1 (LINHORST THOMAS A [US] ET AL) 30 December 2010 (2010-12-30) paragraphs [0052] - [0055], [0060], [0061]; figures 1-24	1-5, 8-10,12, 19
A	US 6 880 859 B2 (BREAY CLIFTON P [US] ET AL) 19 April 2005 (2005-04-19) cited in the application abstract; figures 1-12	1-20

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 April 2014	09/05/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Gutiérrez Royo, M

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2014/016755

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