(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
12 September 2024 (12.09.2024)

WIPO | PCT

(10) International Publication Number
WO 2024/184883 A1

(51) International Patent Classification:
F16L 35/00 (2006.01) *G01M 3/04* (2006.01)
F16L 55/17 (2006.01) *F17D 5/06* (2006.01)
F17D 5/02 (2006.01)

(21) International Application Number:
PCT/IL2024/050240

(22) International Filing Date:
05 March 2024 (05.03.2024)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
301148 05 March 2023 (05.03.2023) IL

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,

(54) Title: CONTAINMENT CONNECTOR

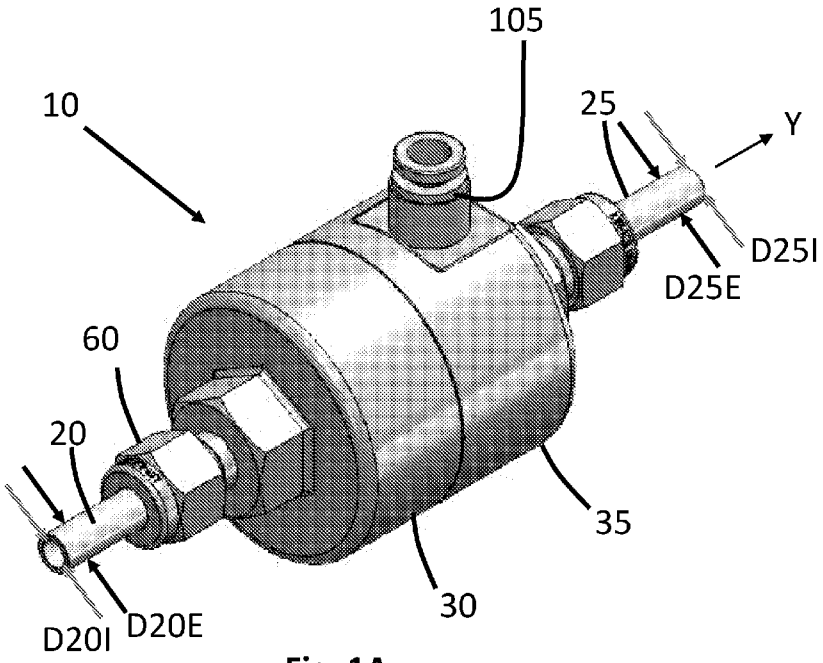


Fig. 1A

(57) Abstract: A containment connector comprising: a. at least one female part, each having a coupling end for hermetically coupling the respective female part to one of the at least one first pipe, and a female mating end having an internal thread for mating with one of at least one male part; b. each of said at least one male part having a coupling end, and a male mating end having an external thread for mating with one of said at least one female part; c. means for sealing the connector by forcing male mating end, and/or a circular groove in each male mating end and an opposite female mating end; d. a space between an interior of the connector and at least a portion of an external surface of the joint; and eat least one port allowing connecting the space with an exterior of the connector.

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[Continued on next page]

TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

CONTAINMENT CONNECTOR

BACKGROUND OF THE INVENTION

Semi-conductor manufacturing systems, for example only, include pipes where toxic gases flow, and joints that connect such pipes. Even though pipe joints are designed to avoid any gas leakage, some failures that lead to gas leaks do occur. Thus, there is a need to further secure the joints by additional means to keep teams and equipment from exposure to toxic or hazardous gases.

BRIEF SUMMARY OF THE INVENTION

According to one aspect, a containment connector for containing a joint joining at least one first fluid pipe and at least one second fluid pipe is provided. The connector comprises at least one female part, and at least one male part. The female parts each have a coupling end for hermetic coupling to the first pipe, and a female mating end with an internal thread for mating with at least one male part. The male parts each have a coupling end for hermetic coupling to the second pipe, and a male mating end with an external thread for mating with at least one female part. A circular groove in the female mating end receives an O-ring for sealing the connector by forcing the O-ring against a flat smooth surface on an opposite male mating end. Alternatively, a circular groove in the male mating end receives an O-ring for sealing the connector by forcing the O-ring against a flat smooth surface on an opposite female mating end. Also, there is a space between an interior of the connector and a portion of an external surface of the joint. The space receives a fluid leaking out of the joint. The connector further includes at least one port connecting the space with an exterior of the connector.

According to one aspect, a containment connector is provided for containing a joint joining at least one first fluid pipe and at least one second fluid pipe, the connector comprising:

a. at least one female part, each having a coupling end for hermetically coupling the respective female part to one of the at least one first pipe, and a female mating end having an internal thread for mating with one of at least one male part;

b. each of said at least one male part having a coupling end for hermetically coupling the respective male part to one of the at least one second pipe, and a male mating end having an external thread for mating with one of said at least one female part;

c. a circular groove in each female mating end for receiving an O-ring for sealing the connector by forcing the O-ring against a flat smooth surface on an opposite male mating end, and/or a circular groove in each male mating end for receiving an O-ring for sealing the connector by forcing the O-ring against a flat smooth surface on an opposite female mating end;

d. a space between an interior of the connector and at least a portion of an external surface of the joint, the space being configured for receiving a fluid leaking out of the joint; and

e. at least one port allowing connecting the space with an exterior of the connector.

In some embodiments the coupling ends have threads for respective nuts pressing sealing elements upon the respective coupled pipes.

In some embodiments the sealing elements are conic ferrules, O-rings, or a combination thereof.

In some embodiments said space has of a volume of at least *1* cm^3.

In some embodiments a port is installed in each of said at least one male part and/or each of at least one female part allows connecting the space with an exterior of the connector.

In some embodiments said port is connected to at least one of a pressure gauge, a leak detector, a closed reservoir configured for safe receiving of a leaked fluid, and a stopper.

In some embodiments each of the at least one female part and each of the at least one male part has the mating end wider than the coupling end.

In some embodiments each of the at least one female part and each of the at least one male part has a rectangular part in between the mating end and the coupling end.

In some embodiments each of the at least one female part and each of the at least one male part has knurling on the mating end and/or on the coupling end.

In some embodiments the pipes and the joint are configured to withstand a predetermined maximal fluid pressure, and the connector is configured to withstand a pressure larger than said maximal fluid pressure by at least *30%*.

In some embodiments each of the at least one male and at least one female parts of the connector include metallic or polymer materials.

According to another aspect, a method is provided for installing a containment connector over a joint joining a first fluid pipe and a second fluid pipe, the method comprising:

a. inserting an O-ring into a circular groove in a mating end of a male part and/or of a female part of the connector, wherein said O-ring allows sealing the connector by coupling a mating end to a flat smooth surface on an opposite mating end of a respective female part or a male part of the connector;

b. inserting an end of the first pipe through a first ordered series including a nut, at least one sealing element, and a coupling end of a female part of the connector having a thread for receiving the nut, or through said first ordered series in reverse;

c. inserting an end of the second pipe through a second ordered series including a nut, at least one sealing element and a coupling end of a male part of the connector having a thread for receiving the nut or through said second ordered series in reverse;

d. screwing said male part into said female part, wherein the male part having an external thread and the female part having a corresponding internal thread, and said O-ring being pressed on said flat smooth surface, wherein a space is formed between an interior of the connector and at least a portion of an external surface of the joint allowing receiving a fluid leaking out of the joint;

e. screwing nuts over the respective sealing elements and over threads of the coupling ends of the connector parts for hermetic coupling the female or male part to the respective pipes; and

f. installing at least one receiving element on at least one port allowing connecting the space with an exterior of the connector.

In some embodiments the method includes a step of joining the first fluid pipe and the second fluid pipe, wherein the step of joining the pipes is executed before or after the step of inserting an end of the first pipe through a first ordered series and the step of inserting an end of the second pipe through a second ordered series.

In some embodiments the method includes inserting an end of the first pipe through an ordered series including a nut, at least one sealing element, and a coupling end of a female part of the connector having a thread for receiving the nut.

In some embodiments the method includes inserting an end of the first pipe through an ordered series including a female part of the connector having a thread for receiving, at least one sealing element, and a nut.

In some embodiments the method includes inserting an end of the second pipe through an ordered series including a nut, at least one sealing element and a coupling end of a male part of the connector having a thread for receiving the nut.

In some embodiments the method includes inserting an end of the second pipe through an ordered series including a coupling end of a male part of the connector having a thread for receiving a nut, at least one sealing element and a nut.

In some embodiments the method includes inserting an O-ring into a circular groove in a mating end of a male part of the connector, wherein said O-ring being configured for sealing the connector by coupling to a flat smooth surface on an opposite mating end of a female part of the connector.

In some embodiments said at least one port is installed in said male part and/or in said female part.

In some embodiments the method includes connecting said port to at least one of a pressure gauge, a leak detector, a closed reservoir configured for safe receiving of a leaked fluid, or a stopper.

Some embodiments further comprise subsequent to steps a)-e) sucking via the at least one port air out of the connector and subsequently leaving the connecter under sub-pressure relative to atmospheric pressure outside the connector..

According to another aspect, a containment connector is provided for containing a joint joining at least one first fluid pipe and at least one second fluid pipe, the connector comprising:

a. at least one female part, each having a coupling end for hermetically coupling the respective female part to one of the at least one first pipe, and a female mating end for mating with one of at least one male part;

b. each of said at least one male part having a coupling end for hermetically coupling the respective male part to one of the at least one second pipe, and a male mating end for mating with one of said at least one female part;

c. means for urging each female mating end against an opposite male mating end, in a direction essentially parallel to the length of a pipe coupled to the male part of the male mating end or the female part of the female mating end, and for sealing a gap between female mating end against an opposite male mating end;

d. a space between an interior of the connector and at least a portion of an external surface of the joint, the space being configured for receiving a fluid leaking out of the joint; and

e. at least one port allowing connecting the space with an exterior of the connector.

In some embodiments means for urging each female mating end against an opposite male mating end are selected from a group consisting of: threads, clamps, clasps, and a combination thereof.

In some embodiments means for sealing a gap between female mating end against an opposite male mating end are selected from a group consisting of: O-rings, gaskets and a combination thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

The subject matter regarded as the invention is particularly pointed out and distinctly claimed in the concluding portion of the specification. The invention, however, both as to system organization and method of operation, together with features and advantages thereof, may best be understood by reference to the following detailed description when read with the accompanied drawings in which:

Fig. 1A is a perspective view of a containment connector for containing a joint joining two pipes according to a preferred embodiment.

Fig. 1B is a cross-section of the connector shown in Fig. 1A.

Fig. 2A is a schematic perspective view of a female part of the connector.

Fig. 2B is a cross section of the female part shown in Fig. 2A.

Fig. 2C shows a segment of a thread on a coupling end of the female or male parts.

Fig. 2D shows a segment of an internal thread of a mating end of the female part shown in Fig. 2A.

Fig. 3A is a perspective view of a male part of the connector shown in Fig. 1A, exhibiting a port.

Fig. 3B is a cross section of the male part shown in Fig. 3A along a plane which bisects the port.

Fig. 3C is a cross section of the male part shown in Fig. 3D along a plane perpendicular to the bisection plane of Fig. 3B.

Fig.3D shows a segment of an external thread of a mating end of the male part shown in Fig. 3A.

Fig. 4A is a perspective enlarged view of the coupling end of the male part shown in Fig. 3A, or of the female part shown in Fig. 2A.

Fig. 4B is a cross section view of the coupling end coupled to a pipe by a hexagonal nut, a conic ferrule and an O-ring.

Fig. 4C is an expanded view of the coupling end, showing the conic ferrule, an O-ring holder, and the hexagonal nut.

Fig. 5 is a flowchart of a method for installing a containment connector over a joint joining two pipes.

DETAILED DESCRIPTION OF THE INVENTION

The present invention will now be described in terms of specific example embodiments. It is to be understood that the invention is not limited to the example embodiments

disclosed. It should also be understood that not every feature of the methods and systems is necessary to implement the invention as claimed in any particular claim of the appended claims. Various elements and features of devices are described to fully enable the invention. It should also be understood that throughout this disclosure, where a method is shown or described, the steps of the method may be performed in any order or simultaneously, unless it is clear from the context that one step depends on another being performed first.

Before explaining an embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments or of being practiced or carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein is for the purpose of description and should not be regarded as limiting.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. The systems, methods, and examples provided herein are illustrative only and not intended to be limiting.

In the description and claims of the present application, each of the verbs "comprise", "include" and "have", and conjugates thereof, are used to indicate that the object or objects of the verb are not necessarily a complete listing of members, components, elements or parts of the subject or subjects of the verb.

Semi-conductor manufacturing systems, for example only, include pipes where toxic gases flow, and joints that connect such pipes. Even though pipe joints are designed to prevent any gas leakage, some failures that lead to gas leaks do occur. Thus, there is a need to secure the joints by additional means to keep teams and equipment protected from toxic or hazardous gases. Such means is a containment connector 10, shown in the perspective view of Fig. 1A and in the corresponding cross-section drawing of Fig. 1B. The connector **10** contains a joint **15** joining two pipes **20** and **25** and thus enables control of the leak from the joint **15**, if it occurs. The connector **10** comprises a female part **30** and a male part **35** which mate with each other to close the vicinity of the joint.

One of the advantages of this kind of containment connector is easy adaptation of the connector's structure for more complex flow systems. For example, some embodiments comprise more than one female part and/or more than one male part, to allow connecting more than two pipes to each other and containing their joints. One or more of such parts e.g., two female parts, may have a structure exactly like, or similar to, the structures described below. Other corresponding parts, e.g., a single male part, may be appropriately adapted in their structure to allow for such connecting, as will be clear to skilled in the art, but will generally be faithful to the structures described below.

Fig. 2A is a perspective schematic view of the female part **30**, and Fig. 2B is a cross section thereof. The female part **30** has a relatively narrow coupling end **40** for hermetically coupling the female part to the pipe **20**, a relatively wide mating end **45** for mating with the male part 35, and a hexagonal part **50** in between. A thread **55** in the coupling end **40**, shown in Figs. 2B and 2C [not shown in **Figure 2A**], enables receiving a nut **60** shown in Fig. 1A for coupling the female part **30** to the pipe **20**, as further detailed below.

The mating end **45** has an internal thread **65**, as shown in Figs. 2B and 2D, for mating with a corresponding external thread of the male part **35**.

Referring now to the male part **35**, it is illustrated in Figs. 3A-3D. Fig. 3B is a cross section of the male part **35** along a plane P1 which bisects port **70**. Fig. 3C is a cross section of the male part **35** along a plane perpendicular to the plane of Fig. 3B. The male part **35** includes a relatively narrow coupling end 40' for hermetically coupling the male part to the pipe 25, a relatively wide mating end 75, from which an external mating thread **80** protrudes, and a rectangular e.g., hexagonal part **50',** between the coupling end **40'** and the mating end **75**. The external mating thread **80** is engaged by rotation with the internal mating thread **65** of the female part 30 around axis Y. The hexagonal parts **50** and **50'** in the female and male parts, respectively, facilitate mutual rotation using a corresponding hexagonal key, a wrench or other suitable tool (not shown).

In alternative embodiments the coupling ends and/or the mating ends and/or nuts comprise knurling, which may facilitate tightening by hand of the parts. With knurling on the mating ends there may be no hexagonal part **45** or other rectangular part for tightening with a tool. Other means can be used to facilitate or enable the tightening, depending upon the amount of required or optimal force.

For further hermetic sealing, a circular groove **85** in the male mating end 75 receives an O-ring **90**, shown in Fig. 1B. Thus, the rotation of the female relative to the male parts in a closing direction forces the O-ring **90** against a flat smooth surface **95** on an opposite female mating end **45**, shown in Fig. 2B.

Referring to Fig. 1B, there is a space **100** between an interior of the connector **10** and a portion of an external surface **16** of the joint **15**. In some embodiments, the space **100** has a volume of at least *5* cm^3, at least *2* cm^3 or at least *1* cm^3. The space **100** can receive a fluid leaking out of the joint **15**, if such a leak occurs. The port **70** allows to safely connect the space **100** with an exterior of the connector **10** in order to safely remove leaked fluid. The port **70** may be connected for example to a pressure gauge, a leak detector, a closed reservoir configured for safe receiving of a leaked fluid, or to a stopper **105**, or a combination thereof.

Referring back to Fig. 1A, the outer diameters **D20E** and **D25E** of the respective pipes **20** and **25** are substantially the same. Also, the inner diameters **D20I** and **D25I** of the respective pipes **20** and **25** are substantially the same. Alternatively, in some embodiments the two pipes **20** and **25** have a different inner diameter, or different outer diameter, or both.

For later use below, proximal ends **20N** and **25N** of respective pipes **20** and **25**, which are coupled by joint **15**, as well as distal ends **20F** and **25F**, are designated on Fig. 1B.

Usually, the pipes **20** and **25** and the joint **15** are designed and made for withstanding a predetermined maximal fluid pressure. Accordingly, the connector is configured to withstand a pressure larger than the predetermined maximal fluid pressure by most preferably at least *60%*, less preferably by at least *30%*, or least preferably by at least *20%*.

The male and female parts of the connector **10** may include metallic or polymer materials or combinations thereof. Preferably, these materials include elastomers. The materials are preferably inert to the fluids that might leak from the joint.

For further discussion of the hermetic sealing of the coupling ends **40** and **40'** to the respective pipes **20** and **25**, reference is made to Figs. 4A, 4B, and 4C which respectively present a perspective enlarged view, a cross section view and an expanded view of the coupling end **40**. The coupling end **40** includes a conic termination **107** for receiving a compatible conic ferrule **110**. A conic ferrule **110**, and an O-ring **115** held by O-ring holder **120** are inserted into the coupling end **40**, and a hexagonal nut **60** is

screwed over thread **55** to ensure hermetic sealing and affixation of the connector to the pipes.

Alternative arrangements of sealing means incorporated in the containment connector can be used to hermetically seal and affix the connector as will occur to the skilled in the art.

Fig. 5 is a flowchart of a method **200** for installing a containment connector **10** over a joint **15** joining two pipes **20** and **25**. The method comprises a step **205** of inserting an O-ring **90** into a circular groove in a mating end **75** of a male part **35**, a step **210** of inserting an end of the pipe **20** through a series of elements, a step **215** of inserting an end of the pipe **25** through a series of elements, a step **225** of screwing the male part **35** into the female part **30**, a step **230** of screwing nuts **60** over sealing elements **110** and **115** and over threads **55** and **55'** of the respective coupling ends **40** and **40'** of the female and male parts for hermetic coupling to the respective pipes **20** and **25**, and the step **235** of installing a receiving element **105** on an exit of a port **70** connecting a space **100** between the connector **10** and the joint **15** with an exterior of the connector **10**.

The O-ring **90** seals the connector **10** by forcing it to a flat smooth surface **95** on an opposite mating end **45** of the female part **35**. An end of the pipe **20** is inserted through a first ordered series which includes a hexagonal nut **60**, a conic ferrule **110**, an O-ring holder **120**, and a coupling end **40** of a female part **30** which has a thread **55** for receiving the nut **60**, or through the first ordered series in reverse. An end of the pipe **25** is inserted through a second ordered series, substantially the same as the first ordered series or through the second ordered series in reverse.

A mating end **75** of the male part 35 has an external thread **80**, while a mating end **45** of the female part **30** has a corresponding internal thread **65**. The space **100** is formed between an interior of the connector **10** and an external surface of the joint **15**, and is ready to receive a fluid leaking out of the joint **15**. The nuts **60** are screwed over the respective conic ferrules **110** and O-ring holders **120**, and over respective threads **55** of the coupling ends **40** and **40'** of the connector male and female parts for hermetic coupling to the respective pipes **20** and **25**.

The method may include a step **220** of joining the fluid pipes **20** and **25**. Usually, the step **220** is executed after the step **210** of inserting an end of the pipe **20** through a first ordered series and the step **215** of inserting an end of the pipe **25** through a second ordered series. In such a case, the proximal ends **20N** and **25N** of the respective pipes

20 and **25**, which the joint **15** couples to each other, are still available for the respective steps **210** and **215** of inserting. The order of inserting is a nut **60**, a ferrule **110** an O-ring holder **120**, and a coupling end **40** or **40'** which has a thread **55** for receiving the nut **60**.

In case that there is an access to the distal ends **20F** and **25F** of the respective pipes **20** and **25**, the step **220** of joining the pipes may be executed before the steps **210** and **215**, and the order inserting of the first and second ordered series is reversed.

In some embodiments, after assembling the containment connector, but before flowing fluid via the pipes, a sub-pressure is created within the connector relative to the environment outside the connector, for example by operationally and fluidically connecting a vacuum pump to the port, opening the port and sucking air out of the connector, and closing the port while the vacuum pump is sucking. This sub-pressure can help prevent build-up of pressure within the connector and allow for time to safely fix the contained leak out of the pipes.

The following are some aspects and embodiments that contribute to the definition of the invention contemplated herein:

AA. A containment connector for containing a joint joining at least one first fluid pipe and at least one second fluid pipe, the connector comprising:

a. at least one female part, each having a coupling end for hermetically coupling the respective female part to one of the at least one first pipe, and a female mating end having an internal thread for mating with one of at least one male part;

b. each of said at least one male part having a coupling end for hermetically coupling the respective male part to one of the at least one second pipe, and a male mating end having an external thread for mating with one of said at least one female part;

c. a circular groove in each female mating end for receiving an O-ring for sealing the connector by forcing the O-ring against a flat smooth surface on an opposite male mating end, and/or a circular groove in each male mating end for receiving an O-ring for sealing the connector by forcing the O-ring against a flat smooth surface on an opposite female mating end;

d. a space between an interior of the connector and at least a portion of an external surface of the joint, the space being configured for receiving a fluid leaking out of the joint; and

e. at least one port allowing connecting the space with an exterior of the connector.

AB. The connector of AA wherein the coupling ends have threads for respective nuts pressing sealing elements upon the respective coupled pipes.

AC. The connector of claim AB wherein the sealing elements are conic ferrules, O-rings, or a combination thereof.

AD. The connector of any one of AA-AC wherein said space has of a volume of at least *1* cm^3. Preferably, the space has a significantly larger volume, for example, at least 10 cm^3.

AE. The connector of any one of AA-AD wherein a port installed in each of said at least one male part and/or each of at least one female part allows connecting the space with an exterior of the connector.

AF. The connector of any one of AA-AE wherein said port is connected to at least one of a pressure gauge, a leak detector, a closed reservoir configured for safe receiving of a leaked fluid, and a stopper.

AG. The connector of any one of AA-AF wherein each of the at least one female part and each of the at least one male part has the mating end wider than the coupling end.

AH. The connector of any one of AA-AG wherein each of the at least one female part and each of the at least one male part has a rectangular part in between the mating end and the coupling end.

AI. The connector of any one of AA-AG wherein each of the at least one female part and each of the at least one male part has knurling on the mating end and/or on the coupling end.

AJ. The connector of any one of AA-AI wherein the pipes and the joint are configured to withstand a predetermined maximal fluid pressure, and the connector is

configured to withstand a pressure larger than said maximal fluid pressure by at least *30%*.

AK. The connector of any one of AA-AJ wherein each of the at least one male and at least one female parts of the connector include metallic or polymer materials.

BA. A method for installing a containment connector over a joint joining a first fluid pipe and a second fluid pipe, the method comprising:

a. inserting an O-ring into a circular groove in a mating end of a male part and/or of a female part of the connector, wherein said O-ring allows sealing the connector by coupling a mating end to a flat smooth surface on an opposite mating end of a respective female part or a male part of the connector;

b. inserting an end of the first pipe through a first ordered series including a nut, at least one sealing element, and a coupling end of a female part of the connector having a thread for receiving the nut, or through said first ordered series in reverse;

c. inserting an end of the second pipe through a second ordered series including a nut, at least one sealing element and a coupling end of a male part of the connector having a thread for receiving the nut or through said second ordered series in reverse;

d. screwing said male part into said female part, wherein the male part having an external thread and the female part having a corresponding internal thread, and said O-ring being pressed on said flat smooth surface, wherein a space is formed between an interior of the connector and at least a portion of an external surface of the joint allowing receiving a fluid leaking out of the joint;

e. screwing nuts over the respective sealing elements and over threads of the coupling ends of the connector parts for hermetic coupling the female or male part to the respective pipes; and

f. installing at least one receiving element on at least one port allowing connecting the space with an exterior of the connector.

BB. The method of BA wherein the method includes a step of joining the first fluid pipe and the second fluid pipe, wherein the step of joining the pipes is executed before

or after the step of inserting an end of the first pipe through a first ordered series and the step of inserting an end of the second pipe through a second ordered series.

BC. The method of BA or BB wherein the method includes inserting an end of the first pipe through an ordered series including a nut, at least one sealing element, and a coupling end of a female part of the connector having a thread for receiving the nut.

BD. The method of BA or BB wherein the method includes inserting an end of the first pipe through an ordered series including a female part of the connector having a thread for receiving, at least one sealing element, and a nut.

BE. The method of any one of BA-BD wherein the method includes inserting an end of the second pipe through an ordered series including a nut, at least one sealing element and a coupling end of a male part of the connector having a thread for receiving the nut.

BF. The method of any one of BA-BD wherein the method includes inserting an end of the second pipe through an ordered series including a coupling end of a male part of the connector having a thread for receiving a nut, at least one sealing element and a nut.

BG. The method of any one of BA-BF wherein the method includes inserting an O-ring into a circular groove in a mating end of a male part of the connector, wherein said O-ring being configured for sealing the connector by coupling to a flat smooth surface on an opposite mating end of a female part of the connector.

BH. The method of any one of BA-BG wherein said at least one port is installed in said male part and/or in said female part.

BI. The method of any one of BA-BH wherein the method includes connecting said port to at least one of a pressure gauge, a leak detector, a closed reservoir configured for safe receiving of a leaked fluid, or a stopper.

BJ. The method of any one of BA-BI further comprising subsequent to steps a)-e) sucking via the at least one port air out of the connector and subsequently leaving the connecter under sub-pressure relative to atmospheric pressure outside the connector..

CA. A containment connector for containing a joint joining at least one first fluid pipe and at least one second fluid pipe, the connector comprising:

a. at least one female part, each having a coupling end for hermetically coupling the respective female part to one of the at least one first pipe, and a female mating end for mating with one of at least one male part;

b. each of said at least one male part having a coupling end for hermetically coupling the respective male part to one of the at least one second pipe, and a male mating end for mating with one of said at least one female part;

c. means for urging each female mating end against an opposite male mating end, in a direction essentially parallel to the length of a pipe coupled to the male part of the male mating end or the female part of the female mating end, and for sealing a gap between female mating end against an opposite male mating end;

d. a space between an interior of the connector and at least a portion of an external surface of the joint, the space being configured for receiving a fluid leaking out of the joint; and

e. at least one port allowing connecting the space with an exterior of the connector.

CB. The containment connector of CA, wherein means for urging each female mating end against an opposite male mating end are selected from a group consisting of: threads, clamps, clasps, and a combination thereof.

CC. The containment connector of CA or CB, wherein for sealing a gap between female mating end against an opposite male mating end are selected from a group consisting of: O-rings, gaskets and a combination thereof.

CD. The containment connector of any one of CA to CC, further comprising any of the features defined in AD-AK.

CLAIMS:

1. A containment connector for containing a joint joining at least one first fluid pipe and at least one second fluid pipe, the connector comprising:
   a. at least one female part, each having a coupling end for hermetically coupling the respective female part to one of the at least one first pipe, and a female mating end having an internal thread for mating with one of at least one male part;
   b. each of said at least one male part having a coupling end for hermetically coupling the respective male part to one of the at least one second pipe, and a male mating end having an external thread for mating with one of said at least one female part;
   c. a circular groove in each female mating end for receiving an O-ring for sealing the connector by forcing the O-ring against a flat smooth surface on an opposite male mating end, and/or a circular groove in each male mating end for receiving an O-ring for sealing the connector by forcing the O-ring against a flat smooth surface on an opposite female mating end;
   d. a space between an interior of the connector and at least a portion of an external surface of the joint, the space being configured for receiving a fluid leaking out of the joint; and
   e. at least one port allowing connecting the space with an exterior of the connector.

2. The connector of claim 1 wherein the coupling ends have threads for respective nuts pressing sealing elements upon the respective coupled pipes.

3. The connector of claim 2 wherein the sealing elements are conic ferrules, O-rings, or a combination thereof.

4. The connector of claim 1 wherein said space has of a volume of at least *1* cm^3.

5. The connector of claim 1 wherein a port installed in each of said at least one male part and/or each of at least one female part allows connecting the space with an exterior of the connector.

6. The connector of claim 1 wherein said port is connected to at least one of a pressure gauge, a leak detector, a closed reservoir configured for safe receiving of a leaked fluid, and a stopper.

7. The connector of claim 1 wherein each of the at least one female part and each of the at least one male part has the mating end wider than the coupling end.

8. The connector of claim 1 wherein each of the at least one female part and each of the at least one male part has a rectangular part in between the mating end and the coupling end.

9. The connector of claim 1 wherein each of the at least one female part and each of the at least one male part has knurling on the mating end and/or on the coupling end.

10. The connector of claim 1 wherein the pipes and the joint are configured to withstand a predetermined maximal fluid pressure, and the connector is configured to withstand a pressure larger than said maximal fluid pressure by at least *30%*.

11. The connector of claim 1 wherein each of the at least one male and at least one female parts of the connector include metallic or polymer materials.

12. A method for installing a containment connector over a joint joining a first fluid pipe and a second fluid pipe, the method comprising:

a. inserting an O-ring into a circular groove in a mating end of a male part and/or of a female part of the connector, wherein said O-ring allows sealing the connector by coupling a mating end to a flat smooth surface on an opposite mating end of a respective female part or a male part of the connector;

b. inserting an end of the first pipe through a first ordered series including a nut, at least one sealing element, and a coupling end of a female part of the connector having a thread for receiving the nut, or through said first ordered series in reverse;

c. inserting an end of the second pipe through a second ordered series including a nut, at least one sealing element and a coupling end of a male part of the connector

having a thread for receiving the nut or through said second ordered series in reverse;

d. screwing said male part into said female part, wherein the male part having an external thread and the female part having a corresponding internal thread, and said O-ring being pressed on said flat smooth surface, wherein a space is formed between an interior of the connector and at least a portion of an external surface of the joint allowing receiving a fluid leaking out of the joint;

e. screwing nuts over the respective sealing elements and over threads of the coupling ends of the connector parts for hermetic coupling the female or male part to the respective pipes; and

f. installing at least one receiving element on at least one port allowing connecting the space with an exterior of the connector.

13. The method of claim 12 wherein the method includes a step of joining the first fluid pipe and the second fluid pipe, wherein the step of joining the pipes is executed before or after the step of inserting an end of the first pipe through a first ordered series and the step of inserting an end of the second pipe through a second ordered series.

14. The method of claim 12 wherein the method includes inserting an end of the first pipe through an ordered series including a nut, at least one sealing element, and a coupling end of a female part of the connector having a thread for receiving the nut.

15. The method of claim 12 wherein the method includes inserting an end of the first pipe through an ordered series including a female part of the connector having a thread for receiving, at least one sealing element, and a nut.

16. The method of claim 12 wherein the method includes inserting an end of the second pipe through an ordered series including a nut, at least one sealing element and a coupling end of a male part of the connector having a thread for receiving the nut.

17. The method of claim 12 wherein the method includes inserting an end of the second pipe through an ordered series including a coupling end of a male part of the connector having a thread for receiving a nut, at least one sealing element and a nut.

18. The method of claim 12 wherein the method includes inserting an O-ring into a circular groove in a mating end of a male part of the connector, wherein said O-ring being configured for sealing the connector by coupling to a flat smooth surface on an opposite mating end of a female part of the connector.

19. The method of claim 12 wherein said at least one port is installed in said male part and/or in said female part.

20. The method of claim 12 wherein the method includes connecting said port to at least one of a pressure gauge, a leak detector, a closed reservoir configured for safe receiving of a leaked fluid, or a stopper.

21. The method of claim 12 further comprising subsequent to steps a)-e) sucking via the at least one port air out of the connector and subsequently leaving the connecter under sub-pressure relative to atmospheric pressure outside the connector..

22. A containment connector for containing a joint joining at least one first fluid pipe and at least one second fluid pipe, the connector comprising:

a. at least one female part, each having a coupling end for hermetically coupling the respective female part to one of the at least one first pipe, and a female mating end for mating with one of at least one male part;

b. each of said at least one male part having a coupling end for hermetically coupling the respective male part to one of the at least one second pipe, and a male mating end for mating with one of said at least one female part;

c. means for urging each female mating end against an opposite male mating end, in a direction essentially parallel to the length of a pipe coupled to the male part of the male mating end or the female part of the female mating end, and for sealing a gap between female mating end against an opposite male mating end;

d. a space between an interior of the connector and at least a portion of an external surface of the joint, the space being configured for receiving a fluid leaking out of the joint; and

e. at least one port allowing connecting the space with an exterior of the connector.

23. The containment connector of claim 22, wherein means for urging each female mating end against an opposite male mating end are selected from a group consisting of: threads, clamps, clasps, and a combination thereof.

24. The containment connector of claim 22, wherein means for sealing a gap between female mating end against an opposite male mating end are selected from a group consisting of: O-rings, gaskets and a combination thereof.

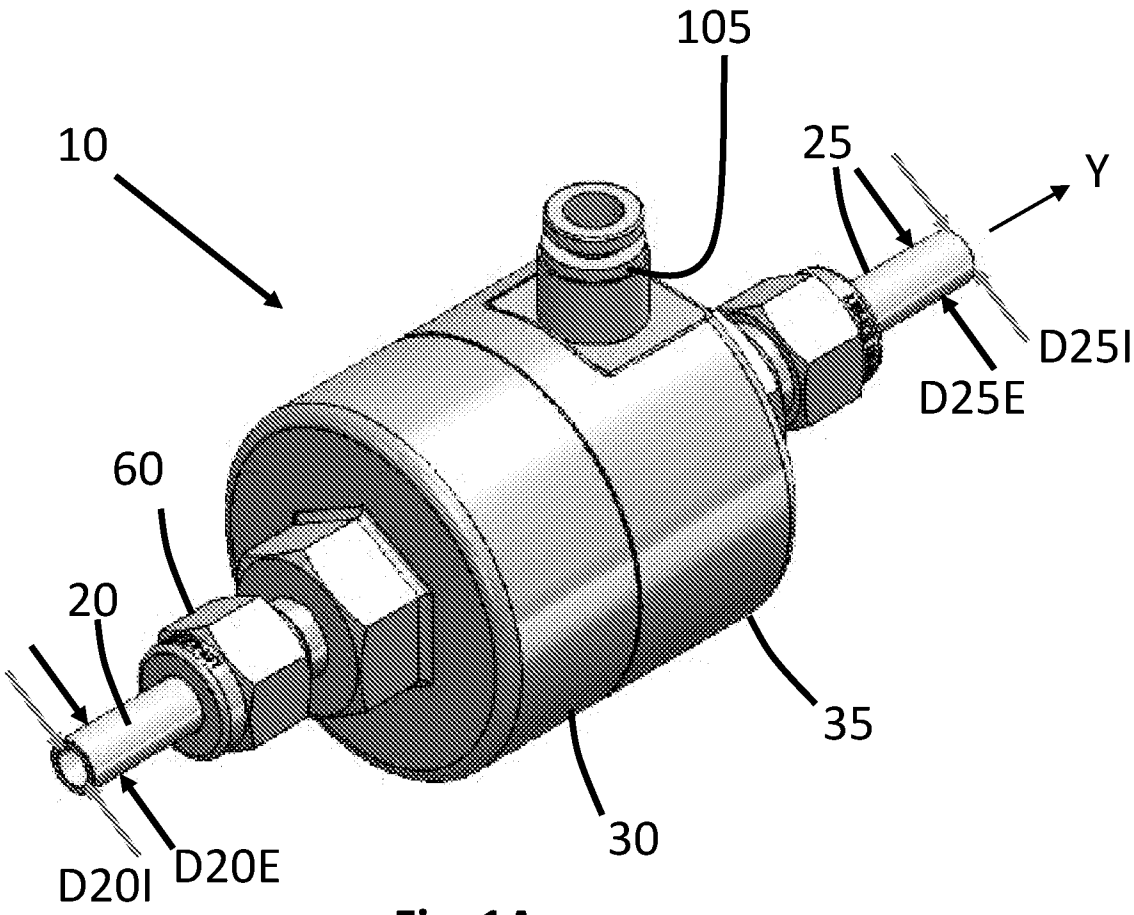

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D25I
D25E
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D20I
D20E

Fig. 1A

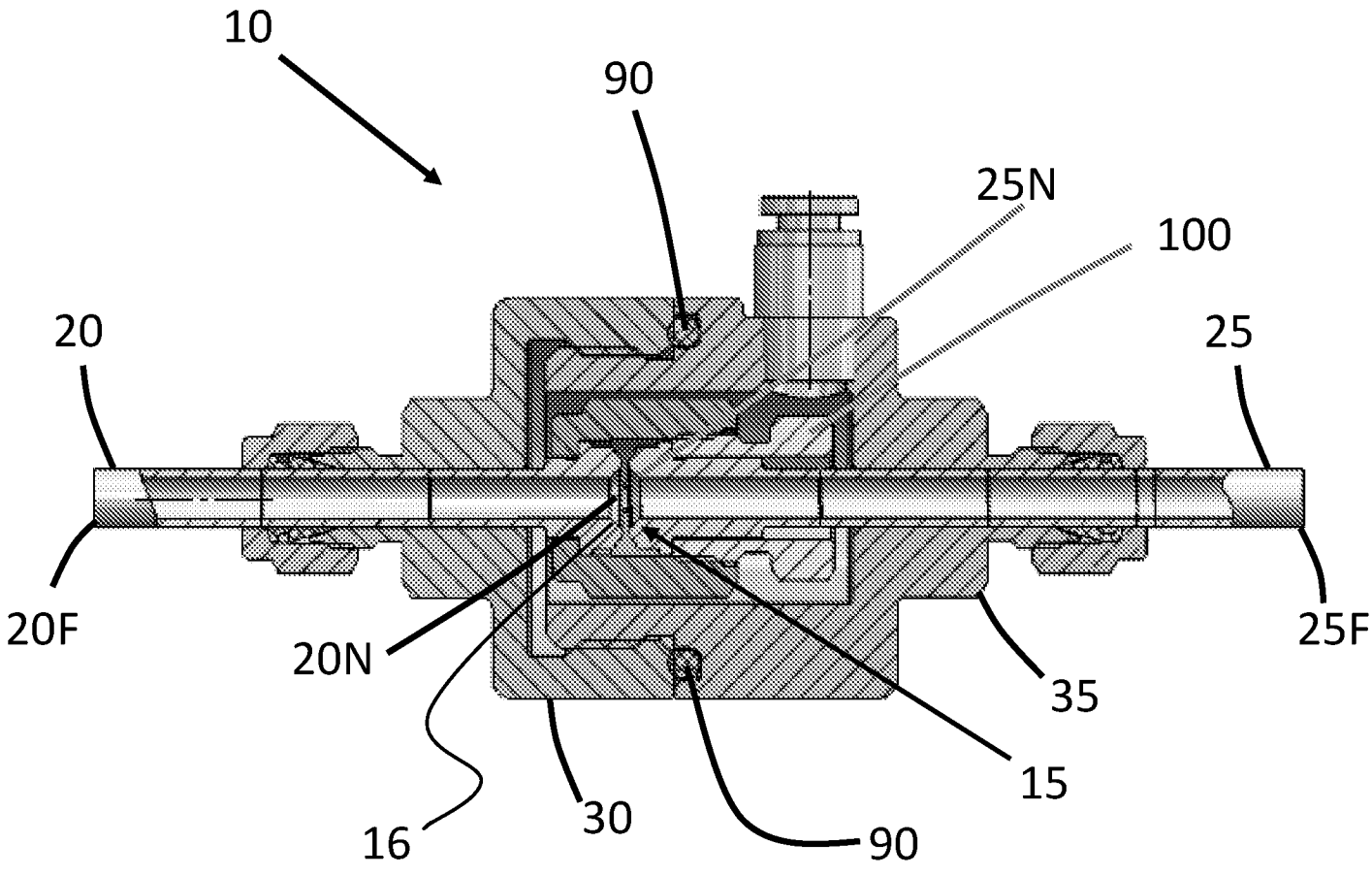

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20F
25F
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Fig. 1B

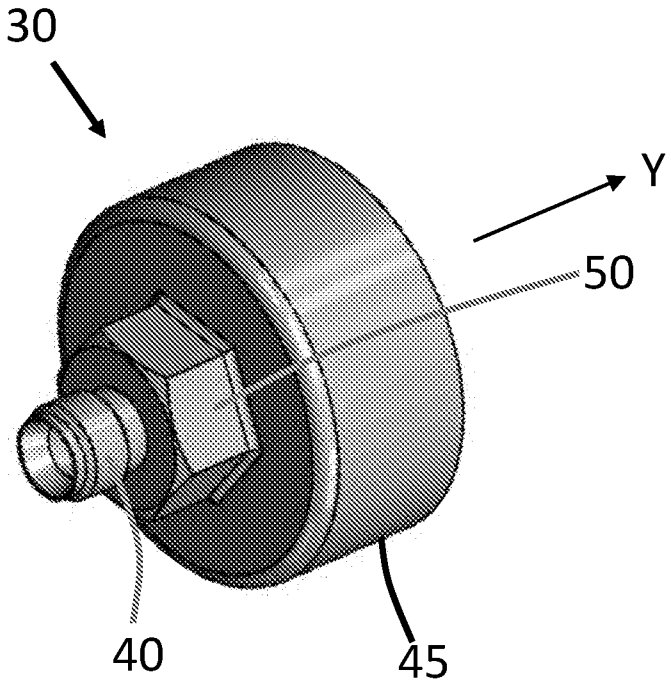


Fig. 2A

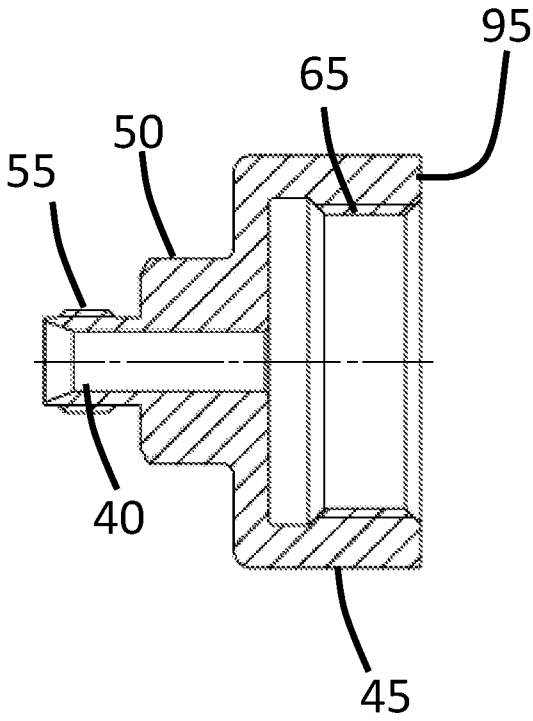


Fig. 2B

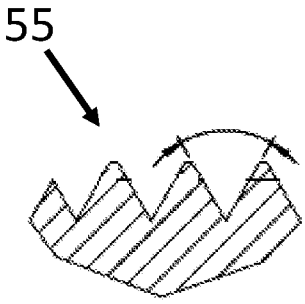


Fig. 2C

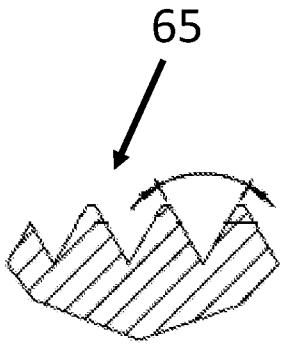


Fig. 2D

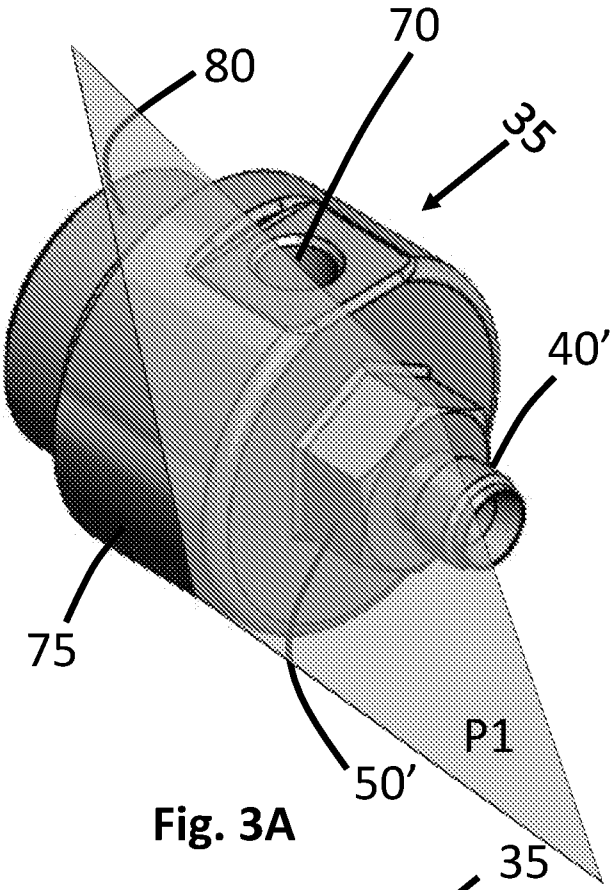


Fig. 3A

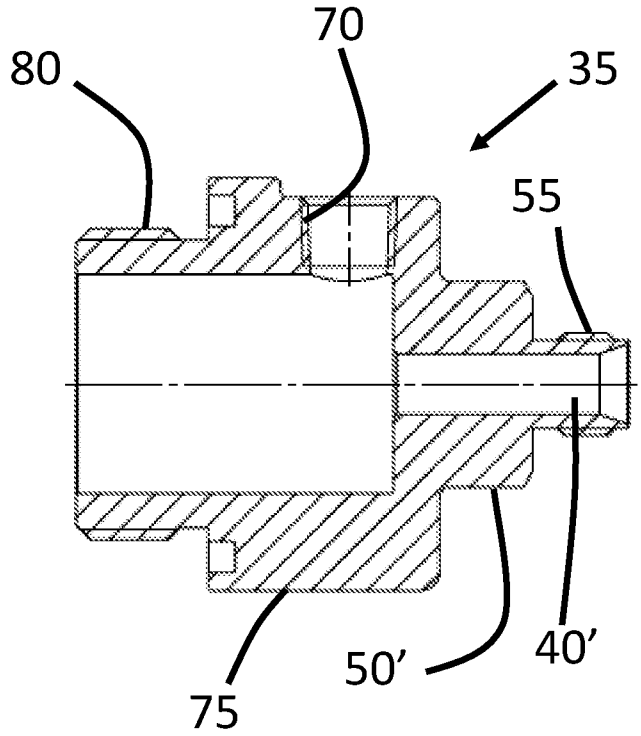


Fig. 3B

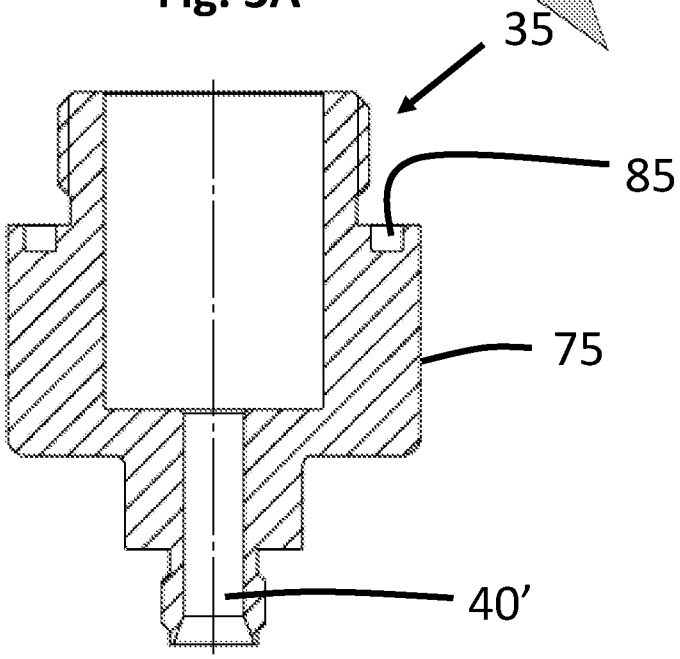


Fig. 3C

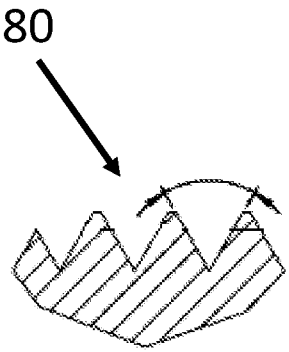


Fig. 3D

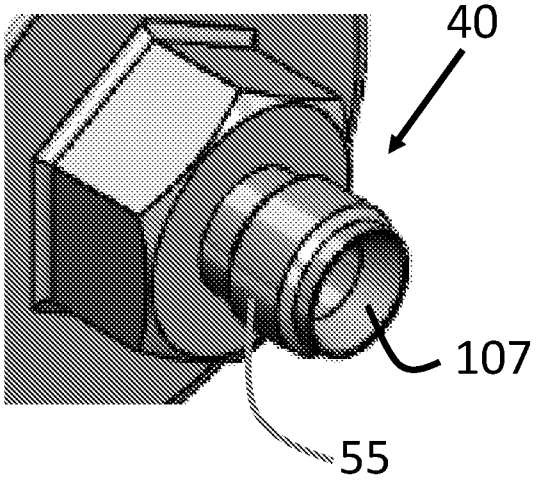


Fig. 4A

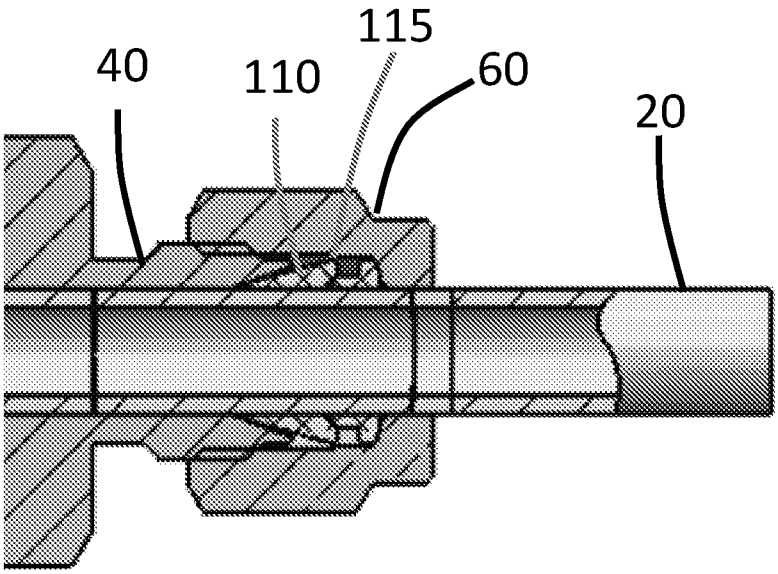


Fig. 4B

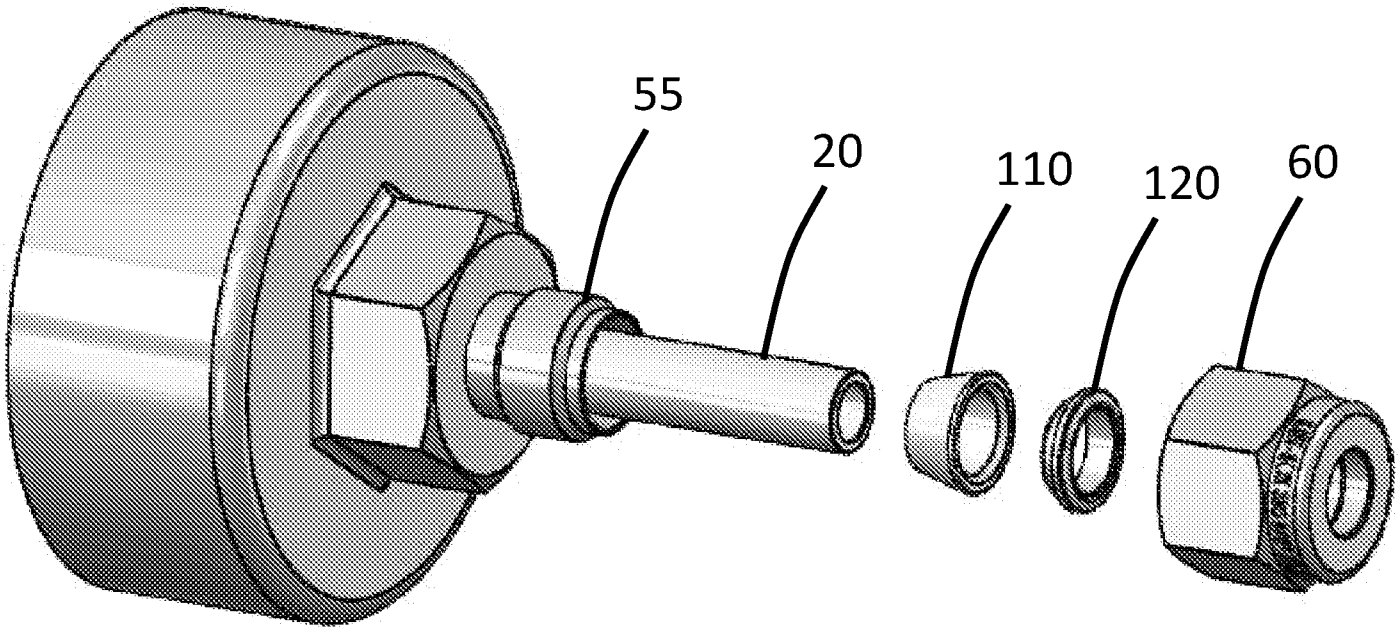


Fig. 4C

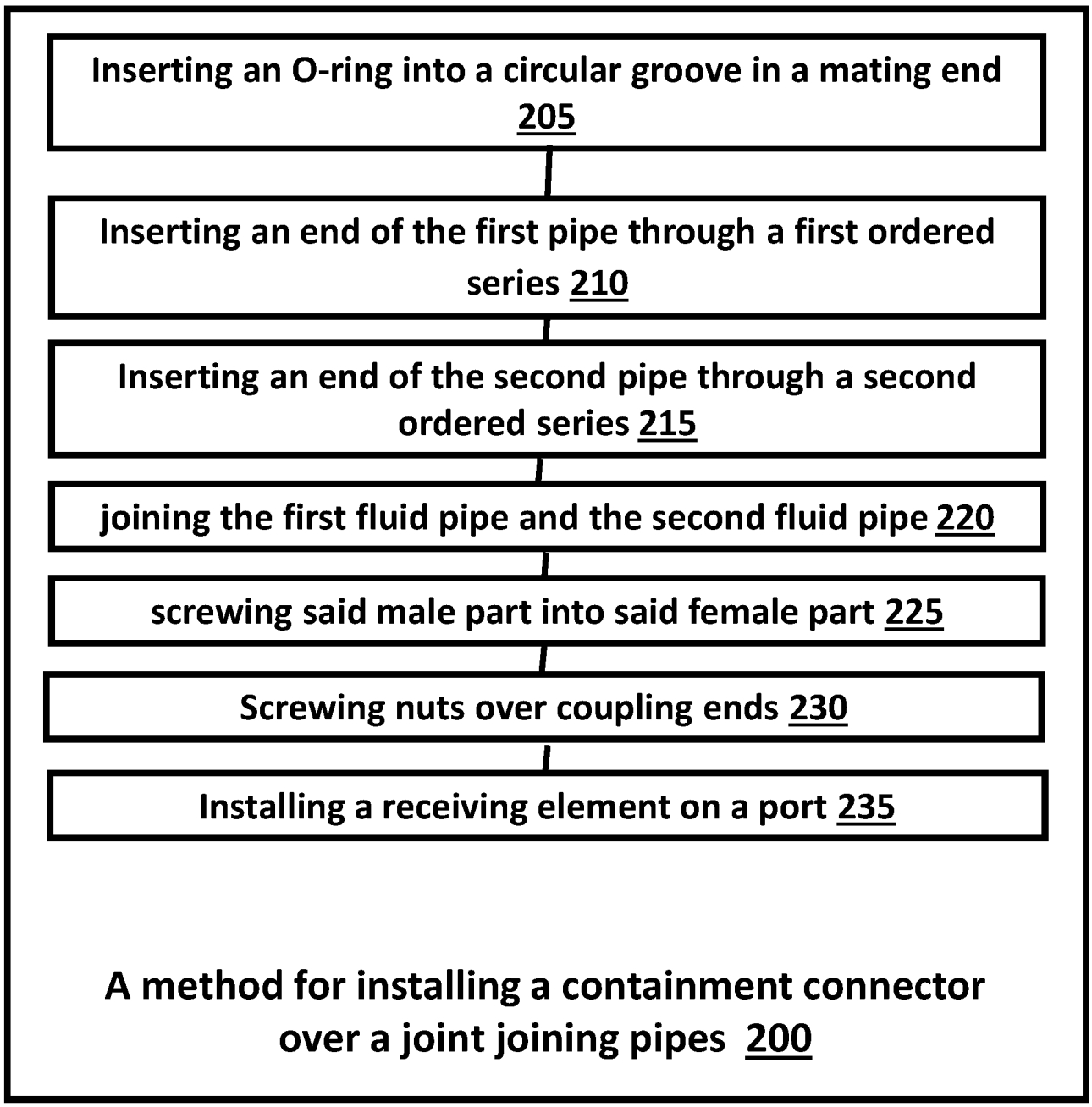

Inserting an O-ring into a circular groove in a mating end 205
Inserting an end of the first pipe through a first ordered series 210
Inserting an end of the second pipe through a second ordered series 215
joining the first fluid pipe and the second fluid pipe 220
screwing said male part into said female part 225
Screwing nuts over coupling ends 230
Installing a receiving element on a port 235
A method for installing a containment connector over a joint joining pipes 200

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL 24/50240

A. CLASSIFICATION OF SUBJECT MATTER

IPC - INV. F16L 35/00, F16L 55/17, F17D 5/02, G01M 3/04 (2024.01)
ADD. F17D 5/04, F17D 5/06 (2024.01)

CPC - INV. F16L 35/00, F16L 55/1715, F17D 5/02, G01M 3/04

ADD. F16L 55/1705, F16L 2201/30, F17D 5/04, F17D 5/06

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)
See Search History document

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2023/0024126 A1 (FUJIKIN INCORPORATED) 26 January 2023 (26.01.2023), entire document, especially Fig 1-3B; para [0035]-[0036], [0040]-[0041], [0044]-[0046], [0048]-[0049], [0053]-[0054], [0056], [0058]-[0059]	1-11, 22-24
Y	US 9,151,426 B2 (SPEARS MANUFACTURING CO.) 06 October 2015 (06.10.2015), entire document, especially Fig 1, 3; col 2, ln 59-67; col 3, ln 1-8, 23-30	1-11, 22-24
Y	US 10,578,503 B2 (SWAGELOK COMPANY) 03 March 2020 (03.03.2020), entire document, especially Fig 1; col 6, ln 9-11, 21-22; col 7, ln 47-50, 55-60; col 8, ln 42-51	2-3, 8
Y	US 9,939,090 B2 (THE GATES CORPORATION) 10 April 2018 (10.04.2018), entire document, especially Fig 1; col 3, ln 58-60, 67; col 4, ln 1-3; col 5, ln 52-55	9
A	US20130277008A1 (HITACHI, LTD.) 24 October 2013 (24.10.2013), entire document	1-11, 22-24
X, D, P	IL 301148 B1 (HAM-LET NOF HAGALIL) 01 November 2023 (01.11.2023), entire document	1-11, 22-24

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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
23 April 2024	JUL 01 2024
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Kari Rodriquez Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL 24/50240

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I: Claims 1-11 and 22-24, directed to a containment connector for containing a joint joining at least one first fluid pipe and at least one second fluid pipe.

Group II: Claims 12-21, directed to a method for installing a containment connector over a joint joining a first fluid pipe and a second fluid pipe.

-*- Continued on extra sheet -*-

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-11 and 22-24

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL 24/50240

-*- Continuation of Box III Observations where unity of invention is lacking -*-

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

SPECIAL TECHNICAL FEATURES

The invention of Group I includes the special technical feature of a connector comprising at least one port, not required by the claims of Group II.

The invention of Group II includes the special technical feature of inserting an end of a first pipe through a first ordered series including a nut, at least one sealing element, and a coupling end of a female part of a connector having a thread for receiving the nut, or through said first ordered series in reverse, not required by the claims of Group I.

COMMON TECHNICAL FEATURES

Groups I-II share the common technical features of a system including:
a containment connector for containing a joint joining at least one first fluid pipe and at least one second fluid pipe;
at least one female part, each having a coupling end, and a female mating end having an internal thread for mating with one of at least one male part;
each of said at least one male part having a coupling end, and a male mating end having an external thread for mating with one of said at least one female part;
at least one of (i) a circular groove in each female mating end for receiving an O-ring for sealing the connector by forcing the O-ring against a flat smooth surface on an opposite male mating end, and (ii) a circular groove in each male mating end for receiving an O-ring for sealing the connector by forcing the O-ring against a flat smooth surface on an opposite female mating end;
a space between an interior of the connector and at least a portion of an external surface of the joint, the space being configured for receiving a fluid leaking out of the joint;
at least one port connecting the space with an exterior of the connector, and
hermetically coupling the female or male part to the respective pipes.
However, this shared technical feature does not represent a contribution over prior art as being obvious over US 2023/0024126 A1 to Fujikin Incorporated (hereinafter "Fujikin") in view of US 9,151,426 B2 to Spears Manufacturing Co., (hereinafter "Spears").
Fujikin discloses, in the embodiment of Fig 1-3B, a system (1; Fig 1; para [0035]) including:
a containment connector (30, 40 collectively; Fig 1; para [0035]) for containing a joint (a joint between pipe members 10A and 10B that includes the flange portion 11 of each of 10A and 10B; Fig 1; para [0035]-[0036]) joining at least one first fluid pipe (10B; Fig 1; para [0035]-[0036]) and at least one second fluid pipe (10A; Fig 1; para [0035]-[0036]);
at least one female part (40; Fig 1; para [0035]), each having a coupling end (41; Fig 1; para [0044]), and a female mating end (a left end of the female part 40 from the perspective of Fig 1-2) having an internal thread (43; Fig 1; para [0044]) for mating with one of at least one male part (30; Fig 1; para [0044]);
each of said at least one male part (30; Fig 1; para [0035]) having a coupling end (36; Fig 1; para [0041]), and a male mating end (34; Fig 1; para [0040]) having an external thread (37; Fig 1; para [0040]) for mating with one of said at least one female part (40; Fig 1; para [0044]);
a circular groove (groove 44, implied to be circular because male part 30 and female part 40 each have a generally cylindrical shape; Fig 1; para [0039]: "The male screw member 30, as shown in FIG. 3A and FIG. 3B, is a metal member formed in a cylindrical shape"; para [0044]: "Returning to FIG. 1 , the female screw member 40 is a so-called cap nut, which is formed in a cylindrical shape . . . A groove 44 for mounting the seal member 50 is formed at a position adjacent to the rear end portion 41 on the inner peripheral surface of the female screw member 40") for receiving an O-ring (the seal 50, implied to be an O-ring having a generally circular shape corresponding to the circular shape of the groove 44; para [0040], [0044]-[0046]) for sealing the connector (30, 40 collectively) by forcing the O-ring (50) against a flat smooth surface (the flat smooth surface at the free end 30a, marked in Fig 2, of the male mating end 34 of the male part 30; para [0040], [0045]-[0046]) on an opposite male mating end (34; Fig 1; para [0045]-[0046]);
a space (gaps G1, G5, G6 and groove 35a collectively; Fig 1; para [0048]-[0049], [0053]-[0054], [0056]) between an interior (an interior surface of 30, 40 collectively; Fig 1; para [0048]-[0049], [0053]-[0054], [0056]) of the connector (30, 40 collectively) and at least a portion of an external surface (an external surface of the joint between pipe members 10A and 10B that includes the flange portion 11 of each of 10A and 10B; Fig 1; para [0035]-[0036], [0048]-[0049], [0053]-[0054], [0056]) of the joint (the joint between pipe members 10A and 10B that includes the flange portion 11 of each of 10A and 10B; Fig 1; para [0035]-[0036], [0048]-[0049], [0053]-[0054], [0056]), the space (gaps G1, G5, G6 and groove 35a collectively) being configured for receiving a fluid (a fluid that leaks from an internal path of the pipe members 10A and 10B, out of the joint, and to the space that includes gaps G1, G5, G6 and groove 35a collectively; Fig 1; para [0035]-[0036], [0058]) leaking out of the joint (the joint between pipe members 10A and 10B that includes the flange portion 11 of each of 10A and 10B; Fig 1; para [0035]-[0036], [0058]);
at least one port (38; Fig 1; para [0058]) allowing a connection of the space (the joint between pipe members 10A and 10B that includes the flange portion 11 of each of 10A and 10B; Fig 1; para [0035]-[0036], [0058]) with an exterior of the connector (an exterior of the connector 30, 40 collectively; Fig 1; para [0035]-[0036], [0058]), and
hermetically coupling the female (40) or male part (30) to the respective pipes (10B and 10A, respectively, where the female part 40 is hermetically coupled to the pipe 10B via the seal 50, and the male part 30 is hermetically coupled to the pipe 10A via the seal 60; Fig 1; para [0035]),
but Fujikin fails to disclose:
the circular groove in each female mating end -- because Fujikin discloses that the circular groove is in a middle of a body of the female part between the ends.
Spears disclose a connector (10; Fig 1, 3; col 2, ln 59 to col 3, ln 2) including a male part (22; Fig 3; col 3, ln 3-5), and a female part (24, 38 collectively; Fig 3; col 3, ln 3-5, 23-30) including a female coupling end (34; Fig 3; col 3, ln 6-8) and a female mating end (32; Fig 3; col 3, ln 6-8, 23-30) that includes a circular groove (the circular groove in 32 for O-ring 41; Fig 2-3; col 3, ln 23-30).
It would have been obvious to one having ordinary skill in the art that the system of Fujikin could have been modified as claimed in view of Spears in order to promote sealing at each end of components of the connector to prevent leakage of hazardous material.
-*- Continued on next extra sheet -*-

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL 24/50240

-*- Continuation of Box III Observations where unity of invention is lacking -*-

As the common technical features were known in the art, these cannot be considered special technical features that would otherwise unify the groups.

Therefore, Groups I-II lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.