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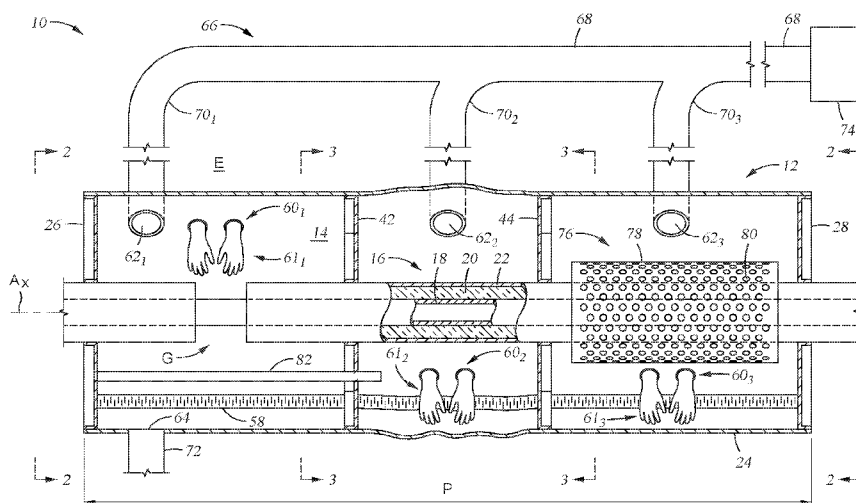


Fig. 1

(57) Abstract: A containment system (10) and method for creating a confined space (14) around a portion of a piping circuit (16), and for maintaining the confined space (14) at a designated pressure with a pressurized blanketing gas. The confined space (14) with its controlled environment protects against process upsets or icing when insulation is removed from sections in extreme temperature services. The containment system (10) includes a shroud assembly (12) that is made up of a cover (24) configured into a tubular shape, and end plates (26), (28) on axial ends of the cover (24) that mount onto a pipe (18) of the piping circuit (16). Support rings (42), (44) are set within the cover (24) that also mount to the pipe (18), and which provide radial support for the cover (24) along the span between the end plates (26), (28). Ports (60) are formed through a sidewall of the cover (24) that provide operations personnel access to the piping circuit (16). Lines (70) carrying the pressurized blanketing gas connect to inlets (62) formed in the cover (24) sidewall.

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PCT PATENT APPLICATION

CONTAINMENT DESIGN TO HANDLE LOW TEMPERATURE SYSTEMS

BACKGROUND OF THE INVENTION

1. Field of Invention

[0001] The present disclosure relates to a system for and method of containing a space around pipe and/or equipment within a piping circuit. More specifically, the present disclosure relates to a system for and method of containing a space that circumscribes at least a portion of a piping circuit, and providing operations and maintenance personnel access to the piping. The access ranges from hand access, to full body access.

2. Description of Prior Art

[0002] Flow circuits in processing facilities that include vessels, tanks, heat exchangers, and reactors (the equipment) typically include piping for transferring fluid between these pieces of equipment. Fluid in some processes is at temperatures that vary significantly from ambient temperature. The equipment and piping is usually insulated when it is important that the fluid temperature not appreciably change when being handled by the system. When the fluid in the system is at a temperature well below ambient, the insulation is often sized to avoid heat gain in the fluid, and to maintain its outer surface at a temperature above ambient dew point to prevent condensate or ice formation.

[0003] Uninsulated systems handling cryogenic fluid or other cold fluids is also at risk of ice formation on its surface. Because of process upsets created by uninsulated high or low temperature piping, and the icing of uninsulated low temperature piping, the entire circuit

containing the affected piping is generally removed from service prior to repairing or maintaining the affected piping in these services. Sometimes one or more processes are associated with the piping circuit being shut down, and also must be taken off line during the maintenance or repair, which significantly increases costs incurred for servicing the affected piping and costs associated with production losses.

SUMMARY OF THE INVENTION

[0004] Disclosed herein is an example of a containment system for use with a piping circuit, and which includes a cover of optionally different sizes and shapes, and that selectively circumscribes a portion of the piping circuit, or equipment, to define a confined space around the selected components. In an example, the space is sized to accommodate full or partial entry by one or more technicians, and to enable access maintenance, repair, or replacement of a targeted part of piping circuit. In an alternative, a smaller version of the system is built around the pipe portion, and between the cover and an outer surface of the portion of the piping circuit are annular support rings that are axially slideable along the portion of the piping circuit, equipment, and other components of the piping circuit. The rings are also in selective supporting contact with the cover. End plates are optionally coupled to opposing axial ends of the cover. An optional larger version of the system is disposed around piping and equipment, and supported on beams. In an alternative, a fluid inlet port is included with the system which is formed through a sidewall of the cover and that is in selective communication with a source of pressurized blanketing gas, so that when pressurized blanketing gas is directed into the confined space, the pressurized blanketing gas provides a thermal barrier between an uninsulated section of the portion of the piping circuit and ambient to the cover. Further included in this example is a diffuser between the fluid inlet port and the portion of the piping circuit, and which disperses the pressurized blanketing gas into the confined space and diverts a stream of the pressurized blanketing gas away from direct contact with the portion of the piping circuit. In one alternative, the fluid inlet port is a first fluid inlet port and the containment system further includes a second fluid inlet port and a manifold connected between the source of the pressurized blanketing gas and the first and second fluid inlet ports. Embodiments exist where the pressurized blanketing gas is nitrogen or dry air, is at a pressure greater than a pressure outside of the cover, and at a temperature so that the pressurized blanketing gas defines a thermal barrier between an uninsulated section in the portion of the piping circuit. The containment system optionally includes a tray supported in the cover that selectively receives tools. Examples exist where the end plates each have an inner ring that mounts onto an outer surface of the portion of the piping circuit, an outer ring circumscribing the inner ring, and sidewalls that extend radially between the inner ring and outer ring, and so that the cover is supported on the piping circuit. Gaps optionally extend radially through the end plates and that are selectively expandable so that the

piping circuit is received in the inner ring. The support rings alternatively include an inner ring that mounts onto an outer surface of the portion of the piping circuit, an outer ring circumscribing the inner ring, and strut members that extend radially between the inner ring and outer ring.

[0005] Also described herein is another example of a containment system for use with a piping circuit, and which includes a cover that is a sheet like transparent material formed into a tubular member, and disposed around a portion of the piping circuit, end plates that sealingly engage opposing ends of the cover, a confined space defined in an annulus between the cover and outer surface of the piping circuit and that is axially bounded by the end plates, and blanketing gas in the contained space that forms a thermal barrier between an uninsulated section of the portion of the piping circuit and ambient to the cover. The containment system optionally includes annular support rings disposed in the confined space, and that each have an outer circumference in supporting contact with the cover. Ends of the cover alternatively extend in a direction axial to the tubular, and that releasably join along a seam that extends substantially the length of the tubular. Access ports are optionally formed through a sidewall of the cover, and gloves sealingly secured along the access ports.

[0006] A method of containing a piping circuit is also described herein, and which includes sealing around a portion of the piping circuit to define a confined space, removing cladding from around a section of the portion of the piping circuit within the confined space so that some of the piping in the section is exposed to conditions in the confined space, and controlling a flow of a blanketing fluid into the confined space so that a thermal barrier is maintained between an outer surface of the piping and ambient to the confined space. In one example, a temperature differential exists radially across the thermal barrier so that ice is prevented from forming on the piping when cryogenic fluids are flowing inside the piping. A cover is optionally used to form a portion of the confined space, the method further including supporting a mid-portion of the cover with an axially slideable element. In one alternative, the blanketing fluid is provided to the confined space at a pressure that is greater than that ambient to the confined space. The method further optionally includes diverting the blanketing fluid from the piping and diffusing the blanketing fluid in the confined space. In one example of the method, a tool is used inside of the confined space, and placed on a tray disposed in the confined space.

BRIEF DESCRIPTION OF DRAWINGS

[0007] Some of the features and benefits of the present invention having been stated, others will become apparent as the description proceeds when taken in conjunction with the accompanying drawings, in which:

[0008] Figure 1 is a schematic example of a containment system for use with a piping run.

[0009] Figure 2 is an axial view of an example of an end plate for use with the containment system of Figure 1.

[0010] Figure 2A is an axial view of an alternate embodiment of the end plate of Figure 2.

[0011] Figure 3 is an axial view of an example of a support ring for use with the containment system of Figure 1.

[0012] Figure 3A is an axial view of an alternate embodiment of the support ring of Figure 3.

[0013] Figures 4 and 4A are elevational and plan views of an alternate embodiment of a containment system mounted on a vessel.

[0014] Figure 5 is a perspective view of an alternate example of a containment system.

[0015] While the invention will be described in connection with the preferred embodiments, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications, and equivalents, as may be included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF INVENTION

[0016] The method and system of the present disclosure will now be described more fully hereinafter with reference to the accompanying drawings in which embodiments are shown. The method and system of the present disclosure may be in many different forms and should not be construed as limited to the illustrated embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey its scope to those skilled in the art. Like numbers refer to like elements throughout. In an embodiment, usage of the term “about” includes +/- 5% of the cited magnitude. In an embodiment, usage of the term “substantially” includes +/- 5% of the cited magnitude.

[0017] It is to be further understood that the scope of the present disclosure is not limited to the exact details of construction, operation, exact materials, or embodiments shown and described, as modifications and equivalents will be apparent to one skilled in the art. In the drawings and specification, there have been disclosed illustrative embodiments and, although specific terms are employed, they are used in a generic and descriptive sense only and not for the purpose of limitation.

[0018] Shown in a side elevational view in Figure 1 is an example of a containment system 10 that includes a shroud assembly 12 for forming a confined space 14 around a portion P of a piping circuit 16. Piping circuit 16 of Figure 1 includes an inner pipe 18 for handling fluids, examples exist where the fluids are liquid, vapor, two-phase flow, a slurry, or combinations thereof. Further examples of fluid include superheated fluids, such as steam, or subcooled fluids, which include cryogenic fluids. In the illustrated example, piping circuit 16 also includes insulation 20, which is shown circumscribing the pipe 18, and which is for providing a thermal barrier between the pipe 18 and that ambient to pipe 18. In a further alternative, piping circuit 16 includes an optional cladding 22 shown covering the insulation 20 and which in an example is formed from a material different from that of the insulation 20. Example materials for the insulation 20 include fiberglass, refractory materials, silica composites, foams, gels, and the like. Example materials for the cladding 22 include aluminum, aluminum alloys, steel, steel alloys, and the like. Shroud assembly 12 includes a cover 24 which is shown as a generally tubular member formed from a planar flexible sheet, such as a transparent polymeric material. End plates 26, 28 are illustrated that are sealingly engaged to opposing axial ends of the cover 24. As

shown, the end plates 26, 28 form axial terminal locations for the confined space 14. Example means for sealingly securing the cover 24 to the end plates 26, 28 include straps, belts, hook, loop fasteners and combinations thereof.

[0019] Shown in an axial view in Figure 2 and taken along lines 2-2 of Figure 1 is an elevational view of examples of the end plates 26, 28. In this example, end plates 26, 28 each have an inner ring 30, 31 that circumscribes the outer surface of the piping circuit 16 when the end plates 26, 28 are mounted on piping circuit 16. Outer rings 32, 33 are disposed radially outward from inner rings 30, 31, and which define an outer circumference of the end plates 26, 28. Sidewalls 34, 35 span the radial space between the inner rings 30, 31 and outer rings 32, 33, and form axial barriers to flow for the confined space 14 (Figure 1). A gap 36, 37 is shown extending radially from inner rings 30, 31 through outer rings 32, 33 and provides a way of fitting the end plates 26, 28 over the piping circuit 16.

[0020] An alternate embodiment of the end plates 26A, 28A are shown in Figure 2A, which have gaps 36A, 37A that extend across the entire diameter of end plates 26A, 28A. In this example, radial flanges 38A, 39A border opposing lateral sides of gaps 37A, 37A, flanges 38A, 39A extend radially outward from opposite sides of inner ring 30A, 31A and project past outer rings 32A, 33A. Flanges 38A, 39A have sufficient axial width to accommodate formation of passages (not shown) that receive optional fasteners 40A, 41A, which couple together flanges 38A, 39A, and the semi-circular portions of end plates 26A, 28A around piping circuit 16.

[0021] Referring back to Figure 1, annular support rings 42, 44 are shown disposed within the confined space 14. Support rings 42, 44 are supported on the piping system 16 by their respective inner radii, and have outer surfaces that provide radial support for cover 24. In an example, support rings 42, 44 are axially slideable along the axis A_x of piping circuit 16 so that space is made available for operations personnel to maintain and/or repair a portion P of the piping circuit 16 within confined space 14. Embodiments exists having a single support ring, or more than two. One advantage provided by the slideable support rings 42, 44 is that a size of a work space is readily adjustable to accommodate various scenarios.

[0022] Referring to Figure 3, shown in an axial side view is an example of support rings 42, 44 and where each have an inner ring 46, 47 circumscribing the outer surface of piping circuit 16. Support rings 42, 44 include outer rings 48, 49, shown spaced radially outward from inner rings

46, 47 and which define an outer circumference of support rings 42, 44. Radially extending struts 50, 51 extend between inner rings 46, 47 and outer rings 48, 49 and provide support for outer rings 48, 49. Gaps 52, 53 are shown that project radially through inner rings 46, 47 and outer rings 48, 49. Similar to gaps 36, 37, gaps 52, 53 provide a way for the support rings 42, 44 to be disposed on the piping circuit 16 (Figure 1).

[0023] In an alternate embodiment shown in Figure 3A, support rings 42A, 44A have gaps 52A, 53A across their entire diameter, so that support rings 42A, 44A are bisected and optionally set over the piping circuit 16 in a clamshell-like fashion. Flanges 54A, 55A border the lateral sides of gaps 52A, 53A and along the diameter of each of the support rings 42A, 44A. Passages (not shown) perpendicularly formed through the flanges 54A, 55A selectively receive fasteners 56A, 57A within for clamping together the two sections of the support rings 42A, 44A.

[0024] Referring back to Figure 1, an example of a longitudinal seam 58 is shown extending substantially the entire length of cover 24; axial longitudinal ends of the material making up cover 24 of Figure 1 are joined along seam 58. Examples of the seam 58 include a zipper, a tongue and groove arrangement, hook and loop fasteners, and the like. In the illustrated embodiment, a series of access ports 60₁₋₃ are shown formed through the sidewall of cover 24, which provide access by operations personnel into the confined space 14. Gloves 61₁₋₃ are optionally provided with each of the access ports 60₁₋₃ that provide operations personnel access to confined space 14 and hardware within. Gloves 61₁₋₃ connect to access ports 60₁₋₃ along their periphery to maintain a sealed environment within the shroud assembly 12.

[0025] Further illustrated in the example of Figure 1 are fluid inlet ports 62₁₋₃ formed through a sidewall of cover 24 and which allow for a flow a blanketing gas to enter into the confined space 14. In an example, the blanketing gas includes nitrogen and is at a pressure so that pressure inside the confined space 14 is greater than that of an environment E ambient to the confined space 14. In a further example, the temperature of the blanketing gas is such that when a portion of the insulation 20 is removed, such as illustrated by gap G, the blanketing gas forms a thermal barrier for the exposed pipe 18 so that fluid within pipe 18 is not affected by the ambient temperature, *i.e.*, causes a localized increase in temperature that could flash a subcooled liquid or condense a superheated vapor. Additionally, the presence of the blanketing gas at a temperature such that ice or other condensate is prevented from forming on the outer surface of pipe 18. It is

within the capabilities of those skilled in the art to designate a pressure and temperature of the blanketing gas so that a thermal barrier is formed between the pipe and environment E ambient to cover 24 and confined space 14. Further included with the containment system 10 of Figure 1 is a fluid outlet port 64 to allow blanketing fluid within confined space 14 to be discharged from within the confined space 14.

[0026] A manifold 66 is shown which provides one example way of directing blanketing fluid to the fluid inlet ports 62₁₋₃. Included with manifold 66 is a supply line 68 from which leads 70₁₋₃ branch and then connect to the respective access port 60₁₋₃. Additionally, a discharge line 72 is shown connected with fluid outlet port 64 and for directing blanketing fluid being discharged through fluid outlet port 64 to a location away from confined space 14. An end of supply line 68 distal from leads 70₁₋₃ connects to a fluid supply 74 which can be any type of compressor or other device for providing a blanketing fluid at a designated pressure and temperature. Examples of operation include a steady flow of blanketing gas from fluid supply 74 to confined space 14 which is then discharged through outlet port 64. Alternatively, batch flows of blanketing gas are dispensed to confined space 14, that are repeated at regular or irregular intervals. Further optional embodiments include a check valve (not shown) in discharge line 72 to prevent back flow into confined space 14, and where the total cross sectional area of fluid inlet ports 62₁₋₃ exceeds the cross sectional area of outlet port 64 so that a backpressure is maintained in the confined space 14.

[0027] Still referring to Figure 1, also shown set within the confined space 14 is a diffuser 76 which is used to divert a direct flow of blanketing fluid from inlet ports 62₁₋₃ away from the piping circuit 16. In the example illustrated, diffuser 76 includes a body 78 which is a tubular-like member that circumscribes a portion P of piping circuit 16. Perforations 80 are formed radially through the body 78 and which allow a diffused flow to enter into the space within body 78 thereby avoiding a direct flow of blanketing fluid onto a dedicated section of the piping circuit 16. Radial struts (not shown) support the diffuser 76 on the piping system 16. Embodiments exist where the diffuser 76 circumscribes a finite portion of the circumference of the piping system 16 and along an arc that is in a path between the inlet ports 61₁₋₃ and outer surface of piping system 14. Diffusing the flow of blanketing gas more evenly distributes the gas within the confined space 14 which minimizes temperature differentials within the confined space 14 and along the portion P of the piping system 16. Optionally, a tray 82 is shown

supported within confined space 14. The tray 82 in one example provides a place for placing tools (not shown) or other objects within the confined space 14 and that are being used by operations personnel. In one example, tray 82 mounts to one or both of the support rings 42, 44, and thus is moveable axially within the confined space 14 with axial movement of the one or both support rings 42, 44.

[0028] In one non-limiting example of operation, the shroud assembly 12 is assembled over a portion P of piping circuit 16 where maintenance and/or repair of piping circuit 16 is to take place. As indicated above, assembling the shroud assembly 12 over the portion P of piping circuit 16 forms the confined space 14. An amount of blanketing fluid is introduced into the confined space 14, such as through the inlet ports 62₁₋₃ and which originates from fluid supply 74. Flowing the blanketing fluid into the confined space 14 at a pressure greater than a pressure in the confined space 14, and so that fluid present in the confined space 14 is evacuated through the outlet port 64, fills the confined space 14 with the blanketing fluid. In an alternative, when the confined space 14 is at a designated condition, *i.e.* designated temperature and/or pressure, a portion of the cladding 22 and insulation 20 is removed from around the pipe 18, which creates gap G in the portion P of the piping circuit 16. Examples exist where the blanketing fluid is at a designated temperature so that a thermal barrier is created around the exposed portion of pipe 18 shown within gap G. Examples of the blanketing fluid include nitrogen gas, such as in a pressurized bottle or cylinder, and which connects to the ports 62₁₋₃. In an alternative, ambient air is directed into the space 14, that is optionally dehumidified. Further optionally, the ambient air is dried prior to being introduced into the space 14, such as through a desiccant or a skid mounted unit having a compressor, tanks, and moisture absorbing material. Drying the air prior to introducing it into the space 14 removes moisture that otherwise might condense on equipment inside the space 14. Pressure of the nitrogen or dried air is maintained at a level greater than that ambient to the cover 24. In a non-limiting example, a thermal barrier provides the functionality of insulation so that although a significant temperature difference exists between the fluid in the pipe 18 and temperature in the environment E ambient to the pipe 18, ice or condensate does not form on the pipe 18. Further in this example, with the thermal barrier in place, heat transfer across walls of the pipe 18 is maintained at a level such that fluid inside the pipe 18 does not undergo a change of state, *i.e.* does not flash or condense. In one alternative use, operations personnel extend hands through the access port 60₁₋₃ and into one of the sets of gloves 66₁₋₃, and

thereby have access to the confined space 14 such as for maintaining or repairing portions of the pipe 18 within portion P of piping circuit 16. As previously noted, during operations on the pipe 18, applying the blanketing fluid enables removal of insulation 20 to expose pipe 18, without allowing ice or condense to form on pipe 18, or causing a state changing condition within the fluid in the pipe 18. Accordingly, the process associated with the piping circuit 16 is not suspended or shut down, but allowed to operate in a normal fashion while the operations to the piping circuit 16 and portion P the of piping circuit 16 within shroud 12 are conducted. When the prescribed maintenance or repair are complete, the insulation 20 and cladding 22 removed are replaced into the gap G.

[0029] Shown in an elevational view in Figure 4 is an example of an alternate embodiment of a containment system 10B mounted to a vessel 84B. Examples of the vessel 84B include anything containing a fluid or a flowable material, such as but not limited to towers, tanks, reactors, mixers, heat exchangers, specialty piping items and the like. Vessel 84B includes insulation 20B on its outer wall 86B, where cladding 22B covers the insulation 20B. An embodiment of a cover 24B is shown mounted on an outer surface of vessel 84B, and which includes a flange 88B on its outer periphery. Flange 88B as shown is a planar member with a ring like or picture frame like configuration that is in sealing contact with an outer surface of the cladding 22B. Flange 88B has a height extending along an axis A_Y of the vessel 84B, a width that extends along a circumference of vessel 84B, and a thickness extending radially from axis A_Y . The example of the flange 88B is illustrated as generally rectangular, but alternative embodiments include any shape, such as but not limited to circular, elliptical, and triangular. An axis A_F of the flange 88B extends radially outward from axis A_Y of the vessel 84B, and that is circumscribed by an inner radius of flange 88B, which defines an opening 89B through the flange 88B along axis A_F and radially outward from axis A_F . The outer surface of vessel 84B is accessible through opening 89B. Further included with cover 24B is a canopy 90B having sidewalls that connect to the inner radius of flange 88B and that project a distance away from vessel 84B and along axis A_F . A top surface of canopy 90B spans radially from axis A_F between terminal ends of the sidewalls distal from flange 88B. The cover, sidewalls, and sealing interface between flange 88B and outer surface of vessel 84B form a confined space 14B along a portion of the outer surface of vessel 84B. One example of securing the containment system 10B to vessel 84B includes belts 92B that are shown at axial opposite ends of flange 88B that restrain flange 88B and canopy 90B to

vessel 84B. Gloves 61B are shown having ends mounted to access ports 60B formed through the top surface of canopy 90B, and that provide access to the outer surface of vessel 84B by operations personnel. In a non-limiting example of use, insulation 20B and cladding 22B are removed from along an area A of the outer surface of vessel 84B, and which registers with the confined space 14B. Examples exist where the cross sectional area of opening 89B about axis A_F is greater than, equal to, or less than that of area A. Fluid for pressurizing confined space 14B is delivered through canopy 90B via supply line 68B, and vented into discharge line 70B.

[0030] An alternate example of containment system 10C is shown in a side perspective view in Figure 5. In this example shroud assembly 12C is supported on a frame 102C; where frame 102C includes a series of horizontally oriented elongate beams 104C (shown in dashed outline) coupled together on their respective ends into a rectangular configuration. Frame 102C of Figure 5 further includes vertically oriented elongate beams 106C (shown in dashed outline), illustrated perpendicular to beams 104C; and on which beams 104C are supported. As illustrated, beams 106C are positioned so that their upper ends are in supporting contact with beams 104C proximate to where adjacent ones of the beams 104C are engaged. Alternately, beams 106C are positioned at different locations along lengths of beams 104C, and are optionally irregularly spaced apart from one another. Shroud assembly 12C of Figure 5 has a shape similar to that of an outer periphery of frame 102C, and is depicted having planar surfaces; and where adjacent planar surfaces are substantially perpendicular to one another. An example of a confined space 14C is formed in the space between the cover 24C and portion P_C of piping circuit 16C. Example fluids handled by piping circuit 16C include those at temperatures higher than ambient temperature, lower than ambient temperature, subcooled temperatures, and cryogenic temperatures. Inlet and outlet ports 62C, 74C are shown formed through the cover 24C, and respectively through upper and lower sidewalls of the shroud assembly 12C. Alternate embodiments have the inlet and outlet ports 62C, 74C on different sidewalls than those illustrated, and in a further embodiment the inlet and outlet ports 62C, 74C are disposed on the same sidewall. In a further example, conditions, such as temperature, humidity and like within confined space 14C are controlled or regulated by providing fluid into space 14C and through inlet port 62C; in a manner similar to or the same as that described with reference to the example of Figure 1. In this example, fluid for conditioning space 14C is discharged through outlet port 74C. A panel 108C is shown formed in a sidewall of cover 24C, and which is at least partially

separatable from the sidewall in which it is formed. Separating panel 108C from the surrounding sidewall provides a technician or other operations personnel full ingress into the space 14C. In an example, the space 14C has ample dimensions to receive and contain a technician or other operations personnel, and while standing. Example dimensions of the shroud assembly 12C, or space 14C, are a height of about 1.0 to 2.0 meters, a length of about 1.5 meters to about 3 meters, and a width of about 1.0 meters to 2.0 meters. Further optionally, the containment system 10C is mobile and transportable to and from different locations.

[0031] The present invention described herein, therefore, is well adapted to carry out the objects and attain the ends and advantages mentioned, as well as others inherent therein. While a presently preferred embodiment of the invention has been given for purposes of disclosure, numerous changes exist in the details of procedures for accomplishing the desired results. For example, a portion of cover 24 is fitted with a reflective foil so that radiative thermal energy is reflected away from the confined space 14. In another example, insulation is provided within sections of cover 24 as well as endplates 26. Further optionally, the blanketing gas is chilled or heated by the fluid within the portion P of the piping circuit 16, such as by a heat exchanger, prior to being introduced into the confined space 14. Embodiments exist where included with the piping circuit 16 are towers, reactors, vessels, heat exchangers, pumps, compressors, and other processing equipment (not shown), and around a portion or all of a confined space 14 is created with embodiments of the containment system 10. These and other similar modifications will readily suggest themselves to those skilled in the art, and are intended to be encompassed within the spirit of the present invention disclosed herein and the scope of the appended claims.

CLAIMS

What is claimed is.

1. A containment system 10 for use with a piping circuit 16 comprising:

a cover 24 that selectively circumscribes a portion of the piping circuit 16 to define a confined space 14 between the cover 24 and an outer surface of the portion of the piping circuit 16; and

characterized by,

annular support rings 42, 44 within the cover 24 that are axially slideable along the portion of the piping circuit 16, and that are in selective supporting contact with the cover 24.

2. The containment system 10 of Claim 1, further characterized by end plates 26, 28 coupled to opposing axial ends of the cover 24.

3. The containment system 10 of Claims 1 or 2, further characterized by a fluid inlet port 62 formed through a sidewall of the cover 24 and that is in selective communication with a source of pressurized blanketing gas, so that when pressurized blanketing gas is directed into the confined space 14, the pressurized blanketing gas provides a thermal barrier between an uninsulated section of the portion of the piping circuit 16 and ambient to the cover 24.

4. The containment system 10 of Claim 3, further characterized by a diffuser 76 between the fluid inlet port 62 and the portion of the piping circuit 16, and which disperses the pressurized blanketing gas into the confined space 14 and diverts a stream of the pressurized blanketing gas away from direct contact with the portion of the piping circuit 16.

5. The containment system 10 of Claims 3 or 4, characterized in that the fluid inlet port 62 comprises a first fluid inlet port 62₁, the containment system 10 further characterized by a second fluid inlet port 62₂ and a manifold 66 connected between the source of the pressurized blanketing gas and the first and second fluid inlet ports 62.

6. The containment system 10 of any of Claims 3 – 5, characterized in that the pressurized blanketing gas comprises nitrogen at a pressure greater than a pressure ambient to the cover 24.

7. The containment system 10 of any of Claims 1 – 6, further characterized by a tray 82 supported in the cover 24 that selectively receives tools.

8. The containment system 10 of any of Claims 1 – 7, characterized in that the end plates 26, 28 each comprise an inner ring 30, 31 that mounts onto an outer surface of the portion of the piping circuit 16, an outer ring 32, 33 circumscribing the inner ring 30, 31, and sidewalls 34, 35 that extend radially between the inner ring 30, 31 and outer ring 32, 33, and so that the cover 24 is supported on the piping circuit 16.

9. The containment system 10 of Claim 8, further characterized by gaps 36, 37 that extend radially through the end plates 26, 28 and that are selectively expandable so that the piping circuit 16 is received in the inner ring 30, 31.

10. The containment system 10 of any of Claims 1 – 9, characterized in that the support rings 42, 44 comprise an inner ring 46, 47 that mounts onto an outer surface of the portion of the piping circuit 16, an outer ring 48, 49 circumscribing the inner ring 46, 47, and strut members 50, 51 that extend radially between the inner ring 46, 47 and outer ring 48, 49.

11. A containment system 10 for use with a piping circuit 16 comprising:

a cover 24 that comprises a sheet like transparent material that is disposed around a tubular portion of the piping circuit 16;

end plates 26, 28 that sealingly engage opposing ends of the cover 24;

a confined space 14 defined in an annulus between the cover 24 and outer surface of the tubular portion of the piping circuit 16 and that is axially bounded by the end plates 26, 28; and characterized by,

gas in the confined space 14 that forms a thermal barrier between an uninsulated section of the tubular portion of the piping circuit 16 and ambient to the cover 24.

12. The containment system 10 of Claim 11, further characterized by annular support rings 42, 44 disposed in the confined space 14, and that each have an outer circumference in supporting contact with the cover 24.

13. The containment system 10 of Claims 11 or 12, characterized in that ends of the cover 24 that extend in a direction axial to the tubular portion releasably join along a seam 58 that extends substantially the length of the tubular portion.

14. The containment system 10 of any of Claims 11 – 13, further characterized by access ports 60 formed through a sidewall of the cover 24, and gloves 61 sealingly secured along the access ports 60.

15. A method of containing a piping circuit 16 comprising:

sealing around a portion of the piping circuit 16 to define a confined space 14;

removing cladding 22 from around a section of the portion of the piping circuit 16 within the confined space 14 so that some of the piping circuit 16 in the section is exposed to conditions in the confined space 14; and

controlling a flow of a blanketing fluid into the confined space 14 so that a pressure in the space exceeds a pressure ambient to the confined space 14.

16. The method of Claim 15, characterized in that a temperature differential exists radially across the confined space 14 so that ice is prevented from forming on pipe 18 of the piping circuit 16 when cryogenic fluids are flowing inside the piping circuit 16.

17. The method of Claims 15 or 16, characterized in that a cover 24 is used to form a portion of the confined space 14, the method further characterized by supporting a mid-portion of the cover 24 with an axially slideable element.

18. The method of any of Claims 15 – 17, characterized in that the blanketing fluid is provided to the confined space 14 at a pressure that is greater than that ambient to the confined space 14.

19. The method of any of Claims 15 – 18, further characterized by diverting the blanketing fluid away from pipe 18 of the piping circuit 16 and diffusing the blanketing fluid in the confined space 14.

20. The method of any of Claims 15 – 19, further characterized by using a tool inside of the confined space 14, and placing the tool on a tray 82 disposed in the confined space 14.

21. The method of any of Claims 15 – 20, characterized in that equipment is disposed in the confined space 14 that is selected from the group consisting of a vessel, a heat exchanger, and a column.

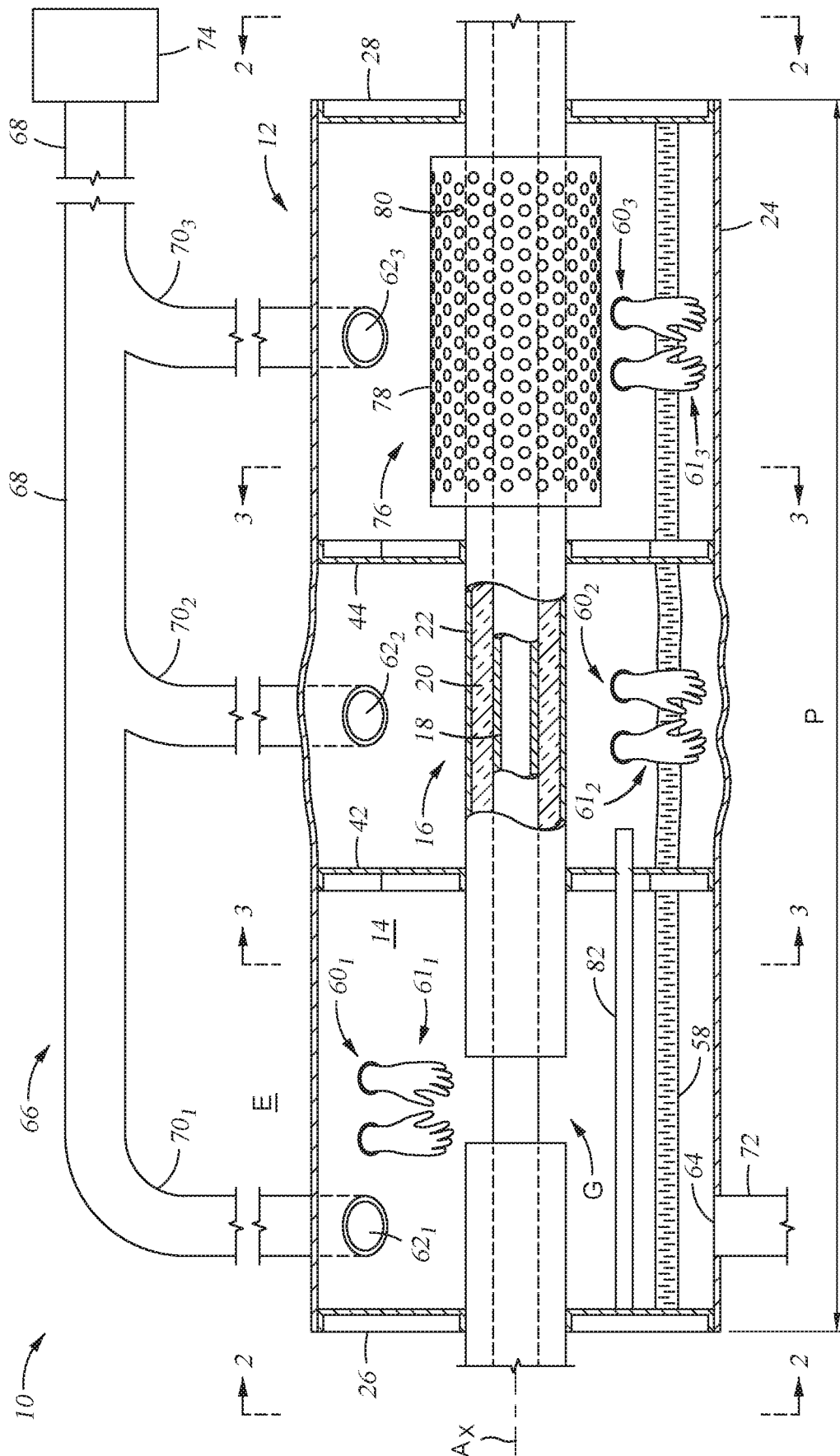


Fig. 1

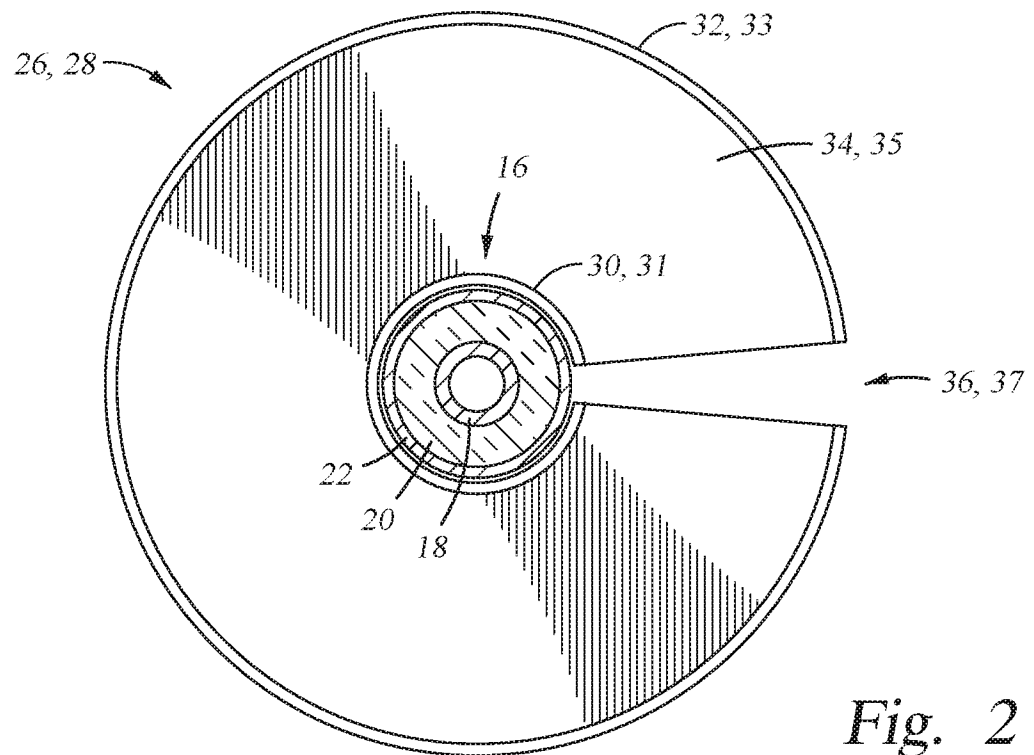


Fig. 2

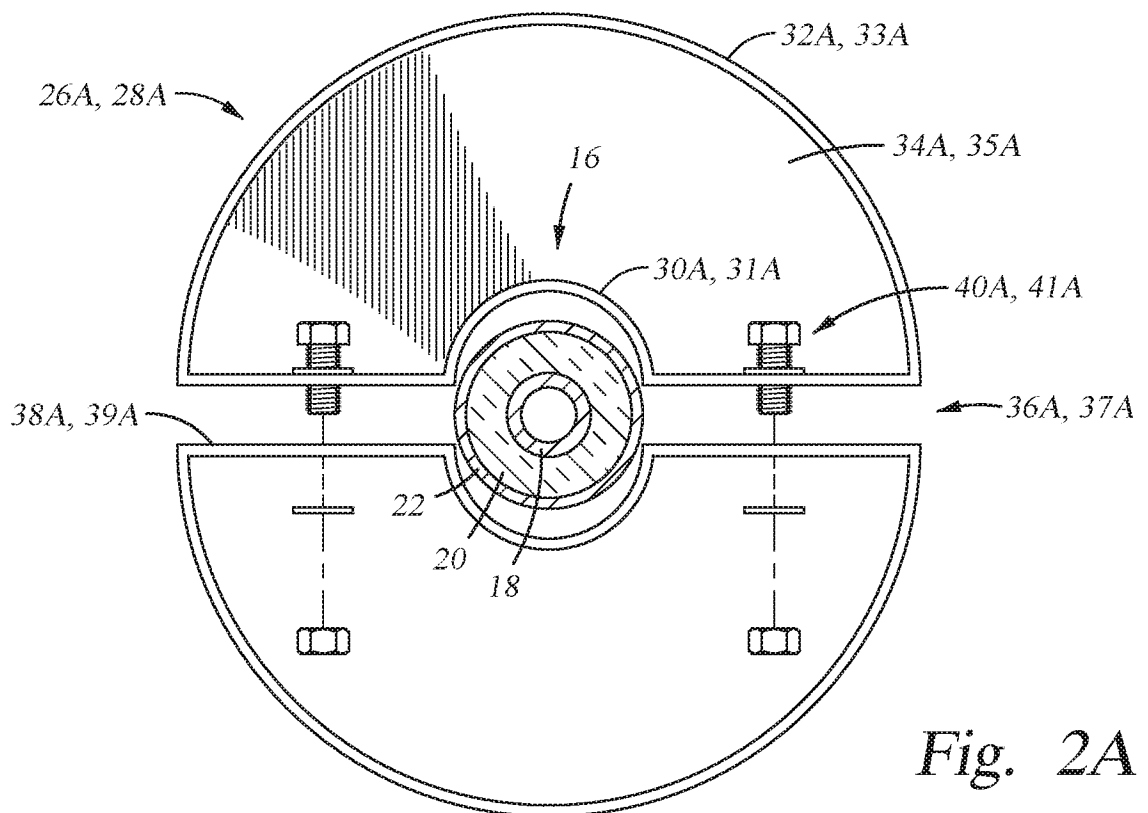
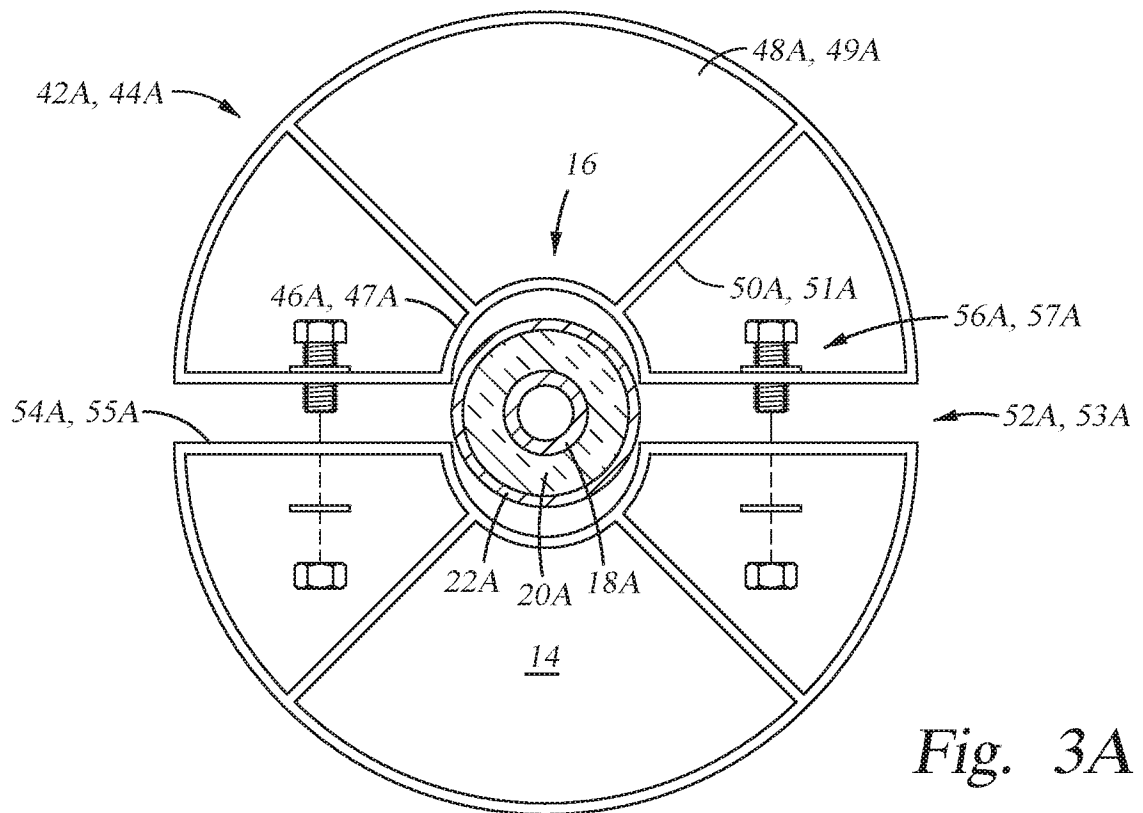
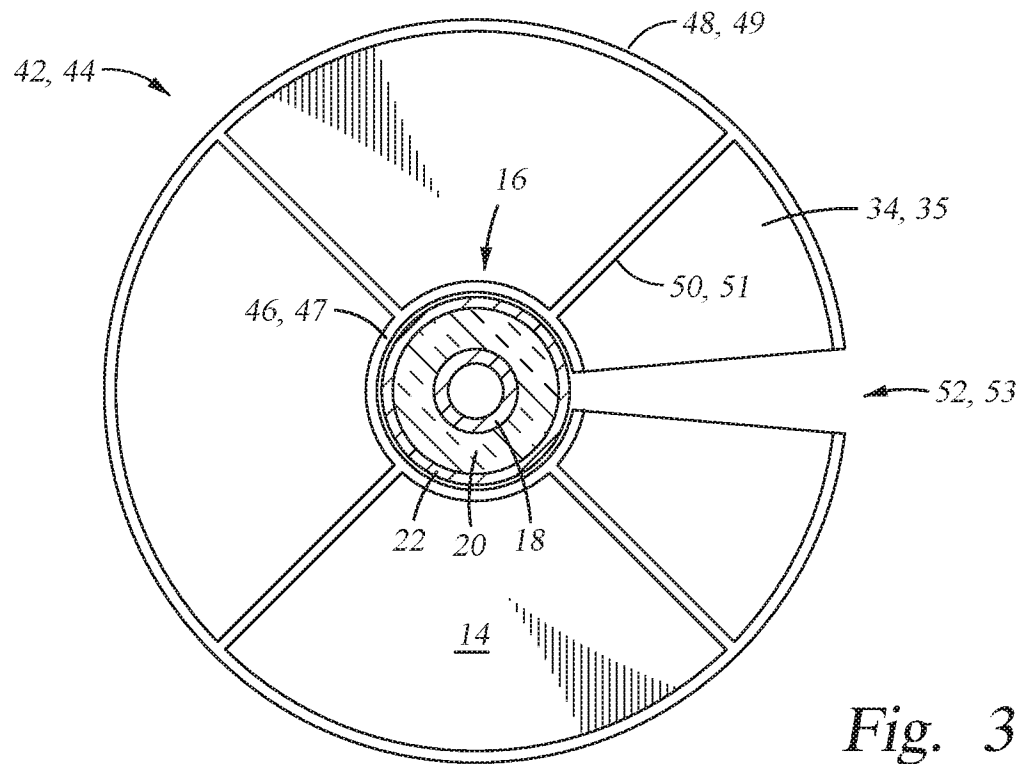
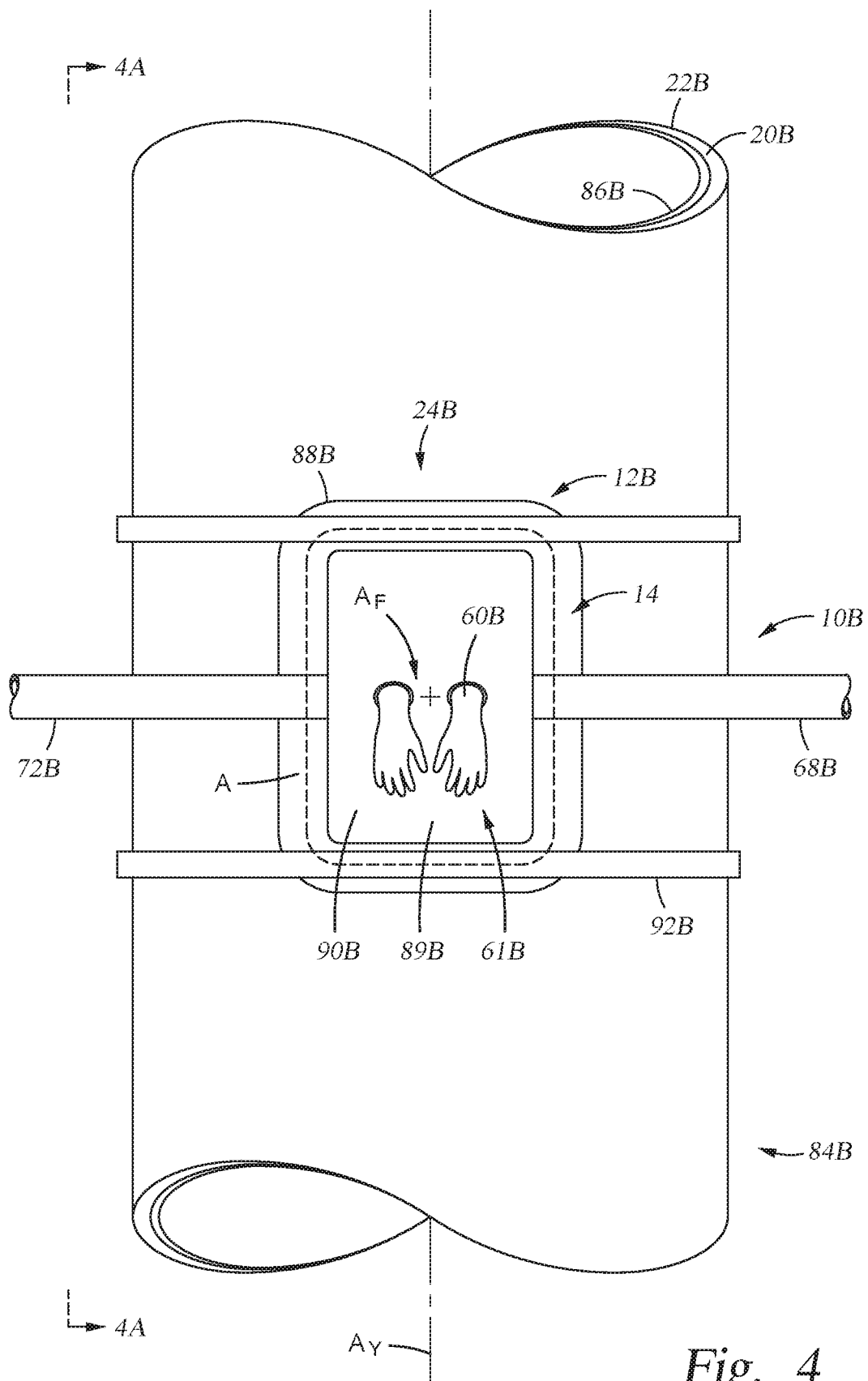
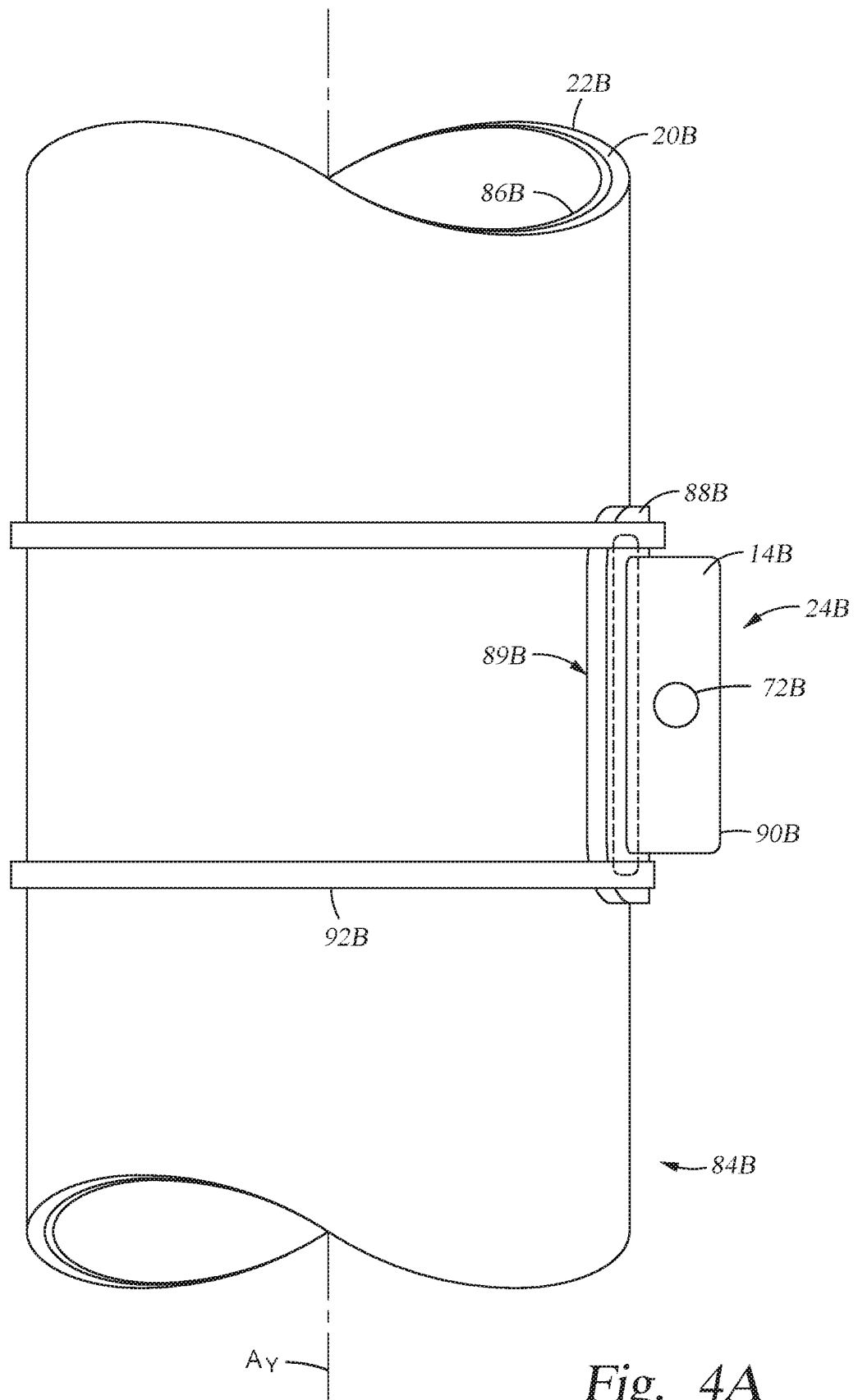


Fig. 2A







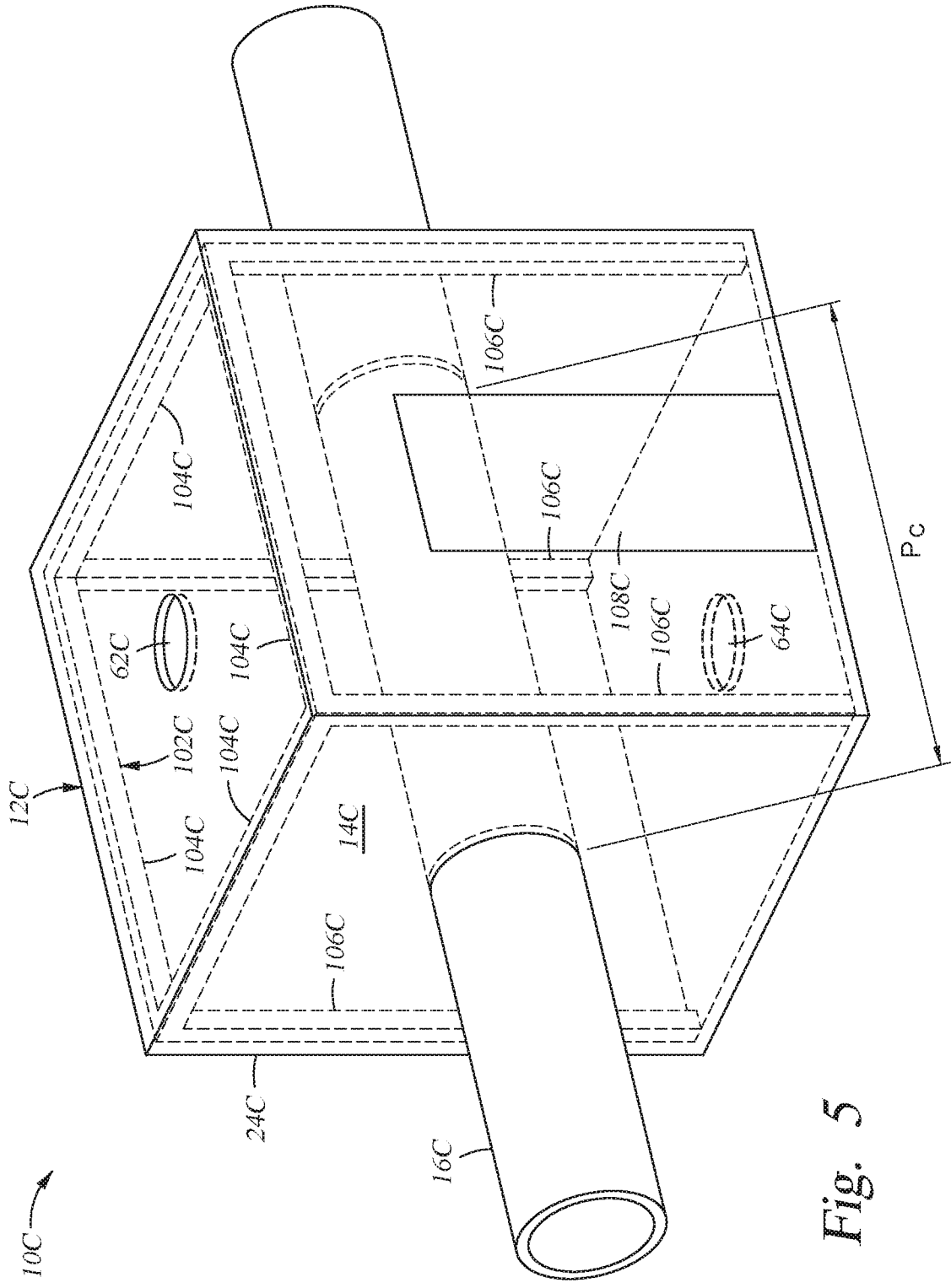


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2019/049056

A. CLASSIFICATION OF SUBJECT MATTER

INV. F16L55/18 B25J21/00 B25J21/02
ADD. G21F7/04

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 G21J B25J G21F

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	JP H11 230475 A (ISHIKAWAJIMA HARIMA HEAVY IND) 27 August 1999 (1999-08-27) figures	1,3-6
X	----- US 4 820 000 A (JACOBSON EARL B [US]) 11 April 1989 (1989-04-11) figures column 2, line 31 - line 45	1,2,11, 13,14
X	----- KR 2018 0043673 A (I BRAIN TEC [KR]) 30 April 2018 (2018-04-30) figures ----- -/-	1,7



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

"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

14 November 2019

Date of mailing of the international search report

24/01/2020

Name and mailing address of the ISA/

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Authorized officer

dall'Amico, Mauro

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2019/049056

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 101 837 904 B1 (DONGNAM KOREA CO LTD [KR]; TAK HYO SUNG [KR]) 27 April 2018 (2018-04-27)	1,8,10
Y	figures paragraph [0040] - paragraph [0043] paragraph [0069] - paragraph [0070] -----	9
X	JP 2012 122586 A (SEKISUI CHEMICAL CO LTD) 28 June 2012 (2012-06-28)	1
Y	figures -----	9
X	KR 2009 0001187 U (CHOI Y) 4 February 2009 (2009-02-04) figures paragraph [0023] paragraph [0035] -----	11,12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2019/049056

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:

see additional 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 an 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.:

1-14

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

Information on patent family members

International application No

PCT/US2019/049056

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP H11230475	A	27-08-1999	NONE
US 4820000	A	11-04-1989	EP 0340239 A1 08-11-1989 US 4820000 A 11-04-1989 WO 8804964 A1 14-07-1988
KR 20180043673	A	30-04-2018	NONE
KR 101837904	B1	27-04-2018	NONE
JP 2012122586	A	28-06-2012	NONE
KR 20090001187	U	04-02-2009	NONE

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-14

containment system

1.1. claims: 1-10

cover with internal support rings

1.2. claims: 11-14

transparent cover with sealing end caps

2. claims: 15-21

removal of cladding from a pipe
