

description

BACKGROUND OF THE INVENTION**1. Field of the Invention**

The present invention relates to an isolator apparatus for isolating a pressure sensor in an instrument such as a pressure transmitter from a fluid such as pressurized process fluid.

2. Description of the Prior Art

A process fluid monitored by an instrument can be corrosive and can damage a pressure sensor in the instrument if direct contact between the fluid and the sensor occurs. An isolator arrangement can be interposed between the pressure sensor and an input flange or a manifold which couples the instrument to a conduit carrying the fluid.

Such a prior art isolator arrangement comprises an isolation diaphragm, isolation fluid and a pressure sealing ring. A thin, flexible, substantially round isolation diaphragm is disposed in a cylindrical inlet port provided in the instrument's housing for receiving the process fluid and deflects in response to pressure exerted on a first side of the diaphragm by the process fluid. The diaphragm is sealingly joined about its outer border, such as by a continuous weld, to a substantially cylindrical side wall of the inlet port thereby sealing the outer border of the diaphragm to the port. A central deflectable portion of the diaphragm is surrounded by the outer border and comprises the active region responsive to pressure. A second side of the diaphragm opposite the process fluid is open to a sealed isolation chamber provided in the instrument, which is substantially filled with a substantially incompressible fluid, such as silicone oil. The isolation fluid couples pressure through a passageway provided in the instrument leading from the isolation chamber to the isolated pressure sensor. Movement of the isolation fluid in response to deflection of the isolation diaphragm thus transfers the process fluid's pressure to the isolated pressure sensor. The pressure sealing ring, such as an "O ring" type made of resilient material, is disposed around the isolation diaphragm and sealingly couples process fluid from the input flange to the isolation diaphragm. In such a prior art arrangement, the sealing ring is compressed between the input flange and the isolation diaphragm. This compression prevents deflection of a portion of the isolator diaphragm adjacent the sealing ring. The annular seal provided around the isolation diaphragm by the pressure sealing ring thus limits the effective area of the isolation diaphragm's active region.

Isolation fluids can expand as temperature increases. Thus, as increased operating temperature can cause an expansion of the isolation fluid which is confined within the enclosed isolation chamber and passageway of the instrument, the isolation diaphragm's active region will respond in the effective area by deflecting to accommodate the increased isolation fluid volume. The accommodation of the expanded isolation fluid volume increases stress in the diaphragm. The stressed diaphragm exerts a pressure on the enclosed isolation fluid and that pressure is sensed by the sensor. The sensor senses the pressure of the process fluid plus the pressure due to the isolator diaphragm stress. The sensed pressure thus suffers from temperature-induced errors. These pressure measurement errors are generally proportional to the change in isolation fluid pressure divided by the change in volume due to diaphragm movement (dp/dv). Since dp/dv is an isolation diaphragm parameter which is a strong function of the effective area of the diaphragm's active region, it is desirable to use an isolation diaphragm having a large effective area, such that it is sufficiently compliant to accommodate the volumetric changes in isolation fluid and thereby minimize pressure measurement error. Increasing, for example, the effective area of a round isolation diaphragm, by increasing the diameter of its deflectable effective area from 1 inch to 1.2 inches, can reduce temperature-induced pressure measurement errors by a factor of two or more.

In such prior art isolation arrangements, however, since the effective area of the action region can be no greater than the region surrounded by the pressure sealing ring, the sealing ring's size becomes a limiting factor. For example, a compressible sealing ring mounted within an inlet port over a round isolation diaphragm having a 1.25 inch (3.28 cm) diameter deflectable active region yields an effective area of the active region having a diameter of approximately only 1.0 inch (2.54 cm) when compressed between the input flange and diaphragm. Further diaphragm constraints arise from the use of increasingly smaller solid state pressure sensors with correspondingly reduced instrument housings, which further restrict the space available for isolation diaphragms. In pressure transmitters, the size of the sealing ring can be further restricted by the space available between bolts joining the transmitter to an industry standard flange adapter union.

US-A-4388833 (Kuwayama) discloses a differential pressure gauge which has incorporated therein a displacement transducer for producing a displacement corresponding to a differential pressure and converting the displacement into an electric signal. The displacement transducer is pro-

vided between first and second plate-like members in a tubular body. Pressure applied to diaphragms, effective as pressure receiving members, is transmitted through through-holes in the plate-like members to the displacement transducer. Each diaphragm is welded to an end face of the tubular body with a metal seal ring. A flange is attached to each end face of the tubular body by means of nuts and bolts with the abutting surfaces of the flange and the metal seal ring being sealed by an O-ring. The metal seal ring has a large surface area in contact with the diaphragm and so reduces the effective active region of the diaphragm.

According to the present invention there is provided apparatus for isolatingly coupling a pressure from a fluid in an input member to a pressure sensor providing an output as a function of the pressure, an inlet port being disposed in the apparatus for receiving the fluid from the input member, isolation means being disposed in the inlet port and having an active region bounded by an outer border for isolatingly coupling the pressure from the fluid to the pressure sensor, sealing means being disposed in the inlet port around the isolation means for sealingly bounding the inlet port, the sealing means having an inlet area coupling the fluid from the input member to the isolation means and support means disposed in the inlet port for supporting the sealing means characterized by the support means being configured to overhang at least a portion of the isolation means adjacent the outer border and spacing at least a portion of the sealing means away from the active region, such that an effective area of the active region is greater than the inlet area of the sealing means.

The invention relates to an isolator apparatus for coupling pressure from a fluid carried in a conduit, such as industrial process fluid, to a pressure sensor in an instrument which provides an output as a function of pressure. The isolator apparatus is coupled by an input member, such as an input flange or flange adapter union or manifold, to the conduit. An inlet port is disposed in the apparatus for receiving the process fluid from the conduit. Isolation means are disposed in the inlet port for isolating the process fluid from the pressure sensor, while coupling the process fluid's pressure to the sensor. The isolation means include an active region responsive to process fluid pressure. Sealing means are disposed in the inlet port around the isolation means for sealingly coupling the process fluid from the conduit and input member to the isolation means. Support means are disposed in the inlet port for spacing the sealing means away from the active region of the isolation means, such that an effective area of the isolation means is substantially the entire active region and the effec-

tive area is not reduced by the sealing means, thereby improving the instrument's output for a selected size of pressure seal.

In a preferred embodiment, the isolation means comprise a thin, flexible, substantially round isolation diaphragm formed of metal which is sealingly joined at an outer border about its periphery, such as by a continuous weld, to a substantially cylindrical side wall forming a cylindrical inlet port in the instrument housing, thereby enclosing an isolation chamber. The portion of the isolation diaphragm surrounded by the joining weld defines the diaphragm's active region which deflects in response to the process fluid pressure acting on a side of the diaphragm exposed to the process fluid. Pressure is coupled from the isolation diaphragm through a substantially incompressible isolation fluid disposed in the isolation chamber, such as silicone oil, to act on a pressure sensor disposed in the instrument. Seal support means comprise a ring-like seal support member having an annular, tapering wall disposed in the inlet port and supported over the outer border of the isolation diaphragm. The tapering wall extends inwardly from the inlet port's side wall and tapers away from the isolation diaphragm a selected distance to define a central opening for passage of process fluid there-through to act on the isolation diaphragm. Sealing means comprise a pressure sealing ring, such as an "O ring" made of resilient material, which is held in compression between the seal support member and the input member, to effect an annular seal therebetween.

The isolator apparatus thus spaces the pressure sealing ring away from the active region of the isolation diaphragm, such that the pressurized fluid acts against substantially the entire active region, including the outer periphery thereof which lies in the recess beneath the overhanging seal support member and pressure sealing ring. The present invention thus improves the effective area of the isolation diaphragm's active region with respect to a given size of pressure seal, which in turn minimizes dp/dv related pressure measurement errors, thereby substantially improving the instrument's output. In further preferred embodiments, various modifications to the seal support member and isolation diaphragm are provided which further improve the isolation diaphragm's active region, facilitate cleaning and repair of the isolation diaphragm and provide protection from damage during handling, and can lower the cost of materials by reducing the amount of instrument parts which need to be fabricated of expensive, corrosion resistant materials. Further, the present isolator apparatus permits the use of instruments having smaller diameter isolation diaphragms with correspondingly reduced sizes of instrument housings, without com-

missing performance.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a drawing of an instrument including a block diagram representation of circuitry of a differential pressure transmitter having isolation diaphragms mounted therein, showing an isolator apparatus according to the invention;

Figure 2 is a partial sectional view of a transmitter similar to that shown in Figure 1, showing a second embodiment of the present invention having an isolation diaphragm of dome-like construction mounted therein;

Figure 3 is a partial sectional view of a transmitter similar to that shown in Figure 1, having a compression-mounted seal support member and sealing ring isolator assembly according to the invention;

Figure 4 is a partial sectional view of a transmitter similar to that shown in Figure 1, showing a further embodiment of the seal support member made according to the invention;

Figure 5 is a partial sectional view of a transmitter similar to that shown in Figure 1, showing a further embodiment of the seal support member made according to the invention;

Figure 6 is a partial sectional view of a differential pressure transmitter taken along line 6-6 of Figure 7 having coplanar isolation diaphragms mounted therein which are coupled to process piping and industry standard flange adapter unions by a further embodiment of the isolator apparatus according to the invention; and

Figure 7 is a plan view of the isolator apparatus taken along line 7-7 of Figure 6 according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In Figure 1, a first embodiment of a pressure transmitter 10 is shown having an isolator apparatus 12 according to the present invention disposed in a sensor module 10A shown in cross section in Fig. 1. The transmitter 10 includes a differential pressure transducer 14 of the capacitive type, as taught by U.S. Pat. No. 3,618,390 issued on November 9, 1971 to Roger L. Frick, which is incorporated herein by reference, and which provides a signal representative of sensed pressure along lines 16 to transmitter circuitry 18. The transmitter circuitry 18 can be of any desired type suitable to transducer 14 for providing an output representative of sensed pressure along line 20 to readout 22. The isolator apparatus 12 is not limited to use only with differential pressure transmitters, but can also be used, for example, with absolute and gauge

pressure transmitters and other apparatus utilizing an isolator arrangement including an isolation diaphragm. The isolator apparatus 12 can also be used, for example, with other types of pressure sensors such as strain gage, piezoresistive, piezoelectric, variable reluctance, and optical.

The transducer 14 comprises a substantially round isolation diaphragm 24 for receiving a pressure P1 and a pressure sensor of the capacitive type shown generally at 26 centrally disposed in the transducer. An inlet port 28 having a substantially cylindrical side wall 30 is provided in a transducer housing 32 to receive the pressurized process fluid to be sensed, which may be gaseous or liquid. The inlet port 28 has a mating process fluid input flange 34, which can comprise a flange as shown, or a standard flange adapter union, connected thereto and retained by retaining bolts 36 and nuts 36A. The input flange 34 has a central threaded opening 38 into which a suitable pressurized fluid supply conduit 40 can be threaded. The conduit 40 is coupled to a source of process fluid having a pressure P1 to be measured.

A base wall 42 is machined in the housing 32 to define a floor for the inlet port 28 which substantially corresponds to the surface contour of the isolation diaphragm 24, shown to be partially corrugated in Figure 1. Along the peripheral edge of the base wall 42 where it joins the side wall 30, an annular shoulder 44 is provided. The isolation diaphragm 24 is continuously welded at a weld 46 along its periphery to the annular shoulder 44 and forms a sealed isolator chamber 48 which opens through an outlet 50 in the base wall 42 to a passageway 52 which connects to the pressure sensor 26. The isolation diaphragm 24 is thin, flexible and formed of metal, and is preferably corrugated to extend its operating range. Operation of the capacitive sensor 26 is described in U.S. Patent 3,618,390, which is incorporated herein by reference.

A suitable isolation fluid 54, preferably a substantially incompressible fluid such as silicone oil, substantially fills the interconnected isolation chamber 48 and passageway 52 communicating with the pressure sensor 26 each half of which is also filled with isolation fluid 54. The isolation fluid 54 thus functions as a pressure transmitting medium between the isolation diaphragm 24 which is exposed to the pressurized process fluid and the isolated pressure sensor 26. Essentially identical dual isolation diaphragms 24 are each disposed on opposite sides of the pressure sensor 26 and communicate with the pressure sensor through isolation fluid 54 for sensing a differential in process fluid pressure. Thus, when a differential in pressure (P1-P2) between the process fluid exists, the isolation diaphragm 24 will deflect accordingly, causing the

isolation fluid 54 to in turn act upon the pressure sensor 26 which provides a capacitive signal to transmitter circuitry 18.

The active region 56 (FIG. 2) of the isolation diaphragm 24 comprises the deflectable portion of the diaphragm 24 responsive to pressure from the process fluid. Since, however, isolation fluids generally expand when the transmitter is subjected to increased operating temperature environments, the isolation diaphragm's active region 56 will also respond by deflecting to accommodate the increased fluid volume. The increased isolation diaphragm stress associated with such temperature induced deflection can introduce pressure measurement errors which are generally proportional to the change in isolation fluid pressure divided by the change in volume due to diaphragm movement (dp/dv). Because dp/dv is a strong function of the total effective area of the isolation diaphragm's active region 56, it is desirable that the isolation diaphragm 24 have as large an effective area in the active region 56 as possible, such that it is of sufficient size and compliance to accommodate the temperature-induced isolation fluid expansion and minimize pressure measurement error.

A pressure seal, which must generally be used with pressure transmitters to sealingly couple the pressurized process fluid from an input flange to an inlet port by providing an annular seal around an isolation diaphragm, has heretofore undesirably limited the size of the isolation diaphragm's effective area of the active region. Such prior art pressure seals typically comprise "O rings" formed of a resilient material, and can also comprise low friction "Teflon" brand material. An isolation diaphragm's effective area is undesirably limited, for example, to that region circumscribed by the annular seal formed by such a pressure sealing ring when placed within an inlet port and compressed by retaining bolts between the isolation diaphragm and input flange.

As shown in Figure 1, however, a seal support member 58 is used to overcome the foregoing problem. The seal support member 58 comprises an annular, tapered wall 58A disposed within the inlet port 28. The tapered wall 58A further comprises a connecting edge portion 58B and a free edge portion 58C at opposite ends thereof. The tapered wall 58A is joined at its connecting edge portion 58B to the isolation diaphragm 24 and tapers from the diaphragm 24 to the free edge portion 58C. The free edge portion 58C extends inwardly from the inlet port's side wall 30 and forms a central, circular opening 60 for passage of process fluid therethrough from the input flange 34 to act on the underlying isolation diaphragm 24. The connecting edge portion 58B is continuously joined, such as by a laser weld shown at 46, to the

outer border of the underlying isolation diaphragm's active region, thus forming a peripheral seal therebetween for containment of the process fluid.

The mounted seal support member 58 thus does not reduce the effective area of the isolation diaphragm's active region 56. The seal support member 58 is suitably sized and tapered such that a conventional pressure sealing ring shown at 62 will be compressed against the coupled input flange 34 to effect an annular seal therebetween. The seal support member 58 overhangs the underlying isolation diaphragm 24 and permits the process fluid to thus act against substantially the entire active region 56. Thus, the effective area of the diaphragm 24 is substantially equal to the entire active region 56 because the sealing ring 62 is not in contact with the active region 56. The present isolation apparatus 12 thus provides an improved effective area of the active region 56 for an isolation diaphragm 24 with respect to a selected size of pressure sealing ring 62, thereby reducing dp/dv related pressure measurement errors and substantially improving transmitter performance.

A further preferred embodiment is shown in Figure 2, wherein an isolation diaphragm 224 is modified to a dome-like construction, such that the isolator chamber 48 can be filled with an isolation fluid 54 while the diaphragm 224 remains in a substantially neutral, low stressed condition. This substantially reduces the stiffness of the isolation diaphragm 224 as it deflects from its neutral position to accommodate the process fluid pressure as well as temperature-induced volume changes of the isolation fluid. Further, a base wall 242 of the inlet port 28 has been modified to define a relatively flat floor, and costs associated with machining a corrugated surface can thus be avoided. If desired, the base wall can be made concave as shown in dashed lines at 242A.

A further preferred embodiment is shown in Figure 3, wherein a seal support member 58 and an isolation diaphragm 24 are preassembled and an inlet port 328 is modified having a tapering side wall 330 extending inwardly from the housing surface 33 such that the generally round inlet port 328 has a gradually decreasing diameter. As shown in dashed lines at 58D, the seal support member is constructed such that its outside diameter is approximately equal to the largest inside diameter of the inlet port 328. The isolation diaphragm 24 and seal support member 58 are preassembled to form an isolator assembly 359 before insertion into the inlet port 328 by joining the peripheral edge of the isolation diaphragm 24 to the seal support member's connecting edge portion 58B with a suitable weld shown at 346. The outer diameter of the seal support member 58 is reduced during insertion into

inlet port 328. The tapered side wall 330 thus radially compresses the inserted isolator assembly 359, thereby causing the isolation diaphragm's active region to become slack. The seal support member 58 and isolation diaphragm 24 can be further joined to the outer periphery of the base wall 42 by an extended weld 346 for containment of isolation fluid. Since the isolation chamber 48 can be filled while the isolation diaphragm 24 remains in a substantially neutral, low stress condition, dp/dv related pressure measurement errors can be similarly reduced and transmitter performance improved.

A further preferred embodiment is shown in Figure 4, wherein a seal support member 458 is modified to provide protection for the inlet port's side wall 30 from corrosive damage which could result from undesired contact with process fluid. The seal support member 458 includes an annular, tapered wall portion 458A similar to that shown in Figure 1 at 58A, but is also integrally formed with an annular, cylindrical connecting wall portion 458B which is further integrally formed with an annular lip portion 458C that rests upon the housing surface 33 to support the seal support member 458 within the inlet port 28. The isolation diaphragm 24 is connected along its peripheral edge to the seal support member 458 with a suitable weld 446. The lip portion 458C is connected to the housing surface 33 by a weld 447 to provide a fluid pressure seal. Since the seal member 458, as well as the isolation diaphragm 24 and joining weld 446, preferably comprise corrosion resistant material, such as Hastelloy C, Elgiloy, or similar materials, the transmitter/transducer housing material which forms the machined inlet port 28 can be manufactured of less corrosion resistant materials, such as Type 316 Stainless Steel. The foregoing modifications similarly improve the isolation diaphragm's active region 56 thereby reducing dp/dv pressure measurement errors, and can also reduce the cost of transmitter materials.

A further preferred embodiment is shown in Figure 5, wherein a seal support member 558 is modified to provide protection for an isolation diaphragm 24 from damage which can result from handling of a transmitter 10 while uncoupled from an input flange 34. This embodiment further includes a welding sleeve 555 which overlies the peripheral edge of the isolation diaphragm 24, extending inwardly from the inlet port's side wall 30 preferably no further than the width of the annular shoulder 44 beneath the diaphragm 24. A continuous peripheral weld 546 connects both the welding sleeve 555 and the isolation diaphragm 24 to the annular shoulder 44. The seal support member 558 includes a horizontal flange portion 558A along the peripheral edge of the member, integrally formed

with a horizontal central plate portion 558C that is offset from the flange portion 558A and being integrally interconnected therewith by an annular, upright, joining wall portion 558B. When fully inserted into the inlet port 28, the flange portion 558A rests upon the welding sleeve 555, such that the seal support member 558 overlies and is spaced away from the isolation diaphragm's active region 56. The central plate portion 558C is provided with a plurality of orifices 559 which permit passage of pressurized process fluid therethrough to act upon the underlying isolation diaphragm 24.

The flange portion 558A and joining wall portion 558B of the seal support member 558 are configured to cooperate with the inlet port's side wall 30 to provide a channel 564 for receiving a conventional pressure sealing ring 62. The seal support member 558 is not welded to the housing 32, and the pressure sealing ring 62 is suitably sized to become compressed within the channel 564, such that the seal support member 558 is easily removed to permit process fluid to be drained and to allow inspection, cleaning or servicing of the isolation diaphragm 24. This embodiment of the present invention similarly improves the isolation diaphragm's active region 56, thereby reducing dp/dv related errors and improving transmitter performance.

In a further preferred embodiment shown in Figures 6 and 7, a differential pressure transmitter is partially shown at 610 which is fluidly coupled to process fluid supplied by a pair of impulse piping legs 612 through the use of a pair of industry standard flange adapter unions 614, an adapter plate 616, and a seal support plate 618. The drawing in Fig. 6 is a sectional view taken along line 6-6 in Fig. 7. The drawing in Fig. 7 is a sectional view taken along line 7-7 in Fig. 6.

The dual isolation diaphragm arrangement and various coupling members illustrated in Figures 6 and 7 (such as the impulse piping legs 612, flange adapter unions 614, adapter plate 616 and seal support plate 618) are essentially identical in construction and comprise features or details which are duplicated on the right and left hand sides of Figures 6 and 7. It is therefore understood that reference is hereinafter made to such features on either side separately, for convenience. The differential pressure transmitter 610 is provided with a pair of substantially round, coplanar isolation diaphragms 620 disposed in closely adjacent, cylindrical inlet ports 622 formed in a coupling surface 624 of a housing 626 of the transmitter 610.

Each isolation diaphragm is sealingly joined, such as by a peripheral weld 628, to an annular shoulder 630 formed in the cylindrical inlet port 622, which forms an enclosed isolation chamber 632 that is filled with a substantially incompressible

isolation fluid 634, such as silicone oil. An active region 636 of the isolation diaphragm 620, which is surrounded by weld 628, comprises the deflectable portion of the diaphragm responsive to pressure from the process fluid. Each isolation chamber 632 opens to a passageway 638 which is also filled with isolation fluid 634 and connects to a suitable pressure sensor (not shown) disposed in the transmitter 610. The pressure sensor senses the pressure of the isolation fluid 634, which corresponds to the process fluid pressures (P1 and P2) exerted upon the two isolation diaphragms 620, and provides a signal representative of the sensed pressure to suitable circuitry which further output a signal representative of such differential pressure being sensed.

The adapter plate 616 and seal support plate 618 are interposed between the flange adapter unions 614 and the transmitter housing 626. The adapter plate 616 and seal support plate 618 are configured such that coplanar isolation diaphragms 620 can be utilized having active regions 636 while still keeping the diaphragms 620 located within a predetermined rectangular area. When coupling process piping to a differential pressure transmitter, this predetermined rectangular area can comprise an industry standard rectangular pattern of bolts, as shown at D1 and D2 in Figure 7, within which the inlet ports 622 and isolation diaphragms 620 are confined.

An industry standard flange adapter union 614 is used to couple process fluid from the impulse piping leg 612 through a central threaded opening 640 formed in the flange adapter union to an adjacent fluid passageway 642 provided in an outer coupling surface 644 of the adapter plate 616. A suitably threaded end 646 of the impulse piping leg 612 is threaded into the flange adapter union's central threaded opening 640. The flange adapter union 614 is generally shaped as outlined in dashed lines on the right-hand side of Figure 7. Each flange adapter union 614 is retained to the adapter plate 616 by two bolts or capscrews 648 which pass through smooth bores 650 provided on opposite sides of the central threaded opening 640 and the capscrews 648 are suitably fastened to the transmitter housing 626, such as by being threaded into suitable threaded bores 652 formed in the housing. The spacing D1 between the flange adapter union bores 650 comprise an industry standard pattern of 1 5/8" (or 41.3 millimeters) bolt centerlines. Each flange adapter union 614 also carries a suitable standard pressure seal 654, such as an O ring formed of resilient material, which is compressed between the flange adapter union 614 and the adapter plate's outer coupling surface 644 in an annular groove 656 formed in a coupling surface 658 of the flange adapter union 614, when clamped

together by the capscrews 648. The seal 654 thus provides a substantially fluid tight annular pressure seal around the coupled flange adapter union's central threaded opening 640 and the adapter plate's passageway 642.

The adapter plate 616, which is interposed between the flange adapter unions 614 and the seal support plate 618, is used to provide proper lateral spacing D2 between the flange adapter unions 614 while permitting closely spaced apart, coplanar isolation diaphragms 620 having active regions 636 as large as possible. The adapter plate 616 is relatively thin and has a flat outer coupling surface 644 against which the flange adapter unions 614 are coupled, and a flat inner coupling surface 660 against which the seal support plate 618 is coupled. The adapter plate is provided with four smooth bores 662 which are spaced apart according to an industry standard spacing of 1 5/8" (D1) by 2 1/8" (D2) rectangular pattern of bolt centerlines. The 1 5/8" (or 41.3 millimeter) (D1) spacing is characteristic of the standard flange adapter union's bolt spacing. The 2 1/8" (or 54 millimeters) (D2) spacing is compatible with an industry standard, ANSI Standard B 16.36 "Steel Orifice Flange Standard" (or DIN Standard 19 213, April, 1980), required for conventional connection of a differential pressure transmitter to a conduit fitted with a standard orifice flange/plate assembly, to which process piping of the type shown in Figures 6 and 7 is plumbed. The lateral spacing D2 also permits the flange adapter unions 614 to swing past each other about their centers when they are being threaded onto side by side impulse piping legs 612.

The adapter plate's passageways 642 extend from the outer coupling surface 644 through to the inner coupling surface 660. The spacing between the passageways 642 is selected such that the centers of the passageways 642 are slightly offset from the centers of the flange adapter unions' central threaded openings 640, as well as being slightly offset from the centers of the inlet ports 622 and isolation diaphragms 620. This spacing of the passageways 642 permits coupling of flange adapter unions 614 at industry standard spacing to a differential pressure transmitter 610 which is equipped with coplanar isolation diaphragms 620 that are closely spaced apart having active regions 636 as large as possible.

The seal support plate 618, which is interposed between the adapter plate 616 and the transmitter housing 626, is used to support suitable pressure seals 664 which are carried in annular grooves 666 formed in the adapter plate's inner coupling surface 660 and provide a substantially fluid tight annular pressure seal when compressed therebetween. The seal support plate 618 is relatively thin and is

vided with four smooth bores which are also spaced apart according to industry standard (D1 by D2) and substantially align with the flange adapter union bores 650, adapter plate bores 662, and transmitter housing bores 652, such that the capscrews 648 pass therethrough to retain the entire assembly to the transmitter 610 and provide the necessary compression for sealing the pressure seals 654 and 664. A pair of fluid orifices 670 are also provided in the seal support plate 618 and are located such that they properly align with the adapter plate passageways 642 and inlet ports 622 to permit process fluid flow therethrough. Each orifice 670 preferably is large enough to expose sufficient surface area of the underlying isolation diaphragm 620 to permit inspection and cleaning if desired. The seal support plate 618 should, however, extend over each inlet port 622 and diaphragm 620 a sufficient distance to provide adequate support for each of the adapter plate's annular seals 664. The seal support plate 618 is sealingly joined to the transmitter housing's coupling surface 624, such as by annular welds 672 provided adjacent the outer periphery of the inlet ports 622, thus forming an annular seal for containment of the process fluid.

In this embodiment of the invention, coplanar isolation diaphragms 620 are confined within a predetermined region, while providing diaphragms 620 which have improved effective areas of the active regions 636. The pressure seals 664 carried in the adapter plate 616 are supported over the active regions 636 of the diaphragms 620 outside of the inlet ports 622. The seal support plate 618 partially overhangs each isolation diaphragm 620 and permits the process fluid to thus act against substantially the entire active region 636. The isolation diaphragm's effective area is thus substantially equal to its active region 636. It is understood, however, that the foregoing invention's utility is not limited to multiple, coplanar isolation diaphragm arrangements. A single isolation diaphragm could be coupled, for example, to a flange adapter union without the use of an adapter plate, by modifying a seal support plate for direct support of an overlying flange adapter union pressure seal. The foregoing isolator apparatus improves an isolation diaphragm's effective area which reduces dp/dv related pressure measurement errors.

Each of the foregoing embodiments of the present invention thus improve the effective area of the active region of an isolation diaphragm with respect to a selected size of pressure seal, thereby substantially improving pressure transmitter performance. The present invention can also reduce the cost of transmitter materials, and permits the use of pressure transmitters having smaller diameter isolation diaphragms with correspondingly reduced

sizes of transmitter housings, without compromising performance.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the scope of the invention.

Claims

1. Apparatus (12) for isolatingly coupling a pressure from a fluid in an input member (34) to a pressure sensor (10A) providing an output as a function of the pressure, an inlet port (28) being disposed in the apparatus (12) for receiving the fluid from the input member (34), isolation means (24) being disposed in the inlet port (28) and having an active region (56) bounded by an outer border for isolatingly coupling the pressure from the fluid to the pressure sensor (10A), sealing means (62) being disposed in the inlet port (28) around the isolation means (24) for sealingly bounding the inlet port (28), the sealing means (62) having an inlet area coupling the fluid from the input member (34) to the isolation means (24) and support means (58) disposed in the inlet port (28) for supporting the sealing means (62) characterized by the support means (58) being configured to overhang at least a portion of the isolation means (24) adjacent the outer border and spacing at least a portion of the sealing means (62) away from the active region (56), such that an effective area of the active region (56) is greater than the inlet area of the sealing means (62).
2. The apparatus of Claim 1 further characterized by the isolation means (24) further comprising a deflectable diaphragm (24) including the active region (56).
3. The apparatus of Claim 2 further characterized by the isolation means (24) further comprising a substantially incompressible fluid (54) coupling the pressure from the diaphragm to the sensor (10A).
4. The apparatus of Claim 3 further characterized by the effective area of the active region (56) of the diaphragm (24) providing an accommodation of volumetric changes of the incompressible fluid (54).
5. The apparatus of Claim 4 further characterized by the sealing means (62) further comprising a resilient seal (62).



vided with four smooth bores which are also spaced apart according to industry standard (D1 by D2) and substantially align with the flange adapter union bores 650, adapter plate bores 662, and transmitter housing bores 652, such that the capscrews 648 pass therethrough to retain the entire assembly to the transmitter 610 and provide the necessary compression for sealing the pressure seals 654 and 664. A pair of fluid orifices 670 are also provided in the seal support plate 618 and are located such that they properly align with the adapter plate passageways 642 and inlet ports 622 to permit process fluid flow therethrough. Each orifice 670 preferably is large enough to expose sufficient surface area of the underlying isolation diaphragm 620 to permit inspection and cleaning if desired. The seal support plate 618 should, however, extend over each inlet port 622 and diaphragm 620 a sufficient distance to provide adequate support for each of the adapter plate's annular seals 664. The seal support plate 618 is sealingly joined to the transmitter housing's coupling surface 624, such as by annular welds 672 provided adjacent the outer periphery of the inlet ports 622, thus forming an annular seal for containment of the process fluid.

In this embodiment of the invention, coplanar isolation diaphragms 620 are confined within a predetermined region, while providing diaphragms 620 which have improved effective areas of the active regions 636. The pressure seals 664 carried in the adapter plate 616 are supported over the active regions 636 of the diaphragms 620 outside of the inlet ports 622. The seal support plate 618 partially overhangs each isolation diaphragm 620 and permits the process fluid to thus act against substantially the entire active region 636. The isolation diaphragm's effective area is thus substantially equal to its active region 636. It is understood, however, that the foregoing invention's utility is not limited to multiple, coplanar isolation diaphragm arrangements. A single isolation diaphragm could be coupled, for example, to a flange adapter union without the use of an adapter plate, by modifying a seal support plate for direct support of an overlying flange adapter union pressure seal. The foregoing isolator apparatus improves an isolation diaphragm's effective area which reduces dp/dv related pressure measurement errors.

Each of the foregoing embodiments of the present invention thus improve the effective area of the active region of an isolation diaphragm with respect to a selected size of pressure seal, thereby substantially improving pressure transmitter performance. The present invention can also reduce the cost of transmitter materials, and permits the use of pressure transmitters having smaller diameter isolation diaphragms with correspondingly reduced

sizes of transmitter housings, without compromising performance.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the scope of the invention.

Claims

1. Apparatus (12) for isolatingly coupling a pressure from a fluid in an input member (34) to a pressure sensor (10A) providing an output as a function of the pressure, an inlet port (28) being disposed in the apparatus (12) for receiving the fluid from the input member (34), isolation means (24) being disposed in the inlet port (28) and having an active region (56) bounded by an outer border for isolatingly coupling the pressure from the fluid to the pressure sensor (10A), sealing means (62) being disposed in the inlet port (28) around the isolation means (24) for sealingly bounding the inlet port (28), the sealing means (62) having an inlet area coupling the fluid from the input member (34) to the isolation means (24) and support means (58) disposed in the inlet port (28) for supporting the sealing means (62) characterized by the support means (58) being configured to overhang at least a portion of the isolation means (24) adjacent the outer border and spacing at least a portion of the sealing means (62) away from the active region (56), such that an effective area of the active region (56) is greater than the inlet area of the sealing means (62).
2. The apparatus of Claim 1 further characterized by the isolation means (24) further comprising a deflectable diaphragm (24) including the active region (56).
3. The apparatus of Claim 2 further characterized by the isolation means (24) further comprising a substantially incompressible fluid (54) coupling the pressure from the diaphragm to the sensor (10A).
4. The apparatus of Claim 3 further characterized by the effective area of the active region (56) of the diaphragm (24) providing an accommodation of volumetric changes of the incompressible fluid (54).
5. The apparatus of Claim 4 further characterized by the sealing means (62) further comprising a resilient seal (62).



6. The apparatus of Claim 5 further characterized by the support means (58) further comprising a seal support member (58) overhanging the active region (56) of the diaphragm (24) and spaced a selected distance therefrom for supporting the resilient seal (62) between the seal support member (58) and the input member (34), the seal support member (58) having a central opening (60) for passage of pressurized fluid therethrough. 5
7. The apparatus of Claim 6 further characterized by the seal support member (58) being removably mounted in the inlet port (28). 10
8. The apparatus of Claim 6 further characterized by the seal support member (58) further comprising a tapered wall (58A) disposed over the outer border of the active region (56) and extending inwardly therefrom and tapering away from the active region (56) a selected distance, such that the sealing member (62) overlies and is spaced away from the active region (56). 15
9. The apparatus of Claim 6 further characterized by the seal support member (58) overlying and extending substantially across the active region (56), the seal support member (58) having at least one orifice coupling the pressurized fluid (54) therethrough from the conduit (40) to the active region (56), such that the active region (56) is provided protection from damage. 20
10. The apparatus of Claim 2 further characterized by the diaphragm (24) being constructed to have a domed shape. 25
11. The apparatus of Claim 6 further characterized by the inlet port (28) comprising a recess in an outer surface of the apparatus, the recess having an annular, tapered side wall (30) extending inwardly from the outer surface and tapering to a decreasing diameter in an inward direction, and wherein the outer border of the isolation diaphragm (24) is sealingly joined to the seal support member (58) bounding the inlet port (28) having an inlet area to comprise an isolator assembly (12), the isolator assembly (12) being compressed in the tapered side wall (30), such that the active region (56) is greater than the inlet area. 30
12. An arrangement for isolatingly coupling pressure from fluid in first and second input members (614), to a pressure sensor, the pressure sensor providing an output as a function of the pressure in said first and second input members (614), the arrangement comprising a pair 35

of apparatus as recited in Claim 6, the inlet ports (622) of said pair of apparatus being disposed in a substantially coplanar relationship.

13. An instrument (610) comprising a pressure sensor for providing an output as a function of first and second pressures, the instrument further comprising first and second input members (34) and an arrangement according to Claim 12 for isolatingly coupling pressure from fluid in said first and second input members (34) to said pressure sensor, said first and second input members (34) comprising a pair of industry standard flange adapter unions (614) spaced apart at an industry standard spacing. 40
14. An instrument (610) according to Claim 13 wherein the pressure sensor is a differential pressure sensor. 45
15. An instrument (610) according to Claims 13 or 14 further comprising an adapter plate (616) having passageways (642) spaced apart so that the centers of the passageways (642) are offset from both the centers of openings (640) in the flange adapter unions (614) and the centers of the inlet ports (622) of said arrangement. 50

Patentansprüche

1. Vorrichtung (12) zum isolierenden Koppeln eines Drucks von einem Fluid in einem Eingangselement (34) auf einen Drucksensor (10A), der ein Ausgangssignal als Funktion des Drucks liefert, wobei ein Einlaßraum (28) zum Aufnehmen des Fluids von dem Eingangselement (34) in der Vorrichtung (12) angeordnet ist, eine Isolationseinrichtung (24) in dem Einlaßraum (28) angeordnet ist und eine aktive Zone (56) aufweist, die von einer äußeren Begrenzung begrenzt ist, um den Druck von dem Fluid isolierend auf den Drucksensor (10A) zu koppeln, eine Abdichtungseinrichtung (62) in dem Einlaßraum (28) um die Isolationseinrichtung (24) herum angeordnet ist, um den Einlaßraum (28) dichtend abzugrenzen, die Abdichtungseinrichtung (62) eine Einlaßfläche aufweist, welche das Fluid von dem Eingangselement (34) auf die Isolationseinrichtung (24) koppelt, und eine Halteeinrichtung (58) aufweist, die zum Unterstützen der Abdichtungseinrichtung (62) in dem Einlaßraum (28) angeordnet ist, dadurch gekennzeichnet, daß die Halteeinrichtung (58) so konfiguriert ist, daß sie zumindest einen Abschnitt der Isolationsein-



- richtung (24), der benachbart zur äußeren Begrenzung liegt, überspannt und zumindest einen Abschnitt der Abdichtungseinrichtung (62) von der aktiven Zone (56) in der Weise fernhält, daß eine effektive Fläche der aktiven Zone (56) größer als die Einlaßfläche der Abdichtungseinrichtung (62) ist. 5
2. Vorrichtung nach Anspruch 1, ferner dadurch gekennzeichnet, daß die Isolationseinrichtung (24) ferner ein auslenkbares Diaphragma (24) aufweist, das die aktive Zone (56) enthält. 10
3. Vorrichtung nach Anspruch 2, ferner dadurch gekennzeichnet, daß die Isolationseinrichtung (24) ferner ein im wesentlichen inkompressibles Fluid (54) aufweist, das den Druck von dem Diaphragma auf den Sensor (10A) koppelt. 15
4. Vorrichtung nach Anspruch 3, ferner dadurch gekennzeichnet, daß die effektive Fläche der aktiven Zone (56) des Diaphragmas (24) eine Anpassung volumetrischer Änderungen des inkompressiblen Fluids (54) bereitstellt. 20
5. Vorrichtung nach Anspruch 4, ferner dadurch gekennzeichnet, daß die Abdichtungseinrichtung (62) ferner eine elastische Dichtung (62) aufweist. 25
6. Vorrichtung nach Anspruch 5, ferner dadurch gekennzeichnet, daß die Halteeinrichtung (58) ferner ein Dichtungsstützelement (58) aufweist, das die aktive Zone (56) des Diaphragmas (24) überspannt und in einem gewählten Abstand davon angeordnet ist, um die elastische Dichtung (62) zwischen dem Dichtungsstützelement (58) und dem Eingangselement (34) zu unterstützen, wobei das Dichtungsstützelement (58) eine zentrale Öffnung (60) für den Durchtritt des unter Druck stehenden Fluids aufweist. 30
7. Vorrichtung nach Anspruch 6, ferner dadurch gekennzeichnet, daß das Dichtungsstützelement (58) herausnehmbar in dem Einlaßraum (28) montiert ist. 35
8. Vorrichtung nach Anspruch 6, ferner dadurch gekennzeichnet, daß das Dichtungsstützelement (58) ferner eine sich verjüngende Wand (58A) aufweist, die über der äußeren Begrenzung der aktiven Zone (56) angeordnet ist und sich davon nach innen erstreckt und sich über einen gewählten Abstand von der aktiven Zone (56) weg in der Weise verjüngt, daß das Dichtungselement (62) darüberliegt und von der aktiven Zone (56) ferngehalten ist. 40
9. Vorrichtung nach Anspruch 6, ferner dadurch gekennzeichnet, daß das Dichtungsstützelement (58) über der aktiven Zone (56) liegt und sich im wesentlichen darüber erstreckt, wobei das Dichtungsstützelement (58) mindestens einen Zugang aufweist, der das unter Druck stehende Fluid (54) durch ihn hindurch von dem Kanal (40) so auf die aktive Zone (56) koppelt, daß die aktive Zone (56) mit einem Schutz vor Beschädigung versehen ist. 45
10. Vorrichtung nach Anspruch 2, ferner dadurch gekennzeichnet, daß das Diaphragma (24) so ausgelegt ist, daß es ein gewölbte Form aufweist. 50
11. Vorrichtung nach Anspruch 6, ferner dadurch gekennzeichnet, daß der Einlaßraum (28) eine Vertiefung in einer äußeren Fläche der Vorrichtung aufweist, die Vertiefung eine ringförmige sich verjüngende Seitenwand (30) aufweist, die sich von der äußeren Fläche nach innen erstreckt und sich auf einen kleiner werdenden Durchmesser in Einwärtsrichtung verjüngt, und wobei die äußere Begrenzung des Isolationsdiaphragmas (24) dichtend mit dem Dichtungsstützelement (58) verbunden ist, das den Einlaßraum (28) mit einer Einlaßfläche begrenzt, um eine Isolatoranordnung (12) zu umfassen, wobei die Isolatoranordnung (12) in der sich verjüngenden Seitenwand (30) so zusammengepresst wird, daß die aktive Zone (56) größer als die Einlaßfläche ist. 55
12. Anordnung für ein isolierendes Koppeln eines Drucks von einem Fluid in einem ersten und zweiten Eingangselement (614) auf einen Drucksensor, wobei der Drucksensor ein Ausgangssignal als Funktion des Drucks in dem ersten und dem zweiten Eingangselement (614) liefert, die Anordnung ein Paar der Vorrichtungen nach Anspruch 6 aufweist, und wobei die Einlaßräume (622) des Vorrichtungspaares im wesentlichen in koplanarer Beziehung angeordnet sind. 60
13. Instrument (610) mit einem Drucksensor zur Bereitstellung eines Ausgangssignals als Funktion eines ersten und eines zweiten Drucks, wobei das Instrument ferner ein erstes und ein zweites Eingangselement (34) und eine Anordnung nach Anspruch 12 aufweist, um den Druck von dem Fluid in dem ersten und dem zweiten Eingangselement (34) isolierend auf den Drucksensor zu koppeln, und das erste und das zweite Eingangselement (34) ein Paar Industriestandard-Flansch/Adapter-Verbindungsstücke (614) aufweist, die beab-



standet in einem Industriestandard-Abstand angeordnet sind.

14. Instrument (610) nach Anspruch 13, wobei der Drucksensor ein Differenzdrucksensor ist.

15. Instrument (610) nach Anspruch 13 oder 14, das ferner eine Adapterplatte (616) mit in der Weise beabstandeten Verbindungswegen (642) aufweist, daß die Mitten der Verbindungswege (642) sowohl zu den Mitten der Öffnungen (640) in den Flansch/Adapter-Verbindungsstücken (614) als auch zu den Mitten der Einlaßräume (622) der Anordnung verschoben sind.

Revendications

1. Dispositif (12) pour transmettre, dans des conditions d'isolement, la pression d'un fluide dans un organe d'entrée (34), à un capteur de pression (10A) qui délivre un signal de sortie en fonction de la pression, un orifice d'entrée (28) étant prévu dans le dispositif (12) pour recevoir le fluide en provenance de l'organe d'entrée (34), un moyen d'isolement (24) étant disposé dans l'orifice d'entrée (28) et comportant une région active (56) limitée par une bordure extérieure, pour transmettre, dans des conditions d'isolement, la pression du fluide au capteur de pression (10A), un moyen d'étanchéité (62) étant disposé dans l'orifice d'entrée (28) autour du moyen d'isolement (24) pour limiter de façon étanche l'orifice d'entrée (28), le moyen d'étanchéité (62) présentant une zone d'entrée qui établit une communication pour le fluide entre l'organe d'entrée (34) et le moyen d'isolement (24), et un moyen de support (58) étant disposé dans l'orifice d'entrée (28) pour supporter le moyen d'étanchéité (62), caractérisé en ce que le moyen de support (58) est configuré de façon à surplomber au moins une partie du moyen d'isolement (24) à proximité de sa bordure extérieure, et maintient au moins une partie du moyen d'étanchéité (62) à distance de la région active (56), de telle sorte que la surface efficace de la région active (56) soit plus grande que la zone d'entrée du moyen d'étanchéité (62).

2. Dispositif selon la revendication 1, caractérisé en outre en ce que le moyen d'isolement (24) comprend en outre une membrane déformable (24) qui inclut la région active (56).

3. Dispositif selon la revendication 2, caractérisé en outre en ce que le moyen d'isolement (24) comprend en outre un liquide pratiquement incompressible (54) transmettent la pression

entre la membrane et le capteur (10A).

4. Dispositif selon la revendication 3, caractérisé en outre en ce que la surface efficace de la région active (56) de la membrane (24) assure une adaptation aux variations volumétriques du liquide incompressible (54).

5. Dispositif selon la revendication 4, caractérisé en outre en ce que le moyen d'étanchéité (62) comprend en outre un joint élastique (62).

6. Dispositif selon la revendication 5, caractérisé en outre en ce que le moyen de support (58) comprend en outre un élément de support de joint (58) en surplomb sur la région active (56) de la membrane (24) à une distance prédéterminée de celle-ci, pour supporter le joint élastique (62) entre l'élément de support de joint (58) et l'organe d'entrée (34), l'élément de support de joint (58) présentant une ouverture centrale (60) pour le passage du fluide sous pression à travers lui.

7. Dispositif selon la revendication 6, caractérisé en outre en ce que l'élément de support de joint (58) est monté de façon amovible dans l'orifice d'entrée (28).

8. Dispositif selon la revendication 6, caractérisé en outre en ce que l'élément de support de joint (58) comprend en outre une paroi conique (58A) qui est disposée au-dessus de la bordure extérieure de la région active (56), s'étend vers l'intérieur à partir de la bordure et s'écarte obliquement de la région active (56) sur une distance prédéterminée, de sorte que l'élément d'étanchéité (62) surmonte la région active (56) à distance de celle-ci.

9. Dispositif selon la revendication 6, caractérisé en outre en ce que l'élément de support de joint (58) surmonte la région active (56) en s'étendant pratiquement sur toute l'étendue de celle-ci, l'élément de support de joint (58) présentant au moins un orifice à travers lequel le liquide sous pression (54) passe d'un conduit (40) à la région active (56), de telle sorte que la région active (56) soit protégée contre un endommagement.

10. Dispositif selon la revendication 2, caractérisé en outre en ce que la membrane (24) est réalisée avec une forme de dôme.

11. Dispositif selon la revendication 6, caractérisé en outre en ce que l'orifice d'entrée (28) est constitué par un évidement dans une surface



- extérieure du dispositif, l'évidement présentant une paroi latérale annulaire conique (30) qui s'étend vers l'intérieur à partir de la surface extérieure et dont le diamètre est décroissant en direction de l'intérieur, et dans lequel la bordure extérieure de la membrane d'isolement (24) est jointe de manière étanche à l'élément de support de joint (58) qui limite l'orifice d'entrée (28) et qui comporte une zone d'entrée, de manière à constituer un ensemble isolateur (12), l'ensemble isolateur (12) étant comprimé contre la paroi latérale conique, de sorte que la région active (56) est plus grande que la zone d'entrée.
12. Système pour transmettre, dans des conditions d'isolement, la pression d'un fluide dans des premier et second organes d'entrée (614) à un capteur de pression, le capteur de pression délivrant un signal de sortie en fonction de la pression dans lesdits premier et second organes d'entrée (614), le système comprenant une paire de dispositifs selon la revendication 6, les orifices d'entrée (622) de ladite paire de dispositifs étant disposés pratiquement dans un même plan.
13. Instrument (610) comprenant un capteur de pression pour délivrer un signal de sortie en fonction d'une première et d'une seconde pression, l'instrument comprenant en outre des premier et second organes d'entrée (34) et un système selon la revendication 12 pour transmettre, dans des conditions d'isolement, la pression d'un fluide dans lesdits premier et second organes d'entrée (34) audit capteur de pression, lesdits premier et second organes d'entrée (34) comprenant une paire de raccords adaptateurs à bride (614) aux normes industrielles, espacée d'une distance correspondant aux normes industrielles.
14. Instrument (610) selon la revendication 13, dans lequel le capteur de pression est un capteur de pression différentielle.
15. Instrument (610) selon la revendication 13 ou 14, comprenant en outre une plaque adaptatrice (616) présentant des passages (642) espacés de sorte que les centres des passages (642) soient décalés, à la fois par rapport aux centres des ouvertures (640) dans les raccords à bride (614) et par rapport aux centres des orifices d'entrée (622) dudit système.