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APPARATUS FOR CONVEYING FLUID PRESSURES
TO A DIFFERENTIAL PRESSURE TRANSDUCER

The present invention relates to apparatus for conveying fluid pressures to a differential pressure transducer.

Known differential pressure transmitters consist of three functional sub units: input members, a transducer, and an electrical input/output unit. To sense differential pressure, the transmitter compares two fluid pressures. The fluid pressures are separately conveyed to the transducer by two input members mounted on opposite sides of the transducer. Each input member is connected to a conduit containing fluid under pressure. Each input member is typically separately cast or machined from stainless steel. The transducer has two separate oppositely facing portions, each of which is affected by one of the two fluid pressures, and in response generates a signal representative of the differential in such pressures. This signal is sent to the input/output unit which functions to power the transducer, to receive the differential pressure input signal from the transducer to transform the input signal into an industry standardized signal representative of differential pressure and to output that standardized signal for use external to the differential pressure transmitter.

A three valve manifold has frequently been used with a differential pressure transmitter. It has typically been interposed between the conduit and the input members of the differential pressure transmitter by bolting it to each of the input members, utilizing o-rings to effect sealing therebetween. Alternatively, the three valve manifold has been installed by interposing short additional sections of piping between the manifold and each of the input members.

10 The three valve manifold is typically used to perform three functions: (1) to selectively admit fluid pressure from both input members to affect the transducer, (2) to exclude fluid pressure from one input member while admitting fluid pressure from the other
15 input member to affect both portions of the transducer, and (3) to isolate the transducer completely from the fluid pressure from both input members. A typical prior art three valve manifold is detailed in the product literature of Anderson, Greenwood & Co. of Houston,
20 Texas, entitled AGCO Manifolds, Catalog 3000, Revised Oct. 1980.

It is desirable to provide the above mentioned fluid pressure conveying functions at reduced cost.

25 Also important is the aspect of increased safety. It is recognized that the input members convey

whatever process fluid is flowing in the conduit. This fluid may be at high pressure and/or temperature. Likewise, it may be caustic, acidic, flammable or noxious. As such, it constitutes a distinct hazard. In order to minimize this hazard, it is desirable to minimise the number of fluid connections associated with a differential pressure transmitter, as such connections are potential sources of dangerous leakage.

According to this invention there is provided apparatus for conveying fluid pressures to a differential pressure transducer, comprising an input member for connection to the transducer and having therein first and second openings open to a common face of the input member; first and second flexible isolation diaphragms sealed to said common face of the input member over the open ends of the first and second openings therein, respectively; and a manifold member having first and second passageways extending therethrough, the passageways opening to a common face of the manifold member, the manifold member being adapted to be secured to the input member with their common faces sealingly engaged whereby in use fluid pressures applied to the passageways in the manifold member act on the diaphragms and thereby cause deflection thereof.

This invention will now be described by way of example with reference to the drawings, in which:-

Figure 1 is an exploded view of a preferred
5 embodiment of apparatus according to the invention
connecting a conduit to a differential pressure trans-
ducer of a differential pressure transmitter;

Figure 2 is a sectional view taken along line
2-2 of Figure 1;

10 Figure 3 is an exploded view of a second
preferred embodiment of apparatus according to the
invention with integral three valve manifold;

Figure 4 is a sectional view taken along line
4-4 of Figure 3;

15 Figure 5 is an exploded view of another
preferred embodiment of apparatus according to the
invention;

Figure 6 is an exploded view of another
preferred embodiment of apparatus according to the
20 invention with an integral three valve manifold; and

Figure 7 is a sectional view taken along
line 7-7 in Figure 6.

5 A preferred embodiment of the invention is
shown in Figure 1, which depicts a differential
pressure transmitter generally at 10.
Differential pressure transmitter 10 has three
major sub-units; input/output unit 12, input
10 member 14, and manifold member 16.

 Physically, input/output unit 12, shown
schematically in Figure 2, is contained in
15 input/output housing 13, which is connected to
input member 14 by neck 18. Manifold member 16
is connected at a first face 20 to first and
second piping legs 24 and 26 respective by means
of flange adaptor unions 22. Manifold member 16
20 is additionally connected at second face 25,
shown in Figure 2, to input member 14, the
connection being effected by conventional means,
as for example in this embodiment by bolts 27
inserted through smooth bores 29 in input member
25 14 and threaded into threaded bores 31 in
manifold member 16. Preferably, manifold member
16 is formed of high density material.

30 Functionally it is the purpose of
differential pressure transmitter 10 to output an
electrical signal, preferably in industry
standardized format, that is representative of
the differential of the two fluid pressures.
35 When such differential pressure is the
differential of pressures taken upstream and

downstream of an orifice in a conduit, this differential may be correlated, through known relationships, to rate of flow in the conduit. To achieve this function, input/output unit 12
5 supplies power to the differential pressure transducer and receives an input signal representative of differential pressure from the transducer. Input/output unit 12 preferably is comprised of circuitry such as in U.S. Patent No.
10 3,854,039, but other known circuitry will also function satisfactorily. The transducer functions to be affected by the fluid pressure and to generate the input signal in response thereto. For packaging convenience, selected
15 components performing various functions may be located in input/output housing 13. In addition to being a supporting structure, neck 18 preferably has a conduit containing the means of communication between input/output unit 12 and
20 input member 14.

Input/output unit 12 operates on the input signal to generate the standardized output signal
25 representative of differential pressure of transmission via leads 15, shown in Figure 2, and for use external to differential pressure transmitter 10. It is understood that input/output unit 12 need not be directly affixed
30 to input member 14. It may be located remotely from but communicatively coupled to the other two sub-units of differential pressure transmitter 10, as for example in a plant control room.

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As previously described, manifold member 16

is connected to first and second piping legs 24 and 26 which may be any means supplying fluid under pressure to manifold member 16. In the embodiment shown in Figure 1, first and second piping legs 24 and 26 are small diameter inlet pipes, typically one half inch diameter, each of which is connected to manifold member 16 by a flange adapter union 22. First piping leg 24 is additionally connected to orifice flange 28 while second piping leg 26 is additionally connected to orifice flange 30. Orifice flanges 28 and 30 support an orifice plate (not shown) in recess 29 between them. Orifice flanges 28 and 30 are shown affixed to conduit 32 and, by means of conventional passageways therein, fluidly connect first and second piping legs 24 and 26 to conduit 32. Flow in conduit 32 is indicated by arrow 34. The orifice plate restricts the flow in conduit 32 in a known manner, thereby generating a differential pressure, which is a function of a rate of flow. It is understood that differential pressure transmitter 10 works equally well with flow in a direction opposite to that indicated by arrow 34. First piping leg 24 intersects and is connected to conduit 32 downstream of the orifice plate and is connected at first face 20 to a first end of first fluid pressure passageway 36 shown in Figure 2. Second piping leg 26 intersects and is connected to conduit 32 upstream of the orifice plate and is connected at first face 20 to a first end of second fluid pressure passageway 38, also shown in Figure 2.

As shown in Figure 2, first and second fluid pressure passageways 36 and 38 in manifold

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member 16 function to separately fluidly couple first and second piping legs 24 and 26 respectively to input member 14. Accordingly, first and second fluid pressure passageways 36 and 38 open at a second end at second face 25 of manifold member 16 and are there fluidly coupled to first and second fluid chambers 40 and 42 respectively. First and second fluid chambers 40 and 42 are separately formed by wall 44 and wall 46 respectively, formed in second face 25 manifold member 16, in cooperation with fluid facing sides of a first and second pressure sensing and transmitting means mounted in input member 14 when manifold member 16 and input member 14 are mated together in their normal position. The first and second pressure sensing and transmitting means comprise first and second flexible isolation diaphragms 50 and 52 disposed on face 53 of input member 14 and having outwardly facing sides 48 and 48A respectively. ~~It is understood that functionally the first and second pressure sensing and transmitting means may directly sense fluid pressure acting on the outwardly facing sides thereof, as for example when they comprise strain gauges, or they may each comprise an isolation diaphragm for isolating a remote sensor element from the fluid, while each transmits a signal representative of the respective fluid pressure to associated signal transmission means for further transmission to such sensor element.~~ The first and second pressure sensing and transmitting means are so oriented as to facilitate fluidly sealing first and second fluid chambers 40 and 42 respectively when mated to manifold member 16.

As shown in Figure 2, first and second isolation diaphragms 50 and 52 have outwardly facing sides 48 and 48A respectively, the peripheries of which are defined by rims 54 and 54A are co-planar, although they need not be to be fully functional. First and second isolation diaphragms 50 and 52 are joined at their rims 54 and 54A to input member 14 as by welding. When manifold member 16 and input member 14 are mated together, rims 54 and 54A additionally abut opposing sealing portions 56 of second face 25 of input member 16, respectively. Sealing portions 56 are formed in second face 25 of manifold member 16 annular to the second end of both fluid passageways 36 and 38. Preferably the planes defined by the sealing portions 56 are substantially co-planar, though they need not be co-planar to be fully functional. When manifold member 16 and input member 14 are mated together, the planes defined by rims 54 and 54A are substantially parallel to the plane formed by the opposing sealing portion 56 of second face 25.

First and second isolation diaphragms 50 and 52 are preferably chosen to be substantially unaffected by or, at least, resistant to the corrosive properties of the fluid. Structurally, they are selected to be able to withstand the pressure of the fluid, yet are flexible enough to deflect responsive to the fluid pressure acting thereon.

Sealing means 58, also shown in Figure 2,

are interposed between input member 14 and manifold member 16 annular to first and second isolation diaphragms 50 and 52 to assist in effecting a substantially fluid tight seal for first and second fluid chambers 40 and 42 when input member 14 and manifold member 16 are mated together. Sealing means 58 preferably are compressible O-rings compressed between manifold member 16 and input member 14 in grooves 60 formed in sealing portion 56 of second face 25. Sealing means 58 are formed from materials preferably chosen to resist damage from the corrosive properties of the fluid.

First and second fluid cavities 61 and 63 are formed in input member 14 in cooperation with first and second isolation diaphragms 50 and 52 respectively and are open to first and second fluid passageways 62 and 64 respectively. First and second fluid passageways 62 and 64 communicatively couple first and second isolation diaphragms 50 and 52 to sensor element 66. Both first and second fluid cavities 61 and 63 and first and second fluid passageways 62 and 64 are filled with a substantially incompressible fluid such as silicone oil 65.

It is the purpose of differential pressure transmitter 10 to measure flow in conduit 32 as shown in Figure 1. This is typically accomplished by restricting the flow with the orifice plate as previously described. With the flow as indicated by arrow 34 in conduit 32, flow past the orifice plate results in an area of high

pressure immediately upstream of the orifice plate and an area of low pressure immediately downstream of the orifice plate in a known manner. Accordingly, in the preferred embodiment shown in Figures 1 and 2, second piping leg 26 contains fluid at the higher pressure while the fluid in first piping leg 24 is at the lower pressure. Lower fluid pressure from piping leg 24 is conveyed through first fluid pressure passageway 36 in manifold member 16 shown in Figure 2 to first fluid chamber 40 where it acts upon outwardly facing side 48 of first isolation diaphragm 50. In a similar fashion, higher fluid pressure from piping leg 26 is conveyed through second fluid pressure passageway 38 shown in Figure 2 to second fluid chamber 42 where it acts upon outwardly facing side 48A of second isolation diaphragm 52.

Fluid pressure acting on first and second isolation diaphragms 50 and 52 deflects such isolation diaphragms. These pressure inputs are transmitted to silicone oil 65, which functions as a means for transmitting the pressure to first and second portions 68 and 70 of sensor element 66. Through the medium of silicone oil 65, sensor element 66 is responsive to the differential between the pressures acting on first and second isolation diaphragms 50 and 52. Sensor element 66 resolves the high pressure and the low pressure and generates an input signal representative of the difference therebetween, i.e. differential pressure. The input signal is transmitted via leads 74 to input/output unit 12.

In the preferred embodiment shown in Figure 2, sensor element 66 is a capacitive device, formed in a known manner. In such device, measuring diaphragm 72 divides sensor element 66 into first and second portions 68 and 70. First portion 68 together with first fluid passageway 62 and first fluid cavity 61 comprise a first separate and sealed, fluid-filled volume. Similarly, second portion 70, second fluid passageway 64 and second fluid cavity 63 comprise a second separate and sealed, fluid-filled volume. Sensor element 66 is externally excited by input/output unit 12 via electrical leads 74. Responsive to differential pressure, measuring diaphragm 72 is deflected as a known function of the differential pressure, varying the capacitance of sensor module 66. The effect of the varied capacitance is to alter the external exciting signal. This alteration comprises the input signal and is sensed via electrical leads 74 at input/output unit 12.

The circuitry of input/output unit 12 operates on the input signal and presents a standardized output signal at electrical leads 15 representative of such capacitance which is in effect representative of differential pressure. At input/output unit 12, the input signal from sensor element 66 is preferably operated on in accordance with US Patent No.3,854,039.

The reference numbering in Figure 3 corresponds to that in Figure 1. It is understood that first and second piping legs 24 and 26 are connected to a conduit substantially as shown in Figure 1. Figure 3 shows a manifold member constituted by a three valve manifold 17, including first, second, and third valve handles 76, 78 and 80 respectively that comprise a portion of the three valve manifold. Manifold 17 is constructed of high density material and preferably formed in substantially an I-shape when viewed from the side as shown. Manifold 17 has a first face 20 at which first and second piping legs 24 and 26 are connected by means of flange adaptor unions 22 and a second face 25, obscured in Figure 3, but shown in Figure 4, adapted to be connected to input member 14.

The reference numbering in Figure 4 is consistent with that in the previous Figures. It is understood that input member 14, as shown in Figure 4, has the same features as input member 14 shown in Figure 2 including a sensor element 66 and associated signal transmission means. In addition to the feature detailed in Figure 3, Figure 4 includes portions of the integral three valve manifold including specifically crossover passageway 82 and first, second and third valves 84, 86 and 88 respectively. As shown, first, second and third valves 84, 86 and 88 are threaded into manifold 17 and are opened and closed by turning handles 76, 78 and 80 respectively. It is understood that other conventional valve structures are suitable to provide the desired function. First piping leg 24, is connected at first face 20 by means of flange adaptor union 22 to first fluid passageway 36A in manifold 17. Second piping leg 26 is connected at first face 20 by means of flange adaptor union 22 to second

fluid passageway 38A. First and second fluid passageways 36A and 38A and cross-over passageway 82 comprise an H-shaped series of passageways in manifold 17. First and second fluid passageways 36A and 38A separately open at second face 25 and fluidly couple first and second piping legs 24 and 26 respectively to input member 14. Crossover passageway 82 intersects and fluidly couples first and second fluid passageways 36A and 38A. First valve 84 is mounted in manifold 17 and intersects first fluid pressure passageway 36A between first face 20 and the intersection of cross-over passageway 82. First valve 84 is capable of selectively substantially isolating input member 14 from the fluid pressure in first piping 24 and of selectively admitting such pressure. Second valve 86 is similarly mounted in manifold 17 intersecting second fluid passageway 38A between first face 20 and the intersection with cross-over passageway 82. Second valve 86 is capable of selectively substantially isolating input member 14 from the fluid pressure in second piping leg 26 and of selectively admitting such pressure. Third valve 88 is mounted in manifold 17 and intersects cross-over passageway 82. It is capable of selectively enabling fluid pressure exchange between first and second fluid passageways 36A and 38A and fluidly isolating such passageways from each other.

A major objective of the three valve manifold is to permit calibration of the "zero" setting of transmitter 10 without removing transmitter 10 from service and without having to interrupt the flow in conduit 32. Under normal operating conditions, when differential pressure transmitter 10 is measuring the differential pressure, both first and second valves 84 and 86 are open and third valve 88 is closed. In

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this configuration, first and second fluid
passageways 36A and 38A are fluidly isolated from
each other. "Zero" calibration is accomplished by
closing either first or second valve 84 or 86 and
opening third valve 88. "Zero" calibration may be
performed, as for example, when second valve 86 is
closed, thereby isolating input member 14 from the
fluid pressure in second piping leg 26. Fluid
pressure from first piping leg 24 is conveyed via
fluid passageway 36A past open first valve 84 to
fluid chamber 40. Third valve 88 is then opened and
the pressure of the fluid in fluid passageway 36A is
transmitted via

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cross-over passageway 82 to the fluid in second fluid passageway 38A and thence to second fluid chamber 42, thereby equalizing the fluid pressure in both first and second fluid chambers 40 and 42 at the pressure of the fluid in first piping leg 24. The transducer is then sensing the same pressure at both first and second isolation diaphragms 50 and 52 or, in other words, is sensing zero differential pressure. In this condition, the standardized output signal from input/output unit 12 may be calibrated to indicate zero differential pressure, equating to a known or zero flow in conduit 32.

Subsequent to performance of the calibration procedure, third valve 88 is again closed, thereby fluidly isolating first and second fluid pressure passageways 36A and 38A from each other. Second valve 86 is then opened, again pressurizing second fluid pressure passageway 38A and second fluid chamber 42 at the pressure of the fluid in second piping leg 26 thereby returning differential pressure transmitter 10 to the previously described operating condition of measuring flow in conduit 32. It should be noted that, if desired, one of first and second piping legs 24 and 26 may be at atmospheric pressure or some other reference pressure and the other leg at a pressure to be measured relative to the reference. The "zeroing" capability of input/output unit 12 is also available for this condition by following the above described procedures.

A further objective of a three valve manifold is to permit removal of differential pressure transmitter 10 for routine maintenance or replacement as may be required, without interruption of flow in conduit 32. This is accomplished by first closing both first and second valves 84 and 86, thereby fluidly isolating the transducer from conduit 32, and then removing bolts 27, shown in Figure 3, from manifold 17. Input member 14 and input/output unit housing 13 may then be separated from manifold 17. Reinstallation follows the reverse of the described procedure insuring that seal means 58 are renewed if such renewal is required to again effect fluid tight seals when input member 14 is mated to manifold 17.

Figures 5 and 6 show further preferred embodiments of the instant invention. The reference numbering is consistent with that of previous figures. Figure 5 shows manifold member 16A, a sub-unit of differential pressure transmitter 10A. Input member 14A is affixed in a conventional manner to manifold member 16A by bolts 90 inserted through smooth bore 89 and threaded into threaded bore 91. Communication between input member 14A and input/output unit 12A is via conduits internal to strut 92. In a preferred embodiment, the underside of input member 14A not shown in Figures 5 and 6, is substantially identical to face 53 of input member 14, including the disposition of first and second isolation diaphragms 50 and 52 therein. Sealing means 58 are disposed between manifold member 16A and input member 14A. Fluid passageways functionally similar to first and second fluid passageways as shown at 62 and 64 in Figure 2 are disposed in strut 92 and communicatively connect isolation diaphragms 50 and 52 to a sensor element 66, as shown in Figure

2, which sensor element is disposed in input/output unit housing 13A remote from the isolation diaphragms. ~~Where sensor elements such as strain gauges are employed as isolation diaphragms 50 and~~
5 ~~52, they are fully disposed in input member 14A and the input differential pressure signal capable of being operated on by input/output unit 12A is sent via communication means disposed in strut 92.~~

Figure 6 shows another preferred embodiment of
10 differential pressure transmitter 10A with manifold 17A. In this embodiment, differential pressure transmitter 10A is as described for Figure 5 and the reference numbering here is consistent with that of Figure 5. Manifold 17A is a rectangular prism in
15 shape. First and second piping legs 24 and 26 are each connected to flange adaptor unions 22 which in turn are conventionally affixed to the underside of manifold 17A, as for example by bolts 95 threaded into threaded bores 94. In this embodiment, the
20 underside of manifold 17A constitutes the first face of manifold 17A corresponding to the previously described first face 20 and upper side constitutes second face 25A corresponding to second face 25 as shown in Figures 3 and 4. The fluid passageways
25 defined in manifold 17A are substantially in the H-shaped pattern as shown in Figure 4.

As is shown in section in Figure 7, the first fluid passageway 36A extends from the intersection of first piping leg 24 with manifold 17A to exit at wall
30 44A of second face 25A, shown in Figure 6, where it is aligned with first isolation diaphragm 50 mounted in the underside of input member 14A. First valve 84A attached to first valve handle 76A intersects the side of the first fluid passageway 36A. Similarly,
35 the second fluid passageway 38A exists at wall 46A, shown in Figure 6, and couples second piping leg 26

to second isolation diaphragm 52. Second valve 86A
attached to second valve handle 78A, intersects the
side of the second fluid passageway. Cross-over
passageway 82A connects the first and second fluid
passageways 36A and 38A and is intersected by the
third valve 88A, attached to third valve handle 80A.

In the preferred embodiments shown, input
members 14 and 14A preferably are functionally
constructed in accordance with US Patent No. 3618390,
but many other known transducers may otherwise be
used.

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CLAIMS:



1. Apparatus for conveying fluid pressures to
5 a differential pressure transducer, comprising an
input member for connection to the transducer and
having therein first and second openings open to a
common face of the input member; first and second
flexible isolation diaphragms sealed to said common
10 face of the input member over the open ends of the
first and second openings therein, respectively; and
a manifold member having first and second passageways
extending therethrough, the passageways opening to a
common face of the manifold member, the manifold
15 member being adapted to be secured to the input
member with their common faces sealingly engaged
whereby in use fluid pressures applied to the
passageways in the manifold member act on the
diaphragms and thereby cause deflection thereof.

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2. Apparatus as claimed in Claim 1, in which
the common face of the manifold member is formed with
grooves extending about the open ends of the openings
therein, the grooves receiving sealing members which,
25 when the input member is secured to the manifold
member, engage the diaphragms carried by the input
member.

3. Apparatus as claimed in Claim 1 or Claim 2,
30 in which the manifold member provides communication
between the passageways therein, and has valves for
controlling the fluid pressure in the passageways.

4. Apparatus as claimed in any preceding
35 claim, in which the openings in the input member are
passageways which extend therethrough, said

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deflection of the diaphragms causing corresponding pressure changes in fluid in the passageways in the input member, which pressure changes are conveyed to a differential pressure transducer.

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5. Apparatus for conveying fluid pressures to a differential pressure transducer, substantially as hereinbefore described with reference to Figures 1 and 2, Figures 3 and 4, Figure 5, or Figures 6 and 7 of the drawings.

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