US 20060056597A1

(19) United States

(12) Patent Application Publication
Inneman et al.

(10) Pub. No.: US 2006/0056597 A1

(43) Pub. Date: Mar. 16, 2006

(54) **OPTICAL DEVICE**

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(21) Appl. No.: **10/522,496**

(22) PCT Filed: **Jul. 28, 2003**

(86) PCT No.: **PCT/GB03/03286**

Related U.S. Application Data

(60) Provisional application No. 60/398,599, filed on Jul. 26, 2002.

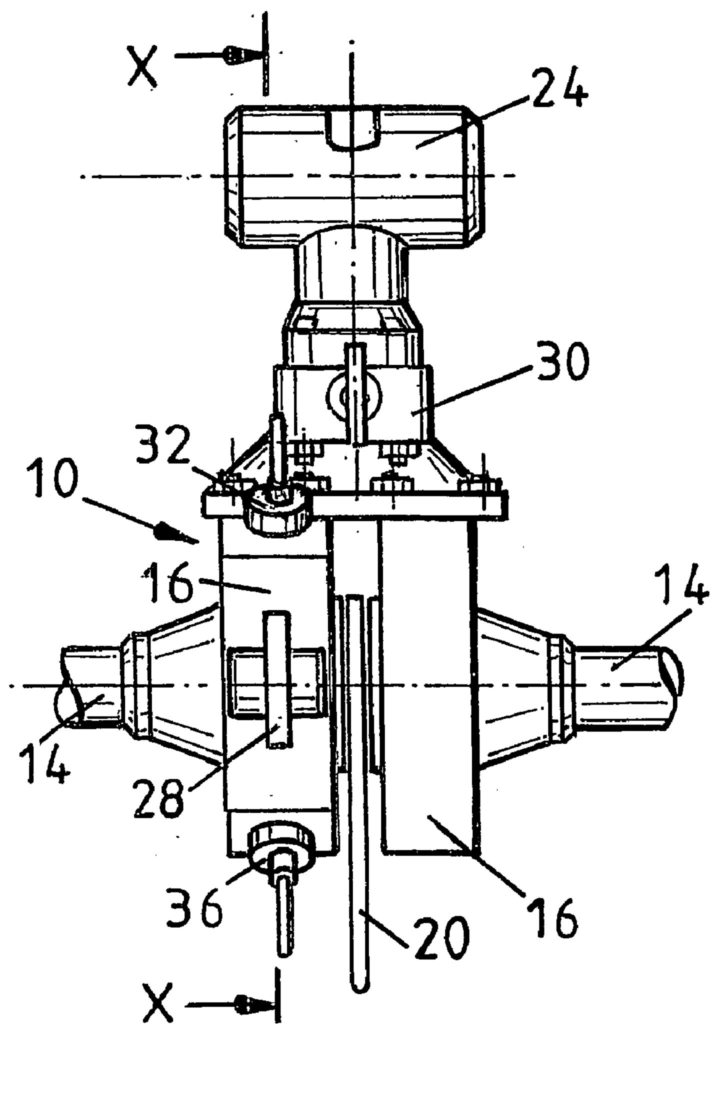
Publication Classification

(51) **Int. Cl.**
G21K 1/00 (2006.01)

(52) **U.S. Cl.** **378/145**

(57) **ABSTRACT**

A pipe coupling flange **(16)** comprising a central bore and having first and second ports for receiving valves and a plurality of channels, wherein a take-off channel links the first port with the central bore, a feed channel links the first port directly or indirectly with the second port; and wherein the second port links directly or indirectly with the exterior of the flange. Across two pipe flanges **(16)**, and fixed directly to the periphery of each flange there may be a Bridge **(30)**. The bridge **(30)** may be capable of having process media **(24)** monitoring devices fixed directly to it.



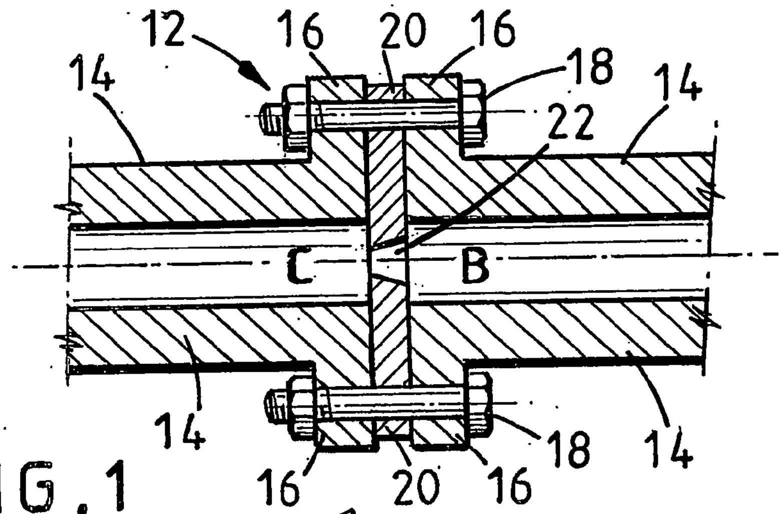
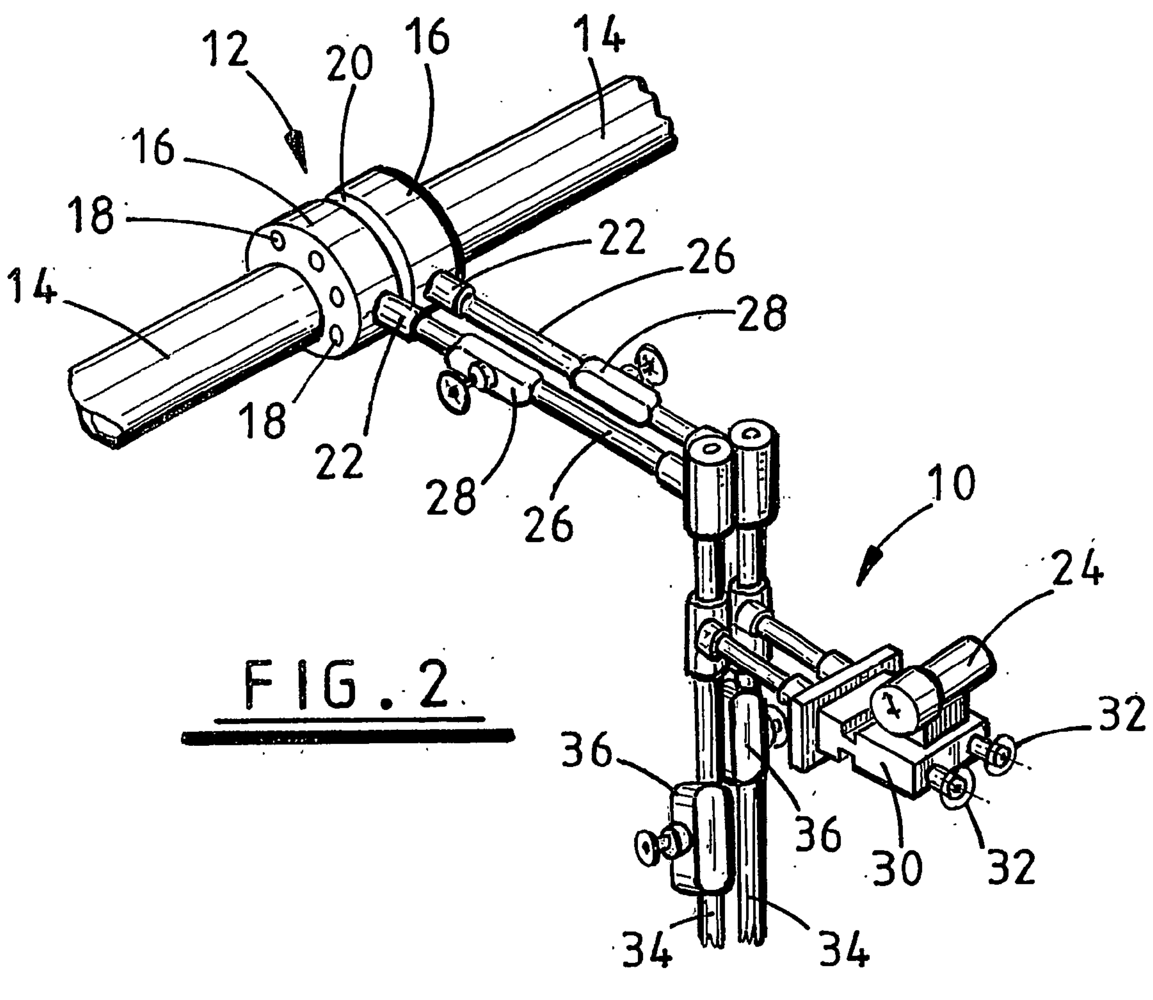

12
16
20
16
18
14
22
14
C
B
14
14
18
16
20
16
A

FIG.1


12
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16
14
16
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10
24
36
36
32
30
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34
34

FIG.2

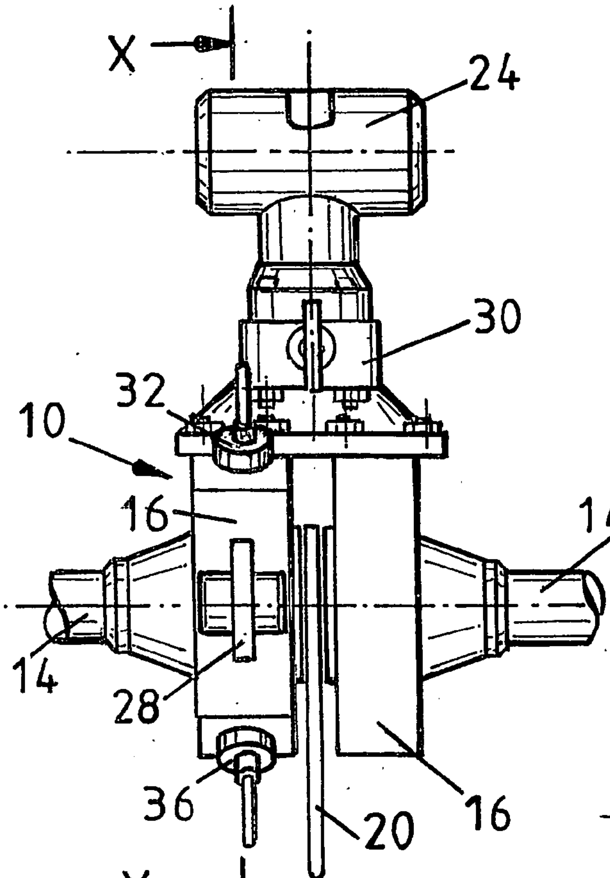
X
24
30
32
10
16
14
14
28
36
20
16
X

FIG. 3a

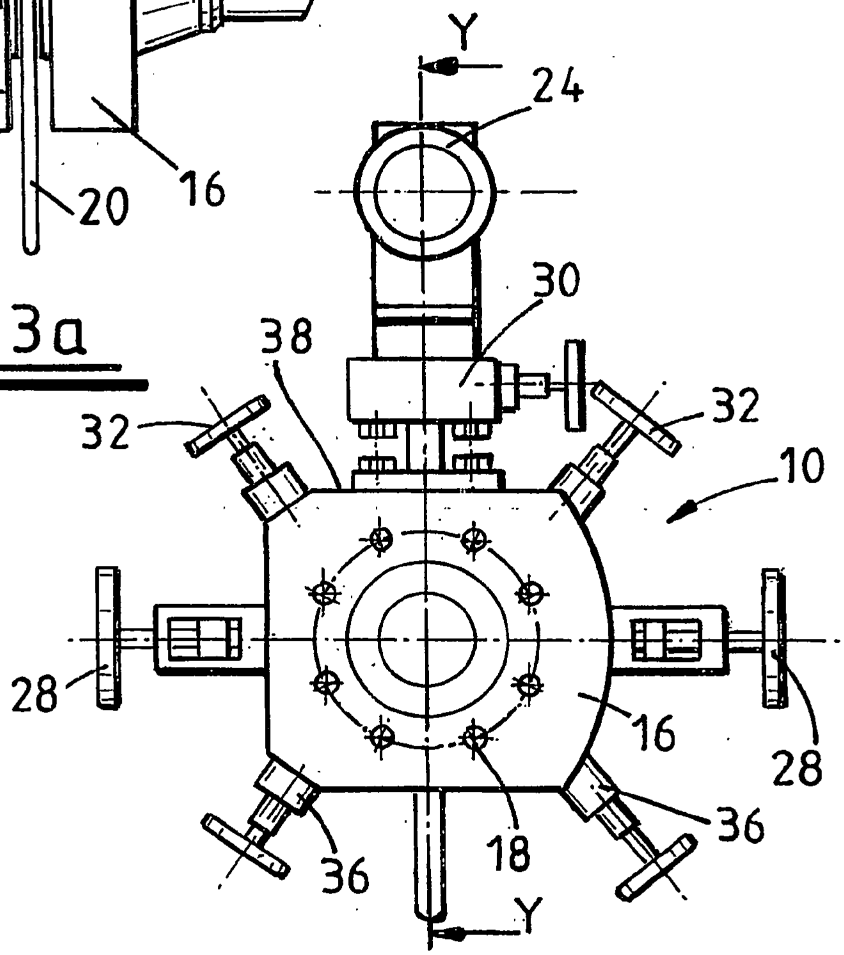
Y
24
30
38
32
32
10
28
28
16
36
18
36
Y

FIG. 3b

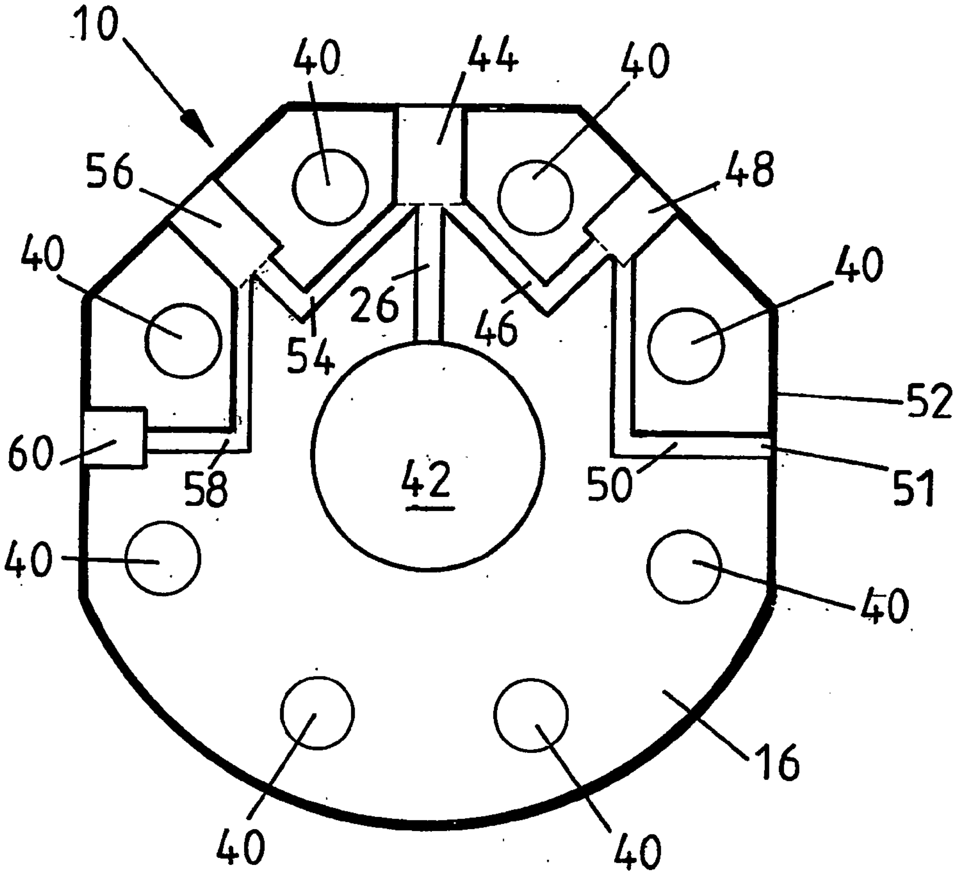
10
40
44
40
56
48
40
40
26
46
54
52
60
58
42
50
51
40
40
16
40
40

FIG. 4

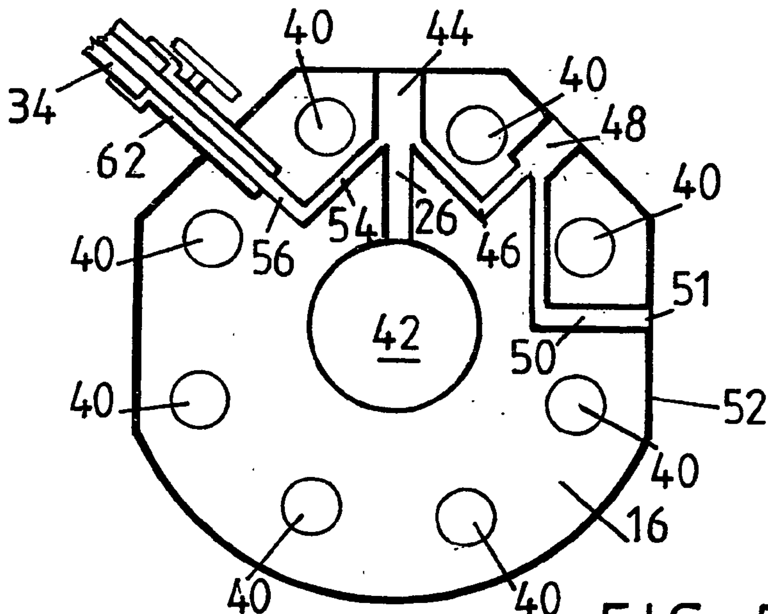
40
44
40
34
48
62
40
54
26
56
46
40
51
42
50
40
52
40
40
16
40
40

FIG. 5

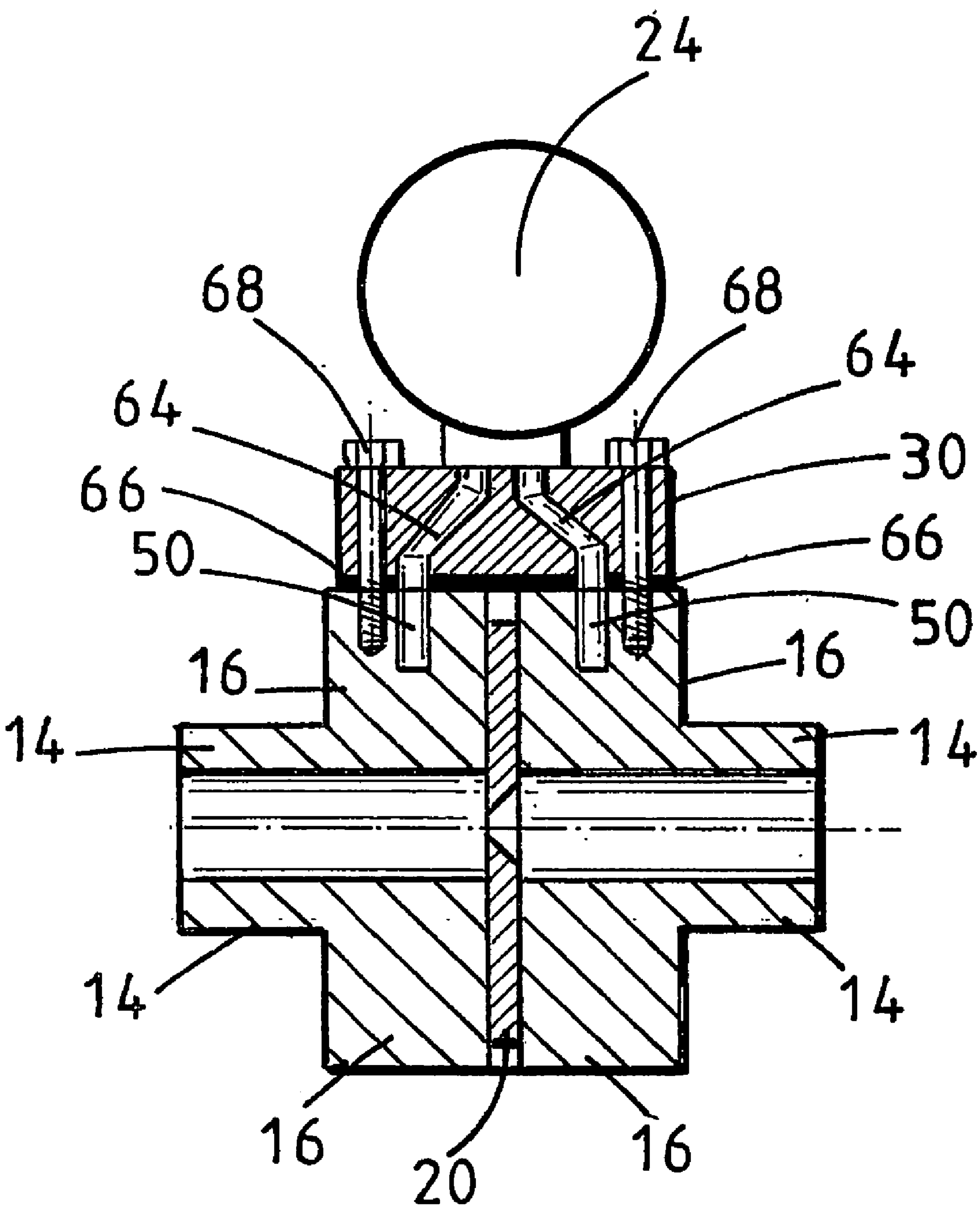

FIG.6

OPTICAL DEVICE

[0001] The present invention relates to pipe couplings and in particular to flanged-pipe couplings of the type, which comprise a bolted pipe joints.

[0002] Flanged pipe couplings are commonplace on manufacturing plant (e.g. chemical plant) since they provide a relatively simple way of securing sections of process pipe work to one another.

[0003] The monitoring of process conditions inside a process pipe can be of paramount importance in controlling the manufacturing and or distribution process. Accordingly, transducers can be fitted to process pipe work to enable test and measurement of the fluid to take place in-situ.

[0004] A common measurement transducer is the differential pressure (or "ΔP") transducer, which is used for measuring pressure differentials that can relate to a number of fluid properties including viscosity and flow rate.

[0005] Current methods of process pipe media monitoring for Differential Pressure Flow Measurement (DPFM) involve:

[0006] 1) Hanging all necessary valves and/or manifolds and process media monitoring devices from two screwed or welded fittings, which are fixed to the periphery of traditional flanges known as "orifice flanges". These flanges are bolted together about a traditional orifice plate and gaskets from which a differential pressure is created.

[0007] 2) Using tube or pipes (commonly referred to as Impulse Lines) to connect the two screwed or welded fittings to the valve and/or manifold assemblies which are located some distance away from the orifice flanges and pipe work.

[0008] 3) Cutting into the main process pipe and manufacturing traditional "Flanged Pipe Tee's". From the leg of the pipe tee, flanged valves or manifolds are connected while process media monitoring devices are connected using tube and fittings or further flanged joints.

[0009] A typical prior art DPFM assembly incorporating a ΔP transducer is shown in **FIG. 2** of the accompanying drawings, whereby a sample of the fluid in the process pipe is taken at either side of a partial obstruction, in this case, an orifice plate located between the process pipe flanges. The transducer is protected by a "double block and bleed" (DBB) valve assembly, which is primarily a safety device, but which has other uses in servicing of the flanged joint transducer and associated pipe work.

[0010] Disadvantages of prior art DPFM assemblies include:

[0011] 1) Excessive weight on the two screwed or welded fittings in the Orifice Flanges. These joints may be subject to failure due to bending moments, vibration and or corrosion.

[0012] 2) Space-inefficiency

[0013] 3) A typical DPFM assembly comprises a large number of pipes, nipples, fittings and valves, all of which need to be sealed. Moreover, because differential pressure measurements are highly complex and require a number of joints to build up an assembly, the risk of process leakage to atmosphere is increased. If there is a leak in any of the seals, then process fluids may escape to atmosphere, which is potentially hazardous to persons nearby, harmful to the environment and wasteful.

[0014] 4) Because there are a number of exposed pipes and fittings, the assembly is susceptible to being knocked and damaged. Moreover, engineers or operators when working or maintaining the plant sometimes use the take-off pipes as "steps". Because the assembly is largely unsupported, except by the nipples where the first take-off pipe emerges from the flange, it is highly susceptible to bending and/or shear loading, for which it was not designed.

[0015] 5) The failure of any of the joints, especially the joint between the process pipe and the first block valve, can be catastrophic, for example, where the process media is a boiling acid.

[0016] 6) The pipes, fittings, valves and transducer are mounted away from the process pipe, which creates a "dead leg", that is to say, a volume of fluid between the process pipe and the transducer that is stagnant. This introduces a number of problems for example; bleeding the DBB assembly wastes unnecessarily large quantities of process fluid; the fluid conditions, for example, the temperature, at the transducer may not be the same as those in the process pipe itself; and the take-off pipes and fittings may become contaminated. Furthermore, the accuracy of readings taken from such installations may be reduced due to length of "Impulse lines" and the quality of workmanship.

[0017] 7) The DPFM assembly needs to be assembled and installed on-site because it is not possible to ship it prefabricated, being a bespoke item.

[0018] 8) The installation of an assembly is costly and time consuming owing to:

[0019] a) The complexity of the set-up, the number of parts involved and the need for specialist engineers to install and test the assembly.

[0020] b) The complex build up of additional support work along with the valve and/or manifold assemblies;

[0021] c) The labour intensive assembling process required to install the additional tube and/or pipe work and fittings, along with the valve/manifold and process media monitoring device; and

[0022] d) The fabrication process required making up the "Flange Tee's" and subsequent interconnecting feeds.

[0023] It is therefore an object of the present invention to propose a solution to one or more of the above problems. In particular, it is an object of the invention to provide a pipe coupling assembly which is a safer, more reliable and more cost efficient method of fixing process media monitoring devices to process pipe work.

[0024] Accordingly, a first aspect of the invention provides a pipe coupling flange comprising a central bore and having first and second ports for receiving valves and a plurality of channels, wherein a take-off channel links the first port with the central bore, a feed channel links the first port directly or indirectly with the second port; and wherein the second port links directly or indirectly with the exterior of the flange.

[0025] The pipe coupling flange of the invention may additionally comprise a third port connected directly or indirectly with the first port via one or more feed channels.

[0026] The above-mentioned indirect connections may comprise one or more channels found in the pipe flange.

[0027] The third port may be adapted to receive an in-line valve, which may be attached to a vent pipe.

[0028] Alternatively, the pipe coupling flange may be provided with a fourth port adapted to receive a pipe joint and a feed channel connecting the third port with the fourth port.

[0029] In a preferred embodiment of the invention, the ports of the pipe coupling flange are adapted to receive rising stem valves. Alternatively, however, the ports may be adapted to receive in-line valves.

[0030] The invention is preferably adapted to receive a transducer, which is connected directly or indirectly, to a port of the pipe coupling flange. The transducer may be connected directly to the pipe coupling flange or it may be connected indirectly, by way of a bridge element.

[0031] Additionally, the bridge may comprise one or more ports and channels for receiving valves or blanks.

[0032] The bridge may be manufactured of any suitable material, although it is envisaged that a metal would be most preferable. The bridge may be fabricated such that it is adapted to receive industry standard transducers. Accordingly, an industry standard footprint is most preferably incorporated into the design of the bridge.

[0033] The flange of the pipe coupling preferably has one or more through apertures to enable adjacent flanges to be connected to one another. Most preferably, the through apertures are adapted to receive bolts.

[0034] The flanges may be manufactured of any suitable material, although metal, and in particular steels and stainless steels, may be appropriate in certain circumstances.

[0035] The flanges may be formed integrally with a process pipe or may comprise collar elements. Where collar elements are provided on the flanges, they are preferably adapted to slidably engage with a process pipe. Where the flanges comprise collar elements, the collar elements are preferably adapted for welded connection to the end of a process pipe.

[0036] The pipe coupling flange of the invention may be used to provide a block and bleed outlet on a process pipe. Where a third port is provided, the pipe coupling flange of the invention may provide a double block and bleed outlet on the process pipe. It is envisaged that two pipe coupling flanges according to the invention will be used together to provide DPFM assembly integrally with the process pipe.

[0037] Where two pipe coupling flanges according to the invention are used to provide a DPFM assembly, an orifice plate is preferably positioned between them to create a partial obstruction in the process pipe.

[0038] A transducer is preferably fitted across the DPFM assembly, which is formed using a pair of pipe couplings according to the invention. The transducer is preferably affixed to the DPFM assembly by way of a bridge or interface block. The bridge preferably has one or more channels therein that connect the outlet channels of the pipe coupling with the inlet ports of the transducer.

[0039] The transducer, where provided, may be a pressure sensor or a differential pressure sensor. All joints and/or interfaces are preferably sealed using gaskets.

[0040] According to a second aspect of the present invention there is provided a pipe coupling comprising of two bolted pipe flanges, rising stem type valves, an interconnecting "Bridge", an orifice plate and pipe gaskets or rings. Thus allowing the installation of process media monitoring devices directly on to the process pipe work.

[0041] The pipe flanges may incorporate valves of the rising stem type. An interconnecting bridge is preferably fixed directly to the periphery of the flanges, which may provide independent process pipe media feeds from each of the two flanges. The bridge may also facilitate the direct fixing of process media monitoring devices.

[0042] The pipe coupling assembly is preferably manufactured of metal along with suitable gasket materials (for example, metal, graphite or compressed fibres) for a traditional pipe flange joint build up. In a most preferred embodiment of the invention, the coupling assembly is compliant with any necessary design codes for valves, manifolds, flanges and pipe work.

[0043] It is envisaged that the pipe couplings of the invention may be supplied in kit form. The kits may comprise one or more pipe couplings, one or more orifice plates and optionally a transducer. The transducer supplied with the kit may be a differential pressure sensor.

[0044] Where the invention is provided in kit form, it is preferably pre-assembled and pressure tested.

[0045] A preferred embodiment of the invention shall now be described, by way of example only, with reference to the accompanying drawings in which;

[0046] **FIG. 1** shows cross-section through a flanged pipe coupling;

[0047] **FIG. 2** shows a perspective view of a prior art differential pressure gauge arrangement fixed across a flanged pipe coupling;

[0048] **FIG. 3***a* shows a side elevation of a coupling according to the invention;

[0049] **FIG. 3***b* shows an end elevation of a pipe coupling according to the invention;

[0050] **FIG. 4** shows a cross-section of **FIG. 3***a* on X-X;

[0051] **FIG. 5** shows an alternative cross-section of **FIG. 3***a* on X-X; and

[0052] **FIG. 6** shows a cross-section of **FIG. 3***b* on Y-Y.

[0053] Referring to **FIG. 1** of the drawings, a bolted pipe joint **12** is shown in which, a pair of adjacent pipes **14** are secured to one another by way of bolts **18** that pass through apertures in flanges **16** located at the ends of the pipes. There is an apertured orifice plate **20** clamped between the flanges **16**. The aperture **22** in the orifice plate **20** is tapered in the flow direction of fluid in the pipe **14**, as indicated by arrow A. As fluid flows through the pipe **14**, it is restricted by the orifice plate **20**. Accordingly, there is a region B of increased fluid pressure upstream of the orifice plate **20** and conversely, a region C of reduced fluid pressure downstream of the orifice plate **20**.

[**0054**] A pressure differential "ΔP" transducer can be fitted across the orifice plate **20** to compare the fluid pressure upstream and downstream of the orifice plate **20** to determine the flow characteristics of the fluid.

[**0055**] **FIG. 2** of the drawings shows a prior art method of affixing a ΔP transducer assembly **10** across an orifice plate **20** in which, a pair of adjacent process pipes **14** are jointed as detailed above.

[**0056**] Each of the pipe flanges **16** have been drilled and tapped to receive a screw-threaded or welded nipple **22**. The ΔP gauge assembly **10** is protected by a "double block and bleed" valve assembly, enabling on the one hand, the transducer **24** to be selectively isolated from the process pipe **14**, and on the other, the connecting pipe work to be "bled" as and when required.

[**0057**] Accordingly, the take-off pipes **26** are fitted with a "primary block" valve **28**, which isolates the assembly **10** from the process pipes **14**. The take-off pipes **26** then lead towards an interface block **30**, which has a "secondary block" valve **32** incorporated therewith. There is also present, located between the primary **28** and secondary **32** block valves, a vent pipe **34**, incorporating a "vent" valve **36**.

[**0058**] With the primary **28** and secondary **32** block valves open and the vent valve **36** closed, the transducer **24** is able to sample the pressure in the process pipe **14** at either side of the orifice plate **20**. After use, the primary **28** and secondary **32** block valves can be closed, and the vent valve **36** opened to drain the take-off pipes **26**.

[**0059**] Furthermore, with the secondary block valve **32** closed, the transducer **24** may be removed for servicing, cleaning or replacement.

[**0060**] Turning now to **FIGS. 3***a* and **3***b,* the pipe coupling **10** comprises of two bolted pipe flanges **16** with an interconnecting bridge **30** fixed directly to the periphery of the two flanges **16**. The two flanges **16** can be bolted **18** together about a traditional orifice plate **20** and flange gaskets. The Bridge **30** facilitates the direct fixing of process media monitoring devices **24** and may incorporate additional ports and/or valves.

[**0061**] The Bridge **30** also allows the two independent process media feeds to be directed to the process media monitoring device **24**. The Bridge **30** allows for opposing lateral movement of the flanges **16** when the orifice plate **20** requires replacing. The two flanges **16** can be separated without the need to disassemble the complete coupling **10**.

[**0062**] As shown in **FIG. 3***b* rising stem valves **28**, **32** and **36** are also fixed to the periphery of each of the pipe flanges **16**. These valves can be arranged to provide the process media control functions required. The Bridge **30** can also facilitate additional rising stem valves and/or ports if required.

[**0063**] In **FIGS. 3***a* and **3***b,* a ΔP transducer assembly **10** according to the invention is shown whereby the "double block and bleed" valve assembly is formed integrally with the process pipe flanges **16**. The ΔP transducer **24** is connected to an interface block **30**, which bolts directly to a machined "flat"**38** on the flange **16** of the process pipe **14**. Each flange **16** comprises a primary **28**, secondary **32** and bleed **36** valve in addition to means for the attachment of a vent pipe **34** (not shown). The operation of the assembly **10** is the same as for a conventional assembly, that is to say; opening the primary **28** and secondary **32** block valves and closing the vent valve **36** for normal operation; or closing the primary **28** whilst opening the secondary **32** block valve and vent valve **36** to bleed the assembly **10**.

[**0064**] **FIG. 4** shows a section of flange **16** of the invention. The flange **16** has a central bore **42**, through which the process fluid flows and bolt apertures **40** for connecting adjacent flanges **16** to one another.

[**0065**] The take-off channel **26** leads to a primary block valve seat **44**, which is adapted to receive a rising stem valve (not shown for clarity) for isolating the process fluid from the transducer (not shown). A first feed channel **46** leads from the primary block valve seat **44** to a secondary block valve seat **48**, which is adapted to receive a rising stem valve. A second feed channel **50** leads from the secondary block valve seat **48** to a port **51**. The bridge and transducer (not shown) are fitted directly to the machined flat face **52** of the flange **16**.

[**0066**] A third feed channel **54** leads from the primary block valve seat **44** to the vent valve seat **56**, which is, adapted to receive a rising stem valve (not shown). Finally, a fourth feed channel **58** leads from the vent valve seat **56** to a bleed pipe nipple seat **60**, which is used for connecting a bleed pipe (not shown) to the assembly **10**.

[**0067**] **FIG. 5** shows an alternative embodiment of the invention whereby the fourth feed channel **58** and bleed pipe nipple seat **60** are replaced by an in-line bleed valve and pipe connector **62**, to which the bleed pipe **34** is directly fitted.

[**0068**] Finally, **FIG. 6** shows a section through the pipe flanges and bridge **30**. The second feed channel **50** leads into channels **64** in the bridge **30** that correspond therewith. The bridge **30** is seated on a seal or seals **66** and is affixed thereto by bolts **68**. The transducer **24** is affixed to the bridge **30** using an industry standard connector (not shown).

1-18. (canceled)

19. An optical device comprising:

a plurality of plates providing a plurality of flat surfaces positioned to provide a function selected from the group consisting of total external reflection and collimation of high energy radiation from a high energy radiation source, the plurality of plates located at a position selected from the group consisting of after the radiation source and before a detector positioned to receive the high energy radiation,

wherein the plurality of flat surfaces are non-parallel.

20. The optical device of claim 19, wherein the source defines an arcuate surface and each of the plurality of flat surfaces is substantially normal to the arcuate surface.

21. The optical device of claim 19, wherein the detector defines an arcuate surface and each of the plurality of flat surfaces is substantially normal to the arcuate surface.

22. The optical device of claim 19, wherein the high energy radiation comprises X-ray radiation.

23. The optical device of claim 19, wherein the high energy radiation comprises extreme ultraviolet (EUV) radiation.

24. The optical device of claim 19, further comprising fixing means for fixing the position of the plurality of plates relative to each other.

25. The optical device of claim 24, wherein the fixing means is transmissive to the high energy radiation

26. The optical device of claim 19, wherein the plurality of plates includes a coating material.

27. The optical device of claim 19, wherein the plurality of plates are formed from a material having a density less than 6 g/cm^3.

28. The optical device of claim 24, wherein the fixing means comprises an adhesive.

29. The optical device of claim 19, further comprising a positioning device for the positioning the plurality of plates relative to each other.

30. The optical device of claim 19, wherein the optical device is a multifoil optic.

31. The optical device of claim 19, wherein the optical device is a Soller slit.

32. A method for performing high energy radiation lithography, comprising the steps of:

receiving high energy radiation from a high energy radiation source;

focusing the high energy radiation from the high energy radiation source using an optical device;

receiving the focused high energy radiation from the optical device onto a lithographic specimen via a lithographic mask.

33. The method of claim 32, wherein the high energy radiation comprise X-ray radiation.

34. The method of claim 32, wherein the high energy radiation comprises extreme ultraviolet (EUV) radiation.

35. A high energy lithographic system, comprising:

a high energy source;

an optical device for focusing high energy radiation from the high energy source;

a mask, which receives focused high energy radiation from the optical device; and

a specimen, which is imprinted with the pattern of the mask by the high energy radiation passing therethrough.

36. The high energy lithographic system of claim 35, wherein the high energy radiation comprises X-ray radiation.

37. The high energy lithographic system of claim 35, wherein the high energy radiation comprises extreme ultraviolet (EUV) radiation.

* * * * *