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(54) Title: FLANGELESS DIFFERENTIAL PRESSURE TRANSMITTER FOR INDUSTRIAL PROCESS CONTROL SYSTEMS

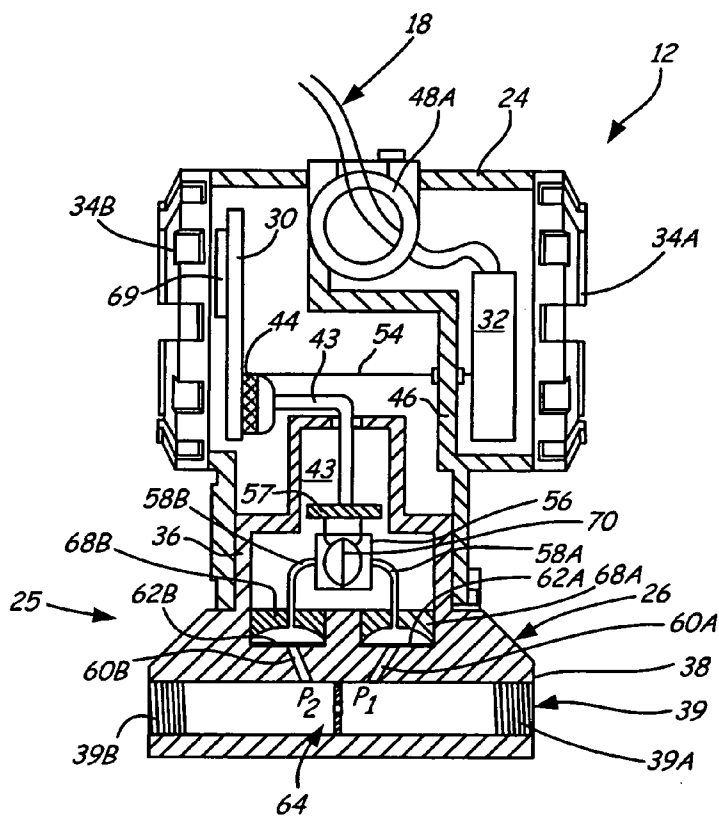


FIG. 3

(57) Abstract: An industrial pressure transmitter (12), for use in industrial process control systems (10), comprises a differential pressure sensor (56) and an integrated process connector (26) connected to the differential pressure sensor (56). A process fluid flow duct (39) extends through the process connector (26) and receives an industrial process fluid. A primary element (64) is positioned in the process fluid flow duct (39) for producing a pressure differential in the process fluid across the primary element (64). The differential pressure sensor (56) is connected to the process fluid flow duct (39) to sense the pressure differential across the primary element (64).

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AMENDED CLAIMS

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CLAIMS:

1. A pressure transmitter for use in industrial process control systems, the pressure transmitter comprising:
 - a sensor module comprising:
 - a differential pressure sensor for sensing a pressure differential in a process fluid;
 - a base having a process fluid flow duct extending from a first side of the base through to a second side of the base for receiving the process fluid;
 - a primary element positioned in the process fluid flow duct between the first side and the second side;
 - first and second isolation diaphragm recesses positioned on a third side of the base facing away from the fluid flow duct;
 - first and second impulse piping lines extending from the fluid flow duct on either side of the primary element, through the base, and to the first and second isolation diaphragm recesses, respectively;
 - first and second fill fluid passageways extending from the first and second isolation diaphragm recesses, respectively, to the differential pressure sensor; and
 - first and second isolation diaphragms positioned within the first and second isolation diaphragm recesses, respectively, to seal the first and second isolation diaphragm recesses from the first and second impulse piping lines, respectively; and
 - a transmitter housing connected to the sensor module, the transmitter housing containing transmitter circuitry for processing output of the pressure sensor.
2. The pressure transmitter of claim 1 wherein the primary element permits fluid flow through the process fluid flow duct from the first side to the second side and causes the pressure differential in the process fluid.
3. The pressure transmitter of claim 1 wherein the primary element is selected from the group consisting of: a venturi tube, an orifice plate, a pitot tube or a flow nozzle.

4. The pressure transmitter of claim 1 wherein the primary element is shaped from the process fluid flow duct and the first and second impulse piping lines and the first and second isolation diaphragm recesses are shaped from the base such that the primary element, the first and second impulse piping lines and the first and second isolation diaphragm recesses are unitary with the sensor module.
5. The pressure transmitter of claim 1 wherein the process fluid flow duct includes couplings for joining a process fluid source to the sensor module, and the sensor module includes couplings for securing the pressure transmitter to a mounting fixture.
6. The pressure transmitter of claim 1 wherein the first and second isolation diaphragms are mounted along a non-mating face of the base.
7. The pressure transmitter of claim 1 wherein the sensor module includes a sensor pocket unitary with the base for housing the differential pressure sensor and wherein the first and second isolation diaphragm recesses open to the sensor pocket.
8. The pressure transmitter of claim 6 wherein the first and second isolation diaphragm recesses are free of mating-related stress.
9. The pressure transmitter of claim 1 and further comprising a-bypass manifold comprising:
 - a bypass flow duct connecting a first end of the process fluid flow duct with a second end of the process fluid flow duct external to the base;
 - a first bypass valve positioned between the bypass flow duct and the first end of the process fluid flow duct; and
 - a second bypass valve positioned between the bypass flow duct and the second end of the process fluid flow duct.
10. The pressure transmitter of claim 1 wherein the first and second isolation diaphragms are secured to first and second diaphragm base disks positioned within the first and second isolation diaphragm recesses of the sensor module, wherein the first and second base disks include openings for receiving the first and second fill fluid passageways.
11. The pressure transmitter of claim 10 wherein the first and second isolation diaphragms are welded to the first and second base disks, respectively, and the first and second base disks are welded to the first and second isolation diaphragm

recesses, respectively, thereby uncoupling the first and second process isolation diaphragms from the base and stress associated with the base.

12. The pressure transmitter of claim 10 wherein the pair of process diaphragm base disks are co-planar with each other.

13. The pressure transmitter of claim 1 wherein the sensor module and the transmitter housing comprise an integral unit.

14. The pressure transmitter of claim 1 wherein the primary element closes off the fluid flow duct into two separate compartments such that fluid is not permitted to flow through the fluid flow duct from the first side to the second side.

15. A sensor module for use in an industrial process transmitter, the sensor module comprising:

a differential pressure sensor for sensing a pressure differential in a process fluid;

a base having a process fluid flow duct for receiving the process fluid;

a primary element positioned in the process fluid flow duct and for causing the pressure differential in the process fluid;

impulse piping lines extending from the fluid flow duct on either side of the primary element;

fill fluid passageways connecting the impulse piping lines with the differential pressure sensor; and

isolation diaphragms for segregating the impulse piping lines from the fill fluid passageways, wherein the isolation diaphragms are positioned internally within the base and mounted along a non-mating face of the base.

16. The sensor module of claim 15 wherein the process fluid flow duct, the primary element and the impulse piping lines are shaped from the base such that the sensor module has a uni-body construction.

17. The sensor module of claim 15 wherein the process fluid flow duct includes couplings for joining a process fluid source to the sensor module, and the sensor module further includes couplings for securing the pressure transmitter to a mounting fixture.

18. The sensor module of claim 15 wherein the pressure transmitter includes a

bypass manifold connecting portions of the process fluid flow duct on either side of the primary element such that fluid is permitted to flow around the primary element.

19. The sensor module of claim 18 wherein the bypass manifold comprises:
 - a bypass flow duct connecting a first end of the process fluid flow duct with a second end of the process fluid flow duct external to the base;
 - a first bypass valve positioned between the bypass flow duct and the first end of the process fluid flow duct; and
 - a second bypass valve positioned between the bypass flow duct and the second end of the process fluid flow duct.
20. The sensor module of claim 15 wherein the isolation diaphragms are secured to a pair of process diaphragm base disks recessed within a surface of the sensor module above the fluid flow duct.
21. An industrial pressure transmitter for use in industrial process control systems, the industrial pressure transmitter comprising:
 - a differential pressure sensor;
 - a flangeless process connector connected to the differential pressure sensor through an internal hydraulic system;
 - a process fluid flow duct extending through the flangeless process connector and for receiving an industrial process fluid;
 - a primary element positioned in the process fluid flow duct for producing a pressure differential in the process fluid across the primary element; and
 - wherein the differential pressure sensor is connected to the process fluid flow duct to sense the pressure differential across the primary element.
22. The industrial pressure transmitter of claim 21 wherein the hydraulic system further comprises:
 - impulse piping lines extending from the fluid flow duct on either side of the primary element within the flangeless process connector;
 - fill fluid passageways connecting the impulse piping lines with the differential pressure sensor; and
 - isolation diaphragms for segregating the impulse piping lines from the fill fluid passageways.
23. The industrial pressure transmitter of claim 22 wherein the isolation diaphragms

are recessed within a top surface of the integrated process connector so as to be mounted along a non-mating face of the flangeless process connector.

24. The industrial pressure transmitter of claim 21 wherein the primary element is selected from the group consisting of: a venturi tube, an orifice plate, a pitot tube or a flow nozzle.

25. The industrial pressure transmitter of claim 21 wherein the primary element is shaped from the process fluid flow duct such that the primary element is unitary with the flangeless process connector.

26. The industrial pressure transmitter of claim 21 wherein the flangeless process connector includes a bypass manifold.

27. The industrial pressure transmitter of claim 26 wherein the bypass manifold comprises:

- a bypass flow duct connecting a first end of the process fluid flow duct with a second end of the process fluid flow duct external to the flangeless process connector;

- a first bypass valve positioned between the bypass flow duct and the first end of the process fluid flow duct; and

- a second bypass valve positioned between the bypass flow duct and the second end of the process fluid flow duct.

28. The industrial pressure transmitter of claim 27 and further comprising a vent valve positioned between the first bypass valve and the first end of the process fluid flow duct.

29. The pressure transmitter of claim 6 wherein the first and second isolation diaphragms are positioned internally within the base of the sensor module.

30. An industrial pressure transmitter for use in industrial process control systems, the industrial pressure transmitter comprising:

- a differential pressure sensor;

- an integrated process connector connected to the differential pressure sensor;
- a process fluid flow duct extending through the integrated process connector and for receiving an industrial process fluid;

- a primary element positioned in the process fluid flow duct for producing a pressure differential in the process fluid across the primary element,

wherein the differential pressure sensor is connected to the process fluid flow duct to sense the pressure differential across the primary element;
and

a bypass manifold comprising:

a bypass flow duct connecting a first end of the process fluid flow duct with a second end of the process fluid flow duct external to the integrated process connector;

a first bypass valve positioned between the bypass flow duct and the first end of the process fluid flow duct; and

a second bypass valve positioned between the bypass flow duct and the second end of the process fluid flow duct.

STATEMENT UNDER ARTICLE 19 (1)

The amendments to the claims are written to bring the claims into accord with allowed claims in the related U.S. Application.

Claim 1 has been amended to include isolation diaphragm recesses positioned on the base, and to specify the relationship of the recesses with respect to the fluid flow duct, impulse piping lines, and isolation diaphragms.

Claim 2 has been amended to specify that the primary element permits fluid flow through the process fluid flow duct.

Claim 4 has been amended to specify that impulse piping lines and isolation diaphragm recesses are shaped from the base.

Claim 5 has been amended to specify that the sensor module includes couplings for securing the pressure transmitter to a mounting fixture.

Claim 7 has been amended to specify that the sensor pocket is unitary with the base and that isolation diaphragm recesses open to the sensor pocket.

Claim 9 has been amended to add the bypass manifold to claim 1.

Claim 10 has been amended to specify that the isolation diaphragms are secured to diaphragm base disks positioned within isolation diaphragm recesses.

Claim 12 has been amended to specify that process diaphragm base disks are co-planar.

Claim 14 has been amended to specify that the fluid is not permitted to flow through the fluid flow duct.

Claim 15 has been amended to specify that isolation diaphragms are positioned internally within the base and mounted along a non-mating face.

Claim 18 has been amended to specify that the bypass manifold connects portions of the process fluid flow duct on either side of the primary element.

Claim 20 has been amended to specify that isolation diaphragms are secured to process diaphragm base disks.

Claim 21 has been amended to specify that a flangeless process connector connects to the differential pressure sensor through an internal hydraulic system.

Claim 22 has been amended to specify impulse piping lines extending from the fluid flow duct within the flangeless process connector.

Claim 23 has been amended to specify that isolation diaphragms are mounted along a non-mating face.

Claim 25 has been amended to specify that the primary element is unitary with the flangeless process connector.

Claim 26 has been amended to specify that the flangeless process connector includes a bypass manifold.

Claim 27 has been amended to specify that the bypass flow duct connects the process fluid flow duct external to the flangeless process connector.

Replacement claim 6 specifies that the isolation diaphragms are mounted along a non-mating face.

Replacement claim 8 specifies that the isolation diaphragm recesses are free of mating-related stress.

Replacement claim 11 specifies that the isolation diaphragms are welded to base disks, which are welded to isolation diaphragm recesses.

Replacement claim 29 specifies that the isolation diaphragms are positioned internally within the base of the sensor module.

New independent claim 30 specifies an industrial process transmitter having a differential pressure sensor, an integrated process connector, a process fluid flow duct, a primary element and a bypass manifold.