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SPECIFICATION

PRESSURE TRANSDUCER

5 The present invention relates to pressure transducers for sensing the pressure of a fluid being conveyed in a pipe.

BACKGROUND OF THE INVENTION

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A pressure transducer conventionally includes a piercing needle which can be advanced to engage and pierce a clamped pipe which is carrying fluid under pressure. The pressurized fluid flows through the
15 pierced hole and communicates with a solid state pressure sensor which can supply sensed pressure data to an electronics package for computational or other use.

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OBJECT OF THE INVENTION

It is an object of the present invention to provide such a pressure transducer wherein the sensor is isolated in an inert protective fluid
25 which transmits the pressure to the sensor.

Other objects and advantages of the present invention will become apparent from the following portion of this specification and from the accompanying drawings which illustrate, in
30 accordance with the mandate of the patent statutes, a presently preferred embodiment incorporating the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an oblique view, partly in section, of a temperature/pressure transducer, made in accordance with the teachings of the present invention, clamped to a water pipe;

Figure 2 is another oblique view, partly in section of the temperature/pressure transducer shown in figure 1;

10 Figure 3 is a cross sectional view of the pressure/temperature sensing module schematically assembled with structure for loading the module with oil;

Figure 4 is an oblique view of the diaphragm as 15 shown in Figure 3,

Figure 5 is an oblique view of the support cup shown in Figure 3;

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENT

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Figures 1 and 2 illustrate a pressure/temperature transducer P/T 14 which is clamped onto a water pipe 31 much like a saddle valve, by tightening a clamping bolt 32 to advance a jaw 33 to clamp the housing 34 to the water pipe proximate a piercing needle 35. Once clamped, the piercing needle can be extended until the pipe wall is pierced, by rotating the body 38 of the piercing needle, which is threadedly received by an internally threaded sleeve 39 in the housing 34 of the pressure sensing device. Surrounding the piercing needle, proximate the pipe is an annular compression seal 40, which effectively seals the pierced hole 42. The compression seal 40 has a through hole 41 larger than the piercing

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needle. A second seal 44 seals the body 38 of the piercing needle and the housing bore 45 in which the body moves. When the piercing needle is retracted, water will pass through the pierced hole 42, through
5 the hole in the compression seal 41, through a needle guide hole 43 in the housing, into the housing bore 45 along the piercing needle and through a hole 49 (figure 2) into a chamber 47 between the housing 34 and a flexible diaphragm 46, which also defines the
10 bottom of an upper sealed chamber 48 in which a solid state pressure sensor 50 is located. The housing additionally supports a temperature sensor (thermistor, for example) 56 that is clamped against the pipe wall when the housing is clamped in position.

15 Oil, such as silicone oil, is permanently captured within this chamber in the manner shown in Figure 3. A first port 70 is connected to the housing 34 at the compression seal bore 41 by establishing a suitable face seal, for example. This
20 port is connected to a source of diaphragm preload pressure $P_1/72$ (10-20 PSI) and the pressure source can be turned on and off with a suitable valve 74. A chuck 76 is also connected to the housing 34 at the fill hole 54 by establishing a suitable face seal,
25 for example. The chuck has a first port 78 which is connected to a source of oil under pressure $P_2/80$ and this pressure source can be turned on and off with a suitable valve 82. The chuck has a second port 84 which is connected to a source of vacuum $P_3/86$ and
30 the vacuum source can be turned on and off with a suitable valve 88. The chuck has an exit bore 90 for receiving a metallic sealing ball 92 which is sized to be larger than the reduced diameter portion 93 of the oil inlet hole. The juncture of the reduced

diameter portion and an enlarged diameter portion 94 of the oil inlet hole defines the location in the hole where the reduced diameter portion will be sealed by the ball. The chuck also supports a
5 displaceable plunger 96 which is sealed within its hole 98 and which will not move when P2 is applied (rearward displacement past the shown position may be prevented with a key/keyway interconnection, for example).

10 With valves 82 and 88 closed and valve 74 open P1 is applied to deflect the top of the diaphragm 46 down against a support cup 100. Figure 4 illustrates the diaphragm at this time and Figure 5 illustrates the support cup. Now, valve 88 is opened and vacuum
15 is applied to eliminate all the air intermediate the diaphragm and the valve. When this is complete valve 88 is closed and valve 82 is opened to fill the space between the diaphragm and the valve with oil. P2 is less than P1 so that the top of the diaphragm will
20 not move off the support cup. When this is complete, valve 82 is closed and the plunger is displaced axially by an air cylinder, for example, to forcefully displace the ball to its final position at the end of the reduced diameter of the oil inlet hole
25 against the tapered surface 106. The volume of oil pushed into the system as the ball is displaced from the juncture of the enlarged and reduced diameter portions to the end of its displacement is a defined volume which is chosen to deflect the top of the
30 diaphragm to its original flat neutral condition (oil will flow through holes 110 in the support cup and a number of nubs 108 will facilitate the separation of the diaphragm from the support cup). When the pre load inlet and chuck are removed, the diaphragm will

be ideally neutral and no pressure will be transmitted from the diaphragm, across the oil to the pressure sensor. The module can be calibrated by determining the sensed pressure after assembly. The
5 spacing between the neutral diaphragm and the support cup is sufficient so that any sensed pressure will not be sufficient to push the diaphragm against the support cup. Accordingly, any pressure applied to the diaphragm will be transmitted through the
10 noncompressible oil to the sensor and will be read by the system.

CLAIMS

1. A method of making a pressure transducer having
a closed chamber having a flexible flat diaphragm
5 defining one side, a support cup including a flat
base mounted within the closed chamber with the flat
base parallel to and selectively spaced from the
diaphragm, a pressure sensor mounted within the
closed chamber, the closed chamber including an inlet
10 bore including an outer enlarged diameter portion, a
first reduced diameter portion extending a selected
distance inwardly from said enlarged diameter portion
towards said closed chamber ending at a second
further reduced diameter portion, and a pressure
15 supply path means for delivering fluid pressure from
a hole in a pressurized pipe to the diaphragm
including a piercing needle, support means for
supporting the piercing needle for displacement into
a pipe to pierce the pipe, and bore means extending
20 from a first location surrounding the piercing needle
to a second location communicating with the diaphragm
the method comprising

applying a preload pressure to the pressure
supply path to displace the diaphragm from its
25 relaxed state to a deflected position against the
flat base to reduce the volume of the closed chamber
by a selected volume,

while maintaining the preload pressure applying
a vacuum to the inlet bore by opening a valve to
30 remove air from the chamber,

after a vacuum is established, closing the valve and filling the chamber with oil at least to the juncture of the first reduced diameter portion of the inlet bore and the enlarged diameter portion of the inlet bore,

forcing a ball smaller than the enlarged diameter portion and larger than the first reduced diameter into said first reduced diameter portion until the ball rests against the second further reduced diameter portion with the volume of oil pushed into the closed chamber being predetermined to be equal to said selected volume so that when the preload is removed, the diaphragm will be at its relaxed state, and removing the preload pressure.

2. A pressure transducer comprising

a closed chamber having a diaphragm defining one side,

a pressure sensor mounted within said closed chamber with a space separating the pressure sensor and said diaphragm,

an inlet bore communicating with said closed chamber including

an outer enlarged diameter portion, a first reduced diameter portion extending a selected distance inwardly from said enlarged diameter portion towards said closed chamber terminating at a second further reduced diameter portion,

a ball wedged into said first reduced diameter portion against said second further reduced diameter portion, and

a non-compressible liquid filling
said closed chamber,

said diaphragm being in the relaxed state.

- 5 3. A pressure transducer according to claim 2,
further comprising support cup means including a flat
base, said support cup means being mounted within
said closed chamber with said flat base parallel to
and selectively spaced from said diaphragm.

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4. A pressure transducer according to claim 3,
further comprising pressure supply path means for
delivering fluid pressure from a hole in a
15 pressurized pipe to said diaphragm including

a piercing needle,

support means for supporting said piercing
needle for displacement into a pipe to pierce the
pipe, and

- 20 bore means extending from a first location
surrounding the piercing needle to a second location
communicating with said diaphragm.