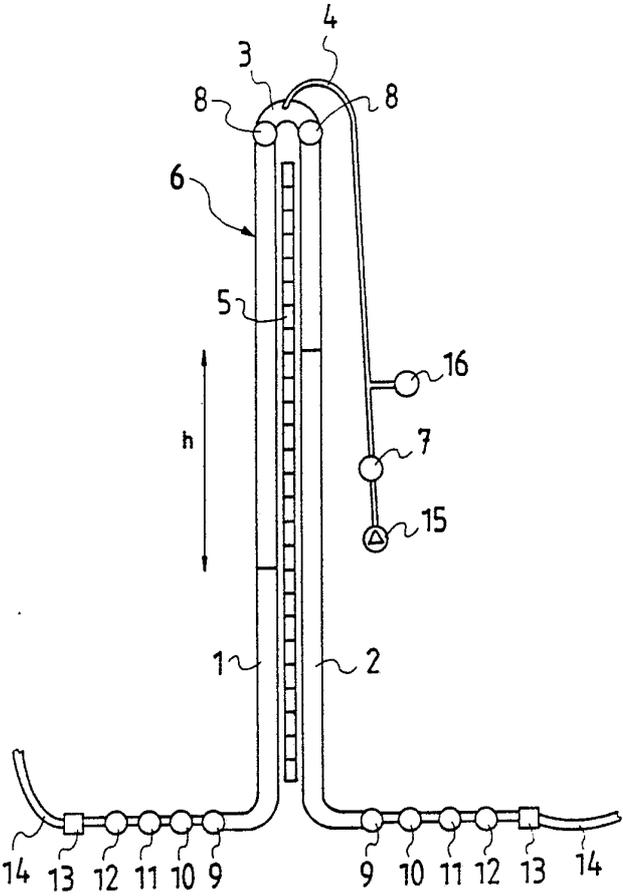




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<p>(21) International Application Number: PCT/FI89/00005 (22) International Filing Date: 6 January 1989 (06.01.89) (31) Priority Application Number: 880046 (32) Priority Date: 6 January 1988 (06.01.88) (33) Priority Country: FI</p> <p>(71) Applicant (for all designated States except US): VALTION TEKNILLINEN TUTKIMUSKESKUS [FI/FI]; Vuorimiehentie 5, SF-02150 Espoo (FI). (72) Inventors; and (75) Inventors/Applicants (for US only) : SAARIKOSKI, Kari [FI/FI]; SALO, Markku [FI/FI]; VTT, Geotekniikan laboratorio, Betonimiehenkuja, SF-02150 Espoo (FI). (74) Agent: PAPULA REIN LAHTELA OY; P.O. Box 981, Kansakoulukatu 5A, SF-00101 Helsinki (FI).</p>		<p>(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), DK, FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), NO, SE (European patent), US.</p> <p>Published <i>With international search report.</i> <i>In English translation (filed in Finnish).</i></p>
<p>(54) Title: DIFFERENTIAL PRESSURE METER</p> <p>(57) Abstract</p> <p>The present invention concerns a differential pressure meter for measuring differential pressure between two different points. As taught by the invention, the meter comprises two vertical, substantially transparent tubes (1, 2), said tubes being connected at the lower ends with the pressure measuring points, and a connecting member (3) connecting the tubes at their upper ends, said connecting member being provided with a duct (4) for introducing pressurized gas in the volume defined by the upper ends of the tubes and the connecting member.</p> 		

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DIFFERENTIAL PRESSURE METER

5 The present invention concerns a differential pressure meter for measuring differential pressure between two different points, to be used for instance in water mains systems or in equivalent systems where differential pressures occur.

10 Differential pressures in water mains systems arise from natural flow resistance, various leakages in the pipe system and blockages which may occur therein. However, these differential pressures are normally relatively small in comparison with the pressure prevailing
15 in the pipe system, and therefore their accurate measuring and inferences to be drawn on the basis of the measurements tend to present difficulties. Nowadays, differential pressures are mainly measured with separate meters located at different points, with the consequence that continuous changes of flow and pressure
20 surges of various magnitudes occurring rather frequently in the flow will interfere with the measurement to such extent that comparison of pressure values recorded at individual measuring points yield virtually no relevant differential pressure information whatsoever. A
25 device illustrating the state of art is disclosed in the patent application DE 585 548.

30 The object of the present invention is to eliminate the above drawbacks. In particular, the aim of the invention is to introduce a novel differential pressure meter, with the aid of which the differential pressures between two different points in water mains or equivalent networks located at a distance from each other
35 can be measured accurately and reliably.

Regarding the characteristic features of the invention, reference is made to the claims section.

The differential pressure meter of the invention comprises two vertical, substantially transparent tubes, the lower end of one tube being connected to one pressure measuring point and the lower end of the other tube being connected to the other pressure measuring point, by means of suitable pipes, tubing or equivalent, and a connecting member connecting the pipes at their upper parts so that they form a pressure-sealed space. As taught by the invention, the connecting member furthermore comprises a duct through which gas can be introduced in said pressure-sealed space in order to raise the pressure in said space to desired level.

Advantageously, a graduation is provided adjacent to the transparent vertical portion of the tubes, either on the tubes themselves or close to them, from which the differential pressures can be read.

In an advantageous embodiment of the invention, the tubes and the connecting member consist of a unitary inverted U-tube, with said duct connected to the curved upper part of the tube.

Advantageously, the duct is connected to a pump, and said duct furthermore includes a venting valve and a shut-off valve. The ends of both tubes also advantageously include on either side of the duct, shut-off valves on equal level so that the tubes can be closed off and separated tightly against pressure.

Advantageously, the lower ends of the tubes, which have a height greater than 1 m, e.g. 1.5 to 3 m, advantageously about 2 m, are provided with appropriate valves for accomplishing various functions. Such valves may be e.g. draining valves, shut-off valves, nozzle valves and venting valves. A draining valve may then be used to empty the water from the instrument, a shut-off

valve to shut off the flow in the tube, a nozzle valve
to damp out abrupt pressure fluctuations and pressure
surges, and a venting valve can be used to remove from
the system any extra air that may interfere with the
5 measurement.

In the differential pressure measuring system of the
invention two vertical, substantially transparent
tubes are used, the lower end of one of them being con-
10 nected to one pressure measuring point and the lower
end of the other being connected to the other pressure
measuring point. In addition, the tubes are intercon-
nected at their upper parts by means of a connecting
member. As taught by the invention, in the volume de-
15 fined by the upper ends of the tubes and the connecting
member is produced a counter-pressure acting against
the pressures being measured, whereby the differential
pressure can be measured by the surface heights in the
tubes.

20 An advantage of the invention over prior art is that it
is possible with the means to measure accurately dif-
ferential pressures e.g. between hydrants located sev-
eral hundred meters apart without incurring interfer-
25 ence from changes of flow or pressure surges occurring
in the pipe systems. Reliable information on the pipe
system that is being measured is thus gained, and the
condition of the pipe system can be efficiently moni-
tored on the basis of this information.

30 The invention is described in detail in the following,
reference being made to the drawing attached, in which
a differential pressure meter conforming to the inven-
tion is described in exemplary manner, without in any
35 way restricting the invention.

A differential pressure meter according to the inven-

tion, depicted in the drawing, comprises two transparent, vertical tubes 1 and 2, interconnected at their upper ends by means of a curved, tubular connecting member 3, in other words, the tubes together with the connecting member constituting an inverted U-tube 6. Between the tubes 1 and 2 is provided a graduation 5, extending substantially over their entire length, and at the upper end of the tubes on equal levels and before the connecting member are provided shut-off valves 8, with which the tubes can be shut off and isolated from each other with pressure-tight sealing. The connecting member 3 comprises a duct 4, which is through a shut-off valve 7 connected with an air pump 15, and this duct furthermore comprises a venting valve 16.

The lower ends of both tubes are provided with tube connectors 13, to which tubing or equivalent 14 can be connected, with which the measuring instrument is connected with the desired measuring points. In addition, in the present embodiment the lower ends of both tubes are provided with four separate valves: a draining valve 9, a shut-off valve 10, a nozzle valve 11 and a venting valve 12.

The differential pressure meter of the invention operates as follows. The pressures in pipe systems of this kind usually amount to several bar, while the differential pressures are only on the order of a few per cent thereof. Thus, the basic idea of the invention is that a counter-pressure is established to the pressures which are being measured and only the differential pressures between the points of measurement are studied, paying no heed to the absolute pressure heights. Therefore, when there is sufficient flow at the points being measured so that a differential pressure is established, water flows through the tubing 14 into the tubes 1 and 2. While the shut-off valves 8 are open.

the volume defined by the tubes 1 and 2 is confluent and equal pressure prevails in both, and this pressure is augmented with a pump 15, or alternatively the pressure is lowered by means of the venting valve 16, so
5 that the surfaces of the water columns in the tubes become visible in the vertical parts of the tubes, opposite to the graduation 5. The true differential pressure h between the two points of measurement is then directly readable on the centimetre graduation.

10

If, however, the differential pressure is of such height that the length of the tubes 1 and 2 does not suffice for displaying this differential pressure, a more approximative measurement can be accomplished by
15 setting with the aid of the valves the water level in both tubes to be at the same, relatively low level and closing the shut-off valves 8. When thereafter pressure is admitted into the tubes 1 and 2 through their lower ends, the water levels will ascend towards the shut-off
20 valves 8, and the pressures can be calculated with fairly good accuracy, using the formula $p * V = \text{Const.}$

CLAIMS

1. A differential pressure meter, e.g. in a water mains system, for measuring differential pressure between two different points, said meter comprising two vertical, substantially transparent tubes (1,2), the lower end of one tube (1) being connected with one pressure measuring point and the lower end of the other tube (2) being connected with the other measuring point, and a connecting member (3) which connects the tubes with each other at their upper ends, characterized in that the connecting member (3) comprises a duct (4) for introducing pressurized gas in the space defined by the upper ends of the tubes and the connecting member.
2. Differential pressure meter according to claim 1, characterized in that adjacent to the transparent part of the tubes (1,2) is provided a graduation (5) for reading the differential pressure.
3. Differential pressure meter according to claim 1 or 2, characterized in that the tubes (1,2) and the connecting member (3) constitute a unitary inverted U-tube (6).
4. Differential pressure meter according to any one of claims 1 to 3, characterized in that the duct (4) of the connecting member (3) comprises a shut-off valve (7).
5. Differential pressure meter according to any one of claims 1 to 4, characterized in that the upper ends of both tubes (1,2) are provided with shut-off valves (8) on identical heights.
6. Differential pressure meter according to any one of

claims 1 to 5, characterized in that the lower end of at least one tube is provided with a draining valve (9), a shut-off valve (10), a nozzle valve (11) and/or a venting valve (12).

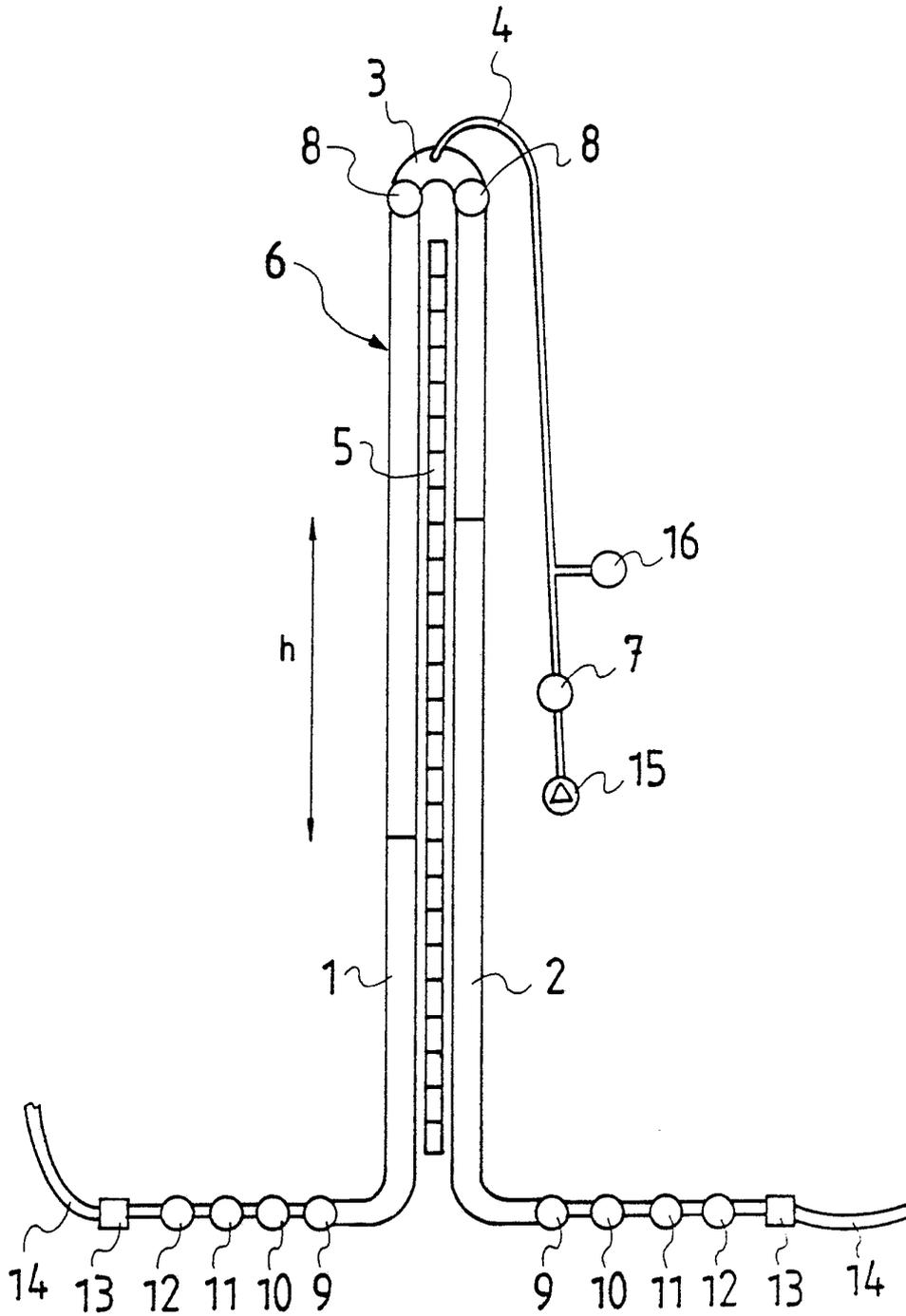
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7. Differential pressure meter according to any one of claims 1 to 6, characterized in that the height of the tubes is over 1 m, e.g. 1.5 to 3 m, preferably about 2 m.

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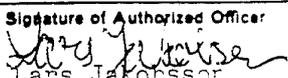
8. A procedure for measuring differential pressure between two points, e.g. in a water mains system, in said procedure being used two vertical, substantially transparent tubes (1,2), the lower end of one tube being connected with one pressure measuring point and the lower end of the other with another pressure measuring point, and said tubes being interconnected at their upper ends with a connecting means (3), characterized in that, in the procedure, in the volume defined by the upper ends of the tubes (1,2) and the connecting member (3) is established a counter-pressure, whereby the differential pressure can be measured by the liquid levels in the tubes.

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INTERNATIONAL SEARCH REPORT

International Application No PCT/EP89 00005

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC →		
G 01 L 7/18		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System :	Classification Symbols	
IPC 4	G 01 L 7/00, 7/18-7/24, 13/04, 19/06	
US C1	73:700, 747-750	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
SE, NO, DK, FI classes as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category ¹⁰ :	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No ¹³
Y	DE, A, 585 548 (GESELLSCHAFT FÜR LINDE'S EISMASCHINEN A-G IN WIESBADEN) 5 October 1933 See the whole document.	1-8
Y	GB, A, 1 346 432 (M.H.GLASSPOOL) 13 February 1974 See the whole document.	1-8
A	US, A, 2 300 327 (W.M.WHITE) 27 October 1942	1, 8
A	US, A, 1 499 759 (H.BACHARACH) 1 July 1924	1, 8
A	US, A, 949 598 (B.J.P.ROBERTS) 15 February 1910	1, 8
<p>* Special categories of cited documents: ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
1989-04-03	1989-04-05	
International Searching Authority	Signature of Authorized Officer	
Swedish Patent Office	 Lars Jakobsson	