PATENT SPECIFICATION (11) 1 499 100

1 499 100

(21) Application No. 50995/73 (22) Filed 2 Nov. 1973 (19)

(23) Complete Specification filed 27 Jan. 1975

(44) Complete Specification published 25 Jan. 1978

(51) INT. CL.² G01L 19/06

(52) Index at acceptance
G1L 3L 3U3 3W

(72) Inventor ALAN STUART LEE

(54) MEASURING FLUID PRESSURE

(71) We, THE ENGLISH ELECTRIC COMPANY LIMITED, of 1 Stanhope Gate, London, W1A 1EH, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method and apparatus for measuring, occasionally, the pressure of a fluid having characteristics which make it unsuitable for connection directly to a pressure gauge which is to be employed. The invention is suited in particular to the occasional measurement of the pressure of a supply of molten sodium to a sodium-lubricated bearing of a pump which pumps sodium from a reservoir to (inter alia) the bearing via a filter, the sodium reservoir being contained in a closed vessel which also contains an inert blanket gas layer, such as argon, above the sodium.

According to the invention there is provided fluid pressure measuring apparatus comprising a pressure-balancing device having a first inlet for admission of a first fluid whose pressure is to be measured, a second inlet connected to a pressure gauge and, through a closable valve, to a source of balancing fluid at a pressure greater than the pressure which is to be measured, and an outlet, the pressure balancing means comprising a cylinder and a free piston having opposed first and second piston elements which are interconnected by a reduced-section stem of the piston and are slideable together in the cylinder, the cylinder being provided with the first and second inlets positioned to give fluid access to the first and second piston elements respectively and with the outlet positioned to allow fluid exhaust from between the two piston elements, and the fit of at least the second piston element in the cylinder being such as to allow slow leakage of fluid from the second inlet to the outlet.

In making full use of the capabilities of such apparatus, the first inlet thereof is connected to admit a said first fluid having characteristics which make it unsuitable for connection directly to the pressure gauge.

The invention further provides a method of measuring the pressure of a fluid contained in containment means having connected thereto the said first inlet of pressure measuring apparatus as set forth above, the method comprising the steps of opening the said closable valve of said apparatus and thereby subjecting the said second piston element thereof to the pressure of the said balancing fluid, waiting until the pressure gauge indicates a steady pressure value, closing the closable valve, monitoring the pressure gauge as the pressure indicated thereby falls, and noting a value at which, temporarily, the indicated pressure remains stationary before resuming its fall.

An example of the method according to the invention, and an embodiment of apparatus for carrying it into effect, are described below with reference to the accompanying drawings, in which:—

Figure 1 is a schematic view of apparatus according to the invention, associated with a reservoir of molten sodium and a conduit conveying a flow of such sodium under pressure;

Figure 2 is a sectional view, on a larger scale, of one element of the apparatus shown in Figure 1; and

Figure 3 is a graph showing, as a function of time, the pressure reading shown by a pressure gauge comprised by the apparatus shown in Figure 1, while carrying out the method of the invention.

Figure 1 shows part of a vessel 11 containing a reservoir of molten sodium 12 above whose surface is provided an inert atmosphere 13 of a blanket gas such as argon. Immersed in the sodium 12 is a pump (not shown) which pumps sodium from the reservoir, a part of the pumped sodium being returned, after passing through a filter 14, through a conduit 15 to a sodium-lubricated bearing (not shown) of the pump. The sodium thus fed to the bearing escapes from the bearing to return to the reservoir; and the remaining, major, part of the output

of the pump may, for example, be fed as coolant to the core of a sodium-cooled nuclear reactor and then pass through heat exchangers before returning, likewise, to the reservoir.

It is required to be able to make occasional readings of the sodium pressure in the conduit 15, as a check that the supply of sodium to the pump bearing is adequate and is not impaired by, for example, a blockage in the filter 14. However, the temperature of the sodium is such that the sodium cannot satisfactorily be applied directly to a pressure gauge 16 which is provided outside the vessel 11, where it is not subjected to elevated temperatures. To enable the necessary checks to be made, there is provided, in the illustrated embodiment of the invention, apparatus which includes the pressure gauge 16 and, further, a pressure-balancing device 17 (shown in Figure 1 and in greater detail in Figure 2) having an inlet 18 connected to the conduit 15 and having a second inlet 19, and a supply 20 of gas under pressure which is connected to the inlet 19 through a pressure-reducing valve 21 and a shut-off valve 22 in series therewith in a conduit 23 which extends through the wall of the vessel 11 and to which the pressure gauge 16 is connected outside the vessel 11. The pressure-balancing device 17, which is disposed in the atmosphere 13, within the vessel 11 and close to the sodium 12 so that it is at a temperature at which sodium is molten, comprises a cylinder 24 having vents 25 and closed at its ends by bored bosses 26 and 27 whose bores constitute the inlets 18 and 19 respectively. Within the cylinder 24 is a free piston 28 having upper and lower piston elements 28A and 28B which are close sliding fits in the cylinder and are joined by a reduced-section stem 28C. The piston elements 28A and 28B are formed with balancing grooves 29 to prevent the occurrence the pressure which is to be measured, and of hydraulic locking forces.

As already described, the inlet 18 is connected to the conduit 15, and the lower face of the piston element 28B is accordingly subjected to the sodium pressure which is to be measured. The inlet 19 is connected to the conduit 23 but, with the shut-off valve 22 closed, as it normally is, gas leakage past the piston element 28A results in the sodium pressure in the inlet 18 holding the piston 28 normally in a raised position in which it abuts the boss 27, which serves as a stop.

In order to make a measurement of the sodium pressure in the inlet 18 (and thus in the conduit 15), the normally closed shut-off valve 22 is opened and gas from the supply 20, at a pressure which is reduced by the valve 21 but which is nevertheless arranged to be higher than the sodium pressure to be measured, is admitted to the inlet 19 so as to force the piston 28 downwardly until it abuts against the boss 26 (which also acts as a stop for the piston). Throughout the whole permitted movement of the piston 28, an annular space 30 between the stem 28C and the cylinder 24 remains in communication with the vents 25; and gas or liquid sodium leaking past the piston elements 28A or 28B respectively are free to escape through the vents 25 into the atmosphere 13 and (in the case of the sodium) back into the reservoir 12. For this reason, the gas supply 20 is a supply of the same gas which composes the atmosphere 13. The sodium reaching the inlet 18 has passed through the filter 14 and requires no further filtering; but preferably a filter 31 is provided in the inlet 19.

Once the piston 28 has been depressed by the gas admitted to the inlet 19, the shut-off valve 22 is closed again; and continued gas leakage past the piston element 28A allows the piston 28 to rise gradually and resume its initiated position in abutment against the boss 27.

The gas pressure P within the conduit 23 (and indicated by the pressure gauge 16) varies, during the above-described excursion, in the manner shown diagrammatically in Figure 3. Before the valve 22 is opened, P has a value Pa, the pressure of the atmosphere 13, due to pressure-equalisation by leakage past the piston element 28A. On opening of the valve 22 at a time To, the pressure P begins to rise steeply and continues to rise with a slight pause, while the piston 28 moves downwardly, at a pressure slightly in excess of the sodium pressure Ps) until it reaches a value Pv which is the pressure determined by the pressure reducing valve 21. The pressure P then remains at the value Pv until, at a time Tc, the valve 22 is closed again, whereupon P begins to fall slowly, due to leakage past the piston element 28A, until it has dropped to the value Ps. Continued gas leakage then allows the piston 28 to rise again, and during the time interval dT while this is occurring the pressure P remains at the value Ps. Once the piston 28 has reached its uppermost position (thus defining the end of the interval dT), continued gas leakage allows the pressure P to continue falling until it finally reaches, once again, the initial value Pa. The varying pressure P is continuously indicated by the pressure gauge 16 which thus, during the interval dT, indicates the sodium pressure Ps which it is required to measure.

With practical manufacturing techniques and working clearances, the interval dT during which the pressure gauge gives a stationary indication, which can thus be recognised and read as the desired indication of the

sodium pressure Ps, can easily be made as long as 10 seconds or more when the value of Ps is in the region of 100 lbs. per square inch.

It will be appreciated that, in the foregoing description with reference to Figure 3, the weight of the piston 28 has been ignored and that the actual pressure of the sodium is greater than the indication given by the pressure gauge 16 by an amount dP, where dP.A=W, W and A being respectively the weight of the piston and area of the bottom face of the lower piston element 28B. It will be appreciated also that the pressure to be measured must be greater than W/A, since otherwise it would not suffice to raise the piston from its lowermost position.

It will be seen that the method according to the invention consists essentially, in this example of its use, in balancing (during the interval dT) the pressure of the hot fluid, which is to be measured, against the pressure of a fluid at lower temperature, and measuring the pressure of the lower-temperature fluid at a convenient location where the measurement can be made with a pressure gauge which could not satisfactorily be subjected to the higher temperature of the hot fluid. The described apparatus by which the pressure balancing is effected, in particular the device 17 comprised thereby, is such that a failure in the supply of the low temperature fluid cannot result in a high-velocity leak of the hot fluid, since the two fluids are separated by the piston 28 and the movement of this piston is limited.

It will be understood that the apparatus provided according to the invention may incorporate modifications of that described above. For example, a scaling factor may be introduced by providing the cylinder 24 with a stepped bore and the piston elements 28A and 28B with correspondingly different cross-sectional areas.

It will also be understood that, although the pressure-measuring apparatus of the invention has been described above in association with a coolant pump of a nuclear reactor which is sodium-cooled, it may with equal advantage be similarly employed in a case where the coolant is some other fluid at elevated temperature, such as another molten metal or alloy.

WHAT WE CLAIM IS:—

1. Fluid pressure measuring apparatus comprising a pressure-balancing device having a first inlet for admission of a first fluid whose pressure is to be measured, a second inlet connected to a pressure gauge and, through a closable valve, to a source of balancing fluid at a pressure greater than an outlet, the pressure balancing means comprising a cylinder and a free piston having opposed first and second piston elements which are interconnected by a reduced-section stem of the piston and are slideable together in the cylinder, the cylinder being provided with the first and second inlets positioned to give fluid access to the first and second piston elements respectively and with the outlet positioned to allow fluid exhaust from between the two piston elements, and the fit of at least the second piston element in the cylinder being such as to allow slow leakage of fluid from the second inlet to the outlet.

2. Fluid pressure measuring apparatus as claimed in claim 1, wherein the first inlet is connected to admit a said first fluid having characteristics which make it unsuitable for connection directly to the pressure gauge.

3. Fluid pressure measuring apparatus as claimed in claim 2 in combination with a pump arranged to pump a liquid at high temperature and to lubricate a bearing of the pump with a portion of the pumped liquid, wherein the first inlet is connected to a conduit through which the said portion of the pumped liquid is supplied to the bearing.

4. Fluid pressure measuring apparatus in combination with a pump, as claimed in claim 3, wherein the liquid which the pump is arranged to pump is molten metal or alloy and the pressure-balancing means is maintained at a temperature above the melting point thereof and the pressure gauge is at a lower temperature than the pressure-balancing means.

5. Fluid pressure measuring means in combination with a pump, as claimed in claim 4, wherein the pressure balancing means is located adjacent a reservoir of the molten metal or alloy, from which reservoir the pump is supplied, and the pressure gauge is located remote therefrom.

6. Fluid pressure measuring apparatus in combination with a pump, as claimed in any of claims 3 to 5, wherein the pump is a coolant-liquid circulating pump of a liquid-metal-cooled nuclear reactor.

7. Fluid pressure measuring apparatus, or a combination of fluid pressure measuring apparatus and a pump, substantially as described herein with reference to, and as shown in, Figures 1 and 2 of the accompanying drawing.

8. A method of measuring the pressure of a fluid contained in containment means having connected thereto the said first inlet of fluid pressure measuring apparatus as claimed in any of claims 1 to 7, comprising the steps of opening the said closable valve of said apparatus and thereby subjecting the said second piston element thereof to the pressure of the said balancing fluid, waiting until the pressure gauge indicates a steady pressure value, closing the closable valve,

monitoring the pressure gauge as the pressure indicated thereby falls, and noting a value at which, temporarily, the indicated pressure remains stationary before resuming its fall.

9. A method of measuring the pressure of a fluid, substantially as described herein.

For the Applicants,
J. S. GASKIN,
Chartered Patent Agent.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1978.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.

1499100 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

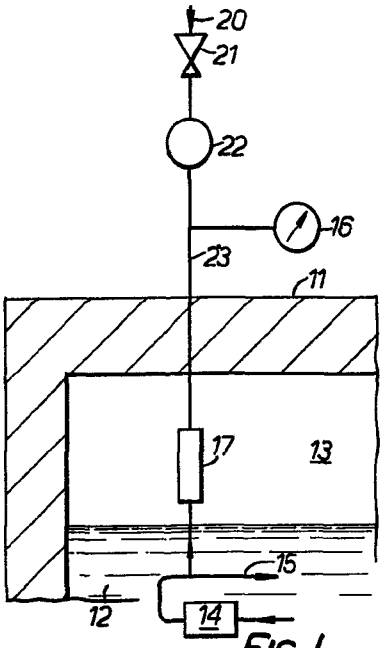

FIG. 1.

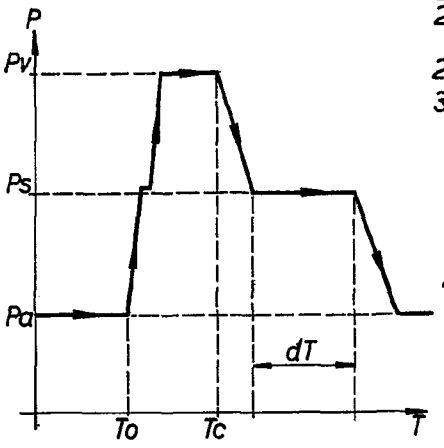

FIG. 3.

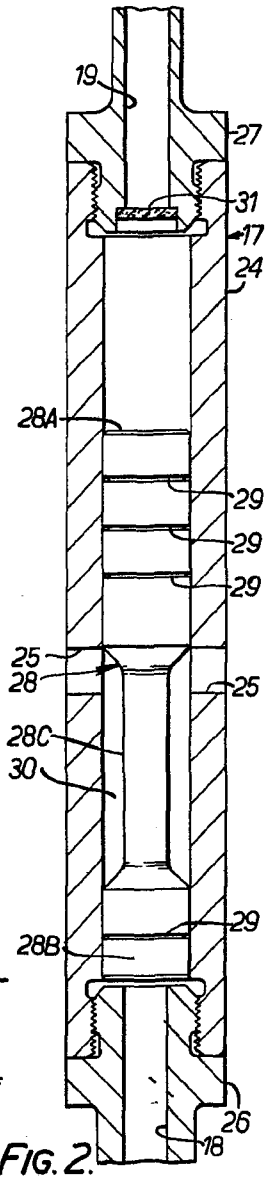

FIG. 2.