June 20, 1967 G. C. BENSON ETAL 3,326,048

MANOMETER

Filed May 14, 1965

Fig-2

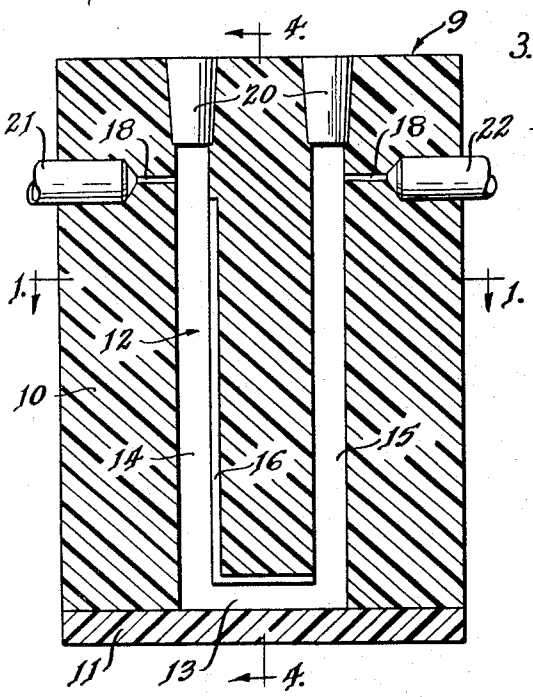


Fig-1

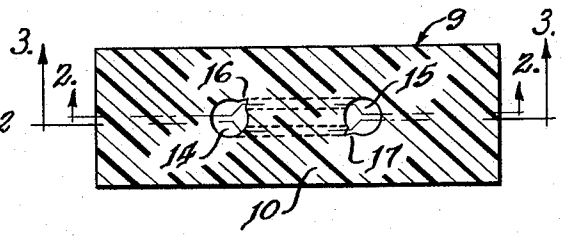


Fig-4

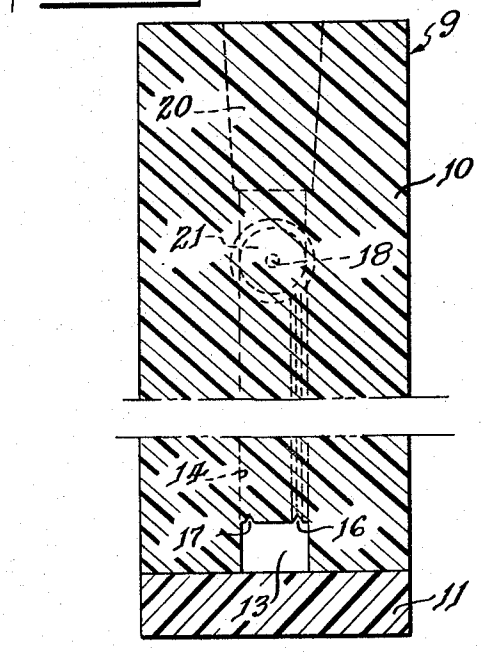


Fig-3

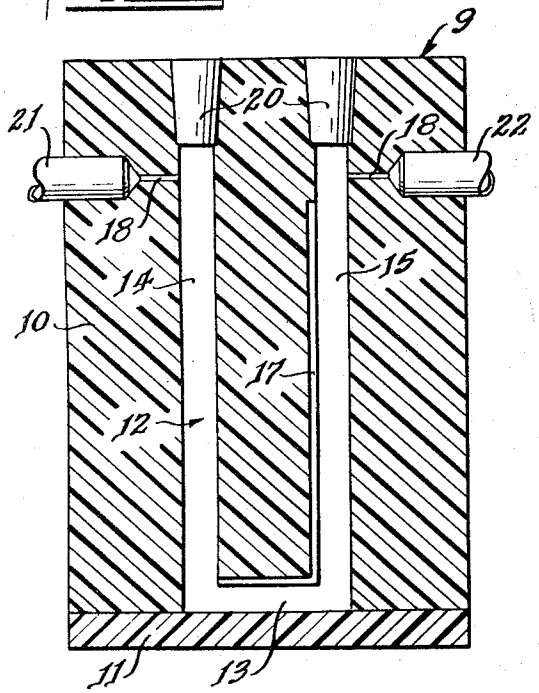
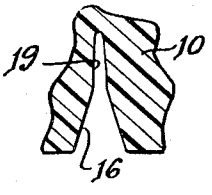


Fig-5



INVENTORS
George C. Benson
John E. Allen

BY

Attorney

United States Patent Office 3,326,048 Patented June 20, 1967

3,326,048

MANOMETER

George C. Benson, Ann Arbor, and John E. Allen, Ypsilanti, Mich., assignors to the United States of America as represented by the United States Atomic Energy Commission

Filed May 14, 1965, Ser. No. 456,014
6 Claims. (Cl. 73—401)

ABSTRACT OF THE DISCLOSURE

A manometer with a U-shaped mercury chamber provided with two separate grooves enabling the manometer to sense small pressure differences while withstanding large pressure differences. The grooves are never completely filled with mercury and so form paths for escape of gas from one side of the manometer to the other. Restricted openings leading to the manometer assure that gas thus escaping will stay in the grooves and not bubble through the mercury, even though the manometer is subjected to large differences in gas pressures.

CONTRACTUAL ORIGIN OF THE INVENTION

The invention described herein was made in the course of, or under, a contract with the U.S. Atomic Energy Commission.

This invention relates to a device that senses small differences in gas pressure and yet can withstand large differences in pressure.

Theoretically a manometer with a very long U-column of mercury is capable of sensing small pressure differences and withstanding large pressure differences. Such a manometer has the theoretical and practical drawback of large size because of the large amount of mercury and also the practical drawback that large pressure differences may force mercury into the gas system.

We have invented a manometer that avoids the above drawbacks of large size and the likelihood of introducing mercury into the gas system and can still sense small pressure differences while withstanding large differences.

According to the present invention, the U-shaped chamber of the manometer of the present invention is provided with two grooves that are never completely filled with mercury and so form paths for escape of gas from one side of the manometer to the other. Restricted openings leading to the manometer assure that gas thus escaping will stay in the grooves and thus not bubble through the mercury, even though the manometer is subjected to large differences in gas pressures.

In the drawings:

FIG. 1 is a horizontal sectional view of the manometer of the present invention taken on the line 1—1 of FIG. 2;

FIG. 2 is a vertical sectional view of the manometer taken on the line 2—2 of FIG. 1 and showing one of two grooves of the present invention;

FIG. 3 is a vertical sectional view of the manometer taken on the line 3—3 of FIG. 1 and showing the other of the two grooves;

FIG. 4 is a vertical sectional view taken on the line 4—4 of FIG. 2; and

FIG. 5 is an enlarged fragmentary sectional view showing one of the grooves.

As shown in FIGS. 2, 3, and 4, a mercury manometer 9 of the present invention is a housing that is formed of a transparent block 10 and a bottom plate 11 attached thereto and has a U-shaped chamber 12. The U of the chamber 12 has a horizontal base 13 and vertical legs 14 and 15 extending upward from the ends of the base.

According to the present invention, two separate grooves

16 and 17 extend along portions of the chamber 12, and restricted openings 18 are connected with the upper ends of the legs 14 and 15 of the chamber 12. As shown in FIG. 2, the groove 16 extends in an interior wall along the complete length of the top of the base 13 of hole 12 and only along the leg 14. The groove 16 extends to the leg 15 but not along it. As shown in FIG. 3, the groove 17 extends in an interior wall along the complete length of the top of the base 13 of hole 12 and only along the leg 15. The groove 17 extends to the leg 14, but not along it. As shown in FIG. 4, the portions of the grooves 16 and 17 in the base 13 of the chamber 12 are spaced from one another, and the base 13 is, in cross section, shaped like a rectangle the top side of which is horizontal and contains the grooves 16 and 17.

The block 10 and bottom plate 11 are made of a plastic such as polystyrene, because it is not wetted by the mercury in the chamber 12 and the levels of the mercury in the legs 14 and 15 can be observed. Glass would also be a suitable material for the block 10 and plate 11 except that there may be some difficulty in forming the grooves 16 and 17 in glass. The block 10 is drilled to form the legs 14 and 15 of the chamber 12, which legs are circular in section because of the drilling. The material of the block 10 at the bottom between the legs 14 and 15 is milled out to form the base 13 of the chamber 12. The grooves 16 and 17 are cut in the legs 14 and 15 and base 13. After cleaning of the base 13, legs 14 and 15, and grooves 16 and 17 with cloth swabs, a continuous needle-point scratch 19 is made at the point of the V of each of the grooves, which scratch is about half the depth of the groove, as shown in FIG. 5. After a final cleaning operation, the bottom plate 11 is glued on the block 10 so as to close the chamber 12 at the bottom of its base 13. Now mercury is poured into the block through the tops of the legs 14 and 15 to a suitable level, which may, for example, lie at about one third of the distance from the top of the base 13 to the restricted openings 18. The upper ends of the legs 14 and 15 are sealed shut by plugs 20 inserted in the legs.

In operation, the manometer 9 is used to compare the gas pressures existing in lines 21 and 22 which are connected to the legs 14 and 15, respectively, at the restricted openings 18. The difference in gas pressures can be read off from markinggs (not shown) on the block 10 at the legs 14 and 15 at which markings the mercury levels lie. If the pressure in line 21 is higher than that in line 22, the mercury level in leg 14 will be lower than that in leg 15, and the difference in mercury levels can be read off as a gas-pressure difference if the block 10 is suitably marked. If the pressure in line 21 is lower than that in line 22, the mercury level in leg 14 will be higher than that in leg 15.

The present manometer 9 operates with a relatively small amount of mercury, because the length of the legs 14 and 15 is only a few inches. Yet the grooves 16 and 17 and the restricted openings 18 allow the manometer to be sensitive to small pressure difference in the lines 21 and 22 without the danger that large pressure differences will force mercury into the gas system to which the lines 21 and 22 belong. The greater the difference in gas pressure in lines 21 and 22, the lower the mercury level in one of legs 14 and 15, and the higher the mercury level in the other of the legs. If, for example, the mercury level in leg 14 is forced down to the base 13, gas from leg 14 will escape through groove 17 in the base 13 and leg 15 without bubbling through the mercury in the base 13 and leg 15, because the groove 17 is never completely filled with mercury because of the inability of the mercury to wet the material of the block 10. Since the gas bypasses the mercury and does not bubble through it, there is no

likelihood that the mercury will be carried up into the line **22**. The gas may escape from leg **14** at a relatively great rate because of its pressure without bubbling through the mercury, because the pressure of the gas will simply force mercury out of the channel **17** and increase the space therein accommodating gas flow. As the mercury level in leg **14** is being forced down to the base **13** of the opening **12**, gas does not escape by way of the groove **16** to bubble through the leg **15**, because the increase in gas pressure resulting in lowering of the mercury level in leg **14** will cause the gas in groove **16** to expel mercury from the groove without bubbling through the mercury. In other words, more of the groove **16** will be occupied by gas. Conversely, if the mercury level in leg **15** is forced down to the base **13**, gas from the leg **15** will escape through groove **17** in the base **13** and leg **14** without bubbling through the mercury in the base **13** and leg **14**. As the mercury level in leg **15** is being lowered, gas does not escape by way of groove **17** to bubble through leg **14**. Instead, more of the groove **17** is occupied by gas, and less, by mercury without escape of gas from the groove **17**.

The restricted openings **18** through which the lines **21** and **22** are connected to the upper ends of the legs **14** and **15** of the chamber **12** make the manometer **9** insensitive to pressure differences of short duration. Moreover, the restricted openings **18** prevent a large pressure difference of appreciable duration from being applied rapidly and thus assure that the gas in the grooves **16** and **17** will do no more than take up more room quietly and gradually expel the mercury from the grooves. Without the restricted openings, a large pressure difference might well make the gas escape laterally of the grooves **16** and **17** in bubbles. The grooves **16** and **17** make it possible for gas to escape from one of the legs **14** and **15** to the other by way of the grooves without bubbling through the mercury. The restricted openings **18** assure that the escaping gas once in the grooves will not escape by bubbling. Thus in a very real sense the restricted openings **18** cooperate with the grooves **16** and **17**.

An example of the manometer **9** that has successfully operated had the legs **14** and **15** with a diameter of ¼", a length of 3" from the top of the base **13** to the restricted openings **18**, and a center-to-center spacing of 1"; the base **13** of the hole **12** with a height of 3/16" and a width

of ¼"; each of the grooves **16** and **17** with a width of .020", a height of .030" to the point of the V, and a depth of 1/64" for the needlepoint scratch **19**; and a depth of mercury of 1" in each of the legs **14** and **15** measured from the bottom of the base **13**. The restrictions **18** were provided by external, adjustable restrictors attached at **21** and **22** rather than by the holes **18**, which only illustrate their function.

It is understood that the invention is not to be limited by the details given herein but that it may be modified within the scope of the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A mercury manometer housing defining a chamber shaped like a U of which the base is horizontal and the legs extend upward from the ends of the base, the chamber having a first groove in an interior wall extending along the entire length of the top of the base of the chamber and from the base along only one of the legs of the chamber, the chamber also having a second groove in an interior wall completely separate from the first groove and extending along the entire length of the top of the base of the chamber in spaced relation to the first groove and from the base along only the other of the legs of the chamber.

2. The manometer specified in claim **1** and further having restricted passages connected with the upper ends of the legs of the chamber.

3. The manometer specified in claim **1** and being formed of a material not wetted by mercury, the grooves being V-shaped.

4. The manometer specified in claim **3** and further having restricted passages connected with the upper ends of the legs of the chamber.

5. The manometer specified in claim **4**, each groove having a deep scratch running along the point of the V.

6. The manometer specified in claim **4** and being formed of a plastic.

No references cited.

LOUIS R. PRINCE, *Primary Examiner.*

D. O. WOODIEL, *Examiner.*