March 28, 1961 T. A. ST. CLAIR ET AL 2,976,726

GAS IMPERVIOUS DIAPHRAGM

Filed Aug. 13, 1959 2 Sheets-Sheet 1

Fig. 2

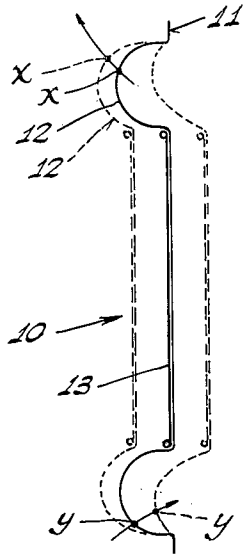



Fig. 1

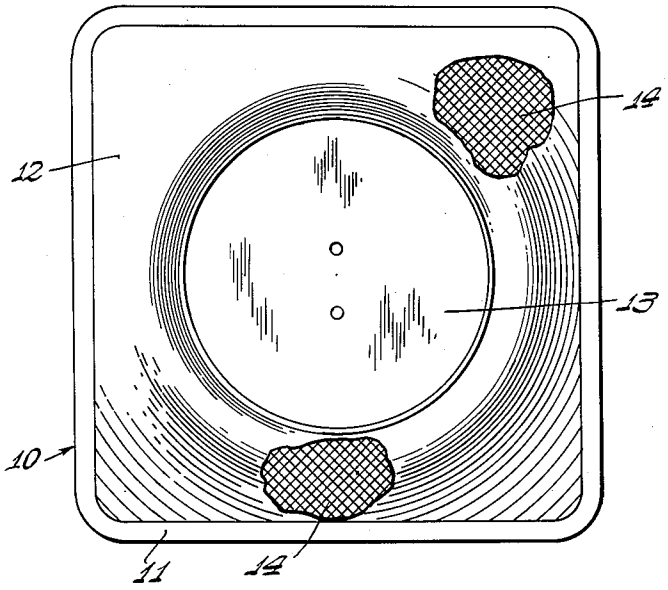



Fig. 4

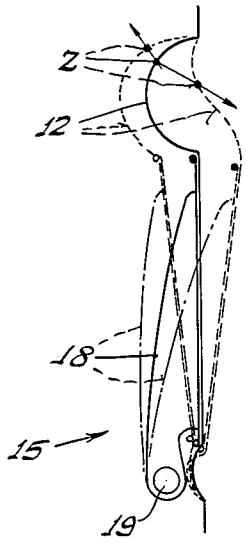
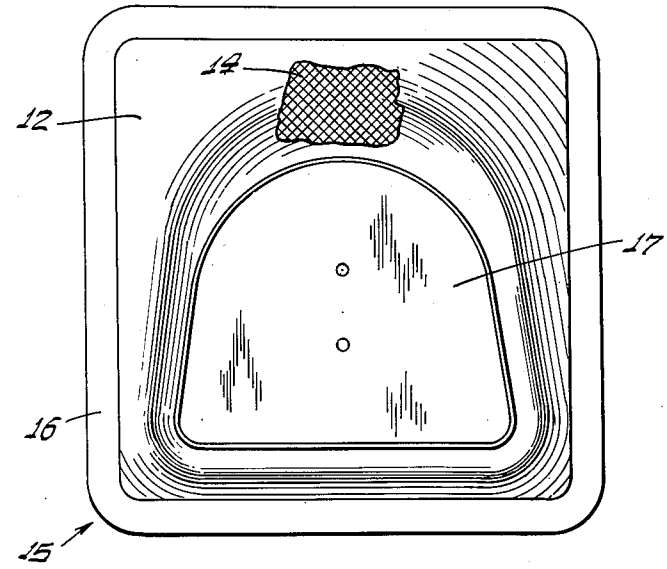



Fig. 3




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March 28, 1961 T. A. ST. CLAIR ET AL 2,976,726

GAS IMPERVIOUS DIAPHRAGM

Filed Aug. 13, 1959 2 Sheets-Sheet 2

Fig. 5

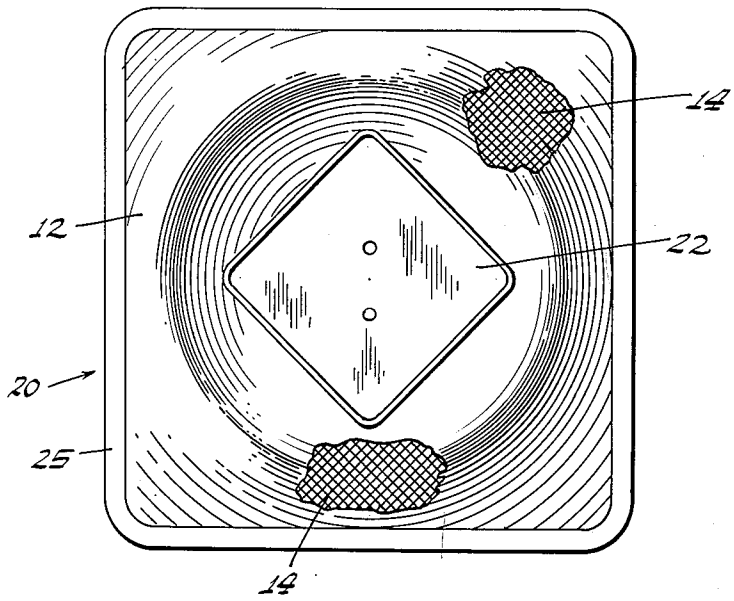
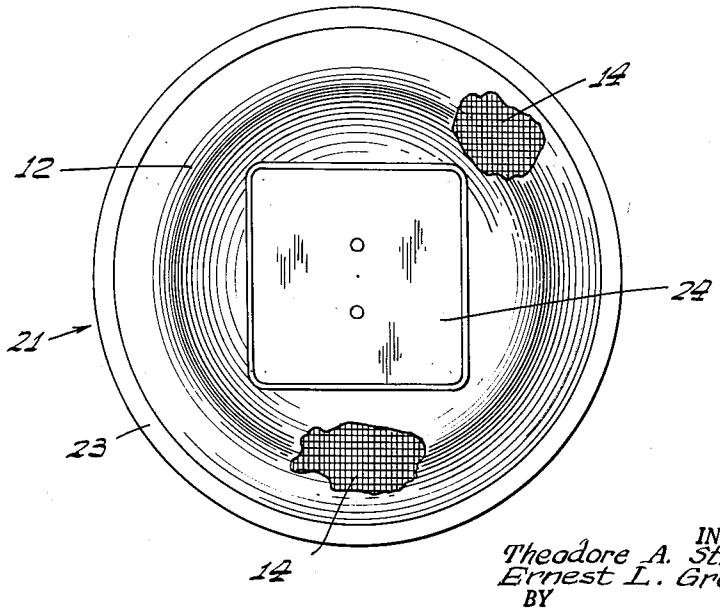



Fig. 6




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# GAS IMPERVIOUS DIAPHRAGM

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7 Claims. (Cl. 73—279)

This invention relates to gas impervious diaphragms, such as are useful in gas meters or the like. More specifically, it pertains to flexible diaphragms adapted to be stroked back and forth or inverted through their center.

Such a diaphragm must have dimensional stability since most of the displacement of gas which is being measured occurs in the flexible area of the diaphragm. Also, the material from which it is fabricated should be reasonably inert to the gases under measurement and their related contaminants and should have a relatively high modulus of elasticity to resist deformation of the diaphragm, i.e. to prevent ballooning and similar distortion, which might result from the pressure differential between its opposed sides. Since the diaphragm must stroke under extremely low differential pressures, in the order of fractions of inches of water per square inch, it must be highly flexible and responsive to such low pressure differentials. In order for a diaphragm to be practical and have the required long life, it should have a relatively unchanged displacement over a period of years and preferably should not exceed 1 to 2% of its original displacement over a period of 20 years.

Prior to the present invention, in order to meet the requirements specified, gas meter diaphragms have been formed of rubber, plastic, neoprene or the like compositions and because of the necessity for extreme diaphragm stability, have included fibrous threads. The reinforcing threads, which in the interest of economy are in the form of a "square" woven fabric, are coated or impregnated and then molded into the form of the diaphragm.

It has been found that diaphragms of the above type present problems in that they exhibit rectilinear rather than radial or curvilinear characteristics. In cyclic tests, the fabric and the coating or impregnating material break down in those areas where the thread is tangent to any fixed arc defined in the diaphragm. In prior diaphragm structures where the frame is equally spaced at all points in its periphery from the centerplate of the diaphragm, the problem is most serious and results in almost certain eventual diaphragm break-down.

The present invention overcomes the problems aforenoted and provides a diaphragm for gas meters, which is adapted to withstand continuous flexing for prolonged periods with little, if any, damage to the reinforcing fibers and the coating or impregnating material.

It is an object of the invention to provide a gas meter diaphragm wherein the fibrous reinforcing threads are so oriented in relation to the non-flexing parts of the diaphragm that they provide radial and circumferential expansion in areas of greatest stress.

It is also an object of the invention to provide a gas meter diaphragm, having a flexible gas impervious diaphragm member including a "square" woven fabric, wherein the flexible member is oriented relative the diaphragm frame and the centerplate so that the diagonals of the "squares" of the fabric are normal to the centerplate in the area of greatest stress on the diaphragm member.



Another object of the invention is to provide a gas meter diaphragm having a frame and a centerplate, with the latter so positioned and/or shaped relative the former that its periphery is unequally spaced therefrom, and in which the flexible diaphragm member, including the "square" woven fabric, is oriented so that the diagonals of the "squares" are normal to the centerplate in the areas thereof closest to the frame.

A further object of the invention is to provide a gas meter diaphragm having a frame and a centerplate, with the former so shaped relative to the latter that they are unequally spaced throughout their peripheries, and in which the flexible diaphragm member, including the square woven fabric, is oriented so that the diagonals of the squares are normal to the centerplate in the areas thereof closest to the frame and the threads of the squares adjacent the centerplate are tangent thereto in the areas spaced the greatest distance from the frame.

A still further object of the invention is to provide a gas meter diaphragm which is relatively simple in structure, inexpensive to manufacture and of such a character it will function over long periods of time with freedom from all difficulties.

Other objects and advantages of the invention will be apparent from the specification and claims, when considered in connection with the attached sheets of drawings illustrating one form of the invention wherein like characters represent like parts and in which:

Figure 1 is a plan view partially broken away illustrating one embodiment of the invention;

Fig. 2 is a diagrammatic cross-sectional view, in solid and dotted lines, of the diaphragm structure of Fig. 1;

Fig. 3 is a plan view, partially broken away, of another form of gas meter diaphragm embodying the invention;

Fig. 4 is a diagrammatic cross-sectional view, in solid and dotted lines, of the diaphragm of Fig. 3;

Fig. 5 is a plan view partially broken away, illustrating another embodiment of the invention; and

Fig. 6 is a plan view partially broken away illustrating still another embodiment of the invention.

Primarily, the present invention resides in the concept of positioning and/or shaping the non-flexing parts of the diaphragm relative to each other so as to define flexible areas of greater and lesser strain and then orienting the flexible material of the diaphragm relative the non-flexing parts thereof so as to compensate for and accommodate the differences in strain.

Referring now to the drawings, and Figs. 1 and 2 in particular, a gas meter diaphragm 10 is shown embodying the concepts of the invention. The diaphragm, similar to conventional gas meter diaphragms which are adapted to be stroked back and forth or inverted through their center, includes a frame member 11, by means of which the diaphragm is mounted in the gas meter, and a flexible gas impervious member 12 connected to and extending between the sides of the frame. A centerplate 13 of rigid material is connected to and carried by the flexible member in any manner known to the art for engaging and operating, by the usual link mechanism, the valve and indexing mechanisms of the meter, not shown.

The flexible gas impervious diaphragm member, as previously noted, comprises a square woven fabric 14 or mesh of reinforcing threads impregnated or coated by rubber, either natural or synthetic, plastic, neoprene or like compositions. For the purpose of the present explanation, the fabric is referred to as being "square" woven, however, it will be understood that any parallelogram type of weave is to be included in the definition of that term.

According to the present invention, and in order to eliminate strain in the flexible member 12 which eventually results in break-down of the flexible material, the

frame 11 and the centerplate 13 of the diaphragm are so shaped and/or positioned relative to each other that areas of the flexible member 12 are defined which are subject to greater or lesser degrees of strain. After these areas are defined the material forming the flexible member is oriented relative to the centerplate and the frame so as to provide radial and circumferential expansion in the areas of greatest strain.

In Fig. 1 the frame 11 is of rectangular or square configuration and the centerplate 13 comprises a circular disk. It will be observed that in this relationship of the frame to the centerplate the areas of greatest strain on the flexible member 12, when the diaphragm is stroked back and forth, are in the narrowest radial areas of the flexible member or in those portions thereof between the centerplate and frame where the peripheries of the former and latter are most closely spaced. The flexible member 12 is positioned in the frame or oriented relative to the frame and the centerplate so that the diagonals of the squares of the square woven fabric 14 are normal to the centerplate in the areas of greatest strain and the threads forming the sides of the squares are tangent to the centerplate in the areas of least strain; the areas of least strain are those wherein there is the widest radial area of flexible material between the periphery of the centerplate and the frame, or as illustrated in Fig. 1, the areas defined between the corners of the frame and the closest related point on the periphery of the centerplate. It will be seen that by orienting the flexible material, as above described, the reinforcing fabric thereof is enabled to expand radially and circumferentially, as the diaphragm is flexed back and forth through its center, by the expanding and contracting of the diagonals of the squares or the parallelgrammic action thereof.

In Fig. 2 the effect of stroking the diaphragm back and forth through its center or inverting it is diagrammatically illustrated, with the normal rest or center position of the diaphragm being shown in solid lines. It will be observed that when the diaphragm is flexed outwardly, or to the left, the fibers as indicated by the point *x* are moved radially outwardly of the center of the diaphragm requiring the material of the flexible member to stretch. This stretching is facilitated in the areas of greatest stress by the orientation of the flexible member relative to the frame and centerplate which enables the squares to change their normal parallelogram shape and the diagonals thereof to elongate in the direction of stretch. It will likewise be observed that the fibers, as indicated by the point *y*, in the area thereof under greatest strain, are moved radially inwardly toward the center of centerplate 13, when the diaphragm is flexed inwardly, or to the right, thereby causing the squares to again change their parallelogram shape and the radial diagonals to shorten as the circumferential diagonals elongate.

By means of the invention as above-described a gas meter diaphragm is provided which consistently conforms to smooth passage in stroke, requires extremely low pressure differential to achieve the stroke, is reinforced to maintain a stable configuration and is adapted to accommodate strain on the flexible member in the areas most likely to break down.

In Figs. 3 and 4 a swing type or hinged diaphragm 15 embodying the invention, is shown which includes a rectangular frame 16 having a square woven, coated or impregnated, gas impervious flexible member 12 extending thereacross. The flexible member carries a D-shaped centerplate 17 having connected thereto a bracket 18 adapted to swing or pivot around a hinge 19. In this form of the invention the radially outward and inward movement of the fibers, on the out-stroke and in-stroke of the diaphragm respectively, as indicated at the points Z, is facilitated by the combined effect of the pivotally mounted diaphragm centerplate 17 and the orientation of the flexible member 12 so that the diagonals of the squares 14 extend normal to the areas of greatest strain and the threads thereof lie tangent to the areas of least strain. When the flexible member 12 is required to move radially inwardly or outwardly, as shown by the points Z, such movement is facilitated by the swinging of the centerplate 17 around the hinge 19 and the elongation or contraction of the diagonals of the squares extending normal to the centerplate.

In Figs. 5 and 6, the invention is shown embodied in diaphragms 20 and 21 respectively. In Fig. 5 a square frame 25 is provided with a flexible diaphragm member 12 having a square centerplate 22. In this form of the invention, in order to define the areas of lesser and greater strain on the flexible member, the centerplate 22 is offset 45° from the frame so that the peripheries of the centerplate and the frame are unequally spaced and the areas of greatest strain lie in the narrowest radial expanse of the flexible member. It will be seen in this form of the invention, as with the previously described forms, that the flexible member is oriented so that the diagonals of the square 14 extend normal to the centerplate in the areas of greatest strain and the threads thereof lie tangent to the centerplate in the areas of least strain.

In Fig. 6 a circular frame 23 is provided with a flexible member 12 having a square centerplate 24. As with the earlier forms of the invention the areas of the flexible member undergoing the greatest strain when the diaphragm is flexed back and forth are those areas wherein the periphery of the centerplate lies closest to the frame. Here again it will be seen that the flexible member 12 is oriented so that the diagonals of the squares 14 extend normal to the centerplate in the areas of greatest strain and the threads thereof lie tangent to the centerplate in the areas of least strain.

Thus, among others, the several objects and advantages of the invention as aforenoted are achieved. Obviously numerous changes in the structure may be resorted to without departing from the spirit of the invention as defined by the claims.

We claim:

1. A stroke-through gas meter diaphragm comprising a frame member, a flexible gas impervious fabric diaphragm having a square weave within said frame member and adapted to be flexed back and forth therethrough and a rigid centerplate carried by said fabric diaphragm, said centerplate having its periphery unequally spaced from said frame, said fabric diaphragm being oriented so that the diagonals of the squares thereof are normal to the portions of the periphery of said centerplate closest to said frame.

2. A stroke-through gas meter diaphragm comprising a frame member, a flexible gas impervious fabric diaphragm having a square weave within said frame member and adapted to be flexed back and forth therethrough and a rigid centerplate carried by said fabric diaphragm, said centerplate being so shaped that its periphery is unequally spaced from said frame, said fabric diaphragm being oriented so that the diagonals of the squares thereof are normal to the portions of the periphery of said centerplate closest to said frame.

3. A stroke-through gas meter diaphragm comprising a frame member, a flexible gas impervious fabric diaphragm having a square weave within said frame member and adapted to be flexed back and forth therethrough and a rigid centerplate carried by said fabric diaphragm, said centerplate being so positioned that its periphery is unequally spaced from said frame, said fabric diaphragm being oriented so that the diagonals of the squares thereof are normal to the portions of the periphery of said centerplate closest to said frame.

4. A stroke-through gas meter diaphragm comprising a frame member, a flexible diaphragm within said frame member and adapted to be flexed back and forth therethrough and a rigid centerplate carried by said flexible diaphragm, said frame being so shaped that the periph-

ery of said centerplate is unequally spaced therefrom, said flexible diaphragm including a fabric having a square weave and being oriented so that the diagonals of the squares thereof are normal to the portions of the periphery of said centerplate closest to said frame.

5. A stroke-through gas meter diaphragm comprising a rectangular frame member, a flexible diaphragm within said frame member and adapted to be flexed back and forth therethrough and a rigid centerplate carried by said flexible diaphragm, said centerplate being so shaped that its periphery is unequally spaced from said frame, said flexible diaphragm including a fabric having a square weave and being oriented so that the sides of the squares adjacent said centerplate are tangent to the portions of the periphery of said centerplate farthest from said frame.

6. A stroke-through gas meter diaphragm comprising a square frame member, a flexible gas impervious fabric diaphragm having a square weave within said frame member and adapted to be flexed back and forth therethrough and a rigid circular centerplate carried by said



fabric diaphragm, said fabric diaphragm being oriented so that the diagonals of the squares thereof are normal to the portions of the periphery of said centerplate closest to said frame.

7. A stroke-through gas meter diaphragm comprising a frame member, a flexible diaphragm within said frame member and adapted to be flexed back and forth therethrough and a rigid centerplate carried by said flexible diaphragm, said centerplate having its periphery unequally spaced from said frame, said flexible diaphragm including a fabric having a square weave and being oriented so that the diagonals of the squares thereof are normal to the portions of the periphery of said centerplate closest to said frame and the sides of the squares adjacent the portions of said periphery most greatly spaced from said frame are tangent thereto.

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