Sept. 12, 1967 T. A. ST. CLAIR ET AL 3,340,734

GAS IMPERVIOUS DIAPHRAGMS

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Fig. 1

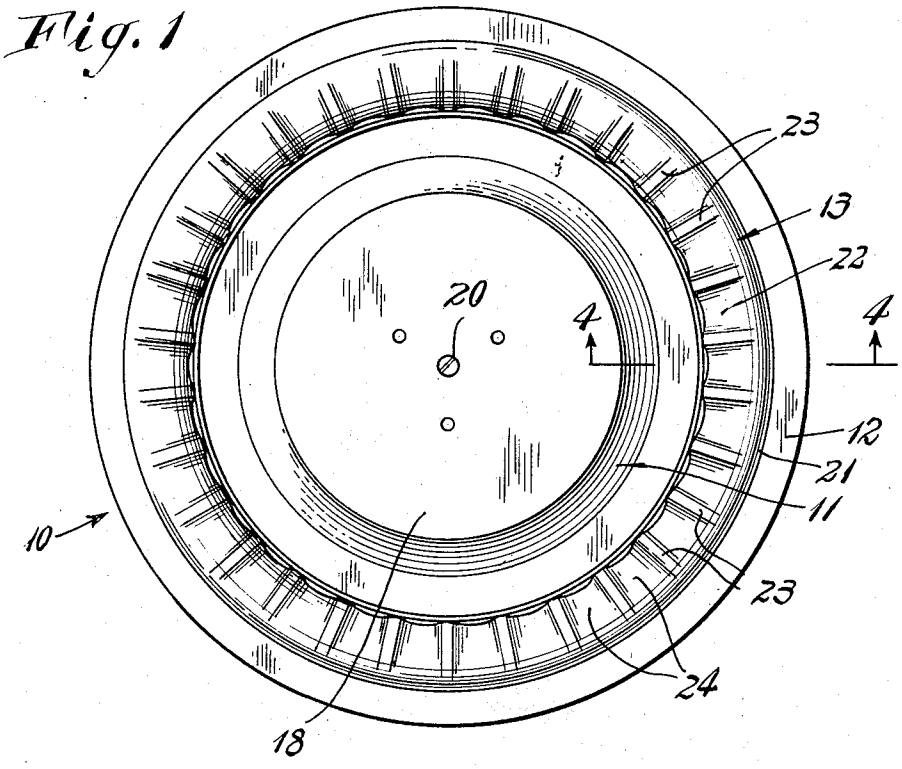


Fig. 2

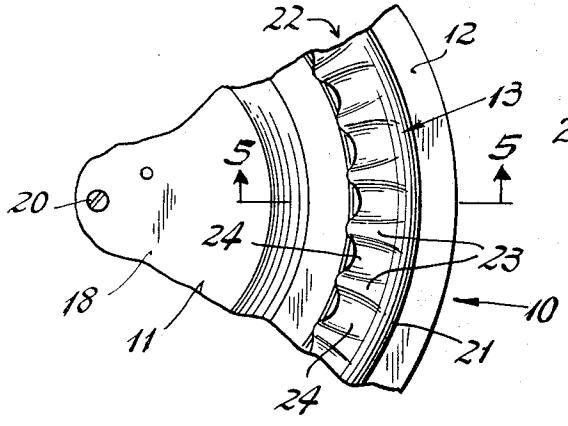
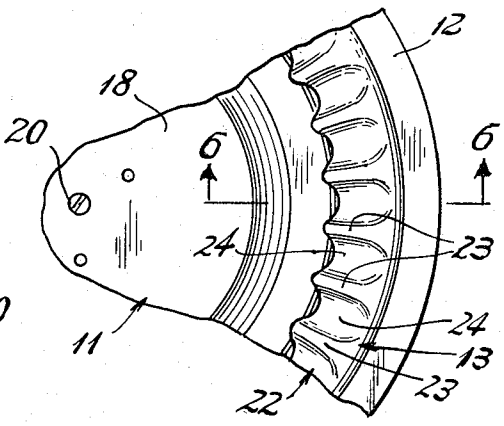


Fig. 3



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Fig. 4

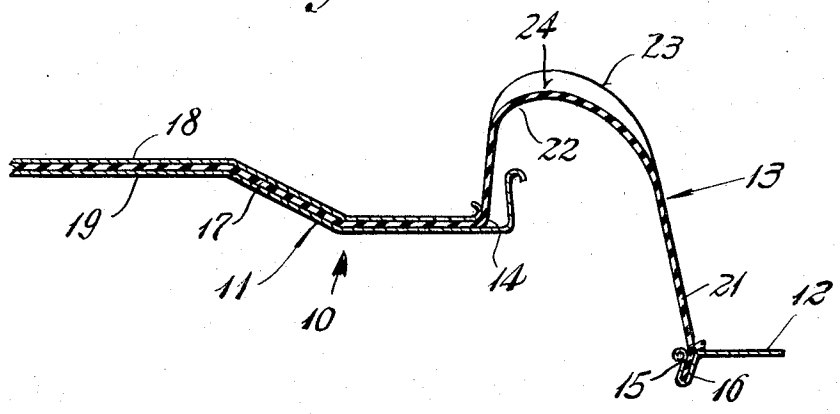


Fig. 5

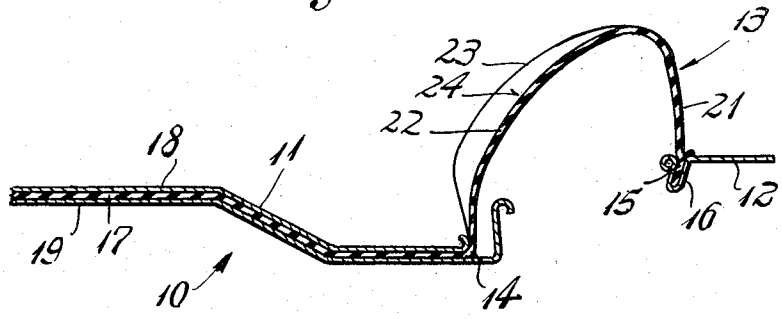
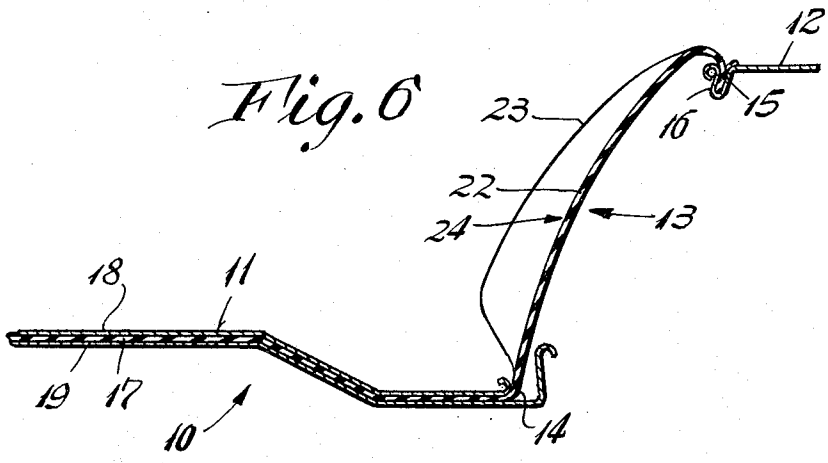


Fig. 6



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GAS IMPERVIOUS DIAPHRAGMS

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ABSTRACT OF THE DISCLOSURE

A stroke-through-center diaphragm for gas meters having a rigid center plate and outer retaining flange concentric with the center plate and a trough-shaped annular member of impervious flexible material extending between the center plate and retaining flange, said annular member at full outstroke having a smooth outer peripheral surface and ribbed inner peripheral surface and upon being moved through center to full inner position decreasing the smooth outer peripheral surface and increasing the inner peripheral surface with the ribs creasing the increased peripheral surface all for the purpose of relieving circumferential stress and facilitating the diaphragm stroke.

Heretofore, difficulties have been encountered in the form of localized areas of stress or wear in stroke-through-center diaphragms, particularly of the type for use in slow operating gas meters, where it is essential that the diaphragms produce a long stroke for imparting the greatest possible displacement per revolution of the meter, such wear being particularly aggravated in diaphragms having a synthetic diaphragm member, since the material of the diaphragm will not respond to multidirectional movement, as required in stroking. It has been found that in such diaphragms, the slightest overstroking or even long continuous use will tend to produce "crows feet" or similar areas of stress that eventually cause the diaphragm to fail.

It is an important object of the present invention, therefore, to provide a diaphragm of the stroke-through-center type, which is capable of full stroke operation and extensive and continuous use without developing points of stress or wear.

According to the invention, this is accomplished by providing the flexible portion of the diaphragm with means for permitting the expansion or contraction thereof during the stroking of the diaphragm, whereby circumferential stress relief of the material of the diaphragm is provided. More specifically, the diaphragm, which is normally movable from full outstroke position through midstroke position to full instroke position, is formed to the shape it will assume in one extreme of the stroking operation and is provided with means for progressively reshaping it as it is moved to its opposite extreme position, such reshaping enabling the flexible portion of the diaphragm to expand or contract, as required, to avoid localized stress and eliminate wear.

In the preferred form of the invention, the stroke-through-center diaphragm includes, in addition to the convetnional center plate and outer retaining flange, a flexible impervious trough-shaped annular diaphragm member having inner and outer peripheral surfaces, the inner peripheral surface being shaped, in the full outstroke position of the diaphragm, to provide a plurality of radially extending ribs which define creases or valleys in the inner surface and are adapted as the diaphragm is stroked, to full instroke position, to progressively pleat the material of the diaphragm member to extend the creases thereacross, whereby the creases may circumferentially contract for providing circumferential stress relief for the diaphragm and to facilitate the diaphragm stroke.

It is also an object of the present invention to provide a method of making stroke-through-center diaphragms, wherein the molding step thereof comprises the improvement of molding the flexible annular trough-shaped diaphragm member in substantially its full outstroke position, thereby shaping such member to provide means which progressively pleat the member as it is stroked through midstroke position to full instroke position, thus enabling the diaphragm to expand or contract for providing circumferential stress relief.

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

FIGURE 1 is a plan view of a stroke-through-center diaphragm according to the invention, in its full outstroke position;

FIG. 2 is a fragmentary plan view of the diaphragm of FIG. 1 in midstroke position;

FIG. 3 is a fragmentary plan view of the diaphragm of FIG. 1 in full instroke position;

FIG. 4 is a fragmentary cross-sectional view of the diaphragm in full outstroke position, as shown in FIG. 1, taken in the direction of the arrows **4—4**;

FIG. 5 is a fragmentary cross-sectional view of the diaphragm in midstroke position, as shown in FIG. 2, taken in the direction of the arrows **5—5**; and

FIG. 6 is a fragmentary cross-sectional view of the diaphragm in full instroke position, as shown in FIG. 3, taken in the direction of the arrows **6—6**.

Referring now to the drawings for a more detailed description of the invention, a stroke-through-center diaphragm **10** is shown, of the type which is adapted to be moved from full outstroke position (FIGS. 1 and 4) through midstroke position (FIGS. 2 and 5) to full instroke position (FIGS. 3 and 6) and vice versa for operating a device, such as a gas meter or the like.

As illustrated, and as is conventional in devices of this type, the diaphragm **10** includes a substantially rigid center plate **11**, a retaining flange **12** concentric with and spaced from the center plate for mounting the diaphragm and a flexible gas impervious annular member **13** extending between and connected to the center plate and flange.

The annular member **13**, which flexes back and forth to enable the diaphragm to be stroked through its cycle of operation, as illustrated, is substantially trough-shaped in cross-section and is connected to the center plate **11** and retaining flange **12** closely adjacent its inner and outer peripheral edges **14** and **15**, respectively. While such connection may be made directly to the edges, as shown in the connection of outer peripheral edge **15** with retaining flange **12**, wherein the edge is crimped in a U-shaped inner circumferential rim **16** of the flange, in the illustrated and preferred form of diaphragm construction, in order to assure that the diaphragm is gas impervious across its entire expanse, the annular member **13** has a central web **17** forming a unitary extension of the inner peripheral edge **14** and extending across the space defined by such edge. This web, which may be connected to the center plate in any known manner, is here shown clamped between the plate forming members **18** and **19** by a nut and bolt type fastener **20**.

While stroke-through-center diaphragms of the type here described have been known and used in the art for a substantial period of time, it has been found that such diaphragms, particularly when they are formed of synthetic materials, tend to wear in localized areas, as the

result of stress in such areas when they are subjected to multidirectional movement; the material forming the flexible annular member is unable to respond to the multidirectional movement required in stroking through a full cycle and is subjected to circumferential stress which eventually causes it to wear and breakdown in localized areas.

The present invention overcomes this problem and eliminates localized wear of the diaphragm by initially forming the flexible annular member thereof in one extreme position of the stroking cycle and shaping it to provide means which progressively redistribute the material of the member as the diaphragm is stroked to the opposite extreme position of the cycle.

According to the invention, the prior method of making stroke-through-center diaphragms, which includes molding the flexible annular member, preferably of synthetic elastomeric material, and then connecting it to a center plate and outer retaining flange to extend therebetween, is improved by molding the annular member in its full outstroke position and shaping it so that radially extending ribs are formed in at least a portion of its surface, the ribs defining radially extending creases therebetween and functioning, as the diaphragm is stroked to full instroke position, to positively pleat the material for extending the creases, thus enabling the creases to circumferentially contract for eliminating circumferential stress.

Referring again to the drawings, and FIGS. 1 and 4 in particular, the diaphragm **10** is shown in its full outstroke position, the annular member **13** thereof being in the position it was initially molded. As will be seen, the annular member has a substantially smooth radially linear outer peripheral surface **21** generated by the movement of a line in the plane of the radius of the member around the axis of the member. While the surface **21** may take many forms, in the illustrated and preferred form of the invention it is frustro-conical and is generated by the movement around the axis of the member of an inwardly inclined line in the plane of the radius of the member.

The inner peripheral surface **22** of annular member **13** is shaped to provide a plurality of radially extending ribs **23**, which define therebetween creases or valleys **24**, the ribs and creases extending substantially across the inner peripheral surface and ending adjacent or in the outer peripheral surface.

Referring now to all of the figures, it will be seen that when the diaphragm **10** is stroked from its full outstroke position (FIGS. 1 and 4) through midstroke position (FIGS. 2 and 5) to full instroke position (FIGS. 3 and 6), the outer peripheral surface **21** progressively decreases in radial dimension or width as the inner peripheral surface increases in such dimension. Simultaneously, the ribs **23** progressively pleat the material of the increasing inner peripheral surface to extend the creases **24** thereacross, thus enabling the creases to circumferentially contract, whereby circumferential stress in the annular member is relieved and the stroking operation is facilitated. It will be understood by those conversant with the art that stroking of the diaphragm in the reverse direction will merely reverse the aforesaid sequence, thus permitting the material of the annular member to progressively redistribute itself and return to its original condition.

It should here be noted that, as used herein and in the appended claims, the term radially linear means linear in a direction in the plane of the radius of the annular member and radial dimension similarly refers to a dimension along a line in the plane of the radius of such member.

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-center diaphragm for gas meters which is movable from full outstroke position through midstroke position to full instroke position, said diaphragm comprising a substantially rigid center plate, an outer retaining flange concentric with and substantially parallel to said center plate, and a flexible impervious trough-shaped annular member connected to and extending between said center plate and flange, said annular member in the full outstroke position of said diaphragm having a substantially smooth outer peripheral surface concentric with the axis of said annular member and having an inner peripheral surface shaped to provide a plurality of spaced radial ribs in said inner peripheral surface defining radial creases therebetween, said creases and ribs extending at least to said outer peripheral surface, said outer peripheral surface decreasing in width and said inner peripheral surface increasing in width as said diaphragm is moved from full outstroke position through midstroke position to full instroke position, said shaped ribs pleating said increased inner peripheral surface to extend said creases thereacross, whereby said creases circumferentially contract for providing circumferential stress relief and to facilitate the diaphragm stroke.

2. A stroke-through-center diaphragm for gas meters which is movable from full outstroke position through midstroke position to full instroke position, said diaphragm comprising a substantially rigid center plate, an outer retaining flange concentric with and substantially parallel to said center plate, and a flexible impervious trough-shaped annular member connected to and extending between said center plate and flange, said annular member in the full outstroke position of said diaphragm having a substantially radially linear outer peripheral surface inclined toward the axis of said member and having an inner peripheral surface shaped to provide a plurality of spaced radial reinforcing ribs in said inner peripheral surface defining radial creases therebetween, said creases and ribs extending at least to said outer peripheral surface, said outer peripheral surface decreasing in radial dimension and said inner peripheral surface increasing in radial dimension as said diaphragm is moved from full outstroke position through midstroke position to full instroke position, said shaped reinforcing ribs pleating said increased inner peripheral surface to extend said creases thereacross, whereby said creases circumferentially contract for providing circumferential stress relief and to facilitate the diaphragm stroke.

3. A stroke-through-center diaphragm for gas meters which is movable from full outstroke position through midstroke position to full instroke position, said diaphragm comprising a substantially rigid center plate, an outer retaining flange concentric with and substantially parallel to said center plate, and a flexible impervious unitary diaphragm member including a trough-shaped annular portion having inner and outer peripheral surfaces and a web extending across the area defined by said inner peripheral surface, said web being reinforced by said center plate, said annular portion being connected to and extending between said center plate and flange, said outer peripheral surface of said annular portion in the full outstroke position of said diaphragm being substantially radially linear and inclined toward the axis of said annular portion and said inner peripheral surface of said annular portion being shaped to provide a plurality of spaced radial ribs defining radial creases therebetween, said creases and ribs extending at least to said outer peripheral surface, said outer peripheral surface decreasing in radial dimension and said inner peripheral surface increasing in radial dimension as said diaphragm is moved from full outstroke position through midstroke postion to full instroke position, said shaped ribs pleating said increased inner peripheral surface to extend said creases thereacross, whereby said creases circumferentially contract for providing circumferential stress relief and to facilitate the diaphragm stroke.

4. A stroke-through-center diaphragm for gas meters which is movable from full outstroke position through

midstroke position to full instroke position, said diaphragm comprising a substantially rigid center plate, an outer retaining flange concentric with and substantially parallel to said center plate, and a flexible impervious trough-shaped annular member connected to and extending between said center plate and flange, said annular member in the full outstroke position of said diaphragm having an outer peripheral surface generated by the movement of a line in the plane of the radius of said member around the center of said member and having an inner peripheral surface shaped to provide a plurality of spaced radial ribs in said inner peripheral surface defining radial creases therebetween, said creases and ribs extending at least to said outer peripheral surface, said outer peripheral surface decreasing in width and said inner peripheral surface increasing in width as said diaphragm is moved from full outstroke position through midstroke position to full instroke position, said ribs pleating said increased inner peripheral surface to extend said creases thereacross, whereby said creases circumferentially contract for providing circumferential stress relief and to facilitate the diaphragm stroke.

5. A stroke-through-center diaphragm for gas meters which is movable from full outstroke position through midstroke position to full instroke position, said diaphragm comprising a substantially rigid center plate, an outer retaining flange concentric with and substantially parallel to said center plate, and a flexible impervious trough-shaped annular member connected to and extending between said center plate and flange, said annular member in the full outstroke position of said diaphragm having an outer peripheral surface generated by the movement of an angularly disposed line in the plane of the radius of said member around the center of said member and having an inner peripheral surface contiguous with said outer surface and shaped to provide a plurality of spaced radial stiffening ribs in said inner peripheral surface defining radial creases therebetween, said creases and ribs extending at least to said outer peripheral surface, said outer peripheral surface decreasing in width and said inner surface increasing in width as said diaphragm is moved from full outstroke position through midstroke position to full instroke position, said

stiffening ribs pleating said increased inner surface to extend said creases thereacross, whereby said creases contract for providing circumferential stress relief and to facilitate the diaphragm stroke.

6. A stroke-through-center diaphragm for gas meters which is movable from full outstroke position through midstroke position to full instroke position, said diaphragm comprising a substantially rigid center plate, an outer retaining flange concentric with and substtantially parallel to said center plate, and a flexible impervious trough-shaped annular member connected to and extending between said center plate and flange, said annular member in the full outstroke position of said diaphragm having an outer peripheral substantially frusto-conical surface generated by the movement of an inwardly angularly disposed line in the plane of the radius of said member around the center of said member and having an inner peripheral surface contiguous with said outer surface and shaped to provide a plurality of formed spaced radial stiffening ribs in said inner peripheral surface defining radial creases therebetween, said creases and ribs extending substantially across the width of said inner peripheral surface and at least to said outer peripheral surface, said outer peripheral surface decreasing in width and said inner surface increasing in width as said diaphragm is moved from full outstroke position through midstroke position to full instroke position, said ribs progressively pleating said increased inner peripheral surface to extend said creases thereacross, whereby said creases contract for providing circumferential stress relief and to facilitate the diaphragm stroke.

References Cited

UNITED STATES PATENTS

1,793,621	2/1931	Kelley	92—104
2,632,475	3/1953	Elo	92—104 X
2,874,569	2/1959	Gray	73—279

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