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DIAPHRAGM

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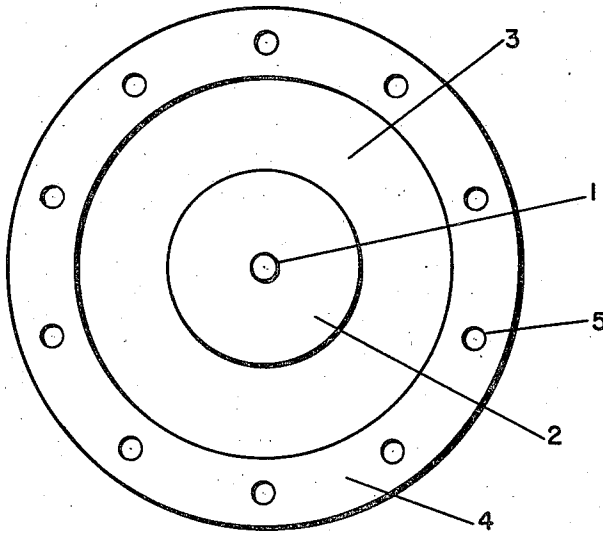


FIG. 1

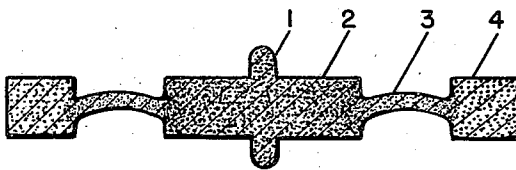


FIG. 2

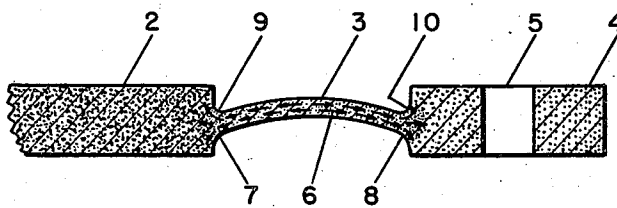


FIG. 3

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4 Claims. (Cl. 137—157)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

My present invention relates to diaphragms of various types and sizes.

The invention is especially adapted to the construction of diaphragms for use with pneumatic or hydraulic valves, switches, pumps, level indicators, and the like.

My invention is intended to reduce the cost of manufacture, increase the serviceability and usefulness, and permit the equivalent of a multi-part diaphragm assembly to be fabricated from like material of varying flexibility formed into a homogeneous unit.

The effective area of a flexible diaphragm is described by a line drawn through the mean area of the flexible portion thereof; therefore, it is desirable to provide a non-yielding center portion, as large as possible, consistent with amount of movement required. In order to permit proper handling and mounting it is also desirable to provide a rigid or semi-rigid outer portion or mounting ring.

In the previous art the above results have been obtained by combining different materials, like rubber and metal, either by mechanical attachment or by adhesion.

Any combination of unlike materials tends to localize strain, due to movement of the diaphragm, at the point or points where the thickness of cross-section is changed, thereby reducing the life of the diaphragm.

My invention provides fillets at the points where there is a change in thickness to prevent localization of strain during normal operation of the diaphragm.

My invention provides a gradient of flexibility from soft to semi-hard or hard material at the point or points of change in thickness of cross-section, thereby reducing the localization of strain during normal operation.

For these reasons my invention is particularly adaptable to diaphragms and the like which are to be used with equipment wherein failure is serious or where long life, in normal operation, is desired.

My invention provides additional material in the flexible portion to lengthen the usable stroke without causing elongation of said material or increasing the operating force.

This invention in providing a semi-hard rim portion, facilitates the sealing at the clamping point, thus eliminating the necessity for gaskets,

which are required with a metal diaphragm or a metal-rubber combination diaphragm to seal the gas or fluid chambers coacting with said diaphragm.

The invention in general consists of a diaphragm made up of a plurality of areas, each area being of a thickness in cross-section and of a flexibility to best suit the purpose at hand. However, I do not mean to limit the invention to the proportion or particular combination shown and described.

The preferred material or composition is rubber, synthetic rubber or the like, it being understood that any material that can be varied, by treatment, composition or other method, from flexible to semi-hard or hard and formed into a homogeneous unit, may be used in constructing the diaphragm without departing from the spirit of my invention.

The invention will be more fully understood after reference to the accompanying drawing, in which one embodiment of my invention is shown.

In the drawing like symbols indicate like parts.

Figure 1 is a plan view of the diaphragm.

Figure 2 is a cross-sectional view showing the change in cross-section.

Figure 3 is a side sectional view showing by unconventional sectional lines the flow that reduces local strain.

In the embodiment shown and described the diaphragm includes a hard center or acting area which has a very hard button at its center, a flexible area, and an outer rim or mounting portion. This type of diaphragm can be fabricated by blanking or moulding the various parts, such as acting area, flexible area, and outer rim, to proper size and thickness. Each part is controlled separately, by pretreatment or composition or other means, so that the assembly after the homogenizing process, will have proper form and characteristics in each area. The controlling of each part prior to the homogenizing process, and the latter process itself, can be accomplished in a number of ways. For instance, the various parts, acting area, flexible portion, and the mounting portion can be formed to proper shape, the flexibility or resilience of each being controlled by composition to obtain the required final result. Each part can be partially cured separately to a degree which, when the parts are placed in close relationship in a die or form and subjected to uniform pressure of proper value, and heat of proper temperature for the proper time, the finished product will be a homogeneous unit, properly cured. The pressure temperature

and time is determined by the nature of the material.

The process can be varied to include the use of material of uniform composition which will respond to pretreatment so as to result in the required hardness or flexibility in the final article. That is, each area can be formed of like material, the individual hardness of each being obtained separately by the degree of heat, the amount of pressure and the time of cure or treatment, in each case an allowance being made for the final cure or treatment received during the homogenizing process.

The process can be performed in one operation, if desired, by forming the various parts of controlled raw material, placing said parts in a die and subjecting each area to proper pressure and temperature for the proper time to obtain the desired hardness or flexibility for each area.

The materials that can be used and the processes that can be employed may be varied with the view of obtaining a homogeneous unit having a gradient of flexibility at the points where one characteristic or hardness joins another characteristic or hardness. This result is based on the fact that the more flexible material will flow, when subjected to heat and pressure, into the harder material. To explain the word "controlled" used above, in materials that are plastic, or in a plastic state, the final result of treatment is the result of composition, pressure, and temperature over a given period of time. The composition can be varied to suit fixed conditions, within limits, of the other three, for instance, accelerators can be added to reduce the time or temperature. The pressure required for a given result is determined by the cross-section or mass but also can be adjusted in the composition.

The above will clearly indicate the advantages which can be gained by fabricating an article, which has several parts, each performing a distinctly different duty, from like material having various flexibilities in each part or area, formed into a unit such as a diaphragm by a suitable homogenizing process.

Observing Figure 1 it will be noted that the button 1 is positioned in the center of the acting area of the diaphragm. This part is made of very hard material to provide proper bearing with coating parts. The acting area 2 is constructed of hard composition and its size is determined by the power and sensitivity desired in use of the diaphragm. The flexible portion 3 is of a thickness determined by pressure requirements, and a shape in cross-section, as indicated in Figure 2, determined by the working stroke of the diaphragm. The rim or mounting portion 4 contains the clamp screw holes 5 and is constructed of semi-hard material to eliminate the necessity of using gaskets to seal the coating chambers.

Observing Figure 3 it will be noted that the flexible portion 3, when considered in cross-section of the diaphragm, is formed in an arc so that its length is greater than the straight line distance from the outside of the acting area 2 to the inside of the rim or mounting area 4, thus permitting movement of the acting area 2 with relation to the mounting portion 4 by deforming the flexible portion 3.

In constructing the diaphragm the flexible material or composition is caused to flow endwise, when considered in cross-section, as indicated by

the arrows, thus providing a gradient from flexible to semi-hard or hard material at the highly stressed points 7 and 8.

Any suitable method of mounting or using the diaphragm may be used without departing from the spirit of my invention.

It is to be understood that in the claims which follow, the term "flexibility" is intended to mean the inherent pliancy or tractability of the substance from which the article is formed rather than the pliancy or tractability of the article as a whole. In other words, "flexibility" is to be considered as a function of the substance rather than as a function of the shape or size of the article into which the substance is formed.

While I have mentioned several uses and shown and described one embodiment of my invention, I do not mean to restrict my invention to any particular form, size, proportion or use of diaphragm as these details may be varied over a wide range without departing from the spirit of the invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent of the United States is:

1. A unitary diaphragm formed of rubber or like material and having a plurality of adjoining portions, the hardness and flexibility of the material of each portion being different from that of adjoining portions and the hardness and flexibility of the material at the juncture of two of said portions varying substantially uniformly from the hardness and flexibility of the material of one portion to the hardness and flexibility of the material of the adjoining portion.

2. A unitary diaphragm formed of rubber or like material and having a plurality of adjoining portions of varying hardness and flexibility including a hard and inflexible central acting portion, a semi-hard and semi-flexible peripheral mounting portion, and a soft and flexible intermediate portion connecting said first two portions, the hardness and flexibility of the juncture of two of said portions varying substantially uniformly from the hardness and flexibility of one portion to the hardness and flexibility of the adjoining portion.

3. A diaphragm formed as a homogeneous unit of rubber or like material and comprising a portion of relatively soft flexible material and a portion of relatively hard inflexible material, said portions being joined to one another by an intermediate portion of homogeneous material which varies substantially uniformly from the soft portion to the hard portion from a relatively soft flexible material to a relatively hard inflexible material.

4. A unitary diaphragm formed of rubber or like material and comprising a central acting portion of hard inflexible material, an outer mounting portion of semi-hard, semi-flexible material, and an intermediate portion of soft flexible material, said intermediate portion being thinner than said central and said outer portions and being joined therewith by means of a filleted juncture, the material of which is homogeneous throughout and which varies substantially uniformly from the hardness and flexibility of one portion to the hardness and flexibility of the adjoining portion.

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