

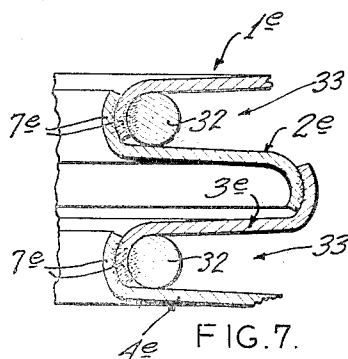
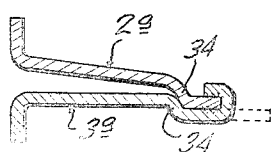
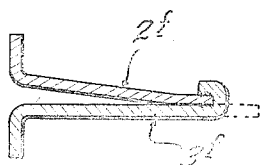
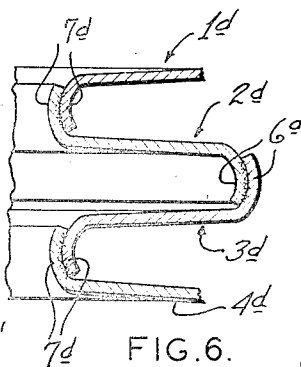
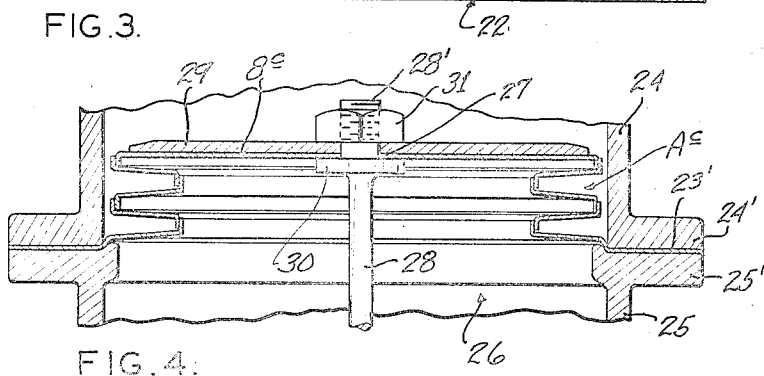
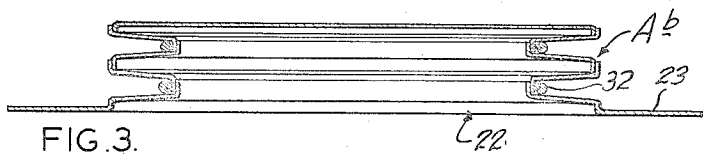
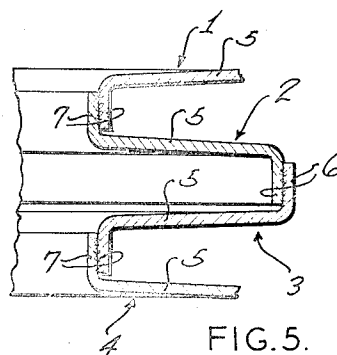
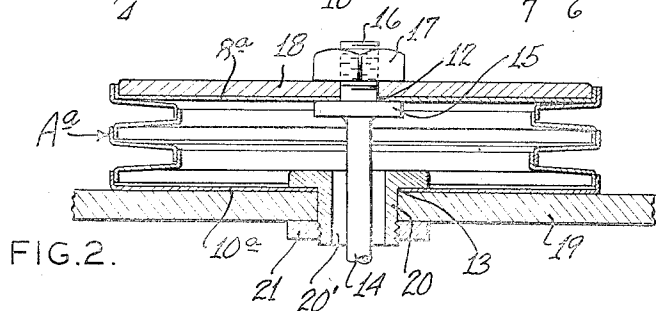
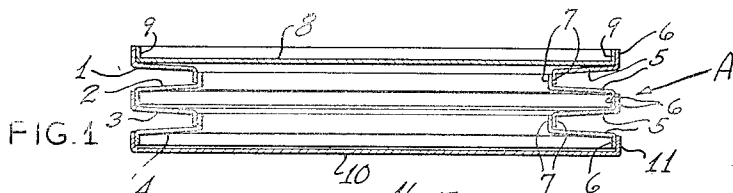
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2,323,985

DIAPHRAGM

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## UNITED STATES PATENT OFFICE

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## DIAPHRAGM

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Application March 17, 1941, Serial No. 383,884

1 Claim. (Cl. 137—156.5)

This invention relates generally to diaphragms and more specifically to diaphragms of the bellows type, the predominant object of the invention being to provide a diaphragm of this type which is of such improved construction and arrangement that the manufacture of the improved diaphragm is very greatly simplified and the production of such diaphragms from materials of high tensile strength is rendered entirely feasible.

Prior to this invention bellows-type diaphragms were, insofar as we are aware, practically always made from materials which were of low tensile strength and high malleability, the materials most commonly used for this purpose being brass, copper, and bronze of high copper content, and while these materials were, because of their nature, well adapted to respond to the drawing and spinning methods heretofore followed in producing bellows-type diaphragms, their low tensile strength and lack of thickness after the forming operations prevented diaphragms made from such materials from having the strength and durability which they should possess.

Of late years there has been a desire among manufacturers to produce bellow-type diaphragms from materials having higher tensile strength than the materials mentioned above so that such diaphragms would be better able to withstand high pressures, one such material being stainless steel, but because of the hardness and consequent low malleability of these materials it was not feasible heretofore to employ them in producing bellows-type diaphragms in accordance with the methods of manufacture, heretofore followed.

The main object of this invention, therefore, is to provide a bellows-type diaphragm which is of such improved and unique construction and arrangement that it may be produced from materials of high tensile strength and low malleability, such object being accomplished by stamping, or otherwise forming, a plurality of diaphragm sections of such simple shape as may be produced without difficulty from relatively hard materials, and assembling the diaphragm sections and welding or otherwise securing them together in their assembled condition to produce a unitary diaphragm structure which possesses the desired strength and durability.

Fig. 1 is a cross-section of a bellows-type diaphragm constructed in accordance with this invention.

Fig. 2 is a cross-section of a slightly modified form of the improved diaphragm showing one application thereof.

Fig. 3 is a cross-section illustrating another form of the invention.

Fig. 4 is a cross-section of still another slightly different form of the invention and showing an application thereof.

Fig. 5 is an enlarged, fragmentary cross-section of the diaphragm illustrated in Fig. 1.

Fig. 6 is a view similar to Fig. 5 but illustrating a slightly modified form of the invention.

Fig. 7 is a view similar to Fig. 6 but illustrating still another slightly modified form of the invention.

Fig. 8 is an enlarged, fragmentary sectional view illustrating a modified manner of securing the diaphragm sections of the improved diaphragm together.

Fig. 9 is a view similar to Fig. 8 but illustrating still another manner of securing the diaphragm sections of the improved diaphragm together.

In the drawing, wherein are shown for the purpose of illustration, merely, a number of embodiments of the invention, A designates, in Fig. 1, the improved diaphragm generally. The diaphragm A is made up of a plurality of diaphragm sections which are assembled and secured together to provide a unitary diaphragm, certain of said diaphragm sections which produce the circumferential wall of the diaphragm being designated by the reference characters 1, 2, 3, and 4. All of the diaphragm sections 1, 2, 3, and 4 are of like shape and construction; that is to say, each of said diaphragm sections includes an inclined annular wall 5 from which are extended in opposite directions and from the opposite ends thereof an outer annular marginal flange 6 and an inner annular marginal flange 7. In assembling said diaphragm sections a complete diaphragm of the desired shape may be produced by inverting diaphragm sections of one dimension with respect to others of slightly different dimensions. Also, it is plain that diaphragms of different sizes may be produced by employing different numbers of the diaphragm sections in producing the diaphragms. The particular diaphragm illustrated in Fig. 1 includes also an upper closure element 8 in the form of a solid, flat plate provided with an annular marginal flange 9, and a lower closure element 10 also in the form of a solid, flat plate provided with an annular, marginal flange 11.

In producing a bellows-type diaphragm in accordance with the present invention the various elements 1, 2, 3, 4, 8, and 10 are assembled as illustrated in Fig. 1; that is to say, the outer, annular flanges 6 of the diaphragm sections 2 and 3 are arranged in overlapping relation, and the inner, annular flanges 7 of the diaphragm sections 1—2 and 3—4 are likewise disposed in overlapping relation. Also the lower closure element 10 is assembled with the diaphragm section 4 so that the marginal flange 11 of said closure element 10 is in contact with the outer, annular flange 6 of said diaphragm section 4.

After the parts of the diaphragm referred to above are assembled as described said parts are welded, or otherwise secured together, at the

flanges of said parts, to produce a unitary structure, said securement of the diaphragm parts preferably, though not necessarily, being accomplished by stitch welding operations performed with the aid of an electric welding apparatus. When the various elements of the diaphragm A are secured together with the aid of an electric welding apparatus the elements 1, 2, 3, 4, and 10 are assembled as described above after which said parts are welded together, the upper closure 8 being omitted from the assembly thus far advanced to permit one of the electrodes of the welding apparatus to be introduced into the interior of the partially assembled diaphragm so that it may be brought into contact with the inner sides of the overlapping flanges. When the elements 1, 2, 3, 4, and 10 of the diaphragm A have been electrically welded together through the overlapping flanges thereof the upper closure 8 is arranged in place and the marginal flange 9 of said closure and the outer, annular flange 6 of the diaphragm section 1 are welded together to complete the diaphragm.

In Fig. 2 a diaphragm of the general type illustrated in Fig. 1 is shown in association with parts of a pressure-carrying structure, a pressure regulator, for instance. In this view the diaphragm Aa is made in accordance with the diaphragm construction shown in Fig. 1 with the exception that the upper and lower closures 8a and 10a have openings 12 and 13 formed therethrough, respectively. The upper closure 8a has secured thereto a stem 14 which may be a valve operating stem, said stem being provided with a flange 15 from which a screwthreaded stem portion 16 extends, and a nut 17, which is mounted on said screwthreaded stem portion, serves to clamp the closure 8a and an associated plate 18 between the flange 15 of the stem and said nut. The lower closure 10a of the diaphragm Aa is clamped to a wall portion 19 by a flanged sleeve 20 which is provided with an enlarged opening 20' formed therethrough through which the stem 14 extends, said sleeve being extended through the opening 13 of the lower closure 10a and through an aligned opening formed through the wall portion 19, and a nut 21, which is mounted on the lower screwthreaded portion of the sleeve, serves to cause the sleeve to clamp the closure 10a of the diaphragm to the wall portion 19.

The diaphragm Ab shown in Fig. 3 differs from the diaphragm structures of Figs. 1 and 2 in that said diaphragm Ab is open at the bottom as indicated by the reference character 22. Also the diaphragm Ab is provided with an outwardly extended annular flange 23 at its lower end. In Fig. 4 an application for the type of diaphragm shown in Fig. 3 is illustrated, in accordance with which the annular flange 23' of the diaphragm Ac is clamped between flanges 24' and 25' of housing portions 24 and 25 so that the interior of the diaphragm is in communication with a pressure chamber 26 located within the housing portion 25. An opening 27 is formed through the upper closure 8c of the diaphragm Ac and a portion 28' of a stem 28 is extended through said opening and through an aligned opening of a plate 29, said closure 8c and said plate 29 being clamped to the stem 28 between a flange 30 formed on said stem and a nut 31 mounted on the stem portion 28'. In welding together the flanges of the various parts of the diaphragms of Figs. 3 and 4 with the aid of an electrical welding apparatus, one electrode of the welding apparatus may be passed

into the interiors of the diaphragms through the open bottoms thereof.

In Fig. 6 a form of the invention is illustrated, wherein the flanges of the various parts of the diaphragm which are welded together to provide the complete diaphragm, are curved transversely to give additional strength to said flanges. In this view fragments of diaphragm sections 1d, 2d, 3d, and 4d, are illustrated, and the flanges 6d and 7d of said diaphragm sections are curved as described.

In Fig. 7 a diaphragm structure similar to the structure illustrated in Fig. 6 is shown and in addition to the showing of Fig. 6 the diaphragm structure of Fig. 7 includes reinforcing rings 32 are seated in the cavities 33 in contact with the outermost flanges of the overlapped pairs of flanges of the overlapped pairs of flanges 1e of the diaphragm sections 1e, 2e, 3e, and 4e. The reinforcing rings are welded, or otherwise secured in place so as to give additional strength to the diaphragm structure at the points of their locations, and said rings may be made in solid, split, or sectional form as desired, said rings preferably, though not necessarily, being assembled in place as the various other parts of the diaphragm are being assembled to produce the complete diaphragm.

If desired the outer edge portions of adjacent diaphragm sections may be secured together as illustrated in Figs. 8 and 9 instead of in the manner shown in Figs. 1 to 7, inclusive. In Fig. 8 the two associated diaphragm sections illustrated are designated by the reference characters 2f and 3f, and, as shown in that view, the outer end portion of the diaphragm section 3f is bent from its straight condition, indicated by dotted lines, to a condition where said outer end portion is turned or crimped over the outer end portion of the diaphragm section 2f. The interengaging outer end portions of the diaphragm sections 2f and 3f are welded, or otherwise secured together to provide for secure and pressure-tight connection of said parts.

The structure illustrated in Fig. 9 is the same as the arrangement shown in Fig. 8, insofar as the securement of the outer end portions of the diaphragm sections 2g and 3g is concerned. However the structure of Fig. 9 differs from the structure of Fig. 8 in that offsets 34 are formed in the diaphragm sections at points adjacent to the outer ends thereof, which cooperate in a manner to provide a locking action between said parts as is shown in Fig. 9.

We claim:

In a diaphragm, a plurality of annular diaphragm sections assembled to provide an expandable and contractile bellows-type wall, said annular diaphragm sections including each; an annular wall portion which extends at an angle to the axis of said bellows-type diaphragm wall, an outer marginal flange and an inner marginal flange, said flanges extending in opposite directions, with the inner flange of one section lying outside of and overlapping the inner flange of a second, adjacent section and being welded thereto, and the outer flange of said second section lying within and overlapping the outer flange of a third section and being welded thereto, the diaphragm formed by said assembly being reinforced by solid rings, said rings being secured by welding the same to said inner flanges.

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