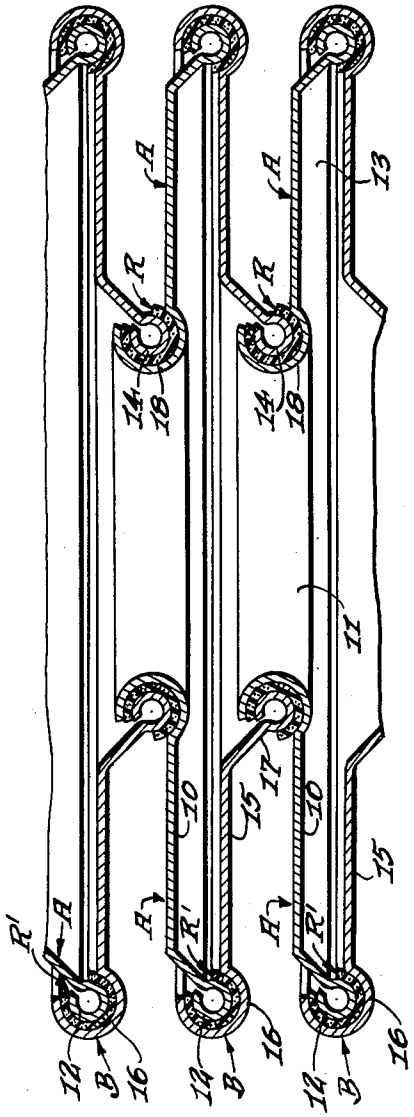
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FLEXIBLE BELLOWS

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FLEXIBLE BELLOWS

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This invention relates to improvements in flexible bellows and has for a principal object, the provision of bellows of greater flexibility than has heretofore been possible.

Another object of the invention is the provision of fabricated flexible bellows adapted to be extended a greater amount, and having a minimum number of flanges.

A further object of the invention is the provision of fabricated metallic bellows in which the fatiguing of the metal, from which the bellows are formed, is reduced to a minimum.

Yet another object of the invention is the provision of fabricated bellows adapted to be easily manufactured on a mass production basis at a lower cost than fabricated bellows of the prior art.

These and other objects of the invention will be readily apparent to those skilled in the art, upon perusal of this specification and the accompanying drawing.

Referring now to the drawing, which is merely given by way of example to illustrate the invention, a cross sectional elevation of one type of bellows made according to the invention is shown.

Referring to the drawing, it will be noted that the bellows shown is built up or fabricated from two differently formed types of diaphragms, one designated as A and the other as B, and these diaphragms are alternated with sealing means between the junctures of the flanges of said diaphragms. The flange A consists of a circular metallic disc 10 with a circular hole 11 in the center formed from a flat sheet of metal, or any other suitable material, such as sheet plastic material, fiber, or the like. The outer edge 12 of this disc is rolled as shown by means of a spinning operation or by a pressing operation, so that it forms a rounded or rolled edge. The disc 10, when formed, is cupped so that when assembled with a diaphragm of the type B, a space 13 is formed therebetween. The edge 14 about the circular opening 11 in the center is made in the form of an annular U-shaped channel, by way of example, and this shaping may be accomplished in the same operation as the formation of a rolled edge 12, for example, in a press of proper design.

The diaphragm B, designated by the numeral 15, is in the form of a flat disc, the outer edge 16 of which is also shaped in the form of a U-shaped channel. The disc 15 has a central offset portion 17 with a circular hole therein and the edge 18 bounding this hole is rolled or beaded, for example, somewhat like the edge 12 formed on the diaphragm A.

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Many diaphragms of both types may be made up, and in assembling them, they are alternately disposed in interlocking relation, as will now be explained. In the two types of diaphragms, the respective dimensions should be such that the rolled inner edge 18 of the diaphragm B easily and loosely fits in the U-shaped inner edge 14 of the diaphragm A. Likewise, the rolled-over outer edge 12 of the diaphragm A loosely fits into the U-shaped channel 16 formed on the outer edge of the diaphragm B. These fits should be such that it is possible to place a sheet of resilient sealing material, such as rubber, artificial or synthetic rubber, or any other sealing material which can be punched out in the form of rings, between them. This is done by positioning the ring sealing material R in the U-shaped channel of one diaphragm, for example, the channel 14 of the diaphragm A, after which the rolled edge of the B type diaphragm, for example, the rolled edge 18, will make a snug fit in this channel.

Likewise, ring R' of the sealing material is placed in the U-shaped channel of the last mentioned type diaphragm, for example, the channel 16, and the rolled or beaded edge of the other type diaphragm, for example, the rolled edge 12 of the diaphragm A may be placed therein with a snug fit.

In order to fabricate a complete bellows, several different procedures may be followed, of which the following is indicated by way of example.

Diaphragms of the two types are assembled in pairs in such a manner that first the inner edges, for example the edges 14 and 17, are joined together with resilient rings of the inner edge diameter, for example the rings R are used. A ring of this type is placed in the U-shaped inner edge channel 14 of the diaphragm A and then the rolled edge 18 of the diaphragm B is placed on top of the resilient ring and pressed downwardly so that the beaded or rolled edge 18 now fits the U-shaped channel 14 closely. The two diaphragms, so assembled, are then placed into a proper tool and the free upright edge of the U-shaped channel 14 is rolled over so as to firmly embrace both the beaded edge 18 and the interleave R of resilient material. It is, of course, immaterial whether this rolling over is effected by means of a spinning operation, by means of a press operation, or in any other suitable manner.

When a sufficient number of A and B diaphragms have thus been assembled in pairs, the pairs are assembled in a similar manner in another operation. It will be noted that when the diaphragms are assembled in pairs, the B

diaphragms are foremost. Now, starting in with one pair which has been so assembled and with the type B diaphragm foremost, a resilient ring R' (or larger diameter than the rings R) is placed in the U-shaped channel 16. The operator then picks up another pair which has been previously assembled and places the curled or rolled edge 12 against the resilient ring R', and presses downwardly, with the result that the portion 12, the resilient ring R' and the curled or rolled edge 12 form a close fit when pressed downwardly. Thereafter, the upright edge of the U-shaped channel 16 on the diaphragm B is rolled or spun over the rolled or beaded rim 12 of the diaphragm A and the resilient ring of rubber or the like, in a manner similar to the first rolling-over process described. It is also true that this operation may be effected by spinning, pressing, or in any other suitable manner.

The assembly may be continued in the same manner and each time a pair of diaphragms is added to the stack being formed, a workable bellows section is formed. The process may be carried on until the number of flanges or sections desired for the particular type of bellows being manufactured have been included in the assembly.

Although the diaphragm A is shown as having the greater portion of its radius outside of the inner rolled edges, and although the diaphragms B have the greater portion of their radius inside of the outer rolled edges, it will be understood that the diaphragms may be formed in any manner desired without departing from the spirit of the invention. As an example of this, the diaphragms may be formed with concentric corrugations or the like, so as to allow them to move through any desired arc, after assembly.

If the bellows diaphragms and the rubber, neoprene or other resilient sealing material are of the proper characteristics, the diaphragms and flexible rings therebetween may be bonded together, for example by properly vulcanizing the rubber or neoprene as an adhesion process. When this is done, the union between the metal diaphragms and the resilient rings is a very close one and it is almost impossible to separate one from the other, so that the entire bellows structure becomes a fluid-tight, integral unit of great strength and flexibility. The strength is governed primarily by the strength of the metals used in the diaphragms and which surrounds the resilient material both at the inner and outer diameters, for example 14 at the inner diameters and 16 at the outer diameters.

Assuming that the bellows are made of brass diaphragms or if the diaphragms are of other metals which have been brass plated, and assuming that the rings R and R' are made from rubber or artificial rubber, it is possible to make practically indestructible bonds between the diaphragms and a completely air-tight and liquid-tight joint is formed at both the inner and the outer edges of each section of the bellows.

It will be clear from the above that the bellows assembled in this manner shows a marked freedom of motion and can be extended to a far greater degree than bellows made of metal alone. The action of my new and improved bellows is governed largely by the degree of compliance of the interleaving ring material (R and R'). Any flexing of this material will take place in "shear" and it is well known that rubber flexed in shear is subject very slightly, if at all, to the phenomenon known as fatigue, which is so apparent

in metals which have been bent repetitively. As a matter of fact, longitudinal motion of my bellows will manifest itself in the edges of the diaphragms as rolling actions of the beaded edges with respect to the rolled-over outer edges, the rolling action taking place within the resilient material. The only stresses to which the metal forming the diaphragms are subjected, occur in the corrugations which may be placed concentrically in the metal, but here the action will be very slight and will never approach the elastic limit of the material from which the diaphragms are made, if the design of the bellows has been executed properly.

One of the greatest advantages of my method of assembly herein described is that it is possible, at will, to fabricate the bellows (*a*) for expansion purposes (*b*) for compression only, or (*c*) for both contraction and expansion purposes. This feature becomes apparent when it is considered that it is possible to vulcanize the resilient material after assembly in any desired position of the assembled bellows.

If the resilient material is of the proper compound, the bellows will always return to the position in which the vulcanizing process was carried out. It is obvious that the snappiness of the return action may be increased by means of a suitable spring arrangement devised to urge the bellows in the desired direction when the same is mounted for any particular use. It will also be apparent that the end diaphragms or plates of the bellows may be mounted in almost any manner desired. They may take many forms or may be shaped to any shape necessary for the purpose for which the bellows are to be used, and they may be soldered to the bellows or rolled in connection therewith in a manner similar to the method described herein above with resilient material bonded to the diaphragm and the end plate.

The system of bellows shown in the drawing may be rapidly assembled in the following manner.

The diaphragms 10 may be formed by curling the outer edges 12 of the discs and by curling the iner edges 11 part way. In other words, instead of first curling them in the form shown in the drawing, they would be curled half way, leaving the free edge from the center of the curve upwardly straight.

The diaphragm 15 would have its inner edge 18 curled as shown and the outer edge 16 would be curled so that the free edge from the center of the curve upwardly would be straight.

Then, the discs would be assembled in pairs by placing a ring of rubber-like material within the partially curled inner edge 14 of disc 10 and then placing the curled inner edge 18 in contact with the rubber-like material R and then finishing curling the edge 14 until it assumes the form shown in Figure 1. A number of these pairs may be so assembled and the rubber-like material may be vulcanized. Then, the pairs are assembled together to form an array by placing a ring of rubber-like material R' within the partially curled outer edge 16, positioning the curled outer edge of the mating diaphragm in contact with the material R', then finishing curling the outer edge 16 until it assumes the shape shown in Figure 1, and subsequently the rubber-like material R' may be vulcanized.

I would point out that in a bellows so formed, strains which are conducive to destroying fabricated metallic bellows of the prior art are elimi-

nated. In such bellows of the prior art, wherein a metallic bond is established between the discs forming the bellows, the flexing of such bellows causes strains in the metal adjacent to such metallic bonds which after a comparatively few expansions and compressions of the bellows produces fatigue in the material. My bellows, constructed in accordance with the present invention, have no such strains and consequently have almost unlimited life, without appreciable fatigue.

Although I have herein shown and described by way of example a preferred embodiment of the invention and a modification thereof, it is obvious that many changes may be made in the arrangements shown and described within the scope of the following claims.

What is claimed is:

1. In a flexible bellows, a plurality of metallic diaphragms having their outer and their inner edges terminating the arcuate portions in excess of 180°, said diaphragms being in two series, one series in which the diameter of its arcuate portion of its inner edge is larger in diameter than the arcuate portion of its outer edge, and another series in which the arcuate portion of its outer edge is larger in diameter than the arcuate portion of its inner edge, said diaphragms being alternated in an array with said larger arcuate portions embracing the smaller arcuate portions, and flexible sealing means between the embrasures.

2. In a flexible bellows, a plurality of diaphragms each in the form of an annulus and each having both its inner and its outer edges arcuate in form, each diaphragm having its outer edge interlocked with one of its neighbors and having its inner edge interlocked with the other of its neighbors on the other side thereof, and flexible sealing means between each such interlock.

3. In a flexible bellows, a plurality of annular diaphragms, each having both its inner and its outer edges arcuate in form, its inner edge being in interlocked relation with the inner edge of one of its adjacent neighbors and its outer edge being in interlocked relation with the outer edge of its other adjacent neighbor, and flexible plastic sealing means between each such interlock.

4. In a flexible bellows, a plurality of annular metallic diaphragms, each having its inner and outer edges arcuate in form and disposed in an array of interconnected pairs, each of said pairs having corresponding arcuate edges of the diaphragms thereof interlocked, the interconnections between said pairs being comprised of other corresponding interlock arcuate edges of neighboring diaphragms, and flexible plastic sealing means between and bonded to the adjacent surfaces of each such interlock.

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