May 19, 1931. C. J. WHITACRE 1,806,009

BELLOWS AND METHOD OF MAKING THE SAME

Filed May 26 1928 2 Sheets-Sheet 1

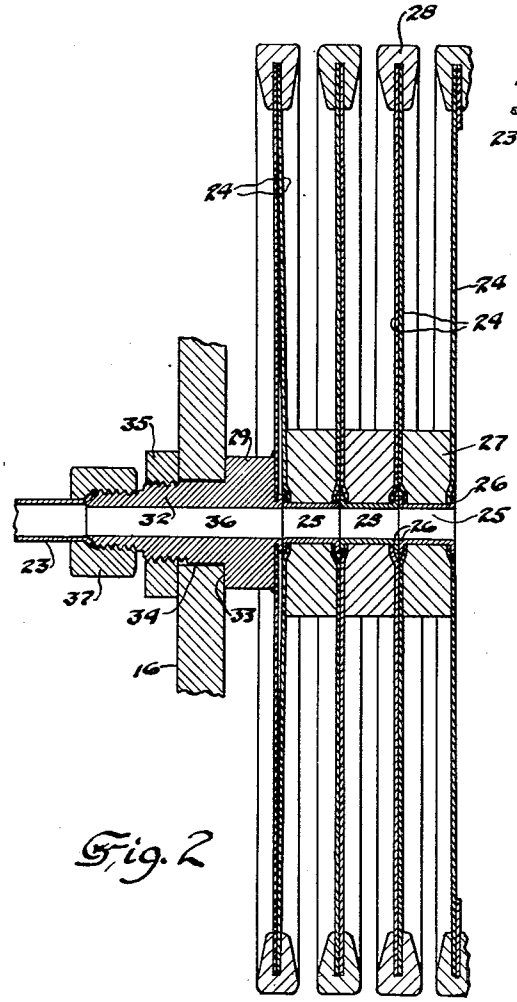

Fig. 2

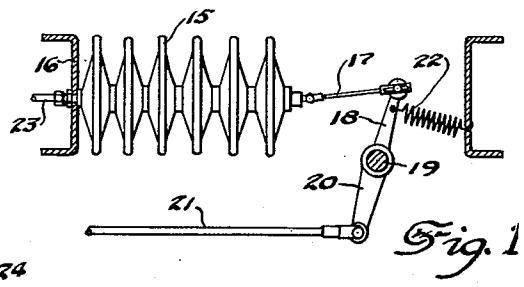

Fig. 1

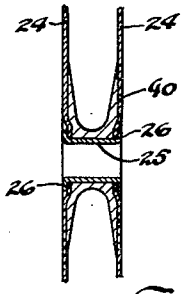

Fig. 4

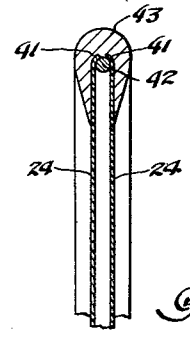

Fig. 5

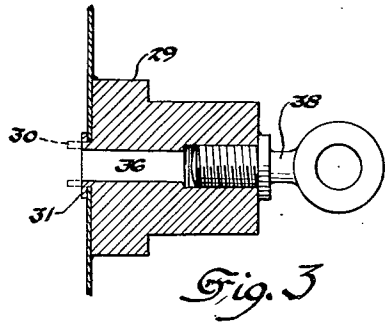

Fig. 3

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BELLOWS AND METHOD OF MAKING THE SAME

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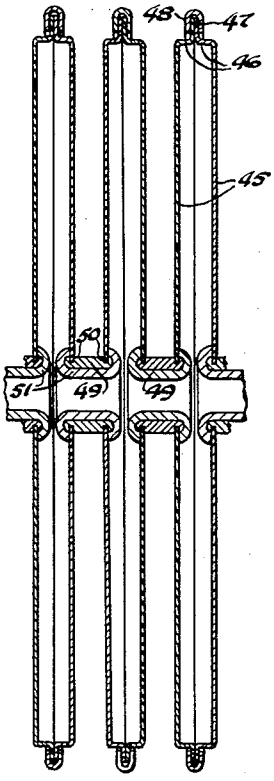

Fig. 6

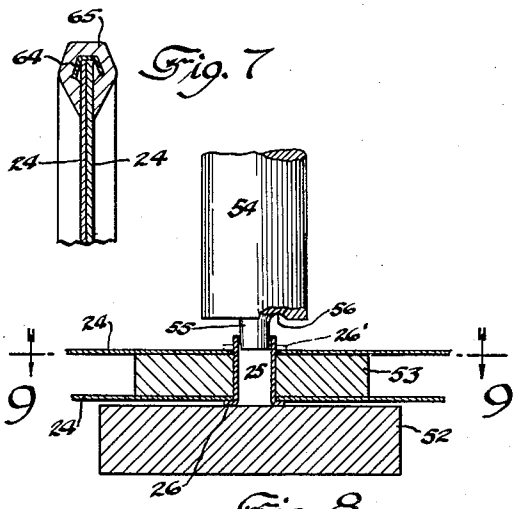

Fig. 7

Fig. 8

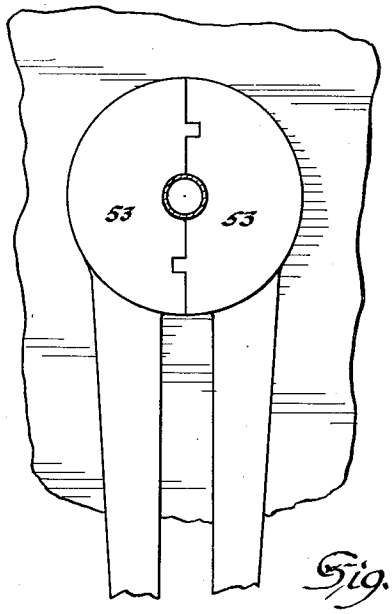

Fig. 9

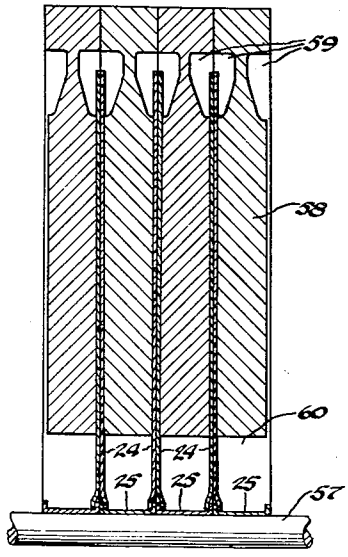

Fig. 10

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UNITED STATES PATENT OFFICE

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BELLOWS AND METHOD OF MAKING THE SAME

Application filed May 26, 1928. Serial No. 280,948.

This invention relates to bellows and method of making the same, the principal object being the provision of a new and novel construction which will permit an unusually large amount of expansion and contraction of the same with a minimum of stresses set up in the walls of the bellows, as well as a simple and economical method of forming the same.

Another object is to provide a bellows of the metallic type in which the metallic walls of the bellows are not integrally united in the manner followed in conventional constructions.

Another object is to provide a bellows having metallic side walls joined to each other and sealed against leakage by a non-metallic connection.

Another object is to provide a bellows in which the stresses set up in the metal walls thereof during expansion or contraction are evenly distributed over such walls and not localized as in conventional constructions.

Another object is to provide a bellows in which the metallic side walls are joined to each other by a resilient non-metallic connection so positioned with respect to the side walls as to form a self-sealing joint between the various metallic members thereof.

Another object is to provide a bellows comprising a plurality of separately formed disc-like members joined in pairs at their outer edges and sealed against leakage by a resilient non-metallic means and joined in pairs at their inner edges by a metallic connection sealed by a resilient non-metallic means.

Another object is to provide a method of making bellows comprising securing a plurality of metallic discs together in pairs adjacent their centers by a metallic sleeve and thereafter vulcanizing a resilient non-metallic material to each pair of discs and their corresponding sleeve, and further securing said discs together in pairs at their outer edges by vulcanizing a resilient non-metallic material to such outer edges.

A further object is to provide a simple and economical method and apparatus for vulcanizing said resilient non-metallic material to said discs.

The above being among the objects of the present invention, the same consists in certain features of construction and combinations of parts to be hereinafter described with reference to the accompanying drawings, and then claimed, having the above and other objects in view.

In the accompanying drawings which illustrate suitable embodiments of the present invention and in which like numerals refer to like parts throughout the several different views,—

Fig. 1 is a more or less diagrammatic side view showing a vacuum operated type of bellows in its normally extended position.

Fig. 2 is an enlarged fragmentary sectional view taken through the axis of the bellows shown in Fig. 1.

Fig. 3 is an enlarged fragmentary sectional view showing an anchoring means for the movable end of the bellows shown in Fig. 1.

Fig. 4 is an enlarged fragmentary sectional view showing a modification of the construction at the inner edges of a pair of bellows discs or side members.

Fig. 5 is an enlarged fragmentary sectional view showing a modification of the construction at the outer edges of a pair of the bellows discs.

Fig. 6 is a fragmentary sectional view showing a modified form of construction employed for bellows of the pressure expanding type.

Fig. 7 is a fragmentary sectional view showing a modified manner of securing the outer edges of the bellows discs together.

Fig. 8 is a more or less diagrammatic fragmentary sectional view showing the manner of securing the central sleeve in place between a pair of bellows discs.

Fig. 9 is a fragmentary sectional view taken on the line 9—9 of Fig. 8.

Fig. 10 is a fragmentary sectional view showing apparatus that may be employed in applying the resilient non-metallic material to the various discs.

Bellows of the metallic type have come

into a wide range of use in recent years for a variety of purposes. There are limitations in such bellows as have heretofore been manufactured that prevent their economical application to a wider range of uses than is now being made, and which limitations are overcome by the use of the present invention. Such limitations are, for instance, the inability of the conventional forms of metallic bellows to expand and contract repeatedly with a relatively great amount of expansion or contraction because of the fact that in the conventional form of bellows the various disc-like portions of the bellows are integrally united at their inner and outer edges, at which points the greatest bending stresses in the metal during expansion and contraction are localized, and upon repeated expansion and contraction of the bellows these stresses cause a crystallization of the metal at these points which ultimately results in a rupture of the metal and consequent destruction of the bellows. Furthermore, where such bellows are made of a single piece of metal formed by any one of the variety of conventional methods into the various disc-like portions, the forming operations tend to cause an unevenness in the thickness of the metal which exaggerates the difficulties mentioned above.

By the use of the present invention a bellows is provided, particularly for the vacuum operated type of bellows, wherein any of the usual stresses apparent in conventional constructions at the inner and outer portions of the bellows are completely eliminated, thereby permitting the bellows to be expanded and contracted to a much greater degree than is possible in the conventional forms of metal bellows without the possibility of consequent rupture, and further provides a construction in which the bellows are self-sealing.

The vacuum operated type of bellows is often employed in connection with the primary or secondary applying means for the brake mechanism of motor vehicles. While the particular application of the bellows to such brake mechanisms may vary with the particular brake mechanism being employed, that shown in Fig. 1 may be taken as an example of one form. As shown in Fig. 1, a bellows designated generally as 15 in that figure is rigidly secured at one end to a channel member 16 which may be considered as one of the frame cross members of a motor vehicle. The opposite or movable end of the bellows 15 may be connected by a rod, link or other member 17 to a lever 18 secured to a brake cross shaft 19 suitably supported from the chassis of the vehicle. The brake cross shaft 19 is generally provided with one or more levers 20 which are connected through linkages such as 21 to the various brakes (not shown) of the vehicle. The bellows 15 is normally held in extended position by spring means such as 22 which holds the brakes in inoperative position. The interior of the bellows is connected by a tube 23 to a suitable source of suction or partial vacuum, suitable valvular means (not shown) being inserted in the connection for controlling the application of suction to the bellows 15. Upon admission of suction through the tube 23 to the interior of the bellows 15, the bellows is caused to collapse against the resistance of the spring 22, thus moving the shaft 19 about its axis in a counter-clockwise direction, as viewed in Fig. 1, and causes the links or rods 21 to be moved longitudinally and apply the brakes of the vehicle.

The bellows, in accordance with the present invention, comprises a plurality of separate metallic discs 24. The discs 24 are joined together at their centers in pairs by metallic sleeves 25, the sleeves 25 being freely receivable in the central opening of the corresponding discs 24 and being provided with peripherally extending flanges 26 at each end thereof, the flanges 26 overlying the adjacent outer surface of the corresponding pair of discs. The discs 24 for each sleeve 25 are maintained against their corresponding flanges 26 by a mass of resilient non-metallic material 27 surrounding each sleeve 25 between the corresponding discs 24. The material 27 which is preferably rubber or a rubber composition is preferably vulcanized or otherwise secured to both the sleeve 25 and the adjacent faces of the corresponding discs 24. The outer edge of each disc of each of the aforementioned pairs of discs is secured in contact with the outer edge of one of the discs of another pair of the aforementioned discs 24 by means of a mass of resilient non-metallic material 28 enclosing such edges and preferably vulcanized or otherwise secured thereto, as is illustrated in Fig. 2. The discs 24 are preferably formed substantially flat with their inner edges sufficiently offset so that each pair of discs connected together at their outer edges by the material 28 which, of course, extends completely around the outer edges of such discs, lie in contact with each other over substantially the full area when in free or collapsed position. I prefer to form the discs substantially flat as shown, and not with the usual corrugations or other uneven surface portions as are often found in conventional constructions, so that when the discs are deformed during operation of the bellows all parts thereof will be subjected to substantially the same and equal stresses, thereby preventing localization of such stresses at any one or more points, lines or areas of the discs.

Each end disc of each bellows may be secured to a post or other member 29 by form-

ing on such member a sleeve-like extension 30, indicated by dotted lines in Fig. 3, which may be inserted in the central aperture in the disc and thereafter flanged over as at 31, after which the disc may be soldered or otherwise further secured to the member 29, if desired. The member 29 for one end of the bellows may be formed with an extended portion 32 and a shoulder 33, the extended portion 32 being adapted to be received in an opening 34 in the supporting member 16 with the shoulder 33 drawn up against one side of the member 16 by a nut 35 threaded on the portion 32 on the opposite side of the member 16. The members 29 are provided with a central opening 36 leading into the interior of the bellows and one of which may be connected by a nut 37 to the tube 23 leading to the source of suction. The member 29 for the opposite end of the bellows may have its central opening 36 internally threaded for reception of the eye member 38 which serves to seal such opening and which serves as a means for connecting the movable end of the bellows to the link or rod 17.

From the foregoing it will be apparent that with this construction when the bellows is extended, any movement between the various discs 24 at their outer edges is taken care of by deformation of the material 28 and therefore causes no stress to be set up in the metal of the bellows at such outer edges. Likewise when the bellows are extended, any movement of one disc relative to another disc at its inner edge is taken care of by deformation of the resilient material 27 between them, thereby eliminating the setting up of any bending stresses at such inner edges. Furthermore, the material 27 and 28, when the bellows is in extended position and a suction is applied to the interior of the same, is drawn by the suction into more firm contact with the discs 24 and thus provides a self-sealing means for the bellows. Thus, with this construction, the only actual stresses set up in the metal of the discs are those evenly distributed stresses caused by the dishing of the discs 24, and no actual stress whatever is set up due to the deformation of one disc relative to the other disc at the outer or inner edges of such discs because there is no metallic connection between such discs at such edges, and at the same time where the material 27 and 28 is of rubber, the greater ability of of such material to deform without rupture in comparison to the metal of the discs 24 itself, permits a greater degree of expansion and contraction of the bellows than is practically possible in the conventional types of the same.

It will be apparent that when the bellows are in extended position and the suction is applied to the same, the suction will tend to draw each contacting pair of discs 24 into close relationship and will tend to separate each separated pair of discs, the last tendency being taken care of by the sleeve members 25 which transmit the effect of the suction from the one pair of discs to the adjacent pair.

In Figs. 1 and 2, the material 27 and 28 between the various pairs of discs 24, is shown as being of rectangular cross section. It may be desirable in some cases, particularly where the relative expansion of the bellows is great, to form the material 27, as indicated in 40 in Fig. 4. As shown in Fig. 4, the resilient material 40 is formed so that its connection with the discs 24 feathers from maximum thickness adjacent the sleeve 25 to nothing at its outer edges, thus eliminating the central portion of the material shown at 27 in Fig. 1, so that such material will not be subject to as great a stress as it otherwise would be.

A modified form of construction for the discs 24 is shown in Fig. 5 in which the periphery of the adjacent discs 24 are turned slightly inwardly as at 41 and interposed between such in-turned edges 41 is a split ring 42 which serves to hold the discs 24 in slightly spaced relationship. The material 43, which serves to secure the outer edges of adjacent discs 24 together in this case, is shown as feathered from maximum thickness at the outer edge to nothing at its inner edges.

In Fig. 6 I show a modified form of bellows formed for pressure operation, that is, in which the bellows are normally maintained in free position and a positive pressure is introduced into the same in order to cause it to expand and perform some useful work. In this case, I prefer to turn the outer edges of adjacent discs 45 inwardly as at 46 and then outwardly as at 47 into contacting relationship so that the main body portions of the bellows 45 are spaced from each other. The edge portions 47 are preferably secured together by line welding or other suitable means and reinforced against separation and further sealed by U-sectioned ring members 48 pressed together over the contacting edges 47. The inner edges of the adjacent discs 45 may be secured together by sleeve members 49 having shoulders 50 bearing against the outer faces of the adjacent discs and sealed internally by a mass of resilient non-metallic material 51, as indicated in Fig. 6.

In Fig. 7 I show another modification of the construction at the outer edges of the discs which may be employed with either of the aforementioned types of bellows. In this figure the outer edges of cooperating discs 24 are relatively loosely secured against separation and in axial alignment by a metallic U-sectioned ring 64, and a rubber covering 65 encloses the ring 64 and is prefer-

ably vulcanized to the outer surfaces of the corresponding discs 24 inwardly thereof.

The vacuum operated type of bellows may be formed in the following manner, as indicated in Figs. 8 to 10 inclusive: A sleeve 25 having a flange 26 formed on one end only thereof may be inserted through the central opening of one of the discs 24 and the disc and sleeve positioned with the flange 26 in contact with a suitable block 52. A separable die member 53 may then be placed around the sleeve 25 above the disc 24, after which a second disc 24 may be placed around the upper end of the sleeve 25 above the die member 53. A tool 54 having a suitable pilot 55 receivable within the sleeve 25 and a curved annular recess 56, may then be applied to the sleeve 25 by inserting the pilot 55 within the sleeve 25 and applying sufficient force axially to the tool 54 so that the curved surface 56 will cause the upper end of the sleeve 25 to be flanged outwardly as at 26′ in Fig. 8. The die member 53 may then be separated and removed from between the discs 24.

A sufficient number of pair of discs 24 secured together as described in connection with Fig. 8 may then be assembled together on a rod such as is shown at 57 in Fig. 10, and a mold applied to the same, as shown in Fig. 10. The mold may comprise a plurality of semi-disc members 58 of a width substantially equal to the width of each pair of discs as connected together as described in connection with Fig. 8, and each semi-disc member cooperates with a like semi-disc member to effect a complete disc member positioned between and extended outwardly of each pair of discs 24. The mold members 58 are each provided with a circular depression 59 which cooperate in pairs to simulate the shape of the finished material 28 which is to surround the outer edges of each contacting pair of discs 24 and are cut-away at their inner edges as at 60 to simulate the material 27 which is to surround each sleeve 25 at the inner edge of each adjacent pair of discs 24. All of the semi-disc members 58 are suitably secured together and the rubber or other resilient material which is to form the portions 27 and 28 is forced into the recesses or cut-away portions 59 and 60 and then preferably submitted to suitable vulcanizing heat until it has become firmly fixed to the corresponding surfaces of the discs 24 and sleeves 25. The molds may then be allowed to cool after which the semi-disc portions 58 may be removed by expanding the bellows sufficiently to permit their removal.

Where the material 27 and 28 is of rubber or rubber composition, which I find it preferable to use, the discs 24 are preferably formed of hard brass and that portion to which the material is to be vulcanized suitably etched previous to vulcanization, thereby effecting a most permanent joint between the rubber and the discs.

Formal changes may be made in the specific embodiment of the invention described without departing from the spirit or substance of the broad invention, the scope of which is commensurate with the appended claims.

What I claim is:

1. A bellows having the outer edges of the wall members thereof joined together in pairs by a yieldable non-metallic material.

2. A bellows having the outer edges of the wall members thereof joined together in pairs by a resilient non-metallic material.

3. A bellows having the outer edges of the wall members thereof joined together in pairs, and sealed against leakage by a resilient non-metallic material surrounding such outer edges.

4. A bellows having the outer edges of the wall members thereof joined together in pairs, and sealed against leakage by a resilient non-metallic material overlying said edges and vulcanized thereto.

5. A bellows having the inner edges of the wall members thereof joined together in pairs by a connecting member and sealed against leakage by a non-metallic material.

6. A bellows having the wall members thereof joined together in pairs adjacent their centers by tubular metallic members and sealed against leakage by a resilient non-metallic material extending between each of said pairs of wall members adjacent said metallic members.

7. A bellows comprising a plurality of apertured discs sealed in pairs against leakage at their outer edges, and secured together in pairs adjacent their centers by a tubular sleeve extending between each of the last mentioned pair of discs, each of said sleeves being provided with flanges freely engaging the opposite side faces of each of said last mentioned pair of discs, and a rubber ring encircling each of said sleeves and abutting the adjacent faces of the cooperating discs.

8. A bellows comprising a plurality of aligned discs alternately joined at their outer and inner edges in pairs to form a unitary structure, the joint between each pair of said discs at their center comprising a flanged sleeve extending between said discs, and a non-metallic material sealing the joint between each of said discs and its corresponding sleeve.

9. A bellows formed of a plurality of centrally apertured discs alternately joined at their inner and outer edges in pairs, the joints between said discs subject to separation upon operation of said bellows being maintained against separation by a metallic

member, and the joints between said discs subject to be drawn into closer relationship upon operation of said bellows being secured together by a resilient non-metallic material.

10. In a bellows, a pair of disc-like members apertured adjacent their centers, a tubular member extending through said apertures and provided with flanges engaging the most remote side faces of said disc-like members, and a resilient non-metallic material surrounding said tubular member and contacting against said disc-like members for maintaining said disc-like members against said flanges and sealing the joint between each of said disc-like members and said tubular member.

11. The method of securing a pair of bellows discs together comprising passing a tubular member through said discs, flanging said member over to prevent removal of said discs therefrom, and then applying a non-metallic material to said sleeve between said discs in sealing relation with respect thereto.

12. The method of making a bellows comprising forming a plurality of centrally apertured discs, securing said discs in pairs against separation adjacent their centers, and thereafter securing one disc of each of said pairs of discs to one disc of another of said pairs of discs at their outer edges by f[illegible] a non-metallic material about said outer edges.

13. The method of making a bellows comprising forming a plurality of centrally apertured metallic discs, securing said discs in pairs adjacent their centers against separation by hollow metallic members, assembling two or more of said pairs of discs together in alignment, and thereafter molding a resilient non-metallic material about each of said metallic members between the corresponding pair of discs and about the outer edges of one disc of one of said pairs of discs and the adjacent disc of the adjacent pair of discs.

14. A bellows formed of a plurality of separately formed discs joined together in pairs at their outer edges and sealed against leakage at such edges by a resilient non-metallic material.

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