

April 16, 1935.

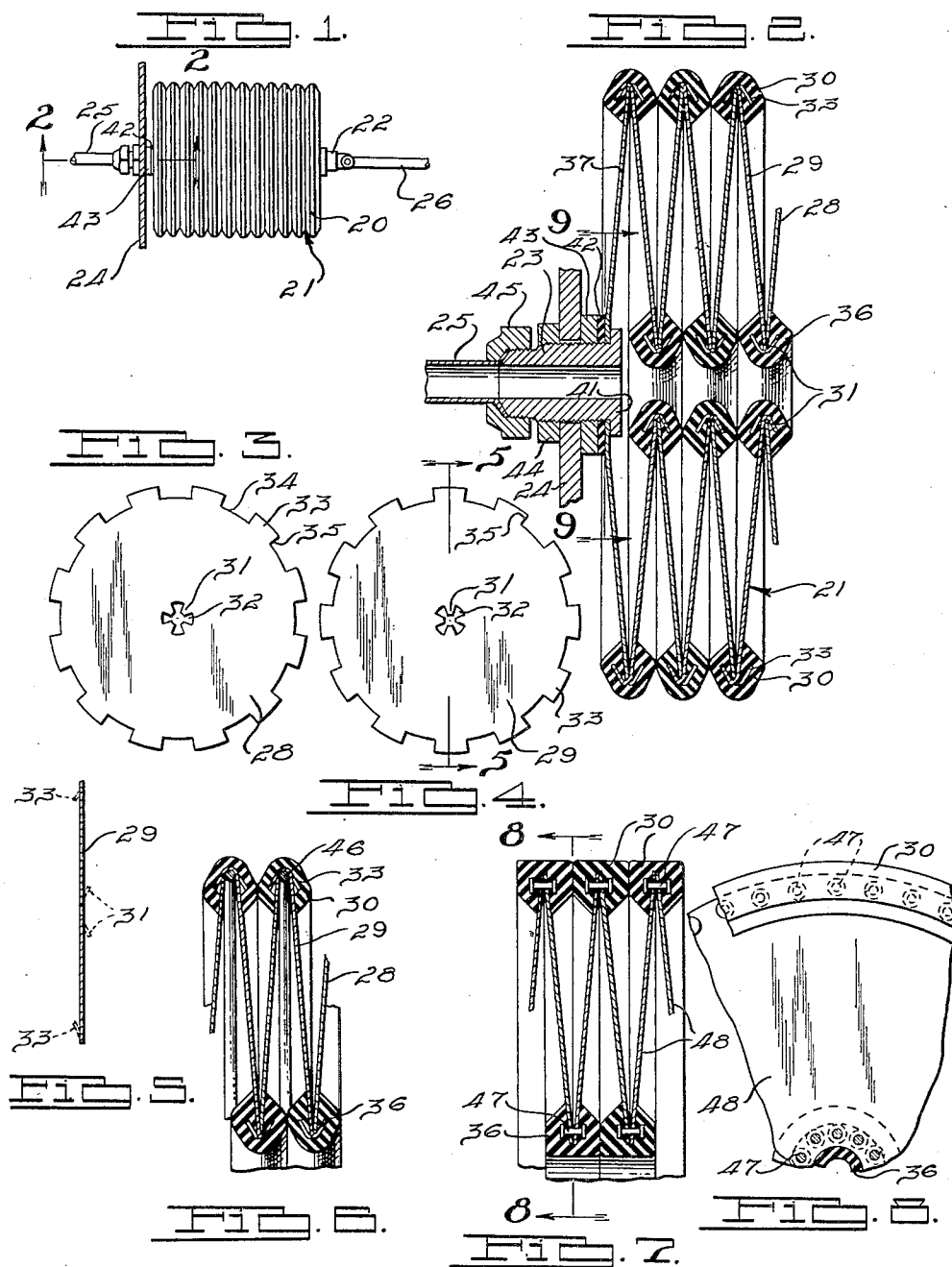
S. F. ARBUCKLE

1,997,565

BELLOWS

Filed Nov. 11, 1932

2 Sheets-Sheet 1



INVENTOR
Samuel F. Arbuckle.
BY *Harness, Wickey, Pierce & Hann.*
ATTORNEYS.

April 16, 1935.

S. F. ARBUCKLE

1,997,565

BELLOWS

Filed Nov. 11, 1932

2 Sheets-Sheet 2

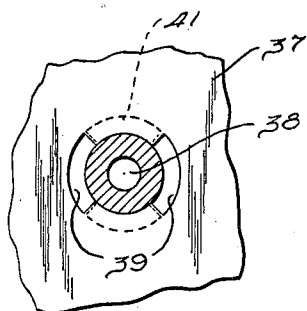


FIG. 9.

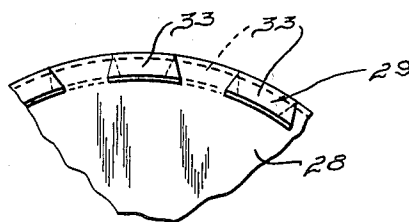


FIG. 10.

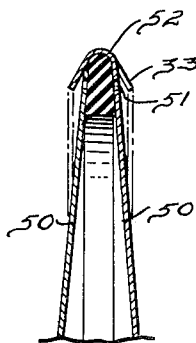
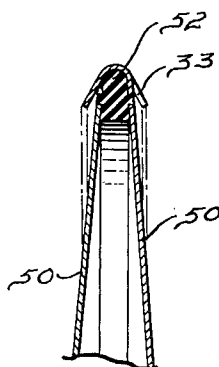


FIG. 11. FIG. 12.

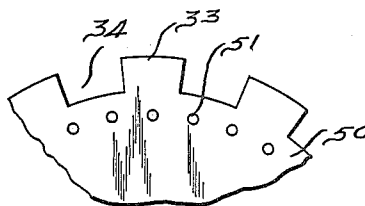


FIG. 13.

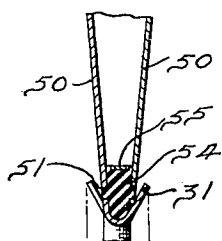


FIG. 14.

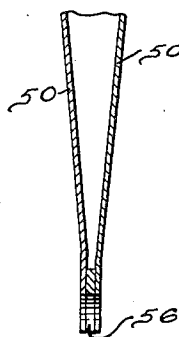


FIG. 15.

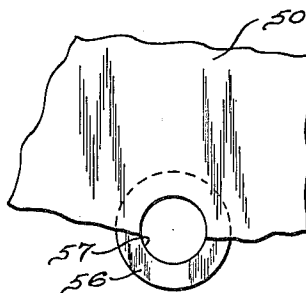


FIG. 16.

INVENTOR
Samuel F. Arbuckle.

BY
Harness, Hickey, Pierce & Hann.
ATTORNEYS.

UNITED STATES PATENT OFFICE

1,997,565

BELLOWS

Samuel F. Arbuckle, Highland Park, Mich., assignor to S. F. Arbuckle Corporation, a corporation of Delaware

Application November 11, 1932, Serial No. 642,154

7 Claims. (Cl. 137—156.5)

My invention relates to pressure elements in the nature of bellows or sylphons and primarily to a bellows which is completely flexible and capable of withstanding high pressures to be utilized primarily for doing work through its expansion.

The main objects of my invention are: to provide a plurality of plates of thin material which are relatively flexible and which are secured together in pairs at their inner and outer peripheral edges by flexible joints which permit the movement of the plates relative to each other; to provide joints between the disc-like plate, which go to make up the bellows, which are flexible and which are sealed by a resilient material against the leakage of the fluid which provides the pressure; to provide the peripheral edges of the adjacent discs with extending tenons, the side edges of which are radially disposed so that when they are mated in overlapping relation the bottom portion of the tenons will be in close adjacent relation to each other, forming a lock for preventing the upper portion of the tenons from pulling between the adjacent tenons of opposite discs; to have the tenons disposed in angular relation to the adjacent discs to permit the discs to move outwardly a predetermined distance before the tenons are engaged, which thereafter serve as stop elements to limit the further movement of the discs; to provide a device in the nature of a bellows or sylphon which is operated under pressure either by internal or external pressure, as the case may be, which is simple in construction, economical of manufacture and positive in operation.

Other objects and features of novelty of my invention will be either specifically pointed out or will become apparent when referring, for a better understanding of my invention, to the following description, taken in conjunction with the accompanying drawings, wherein:

Figure 1 is a view, in elevation, of a bellows or sylphon embodying features of my invention,

Fig. 2 is an enlarged broken sectional view of the structure illustrated in Fig. 1, taken on the line 2—2 thereof,

Fig. 3 is a disc-shaped metal element which forms one portion of a pair of plates which go to make up my device,

Fig. 4 is a plan view of a disc to be mated with the disc in Fig. 3, to form a pair of discs of my device,

Fig. 5 is a sectional view of the structure illustrated in Fig. 4, taken on the line 5—5 thereof,

Fig. 6 is a broken sectional view similar to the

structure illustrated in Fig. 2, showing a modified form thereof,

Fig. 7 is a view similar to the structure illustrated in Figs. 2 and 6, showing a further modified form thereof,

Fig. 8 is a broken sectional view of the structure illustrated in Fig. 7, taken on the line 8—8 thereof,

Fig. 9 is a sectional view of the structure illustrated in Fig. 2, taken on the line 9—9 thereof,

Fig. 10 is a broken view of a portion of a pair of discs illustrating the overlapping relation of the tongues thereof,

Fig. 11 is an enlarged broken view of two assembled discs showing a further modified form thereof,

Fig. 12 is a view similar to that of Fig. 11, before the sealing operation,

Fig. 13 is a broken view of one of the plates employed in the structure illustrated in Figs. 11 and 12,

Fig. 14 is a broken sectional view of a pair of plates illustrating a modified form of construction at the inner portion thereof,

Fig. 15 is a broken sectional view of a pair of plates illustrating a further modified form of connection at the inner portion thereof, and

Fig. 16 is a broken plan view of the structure illustrated in Fig. 15.

In the patent to C. J. Whitacre No. 1,806,009 issued on May 19, 1931, and assigned to the assignee of the present invention, is illustrated, described and claimed a bellows of the flexible type having disc-like plates which are retained together at their inner and outer periphery in pairs, solely by rubber annular vulcanized members which sealed the edges of the discs together and permitted the ready separation of the opposite pairs from each other to provide an extremely flexible bellows. The bellows therein illustrated and described, was employed primarily for operation by external pressures which forced the discs together as the air on the inner side thereof was withdrawn. While this type of bellows operated successfully on external pressures, internal pressures caused the edges of the pairs of mated plates to separate, stretch the rubber and tended to tear the rubber from sealed relation to the plate. On ordinary pressures the type of construction in the patent operated satisfactorily but on higher internal pressures difficulties were experienced.

The present invention relates primarily to a bellows which will stand high internal pressure without damage to the rubber seal provided about

the mated peripheral edges of the disc and which may therefore be substituted for longitudinally movable devices such as pistons and cylinders for producing heavy work. The novelty of the present invention resides in the locking of the peripheral edges of the pairs of plates together to prevent and limit the separation thereof and to provide complete flexibility to the disc to permit them to be separated a maximum amount. This type of bellows can be employed to advantage in the place of a cylinder not only because of the cheapness of construction and the minimum amount of space required, but also in view of the fact that only half of the volume of fluid pressure is required to produce the same longitudinal movement of an actuating arm.

In Fig. 1, I have illustrated a bellows 20 made up of a plurality of pairs of discs 21 which is provided with lugs 22 and 23, which may be welded to the plate but which preferably are mechanically secured thereto through a 90 degree movement of the lugs, as illustrated in Fig. 9. One end of the bellows may be attached to a fixed element 24 and have a fluid conductor 25 secured thereto while the other end may be provided with an actuating rod 26 for producing work.

Referring to Figs. 2 to 5 inclusive, I have illustrated the bellows 20 having the pairs of discs 21 made of plates 28 and 29, as illustrated in Figs. 3 and 4 respectively. The plates are similar stampings mounted together in such offset relation to each other that the inwardly projecting tongues 31 of the plate 28 may be disposed in the spaces 32 between the tongues 31 of the plate 29, while the extending tenon 33 at the outer periphery of the plate 28 mate with the spaces 34 between the tenons 33 of the plate 29. It will be noted that the side edges 35 of the tenons are radially disposed so that the tenons are wider at their top edge than at the edge aligned with the bottom of the slot 33, the purpose of which will be referred to hereinafter.

A plurality of the plates 28 and 29 are assembled together in pairs at their inner edges through the bending of the tongues 31 into the spaces 32 of the opposite plates closely to the base of the tongues, and bent substantially 145 degrees so as to be spaced from the adjacent plates, as illustrated clearly in Fig. 2. After the discs are assembled in this manner a rubber seal 36 is provided over the peripheral edges of the assembled disc by a vulcanizing operation, preferably such as to employ the spraying process which is now successfully utilized. The plates are disposed in disconnected pairs, that is to say, are connected only at their inner peripheral edges, which edges are readily available for the spraying or other operation for securing, preferably by vulcanization, the annular rubber seal 36 thereon. Thereafter, the pairs of plates are connected together, one plate 28 of one pair being mated to a plate 29 of an adjacent pair and the tenons 33 bent over the adjacent plate so as to be spaced therefrom, as clearly illustrated in Fig. 2. After the assembly of all the plates in this manner, they may be placed under tension to pull the edges of the discs away from each other so that the peripheral edges and surfaces are exposed for the spraying or other vulcanizing process for securing a rubber seal 30 to the outer peripheral edges of the pairs of plates 21.

The thickness of the metal of the discs 28 and 29 and the type of metal employed, depends upon the service for which the bellows is to be employed, being such as to withstand the pressure

and at the same time to permit the discs to assume conical shapes. When the pressure is introduced to within the bellows, the discs assume a flat conical shape, the only substantial opposition thereto is that of the metal itself, the selection of which and the thickness depending primarily upon the pressure employed. The joints at the inner and outer peripheries of the plates permit the ready movement of the plates from each other and does not substantially interfere with the expansion of the bellows. However, the plates of the bellows are prevented from separating from each other by the angularly disposed tongues 33 and tenons 31 which securely retain the plates and limit their movement. The greater width of the overlapped portion of the tenons 33, prevent the plates from being stressed to such an extent as to cause the tenons to be drawn through the base of the slots 34 which is of less width than the width of the tenons. This is clearly illustrated in Fig. 10 wherein the tongues of adjacent plates are in overlapping relation. The angular disposition of the tongues 31 and tenons 33 from the adjacent plates limits the outward movement of the plates and function as stops for limiting the degree of expansion of the bellows and at the same time provides complete flexibility to the plate edges. The overlapping relation of the tongues is somewhat exaggerated in Fig. 10 to clearly bring out this locked relationship.

Referring to Figs. 2 and 9, I have illustrated the lug 23 attached to the outer disc 37 which, as illustrated in Figs. 2 and 9, is provided with a central opening 38 communicating with two cut-away sector portions 39 through which the sector shaped end 41 of the lug 23 extends. Thereafter, a washer 42 is passed over the lug and a nut 43 screwed down onto the sealing washer to completely retain and seal the lug to the plate 37. An additional screw 44 is employed for clamping the lug and bellows to the fixed element 24 and the conduit 25 is secured to the end of the lug by the clamping nut 45. A plate 37 is similarly employed on the opposite end of the bellows having a lug 22 secured thereto in the same manner as the lug 23 above described, was secured to plate 37 as illustrated in Fig. 2. The lug is of somewhat different form, having the central aperture omitted.

Referring to Fig. 6, I have shown a modified form of the structure illustrated in Fig. 2, wherein a spacing element 46 is employed between the outer peripheral edges of the adjacent discs 28 and 29 for spacing them a predetermined distance apart. This disc is preferably a metal split spring ring having the ends slightly spaced apart to permit the ring to assume a smaller diameter when the discs are separated under pressure while the tenons 33 are bent over the adjacent discs in substantially the same manner as that illustrated and described in relation to the structure illustrated in Fig. 2. In this instance it will be noted that the rubber seal 30 is not disposed between the tenons and the metal but is secured outwardly and frontwardly thereof, to permit a freer hinge action of the edges of the associated plates than would otherwise be possible if the rubber were disposed therebetween. It is to be understood that a similar ring 46 may be utilized at the inner edges of the mated pairs of plates if desirable.

Referring to Figs. 7 and 8, I have shown a further modified form of construction, wherein rivets 47 are disposed near the peripheral edge of the mated plate 48, of a length greater than

the thickness of the plates to permit a slight separation of the plates but to limit the separation beyond a predetermined distance to limit the stretching of the rubber. The rivets may be employed both at the inner and outer edge of the plates and it is to be understood that any of the constructions or the combinations thereof herein illustrated and described or other similar constructions can be employed for permitting the ready separation of the discs and at the same time limit the separation thereof at the peripheral edges. The rubber sealing material 30 is secured at the mated edges in a manner explained hereinabove, or in any other suitable manner.

In Figs. 11, 12 and 13, I have illustrated a further modified form of my invention wherein the spacing and sealing of the peripheral edges of the discs is accomplished by a flexible element which is vulcanized on the inner side of the disc. A pair of plates 50 having tongues 33 and spaces 34 at the peripheral edges and which may be provided with a plurality of apertures 51 near the edge, as illustrated more clearly in Fig. 13, are mated as herein described with the tongues 33 moved into interlocking engagement as illustrated in Figs. 11 and 12, after an inner annular rubber element 52 has been inserted about the inner peripheral edge of the disc. The tongues 33 move into locking engagement as illustrated in Fig. 10 and as described hereinabove to prevent the separation of the peripheral edges of the plates and to permit the flexing thereof. A fluid under pressure is then introduced into the space between the plates of Fig. 12 which compresses the rubber member 52, as illustrated in Fig. 11, to force the portions thereof into the apertures 51 when provided, which is thereafter heated so as to become vulcanized to the plates when compressed to thereby entirely seal the peripheral edges of the assembled plates. The apertures 51 receive a portion of the rubber to further lock the rubber in perfect sealed relation to the plates.

In Fig. 14, I have illustrated an annular rubber ring 54 sealed about the outer surface of a pair of plates 50 at the inner connection of the plates. In this construction, I may provide a metal ring 55 about the annular rubber element 54 so that when the inner tongues 31 are bent inwardly into interlocking relation to each other the rubber will be compressed against the resistance of the ring 55 to force it into intimate engagement with the metal of the plates 50 and into the apertures 51 thereof, when provided, after which the inner portion of the disc may be heated to cause the vulcanization of the rubber. The same assembly may be effected by eliminating the ring 55 and forming the connection of the plates at their inner edges by tongues 31 and thereafter employing a tool to encompass the rubber ring 54 to press it into intimate relation to the plates and into the apertures 51 and to retain the element under compression until the plates and rubber element are heated to effect the vulcanization. In this manner, complete flexibility of the bellows is provided at the inner and outer connection between the plates which are completely sealed against fluid pressure.

Referring to Figs. 15 and 16, I have shown a further method of connecting the inner edges of the plates which is illustrated, described and claimed in my Patent No. 1,367,792, issued February 8, 1921. In this construction a washer or disc 56 is disposed between each of the plates 50

of a pair of plates 21 at their central portions, after the central portions of the plates and the washers have been tinned and after a plurality thereof have been assembled with the washers aligned in central relation to the plates. Heat is provided to the central portion of the plates, preferably through the action of electric current therethrough, to melt solder and to cause a bond to be effected between the washers 56 and the plates, after which the central aperture 57 may be drilled therethrough to form the bellows. While this construction provides a more rigid connection between the plates at the central edges, for a majority of applications, sufficient flexibility will be provided to effect an operation since the outer edge practically controls the amount of flexibility obtainable in the bellows unit. When a maximum amount of flexibility is desired the inner flexible assembly, as illustrated in Fig. 14 and in other figures, is utilized.

The bellows thus formed are entirely flexible and are capable of withstanding a large internal pressure to produce a predetermined amount of work, an amount for which the particular bellows are constructed. The joined edges of the associated discs are completely flexible, the limitation of movement of the plates under pressure being caused primarily by the metal and thickness of the plates which are chosen for the particular work for which the bellows are to be employed. The tenons at the outer peripheral edges of the discs are united in locked engagement with each other and are spaced from the associated discs to function as stops for limiting the expansion of the plates to a predetermined angle. Sealing materials are employed for covering the tongues and tenons at the edges of the plates or disposed between the joined plates to completely seal the edges against the escape of the fluid pressure. This sealing material in no way interfering with the flexibility of the joints at the edges.

Couplings in the nature of lugs are secured to the end plates of the bellows by any suitable means such as welding, brazing or by mechanical connection, the latter being the preferred form. The fluid pressure is conducted through one of the lugs to and from the bellows, while the other lug is employed for connecting the bellows to the work. The bellows thus constructed may be made of any size and to operate on any pressure and can be used as a substitute for pistons and cylinders for doing any amount of work. An additional advantage is provided in the simplified construction and the requirement for only half of the volume of energy to accomplish the same degree of work.

While I have indicated hereinabove that the plates of the bellows were made of metal, it is to be understood that any suitable material such as fibre and the like, whether resilient or not, could be employed when the material is more or less lacking in resiliency, the rubber sealing element aids in returning the bellows to its original form. When necessary the rubber may be extended between the plates to a point beyond that illustrated, to increase this effect. The ring 46 also assists in returning the bellows to its original form. The rubber and interlocking relation of the plates permits the variation in the peripheral dimension of the pairs of plates as the bellows is expanded or contracted and at the same time seals the edges of the plates and retains them against separation beyond a predetermined allowable limit.

While I have described and illustrated several

embodiments of my invention, it will be apparent to those skilled in the art that various changes, omissions, additions and substitutions may be made therein without departing from the spirit and scope of my invention, as set forth in the accompanying claims.

I claim as my invention:

1. A bellows having the outer edges of the pairs of members retained against separation beyond a predetermined angle by spaced tangs which interfit and overlap the members to provide flexibility thereto, and a resilient non-metallic material sealing the edges against leakage.

2. A bellows having the members thereof joined together in pairs at their inner and outer edges by tangs which overlap the members and sealed against leakage by a non-metallic material.

3. A bellows having the outer edges of the pairs of members retained against separation beyond a predetermined angle by spaced tangs which interfit and overlap the members to provide flexibility thereto, and a resilient, non-metallic material sealing said edges on the inner side of said members.

4. A bellows having the outer edges of the pairs of members retained against separation beyond a predetermined angle by spaced tangs which inter-

fit and overlap the members to provide flexibility thereto and to form a locking relation with each other, means for sealing said edge, and means for rigidly connecting the inner edges of the pairs of discs together.

5. A bellows having the members joined together in pairs at their inner and outer edges by tangs which overlap the members and sealed against leakage by non-metallic material disposed on the opposite sides of the members from that over which the tangs extend.

6. A bellows formed from a plurality of disc members, said disc members being provided with a plurality of circumferentially disposed tangs having radially disposed sides which are bent back into overlapping engagement with an adjacent disc member to form a positive lock for the edges.

7. A bellows formed from a plurality of disc members, said disc members being provided with a plurality of circumferentially disposed tangs having radially disposed sides which are bent back into overlapping engagement with an adjacent disc member to form a positive lock for the edges, and resilient non-metallic material sealing said engagement.

SAMUEL F. ARBUCKLE.