July 28, 1931. L. M. PERSONS 1,816,610

METHOD OF AND MEANS FOR FORMING BELLOWS

Original Filed May 10, 1924 3 Sheets-Sheet 1

Fig. 2.

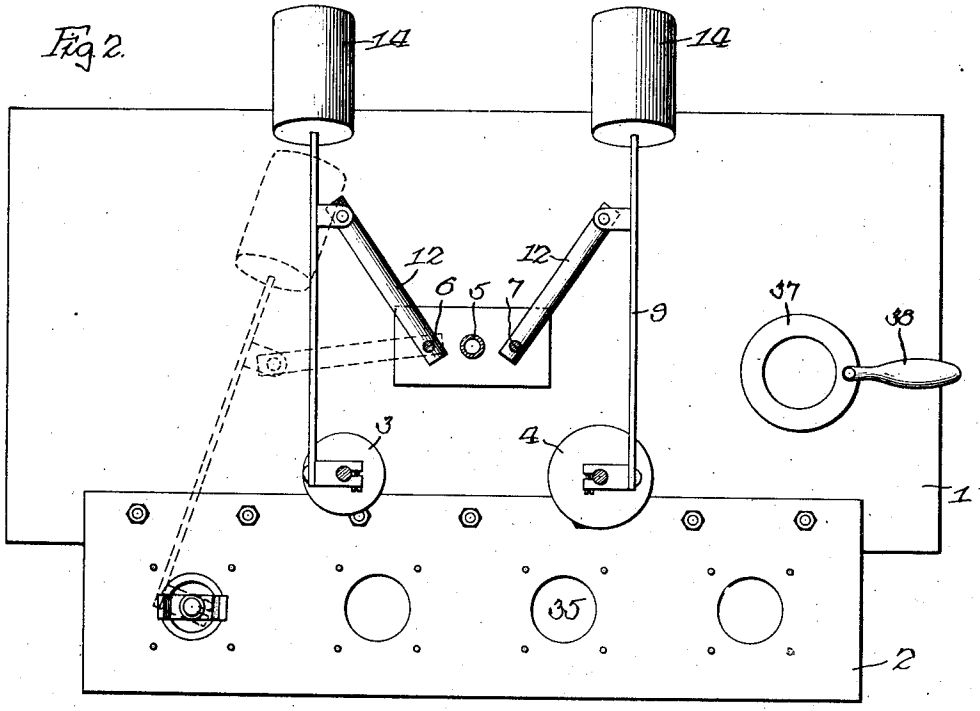
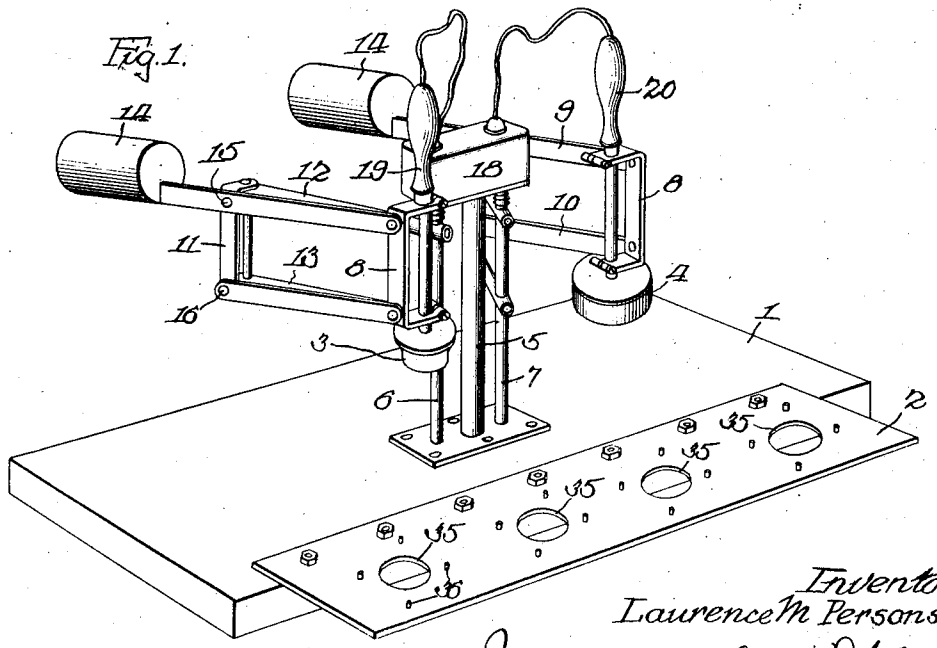


Fig. 1.



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Fig. 3.

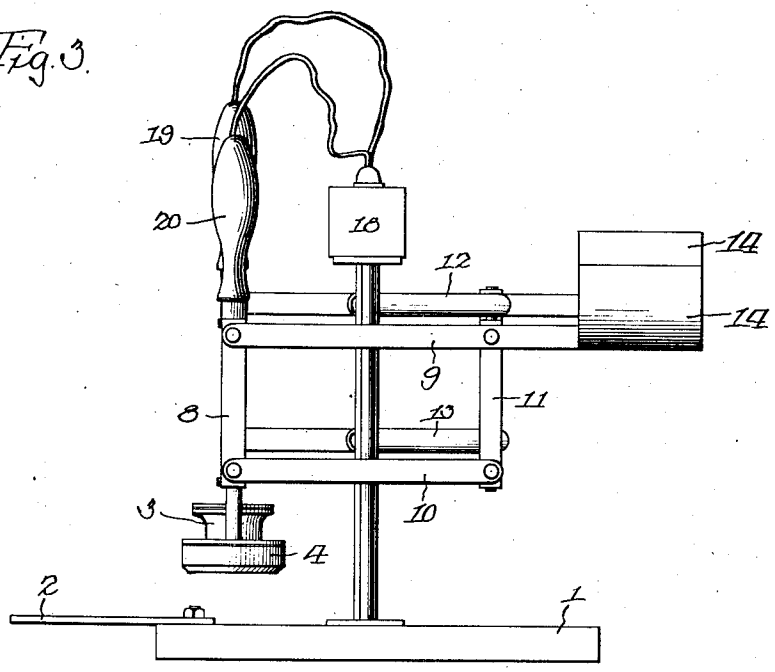
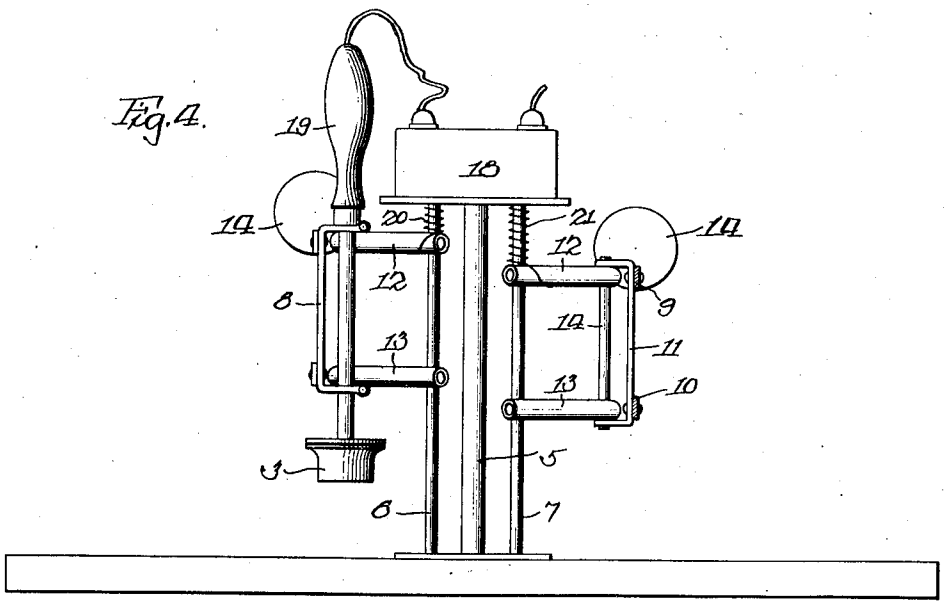


Fig. 4.



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Original Filed May 10, 1924 3 Sheets-Sheet 3

Fig. 5.

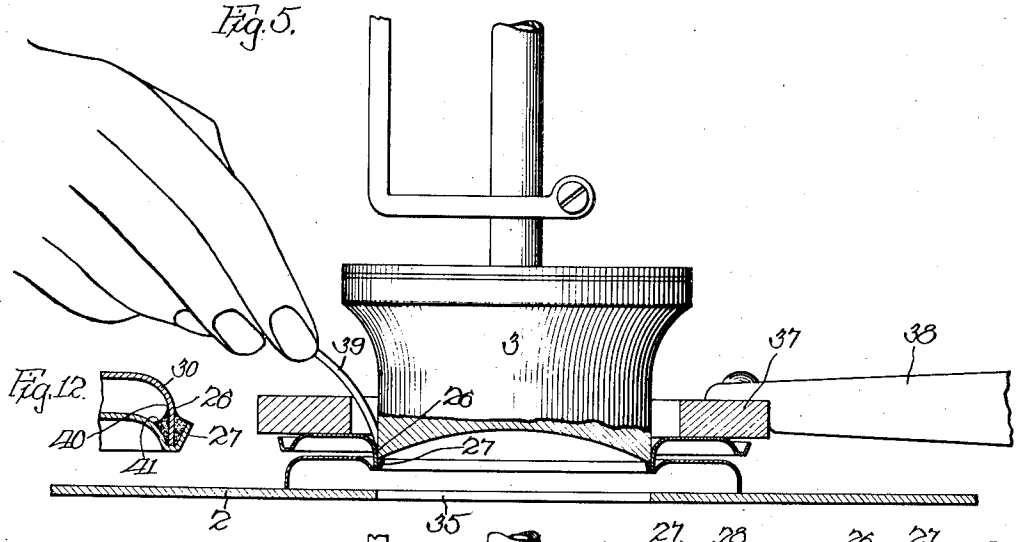


Fig. 12.

Fig. 6.

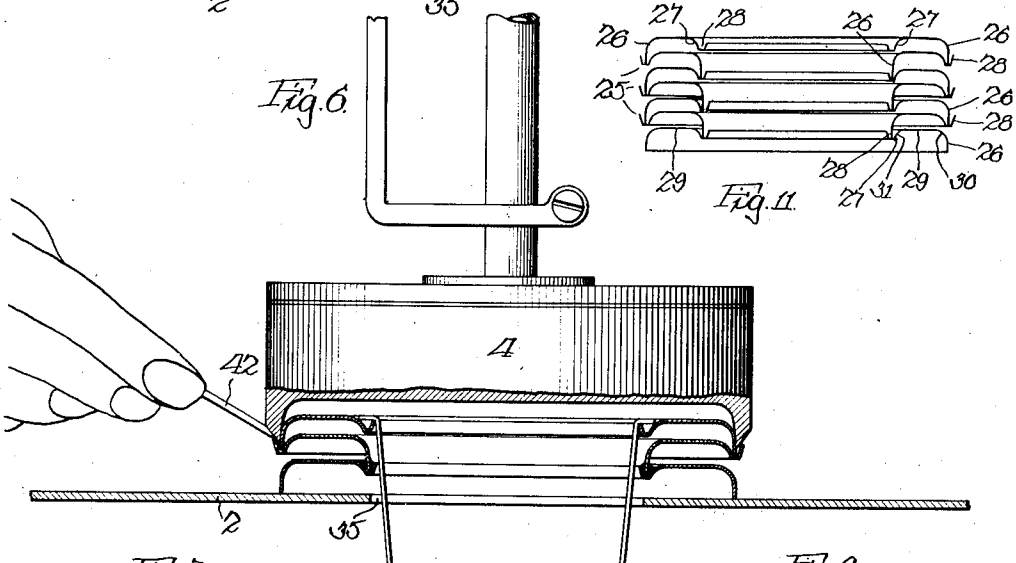


Fig. 11.

Fig. 7.

Fig. 9.

Fig. 8.

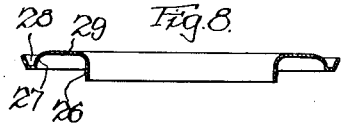
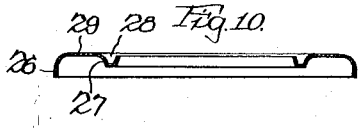


Fig. 10.



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Patented July 28, 1931 1,816,610

UNITED STATES PATENT OFFICE

LAWRENCE M. PERSONS, OF CHICAGO, ILLINOIS, ASSIGNOR TO COOK ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS

METHOD OF AND MEANS FOR FORMING BELLOWS

Original application filed May 10, 1924, Serial No. 712,177. Divided and this application filed October 8, 1926. Serial No. 140,398.

My invention relates to a method of and means for forming flexible metal walls for collapsible and expansible vessels, particularly of the class adapted for use as pistons in fluid supply pumps, or as thermo-sensitive or pressure-sensitive elements in regulators and other instruments.

The object of my invention is to provide collapsible and expansible vessels of greater life, strength and durability.

A majority of devices of this type now on the market and in use commercially are produced by corrugating flexible tubular walls by processes which limit the hardening or elasticity of the material. Care must be taken to avoid working temper into the metal during the forming of the walls, which at the present time seems almost unavoidable in corrugating processes. A subsequent annealing step is required to remove the temper, and it seems that metal in an annealed state possesses a very low elastic limit; consequently collapsible and expansible vessels made by forming the side walls out of corrugations do not have the hardness or spring to prevent the metal from being carried beyond the elastic limit of the metal by the strain to which these devices are subjected continuously. The degree of hardening or spring of a metal bellows is one of the most important factors in producing long life. It has been found that brass and bronze are some of the metals which meet the requirements of a metal suitable to such use, due to their resistance to oxidation and corrosion, and which may be hardened by rolling or by other suitable methods of working them. In forming the devices of such metals, the methods of treatment are limited if the hardness and spring necessary to long service are to be retained. Corrugating methods required to form flexible metal walls for collapsible and expansible vessels from a single sheet or tube will not secure the elasticity required for service. A different method of forming the bellows has been to divide the flexible metal walls into a plurality of substantially annular disks and to unite these disks at their adjoining edges in different ways. Different forms of disks have been proposed, as well as different types of joints, but, notwithstanding, a structure was always produced which failed to transmit the movement substantially perpendicularly between sections, with the attendant consequence that the material at the union would be subjected to considerable strain and eventually weakened. On the other hand, bellows of the sectional type would be provided with the ordinary pressed or soldered joint which would soon admit of slow crystallization. Such bellows have caused considerable annoyance and trouble in the field. Bellows of the corrugated type, which did not possess these joints, were found to weaken at the corrugations, because the repeated strains of tension and compression of varying intensity on the metal at the curved portions or bends composing the corrugations resulted in the occurrence of cracks, due to rapid crystallization of the metal, particularly at the point where the lateral portions merge into the curved portions.

To overcome the above objections, and to secure the benefits of my invention, I propose to employ a method of making flexible walls for collapsible and expansible vessels, in which the walls are formed of a plurality of sectional parts, preferably of diaphragm-like construction formed from a flat sheet, the hardness or elasticity of which can be controlled very accurately, inasmuch as very little forming is necessary to provide each section in its final shape for assembly into a completed unit. More particularly the method comprises taking a diaphragm section and forming curved flanges at the edges, one of which is curved slightly greater than the other, although not necessarily so, and the other of which has a gutter provided at the edge so as to receive the longer flange of the adjacent section. I also propose providing a seal, where adjoining gutters and flanges meet, in a manner and by apparatus which forms a tight joint, by allowing air bubbles in the solder, which might otherwise cause a leak, to escape. A stronger joint is thereby provided, because the solder will engage a larger area of the edges of the diaphragm.

The inventive idea involved is capable of embodiment in a variety of methods, and for

the purposes of illustration, one of these embodiments is hereinafter specifically described and shown in the accompanying drawings, in which:

Figure 1 is a perspective view of one form of apparatus capable of practicing my invention;

Fig. 2 is a top plan view, partly in section, and partly in elevation, of this apparatus;

Fig. 3 is an elevation of the right hand side of the apparatus;

Fig. 4 is an elevation of the front of the apparatus with a portion thereof omitted;

Fig. 5 illustrates the manner of using the soldering iron for soldering the inner edges of the different sections;

Fig. 6 illustrates the manner of using the soldering iron for soldering the outer edges of these sections;

Figs. 7 to 10, inclusive, illustrate the two different sets of sections employed;

Fig. 11 illustrates a vertical section of an assembled vessel; and

Fig. 12 is an enlarged detail view of the soldered joint employed about the outer periphery of the sections.

The apparatus capable of practicing the method of making flexible metal walls of a collapsible and expansible vessel, such as a bellows, according to my invention, comprises a base 1, which may include a work table 2 suitably extending from one side thereof, and a plurality of soldering irons 3 and 4 suitably carried by a super-structure mounted on the base. The super-structure may comprise a stationary upright 5 and a pair of rotatable standards 6 and 7, oppositely disposed, on each side of upright 5.

Each iron may be carried in the horizontally extending legs of holders 8. These holders are suitably carried at the forward end of two sets of levers, each set comprising a pair of parallel bars 9 and 10 pivotally connected to the holders 8 and also to members 11 at the rear. The horizontal legs of the members 11 are pivotally attached, for horizontal movement, to the outer ends of rods 12 and 13, which are carried by the rotatable standards 6 and 7, and which likewise swing in a horizontal direction. The upper bars 9 are slightly longer than the lower bars 10 and are provided with counterbalancing weights 14, which tend to pivot these bars about the connections 15 and 16 located on bars 11. Vertical rods 14′ serve to space the outer ends of bars 12 and 13 and provide pivot points for the bars 11. By providing rotatable standards 6 and 7 and extensible levers for carrying the irons 3 and 4, it is possible to swing or move these irons in a plurality of directions, so that they may be moved to any point over the work table 2.

Irons 3 and 4 are preferably electrically heated, the circuit in the present disclosure extending from under the base 2 in the hollow upright 5, so that the lead wires may be properly connected to the circuit of each iron at an outlet box 18. The lead wires extending to each iron extend upwardly out of the outlet box 18 to the ends of the iron handles 19 and 20. The present disclosure does not pertain to any particular type of soldering iron, inasmuch as any suitable type of iron may be supported by the holders 8. Springs 20 and 21 are coiled about the standards 6 and 7 near the upper ends for automatically returning each iron, when released by the operator, from over the table 2. Weights 14 normally tend to raise the irons 3 and 4 away from the table 2 and the base 1, as shown in Fig. 1. I find that there is considerable advantage obtained by employing the arrangement described because each iron is alternately used by the operator, and, when one is not in use, it is advisable to remove it as far as it is conveniently possible from the operator to eliminate the possibility of burns and to clear the front of the table.

As previously explained, the flexible walls of the collapsible and expansible vessel, according to the teachings of my invention, are divided into a plurality of sections 25, as shown in Fig. 11, each section having its inner and outer edges upwardly turned to form flanges 26 and 27. It will be observed that these flanges are alternately arranged on the succeeding or adjacent sections so that, say, on the first section, the flange 26 is disposed at the outer periphery and the flange 27 is disposed at the inner periphery, and on the second or next section, the flange 27 is formed at the outer periphery and the flange 26 is formed at the inner periphery. Consequently, I provide two sets of disks. The edges of the flanges 27 are preferably turned over to form gutters 28, which are adapted to receive the adjoining flanges 26 of an adjacent section.

It will be noted that it is preferable to connect the flanges 26 and 27 to the lateral portion 29 of each section by the curved portions 30 and 31. These curved portions tend to stiffen the walls of each section, that is, the flanges 26 and 27 confine or localize the deflection of each section to its lateral portion 29 at or about these curved portions. While it is not essential, it is preferable to make the curved portion 30 slightly larger than the curved portion 31. The manner, in which each set of disks is formed, is shown in Figs. 7 to 10, inclusive.

In assembling the various sections of the flexible walls of a collapsible and expansible vessel, embodying my invention, these sections are inverted and the first section is placed over openings 35 provided in the work table 2. A plurality of pins 36 may project from the table about these openings, so as to serve as centering means whereby to hold these first sections over the openings 35. The

gutter 27 of these first sections is preferably formed about the inner periphery thereof. The second section is then placed over the first and held in position by means of an iron ring 37 having a handle 38. The manner in which these rings are laid upon the second section is illustrated in Fig. 5. The smaller iron 3 is then moved forwardly so that it circumferentially lies against the walls of flange 26 of the second disk and also against a portion of the gutter 27 of the first disk, whereby heat is imparted to these parts. In Fig. 5, I have illustrated the manner of applying solder 39 to the iron. I find that by applying the solder to the exterior of the iron at a single point and by suitably revolving the iron in its holder 8, the solder will quickly flow about this gutter passing down and around the depending flange 26 to the portion of the gutter on its opposite side. As illustrated in Fig. 12, the solder tends to rise as the result of molecular adhesion, along the rear face of flange 26, this being shown at 40, that is, the surface 41 of the solder tends to assume an arcuate formation. By revolving the iron while the solder is flowing about the gutter, the additional advantage of liberating any trapped air bubbles can be obtained, which assures a larger area of contact between the solder and the walls of the gutter 27 and flange 26.

The next step in the assembling of the sections into a completed bellows unit is illustrated in Fig. 6 and comprises adding the succeeding section so that its flange 26 extends downwardly into the outer gutter of the second section. Before the soldering iron 4 is moved over this section, spring fingers 38, carrying a weight 39, are inserted upwardly through the openings 35 in the work-table 2, and also through the center opening of these sections so as to engage the inner periphery of the section being soldered. The soldering iron 4 is then placed over the outer gutter, as illustrated in Fig. 6, to apply heat to the adjoining parts of the sections; solder 42 is then brought into contact with the side of this iron while the iron is rotated, whereby the solder is permitted to flow freely through the gutter and about the cooperating flange 26, the solder flowing under this flange and upwardly to the inner side thereof, and rising against the inner wall of flange 26 in the same manner as illustrated in Fig. 12. It is to be understood, of course, that any suitable flux may be applied at any time to the metal during the soldering process. The number of sections soldered together will depend upon the desired length of the flexible wall of each collapsible and expansible vessel which is made.

With the sections assembled in this manner, preferably soldered together by the process above described, it will be obvious that the flexible wall of the collapsible and expansible vessel will have a greater elastic limit than when the wall is made of corrugations, because the metal of the wall comprising the sections, herein disclosed, undergo minimum forming operations. Only slight forming is necessary, and consequently, it is possible to provide a collapsible and expansible vessel which is built up of diaphragm-like sections formed from flat sheet metal, the hardness of which can be very accurately controlled. Temper will not be imparted to the metal as the result of the forming operations providing the flanges and gutters, so that there will be no need of a subsequent annealing step in the process to lower the elastic limit of the metal. It has been found that the provision of the curved portions 30 and 31 at the points where the flanges 26 and 27 merge with the flat portion 29 will confine the deflection about these curved portions to prevent the flat portion from buckling in and out. Any such buckling of the flat portion appreciably decreases the life of the collapsible and expansible vessel. However, these curved portions do not transmit the movement to the flanges 26 and 27 so as to weaken the material at the joints. It may be said that certain experiments have shown that a bellows constructed in accordance with my invention is still operating after a performance of over two hundred million strokes.

Certain advantages may be obtained by the use of the same or similar apparatus shown herein when practicing the method of forming collapsible and expansible vessels as disclosed herein. The soldering irons may be supported on extensible frames which permit each iron to extend forwardly over the work table when it is desired to use the same. Provision is made to immediately withdraw the iron from over the work table to a position where the operator is less apt to accidentally touch the same. Counterbalancing weights are provided to raise the irons from the surface of the work table and springs are used to automatically swing the supporting frames backwardly. Both of these irons are so positioned relative to the work table that they may be easily operated without loss of time when reaching for one or the other. I obtained an increased production as the result of the use of this apparatus and find it has materially reduced the cost of the manufacture of the collapsible and expansible vessels.

On the other hand, it permits the use of soldering irons which are rotatably mounted and which are provided with annular heating tips whereby the heat and solder may be applied substantially at the same time to all points about the gutter and cooperating flange, thereby producing a remarkably uniform joint. Slight rotation of these irons at the time of heating and applying solder tends to work the solder uniformly about the gutter

and obtain a maximum hold or engagement over a larger area. The present application is a division of my copending application, Serial No. 712,177, filed May 10, 1924, in which is broadly claimed the collapsible and expansible vessel.

It will be obvious to those skilled in the art that various other forms of apparatus may be used; also certain alterations or omissions in the steps of the process are possible without departing from the spirit and scope of the invention.

I claim:

1. The process of forming flexible metal walls for expansible and contractible vessels formed of a plurality of individual disks which comprises forming flanges about the inner and outer peripheries of said disks and alternately turning over at least one of these flanges to form a gutter to receive the flange of an adjoining disk, then assembling said disks, first, by applying heat circumferentially to the gutter of the first disk with the flange of the adjoining disks cooperating therewith, second, by rotating the heating element, and finally, by applying the solder during said rotation to cause a substantially uniform flow throughout the gutter.

2. The process of forming flexible metal walls for expansible and contractible vessels which comprises alternately forming cooperating flanges and gutters along the inner and outer peripheries of a series of disks, then assembling said disks by applying heat to each gutter and solder to the heating element to permit the solder to flow into the gutter, and rotating the heating element to cause the solder uniformly to flow about the gutter and the cooperating flange of the adjacent disk which is inserted therein.

3. The process of forming flexible metal walls for expansible and contractible vessels formed of a plurality of individual disks which comprises alternately forming gutters and cooperating flanges about the peripheries thereof, then heating said gutters and rotating a tool thereabout, then assembling said disks by filling said gutter with solder during the rotation of the tool to cause the solder to flow about the gutter and the cooperating flange inserted therein.

4. In a device of the class described, the combination with a plurality of soldering irons, each to perform a series of different soldering operations, a base presenting a definite work area for said irons, and extensible frames for supporting said irons upon said base for universal movement in various directions over and down upon said work area while in a vertical position whereby said irons may be alternately used, each to perform its particular soldering operation at any or all of a plurality of points.

5. In a device of the class described, the combination with a plurality of soldering irons, of a base presenting a definite work area for said irons, and a mounting for suspending said irons on said base including means for providing universal movement whereby either iron may be selectively moved over and down upon said working area to any of a plurality of points thereon and automatically returned when released to prevent interference with the use of the other iron.

6. In a device of the class described, the combination with a plurality of soldering irons, of a base presenting a definite work area to receive a plurality of devices to be soldered by a series of soldering operations, and a mounting for supporting said irons on said base including means for providing universal movement thereto whereby a series of soldering operations may be successively performed upon the devices first by one iron and then by the other iron.

7. In a device of the class described, the combination with a plurality of soldering irons, of a base presenting a definite work area to receive a plurality of devices to be soldered, a mounting for supporting said irons in a position of rest over said base including means for providing universal movement to said irons over said work area whereby each iron may perform a soldering operation to all of said devices successively, and means for automatically returning each iron from over said work area to its position of rest.

8. In a device of the class described, the combination with a plurality of soldering irons of different sizes, each to perform a different soldering operation, of a base presenting a definite work area for the reception of devices to receive different soldering operations thereon, and a mounting for supporting said irons in a position of rest over said base and movable forwardly over said work area only when manually gripped by the operator, said mounting including means for immediately returning each iron to its position of rest when manually released by the operator whereby to prevent interference with the other iron when either iron is used.

9. In a device of the class described, the combination with a plurality of soldering irons of different sizes, each to perform a different soldering operation, of a base presenting a definite work area for the reception of devices adapted to receive different soldering operations thereon, and a mounting for supporting said irons, in a raised position of rest over said base, to be movable forwardly over and upon said work area whereby each iron may perform its particular soldering operation on any or all of said devices, said mounting including means providing for the return of each iron thereafter to its position of rest over said base.

10. The process of making expansible and

contractible tubular walls consisting in forming sectional sheet metal plates with inner and outer peripheries drawn to form alternately arranged gutters and cooperating flanges between adjacent plates without appreciably lowering the limit of elasticity affecting the temper of the metal, subjecting the gutters and flanges as they are successively assembled to heat, and then flowing molten solder into each gutter to puddle the solder therein and thereby thoroughly to imbed in the solder the cooperating flange in the gutter.

11. The process of making a bellows member comprising the provision of sectional sheet metal annular plates having the inner and outer peripheries drawn with alternately arranged gutters and cooperating flanges extending therefrom, assembling said plates by successively placing one on the other with the flange of one plate in the gutter of the adjacent plate, and, as each plate is assembled, equally heating the entire gutter with the flange therein and puddling molten solder in the gutter to imbed the flange a substantial distance in the solder.

12. The process of making an expansible and contractible bellows comprising the provision of sectional sheet metal annular plates and the forming of said plates cup shape to provide on the inner and outer peripheries alternately arranged gutters and cooperating flanges between adjacent plates, and soldering said cooperating flanges in said gutters so that with the cupped formation of said plates movement therebetween during expansion and contraction is transmitted at the joints substantially perpendicular to each plate.

13. The process of making a metallic bellows member comprising assembling a plurality of sheet metal sections having cooperating flanges and gutters upon their inner and outer peripheries, assembling such sections with the flange of one section in the gutter of the adjacent section, and applying solder in a molten state to each gutter after the flange is inserted therein, thereby puddling the solder to substantially imbed the flange therein.

14. The process of making a metallic bellows member comprising assembling a plurality of sheet metal plates having cooperating flanges and gutters upon the inner and outer peripheries so fitted together as to present internal and external annular peripheral joints, and applying solder to the joints by puddling the solder upon the gutter of one section so as to imbed the cooperating peripheral flange of the adjacent section, with the solder rising upwardly of the side faces of the imbedded edge.

15. The process of making a metallic bellows member comprising forming cooperating flanges and gutters upon the inner and outer peripheries of a plurality of sheet metal plates, assembling such plates with the flange of one section in the gutter of the adjacent section, applying heat directly thereto after each plate is assembled by bringing a heating tool in contact with a side face of the flange and an edge of the gutter, and thereafter flowing molten solder from said heating tool into said gutter to imbed the edge of the flange in the solder.

In witness whereof, I have hereunto subscribed my name.

LAWRENCE M. PERSONS.

CERTIFICATE OF CORRECTION.

Patent No. 1,816,610. Granted July 28, 1931, to

LAWRENCE M. PERSONS.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, lines 47 and 48, claim 3, strike out the words "assembling said disks by" and insert the same after the word "then" in line 46; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 22nd day of September, A. D. 1931.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)