W. M. FULTON.

FLEXIBLE CORRUGATED METAL WALL FOR COLLAPSIBLE AND EXPANSIBLE VESSELS.

APPLICATION FILED JAN. 11, 1910.

976,060. Patented Nov. 15, 1910.

Fig. 1.

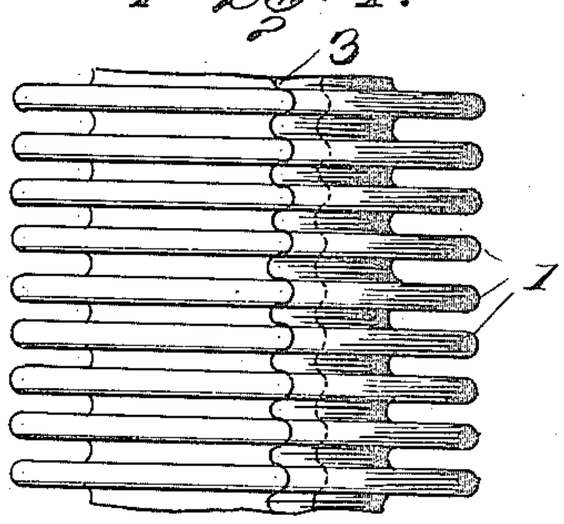

Fig. 2.

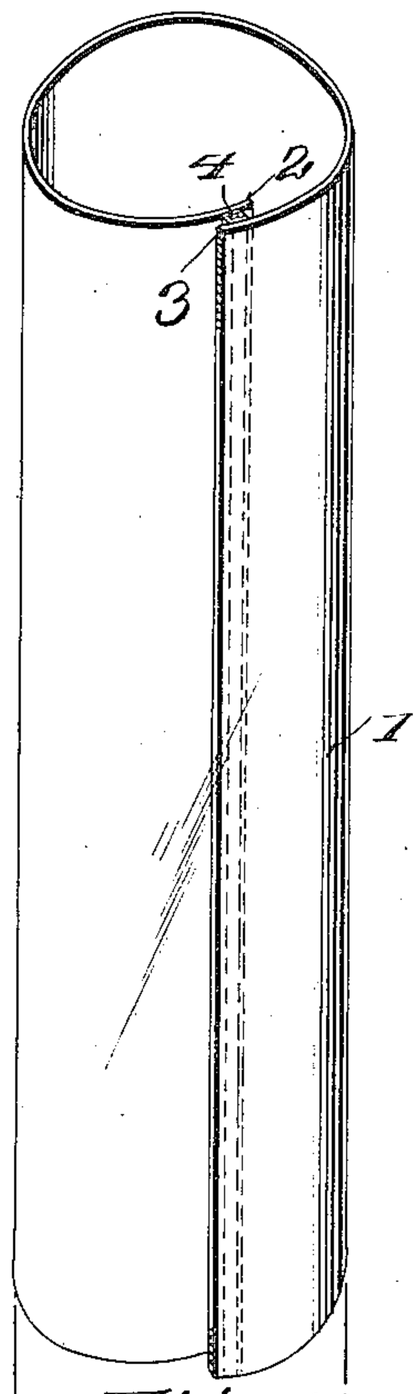

Fig. 3.

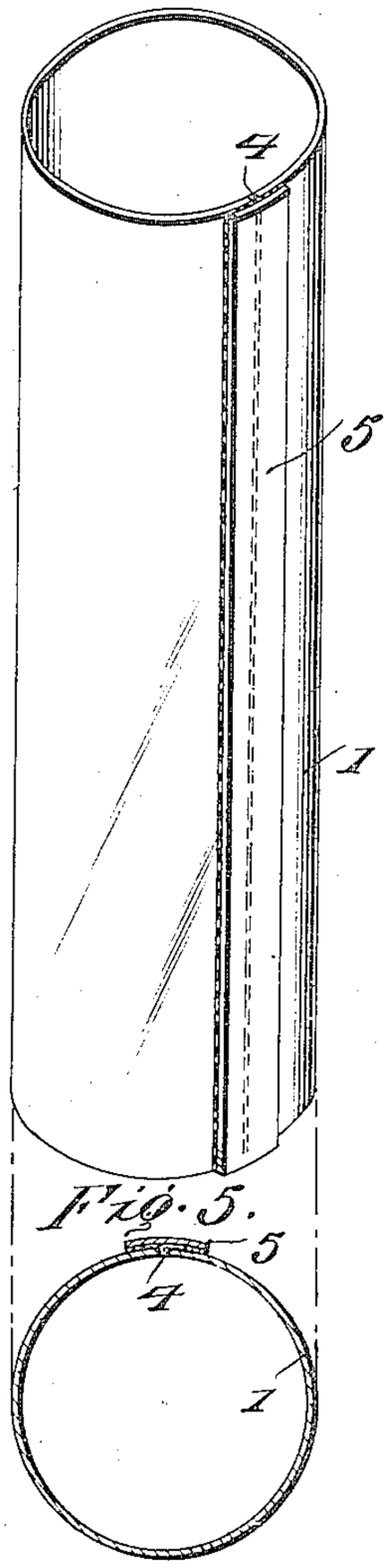

Fig. 6.

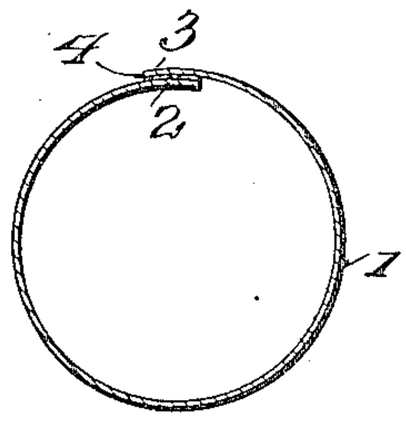

Fig. 7.

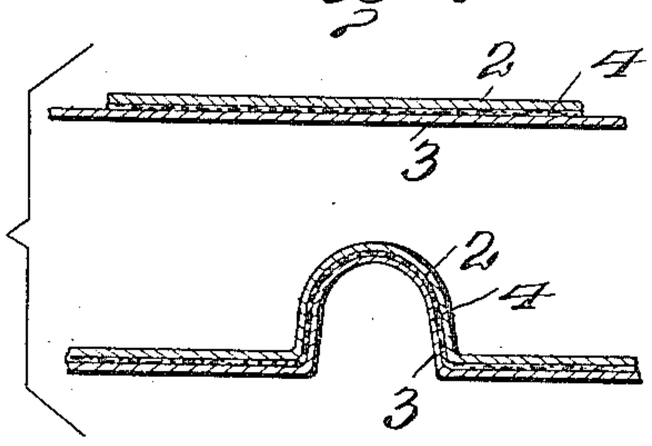

Fig. 4.

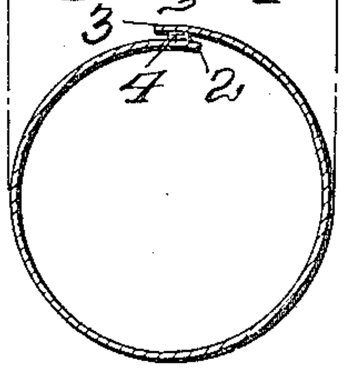

Fig. 5.

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UNITED STATES PATENT OFFICE.

WESTON M. FULTON, OF KNOXVILLE, TENNESSEE, ASSIGNOR TO THE FULTON COMPANY, OF KNOXVILLE, TENNESSEE, A CORPORATION OF MAINE.

FLEXIBLE CORRUGATED-METAL WALL FOR COLLAPSIBLE AND EXPANSIBLE VESSELS.

976,060. Specification of Letters Patent. Patented Nov. 15, 1910.

Original application filed May 16, 1906, Serial No. 317,157. Divided and this application filed January 11, 1910. Serial No. 537,477.

To all whom it may concern:

Be it known that I, WESTON M. FULTON, of Knoxville, Tennessee, have invented a new and useful Improvement in Flexible Corrugated-Metal Walls for Collapsible and Expansible Vessels, which invention is fully set forth in the following specification.

This invention relates to flexible corrugated metal walls for collapsible and expansible vessels, and more particularly the invention relates to making the seams of such vessels wherein non-weldable metals, such as brass or copper, are employed, and has for its object to provide corrugated collapsible and expansible vessels with seams having the capability of withstanding the repeated strains due to expansion and contraction, both under changes of temperature and under the action of flexure during the extension and collapsing of the vessel, without weakening the seam and causing the same to part and the vessel to leak.

A further object is to enable the walls of such vessels to be made of thin metal of non-weldable character and with deep corrugations whereby vessels of the character referred to may possess great flexibility and resiliency combined with durability.

In my prior application, Ser. No. 317,157, filed May 16, 1906, I have described and claimed the method of making flexible corrugated walls above referred to, and, therefore, do not claim such method in this divisional application thereof.

In collapsible and expansible metal vessels which are to be sensitive to action of slight variations of temperature or pressure, it has been common to make their walls of thin resilient metal, such as iron or steel. Such vessels are often required to be subjected to the corroding action of gases, such as air and steam, as when they are in open communication with a steam boiler, under which conditions they soon rust out and leak. Although steel or iron possesses the advantage of great resiliency and the further advantage of affording a seam that can be formed by processes of welding, yet it is not suitable in situations where oxidizing agencies are present even when the metal is protected by non-oxidizing coatings such as tin, because of the continuous changing strains in the surface of the walls which causes breaks in the continuity of the coating and exposure and rusting of the iron.

It has been proposed to construct corrugated metal walls of non-oxidizable metals such as copper and brass, but such metals, because difficult or impossible to weld, necessitates the wall to be made either in a single piece, which is impracticable for large diameters of tubing, or the wall must be made up of parts cemented together by some process other than welding. To secure the necessary flexibility in the wall whether made of steel, copper or other metal, the walls must be of requisite thinness and the corrugations deep.

As far as the present inventor is aware, the walls of collapsible and expansible vessels heretofore made have had their seams formed by welding, or in case of non-weldable metal, by use of some form of brazed butt seam, the faces of the meeting edges either being perpendicular to the plane of the sheet metal, or inclined thereto to form a bevel. Such seams necessitate the use of comparatively thick sheet brass or copper, and thereby limit the flexibility and sensitiveness of the corrugated collapsible and expansible vessel. Such seams are also greatly lacking in durability, because they yield to bending strains, come apart, and cause leakage. The defective character of such seams arises chiefly from the fact that the trend of all such seams is across the thickness of the metal, and when the sheet of metal having such a seam is bent, the convex side of the bend is under tension while the concave side is under compression. If in this bend occurs the seam as when the seam is perpendicular to the plane of the corrugations, or when the seam is in the plane of the bend, the cementing material tends to be pulled apart near one surface and compressed near the other. Repeated bending strains during the to and fro movements of the walls of the vessel, especially when heated highly, as by steam, soon granulates the cementing material and destroys the seam.

Another cause for the unsatisfactory character of flexible corrugated walls having brazed seams of the kind above referred

to, lies in the fact that the alloy, such as spelter, used for cementing the abutting edges, has not the same tensile strength as the metal constituting the walls of the vessel. The seams are therefore generally weaker than the body. A further cause resides in the fact that the coefficient of expansion of such cementing materials as spelter is different from that of the copper or brass or like alloys used for making the walls of the expansible and collapsible vessel. There results in the use of a vessel with such a seam unequal expansion and contraction between the cementing material and the metal of the wall. Strains are set up between the two when the vessel is subjected to wide ranges of temperature, combined with those due to the extensive flexure in the corrugations, thereby resulting in the breaking down of the seam. Although this inequality in expansion and contraction exists in uncorrugated or straight-walled tubing, it does not result in serious consequences because such tubes are not also subject to repeated bending strains; but such tendencies become an important factor in the construction of flexible, collapsible and expansible metal vessels. The walls of such vessels are to be provided with deep corrugations and are made of thin metal to secure sensitiveness to changes of temperature and pressure, and are subjected to forces not to be reckoned with in the case of straight tubing having comparatively thick walls.

It is the object of this invention to provide a corrugated collapsible and expansible vessel, particularly when made of non-weldable metal, with a seam wherein the cementing agent holding the surfaces of the sheet metal along the seam is distributed in a very thin layer or film parallel to and in the median plane between the convex and concave surfaces of the bends whereby flexures at such bends are substantially without effect on the cementing material either to put it under tensional or compression strains, thereby increasing the strength of the seam and increasing the life of the flexible walls of the vessel.

A further object of the invention is to increase the efficiency of such seams by providing a cementing material which will have a tensile strength and coefficient of expansion substantially the same as that of the metal walls of the vessel. As for example, in the case of a corrugated collapsible and expansible vessel made of soft low brass, I have found that an alloy consisting of 60 parts of silver, 25 of copper and 15 parts of zinc meets these requirements. In using other metals, other alloys would be used, the selection of the alloy being determined by the requirement that the conditions named above be observed.

The inventive idea involved is capable of expression in a variety of forms, some of which are hereinafter described for the purpose of illustration.

Assuming that a flexible corrugated collapsible and expansible vessel is to be made of a non-weldable metal such as brass or copper, I form a tube of the sheet metal by bending the sheet into tubular form and lapping the opposing edges so as to form a seam which will lie in a plane parallel with the surface of the metal composing the wall; introducing between the lapped edges a metallic alloy having a coefficient of expansion and a tensile strength practically the same as the metal forming the body of the tube; then applying heat to melt the alloy and pressure to compress the same to a thin film between the lapped edges; and allowing the alloy to congeal under pressure; and finally providing the tube with deep corrugations to render the same flexible. These corrugations may assume various forms and directions relatively to the axis of the vessel, those preferred being as illustrated in Fig. 1. Although I have described forming the tube first and then corrugating, I may corrugate first and then form into a tube and make the seam afterward.

It is an important feature of my invention that the thickness of the cementing material between the surfaces of the seam be reduced to the minimum. This is effected by compressing the seam while the cementing material is molten and holding the seam under pressure while cooling. The extent of pressure necessary to secure the desired results may vary between that which will compress the cementing material to a minimum thickness without affecting the sheet metal, to that which will reduce the thickness of the seam nearly to the thickness of the adjoining wall of the tube.

Any suitable means for applying heat to the seam and compressing the same may be employed, but I prefer to employ my improved brazing machine described in my application Serial No. 273,766, filed August 11, 1903, which is capable of applying a yielding pressure during the act of brazing and effecting the heating by passage of a heating current through the seam to be brazed.

The lap seam described above is at right angles to the plane of the corrugations, but it may assume other angles thereto, and yet secure the advantages of having the cementing alloy in the median plane parallel to the surface of the wall and substantially uninfluenced by bending strains. Instead of using a lap seam, the edges of the sheet may meet as in a butt seam and a strip of metal placed over the joint and cemented to the portions of the wall adjoining the butt seam.

To better illustrate the nature of the invention, reference is had to the accompanying drawings, in which,

Figure 1 shows in elevation a portion of a wall for a collapsible and expansible vessel having a seam made in accordance with my invention. Fig. 2 is a perspective view, and Figs. 4 and 6 end views of a blank tube showing the lap seam in course of making. Figs. 3 and 5 illustrate another form of seam embodying the inventive idea, and Fig. 7 shows details.

Referring to Figs. 2, 4 and 6, a brass or copper metal sheet 1, for example, is bent into the form of a tube with edges 2, 3 overlapping, and between these overlapping edges is placed a strip 4 of cementing alloy, preferably of slightly less width than the overlapping edges. The nature of this alloy, as stated above, depends on the nature of the sheet metal wall 1, and in the case of soft low brass, is preferably composed of silver, copper and zinc in the proportions substantially as stated above, having a coefficient of expansion and tensile strength, as of brass. Heat sufficient to melt the alloy, and pressure sufficient to compress the same, are simultaneously applied to reduce the cementing alloy to a thin film. If desired, the pressure may be sufficient to reduce the thickness of the seam nearly or quite to that of the wall of the tube. While the edges are thus held together, the seam is permitted to cool to the congealing point of the alloy, and will assume the position shown in Fig. 6. The tube is next corrugated.

The advantages of this form of seam in a corrugated vessel will be manifest from a consideration of Fig. 7, in which is shown an edge view of the longitudinal seam as would appear in the flat seam of tube 1, Fig. 6, and the same seam when given a series of bends. It is well understood that the material on and near the convex portion of the bend is under tension, whereas on the concave side, the material is under pressure, and in the central layers the material is under substantially no strain. As this region is occupied by the very thin layer of cementing material, the latter is in the best position to be effective in holding the edges together under the bending back and forth that takes place at the bends in the expanding and collapsing of the vessel. Furthermore, the cementing material having been selected to harmonize with the tensile strength and coefficient of expansion of the sheet metal composing the wall, tendency to displacement of the cementing material is further lessened, thereby rendering the seam peculiarly effective in vessels of the kind under consideration.

In Figs. 3 and 5 is illustrated another form of applying the principle of the invention, in which the edges of the sheet metal wall 1 are brought together face to face, and a retaining strip 5 is applied over the junction and made fast to the tube walls in the manner described above. Although this form of seam is effective, I prefer to construct the wall in the manner first described.

What I claim is:—

1. A flexible corrugated metal wall having a seam therein which lies in a plane parallel with the surface of the wall and which is cemented by a material different from the metal composing the wall.

2. A flexible corrugated metal wall characterized by having a cemented seam lying in a plane parallel to the surface of said wall, the cementing material of said seam having substantially the same tensile strength and coefficient of expansion as the metal wall.

3. A flexible corrugated metal wall having a longitudinal seam therein which is cemented by a material whose tensile strength is the same as that of the metal composing the wall.

4. A flexible corrugated metal wall having a longitudinal seam therein which is cemented with material whose coefficient of expansion is the same as that of the metal wall.

5. A flexible corrugated metal wall having a longitudinal seam therein which is cemented with a material whose tensile strength and coefficient of expansion are both the same as that of the metal composing the wall.

6. A flexible corrugated wall of brass, capable of elongation and compression along the line of one dimension only, having a longitudinal seam therein lying in a plane parallel with the surface of the wall.

7. A flexible corrugated wall of brass having a longitudinal seam therein cemented with a material whose tensile strength and coefficient of expansion are both the same as the brass composing the wall.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

WESTON M. FULTON.

Witnesses:
MARY L. JONES,
JNO. S. BROWN.