W. M. FULTON.

FLEXIBLE CORRUGATED METAL WALL FOR COLLAPSIBLE AND EXPANSIBLE VESSELS.

APPLICATION FILED MAY 5, 1909.

979,460. Patented Dec. 27, 1910.

Fig. 1.

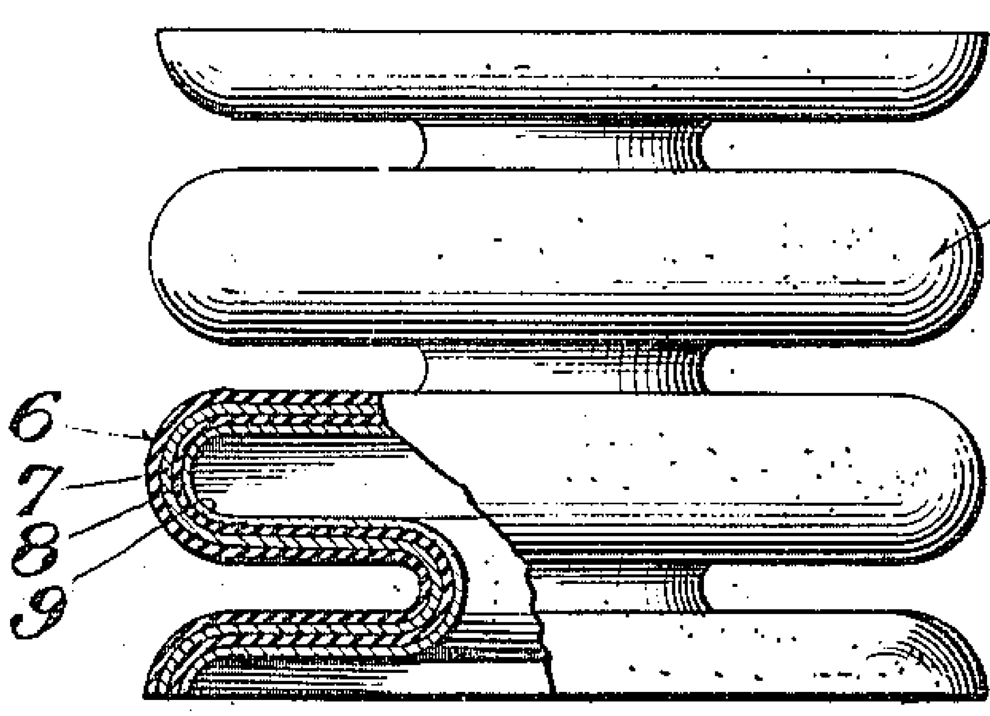


Fig. 2.

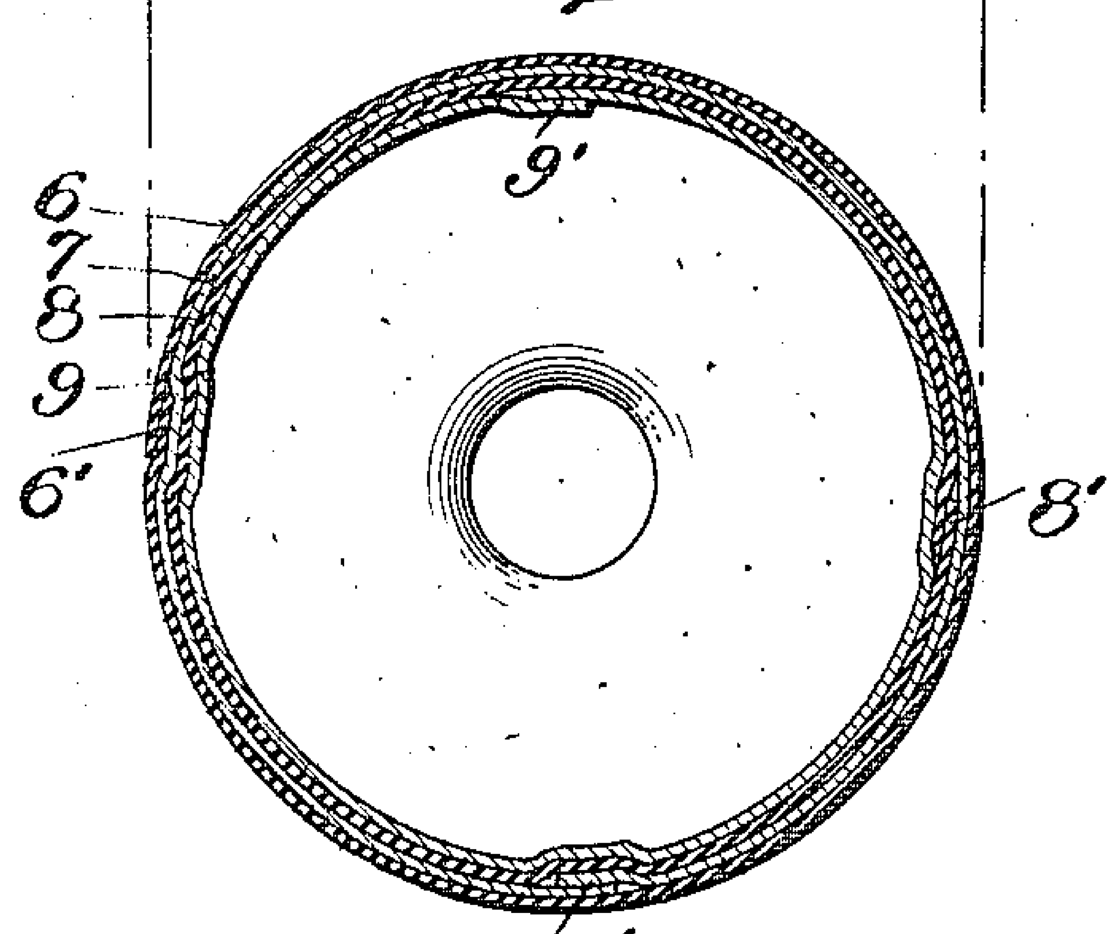


Fig. 6.

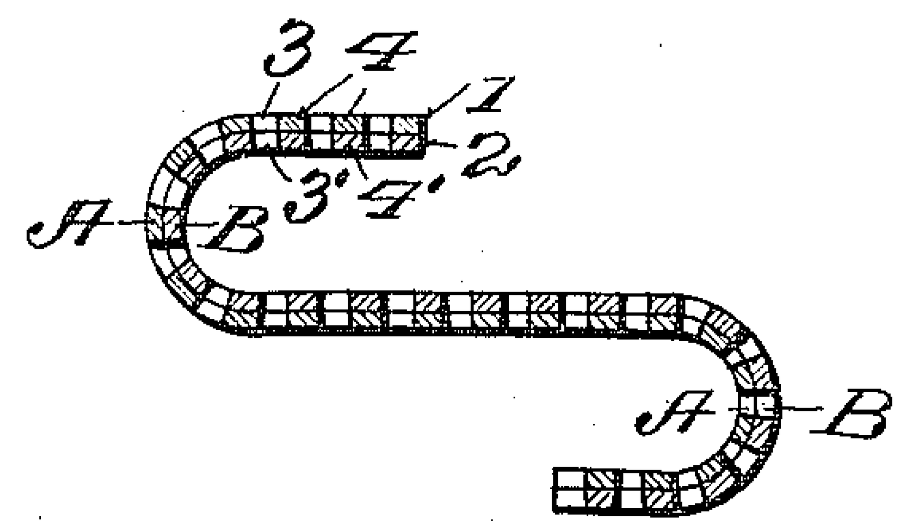


Fig. 7.

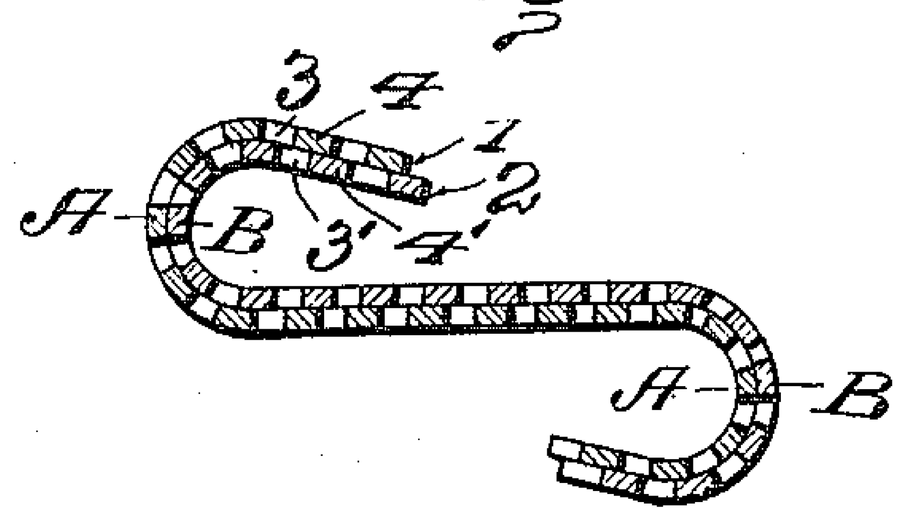


Fig. 8.

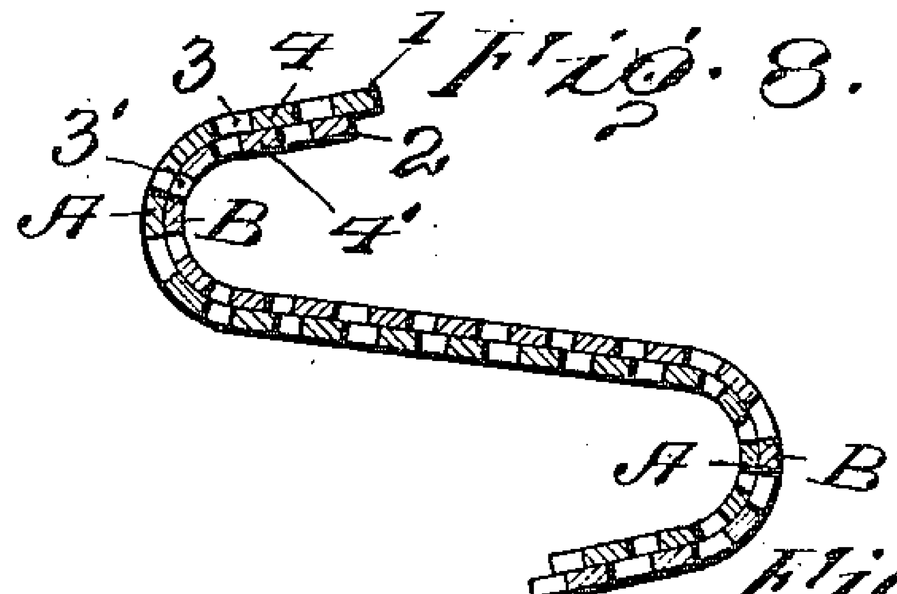


Fig. 4.

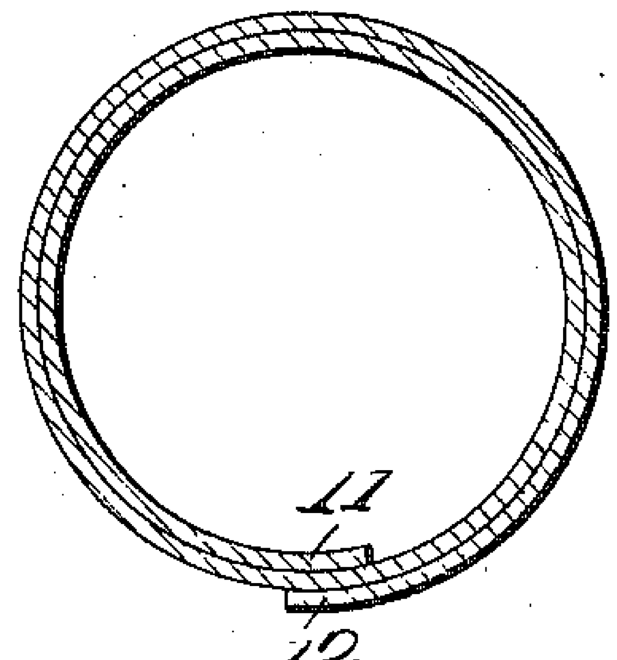


Fig. 5.

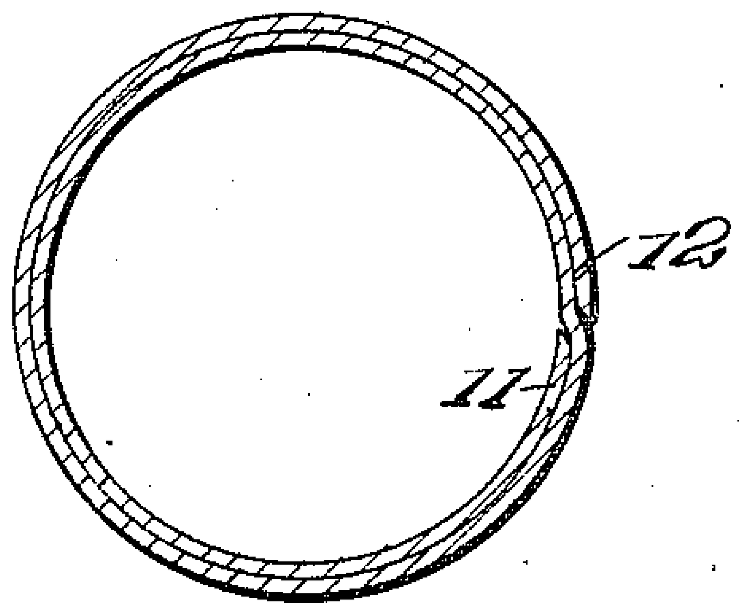
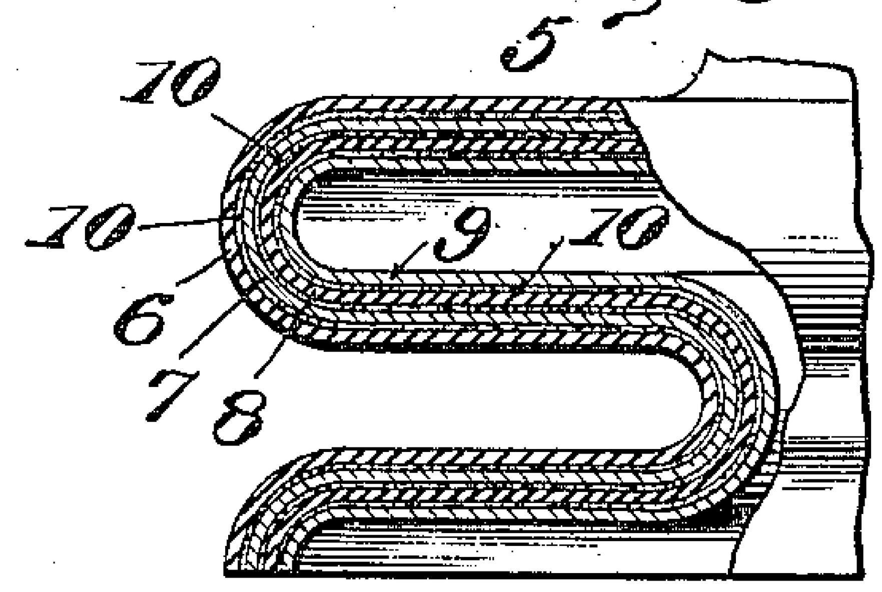


Fig. 3.



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UNITED STATES PATENT OFFICE.

WESTON M. FULTON, OF KNOXVILLE, TENNESSEE.

FLEXIBLE CORRUGATED-METAL WALL FOR COLLAPSIBLE AND EXPANSIBLE VESSELS.

979,460. Specification of Letters Patent. Patented Dec. 27, 1910.

Application filed May 5, 1909. Serial No. 494,202.

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 improvements in flexible corrugated metal walls for collapsible and expansible vessels, and has for its object to provide a flexible and durable wall capable of withstanding heavy pressures such as occur in vessels of this class when confining steam or water under pressure.

Heretofore in constructing the walls of collapsible and expansible vessels which are required to withstand heavy fluid pressure, it has been the practice to use a single thickness of sheet metal of such thickness as is requisite to afford the necessary strength to resist the pressure of the confined fluid. Certain disadvantages result from the use of such thick sheet metal in walls of collapsible and expansible vessels. Among these disadvantages may be mentioned diminished resiliency in the walls whereby sensitiveness to fluctuation of fluid pressure is sacrificed; increased tendency of the thick walls to crack at the bends, due to increased strains in the outer and inner layers at these points; and greater tendency of the vessel to leak along the seam because of its increased thickness. The presence of a thicker seam in the walls of the vessel also accentuates the difference in resiliency between the seam and other portions of the wall, and this is undesirable.

A brief consideration of some of the properties of corrugated sheet metal and some of the mechanical principles applicable thereto will assist in the understanding of the present improvement. It is a well-known fact that when metal, such as used for the construction of flexible walls of collapsible and expansible vessels, is rolled into thin sheets, its tensile strength becomes considerably greater in proportion to its thickness as the sheet is thinned down. This fact makes it desirable to use as thin sheets of metal as practicable for the walls of such vessels. In certain collapsible and expansible vessels, however, considerable strength is required in the walls requiring the use of thicker sheet metal. When such a sheet metal is placed under a bending strain it is found that the filaments of metal along the convex side of the bend are stretched, and those on the concave side are shortened, while along the so-called "median line" within the bend the filaments are not subjected to strains tending to either stretch or shorten them. It is, therefore, evident that when a flexible wall provided with such bends is collapsed that all the particles of metal on the convex side of the "median line" are stretched apart while the particles of metal on the concave side of the same "median line" are upset. When the wall is expanded a reverse set of strains is produced.

If the wall is comparatively thick, as it is in the case of collapsible and expansible vessels under consideration, the particles around the concave and convex surfaces of the wall are subject to great strain. The wall by repeated collapsing and expanding weakens at these points and finally breaks through. Furthermore, with increased thickness of the wall greater force is required to overcome its resilience, and hence its flexibility will not be great.

In accordance with my invention, I provide flexible walls for collapsible and extensible vessels by building them up of a plurality of thin sheets of metal in contact with each other, directly or through the medium of a lubricating material such as graphite, soapstone or the like, which reduces friction between the layers. The several laminations of the wall may be of the same or of a different metal. When fluids are to be confined which have a corroding action on the wall of the vessel, I prefer to make the exposed layer of metal which is capable of resisting the action of the fluid. In case the wall confines steam or water the inner layer is preferably made of copper, while the remaining layers of the wall are made of a cheaper metal such as steel, thereby combining strength and elasticity, while protecting against corrosion.

The invention is not confined to any particular kind of metal or number of laminations, provided there is a plurality of such laminæ. I have found, for example, four layers of sheet metal each of about .01 inch thickness, suitable for the walls of collapsible and expansible vessels designed to confine steam or hot water under pressure.

My improved wall may be assembled in a variety of ways and may be made from seamless tubing, or from sheets bent into cylindrical form with their edges united by any kind of a seam. I prefer, however, to separately bend up each of the several sheets into cylindrical form, secure the lapped edges by brazing, and assemble the cylinders into a nest, each seam being displaced with respect to its neighbor so as to distribute the seams around the circumference of the wall. The nested cylinders are then corrugated, and the corrugations may be of any desired configuration. Instead of constructing the wall of separate sheets, it may be formed out of a single sheet of metal bent into a spiral form with its edges secured to the wall by brazing or otherwise.

The inventive idea involved is capable of being embodied in a variety of forms, some of which, for the purpose of illustration of the invention, are shown in the accompanying drawings, in which—

Figure 1 is a view in elevation and in part section of a corrugated sheet metal wall made in accordance with my invention; Fig. 2 is a plan view of Fig. 1, showing the arrangement of the lapped seams; Fig. 3 is a detail view showing a laminated wall with lubricant between the layers; Figs. 4 and 5 are views in plan of laminated walls showing different embodiments of my improvement; and Figs. 6, 7 and 8 are diagrammatic views for the purpose of illustrating the operation of my laminated wall.

Referring to Figs. 6, 7 and 8, I have therein shown diagrammatically a laminated sheet metal wall built up of two layers 1, 2, of thin sheet metal highly magnified and bent into the form of a corrugation. Each sheet 1 and 2 is represented as composed of small sections 3, 3′, 4, 4′, of white squares and hatched squares respectively. In Fig. 6 the corrugated wall is assumed to be in its normal position, while in Fig. 7 the wall is shown as collapsed below its normal position, and in Fig. 7 it is expanded above its normal position. Compare the laminated wall when in normal position, as shown in Fig. 6, and collapsed position, as in Fig. 7. The corresponding sections 3, 3′ and 4, 4′, register with each other in normal position. When the wall is collapsed, as shown in Fig. 7, the layer 1 of metal on the convex side of the bends, or above the so-called "median line," is placed under tension to separate its portions 3, 4, while the layer below the "median line" is placed under compression to contract its portions 3′, 4′. Since the layers of metal 1 and 2 are free to glide over each other during the collapsing of the wall, the sections 3, 3′, and 4, 4′, will shift their positions past each other, as indicated in Fig. 6. The sections at the apex and in the vicinity of the line A—B will not shift, or at least very little, with respect to each other. It will thus be observed that by laminating the metal in the wall of the corrugation, the metal of the wall above and below the so-called "median line" has greater freedom of movement, thereby relieving the layer 1 of some of its tendency to stretch, and of layer 2 to contract. The wall as a whole is more flexible, because enabled to be collapsed and extended from its normal position with less force than in the case where the two layers form a homogeneous wall. The wall possesses greater strength because made up of layers of metal rolled into thin sheets having a proportionally greater tensile strength. In Fig. 8 the wall is shown in its expanded position. While taking this position, the wall has been expanded above the normal position shown in Fig. 6, and the layers 1 and 2 of the wall have been subjected to a reverse set of bending strains causing them to shift in the opposite direction to that when the wall is collapsed, as may be seen by considering the sections 3, 3′ and 4, 4′. The same freedom of movement of the layers of metal to glide past each other exists during the collapsing of the wall as during the period of expanding, and for the same reasons as explained in considering Fig. 7. The movement, however, is in an opposite direction.

In Figs. 1 and 2, I have shown a collapsible and expansible corrugated tubular wall 5 built up of four separate sheets or laminæ 6, 7, 8 and 9, of thin sheet metal such as brass, steel, copper or the like. Each sheet has been bent up into tubular form and its edges united by a brazed lapped seam 6′, 7′, 8′ and 9′, as shown in Fig. 2, and as described and claimed in my application Serial No. 317,157, filed May 16th, 1906. The diameter of each tube has been adjusted so that the tubes will fit or nest together. The seams of the tubes are preferably adjusted at equal angular distances, and the tube is then provided with corrugations of any desired form. By the proper distribution of the seams there is effected a balance of the slight inequalities in resilience between the wall at the seam and elsewhere. While the wall is somewhat thickened at the lapped seam, this thickening by presence of the seam has been distributed around the wall, and is decidedly less at any one seam than at the lapped seam of a solid wall having the same thickness elsewhere.

The wall as thus constructed in laminæ safe-guards against any accidental flaws or imperfections at the seams. While a flaw might occur in one seam, such defect would not detract seriously from the efficiency of the wall, because of the fact that the remaining seams would prevent all possibility of leakage.

The laminated walls here illustrated are shown as magnified for the purpose of better illustration. A thickness of .01 inch for each layer of sheet metal I have found practical for constructing a collapsible and expansible wall having four layers and designed to be used for confining steam or water under pressures such as occur in heating systems. This is given as an illustration merely, and is not intended as a limitation to the use of any particular thickness of sheet metal or to the number of layers in my laminated wall.

A collapsible and expansible wall as thus constructed of laminæ possesses greater flexibility than a similar wall made of solid sheet metal and of the same thickness, for the reasons above explained in connection with the diagrams Figs. 6, 7 and 8, and also has greater capability for withstanding heavy pressures of fluids confined thereby, as also above explained.

In Fig. 3 is shown, in highly magnified form, a portion of a laminated wall 5 having between its layers a lubricating material 10, such as graphite, the advantage of which is to facilitate the adjustment of the layers in the wall during collapsing and expanding of the same.

Instead of constructing the laminated wall of independent sheets of metal, as shown in Figs. 1 and 2, I may employ a single sheet of metal coiled in the manner shown in Figs. 4 and 5 to form a plurality of layers, and braze both edges 11, 12, to the wall, or only braze the outer edge, leaving the inner edge to be held by the configuration of the wall. The edges 11, 12, may overlap each other as shown in Fig. 4, or they may terminate without overlapping, as illustrated in Fig. 5, and then be pressed flush with the surfaces of the wall. This may be done in the brazing operation. I prefer, however, the construction shown in Figs. 1 and 2, wherein a plurality of independent sheets are employed which afford opportunity of using metals of different kinds in the several layers, and thereby utilizing in combination the desirable properties of the different metals, such as combining the use of a metal like copper, which resists corrosion of steam, and that of steel, which lends strength and elasticity to the wall.

What I claim is:—

1. A collapsible and extensible corrugated wall composed of superimposed layers of sheet metal.

2. A collapsible and extensible corrugated tubular wall composed of superimposed layers of sheet metal.

3. A collapsible and extensible corrugated tubular wall composed of superimposed layers of sheet metal and lubricating material between the layers.

4. A collapsible and extensible corrugated tubular wall composed of superimposed layers of sheet metal one of which layers differs from the other in its chemical properties.

5. A flexible corrugated wall composed of a plurality of thin layers having a film of lubricant between said layers.

6. A tubular laminated metal wall capable of being expanded and collapsed in the direction of its axis and having a film of lubricant between the laminations.

7. A flexible corrugated tubular metal wall composed of a plurality of thin layers having longitudinally disposed lap seams.

8. A flexible corrugated tubular metal wall composed of a plurality of thin layers having longitudinally disposed lap seams, no two of which seams coincide.

9. A flexible corrugated tubular metal wall composed of a plurality of thin layers having longitudinally disposed lap seams, arranged at approximately equal intervals around the circumference of the wall.

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

WESTON M. FULTON.

Witnesses:
MARGARET COOMES,
E. J. S. HYATT.