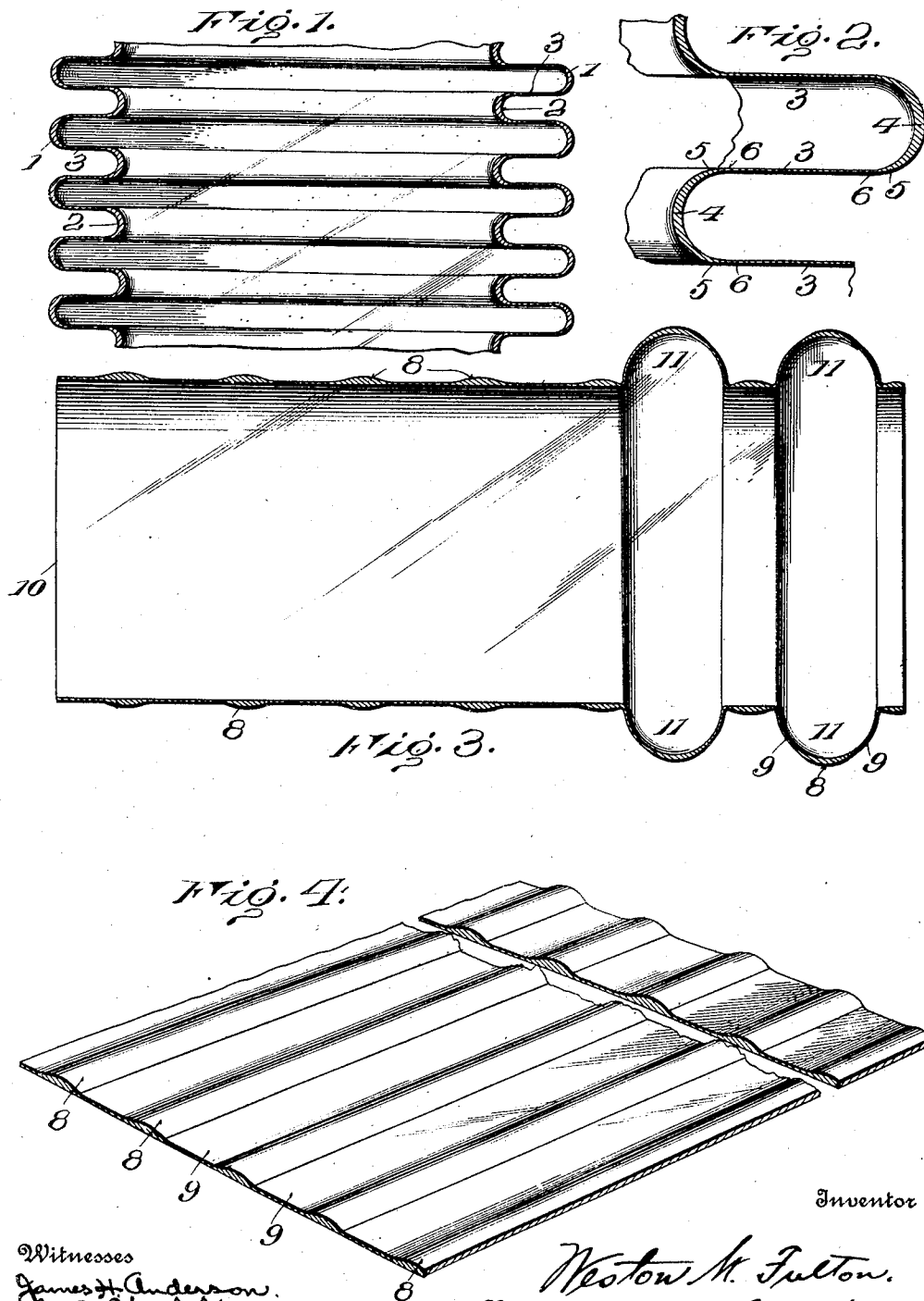


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FLEXIBLE, TUBULAR, CORRUGATED METAL WALL.
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FLEXIBLE, TUBULAR, CORRUGATED-METAL WALL.

1,095,100.

Specification of Letters Patent.

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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, Tubular, Corrugated-Metal Walls, which invention is fully set forth in the following specification.

This invention relates to improvements in flexible, corrugated metal walls designed for use in vessels intended to expand or contract under the influence of internal or external pressure, and which, in a great variety of uses, are necessarily constructed so as to be extremely sensitive to pressures causing said expansion and contraction.

Illustrations of metal walls of the character affected by the present improvements are found in my U. S. Patents Nos. 887,084; 903,465; 947,229; 967,010; 975,519; 976,060; and 979,460.

It has heretofore been proposed to construct flexible tubular walls either by building up the wall with annular disks united at their exterior and interior peripheries, or by providing a seamed or seamless metal tube with deep corrugations. When the tubes were made with disks as mentioned above, it was found that they were open to a serious defect, viz., the disks came apart under continuous vibratory movement, opening cracks or seams. This defeated the object of their use in constructing vibratory vessels which depend for their successful operation on confining an expansible fluid. Furthermore, in order to secure the requisite flexure of the tubular wall, the portions of the disk between the joints were necessarily made broad, and this gave rise to buckling defects, whereby lost motion and wear, independent of that due to the expansion and contraction of the wall along its axis, were introduced, thereby necessarily shortening the life of the wall.

Flexible, circumferentially - corrugated tubes having alternate concave and convex portions united by lateral portions, afforded a tube free from seams at the bends, and enabled the lateral portions to be narrowed, thereby reducing the tendency in these portions to buckle. Moreover, in flexible tubular walls of this character, this kind of flexibility and wear is more uniformly distributed in the bends and lateral portions. Nevertheless, the wear in this type of wall is sustained largely by the metal in the bends,

and it has been found that the continual flexure back and forth of these curved portions, due to the vibratory movements of the wall, is accompanied by changes of curvature of the bends, resulting in lines of wear, which develop under these bending strains, and cause cracks to appear, thus rendering the vessel useless for the purpose designed. Again, in certain uses of the flexible wall (as where the corrugated flexible wall enters into the construction of a vibratory vessel containing a fluid exerting pressure on its corrugations), it has been the practice to reinforce the bends by wire braces, or by metal bands conforming more or less to the curve of the bends. Such reinforcing devices, however, have been found unsatisfactory for a number of reasons, among which may be mentioned the fact that, while the braces reinforce the wall against that portion of the confined fluid pressure acting perpendicular to the axis of the wall, their presence has been found to decrease the durability of the wall under vibratory movement, either in line with the axis of the vessel, or when the vessel is flexed out of line with its axis. Experience has taught that the presence of these braces often results in increased wear, and consequent deterioration at the bends.

The present invention relates particularly to improvements in flexible, metal walls provided with corrugations, and has for its object to effect a distribution of the wearing strains between the alternate concave and convex portions of the wall and the lateral portions thereof connecting said concave and convex portions (to the end that the life of the wall in actual service may be prolonged), without interfering with the sensitiveness of the vessel to expansion and contraction along the line of its axis, or with the flexure of the vessel so that its axis forms the arc of a circle; and particularly is it the object to thus prolong the life of the vessel while confining fluids under pressure, and without rendering the walls liable to rupture by such pressure, with the consequent escape of the fluid contained therein.

The object of the invention is secured by providing a flexible, corrugated metal wall, in which the metal in the wall is of greater thickness in the bends than in the portions of the wall between the bends, and preferably the thickness of the metal in the bends

is made greatest at the center of the bends, and gradually tapers to or beyond the point where the bends join the lateral portions connecting the bends; that is, the metal in said lateral portions attains its minimum thickness a short distance beyond the line where the bend runs into or joins such lateral portion. By this means, all sharp lines of demarcation between the thick curved portions and the thin lateral portions are avoided, the wearing strains at the bends are greatly relieved and uniformly distributed between the bends and the lateral portions, and all without destroying the essential ability of the wall to sensitively respond to external or internal pressures.

Figure 1 is a central, vertical sectional view showing a flexible corrugated metal wall provided with my improvement. Fig. 2 is a sectional detail showing a portion of the wall highly magnified. Figs. 3 and 4 illustrate one method of making the wall.

In Fig. 1 is illustrated a corrugated metal wall capable of vibratory movement, the corrugations comprising a series of alternately disposed convex portions 1 and concave portions 2 joined by lateral portions 3. The bent portions 1, 2, are thickened in relation to the lateral portions 3, the thickness of the wall being greatest at the middle of the bends and thinning out and merging into the thickness of the lateral portions 3. This is better shown in Fig. 2 where a portion of the corrugated wall is shown enlarged. In cross-section, the bends present the outline of a meniscus or a section of a concavo-convex lens the thickest portion 4 being located at the center and gradually thinning down around the bends at the points 5, 5 and attaining the thickness of the lateral portions as indicated at 6, 6, beyond the points 5, 5. Sharp lines of demarcation between the thinner lateral portions and the thicker bent portions are absent in this construction, thereby avoiding sharp angles about which the metal can bend and develop lines of wear.

The relative thickness of the lateral portions of the wall and that of the concave and convex portions is sufficient to effect an equal distribution of wear between these parts when the wall is subjected to vibratory movements in line with its longitudinal axis or when flexed from side to side of this axis. The relative thickness of the lateral portions to that of the bent portions may vary within wide limits depending on the character of the metal, the degree of flexibility required in the wall, and on the demands to be made on the wall under working conditions.

The wall embodying my improvement may be made in various ways one of which, and the one I prefer to employ, is illustrated in Figs. 3 and 4 and consists in taking a

piece of sheet metal, such as a sheet of brass, copper, steel or the like of a thickness slightly in excess of the thickness of the future lateral portions of the corrugated wall and passing it between a pair of shaping rolls one of which has preferably a plain surface and the other has an undulating surface. The sheet after being subjected to such rolls will have the configuration shown in Fig. 4 and will present on the lower side which is to be the inner surface of the tube a plain surface, while the upper surface which is to be the outside of the tube will present a series of raised portions 8 alternating with more or less plain surfaces 9. In cross-section the sheet presents a series of plano-convex ribs united by flat webs. In the next step the resulting sheet is formed into a cylindrical tube having the thick portions 8 of the sheet passing around the circumference of the tube. The edges of the sheet are next brazed or welded together to form a longitudinal seam preferably in the manner described in my U. S. Patent 976,060 of Nov. 15, 1910.

Instead of making the tube in the manner above described, a seamless tube may be taken having comparatively thick walls and by means of a mandrel and lathe tools it may be thinned down at successive intervals leaving the intermediate metal to constitute the thickened portions of the tube. In whatever way the blank tube is prepared with thick and thin portions, it is next submitted to the corrugating operation which I prefer to accomplish in the manner described in my U. S. Patent 971,838 of Oct. 4, 1910 to which reference is had for the details of procedure. Briefly stated the tube is subjected to the action of corrugating rolls and which impress a series of broad shallow outwardly extending corrugations 11 with the thickened portions 8, located at the crests of the bent portions and with two thin portions 9 forming the sloping sides of the corrugations. At this stage the corrugations 11 are united by other thickened portions 8 which are now subjected to a corrugating operation to shape them into shallow inwardly extending corrugations. The corrugations are narrowed and deepened by successive application of the corrugating rolls until the tube assumes the shape shown in Fig. 1.

In the operation of my improved flexible wall it will be noted that the bends of the corrugations which constitute the concave and convex portions of the wall are strengthened to resist fluid pressure acting perpendicular to the longitudinal axis of the tube and effect a more equal distribution of the strains between the curved and lateral portions of the wall under the action of both vibratory movements and flexure of the wall out of the line of its axis. This also con-

finer the flexure of the bends within safe limits and avoids abrupt lines of wear between the bends and lateral portions.

It is to be understood that I do not limit my invention in its application to corrugations lying in planes perpendicular to the axis of the wall as shown by way of illustration, but it may be applied to spiral corrugations with equally good results and the wall instead of being circular in cross-section may be oval or of other desired shape.

What I claim is:—

1. A flexible wall for expansible and contractible vessels consisting of corrugated flexible metal, and having the metal at the bends of the corrugations thicker than that of the portions of the wall connecting the bends.

2. A flexible wall for expansible and contractible vessels consisting of a corrugated flexible metal tube, and having the metal at the bends of the corrugations thicker than that of the portions of the wall connecting the bends.

3. A flexible wall for expansible and contractible vessels, consisting of corrugated flexible metal, and having the metal at the centers of the bends of the corrugations thicker than that of the portions of the wall connecting said bends.

4. A flexible wall for expansible and contractible vessels, consisting of corrugated flexible metal and having the metal at the centers of the bends of the corrugations

thicker than that of the portions of the wall connecting said bends, and the thickness of the metal of the bends tapering gradually toward the said connecting portions.

5. A flexible tubular wall for expansible and contractible vessels, consisting of corrugated metal, and having the metal of the bends of the corrugations flexible and thickest at their central portions and tapering from said central portions toward and into the portions of the wall connecting said bends.

6. A flexible tubular wall for expansible and contractible vessels, consisting of corrugated metal, and having the metal of the bends of the corrugations thickest at their central portions, said bends being connected by thin flexible portions of the wall into which the thicker bend portions gradually taper.

7. A flexible wall for expansible and contractible vessels, consisting of corrugated metal, and having both the bends of the corrugations and the portions connecting said bends flexible, the metal of the bends being thicker than the connecting portions and gradually tapering thereinto.

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

WESTON M. FULTON.

Witnesses:

C. H. BROWN, Jr.,
I. A. MARTIN.