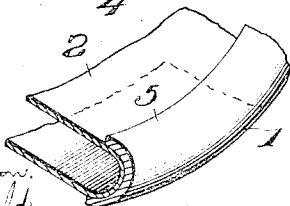
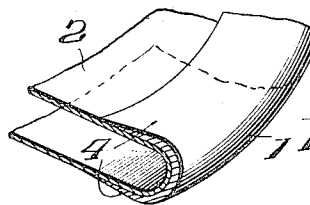
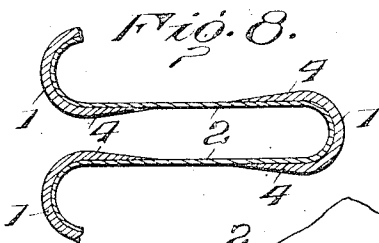
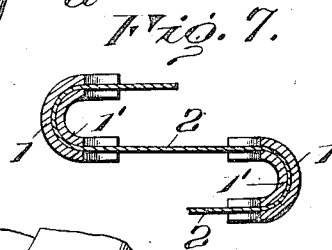
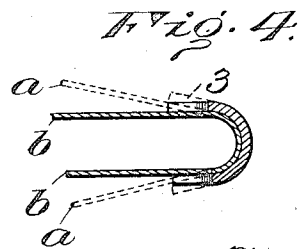
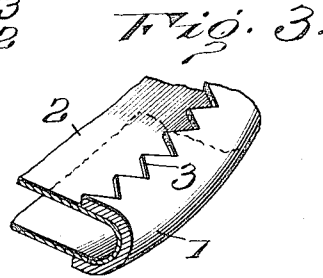
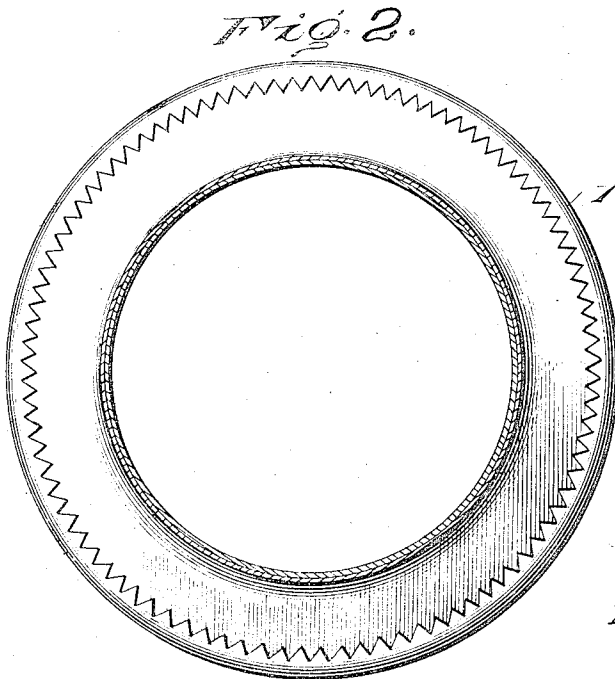
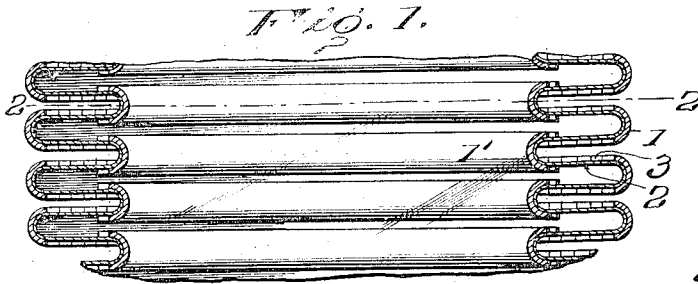


W. M. FULTON.
METHOD OF MAKING FLEXIBLE TUBULAR CORRUGATED METAL WALLS.
APPLICATION FILED DEC. 22, 1913.

1,151,777.

Patented Aug. 31, 1915.
2 SHEETS—SHEET 1.



Inventor

Fig. 10.

Wm. M. Fulton

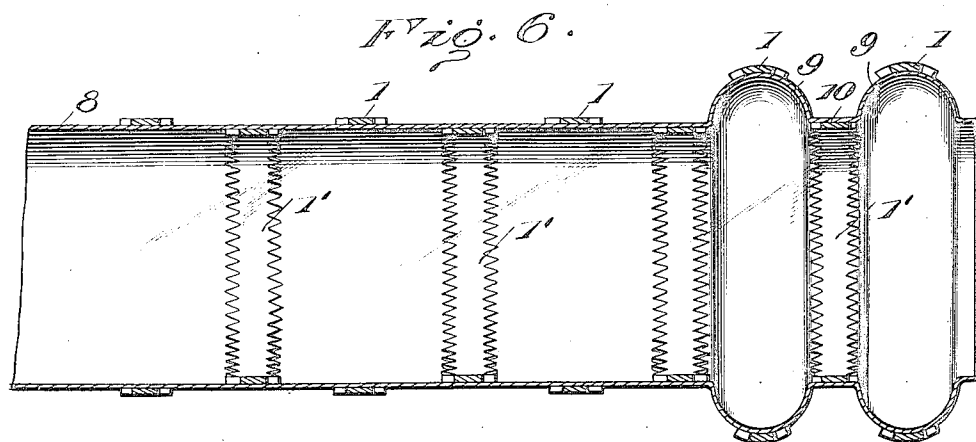
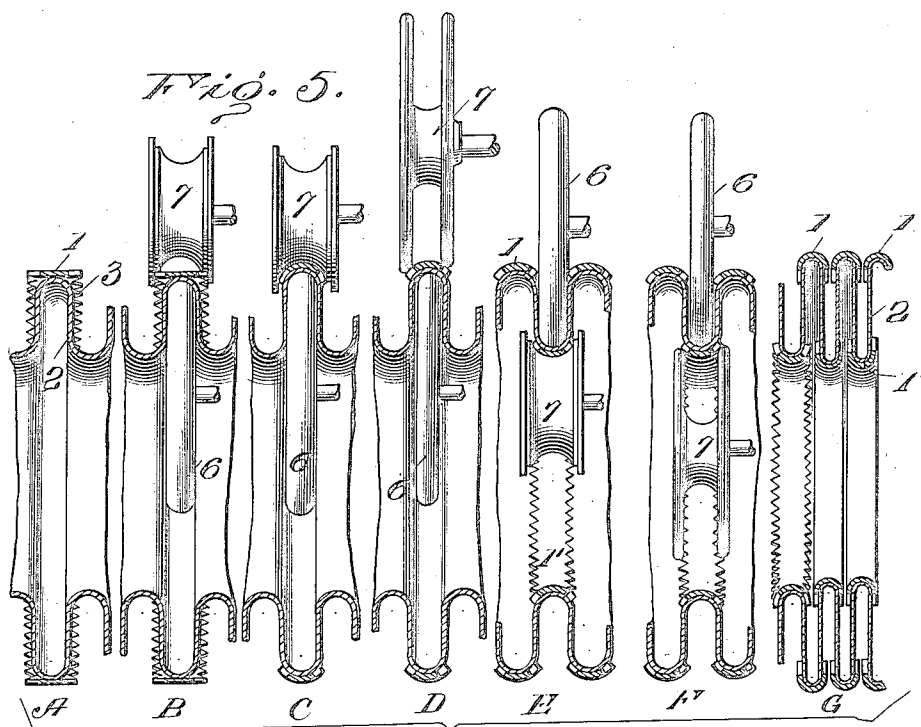
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2 SHEETS—SHEET 2.



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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.

METHOD OF MAKING FLEXIBLE TUBULAR CORRUGATED METAL WALLS.

1,151,777.

Specification of Letters Patent. Patented Aug. 31, 1915.

Application filed December 22, 1913. Serial No. 808,240.

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 Methods of Making Flexible Tubular Corrugated Metal Walls, which invention is fully set forth in the following specification.

This invention relates to improvements in methods of making flexible tubular corrugated metal walls for confining fluids.

Vibratory tubular walls have heretofore been made in one of two general ways, either the wall has been built up of flat annular disks soldered or brazed to each other at their edges or a tube was provided with corrugations sufficiently deep to give to the wall the requisite flexibility. In the disk construction, flexibility was secured by making the width of the annular part quite wide. Whether the meeting edges of the disks were brazed flat together or bent into curved lapped joints, it was found that the joints did not stand up under the vibratory movements of the wall and cracked apart. The width of the disks introduced buckling difficulties resulting in lost motion in the extension and contraction of the wall and extra wear on the disks.

In the corrugated construction circumferential joints have been avoided and flexibility secured at the bends as well as in the connecting portions between the bent portions of the wall. This construction has also enabled the narrowing of the connecting portions and thereby avoiding in large measure buckling difficulties in these portions. While these advantages have been secured by the introduction of the flexible corrugated wall, disadvantages have been introduced especially in those situations in which the flexible wall is used to contain an expansible fluid, the fluctuations of pressure of which on the walls causes the vibratory movement of the wall. In practice, the lateral pressure of such fluid on the wall perpendicular to the axis of the tubular wall becomes at times excessive and has resulted in the use of non-flexible braces which are applied in the form of rings on the concave side of the bends. Such practice is illustrated in U. S. Patent No. 823,382. For the same purpose the convex sides of the bends have received like braces which are recessed

to receive the crests of the bends. While these devices overcome the outward pressure of the fluid in the vessel, no account has been taken in their use of their effect on the bending strains in the vicinity of the wall where they are located. The extension and contraction of a corrugated metal wall is accompanied by changes in the radius of curvature of the bends. The presence of rigid braces either on the concave or on the convex side of the bends localizes these bending strains along narrow lines where the wall bends at the brace. Their presence accentuates the wear at the bends in the wall and hastens deterioration at these concave and convex portions.

My invention relates to flexible tubular walls provided with corrugations and particularly to improvements in means for bracing the concave and convex portions against outwardly exerted fluid pressure while giving to the said curved portions a durability equal that of the lateral portions of the wall connecting the concave and convex portions, and my invention accomplishes the above objects by associating with those portions of the flexible corrugated wall constituting the bends, resilient members adapted to reinforce the bends against fluid pressure forcing them outward and to yieldingly restrain the flexure of the bends in their vibratory movement either in one direction or both directions with respect to their position of rest and thereby more equally distribute the working strains between the curved portions and lateral portions of the wall and increase the durability of the wall.

In order that the invention may be readily understood reference is had to the accompanying drawings which are intended to assist the description and to illustrate some of the ways in which my method may be carried out.

In the drawings:—Figure 1 is a view in central vertical section showing a flexible corrugated wall provided with my improvement. Fig. 2 is a horizontal sectional view taken on line 2—2 of Fig. 1. Figs. 3 and 4 are detail views highly magnified. Fig. 5 is a view illustrating one manner of applying the flexible braces to the convex sides of the bends outside and inside the wall of the tube. Fig. 6 is a view in longitudinal cen-

tral section showing a somewhat different manner of applying the braces. Figs. 7, 8, 9 and 10 are detail views magnified, showing portions of bends to which different forms of my improved brace are applied.

Referring to Figs. 1, 2, 3 and 4 of the drawings, a flexible tubular corrugated wall is therein shown, the bends of which are provided on their convex surfaces with braces 1 made of highly resilient material, such as thin sheet brass, steel or the like. In the drawings, the thickness of the metal comprising the walls and braces is somewhat enlarged for the sake of distinctness. In practice, very thin metal is used and seldom not more than one one-hundredth of an inch in thickness. These braces conform to the shape of the bends and preferably overlap the marginal surfaces of the portions 2 of the wall which connect the oppositely curved portions forming the bends of the corrugations. In the form of brace illustrated in Figs. 1-4, gradually increased flexibility is given the margins of the braces 1 by providing the margins where they extend over the connecting portions 2, with serrations 3. The resiliency of the braces 1 are thus graduated along their margins to the degrees of flexure of the bends where the latter merge into the lateral connecting portions 2 of the wall, thereby avoiding along these lines sharp lines of wear and more equally distributing the strains between the curved portions and the lateral connecting portions of the wall during its vibratory movements and also movements from side to side of its longitudinal axis.

In Fig. 4, a fragment of the corrugated wall is shown while its bend is at the outward limit of an expansion a of the vessel and while the bend is passing through its normal position of rest, b . In the position, a , of expansion, the curved portion of the wall and the brace member increase their radii of curvature and a slight slip takes place between the parts. The resilient margin or serration 3 reinforces the bend where it merges into the connecting portion 2 and transfers part of the bending strains heretofore sustained by the metal in the bend where no brace or where an inflexible brace has been used to the connecting portion. The work is thus more evenly divided between these two elements of the wall with evident advantages. During the contracting movement of the flexible wall the brace participates in the movement of the surface in contact with it and owing to the marginal resiliency of the brace continues in contact with the wall to the position of rest b , thereby hugging the wall in its movements and excluding dirt and moisture from between the surfaces.

In Figs. 8 and 9, a modified form of resilient brace is shown. Instead of serrating the

margin, the margin is unbroken in outline and thinned down at 4 and vanishes to an edge. It will be apparent from what has been explained above in respect to the serrated form of brace that this form accomplishes the same results and in substantially the same manner.

In Fig. 10 is shown a flexible brace in all respects like the two forms previously described except that serrations and the thinned margin are omitted. While this form does not participate in all the advantages possessed by the other forms in the matter of flexibility, yet it embodies the idea of means for reinforcing the flexible bends of a corrugated metal wall with a resilient brace which is within the scope of my invention.

While I have so far described my improvement as applied to the convex surfaces of the bends in the flexible wall, I may apply the flexible brace in any of its forms to either side or to both the convex side and concave side. This construction is illustrated in Fig. 5 in which a serrated brace 1 is shown on the convex surface of the bend and a similar brace 1' is shown as placed against the concave surface. The principle of construction is the same for both forms.

The material of the braces is preferably the same as that of which the walls of the tube are made, yet it is to be understood that the wall and braces may be of different material.

It will be observed that all forms of my resilient brace secure protection of the circumferential curved portions of the wall against internal pressures while having the other advantages peculiar to their construction as above pointed out.

The braces may be applied to the tubular wall in various ways. Two of such methods are illustrated in Figs. 5 and 6.

In accordance with the method indicated in Fig. 5, a flexible corrugated tubular wall is made preferably in the manner shown and described in my U. S. Patent 971,838 of Oct. 4, 1910, having broad corrugations therein. For the purpose of simplifying the description of the method, attention is confined to a single portion of the corrugated tube containing a concave and convex portion as it passes through the several stages indicated in A to G of Fig. 5. A cylindrical ring 1 is made of resilient material, preferably of the same material as the wall to which it is to be applied and of a width equal that of the corrugation. In the illustration the margins are provided with serrations. This ring or brace is of suitable diameter to slip over the outside corrugation and is positioned on the convex side of the bend as shown in stage A where it may be soldered to hold it in place though such expedient may be omitted. The corrugation and its

external brace 1 are next positioned as at B between a die roll 6 and matrix roll 7 which are operatively supported by any suitable means, but preferably the means shown in my U. S. Patent No. 971,838, are used. Then by closing the rolls 6, 7, on the work, as shown at C, the brace is wrapped around the convex side of the bend in the corrugation. This operation is repeated with another set of rolls to narrow and deepen the corrugation and to extend the serrated margin of the brace over the lateral portions of the wall connecting the bends. Such step is shown at C and may be repeated to further narrow and deepen the corrugations but before the bends reach their final dimensions the internal brace 1' is applied to the convex side of the inner bend. For this purpose a ring 1' of metal is inserted into the tube and positioned against an inner bend. Die and matrix rolls 6, 7, are applied to the work as in the first stages of the operation, but in this case are reversed in position as shown at E and F. By repeating the applications of these shaping rolls the corrugations merge into the form indicated at stage G with the braces in position as shown. This method is equally applicable to any form of brace.

In Fig. 6 is illustrated another method of accomplishing the same result. The brace rings 1, 1', are applied at intervals both interiorly and exteriorly on an uncorrugated tube 8 such as a seamed or seamless tube of resilient metal. These braces are preferably tacked to the wall of the tube by solder and at places which are subsequently to become the crests of the bends on their convex sides. A series of broad outwardly extending corrugations 9, are then formed in the tube by a pair of die and matrix rolls in the manner described in the above U. S. Patent 971,838. Two of such corrugations are shown at the right hand end of tube 8, leaving between them a narrow uncorrugated portion 10 which is in width substantially equal the width of the internal brace 1'. By means of a set of narrower rolls these broad corrugations are narrowed and deepened while bending the brace over the convex surface of the bend. At the same time the narrow uncorrugated portions 10 are forced inward and somewhat narrowed and if need be the matrix roll may be placed inside the tube against the interior brace and a companion die roll placed opposite on the outside to work the inner brace into proper form around the inner bend. During the final steps of deepening and narrowing the corrugations the solder loosens its hold considerably and after the wall is in use for a short while, the braces come loose sufficiently to allow more or less slippage between the surfaces of the wall and the brace. This method is equally applicable to any form of

brace whether applied to the convex or concave surface of the bend, or to both sides.

The degree of resilience to be given the brace will be governed by the degree of resilience of the particular wall to which it is applied. For any given wall a brace is selected in form and of material indicated by experience and test corrugations made with such brace. Then this wall is placed in a testing machine of any known form adapted to extend and collapse the bends. An endurance test of this kind reveals whether the lateral portions or the bends give way first. From this data another brace from the same stock is selected of decreased or of increased stiffness as the data indicates and other braces are made until the curved and lateral portions of the wall have approximately equal durability. Having thus determined the particular kind of brace best suited for a particular tubular wall, the construction of other walls of the same materials is determined thereby.

While I have described my invention as peculiarly applicable to tubular corrugated walls, I do not desire to limit my application to such walls since it is applicable to other forms of corrugated walls such as flat corrugated flexible walls and wherever the bends of flexible corrugations are subject to flexure back and forth.

The article herein described and not claimed forms the subject-matter of my U. S. Patent No. 1,096,296, of May 12, 1914, wherein the same is claimed.

What is claimed is:—

1. A method of reinforcing corrugations in flexible corrugated tubular metal walls, consisting in corrugating a tubular metal wall, applying resilient metal bands or braces to corrugations of said wall and subjecting said bands or braces to a corrugating operation to conform the same to the bends of the corrugations.

2. A method of reinforcing corrugations in flexible corrugated tubular metal walls, consisting in corrugating a tubular metal wall, applying separate resilient metal bands or braces to successive corrugations of the wall, and subjecting said bands or braces to a corrugating operation to conform the same to the bends of the corrugations.

3. A method of reinforcing corrugations in flexible corrugated tubular metal walls, consisting in corrugating a tubular metal wall, applying separate resilient metal bands or braces to the convex bends of said corrugations, and subjecting said bands or braces and wall to a further corrugating operation to conform said bands or braces to the convex bends of the corrugations.

4. A method of reinforcing corrugations in flexible corrugated tubular metal walls, consisting in corrugating a tubular metal wall, applying separate resilient metal

bands or braces to successive corrugations
of the wall, cementing said bands or braces
to said corrugations and subjecting said
bands or braces to a corrugating operation
5 to conform the same to the bends of the
corrugations.

In testimony whereof I have signed this

specification in the presence of two subscri-
ing witnesses.

WESTON M. FULTON.

Witnesses:

I. A. MARTIN,
H. S. McCoy.