Aug. 24, 1926. 1,597,206

H. C. MALLORY

METHOD OF PRODUCING EXPANSIBLE COLLAPSIBLE ELEMENTS

Filed March 23, 1920 2 Sheets-Sheet 1

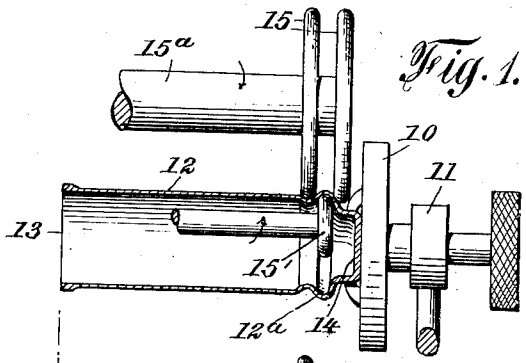


Fig. 1.

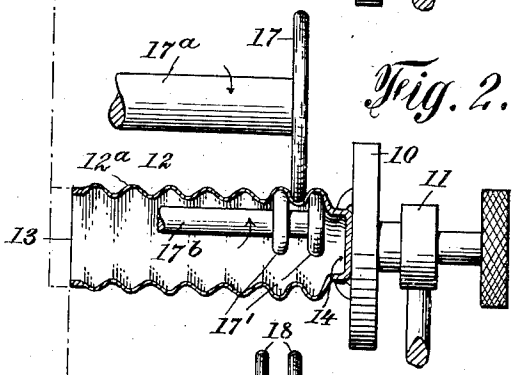


Fig. 2.

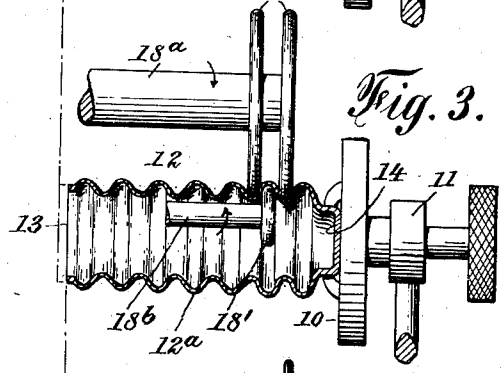


Fig. 3.

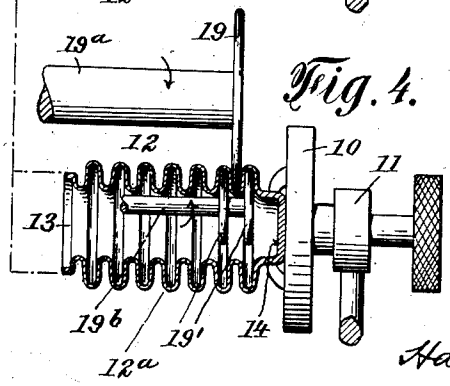


Fig. 4.

Inventor
Harry C. Mallory
BY Conrad A. Bulard
his ATTORNEY

Aug. 24, 1926. 1,597,206

H. C. MALLORY

METHOD OF PRODUCING EXPANSIBLE COLLAPSIBLE ELEMENTS

Filed March 23, 1920 2 Sheets-Sheet 2

Fig. 5.

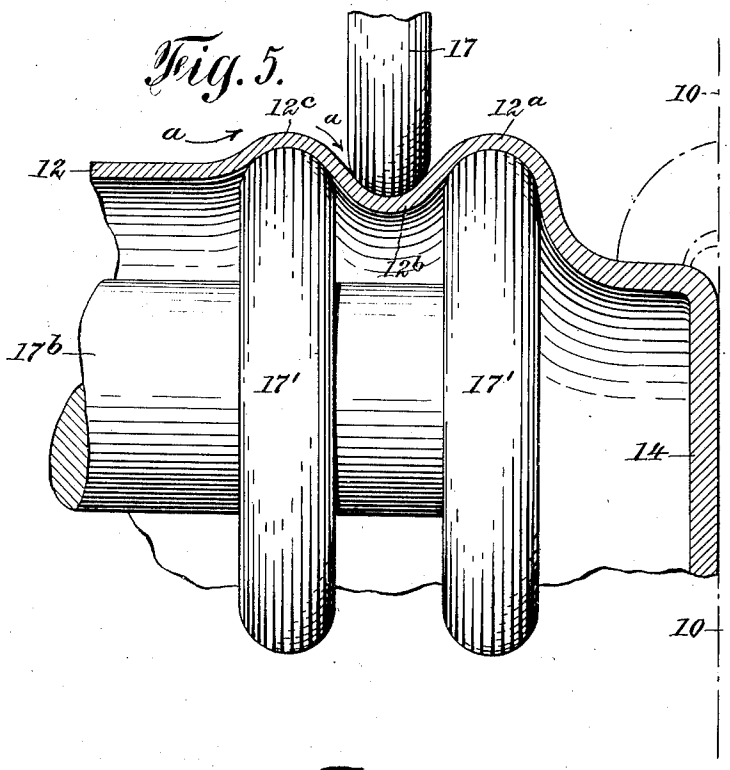
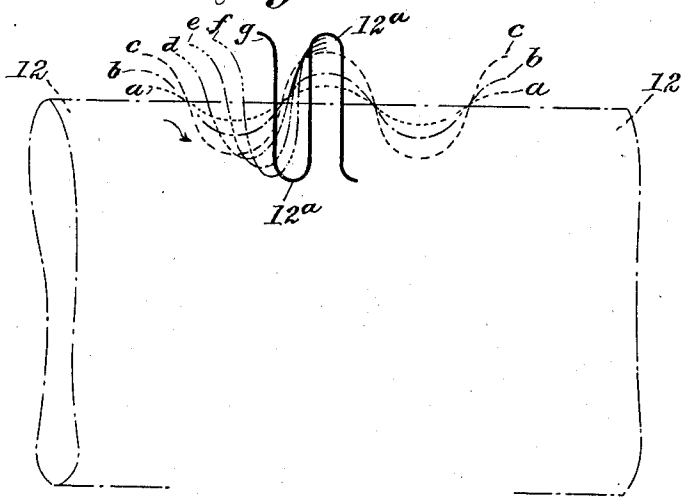


Fig. 6.



Inventor
Harry C. Mallory
BY Conrad A. Dietrich
his ATTORNEY

Patented Aug. 24, 1926. 1,597,206

UNITED STATES PATENT OFFICE.

HARRY C. MALLORY, OF BELLEPORT, NEW YORK, ASSIGNOR, BY MESNE ASSIGNMENTS, TO AMERICAN RADIATOR COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

METHOD OF PRODUCING EXPANSIBLE-COLLAPSIBLE ELEMENTS.

Application filed March 23, 1920. Serial No. 368,116.

My invention relates to improvements in methods of producing expansible-collapsible elements, and the same has for its object more particularly to provide a method of producing corrugations in a hollow cylindrical or tubular blank, which method consists in drawing the wall of said blank over suitable dies, whereby the shape thereof is altered without subjecting said wall to any rolling or swaging action.

Further, said invention has for its object to provide a method of corrugating a hollow cylindrical or tubular blank which consists in securing the blank at one end to a suitable support, and then subjecting it to the action of appropriate dies, beginning adjacent to the secured end, and working progressively outwardly therefrom and drawing the metal of the wall from its free end over or between said dies towards its secured end into corrugations or folds of substantially uniform temper throughout.

Further, said invention has for its object to provide a method of producing corrugations in a hollow cylindrical or tubular blank one end of which is firmly secured to a support in which the wall of the blank, proceeding from said secured end towards its free end, is passed over appropriate dies, in such a manner that the metal of the wall is drawn inwardly from the free end of said blank towards its secured end to produce a series of shallow corrugations, after which the blank is subjected successively to other dies in order to progressively deepen and contract said corrugations.

Further said invention has for its object to provide a method of corrugating a hollow cylindrical blank, in which the wall of the blank is initially drawn over substantially the entire effective surface of one member of a set of cooperating dies, and over a part of the effective surface of the remaining member or members of said dies in order to produce shallow corrugations extending approximately an equal distance inside and outside of the original wall line or diameter of the blank, which corrugations are thereafter drawn, in succession, over or between additional dies serving to deepen and contract said corrugations by reducing the radius of the curved inner and outer bends of said corrugations and forming intermediate portions connecting the ends of said curved bends.

Other objects will in part be obvious, and in part be pointed out hereinafter.

To the attainment of the aforesaid objects and ends my invention consists in the successive steps or operations hereinafter described and then pointed out in the claims.

In the accompanying drawings forming part of this specification wherein like characters of reference indicate like parts, I have illustrated the first, last and several of the intermediate steps or operations performed in carrying out my method, and in connection therewith the essential parts of a machine whereby said method may be carried into effect.

In said drawings:—

Figure 1 is a side elevation showing a pair of cooperating dies, and in section, a hollow, cylindrical blank engaged thereby for producing the initial, shallow corrugations.

Fig. 2 is a similar view showing the second operation in which the initial, shallow, corrugations are slightly deepened;

Fig. 3, is a similar view showing a further operation in which the corrugations have been drawn into semi-circular bends extending substantially an equal distance inside and outside of the original diameter of the wall of the blank;

Fig. 4, is a similar view showing the final drawing operation in which the corrugations are deepened and contracted to the desired extent;

Fig. 5, is an enlarged detail side view showing a set of dies for drawing the corrugations, showing the manner in which a portion of the wall of a blank is drawn over approximately the entire effective surface of the upper die, and over approximately one quarter of the effective surface of each of the cooperating lower dies, and

Fig. 6, is a diagrammatic view showing the development of a corrugation from the blank to the completed corrugation in seven successive drawing operations.

To produce a corrugated element for use as an expansible-collapsible vessel, I take a hollow, cylindrical blank 12 of appropriate thickness, by preference one that is open at one end, as 13, and closed at the other 14. The blank is then secured at its closed end

14 in a chuck 10 which is freely revoluble in a bearing 11. Then the dies 15, 15^1 are simultaneously advanced towards the closed end 14 of the blank—the die 15^1 being disposed within the blank, and the die 15 without the blank. When said dies are duly positioned with respect to the blank, the same are placed in operation, rotating towards each other, and are brought together with the wall of the blank 12 therebetween. As soon as the wall of the blank becomes engaged by said rotating dies 15, 15^1, the blank and the chuck 10 supporting the same, will be caused to rotate by the frictional engagement of the dies 15, 15^1, with said wall, and the metal thereof will be drawn slightly inwardly from the free end 13 of said blank towards its closed end 14, and a very shallow circumferential corrugation 12^a formed therein adjacent to its closed end 14. Upon completing said first shallow corrugation, the dies 15, 15^1 are separated again and moved outwardly a step, towards the open end 13 of the blank, and then brought together again into engagement with the wall of the blank, and a corresponding second shallow corrugation 12^a. This operation is repeated until the desired number of corrugations or bends have been produced in the blank.

Hereupon the partly corrugated blank is subjected to the second step or operation, as illustrated at Fig. 2, in which the dies are reversed, i. e. the upper die 17 being a large single one, and the lower die 17^1 being a small, double one whose members are separated from each other by a distance equal to the width of the upper die 17, plus double the thickness of the metal of the wall of the blank and the requisite clearance. In this second operation the corrugations are successively deepened into semi-circular, or substantially semi-circular folds extending approximately an equal distance within and without the original diameter of the blanks. The dies 17, 17^1 used in this operation are of substantially the same diameter as those used in the first operation, but are appreciably narrower in width.

A succeeding operation, however, not necessarily the third, is illustrated at Fig. 3. In this operation the dies are again reversed, and the upper die 18 formed as a double one, and the lower, smaller die 18^1 as a single one. The dies in this instance are also of the same diameter as in the preceding constructions, but appreciably narrower in width than those shown at Fig. 2, and serve to deepen the corrugations somewhat further and bring the same more closely together.

The final operation is illustrated at Fig. 4. In the regular course of operation, several operations may occur between the operation illustrated at Fig. 3, and that shown at Fig. 4. In said last named figure, the dies 19, 19^1 are reversed, and the upper die 19 formed as a single die, and the lower die 19^1 as a double one. The dies 19, 19^1 are, as heretofore, of the same diameter but materially thinner in width. In this final operation the corrugations, as previously developed, are further deepened and contracted to the degree desired in the finished product.

In each of the sets of dies hereinabove described the distance between the inner opposing faces of the double dies is always about equal to the width of the single die plus double the thickness of the metal of the wall of the blank to be operated upon, sufficient clearance being provided in each case to insure the proper drawing of the metal of the wall over and between said dies.

At Fig. 5 the operation illustrated and described in connection with Fig. 2, is represented on an enlarged scale in order to show graphically the manner in which the wall of the blank is acted upon by the dies. In Fig. 5 the blank is shown with the first partly-drawn corrugation 12^a formed adjacent to the closed end 14 of the blank, and the dies 17, 17^1 acting to produce the second corrugation 12^b and forming about one-half of the succeeding corrugation 12^c by drawing the metal of the wall of the blank inwardly from the free end 13 of the blank, as indicated by arrows *a*, over and between the effective surfaces of said dies and conforming the wall of the blank thereto.

At Fig. 6 I have shown diagrammatically the development of one corrugation from the original blank to the completed corrugation resulting from the operation of a series of seven sets of dies acting in succession upon the wall of the blank. In this figure, the successive operations are illustrated by a series of curved lines indicated by the letters *a* to *g* inclusive.

It will be understood of course, that between the initial and final drawing operations as illustrated at Figs. 1 and 4, respectively, any desired number of intermediate drawing operations may be performed. I have as a matter of convenience shown only four operations to illustrate my method.

It is to be noted particularly that in carrying out my method I prefer to secure one end of the blank firmly in position upon the chuck 10 which, while capable of free rotary movement, is preferably held against all longitudinal movement, and that in corrugating the wall of the blank I prefer to begin the operation at or adjacent to the fixed end of the blank, and progressively work outwardly towards the free end of the blank until the desired number of corrugations have been produced and that as a result of the construction and disposition of the dies with reference to each other, the metal of the wall of the shell between the dies and the open, free end of the blank

will be progressively drawn inwardly towards, over and between said dies in the formation of the corrugations thereby. This action is due to the fact that the wall of the blank between the die and the free end of the blank being unconfined or unrestrained will offer less resistance to the drawing action of the dies than the closed end of the blank or the corrugated portion of the blank between said dies and said closed end, and will cause the metal of the blank to be drawn inwardly over and between said dies and thus insure the uniform temper of the metal.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:—

1. The method of producing corrugated expansible-collapsible elements which consists in taking a cylindrical blank, securing one end of said blank to a support, subjecting the said blank to the action of suitable dies and successively drawing the same over said dies from the free end of said blank towards its secured end to form a series of shallow, parallel corrugations therein, and then subjecting said blank to the further action of said dies whereby to progressively deepen said corrugations and draw the same closer together, substantially as specified.

2. The method of producing corrugated expansible elements which consists in taking a hollow, cylindrical blank, securing one end of said blank to a support, subjecting said blank to the action of suitable series of dies and successively drawing the same over said dies from the free end of said blank towards its secured end and initially forming shallow circumferential corrugations therein, and then subjecting said partially corrugated structure to the action of additional sets of dies whereby further to draw said blank from its free end towards its secured end and progressively to deepen and contract said corrugations, substantially as specified.

3. The method of producing expansible-collapsible elements which consists in taking a hollow cylindrical blank, open at one end and closed at its other end, securing said blank at its closed end to a revoluble support, subjecting said blank to the action of a set of cooperating revolving dies, while upon said support, beginning adjacent to its closed end, and drawing the wall of said blank over and between said dies, from the free open end of said blank towards its closed fixed end whereby to form corrugations therein, substantially as specified.

4. The method of producing expansible-collapsible elements which consists in taking a hollow cylindrical blank having an open end and a closed end, securing said blank at its closed end to a revoluble support, subjecting said blank, while on said support, to the action of a set of cooperating, revolving dies, and, proceeding from the secured end of said blank towards its free end, drawing the metal of the wall of said blank inwardly, from the free end thereof towards its secured end, over and between said dies and simultaneously forming corrugations in said wall, substantially as specified.

5. The method of producing expansible-collapsible elements which consists in taking a hollow cylindrical blank having an open end and a closed end, securing said blank at its closed end to a revoluble support, subjecting said blank, while on said support, to the action of a set of cooperating, revolving dies, and, proceeding from the closed, secured end of said blank towards its free, open end, drawing the metal of the wall of said blank inwardly, from the free open end thereof towards its closed, secured end, over and between said dies and initially forming shallow corrugations in said wall, and then subjecting said blank successively to the action of other sets of dies which serve to draw the metal of the wall of said blank further inwardly towards its closed end and to deepen and contract said corrugations, substantially as specified.

6. The method of producing expansible-collapsible elements which consists in taking a hollow cylindrical shell having an open end and a closed end, securing said blank at its closed end to a revoluble support, subjecting said blank, while on said support, to the action of a set of cooperating revolving dies, and, proceeding from the closed, secured end of said blank towards its free, open end, drawing the metal of the wall of said blank with a step-by-step movement inwardly from the free, open end thereof towards its closed, secured end, over and between said dies and initially forming shallow corrugations in said wall, and then subjecting said blank successively to the action of other sets of revolving dies which serve to draw the metal of the wall of said blank further inwardly and progressively deepen and contract said corrugations, substantially as specified.

7. The method of producing expansible-collapsible elements which consists in taking a hollow cylindrical shell having an open end and a closed end, securing said blank at its closed end to a revoluble support, subjecting said blank, while on said support, to the action of a set of cooperating, revolving dies, and, proceeding from the secured end of said blank towards its free end, drawing the metal of the wall of said blank progressively inwardly from said free end towards said secured end and initially forming shallow corrugations in said wall, and then subjecting said blank successively to the action of other sets of revolving dies of gradually diminishing width which serve to draw the

metal of the wall of said blank further inwardly towards its closed end and progressively reducing the diameter of the curved inner and outer ends of said corrugations and forming substantially flat, parallel portions intermediate said curved ends, substantially as specified.

8. The method of producing expansible-collapsible elements which consists in taking a hollow blank, open at one end and closed at its other end, securing the same at its closed end to a support, subjecting said blank to the action of suitable dies and successively drawing the same over said dies from the free end of said blank towards its secured end whereby to form corrugations therein, substantially as specified.

9. The method of producing corrugated expansible-collapsible elements which consists in taking a hollow blank, securing the same at one end to a support, subjecting said blank to the action of suitable dies and successively drawing the same over said dies from the free end of said blank towards its secured end to form a series of shallow, parallel corrugations therein, and then subjecting said blank to further action of dies whereby to deepen said corrugations and draw the same closer together; all of the said several corrugating operations proceeding from the secured end of said blank towards the free end thereof, substantially as specified.

Signed at the city of New York, borough of Manhattan, New York County, in the State of New York, this 28th day of February, one thousand nine hundred and twenty.

HARRY C. MALLORY.