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METHOD OF FORMING HIGH PRESSURE TANKS

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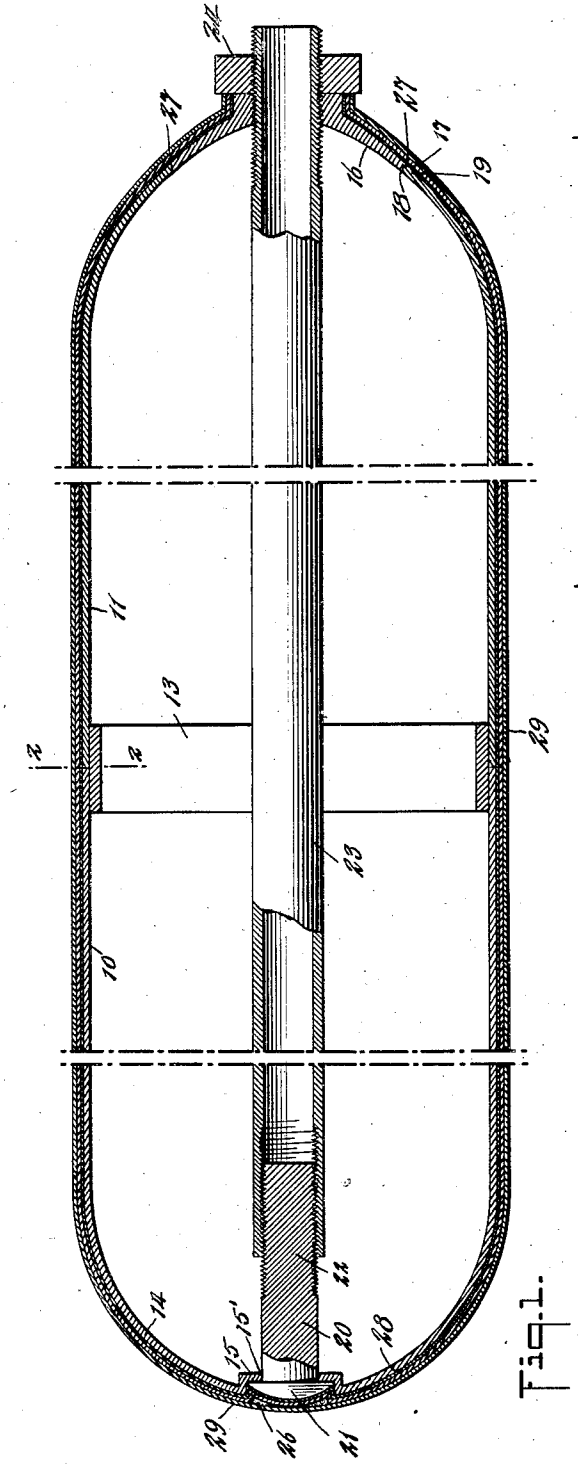


Fig. 1.

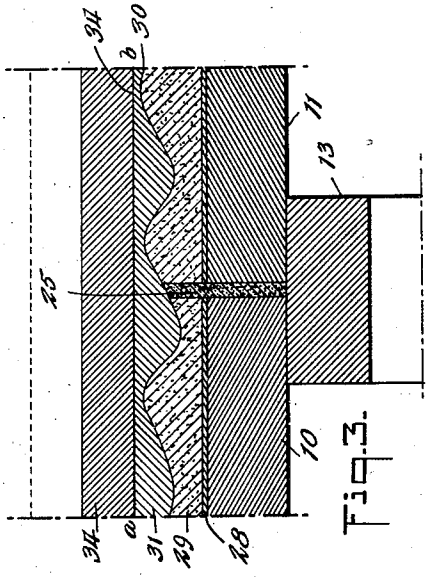


Fig. 3.

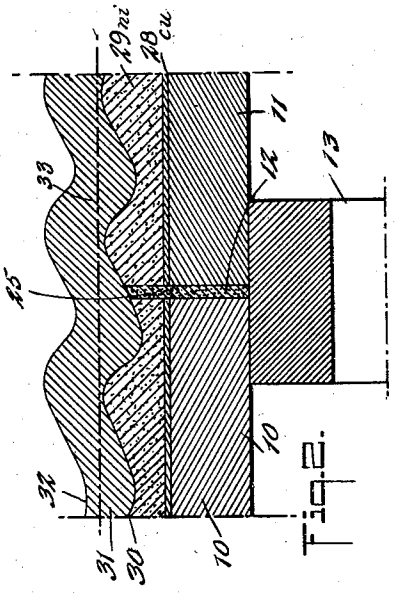


Fig. 2.

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METHOD OF FORMING HIGH PRESSURE TANKS

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Application February 2, 1931, Serial No. 512,990

2 Claims. (Cl. 204—6)

The invention relates to a method of forming hollow metallic articles by electrolytic deposition.

The present disclosure constitutes a companion application with my two copending applications, entitled "Electrolytically formed tanks", filed February 2, 1931 Serial No. 512,991 and entitled "Seamless tanks", filed February 2, 1931, Serial No. 512,992.

In the manufacture of receptacles, tanks, containers and the like designed to withstand high internal or external pressures on the walls thereof, it has been necessary heretofore to make the walls with an amount of material necessary to give the requisite tensile strength and rigidity to maintain the configuration of the article under the distorting strains to which they are intended to be subjected. This necessity for structural strength has required the use of a material amount of metal in forming the walls and this in turn has made them heavy in weight and of course expensive to manufacture.

The primary object of this invention, as is the object in the above identified copending applications, is to provide a high pressure tank or other hollow structure having a high degree of tensile strength and which at the same time will be light in weight and which can be manufactured economically both in labor cost and in the amount of material used.

The invention features primarily the formation on a suitable mold or pattern of alternate layers of a shell comprising electrolytically deposited metals formed and assembled in a novel way to give to the resulting shell a tensile strength greater than would be obtained by following conventional methods.

Heretofore in forming hollow articles by electrolytic deposition on molds and patterns, it has been a usual practice to form the first deposit or layer on a mold covered with some form of deposit receiving material such as graphite, or to form this initial deposit on a metal mold of some readily fusible or meltable material. Such surfaces are rough, or perhaps more accurately defined, are porous or coarse grained and react on the deposited layer to give to it a rough texture necessitating the formation of a layer of material thickness in order to give the requisite strength required of the shell forming the completed article. Continuing the deposition following known practices, there results a development of positive granulation in the succeeding layers with resulting lack of cohesion between the particles and a resulting weakness in tensile strength. The present invention features the formation of the electrolytic deposition on surfaces which are smooth, even high polished, which are homogeneous, non-porous and otherwise capable of forming a fine grained, adhesive layer of high tensile strength in distinction from the layers of low tensile strength formed heretofore when the same metals have been deposited on the usual metal mold and other surfaces. Examples of surfaces which act satisfactorily when following the method herein disclosed are polished sheet aluminum, highly polished electrolytically deposited copper and nickel, particularly copper.

In forming articles by electrolytic deposition it has been found that the presence of cracks, joints, re-entrant angles and other recesses and depressions in the surface receiving the deposition has the effect of weakening the deposited layer.

Accordingly, the present disclosure features the providing of deposit receiving surfaces which are continuous, free of joints, cracks or other imperfections or breaks in the continuity of the surface designed to receive the deposit.

Referring to the apparatus feature of the disclosure, an object of the invention is to provide a neat appearing tank designed to contain fire extinguishing and other chemical fluids under high pressure; which will be resistant to any chemical reactions with such fluids, which will be light in weight and which will possess certain economical factors in design and construction contributing to low manufacturing costs.

Various other objects and advantages of the invention will be in part obvious from a consideration of the method features of the disclosure and from an inspection of the accompanying drawing and in part will be more fully set forth in the following particular description of one method of practicing the invention, and the invention also consists in certain new and novel modifications of the preferred method and other features of construction and combinations of parts hereinafter set forth and claimed.

In the accompanying drawing:

Fig. 1 is a view in axial cross section of a tank in process of manufacture, before the form or mold is removed, illustrating a preferred embodiment of the invention and parts broken away to reduce the size, but it is to be understood that the layers are shown in enlarged cross sectional dimensions;

Fig. 2 is an enlarged cross sectional view taken on the line 2—2 of Fig. 1; and greatly enlarged to show the relation in an exaggerated form of the deposited layers;

Fig. 3 is a view similar to that shown in Fig. 2 illustrating on the same scale the two innermost deposited layers in a stage of the forming of the shell shown in Fig. 2, prior to the addition of the third layer shown in this figure.

Referring particularly to the showing in Fig. 1, there is disclosed an internal mold or pattern consisting primarily of two open end cylindrical shells 10 and 11 disposed with their open ends in abutting relation to form a joint 12. These shells are formed of sheet aluminum, preferably spun to shape to avoid the presence of joints or other breaks in the exposed surfaces. For the purpose of insuring the maintaining of the abutting ends in fixed abutting relation, it is herein suggested that the ends of the shells be telescoped over a rugged rigid aluminum reinforcing ring 13 designed to have a snug fit in the open ends of the shells. The shell 11 is provided at its opposite end with a dome-like, substantially semi-spherical head 14 provided at its crown with a bolt opening 15'. At the opposite end of the shell 11 is fixed a preformed threaded brass collar 16 designed to form part of the finished fire extinguishing devices. The collar is provided with a shouldered portion 17 merging at its inner end into a pointed edge 18 designed to form on both the inner and outer surfaces a smooth joint with the adjacent portion 19 of the shell 11 which telescopes the same. In assembling the mold, a bolt 20 is inserted into the opening 15 with the headed end 21 of the bolt fitting within a countersunk recess 15 in the portion of the dome head 14 which contains the opening 15'. The shank 22 of the bolt extends into the interior of the shell and projects for a short distance axially thereof. The bolt is in threaded engagement with a tie rod 23, the opposite end of which extends through the opening in the collar 16 and is provided exteriorly thereof with a nut 24. The parts are so designed that tightening up on the nut 24 will cause the shells 10 and 11 to be drawn together by axially directed pressure. Preferably the nut 24 is formed of insulating material where it is designed to stop off depositions on the outer end of the collar 16.

It is a feature of the disclosure that the portion of the mold which is designed to receive the metal deposited by electrolytic deposition as hereinafter described be continuous and smooth. To attain this, it is necessary that all cracks, joints and other recesses be filled and smoothed to provide a continuity of surface across the same. For this purpose, solder, preferably a tin solder filler 25 is inserted in the joint 12 before, but preferably after the nickel layer 29 hereinafter described has been deposited and a similarly solder filler 26 is positioned about the periphery of the bolt head 21 to fill in the recess between the outer periphery of the head and the adjacent portion of the dome head 14. Preferably the solder 26 is inserted in place after the nickel layer 29 is in place. Similarly, filling solder 27 is positioned to fill out any depressions which may be formed between the collar 16 and the portion 19 of the shell 11. When the parts have thus been assembled, the exposed surface designed to receive the outermost depositions of metal is cleaned conventionally and then highly polished.

While not vitally necessary to the success of the method herein disclosed, it is suggested as preferable practice to first deposit on the polished surface of the mold a thin layer of copper, or more accurately defined, a cloud-like mist of copper 28. The layer may be deposited by chemical precipitation or by electrolytic precipitation. This copper layer, if used at all, is so thin that it offers no resistance to the aluminum dissolving action hereinafter described and has no effect upon the requisite smoothness of the polished aluminum mold.

The mold, either with or without this film of copper, is positioned in an electrolytic bath containing nickel and a layer 29 of nickel is formed thereon. In the practicing of this method, certain refinements are observed in that preferably the temperature is maintained between 110° F. and 140° F. It has been found that where the temperature was materially below 110° F., the deposit tended to become brittle, and at temperatures materially greater than 140° F., the resulting layer tended to lack the requisite tensile strength.

This deposition of nickel is continued until there is a layer formed of about fifteen thousandths of an inch and this is best attained with a current density of about twenty-five to thirty amperes per square foot. While the nickel layer thus formed is characterized by a much smoother outer face than would be the case if it were formed on the relatively rough mold surfaces heretofore known in this art, it is still true that the outer surface is not strictly smooth and under the microscope would show irregularities, indentations, ridges and the like, shown in an exaggerated form by the line 30 in Figs. 2 and 3.

The recesses are filled with solder if not already filled, as above suggested, and the nickel and solder surface is then polished.

For the purpose of filling up these imperfections, pores and other minute recesses exposed in the nickel layer, the assemblage is then inserted in an electrolytic tank containing copper and a copper layer 31 is deposited thereon as shown in Fig. 3. In general, the outer surface 32 of the copper layer will conform at least substantially to the configuration of the outer face 30 of the nickel layer. This electric deposition of copper takes place under substantially the same conditions as is indicated above in the deposition of nickel except that the current strength is usually somewhat higher being about 30 to 40 amperes per square foot.

The assemblage is then removed from the copper bath and the copper surface is ground down to provide a smooth surface indicated by the line *a—b* in Fig. 3. Preferably, the grinding is continued substantially until the high points 33 of the nickel begin to show or are about to show. This outer surface 34 of the copper is polished to provide the smooth, continuous, homogeneous and non-porous surface corresponding to the surface of the polished aluminum mold which received the first deposit 28 or 29 as the case may be.

The assemblage with its polished exposed copper surface is again positioned in the electrolytic tank containing nickel, and a third or in the instant case, a fourth layer 34 is formed on the smooth polished outer face of the copper layer 31. It is noted from the construction shown in Fig. 3 that there is formed in effect two relatively thick layers 29 and 34 of nickel and a thin filling layer 31 of copper positioned between the two nickel layers. There is therefore formed in effect a shell, composed largely and primarily of alternate layers of electrolytically deposited nickel with just enough copper in an intermediate layer

to cover imperfections and close up pores which may be formed in the inner nickel deposition. In the final analysis, there is formed practically a nickel shell formed of extremely thin laminations of the order of about twenty-five thousandths of an inch, with the laminations separated by even a thinner film copper electrolytically deposited and which copper is used primarily for the purpose of providing smooth deposit receiving surfaces for the succeeding nickel layer rather than to add structural strength to the nickel.

For ordinary purposes, the tank with two layers of nickel and an intermediate layer of copper is sufficient to give the requisite rigidity to tanks designed to withstand pressures of 500 to 700 pounds, but it is obviously within the scope of the disclosure to position a succeeding layer of copper on the nickel layer **34**, to grind down this next copper layer as suggested for the layer **31** and to then deposit a succeeding layer of nickel on the copper layer, and to continue this alternate deposition of copper and nickel until any desired or requisite thickness of shell has been obtained.

When the desired article has been completely formed, preferably with a nickel or chromium outer surface to give it a pleasing, polished appearance, the aluminum mold, together with the reinforcing ring, is dissolved out of the finished tank. Preferably the mold when formed of aluminum is dissolved out of the completed article with solution of sodium hydroxide, but it is within the scope of the disclosure to use other suitable solvents, such for instance as hydrochloric acid. Dissolving the sheet aluminum form from the mold as thus described, carried with it any thin film of copper such as the film **28** hereinbefore described so that there remains a nickel lined receptacle. The nut **24** is unscrewed either before or after the mold has been dissolved and the connecting rod **23** and bolt **20** withdrawn through the opening in the collar **16**. The finished tank contains the collar **16** which is electrolytically soldered in place by means of the laminated shell thus described.

Pressure tanks as thus formed are capable of withstanding high pressures and in the illustrated instance a tank weighing seven and one-half pounds and having a capacity of twelve quarts was subjected to an internal pressure of one thousand pounds, without becoming distorted or leaky. The tank thus formed under test showed greater tensile strength than was the case where the article was formed on a fusible metal form following conventional practices and where no particular care was taken to polish the surface of the mold or to polish the surface of the copper deposits as they were formed on the nickel layers. While the invention has been described, particularly with reference to the combination of nickel and copper, these metals have been selected primarily due to the high tensile strength of nickel and to the ease with which the copper could be used as a filler and due to the ease with which it could be highly polished, but it is obvious that other equivalent metals might be utilized and as one illustration, it is suggested that cobalt and cadmium be substituted for the nickel and copper. Sheet aluminum has been selected as the material from which the mold was formed due to the ease with which it could be subsequently dissolved without effecting the electrolytically deposited metals and due to the fact that it could be easily provided with a high lustre or polish. It is obvious, however, that other homogeneous, fine grained and non-porous metals might be used, as one illustration, it is suggested that zinc may be substituted for the aluminum mold or frame herein disclosed.

I claim:

1. In the art of forming hollow metal articles lined with nickel by electrolytic deposition, the method which consists in assembling parts of a mold having smooth deposit receiving, exposed surfaces and with the parts in abutting relation forming joints, depositing a thin layer of copper on the mold, subjecting the mold thus prepared to the action of an electrolytic bath containing nickel, at a temperature not materially greater than 140° F. and not materially lower than 110° F. with a current density of approximately 25–30 amperes per square foot and until about twenty-five thousandths of an inch of nickel has been deposited to form the lining of the completed article as a one-piece layer of nickel on said copper coated smooth receiving surface of the mold, soldering any exposed joints between the parts of the mold to provide with the initial nickel layer a continuous, smooth, unbroken surface to receive the succeeding deposition and electrolytically depositing an additional layer of metal on the nickel lining and subjecting the mold with its thin layer of copper to the dissolving action of a reagent incapable of dissolving nickel or copper.

2. In the art of forming hollow metal articles lined with nickel by electrolytic deposition, the method which consists in assembling parts of a mold having smooth deposit receiving, exposed surfaces and with the parts in abutting relation forming joints, depositing a thin layer of copper on the mold, subjecting the mold thus prepared to the action of an electrolytic bath containing nickel to form the lining of the completed article as a one-piece layer of nickel on said smooth receiving surface of the mold, soldering any exposed joints between the parts of the mold to provide with the initial copper and nickel layers a continuous, smooth, unbroken surface to receive the succeeding deposition, electrolytically depositing an additional layer of metal on the nickel lining and dissolving the mold with its thin layer of copper out of the resulting nickel lined article.

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