No. 789,342.

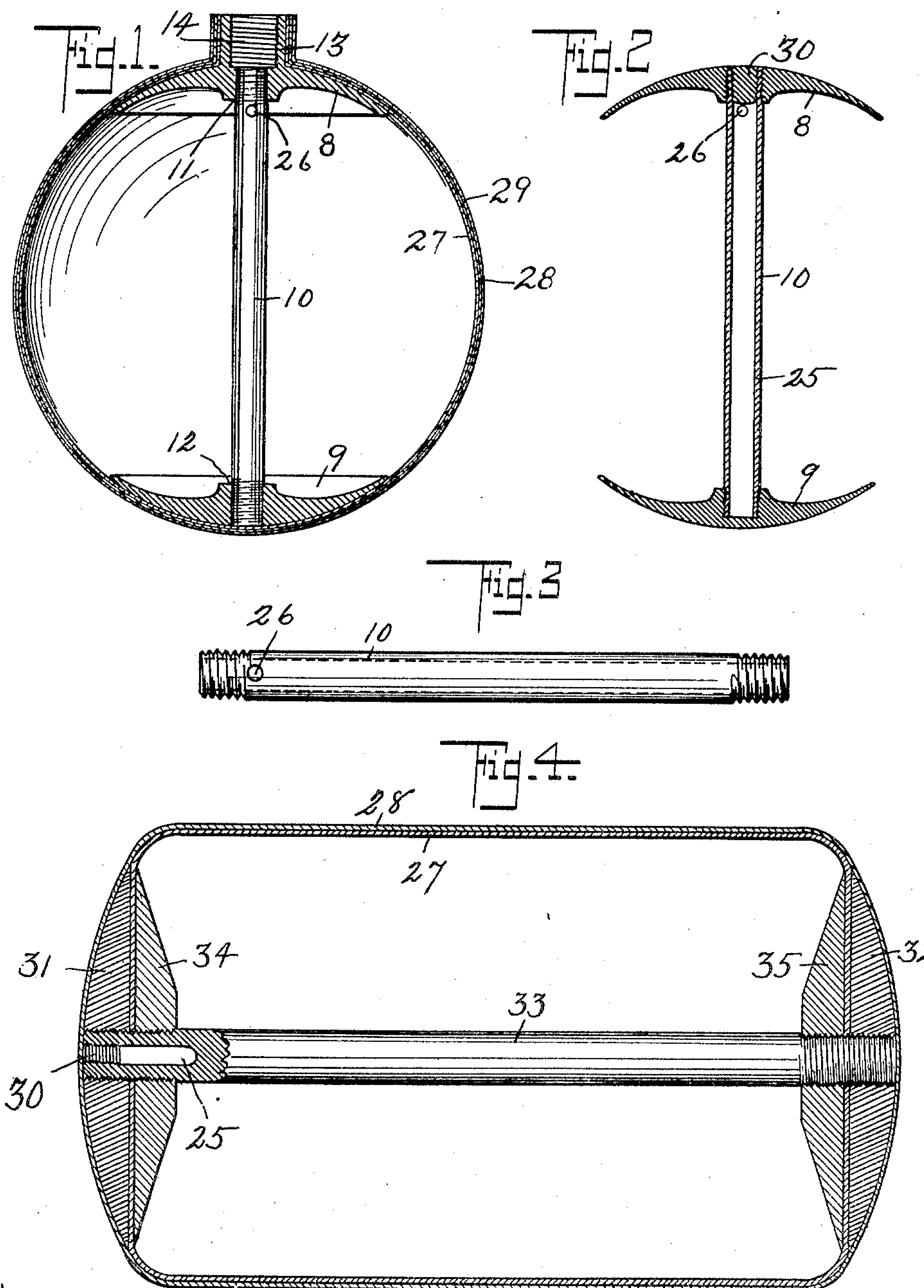
PATENTED MAY 9, 1905.

F. A. VOELKE.

PROCESS OF CONSTRUCTING SEAMLESS, HOLLOW ARTICLES.

APPLICATION FILED JAN. 20, 1904.

2 SHEETS—SHEET 1.



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2 SHEETS—SHEET 2.

Fig. 5.

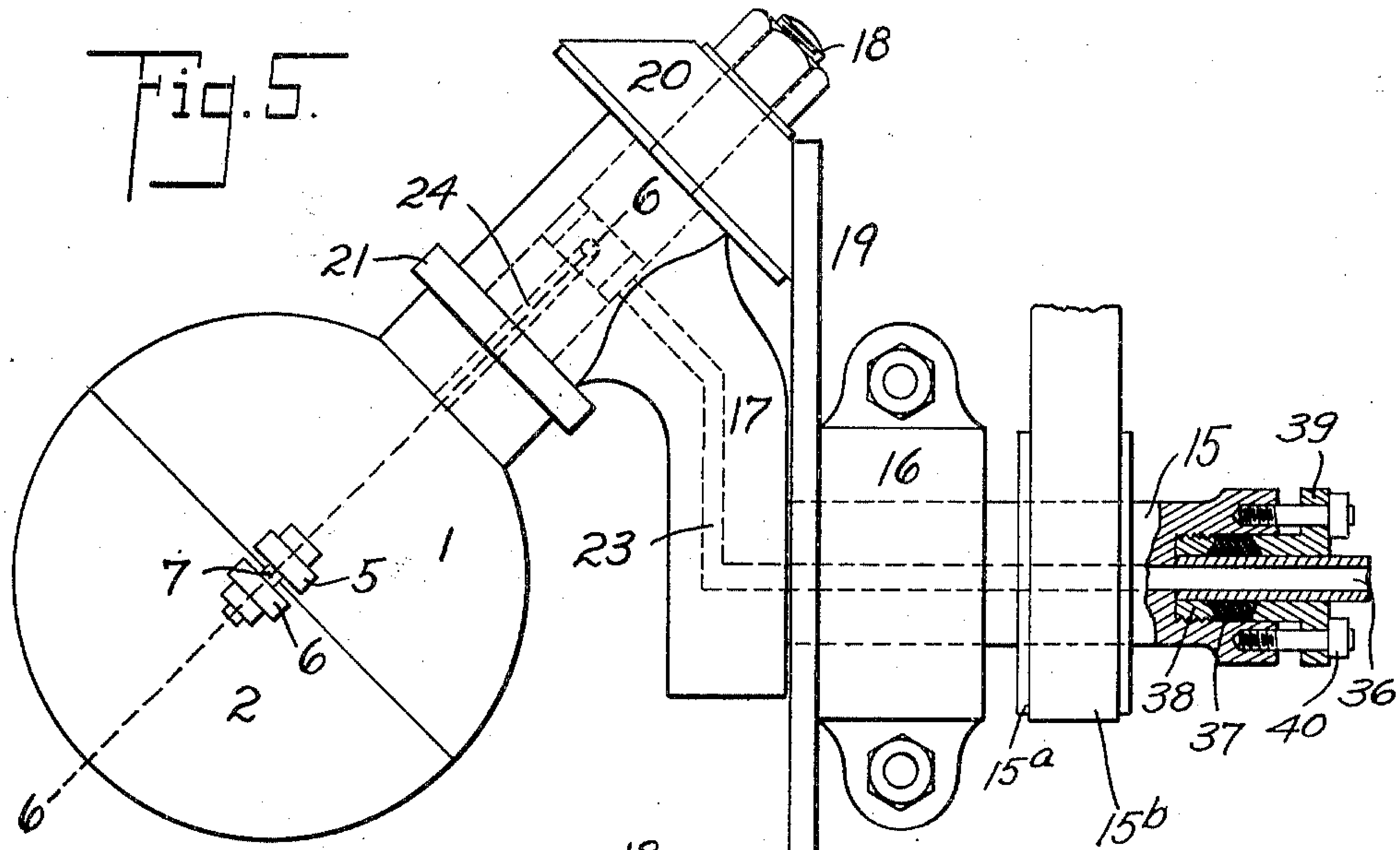
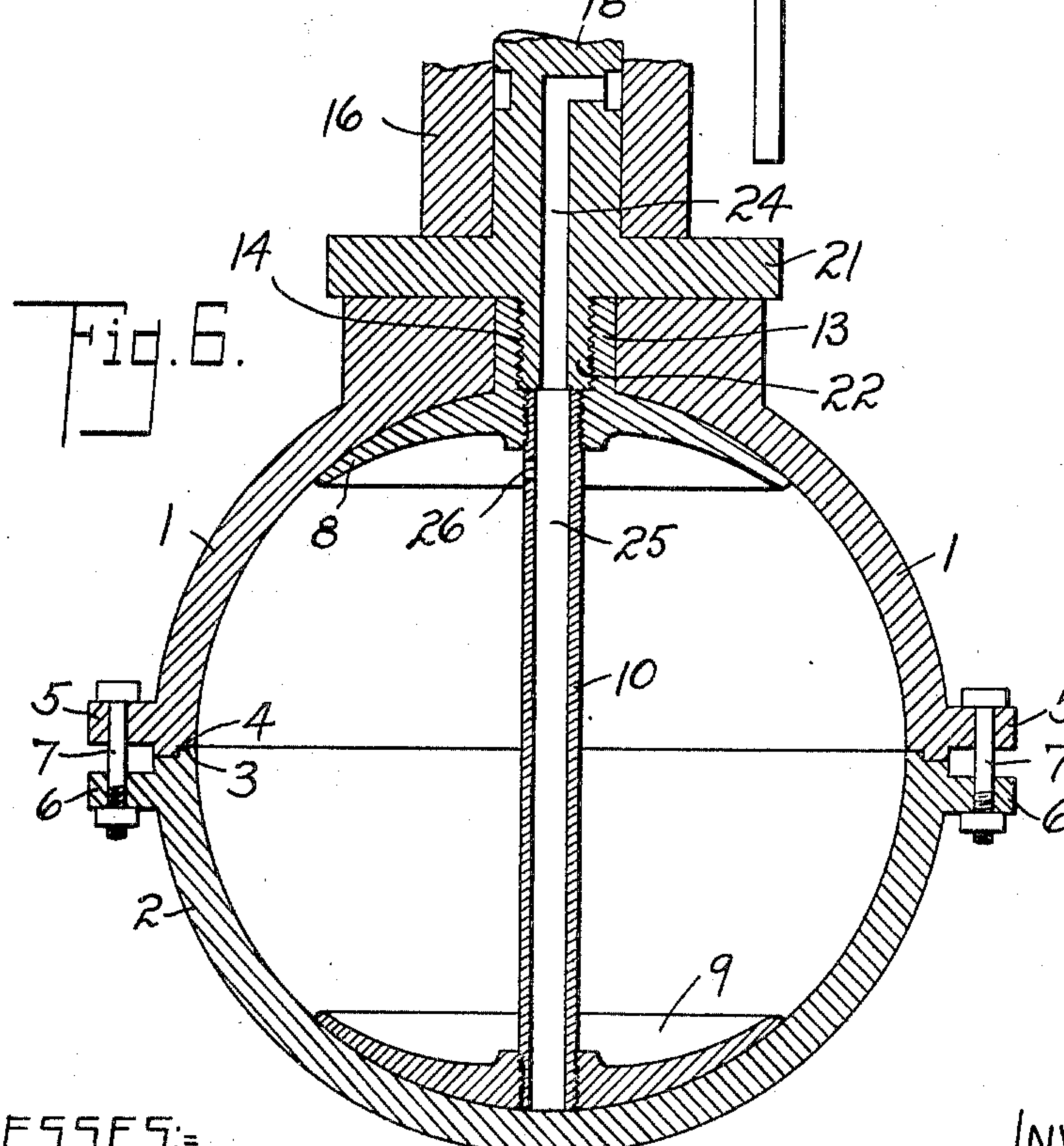


Fig. 6.



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UNITED STATES PATENT OFFICE.

FRED A. VOELKE, OF TIPTON, INDIANA.

PROCESS OF CONSTRUCTING SEAMLESS HOLLOW ARTICLES.

SPECIFICATION forming part of Letters Patent No. 789,342, dated May 9, 1905.

Application filed January 20, 1904. Serial No. 189,854.

To all whom it may concern:

Be it known that I, FRED A. VOELKE, a citizen of the United States, and a resident of Tipton, in the county of Tipton and State of Indiana, have invented certain new and useful Improvements in Processes of Constructing Closed Seamless Hollow Articles, of which the following is a specification.

This invention relates to a process by which hollow seamless articles may be constructed. Included among those articles that may be constructed by this process are both closed hollow articles that are used for purposes that subject them to compression and others that are required to stand stresses applied from the inside of the article. A float is an article of the class first specified, and a cylinder for holding air or gas under compression belongs to the other class.

By this process vessels and other hollow articles can be constructed that are seamless and yet completely closed and that are braced externally or internally, according as they are required to withstand compression or bursting stresses. It is furthermore possible by this process to build up the shells of these articles with a plurality of seamless metalic laminæ, each having the form of the integral article. The laminæ are disposed one upon another and are united so that they form a single shell. The shell may consist of any number of these laminæ. The use for which it is intended, the degree of stress which it may be called upon to withstand, the way in which the stress is applied, and other reasons determine their number and the shape of the shell. So, too, there is to some extent an opportunity for choice in the selection of the metals of which the laminæ shall be constructed, as will presently appear.

Articles of the character described may be made in many shapes by this process, which in all cases consists of the same successive steps applied in the same order and in substantially the same way. In one respect only, and that is merely a matter of manipulation, which will be explained hereinafter, does the difference in shape require a modification of the process. In all cases the process is substantially the same, whatever the shape of the article.

The product of this process is made the subject of a separate application, filed January 13, 1904, Serial No. 189,855, wherein it is specifically described and claimed.

A sphere and a cylinder have been selected as examples, as they are the shapes in which vessels of the character before instanced are usually made, and the process that constitutes the present invention will be disclosed and fully described as their construction is described.

In the drawings, Figure 1 shows a completed float. It is shown in section in order to show its braces. Fig. 2 shows the braces of the float, which are adapted to resist compression. Fig. 3 shows one member of the braces. Fig. 4 is a longitudinal section of a cylinder that is strengthened to resist high internal pressure. Fig. 5 represents apparatus for rotating the mold in which the core or pattern for a spherical float is formed in accordance with one of the steps of the process, and Fig. 6 is a cross-section on the line 8 8 of Fig. 5 and shows the construction of said mold and its attachment to the rotating apparatus.

The process involves, broadly speaking, four steps, which are applied in the order set forth below, and some of these include several distinct operations, which constitute subordinate steps in the process, as will be set forth.

Certain parts of the process may be modified or varied, as will be pointed out in the course of the specification, without departing from the essence of the invention.

The four steps of the process and the order in which they are applied are as follows: first, the construction of a core or pattern of the desired form, upon which the shell of the closed hollow seamless article is made; second, the electrolytic deposition of a metallic surface upon the core or pattern; third, the expulsion of the core or pattern from the shell, and, fourth, the building up of a shell of the desired thickness that is composed of a plurality of seamless metallic laminæ, each of which has the form of the integral article and all of which are united to constitute a single shell.

The strengthening-pieces, if any are to be employed, are embedded in the core, so that the metallic surface is deposited upon them also, as will be further explained, thus securing them and the braces attached to them in place. The first step mentioned in the process requires a mold of metal or other suitable substance within which the core for the article can be formed. The contour of the inner surface of the mold must conform to the desired exterior form of the article.

In the drawings, a mold for a spherical float is represented in Figs. 5 and 6, and is shown as attached to the apparatus that is employed to rotate it, for a purpose hereinafter to be described. The mold may be constructed in any way that will give the necessary access to its interior and enable its parts to be locked tightly and securely together. In the drawings the mold is made of hemispherical parts whose meeting edges 3 and 4 are rabbeted, so as to insure a tight joint. Suitable means are employed for securing together the parts 1 and 2 of the mold, and in the drawings the opposing ears 5 and 6, through which bolts 7 pass, fulfil that function.

A fusible metal, wax, paraffin, or other suitable material may be used to make the core or pattern.

The mold is first heated to the melting temperature of the material that is to be used for the core and then the proper quantity of material is placed within its lower half. When this process is employed, it is possible to strengthen the hollow article at those parts that are required to resist stresses by strengthening pieces and braces. These are shown in connection both with the spherical float and the cylinder for holding compressed air represented in the drawings.

Confining myself for the present to the construction of the spherical float, there are represented in Figs. 1 and 2 strengthening means comprising plates 8 and 9, which conform in their outer contour to the inner face of the mold and which are connected, one at each end, to the brace 10. If these braces and strengthening-pieces are to be employed, the plate 9 is placed within the lower half 2 of the mold either before or after the molten material for the core is placed therein, and it, the brace 10, and upper plate 8 are all attached together. In the drawings screw connections are shown at 11 and 12 between the brace 10 and the plates 8 and 9, respectively, which make it possible to adjust the distance between the tops of the plates 8 and 9 to the internal diameter of the mold.

In Fig. 1 the upper plate 8 is shown with a neck 13, through which there is a bore that leads to the threaded socket that receives the brace 10. The upper part of the bore is represented as having a female screw-thread 14. In Fig. 2 the plate 8 is shown without a neck, and the upper end of the brace 10 is screwed into a perforation through it.

When strengthening-pieces and the material for the core have been placed within the mold and the brace has been adjusted, the parts of the mold are locked together and the formation of the core is proceeded with. To form the core, the mold is tumbled while the paraffin or other material within it is cooling in such a way that the material is distributed over the inner face of the mold, and the best results are obtained by subjecting it at the same time to a constant pressure of air that is delivered within the mold. Any suitable means may be employed to give the mold the desired motion, and an apparatus that will give it a universal rotary motion is preferred. An apparatus adapted to so rotate a sphere is represented in Fig. 5. It is obvious that when an article of another form than a sphere is to be rotated other apparatus specially adapted to meet the different conditions must be employed in order to obtain corresponding results. The particular manner in which the mold for each different form of article must be rotated can be readily determined, and it then becomes a simple mechanical problem to construct the necessary apparatus.

Returning to the rotation of the sphere by the apparatus shown in Fig. 5, we find that the apparatus is adapted to rotate the mold horizontally and at the same time in a plane at an angle of forty-five degrees to its horizontal axis.

The description of the apparatus represented in Fig. 5 is as follows: 15 represents a driven shaft, and 16 the bearings for one end of the shaft. A pulley 15^a is shown upon the driven shaft that is driven by the belt 15^b. 17 is a bracket that is rotative by said shaft, and 18 is a shaft journaled in said bracket at an angle of forty-five degrees with the stationary friction-disk 19, the latter being attached to the bearings 16 or otherwise rigidly supported. The shaft 18 carries on its upper end a friction-wheel 20, that is adapted to engage the friction-disk 19 and on its lower end the face-plate 21, to which the mold is attached by some suitable means.

In Fig. 6 a strengthening-piece 8 is represented with a neck 13, that extends up through the upper half 1 of the mold, and the mold is attached to the face-plate 21 by means of a screw-threaded bolt 22, that projects from said plate and engages the female screws 14 within the neck. Thus the mold, having within it the material out of which the core is to be made, the strengthening-pieces 8 and 9, and the brace 10, is firmly attached to the apparatus by which it is to be given a universal rotation. It has been found desirable in forming the core for a sphere to so proportion the parts of the apparatus that the relative speed of rotation on the horizontal axis to that on the axis that is at forty-five degrees thereto is in the ratio of one to two and one-half.

As the mold is rotated rapidly in the manner described the melted paraffin contained within it is thrown outwardly against the inner face of the mold and is distributed evenly over it. As the mold and the paraffin cool the paraffin becomes set, and there is thus formed within the mold a hollow core or form of paraffin whose outer contour is that of the inner face of the mold. The strengthening pieces and braces, if any were placed within the mold with the paraffin, have become embedded in the paraffin core, so that they remain in place within the core when it is removed from the mold.

The apparatus shown in Fig. 5 is also adapted to subject the material for the core to air-pressure while it is being rotated within the core. For that purpose the shaft 15 is tubular, and passages 23 and 24 lead from it through, respectively, the bracket 17 and the shaft 18 and its projection 22. The upper end of the brace 10 is bored longitudinally, as at 25, and has a lateral passage 26 leading therefrom into the mold. Thus air is forced into the mold when it is attached to the face-plate 21 through the tubular shaft 15 and the connecting-passages mentioned and is maintained at any desired pressure by means adapted therefor.

Fig. 5 represents a pipe 36, that leads to a blower (not shown) or other source of air-pressure. The pipe 36 connects with the air-passages 23, and packing 37, to prevent the escape of air, is placed around the pipe 36 at this point and is secured between the nut 38 and the plug 39, the plug 39 being held against the packing by bolts 40.

While it is not essential to the process to use the air-pressure during the tumbling of the mold, it has been found in practice that wax and paraffin cores formed solely by rotating the mold in the manner described above are apt to fall away from the mold in cooling on account of the contraction of the material, so that the core will be more or less defective. The constant air-pressure on the inside of the core while it is cooling keeps it forced out against the face of the mold at all points. Thus the air-pressure not only produces a clear sharp outline by forcing the molten material for the core into all parts of the mold, but it insures the production of a perfect core, because it keeps the material in that position until it has solidified. In this connection attention is called to the fact that as the mold and core cool the orifice 26, through which air is forced into said mold, becomes sealed with wax, so that air is retained within the core under the pressure to which the mold was subjected while rotating. The compressed air within the core increases its power to withstand compression, and so enables it to be more readily handled. The location of the orifice 26 near the face of the mold insures that in the rotation of the mold the orifice will become filled with wax, which when it cools will seal the orifice. The core thus produced is subjected to the second step in the process, which, as before stated, involves the electrolytic deposit of a metallic surface upon it. To prepare it for that, the core is coated with graphite or some other substance that is adapted to receive a deposit in an electrolytic bath. This graphite coating is applied in any convenient manner.

The bath to which the core is introduced may consist of a solution containing copper, nickel, or any other suitable material. It has been found that when the core or the cathode or both of said parts are kept in motion in this solution a heavier and more evenly distributed deposit of the metal is secured than when said parts are maintained in fixed relation. The electrolytic deposit thus formed is represented by 27 in Fig. 1, and as there shown is a continuous seamless metallic layer. This layer is deposited not only over the paraffin core, but also upon the strengthening-pieces, thus uniting and binding these pieces to the shell, as represented in Fig. 1, which shows the electrolytic deposit 27 over both the strengthening-pieces 8 and 9 and the neck 13.

When the core has been coated by electrolysis, it is expelled from the shell thus formed, which constitutes the third step in the process. In order to accomplish this, the article after it has been removed from the electrolytic bath is placed within an oven that is heated to a temperature somewhat above the fusing-point of the material of which the core is made, the passage through which air was forced into the vessel during rotation—the passage 25 in the drawings—being directed downward. The core is thus melted within its metallic shell and is in part reduced to vapor. The fluid substance of the core will drain off from the shell through the orifice and the vapor generated from it will as it expands press upon the fluid and expel it forcibly from the mold. The residual vapor is finally disposed of by heating the shell to a higher temperature, and thus burning out the vapor. It is not always essential that material of the core should be completely removed from the articles. The shell is now ready for the fourth and final step in the process, which consists in further strengthening it by building it up with a plurality of seamless metallic laminæ, each having the form of the article. This is done by dipping the shell into a bath of some suitable molten metal or its alloy adapted to adhere to said shell.

Thus, for example, the electrolytic shell formed upon the core may be copper and the bath into which it is dipped may be molten aluminium-bronze. When the shell that has been formed by electrolysis, as described above, is dipped into the molten metal or alloy, a coat of this metal or alloy is deposited upon the shell, so as to form a continuous seamless metallic layer or lamina over the shell formed by electrolysis, such as that represented by 28 in Fig. 1. By heating the molten metal or alloy into which the shell is to be dipped to nearly the temperature at which the metal of the shell will fuse the two metals or the alloy of the bath and the metal of the shell, as the case may be, fuse, so that the outer layer produced by dipping blends with the metal of the shell, thus making practically one integral compact shell. A third metallic layer 29, like the other two in that it is continuous and seamless and has the form of the article, is next formed upon the layer 28 by electrolysis in the same way that the shell 27 was formed. This outer layer 29 further strengthens the shell, and since it completely covers over the layer next below it no galvanic action will be set up between the metals if the article is placed in liquid that is calculated to produce such action between metals of different kinds. In this way by depositing layers one upon the other by introducing the article into an electrolytic bath and dipping them into a bath of a molten metal or alloy a shell of the character described can be built up to any desired thickness and which, if desired, is also strengthened and braced from within in the manner described above.

The float shown in Fig. 1 is made with a neck 13 in order that it may be attached thereby to a valve-operating lever or other connection; but, if desired, the float or other article may be made by this process with a continuous unbroken surface. This may be done by using a strengthening-piece without a projecting neck, such as 8, (shown in Fig. 2,) and inserting a plug 30 within its bore after the core has been removed from the shell 27. The layers 28 29 and whatever other layers may be formed thereon will then cover the plug, as well as the surface of the article.

In Fig. 4 means are shown for strengthening a vessel that must withstand stresses applied from within consisting of pairs of strengthening-pieces 31 34 and 32 35, that are screwed upon the brace 33. In this form the brace 33 projects beyond the shell 27, formed by the electrolytic layer or said layer and subsequent layers formed as stated above, and the strengthening-pieces 31 and 32 are screwed or otherwise secured upon the ends of said brace, respectively, and down upon the shell. Then the shell is built up over said strengthening-pieces and the ends of the braces by electrolysis and dipping in the manner described above. The shell may be made any thickness desired both before and after the strengthening-pieces 31 and 32 have been put in place.

The construction of spherical and cylindrical bodies by this process has been described above by way of illustration; but it is obvious that hollow seamless articles of various other shapes may also be constructed by it, including many forms that are open to a more or less extent.

What I claim is—

1. The process of constructing closed, seamless, hollow articles, consisting in the formation from a fusible substance of a pattern having the form of the article that is to be made, having embedded within it a perforated strengthening-piece for the article that is to be made; the electrolytic deposition of a coating upon said pattern; heating the shell thus formed to a temperature above the fusing-point of the substance of which said pattern is made, and its removal from said shell through the perforation in said strengthening-piece; plugging said perforation; and forming a continuous metallic layer over both said electrolytic coat and said plug.

2. The process of constructing seamless, hollow articles, consisting in the formation from a fusible substance of a pattern having the form of the article that is to be made, by so tumbling a form for the pattern containing the substance in a molten state, while said substance is cooling, that it is forced upon the inner surface of the mold and solidifies thereon, and also subjecting said substance while cooling within said mold to fluid-pressure tending to force it upon the inner surface of said mold; and the electrolytic deposition of a continuous metallic layer over the pattern, whereby an integral, seamless, hollow shell is formed.

3. The process of constructing seamless, hollow articles consisting in the formation from a fusible substance of a core having the form of the article that is to be made, by so tumbling a form for the core containing the substance in a molten state, while said substance is cooling, that it is forced upon the inner surface of the mold and solidifies thereon, and also subjecting said substance while cooling within said mold to air-pressure tending to force it upon the inner surface of said mold; the electrolytic deposition of a continuous metallic layer over the core; heating of the shell thus formed to a temperature above the fusing-point of the material of said core, and its removal thereby from said shell; and the deposition of one or more seamless metallic layers upon said shell.

4. The process of constructing seamless, hollow articles consisting in the formation from a fusible substance of a pattern having the form of the article that is to be made, by so tumbling a form for the pattern containing the substance in a molten state, while said substance is cooling, that it is forced upon the inner surface of the mold and solidifies thereon; the electrolytic deposition of a continuous metallic layer over the pattern; and heating the shell thus formed to the temperature at which the substance of which the pattern is

made is partially vaporized, so that it is expelled from the shell by the expansion of such vapor.

5. The process of constructing seamless, hollow articles consisting in the formation from a fusible substance of a core having the form of the article that is to be made, by so tumbling a form for the core containing the substance in a molten state, while said substance is cooling, that it is forced upon the inner surface of the mold and solidifies thereon; the electrolytic deposition of a continuous metallic layer over the core; heating the shell thus formed to the temperature at which the substance of which the core is made is partially vaporized, so that it is expelled from the shell by the expansion of such vapor; and the deposition of one or more seamless metallic layers upon said shell.

6. The construction of seamless, hollow articles consisting in the formation from a fusible substance of a pattern having the form of the article that is to be made, and having embedded in it a brace for the article to be made; and the electrolytic deposition of a continuous metallic shell upon said pattern and said brace, whereby an integral seamless, hollow shell is formed.

7. The construction of seamless, hollow articles consisting in the formation from a fusible substance of a core having the form of the article that is to be made, and having embedded in it strengthening-pieces for the article to be made, that are connected by a brace for said article; the electrolytic deposition of a continuous metallic shell upon said core and strengthening-pieces; heating of the shell thus formed to a temperature above the fusing-point of the material of which said core is made, and its removal thereby from said shell; and dipping said shell into a molten metal or alloy adapted to adhere to said shell, whereby an integral, seamless, hollow shell is formed.

8. The construction of seamless, hollow articles, consisting in the formation from a fusible substance of a pattern having the form of the article that is to be made, and having embedded in it strengthening-pieces for the article to be made; and the electrolytic deposition of a continuous metallic shell upon said pattern and said strengthening-pieces, whereby an integral seamless, hollow shell is formed.

9. The construction of seamless, hollow articles consisting in the formation from a fusible substance of a core having the form of the article that is to be made, and having embedded in it strengthening-pieces for the article to be made, that are connected by a brace for said article; the electrolytic deposition of a continuous metallic shell upon said core and strengthening-pieces; heating of the shell thus formed to a temperature above the fusing-point of the material of which said core is made, and its removal thereby from said shell; and dipping said shell into a molten metal or alloy adapted to adhere to said shell, whereby an integral, seamless, hollow shell is formed; securing upon said shell other strengthening-pieces; and forming additional continuous, seamless layers upon said shell and over said last-mentioned strengthening-pieces by electrolytic deposition and dipping in a molten metal or its alloy, alternately, till a shell of the desired thickness is obtained.

10. The process of constructing seamless, hollow articles consisting in the formation from a fusible substance of a core having the form of the article that is to be made, by so tumbling a form for the core containing the substance in a molten state, while said substance is cooling, that it is forced upon the inner surface of the mold and solidifies thereon, and subjecting said substance while cooling within said mold to air-pressure tending to force it upon the inner surface of said mold; the electrolytic deposition of a continuous metallic shell upon said core; heating the shell thus formed to the temperature at which the substance of which the core is made is partially vaporized so that it is expelled from the shell by the expansion of such vapor; dipping said shell into a molten metal or alloy adapted to adhere to said shell; and forming additional seamless layers thereon by electrolytic deposition and dipping in such molten metal, or alloy, alternately, till a shell of the desired thickness is obtained.

11. The process of constructing seamless, hollow articles, consisting in the formation from a fusible substance of a pattern having the form of the article that is to be made, by subjecting said substance, while cooling within a form for said pattern, to pressure that forces it against the inner surface of said mold; and the electrolytic deposition of a metallic layer over said pattern, whereby an integral, seamless, hollow shell is formed.

12. The process of constructing seamless, hollow articles, consisting in the formation from a fusible substance of a pattern having the form of the article that is to be made, by subjecting said substance, while cooling within a form for the pattern, which also contains a strengthening-piece having an orifice for the admission of fluid under pressure, to a fluid-pressure that forces the substance against the inner surface of said mold; and at the same time so tumbling said mold that said substance is both forced upon the inner surface of the mold and also, as it cools, automatically seals the orifice through which the fluid-pressure is delivered.

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Witnesses:

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John M. Ogle.