N. HUGGINS.

PROCESS AND APPARATUS FOR DENSIFIED ELECTRODEPOSITION.

APPLICATION FILED MAY 15, 1916.

1,236,438.

Patented Aug. 14, 1917.

2 SHEETS—SHEET 1.

Fig. 1.

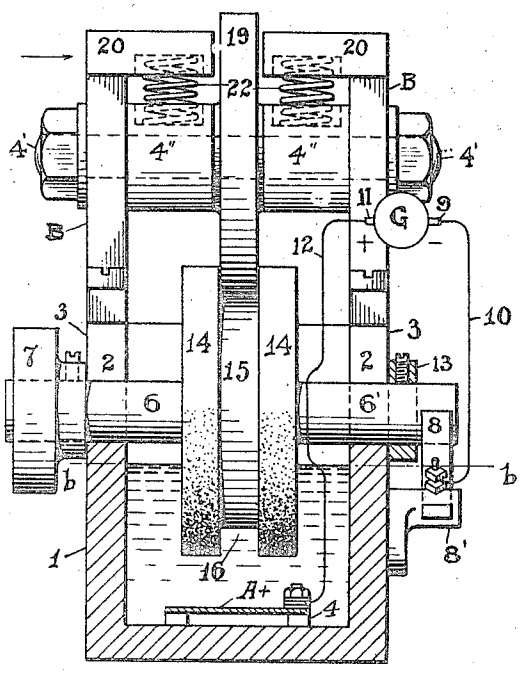


Fig. 3.

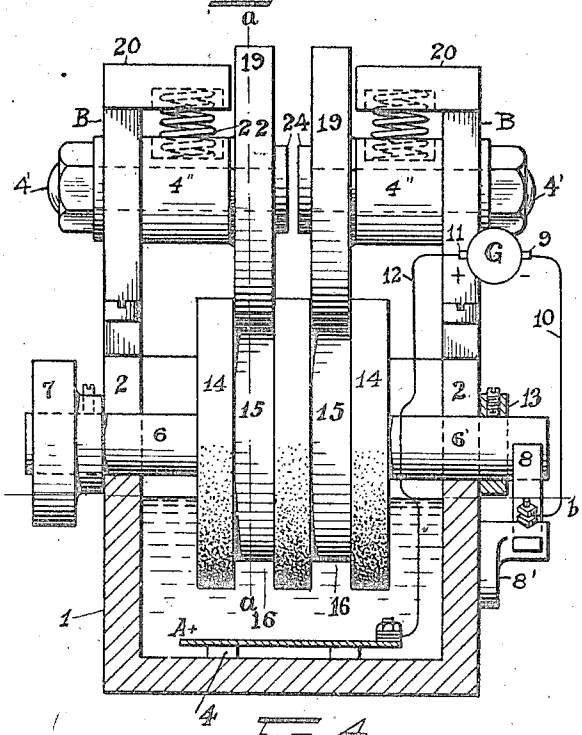


Fig. 2.

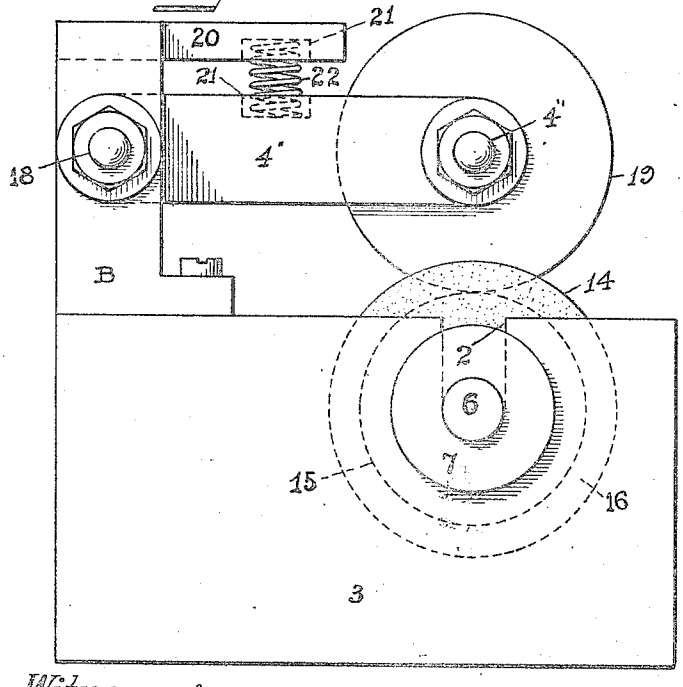
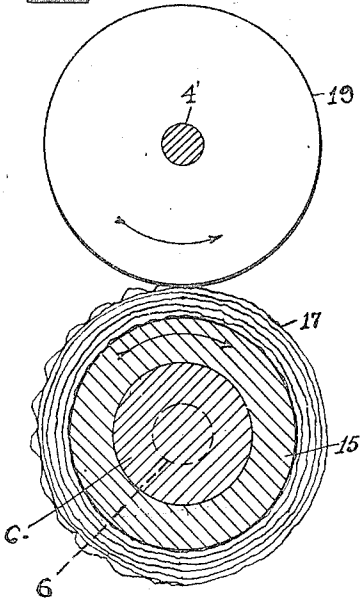


Fig. 4.



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2 SHEETS—SHEET 2.

Fig. 5.

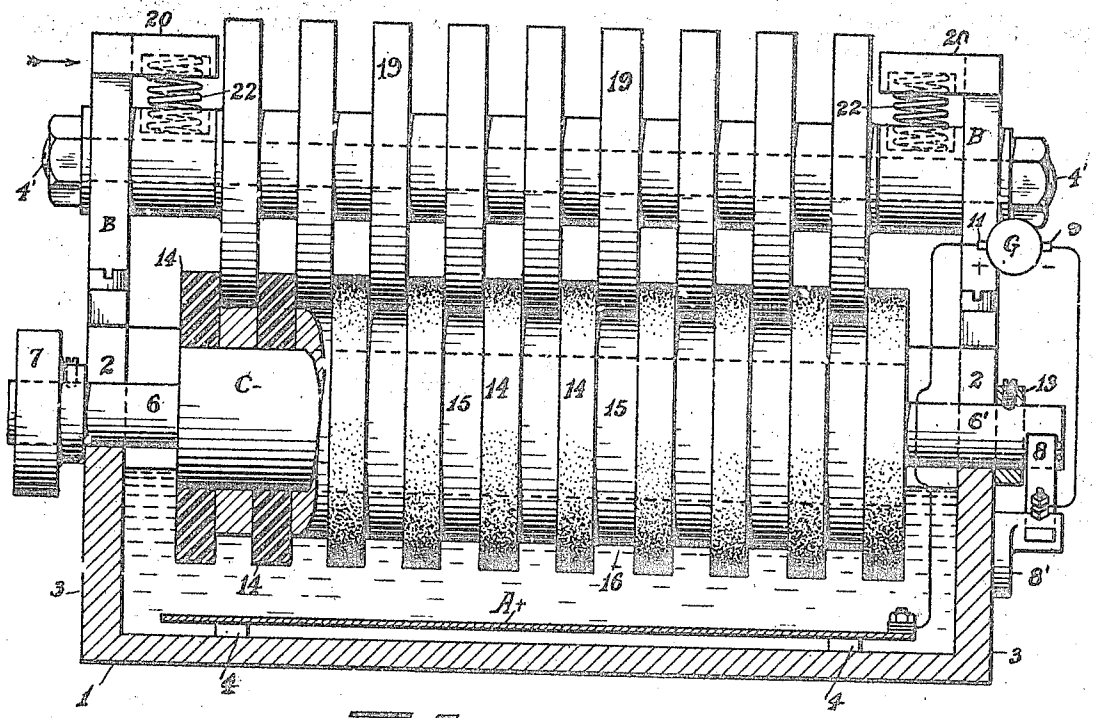


Fig. 6.

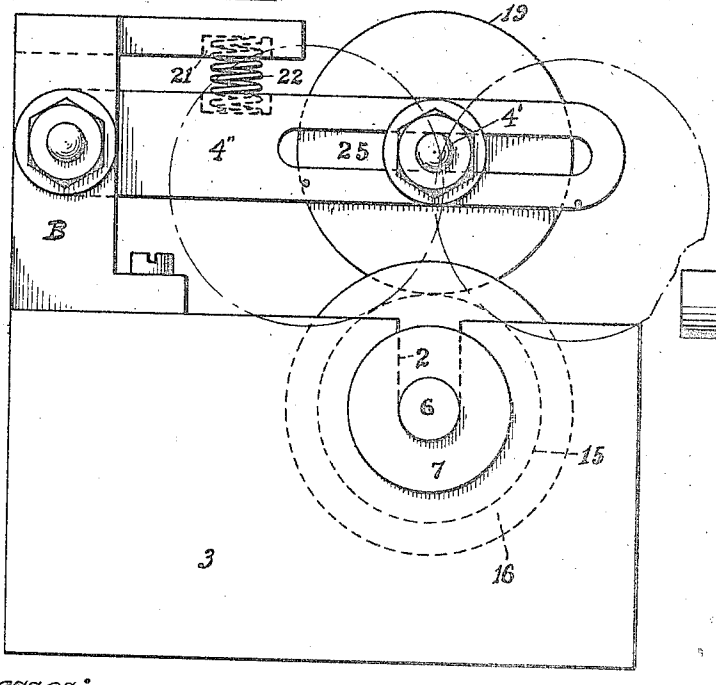
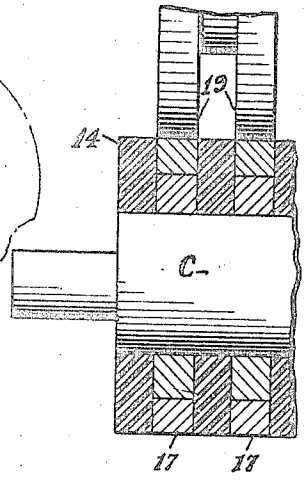


Fig. 7.



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UNITED STATES PATENT OFFICE.

NATHANIEL HUGGINS, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO COPPER PRODUCTS COMPANY, A CORPORATION OF MAINE.

PROCESS OF AND APPARATUS FOR DENSIFIED ELECTRODEPOSITION.

1,236,438. Specification of Letters Patent. Patented Aug. 14, 1917.

Application filed May 15, 1916. Serial No. 97,493.

To all whom it may concern:

Be it known that I, NATHANIEL HUGGINS, a citizen of the United States, residing in New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Processes of and Apparatus for Densified Electrodeposition, of which the following is a specification.

One great trouble in the electro-deposition of metallic articles, especially those formed of pure copper and other soft metals of substantially similar character, lies in the fact, that frequently for various reasons as yet still undiscovered, but which by those most skilled in the art, are believed to be brought about by improper composition of the bath, variations in the current, etc., is that the metal deposited is spongy and unevenly deposited.

The objects of my present invention are to provide a new and improved process or method, and apparatus for carrying the same into effect, for forming metallic articles for any desired use and purpose, homogeneous and solid throughout their entire structure, in a cheap and efficient manner.

Such process and apparatus are substantial improvements upon the process and apparatus for forming metal-rings, especially adapted for use as driving-rings or bands for artillery projectiles, set forth, described and claimed in my copending application for my new and improved process for making metal-rings, etc., and apparatus for carrying the same into effect, Serial No. 91,866, filed April 18, 1916; and up to a certain point the process and apparatus herein are identical with those therein, which consists in (1) the forming and securing to a suitable conducting-cathode usually of brass, of a body or bodies of softer and usually more easily fusible metal or material, of high electric conductivity; which body or bodies are hereinafter, for convenience of description, designated as conducting-mold-blanks; which mold-blanks are placed within a mold of non-conducting and insulating material of the shape and contour of the article to be electrolytically produced; (2) immersing such mold, etc., in an electrolytic-bath; and by electro-deposition forming the article in such molds; (3) removing the article and conducting-mold-blank from the bath and cathode; and (4) lastly removing the conducting-mold-blank from the article either by swaging, or by melting off, or fusing, or in any other desired manner.

As is well known in the art of electro-deposition, the metals are deposited upon the cathodic surface of the mold in the form of thin laminæ of crystalline structure superposed one upon the other until the article is of the required thickness, and such laminæ crystals are of exceedingly minute and micrometric size; and frequently do not cohere perfectly with one another, thus giving rise to a soft spongy and heterogeneous deposit, instead of the hard and homogeneous solid one desired. This liability to sponginess of product is especially found in cases where the cathodic mold is moved in any manner in, or in and out of, the electrolytic-bath during deposition; such movement in my aforesaid copending application and also herein being a rotative one, such motion being best adapted for the electro-deposition of rings.

I have discovered that all liability to sponginess may be avoided by submitting the deposit during deposition to mechanical pressure; and this method may be brought about by any suitable mechanical means; and in the particular apparatus herein shown especially adapted for use in the formation of electrolytically deposited rings; such pressure is brought about upon the ring being deposited by a pressure-traction-wheel, which is mounted adjacent to the rotating ring-depositing combined cathode and mold; which pressure-wheels are yieldingly pressed upon the ring being deposited during its rotation with sufficient pressure to consolidate the same and remove any sponginess that might otherwise be left therein.

My said process, and apparatus for carrying the same into effect, is fully shown and described in the following specification, of which the accompanying drawings form a part, wherein similar numerals or letters of reference designate like or equivalent parts, wherever found throughout the several views, and in which:—

Figure 1 is a front view, in partially vertical central section, of my improved apparatus for carrying out the process herein disclosed for forming rings by electrolytic deposition.

Fig. 2 is a side view of the structure shown in Fig. 1, looking from the left thereof in the direction of the arrow.

Fig. 3 is a modified form of the construction shown in Figs. 1 and 2, wherein two rings are shown in process of formation.

Fig. 4 is a diagrammatic view partially in central cross-section, on the line *a*—*a* of Fig. 3, of the cathode mold and pressure-wheel used in such apparatus, showing the ring in process of deposition and consolidation.

Fig. 5 is a front face view of a train of nine cathodic-molds for the formation of the electrolytic-rings, the electrolytic bath receptacle or basin and the left hand portion of the cathodic-ring forming mold-train being shown in substantially central vertical section.

Fig. 6 is a side view of the structure shown in Fig. 5, looking from the left thereof in the direction of the arrow; and Fig. 7 is a view of a portion of the cathode and annular molding mechanism, with the deposited-rings completed and ready to be removed, taken in substantially central vertical longitudinal section; and differing only from that portion of the rotating-cathode and mold shown in section in Fig. 5, in that the deposited rings are completed and ready for removal, and not in process of formation.

Referring to the drawings:—

In Fig. 1 the reference numeral 1, designates the electrolytic-bath-receptacle, or tank, containing electrolytic-liquid, usually up to the height of the line *b*—*b* so as to immerse the cathode C—, to a point just below the journals 6 thereof resting in the journal slots 2, which slots are open at the top and are formed in the end walls 3, of the receptacle which is of any suitable insulating material. Located in the tank, usually supported on the bottom by insulating studs 4, is the anode A+, usually in the form of a plate. The cathode C—, is usually formed of brass, or other suitable metal or alloy having high electric conductivity, and consists of the central conducting-cylinder or mandrel 5, having at either end the integrally formed journals 6 and 6′, removably and revolubly fitting in the journal-slots 2.

Removably secured upon the journal 6 is a pulley or gear-wheel 7, by means of which such cathode may be rotoated.

The other journal 6′, has in contact therewith a commutator-contact 8, usually supported upon a bracket 8′, on the receptacle-wall leading from which spring to the minus-pole (—) 9, of the electric-generator G, is the conducting wire 10; while from the plus-pole (+) 11, an insulated conducting-wire 12, connects with the anode A+. On the journal 6′ is removably secured a collar 13, to prevent end thrust during rotation of the cathode.

To produce rings by my improved electrolytic process I superpose alternately upon the conducting-cylinder a plurality of alternately arranged insulating mold-rings 14, of hard-rubber, glass or other suitable insulating material; between which are interposed conducting mold-blank-rings 15, usually of lead, or other comparatively soft and easily fusible metal; and when ready to be inserted in the electrolytic-bath, a peripheral-annular-mold space or cavity 16, of the shape and contour of the ring to be electrolytically produced, is left between the insulating-mold-rings 14, upon insertion in the bath; upon turning on the current, and rotating the cathode C—, the electrolytic rings 17 required, are formed by electro-deposition upon the conducting-mold-rings 15, in the annular mold-space or cavities 16, until the same are completely filled as shown in Fig. 7.

Thus far, the apparatus described is that shown, disclosed and claimed, in my copending application herein-before referred to, and differs in no essential particulars therefrom. But to bring out the formation of a solid non-spongy and homogeneous electrolytic-ring, by my improved process, upon the bath receptacle 1, at either end thereof, are rigidly mounted two brackets B, forming supports for a supporting stud-shaft 18, upon which are vibratorily supported pressure levers 4″, through the outer vibrating free ends of which pass the pressure-wheel shaft 4′, upon which are revolubly mounted the pressure-wheels 19, which are formed of any suitable hard metal, such as bronze, or steel; which pressure-wheels are of the same thickness as the mold-spaces 16 alined between the insulating rings 14 forming the mold spaces, in which the rings to be formed, are to be deposited upon the removable fusible-rings 15.

Formed integral with or secured to the brackets B, at the top thereof are the extensions 20, between the underside of which and the upper side of the vibrating pressure-levers 4″, and with the ends thereof lying in suitable sockets 21 (indicated by dotted lines in Figs. 1, 2, 3, 5 and 6), are the pressure springs 22, usually of the coil-spring form shown. These pressure springs 22, are of sufficient tension and strength to force down the levers 4″ in such manner upon the molding blanks 15, and upon the rings 17 deposited thereon, so as to compress the ring being deposited, sufficiently to remove all sponginess and mechanically compact the same, so as to produce and form a solid metallic-ring of homogeneous structure throughout the same.

As shown in Figs. 1 and 5, the shaft 4′ carries either the single pressure-wheel 19 shown in Fig. 1, or the train of like pressure-wheels 19, shown in Fig. 5, and such

shaft 4′ extends across the bath receptacle and is mounted in the brackets B. In some cases, however, it may be desirable, where a train or plurality of pressure-wheels are used, as shown in Fig. 3, to individually vary the pressure upon such wheels; and in Fig. 3, I have shown a structure wherein this can be brought about; and therein instead of one shaft 4′, I have shown two, the same being split at the center, as indicated at 24 of such Fig. 3, whereby it will be seen that the pressure wheels 19 will be individually pressed into their respective annular molds upon the ring being deposited, and that the pressure exerted by the same may be individually varied.

As indicated in Fig. 6 in dotted lines, the pressure exerted upon the rings in process of construction may be varied, merely by shifting the position of the pressure-wheels 19 longitudinally of the pressure-levers 4″; and for such purpose, as shown in Fig. 6, where it is so desired to vary such pressure, such pressure-levers are provided at the outer end with a slot 25, through which passes the pressure-shaft 4′, which carries the pressure-wheel or wheels 19.

It will be understood from the drawings and description, that the pressure exerted upon the ring being deposited by the pressure-wheels 19, is purely tractional, and while the cathode and the mold are positively rotated, the rotation of the pressure wheels 19 is brought about solely by frictional contact with the mold-rings, and the rings being deposited.

The rotation of the cathode and the pressure-wheel in the various positions to which they may be adjusted by variation of the position of the shaft 4′ in the slot 25 of the pressure-lever 4″, is clearly shown in full in dotted lines in Fig. 6. It will be seen by an examination of such drawing that the maximum of pressure will be exerted upon the ring being deposited when the pressure-wheel 19 is in the central and medial position immediately superposed upon the top of the ring within the mold, as shown in full lines; and that the pressure may be varied by shifting such pressure-wheel outward or inward into the positions shown in dotted lines in such Fig. 6.

It will be seen herein that during deposition of the ring as the cathode C— is rotated in the electrolytic fluid in the bath receptacle, that it is only during such immersion that there is any deposition; and that the pressure for consolidating the metal deposited is brought about at the top of the mold at a point wherein the rings being deposited are in the atmosphere and out of the bath; but I do not intend to limit myself strictly to a method or apparatus in which the consolidating action is brought about outside of the bath, as in cases of the depositions of certain metals, or for certain purposes, it may be desirable to have the consolidation performed under the surface of the electrolytic fluid, and within the bath out of contact with the atmosphere.

The process for the removal of the deposited articles, in this case rings; from the depositing blanks or mold-rings, forms no particular part of this process, and is fully set forth, described and claimed in my before mentioned copending application, and I have therefore not deemed it essential to more fully describe the same herein.

I have found in practice that in order to form the rings of exceedingly smooth end surface whereby the same when finished will need no tooling or dressing, it is preferable to form the insulating mold-blank-rings 14 of glass, porcelain or any other exceedingly hard-substance with a very smooth surface, which will not be affected by the action of the liquid in the bath.

In like manner I have also found that the consolidating pressure rings may be formed of glass like material and that they may be used with equal efficiency and effect for consolidating the rings during deposition without any changes or deterioration.

I claim:—

1. The hereinbefore described process for the formation of metallic articles which consists of the following steps:—(1) forming a conducting-mold-blank; (2) positioning such mold-blank upon and in contact with a cathode; (3) positioning insulation upon the cathode to wall such mold-blank to form a molding-cavity outward of such mold-blank; (4) immersing the cathode in an electrolytic-bath; (5) electrolytically depositing upon the face of the conducting-mold-blank the required quantity of deposition to form the article desired to be produced; (6) during such deposition subjecting the deposition to mechanical pressure so as to by such pressure consolidate and compact the same so as to form a homogeneous metallic structure; (7) removing the conducting mold-blank and article from the cathode; and (8) separating the mold-blank from the article.

2. The hereinbefore described process for the formation of metallic articles which consists of the following steps:—(1) forming a conducting-mold-blank of a lower fusibility than the article to be produced; (2) positioning such mold-blank upon and in contact with a cathode; (3) positioning insulation upon the cathode to wall such mold-blank to form a molding-cavity outward of such mold-blank; (4) immersing the cathode in an electrolytic-bath; (5) electrolytically depositing upon the face of the conducting-mold-blank the required quantity of deposition to form the article desired to be produced; (6) during such deposition subject-

ing the deposition to mechanical pressure so as to by such pressure consolidate and compact the same so as to form a homogeneous metallic structure; (7) removing the conducting-mold-blank and article from the cathode; and (8) separating the mold-blank from the article by fusion.

3. The hereinbefore described process for the formation of metallic rings, which consists of the following steps:—(1) forming an annular conducting-mold-blank or ring or a plurality thereof; (2) positioning the same upon and in contact with the periphery of a cylindrical-conducting-cathode; (3) interposing upon such cylindrical-cathode insulating-rings to form an annular molding-cavity outward of the peripheral surface of each of such mold-blank ring or rings; (4) immersing the cathode so supplied in an electrolytic depositing bath; (5) electrolytically depositing upon the face of the conducting-mold-blank ring or rings within the insulating rings the required quantity of deposition to form the ring or rings desired to be produced during rotation of the cathode; (6) during such deposition subjecting the deposition to mechanical pressure so as to by such pressure consolidate and compact the same so as to form a homogeneous metallic structure; (7) removing the conducting-mold-blank or blanks, article or articles from the cathode; and (8) separating the two.

4. The hereinbefore described process for the formation of metallic rings, which consists of the following steps:—(1) forming an annular conducting-mold-blank or ring, or a plurality thereof; (2) positioning the same upon and in contact with the periphery of a cylindrical-conducting-cathode; (3) interposing upon such cylindrical-cathode insulating-rings to form an annular molding-cavity or cavities outward of the peripheral surface of the mold-blank ring or rings; (4) immersing the cathode so supplied in an electrolytic depositing bath; (5) electrolytically depositing upon the face of the conducting-mold-blank ring or rings within the insulating rings the required quantity of deposition to form the ring or rings desired to be produced during rotation of the cathode; (6) during such deposition subjecting the deposition to mechanical pressure so as to by such pressure consolidate and compact the same so as to form a homogeneous-metallic-structure, the pressure being exerted upon that portion of the ring or rings at the moment at the top and in the atmosphere; (7) removing the conducting-mold-blank or blanks, ring or rings from the cathode; and (8) separating its mold-blank from each ring.

5. The hereinbefore described process for the formation of metallic-rings, which consists of the following steps:—(1) forming an annular conducting-mold-blank or ring, or a plurality thereof of a lower fusibility than the rings to be produced; (2) positioning the same upon and in contact with the periphery of a cylindrical-conducting-cathode; (3) interposing upon such cylindrical-cathode insulating-rings to form an annular molding-cavity outward of the peripheral surface of the mold-blank-ring or rings; (4) immersing the cathode so supplied in an electrolytic depositing bath; (5) electrolytically depositing upon the face of the conducting-mold-blank ring or rings within the insulating rings the required quantity of deposition to form the ring or rings desired to be produced; (6) during such deposition subjecting the deposition to mechanical pressure so as to by such pressure consolidate and compact the same so as to form a homogeneous metallic structure; (7) removing each conducting-mold-blank and ring from the cathode; and (8) separating the two by fusion.

6. The hereinbefore described process for the formation of metallic rings, which consists of the following steps:—(1) forming an annular conducting-mold-blank or ring or a plurality thereof; (2) positioning the same upon and in contact with the periphery of a cylindrical-conducting cathode; (3) interposing upon such cylindrical-cathode insulating-rings to form an annular molding-cavity outward of the peripheral surface of each of such mold-blank ring or rings; (4) immersing the cathode so supplied in an electrolytic depositing bath; (5) electrolytically depositing upon the face of the conducting-mold-blank ring or rings within the insulating rings the required quantity of deposition to form the ring or rings desired to be produced; (6) during such deposition subjecting the deposition to mechanical pressure exerted upon the ring or rings being deposited by pressure consolidating traction wheels; (7) removing the mold-blank-ring or rings and the rings deposited thereon from the cathode; and (8) separating the two.

7. In a device of the class described, an electrolytic bath tank or receptacle adapted to contain electrolytic fluid; an electric-cathode located in the tank; an electric-anode also located in the tank; a conducting-mold-blank or blanks positioned on and in contact with the cathode; walls of insulating material adjacent to the mold-blank or blanks, also mounted on the cathode extending beyond the mold-blank or blanks to form a deposition cavity or cavities wherein the article or articles required to be produced may be electrolytically deposited; and means for compressing the foliated electrolytically deposited laminæ during such deposition.

8. In a device of the class described, an

electrolytic bath tank or receptacle adapted to contain electrolytic-fluid; an electric-cathode located in the tank; an electric-anode also located in the tank; a conducting-mold-blank or blanks positioned on and in contact with the cathode; walls of insulating material adjacent to the mold-blank or blanks, also mounted on the cathode extending beyond the mold-blank or blanks to form a deposition cavity or cavities wherein the article or articles required to be produced may be electrolytically deposited; means for mechanically compressing the foliated electrolytically deposited laminæ during such deposition; and means for moving the cathode and its accompanying mold-blank or blanks in the bath, during such deposition and mechanical compression and consolidation.

9. In a device of the class described, a receptacle adapted to contain an electrolytic-fluid; an anode located in the receptacle; a cathode adapted to be removably and revolubly mounted in the receptacle; a plurality of conducting-mold-blanks in contact with such revoluble cathode carried thereby; walls of insulating material walling the mold-blanks, and extending beyond the outer surface thereof so as to form the molds of the shape and contour desired to be electrolytically produced; means for mechanically compressing the foliated electrolytically deposited laminæ during such deposition; and means for moving the cathode and its accompanying mold-blank or blanks in the bath, during such deposition and mechanical compression and consolidation.

10. In a device of the class described, a tank or receptacle for holding an electrolytic-depositing bath; a cathode located in such receptacle removably and revolubly mounted in such receptacle; an annular conducting mold-blank-ring, or a plurality thereof, located upon and in contact with the periphery of the cathode, insulating rings also mounted upon the cathode and extending beyond the outer peripheral surface of such conducting-mold-blank ring or rings so as to leave a cavity of cavities of the form of the ring or rings to be deposited; a source of electrical supply connected with the cathode and anode; means for rotating the cathode; and a revolubly mounted wheel or wheels fitting in the molding-cavity or cavities exerting mechanical pressure upon the ring or rings being electrolytically deposited therein, during the rotation of the cathode, with yielding pressure so as to compact and consolidate the foliated laminæ being deposited while in a substantially nascent state during such deposition.

11. In a device of the class described, a tank or receptacle for holding an electrolytic-depositing bath; a cathode located in such receptacle removably and revolubly mounted in such receptacle; an annular conducting-mold-blank ring, or a plurality thereof, located upon and in contact with the periphery of the cathode, insulating rings also mounted upon the cathode and extending beyond the outer peripheral surface of such conducting mold-blank ring or rings so as to leave a cavity or cavities of the form of the ring or rings to be deposited; a source of electrical supply connected with the cathode and anode; means for rotating the cathode; a revolubly mounted wheel or wheels fitting in the molding-cavity or cavities exerting mechanical pressure upon the ring or rings being electrolytically deposited therein, during the rotation of the cathode, with a yielding pressure so as to compact and consolidate the foliated laminæ being deposited while in a substantially nascent state during such deposition, which pressure is exerted upon that portion of the ring or rings being deposited at the moment at the top, out of the electrolytic bath and in the atmosphere.

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