Feb. 27, 1940. R. K. HOPKINS 2,191,470

MANUFACTURE OF VENEERED ARTICLES

Filed Feb. 18, 1936

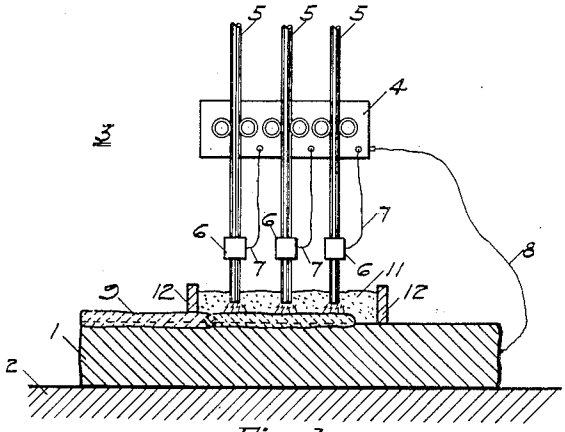


Fig. 1

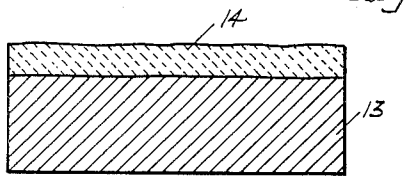


Fig. 2

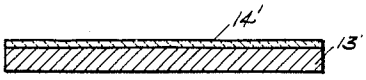


Fig. 3

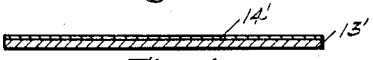


Fig. 4

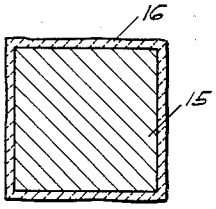


Fig. 5

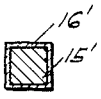


Fig. 6

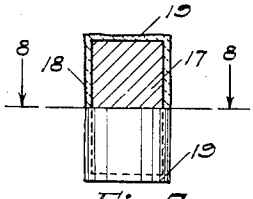


Fig. 7

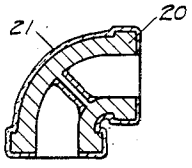


Fig. 9

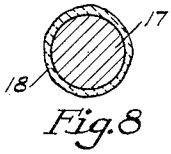


Fig. 8

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MANUFACTURE OF VENEERED ARTICLES

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Application February 18, 1936, Serial No. 64,497

15 Claims. (Cl. 29—189)

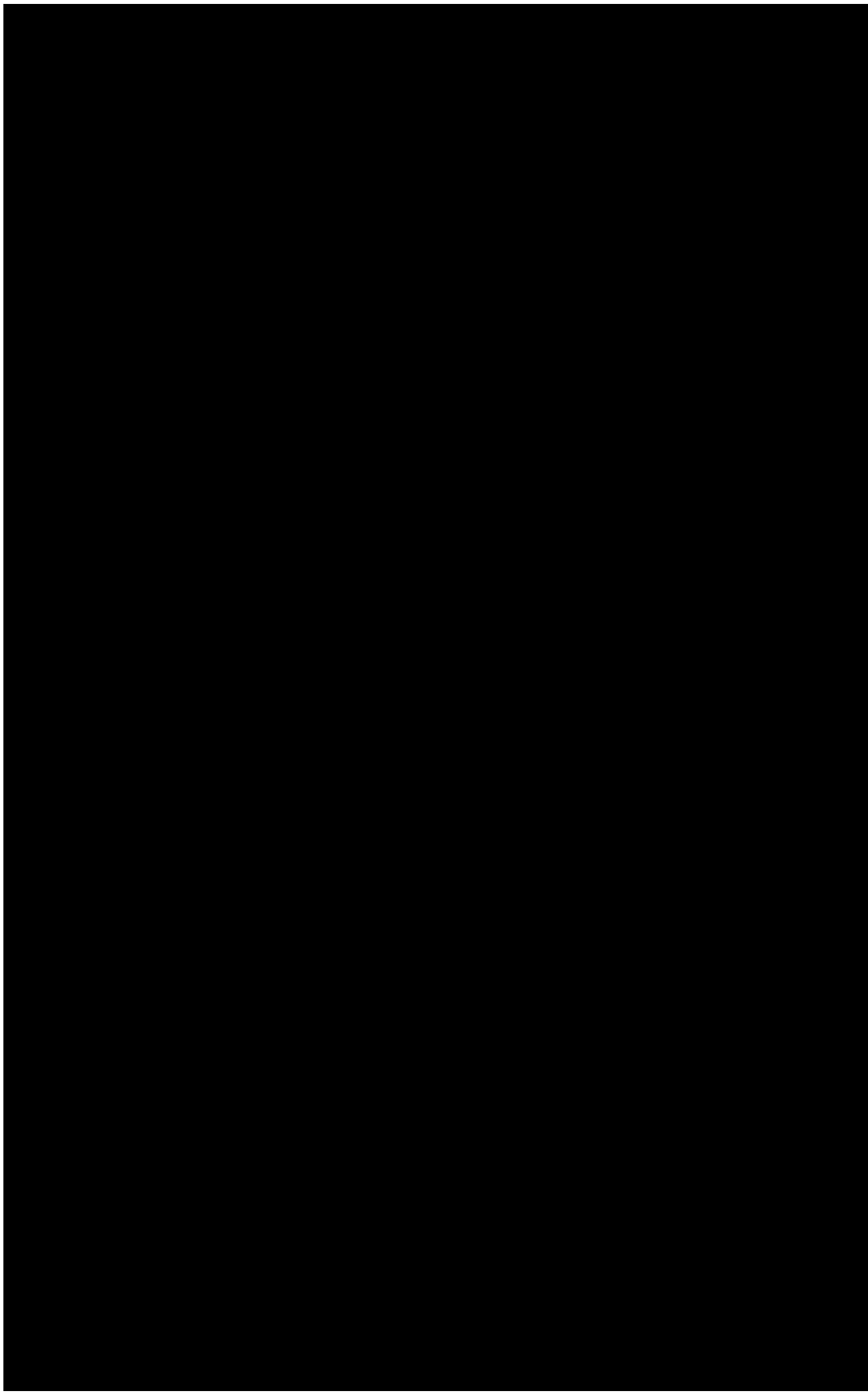
This invention relates to the manufacture of metallic articles having relatively thin metallic coatings of a different material than that comprising the body of the article and in particular to the manufacture of metallic articles which may be formed from billets or slabs by rolling, forging, or similar operations and which have a part or all of their surfaces covered by a protective metallic coating.

It has long been the practice to protect metallic surfaces from the effects of corrosive mediums by coating them with various materials of corrosion resistant properties superior to those of the metallic surfaces. Since the commercial advent of pure metals, and alloys, such as chromium-iron, chromium-nickel iron, etc., of superior corrosion resistant properties the tendency has been to use such high corrosion resistant materials in place of the prior coating materials because of their longer life, their greater strength, and other very highly desirable properties. This tendency has been especially pronounced in the processing arts because of the drastic conditions generally employed. This tendency has been so pronounced in some arts that equipment may be found made up entirely of high corrosion resistant materials. In general such equipment is not practical as it is always very expensive and hard to fabricate and sometimes lacks strength and other necessary qualities.

As stated, the more general tendency is to use the high corrosion resistant materials as coatings. Various ways have been proposed for coating metallic surfaces with the high corrosion resistant materials, for instance (1) by applying a thin sheet to the metallic surface and attaching it thereto at spaced points as by welding, riveting, etc., (2) by electro-plating, (3) by spraying the high corrosion resistant material on the metallic surface while the high corrosion resistant material is in the molten condition, as in the "Schoop" process, (4) by welding, either by gas welding or electric welding, the high corrosion resistant material on to the metallic surface, and (5) by fabricating, by rolling operations or by casting and rolling operations, veneered plate that includes a thin sheet or layer of the high corrosion resistant material attached to the thick base metal.

The first proposal is at best of very limited application as the coating is subject to rupture at the bonds if even moderately elevated temperatures are involved due to the stresses set up in the coating by reason of poor heat exchange, temperature gradients, and diverse coefficients of expansion. The second proposal is very expensive and can only be applied successfully to small articles of more or less regular pattern. The third proposal is not of general application for obvious reasons and in any case it is extremely difficult to obtain a truly impervious coating of uniform thickness that can withstand even a modicum of abuse and mechanical wear. The fourth proposal, since it necessarily is entirely manual and since only a narrow bead can be deposited at one time, is very slow and expensive and has not even been commercially attempted with articles of large exposed area. The fifth proposal is probably the most promising of the prior proposals but it too has limitations which disqualify it from numerous applications. In the first place, veneered plate of heavy gauges has not been, and probably never will be made by the present processes due to manufacturing limitations. Thus veneered plate is not available for articles, such as large pressure vessels and the like, that for strength must be of heavy wall thickness. In the second place, by reason of its mode of manufacture, veneered plate generally includes areas at which the coating is not attached to the base metal. By reason of this inherent defect veneered plate is subject to the same disadvantages as the linings of proposal one and cannot safely be used to fabricate articles subjected to elevated temperatures.

In the processes of the prior art for making veneered plate with which I am familiar the union between the base plate and the sheet of coating metal is secured only by reason of the rolling operations. It is necessary that a high pressure be attained at the interface between the plates accompanied by a high degree of working to force the surfaces into intimate contact and, obviously, the operation must in addition be carried on at a welding temperature. In one such process, for example, a pair of veneering plates are separated by insulating material, edge welded, placed in the center of an ingot mold and base metal cast about them. After rolling to gauge the edges are sheared and the plates separated, the insulating material acting as the parting plane. The surfaces to be welded are thus located in a plane substantially midway between the rolling surfaces. In accordance with the well known fact that pressure exerted along localized portions of the surface of such a body, as for example, by the rolls, is distributed internally in the mass and decreases in intensity to a minimum at the zone midway between the rolls, the pressure at the interfaces to be welded



one side, or part thereof, or it may be desired to coat the slab on two opposite sides, or the entire periphery may be coated and the ends may also be covered.

Fig. 2 shows a section of a slab 13 which has been coated on one side by layer 14 preparatory to rolling to a thinner plate, veneered on one side as shown in Fig. 3. As shown, the base slab 13 of Fig. 2 has been reduced in thickness to plate 13' of Fig. 3 and the coating surface has been reduced proportionately as shown at 14'. Similarly Fig. 4 shows a still thinner sheet rolled from the original slab 13 of Fig. 2 and again the reduction in thickness of the base metal 13' and the veneer 14' is proportional.

The desired thickness of the finished veneer 14' and that of the base plate 13' are the factors which determine the thickness of the original slab 13 to be veneered. The veneering operation, when carried out under conditions now preferred, produces a coating from 3/8" to 1/2" thick. These values are not limiting values but are merely those obtained under conditions at present considered preferable, although the veneer may be produced within wide limits of thickness under other conditions. However, consideration of the fact that there is some preferred thickness for the original veneer will readily lead to the understanding that the proportions of the final rolled article determine the thickness of the original slab. By way of example, but not of limitation, it may be desired to produce a final plate 3" thick with a coating of 1/8" of protective veneer. If under preferred operating conditions an original veneer 3/8" thick is to be deposited, then the rolling operation is seen to cause a reduction of the original veneer to one sixth of its original thickness. Since the reduction of the veneer and the base slab have been found to be proportional, then the original base slab must be six times as thick as the desired final plate, that is, it must be 18" thick. Similarly if the final plate is desired to have 3" of base plate and say 1/8" of veneer then the original slab should be 9" thick, where a 3/8" veneer is to be deposited. The same rule applied to the production of intermediate and thin plates. For example it may be desired that the final sheet shall have a base metal thickness corresponding to what is known in the trade as #10 gauge sheet approximately .14" thick, on which it is desired to have a protective coating .01" thick. If the original veneer is to be 3/8" thick, as in the previous example, then the reduction in veneer thickness by rolling is seen to be 37.5 fold, and the original base slab must be 37.5 times as thick as #10 gauge sheet or 5.25" thick.

By veneering both sides of the slab a plate coated on both sides is produced. The veneer on one side may be of a different composition from that on the other side, as for example for the fabrication of a container exposed to the corrosive action of some material on the inside and perhaps exposed to the weather or corrosive fumes on the outside. Moreover the veneer on one side may be of different thickness from that on the other side. This may be accomplished by depositing the veneering material in a thicker layer on one side than the other or by veneering one side of a slab and partially rolling it to size before veneering the other side after which the rolling operation may be completed. The method just described is in connection with the production of coated flat plate. The same method may also be applied to the coating of other forms of plate. For example, a highly successful method for the fabrication of cylindrical pressure vessels comprises piercing billets and rolling the pierced billets out to form seamless cylindrical rings which are assembled and joined to form a cylindrical vessel free from longitudinal seams. My method of coating may be applied equally well to the coating of this form of plate. The layer of coating material may be deposited on the ring, either on its external or its internal surface, or both, at any intermediate stage of the operation. For example the billet may be externally coated before or after piercing, or it may be internally coated after piercing, or the ring may be partially rolled to size, as desired, and then coated. The subsequent rolling operation, as in the case of the flat slab, is employed to achieve the desired reduction in thickness of the base metal and the coating as well as the desired refinement of grain of the coating.

Fig. 5 shows sectionally a billet 15 of square cross section which has been veneered on the four surfaces 16 parallel to the longitudinal axis of the billet. Fig. 6 shows a section of a square bar rolled from the composite billet of Fig. 5. The bar consists of the base metal core 15' and the complete coating 16' and here, as in the case of rolling sheets, the reduction of area is of the same order for both base metal and veneer. Any desired shape may be rolled from such a billet as shown in Fig. 5. The billet itself may be of any suitable section, such as round, polygonal, rectangular and so forth, best suited to the rolling operations to follow. By this means, as already pointed out, any shape which may be produced by well known rolling operations may be produced as a veneered product, the great desirability of which in numberless uses is at once apparent.

Fig. 7 shows an axial section of a cylindrical billet and Fig. 8 is a cross sectional view of the same billet. Billet 17 is coated on its cylindrical surface 18 and on the ends 19 with a suitable coating material. The coating 18 may be deposited directly on the cylindrical billet 17 by the method disclosed in my copending application or the billet 17 with its cylindrical veneer 18 may be formed by rolling or forging a previously coated billet as described in connection with Figures 5 and 6. The veneered billet, after being cut to proper length for the operation to follow may then have deposited on the ends the coating 19, the deposition being accomplished by my coating process.

Fig. 9 shows sectionally an example of a forged article produced from the billet of Figs. 7 and 8. The example illustrated herein is the forged blank from which a pipe elbow may be produced. The body 20 of the elbow is of base metal derived from the body 17 of the billet of Figs. 7 and 8 and this body 20 is externally covered by coating 21 derived from veneer 18 and 19. The example herein shown consists of an article produced preferably by a forging or extruding operation performed by inserting the coated billet 17 into a die and exerting pressure thereon to form the desired article. In this type of operation it is readily seen that all portions of the surface of the original billet are not necessarily deformed to the same extent and thus an original billet covered with a uniform thickness of coating material may not necessarily result in a finished article coated with a uniform thickness of protective material. Depending on the shape of the original billet, the shape of the resulting article, and the method by which it is produced it is, however, a

relatively simple matter to proportion the coating of the billet to give a satisfactory protective coating to the surface of the finished article.

The original billet 17 need not be of cylindrical form but may be of any form suitable for the production of the desired finished article. The forming operation may consist of hammer forging, drop forging, extruding or similar operation or combination thereof as desired. Also when desired only a portion of the surface of the billet 17 may be covered to produce a finished article having a coating on only a desired portion of its external surface.

One of the outstanding features of my invention lies in the fact that the perfection of the bond between the base metal and the veneer is not dependent upon the amount of rolling or working resorted to, nor upon the magnitude of the pressure used, nor is it necessary to employ welding temperatures during the forming operation for the purpose of forming the bond. As has already been clearly pointed out the bond between the base metal and the coating is formed as a completely integral union of the component materials before the forming operations have been initiated and the forming does not change the nature of the bond.

I have fully described my invention in connection with numerous examples of the application thereof whereby anyone skilled in the art is enabled to apply my process as desired. It is to be understood that the scope of my invention is not limited to the cited examples but includes all applications of my process as fall within the scope of the appended claims.

I claim:

1. The method of manufacturing metallic articles coated with a layer of metal of different composition which comprises coating the surface of a body of metal with a layer of metal of different composition integrally fused to said surface throughout by electrical arc deposition under a blanket of flux, mechanically reducing the thus coated body of metal to work refine the metal of the coating layer and to form the desired coated article.

2. The method of manufacturing metallic articles coated with a layer of metal of different composition which comprises integrally fusing a layer of metal of uniform character to the surface of a body of metal of different composition by electric arc deposition, maintaining a blanket of flux on said surface and over and around the arc during the deposition of said layer of metal, and mechanically reducing the thus coated body of metal to work refine the metal of the coating layer and to form the desired coated article.

3. The method of manufacturing metallic articles coated with a layer of metal of different composition which comprises coating a portion of the surface of a body of metal with a layer of metal of different composition by electrical arc deposition under a blanket of protective flux, mechanically reducing the thus partially coated body of metal to work refine the coating metal, similarly coating a further portion of the surface of said body of metal, and mechanically reducing the thus coated body of metal to work refine the coating metal and to form the desired coated article.

4. The method of manufacturing metallic articles coated with a layer of metal of different composition which comprises striking and maintaining an arc between a fusible metallic electrode and the surface of a body of metal, introducing constituents of a desired layer of metal of different composition to be fused by the arc, effecting relative motion between the electrode and the body of metal to deposit the molten metal as a band on said surface, similarly depositing a band adjacent said first band, repeating said band depositing operation to cover a desired portion of the surface of said body of metal with a continuous coating of metal of desired composition wherein said adjacent bands are fused and merged to one another and to said body of metal, maintaining during said band depositing operation a blanket of flux on said surface of said body of metal in the path of the electrode and mechanically reducing the thus coated body of metal to work refine the coating metal and to form the desired coated article.

5. The method of manufacturing metal plate having base metal coated on one side with a layer of work refined metal of one thickness and coated on the other side with a layer of work refined metal of different thickness from said obverse layer which comprises coating one side of a slab of metal with a layer of metal of different composition by electric arc deposition under a protective blanket of flux to form a continuous layer of metal integrally fused to the surface of said slab, reducing the thus coated slab to desired intermediate dimensions, similarly coating the uncoated side of the partially reduced slab with a layer of metal of composition different from that of said slab, and reducing the thus coated partially reduced slab to the desired dimensions to form a plate coated on one side with a layer of work refined metal of one thickness and coated on the other side with a layer of work refined metal of a different thickness from said obverse layer.

6. The method of manufacturing a metallic cylinder internally coated with a layer of work refined metal of different composition which comprises, coating the internal surface of the cylinder with a layer of metal of different composition by electric arc deposition under a protective blanket of flux to form a continuous layer of metal integrally fused to the internal surface of said cylinder, passing one of a pair of rolls through the hollow cylinder, and reducing the coated cylinder to form a cylinder of the desired wall thickness and diameter and to work refine the coating metal.

7. The method of manufacturing a metallic hollow cylinder internally coated with a layer of metal of different composition which comprises, passing one of a pair of rolls through the cylinder to some intermediate thickness and diameter, coating the internal surface of the partially formed cylinder with a layer of metal of different composition by electric arc deposition under a protective blanket of flux to form a continuous layer of metal integrally fused to the surface of said cylinder, and further reducing the coated cylinder to the desired wall thickness and diameter whereby the cast metal is work refined.

8. The method of manufacturing rolled metallic shapes coated with a layer of work refined metal of different composition from that of the core of said rolled shapes which comprises coating the surface of a metal body with a layer of metal of different composition by electric arc deposition, maintaining a blanket of flux on the surface being coated and around and over the arc during said deposition to form a continuous layer of metal integrally fused to said surface of said body, and rolling the thus coated

body to the desired shape and dimensions to form the desired coated rolled shape and to refine the coating metal.

9. The method of manufacturing forged metallic articles externally coated with a layer of work refined metal of different composition which comprises coating the surface of a metal body with a layer of metal of different composition by electric arc deposition, maintaining a blanket of flux on the surface being coated and around and over the arc during said deposition to form a continuous layer of metal integrally fused to said surface of said body, and forging the thus coated body to the desired form and dimensions to form the desired externally coated forged article and to refine the coating metal.

10. The method of manufacturing forged metallic articles externally coated with a layer of metal of different composition which comprises coating the surface of a metal body with a layer of metal of different composition by electric arc deposition under a protective blanket of flux to form a continuous layer of metal integrally fused to said surface of said body, forming the thus coated body to desired cross sectional dimensions and shape for subsequent forging, cutting the thus formed billet to desired length for subsequent forging, similarly coating the thus exposed surfaces of the ends of the cut billet with a layer of metal by electric arc deposition, and forging the thus coated billet to the desired form and dimensions to form the desired externally coated forged article.

11. The method of manufacting metallic articles which comprises the steps of coating portions of the surface of a body of metal with cast metal of different composition, said coating being deposited by electric discharge under a blanket of flux, and mechanically reducing the thus coated body of metal to form the desired article, said electrically deposited metal forming a surface of the article.

12. The method of manufacturing which comprises coating a portion of a slab of metal with a layer of metal of different composition by electric arc deposition to integrally fuse the coating to the slab and mechanically reducing the thus coated slab to the desired dimensions, said electrically deposited metal forming a surface of the article.

13. The method of manufacturing which comprises coating a portion of a slab of metal with a layer of metal of different composition by electric arc deposition to integrally fuse the coating to the slab and mechanically reducing the coated slab to the desired dimensions, said electrically deposited metal forming a surface of the reduced coated slab.

14. A method of manufacturing coated metal articles in which the coating is of different composition than the article, comprising the steps of integrally bonding a metal layer, deposited by a submerged electric discharge, with the metal to be coated, and reducing the coated metal to the desired form, said electrically deposited metal forming a surface of the article.

15. A method of manufacturing coated metal articles in which the coating is of different composition than the article, comprising the steps of successively depositing by electric discharge under a blanket of flux and over zones of the metal to be coated molten metal to form an integrally bonded continuous layer, and reducing the coated metal to the desired form, said electrically deposited metal forming a surface of the article.

ROBERT K. HOPKINS.

CERTIFICATE OF CORRECTION.

Patent No. 2,191,470. February 27, 1940.

ROBERT K. HOPKINS.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, first column, line 43, claim 1, before "mechanically" insert --and--; same page, second column, line 55-56, claim 7, before "cylinder" insert --hollow cylinder, reducing the--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 25th day of June, A. D. 1940.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.

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