

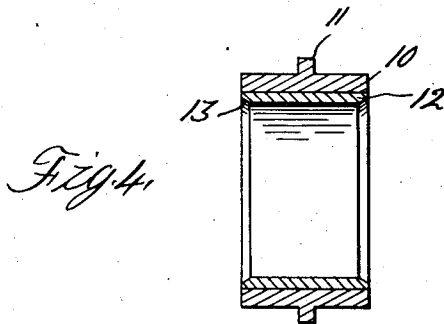
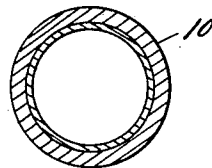
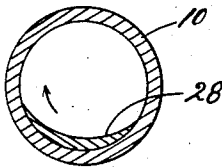
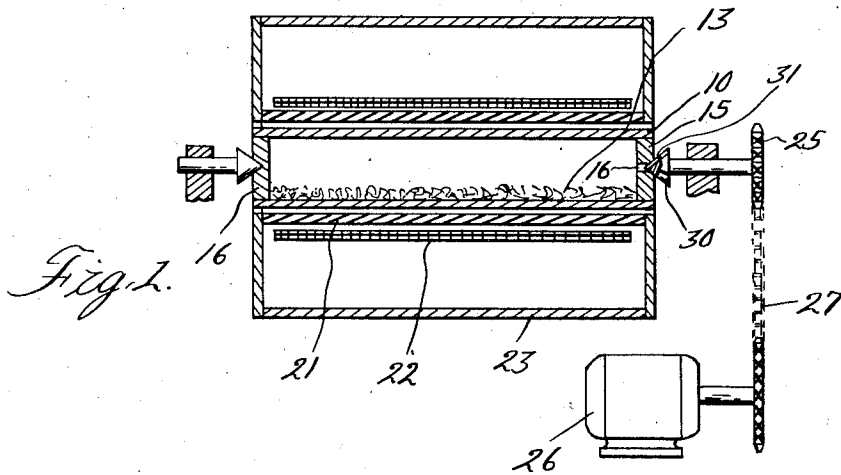
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W. BROWN

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COMPOSITE METAL ARTICLE AND METHOD OF FORMING THE SAME

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INVENTOR

Walter Brown

BY

Whittemore Halbur

Whittemore & Belknap

ATTORNEYS

UNITED STATES PATENT OFFICE

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COMPOSITE METAL ARTICLE AND METHOD
OF FORMING THE SAME

Walter Brown, Toledo, Ohio

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8 Claims. (Cl. 91—70.1)

The invention relates to the manufacture of composite metal articles composed of two or more different metals or alloys which are integrally bonded together. More particularly the invention relates to tubing or tubular articles having an inner lining of a different composition from the outer material.

The object of the invention is to provide an improved process for obtaining the inner metallic lining in good condition and well bonded to the outer material. A further object is to provide a process adapted for readily producing certain articles of commerce where it is desirable to have in a single article properties which can only be obtained by using two or more different metals or alloys.

These and other objects are attained in the manner hereinafter more fully described and illustrated in the accompanying drawing, wherein

Figure 1 is a sectional view of an apparatus in which my improved method may be carried out;

Figure 2 is a transverse section through the tubular article during the process;

Figure 3 is a cross section of the article at the end of the process;

Figure 4 is an axial section through a valve seat bushing made in accordance with my invention.

In order to carry out my invention, which is hereinafter more fully set forth, it is necessary that the metal or alloy forming the inner lining shall have a lower melting point than the metal or alloy constituting the outer portion. My invention is applicable to various metals and alloys but there are certain particularly advantageous combinations, one of which consists of an outer steel shell provided with a brass or bronze inner lining and another consists of an outer steel or alloy shell with an inner lining of a hard non-machinable alloy of the cobalt chromium type such, for example, as "Stellite" or other metals having similar properties and normally used for cutting tools.

In carrying out the process for obtaining the composite metal article, I provide a tube 10 within which is placed the quantity of metal or alloy necessary to provide an inner coating of the desired thickness. The alloy is preferably introduced into the tube in the form of small pieces 13 and after it is placed therein the ends of the tube are closed in a suitable manner. 14 and 15 represent end plugs made of steel, graphite or other suitable material and designed to fit in the ends of the tubes to close the same ex-

cept for a small vent which may be provided in one of the plugs. The tube 10 is placed within a furnace adapted to heat the same to the melting point of the inside alloy 13. The tube is preferably arranged for rotation within the furnace and one method is to mount the same between centers 11 and 12 which engage counter-sinks in the respective end plugs. The plug 15 has a vent 16 extending through the same and the center 30 engaging the plug has flattened sides 31 forming edges for driving the tube and also providing clearance for venting the inside of the tube.

While any suitable type of furnace may be used, it has been found particularly advantageous to employ a high frequency induction furnace, as in this type of furnace the hottest part is the metal itself. Thus, as illustrated in the drawing, there is the quartz tube 21, outside of which is the induction coil 22 for supplying the power to the furnace, this being placed within a protective housing 23.

The tube may be rotated in any suitable manner but, as shown, it is connected to a sprocket wheel 25 and driven from an electric motor 26 by means of a chain 27.

In carrying out the process the tube is rotated and the current to the induction furnace turned on, thereby developing heat in the tube and alloy while they are being rotated. When the temperature reaches the melting point of the alloy it is reduced to a molten condition and forms a pool 28 at the bottom of the tube with which the side walls are continuously washed during the rotation. The washing of the side walls removes any dirt or other foreign substance adhering to the walls and permits the molten metal to come into actual contact with the metal of the outer tube 10. The tubing is then removed from the furnace and the rotation of the same continued while allowing the molten metal to cool off and gradually lose its fluidity. During this operation the fluid is bonded to the outer tube and as solidification takes place the alloy becomes formed into a circular ring, all portions of which are equally spaced from the surface of rotation.

With some metals it is advantageous to increase the speed of the tubing, after the metal has given the walls the washing action, and cause a true circle of the molten metal before the metal starts to solidify, as certain metals have a tendency to fold over and leave seams in same.

It will be noted that the closing of the ends of the tube precludes the entrance of oxygen into

the tube and maintains the molten metal under a non-oxidizing condition.

The process as above described may be used in the manufacture of various articles such as copper lined tubing, bronze lined steel pipe, bronze lined bearings, etc. Another use for the process is in the manufacture of oil well valve seat bushings wherein the outside shell is formed of steel or other tough metal or alloy and the inside lining is composed of a cobalt chromium alloy of the Stellite type. As an example of a suitable cobalt chromium alloy, the following composition is given:

	Approximate percentage
15 Cobalt-----	50
Chromium-----	32
Tungsten-----	16
Molybdenum-----	2

20 Figure 4 shows an oil well valve seat bushing comprising an outer ring 10 formed of steel or other tough alloy having an annular rib 11 on the periphery thereof. The inner ring 12 is of uniform diameter and has the beveled seats 13.

25 The valve seat bushing, above described, when constructed in accordance with the method hereinbefore set forth is of great utility and is far superior to an all-steel bushing or the all-alloy bushing whether or not the same has been heat treated to secure hardness in the valve seat. The bushing is capable of standing up for long periods of time in actual service and the bond between the inner and outer metals is excellent due to the method of uniting the two metals.

35 It is to be understood that the invention is not limited to the particular articles above described, but may be used generally in the formation of an inner lining of one metal on another metal, and more particularly for the purpose of lining a tubular outer shell with a metal or alloy of relatively high fusing point.

What I claim as my invention is:

1. The process of forming composite articles of two metals of different composition having melting points above 1000° F. which consists in placing one metal in a solid state within a tube of dissimilar metal, sealing the opening at both ends of the tube, heating the tube to a temperature sufficient to melt the first mentioned metal, rotating the tube to cause the molten metal to adhere to the inner walls of said tube by centrifugal force cooling the tube while maintaining said rotation until said molten metal is solidified and removing from the rotating means the sealed tube lined with the first named metal.

2. A process of forming composite articles which consists in forming a tube with inwardly projecting flanges at both outer ends thereof, introducing a solid metal into said tube, heating said tube to the melting point of said solid metal while maintaining said tube substantially sealed, rotating said tube while maintaining the seal to distribute the molten metal into intimate contact with the walls of said tube and the walls of said flanges, cooling said tube while maintaining the rotation thereof until the inner metal is solidified thereby forming a solid lining integrally united to said tube and said flanges.

3. A process for lining tubing which consists in introducing solid metal into a tube, said metal having a melting point of at least 1000° F.,

hermetically sealing the ends of the tube except for a small vent, heating said tubing to above the melting point of said metal and rotating said tubing to distribute the molten metal into intimate contact with the walls of said tube.

4. A process for lining tubing with metal or alloy, having a melting point of at least 1000° F., which consists in introducing the lining metal in a solid state into a tube, closing the ends of said tube with end pieces, welding said end pieces to said tube to provide a tight seal, heating said tube to the melting point of the inner metal, rotating said tube to distribute the molten metal into contact with the walls of said tube and cooling said tube while maintaining the rotation thereof until the inner metal is solidified thereby forming a solid lining integrally united to said tube and said end pieces.

5. A process for lining tubing with metal or alloy having a melting point of at least 1000° F. which consists in introducing the lining metal in a solid state into a tube, closing the ends of said tube to provide a tight seal sufficient to resist the penetration of the molten lining metal, heating said tube to the melting point of the inner metal, rotating said tube to distribute the molten metal into contact with the walls of said tube and cooling said tube while maintaining the rotation thereof until the inner metal is solidified thereby forming a solid lining integrally united to said tube and the closed end portions thereof.

6. A process for lining tubing with metal or alloy having a melting point of at least 1000° F. which consists in introducing the lining metal in a solid state into a tube, sealing the ends of said tube to prevent the inflow of oxidizing gases and permit relief of internal gaseous pressure, heating said tube to the melting point of the inner metal thereby causing an outflow of the expanded gas within said tube, rotating said tube while cooling the same to centrifugally cast the molten metal and removing the closed tube from the rotating means after the solidification of said inner metal.

7. A process for lining tubing with a copper alloy having a melting point of at least 1000° F. which consists in introducing the copper alloy in a solid state into a tube, sealing the ends of said tube to prevent the inflow of oxidizing gases and permit relief of internal gaseous pressure, heating said tube to the melting point of the copper alloy thereby causing an outflow of the expanded gas within said tube, rotating said tube while cooling the same to centrifugally cast the copper alloy and removing the closed tube from the rotating means after the solidification of said copper alloy.

8. A process for lining tubing with a cobalt-chromium alloy having a melting point of at least 1000° F. which consists in introducing the cobalt-chromium alloy in a solid state into a tube, sealing the ends of said tube to prevent the inflow of oxidizing gases and permit relief of internal gaseous pressure, heating said tube to the melting point of the cobalt-chromium alloy thereby causing an outflow of the expanded gas within said tube, rotating said tube while cooling the same to centrifugally cast the cobalt-chromium alloy and removing the closed tube from the rotating means after the solidification of said cobalt-chromium alloy.

WALTER BROWN.