

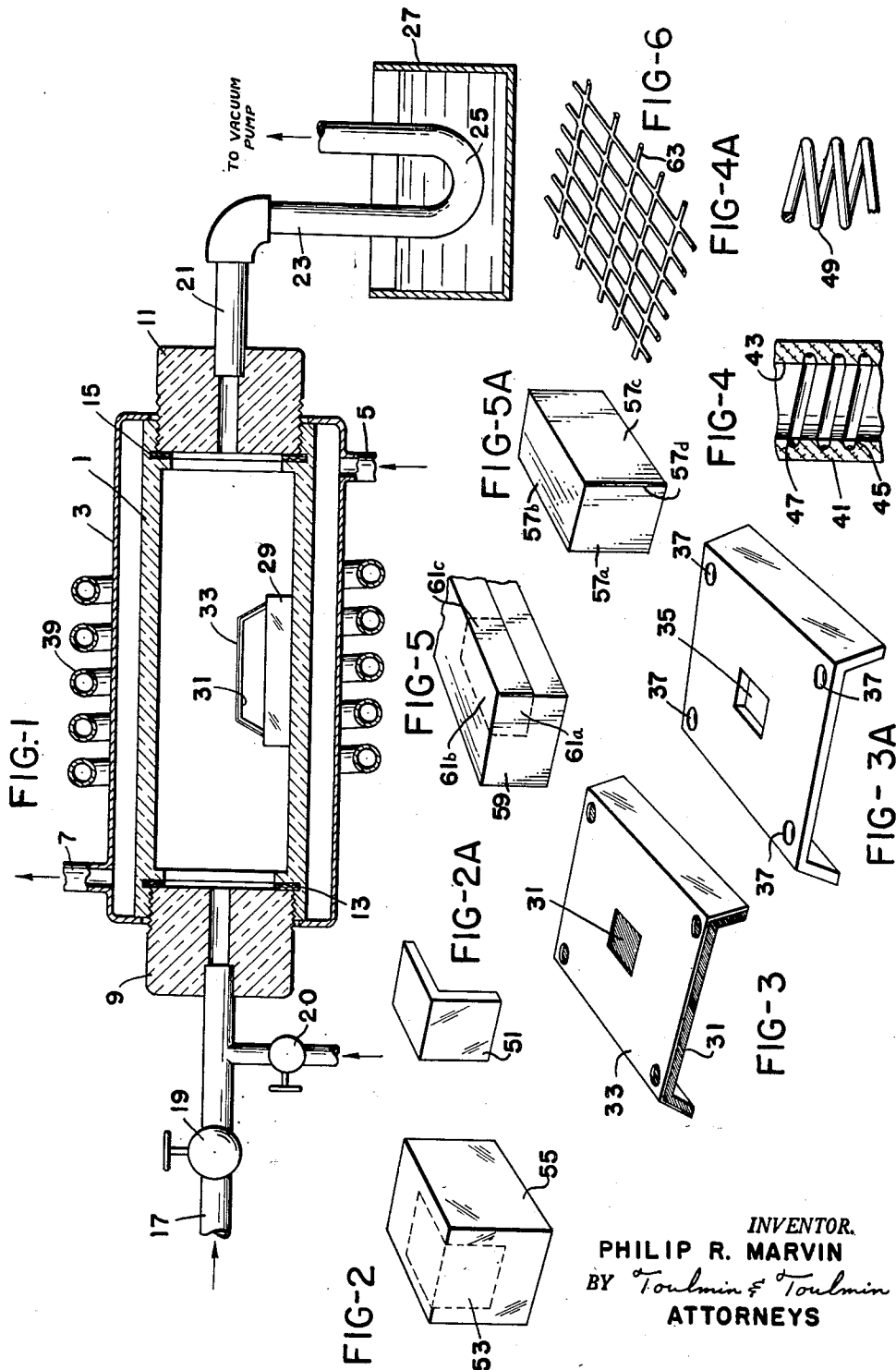
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METHOD OF PRODUCING METAL SHAPES BY GAS PLATING

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METHOD OF PRODUCING METAL SHAPES BY GAS PLATING

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This invention relates to the production of metallic articles and particularly to articles of irregular shape; more specifically the invention relates to the production of articles which include as an important constituent the higher melting point metals such as tungsten and molybdenum.

A primary object of the invention is to describe a novel process for the production of metallic objects such as frames, trim, angles, stripings, springs and combinations of these. The process of the invention particularly contemplates the provision on a combustible material of a heat conductive film, the heating of this film in a vacuum or in a chamber evacuated to an extent such that the heat does not cause the combustible material to be consumed, the contacting of the film with a heat decomposable gaseous compound which is decomposable at the temperature of the film to deposit metal thereon, the removal of the supported metal from the vacuum, and the burning of the combustible material from the metal constituting the article.

The combustible material may be substantially planar, that is, for example a sheet of paper. Or the material may suitably be three-dimensional, a box for instance. In either event the surface or surfaces thereof are very lightly coated with the heat conductive film which is formed thereon in a desired configuration. The film is most suitably formed of a metallic paint—e. g. aluminum, or a printing ink (the carbon of which is electrically conductive); the film may thus be simply painted, sprayed or coated on the combustible material in any suitable manner.

The shape of the object to be formed is substantially immaterial for practically any shape may be arranged to have a film thereon contacted by the heat decomposable gas. The invention however finds its greatest utility where the shape is relatively complicated or where the metal of which the article is constituted, in whole or in part, has a high melting point and consequently a high temperature for working, drawing, rolling and so forth under normal processing conditions.

Articles formed under the conditions outlined have a decided advantage with respect to the purity of the metallic constituent, over most other processes. Further the metal is not subjected during processing to arduous mechanical working and accordingly the products have desirable physical qualities of strength, ductility, elasticity and so on, depending upon the nature of the article itself.

The invention will be more fully understood by the following detailed description and accompanying drawings wherein specific examples of articles produced in accordance with the invention are set forth by way of illustration only and are not to be construed as limitative of the inventive concept.

In the drawings:

Figure 1 illustrates an apparatus arrangement useful in the practice of the invention;

Figures 2 and 2A illustrate, respectively, a blank and the product producible from the blank in the practice of the invention;

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Figures 3 and 3A illustrate, respectively, a blank for the production of an article in accordance with the practice of the invention and the article producible therefrom;

Figures 4 and 4A illustrate, respectively, a blank for the production of a spring and the spring itself in accordance with the principles of this invention;

Figures 5 and 5A illustrate, respectively, a blank and a three-sided article producible from the blank in accordance with the principles of the invention; and

Figure 6 illustrates a network produced of metal in accordance with the invention.

Referring to the drawings there is shown in Figure 1 a glass vessel surrounded by a water jacket 3 having inlet 5 and outlet 7 and adapted to maintain the interior walls of the vessel cool. Vessel 1 has closing portions 9, 11 tightly and removably sealed thereto with the aid of gaskets 13, 15.

Closing portion 9 has, preferably integral therewith, a gas inlet line 17 having valve 19 which is adapted when opened to permit a flow of plating gas therethrough to the interior of vessel 1.

Closing portion 11 has, also preferably integral therewith, a gas outlet line 21 for the passage of gases outwardly from the vessel 1. This line 21 communicates through a suitable L-shaped coupling with conduit 23 which terminates in a U-shaped portion 25 which extends through a cooling liquid, as dry ice and acetone, in trap 27. A vacuum pump (not shown) is adapted to produce a vacuum in the apparatus and to draw exhaust gases to the trap.

Positioned in the vessel 1 on a suitable base of insulating material 29 is a heavy cardboard 31 having a metal film 33, on the upper surface thereof, a coating of aluminum paint; the cardboard 31 is in the shape illustrated in Figures 3 and 3A and is in the form of an ordinary electric switch plate, which plate has therethrough a central opening 35 through which the actuating member of the switch passes. Also provided at 37 are openings for the receipt of holding means such as screws for fastening the plate to a wall.

The metal film 33 on the cardboard 31 is adapted to be heated by means of an induction coil 39 which surrounds the vessel 1 and water jacket 3 and is provided with energy from a source not shown.

In the operation of the apparatus valve 19 is closed, the vacuum pump is operated and energy is supplied to the coil 39 to heat the film 33. This procedure effects complete evacuation of the apparatus prior to the introduction of the plating gas itself.

When the apparatus has been completely evacuated the valve 19 is opened with the vacuum pump still operating and a flow of plating gas enters through line 17 to contact the film 33.

A most suitable plating gas is nickel carbonyl as the nickel film deposited therefrom on the film 33 provides a fine finish which is non-corrosive and does not require further treatment. However the plating gas may be any of those indicated in the following table, which is set forth by way of example only:

Plating Material	System Pressure, mm. of Hg	Temperature Range of Base Material in Degrees Fahrenheit
Ni(CO) ₄	0.5-1.0	350-450
Cr(CO) ₃	0.5-1.8	375-450
Mo(CO) ₆	0.5-1.8	450-650
W(CO) ₆	0.5-1.8	525-775
Cu(C ₂ H ₅ O) ₂	0.5-1.8	400-750

It will be noted that for the nickel carbonyl the tem-

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perature of the film 33 should be at least about 350° F. when the plating gas enters the chamber of vessel 1. Preferably the temperature is somewhat higher, but not above the maximum indicated of 450° F., as higher temperatures than this offer no advantages. The heavy cardboard 31 will not be seriously affected by the temperature and will not burn since there is substantially no air in the chamber.

The plating is continued for a period of time sufficient to effect deposition of about 1/8 of an inch of metal over the film 33. Thereafter the heat energy to the film is cut off and the work cooled before removing it from the chamber.

In order to assist in breaking the vacuum within the vessel 1 a conduit having a valve 20 may be connected to a source of carbon dioxide and when valve 19 is cut off CO₂ may be put through the chamber to clear out any remaining heat decomposable carbonyl and to provide a pressure in the chamber which permits of readily opening the same.

After removal from the apparatus the cardboard is fired at low temperature in the air and is burned from the metallic plate which remains. In the case of aluminum paint combustible constituents of the paint itself will also be removed and the film of aluminum will ordinarily be so thin as to be substantially indistinguishable on the plate back. The completed product will then have the configuration indicated in Figure 3A.

In a further embodiment of the invention the spring shown in Figure 4A may be produced by forming a hollow cylinder 41 of cardboard of considerable wall thickness and lightly forming a spiral groove in the internal surface 43 thereof as at 45.

A sharp tool carrying aluminum paint on the end thereof is then inserted in the hollow of the cylinder and the groove is painted as indicated at 47. This coil is then placed in the apparatus of Figure 1 and heat applied until the very thin aluminum film attains a temperature in the range of 525-775° F. The vacuum pump is operated with valves 19 and 20 closed in order to insure of complete evacuation of the equipment and of any gases formed from the paint film; upon completion of the evacuation valve 19 is opened to introduce tungsten carbonyl into the apparatus to provide a pressure of carbonyl therein of about one mm. of mercury. The carbonyl enters the hollow of the cylinder, contacts the paint and deposits thereon to form a spiral of metal. This spiral of metal may be of considerable thickness, and it is to be understood that the original paint thickness has little to do with the ultimate metal thickness deposited, the initial film serving merely as a heat conductive pattern upon which the metal of the gas deposits. The resultant product of the plating operation when cooled and fired, and removed therefrom, is a coil spring such as shown at 49 in Figure 4A.

Referring briefly now to Figures 2 and 2A the angle iron is producible from the film 53 which is painted on the box 55 of Figure 2, in the same manner as described hereinbefore, and the metal may be any of those derivable from the compounds indicated in the table set out above.

The structure of Figure 5A which is producible from the blank of Figure 5 illustrates a material having three sides 57a, 57b and 57c. To produce this a box 59 is painted as at 61a, 61b and 61c, support for the latter film (61c) being a cutout portion of the cardboard box. The structure of Figure 5A may be slit at the vertical edge 57d

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and the edges bridged by contact of gas with the adjacent edges during the plating operation. If desired the lateral edge may be cut sufficiently remote from the forward edge to avoid such bridging.

The cardboard material is most flexible and may be formed into an indefinite number of shapes and may be rolled or otherwise mechanically worked to insure of achieving a desired result. Fabric may also be employed and an open net structure is useful in the production of an open metal network or grid such as is shown in Figure 6 at 63. Combinations of the cardboard or the like cellulosic material, fabric or other easily combustible material may be utilized to achieve particular results.

The process of invention is applicable to intricate shapes as will be noted from the specific examples set out hereinbefore and is of particular utility in the deposition of the high melting point metals because of the difficulties which are inherent to the normal working processes of the same. The products in each case are smooth finished, bright and in general corrosion resistant due to their purity.

It will be understood that this invention is susceptible to modification in order to adopt it to different usages and conditions and accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

I claim:

1. A method of producing integral metal shapes by gas plating which consists in the steps of providing a shape from cellulosic material which is combustible at a relatively low temperature, applying a coating film thereover which is heat conductive, heating the resultant coated-shape under reduced atmospheric pressure conditions to a temperature to cause a gaseous metal compound brought into contact therewith to be decomposed, contacting the heated coated-shape with a gaseous metal compound which decomposes depositing the metal constituent as a coating thereon, and continuing the deposition of metal to build up a relatively thick coating of metal, and then burning away the cellulosic material to provide a completed metal shape.

2. A method of producing integral metal shapes by gas plating which consists in the steps of providing a shape from cardboard, applying a coating of aluminum onto the surface of the cardboard forming a thin film of aluminum thereon, heating the resultant aluminum coated shape to a temperature to cause a gaseous metal compound brought into contact therewith to be decomposed, contacting the heated aluminum coated shape with gaseous metal compound which decomposes depositing the metal constituent as a coating thereon, continuing the deposition of metal to build up a relatively thick coating of metal on the aluminum coated cardboard shape, and then burning away the cardboard to provide a completed metal shape.

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