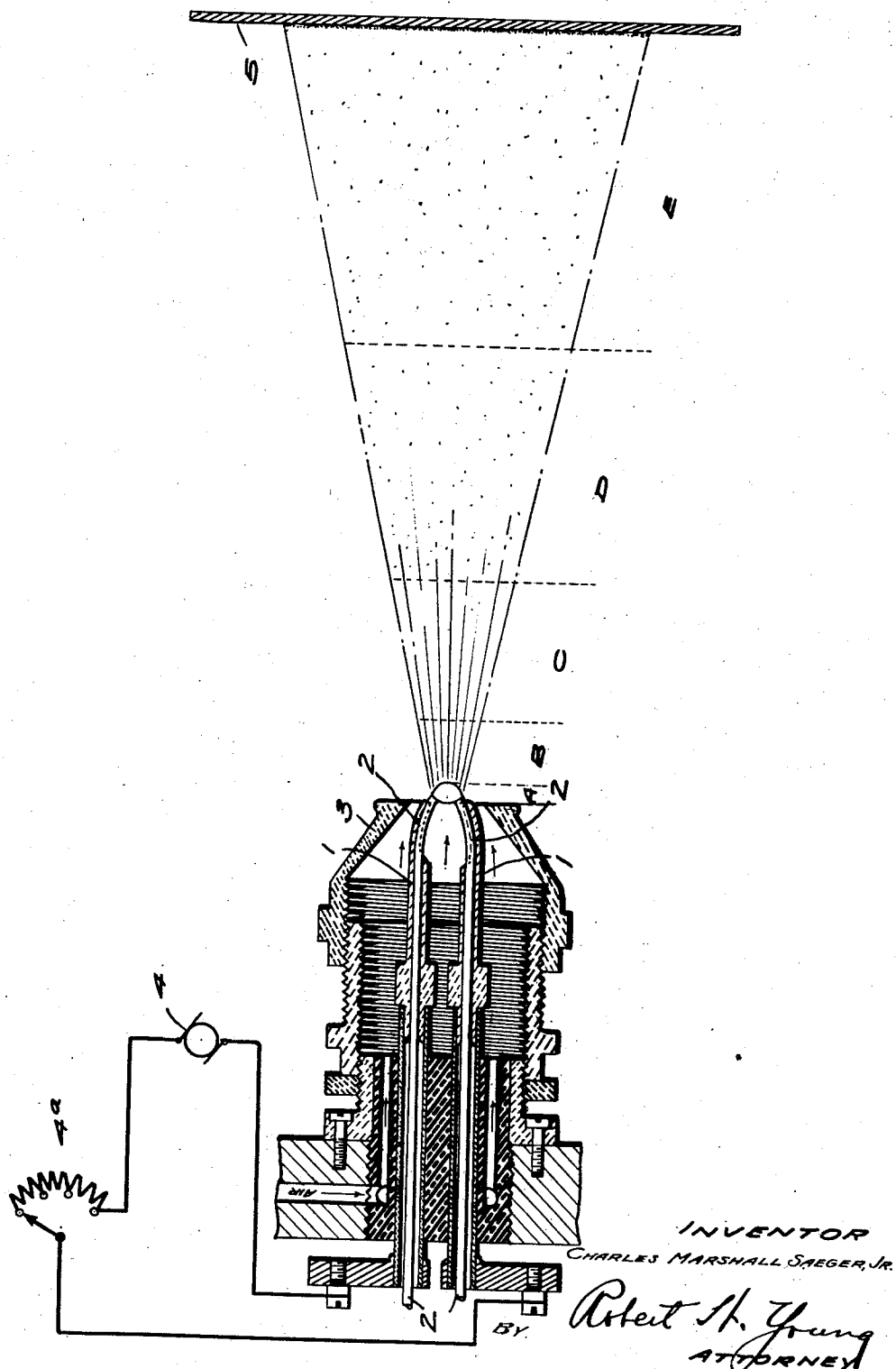


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METAL COATING METHOD

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METAL COATING METHOD

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

5 This invention relates to the art of coating surfaces with metal by the use of spraying devices and has for its principal object the provision of an improved method wherein the spray is composed of particles which are more finely comminuted and of greater uniformity in size throughout than has been attainable with the methods heretofore devised.

10 In accordance with the methods and devices heretofore employed in coating with metal, the metal which has been selected for the purpose has first been brought to the melting point by application of heat; then, the molten metal has been atomized and projected against the surface to be coated by some suitable means, such as an air jet. The results accomplished have been far from satisfactory, due to inability to obtain the degree of comminution and uniformity of size which is to be desired in the sprayed particles of metal. Large globules as well as more finely divided particles have been found to compose the spray produced in the old way.

15 The new method will be more fully understood when the following specification is read in connection with the accompanying drawing which illustrate the manner in which the spray is produced and projected against a surface to be coated by one of the various forms of apparatus which may be utilized for the purpose.

20 Referring to the drawing the numeral 1 designates the guide tubes through which wires 2 of the desired metal for coating are fed by suitable mechanism (not shown) to the point where these wires come into initial contact with each other. The guide tubes are suitably positioned within an adjustable nozzle 3, through which air, or other suitable gas, may be forced past the ends of the wires in the form of a jet of regulatable velocity.

25 The speed of wire feed into the vaporizing zone may or may not be varied. If varied, the amperage will vary in proportion to the increase or decrease of the wire speed. For example, with a wire speed of 12 feet per minute, 20 amperes will pass through the wires. If this speed be increased to 14 feet per minute, the amperage will be raised automatically to 24 amperes. The current, or amperage, is, therefore, a function of the wire speed.

30 The guide tubes 2 are insulated electrically and are connected with the opposite poles of a suitable

source of electric current 4. The current may be regulated by rheostat 4a.

The spray device is shown mounted in position to project a spray produced thereby against a surface of plate 5, which is to be coated.

35 In accordance with the improved method, instead of melting and atomizing a coating metal, the metal is vaporized and then condensed like steam into a fog of finely divided particles of great uniformity in size, which particles are projected against the surface to be coated. An example of this method will be described in connection with the use of zinc as the particular coating metal.

40 Assuming that No. 18 zinc wire is used, the electric current applied through the wires should have a voltage of 18, an amperage of 20, and wire speed of 12 feet per minute. The air pressure of the jet should be 90 to 95 pounds per square inch and the air velocity should be from 25 to 30 cubic feet per minute.

45 The zinc wires are fed through the guide tube until they touch. At first, an explosive arc is created, somewhat like that produced by a "short circuit". In this manner the ends of the wires are burned away until the degree of separation is sufficient for the production of a steadily burning arc. This arc contains vapor and forms the zone designated by the reference character A in the drawing. For zinc, a temperature of 930 degrees centigrade is required to produce vaporization. The air jet, as it strikes the metallic vapor in zone A, blows the vapor outward toward the plate 5 and commences to cool the vapor as it passes through zone B. In zone C, slightly further removed from the nozzle, the vapor starts to condense. In the zone D, there is still some uncondensed vapor, but a fog of condensed metal particles is visible. In zone E the fog is quite dense and is composed of larger particles, which are sprayed against the adjacent surface of plate 5 in the form of a coating of uniform density throughout.

50 For any given metal, it is necessary to determine the vaporizing temperature from some available source of information, such as the Smithsonian Physical Tables, and then to regulate the characteristics of electric current and air jet accordingly for the size of wire and wire feed speed to be used.

55 It should be apparent that the proposed method may be carried out in spray devices of various kinds.

The correctness of the conditions for production of a vaporizing arc in any apparatus em-

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ployed and for any desired metal may be tested by spectroscopic examination of the metal spraying arc during operation. For example, with an apparatus in which zinc wires were used in the production of an arc, it was found that, when the arc had been started and its flame was analyzed by observation through a spectroscope, the bright line emission spectrum characteristics of atomic zinc were seen. The spectral images of the arc extended from one wire end to the other and had the same shape and size as the arc flame. This indicated that the entire volume of the arc was filled with vapor of zinc metal in optically excited and ionized atomic states. In this type of apparatus, the wires of any material whatsoever are probably vaporized by an electron bombardment and very high temperature in the arc stream, the continuous operation of the arc in spite of the strong air currents directed against it being evidence that a copious supply of electrons and metallic ions is present to carry the electric current across the arc gap.

Regardless of the particular metal to be sprayed or the particular apparatus to be used, the conditions should be so regulated that the resultant method will comprise the following general steps:

- (1) Vaporization of the metal;
- (2) Removal of the metal vapor from the point of its production to displace the equilibrium between the solid metal, liquid metal, and metal vapors toward the formation of more vapor;
- (3) Condensation of the metal vapor to a "fog" of finely comminuted metal particles; and
- (4) Directing the condensed metal toward the surface to be coated and thereby causing these particles to impinge against the latter.

While mention has been made of air as the gas which is used in the vapor projecting jet, it is to be understood that other gases may be utilized without departing from the scope of the present invention. For instance, an inert or non-oxidizing gas, such as the exhaust gas from an internal combustion engine, may be found highly desirable under certain conditions of practice.

In order that the metallic coating may adhere to the surface to be coated, it has been found necessary to sand-blast the surface before spraying on the metal. A variation in the method of spraying has been devised to avoid sand-blasting the surface to be coated. This variation will now be described. A preliminary coat of a material which will present a tacky non-porous surface is first applied. Rubber cement is preferable because it will form a coating impervious to mois-

ture, and gas but other rubber-like or plastic materials, such as resin, or shellac, may be used. A second coat of condensed metallic vapor is then applied to the preliminary coat. This second coat might, however, be formed by applying metallic powder produced in a manner which will be described hereinafter.

Metallic powder for use in the multiple coating just described may be produced by directing the spray of condensed vapor into a condensation chamber (not shown) instead of against the surface to be coated. The condensed particles will thus be cooled and will fall to the bottom of the chamber in the form of powder.

A still further variation in the method consists in the production of a metallic alloy by using one wire of one metal and the other of a different metal. An intimate mixture of exact proportions can be obtained in this manner. Different alloys of the same combination of metals may be produced readily by appropriate variation of the relative sizes of the wires, or of the speeds of wire feeding. The final product in any event may be in the form of a coating or powder, as preferred.

I claim:

1. The method of coating surfaces with metal which consists in feeding wires of the desired metal for coating into initial contact with each other simultaneously with the passing through said wires of an electric current of an intensity to create an arc composed of vapor of metal in optically excited and ionized states, and subjecting the arc to the condensing action of a jet of compressed air or gas of such velocity as to continuously displace quantities of the vapor in the direction of the surface to be coated without interrupting the continuous operation of the arc.

2. The method of coating surfaces with metal which consists in feeding electrically charged rods of the coating material into initial contact with each other to create an electric arc at the point of contact, continuously feeding the said rods at a rate of speed proportionate to the consuming action of the electric arc for maintaining the ends of rods at a degree of separation sufficient for the production of a steadily burning arc, maintaining said arc at a temperature sufficient to produce vaporization of the consumed metal, and simultaneously causing the material to impinge on the work by means of a condensing and directing jet of air or gas projected through the vaporizing arc.

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