

April 16, 1946.

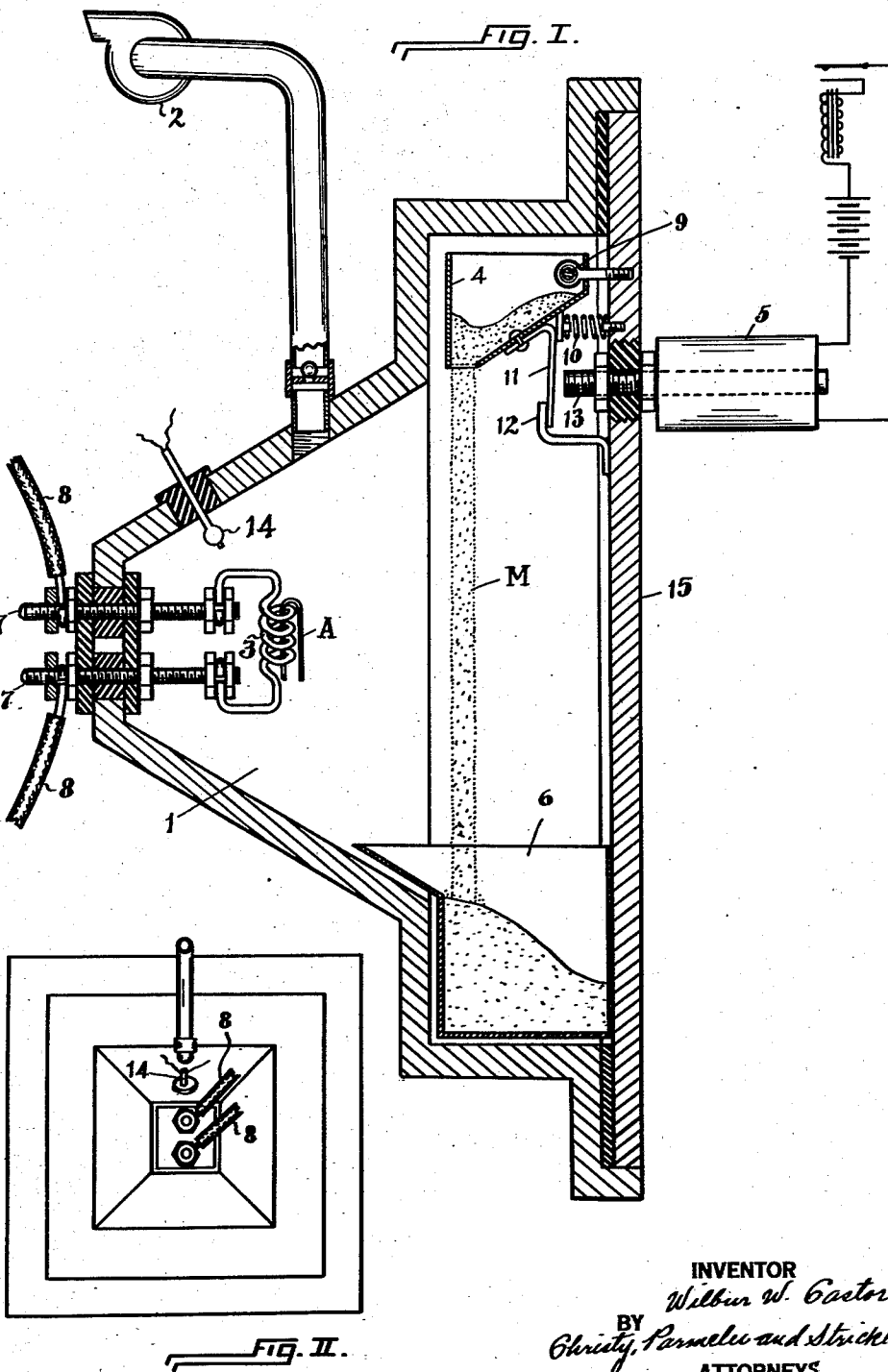
W. W. CASTOR

2,398,517

APPARATUS FOR PLATING FINELY DIVIDED MATERIAL

Filed Nov. 4, 1941

2 Sheets-Sheet 1



INVENTOR
Wilbur W. Gaster
BY
Christy, Parmelee and Strickland
ATTORNEYS

April 16, 1946.

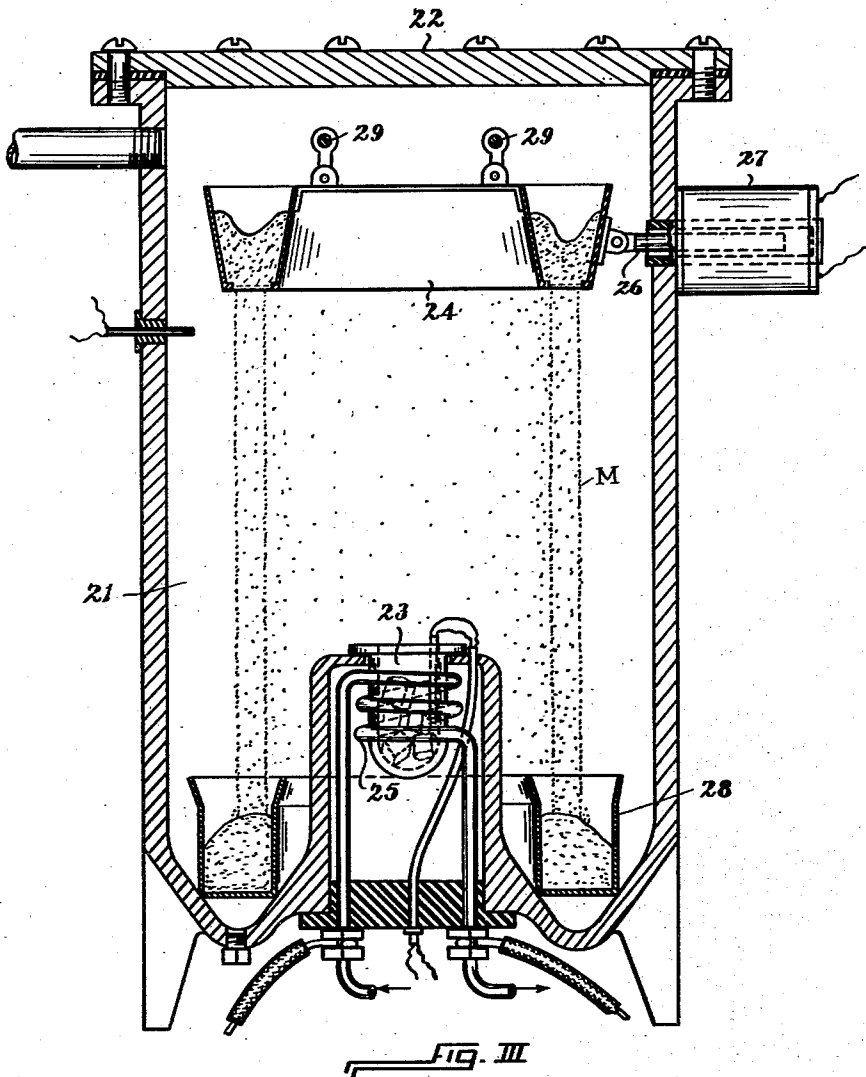
W. W. CASTOR

2,398,517

APPARATUS FOR PLATING FINELY DIVIDED MATERIAL

Filed Nov. 4, 1941

2 Sheets-Sheet 2



INVENTOR
Wilbur W. Castor
BY
Christy, Parmelee and Strickland
ATTORNEYS

UNITED STATES PATENT OFFICE

2,398,517

APPARATUS FOR PLATING FINELY DIVIDED MATERIAL

Wilbur W. Castor, Mount Lebanon, Pa.

Application November 4, 1941, Serial No. 417,866

1 Claim. (Cl. 91-12.2)

This invention relates to metal plating, and specifically to apparatus for plating by condensation of metal from vaporous to solid state. The object in view is primarily the production of plated articles of minute size, articles that in this respect are of very different character from articles that have in such manner been plated heretofore, and articles designed for and adapted to other specific uses, as will hereinafter be enumerated.

In the accompanying drawings Fig. I is a view in vertical section of apparatus of the invention, with accessory instrumentalities shown diagrammatically; Fig. II is a view to smaller scale, showing in side elevation the apparatus of Fig. I; and Fig. III is a view corresponding to Fig. I, that shows the apparatus in modified form.

In a companion application I have described and claimed a metal-plated particle—typically, a particle of mica plated with aluminum—adapted to be used, in substitution for a homogeneous particle of aluminum, in the preparation of aluminum paint. I now show the apparatus in which and the method by which the plating of such an article is effected.

In Fig. I of the drawings a vacuum chamber 1 is shown. Its walls may conveniently be formed of steel. A vacuum pump 2 is connected with the chamber, for the purpose of exhausting the air and creating within the chamber an approximately perfect vacuum. It may be understood that the illustration of the pump is conventional merely. I have in fact employed an oil pump and a mechanical pump operating together, and I have done this both to speed up the evacuating operation and to afford a vacuum of the desired degree of perfection.

A tungsten filament, consisting in this instance of a wire 0.032 of an inch in diameter and two inches long, conveniently formed into a coil 3, is suitably mounted within the chamber and approximately in the centre thereof, and provision is made for bringing this filament into an electric circuit. As here shown, the filament is mounted upon and carried by binding posts 7, 7; these extend through the chamber wall, and with them the leads 8 of an electric circuit may be connected. The chamber contains a dredge 4 and a receptacle 6, so shaped and arranged that from the dredge 4 finely divided material disseminated by the shaking of the dredge may be caused to fall—to be rained down as a curtain M throughout substantially the entire vertical extent of the chamber. The falling curtain of material passes near the centrally arranged fila-

ment 3. The dredge is so mounted that it may be shaken. As here shown it is pivoted upon a horizontally extending axle 9. A spring 10 is provided, under whose tension the dredge is normally held at one end of a suitable range of oscillation. To such limit the oscillating dredge is held by the abutment of a dredge-borne finger 11 upon a stop 12. The finger 11 serves also as the armature of an electro-magnet 5, and in response to intermittent energizing of the magnet the spring-backed dredge oscillates between positions in which the finger 11 abuts upon stop 12 and upon the core 13 of the electro-magnet.

The chamber is advantageously equipped with a thermocouple 14; it may be equipped with a vacuum gauge as well; and it will be understood that the current that is caused to flow through the filament 3 may be subject to observation (that its character may be properly adjusted) by means of an ammeter and a volt meter. Suitable means (not shown) may also be provided for cooling the chamber and its contents.

The chamber wall on one side 15 is removable, that access may be had for the charging and removal of materials and for the maintenance of operative conditions.

In typical operation the chamber is opened and two hairpin bends of aluminum wire A are hung on the coil 3. The aluminum wire may be 0.032 of an inch in diameter and the two pieces may be each half an inch long. A charge of mica particles is placed in the dredge 4. The particles of this charge may be of the order of 0.5-5.0 microns in thickness. The quantity may be a tenth of a gram and upward. The chamber then is closed and is evacuated to a pressure of 25 microns. A current of 150 amperes at a tension of 5 volts is caused to flow in the circuit that includes the filament 3, and under the heat generated by such flow the aluminum of the two lengths of wire is initially melted and flows as a coating upon the tungsten filament. The flow of current is continued; and, under continued heat, the aluminum coating upon the tungsten filament is vaporized and the vapor fills the evacuated chamber. The dredge 4 then is agitated and the mica particles are rained down in the form of a curtain M through the vapor. Upon the descending particles the vapor condenses and forms a fine plating over all of the surfaces of all of the particles. The so plated particles fall into the receptacle 6; and, when the descent of the particles is completed, the flow of current through the tungsten filament, and the flow of the current that effects oscillation of the dredge as well, are

cut off; the vacuum within the chamber is relieved; cooling is resorted to; the chamber is opened; and the plated particles are removed from the receptacle 6.

The particles will be found to be plated with a continuous and all-covering plating of aluminum of a thickness of the order of three to five millionths of an inch, and a film of lustrous appearance. Such particles, when they have been subjected to an operation of filming over with stearic acid, may advantageously be applied in place of all-metal flakes of aluminum, in the preparation of paints, lacquers, etc., as is explained in the companion application, alluded to above.

It is manifest that the aluminum vapor when it has been caused to fill the chamber 1 will condense, not on the falling particles of mica only, but upon all surfaces with which it comes into contact. In continued operation of the apparatus, therefore, the inner surfaces of the chamber walls and the surfaces of dredge 4 and receptacle 6 will from time to time be scraped to recover condensed aluminum. This, however, is familiar practice in the use of apparatus for coating in like manner the surfaces of mirrors.

The color of the plating upon the particles may be modified by including within the chamber small quantities of specific substances. For example, a small amount of paraffin oil will give to the plating a purplish cast; the inclusion of wool fibre will produce an amber tinged plating, etc. Excessive and prolonged temperature maintained in the tungsten filament will result in a yellowing of the deposit. Inevitably there will be some small wastage of the tungsten filament; normally this is so slight as to have no appreciable modifying effect upon the plated particles so far as concerns their intended uses; and, manifestly, in the interest of economy, conditions of operation (and, particularly, time and temperature) will be so controlled and limited that, while the desired end is gained, the tungsten is not unnecessarily spent.

In the apparatus in modified form and as shown in Fig. III, the chamber 21 is cylindrical and stands vertically; and it is provided with a removable upper head 22. The aluminum to be vaporized and condensed is initially carried in a small crucible 23 of suitable material and the crucible in the assembly is so mounted that its contents come within the electro-magnetic field of a coil 25. The coil is such and the energizing current, voltage, and frequency are such as to vaporize the charge of aluminum within the crucible. The crucible is arranged coaxially with and in the lower part of the chamber. The dredge 24 and the receptacle 28 are in this case of annular form, and the curtain that is rained down is in the form of a cylindrical shell, surrounding the cloud of vapor that rising from the crucible spreads and fills the chamber. By way of illustrating alternative means of agitating the dredge, the dredge here is shown to be linked to and suspended from spindles 29, and to be articulated to the armature 26 of an A. C. solenoid 27. It is manifest that the vibratory movement of the armature is imparted directly and immediately to the dredge.

Procedure is essentially such as has already been detailed. When by the maintenance of an electro-magnetic field of sufficient intensity the charge of aluminum passes to vaporous condition, rising as a cloud from the crucible and spreading within the chamber, the dredge is agi-

tated; the particles of mica are rained down through the vapor; and aluminum condenses upon them as they fall.

I have described the plating of mica with aluminum as typical procedure. The invention in its broader aspect contemplates the plating of powdered material generally with metal generally, and presently I shall indicate the wide and diverse fields of utility that may be served in the practice of my invention. Among materials to be plated, I contemplate flake-like particles of mica and of graphite; amorphous and porous particles, such as particles of carbon, dense and crystalline particles, such as those of silica; and particles of metal, ordinarily base metal such as iron and copper, to be plated with precious metal, such as silver and gold. Procedure with the apparatus of Fig. I is subject to this limitation, that the vaporized metal must have a point of vaporization in vacuo definitely lower than the melting point of tungsten; but the apparatus of Fig. II is attended by no such limitation in use. Metals generally may be vaporized and condensed within it.

The utility of the invention in widely varied fields may be indicated. In the field of paints and lacquers, a quantity of aluminum-plated flakes of mica, or of gold-plated grains of silica for a given coverage is cheaper than a like quantity of homogeneous metallic particles, and may be provided at less total cost; the plated material is of less specific gravity, and in consequence is better suited to the conditions of use; the plated particles may be produced in quantity and of better uniformity in size than is possible in the production of homogeneous metal particles, and on that account also the plated material is better adapted to the use and will afford better coverage.

In the allied art of the decoration of ceramic ware the plated powder may be used to advantage, in place of homogeneous metallic powder; and in the art of printing the plated powder may advantageously be used in place of homogeneous metal powder in the preparation of printing inks (using ink in an extended sense, to include liquid and plastic preparations that are printed as ink is printed).

In the art of powder molding, plated powder is equally responsive with homogeneous metal powder to the molding operation, and may be employed with the advantage of cheapness, and, where weight is disadvantageous, with the advantage of lightness. The carrier particles may be either inert and rigid or they may be of material (copper, for example) that is itself responsive to the molding stresses.

If the carrier particles be of graphite, the coefficient of friction under the compressive stress will be reduced.

These observations are equally applicable to powder molding with fusion of the particles at suitable temperature.

The production of articles of two metals intimately mingled but unalloyed becomes possible by plating of particles of one metal with another and integrating a mass of such particles.

In the manufacture of abrasive instruments, particles of abrasive may initially be plated with metal that they may be the more securely held in the body of metal that constitutes the matrix in which they are in the course of manufacture included.

In the practice of the invention particles of a given metal may be plated with another metal

be protected from oxidation, and so the alloying of the two metals involved may be facilitated.

The plated coating may be relied upon, not only to prevent particular finely divided material from oxidation, but also to isolate it, so that it will not injuriously react with other materials with which for other reasons it is desirably brought into contact.

A catalytic sponge may be prepared by plating porous particles of copper, for example, with the desired metal or compound—with nickel, for example.

I claim as my invention:

An apparatus of the class described for coating finely divided particles with metal comprising a chamber, means for evacuating air from the chamber, means for generating a metal vapor in the chamber, and means within the vessel for holding and sifting finely divided solid material into the vessel to cause it to fall through the vapor.

WILBUR W. CASTOR.