May 16, 1933. P. S. CASE 1,909,252

PRODUCTION OF COATINGS

Filed Aug. 12, 1929

Fig. 1.

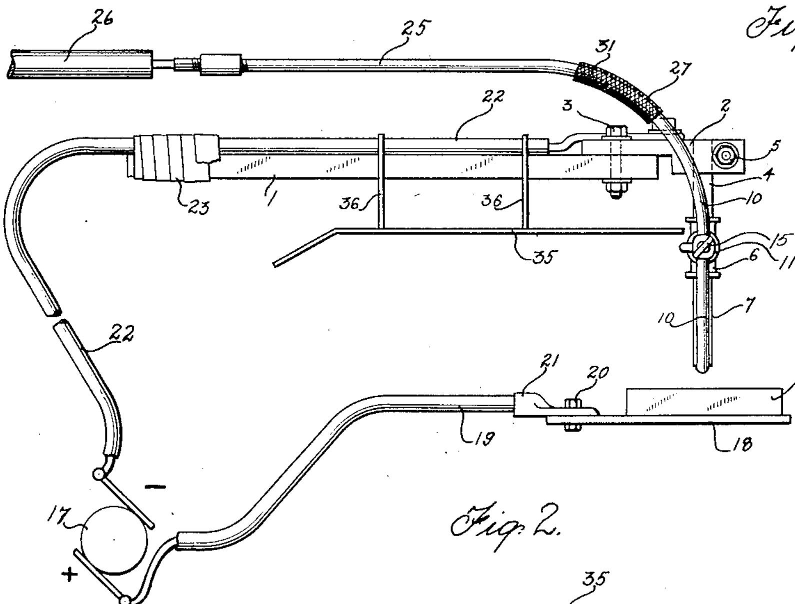


Fig. 2.

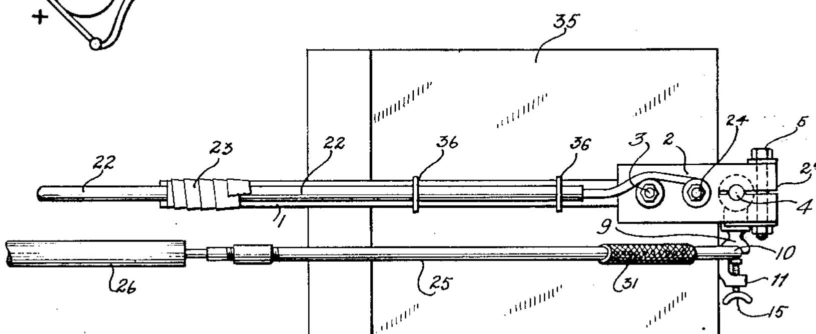


Fig. 3.

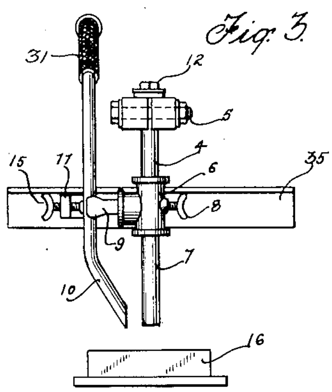
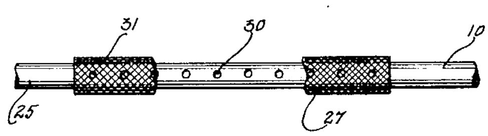


Fig. 4.



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Patented May 16, 1933 1,909,252

UNITED STATES PATENT OFFICE

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PRODUCTION OF COATINGS

Application filed August 12, 1929. Serial No. 385,430.

My invention relates to the production of coatings of high melting point materials by the aid of the electric arc and especially to a device for producing such coatings.

My invention is useful for producing coatings of high melting point materials and particularly easily-oxidized refractory metals and alloys, such as tungsten, ferro-tungsten, and the like. It also may be used to produce coatings of other easily oxidized metals such as chromium, or of refractory non-metallic materials such as magnesia. The process consists broadly in producing an uninterrupted arc, preferably a long or flame-like arc between an electrode and the electrically conductive body to be coated, and feeding a continuous uniform stream of powdered coating material onto an area of the body softened or superficially melted by the heat of the arc.

The stream of powdered coating material is produced by mixing the powder with air or other gas in definite proportions so as to form a cloud or mixture capable of being conducted through pipes. This mixture is thickened by extracting a portion of the gas so as to produce a steady stream of mixture of comparatively higher density and of low velocity. The stream is steadily produced and passed into the arc with the volume and velocity of the gas decreased to a low value so that a material oxidation of the coating powder or a blowing out of the arc will not result.

My invention will be more fully understood in connection with the description of the drawing constituting a part hereof, in which

Figs. 1, 2, and 3 are respectfully side, top and end views of my coating device,

Fig. 4 is an enlarged view of a thickener.

The coating device is operated by a handle 1 having an electrically conductive head 2 secured thereto by a bolt 3. The head carries an inert electrode of carbon or the like and provides a support for a delivery tube to convey the powdered coating material to the end of the electrode and to direct the material into the zone of the arc. At a suitable distance from the end of the handle a split collar 2*a* is formed in the head 2 and a nipple 4 is clamped in the collar by means of a bolt 5 so that the nipple and the electrode attached to the nipple can be adjusted. The other end of the nipple 4 is screwed into a hollow T shaped member 6. The electrode 7 is inserted into the member 6 and held therein by means of a threaded wing bolt 8. A bracket 9 for holding the delivery tube 10 is screwed into the lateral extension of the T member 6. The extremity of the bracket 9 is formed with a yoke 11 that is provided with a wing bolt 15 which secures the delivery tube 10 in the yoke and provides means to remove the tube and to adjust it in vertical and horizontal planes so that its tip can be positioned to discharge material near the end of the electrode 7.

An arc is drawn between the electrode 7 on the negative side of the arc and the work or object 16 which is to be coated placed in the electrical circuit on the positive side of the arc. The work is necessarily an electrically conductive body and is connected to one terminal of a current source 17 through a metallic support 18 and the lead 19. The lead 19 may be attached to the support by a bolt 20 that is passed through an opening in the terminal 21 and the support. The negative side of the current source 17 is connected to the electrode 7 through the lead 22 which may be bound to the handle 1 by taping 23 which if desired may extend the length of the handle to form a smooth grip. The end of the lead 22 is secured in electrical contact with the head 2 by a bolt 24. The circuit is completed through the head 2, the nipple 4 and a T member 6, which latter holds the electrode 7.

The powdered coating material is supplied to the delivery tube 10 through an extension tube 25 in the form of a mixture or cloud of gas and powder. This mixture may be produced in any convenient mixing apparatus which will continuously supply a mixture of constant density and volume. The cloud or mixture is conducted to the extension 25 through a pipe 26. In order to conduct the powder through the horizontal or any upwardly inclined portions of the conveyer tubes a large amount of gas is mixed with the powder and this mixture projected through the tube at a high velocity. The volume and velocity of the gas in such a stream is so great that it will blow out the electric arc or cause it to fluctuate so much that the supply of powder delivered to the arc in this manner cannot be regulated in proportion to the heat of the arc. Therefore means are provided to reduce the velocity of the stream of the mixture and to decrease the volume of the gas in the stream prior to projecting it into the arc, and to maintain a steady flow of coating powder into the arc and onto the piece to be coated. These functions are accomplished with the aid of a thickener 27 placed near the head 2 in the line between the extension tube 25 and the delivery tube 10.

The thickener 27 comprises a series of holes 30 about 1/8 inch in diameter bored in the wall of the conveyer tube and covered by a fine screen or porous sleeve 31 which allows the gas to pass through the holes but retains the powder. The escape of the gas reduces the pressure in the tube and consequently the velocity of the stream and the volume of gas present in the stream beyond this point. It has been found that a wire screen of about 80 meshes to the inch is suitable with a powder which passes a screen of 30 meshes and is retained on a screen of 60 meshes to the inch. The best results have been obtained by spacing the holes 30 longitudinally along the top walls of the tube on the outside arc of a downwardly bent portion of the tube. By placing the holes at this point advantage is taken of the fact that the proportion of gas present in the stream of the mixture is greatest along the top wall of the tube and that the action of gravity at this point tends to cause the powder to fall away from the screen and prevent the screen from being clogged by the powder. Also the tube being vertical at this point the coating powder is fed by gravity into the zone of the arc without any further need of the accelerating action of the gas current.

By varying the size and number of the perforations 30 and the fineness of the screen 31, the density and velocity of the mixture may be regulated at will. The regulation may be fixed by closing the desired number of perforations, as by putting stoppers in the perforations 30 until the desired regulation is obtained. Temporary regulation may be obtained by placing the hand on the screen over the perforations.

A shield 35 is disposed between the handle 1 and the electrode 7 to protect the operator from the arc. The shield 35 is attached to the insulated handle 1 by means of brackets 36 which are bent snugly around the insulated lead 22 and serve to hold the lead in place along the handle 1.

As a specific example of the operation of my device for building up coatings, tungsten powder consisting of about 99% tungsten, 0.16% iron and the remainder impurities is taken. The best results are obtained with powder which passes a standard screen of 30 meshes to the inch and is retained on a standard screen of 60 meshes to the inch but other sizes of powder may be used. A mixture or dust-cloud consisting of the powder and air is conducted through the conduit 26 and supplied to the extension 25. This mixture may contain about 1 part by volume of the powder and 800 parts by volume of air, and for the best results should be supplied as a continuous stream of uniform content of powder and air. In passing through the perforated arcuate portion of the extension 25, a large proportion of the air is permitted to escape through the perforations 30 and screen 31. The diminution in volume or thickening of the mixture together with the change in direction effected by the curved portion of the extension 25, produces a suspension which may contain for example, 1 part of powder and 75 parts of air.

After the powder has passed beyond the thickener 27 the solid particles are more or less suspended in the remaining air. The stream of powder intermixed with some air flows through the tube 10 by gravity assisted by the momentum of the powder and also slightly assisted by the remaining air. With such a suspension the current of air issuing from the delivery tube 10 is reduced to a negligible amount and does not blow out the arc or affect the continuous and steady operation of the arc. So long as a continuous and regular supply of the mixture or cloud of powder and air is delivered to the extension tube 25 a substantially uniform flow of the powder will be delivered to the arc. The character of the stream issuing from the delivery tube may be changed by changing the character of the stream delivered to the extension tube 25 and by operating the thickener as described.

As a specific example of the method of coating with tungsten, a flame-like arc two or three inches long is drawn between a carbon electrode and a steel article upon which the coating is to be formed. A shallow pool of molten steel appears almost immediately under the arc. The metal powder feed is then started and the suspension of powder is directed into the pool. The pool is promptly covered with the powder and an alloy with the tungsten is formed. As more powder is added, it fuses or becomes plastic and alloys or amalgamates with the partly molten and plastic surface of the alloyed metal.

To avoid local over-heating or melting of the article, the arc is moved about over the surface to be coated so that a pool of molten base metal or an area of semi-molten alloy is formed progressively just ahead of the stream of powder. With further heating of the alloy-coating and with further additions of powder, a coating is built up which grows richer in the constituents of the powder as its thickness increases. A tungsten-containing coating ¼ of an inch thick was formed in this way with 99% tungsten powder upon a steel base. The coating was perfectly alloyed with the base and it showed throughout a perfect union of the tungsten with the underlying metal. Analysis showed only 6.0% iron in the surface layer of the coating.

The best results are obtained with a long flame-like arc but comparatively short arcs may be used. Direct current arcs are preferred with the connections made so that the object to be coated is the positive electrode. With the above described tungsten powder suspension, I have obtained the best results with direct currents of 350 to 500 amperes with voltages of 110 to 130.

As the small particles of coating material are projected upon the heated area, they present the maximum heat absorbing area per unit of volume of material. The particles become heated to the point of alloying or amalgamating with the material of the object without excessively pre-heating the object or the powder. Under the best conditions the action appears to approximate a momentary fusion or plasticizing of the metal powder and an immediate cooling of the surfaces so that no harmful oxidation results. The coating action is distinguished from the action of depositing fused metal from a weld rod or of fusing pellets of metal which may be fed into an arc. With the use of pellets or weld rods the material to be coated, as well as all of the substance of the rods or pellets must be fused. This necessitates the superheating for a considerable length of time of the weld rod material and a serious exposure to oxidizing conditions results so that deposits free from oxides are never possible. Such readily oxidized metals as 99% tungsten cannot be successfully deposited by fusing rods or pellets.

My invention is not limited to the production of coatings upon conductive materials which are easily fused. Adherent coatings have been successfully formed on other conductive objects, such as graphite.

I claim:

1. A device for producing coatings which comprises a substantially inert electrode, a tubular delivery member having a discharge to deliver a stream of powdered coating material near one end of the electrode, means to conduct a cloud-like mixture of powdered coating material and gas, and means to extract gas from said mixture and supply powder at a low velocity to said delivery member.

2. A device for producing coatings which comprises a substantially inert electrode, a tubular delivery member having a discharge to deliver a stream of powdered coating material near one end of the electrode, a handle for supporting said electrode and tubular delivery member, means on the handle to adjust and mount said electrode and tubular member, means to conduct a cloud-like mixture of powdered coating material and gas, and means to extract gas from said mixture and supply powdered coating material at a low velocity to said delivery member.

3. The combination with an electrode and means to produce an arc between the electrode and a conductive article, of means to conduct a cloud-like mixture of powdered coating material and gas, means to extract gas continuously from said mixture to produce a continuous thickened stream of powdered coating material, and means to deliver said stream onto an area of the article which is heated by the arc.

4. The combination with an electrode and means to produce an arc between the electrode and a conductive article, of means to conduct a cloud-like mixture of powdered coating material and gas, and a thickener to extract gas continuously from said mixture, said thickener including a perforated portion of said conducting means and a porous fine-mesh covering for said perforated portion.

5. The combination with an electrode and means to produce an arc between the electrode and a conductive article, of means to conduct a cloud-like mixture of powdered coating material and gas, and a thickener to extract gas continuously from said mixture, said thickener including an arcuately bent portion of said conducting means having a series of openings through the outer perimetrical wall of the bent portion and a porous covering for said perforated portion.

In testimony whereof, I affix my signature.

PHILIP S. CASE.