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Early Thermal Spraying—*JTST* Historical Patent #3*

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COMPLETE SPECIFICATION

IMPROVEMENTS IN THE METHOD AND APPARATUS FOR SPRAYING MOLTEN METAL AND OTHER FUSIBLE SUBSTANCES

We, THE BRITISH METAL SPRAY COMPANY LIMITED, of 6 Bennett's Hill, Birmingham, Manufacturers, British company, Assignees of MAX ULRICH SCHOOP, of Höngg, near Zurich, Switzerland, a citizen of the Swiss Republic, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:

The object of this invention is to effect improvements in the art of coating surfaces or articles of various kinds, with metal, metal alloys, enamel and the like fusible substances, which are conductive to electricity, by spraying or projecting the substance in a molten state.

In the Specification of our Patent 28,001/1912, a method of applying to a surface a coating of glass, metal or other fusible substance has been described, which consists in feeding the solid, non-pulverulent body of the fusible substance towards a melting appliance, at the rate at which the melting takes place, and at the same time blowing the melted substance against the surface. In this method it has also been proposed to melt the glass, metal or other fusible substance by electrical means, as for instance by directing an arclight by magnetic action towards the end of the rod to be fused.

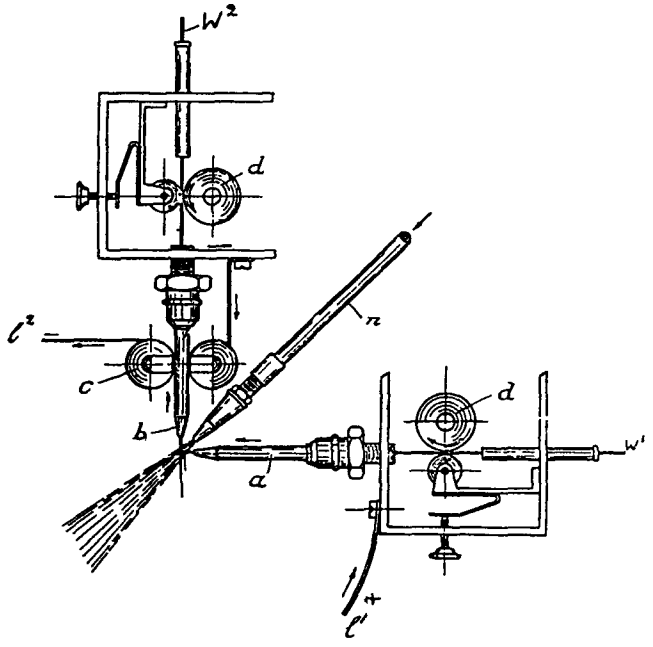
According to the present invention, the melting is effected by means of an electric current passed between two electrodes, consisting of pieces of wire or filament of the substance to be fused and sprayed, these two electrodes being fed convergently at the requisite rate.

The accompanying drawing shows by way of example an embodiment of the invention.

In said drawing, *a* and *b*, are two feed tubes terminating in nozzles and preferably made of iron, the tube *b* forming the armature of an electromagnet *c*. Through these tubes two wires w^1, w^2 are fed by means of feed rollers *d* in such way that the ends of the wires, issuing from the nozzles, cross each other as shown in the drawing. The two feed tubes, and the wires issuing therefrom, form parts of an electric circuit, other parts of which are shown at l^1, l^2, through which current flows, as indicated by arrows. The coils of the electromagnet also form part of the circuit. The tube *b* is elastically supported so that it can vibrate, and the tubes are placed at any desired angle preferably about 45° to each other, (for convenience sake they are shown in the drawings at 90°) with the wires making slightly frictional contact where they cross, so that the nozzles are separated by only a small fraction of an inch. When the electromagnet *c* is energized it attracts the tube *b* and by this means slightly withdraws the wire electrode w^2 from the wire electrode w^1. A blast pipe *n* has its nozzle directed towards the place where the wire electrodes cross, in order to direct a current of air or other gas on to the electrodes. The blast apparatus may be used for driving a turbine which actuates the wire feed mechanism.

The action of the apparatus is as follows:

Current flowing through the circuit, while the electrodes are in touch, energizes the electromagnet *c*, whereby the electrodes are drawn apart, and a small arc is formed, some of the metal being thereby fused. This molten metal is at once driven away, in the form of a fine spray, by the current of gas from the pipe *n*, which also extinguishes the nascent arc, so that the magnet allows the electrodes to approach each other again. The magnet is then again energized, and another arc is formed, and so on, the



*This series of historical patents concerned with thermal spray technology has been compiled by C.C. Berndt (SUNY at Stony Brook, NY) and K.A. Kowalsky (Flame-Spray Industries Inc., NY).

action being repeated with great rapidity, so that a continuous stream of spray is driven from the electrodes and projected on to the surfaces to be coated.

The potential difference at the electrodes varies, of course, according to the conductivity of the metal alloys, enamel or other fusible substance, and the thickness of the filament. Values ranging from 40 to 75 volts are generally suitable. The rate of consumption of the positive electrodes is somewhat higher than that of the negative electrodes and for this reason a more rapid feed, or a thicker wire, for the positive electrode is used.

The vibratory arrangement which has been described may be applied to both the electrodes and the vibration may be effected by other than by electromagnetic means. In case of eletromagnetically effected vibration an electric circuit, independent of the main circuit, supplying current to the electrodes may be used. The advantage of the vibration lies in the fact that it produces a more uniform and localized consumption for the electrodes. If the electrodes are merely fed towards each other without vibration, there is a tendency for the arc to flicker or to spread and burn the tubes, and in some cases the electrodes tend to weld together, if a lower potential difference is used in order to avoid an excessive arc.

An angle of about 45° or 50° for the two electrode tubes is found advantageous for most purposes, but the angle may vary, in the drawing for example the angle is shown as being 90°.

The best angle for the blast nozzle is easily ascertained in each particular case, as is also the most advantageous distance of the blast nozzles close to the electrodes. In some cases it is best to have the blast nozzles close to the electrodes, but in others a distance of $1-1\frac{1}{4}$ inches from the arc is better. In the case of some metals, especially those of low melting point, part of the metal may be vaporized by the current. The vapor forms a fine condensate, or is projected with the spray against the surface to be coated.

Colonel Morcom in our British Patent No. 19,005 of 1913 claimed a process for forming or making an alloy or mixture of fusible substances by using one or more metals that are to form said alloy or mixture as one of the electrodes and the other metal or metals as the other electrode of an electric arc and projecting or bringing together said metals by means of a blast, according to the present invention, however, it is not intended to form an alloy by means of an electric current, but to melt a metal, metal alloy, or the like fusible substance and to project the molten substance on to a surface to be coated.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:

1. The method of coating a surface or object with a metal, metal alloy, enamel or the like fusible substance conductive to electricity consisting in melting the said substance by passing an electric current through electrodes formed by the fusible substance which is to form the coating material, thus melting said electrodes and projecting the molten substance on to the surface or object to be coated, by a current of gas.

2. In the method as set forth in the preceding claim, convergently feeding the electrodes at any desired angle and if desired, at the rate at which they are consumed, or at different rates.

3. In the method as set forth in the preceding claims, vibrating either or both of the electrodes so as to alternately make and break contact between said electrodes, or to form arcs between said electrodes when contact is broken, which arcs are blown out as soon as they are formed, by the gas current.

4. In the method as set forth in Claim 3 effecting the vibration of either or both of the electrodes by electromagnetic means which may or may not be actuated by the current passing through the electrodes.

5. An apparatus for coating a surface or object with a fusible substance, comprising means for convergently feeding two fusible electrodes, means for feeding two said electrodes an electric current capable of melting the same and means for directing a current of gas towards said electrodes whereby molten matter is projected from said electrodes in the form of spray, with or without means such as electromagnets for vibrating either or both of the electrodes, whereby contact between said electrodes is alternately made and broken, and whereby arcs are formed between said electrodes when contact is broken, which arcs are blown out in statu nascendi *by the current of gas.*

6. In an apparatus as set forth in Claim 5, means for electrically connecting said electromagnetic means in series with the electrodes.

7. In an apparatus as set forth in Claims 5 and 6, iron guide tube or tubes for either or both of the electrodes, means for elastically supporting said guide tube or tubes, an electromagnet or magnets positioned to attract either or both of said guide tubes whereby the electrode such as wire, in the tube is removed from contact with the other electrode or wire, to form an arc gap.

8. The method of coating a surface or object with a metal, metal alloy, enamel or the like fusible substance and apparatus therefor, working, constructed, and operating substantially as described and as shown in the accompanying drawings.

Dated this 9th day of July, 1920

ALBERT L. MOND

19, Southampton Buildings,
Chancery Lane, London W.C. 2,
Agent for the Applicants.