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METHOD AND APPARATUS FOR APPLYING POWDERED HARD SURFACING ALLOY WITH INDUCTION HEATING

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Fig. 1

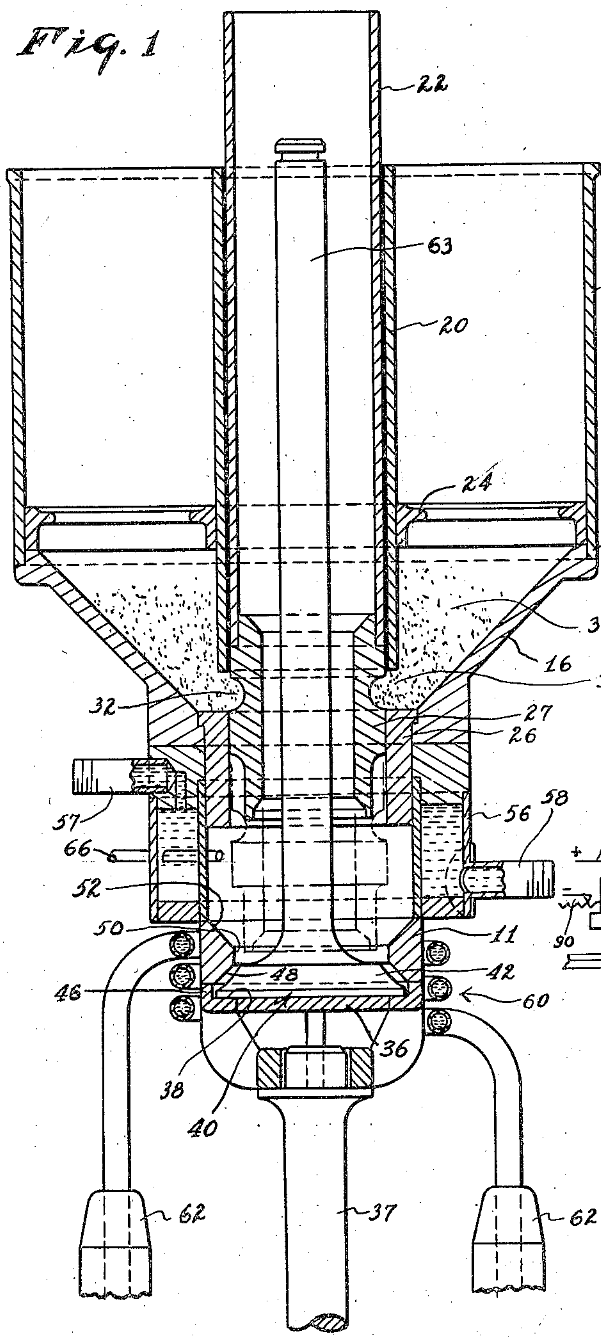


Fig. 2

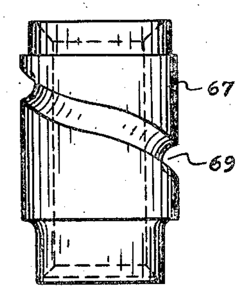


Fig. 3

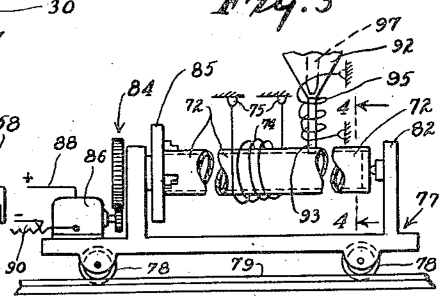
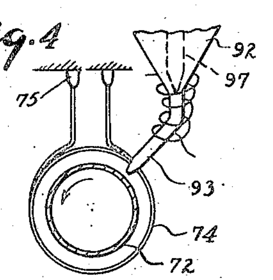


Fig. 4



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METHOD AND APPARATUS FOR APPLYING POWDERED HARD SURFACING ALLOY WITH INDUCTION HEATING

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5 Claims. (Cl. 117—22)

This invention relates to methods and apparatus for applying hard surfacing alloys to work pieces without the use of flames.

In order to increase the wear resistant qualities of certain parts, such as steam valves, internal combustion engine valves, pump sleeves and the shafts and axles of industrial machinery, it has been a common practice to apply a layer of hard surfacing material over the metal from which the parts are made. This hard surfacing material has been applied by the use of high temperature gas flames or by electric arcs. In some cases the alloy is fed to the work piece through the torch which projects flames against the surface to be covered.

Certain improved methods of applying hard surfacing alloys have been devised with the alloy applied in the form of a powder which is melted after it contacts with the work piece, or during the time that it is passing through a flame on its way to the surface of the work piece. One of the problems, in applying hard surfacing alloy in powdered form, has been the difficulty in controlling the flow of powder; with some methods, great care is necessary in order to prevent the powder from being blown about by the products of combustion from the heating torch. The application of more and larger flames, in order to obtain faster heating of the powder, makes the control of the powder flow more difficult.

It is an object of this invention to provide improved methods and apparatus for applying powdered hard surfacing alloys in a quiet, and when desirable, a controlled atmosphere and without the use of flames. It is another object of the invention to apply the hard surfacing alloy more quickly so that the cost of the hard surfacing is reduced.

Still another object of the invention is to heat a powdered hard surfacing alloy, and the work piece to which it is applied, by induction heating means combined with apparatus for applying the alloy powder to the work piece in the electro magnetic field in which the work piece is heated. In the preferred embodiment of the invention, the powder passes through an electro magnetic field and may be preheated before coming in contact with the surface to be coated.

Other objects, features and advantages of the invention will appear or be pointed out as the description proceeds.

In the drawing, forming a part hereof, in which like reference characters indicate corresponding parts in all the views:

Figure 1 is a vertical sectional view of apparatus for hard surfacing a poppet valve in accordance with this invention;

Figure 2 is a side elevation of a modified type of plunger for use in the apparatus shown in Figure 1;

Figure 3 is a fragmentary, diagrammatic view showing a modified form of the invention; and

Figure 4 is a sectional view taken on the line 4—4 of Figure 3.

The apparatus shown in Figure 1 includes a hopper 10 supported by a housing 11. The hopper 10 includes a sloping bottom 16 and a side wall 17. This side wall fits over an annular shoulder 18 extending around a top rim of the bottom 16.

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Within the hopper 10, there is a center sleeve 20 provides a cylindrical bearing having an operating sleeve 22. The sleeve 20 is supported, with its axis substantially coincident with the vertical axis of the hopper, by a frame 24. This frame is rigidly connected to the sleeve 20, and is held in position in the hopper by resting on the top face of the sloping bottom 16.

The hopper bottom 16 has an outlet fitting 26 in which a plunger 27 moves upwardly and downwardly; the plunger 27 operating as a sleeve valve. This plunger 27 has its upper end connected to the operating sleeve 22 which raises and lowers the plunger. The operation is preferably carried out mechanically, but no description of the mechanical actuating means is necessary for a complete understanding of this invention.

There is a gap 30 between the lower end of the sleeve 20 and the top surface of the outlet fitting 26. The plunger 20 has an annular recess 32 with a height substantially equal to the width of the gap 30. When the plunger 27 is at the top of its stroke, as shown in full lines in Figure 1, the annular recess 32 is in register with the gap 30. Hard surfacing alloy powder 33, in the hopper 10, flows into and fills the annular recess 32 when the plunger is in this position.

The portions of the plunger 27, immediately above and below the annular recess 32, are of substantially the same diameter as the opening through the outlet fitting 26 so that the plunger has a sliding fit in the outlet fitting 26 and moves as a piston in the fitting. When the operating sleeve 22 moves downwardly, the plunger 27 is carried into the broken line position, and the powder in the annular recess 32 drops from the recess below the bottom face of the fitting 26.

The housing 11 has a bottom 36 which is rigidly connected with a plunger 37; and this bottom 36 is the work support of the apparatus. In the construction shown, the bottom 36 has a central opening and an annular shoulder 38 for supporting a poppet valve 40. The poppet valve is the work piece and it has a face 42 to which the hard surfacing alloy is to be applied.

The valve 40 is held in a centered position by a side wall 46 extending upwardly from the shoulder 38 on which the work piece rests. The plunger 37 moves downward to lower the shoulder 38 into position to receive a valve. The plunger 37 then moves upward to carry the parts into the positions shown in Figure 1, and the apparatus is then ready to apply hard surfacing material to the face of the valve. The inside wall of the housing 11 is shaped so that it has a face 48 confronting the valve face 42 and spaced from the valve face 42 uniformly, around the entire extent of the valve face, by a predetermined clearance. There is a short cylindrical section 50 of the inside wall of the housing 11, immediately above the undercut face 48; and there is another section 52, of the inside wall, which diverges upwardly to provide a sloping surface on which the powder drops from the recess 32 of the plunger.

The housing 11 has a water jacket 56 supplied with water through an inlet fitting 57. Water flows from the water jacket 56 through an outlet fitting 58. The lower end of the housing 11, and the housing bottom 36, are surrounded by an induction heating coil 60. This heating coil, which is preferably a tube in which water circulates, is held in place by terminal blocks 62 rigidly connected to the underlying support 13.

The housing 11 is of composite construction. The water jacket is preferably made of brass, bronze or copper so that it is non-magnetic. The bottom 36 and the portion of the housing as far up as the water jacket 56, is preferably made of lava or other refractory material.

The hard surfacing powder 33, which is used for applying a hard surfacing coating or layer to the face 42, is preferably non-magnetic, or only slightly magnetic. Alloys commonly used are high nickel steels, and some of the more desirable alloys have melting points substantially higher than the melting points of the steels used for the work pieces to which the hard surfacing alloy is to be applied.

In the operation of the apparatus, the housing 11 and the powder hopper are first removed from the housing bottom 36. The valve 40 is then placed in position, as shown. The housing 11 with the powder hopper 10, and other connected parts, are then brought down over the valve 40 with the valve stem 63 extending upwardly into the operating sleeve 22. Flexible hoses are connected with the water jacket fittings 57 and 58 so that the housing 10, and its water jacket 56, can be conveniently lifted over the upper end of the valve stem 63.

When the housing 11 has been lowered into place, the operating sleeve 22 is moved downwardly, from the full line to the broken line position shown in Figure 1, and this carries a supply of powder into the housing 11. As the powder drops from the annular recess 32, it falls on the sloping face 52 and slides down this face to the cylindrical section 50 of the inside wall of the housing. The powder drops along this cylindrical wall into contact with the sloping face 42 of the valve or work piece.

The face 42 is strongly heated by the induction coil 60. The heating is affected by the frequency of the current in the coil 60. The current used is preferably a high frequency current for concentrating the heating in the surface metal of the valve 40. This high frequency current heats the powder which has an extremely large area of surface in proportion to its mass.

All of the powder is heated regardless of the density of the powder supply. This is an important advantage of induction heating because the conduction of heat, applied from the outside of a mass of powder, is slow because of the light contact, or absence of contact of adjacent powder particles with one another. The heating of the powder by the electro magnetic field makes possible much more rapid fusing of the powder than can be obtained by other means, such as flames, which apply heat to a powder layer from the outside only.

The induction heating of the powder also possesses outstanding advantages over the methods in which the powder is applied to a work piece through a heat flame with the products of combustion acting as a carrier for the powder particles. Such methods, which put the powder through the flame, obtain heating of all particles of the powder, but the rate at which the powder is supplied to the flame must be controlled and maintained at a limited value which will not cause clogging of the burner. The induction heating can be applied to a blanket or layer of powder particles with the layer of any desired thickness without interfering with the uniform heating of the powder through the entire cross section of the layer.

With this invention, the induction coil 60 may be extended upwardly beyond the work piece surface 42 to which the hard surfacing is to be applied, thus extending the electromagnetic field upward so that the powder passes through the field before it reaches the work piece. This preheats the powder. A separate coil may be employed to preheat the powder before it comes in contact with the work piece. When desirable the apparatus can be constructed so that the powder is fused before it strikes the surface of the work piece. If the powder is not fused, before striking the surface 42, it will distribute uniformly over the surface 42, because of the manner in which it is applied uniformly around the entire angular extent of the surface 42. The confronting face 48, becomes highly heated during the operation of the apparatus and supplies substantial quantities of heat by radiation to the face 42. When fused the powder will distribute uniformly over the face because of the wetting action of the molten alloy on the work piece surface.

The operation can be carried out in the presence of air for most work pieces and for most hard surfacing alloys. However, when the alloy or work piece is of a metal which needs protection from the atmosphere while hot, the space within the housing 11 is filled with helium, or argon, or some other protecting atmosphere. This gas is introduced into the housing 11 through an inlet fitting 66, and the protecting gas is at a pressure sufficient to force air out of the housing 11. No outlet fitting is provided because the gas can leak, to some extent, around the edges of the valve 40, and out through the opening in the bottom of the housing.

In the operation of the device, the current supplied to the coil 60 is preferably intermittent, and the heating of the powder can be controlled by co-ordinating the operation of the powder feed with the supply of current to the induction coil. For example, more heat is induced in the powder, if the current is turned on before the powder is supplied to the work piece. Figure 2 shows a modified plunger 67 which is similar to the plunger 27 in Figure 1 except that the plunger 67 has a differently shaped recess for the powder. In the plunger 67 there is a recess 69 which extends around the circumference of the plunger with an axial component. The recess 69 follows a closed path, however, not a helical one; that is, the direction of the extent of the recess 69, on the side opposite that illustrated, is substantially the same as on the side shown.

When this plunger 67 moves axially, the right-hand side of the recess 69 moves into position to spill powder before the other portions of the recess. Thus, the powder drops from the recess 69 at an initial location and then progressively in both directions around the circumference of the plunger. This plunger 67 requires a somewhat longer stroke than the plunger 27 shown in Figure 1 and is used only where it is desirable to apply the powder progressively along the surface of the work piece.

The apparatus can also be made with rotary powder feeding means. Instead of reciprocating the plunger 67, a rotary action can be imparted to this plunger, and the recess for the powder is made helical and long enough to extend simultaneously above and below the upper and lower ends of the outlet fitting 26.

Figures 3 and 4 show a modified form of the invention in which the work piece is a sleeve or shaft 72. This work piece 72 extends through an induction heating coil 74 supported by fixed terminals 75. The work piece 72 is supported by a carriage 77 with wheels 78 that run on a track 79.

A plug 81, in one end of the sleeve 72, is supported by a tail stock 82 on the carriage 77. At the other end, the sleeve 72 is connected to a head stock 84 having a face plate 85 rotated by a motor 86 to which power is supplied by conductors 88, one of which contains an adjustable impedance 90. This structure, illustrated diagrammatically, is merely representative of means for supporting and rotating the work piece 72 while producing relative axial movement of the work piece and the induction heating coil 74. It will be evident that the work piece 72 can be rotated, without axial movement, and the induction coil 74 moved longitudinally along the work piece.

The powdered hard surfacing alloy is contained in a hopper 92 located above the work piece 72. The powder flows from the hopper 92, through an outlet fitting 93, to the surface of the sleeve 72. The torch end of the outlet fitting 93 is located near the top of the work piece 72, but preferably on one side of the top and in a correlation with the direction of movement so that powder dropping from the fitting 93 by gravity, is first carried upwardly, thus providing a longer period of time during which the powder rests by gravity on the surface of the rotating work piece. This allows a greater period for fusion and adhesion of the powder to the work piece before being carried around to the underside of the work piece where the combined centrifugal force and force of gravity would cause the powder to drop off the work piece if no adhesion were present.

The outlet fitting 93, which may be constructed of lava or other refractory material, is preferably surrounded by an induction heating coil 95 for imparting preheat to the powder flowing to the work piece 72. In the construction shown, the flow of powder from the hopper 92 is controlled by a needle valve 97 which is moved upwardly or downwardly from the mouth of the hopper 92 to stop and start the powder flow, and to control the rate of powder flow.

The combination shown in Figure 3 can be modified by locating the hopper and outlet fitting 93 intermediate the ends of the coil 74 so that more or less of the heating occurs after the powder is applied to the work piece. In the combination shown in Figure 3, most of the heat is applied to the work piece after the powder strikes the surface. The magnetic field of the coil 74 extends only slightly ahead of the location where the powder falls on the work piece.

The preferred embodiment and some modifications of the invention have been shown and described, but changes and other modifications can be made and some features can be used in different combinations, without departing from the invention as defined in the claims.

What is claimed is:

1. Apparatus for applying metal hard surfacing material to a work piece including a support on which the work piece is held with at least a portion of the area to be surfaced disposed at an incline to the horizontal but facing upwardly, a hopper located above the work piece, a dispenser at the bottom of the hopper including means for removing from the hopper measured quantities of powdered hard surfacing material, the dispenser being located in position to drop the powdered material downwardly toward the area of the work piece to be surfaced and to distribute the powdered material uniformly throughout the length of the area with at least part of the powdered material at the high end of the area which slopes at an angle to the horizontal, induction heating means below the dispenser, at least part of the induction heating means being located adjacent to the work piece and in position to fuse the powdered material for flow across the width of the sloping portion of the area, and guide means for the liquified material including a face confronting at least the sloping portion of the area to be surfaced and spaced from said area by a predetermined limited clearance substantially equal to the intended thickness of the hard surfacing coating which is to be applied to the area, the induction heating means being at least partially located in position to heat the area of the work piece to a temperature which bonds the material of the surface of the work piece to the hard surfacing material.

2. Apparatus for applying metal hard surfacing material to a work piece including a support on which the work piece is held with at least a portion of the area to be surfaced disposed at an incline to the horizontal but facing upwardly, a hopper located above the work piece, a dispenser at the bottom of the hopper including means for removing from the hopper measured quantities of powdered hard surfacing material, the dispenser being located in position to drop the powdered material downwardly toward the area of the work piece to be surfaced and to distribute the powdered material uniformly throughout the length of the area with at least part of the powdered material at the high end of the area which slopes at an angle to the horizontal, and induction heating means below the dispenser, at least part of the induction heating means being located adjacent to the work piece and in position to preheat the powdered material as it falls toward the sloping portion of the area, the induction heating means being at least partially located in position to heat said area of the work piece to a temperature which bonds the material of the surface of the work piece to the hard surfacing material.

3. The method of coating an area of a metal work piece with hard surfacing material, which method comprises locating the work piece with the area to be coated facing upwardly, dispensing powdered metallic hard surfacing material in an amount sufficient to form a coating of a predetermined thickness, the powder being dispensed above the area of said work piece which is to be coated and with the material substantially uniformly distributed throughout a region extending along the full length of said area, allowing the dispensed powder to fall by gravity and to contact the area of the work piece which is to be coated, and fusing the powder on the work piece and welding the fused material to the work piece by induction heating of both the powder and the work piece with a high frequency electro magnetic field.

4. The method of coating an area of a metal work piece as described in claim 3, and in which the powder is heated by the induction heating to a temperature higher than that to which the work piece is heated.

5. The method of coating an area of a metal work piece as described in claim 3, and in which the powder is preheated before it comes into contact with the work piece.

References Cited in the file of this patent

UNITED STATES PATENTS

1,726,431	Fourment	Aug. 27, 1929
2,320,801	Simons	June 1, 1943
2,358,090	Longoria	Sept. 12, 1943
2,363,741	Montgomery	Nov. 28, 1944
2,434,736	Dryer	Jan. 20, 1948