ABSTRACT: An improved spray metallizing device of the electric arc type in which a pair of wires are advanced progressively to an arc-forming station, the molten wires being atomized by a gas jet forcing the particles away from the station, characterized by novel wire feed means automatically effective, upon interruption of the spraying cycle, to retrace the wires from the arc zone to predetermined positions whereby initiation of the metallizing cycle will be effected properly to position the wires in the arc zone.
ELECTRIC ARC METALLIZING DEVICE

This invention is in the field of metallizing devices of the electric arc type in which an arc is struck between two electrically charged wires to be melted, the wires being progressively fed to an arc zone. An air or gas jet atomizes the molten metal formed at the arc zone and propels it against a substrate to be coated.

It is known to provide metal spraying or coating devices operating on the principle of wires to be metallized being advanced to an arc-forming zone, the molten metal thus formed being atomized and expressed against a substrate. Such known devices have drawbacks which have heretofore reduced their utility in large volume applications, and particularly their use in automated or semiautomated procedures.

As will be readily understood by a worker familiar with metallizing devices, the position of the wires, particularly as the arc is initiated, is critical to the satisfactory operation of the device. In prior art devices, it is not uncommon, after a metallizing application has been interrupted and is attempted to be reinstated, for the wires to have become fused together. Under such circumstances, when the voltage is again applied through the wires in an attempt to reignite the spray operation, the current drain will be sufficiently high to activate the circuit breakers which protect the apparatus. Under these conditions, it is required that the fused portion of the wires be manually removed, and the wires properly repositioned in the arc-forming zone.

Another failing of known metallizing systems of this sort lies in the tendency of the wires, after the current flow has been interrupted, to become warped and deflected from their normal position adjacent to the arc zone. Under such circumstances, upon reinitiating of the metallizing cycle, the wires may meet at a position other than the intended melting zone, or portions other than the tips of the wires may be advanced into arcing relation in or near the zone. Since the gas dispersion or atomizing jet must be precisely related to the arcing station in order to assure that the atomized, molten metal will be propelled in a particular pattern and to a selected substrate area, it will be obvious that arcing at any position displaced from the desired position will result in the jets depositing the atomized material at a point remote from the intended deposit area.

Where a metal or arcing is achieved at a position removed from the tips of the wires, a length or section of wire will be separated from the body portion without being melted, the separated wire increment being propelled by the jet against the substrate surface and possibly bonded to the surface by following, properly molten spray. Obviously, such discrete lengths of wire will ruin the surface finish and require individual processing for their removal from the substrate.

For the foregoing reasons, prior art metallizing devices have been found unsuitable for production of an automated or semiautomated system, particularly where intermittent stop and start operations are required, since such known devices, in a significantly high percentage of cases, will not produce a proper metallizing spray upon reinitiation of the spraying cycle.

The present invention relates to an improved metallizing spraying device of the wire fed, electric arc type characterized by drive mechanism which incorporates means for removing the wire from its position adjacent the arc-forming zone immediately upon cessation of a metallizing cycle. Preferably such removal involves retraction movement of the wires into the electrode guides, such retraction movement functioning to insure against the wire tips becoming fused together.

The retraction movement of the wires into the guides serves the further function of straightening the wires by realigning them within the guide channels of the electrodes. When the metallizing operation is again instituted, the realigned, retracted wires will be fed so as to be precisely located at the arc-forming station, to assure a proper melt and deposition of an accurate pattern from the very inception of the operation.

The invention further contemplates a novel electrode shield wherein the propelling jet is disposed in a position within the shield adjacent to but behind the electrodes, the shield incorporating an open back area rearwardly of the jet location. By this means, the jet induces a rearward-to-forward airflow through the shield about the electrodes in a venturi-type flow pattern, whereby additional cooling of the electrodes is accomplished.

Additionally, the air moved by the venturi effect provides a confining cone about the metal spray, to provide a more precise pattern and cool the substrate areas surrounding the spray impact area.

Accordingly, it is an object of the invention to provide an improved metallizing spray device of the electric arc, wire-fed type.

A further object of the invention is to provide a device of the class described and incorporating an improved drive mechanism whereby, when the metal-applying cycle is interrupted, the wires are automatically positioned in a manner which will assure their perfect alignment when the spraying operation is recommenced.

A further object of the invention is the provision of a spray device of the type described in which the wires to be atomized cannot accidentally become fused together when the metallizing cycle is interrupted.

Still a further object of the invention is the production of a metallizing device of the type described, including a novel spray head having a venturi generating passage which introduces air flow through the passage, to cool the electrodes and substrate and provide a predetermined, controlled dispersion pattern of deposited metal.

To attain these objects and such other objects as appear herein or may be hereinafter pointed out, reference is made to the drawings in which:

FIG. 1 is a schematic view of a metallizing device of the type described;
FIG. 2 is a top plan view showing the dispensing head of the metallizing device;
FIG. 3 is a side elevational view of the metallizing head of FIG. 2;
FIG. 4 is a horizontal sectional view taken on the line 4-4 of FIG. 3;
FIG. 5 is a vertical section taken on the line 5-5 of FIG. 2;
FIG. 6 is an exploded perspective view of the metallizing head of FIG. 2;
FIG. 7 is a circuit diagram of the control mechanism for the metallizing apparatus.

Reference will now be made to the drawings, and particularly FIG. 1, wherein the metallizing device comprises generally a wire feed apparatus 10 which advances wires to be melted and atomized from pay-off reels or spools 11, 12 to the dispenser head 13. The power supply 14 applies a DC voltage to the electrodes 15, 16 through which the wires to be melted, 17, 18, respectively, are fed. The charged wires converge toward a melting zone 19 forward of the electrode tips 19, 20. The wires are continuously advanced into arc defining melting position within the zone, the molten wire being expressed from the zone by air or gas expressed through a jet 21 disposed behind the electrode tips. The device as heretofore described is essentially conventional, the novel features being more particularly described hereinafter.

Turning first to the atomizing and dispensing head or gun 13, as particularly illustrated in FIGS. 2-6, it will be seen that the body of the gun comprises a multipart structure including a handle component 22, a spacer block 23, an electrode support block 24 and a top shield 25. Each of the components 22 to 25 is optionally but preferably fabricated of an insulative plastic material which is highly resistant to heat, a preferred example of such material being thin base phenolic.

The handle 22 includes a pistol grip portion 26, the handle being attached to the spacer block 23 as by bolts 27, 27 extending through apertures 28, 28 in the grip portion and threaded into complementally threaded mounting apertures.
The device is to be provided with remote controls on the gun purge, a vertically directed central bore 30 is formed through the pistol grip 26, control wire 31 being directed through the bore.

The spacer block 23 includes a pair of vertically directed, large bore members 32, 33 for rotatably receiving the lower ends of a pair of conductive, cylindrical electrode receiver terminals 34, 35. The electrode terminal 35 includes vertically spaced receiver boxes 36, 37. The electrode terminal 34 is provided with vertically spaced receiver boxes 38, 39.

The upper surface of the spacer block 23 is provided with a pair of converging, generally U-shaped channels 40, 41, within which channels conduit terminals 42, 43 are disposed, the width of the channels 40, 41 being such as to permit angular movement of the conduits within the channels, for purposes which will be explained more fully hereinafter.

The conduit terminals 42, 43 are mounted within the apertures 39, 37, respectively, in the electrode terminals 34, 35, respectively, locking screws 44, 45 being driven into threaded receiver ways 46, 47, respectively, to lock the conduit terminal 42 to the electrode terminal 34 and the conduit terminal 43 to the electrode terminal 35, and assure that the locked-together parts are in constructive engagement.

Spacer block 23 includes an access aperture 48 in alignment with the bore 30 in the pistol grip 26, the aperture 48 being provided with branching access boxes leading to the wiring apertures 49, 50 in the rear end surface of the spacer block 23.

A switch plate 51 is mounted to the rear face, as by self-tapping screws 52 driven into receiver apertures 53 of the spacer block. The plate 51 carries control switches 54, 55, for purposes which will become apparent from the subsequent portion of the description.

The electrode support block 24 is disposed atop spacer block 23, the block being provided with vertically directed apertures 32a, 33a in alignment with the apertures 32, 33 in the spacer block, for receipt of central portions of the electrode terminals 34, 35. The undersurface of the support block 24 is provided with a pair of spaced arcuate slots 56, 57, the slots being surrounded by enlarged arcuate channels or recess portions 58, 59.

A pair of electrode support bolts 60, 61 are directed upwardly through the slots, 56, 57, the heads of the bolts lying within the arcuate recesses 58, 59 respectively. The threaded ends of the bolts 60, 61 are driven into tapped apertures 62, 63, respectively, in the electrodes 15, 16 respectively.

The electrode terminals 15, 16 include cylindrical mounting shoulders 64, 65, respectively, the shoulders being passed through the upper apertures 38, 36, respectively, in the electrode terminals 34, 35. Locking screws 66, 67 are driven into tapped apertures in the sides of the terminals into contact with the shoulders 64, 65, to retain the electrodes within the terminals and to assure good electrical contact between the terminals and the electrodes.

It will be observed that the included angle defined between the electrodes may be varied within a range by loosening the electrode retainer screws 60, 61 and adjusting the screws within the confines of the slots 56, 57, retightening the screws when the desired included angle is achieved. The angular adjustment is accomplished by the rotative mounting of the electrode terminals 34, 35 within the supporting bosses, such adjustment of the included angle permitting most efficient dispersion of the spray, taking into account the composition of the wire, speed of feed, air pressure, amperage, etc.

The gas discharge jet 21 is supported between the electrodes by retainer screws 68, 69, extending upwardly through apertures 70, 71 in the electrode support block 24, the upper edges of the screws being mounted in complementally threaded apertures 72, 73 in the jet.

A top shield 25 is mounted over the spacer block. The shield includes a pair of depending flanges 74, 75 which, with the top wall portion 76, define an essentially inverted U-configuration. The top shield 25 includes a pair of cuplike recesses 77, 78 which, in the assembled position of the device movably receive the upper ends of the electrode terminals 34, 35 respectively.

The top shield 25, electrode support block 24 and spacer block 23 are assembled by a pair of through bolts 79, 80.

Through bolt 79 extends downwardly through registering aperture 81 in the shield, 82 in the support block, and is threaded into the vertically spaced recess aperture (not shown) in the spacer block 23. In similar manner, through bolt 80 is directed downwardly through registering apertures 83 in the shield 84 in the support block, the lower end of the bolt 80 being threaded into an upwardly directed registering aperture (not shown) in the spacer block 23.

The shield 25 includes a pair of forwardly directed spacer lugs 85, 86 which project beyond the front faces of the block 23, electrode support 24 and shield 25. A front shield 87 is mounted with its rear face 88 pressed against the front faces of the spacer lugs 85, 86 as by bolts, such as bolts 89, 90, extending through the apertures 91, 92 and threaded into horizontal bosses (not shown) formed in the shield 25.

As best seen in FIGS. 3, 4 and 5, a clearance area is thus defined between the front shield and the front faces of the remaining portions of the dispenser gun to permit the ingress of air through the clearance area.

The front shield 87 is provided with a forwardly directed aperture 93 which, as best seen in FIGS. 4 and 5, is essentially in the form of a truncated rectangular pyramid, the walls converging progressively in a forward direction. The tips 19, 20 of the electrodes 15, 16 are disposed within the through aperture 93, as is the forwardmost end 94 of the jet 21.

The electrodes 15, 16 as best seen in FIG. 4, are hollow throughout their length, including wire guide bosses 95, 96 respectively. Optionally and preferably, the electrodes may be comprised of a two or more piece structure including replaceable tips 97, 98 threaded into major body portions 99, 100 respectively. Insulator sleeves 101, 102 may be disposed within the major body portions 99, 100, the wire guide bosses 95, 96 being formed, in fact, in the insulator sleeves and the tubes 97, 98.

To the outer enders 103, 104 of the major body portions of the electrodes there are connected a pair of kink resistant wire conduits 105, 106 which act to shield the wires as they traverse the space extending between the wire feed mechanism 10 and the dispenser head 13.

It will be understood that wires 17, 18 from the supply reels or spools 11, 12 extend through the conduits 105, 106, through the bosses 95, 96 in the electrodes 15, 16 respectively, in an arcuate area of zone 2 located at or slightly beyond the front extremity of the front shield 87. As best seen in FIG. 5, the front end of the noted shield may incorporate a beveled or flaring portion 107, particularly in a vertical direction, to aid in the dispersion of the metal. It will be understood that, as is the case in known devices, wires 17, 18 are advanced to the arc zone at a predetermined rate which is a function of the gap and composition of the wires employed, the electrical values applied to the wires, and the rate at which the metal is to be atomized.
Turning now to the wire driven mechanism which is shown diagrammatically in FIG. 1, it will be seen that such mechanism includes drive motor Mo, preferably of the DC shunt type, a reduction gear set G and a pair of friction drive wire grippers 109, 110 controlling the wires 17, 18, respectively. It will be understood that the wire grippers may comprise any conventional driving expedient, such as a pair of gripping rollers between which the wire is arranged, one roller being positively driven by the gear mechanism and the other being an idler roller, to maintain frictional contact between the wire and the drive roller.

The precise structure of the means for communicating movement to the wire may be varied.

Interposed between the wire spools 11, 12 and the wire drive grippers is a pair of wire straighteners S, S, the straighteners assuring that there are no crimps or bends in the wires which would induce the wires to vary from a straight feed as they ultimately emerge from the electrode tips.

The means for controlling the operation of the motor Mo forms an important part of the invention and its operation will be best understood in conjunction with a description of the control circuit illustrated in FIG. 5.

Main power switch S1 may be activated to connect the primary control transformer T1 to a 220 volt circuit drawn from a three phase, 220/440 volt main. The operation of the switch S1 also provides power to energize a solenoid coil M1 when subcontrol switch S2 is closed. Closing of such switch serves to energize solenoid coil M1, closing solenoid contacts M and thus putting the three phase mains input to a wire melt rectifier assembly 111 which includes a transformer for reducing the voltage to a desired level and a full wave bridge rectifier which may be adjusted to supply a voltage to the electrodes 15, 16 which will normally vary between about 30 to about 40 volts at a capacity of from about 300 to 500 amps.

A fan motor 112 for cooling the control apparatus is also activated responsive to operation of the switch S1. The transformer T1 provides 115 volts across the conduits 113, 114.

Operation of the remainder of the control device is instituted by the remote switches S4, S5 mounted on the dispenser head controlling, respectively, the air jet and the wire feed.

The switches S4, S5 may be electrically or mechanically interlocked so that a wire feed may not be effected unless the air solenoid 115 is first energized, to initiate the air flow through the jet.

Rectifier A is energized on closing of the switch S1, the rectifier functioning to supply DC power for the field winding 116 of the shunt motor Mo. Rectifier A additionally supplies power for the motor reversion control circuit. The output of rectifier A is continuously connected to the field windings through conduits 122 and 123.

Rectifier B is connected to AC power from the secondary of transformer T1 through an auto transformer T2 which applies a variable voltage to the rectifier B and in turn, supplies a variable DC power to the armature 117 of the wire drive motor Mo, thereby providing facility to vary the speed of the driven motor and hence the wire feed.

When wire feed switch S5 is closed, coil CCR1 of control relay CR1 is energized, thereby applying DC power from rectifier B to the armature 117 of the motor Mo.

The output of rectifier B flows through the normally closed contacts 2CR1B, 3CR1B, normally closed contacts 1CR2A of control relay CR2 and conduit 119 to the armature 117. The negative output of rectifier B is connected to the other terminal of the armature through now closed contacts 2CR1B, conduit 120, normally closed contacts 2CR2A and conduit 121. The energized motor Mo will thus induce a progressive feed of the wires to the melt zone, the molten wires being atomized and projected against a substrate by the air of gas jet in a well known manner.

During the time the motor Mo is running to advance the wires to the arc zone, a capacitor C1 is being charged through resistor R1 and normally closed contacts TDRA of the time delay relay TDR.

When the remote wire feed switch S5 is opened, the coil CCR1 is deenergized, closing contacts 2CR1A, 3CR1A shunting the resistor R2 across the armature, to provide dynamic braking. The shunt resistor R2 thus assures that wire feed to the melting zone will be promptly interrupted when switch S5 is opened.

When the coil CCR1 of control relay CR1 is deenergized, contacts 1CR1A of said relay are closed, thus energizing the coil of time delay relay TDR. The time delay relay is calculated to provide about one second delay before the contacts TDRA are opened and the contacts TDRB are closed, such time permitting full braking of the motor Mo by the armature shunt resistor R2.

When contacts TDRB are closed after the time delay period, the charged condenser C1 is discharged through the coil CCR2 of rotation direction control relay CR2, thereby momentarily opening the normally closed contacts 1CR2A and 2CR2A of said relay to remove the shunt from across the armature and closing contacts 1CR2B and 2CR2B.

During the period that the coil CCR2 is energized by the discharging condenser, it will be appreciated that the conduits 121 and 119 leading to the armature 117 are connected to the output of rectifier A in such manner as to provide a reverse polarity to that encountered during normal or forward drive operation. Thus, during the discharge period, of condenser C1, the wire drive motor Mo operates in a reverse direction to provide retraction movement of the wires 17 and 18.

After the condenser C1 is discharged, the deenergized coil CCR2 permits the contacts of CR2 to return to their normal condition (1CR2A and 2CR2A closed), thus reconnecting the shunting resistor R2 across the armature and securing a prompt braking of the reverse wire movement.

The value of the capacitor C1 is selected to energize the coil of CCR2 for a time period calculated to withdraw the wires a distance sufficient to retract the wires 17 and 18 to a position within the tips 19, 20 of the electrodes. By this expedient, the drive control circuit assures that there is no possibility of the wires being fused together. Also, the retraction movement into the tips straightens the wires which may have acquired a bend, set or sag, so that, when the metalizing procedure is again commenced, the wires will converge at the precise desired position in the arc zone, thus assuring that the atomized molten metal will be deposited at a predetermined desired position relative to the head.

From the foregoing it will be appreciated that when the metalizing operation is interrupted, there is automatically effected a sequence which includes a rapid braking of the movement of the wires, melting of the zone, retracting the molten wires into the electrodes and rapid braking of the wires, when the desired retracted position is achieved. By these means, the possibility of the wires becoming fused together at the termination of a metalizing operation and, thus, impeding the institution of a subsequent metalizing step is eliminated.

Further, the wires, by reason of their having been retracted into the electrodes, are automatically straightened so that on subsequent feed they will meet at the desired position in the arc zone.

While there is illustrated and described a preferred embodiment of the invention, it should be understood that the concepts herein disclosed may be achieved with a variety of actuating or controlling mechanisms. Specifically, it will be readily recognized, in the light of the foregoing teachings, that other circuits and mechanisms for inducing the desired movements of the wire may be designed, without departing from the spirit of the invention.

There is further disclosed a novel metalizing device, incorporating a structural assembly which provides for the formation of a venturi effect, inducing an augmented flow beyond the air or gas flow provided by the metal atomizing jet. Such additional flow increases the cooling effects on the components of the metalizing device and on the substrate and also functions to confine the flow of molten material to a more precise predetermined pattern than would be otherwise possible.
As many changes could be made in the above equipment, and many apparently widely different embodiments of this invention could be made without departing from the scope of the claims, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. An electric arc-metallizing device comprising a pair of electrode guide means for guiding wires to be atomized to a predetermined, spaced, arc-forming relation within an arc zone, jet means adjacent said zone for atomizing and propelling molten wire from said zone, drive means for advancing said wires progressively to said predetermined spaced relation at said zone, control means for activating said drive means to advancing position of said wires and automatic means for withdrawing said wires from said zone responsive to deactivation of said control means.

2. A device in accordance with claim 1 wherein said drive means comprises reversible motor means, and said automatic means includes means for reversing said motor means responsive to deactivation of said control means to induce a diverging, retractile movement of said wires.

3. A device in accordance with claim 2 and including automatic brake means for said motor means, said brake means being activated to decelerate said motor means in advance of activation of said means for reversing said motor.

4. A device in accordance with claim 3 wherein said automatic brake means is activated to decelerate said motor means following retractile movement of said wires.

5. An electric arc-metallizing device of the wire-fed type comprising a pair of electrode guide members including wire guide channels converging toward an arc zone, motor means in driving connection with said wires for feeding a pair of wires through said channels at a selected rate to a predetermined arc-forming spacing in said zone, gas jet means adjacent said zone for atomizing and propelling molten wire in said zone away from said electrode members, control means for said motor means actuable to start and stop position, said control means including automatic motor reversing means for retracting said wires into said channels and away from said zone responsive to movement of said control to said stop position.

6. A device in accordance with claim 5 and including brake means for said wires operable in advance of said reversing means for rapidly stopping advance movement of said wires responsive to movement of said control means to said stop position.

7. A device in accordance with claim 6 wherein said motor means comprises a DC shunt motor and said brake means comprises a shunt resistor applied across the armature of said motor.

8. A device in accordance with claim 7 wherein said automatic reversing means includes means for reversing the polarity of the voltage applied to the armature of said motor.

9. A device in accordance with claim 5 wherein said motor means comprises a DC shunt motor, and said automatic reversing means includes means for reversing the polarity of voltage applied to the armature of said motor.