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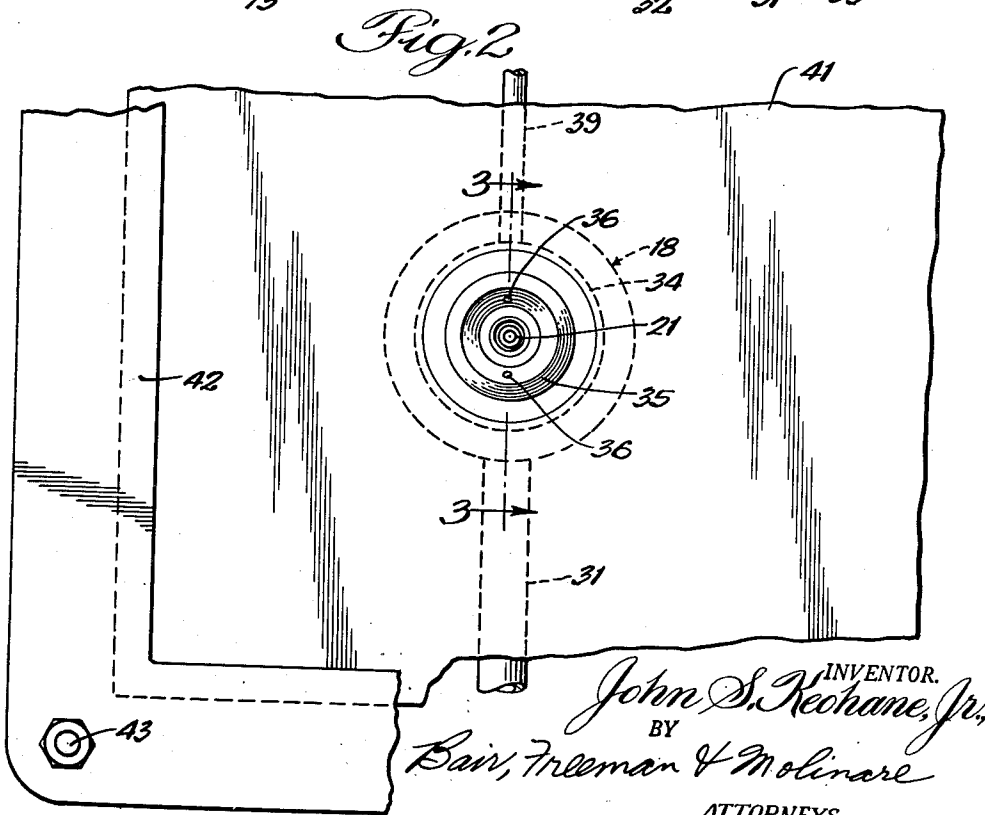
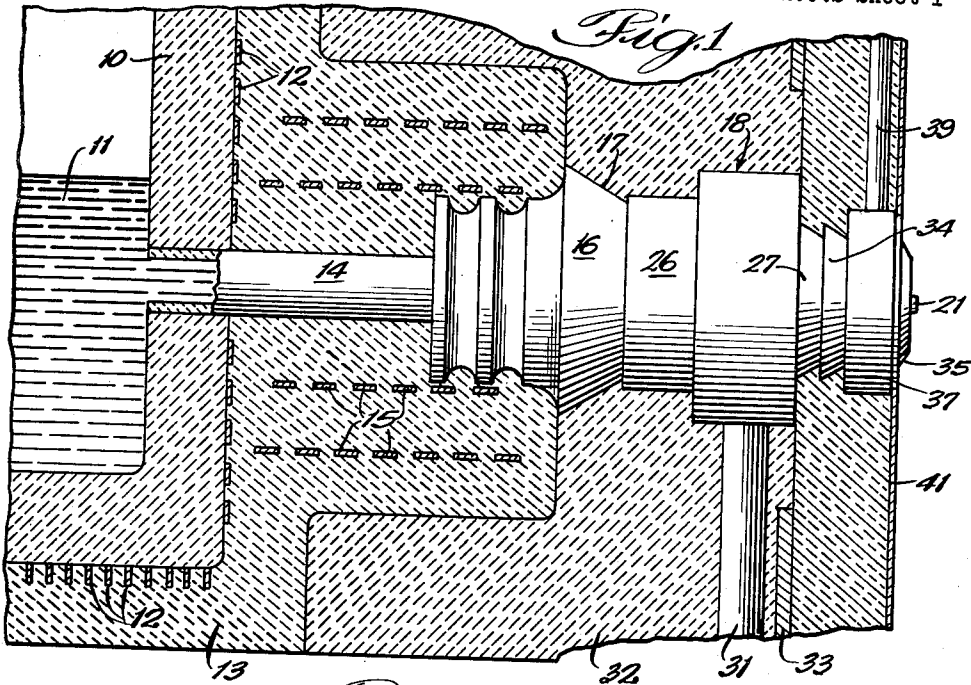
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METAL SPRAYING APPARATUS AND METHOD

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2 Sheets-Sheet 1



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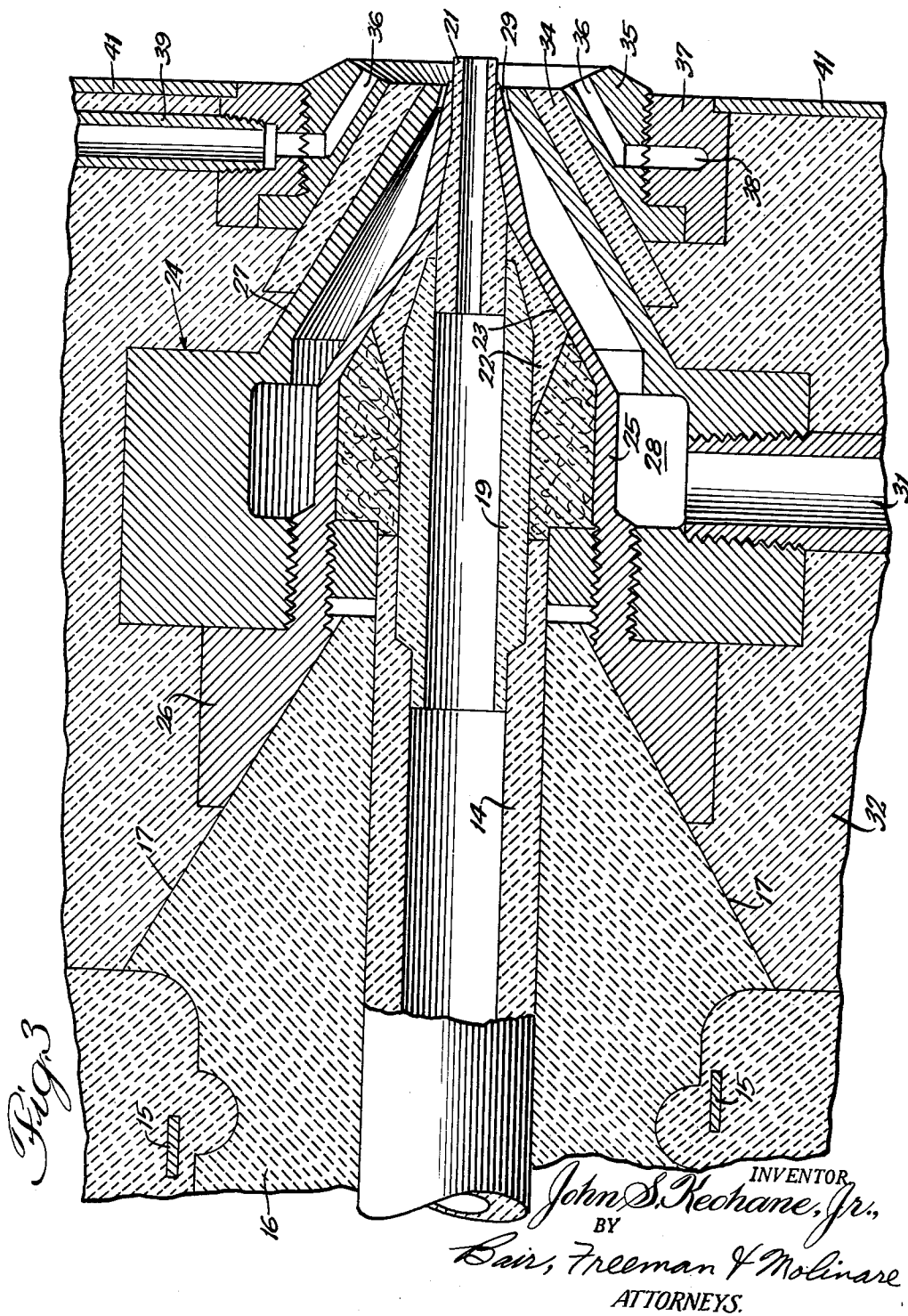
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METAL SPRAYING APPARATUS AND METHOD

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This invention relates to metal spray apparatus and method and more particularly to the spraying of pre-molten metal.

In metal spray apparatus, as heretofore constructed, a great deal of difficulty has been encountered in producing a spray of uniform metal particles at a temperature low enough to avoid burning of the material on which the metal is deposited, but still high enough to permit the metal to adhere to the material, coat it and control its thermoplasticity, thereby controlling the particle size. In apparatus of the type in which metal is melted directly at the spray nozzle from a wire or powdered metal, it is very difficult to obtain uniform particle sizes in the spray and to avoid excessive oxidation of the metal and burning of the material upon which it is sprayed due to the intense heat required at the spray nozzle. In apparatus for spraying pre-molten metal, difficulty has been encountered in obtaining a uniform spray, in controlling starting and stopping of the spray and in maintaining the spray apparatus in properly adjusted operating condition.

It is one of the objects of the present invention to provide metal spray apparatus and method for spraying pre-molten metal which produces an extremely uniform fine spray of molten metal particles at an accurately controlled temperature to avoid excessive oxidation of the metal and burning of the material onto which it is sprayed.

Another object is to provide metal spray apparatus and method in which the spraying operation is stopped by freezing the metal in the spray tip and is started by passing hot gas over the tip to melt the metal and to induce a spray therefrom.

According to a feature of the invention, the molten metal is supplied from a pot or furnace, or a group thereof, through a heated conduit to a restricted discharge tip which is unheated and around which heated gas, such as air, is passed to melt the metal in the tip and to aspirate it therefrom in the form of a spray. The spray may be stopped by cutting off the heated air and cooling the discharge tip as by passing cool air therearound to freeze the metal in the tip only.

A further object is to provide metal spray apparatus in which molten metal is discharged from the tip by a stream of heated gas which breaks the metal up into a spray of fine particles and in which a stream of cool gas is directed against the spray further to break up, control and direct the metal particles and to cool the metal and the surface against which it is sprayed.

Further features of the invention relate to construction of the spray head for easy assembly and for maintaining the parts accurately in proper adjusted position without disturbance due to thermal expansion.

As a feature of the metal spray apparatus the parts thereof are of suitable material to resist abrasion and minimize contamination to metal to be sprayed.

The above and other objects and features of the invention will be more readily apparent from the following description when read in connection with the accompanying drawings, in which:

FIGURE 1 is a cross section with parts in elevation of metal spray apparatus embodying the invention;

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FIGURE 2 is a partial front view looking from the right of FIGURE 1 and

FIGURE 3 is an enlarged sectional view through the spray head.

As shown in FIGURE 1, metal to be sprayed is pre-melted in a pot or furnace, indicated generally at 10, the metal being maintained in molten condition in the furnace, as indicated at 11. The pot or furnace may be heated in any desired manner, but as shown is maintained in heated condition to maintain the metal molten by electric heating elements 12 positioned around the bottom and sides of the pot and embedded in rigid insulating material 13, such as aluminum oxide or similar refractory material.

Molten metal from the pot 10 flows out through a conduit 14 of refractory material which communicates with the lower part of the pot and extends horizontally outward therefrom. The conduit 14 is embedded in the insulating material 13 throughout the major part of its length and heating elements 15 embedded in the material 13 around the conduit maintain the conduit in heated condition so that the metal therein will remain molten. The outer end of the conduit is surrounded and embedded in a conical refractory member 16 which is fitted over the end of the conduit and which terminates in an outwardly tapering conical surface 17. As best seen in FIGURE 3, the end of the conduit 14 preferably projects slightly beyond the conical member 16.

The outer end of the conduit communicates with a spray head, indicated generally at 18 in FIGURE 1 and shown in detail in FIGURE 3. The spray head comprises a tube 19 of refractory material which fits telescopically into the end of the conduit 14, as shown, and projects outward therefrom. A second refractory tube 21 of materially smaller diameter than the conduit 14 or the tube 19 fits telescopically into the end of the tube 19 and constitutes a reduced diameter discharge tip terminating at its outer end in a discharge orifice through which the metal to be sprayed is discharged. The tubes 19 and 21 are secured together by a mass of refractory material 22 which may be flame sprayed aluminum oxide bonding to the exterior surfaces of the tubes 19 and 21 at the juncture thereof. The mass of material 22 terminates at its outer end in a conical surface 23 tapering toward the discharge orifice and providing a mounting surface, as defined hereinafter.

An annular air chamber 24 which may be formed of high melting point metal, such as steel, is fitted around the tubes 19 and 21. As shown, the air chamber is formed by an inner member 25 having a conical inner surface complementary to the surface 23 connected by a cylindrical portion to a ring 26 having a conical inner surface complementary to and engaging the conical surface 17. An outer annular element 27 is threaded to the exterior of the cylindrical portion of the member 25 to define between them an annular air chamber 28 connected through a space between conical portions of the members 25 and 27 with an annular air discharge nozzle 29 around the discharge tube 21 and slightly upstream from the discharge orifice end of the tube 21. The air chamber 28 is supplied with heated gas, such as heated air, through a pipe 31 connected thereto and embedded in loose insulating material 32 lying around the nozzle structure and between the metal pot and a front wall 33 of the complete apparatus.

A second annular nozzle structure is supported around the nozzle structure 24 and is spaced therefrom by a conical spacing and insulating block 34 of refractory material, such as steatite. The outer surface of the conical block 34 is engaged by the conical inner surface of

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an annular nozzle member 35 which, as shown, is formed with two inwardly and outwardly directed and diametrically opposite discharge nozzles 36. A second annular ring 37 is threaded over the exterior of the ring 35, as shown, and is formed with an annular groove 38 therein communicating with the nozzles 36 and supplied with cool gas, such as air, through a pipe 39.

It will be noted that the several parts of the spray head assembly are fitted together through engaging conical surfaces without any rigid fastenings so that the parts can move slightly relative to each other to accommodate thermal expansion. The parts are resiliently held in assembled relation according to the present invention by a spring plate 41 engaging an annular recess in the front peripheral face of the ring member 37. As shown in FIGURE 2, the outer edges of the spring plate 41 are anchored in an annular rectangular shaped ring 42 which may be secured to the outer wall 33 of the unit by means of screws 43. With this construction, the nozzle parts are very accurately located and positioned relative to each other but are enabled to move slightly relative to each other to accommodate thermal expansion without disturbing the essential relationship of the several nozzle parts and without interfering with proper operation of the apparatus.

In operation of the apparatus, premolten metal 11 in the pot 10 will tend to flow under a relatively low gravitational force through the conduit 14 and the tubes 19 and 21 to the metal discharge orifice. It will be noted that the heating elements 15 around the conduit terminate short of the spray head so that the spray head will remain relatively cool except under operating conditions and due to the small size of the tube 21 and particularly the discharge end thereof, the metal will tend to freeze in the discharge end of this tube to prevent free flow there-through. Freezing of the metal in the discharge tube may be assured by passing cool air, or similar gas, through the nozzles 29 or 36 to cool the projecting tip of the discharge tube. The metal will, however, remain molten throughout the full length of the tube 14 and under normal conditions throughout the length of the tube 19 and the inner portion of the discharge tube 21.

To start up a spraying operation, heated gas, such as hot air heated to a temperature above the melting point of the metal to be sprayed, is forced through the pipe 31 and the annular nozzle 29 around the discharge tube. This heated gas will very quickly melt the small quantity of frozen metal in the discharge tube and will aspirate molten metal from the discharge tube and force it out in the form of a spray of metal particles from the discharge tube. Simultaneously, relatively cool gas, such as air, is forced through the pipe 39 and through the nozzles 36 against the spray at a point spaced outward from the discharge tube. This cool air will further break up the metal particles and reduce the temperature thereof and when the nozzles 36 are diametrically opposite, as shown, will tend to form the spray into a flat, relatively wide spray which is highly advantageous for most coating operations. As the metal is sprayed against material to be coated, this stream of cool gas will tend not only to cool the metal itself, but also to cool the material against which it is sprayed to avoid burning thereof.

It has been found that by use of the spray apparatus of the present invention an extremely uniform coating of metal particles such, for example, as aluminum can be formed on relatively fragile materials, such as paper or cloth, without excessive oxidation of the metal particles or burning of the materials at a distance of less than three inches. By the combined action of the hot gas stream from the annular nozzle 28 and the cool gas stream from the nozzles 26, the metal is broken up into extremely small and extremely uniform particles which are uniformly deposited on the material to receive them without any overheating or burning at any point. It will be apparent that the temperature of the particles in the spray

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can be controlled by controlling not only the temperature of the hot gas supplied through the pipe 31, but also by controlling the temperature of the cool gas supplied through the pipe 33 and the relative volumes of the gases. In this way, accurate control can be effected to obtain the desired metal particle temperature and to obtain proper spraying with the material to be sprayed at different distances from the spray head.

At the completion of a spraying operation, flow of molten metal from the nozzle can be stopped simply by cutting off the supply of hot gas and allow the metal to freeze in the tube or even more rapidly by discharging cool gas through the nozzle 29 to cool the discharge tube rapidly.

While one embodiment of the invention has been shown and described herein, it will be understood that it is illustrative only and not to be taken as a definition of the scope of the invention, reference being had for this purpose to the appended claims.

What is claimed is:

1. The method of spraying molten metal which comprises supplying molten metal to a restricted orifice, directing heated gas at a temperature in excess of the melting point of said metal in a substantially annular stream over the orifice and radially inward thereof in the general direction of orifice discharge to aspirate molten metal from the orifice and to break up the molten metal into discrete particles, and directing a further stream of cool gas at a temperature substantially below the melting point of said metal generally in the same direction as and radially inwardly against the first named stream and the particles therein beyond the orifice.

2. The method of spraying molten metal which comprises supplying molten metal to a restricted orifice, cooling the orifice to freeze the metal therein thereby to stop the spray, and directing heated gas at a temperature above the melting point of the metal over the orifice to melt the metal therein and to aspirate molten metal therefrom.

3. The method of claim 1 in which the cool gas is directed against the first named stream and the particles in two streams on opposite sides of the first named stream and generally in the same direction as and radially inwardly of the first named stream beyond the orifice to produce a flat spray.

4. In metal spray apparatus, a spray head comprising a tube of refractory material through which molten metal may flow, a second refractory tube of smaller diameter than the first named tube fitting telescopically into the end of the first named tube and constituting a discharge tip, a mass of refractory material secured around the tubes at the juncture thereof and having a conical outer surface tapering toward the discharge tip, an annular nozzle member fitting over the second tube and having an internal conical surface fitting against said conical outer surface, said nozzle member defining a substantially annular discharge nozzle around and upstream from the discharge tip, means to supply gas under pressure to the nozzle member, and resilient means yieldingly urging the nozzle member axially of the tubes toward the conical outer surface.

5. In metal spray apparatus, a spray head comprising a tube of refractory material through which molten metal may flow, a second refractory tube of smaller diameter than the first named tube fitting telescopically into the end of the first named tube and constituting a discharge tip, a mass of refractory material secured around the tubes at the juncture thereof and having a conical outer surface tapering toward the discharge tip, an annular nozzle member fitting over the second tube and having an internal conical surface fitting against said conical outer surface, said nozzle member defining a substantially annular discharge nozzle around and upstream from the discharge tip, means to supply gas under pressure to the nozzle member, said nozzle member having an outer conical surface tapering toward the discharge tip, a second

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annular nozzle member fitting over the first named nozzle member and having an internal conical surface complementary to and engaging the outer conical surface thereon and defining at least one discharge nozzle substantially parallel to the adjacent conical surfaces, means to supply 5 cool gas under pressure to the second nozzle member, and spring means urging the second nozzle member axially toward the outer conical surface on the first named nozzle member.

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