Nov. 15, 1938. R. L. BINDER 2,136,668

METAL SPRAYING APPARATUS

Filed Jan. 17, 1936

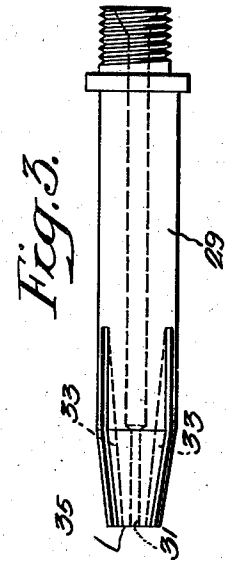


Fig. 3.



Fig. 4.

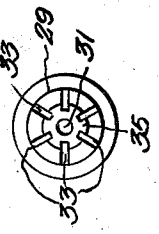


Fig. 5.

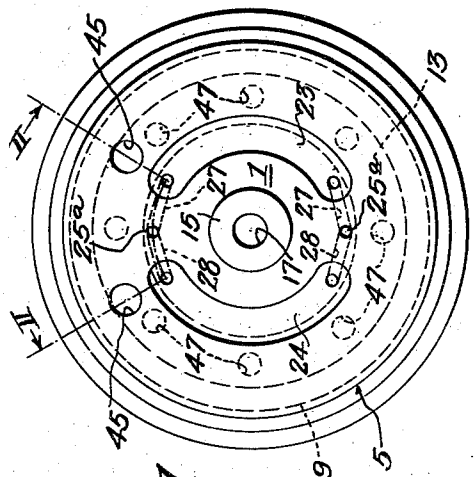


Fig. 1

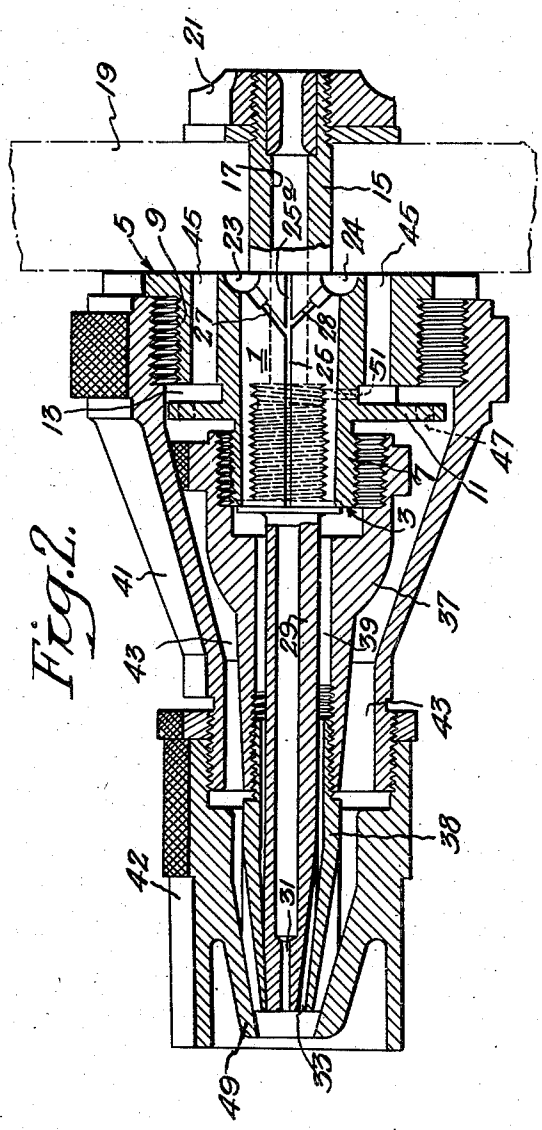


Fig. 2.

Inventor
Richard L. Binder
by Morrison & Rohrer
Attorney.

Patented Nov. 15, 1938 2,136,668

UNITED STATES PATENT OFFICE

2,136,668

METAL SPRAYING APPARATUS

Richard L. Binder, Philadelphia, Pa.; Gertrude Schemm Binder, administratrix of said Richard L. Binder, deceased, assignor to Metals Coating Company of America, Philadelphia, Pa., a corporation of Delaware

Application January 17, 1936, Serial No. 59,589

13 Claims. (Cl. 91—12.2)

This invention relates to metal spraying apparatus, and more particularly to the nozzle structure in such apparatus by means of which the metal to be sprayed is projected onto the material to be coated.

In one well known form of metal spraying apparatus, the metal to be sprayed is fed in the form of a wire or band through a nozzle system in which it is melted by an ignited combustible gas mixture, a stream of gas under pressure (such as compressed air), also fed through the nozzle system, serving to atomize the molten metal and to project the atomized metal onto the work. The nozzle systems heretofore in use have been subject to a number of objections both as to structure and operation. In the first place, the metal directing and gas directing means have been formed of a plurality of parts which require accurate assembly to provide the necessary passages for the metal and the gases. Aside from increasing the cost of manufacture, care must be exercised in assembling the parts, or the nozzle system may be rendered inoperative. Moreover, even when the parts are assembled in proper relation, they must constantly be held tightly together in order to prevent leakage of the gases, and this requires frequent inspection and servicing. Even when the foregoing precautions have been observed, there is always present the very serious objection of the possibility of "flash back" of the ignited gas mixture through the nozzle system and back to the gas supplies, with attendant dangers of explosion and injury to operator and surrounding property. Another serious objection to prior art nozzle systems is that their efficiency from the standpoint of rate of deposit of the molten metal has been limited by the nature of their structures. Also, in some types of nozzles heretofore in common use, much of the heat developed by the flame passes back along the inner nozzle members and raises their temperature sufficiently to produce ignition of the combustible gas within the gas chamber in advance of the intended flame zone. This pre-ignition of the combustible gas causes the inner nozzle members to overheat and burn out, thereby rendering the apparatus inoperative.

The primary object of my invention is to provide an improved nozzle system for metal spraying apparatus which will be free from the aforesaid difficulties and disadvantages characteristic of prior art nozzle systems.

More specifically, it is an object of my invention to provide an improved nozzle structure for metal spraying apparatus which will require no expert or even exceptionally careful assembly, in which the possibility of leakage of the gases is entirely eliminated, and which will have a long life.

Another and very important object of my invention is to provide an improved nozzle structure as aforesaid in which the danger of "flash back" of the ignited gas mixture is removed and which therefore affords adequate safety to the operator and his surroundings.

Still another object of my invention is to provide an improved nozzle structure in which the combustible gases will be properly mixed and directed to the ignition point.

It is another object of my invention to provide an improved nozzle structure in which the heat passing from the flame to the nozzle parts will be effectively drawn off and in which the danger of burning out of the inner nozzle members is practically eliminated.

A further object of my invention is to provide an improved nozzle structure which will deposit the molten metal with maximum efficiency from the standpoint of rate of deposit of the metal.

A still further object of my invention is to provide an improved nozzle structure in which the flame can be concentrated upon the metal wire or band at the most efficient point.

It is also an object of my invention to provide improved nozzle structure of the type described which is comprised of a minimum number of parts and is simple in construction, which is inexpensive to produce and readily lends itself to the requirements of economical commercial manufacture, and which can be used with high efficiency by even an unskilled operator.

In accordance with my invention, I form the nozzle head or base of one integral piece and mount thereon a series of three concentric hollow nozzle members the innermost of which constitutes a guide for the metal wire or band, the intermediate one, together with the innermost one, forming a passage for the mixture of combustible gases, and the outermost one cooperating with the intermediate one to provide a passage for the compressed air or other suitable gas used in atomizing the molten metal. In the nozzle head, I form a series of passages inclined at suitable angles to each other and to a pair of gas mixing channels with which said passages communicate for directing the combustible gases in a direct, forward direction into and through said mixing channels, the angular relation between said passages and said channels being such that a greater resistance is offered to the passage of the combustible gases in a backward direction, or toward the source of supply, than in a forward

direction, or toward the melting point. In addition, I provide a cushioning passage between the aforesaid inclined passages which also helps to prevent flash back of the combustible mixture. For most efficient melting of the metal, I form the innermost nozzle member with a series of longitudinally extending flutes at its forward end, the depth and number of said flutes varying as and being a function of the wire itself, and said flutes gradually increasing in depth as they approach the tip of the nozzle. In addition, I provide means for directing a cooling medium through the bore of the innermost nozzle member for drawing off the heat absorbed by the nozzle structure from the flame. Since the one-piece nozzle head prevents leakage of the gases, the inclined passages and the cushioning passage, as well as the aforesaid gradually deepening flutes, prevent flash back of the combustible gas mixture, the structure of the innermost nozzle member is made to conform specifically to the requirements of any particular wire, and the aforesaid cooling medium draws the heat away from the inner nozzle structure, it will be readily apparent that my improved nozzle system has many advantages over those heretofore in use and none of their disadvantages.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with additional objects and advantages thereof, will best be understood from the following description of one embodiment thereof, when read in connection with the accompanying drawing in which—

Figure 1 is an end elevation of one form of my improved nozzle system viewed from the rear,

Figure 2 is a view partly in side elevation and partly in section taken approximately on the line II—II on Figure 1,

Figure 3 is a side elevation of a wire directing nozzle member designed for a relatively thin wire,

Figure 4 is an end view thereof viewed from the front, and

Figure 5 is a view similar to Figure 4 but showing a wire directing nozzle designed for a relatively thick wire.

Referring more specifically to the drawing wherein similar reference characters designate corresponding parts throughout, I have shown, in Figures 1 and 2, a nozzle system comprising a nozzle head generally designated as 1 and having a front face 3 and a rear face 5, the latter being of greater diameter than the former. The head 1 also has a front peripheral portion 7 of substantially the same diameter as the front face 3 and a rear peripheral portion 9 of substantially the same diameter as the rear face 5, the portions 7 and 9 being longitudinally displaced, as clearly shown in Figure 2. Intermediate the peripheral portions 7 and 9 is an annular flange or baffle member 11, more fully referred to hereinafter, which is spaced from the portion 9 to provide an annular space 13 therebetween.

The structure thus far described is constituted by one integral piece and will be hereafter termed the body portion of the nozzle head. Also formed integrally thereon, is a rearward extension 15 which, together with the body portion, is provided with a central bore 17 through which the material to be sprayed, such as metal, may be fed in the form of a wire, for example, toward the forward end of the nozzle structure where melting of the metal takes place. The nozzle head 1 may be secured to a casing of the type shown in U. S. Patent No. 1,100,602, for example, in which the wire feeding mechanism is housed by inserting the extension 15 through the front wall 19 of the casing and locking it thereto, as by a nut 21. If desired, a suitable packing may be placed between the rear face 5 and the wall 19 to prevent leakage of gases presently to be described, but I prefer to omit this packing and to finish both the face 5 and the wall 19 to a smooth finish and draw the two tightly together.

The rear face 5 is provided with a pair of arcuate cavities 23, 24 which are radially spaced from and extend partially around the extension 15, the cavities being spaced from each other at their ends, as clearly shown in Figure 1. The cavities 23 and 24 are arranged to have communication with suitable ports (not shown) in the casing wall 19 through which are fed two different gases which, when mixed, constitute a combustible mixture. For example, acetylene, hydrogen, or some other burnable gas may be fed to the cavity 23, and oxygen may be fed to the cavity 24.

Radially spaced from the bore 17 and extending longitudinally clear through the body portion of the head 1 between the ends of the cavities 23, 24 are two diametrically opposite channels 25 wherein the aforesaid gases are mixed, a plurality of ducts 27, 28 serving to establish communication between the cavities 23, 24, respectively, and each of the channels 25. The ducts 27 and 28 extend from the ends of their respective cavities in a forward direction at an angle to the channels 25 and to each other, and they meet their associated channels a relatively short distance from the face 5 whereby to provide short lengths of channels 25a for a purpose shortly to be explained. It will also be noted that the ducts leading from one of the cavities, for example the ducts 27, make a smaller angle with the channels 25 than do the ducts 28 leading from the other cavity and therefore meet their respective channels 25 at points slightly forward of the meeting points of the ducts 28 with the channels. The angles which the ducts 27 and 28 make with the channels 25 are such that, whereas the gases comprising the combustible mixture may each be fed in a direct, forward progression, the resistance offered to their passage in a rearward direction from the channels 25 to the cavities 23 and back to the sources which supply them is much greater than the resistance offered to them in passing in a forward direction from the cavities 23, through the ducts 27 and 28 and through the channels 25 where they are mixed. This effectively prevents the possibility of the ignited gas mixture flashing back to the supply tank and causing damage.

By having the ducts 27 meet the channels 25 slightly forward of the meeting points of the ducts 28 with the channels 25, the gas passing through the ducts 27, preferably the burnable gas, effects an injector action on the gas passing through the ducts 28, which further increases the tendency of the gases to travel forwardly instead of rearwardly, whereby flash-back of the ignited gas mixture is further effectively prevented. To still further insure against the possibility of flash-back, the channel portions 25a are provided. Should some circumstance arise which would ordinarily cause flash-back of the ignited mixture, a pressure will be built up in the channel sections 25a since they are backed up against the wall 19, and the pressure built up therein will

tend to cushion and repel the backward travel of the mixture. Thus, the combined injector action of one gas upon the other, the cushioning action of the channel sections 25a, and the angular relations between the ducts 27 and 28 with the channels 25 make the nozzle system fool-proof so far as flash-back is concerned.

Screwed into or otherwise suitably secured within the forward end of the bore 17 is an inner nozzle member 29 through which the wire is fed to the melting point, the forward end thereof having a bore 31 of a diameter just sufficient to accommodate the wire stock. The tip of the nozzle 29 is tapered and provided with a plurality of circumferentially-spaced, longitudinally-extending flutes 33 along which the combustible gas mixture is conducted in a manner presently to be set forth. In order to obtain maximum melting efficiency and benefit of the greatest number of heat units from the combustible mixture, it is necessary to direct the ignited mixture as close to the wire as possible. I have found that with a high melting temperature metal, which usually is supplied in small diameter, a wire nozzle constructed with three flutes, as shown in Figures 3 and 4, is most desirable, the flutes 33 being relatively deep at the tip end 35 of the nozzle. On the other hand, where a larger diameter wire is to be used, as in the case of a relatively low melting temperature metal, the bore 31 is, of course, of greater diameter, and the flutes 33 are not only greater in number, but also less deep at the tip end 35. For purposes of illustration, I have shown the nozzle member 29 of Figure 5 formed with six flutes 33, but in any case, the number and maximum depth of the flutes 33 will be a function of the diameter of the bore 31 or the diameter of the particular wire employed.

The peripheral portion 7 may be threaded to receive a nozzle part 37 into the forward end of which is fitted a nozzle part 38 somewhat similar in construction to the tip of the nozzle member 29, the two nozzle parts 37 and 38 combining to form an intermediate, or gas, nozzle which is spaced from and cooperates with the wire nozzle 29 to provide an annular chamber 39 therebetween into which the combustible gas mixture is fed from the channels 25. The peripheral portion 9 is also threaded to receive a nozzle part 41 onto the forward, reduced end of which is fitted a nozzle part 42, the parts 41 and 42 combining to constitute an outer, or atomizing, nozzle which cooperates with the gas nozzle 37, 38 to provide an annular chamber 43 through which the atomizing gas, for example compressed air, nitrogen, or the like, is passed. The atomizing gas is fed from a suitable supply tank, through ports (not shown) in the wall 19 which communicate with a pair of passages 45 in the nozzle head 1 extending longitudinally therethrough from the rear face 5 to the annular space 13. A plurality of circumferentially spaced apertures 47 in the baffle member 13 break up the flow of the compressed atomizing gas and distribute it evenly around the chamber 43.

In operation, the metal wire is fed through the bores 17 and 31, while the combustible gas is fed through the cavities 23 and 24, the ducts 27 and 28, the channels 25, the chamber 39 and the flutes 33 to the flame zone, approximately 3/32" or 1/8" in front of the nozzle part 42, where the wire is melted. As the gas mixture passes down the flutes 33, it expands somewhat by reason of the deepening of the flutes and creates a suction or injector effect which also helps to prevent flash-back. Compressed air or other suitable gas is at the same time fed through the passages 45, the space 13, the apertures 47 and the chamber 43, and is directed to the apex of the conical flame zone by the conical member 49 on the nozzle part 42, atomizing the molten metal there and projecting it onto the material being coated. Forming the flutes 33 in the manner heretofore described enables bringing the cone of combustion closer to the axis of the wire than with constructions heretofore used and therefore a greater melting capacity is obtained. Hence, with a nozzle structure as herein described, the wire can be fed faster and deposited faster, whereby a greater efficiency is obtained than was heretofore possible.

To prolong the life of the nozzle structure and at the same time to prevent undue heating of the nozzle part 38 and the innermost nozzle member 29 by the heat which they ordinarily absorb from the flame, I provide a radial port or orifice 51 in the nozzle head 1, the orifice preferably extending from the annular space 13 to the bore 17, as clearly shown in Figure 2. Of the compressed air or other atomizing gas which is fed through the passages 45, a portion will find its way into the orifice 51 and thence through the bore 17 and the larger, rear bore of the nozzle member 29 where it will circulate around the wire and absorb heat from the inner nozzle members. In this manner, the nozzle members 29 and 37 are prevented from becoming too hot and pre-igniting the combustible gas, and the flow of combustible gas is maintained uniform and undisturbed.

Although I have shown and described one form of my invention, I am fully aware that many modifications thereof are possible, and I therefore desire that my invention shall not be limited except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In a nozzle system for atomizing and spraying a normally solid material, a nozzle head having front and rear faces and a central bore for the reception of said material, said rear face being provided with a pair of spaced cavities of finite length spaced from each other at their ends, and said head having a pair of longitudinally extending channels therein spaced radially from said central bore and located at diametrically opposite points between the ends of said cavities, said head also having a plurality of ducts therein extending from the ends of said cavities to said channels at an angle thereto.

2. The invention set forth in claim 1 characterized in that the ducts leading from one of said cavities form a different angle with their respective channels than the ducts leading from the other of said cavities.

3. The invention set forth in claim 1 characterized in that the ducts leading from one of said cavities form a different angle with their respective channels than the ducts leading from the other of said cavities, but adjacent ducts meeting their associated channel in close proximity to each other.

4. The invention set forth in claim 1 characterized in that the ducts leading from one of said cavities form a different angle with their respective channels than the ducts leading from the other of said cavities, the angular relations between said ducts and said channels being such

that a greater resistance is offered to the passage therethrough in a rearward direction of a gas under pressure than in a forward direction.

5. In a nozzle system for atomizing and spraying a normally solid material, a nozzle head comprising a body portion having front and rear faces and a central bore for the reception of said material, said rear face being provided with a pair of spaced cavities of finite length spaced from each other at their ends, and said body portion having a pair of channels therein extending longitudinally clear through said body portion from said rear face to said front face at diametrically opposite points between the ends of said cavities and in radially spaced relation to said central bore, said head also having a plurality of ducts therein extending from the ends of said cavities to said channels at an angle thereto, said ducts meeting their respective channels at points forward of but relatively close to said rear face whereby a short length of each of said channels is provided between each of said meeting points and said rear face.

6. In a nozzle system for atmomizing and spraying a normally solid material, a one piece nozzle head comprising a body portion having front and rear faces respectively of lesser and greater diameters, the peripheral portion adjacent said rear face being adapted to receive an outer nozzle member thereon and the peripheral portion adjacent said front face being adapted to receive an intermediate nozzle member thereon, an extension on said rear face concentric therewith, said body portion and said extension having a central bore therein the forward end of which is formed to receive an inner nozzle member, and an annular baffle member on said body portion between said peripheral portions, said annular member being in spaced relation to said rear peripheral portion and having a diameter intermediate those of said front and rear faces.

7. In a nozzle system for atomizing and spraying a normally solid material, the combination of a nozzle head comprising a body portion having front and rear faces respectively of lesser and greater diameters, an outer nozzle member on the peripheral portion adjacent said rear face, an intermediate nozzle member on the peripheral portion adjacent said front face, said outer and intermediate nozzle members cooperating to provide a chamber therebetween for an atomizing gas, an extension on said rear face concentric therewith, said body portion and said extension having a central bore therein for the reception of said material, an inner nozzle member fitted into the forward end of said bore for receiving said material from said bore as the material is advanced therethrough, said inner nozzle member cooperating with said intermediate nozzle member to provide a chamber therebetween for a combustible gas mixture, and an annular baffle member on said body portion between said peripheral portions, said annular member being in spaced relation to said rear peripheral portion and having a diameter intermediate those of said front and rear faces.

8. The invention set forth in claim 7 characterized in that said rear face is provided with a pair of spaced, arcuate cavities arranged about said extension and adapted to be coupled to separate sources of supply of gases which, when mixed, constitute a combustible gas mixture, said body portion being provided with a pair of diametrically opposite channels extending longitudinally therethrough from said rear face to said front face between the ends of said cavities and communicating with said combustible gas mixture chamber, said body portion also having a plurality of ducts therein extending from the ends of each of said cavities to each of said channels at angles thereto and serving to conduct the gases of said mixture into said channels to be mixed therein, and said body portion also having a plurality of passages therein extending from said rear face to the space between said baffle and said rear peripheral portion, said passages being adapted to be coupled to a source of supply of an atomizing gas, and said baffle having a plurality of circumferentially spaced apertures therein establishing communication between said space and said atomizing gas chamber.

9. In a nozzle system for atomizing and spraying a normally solid material, a nozzle head having front and rear faces respectively of lesser and greater diameters and a central bore for the reception of said material, said rear face being provided with a pair of spaced cavities, and said head having a pair of longitudinally extending channels therein spaced radially from said central bore and having a plurality of ducts therein establishing communication between each of said cavities and each of said channels, and an annular baffle member on said head between said faces and of a diameter intermediate those of said faces.

10. In a nozzle system for atomizing and spraying a normally solid material, a nozzle head having front and rear faces respectively of lesser and greater diameters and a central bore for the reception of said material, a rear peripheral portion on said head of substantially the same diameter as said rear face and a front peripheral portion thereon of substantially the same diameter as said front face, said peripheral portions being longitudinally displaced, and an annular baffle member on said body intermediate said peripheral portions and spaced from said rear peripheral portion to provide an annular space therebetween, said head being provided with a plurality of longitudinally extending passages therein extending from said rear face to said annular space.

11. In a nozzle system for atomizing and spraying a normally solid material, a nozzle head having a bore therein for the passage of said material, at least one channel therein for the passage of a combustible gas, and at least one passage therein for the passage of atomizing gas, said head also having means for directing a cooling medium through said bore.

12. In a nozzle system for atomizing and spraying a normally solid material, a nozzle head having a bore therein for the passage of said material, at least one channel therein for the passage of a combustible gas, and at least one passage therein for the passage of an atomizing gas, said head also having a radial orifice therein establishing communication between said bore and a region where said atomizing gas passes.

13. The invention set forth in claim 7 characterized in that said head is also provided with a radial orifice extending from said bore to the space between said baffle member and said rear peripheral portion.

RICHARD L. BINDER.