JTTEES 7:328-333

Early Thermal Spray Application— *JTST* Historical Patent #8*

UNITED STATES PATENT OFFICE
1,968,329

METAL SPRAYING APPARATUS

Donald D. Taylor, Duncannon, Pa., assignor to
Advance Engineering Corporation, Duncannon, Pa.,
a corporation of Pennsylvania

Application April 27, 1933, Serial No. 668,248, Patented July 31, 1934
6 Claims. (Cl. 91-12.2)

My invention relates to improvements in metal spraying equipment and has to do, more particularly, with improvements in pistols for spraying such metals as lead, tin, zinc and others of comparatively low melting points, either pure or alloyed.

The primary object of my invention is to provide a metal spraying device which may be operated for long periods without interruption due to clogging of the metal-spraying jet with dross unavoidably produced by accumulation of impurities from the commercial metal stock employed, as well as oxidation of the metal itself incident to its reduction by heat to the molten state.

It is another object of my invention to provide a metal-spraying device which employs a simple semi-automatic or manual feed for the metal stock instead of the conventional mechanical feeding mechanism, and yet is comparable, if not superior, to mechanically-fed devices in that it is not subject to clogging in use.

It is an object of my invention to provide a metal-spraying device which will handle bar stock, providing adequate support therefor, as well as efficient and uniform melting thereof.

Further objects, and objects relating to details and economies of construction and use will more definitely appear from the detailed description to follow. In one instance, I accomplish the objects of my invention by the means described in the following specification. My invention is clearly pointed out in appended claims. A preferred embodiment of my invention is illustrated in the accompanying drawings forming a part of this specification, in which:

Figure 1 is a view, in side elevation, of a preferred form of metal-spraying pistol of the type to which my invention pertains;

Fig. 2 is a view, in top elevation, of the pistol shown in Fig. 1;

Fig. 3 is a vertical sectional view of the pistol illustrated in Figs. 1 and 2, showing internal details of construction embodying my invention;

Fig. 4 is a detail sectional view taken on the line 4-4 of Fig. 3, and disclosing the stock supporting and melting chamber, the duct for feeding molten metal stock to the spray jet, and the notched chamber wall which precludes passage of floating dross to the duct and its jet;

Fig. 5 is a detail sectional view taken on the line 5-5 of Fig. 3, and showing the construction of the dross-retaining wall of the melting chamber or sump;

Fig. 6 is a fragmentary vertical sectional view of a metal-spraying pistol generally similar to that illustrated in Fig. 3, but provided with a modified form of dross-retaining sump constituting another embodiment of my invention;

Fig. 7 is a transverse sectional view similar to that of Fig. 5, and disclosing the modified form of my invention illustrated in Fig. 6;

Fig. 8 is a detail sectional view similar to that in Fig. 6 and disclosing another modified form of my invention as embodied in a metal-spraying pistol of the general type disclosed in Figs. 1, 2 and 3; and

Fig. 9 is a horizontal detail sectional view of the stock receiving sump, jet feeding duct, and dross retaining means shown in Fig. 8.

The same reference numerals refer to the same parts throughout the several views.

In its broader aspects my invention consists in the provision, in a metal-spraying device adapted to be substantially continuously charged with bar or strip stock, and having a receptacle or sump portion in which stock is heated, reduced to the molten state, and from which molten stock flows to the metal spraying jet, of simple means for preventing the access of dross to the jet, thereby precluding the clogging to which the jets of such devices are so generally subject.

More specifically, and with reference to the accompanying drawings, my invention is preferably embodied in a metal-spraying pistol of the general type disclosed in my copending application, Serial No. 613, 531, filed May 25, 1932 which has matured into Pat. No. 1,934,891 issued Nov. 14, 1933. The present device consists of a head member 10, supported from a control member 11 having a handle or grip portion 12 of low heat conductivity attached thereto by means of an assembly screw 13 and a dowel pin 14. Head member 10 is preferably made in the form of a light brass or bronze casting having walls of thin cross section to reduce weight, and is provided with an open-top chamber or receptacle 14 within which bar or strip metal spray stock 31 is disposable for support and feeding. The lower portion of the chamber 14 is provided with an upstanding wall 15 which defines, with the walls of the receptacle 14, a sump for holding a small quantity of molten metal as well as supporting

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

the lower end of the bar of stock 31. Threaded into the forward portion of the head member 10 is a spray jet 16, preferably of steel, through which molten metal is drawn by the atomizing action of an air jet 17 concentrically disposed therearound by threaded attachment to the head member 10. Air jet 17 is supplied with compressed air by means of a duct 18 formed in the head member 10 and which extends beneath the sump and communicates with the air duct 19 in the control member 11 by the air tube 20. A needle valve 21 is provided for adjusting the amount of air passing to the air jet 17, and a plunger valve 22 having a spring 23 and trigger control 24, is provided for positively controlling the passage of air from the coupling nipple 25 adapted to be connected to a flexible air line (not shown). For the purpose of heating the head member 10 and progressively melting the stock disposed in the receptacle 14 and the sump constituting its lower portion to provide a constant supply of molten metal for atomization by the jets 16, 17, there is provided a gas torch the outlet end 27 of which is journaled in the web 26 formed in the rear end of the head casting 10 and directs the flame issuing from the torch directly upon the portion of the head 10 which constitutes the receptacle 14 in which stock to be melted is disposed. The receptacle 14, together with its sump and the other portions of the head 10, are thus maintained in a highly heated condition. While the stock 31 is preheated to a large extent in the upper portion of the receptacle 14, actual melting is accomplished at the lower end of the stock resting in the sump, both by reason of direct heat transfer through contact with the bottom of the sump and by reason of heat transfer through the already molten metal retained in the sump, about the lower end of the bar of stock 31, by the sump wall 15.

Probably the most serious difficulty encountered in metal-spraying devices of the above-specified general character is that due to the clogging of the metal spraying jet with particles of dross produced, among other things, by oxidation of the metal stock in the melting chamber. In the device disclosed and claimed in my previously filed application referred to, this difficulty is avoided or lessened by constantly shielding the surface of the molten and melting stock with a blanket of non-oxidizing gas which isolates the hot metal from the external atmosphere. While such a method and means is generally effective for the purpose, when the stock employed is of low grade, containing solid impurities, or is coated with dirt or grease, a certain amount of dross will accumulate in the melting chamber even though little or no oxidation of the metal itself takes place. Molten metal in such a metal spraying apparatus is normally drawn through the spray jet as fast as it is produced, with the result that the surface of the molten metal falls to the level of the duct feeding the jet and lodges therein, ultimately clogging it.

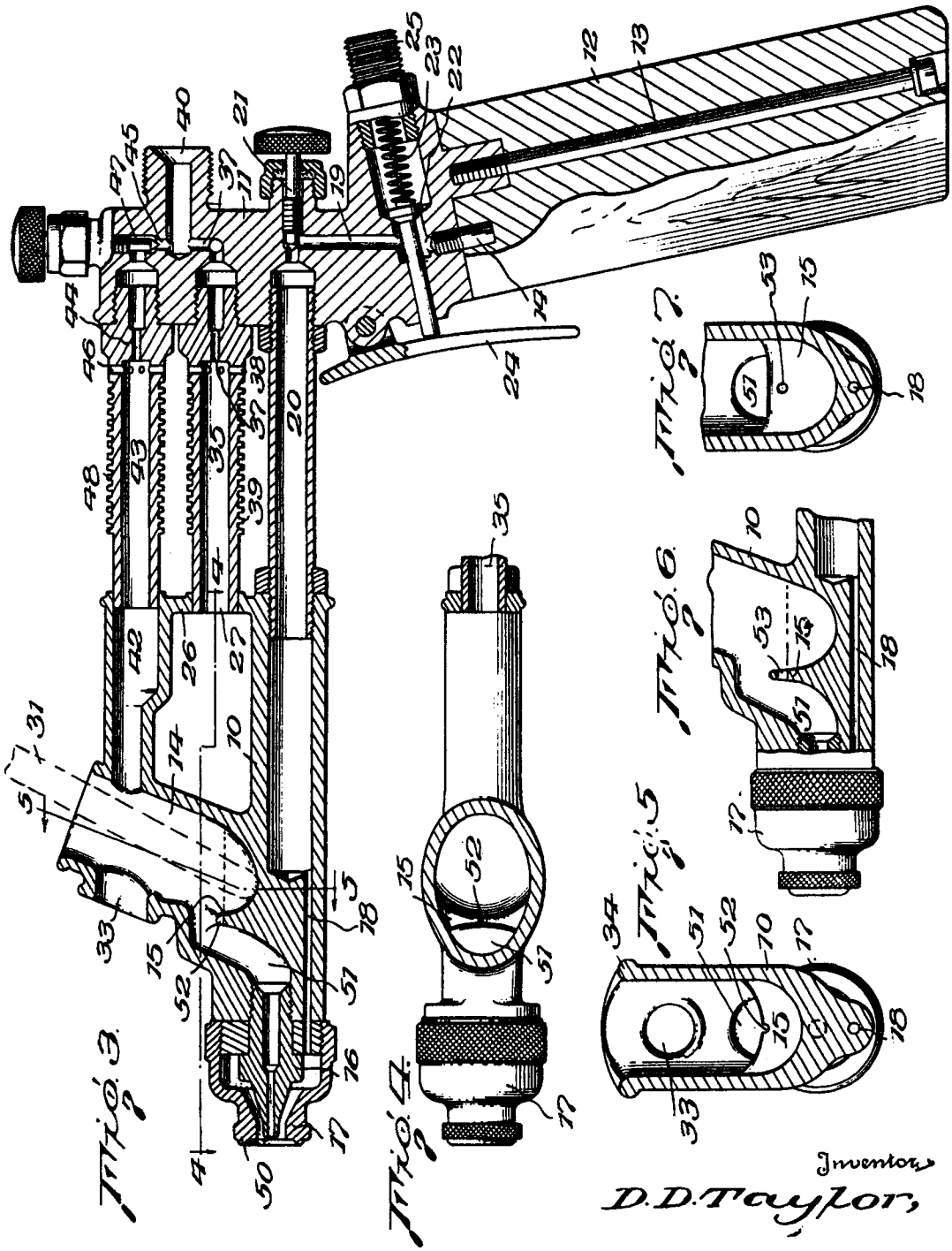
The present invention has as its object not the prevention of dross formation, but rather the preclusion of dross entry into the duct which feeds the metal spraying jet. My invention is capable of embodiment in any of several structural forms, each equally effective for the purpose. Referring to Figs. 3, 4 and 5, which illustrate one species embodiment of my generic invention, the preclusion of dross entry into the jet 16 is accomplished by utilizing the forward wall 15 of the sump as a weir or spillway over which molten metal in excess of the amount retainable in the sump spills or overflows in a thin stream or sheet; and extending the duct 51, through which molten metal is conveyed to the jet 17, so that its mouth is open to the atmosphere through the chamber 14 in the head 10. It is a well known fact that insoluble solid particles floating upon the surface of a liquid are attracted to each other by reason of surface tension phenomena, and in the case of dross floating on molten metal this is quite evident, since the dross tends to form a continuous film of considerable tenacity over the entire surface of the body of molten metal. By charging the metal stock into the sump, continuously melting it therein, and allowing molten metal to leave the sump only by overflowing a wall or spillway narrower in width than the diameter of the dross film upon the surface of the molten metal in the sump, surface tension or cohesion of the dross particles prevents their passage over the spillway. While the exact nature of the phenomenon of dross retention by the construction disclosed is not fully understood, it is probable that another physical factor contributing to the result involves the well known principle of physics that the velocity of a flowing body of liquid in contact with air is less at its surface than at levels beneath the surface. Thus, metal overflowing the sump wall is drawn rather from a level slightly beneath the surface than from the surface itself and there is, accordingly, but little tendency for dross to be carried over the wall. It is characteristic of spray nozzles of the type disclosed that the material atomized is drawn through the jet by suction. In spraying devices of the type in which the duct feeding the metal spraying jet communicates directly with the sump, molten metal is drawn therefrom by suction, and if the surface of the metal in the sump falls to the level of the duct, any dross floating thereon is drawn in with the clean metal. In the present construction, however, the 5.1 duct for molten metal does not open into the sump proper but rather to the air space thereabove. Thus, any tendency toward development of vacuum in the duct 51 is prevented, and the metal leaving the sump does so purely by reason of gravitation over the wall 15 unaugmented by any suction generated by the rush of air past the nozzle 16. Preferably the wall 15 is provided with a narrow notch 52 at its upper edge, through which notch the metal overflowing the sump passes to the duct 51 free of dross. Such a notch 52 has been found especially desirable when the pistol is not held steadily and the molten metal in the sump is agitated so that its level with respect to the top edge of the wall 15 fluctuates and there is a possibility of the dross film being broken and portions thereof being carried over the wall 15 by flotation. When the pistol is formed with such a notch, the portions of the wall to either side and above the notch 52 serve to positively retain the dross.

The gaseous mixture for the torch which heats the head portion 10 of the pistol is provided by the mixing tube 35, threaded, at its rear end, in the control portion 11, and provided with a gas jet 36 fed by the gas duct of the control portion and air intake ports 38 through which atmospheric air is drawn. The nipple 40 is adapted for attachment to a supply line, (not shown), for acetylene or other inflammable gas, and feeding thereof to the mixing tube 35 is adjusted and controlled by means of the needle valve 41. The mixing tube 35 is preferably provided with cooling ribs 39 which dissipate heat, tending to reduce heating of the control portion 11, and retarding active combustion of the gases passing through tube 35 until they have been intimately mixed and have passed through the forward portion 27 of the torch.

July 31, 1934. D. D. TAYLOR 1,968,329

METAL SPRAYING APPARATUS

Filed April 27, 1933 2 Sheets-Sheet 2



Inventor,
D. D. Taylor,
By Church + Church
His Attorneys

July 31, 1934. D. D. TAYLOR 1,968,329

METAL SPRAYING APPARATUS

Filed April 27, 1933 2 Sheets-Sheet 1

Fig. 1.

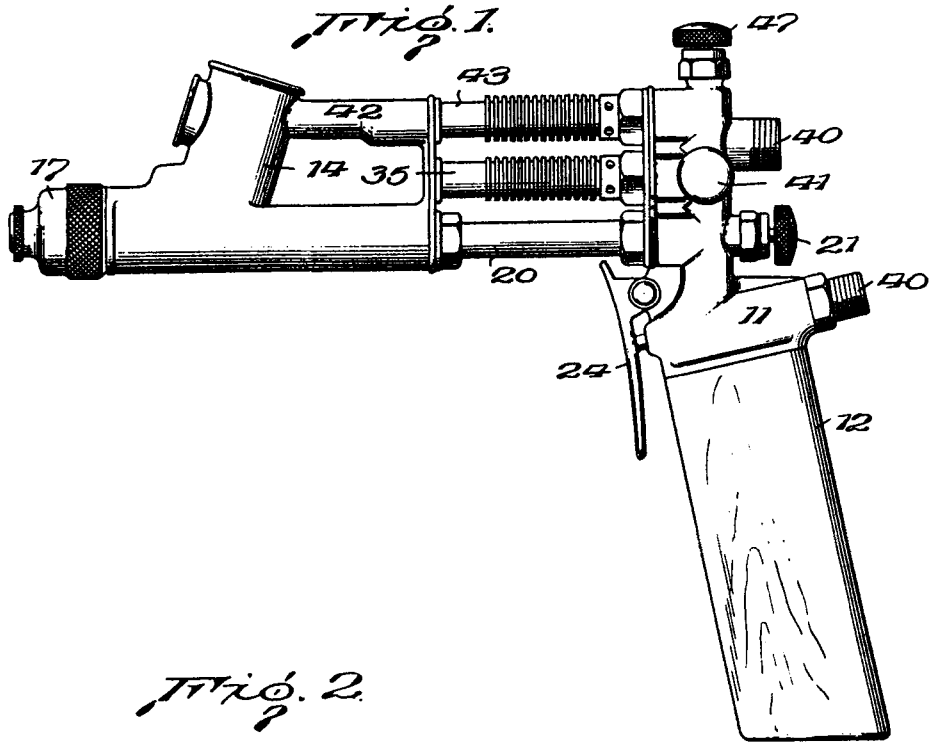
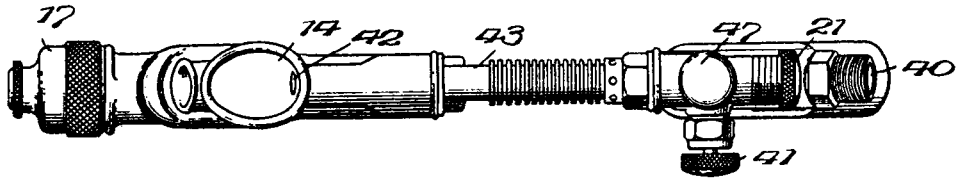


Fig. 2.



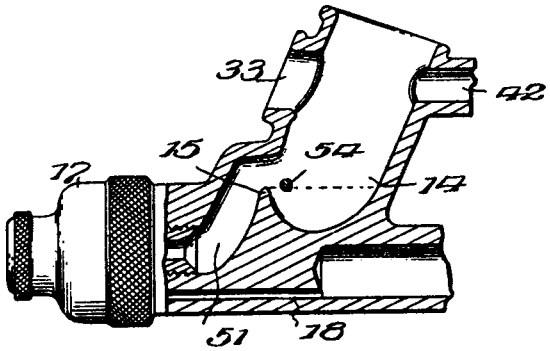


Fig. 8.

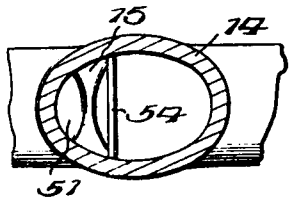


Fig. 9.

Inventor

D. D. Taylor,

By Church + Church

His Attorneys

A second torch, similar to the first torch above described, is disposed above the first torch and is provided with an elongate chamber 42 in the head 10 for directing a tongue of flame forwardly through the opening 33 in the head 10 to a position well beyond the pistol. Like the first torch, it is provided with a mixing tube 43 having a jet 44 for the inflammable gas fed by the duct 45 communicating with the nipple 40. Ports 46 are provided through which air is drawn into the tube 43, and a valve 47 controls the amount of inflammable gas fed through jet 44. Cooling ribs 48 similar to those 39 of the mixing tube 35 are also provided. This second torch is provided primarily for the purpose of preheating the object to be coated or for heating coatings previously applied so that they may be "wiped" or "paddled" in the usual manner to provide a smooth or modified surface. The second torch, through contact of its flame with the portion 42 of the head member 10 serves also to maintain the head 10 and its sump in a heated condition so that spraying may be resumed with a minimum of delay, even though the first torch be extinguished during use of the second torch

The operation of the embodiment of my invention illustrated in Figs. 1 to 5 should be obvious from the foregoing description. Acetylene or other inflammable gas passes through the nipple 40, is throttled by the valve 41, is mixed with air entering through the ports 38, passes through the mouth 27 of the torch and, burning, impinges upon the walls of the head 10 constituting the receptacle 14 in which the stock 31 is disposed. Actual melting of the stock is effected by reason of the contact of its lower end with the bottom of the sump and the molten metal retained therein. Molten metal in excess of the amount retainable in the sump overflows the wall 15, passing through the notch 52 therein and to the duct 51 by gravity. Air passing through the orifice of jet 17 across jet 16 draws through jet 16 such molten metal as has spilled through notch 52 into the duct 51. Since the duct 51 is open to the atmosphere through the chamber 14 of the head, well removed from the edge of the wall 15, there is no tendency for dross to be drawn from the sump either across the edge of the wall or through the notch 52 formed therein. Surface tension between the dross particles floating on the surface of the molten metal in the sump, and the restricted size of the notch 52 and the stream of metal capable of passing therethrough, prevent dross from flowing into the duct 51 by flotation upon the stream of clean metal. For the purpose of preheating objects to be sprayed, as well as heating previously deposited coatings or fillings so that their surfaces may be worked, the second torch may be brought into play merely by opening the valve 47 and igniting the gas at the orifice 33. During this use of the pistol, the stock 31 is withdrawn and the valve 41 controlling the stock heating torch is closed. As a rule, the absorption of heat from the second torch by the upper portions of the head 10 will be sufficient to maintain the chamber 14 sufficiently heated that spraying may be resumed almost immediately after the stock-heating torch is relighted.

In Figs. 6 and 7, I have disclosed a slightly modified sump construction for preventing the passage of dross to the duct 51. In this metal-spraying pistol the general construction is identical with that previously described, with the exception that, instead of a notch 52 in the sump wall 15, there is provided an aperture 53 adjacent the top edge of the wall 15, which aperture serves the same function as the notch 52, namely, permitting only clean, dross-free molten metal to pass from the sump to the duct 51.

In Figs. 8 and 9 I have disclosed another means of withholding dross, floating upon the surface of the molten metal in the sump, from being carried over the wall 15 and into the duct 51 by flotation upon clean metal flowing thereover. In this construction there is provided, slightly inward of the top edge of the wall 15, a rod or pin 54 anchored at its ends in the walls of the chamber 14 and set at such a level, with respect to the top edge of the wall 15, that it will be in contact with the surface of the molten metal. Thus, dross floating upon the surface of the metal in the sump will be disposed in a plane above the lower edge of the rod or pin 54, and, due to its buoyancy, can not escape therebeneath to be carried over the edge of the wall 15 by flotation upon overflowing clean molten metal. Even though the accumulation of dross upon the surface of the metal in the sump reach considerable thickness, it will be retained by the pin 54, due to surface tension or cohesive character.

It will also be noted that, by arranging the outlet from the sump at a level well above its bottom, a quantity of molten metal is always retained therein, regardless of the rate at which the metal is sprayed. Since the sump also constitutes a receptacle for holding the lower end of the as yet unmolten stock in position, this quantity of molten metal maintained in the sump serves as a heat-transferring medium between the sump walls and the surface of the unmolten stock, facilitating uniform melting thereof with low torch heats.

While I have disclosed what I regard to be preferred embodiments of my invention, I am aware that the disclosed construction may be varied considerably without departing from the scope of my invention. For example, instead of one notch 52, several may be provided, even to the extent of making the top edge of the wall 15 serrate in character. Likewise, instead of one perforation as shown in Figs. 6 and 7, there may be two or more, or the perforation may be of form other than circular. Other changes of a similar nature may appear to those skilled in the art. I, therefore, claim my invention broadly, as indicated by the appended claims.

What I claim is:

1. In a metal-spraying pistol, an atomizing nozzle for projecting metal in spray form and including a jet for compressed air and a jet for molten metal, a receptacle into which metal stock to be sprayed is continuously chargeable during the spraying operation, means for heating said stock as charged to provide a continuous supply of molten metal, a sump at the base of said receptacle and out of direct communication with said molten-metal jet, which sump receives and retains stock as it is reduced to the molten state, a duct having its inlet end disposed adjacent said sump, external thereof, and having its other end in communication with said molten-metal jet, and molten-metal filtering means associated with said sump, and arranged to discharge, by gravity, into said duct, said last-mentioned means comprising a spillway or weir built into a wall of said sump, said spillway being of such form, relative to the dimensions of said sump, as to restrain and preclude the passage of dross therethrough by flotation upon the stream of molten metal discharged through said spillway.

2. In a metal-spraying pistol, an atomizing nozzle for projecting metal in spray form and including a jet for compressed

air and a jet for molten metal, a receptacle into which metal stock to be sprayed is continuously chargeable during the spraying operation, means for heating said stock as charged to provide a continuous supply of molten metal, a sump at the base of said receptacle and out of direct communication with said molten-metal jet, which sump receives and retains stock as it is reduced to the molten state, a duct having its inlet end disposed adjacent said sump, external thereof, and having its other end in communication with said molten-metal jet, and molten-metal filtering means associated with said sump, and arranged to discharge, by gravity, into said duct, said last-mentioned means comprising a spillway or weir built into a wall of said sump, said spillway having a length less than the diameter of said sump so that the film of dross normally floating upon the surface of the molten metal in said sump will, by reason of the cohesion normally existent between its particles, be restrained against passage through said spillway by flotation upon the molten metal leaving said sump.

3. In a metal spraying pistol, an atomizing nozzle for projecting metal in spray form and including a jet for compressed air and a jet for molten metal, a receptacle into which metal stock to be sprayed is continuously chargeable during the spraying operation, means for heating said stock as charged to provide a continuous supply of molten metal, a sump at the base of said receptacle and out of direct communication with said molten-metal jet, which sump receives and retains stock as it is reduced to the molten state, a duct having its inlet end disposed adjacent said sump, external thereof, and having its other end in communication with said molten-metal jet, and molten-metal filtering means associated with said sump, and arranged to discharge, by gravity, into said duct, said last-mentioned means comprising a spillway or weir built into a wall of said sump, said spillway being defined by an aperture in said sump wall directly adjacent its upper edge, and serving to permit metal melted in excess of the capacity of said sump to discharge therefrom without carrying particles of dross therewith by flotation.

4. In a metal-spraying pistol, an atomizing nozzle for projecting metal in spray form and including a jet for compressed air and a jet for molten metal, a receptacle into which metal stock to be sprayed is continuously chargeable during the spraying operation, means for heating said stock as charged to provide a continuous supply of molten metal, a sump at the base of said receptacle and out of direct communication with said molten-metal jet, which sump receives and retains stock as it is reduced to the molten state, a duct having its inlet end disposed adjacent said sump, external thereof, and having its other end in communication with said molten-metal jet, and molten-metal filtering means associated with said sump, and arranged to discharge, by gravity, into said duct, said last-mentioned means comprising a spillway or weir built into a wall of said sump, said spillway having the form of a small perforation in the wall of said sump at a point beneath the top edge thereof, said perforation being of such size as to allow metal melted in excess of the capacity of said sump to flow therethrough from a level beneath the floating dross film in a stream of such form as to be incapable of carrying dross therethrough by flotation.

5. In a metal-spraying pistol, an atomizing nozzle for projecting metal in spray form and including a jet for compressed air and a jet for molten metal, a receptacle into which metal stock to be sprayed is continuously chargeable during the spraying operation, means for heating said stock as charged to provide a continuous supply of molten metal, a sump at the base of said receptacle and out of direct communication with said molten-metal jet, which sump receives and retains stock as it is reduced to the molten state, a duct having its inlet end disposed adjacent said sump, external thereof, and having its other end in communication with said molten-metal jet, and molten-metal filtering means associated with said sump, and arranged to discharge, by gravity, into said duct, said last-mentioned means comprising a spillway constituted by a portion of the sump-defining wall which is of lesser height than the major portion of the sump-defining wall, and a dross guard therefor consisting of a bar disposed substantially parallel to and slightly inward of the crest of said spillway, the lower edge of which bar extends beneath the normal level at which molten metal stands in said sump, so that molten metal overflowing said spillway is drawn from a level beneath that at which the dross film stands in said sump.

6. In a metal-spraying pistol, an atomizing nozzle for projecting metal in spray form and including a jet for compressed air and a jet for molten metal, a receptacle into which metal stock to be sprayed is continuously chargeable during the spraying operation, means for heating said stock as charged to provide a continuous supply of molten metal, a sump at the base of said receptacle and out of direct communication with said molten-metal jet, which sump receives and retains stock as it is reduced to the molten state, a duct having its inlet end disposed adjacent said sump, external thereof, and having its other end in communication with said molten-metal jet, and molten-metal filtering means associated with said sump, and arranged to discharge, by gravity, into said duct, said last-mentioned means comprising a spillway or weir constituted by a portion of the sump-defining wall which is of a lesser height than the major portion of the sump-defining wall and is provided with a slightly serrate top edge such that molten metal in excess of the capacity of the sump flows thereacross in a thin stream incapable of carrying sump dross therewith by flotation.

DONALD D. TAYLOR