

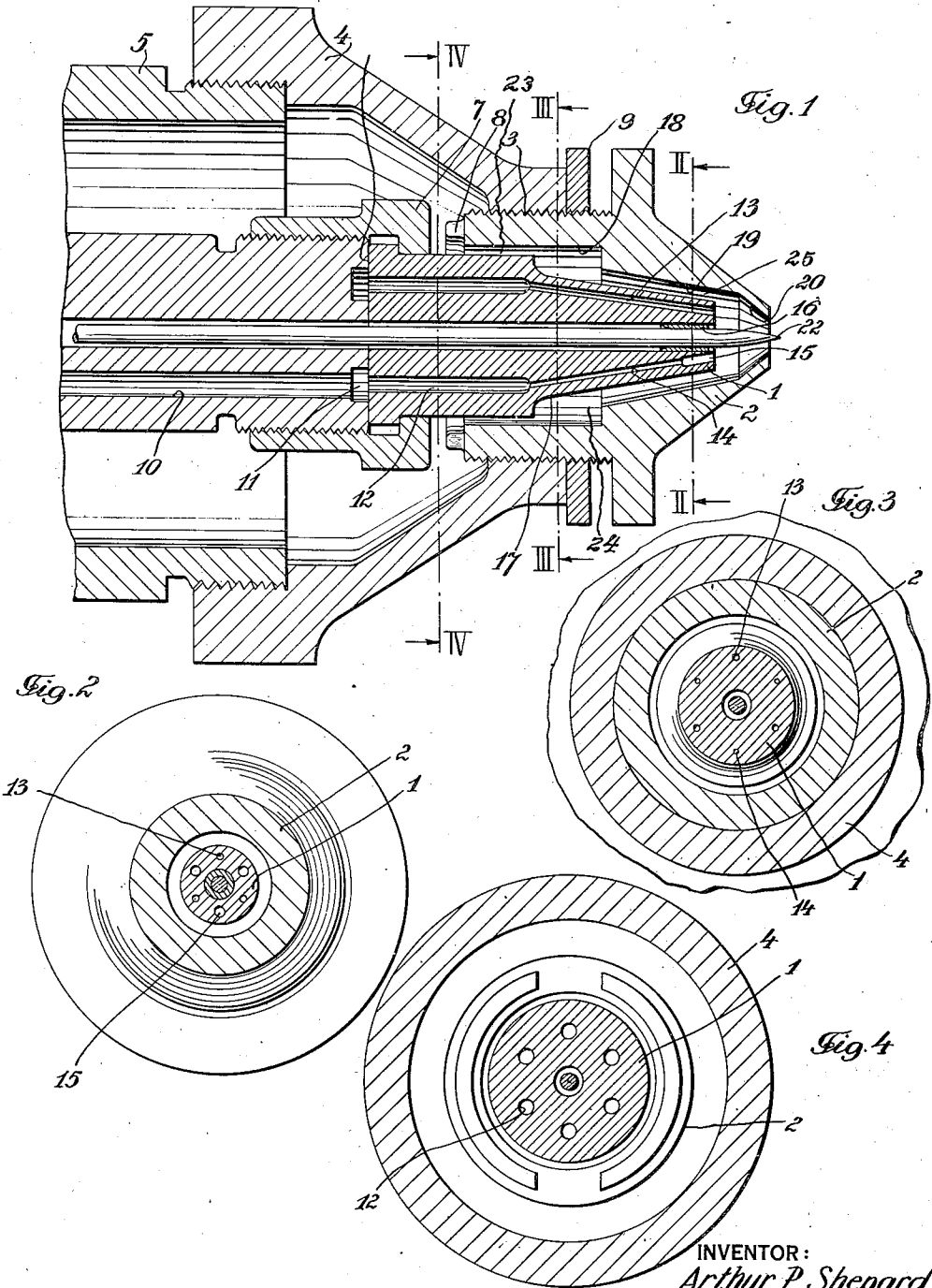
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METAL SPRAY GUN

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## METAL SPRAY GUN

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This invention relates to improvements in metal spray guns.

Metal spray guns of the wire feeding gas blast type are devices in which a metal rod or wire is continuously fed into a melting zone in which the metal is melted, being thereafter finely divided and expelled from the gun in sub-divided form by a blast of air or other gas. A mixture of combustible and combustion supporting gases, such as an air or oxygen and acetylene or propane mixture, are fed to the melting zone through suitable jets surrounding the feeding path of the metal rod or wire and, when ignited, cause the melting of the same. Air or other gas is forcefully directed against the molten metal at the tip of the metal rod or wire in such manner that it impinges sharply against the tip to thereby substantially blast the metal into fine particles. The nozzle construction of metal spray guns of the type in question usually includes a burner tip, provided with a wire feeding orifice and a multiple number of burner jets, substantially surrounding the axis of said orifice, and an air cap, extending with a portion of its inner surface, adjacent the air cap tip, to in advance of said orifice, preferably in substantially converging relation to said axis, and defining with a backwardly extending portion of its inner surface and with said burner tip a gas blast passage. It is to such nozzle construction that the invention primarily relates.

The hitherto used metal spray guns of the wire feeding gas blast type are of relatively low spraying speed and efficiency and are subject to the danger of backfiring, i. e., the ignition of the combustible gas mixture inside the gas jets or the gas passages.

I have devised an improved nozzle construction for a metal spray gun of the wire feeding gas blast type permitting a more efficient and higher speed spraying of metal with a materially reduced tendency to backfire, than was hitherto possible with conventional devices.

The invention will be more fully understood from the following description read in conjunction with the drawing illustrating a preferred embodiment of the structure in accordance with the invention in which—

Fig. 1 is a vertical section through a preferred embodiment of a nozzle construction in accordance with my invention;

Fig. 2 is an end view of the construction illustrated in Fig. 1 in the plane indicated by II—II;

Fig. 3 is a sectional view of the burner tip por-

tion of the construction illustrated in Fig. 1 in the plane indicated by III—III, and

Fig. 4 represents a sectional view of the burner tip and air cap portion of the construction illustrated in Fig. 1 on the plane indicated by IV—IV.

Referring to the drawing, 1 represents the inner nozzle or burner tip; 2 represents the air cap which is adjustably screwed by a thread 3 into a housing 4. The housing 4 is secured to the gun head 5 of which only part is shown in the drawing. The inner nozzle or burner tip 1 is seated on the flat seat 6 of head 5 and is held there securely by nut 7. Air cap 2 has two slots cut in its rim at 8 as illustrated in Figs. 1 and 4. Lock nut 9 is provided for securing air cap 2 in any desired position. A port 10 leads from a mixing chamber for combustible and combustion-supporting gases (not shown), to circular channel 11 cut in the flat seat 6. Inner nozzle or burner tip 1 is provided with a multiple number of gas passages 12. Communicating with these gas passages are burner jets 13 and 14. These burner jets 13 and 14 are alternately spaced as indicated in Fig. 3. Burner jets 13 extend to the tip of the inner nozzle, while burner jets 14 communicate with enlarged jet portions 15. Enlarged jet portions 15 extend to the discharge end of the inner nozzle or burner tip as indicated in Fig. 1. Mounted at the discharge end of inner nozzle or burner tip 1 is a bushing 16 which is set back slightly from the burner jet openings. Burner tip 1 is constructed with a substantially cylindrical surface 17 which extends into and is concentric with the cylindrical surface or bore 18 of the air cap 2. Part of the inner surface of air cap 2 has a conical surface 19 with a comparatively shallow angle of slope relative the air cap axis or the axis of the wire feeding orifice. This first conical surface 19 adjoins a second conical surface 20, adjacent the air cap tip, with a comparatively steeper angle of slope relative such axis. The surface at the juncture of the two conical sections 19 and 20 is preferably curved slightly as at 21. The rod-like shape of metal 22 extends through wire feeding orifice formed by guide bushing 16 in the inner nozzle or burner tip 1.

In the practical operation of the improved gun nozzle structure in accordance with my invention, a mixture of combustible and combustion supporting gases enters through gas passage 10 and thence through channel 11 to gas passages 12 in the inner nozzle or burner tip 1. Gas passages 12, alternately connected with burner jets

13 and 14 permit the combustible mixture of gases to flow to the discharge end of inner nozzle or burner tip 1. The gas entering burner jets 13 passes directly to the discharge end of the burner tip whereas the gas entering burner jets 14 flows first through enlarged jet portions 15 before passing to the discharge end of the burner tip 1. Burner jets 13 are larger in cross-sectional area than burner jets 14, whereas enlarged burner jet portions 15, preferably obtained by counterboring or countersinking burner jets 14, are of larger cross-sectional area than jets 14. In many cases it is of advantage and preferred to construct enlarged jet portions 15 also of larger cross-sectional area than burner jets 13. When resorting to such construction the combustible gas mixture entering gas passages 13 from channel 11, under substantially the same pressure, permits a greater volume of gas to flow through the wider jets 13 than flows through the smaller jets 14. This particular distribution of the combustible gases substantially eliminates the shrill undesirable whistle which sometimes occurs when the same volume of gas is permitted to discharge from each of the burner jets which is especially noticeable when using propane as the combustible gas component of the mixture. In most instances a few thousandth of an inch difference between the cross-sectional areas of burner jets 13 and 14 will give the desired result. The flames issuing from the enlarged jet portions, such as jet portions 15, are shorter than the flames issuing from the discharge end of the non-enlarged jets, such as jets 13. When enlarged jet portions are substantially evenly distributed among the burner jets surrounding the axis of the wire feeding orifice and particularly when such enlarged burner jet portions alternate with non-enlarged burner jet openings, as illustrated in the preferred embodiment of the invention shown in the drawing, a substantially ribbed-like flame is produced with the hot tip of the flames, issuing from burner jets 13, projecting farther than the hot tips of the flames, issuing from the burner jets 15, in which manner the melting zone is considerably elongated. This longer heating zone permits a more rapid melting of the metal and even of relatively high melting point metals so that the metal wire or rod 22 passing through the wire feeding orifice as defined by the bushing 16 may be fed more rapidly through the nozzle and permits a more efficient and speedier spraying operation. As shown in the drawing, the wire feeding orifice through the bushing 16 is set back slightly relative the discharge ends or openings of burner jets 13 and 14. Such construction greatly reduces the hazards of backfiring and thus permits the use of a greater combustible gas flow with a resultant increase in spraying speed and efficiency. When used in conjunction with other structural elements of the improved construction in accordance with the invention, tending to enhance spraying speed and efficiency or to reduce backfire hazards, it will still further enhance these advantages.

Air or other blasting gas enters chamber 26 under pressure from an inlet duct (not shown). This blasting gas passes through a substantially annular pressure reduction orifice 23, substantially defined by the cylindrical surface 18, formed on the backwardly extending portion of the inner surface of the air cap 2, and the cylindrical surface 17, formed by a part of the back-

wardly extending surface of the inner nozzle or burner tip 1. After passing the pressure reduction orifice 23 the blasting gas enters chamber 24 and flows thence through the space between the sloped inner surface 19 of air cap 2 and the surface of the conical end of the inner nozzle or burner tip 1, defining annular orifice 25, and out through the discharge end of the air cap 2. The inner surface 20 of the air cap 2, adjacent the discharge end thereof, has an average angle of slope, with respect to the axis of the wire feeding orifice, greater than the average angle of slope, with respect to such axis, of its adjoining inner surface portion 19. As illustrated, both surface portions 19 and 20 each form a conical surface, the conical surface 20 having a greater average angle of slope, with respect to the axis of the wire feeding orifice, than has the conical surface 19. The blasting gas, passing with relatively high velocity through annular orifice 25, is deflected at a relatively small angle to the axis of the wire feeding orifice by the lesser sloped surface 19 of air cap 2. This relatively shallow angle of surface 19 permits the blasting gas to pass outside of the envelope of flame in advance of the inner nozzle or burner tip 1 before being deflected by the steeper angled inner air cap surface 20. The blasting gas will thus converge at the most desirable steep angle at a point sufficiently in advance of the flame envelope to substantially avoid the building up of a detrimental back pressure at the discharge end of the inner nozzle or burner tip 1. The rapid and relatively steep angled convergence of the blasting gas at the molten tip of the metal wire or rod produces a very fine and complete break-up or atomization of the metal and blasts the same forward in a strong fine spray. In this manner a more efficient and speedier spraying operation is realized and, when using such construction in conjunction with the burner jet construction in accordance with the invention, the increase in spraying efficiency and speed, already greatly improved by such jet construction, is still further enhanced by this inner surface double slope improvement in the air cap. The material reduction in back pressure at the discharge end of the inner nozzle or burner tip 1, obtained when using the inner surface double slope construction, in accordance with the invention, considerably lessens the tendency to backfire. This beneficial effect is still further enhanced by utilizing this construction in conjunction with other structural features of my improved nozzle construction which possess such backfire hazard reducing effect.

When using the inner air cap surface double slope construction, in accordance with the invention, I have found it of advantage to utilize an average angle of slope, with respect to the axis of the wire feeding orifice, of the surface portion adjacent the air cap tip, of approximately 5 to 15 degrees and preferably of 10 to 11 degrees and an average angle of slope, relative such axis, of the gas blast passage delimiting portion of its inner surface, of approximately 3 to 12 degrees and preferably of  $5\frac{1}{2}$  to  $6\frac{1}{2}$  degrees.

The provision of an air reduction orifice of substantially constant cross-sectional area throughout a given longitudinal adjustment of the air cap permits the adjustment of the air cap 2 with respect to the discharge end of the burner tip 1 without materially affecting the quantity of flow of the blasting gas and irrespective of whether the air cap is moved towards or away from the burner

tip. This construction also aids in increasing the spraying efficiency and speed and further aids in materially reducing the danger of backfiring as it tends to eliminate the building up of back pressure which would result when moving the air cap towards the burner tip in the absence of the substantially constant cross-sectional area pressure reduction orifice, in accordance with the invention.

Air cap 2 is preferably provided adjacent its threaded end 3 as shown in Figs. 1 and 4 with slots 8 to prevent the possibility of accidentally shutting off the gas blast supply from chamber 26 by screwing the air cap 2 back too far until the back of its end strikes nut 7. With the provision of such slots 8 sufficient air will pass through these slots even if the air cap 2 is screwed back as far as it will go.

The foregoing description is furnished by way of illustration and not of limitation and it is, therefore, my intention that the invention be limited only by the appended claims or their equivalents wherein I have endeavored to claim broadly all inherent novelty.

I claim:

1. In the nozzle construction of a wire feeding metal spray gun of the gas blast type, including a burner tip provided with a wire feeding orifice, a multiple number of burner jets substantially surrounding the axis of said orifice and means to supply a combustible gas through said jets, the improvement comprising an air cap having a first inner surface portion immediately surrounding said burner tip, defining therewith at least one gas blast passage, starting at a point prior to said orifice and having only one other second inner surface portion extending said gas blast passage to in advance of said orifice, and directing gas blast, issuing from said gas blast passage, against the molten tip of the wire feeding through said orifice, the average angle of slope, with respect to said axis of said second inner surface portion being greater than the average angle of slope, with respect to said axis, of said first inner surface portion.

2. The improvement in accordance with claim 1 in which said first and second inner surface portions each defines a conical surface.

3. In the nozzle construction of a wire feeding metal spray gun of the gas blast type, including a burner tip provided with a wire feeding orifice, a multiple number of burner jets substantially surrounding the axis of said orifice and means to supply a combustible gas through said jets, the improvement comprising an air cap, substantially longitudinally adjustable with respect to said burner tip and having a first inner surface portion immediately surrounding said burner tip defining therewith at least one gas blast passage, starting at a point prior to said orifice and having only one other second inner surface portion extending said gas blast passage to in advance of said orifice, and directing gas blast, issuing from said gas blast passage, against the molten tip of the wire feeding through said orifice, the average angle of slope with respect to said axis of said second inner surface portion being greater than the average angle of slope, with respect to said axis, of said first inner surface portion, said burner tip and said air cap having cooperating backwardly extending surfaces, and, in communication with said gas blast passage, a blasting gas pressure reduction orifice of substantially constant cross-sectional area throughout a given longitudinal adjustment of said air cap, said pres-

sure reduction orifice being defined by at least part of said backwardly extending surfaces.

4. The improvement in accordance with claim 3 in which said blasting gas pressure reduction orifice is a substantially annular orifice and in which said backwardly extending surfaces form substantially cylindrical surfaces substantially co-axially aligned with said burner tip.

5. In the nozzle construction of a wire feeding metal spray gun of the gas blast type, including a burner tip provided with a wire feeding orifice, a multiple number of burner jets substantially surrounding the axis of said orifice and means to supply a combustible gas through said jets, the improvement comprising an air cap, substantially longitudinally adjustable with respect to said burner tip and having a first inner surface portion immediately surrounding said burner tip, defining therewith at least one gas blast passage, starting at a point prior to said orifice and having only one other second inner surface portion extending said gas blast passage to in advance of said orifice, and directing gas blast, issuing from said gas blast passage, against the molten tip of the wire feeding through said orifice, said burner tip and said air cap having cooperating backwardly extending surfaces, and, in communication with said gas blast passage, a blasting gas pressure reduction orifice of substantially constant cross-sectional area throughout a given longitudinal adjustment of said air cap, said pressure reduction orifice being defined by at least part of said backwardly extending surfaces.

6. The improvement in accordance with claim 5 in which said blasting gas pressure reduction orifice is a substantially annular orifice and in which said backwardly extending surfaces form substantially cylindrical surfaces substantially co-axially aligned with said burner tip.

7. In the nozzle construction of a wire feeding metal spray gun of the gas blast type, including a burner tip provided with a wire feeding orifice, a multiple number of burner jets substantially surrounding the axis of said orifice and means to supply a combustible gas through said jets, the improvement comprising an air cap, substantially longitudinally adjustable with respect to said burner tip and having a first inner surface portion immediately surrounding said burner tip, defining therewith at least one gas blast passage, starting at a point prior to said orifice and having only one other second inner surface portion extending said gas blast passage to in advance of said orifice, and directing gas blast, issuing from said gas blast passage, against the molten tip of the wire feeding through said orifice, the average angle of slope, with respect to said axis of said second inner surface portion being greater than the average angle of slope, with respect to said axis, of said first inner surface portion, and a multiple number of burner jets, at least some of which being, at least at their end portions, adjacent the jet openings, of larger cross-sectional area than the remaining jets, at least at their end portions, adjacent the jet openings.

8. The improvement in accordance with claim 7 in which at least some of said burner jets are at their end portions, adjacent the jet openings, of larger cross-sectional area than the jet portions, extending backwardly therefrom.

9. The improvement in accordance with claim 7 in which each alternate of said burner jets is at its end portion, adjacent the jet opening, of larger cross-sectional area than its jet portion, extending backwardly therefrom and of larger

cross-sectional area than the corresponding jet portions of the other burner jets.

10. The improvement in accordance with claim 7 in which each alternate of said burner jets is at its end portion, adjacent the jet opening, of larger cross-sectional area than its jet portion extending backwardly therefrom and in which said backwardly extending jet portion is of smaller cross-sectional area than the jet portions of smallest cross-sectional area of the other burner jets.

11. In the nozzle construction of a wire feeding metal spray gun of the gas blast type, including a burner tip provided with a wire feeding orifice, a multiple number of burner jets substantially surrounding the axis of said orifice, means to supply a combustible gas through said jets and an air cap having a first inner surface portion immediately surrounding said burner tip defining therewith at least one gas blast passage and having a second inner surface portion extending to in advance of said orifice, and directing gas blast, issuing from said gas blast passage, against the molten tip of the wire feeding through said orifice, the improvement comprising a multiple number of burner jets, at least some of which being, at least at their end portions, adjacent the jet openings, of larger cross-sectional area than the remaining jets, at least at their end portions, adjacent the jet openings.

12. In the nozzle construction of a wire feeding metal spray gun of the gas blast type, including a burner tip provided with a wire feeding orifice, a multiple number of burner jets substantially surrounding the axis of said orifice, means to supply a combustible gas through said jets and an air cap having a first inner surface portion immediately surrounding said burner tip defining therewith at least one gas blast passage and having a second inner surface portion extending to in advance of said orifice, and directing gas blast, issuing from said gas blast passage, against the molten tip of the wire feeding through said orifice, the improvement comprising a multiple number of burner jets, at least some of which being at their end portions, adjacent the jet openings, of larger cross-sectional area than the jet portions, extending backwardly therefrom.

13. In the nozzle construction of a wire feeding metal spray gun of the gas blast type, including a burner tip provided with a wire feeding orifice, a multiple number of burner jets substantially surrounding the axis of said orifice, means to supply a combustible gas through said jets and an air cap having a first inner surface portion immediately surrounding said burner tip, defining therewith at least one gas blast passage, starting at a point prior to said orifice and having only one other second inner surface portion extending said gas blast passage to in advance of said orifice, and directing gas blast, issuing from said gas blast passage, against the molten tip of the wire feeding through said orifice, the improvement comprising a multiple number of burner jets, each alternate of which being at its end portion, adjacent the jet opening, of larger cross-sectional area than its jet portion extending backwardly therefrom, said backwardly extending jet portion being of smaller cross-sectional area than the jet portions of smallest cross-sectional area of the other burner jets.

14. In the nozzle construction of a wire feeding metal spray gun of the gas blast type, including a burner tip provided with a wire feeding orifice, a multiple number of burner jets substantially

surrounding the axis of said orifice and means to supply a combustible gas through said jets, the improvement comprising an air cap, substantially longitudinally adjustable with respect to said burner tip and having a first inner surface portion immediately surrounding said burner tip, defining therewith at least one gas blast passage, starting at a point prior to said orifice and having only one other second inner surface portion extending said gas blast passage to in advance of said orifice, and directing gas blast, issuing from said gas blast passage, against the molten tip of the wire feeding through said orifice, the average angle of slope, with respect to said axis of said second inner surface portion being greater than the average angle of slope, with respect to said axis, of said first inner surface portion, a multiple number of burner jets, each alternate of which being at its end portion, adjacent the jet opening, of larger cross-sectional area than its jet portion extending backwardly therefrom, said backwardly extending jet portion being of smaller cross-sectional area than the jet portions of smallest cross-sectional area of the other burner jets, said burner tip and said air cap having cooperating backwardly extending surfaces, and, in communication with said gas blast passage, a substantially annular blasting gas pressure reduction orifice of substantially constant cross-sectional area throughout a given longitudinal adjustment of said air gap, said pressure reduction orifice being defined by at least part of said backwardly extending surfaces to form substantially cylindrical surfaces having a substantially common axis with said burner tip.

15. In the nozzle construction of a wire feeding metal spray gun of the gas blast type, including a burner tip provided with a wire feeding orifice, a multiple number of burner jets substantially surrounding the axis of said orifice and means to supply a combustible gas through said jets, the improvement comprising an air cap, substantially longitudinally adjustable with respect to said burner tip and having a first inner surface portion immediately surrounding said burner tip, defining therewith at least one gas blast passage, starting at a point prior to said orifice and having only one other second inner surface portion extending said gas blast passage to in advance of said orifice, and directing gas blast, issuing from said gas blast passage, against the molten tip of the wire feeding through said orifice, the average angle of slope, with respect to said axis of said second inner surface portion being greater than the average angle of slope, with respect to said axis, of said first inner surface portion, and a wire feeding orifice set back relative to at least some of the burner jet openings.

16. In the nozzle construction of a wire feeding metal spray gun of the gas blast type, including a burner tip provided with a wire feeding orifice, a multiple number of burner jets substantially surrounding the axis of said orifice, means to supply a combustible gas through said jets and an air cap having a first inner surface portion immediately surrounding said burner tip defining therewith at least one gas blast passage and having a second inner surface portion extending to in advance of said orifice, and directing gas blast, issuing from said gas blast passage, against the molten tip of the wire feeding through said orifice, the improvement comprising a wire feeding orifice set back relative to at least some of the

burner jet openings and the face of the burner tip.

17. In the nozzle construction of a wire feeding metal spray gun of the gas blast type, including a burner tip provided with a wire feeding orifice, a multiple number of burner jets substantially surrounding the axis of said orifice and means to supply a combustible gas through said jets, the improvement comprising an air cap, substantially longitudinally adjustable with respect to said burner tip and having a first inner surface portion immediately surrounding said burner tip, defining therewith at least one gas blast passage, starting at a point prior to said orifice and having only one other second inner surface portion extending said gas blast passage to in advance of said orifice, and directing gas blast, issuing from said gas blast passage, against the molten tip of the wire feeding through said orifice, the average angle of slope, with respect to said axis, of said second inner surface portion being greater than the average angle of slope, with respect to said axis, of said first inner surface portion, said first inner surface portion defining a first conical sur-

face and said second inner surface portion defining a second conical surface, a multiple number of burner jets, each alternate of which being at its end portion, adjacent its jet opening, of larger cross-sectional area than its jet portion extending backwardly therefrom, said backwardly extending jet portion being of smaller cross-sectional area than the jet portions of smallest cross-sectional area of the other burner jets, a wire feeding orifice set back relative the burner jet openings and the face of the burner tip, said burner tip and said air cap having cooperating backwardly extending surfaces, and, in communication with said gas blast passage, a substantially annular blasting gas pressure reduction orifice of substantially constant cross-sectional area throughout a given longitudinal adjustment of said air cap, said pressure reduction orifice being defined by at least part of said backwardly extending surfaces to form substantially cylindrical surfaces having a substantially common axis with said burner tip.

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