March 26, 1946. A. P. SHEPARD 2,397,165

GUN CONSTRUCTION FOR GAS BLAST SPRAYING HEAT-FUSIBLE MATERIALS

Filed Oct. 25, 1943 3 Sheets-Sheet 1

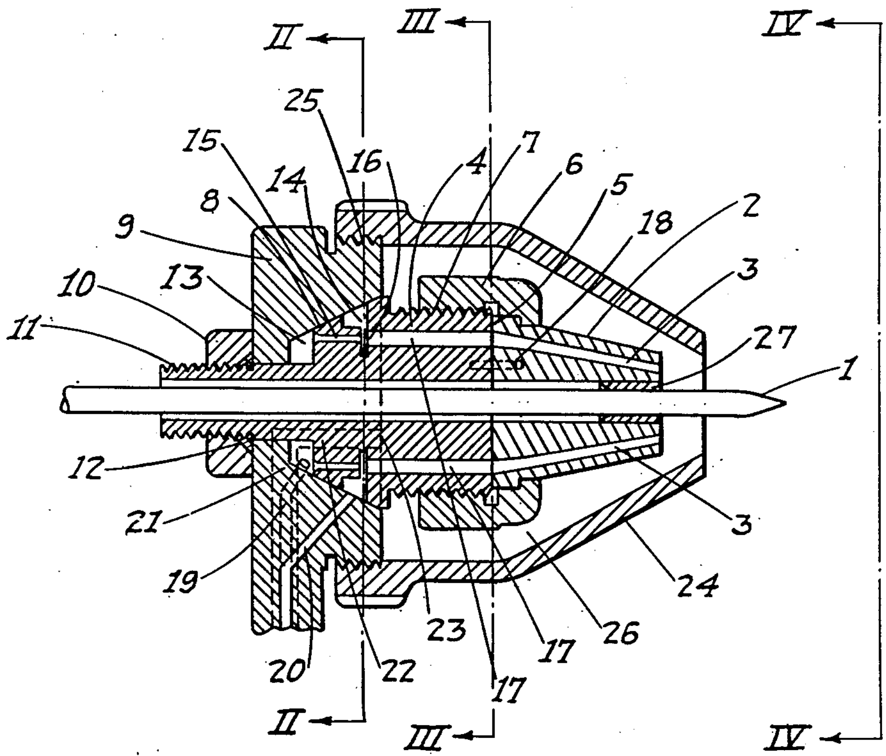

Fig. 1

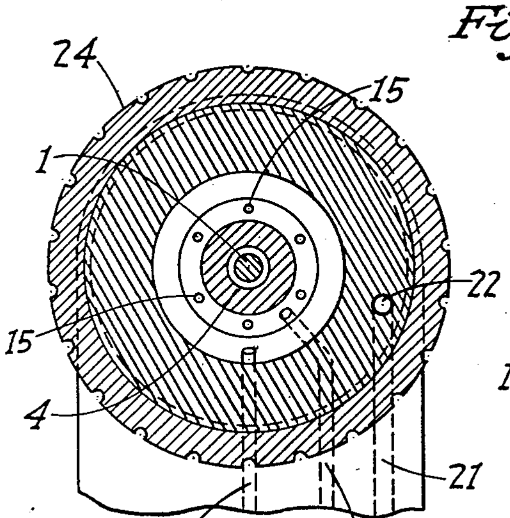

Fig. 2

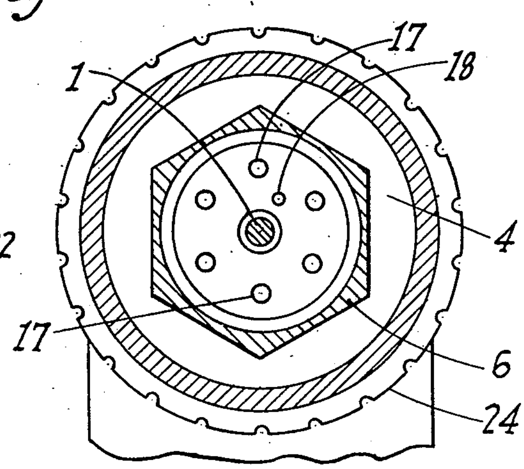

Fig. 3

Inventor
Arthur P. Shepard
By Burgess + Dinklage
Attorneys

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Filed Oct. 25, 1943 3 Sheets-Sheet 2

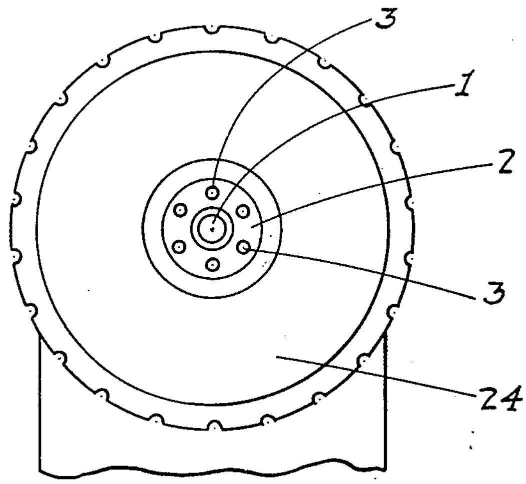

Fig. 4

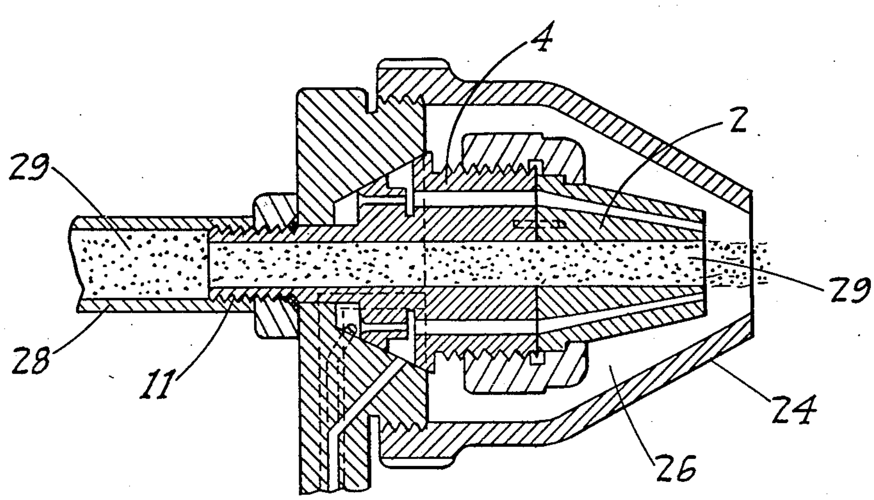

Fig. 5

Inventor
Arthur P. Shepard
By Burgess & Dinklage
Attorneys

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GUN CONSTRUCTION FOR GAS BLAST SPRAYING HEAT-FUSIBLE MATERIALS

Filed Oct. 25, 1943 3 Sheets-Sheet 3

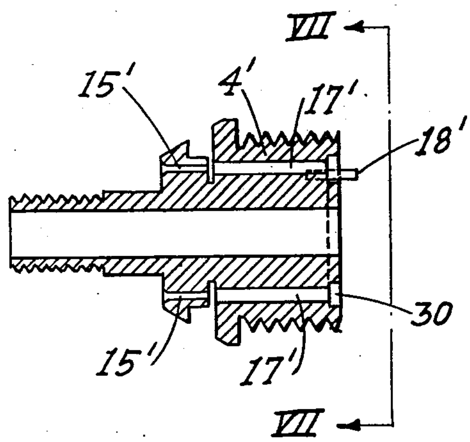

Fig. 6

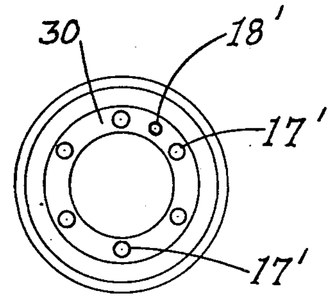

Fig. 7

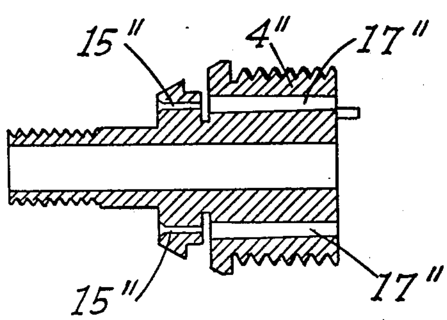

Fig. 8

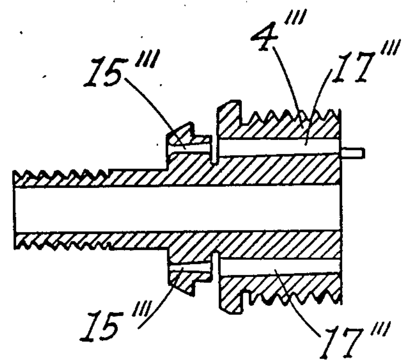

Fig. 9

Inventor
Arthur P. Shepard
By Burgess + Dinklage
Attorneys

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UNITED STATES PATENT OFFICE

2,397,165

GUN CONSTRUCTION FOR GAS BLAST SPRAYING HEAT-FUSIBLE MATERIALS

Arthur P. Shepard, Flushing, N. Y., assignor to Metallizing Engineering Co., Inc., Long Island City, N. Y., a corporation of New Jersey

Application October 25, 1943, Serial No. 507,528

12 Claims. (Cl. 91—12.2)

This invention relates to improvements in gun construction for gas blast spraying heat-fusible materials. Heat-fusible material spray guns of the gas blast type are devices in which such material is fed into a melting zone in which it is melted, being thereafter expelled from the gun in subdivided form by a blast of air or other gas. The materials to be sprayed may be fed into the melting zone either in the form of a rod or wire or in the form of powder. A mixture of fuel gas and combustion supporting gas such as a mixture of acetylene or propane and air or oxygen is fed to the melting zone through suitable jets which discharge the combustible gas mixture which when ignited causes the melting of the metal. When powder is used, the same may not always be completely melted as in some cases only some of the powder is melted, or some of the particles of powder may be only partially melted or heat softened. In cases where a wire or rod is used, air or other gas is forcefully directed against the molten material at the tip of the rod or wire in such manner that it impinges sharply against the tip to thereby substantially blast the material into fine particles. The construction of heat-fusible material spray guns of the gas blast type usually includes a combustible-gas nozzle or burner tip which is provided with a material feeding conduit and a multiple number of combustible-gas jets, substantially surrounding the axis of the feeding conduit, and a blast gas nozzle surrounding the combustible-gas nozzle and the feeding conduit. It is to such construction that the invention primarily relates.

Spray guns of the above described type are well known for the spraying of metal, and for convenience the following description is made in connection with metal spray gun constructions, it being understood that the principles of the invention are applicable to constructions using other heat-fusible materials, as for instance, plastics.

The hitherto used spray guns of the gas blast type, in which the heat-fusible material to be sprayed is for instance metal, are of relatively low spraying speed and efficiency and are subject to the danger of backfiring, i. e.: ignition of a combustible gas mixture inside the gas jets or the gas passages. Guns of this type require for satisfactory operation the accurate maintenance of a predetermined pressure relationship between the fuel gas and the combustion supporting gas. This has required that accurate regulators be used and that considerable care be exercised by the operator in obtaining and maintaining the proper pressure relationship between the two gases. If this proper pressure relationship is not maintained even a relatively slight change in the pressure of either the combustible or the combustion supporting gas or both will cause the flame at the tip of the combustible-gas nozzle to become unbalanced in that either there is an excess of fuel gas or an excess of combustion supporting gas, according to the direction of the unbalance. This unbalanced flame condition causes greatly reduced spraying speeds and loss of efficiency and in some cases causes backfiring of the flame into the combustible-gas nozzle. Another disadvantage of hitherto used metallizing guns is the fact that they require a supply of fuel gas at a relatively high pressure and if not so supplied with high pressure fuel gas, will either not operate at all or will operate with materially reduced spraying speeds. On the other hand, it is often disadvantageous to supply fuel gas to a metallizing gun at high pressure. For instance, as is well known, the use of acetylene above a pressure of fifteen pounds per square inch gauge is considered hazardous because of the danger of disassociation of the acetylene. Further, some gases are not normally supplied at high pressure. Natural gas and coal gas for example, which are sometimes used for metallizing guns, are usually supplied at relatively low pressures. For this reason, when these gases are used for metallizing guns, it has in the past been necessary that elaborate and expensive compressor equipment be installed between the gas source and the metallizing gun to raise the gas pressure to that required by the gun.

One object of this invention comprises, inter alia, a heat-fusible material spray gun of the gas blast type construction which overcomes the foregoing and other disadvantages.

A further object of this invention is a heat-fusible material blast gas spray gun construction which permits use of a combustion supporting gas at a relatively high pressure and a fuel gas at a relatively low pressure.

Another object of this invention is a gun construction of the type referred to which is comparatively little sensitive to relatively large variations in the pressures of either one or both of the fuel gas and the combustion supporting gas, i. e.: a gun in which the relative quantitative relation between the fuel gas and the combustion supporting gas in the flame changes relatively little with a relatively large change in their relative pressures.

Still another object of the invention is a heat-fusible material spray gun construction of the gas blast type having a reduced tendency to backfire and reduced tendency to be damaged or burned if a backfire should occur.

These and still further objects of the invention will be more fully understood from the following description read in conjunction with the drawings illustrating preferred embodiments of the structure in accordance with the invention in which—

Fig. 1 is a central section taken longitudinally through the gas head part of a metallizing gun in accordance with my invention;

Fig. 2 represents a section through the part of the metallizing gun shown in Fig. 1 in the plane II—II;

Fig. 3 is another section of the part of the metallizing gun shown in Fig. 1 taken through the plane III—III;

Fig. 4 is a view of the part of the metallizing gun shown in Fig. 1 viewed in the direction IV—IV;

Fig. 5 is a section taken longitudinally through the gas head part of a metallizing gun in accordance with my invention showing certain feed conduit modifications;

Fig. 6 is a longitudinal section of one element of a metallizing gun in accordance with my invention showing a preferred embodiment;

Fig. 7 is a view of the element shown in Fig. 6 from the direction VII—VII;

Fig. 8 is a longitudinal section of one element of a metallizing gun in accordance with my invention showing a further preferred embodiment of my invention; and

Fig. 9 is a section of one element showing a still further embodiment of my invention.

Referring to Figs. 1, 2, 3 and 4, numeral 1 designates the metal to be sprayed which is shown in the form of a rod or wire. 2 is a combustible-gas nozzle through which pass combustible-gas jets 3. Combustible-gas nozzle tip portion 2 is mounted on gas seat plug or nozzle rear portion 4 and is seated with a gas tight seal at seat 5 held securely in place by nut 6 which screws onto threads 7 on gas seat plug 4. Gas seat plug 4 is constructed with a taper plug section 8 which fits into and seats with the taper seat in gas head 9 being held securely in place by means of nut 10 which screws onto threads 11 on the extending shank of gas seat plug 4. Nut 10 is recessed to form space for packing 12 which is compressed tightly against the shank of gas seat plug 4 and the face of gas head 9 so as to form a gas tight seal between head 9 and the shank of gas seat plug 4.

Gas seat plug 4 is provided with annular surfaces defining with the inner surfaces of gas head 9 gas manifolds 13 and 14. Manifold 14 extends into a relatively narrow extension groove 16 which extends inwardly i. e.: toward the axis of gas seat plug 4. Gas jets 15 are provided in gas seat plug 4 and extend from manifold 13 to the narrowing portion on groove extension 16 of manifold 14. Gas jets 17 are provided in gas seat plug 4 and extend from groove extension 16 to the face of the plug at seat 5. Gas jets 17 are at least at their inlet of larger cross-sectional area than jets 15 at least at their outlet.

Gas jets 17 and combustible-gas jets 3 are so located that their connecting ends are in substantial alignment at seat 5; to insure this alignment a dowel pin 18 may be provided in the face of gas seat plug 4 to match with a corresponding hole provided in combustible-gas nozzle tip portion 2.

A gas duct 19 is provided in gas head 9 and leads from a source of relatively high pressure gas (not shown) to gas manifold 13. Gas duct 20 leads from a source of relatively low pressure gas (not shown) and connects with the gas manifold 14 and groove extension 16. Compressed gas blast duct 21 leads into compressed blast gas duct 22. Duct 22 emerges at its outer end at 23 at the face of gas head 9. A blast gas nozzle on cap 24 is provided which screws onto gas head 9 at threads 25 and forms a blast gas chamber 26.

When using metal in the form of rod or wire as is illustrated in Fig. 1 a relatively hard guide bushing 27 may be provided in combustible-gas nozzle tip portion 2.

In operation, a fuel gas, a combustion supporting gas and a blast gas are supplied to the gas head 9 from appropriate supply sources (not shown). In the most preferred method of operation a combustion supporting gas such as air or ogygen at relatively high pressure is supplied to duct 19 and a fuel (such as acetylene, propane or the like) at relatively low pressure is supplied to duct 20. The combustion supporting gas flows through duct 19 into manifold 13 and thence through gas jets 15, across groove extension 16 and into gas jets 17, the ends of which are in substantially gas flow directional alignment with the outlet ends of gas jets 15. Fuel gas flows through duct 20 into the manifold 14 and continues its flow into groove extension 16 which, as illustrated, preferably extends down and beyond inlet ends of jets 17, freely supplying fuel gas thereto. The relatively high velocity of the gas passing from gas jets 15 across groove extension 16 and into gas jets 17 causes fuel gas to flow from groove extension 16 into gas jets 17 where it mixes with the combustion supporting gas. The mixture of fuel and combustion supporting gases flows from gas jets 17 through combustible-gas jets 3 and out of the end of gas nozzle tip portion 2 where combustion takes place. The heat formed by the combustion of the gases in front of the combustible-gas nozzle tip portion 2 melts the wire 1 which is fed substantially continuously into the flame. The blast gas which may, for instance be air, flows through duct 21 and duct 22 and emerges at 23 from gas head 9 into blast gas chamber 26 whence it is directed by blast gas nozzle 24 against the tip of the molten wire 1 to finely divide and propel the metal.

While in the illustration just given, the combustion supporting gas was considered at high pressure, the construction in accordance with this invention can also operate when the fuel gas is supplied at a relatively high pressure and the combustion supporting gas at a relatively low pressure. In this case, however, the fuel gas is supplied through duct 19 whence it flows into manifold 13, through gas jets 15, across groove extension 16, and into gas jets 17. In this case, the combustion supporting gas is supplied at relatively low pressure through duct 20 to manifold 14 whence it passes into groove extension 16, flowing thence by reason of the relative gas velocity of the gas emerging from jets 15, into jets 17 where it mixes with the fuel gas also entering jets 17. The mixture of combustible and combustion supporting gases flows from jets 17 through gas jets 3 and out of combustible nozzle tip portion 2, the remainder of the operation being similar to that previously described.

If desired, material may be fed to the melting zone in granular form such as in the form of a powder. The structure in accordance with this invention using, for instance, a metal powder is shown in Fig. 5. The construction is similar to that shown in Fig. 1 except that in this case the metal powder conduit 28 has been connected by screwing it onto threads 11 to the back end of gas seat plug 4 so as to permit of feeding metal powder 29 through the central duct in gas seat plug 4 and combustible-gas nozzle tip portion 2. The operation of the device is similar to the case in which the metal was supplied in the form of a wire as previously described, except that in this case it may only be necessary to heat soften or partially melt the metal in the flame. Furthermore, in this case the blast gas emerging from blast gas chamber 26 and directed by blast gas nozzle 24 need only propel and need not necessarily finely divide the metal being sprayed.

One of the primary advantages of the structure in accordance with my invention is not only its greatly reduced tendency to backfire, i. e.: burn back inside the jets, but also the reduced tendency for damage to occur as the result of backfiring, if this should occur. In previously known constructions, when backfiring occurs the nozzle usually becomes irreparably damaged within a few seconds after backfiring and in many cases the gas head itself is burned out. With the construction in accordance with this invention, damage from backfiring is extremely unlikely. When backfiring does occur, the flame burns in gas jet 17 because the combustible mix does not exist any further back. The volume of the exhaust gases generated by the combustion so restricts the flow of both the fuel and combustion supporting gases that a very small flame in gas jets 17 results. Ordinarily this flame is so small that the heat which it produces is dissipated through the structure of gas seat plug 4 and combustible-gas nozzle tip portion 2, and is carried away by the cooling effect of the blast of air or gas in chamber 26 so that no burning out of the nozzle or other parts results.

With the structure shown in Fig. 1 it is possible for an individual jet to backfire and for the remaining jets to continue to function normally. This is sometimes an advantage as the spraying function can then continue despite the relative impairment due to the loss of one of the multiple number of jets. However, this can also be a disadvantage because the operator may not be aware that a jet has backfired. I have discovered that a small channel provided to connect the multiple jets of the mixed fuel and combustion supporting gases will alleviate this last mentioned disadvantage.

Referring to Figs. 6 and 7, 4′ represents a gas seat plug showing an alternative form of my invention. This gas seat plug 4′ is constructed similarly to gas seat plug 4 shown in Fig. 1 and has gas jets 15′ and 17′ and dowel pin 18′. An annular groove 30 is provided in the seat connecting the multiple jets 17 together. This annular groove need not be and is preferably not large enough to permit the flow of very much gas. For instance, it is preferable to construct the groove with a cross-section considerably smaller than the cross-section of one of the jets 17′. The function of this groove is not to permit of the flow of gas under normal conditions but is to connect the jets so that if any one of the jets should backfire then all of the jets will instantly backfire. With this construction, which is preferred for ordinary metallizing use, the operator will known instantly if a backfire should occur.

An alternative structure in accordance with my invention is shown in Fig. 8 which illustrates a gas seat plug 4″. This plug is constructed similarly to the gas seat plug 4 illustrated in Fig. 1 and has gas jets 15″. In this case however, gas jets 17″ are constructed larger at their inlet than at their outlet end. In this construction, the jets 17″ have a smooth and preferably long taper and the taper is most preferably curved somewhat so that the slope of the taper diminishes from the inlet to the outlet end.

Another alternative structure in accordance with my invention is illustrated in Fig. 9 in which gas seat 4‴ is similar to those illustrated in Figs. 1 and 8, except that jets 15‴ are slightly tapered, the inlet ends being smaller and the outlet ends being larger. The amount of this taper depends upon the pressure differential between the inlet and outlet end of the jets 15‴ and should be so proportioned as to obtain the maximum velocity of gas emerging from jet 15‴. The gas jets 17‴ may be tapered as shown and as described in connection with the embodiment of my invention shown in Fig. 8 or they may be straight as shown in the embodiment of my invention shown in Fig. 1.

In all cases, I prefer to round the edges slightly at the inlet end of jets 15, 15′, 15″ and 15‴, although this is not necessary.

As previously discussed, it has been found desirable to have combustible-gas jets 3 substantially in line with gas jets 17. I have discovered that if the inlet ends of combustible-gas jets 3 are slightly larger than the outlet ends of gas jets 17, that the necessity for accurate alignment is reduced and that no appreciable impairment of efficiency results from a slight misalignment. I preferably make the inlet ends of combustible-gas jets 3 approximately 50 per cent larger on the diameter than the diameter of the outlet ends of gas jets 17.

I preferably make combustible-gas jets 3, where they emerge from the combustible-gas nozzle tip portion 2, either the same as, or slightly smaller than the outlet ends of gas jets 17. I have found that with the inlet ends of combustible-gas jets 3 enlarged, it is possible to have these jets out of line to a slight degree with gas jets 17 without too great an impairment of efficiency. With the inlet ends of combustible-gas jets 3 50 per cent larger on the diameter than the outlet ends of gas jets 17, I prefer not to have these two jets out of line by more than 25 per cent of the diameter of the outlet ends of gas jets 17.

While the structures shown in the illustrations are necessary specific, my invention applies broadly to the improvement in gun construction for gas blast spraying heat-fusible material and preferably metal which essentially comprises at least one gas chamber, at least one first gas jet, first means for supplying one of a fuel gas and combustion supporting gas at relatively high pressure to said first gas jet, at least one second gas jet, dimensioned and shaped for substantially free, non-turbulent gas flow to the discharge end of said nozzle, leading from said gas chamber with its inlet in open communication therewith and positioned with its inlet in gas flow directional alignment with the outlet of said first gas jet, and second means for freely supplying the other of such fuel gas and combustion supporting gas at relatively low pressure to said gas chamber.

In using the structure in accordance with my invention I usually prefer to use oxygen for the combustion supporting gas and I prefer to use the oxygen at a relatively higher pressure than the fuel gas. As oxygen may be compressed to any reasonable pressure without any appreciable danger, this makes it possible to maintain, in connection with the structure in accordance with my invention, very high outlet velocities of the oxygen and thus of the fuel gas and oxygen mixture at the nozzle tip, which results in higher spraying speeds at higher efficiencies.

As an example of the operation of the particular structure in accordance with my invention, oxygen is supplied to the gas head at a pressure of 35 pounds per square inch gauge and acetylene is supplied at a pressure of 15 pounds per square inch gauge. With these pressures, it has been found that a variation in relative balance of the pressures between the oxygen and the acetylene of as much as eight pounds per square inch will cause only the same unbalance condition at the flame which would be caused by an unbalanced pressure of only 3 pounds per square inch with previously known metallizing guns.

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 a gun construction for gas blast spraying heat-fusible material having a combustible gas nozzle with at least one combustible gas jet discharge end, means for continuously feeding heat-fusible material to a point in gas flow directional alignment with said discharge end, and means for directing an atomizing blast gas toward said point, the improvement in combustible-gas nozzle for such gun which comprises at least one gas chamber, at least one first gas jet, first means for supplying one of a fuel gas and combustion supporting gas at relatively high pressure to said first gas jet, at least one second gas jet of internally streamlined surface, dimensioned and shaped for substantially free, non-turbulent gas flow to the discharge end of said nozzle, leading from said gas chamber with its inlet in open communication therewith and positioned with its inlet in gas flow directional alignment with the outlet of said first gas jet, and second means for freely supplying the other of such fuel gas and combustion supporting gas at relatively low pressure to said gas chamber.

2. In a gun construction in accordance with claim 1 in which said inlet of said second gas jet is larger than the outlet of said first gas jet.

3. In a gun construction for gas blast spraying heat-fusible material having a combustible gas nozzle with at least one combustible gas jet discharge end, means for continuously feeding heat-fusible material to a point in gas flow directional alignment with said discharge end, and means for directing an atomizing blast gas toward said point, the improvement in combustible-gas nozzle for such gun which comprises at least one gas chamber, a multiple number of first gas jets spaced around the axis of the gas nozzle, first means for supplying one of a fuel gas and combustion supporting gas at relatively high pressure to each of said first gas jets, a multiple number of second gas jets, one for each of said first gas jets, each of internally streamlined surface dimensioned and shaped for substantially free, non-turbulent gas flow to the discharge end of said nozzle, each leading from said gas chamber with its inlet in open communication therewith and each positioned with its inlet in gas flow directional alignment with the outlet of its first gas jet, and second means for freely supplying the other of such fuel gas and combustion supporting gas at relatively low pressure to said gas chamber, the inlet of each second gas jet being larger than the outlet of its first gas jet.

4. In a gun construction according to claim 3 in which the inlet of each second gas jet is larger than it outlet.

5. In a gun construction according to claim 3 in which the outlet of each first gas jet is larger than its smallest cross-sectional area.

6. In a gun construction for gas blast spraying heat-fusible material having a combustible gas nozzle with at least one combustible gas jet discharge end, means for continuously feeding heat-fusible material to a point in gas flow directional alignment with said discharge end, and means for directing an atomizing blast gas toward said point, the improvement in combustible-gas nozzle for such gun which comprises a substantially annular manifold substantially concentrically arranged with respect to the axis of the gas nozzle, a multiple number of first gas jets spaced around said axis and each ending with its outlet in said manifold, first means for supplying one of a fuel gas and combustion supporting gas at relatively high pressure to each of said first gas jets, a multiple number of second gas jets, one for each of said first gas jets, each of internally streamlined surface dimensioned and shaped for substantially free, non-turbulent gas flow to the discharge end of said nozzle, each leading from said manifold with its inlet in open communication therewith and each positioned with its inlet in gas flow directional alignment with the outlet of its first gas jet, and second means for freely supplying the other of such fuel gas and combustion supporting gas at relatively low pressure to said manifold, the inlet of each second gas jet being larger than the outlet of its first gas jet.

7. In a gun construction according to claim 6 in which said manifold extends across the inlet of each of said second gas jets to permit gas to flow from said manifold into and from all sides of said inlets.

8. In a gun construction according to claim 6 in which said manifold is substantially defined by a groove in at least one of two mating conical surfaces of said nozzle, and in which said groove extends across the inlet of each of said second gas jets to permit gas to flow from said manifold into and from all sides of said inlets.

9. In a gun construction for gas blast spraying heat-fusible material having a combustible gas nozzle with at least one combustible gas jet discharge end, means for continuously feeding heat-fusible material to a point in gas flow directional alignment with said discharge end, and means for directing an atomizing blast gas toward said point, the improvement in combustible-gas nozzle for such gun which comprises a gas nozzle rear portion including a multiple number of first gas jets, first means for supplying one of a fuel gas and combustion supporting gas at relatively high pressure to each of said first gas jets, a multiple number of second gas jets, one for each of said first gas jets, each of internally streamlined surface dimensioned and shaped for substantially free, non-turbulent gas flow to its outlet and each positioned with its inlet in gas flow directional alignment with the outlet of its first gas jet, second means for freely supplying the other of

such fuel gas and combustion supporting gas at relatively low pressure to the inlet of each second gas jet, the inlet of each second gas jet being larger than the outlet of its first gas jet, a gas nozzle tip portion removably mounted on said rear portion and a multiple number of third gas jets in said tip portion, one for each of said second gas jets and in approximate alignment therewith.

10. In a gun construction according to claim 9 in which the inlets of said third gas jets are larger than the outlets of said second gas jets.

11. In a gun construction according to claim 9 in which a groove is provided on at least one of the mating surfaces of said gas nozzle rear and tip portion substantially connecting all of said second gas jet outlets and said third gas jet inlets.

12. In a gun construction for gas blast spraying heat-fusible material having a combustible gas nozzle with at least one combustible gas jet discharge end, means for continuously feeding heat-fusible material to a point in gas flow directional alignment with said discharge end, and means for directing an atomizing blast gas toward said point, the improvement in combustible-gas nozzle for such gun which comprises a gas nozzle rear portion, including a substantially annular first manifold, substantially concentrically arranged with respect to the axis of the gas nozzle and substantially defined by a groove in at least one of two mating conical surfaces of said nozzle, a multiple number of first gas jets substantially evenly spaced around said axis and each ending with its outlet in said manifold, a substantially annular second manifold for supplying one of a fuel gas and combustion supporting gas at relatively high pressure to each of said first gas jets, a multiple number of second gas jets, one for each of said first gas jets, each of internally streamlined surface dimensioned and shaped for substantially free, non-turbulent gas flow, each leading from said first manifold with its inlet in open communication therewith and each positioned with its inlet in gas flow directional alignment with the outlet of its first gas jet, the outlet of each first gas jet being smaller than the inlet of its second gas jet, said first manifold extending across the inlet of each second gas jet to permit gas to flow from said manifold into and from all sides of said inlets, means for freely supplying the other of such fuel gas and combustion supporting gas at relatively low pressure to said first manifold, and a gas nozzle tip portion, removably mounted on said gas nozzle rear portion, including a multiple number of third gas jets, one for each of said second gas jets and in approximate alignment therewith, and a groove on at least one of the mating surfaces of said gas nozzle rear and tip portion substantially connecting all of said second gas jet outlets and said third gas jet inlets.

ARTHUR P. SHEPARD.