

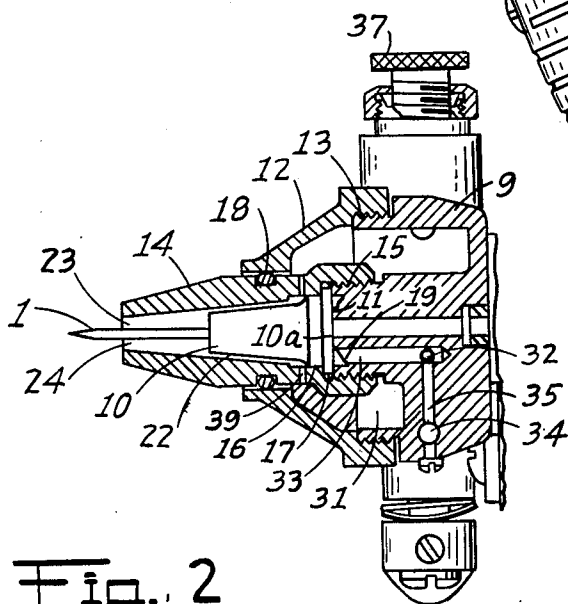
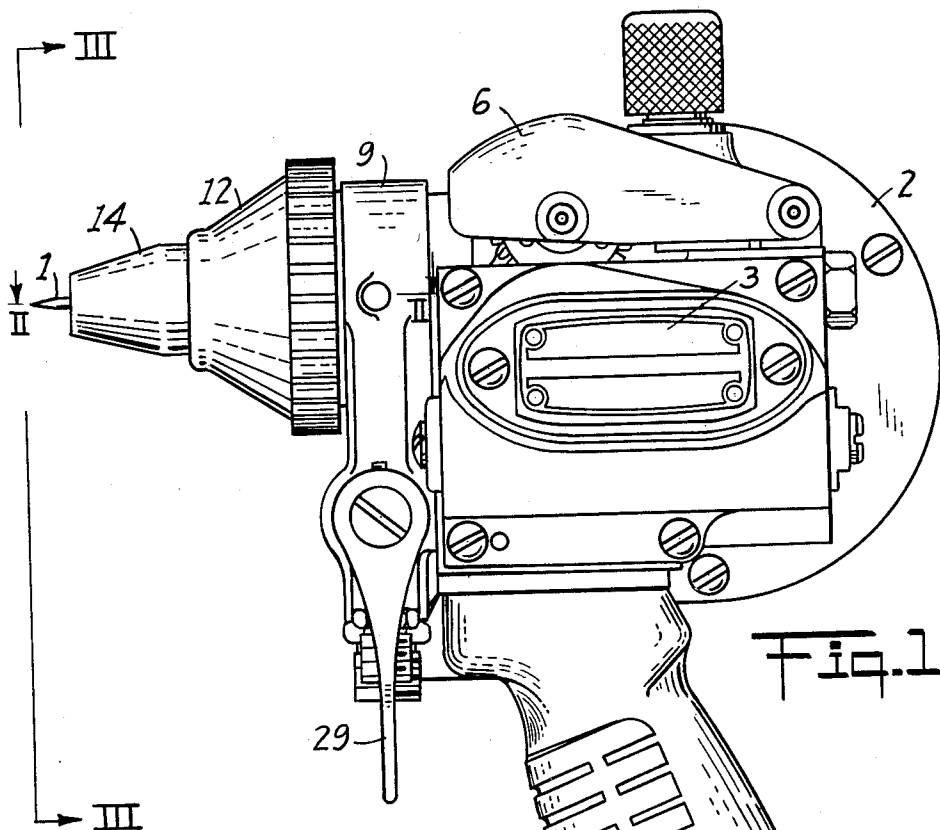
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GUN CONSTRUCTION FOR BLAST GAS SPRAYING
HEAT FUSIBLE MATERIALS

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Filed April 13, 1948

2 Sheets-Sheet 1



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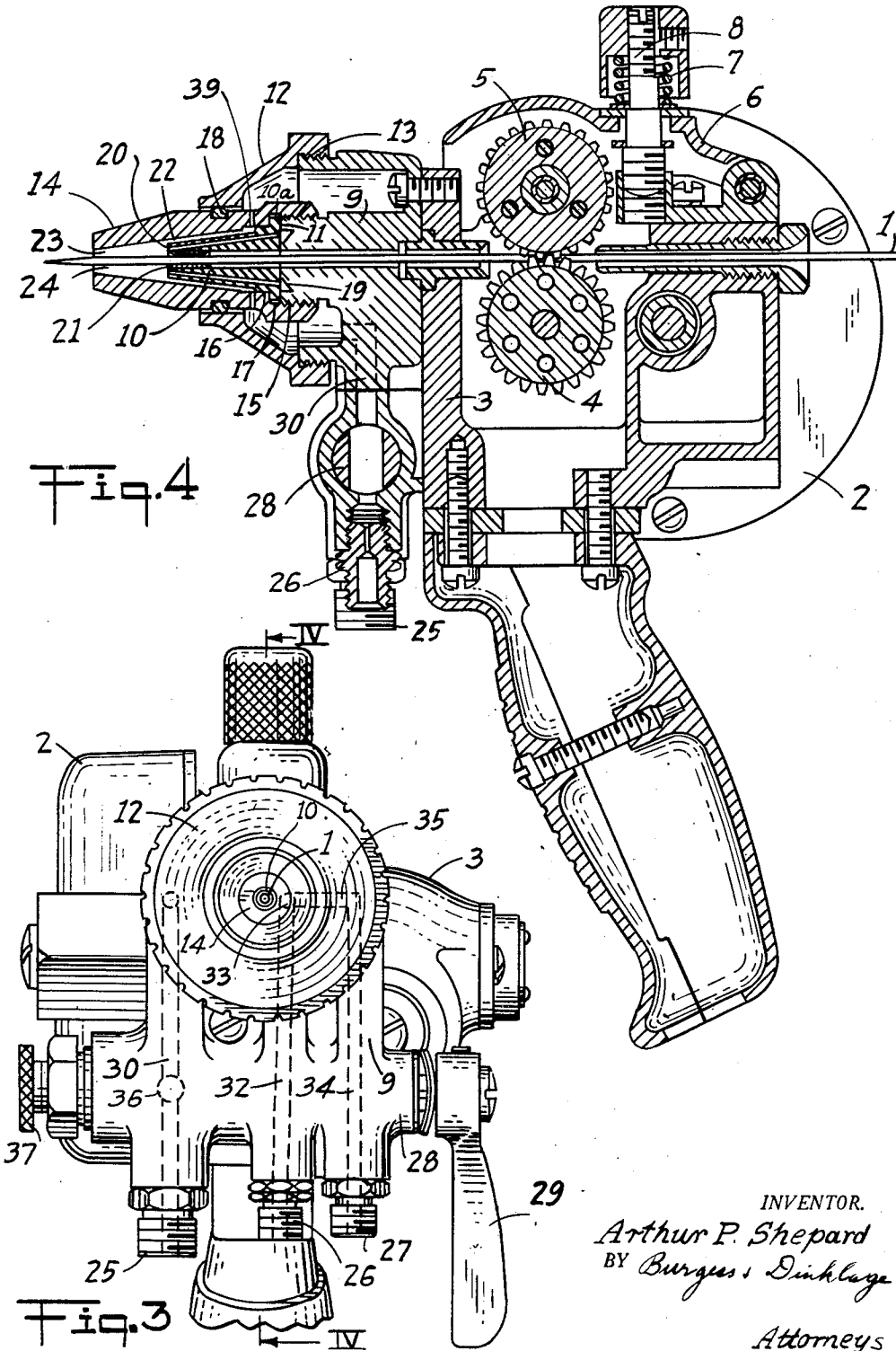
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UNITED STATES PATENT OFFICE

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GUN CONSTRUCTION FOR BLAST GAS
SPRAYING HEAT FUSIBLE MATERIALS

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16 Claims. (Cl. 91—12.2)

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This invention relates to improvements in gun construction for blast gas spraying heat-fusible materials.

Heat-fusible material spray guns of the blast gas type are devices in which such material is fed into a melting zone in which it is melted, being thereafter sprayed from the gun in subdivided form by a blast of air or other gas. The metals to be sprayed are fed into the melting zone in the form of a rod or wire. 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 by suitable means which discharge the combustible-gas mixture which, when ignited, causes the melting or heat softening of the material to be sprayed. The material to be sprayed is usually solid metal in the form of a rod or wire. Hence, devices of this sort are commonly called metal spray guns. The metal is sometimes sprayed, for guns of this type, in the form of a rod or wire composed of finely divided metal bonded together by a plastic material. Upon heating, such plastic material softens or disintegrates, releasing the metal in the heating zone so that the metal particles may be heated and expelled by the blast of air or other gas. In cases where a solid wire or rod is used, air or other gas is forcibly directed against the molten material at the tip of the rod or wire in such a manner that it impinges sharply against the tip to thereby substantially blast the material into fine particles. The construction of heat-fusible metal spray guns of this type 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.

The hitherto used metal spray guns of the blast gas type have required a relatively large amount of air or other blast gas. This requirement has limited the use of such guns to installations where a relatively large supply of pressurized air or other blast gas was available or the relatively few and important installations where the additional installation of large capacity air compression equipment was warranted.

Metallizing guns have been developed in the past using moderate amounts of air for the blast gas. These older type guns however have a very low metal capacity. For instance, one such type of gun utilized as the blasting medium about 780 cu. ft. per hr. of compressed air and only sprayed

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about 3 pounds of carbon steel per hr. Hence, each pound of carbon steel sprayed required about 260 cu. ft. of compressed air.

More recently, high capacity metallizing or metal spray guns have been developed. Some such guns, for instance, will spray approximately 9 pounds per hr. of carbon steel utilizing approximately 1100 cu. ft. per hr. of compressed air while another such gun, for instance, will spray approximately 19 pounds of carbon steel per hr. utilizing about 1320 cu. ft. per hr. of compressed air. These high capacity metallizing guns are much more efficient as they utilize only between about 70 and 120 cu. ft. of air per pound of carbon steel sprayed.

Though the capacity of the last mentioned guns, in terms of metal per time unit sprayed, and also their efficiency in terms of pounds of metal sprayed per cu. ft. of air used, has increased, the improvement in efficiency is possible only with increased amounts of air or other blast gas.

No metal spray gun in the past has been able to spray properly with a relatively low capacity air, or other gas supply. The older type metal spray guns are unsatisfactory from an efficiency standpoint in terms of pounds of metal sprayed per cu. ft. of air or other blast gas although they use somewhat less blast gas per hr. than the more efficient larger metal spray guns.

One object of this invention comprises, inter alia, a metal spray gun of the wire feed blast gas type substantially overcoming the foregoing and other limitations and disadvantages.

A further object of this invention is a metal spray gun of the wire feed blast gas type which utilizes blast gas from a low capacity source for its operation.

A further object of this invention is a metal spray gun of the wire feed blast gas type which utilizes blast gas from a low capacity source for its operation and simultaneously maintains an efficient ratio between metal sprayed and blast gas consumed.

These and still further objects of the invention will be more fully understood from the following description.

The construction in accordance with this invention, which will be hereinafter more fully set forth, utilizes for the first time the energy contained in the expanding gaseous products of combustion from the heating zone to materially aid the blast gas in the atomization of the molten metal. In the past, metal spray gun constructions have utilized the combustion supporting

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gases only for the provision of the necessary heating effect which results from the combustion of such gas mixtures. The construction in accordance with the invention makes possible the material reduction in the quantity of blast gas required by the utilization of this new principle in which a material portion of the blasting and propelling function is carried out, for the first time, by the combustible-gas mixture and the products of combustion thereof.

The invention is broadly addressed to heat-fusible material spray guns of the wire feed type. Within the preferred embodiments of the invention, however, the same will be hereinafter described specifically in connection with guns in which the heat-fusible material is metal in wire or rod form.

In accordance with the invention the combustion chamber of a metal spray gun of the wire feed type, i. e., the chamber within which heat is generated for the melting of the wire to be sprayed, is made relatively long, in the direction parallel to the wire, with respect to the "net area" of the end orifice of the blast gas nozzle, such that the ratio of the length in inches of said combustion chamber to the net area in square inches of the end orifice of the blast gas nozzle is at least 11.5 and preferably at least 13. The upper limit of this ratio should preferably not exceed about 30. I prefer however a construction wherein said ratio is about from 15-25. By "length" of combustion chamber is meant the distance between the tip of the combustible gas nozzle at one end of said chamber and the orifice of the blast gas nozzle at the other end of said chamber.

Wherever the expression "net area" or similar term is used herein in connection with the end orifice or opening of a blast gas nozzle of a heat-fusible material (such as metal) spray gun of the wire feed type, it is intended to designate thereby the inner diameter area of the blast gas nozzle end-orifice minus the cross-sectional area of the wire orifice, i. e., that orifice from which the rod or wire passes into and through the combustion chamber. This cross-sectional wire orifice area relatively closely approximates that of the cross-section of the wire passing through the end-orifice of the blast gas nozzle and affords thus a measure for the determination of the net area as herein defined.

Within the preferred embodiment of the invention the blast gas supply to the combustion chamber of the spray gun is so coordinated with the blast gas nozzle-end orifice net area and the combustion chamber length that the combustion gas pressure developed in accordance with the invention within the combustion chamber is utilized to the fullest extent. To this end the means supplying blast gas to the combustion chamber are so dimensioned and arranged that they restrict the flow of blast gas into the combustion chamber to be of the order of about 1-3 and preferably 1.75 to 2.25 cu. ft. of air per minute per $\frac{1}{100}$ square inch of the net area of the end orifice of the blast gas nozzle.

The following drawings illustrate preferred embodiments of the structure in accordance with the invention and are given for purposes of illustration and not of limitation, in which:

Fig. 1 is a side elevation view of a metal spray gun incorporating the invention;

Fig. 2 is a sectional view of part of the construction shown in Fig. 1 taken through the plane II-II as indicated in Fig. 1;

Fig. 3 is a front view of the metal spray gun

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construction shown in Fig. 1 viewed in plane III-III;

Fig. 4 is a sectional view of the metal spray gun construction shown in Fig. 3 taken through the plane IV-IV.

Referring to Figs. 1, 2, 3, and 4, numeral 1 designates the metal to be sprayed which is in the form of a rod or wire. 2 is a turbine housing containing a turbine (not shown) which operates through a gear train (not shown) in gear housing 3 to drive rolls 4 and 5, which are mounted to contact and feed the metal rod or wire 1, forward through the metal spray gun toward the melting zone. Upper feed roll 5 is mounted in a hinged housing 6 which is pressed by spring 7 so as to cause feed roll 5 to engage the metal wire 1 and cause it to feed. Thumb screw 8 is arranged to compress spring 7 so as to exert adjustable pressure on housing 6 and hence on feed roll 5 and its contact with metal wire 1. The wire feed may be started or stopped by sufficient adjustment of thumb screw 8.

Gas head 9 is mounted on the gear housing 3. Combustible gas or wire nozzle 10 is mounted on gas head 9 at seat 11. Gas blast housing 12 is mounted on gas head 9 by engaging threads 13. Blast gas nozzle 14 screws on to the gas head at threads 15. Blast gas nozzle 14 has an inner bore 16 which closely fits the mating outside diameter of wire nozzle 10 and also has a shoulder 17 which contacts the mating flange 18a of wire nozzle 10.

Gas head seat 11 is provided with an annular groove 19 which forms a manifold for mixed combustible and combustion supporting gases. Wire nozzle 10 is provided with a multiple number of annularly spaced gas passages 20 leading from manifold 19 to the tip of wire nozzle 10. Wire nozzle 10 is provided with a hardened sleeve 21 which guides metal wire 1. The external surface of wire nozzle 10 is conical and is located in spaced relation with the conical inside of blast gas nozzle 14 so as to provide the thin conical space 22 for passage of blast gas. The end of blast gas nozzle 14 has its conical interior surface terminated to form, around wire 1, the orifice 23. A multiple number of radial holes 39 are provided through the blast gas nozzle 14 from its outside to its inside surface. The blast gas nozzle 14 and the wire nozzle 10 form combustion chamber 24 which is defined by a portion of the interior conical surface of blast gas nozzle 14, the end of wire nozzle 10 and the orifice 23. The combustion chamber 24 is made relatively long in a direction parallel to the wire 1 as compared to the diameter of the orifice 23. The annular blast gas passage 22 is in the form of a thin frustrated cone with a relatively small apex angle.

Gas head 9 is provided with inlet connections 25, 26 and 27 to which hoses may be attached providing sources of supply for blast gas, combustible-gas and combustion supporting gas respectively. A plug type valve 28 with handle 29 is provided to simultaneously control the gases entering through the inlets 25, 26 and 27.

Conduit 30 connects between inlet fitting 25 and blast gas chamber 31 in the gas head and enclosed by blast gas housing 12. Conduit 32 leads from combustible-gas inlet 26 and connects with conduit 33 which in turn connects with annular manifold 19 at seat 11. Conduit 34 leads from combustion supporting gas inlet 27 to conduit 35 which in turn leads to conduit 33 and hence to manifold 19.

An extra blast gas passage is provided in plug valve 28 at 36 which connects through conduits

(not shown) to the turbine (not shown) in housing 2. The flow of that portion of the blast gas used to operate the turbine is controlled by means of the thumb screw 37 which operates a needle valve (not shown).

In operation, the metal spray gun is connected at inlets 25, 23 and 27 to sources of compressed blast gas, compressed combustible-gas and compressed combustion supporting gas, respectively. The combustible-gas enters inlet 26, passes through conduit 32 and into conduit 33. Compressed combustion supporting gas enters inlet 27 and passes through conduits 34 and 35 and thence into conduit 33 where it mixes with the combustible-gas forming a combustible-gas mixture. This combustible-gas mixture flows from conduit 33 into annular manifold 19 and thence through the multiple number of gas passages 20 to the end of wire nozzle 10 where the combustible-gas mixture enters the combustion chamber 24. The combustible-gas mixture burns at the end of wire nozzle 10 and forms an envelope of hot gases surrounding the tip of metal wire 1 and extending through combustion chamber 24 and through orifice 23 to a point beyond orifice 23.

Blast gas enters inlet 25 and a portion of it passes through auxiliary passage 36 to the turbine (not shown) causing it to rotate within housing 2. The rotating turbine, operating through the gear train (not shown) causes feed rolls 4 and 5 to rotate and hence feed the metal wire 1 forward through the heating zone in combustion chamber 24. That portion of the blast gas not diverted to the turbine through auxiliary passage 36 passes through conduit 30 into blast gas chamber 31. From chamber 31, the blast gas passes through the multiple number of holes 39 and thence through the annular passage 22 into the combustion chamber 24 where it surrounds the envelope of burning combustible-gas mixture, passing through combustion chamber 24 and through orifice 23.

The combustible-gas mixture burning in chamber 24 forms combustion products which are greatly expanded from the original volume of the combustible-gas mixture. The combustion chamber 24 is made relatively long with respect to the size of the orifice 23, in such ratio that the gaseous products of combustion as well as the blast gas are compressed within combustion chamber 24 at a relatively high pressure. When such compressed gases thereafter emerge through orifice 23 together with the still unburned portion of the combustible-gas mixture and also together with the compressed blast gas, a considerable expansion of all the gases at the orifice 23 occurs, resulting in a high velocity being imparted to all the gases. The emerging gases then impinge on the molten wire tip at this high velocity, causing the atomization or breaking up of the molten metal. In this manner the products of combustion of the combustible-gas mixture materially aid the blast gas in causing such atomization of the molten metal.

In a typical example of a construction in accordance with the invention, the length of the combustion chamber, i. e., the distance between the center of the wire orifice (at tip of wire nozzle) and the center of the blast gas nozzle tip, is for instance about .425", the wire orifice has a diameter of about .091" and the blast gas nozzle tip opening has a diameter of about .200". The net area of the end orifice is then about

$$\frac{.200^2 \times \pi}{4} - \frac{.091^2 \times \pi}{4} = .0249 \text{ sq. in.}$$

The ratio of combustion chamber length in inches to net area of blast gas orifice in square inches is then

$$\frac{.425}{.0249} = 17.1$$

In the preferred construction of the invention and for the best utilization of the principle underlying my invention, the annular passage for blast gas leading into said combustion chamber is made in the form of a very thin continuous surfaced frustrated cone. The apex angle of the sides of said frustrated cone is usually of a relatively small angle, preferably of an angle not less than about 7° and not greater than about 18°, and more preferably not less than about 10° and not greater than about 16°. Most preferably I make this angle substantially 16°.

In the application of the principle of my invention, the utilization of combustion gases within the combustion chamber and the restricted admission of blast gas tend toward overheating of the blast gas nozzle. Thus the specific air cone construction serves not only to assure that a continuous, although thin, cone of blast gas is maintained but also that an envelope of air surrounds the combustible-gas mixture and the products of combustion thereof, to completely line or cover the inside surface of the blast gas nozzle to prevent the overheating thereof.

Since this cone of blast gas must necessarily be very thin because of the restricted amount of blast gas, it is essential for best results that said cone of blast gas be as even in thickness as possible and as accurately distributed as possible around the inside surface of the blast gas nozzle, otherwise there is danger of inadequate cooling and also of distortion of the combustible-gas mixture envelope and hence of the resulting spray. In order to safeguard against such danger, I prefer a construction in accordance with the invention which provides an inner annular locating surface in the blast gas nozzle, which locates on an outer annular surface of the wire nozzle. In this manner it is possible to locate the wire nozzle within the blast gas nozzle sufficiently accurately to provide the necessarily accurate conical space for the blast gas. This is, for instance, illustrated in Figs. 2 and 4 in which, when blast gas nozzle 14 is mounted in place, it locates the wire nozzle 10 centrally by bore 16 and forces the nozzle tightly against gas head seat 11 by a clamping action between the wire nozzle flange 10a and shoulder 17.

For the purpose of still further assuring the proper concentric locating of the wire nozzle, I prefer to additionally construct the blast gas nozzle with a threaded nut portion, such as threaded portion 15, for direct attachment to the wire nozzle seat portion of the gas head 9, so that said blast gas nozzle can be utilized not only for properly concentrically locating the wire nozzle but also for attaching said wire nozzle to said seat portion of said gas head by a locating and clamping action as is for instance obtained by shoulder 17 acting on flange 10a. This construction enables the accurate positioning of elements defining the conical space provided for the blast gas passage between the wire nozzle and the blast gas nozzle by not only locating the nozzle radially but also providing the desirable locating means

for keeping the axis of the wire nozzle parallel to the axis of the blast gas nozzle.

As exemplified in the drawings, blast gas is supplied to the combustion chamber by way of the annular blast gas chamber 31, the conical duct 22, and the multiple number of radial metering passages 39. The latter are preferably positioned at a point forward of shoulder 17 of blast gas nozzle 14. These radial metering holes 39 provide the blast gas flow restriction and are so dimensioned that they control and determine, together with passage 22, the proper flow of blast gas into the blast gas nozzle at the rate of the order of 1-3 and preferably 1.75 to 2.25 cu. ft. of blast gas per minute per $\frac{1}{100}$ square inch of the net area of the blast gas nozzle tip orifice.

In accordance with the requirements of the preferred embodiment of my invention, I provide suitable blast gas sealing means. In the illustration shown these may comprise an annular groove containing resilient packing ring 18 forming a seal between blast gas nozzle 14 and blast gas housing 12.

In the practical operation of the particular structure in accordance with the invention illustrated in the drawings, oxygen is supplied as the combustion supporting gas to the gas head at a pressure of 15 pounds per square inch gage. Acetylene, as the combustible-gas, is supplied to the gas head at a pressure of 15 pounds per square inch gage. Air, as the blast gas, is supplied to the gas head at a pressure of 60 pounds per square inch gage. With this combination of pressures and gases and with a construction in accordance with the invention, it has been found practical to spray about 5.1 pounds of carbon steel per hour with a consumption of less than 300 cu. ft. per hour of air for the nozzle in the spraying operation. Hence each pound of carbon steel sprayed utilizes only 59 cu. ft. of air. It will be seen that a metal spray gun construction in accordance with the invention will spray substantially more efficiently in terms of air required per pound of metal sprayed than the modern high capacity equipment and yet, at the same time, does so with less than one-third the air requirement.

Within the broad concept of the invention the same comprises for use in the spray head of a heat-fusible material spray gun of the wire feed type, the combination of a blast gas nozzle defining a combustion chamber having an orifice at one end, a combustible gas nozzle positioned with its tip at the other end of said chamber, and means defining a wire orifice at said other end, the ratio of length of said combustion chamber to the net area in square inches of said orifice of said combustion chamber being at least 11.5. Within one of the preferred embodiments of the combination, the total cross-sectional area of the conical blast gas duct defined between the inner surface of the blast gas nozzle and the outer surface of the combustible gas nozzle is preferably greater than the total cross-sectional metering area of the metering means provided to restrict flow of blast gas at the herein stated rate, i. e., of the order of 1 to 3 cu. ft. and preferably 1.75 to 2.25 cu. ft. of blast gas per minute per $\frac{1}{100}$ square inch of the net area of the orifice of the combustible gas nozzle.

Wherever reference is made herein to volumes of gases or flow rates thereof, such references refer to the measurement of such gases under "free" conditions, i. e., standard conditions at atmospheric pressure and 70° F., although it is

understood that the actual pressure of the gases at the entrance to the metal spray gun is at a considerably higher pressure.

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. For use in the spray head of a heat-fusible material spray gun of the wire feed type, the combination of a blast gas nozzle defining a combustion chamber having an orifice at one end, a combustible gas nozzle positioned with its tip at the other end of said chamber, and means defining a wire orifice at said other end, the ratio of length of said combustion chamber to the net area in square inches of said orifice of said combustion chamber being at least 11.5, said net area being the inner diameter area of said combustion chamber orifice minus the cross-sectional area of said wire orifice.

2. The combination in accordance with claim 1 in which said ratio is not in excess of about 30.

3. The combination in accordance with claim 1 in which said ratio is from about 15 to 25.

4. The combination in accordance with claim 2 in which said combination additionally includes means for supplying blast gas to said chamber and including means dimensioned to restrict the flow of blast gas into said chamber to a rate of the order of 1 to 3 cu. ft. of blast gas per minute per $\frac{1}{100}$ square inch of said net area.

5. The combination in accordance with claim 4 in which said ratio is from about 15 to 25 and in which said rate of flow is of the order of about 1.75 to 2.25 cu. ft. of blast gas per minute per $\frac{1}{100}$ square inch of said net area.

6. For use in the spray head of a heat-fusible material spray gun of the wire feed type, the combination of a blast gas nozzle defining a frusto conical combustion chamber having an orifice at one end, a combustible gas nozzle mounted at least partly within said blast gas nozzle in spaced relation thereto, to define between the outer surface of said wire nozzle and the inner surface of said blast gas nozzle a frusto conical blast gas duct converging towards the longitudinal axis of said combustion chamber at an angle not exceeding substantially 18°, means defining a wire orifice at the tip of said combustible gas nozzle and substantially in alignment with said axis, means for supplying blast gas to said duct and including metering means dimensioned to restrict the flow of blast gas to a rate of the order of 1 to 3 cu. ft. of blast gas per minute per $\frac{1}{100}$ square inch of the net area of said blast gas nozzle orifice, the ratio of axial length in inches of said combustion chamber to the net area of said nozzle orifice in square inches being from about 11.5 to 30, said net area being the inner diameter area of said combustion chamber orifice minus the cross-sectional area of said wire orifice.

7. The combination in accordance with claim 6 in which the total cross-sectional area of said conical blast gas duct is greater than the total cross-sectional metering area of said restricting means.

8. The combination according to claim 7 in which said ratio is from about 15 to 25 and in which said rate of flow is of the order of about

1.75 to 2.25 cu. ft. of blast gas per minute per $\frac{1}{100}$ square inch of said net area.

9. The combination in accordance with claim 7 in which said combustible gas nozzle has an outer annular locating surface adjacent the base thereof, in which said blast gas nozzle has an inner annular locating surface for mating alignment with said outer locating surface, and in which means are provided for securing said locating surfaces in mating alignment with each other.

10. The combination according to claim 9 in which said ratio is from about 15 to 25 and in which said rate of flow is of the order of about 1.75 to 2.25 cu. ft. of blast gas per minute per $\frac{1}{100}$ square inch of said net area.

11. For use in the spray head of a heat-fusible material spray gun of the wire feed type, the combination of a substantially cylindrical, circumferentially threaded combustible gas nozzle seat portion, a blast gas nozzle threaded with one end onto said seat portion, having an orifice at its other end and defining a frustro conical combustion chamber, a substantially frustro conical combustible gas nozzle, having means defining a wire orifice substantially in alignment with the longitudinal axis of said chamber, said combustible gas nozzle extending at least partly into said blast gas nozzle in spaced relation thereto to define between the outer surface of said combustible gas nozzle and the inner surface of said blast gas nozzle a frustro conical blast gas duct converging towards the longitudinal axis of said combustion chamber, means for supplying blast gas to said duct, outer locating surface means adjacent the base of said combustible gas nozzle, inner locating surface means on said blast gas nozzle for mating alignment with said outer locating surface means, and shoulder means for securing said locating surface means in position against said seat portion.

12. The combination in accordance with claim 11 in which both said locating surface means are substantially annular locating surfaces, in which said shoulder means is a substantially annular shoulder and in which said blast gas supplying means include a multiple number of radially arranged metering orifices terminating at the base

of said conical duct forward of said locating surfaces.

13. The combination according to claim 11 in which the ratio of axial length in inches of said combustion chamber to the net area of said blast gas nozzle orifice in square inches is from about 11.5 to 30, and in which said means for supplying blast gas to said duct include metering means dimensioned to restrict the flow of blast gas to a rate of the order of about 1 to 3 cu. ft. of blast gas per minute per $\frac{1}{100}$ square inch of said net area, said net area being the inner diameter area of said combustion chamber orifice minus the cross-sectional area of said wire orifice.

14. The combination according to claim 13 in which said conical blast gas duct converges towards the longitudinal axis of said chamber at an angle not exceeding substantially 18° and in which the total cross-sectional area of said conical blast gas duct is greater than the total cross-sectional metering area of said metering means.

15. The combination according to claim 11 in which the ratio of length in inches of said combustion chamber to the net area of said blast gas nozzle orifice in square inches is from about 15 to 25, and in which said means for supplying blast gas to said duct include a metering means dimensioned to restrict the flow of blast gas to a rate of the order of about 1.75 to 2.25 cu. ft. of blast gas per minute per $\frac{1}{100}$ square inch of said net area, said net area being the inner diameter area of said combustion chamber orifice minus the cross-sectional area of said wire orifice.

16. The combination in accordance with claim 15 in which said conical blast gas duct converges towards said axis at an angle of about 16° .

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,227,753	Ingham	Jan. 7, 1941
2,361,420	Shepard	Oct. 31, 1944
2,414,181	Vandersee	Jan. 14, 1947