May 22, 1945. R. S. BABCOCK 2,376,413

BLOWPIPE NOZZLE

Filed Feb. 26, 1941

Fig. 1.

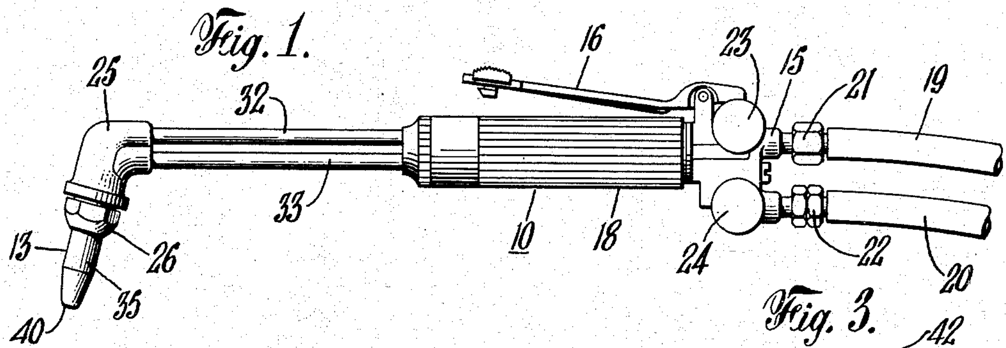


Fig. 2.

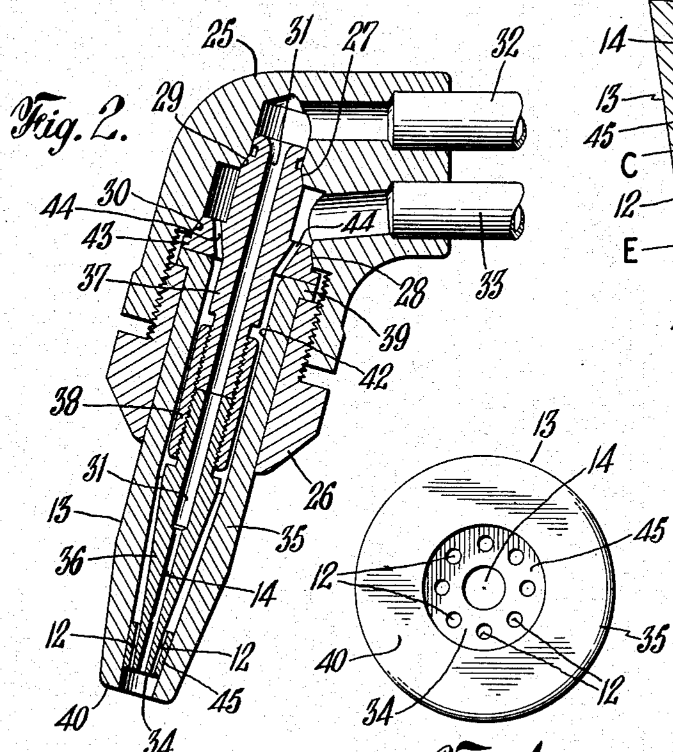
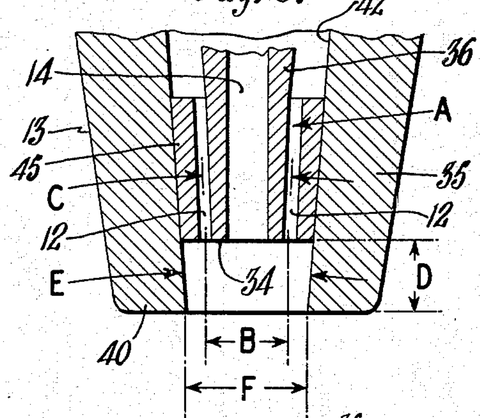


Fig. 4.

Fig. 3.



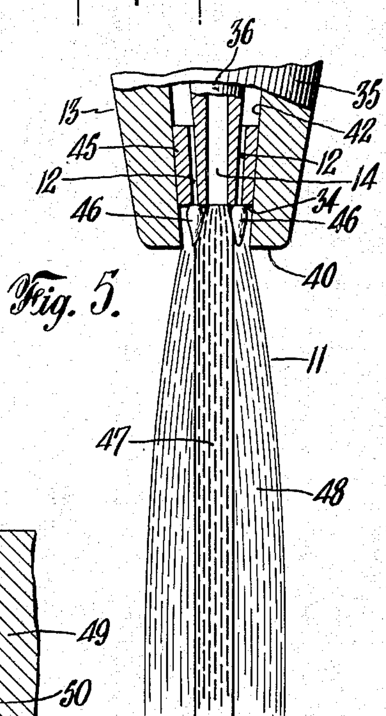


Fig. 5.

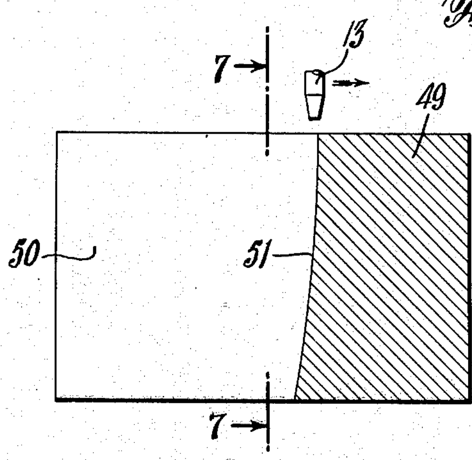


Fig. 6.

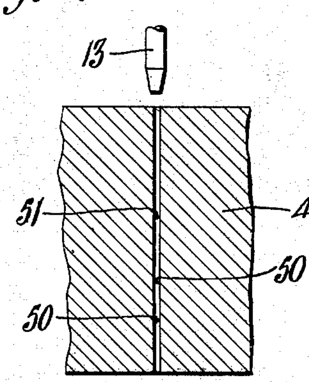


Fig. 7.

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BLOWPIPE NOZZLE

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1 Claim. (Cl. 158—27.4)

This invention relates to a blowpipe nozzle and more particularly to oxy-acetylene cutting blowpipe nozzles for cutting metallic bodies in which a stream of oxidizing gas, such as oxygen, is applied to a portion of the metallic body preheated by a flame produced by the combustion of a mixture of oxygen and acetylene.

Oxy-acetylene cutting is a process of severing ferrous metals by utilizing the rapid chemical reaction which takes place between heated iron and oxygen. The heat liberated by this reaction is sufficient not only to melt the iron oxide but also to melt some of the steel or iron. In a practical application of the oxy-acetylene cutting process, the jet or stream of oxygen which does the cutting issues from an orifice in the center of a nozzle or tip of a cutting blowpipe. Surrounding the cutting orifice of the nozzle or tip are several smaller orifices for oxy-acetylene heating flames. These are used to preheat the metal to its kindling temperature. Theoretically, the heat of the cutting reaction should be sufficient to keep the cut going after it has started. In practice, however, the heating flames are kept burning constantly to melt the surface scale and thereby insure the proper reaction with continuous and rapid cutting. The flow of cutting oxygen is controlled by a conveniently located valve on the blowpipe handle, and the cutting oxygen jet may be guided along any line desired, whether straight, curved, or irregular, and may also be inclined at an angle, as in deseaming.

To start cutting, the blowpipe is held with the nozzle perpendicular to the surface of the work and with the inner cone of the heating flame about $\frac{1}{16}$ inch above the end of the line to be cut on the edge of the work. The blowpipe is held steady until this spot has been raised to a bright red heat, and the cutting valve lever is then pressed down slowly while moving the blowpipe along the line to be cut. If the cut has started promptly, a shower of sparks will fall from the underside of the work, thus indicating that the cut is penetrating clear through. The movement of the blowpipe is then regulated just fast enough so that the cut continues to penetrate the work completely.

As used throughout this specification and in the claims, the term "oxy-acetylene cutting" is intended to include all oxy-acetylene working of ferrous metals, such as scarfing, deseaming, desurfacing, grooving, slotting, severing, and the like.

The principal object of this invention is to provide an oxy-acetylene cutting nozzle having operating characteristics superior to those now known. Other objects of this invention are to improve both cutting and deseaming nozzles in general by providing means associated therewith for increasing the overall efficiency of the thermochemical reaction; to produce smoother and more uniform reaction zones by controlling the radial expansion of the cutting gas; to obtain a ring preheat flame, the uniformity of which, being essentially independent of the number of orifices producing said ring flame, increases the cutting efficiency; to provide an oxy-acetylene nozzle having a skirt extending beyond the normal face of the nozzle, the size of said skirt being proportioned to obtain the best operating characteristics of the nozzle; to provide an improved means for utilizing discharged preheat gases to retard the radial expansion of the oxygen jet discharged by an oxygen orifice to thereby increase the axial velocity of the oxygen jet to a value above the acoustic.

According to the invention there is provided a blowpipe nozzle consisting of a conventional cutting or deseaming nozzle having a cylindrical flange or skirt extending beyond the normal face thereof. The skirted portion is constructed in a manner whereby a sufficient quantity of the heat induced therein will be conducted back to the nozzle body, preventing deterioration of such skirt and increasing the heat content of the preheat gas, which increase in heat content of the gas improves the overall efficiency of the nozzle. In addition to the construction and arrangement of the skirt to properly utilize the induced heat, it also has internal dimensions, which, in conjunction with the arrangement and size of the preheat and cutting oxygen orifices, produce a ring preheat flame and an oxygen stream having divergent jet characteristics.

More particularly, according to the invention, the skirt extends beyond the normal face of the nozzle so that the skirt opening, coupled with the exhausting preheat gases, retards the radial expansion of the oxygen jets beyond the oxygen orifice and thereby increases the axial velocity of the oxygen jet to values above the acoustic. For best results, it has been determined by actual tests, that the skirt should have a length equal to or greater than the length of the inner cone of the preheating flame. Further, that the internal diameter of the skirt adjacent to the normal face of the nozzle should be equal to or greater than the sum of the diameter of the preheat hole circle plus the diameter of one preheat hole, preferably equal to the sum of the diameter of said circle plus the width of three of said preheat holes. In addition the preheat hole circle should have a diameter substantially equal to one and one-half that of the cutting oxygen orifice. The skirt itself may be either cylindrical, convergent, or divergent, the diameter of the skirt being measured at the rearmost portion thereof.

Referring to the accompanying drawing:

Fig. 1 is a view in side elevation of a cutting blowpipe having a nozzle embodying features of this invention;

Fig. 2 is an enlarged fragmentary cross-sectional view of the head portion of the blowpipe shown in Fig. 1;

Fig. 3 is an enlarged fragmentary sectional view similar to Fig. 2 of the nozzle tip;

Fig. 4 is a plan view of the end of the nozzle shown in Fig. 3;

Fig. 5 is a fragmentary sectional view showing the nozzle in operation; and

Figs. 6 and 7 are longitudinal and transverse sections, showing the use of the nozzle in cutting a body steel, Fig. 7 being taken on line 7—7 of Fig. 6.

In the cutting blowpipe 10, shown by way of example, an oxy-acetylene flame 11 is produced at a series of preheat gas openings 12 in the blowpipe tip or nozzle 13, which surround a larger central oxygen orifice 14. This central orifice 14 is connected with the oxygen inlet 15 and has a separate controlling valve operated by conveniently located cutting valve lever 16 on the blowpipe handle 18. The function of the oxy-acetylene flame is to preheat the metal that is to be cut. Commercially pure oxygen is supplied to the blowpipe through a hose 19 while acetylene is supplied to the blowpipe through a hose 20. Such hoses are connected to the blowpipe 10 by means of suitable oxygen and acetylene connections 21 and 22, respectively, the supply of oxygen and acetylene being adjusted by valves 23 and 24. Oxygen and acetylene are mixed within the blowpipe to provide a suitable combustible mixture for supplying the preheating flame, while the cutting oxygen is conducted directly from the oxygen inlet 15 to the central orifice 14 of the nozzle 13 by way of the cutting oxygen valve.

Conventional oxy-acetylene cutting blowpipes are of either the low-pressure, or medium-pressure type. Simply by changing the size of the cutting nozzle or cutting tip, a single cutting blowpipe may be adapted to cut a wide range of metal thickness. Furthermore, interchangeable nozzles used on cutting blowpipes may be of either one-piece or two-piece construction. In the one-piece construction, the necessary holes for preheating flames and cutting jets are drilled through a solid piece of metal, usually pure copper. The two-piece nozzle has an external nozzle of pure copper that is used with any one of a series of internal nozzles of brass. For certain types of cutting blowpipes, there are also available cutting tips or nozzles for such operations as rivet cutting, cast-iron cutting, sheet-metal cutting, desurfacing, and deseaming. While a hand-cutting blowpipe has been shown in the drawing, it will be understood that the invention is not limited thereto, but includes blowpipes for machine cutting as well.

The nozzle 13 is secured in position on head 25 of the blowpipe 10 by means of a hollow nut 26 which is threaded into the head 25 and forces seating surfaces 27 and 28 on the nozzle into sealing engagement with the corresponding seating surfaces 29 and 30 formed within the head 25. Thus cutting oxygen is delivered to central passageway 31 of the nozzle 13 through pipe 32, while a combustible mixture of oxygen and acetylene is delivered through pipe 33 to the preheating gas orifices 12 which surround the cutting oxygen orifice 14 in the normal end face 34 of the nozzle.

According to the invention, both one- and two-piece nozzles are equally efficient and the addition of a skirt to otherwise conventional oxy-acetylene nozzles having either a conical divergent cutting oxygen orifice or a cylindrical cutting oxygen orifice, was found to have a definite beneficial effect upon the operation of the nozzle.

The skirted nozzle, shown in the drawing by way of example, consists essentially of an outer body or casing 35 and an inner member 36 containing the central oxygen passage 31 terminating in orifice 14, and the preheat gas ports 12. The member 36 is shown connected to part 37 by a nipple 38 but may be integral with the latter. The outer casing 35 has a cylindrical flange 39 on the rear portion thereof adapted to be engaged by the externally threaded nut 26 which surrounds the casing 35 and secures the nozzle 13 to the blowpipe head 25. The body thickness of this outer member 35 must be great enough to conduct a sufficient quantity of heat from skirt 40 to prevent damage to the skirt 40 by reason of its close proximity to the high temperature flame 11 emanating from the preheat ports 12. The inner member 36, nipple 38 and part 37, generally cylindrical in shape, are slightly smaller than the inner diameter of casing 35 in order to provide an annular passageway 42 for the oxy-acetylene gas mixture. On the rear portion of part 37 of the inner member 36 is a cylindrical flange 43, the forward surface of which coacts with the cylindrical flange 39 on the casing 35 to form a gas-tight seal.

The inclined seats 27 and 28 coacting with the corresponding seats 29 and 30 in the blowpipe head 25, form gas-tight seals and prevent the mixture of the preheat gas with the cutting oxygen as these gasses pass from the blowpipe head 25 to nozzle passages 31 and 44, respectively. On the forward portion of the inner member 36 is a conical flange 45 in which the series of preheat gas ports 12 are annularly disposed and concentrically aligned with the central oxygen orifice 14. This conical flange 45 conforms in shape with the forward conical portion of the casing 35, forming a gas-tight seal therewith, causing all the preheat gas to flow through the preheat orifices 12. In the illustrated example, skirt surface E and longitudinal axes C of the preheat orifices 12 form included angles of about 9° and 5°, respectively, with the longitudinal axis of the cutting oxygen orifice 14.

In the example of the nozzle illustrated in Fig. 2, the inner piece of the "two-piece" nozzle 13 consists of the member 36 and part 37 connected by the nut 38. However, it will be understood by those skilled in the art that the entire inner piece may consist of a single member of conventional style. The nozzle may also consist of the so-called Zobel type, or the conical divergent type, or of the one-piece swaged type. Such types are well known to those skilled in the art.

Referring to Fig. 3, from experiments actually conducted on skirted nozzles, according to the invention, it has been found that the diameter B of the preheat hole circle should be about one and one-half times the diameter of the cutting oxygen orifice 14, and that the internal diameter F of the skirt 40, for good results, should be approximately equal to or slightly greater than the sum of the preheat circle diameter B and the diameter A of one preheat swaged port 12, preferably so that a distance equal to the diameter of one port intervenes between the edge of the port and the skirt. The length D of the skirt 40, which is equally as important as the diameter F, depends upon the normal length of the inner cone 46, Fig. 5, of the preheat flame 11 and should be equal to or slightly longer than the inner cone 46. It has also been observed that when cutting work with the skirted nozzle 13, the tendency for slag to find its way into the preheat holes 12 is almost completely eliminated and therefore permits the use of a large number of small preheat flame ports 12 when necessary.

In operation, the preheat flames emanating from the series of ports are adjusted so that the inner cone 46 does not extend beyond the inner surface of the skirted portion 40. The oxygen stream 47 emanating from the central orifice 14 partially fills that area surrounded by the skirt 40 and allows a narrow space for the passage of the outer envelope 48 of the gases forming the preheat flame 11. By so confining the outer envelopes of the individual flames, a ring flame is essentially obtained, adding to the efficiency of the nozzle and eliminating the necessity for an excessively large number of small preheat gas ports 12. Furthermore, it has been found that, with a properly designed skirt 40, the outer annular envelope 48 of the preheat flames 11, which surround the oxygen stream 47, extends approximately 10 to 12 inches beyond the face of the nozzle 13. When employing the cylindrical bore cutting oxygen orifice 14 in the skirted nozzle 13, the usual radial expansion of the gas 47 upon being discharged into the atmosphere is partially prevented because of the cushioning effect provided by the presence of the annular heating flame 48, producing jet characteristics very similar to those obtained from a conical divergent nozzle, as evidenced by the kerf contour.

The stream shape shown in Fig. 5 is representative of that obtained with a skirted cylindrical nozzle 13 constructed in accordance with the invention. The length, uniformity and symmetry of the outer preheat envelope 48 is strikingly obvious and the outer envelope 48 does not undergo any great degree of radial expansion which condition, of itself, indicates that a great part of the heat is efficiently applied to the cutting area to aid the operation.

Referring to Figs. 6 and 7, a steel body 49 is shown being cut by the oxygen stream 47 of Fig. 5 assisted by the oxy-acetylene heating flame 48. The nozzle 13 is constructed and arranged to cause the zone of secondary combustion of said flame to flow with the cutting oxygen to form a composite cutting stream in which the cutting oxygen is surrounded by a single well-defined heating flame. The skirted cylindrical bore nozzle 13 is definitely superior, in cutting the steel body 49, than any known non-skirted nozzle because the walls 50 of kerf 51 are smoother and the actual operating efficiency is higher.

Among the advantages of the skirted nozzle of the invention, over those formerly known, may be listed: the high overall efficiency of the operation because of the added heat applied to the work, smoother and more uniform cuts because of the added heat and the production of an essentially ring-type flame.

It has been found, through investigation, that the amount of heat applied to a metal body during a conventional cutting operation has an injurious effect upon the resultant kerf walls, in that an oxidic coating formed on these walls, in such instances, becomes loose and pieces thereof are drawn into and disrupt the cutting stream. The most probable cause of such loosening of oxide is the insufficiency of heat, that is, the oxide is formed through the combustion of the steel and within a short interval of time, with ordinary nozzles, sufficient cooling may take place to cause the oxide to chip, because of the contraction of the base metal. However, with a skirted oxy-acetylene nozzle made and used according to the invention, additional heat is drawn into the kerf 51, Figs. 6 and 7, and keeps the oxide closer to the temperature of the adjoining base metal 49, so that the outside cools more slowly and there is no chipping or loosening of the scale in the vicinity of the reaction zone. This condition results in the production of highly smooth and uniform walls 50.

It is known that a skirted nozzle has heretofore been used, primarily as a matter of necessity, especially with gases other than acetylene, such as propane, having a relatively low rate of flame propagation compared to the oxy-acetylene flame. With such fuel gases, the normal lineal velocity of gas at the mouth of the nozzle greatly exceeds the rate of flame propagation and causes the flame to be blown away from the face of the nozzle. To overcome this difficulty, a means must be employed to decrease the gas velocity at the periphery of the gas stream without affecting the internal velocity of the stream merely in order to insure stable operation of the apparatus. A skirted nozzle for fuel gases other than oxy-acetylene was, therefore, adapted for such purpose and has since been considered standard practice. The skirted type of nozzle heretofore used for fuel gas other than acetylene, such as propane, was not intended to be used for oxy-acetylene cutting because, due to the intense heat of the oxy-acetylene flame, the skirted portion of the nozzle was quickly burned away. Therefore, the development of the art was such that nozzles for oxy-acetylene cutting in air generally had a smooth non-skirted end face, while cutting nozzles for fuel gases other than acetylene, such as propane, had a skirt. The nozzle of the present invention, however, provides an oxy-acetylene cutting nozzle having operating characteristics far superior to those of existing non-skirted oxy-acetylene cutting nozzles and to skirted nozzles for other gases, e. g., oxy-propane.

The skirt influences the efficiency of cutting operations by concentrating the secondary envelope of the preheating flames and also by retarding the normal free expansion of the oxygen stream outside of the oxygen orifice. If the normal expansion is retarded by the presence of a surrounding medium moving at a velocity somewhat less than the acoustic, but appreciably faster than the surrounding air streams, then radial expansion of the oxygen stream will be retarded and an increase in the axial expansion away from the orifice must result. Such a theory presupposes less turbulence in the oxygen stream and a more uniform kerf width. These have generally been observed in actual tests with cuttnig nozzles embodying the invention.

The skirt material should be able to withstand the heat from the oxy-acetylene flame or to have a conductivity high enough to prevent localized heat from melting the skirted section. These conditions are satisfactorily found in the use of copper which is cheap, readily machined, and already used in nozzle construction. The skirt should be an extension of the nozzle, in the one-piece construction, or an extension of the external member if made of two-piece construction. Sufficient material should be allowed in the section adjoining the skirt of the nozzle body to provide for the required heat transfer.

Among the more important features of the present invention are the following:

1. The use of a skirt section extending beyond the normal face of an oxy-acetylene nozzle.

This is only possible for high flame-temperature gases, through the spacing of the preheat holes between the oxygen orifice and the surrounding skirt, so that the preheat flame cones do not contact the skirt. Absorption of heat by the skirt is therefore reduced because the flames do not contact the skirt material. The heat picked up through convection and radiation is of a relatively small amount.

2. The use of a skirt section involving preheat and skirt dimensions within certain proportional limits for optimum operation with oxy-acetylene.

By holding the dimensions within certain limits, satisfactory operation of the nozzles can be restricted to the use of oxy-acetylene alone. The flame intensity of other commercial fuel gases is so low by comparison with the more rapidly burning oxy-acetylene flames that their use with the optimum, skirted, oxy-acetylene design nozzle is precluded.

3. The use of a skirted section extending beyond the normal face of the nozzle so that the skirt opening, coupled with the exhausting preheat gases, retards the radial expansion of the oxygen jet beyond the oxygen orifice and thereby increases the axial velocity of the oxygen jet to values above the acoustic.

Kerf samples of cuts made with skirted, cylindrical bore, oxy-acetylene nozzles seem to bear out this point. Radial drillings through the skirted section emitted preheat flames under normal conditions which indicates that a slight back pressure exists within the skirt cavity.

In conclusion, skirted oxy-acetylene cutting nozzles constructed according to the invention will cut faster and more efficiently than known oxy-fuel gas nozzles which are not suited to the high temperature of the oxy-acetylene flame. In such skirted oxy-acetylene cutting nozzles, the diameter of the preheat hole circle should be held within a definite relationship to the diameter of the cutting oxygen orifice, and the diameter of the mouth of the skirt should be maintained within certain limits with respect to the preheat hole circle.

What is claimed is:

A blowpipe nozzle having an end face, a central cutting oxygen orifice terminating at said end face and adapted to discharge a cutting stream of oxygen, a plurality of oxy-acetylene preheating gas ports terminating at said end face in a circle concentric with said orifice and adapted to discharge jets of oxy-acetylene preheating gas which, when ignited, produce flames each having an inner cone and an outer heating envelope, and means for merging and concentrating said outer envelope symmetrically about said cutting stream for a substantial distance axially thereof into a single annular heating flame, said means comprising an annular skirt on said nozzle adapted to surround said flames in concentric relation with said oxygen stream, said skirt having an inner diameter adjacent to said face equal to the sum of the diameter of said circle and the width of three of said ports, said circle having a diameter equal to substantially one and one-half times the diameter of said orifice.

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