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F. J. EICHELMAN

2,655,206

CUTTING TORCH TIP, INCLUDING HIGH AND LOW VELOCITY PREHEAT PASSAGES

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Fig. 2

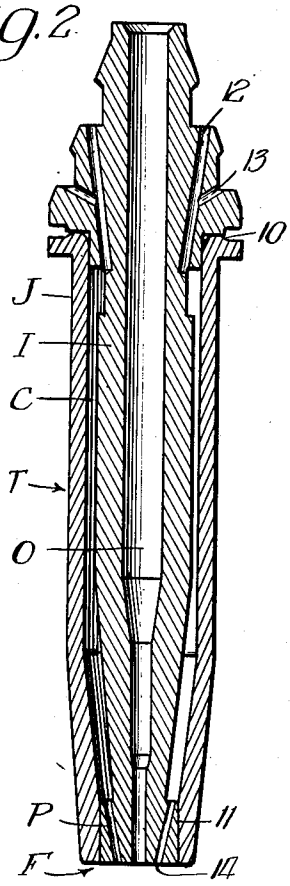


Fig. 3

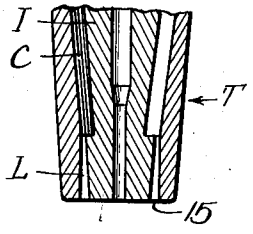


Fig. 6

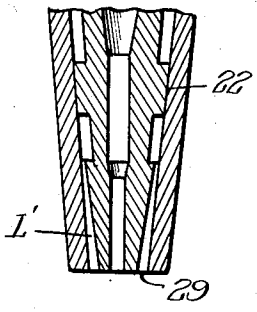


Fig. 5

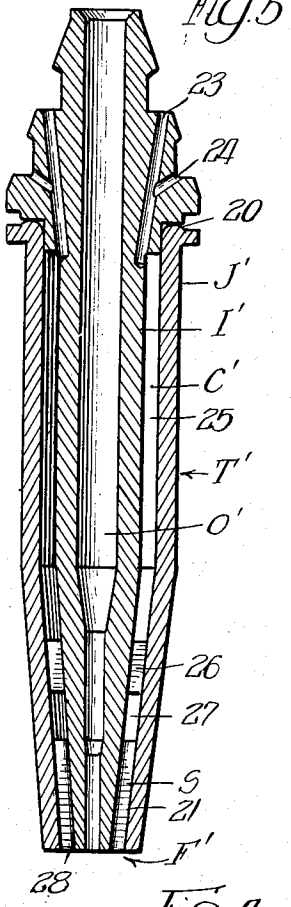


Fig. 1

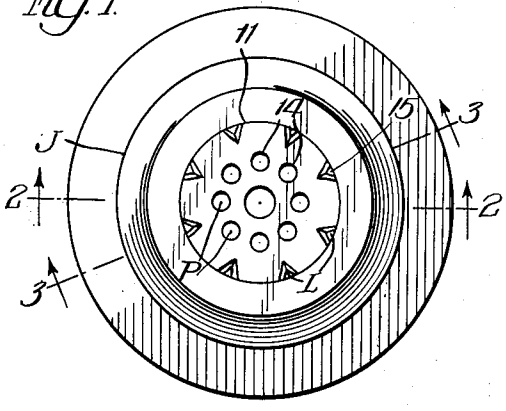
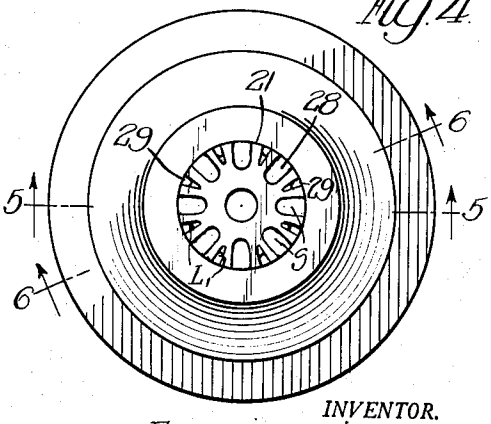


Fig. 4



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CUTTING TORCH TIP, INCLUDING HIGH AND LOW VELOCITY PREHEAT PASSAGES

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9 Claims. (Cl. 158—27.4)

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This invention relates to improvements in torch tips and the production of heating flames, particularly useful for initiating the cutting of ferrous metals or similar thermochemical metal-removing operations. More specifically, my invention is concerned with improved torch tips of this class in which fuels normally considered to be slow burning can be efficiently and effectively used to initiate thermochemical metal-removing operations, and with improvements in methods of utilizing these fuels.

I have found, by experiment, that tips of the class described having a flush profile or plain face (by which is meant that the gas delivery passages from the tip terminate in a common plane which also includes the extremity or face of the tip) can be made to utilize normally slow burning fuels to produce stable heating flames of high velocity and high temperature concentrated in a zone near the face of the tip. This is accomplished by providing for control and regulation of the relative velocities at which two or more jets of fuel mixture are supplied to form the heating flames and adjacent supplementary fuel jets or pilot flames, for example, by means of a novel arrangement of delivery passages for the fuel mixture as more fully hereinafter described. The invention thus provides effective utilization of the normally slow burning fuels and a tip that operates efficiently and effectively with decreased absorption of heat by the tip itself, and with increased useful life.

Torch tips for oxy-acetylene metal cutting operations are customarily made with a flush profile. This is desirable from the standpoint of tip life and to reduce heat absorption by the tip. It presents no obstacles in practice because the low decomposition temperature and the high rate of combustion of acetylene permit the formation of high velocity heating flames of high temperature concentrated near the end of the tip where they can be effectively applied to the work. This is also true in the use of hydrogen as a fuel, and, according to Quelch (see, for example, United States Patent 1,679,586, dated August 7, 1928), the same is true of fuel gases generally that have igniting temperatures below 600° C.

When other fuels which are normally slow burning, for example, natural gas, propane, ethylene, or gas mixtures in which a lower ether or alcohol is a principal fuel constituent, replace acetylene in metal cutting operations, the requirement that they provide heating flames of high velocity and high temperature concentrated near the tip face are unchanged, but the characteristics of these fuels, presumably their higher decomposition temperatures and slower rates of combustion, prevent their successful use with flush profile tips such as are used with acetylene. Quelch, above, attributes these drawbacks to fuel gases generally that have igniting temperatures above 600° C. It is true that all, or nearly all, fuels so classified will not allow successful practical operation of flush profile cutting tips, because the heating flames produced are either unstable and tend to waver and to be blown from the zone to be heated if their velocity is high, or, if their velocity is reduced, the flames are elongated, soft and billowy, and the heat produced is not adequately concentrated to efficiently serve to initiate thermochemical metal-removing operations. In either case the heating flames produced do not provide the necessary degree and concentration of heat.

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The most nearly successful prior efforts to overcome the difficulties described have virtually all centered around the provision of torch tips for use with slow burning fuels that have been constructed with a cup surrounding the delivery end of the gas passages, that is, the tip is arranged so that the fuel mixture issues from orifices within a recess in the face of the tip. This expedient permits slow burning fuels to be used successfully to preheat metals for flame cutting, and it probably functions by protecting the flame and allowing the fuel to be heated sufficiently to develop adequate heat at a point where it can be utilized. Such a device necessarily involves absorption of considerable heat by the metal of the tip surrounding the flame, as well as by the entire tip. As a consequence such tips have a relatively short useful life, and suffer from accelerated disintegration and erosion of the metal.

Despite the inherent drawbacks attending the use of such tips, prior to this invention, the recessed or cupped face types of torch tips have represented the only real approach to a solution of the problem of employing slow burning fuels to initiate the flame cutting of metals and like operations.

The principal objects of my invention are to provide for the effective utilization of slow burning fuels of relatively high igniting temperature to produce stable, high temperature heating flames to initiate thermochemical metal-removing operations; to provide torch tips or nozzles which, as indicated above, are capable of utilizing such fuels to produce stable, high temperature heating flames of high velocity that result in large volumes of heat concentrated near the tip-

face. As used throughout this specification and the appended claims, the term "slow burning fuels" will be understood to include generally those fuel gases and gas mixtures which have igniting temperatures above about 600° C., and particularly fuels composed of or containing substantial proportions of natural gas, propane or other lower hydrocarbons of the methane series, the lower olefine hydrocarbons, the lower aliphatic alcohols and ethers, and various complex mixtures resulting from the cracking of petroleum fractions, all of which have heretofore required the use of a cupped or recessed tip when employed as heating fuels for flame cutting and like operations.

Other objects of the invention are to provide tips of this class having an increased useful life, and in which tendencies to become heated and deteriorated or eroded in use are minimized; to provide such tips characterized by a flush profile or plain face, and which are simple and economical, both as to construction and in operation. Other objects and novel features of the invention will appear from the following description and from the drawings, in which:

Fig. 1 is a view of the terminal end of a torch tip embodying my invention;

Fig. 2 is a longitudinal cross-section, somewhat reduced in size, of the tip shown in Fig. 1 taken on line 2—2;

Fig. 3 is a partial longitudinal cross-section, also reduced, of the tip shown in Fig. 1 taken on line 3—3;

Fig. 4 is a view of the terminal end of a torch tip embodying a modification of the invention;

Fig. 5 is a longitudinal cross-section, somewhat reduced, of the tip shown in Fig. 4 taken on line 5—5; and

Fig. 6 is a partial longitudinal cross-section, also reduced, of the tip shown in Fig. 4 taken on line 6—6.

In accordance with the invention, a two piece torch tip T (Figs. 1, 2 and 3) or T' (Figs. 4, 5 and 6) is formed of a jacket J or J' and an internal member or tip core I or I' which define between them an annular chamber C or C' constituting a generally longitudinal passage for a combustible mixture of fuel and oxygen. The internal member or tip core I or I' has a central longitudinal passage O or O' for cutting or metal-removing oxygen, and this oxygen is delivered as a jet from the central orifice in the face of the tip. Surrounding the central orifice at the face of the tip is a ring of orifices for discharging the combustible mixture of fuel and oxygen from chamber C or C' through passages P (Fig. 2) or slots S (Fig. 5) to form preheating flames. As is sometimes the practice in this art, the internal members or tip cores shown and described as part of the structure of two piece torch tips will be briefly referred to throughout this specification and in the appended claims as "tip internals" or "internals." The portions of the tips described thus far are more or less conventional in torch tips heretofore known, particularly in torch tips employing actylene as fuel.

However, as shown, the tips T and T' have flush profiles F and F', and they are nevertheless capable of utilizing effectively the slow-burning fuels by reason of supplementary heating flames produced in the tips illustrated, by a combustible gas mixture discharged from tapering passages L and L' at lower velocity than is delivered from passages P or slots S to form the main heating flames. The combustible gas mixture which forms the supplementary heating flames is supplied from chambers C and G' which also supply the main heating flames, and is supplied to the inlets of tapered passages L and L' and to the inlets of passages P or slots S at the same pressure. The passages L and L' increase in cross-sectional area from their inlets to their discharge orifices in the face F or F', and thus the supplementary heating flames are supplied with gas at reduced pressure. Passages P and slots S are of uniform cross-section throughout their length, and thus the main heating flames are supplied with gas at high pressure. The main heating flames are sustained, and the fuel supplied to them is caused to burn steadily at or near the face of the tip to produce a stable, high velocity flame of high temperature by reason of the adjacent streams of combustible gas mixture at low velocity. These supplementary gas jets stimulate the main flames and induce rapid combustion of the fuel in the main heating flames, probably by immediately raising its temperature to its igniting temperature.

Referring specifically to the embodiment of the invention shown in Figs. 1, 2 and 3, the jacket J and internal I are arranged to fit closely together and to form gas-tight seals at shoulder 10 and for a short distance near the discharge end of the tip T, as at 11. Cutting oxygen is supplied to passage O, and oxygen and fuel to form a combustible gas mixture are separately supplied to passages 12 and 13, respectively, from a conventional cutting torch body (not shown). Oxygen and fuel together are delivered from passage 12 into the annular chamber C where they are mixed thoroughly. The passages P conduct the mixed gases to discharge orifices 14. Passages P are of uniform size throughout, and are preferably inclined somewhat inwardly from their inlets to orifices 14, so that orifices 14 direct the gas mixture toward the projected axis of oxygen passage O. The tapered passages L also conduct mixed gases from chamber C to discharge orifices 15, and, as shown, the passages L are formed between jacket J and internal I by grooves or slots milled or cut in the end portion of the internal I. The passages L are enlarged in size from their inlets to the orifices 15 in order to reduce sharply the emergent velocity of gas passing through them.

As shown in Figs. 1 and 3, the passages L are in the form of grooves having a V-shaped cross-section, but it will be understood that these grooves may be U-shaped (as shown at L' in Fig. 4), or they may be square or rectangular or circular or of any other cross-sectional shape. Also, the grooves shown may be replaced by drilled passages, so long as the passages, in whatever form provided, increase appropriately in cross-sectional area from inlet to outlet to provide low velocity supplementary jets or flames at the tip face.

Referring to Figs. 4, 5 and 6, the jacket J' and internal I' are fitted together to form gas-tight seals at 20 and 21, and, additionally, at an annular abutment 22. Cutting oxygen, oxygen and fuel are separately supplied to passage O' and to passages 23 and 24 from a torch body (not shown). Oxygen and fuel are mixed in an upper part 25 of chamber C'. Thence, the mixed gases pass through grooves 26 in annular abutment 22, which grooves with the jacket J' form passageways to annular chamber 27. The chambers 25 and 27, with abutment 22 and grooves 26, cooperate to produce additional mixing of the fuel

and oxygen, and to insure that the combustible gas mixture delivered to slots S and passages L' will be uniform in composition and density. From chamber 27, gas to form a row of main heating flames is delivered by the slots S to orifices 28. The slots S are of uniform size throughout, and with the interior wall of jacket J' at 21, slots S form passageways of constant cross-sectional area from their inlets to their outlets. The tapered passages L' also conduct mixed gases from chamber 27 to discharge orifices 29, and passages L' also are formed between jacket J' and internal I' by grooves in the end portion of internal I'. As shown, the passages L' increase in size from their inlets to the orifices 29, and thus serve to reduce the emergent velocity of the mixed gases to form the supplementary gas jets or pilot flames.

The torch tips of this invention may be used for cutting, piercing, desurfacing, flame machining and for other thermochemical metal-removing operations using slow burning fuels in exactly the same way as torch tips are used in which acetylene is the fuel, and it is unnecessary to describe in detail these well known operations.

The provision of a torch tip of the class described that is capable of effectively and efficiently employing slow burning fuels, particularly natural gas, propane and other fuels of relatively high ignition point, with a flush profile or plain face makes possible a tip much cooler in use, that is, less heat is absorbed by the metal of the tip, than is possible in the case of tips heretofore employed with such fuels in which a cupped face or recessed profile end was necessary.

This has been demonstrated by comparative tests in which surface metal temperatures along tips of the two types were accurately measured. The surface of the recessed or cupped face type of tips was found to reach 600° F. at the flame end of the tip, and a temperature of 550° F. at a point one-half inch rearwardly of the flame end, while the metal at one inch from the tip end was at 500° F. In these tips, which were of two different commercially available types, the temperature at the tip nut, or approximately three inches from the flame end, was 350° F. in one case, and was 300° F. in the other. By comparison, tips of the same size as to cutting oxygen passages, in which were used the same proportions and volumes of the same hydrocarbon fuel (propane) with the same fuel-oxygen ratio for preheating, were found to develop a temperature of only 400° F. at the flame end of the tip, 350° F. one-half inch rearwardly of the flame end, 300° F. one inch from the flame end of tip, and 200° F. at the tip nut. From this it will be seen that the tendency toward deterioration by heating of the tip has been greatly reduced by means of the present invention, and this results in an appreciably increased useful life of the new tips.

Other tests were made in which the times required for preheating a given body of ferrous metal in order to make possible piercing of the metal by the cutting oxygen jet were determined. In these tests, two commercially available forms of tips having recessed or cupped faces were compared with tips embodying the present invention which had flush profiles or plain faces. In every case, sections cut from the same plate were used, so that the composition and thickness of the plate section to be pierced were identical, and the same volumetric rates of a fuel composed of oxygen and propane in the ratio of five volumes of oxygen to one of propane were employed in each test of each tip. The tip sizes (i. e. diameter of the cutting oxygen passage) tested were selected to be as nearly the same as is possible for each series of tests.

Minimum preheating times required to enable a given plate thickness to be pierced using tips of comparable sizes did not differ by more than 1 to 2 seconds between any of the tips tested when optimum volumetric rates of the preheating gas mixture were employed. These differences in piercing times probably are within the limits of accuracy of the testing method, and these tests indicate that my new flush profile tips are fully as effective as the recessed or cupped face tips heretofore employed for like purposes. The table presents specific data for one series of tests and will serve to illustrate the foregoing:

Table

	Commercial Recessed Face Tips		Flush Profile Tip (Figs. 1, 2 and 3)
	Type A	Type B	
Tip Size	#50	#50	#51.
(Dia. Oxygen Passage)	0.700 in.	0.700 in.	0.0670 in.
Plate Thickness	½ in.	½ in.	½ in.
Propane Rate, C. F. H.	12	12	12.
Preheat Oxygen Rate, C. F. H.	60	60	60.
Oxygen/Propane Ratio	5	5	5.
Minimum Time to Pierce, Seconds.	7	9	7.

The conditions employed in this series of tests were identical with the exception of the sizes of the cutting oxygen passages, which was one drill size larger in the case of the two commercial recessed face tips. This deviation in the tests was, however, a factor tending to favor the recessed face tips.

Variations in the method of forming the tips of this invention and in the arrangement of the component parts of the tip are possible. For example, the tips may be made in a single piece in which one or more longitudinal passageways replace the annular chamber for the combustible gas mixtures, or the chamber as shown in the two piece tips illustrated may be modified by providing a close fit between the jacket and tip internal throughout, and the internals may be provided with a series of longitudinal grooves to conduct the combustible gas mixture through the tip. In every case it is necessary that the essential features of this invention be provided by means of a flush profile or plain face at the extremity of the tip in which means are provided for discharging a combustible gas mixture to form supplementary gas jets at low velocity as well as to provide gas to form the main heating flames at high velocity. It is preferable to have the supplementary gas jets arranged to surround the main heating flames, but in some modifications of the tips this arrangement may be reversed. When the gas mixture for the main heating flames and lower velocity jets is discharged from annular rows of separate discharge orifices, it is also preferable to arrange the orifices through which gas is supplied to form supplementary jets or pilot flames between those supplying the main heating flames, but this arrangement is not essential. Nor is it essential to employ a plurality

of separate orifices, since either the supplementary gas supply, or the main heating flame, or both, can be supplied at the tip face through separate annular orifices arranged to supply the combustible gas mixture at low and high velocities, respectively. Other arrangements also are possible, and, by way of example, the form of my new tip shown in Figs. 4, 5 and 6 may be modified by omitting the tapered passages L' and replacing them by a tapered annular orifice surrounding the entire extremity of the internal I', and thus lying between the main heating flame passages formed by slots S. In this modification, the main and supplementary gas jets will tend to merge, and separate pilot flames will not be present as such, but because part of the combustible gas mixture is supplied at lower velocity, the main heating flames will be adequately supported and the objects of the invention will be attained. Tests have shown that it is not always essential to maintain entirely separate flames to achieve the purposes of this invention. For example, I have found that if the pressure of the combustible gas mixture supplied to tips made as illustrated in the drawings is increased substantially, the supplementary heating flames supplied by passages L (Fig. 3) or L' (Fig. 6) may be apparently blown from the tip face so that separate flames are not visible as such. Despite this ostensible absence of separate supplementary heating flames, the desired effect is obtained and the main heating flames are caused to burn steadily and smoothly at the tip face. It thus appears that the maintenance of the desired heating flames is dependent on relative velocities of the combustible gas mixture delivered to the tip face regardless of whether the actual flames merge or are independent, and that the proper combustion of the combustible gas mixture supplied at both high and low velocities is a function to which both the higher and lower velocity streams mutually contribute.

In carrying into practice the principles of this invention, the relative apparent emergent velocities of the combustible gas streams supplying the main heating flames and those supplying the supplementary gas jets or pilot flames may vary considerably. In the case of tips made as shown in the accompanying drawings, the emergent velocity of the gas streams forming the supplementary gas jets or pilot flames normally is about one-tenth of the velocity of the gas streams supplying the main heating flames, but this is not essential and the objects of this invention can be attained under certain conditions with supplementary gas jets of an apparent velocity as high as one-half of that of the gas streams supplying the main heating flames, and other conditions, with a velocity as low as one-twentieth of that of the gas for the main heating flames. The ratios referred to are those of the uncorrected apparent emergent velocities, and as such they also express approximately the ratios of the cross-sectional area at the inlet to the passageways supplying the supplementary gas jets to the cross-sectional area at the delivery end of those passages.

The expression "flush profile" as used throughout this specification and the appended claims is intended to include not only the form of tips illustrated in which all of the gas discharge orifices and the extremity or face of the tip are in a common plane, but also to include tips otherwise embodying the essentials of this invention in which this is substantially the case, since tips having slightly convex or other forms of profiles may be made without departing in essence from my invention.

Various other modifications of the invention are possible and will be apparent to those skilled in the art, and it is intended to include all such modifications embodying the principles of my invention within its scope as defined by the appended claims.

I claim:

1. Torch tip for cutting and similar thermochemical metal-removing operations initiated by heating flames produced by burning a combustible gas mixture, comprising a tip body having a flush profile, a central discharge orifice means for oxidizing gas and at least two discharge orifice means for said combustible gas mixture in the profile end of said tip body, passage means for delivering oxidizing gas to its discharge orifice means, a single mixing means for producing a combustible gas mixture, additional separate passages for oxidizing gas and fuel gas communicating with said mixing means and passage means for delivering said combustible gas mixture to at least one of its discharge orifice means at high velocity and to at least one other of its discharge orifice means at substantially lower velocity.

2. Torch tip for cutting and similar thermochemical metal-removing operations initiated by heating flames produced by burning a combustible gas mixture, comprising a tip body having a flush profile, said tip body including annular walls forming a mixing chamber therebetween to produce a combustible gas mixture, means forming a longitudinal passage within said body for oxidizing gas terminating in a central discharge orifice, additional separate passages for oxidizing gas and fuel gas communicating with said mixing chamber, at least one longitudinal passage for said combustible gas mixture terminating in a plurality of separate low velocity and high velocity passages leading to separate low velocity and high velocity discharge orifices circularly arranged to surround said central discharge orifice at the profile end of said tip body, at least one of said low velocity passages having a gradually increasing cross-sectional area and terminating in a separate low velocity orifice situated adjacent to a separate high velocity orifice, at least one of said high velocity passages having a uniform cross-sectional area and terminating in a high velocity orifice, to discharge said combustible gas mixture from at least one of its low velocity orifices at low velocity and from at least one other of its high velocity orifices at high velocity.

3. Torch tip for cutting and similar thermochemical metal-removing operations initiated by heating flames produced by burning a combustible gas mixture containing a slow burning fuel, comprising a tip body having a flush profile, a longitudinal passage for oxidizing gas terminating in a discharge orifice in the profile end of said tip body, a mixing chamber for producing a combustible gas mixture, additional separate passages for oxidizing gas and fuel gas communicating with said mixing chamber, and at least one longitudinal passage for said combustible gas mixture terminating in a plurality of passages leading to discharge orifice means in the profile end of said tip body, at least one of said last-named passages increasing in cross-sectional area toward its outlet to deliver said combustible gas mixture from said tip at lower velocity than said

combustible gas mixture is delivered from said tip by at least one other of said last-named passages.

4. Torch tip for cutting and similar thermochemical metal-removing operations initiated by heating flames produced by burning a combustible gas mixture containing a slow burning fuel, comprising a tip jacket and tip internal together constituting a tip body having a flush profile; a central longitudinal passage through said internal for oxidizing gas terminating in a discharge orifice at the profile end of said internal; at least one passage for said combustible gas mixture defined between said jacket and said internal and terminating short of the profile end of said tip body; additional separate passages for oxidizing gas and fuel gas communicating with said passage for said combustible gas mixture; and a plurality of passages connecting said combustible gas mixture passage with discharge orifice means in the profile end of said tip body, some of said last-named passages increasing in cross-sectional area between their inlets and the corresponding discharge orifice means to deliver said combustible gas mixture therefrom at lower velocity than it is delivered from others of said discharge orifice means.

5. Torch tip for cutting and similar thermochemical metal-removing operations initiated by heating flames produced by burning a combustible gas mixture containing a slow burning fuel, comprising a tip jacket and tip internal together constituting a tip body having a flush profile; a central longitudinal passage through said internal for oxidizing gas terminating in a discharge orifice at the profile end of said internal; said internal having a portion intermediate its ends smaller than the interior dimension of said jacket and forming therebetween an annular chamber for said combustible gas mixture terminating short of the profile end of said tip body, and additional separate passages for oxidizing gas and fuel gas communicating with said annular chamber for said combustible gas mixture, and two separate sets of grooves formed in the surface of said internal adjacent the profile end of said tip body forming with said jacket two sets of separate passages connecting said chamber with corresponding separate sets of discharge orifices situated adjacent to one another in the profile end of said tip body, the grooves forming one of said separate sets having gradually increasing depth between said annular chamber and the corresponding discharge orifices to define low velocity combustible gas passages and the grooves forming the other of said sets having uniform cross-sectional area throughout their length to define high velocity combustible gas passages.

6. Torch tip for cutting and similar thermochemical metal-removing operations initiated by heating flames produced by burning a combustible gas mixture containing a hydrocarbon of the methane series as fuel, comprising a tip jacket and tip internal together constituting a tip body having a flush profile; a central longitudinal passage through said internal for oxidizing gas terminating in a discharge orifice at the profile end of said internal; said internal having a portion intermediate its ends smaller than the interior dimension of said jacket to define therewith an annular chamber for said combustible gas mixture terminating short of the profile end of said tip body and additional separate passage for oxidizing gas and fuel gas communicating with said annular chamber for said combustible gas mixture; and two sets of separate passages connecting said annular chamber with two rows of corresponding discharge orifice means in the profile end of said tip body arranged to surround said central discharge orifice, the passages leading to at least one of said rows being defined between said jacket and grooves formed in the surface of said internal of increasing depth from said annular chamber to the corresponding discharge orifice, and the passages leading to the other of said rows having uniform cross-section throughout their length.

7. Torch tip as defined in claim 6, in which said grooves in said internal increase in depth sufficiently to form passages having a cross-sectional area at the discharge end approximately ten times the cross-sectional area of said passages at said annular chamber.

8. Torch tip as defined in claim 2, in which said separate high and low velocity orifices are disposed in separate annular rows.

9. Torch tip as defined in claim 2, in which said separate high and low velocity orifices are disposed in the same row.

FRANCIS J. EICHELMAN.

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