June 12, 1945. M. H. WIGTON 2,378,346

APPARATUS FOR MIXING AND BURNING FUEL

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Fig. 1

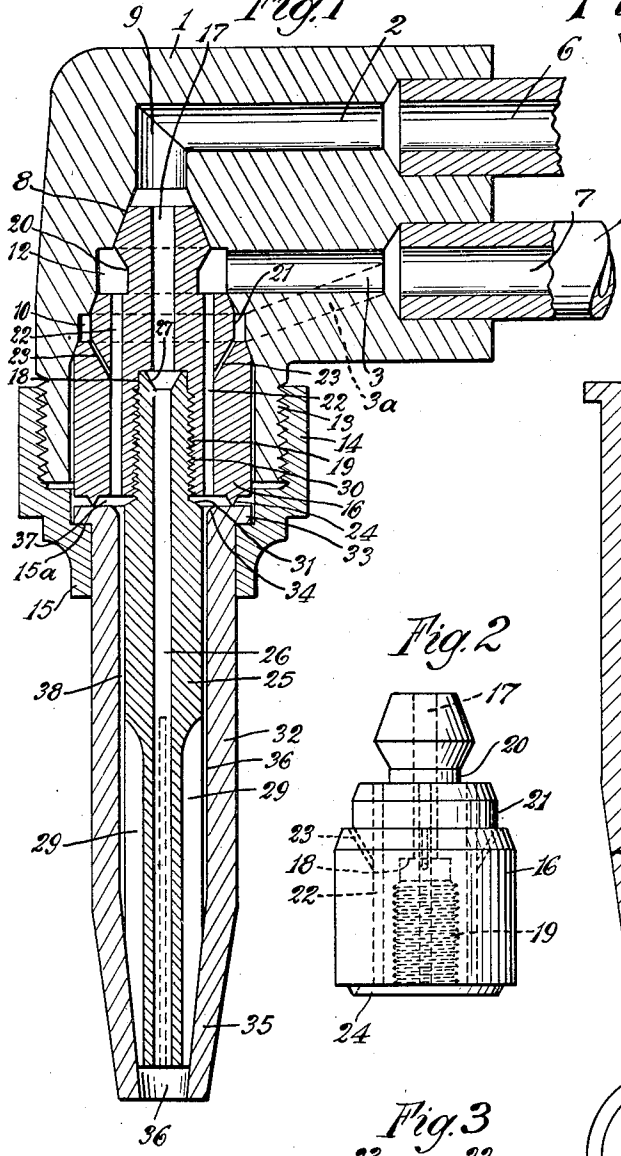


Fig. 11

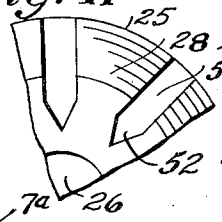


Fig. 6

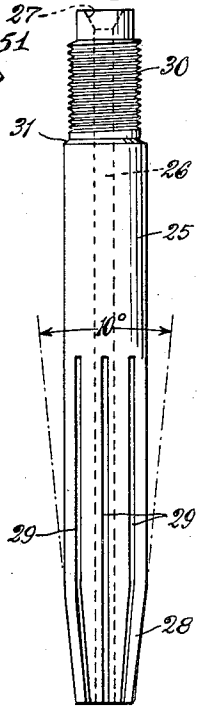


Fig. 4

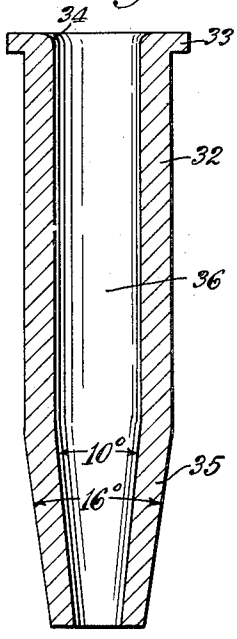


Fig. 2

Fig. 7

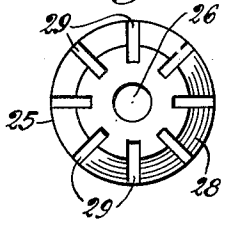


Fig. 5

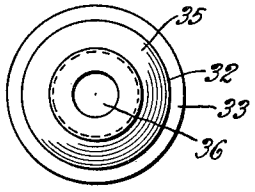


Fig. 3

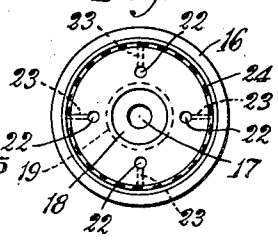
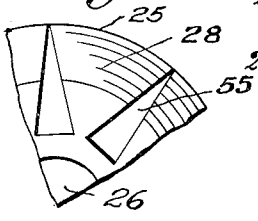


Fig. 12



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APPARATUS FOR MIXING AND BURNING FUEL

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Fig. 8

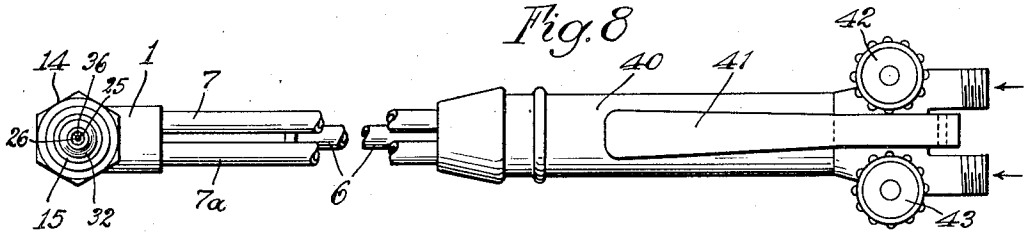
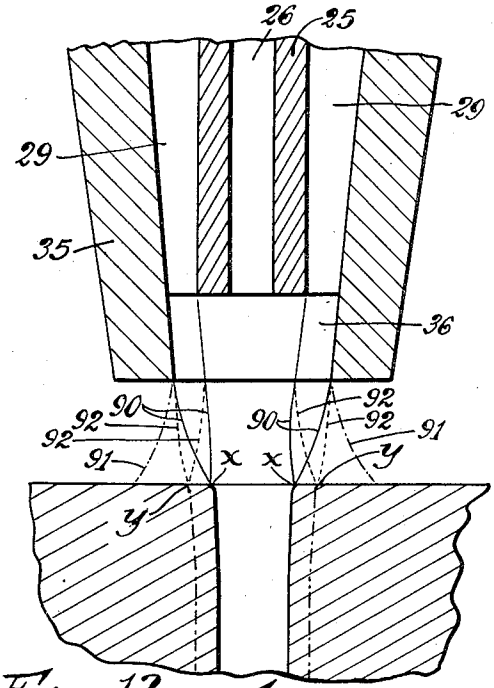


Fig. 9



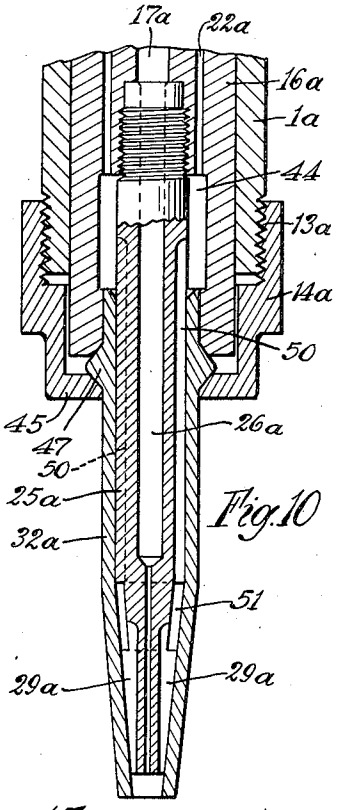


Fig. 10

Fig. 13

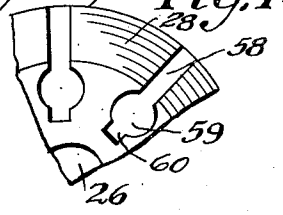


Fig. 14

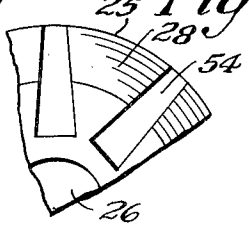
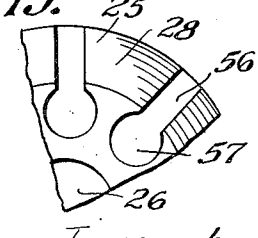


Fig. 15.



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UNITED STATES PATENT OFFICE

2,378,346

APPARATUS FOR MIXING AND BURNING FUEL

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Application June 17, 1940, Serial No. 340,897

10 Claims. (Cl. 158—27.4)

This invention relates to an apparatus for the burning of fuel, and is a continuation in part of the application on the method of mixing and burning fuel which has matured into Patent No. 2,335,330, November 30, 1943. In the particular form here shown, it comprises a torch which includes means for receiving and mixing fuel and oxygen or fuel and air, and for conducting a mixture to a point of burning. It includes, also, means for conducting an unmixed supply of oxygen or air to the point of burning. One object of the invention is to provide means for efficient burning of the so-called "slow burning" gases. Typical of these gases is butane. The invention is not limited to the burning of butane. The details of burning and the specific objects of the method of burning will be set out below. The apparatus of the present invention, showing two forms of mechanism suitable for carrying out this method, is illustrated in the accompanying drawings wherein:

Figure 1 is a longitudinal section through the burner tip and associated parts;

Figure 2 is an elevational view of the tip base;

Figure 3 is an end view of the base of Figure 2;

Figure 4 is a longitudinal section view of the tip sleeve;

Figure 5 is an end view of the sleeve;

Figure 6 is an elevation of the tip core;

Figure 7 is an end view of the core;

Figure 8 is a bottom view of a welding or cutting tool appropriate for the employment of the tips herein described and shown;

Figure 9 is a diagrammatic illustration of the flame operation of my tip, as contrasted to the application of the prior art tips;

Figure 10 is an axial longitudinal section through a variant form of my device; and

Figures 11, 12, 13, 14 and 15 are fragmentary end views of cores similar to that shown in Fig. 7 but showing different styles of slots or grooves that may be provided in the core for preheat ports.

Like parts are designated by like characters throughout the specification and the drawings.

Referring, for example, to Figure 8, I illustrate a tool appropriate for use with my nozzle. It includes, for example, a body portion 40 provide with a pipe or line 6, adapted, for example, to take high pressure oxygen controlled by any suitable valve, which may be controlled by the handle or lever 41, mounted in any suitable fashion on the tool body 40.

I illustrate two additional passage members 7 and 7a, controlled, respectively, by any suitable valve handles 42 and 43. The line 7 may be employed for directing oxygen, preferably under low pressure, whereas the line 6 may be employed to deliver oxygen at higher pressure. The line 7a may be employed to deliver an appropriate fuel, such, for example, as butane. All three passages extend to a head portion provided with an inlet 2 for the passage 6, and inlets 3 and 3a for the passages 7 and 7a, respectively.

As shown, the head 1 has a generally tapered enlarged cavity 8 formed in it. The passage 9, which is a continuation of the passage 2, enters the cavity 8 at its apex. The cavity 8 has an annular enlargement 10 which is in communication with the passage 3a, which delivers fuel thereto. An annular enlargement 12 is formed in the cavity 8 and the passage 3 communicates with this enlargement 12, and may deliver low pressure oxygen thereto. The head may have an exteriorly threaded extension 13 within which a part of the cavity 8 is formed and which receives in threaded engagement a tip retainer 14, which includes a portion 15, preferably provided on its interior with a retaining shoulder 15a.

The tip comprises a base 16 which corresponds in shape generally to the cavity 8. A longitudinal passage 17 is formed in the tip. This passage is enlarged adjacent its downstream end to form a shoulder 18. It may, also, be interiorly threaded as at 19 to receive the tip core as will be described below. The base 16 is grooved or cut away as at 20 to provide what is in effect a continuation or extension of the enlargement 12 of the cavity 8. The base is also cut away or grooved as at 21 to provide what is in effect an extension or continuation of the enlargement 10 of the cavity 8. Thus, when the base is in place, one annular passage is formed about its exterior by the grooves 12 and 20, and a second annular passage is formed by the grooves 10 and 21, these passages being in communication, respectively, with the passages or ducts 3 and 3a.

Running through the base are one or more longitudinal passages 22 which communicate with the cutaway portion 20 and extend to the outer or downstream end of the base. For each passage 22 there is formed a passage 23 which extends from the space 21 at an incline and enters the passage 22. Thus, fluid in the spaces 10 and 21 flows into the passages 22. The outer or downstream end of the base may be provided with a raised land 24.

Associated with the tip base is a tip core formed generally of a body portion 25 which

is provided with a central bore or passage 26, the upper or upstream end of which may be enlarged as at 27 if desired. The outside of the core is tapered or inclined as at 28 and a plurality of preferably symmetrically arranged slots or grooves 29 are formed in the exterior of the core. As shown, particularly in Figure 7, these slots or grooves are preferably arranged radially or generally radially with respect to the center of the core and their depth is relatively greater than their width it being understood that where the words "radially arranged" are used in the context it means an arrangement wherein the slots are disposed with their major cross-sectional dimension disposed generally upon radii related to a common point or projection preferably falling within the cutting port. This is true even at the outer or downstream end of the tip. They may advantageously be of generally rectangular cross section and of generally constant width. It will be understood, however, that these slots may be varied in shape and cross section. It is important, however, that the slots be of sufficient depth in relation to their width to provide a substantial space at the inner end of each slot, for a purpose which will later be brought out in detail.

At its inner or upstream end, the core may be reduced and threaded as at 30 to be received in the correspondingly threaded portion 19 of the base. Adjacent the threading or the reduced portion, the core is provided with an angularly disposed shoulder 31. This angle in the particular form shown is of approximately 15 degrees with respect to a line drawn at right angles to the central longitudinal axis of the core.

Associated, also, with the core and base and surrounding the core is a core sleeve comprising a generally hollow body 32 which may be shouldered at its upstream end as at 33. The upper edge of the central bore is preferably rounded as at 34. The sleeve is tapered as at 35. Internally the size and shape of the taper correspond generally to the external size and shape of the tapered portion 28 of the core 25. As shown, the angle of inclination of the sleeve with respect to its central longitudinal axis is 10 degrees, and the corresponding angle of inclination of the exterior of the tapered portion of the sleeve is 16 degrees. The taper, of course, reduces the diameter of the internal bore or space 36 formed within the sleeve.

The parts are assembled generally as shown, the core being screwed or otherwise placed in engagement with the base; the sleeve is positioned about the core and the parts are then held in place by the retainer 14 and the shoulder 15*a*. The raised land 24 assists in preventing leakage and otherwise in spacing the parts.

High pressure oxygen is supplied through the conduit 6. Low pressure oxygen is supplied through the conduit 7, and fuel for mixing therewith through the conduit 7*a*. The mixed low pressure oxygen and fuel passes downwardly through the apertures 22 to the space 37, thence through the space 38, and finally out through the bore 36 for use. The gas is delivered to the low pressure oxygen passing downwardly through the passage 22 by means of the inclined passages 23. Thus, butane mixed with oxygen is moving downwardly through the passages 22. It emerges from the downstream end of these passages into the more or less irregular, annular space 37 formed between the lower end of the base 16, the upper end of the sleeve 32, the land 24 and the inclined shoulder 31. The angular relationship of these parts is such that as the mixed gas and oxygen move through the space just mentioned, they are sufficiently disturbed to remove stratification and, thus, to cause satisfactory aand uniform mixing. The spaces are, however, of such size, shape and angular disposition that rectilineal flow free from eddies due to obstructions is provided.

As the now properly mixed gas and oxygen move downwardly from the space 37 into the annular space 38 between the core 25 and the sleeve 32, they finally enter the grooves or slots 29 and are discharged at the outer or downstream end of these slots. These mixed jets of gas and oxygen, when they burn, form what are called the "preheating flames." Since they begin inside of the outer end of the bore 36, they are to some degree protected and controlled, and since these "preheating flames" are relatively deep in a radial direction, they are not materially diluted by the air about them and satisfactory preheating, burning conditions prevail. This is accomplished in part by the arrangement of the direction and the dimensions of the "preheating flames," which are in turn controlled by the shape and depth of the slots 29 and by the positioning of the downstream end of the core sufficiently within the downstream end of the sleeve. The proportions of gas and low pressure oxygen are so controlled as to provide a completely oxidized mixture, and when the preheating jets burn, they do so without the necessity of the addition of any atmospheric air. Any entrainment of atmospheric air with the jets is incidental and is not relied upon in producing or supporting the necessary combustion.

In Figure 10, I illustrate a variant form of my device in which a portion of the head is illustrated, as at 1*a*. Within it is the member 16*a*, corresponding to the member 16 in Figures 1 and following, although of modified form, shown, for example, as having a generally cylindrical exterior. It is provided with a plurality of passages 22*a*, through which properly mixed low pressure oxygen and fuel are delivered to the space 44. The member 1*a* is exteriorly screw-threaded as at 13*a* to receive the retainer 14*a*, which has an inwardly extending flange 45 abutting against an enlargement 47 on the sleeve 32*a*. Within the sleeve is the tip 25*a*, having a central passage 26*a* in communication with the high pressure oxygen outlet 17*a*.

The mixed low pressure oxygen and fuel passes downwardly from the space 44, along a plurality of slots 50. These slots 50 communicate with a space 51, in communication with a plurality of slots 29*a*, corresponding in size and form to the slots 29 of Figure 7.

Different forms of slots or grooves may be used. Ordinarily, only a single type of groove would be used in any core but two or more might be used in the same core. A straight-sided groove 51 having a pointed inner end 52 may be provided as shown in Fig. 11, or a straight-sided groove 57 having a more or less curved or circular enlargement 57 at its inner end might be used as shown in Fig. 15. Other forms may involve a groove 55 having a triangular cross-section as shown in Fig. 12 or a groove 54 whose sides diverge toward its inner end which is wider than its outer end as illustrated in Fig. 14. A further modification of the groove 29 may be provided such as groove 58 shown in Fig. 13 which has a more or less curved or circular enlargement 59 with its inner end restricted as at 60. In each or all of them,

however, the radial depth of the slot is greater than the peripheral width of the slot and, preferably, the radial depth is substantially greater than the peripheral width.

Although there is shown an operative form of the device, it will be understood that many changes in the form, shape and arrangement of parts might be made without departing from the spirit of this invention, and it is wished that the showing be taken as, in a sense, diagrammatic.

And although the device has been described above as a cutting torch, it is not limited to that use and may be used as a heating torch generally for any purposes for which a heating torch can be used, and it is not limited to cutting.

The use and the operation of this invention are as follows:

The apparatus herewith disclosed, while its use is not limited to the burning of any particular gas, is of special advantage in supplying a more useful source of heat for preheating steel or other metal for cutting or wherever rapid heating is desired. It is particularly advantageous in utilizing relatively slow burning gases such as gases which burn with the rate of burning of hydrogen or even slower—that is to say, burning these gases with oxygen as the combustion supporting medium. Such slow burning gases may be differentiated from fast burning gases of which acetylene is typical.

The desired burning of such gases is accomplished by the tip shown herewith which is so designed that the gases can be supplied at a higher speed than is possible with conventional tips and, thus, a greater heat input is applied at a higher temperature to a highly localized surface. My apparatus and method also produce economies of fuel and oxygen, and permit the cutting of a narrower kerf.

The structure of the present invention operates to carry out the following steps:

1. The fuel and low pressure oxygen are proportionately mixed;

2. They are, then, mingled with a flow free from turbulence or fluctuation;

3. They, then, pass through an annular passage;

4. They are, then, conducted into suitable passages free of any shoulders, sharp corners or other obstructions, avoiding both turbulence and pulsation;

5. The gases, then, pass to the burner ports, producing a flame, the character of which is determined by the construction shown.

In the particular embodiment shown, the tip is positioned in a head or suitable means for holding the tip and for supplying gas to it. The base **16** preferably provides a part which may be used for all tip sizes—that is to say, it will receive a variety of different tips **25**. It comprises means for receiving the core tip and sleeve and means for proportionally mixing the fuel and the gas which supports combustion. The seat upon which the tip is seated comprises a part of the base and is so formed that dirt is prevented from lodging upon it. The gases are mixed by conducting the fuel gas into the oxygen passage through smaller tributary passages at a pressure equal to or preferably greater than the oxygen pressure. In case of restriction of the tip, the fuel gas will prevent the oxygen from backing up into the fuel line and the construction also causes the fuel gas to flow into the oxygen stream in a manner which provides proportional mixing.

After being proportionally mixed, the gases tend to dissolve or to diffuse into each other. This does not take place instantaneously and it is important to provide, as the present mechanism and method do provide, for mixing and dissolving of the gases as completely as possible to avoid uneven combustion. The passages and parts of the apparatus herewith disclosed are so shaped as to hasten the mixing and solution of the gases. They prevent stratification and provide some mingling free from turbulence, pulsation or irregularity which would produce uneven burning. The relationship of the area of the annular passage defined between the tip and the tip sleeve to the area of the passages **29** formed in the tip itself allows the gas to flow into the preheat ports—that is to say, the discharge ends of the passages **29**—at a low velocity without being affected by shoulders or other obstructions. The burner port itself, as shown particularly in Figure 7, consists of a number of relatively narrow and relatively deep slots arranged generally radially around the center—that is to say, around the outlet end of the oxygen port **26**.

This design anticipates adjustment of the flame to a completely balanced mixture of five to six cubic feet of oxygen to one cubic foot of commercial propane, as compared to 4.5 cubic feet of oxygen to one cubic foot of propane, as used in other equipment now produced. Atmospheric oxygen is not relied on. This flame has a higher temperature and a higher rate of flame propogation than one which contains less oxygen and depends on additional oxygen from the atmosphere. This is due to the fact that additional oxygen from the atmosphere also carries with it four parts of inert gas, which cools the flame and reduces the rate of flame propagation. My method and apparatus reduce the quantity of additional oxygen from the atmosphere which is burned, and thus eliminate very largely the taking up of the inert gas which is present in the atmosphere. In considering the slots **29**, it is important that they be relatively narrow as compared to their depth and that they extend as close to the center of the tip as is practicable. Actually in Figures 1 and 7, in order to avoid confusion of the lines of the drawings, their inner surfaces are shown as spaced from the passage **26** farther than would be the case in practice. In practice, the inner surfaces of these slots **29** are preferably as close to the walls of the passage **26** as structural and manufacturing conditions will permit.

While I find a generally rectilinear cross section desirable, it will be understood that my primary purpose is to provide a substantially large space at the bottom of each of the slots **29** or **29a** for delivering against the metal a jet of completely oxidized mixture, which does not rely at all on atmospheric oxygen. The form of the passages might be considerably varied. Thus, a slight inward convergence is practical, or the inner ends of the apertures might be somewhat rounded or arcuate in cross section. The advantage of the sharp corners, however, is that the corners obtain in effect a pilot result, since the gases which flow down the corners are retarded enough at these points to assist in piloting the stream even though the main portion of the stream is moving at a rate greatly in excess of the rate of flame propagation for the fuel used, thereby being effective to maintain ignition and to prevent the flame from being blown from the tip.

In the use of my device, as contrasted, for example, with prior art tips, Figure 9 illustrates

in the light full line, at **90**, the shape of my fully oxidized jet. Since it does not depend on atmospheric air, its zone of ignition is at the end of the tip at the inner side of the jet, and completes its burning as at *x* in Figure 9. As the jet leaves the tip, the outer portion of the jet mixes with the atmospheric air and produces a shielding flame of lower temperature, which, however, has some advantage in preheating the metal under treatment as the tip is advanced to cross the work. This outer flame is indicated as at **91**. It is the ignition zone, however, as at *x*, which defines the width of the kerf cut and the amount of metal which has to be oxidized in order to cut through the work. In the earlier tips, where the delivery slots **29** are parabolic or circular in cross section or are arranged with converging walls, the jets rely on atmospheric oxygen for complete combustion, and the form of the actual cutting flame is shown in Figure 9 in dotted line, as at **92**, **92**, with the zone of ignition on the exterior of the flame. In contacting the metal, as at *y—y*, this results in a wider kerf, and the necessity of oxidizing a greater volume of metal in order to complete the cut.

To summarize, I employ an oxygen-rich mixture, adding to the fuel the full amount of oxygen for complete combustion of the preheating jets or flames, as shown in the space bounded by the lines **90**. I do this by providing in the slots **29** an inner space, near the passage **26**, of substantial cross sectional area, down which the completely combustible mixture is delivered. The inner portion of the jet is shielded or separated from the outside air by a substantial flame wall, as shown at **91**.

Where a parabolic or circular or converging wall slot is employed, if there is any area of delivery of a completely combustible and shielded mixture, which is dubious, it is so much smaller than the corresponding area in the jet in my structure and method that it cannot have the efficient heating effect necessary to obtain an economical and an efficient result. It becomes necessary, in such tips, to rely on the supply of oxygen from the atmospheric air. For this reason the ignition point or zone of the prior art jet is on the outside of the flame, as shown at *y*, whereas my ignition point is on the inner side or edge of each jet, as at *x*. The result is actually a narrower kerf or width of metal to be oxidized.

Furthermore, since in my method and apparatus the portions of the flame which actually contact the metal at the heating point are closer together, they are concentrated on the surface of the steel, the two closely approached heating areas reinforcing each other and decreasing the amount of steel which has to be burned to make the cut. I concentrate the hottest part of the flame on a narrower area than is practical or possible with any prior art tip known to me.

The net results are that less fuel is needed because of the time and temperature relationship, it requiring less fuel to heat a smaller volume of steel, and my jet or tip, involving the heating of a smaller area of the steel to make the cut. Less oxygen is needed since a smaller amount of oxygen is necessary in order to satisfy the lower volume of fuel employed. Also, less oxygen is required because less steel needs to be oxidized, due to the smaller volume of weight of steel removed in the smaller kerf.

It will be understood, of course, that in the operation of the device, the high pressure oxygen, supplied for burning the metal, is controlled by the lever **41** and the operator, as he moves the tip across the work, is preheating the metal by the jets, bounded within the lines **90**, and is burning the metal by supplying the high pressure oxygen to the preheated area. The low pressure oxygen may be controlled in relation to the fuel by any appropriate setting of the valves **42** and **43**.

The purpose of this arrangement is to provide that the gases burning near the center of the flame may be shielded from the atmosphere so that this higher temperature flame may be produced. This effect, combined with the completely mixed non-turbulent flow of the gases which allows a hotter, more concentrated flame which burns more rapidly, thereby reduces the amount of time necessary to bring the surface upon which the flame is impinged to a given temperature.

A principle which is involved in the present invention includes mixing and guiding means in which the proportionately mixed gases are redirected at a generally obtuse angle for the purpose of "stirring" these gases to break up whatever stratification may have taken place and, thus, to cause uniform and satisfactory mixing throughout.

I claim:

1. A blowpipe including a tip sleeve having a smooth inner wall free from sharp surfaces, a core member having a smooth outer contour substantially longitudinally coextensive with the inner wall of the sleeve at its inner end and spaced from said wall throughout the major portion of the cooperating surfaces of the core member and sleeve, said core member terminating at its outer end a short distance within the sleeve to provide a recess, said core member having a longitudinal bore and a plurality of radially arranged slots formed in its outer surface and terminating at said recess, the peripheral width of said slots being less than their radial depth and being spaced from each other an angular distance substantially less than 90°, and a head member having a plurality of passageways therethrough and supporting said core member and tip sleeve with the sleeve turned outwardly at its inner end to provide a shoulder for securement, one of said passages communicating with said bore and the other passages constituting bifurcated passages receiving fuel through one branch and a combustion supporting gas through the other branch, said fuel and gas being mingled within the head and discharged into a mixing chamber bounded over a portion of one wall thereof by the outwardly flared portion of the sleeve and having an outlet leading to said slots between said tip sleeve surface and the outer contour of the core member, which outlet is bounded upon one side by the rounded edge of said flared portion.

2. In a burner, a sleeve, a tip member telescoped in said sleeve, said sleeve and tip member having smooth walls throughout their telescoping portions which walls are spaced from each other at their inner ends and throughout a major portion of their length to provide an annular passageway, said tip member having a longitudinal bore and a plurality of generally radially arranged slots of generally uniform peripheral width formed in its wall at its outer end, the width of said slots being less than their depth and being spaced from each other an angular distance substantially less than 90°, the inner sur-

face of said slots approaching close to said axial bore, and means for supporting the tip member and sleeve at their inner ends including a head member.

3. A blowpipe cutting tip for slow burning gases including a core having a passage terminating at the outer end in a cutting port and a plurality of slots in its outer wall cut radially with respect to the cutting port to a depth providing an inner wall separated from the cutting port by a thin partition of core stock, and a sleeve received externally upon the core and defining therewith a smooth walled annular passage between them throughout the major portion of their telescoping length, said slots terminating in preheat ports of a radial depth substantially greater than their width and said sleeve providing a wall circumferentially engaging the core at its port end and extending beyond the plane of said preheat ports to provide a peripheral boundary wall of the slots at said engagement to provide conduits, said boundary wall and inner wall converging in the direction of the preheat ports to confine the discharge of gases to the preheat ports as defined.

4. In a blowpipe tip having a plurality of bifurcated passages with converging branches connecting with each other at an acute angle and terminating in a circular chamber, the combination of outer and inner tip members providing spaced circular walls defining an outlet from said chamber in the form of a substantially annular passageway having a rounded edge at its mouth, said walls being substantially smooth beyond said rounded edge throughout their length and terminating in an inward taper on the outer wall, said inner tip member having a plurality of burner ports comprising openings longer than they are wide arranged with the longer dimensions disposed radially and with adjacent openings spaced from each other an angular distance of substantially less than 90°, and conduit means interconnecting said annular passageway and said ports and having elongated inlets opening upon the inner wall of the annular passageway beginning at a point within the annular passageway in a groove progressively deepened radially to the radial depth of said longer dimension, said rounded edge causing a stirring of the fast-flowing gases flowing through said passages and said passageway and conduit means conducting said stirred gases to the ports for discharge in a stream therefrom substantially free from turbulence.

5. In a blowpipe tip having a plurality of passages converging and connecting with each other at an acute angle and terminating in a circular chamber for mixing a slow burning gas and oxygen in proportions capable of supporting complete combustion without reliance upon atmospheric oxygen, spaced circular walls defining an outlet from said chamber characterized by a single passageway having a rounded edge at its mouth, said single passageway being substantially smooth for a substantial length and terminating in a tapering wall, a port for discharging a stream of oxygen for cutting metal, a plurality of burner nozzles comprising openings longer than they are wide arranged according to a predetermined pattern with respect to the oxygen port with adjacent openings spaced from each other a distance less than their longer dimension, and conduit means having elongated inlets opening into the single passageway and beginning at a point well within the single passageway, said rounded edge causing a stirring of the fast-flowing gases flowing through said passages at a rate of flow greater than the rate of flame propagation of said fuel, and said passageway and conduit means conducting said stirred gases to the burner nozzle for discharge in a stream therefrom substantially free from turbulence.

6. A blowpipe tip for slow burning gases comprising means defining a plurality of flow accelerating conduits terminating in ports longer than they are wide, said conduits comprising slots having bottom walls which are parallel with the longitudinal axis of the tip and outer walls defining a tapering frusto-conical surface of revolution at its outer end, said ports being arranged angularly with respect to each other a distance substantially less than 90° to provide a predetermined pattern wherein the burning of the gases at an edge remote from the center of the tip shields the inner portions of adjacent flames from entrainment of atmosphere whereby the gases may burn without reliance upon oxygen in the atmosphere, and means providing a wall extending beyond the ports to define a peripheral boundary for the ports to assist said remote edge in shielding said inner portions from entrainment of air.

7. In a burner, a sleeve having a smooth inner wall free from obstructions, a tip member having a smooth outer surface positioned within said sleeve and spaced from the inner surface of said sleeve to provide an annular channel free from obstructions, said tip member having a longitudinal bore and a plurality of generally radially arranged slots of generally uniform width formed in its outer surface inwardly of the channel and with the outer surface circumferentially in contact with the sleeve at the end thereof, said slots terminating in ports the peripheral width of said ports being less than their depth and angularly spaced with respect to adjacent ports substantially less than 90°, and a head member, said tip and sleeve being secured to the head member with the sleeve extending at its outer end a predetermined distance beyond the tip member.

8. In a burner for slow burning gases, a head having a circular land thereon, a tip member secured to the head and having a longitudinal passage therethrough adapted to receive cutting oxygen from a source of oxygen under pressure through the head, a plurality of generally radially arranged slots whose inner edges are closely spaced to the passage, a sleeve member telescoped on said tip member and having a smooth inner surface spaced from the tip at the end thereof proximate to the land, means for holding the upper end of the sleeve against said land to provide a mixing chamber inside the land, said slots terminating at the end of the tip member in ports the radial dimension of which is substantially greater than the peripheral width thereof, adjacent ports being spaced angularly with respect to each other substantially less than 90°, means for delivering a mixture of slow burning gas and oxygen to said slots through said mixing chamber including bifurcated passages in the head receiving and mixing fuel and a combustion supporting gas, and means for confining and accelerating the flow of the mixture in the slots to the ports including an inwardly tapering wall on the sleeve extending a slight distance beyond the ports and held in contact with the outer surface of the tip means in relationship to the engagement between the end of the sleeve and said land.

9. In a burner for slow burning gases, a sleeve

having a smooth inner wall free from obstructions, a tip member having a smooth outer wall throughout the length of the sleeve and supported at the front end thereof circumferentially in engagement with the sleeve and spaced from the inner wall of the sleeve over a major portion of the remaining length thereof, said tip having a passage for cutting oxygen terminating in a cutting port and having a plurality of slots formed in its outer surface arranged generally radially with respect to the cutting port, the peripheral width of said slots being less than their depth at the exposed end of the tip and arranged with respect to adjacent slots an angular distance substantially less than 90°, and a head member supporting the sleeve and tip as a unitary assembly with respect to each other at their back ends with the sleeve extending beyond the tip a predetermined distance.

10. A tip for a blowpipe comprising a core member having a smooth outer contour and a plurality of radially arranged slots circumferentially spaced angularly a distance substantially less than 90° and whose radial dimension is greater than the peripheral dimension, and whose cross section has at least two corners which provide sharp corners, a sleeve member received over the core member and spaced therefrom for a substantial distance to provide an annular passageway around the core member, said sleeve member having a wall tapering into contact with the core at a point intermediate the ends of said slots and extending beyond the core to provide an outer wall for the slots, a gas mixing chamber in said tip at the rear thereof, and means for directing flow into the passageway including a rounded lip upon one of the members bounding the mouth of said annular passageway, said tapering wall and the portion of said slots above the point of contact between the wall and the core member comprising means for varying gradually the cross section configuration of the paths the gases travel beyond said rounded lip and immediately prior to combustion.

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