

Aug. 26, 1969

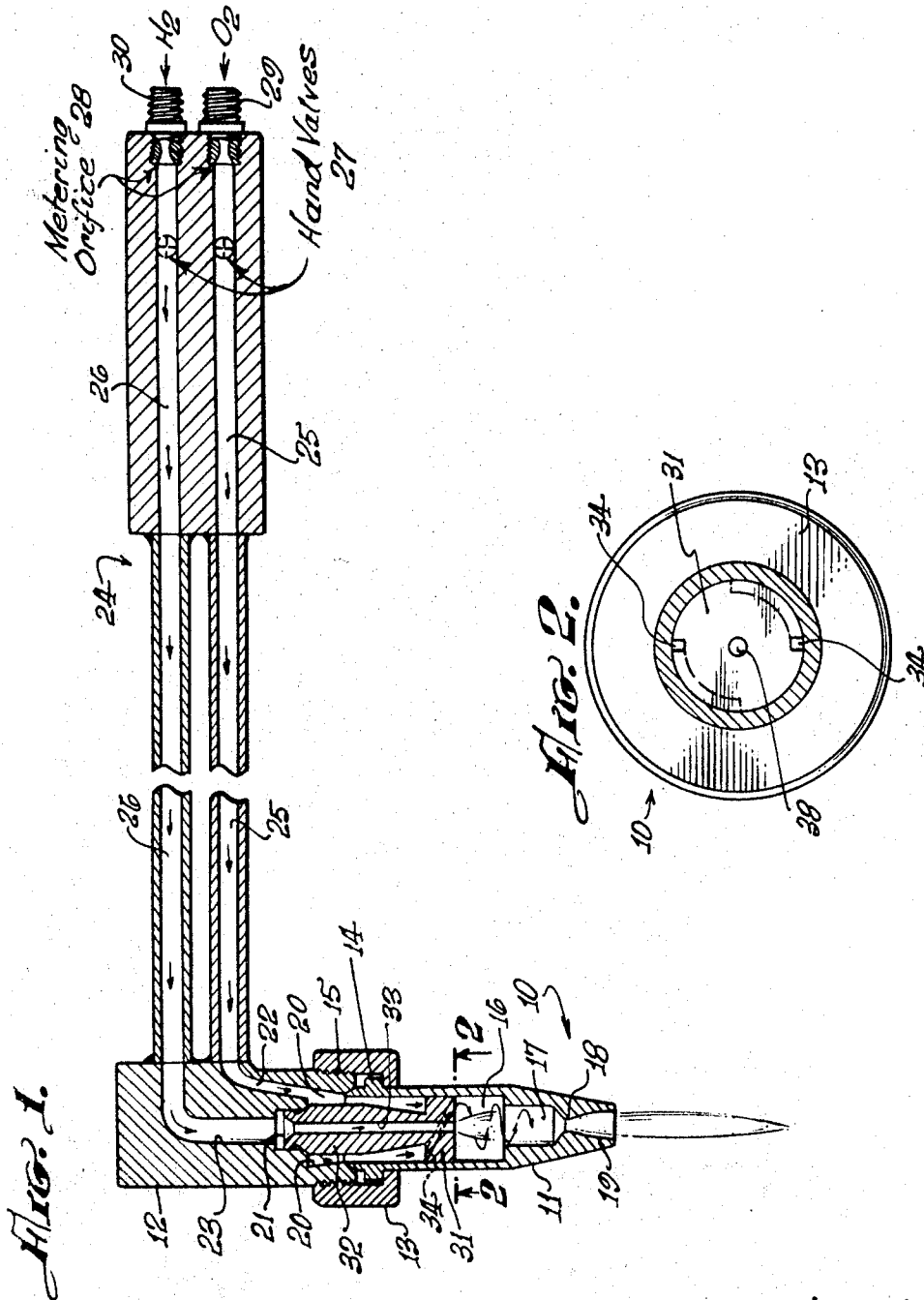
H. T. CHILDREE

3,463,601

TORCH ASSEMBLY

Filed Oct. 20, 1967

3 Sheets-Sheet 1



INVENTOR.

HERMAN M. CHILDREE,

By L. E. Carnahan

AGENT?

Aug. 26, 1969

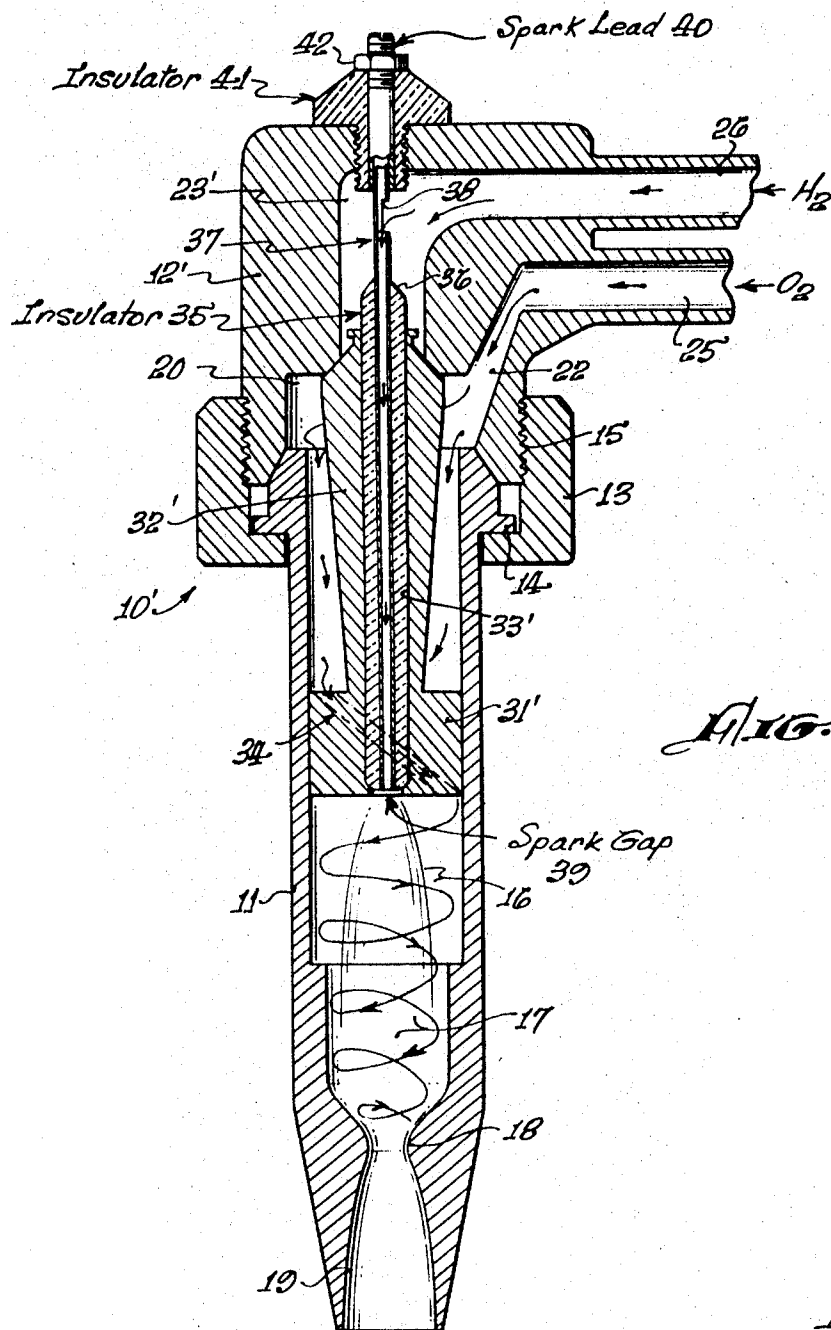
H. T. CHILDREE

3,463,601

TORCH ASSEMBLY

Filed Oct. 20, 1967

3 Sheets-Sheet 2



INVENTOR.
HERMAN T. CHILDREE,

By

L. E. Carnahan

AGENT.

Aug. 26, 1969

H. T. CHILDREE

3,463,601

TORCH ASSEMBLY

Filed Oct. 20, 1967

3 Sheets-Sheet 3

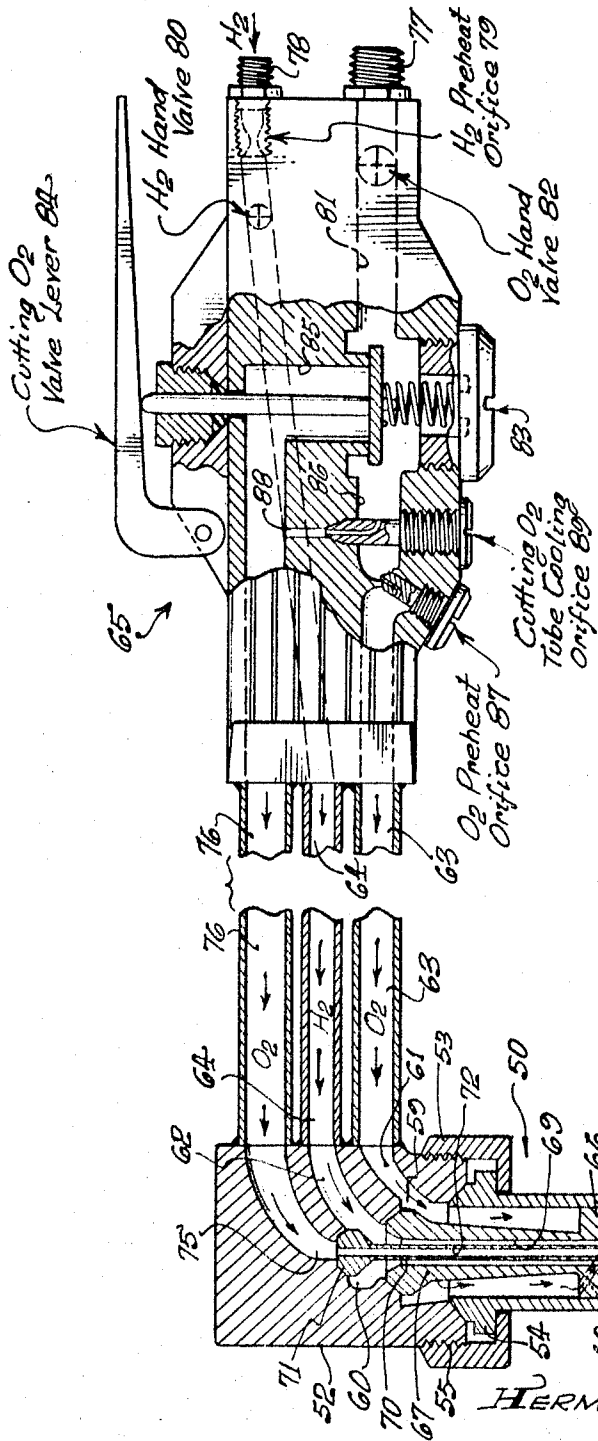


Fig. A

INVENTOR.

HERMAN T. CHILDREE,

By

L. E. Carnahan

AGENT.

1

2

3,463,601

TORCH ASSEMBLY

Herman T. Childree, Cason, Tex., assignor to General Dynamics Corporation, a corporation of Delaware
Filed Oct. 20, 1967, Ser. No. 676,952
Int. Cl. F23r 1/04; B23k 7/00; B05b 7/10
U.S. Cl. 431—158 6 Claims

ABSTRACT OF THE DISCLOSURE

This disclosure describes an apparatus that will burn volatile gaseous mixtures and exhaust them at sonic or supersonic speeds in such a manner that will result in a versatile unit suitable for numerous uses, and specifically applicable for cutting torches utilized for stainless steels and other metals and produces a cut relatively free of slag. The vortex action of the fluid within the unit creates an environmental condition that establishes a boundary layer and results in a relatively cool operation.

BACKGROUND OF THE INVENTION

This invention relates to a metal cutting process utilizing a novel device generating a high velocity, high temperature jet against a surface of the metal body to form a cut or kerf.

Cutting nozzles or tips heretofore used for metal cutting processes have been formed with either straight cylindrical or stepped cylindrical bores, or divergent nozzles.

The increasing technological advancement in metals to meet demands for higher strength and temperature requires improved methods of cutting these materials. The carbon arc method is being used for some applications; however, this presents the problem of slag removal after cutting.

SUMMARY OF THE INVENTION

The principle objectives of the present invention are to provide an improved means for cutting metal bodies within a high temperature jet supplied at high pressure and discharged from a sonic or supersonic outlet nozzle. Thus, the inventive apparatus is capable of cutting various metals which have heretofore required carbon arc or plasma apparatus.

The present invention device requires the presence of a preheating flame surrounding the oxygen jet. Devices of this type have been very successful, especially embodiments equipped with a divergent nozzle.

While the device as disclosed herein is described primarily for the combustion of hydrogen and oxygen, it is not intended to indicate that other fuels cannot be used. Various tests have been conducted using other fuels, such as propane and natural gas with favorable results. Air may also be substituted for the oxygen in specific applications. The inventive device, properly sized for a specific combustible gaseous mixture, provides a versatile unit that delivers the high temperature-high velocity flames necessary to fulfill the requirements of a metal cutting apparatus.

Therefore, it is an object of this invention to provide an improved metal cutting apparatus.

Another object of the invention is to provide a device that operates at a high combustion chamber pressure and exhausts through a sonic nozzle.

A further object of the invention is to provide a device that operates at a high combustion chamber pressure and exhausts through a specifically designed supersonic nozzle. This method of discharge transforms the high combustion chamber pressure into velocity without substantial loss.

Still, a further object of this invention is to provide a device in which a specifically designed nozzle is used to inject oxygen into the center of the high velocity exit. This nozzle transforms the oxygen pressure into velocity without substantial loss.

Another object of the invention is the generation of an environmental condition within the combustion chamber that results in a relatively cool operation.

Still another object of the invention is to provide a preheating flame surrounding the high temperature, high velocity exit.

Yet another object of the invention is to provide cooling of the combustion chamber and/or exit nozzle for specific applications by using one of the operating gases or water if available.

Still another object of the invention is to provide a method of injecting a powdered medium into the combustion chamber for specific applications.

A further object of the invention is to provide a means of igniting the combustible mixture by a centrally located spark gap.

The above and other objects and novel features of the invention will become readily apparent from the following description and accompanying drawings, wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal partial sectional view of one embodiment of the invention;

FIG. 2 is a cross-sectional view of the FIG. 1 device taken along the lines 2—2 thereof;

FIG. 3 is a partial sectional view of a modification of the FIG. 1 embodiment; and

FIG. 4 is a longitudinal view, partially in section, of another embodiment of the invention.

DESCRIPTION OF THE EMBODIMENT

Referring now to the drawings and particularly to FIG. 1, there is illustrated an embodiment of a torch assembly for carrying out certain objects of this invention, and which comprises an outer body generally indicated at 10 and composed of housing sections 11 and 12 interconnected by a coupling 13 which abuts a flange 14 of housing 11 and is threadably secured to housing 12 as indicated at 15. Housing section 11 is provided with a central cavity of various diameters, the larger diameter portion indicated at 16 and defining a chamber to be described hereinafter, an adjacent smaller diameter portion 17 defining a combustion chamber, and an adjacent portion defining a nozzle having a throat section 18 and a supersonic exit section 19. Housing section 12 is provided with a cavity in one end thereof having a first diameter portion defining a chamber or annulus 20 and a smaller diameter portion defining a chamber 21, a passageway 22 extending from chamber 20 to the external surface of the housing 12, and a passageway 23 extending from chamber 21 to the external surface of the housing 12. Attached to housing section 12, such as by welding, is a housing generally indicated at 24, housing 24 being provided with fluid passageways 25 and 26 which respectively cooperate with passageways 20 and 21 of housing section 12. Positioned in each of passageways 25 and 26 of housing 24 is a hand valve indicated generally at 27 and a metering orifice 28. Connector members 29 and 30 are secured to housing 24 and function for the interconnection, for example, of passageway 25 to an oxygen (O₂) supply and passageway 26 to a hydrogen (H₂) supply. Positioned within outer body 10 is an inner body member having a piston-like portion 31 and a tapered portion 32, portion 31 being located in chamber 16 of housing section 11 and tapered portion 32 extending outwardly from chamber 16 and through chamber 20 and terminating in chamber 21 in housing section 12. Inner

body portions 31 and 32 are provided with a central passageway 33 which interconnects the forward section of chamber 16 with passageways 23 and 26 of housing section 12 and housing 24, respectively, for the supply of hydrogen to chamber 16. Inner body portion 31 is also provided with swirl or vortex generating slots 34 (see FIG. 2) which serve to pass oxygen flowing from the source through passageways 25 and 22, chamber 20, the rearward section of chamber 16 to the forward section of chamber 16 which functions as a premix and conditioning chamber.

The length and diameter of the premix and conditioning chamber 16 and the combustion chamber 17 are sized and dimensioned for a specific gaseous mixture and input requirement. The supersonic nozzle 19 is of a specific type which transforms the static pressure in the combustion chamber 17 into a velocity above that of sound. When leaving the nozzle, it takes the form of a parallel or cylindrical jet without being subject to a compression shock or impulse.

The method of applying the gaseous mediums to the device is not part of this invention and therefore will not be discussed in detail, although, while not a specific requirement, better operation will be obtained if high pressure gaseous mediums are applied through restrictions such as metering orifices 28 or flow nozzles. These restrictions will enable the flow of gases to remain constant, assuming the supply pressure is in the amount necessary to keep the critical pressure ratio required for the gases in use.

Oxygen under pressure is applied to the oxygen annulus (chamber 20 and rearward section of chamber 16). The oxygen is admitted into the premix and conditioning chamber (forward portion of chamber 16) by way of the swirl slots 34. As the flow enters this area, a vortex is generated flowing from the premix and conditioning chamber 16 into the combustion chamber 17. This oxygen flow continues through the throat 18 of the nozzle and discharges through the nozzle exit section 19.

Gaseous fuel is applied to the chamber 21 and through the passageway 33 and flows into the center of the premix and conditioning chamber 16. It begins to mix with the oxygen as it flows into the combustion chamber 17, continues through the throat 18 of the nozzle and discharges through the nozzle exit 19.

The gaseous mixture is ignited externally as known in the art. Combustion occurs in the premix and conditioning chamber 16 and the combustion chamber 17. The vortex action of the oxygen creates an environmental condition within the device that establishes a boundary layer and results in a relatively cool operation. The combustion reaction of the gaseous mediums creates a pressure increase within the combustion chamber 17. This increase in pressure causes the flow from the nozzle exit 19 to become supersonic and delivers a cylindrical high velocity, high temperature jet suitable for metal cutting applications.

Sonic flow can be produced by removing the expansion portion of the nozzle; namely, exit portion 19, by terminating the nozzle at the center of the nozzle throat 18.

The FIG. 3 embodiment is essentially the same as the FIG. 1 embodiment except that it is provided with internal ignition mechanism. In the FIG. 3 embodiment, as compared with the FIG. 1 embodiment, the housing section 12' of outer body 10 and the inner body (portions 31' and 32') are modified as follows: The passageway 33' extending through inner body portions 31' and 32' is enlarged and an insulator 35 is positioned therein. Insulator 35 is provided with a central passageway 36 within which is located a fuel tube 37 having an opening 38 therein, whereby gaseous fluid from passageways 26 and 23' is transmitted therethrough to premix and conditioning chamber 16. Insulator 35 and fuel tube 37 terminate a predetermined distance from the end of passageway 33' in inner body portion 31' and thus define a spark gap 39. Fuel tube 37 extends outwardly through housing section 12' and terminates in a spark lead 40. An insulator

41 insulates tube 37 from housing section 12' and tube 37 is secured therein by a nut 42 threaded on the end thereof. The outer end of fuel tube 37 is plugged or otherwise constructed of solid material so as to prevent leakage of fuel externally. Also, housing 12' is modified such that passageway 23' is enlarged to accept the end of inner body portion 32' thus eliminating chamber 21 of the FIG. 1 embodiment.

Utilizing the FIG. 3 embodiment, a high voltage may be applied between the fuel tube 37 and the inner body portion 31' causing a spark to be created at the surface of the inner body and fuel tube (spark gap 39) whereby ignition of the combustible mixture in the premix and conditioning chamber 16 is easily obtained.

FIG. 4 illustrates another embodiment of the invention. The embodiment illustrated therein comprises generally an outer body 50 composed of housing sections 51 and 52 coupled together by a coupling unit 53 in a manner like that described with respect to the FIG. 1 embodiment by the utilization of a flange 54 on housing section 51 and the threaded interconnection indicated at 55. Housing section 51 is provided with chamber 56 and 57 and a divergent sonic nozzle portion 58. Housing section 52 is provided with a pair of chambers 59 and 60 which function similarly to chambers 20 and 21 in FIG. 1, and are in communication via respective passageways 61 and 62 of housing section 52 with oxygen and hydrogen supply passageways 63 and 64 of a control housing generally indicated at 65. An inner body member composed of portions 66 and 67, similar to inner body portions 31 and 32 of FIG. 1, is positioned in chambers 56 and 59 of outer body 59. Inner body portion 56 is provided with swirl or vortex generating slots 68 which function similar to slots 34 in FIG. 1. Body portions 66 and 67 are provided with a central aperture or passageway 69 within which is located a cutting gas supply tube 70, tube 70 terminating at one end in chamber 60 and at the other end in nozzle 58. Tube 70 is provided at one end with an enlarged portion 71, a central passageway 72 and an exhaust nozzle comprising a throat section 73 and a supersonic exit section 74. Housing section 52 is provided with a passageway 75 extending from chamber 60 to the external surface and adapted to align with a cutting gas supply passageway 76 of control housing 65. The enlarged portion 71 of tube 70 serves to seal the area of chamber 60 about passageway 75 and thus prevents leakage of the cutting gas into chamber 60 and directs the cutting gas through the passageway 72 of tube 70. Control housing 65 is provided with an oxygen inlet 77 and a hydrogen inlet 78. Hydrogen inlet 78 is connected with passageway 64 and is provided with a preheat orifice 79 and a hand valve indicated at 80. Oxygen inlet 77 is connected with a passageway 81 having therein a hand valve indicated at 82. Passageway 81 discharges into a spring biased valve assembly for the cutting gas, generally indicated at 83, and including a valve control lever 84. Valve assembly 83 controls the supply of oxygen to a passageway 85 which is in communication with cutting gas supply passageway 76. Oxygen is supplied from the lower portion of valve assembly 83 via a short passageway 86, and an adjustable preheat orifice assembly 87 to the supply passageway 63. A passageway 88 interconnects passageways 86 and 76 and is controlled by an adjustable tube cooling orifice assembly 89.

The FIG. 4 embodiment offers the following advantages over the FIG. 1 embodiment: (1) the preheat gases exhaust from the device at a sonic speed; (2) the cutting gas is preheated as it flows through its supply tube 70 which is located centrally in the preheat and conditioning chamber 56 and the combustion chamber 57; and (3) the cutting gas velocity is generated by the use of the nozzle (elements 73 and 74) in which the supply is transformed to velocity with substantially no loss. This cutting gas flow exhausts from the nozzle 74 in a cylindrical high velocity jet.

The basic operation of the device as illustrated in FIG. 4 is essentially identical to that as described above for the FIG. 1 device, wherein gaseous oxygen under pressure is applied to the oxygen annulus composed of chamber 59 and the rearward portion of chamber 16. The oxygen enters the premix and conditioning chamber 56 by way of the swirl slots 68. A vortex is generated within the chamber 56 and is intensified by the sharp reduction in diameters as it enters the combustion chamber 57. The oxygen flow continues through the combustion chamber 67 and discharges from the device at the sonic exit nozzle 58. Gaseous fuel is applied to the fuel annulus or chamber 60, passes through the inner body via passageway 69, and enters at the center of the premix and conditioning chamber 56. Mixing of the gaseous fuel and oxygen is started at this point and continues as the combined flow exhausts from the sonic exit nozzle 58. Ignition of the gaseous mixture may be accomplished in conventional manner. The gaseous cutting medium is applied to the inlet of the cutting gas supply tube 70 and continues through the passageway 72 thereof and enters the throat 73 of the exit nozzle 74. Assuming the cutting gas pressure is applied at the correct pressure, the cutting gas exit nozzle 74 transforms the static pressure into velocity with substantially no loss and thereby produces a high velocity cylindrical jet. The combustion reaction within the premix and condition chamber 56 and the combustion chamber 57 creates a pressure within these chambers which generates a high temperature, high velocity flame exhausting from the sonic exit nozzle 58. These high temperature gases surround the cutting gas tube 70 enabling an amount of heat to be transferred into the cutting gas. As the high velocity cutting gas exhausts from the device in the form of a cylindrical jet, it is located centrally within the high temperature sonic flow from the device thereby creating an ideal condition for metal cutting.

The inventive device of any of the above described embodiments may be further modified by directing one of the operating gases around the combustion chamber and exit nozzle. The illustrated device has successfully operated using oxygen and hydrogen as an operating medium. In this specific instance, the hydrogen could be used to cool the device. Water can also be used to cool the device when available; however, in general application, the sonic modification does not require cooling of any type.

The inventive device may also be modified by providing preheat tubes which surround the combustion chamber and the exit nozzle. These preheat tubes are similar to those presently in use on prior devices and carry a mixture of a combustible gaseous mixture and when ignited may add to the heat supplied by the exit nozzle. Also, as these gases flow through their respective tubes contained in the outer body, heat may be removed from the device thereby offering an amount of cooling.

Also, although not shown, the illustrated device can be modified to provide injection of a powdered medium for a desired atmospheric condition for specific applications.

Also, as pointed out above with respect to FIG. 1, the FIG. 3 embodiment can be readily modified to provide sonic flow by terminating the nozzle at the throat 18. In addition, it is within the scope of this invention to utilize the ignition means of the FIG. 3 embodiment in the FIG. 4 device by appropriate modifications.

It is thus seen that this invention provides an apparatus that will burn volatile gaseous mixtures and exhaust them at sonic or supersonic speeds in such a manner that will result in a versatile unit suitable for numerous uses, and which is specifically adapted for cutting torches.

While the invention has been described for cutting torch applications, it is readily seen that the concept may be utilized as an ignitor assembly, the illustrated

device being modified for the specific application as an ignitor.

Although particular embodiments of the invention have been illustrated and described, changes and modifications will become apparent to those skilled in the art, and it is intended to cover in the appended claims all such changes and modifications as come within the true spirit and scope of the invention.

What I claim is:

1. An assembly for a torch or the like comprising: a housing having a cavity therein, said cavity being open at one end; a member positioned in said housing cavity so as to define a chamber at the open end of said cavity; said chamber having a first diameter portion adjacent said member, a second diameter portion adjacent said first diameter portion and a smaller in cross-section than said first diameter portion, and a third diameter portion adjacent said second diameter portion and having a decreasing cross-section terminating at said open end of said housing cavity; said housing being additionally provided with a pair of passageways extending from the external surface thereof to said housing cavity, said passageways terminating at different portions of said cavity; said member being provided with a longitudinally extending portion which functions to prevent fluid communication between the portions of said housing cavity in which said passageways terminate; said member being provided with swirl-generating slots-like means for providing fluid communication between the portion of said cavity into which one of said passageways terminates and said chamber; said chamber also being provided with a passageway extending longitudinally therethrough for providing fluid communication between the portion of said cavity into which the other of said passageways terminates and said chamber; said housing additionally including two housing sections and a coupling member, one of said housing sections being provided with an outwardly extending flange, the other of said housing sections being with threads at one end thereof, and said coupling member being provided with a flange portion and a threaded portion, whereby said flange portion of said coupling member abutts said outwardly extending flange of said one housing section and said threaded portion of said coupling member is threaded onto said threads of said other of said housing sections.

2. The assembly defined in claim 1, wherein said housing includes a portion defining an extension of said cavity at the open end portion thereof; said extension of said cavity having an increasing cross-sectional diameter with the smaller cross-section thereof being adjacent the terminal end of said third diameter portion of said chamber, thereby cooperating with said third diameter portion of said chamber to define a converging-diverging nozzle.

3. The assembly defined in claim 1, additionally including ignition means operative mounted in said housing; said ignition means including a hollow insulator positioned in said passageway of said member; said insulator terminating a predetermined distance from said chamber; a tube-like member extending through an aperture in said housing, through said insulator, and terminating a predetermined distance from said chamber; said tube-like member being provided with an opening therein to provide fluid communication between said portion of said cavity into which said other of said passageways terminates and said chamber; and an insulator means positioned in said housing aperture and around said tube-like member extending therethrough.

4. The assembly defined in claim 1, wherein said housing is additionally provided with a third passageway extending from the external surface thereof to said housing cavity, said third passageway terminating at a different portion of said cavity than the terminal of said pair of passageways; a hollow member extending through said longitudinally extending passageway of said member; said hollow member being configured at one end thereof

7

so as to provide fluid communication from said third passageway only through said hollow member; said hollow member terminating adjacent said open end of said housing cavity; said hollow member being provided with a converging-diverging portion in the terminal end portion thereof.

5. The assembly defined in claim 5, in combination with a fluid control mechanism, said fluid control mechanism being connected to said assembly housing such that said passageways of said assembly housing are each operatively connected with cooperating passageways of said fluid control mechanism; each of said passageway of said fluid control mechanism being provided with means adapted for controlling fluid to said passageways of said housing assembly.

6. The assembly defined in claim 1, in combination with a fluid control mechanism, said fluid control mechanism being connected to said assembly housing such that said

8

pair of assembly housing passageways are operatively connected with a pair of cooperating passageways of said fluid control mechanism; each of said fluid control mechanism passageways being provided with means adapted for controlling fluid to said passageways of said housing assembly.

References Cited

UNITED STATES PATENTS

2,712,351	7/1955	Roth et al.	431—158 X
2,958,194	11/1960	Bayley	431—158 X
3,224,486	12/1965	Celler et al.	431—158
3,251,394	5/1966	Thorpe et al.	431—158

15 EDWARD G. FAVORS, Primary Examiner

U.S. Cl. X.R.

239—406