

[54] CUTTING TORCH

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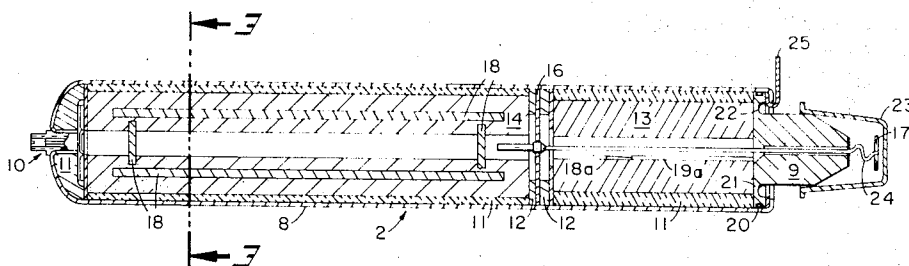
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[57] ABSTRACT

A method for cutting metal is disclosed in which a fuel and an oxidizer are burned within a combustion chamber at higher than ambient pressures to produce a gas stream comprising an oxidizer-rich core surrounded by a fuel-rich sheath. This gas stream is caused to impinge upon a body of metal to be cut at approximately sonic velocities by passing the gas stream through a choked nozzle arranged with respect to the combustion chamber so that the oxidizer-fuel orientation in the gas stream is maintained. Portable hand-held apparatus for generating the cutting gas stream are disclosed which employ a solid fuel material and a solid oxygen generating material to produce a portable self-contained unit.

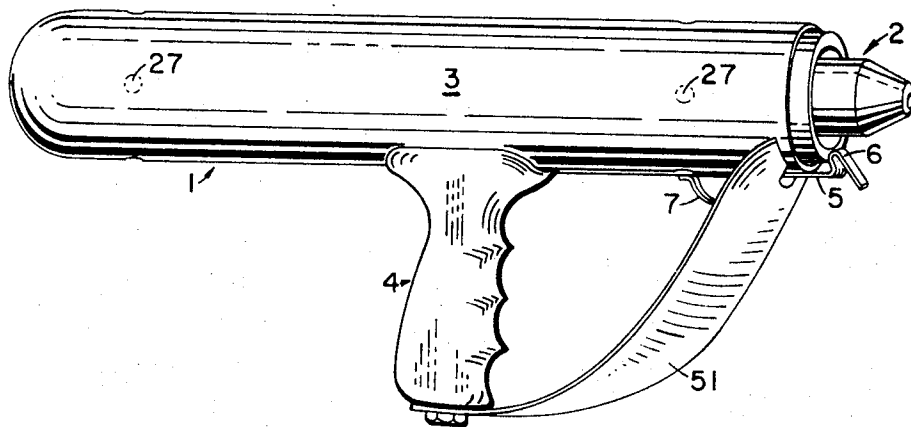
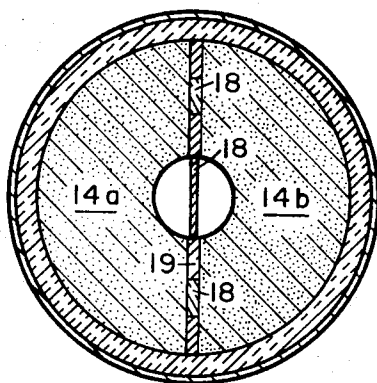
6 Claims, 3 Drawing Figures



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SHEET 1 OF 2



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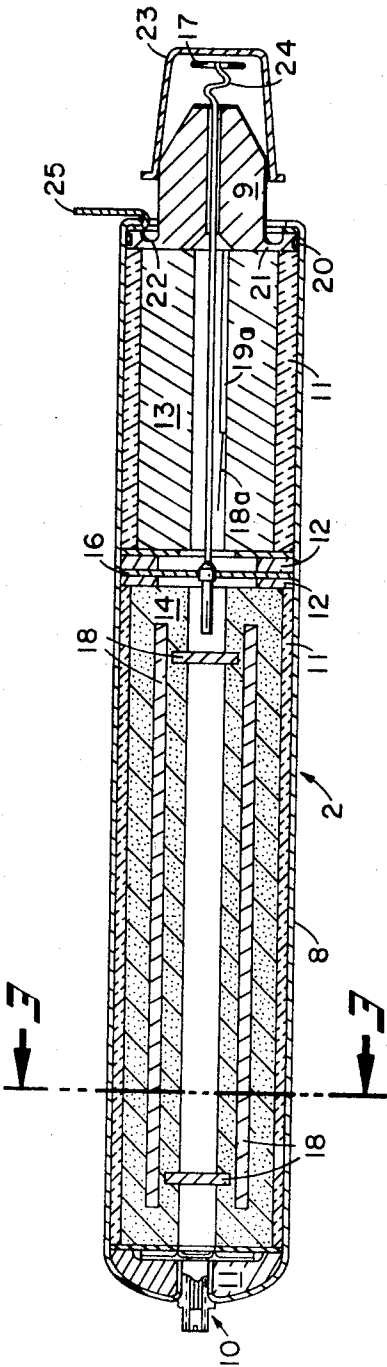


FIG. 2

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CUTTING TORCH

BACKGROUND OF THE INVENTION

Prior to this invention metal cutting torches generally consisted of the oxy-acetylene type cutting apparatus normally dependent for operation on external sources of both the fuel and the oxidizer component. Usually, both of these materials are fed in the form of high pressure gases to a cutting torch nozzle containing concentric outlets for the various components and the gases emitted from the nozzle were burned at ambient pressures at the tip of the nozzle. Such apparatus although quite useful in the cutting of metal such as iron and steel has the disadvantage of being relatively bulky and cumbersome even when a relatively limited burn duration is desired. Therefore, they lack the degree of portability which would be required for many emergency type situations. They are also relatively ineffective in the cutting of such metals as aluminum, which by virtue of its thermal conductivity and a tendency to form an oxidized coating manage to withstand the cutting effects of the torch which to a great extent are caused by a burning of the metal, heated by the fuel-rich portion of the gas stream, with the oxygen-rich core of the gas stream. According to this invention, a method for cutting metals, including such difficult to cut metals as aluminum, is provided as are portable self-contained devices with which the method can be carried out.

Accordingly, it is an object of this invention to provide a method for generating a metal-cutting gas stream.

It is another object of this invention to provide apparatus for generating a metal-cutting gas stream.

It is another object of this invention to provide self-contained portable apparatus for generating a metal-cutting gas stream.

These and other objects of the invention will be readily apparent from the following description with reference in the accompanying drawings wherein:

FIG. 1 is a side view partly broken away of an embodiment of this invention,

FIG. 2 is a side section view through a reusable cartridge of this invention, and

FIG. 3 is a transverse section along lines AA of FIG. 2.

DESCRIPTION OF THE INVENTION

It has been found that when a cutting gas stream is emitted from an orifice at sonic velocities improved cutting of many metals can be obtained. In those metals in which the cutting occurs as the result of an oxidation of the metal, it is preferable that the cutting gas stream be emitted in the form of an oxidizer-rich core surrounded by a fuel-rich sheath in which form the fuel-rich portion tends to preheat the metal to be cut and the oxidizer-rich portion serves to accomplish the burning of the metal itself. With metals such as aluminum in which oxidation performs a relatively insignificant function in the cutting process, this particular orientation of the components of the gas stream is not required and cutting occurs by a combination of fusion and physical displacement by the high velocity gas stream. Sonic velocity is readily obtained by passage of the gas stream through a choked orifice and supersonic velocities can readily be obtained by the proper expansion of such a gas stream. The exact pressure drop across an orifice that is required to produce a choked condition

is readily calculable for any compressible fluid according to known equations. As a general rule, if the upstream pressure is approximately twice the downstream pressure, a choked condition exists. Thus, a chamber pressure of about 30 psia is sufficient to produce choking of an orifice venting to the atmosphere. Various types of apparatus can be used for carrying out the process of this invention and these include combustion units utilizing fluid fuels and oxidizers, solid fuels and oxidizers and hybrid systems employing a fluid and a solid component. All of these devices comprise a combustion chamber provided with a choked orifice through which combustion products generated in the combustion chamber by reaction of the fuel and oxidizer are emitted. In addition, in those instances in which the cutting process is independent of an external source of heat once cutting has been established, such as after the preheat phase in iron cutting wherein cutting can be continued merely by supplying oxygen to the already heated cut surface; the cutting can be accomplished substantially by emitting the oxygen at sonic velocities out the orifice onto the metal cut. A preferred self-contained portable embodiment of this invention utilizes a hybrid combustion unit in which a combustion chamber closed at one end with a nozzle having an axially extending port aligned with a port in a solid fuel element contained within the combustion chamber is provided with means for supplying a gaseous oxidizer to the fuel port and for igniting the solid fuel with the oxidizer. While the oxidizer can be supplied from sources external of the device itself, the preferred embodiment of this invention utilizes a self-contained portable device in which both the fuel material and the oxygen generating material are in the form of solid components mounted within a pressure vessel.

Referring now to FIG. 1, the portable hand-held cutting torch comprises a reusable handle assembly shown generally as 1 which contains a replaceable cartridge 2. The handle assembly comprises a tubular receptacle 3 closed at one end and provided with means for holding the receptacle in the human hand illustrated by grasping means 4, for example. Other means could be provided if desired and a thermally insulated portion of the receptacle 3 may be desirable in some embodiments. A protective shield 51 for protecting the hands of the user from the heat and sparks which may be generated during the operation of the device may also be provided. The reusable cartridge 2 is releasably received within the tubular receptacle of handle and secured therein by releasable latching means 5 which are mounted on the case and extend through a notch in the shield 3. As shown the latching means 5 has a cartridge engaging portion 6 which may be moved in a downward motion by means of the tip fixed thereon to release the cartridge, however, loop means 7 may be provided for use in removing a used cartridge in those cases in which the tip become too hot to touch. Spacing means 27 illustrated as a series of circumferentially disposed dimples maintain the cartridge 2 within the tubular receptacle 3 and in spaced apart relationship therefrom to form a gas passage from the closed rearward portion of the receptacle 3 to the open front portion as will be more fully explained hereinafter. Biasing means, not shown, preferably comprising a spring may be disposed within the receptacle 3 between the rear end of the cartridge and the closed end of the handle to provide a positive

force for assistance in extrication of the used cartridge from the device.

Referring now to FIGS. 2 and 3, cross-sections through the cartridge assembly 2 are shown. The cartridge assembly 2 comprises a case 8 having a nozzle 9 mounted in one end and a pressure relief valve 10 in the other. The internal surface of the case is provided with thermal insulation 11 and 12. The case 8 contains a solid fuel material grain 13 provided with a port aligned with a port in the nozzle 9 and a solid element of oxygen generating material 14. The fuel material 13 is selected from any of a number of solid materials which burn with oxygen in a char-free manner, the preferable material because of low cost and commercial availability being polymethylmethacrylate. The solid oxygen generating material 14 may be any of a number of conventional oxygen candle compositions of the types known to the art. Such compositions generally consist of an oxidizing agent such as a chlorate or a perchlorate and a metallic fuel such as iron or magnesium compacted with fibrous binders such as fiberglass or asbestos to assist in the maintenance of the structural integrity of the composition. The individual components themselves and their relative proportions are widely adjustable to produce various desirable characteristics such as ignition temperature, burning rate, and mass flow rate as is known to the art and a suitable composition for use in the torch consists of 86.5 percent (by weight) NaClO_3 , 12.5 percent iron powder and 1 percent chopped fiberglass. In order to provide for a rapid ignition of the oxygen-generating material 14 and for a higher burning rate than would be obtained if the ignition occurred merely at the end of the candle, paths for internal ignition of the candle are provided as disclosed in copending, coassigned patent application of R. O. Mac Laren and H. J. Hyer for High Rate Gas Generator, filed Sept. 15, 1971, Ser. No. 180,682. The ignition train comprises a pull fuse igniter 15 supported in proximity to the oxygen generator 14 by means of perforated plate 16 and actuated by means of ring 17 affixed to the pull cord 24. Flame from the igniter is directed onto an ignition train comprising Quick Match sections 18 which are mounted between the segments 14a and 14b of oxygen generating material which are held together by a glue formed of an igniter material 19. This igniter material 19 may be formed from one of many conventional pyrotechnic compositions which are more readily ignitable than the body of the oxygen generating material 14. Compositions of various peroxides with a metal are suitable as are the composition disclosed in copending, coassigned patent application of H. J. Hyer for Igniter Composition, filed Sept. 17, 1971, Ser. No. 181,641, a particularly suitable composition being approximately 30 percent iron, 32 % NaClO_3 , 26 % Al_2O_3 , 1 % asbestos, 1 % ZnO , 5 % borax and 5 % dextrin. The composition is applied in the moist state and upon drying forms a binder between the elements. In addition, to provide for more rapid ignition of the fuel grain 13 once the oxidizer generating grain 14 has been ignited a quick-match 18a may be inserted in a portion of the ignition material 19a applied to the port in the fuel material 13.

The nozzle 9 comprises a mass of metal provided with an axially extending port. The mass of metal should be sufficient to act as a heat sink to absorb the heat generated during operation of the torch in a manner which prevents any substantial change to the con-

figuration of the port itself. For this reason it is preferable that the torch tip does not taper to a point at the outlet to the port since by so doing the tip of the torch would tend to ablate away under the conditions existing in operation. For that reason, a substantial shoulder portion is provided at the front of nozzle 9. Nozzle 9 is maintained in gas sealing relationship with the combustion chamber by means of an O-ring seal 20 mounted within a peripheral groove in the annular flange portion 21 of nozzle 9. In order to protect the seal 20 from degradation by the heat conducted from the body of nozzle 9, means are provided for reducing the heat conduction path from the body of nozzle 9 to the seal 20 which, as illustrated, may comprise intermediate flange portion 22 having a thickness substantially less than that of the flange 21 itself. A removable cap 23 is preferable provided over the end of nozzle 9 to prevent inadvertent actuation of the igniter and anti-roll means 25, in the form of a metal snap ring with a pendent arm may also be provided. This ring can be snapped around nozzle 9 to prevent the spent cartridge, which gets hot during use, from rolling down inclines on which it may be deposited.

In operation the burning rate of the fuel material is controlled primarily by the oxygen flow rate produced from the oxygen generator 14. In a specific torch having a total burn time of about 3 minutes, an oxygen flow rate of 0.008 lbs/per second was obtained by using an oxygen candle 9 inches long having a 2.2-inch O.D. The polymethylmethacrylate fuel grain had an initial I.D. of one-half inch and a length of approximately 4 inches. The nozzle throat was 0.2 inches in diameter. The device operated at approximately 35 psia and produced an approximately 5,000° F gas stream having a fuel-rich sheath surrounding an oxidizer-rich core which was emitted at sonic velocity from the tip of the torch. Such a torch was capable of cutting through a three-eighth inch channel iron of three-eighth inch aluminum plate and could cut 15 half-inch reinforcing rods or about 80 inches of 20-gauge steel during its burn duration.

In operation, the cartridge would be loaded into the handle assembly and when operation was desired the cap 23 would be removed and the fuse actuated by pulling ring 17. After the ignition sequence is completed, a steady cutting flame is emitted from the nozzle and cutting may be obtained by moving the torch across a metal surface in the conventional manner. Since the velocity of the gas decreases at a distance from the tip, the torch should be held sufficiently close to the metal surface such that a substantial portion of the gases contacting the surface are still at sonic velocities. The flame emitted from the torch described above exhibited shock diamonds in the stream at distances of 3 - 4 inches from the top indicating sonic velocities at this point. Efficient cutting is obtained within this distance. When the cartridge has been exhausted it may be removed by pulling down on the latch portion 7 thereby releasing the cartridge assembly 2 and another assembly could then be dropped into the holder. During operation the cartridge gets hot but the air space formed between cartridge 2 and handle 3 by spacing means 27 insulates the handle and permits it to be maintained at a temperature substantially below that of the cartridge 2. In the event of an overpressurization within the cartridge 2 caused by the plugging of the nozzle 9 by some portion of the grain, for example, the

exhaust gases would be vented through pressure relief valve 10. Since the cartridge 2 is maintained in spaced apart relationship within holder 3 by means of the spacing means 27, a gas flow path to the front is also provided around the cartridge thereby preventing any of the high temperature gases emitted through the safety valve from being directed at the user.

Since the device, like any other torch, generates very high temperature gases and, in cutting, produces metal sparks; prudence and good safety practice should obviously be followed in its use. Safety goggles and insulated gloves should be used, accident victims should be covered with asbestos blankets and use in the presence of flammable liquids and gases should be avoided.

While this invention has been described with respect to specific embodiments thereof, it should not be construed as being limited thereto. Various modifications will be apparent to workers skilled in the art which can be made without departing from the scope of this invention which is limited only by the following claims wherein:

I claim:

1. A portable cutting torch comprising:

- a. an expendable cartridge, said cartridge comprising a pressure vessel being provided with a nozzle at the forward end for emitting a stream of high temperature gases and self-sustaining means for generating pressurized high temperature gases within said combustion chamber; and

b. reusable handle means, said handle means comprising a sleeve member receiving substantially all of said cartridge with said nozzle means extending from the forward end of said sleeve, and

c. spacing means for maintaining a substantial portion of said cartridge means within said sleeve means in spaced-apart relationship therefrom.

2. The combination of claim 1 further comprising means for releasably maintaining said cartridge within said sleeve means.

3. The combination of claim 2 further comprising pressure relief means disposed on the rearward end of said cartridge and flow directing means for directing gases emitted from said pressure relief valve through the space between said cartridge and said sleeve means and out the forward end of said sleeve means.

4. The combination of claim 2 further comprising grasping means affixed to and depending from said sleeve means.

5. The combination of claim 1 further comprising pressure relief means disposed on the rearward end of said cartridge and flow directing means for directing gases emitted from said pressure relief valve through the space between said cartridge and said sleeve means and out the forward end of said sleeve means.

6. The combination of claim 1 further comprising grasping means affixed to and depending from said sleeve means.

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