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Haselmann

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[54] **BURNER NOZZLE**

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[52] **U.S. Cl.** **239/419.3,** 239/424.5

[51] **Int. Cl.** **F23d 11/16**

[58] **Field of Search** 239/419.3, 422–424.5

[56] **References Cited**

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Attorney—Larson, Taylor and Hinds

[57] **ABSTRACT**

A burner nozzle for cutting purposes and provided with channels conducting cutting gas, burner gas and heating gas. The cutting gas channel extends rectilinearly through the entire nozzle. One of the other channels is annularly formed around the cutting gas channel and is connected at the outlet end of the nozzle to an annular chamber. Said chamber is connected with a plurality of narrow channels being inclined or turned relative the axis of the nozzle. Said narrow channels are mainly intended for the burning gas and said annularly formed channel is intended for the heating gas. The burning and heating gases are mixed when the heating gas flows out from said annular chamber in said inclined or turned channels. The gas mixture is arranged to flow annularly out around the jet of cutting gas and form a heating flame.

8 Claims, 10 Drawing Figures

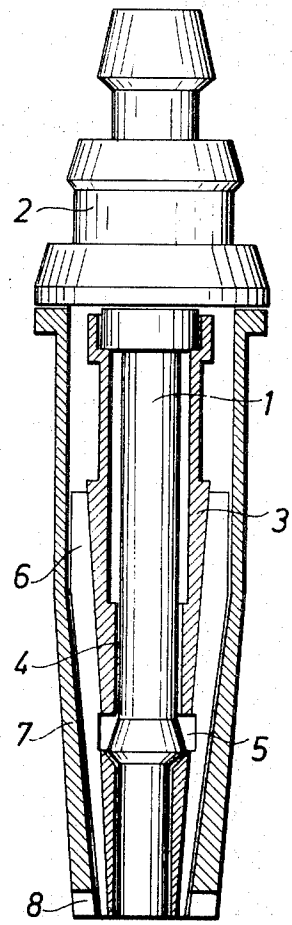


Fig.6

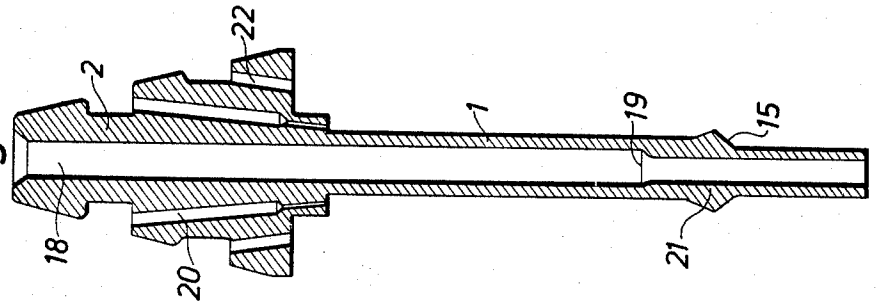


Fig.5

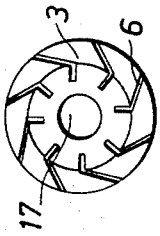


Fig.4

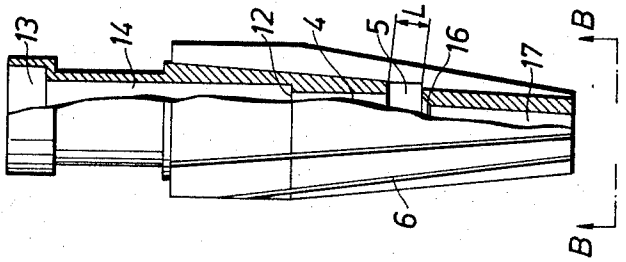


Fig.3

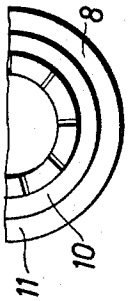


Fig.2

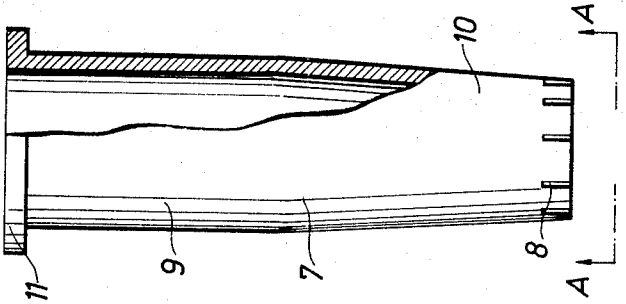


Fig.1

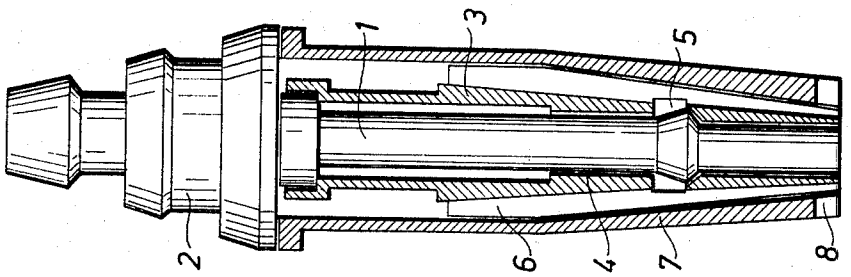


Fig.10

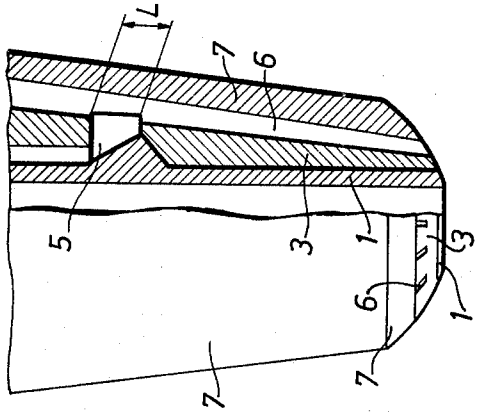


Fig.7

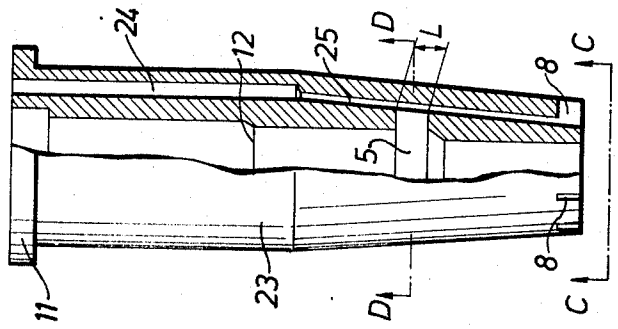


Fig.9

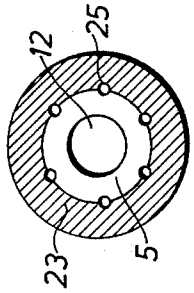
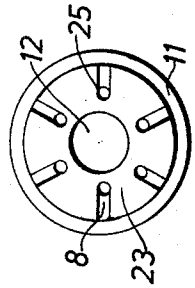


Fig.8



BURNER NOZZLE

The present invention relates to a burner nozzle, and more particularly to burner nozzles which are intended for cutting purposes. Nozzles of this latter type are normally provided with a number of channels or passages for conducting cutting gas, burner gas and heating gas through the nozzle. Moreover, the cutting gas channel or channels normally extend substantially rectilinearly through the entire nozzle.

The gas used in such nozzles for cutting and heating purposes is normally oxygen, although it is also possible to use other gases, such as air for example. In order to provide for a highly effective heating flame, the heating gas is mixed in the nozzle with a suitable burner gas, which may comprise for example propane, natural gas, MAPP gas or acetylene. The mixing chamber in which the heating and burner gases are mixed in known cutting nozzles has a relatively large volume, for instance of the order of 100–200 mm², and hence a relatively highly explosive gaseous mixture is constantly present in the nozzle while it is in use. In the occurrence of a flash back in such a nozzle, for example as a result of the nozzle orifice becoming blocked, combustion takes place within the nozzle, which may result in an explosion either in the nozzle or in the lines which lead from the gas sources. Attempts have been made to counteract these dangerous conditions by providing the burners with an injector which projects towards the nozzle, or by mixing the gases in the actual nozzle, or by a combination of these measures.

A burner has been proposed for flame cleaning which is proof against flash back. This nozzle is provided with a central body portion in which are disposed slots for the burner gas and which has a centrally located hole which terminates within the central body, this hole being intended for the heating gas. The central body is surrounded by a casing in a manner whereby the slots form burner gas channels. The burner gas channels communicate with the central hole, from which the heating gas is passed out into the burner channels and is mixed with burner gas present therein. It is true that the volume of the mixing chamber has been reduced with this type of nozzle, but the proposed design of the flame cleaning burner cannot be used for a cutting nozzle, since a cutting nozzle requires the presence of a through-passing, centrally located cutter gas channel and places high requirements on the uniformity of the heating flame and the gas mixing conditions.

The types of burner nozzles described above operate with gaseous mixtures for the heating flame which have completely different mixing ratios. Thus, a known type of blowtorch has a mixing ratio of heating oxygen to acetylene of 1–1.3 while the corresponding ratio for the flame purifying torch described above is 1.8–2.5. By providing a burner nozzles intended for cutting purposes with an annular channel arranged around the cutting gas channel and connected at the outlet end of the nozzle with an angular chamber connected with a number of relatively narrow channels which are inclined or turned relative to the nozzle axis the heating and burner gases passed through this system of channels being mixed in the narrow and inclined channels and by arranging for the gaseous mixture to flow out in an annular path around the cutting gas jet to form a heating flame, the high explosion risks associated with conventional torches are avoided and a uniform heating flame

is obtained. Thus, in accordance with this arrangement the heating gas is either supplied to the annular channel or the narrow, inclined channels, and the burner gas is supplied to the channel system not intended for the heating gas. It is considered more to advantage to permit the annular channel to comprise the heating gas channel and to use the narrow, inclined channels for the burner gas. In addition to increased safety, the nozzle according to the invention can also be started more quickly and cuts more rapidly and is more economic than cutting torches known to the art.

Moreover, the disadvantages which render it unsuitable to modify the above mentioned flame cleaning burner for cutting purposes are eliminated with the nozzle of the present invention. Thus, the arrangement of an annular chamber connected to the heating gas channel provides for a well defined connection between the heating gas channel and the burner gas channels, this connection being a factor of considerable importance in determining the uniformity of the heating flame and influences the gas mixing ratio. The condition of the heating flame can be further improved by applying a further development of the invention, which comprises a gas directing promontory arranged in the nozzle chamber. Thus, the nozzle according to the present invention is provided with three completely separated gas supply systems, the central channel being intended for the cutting oxygen, and the two remaining channels being intended for the burning gas and the heating oxygen. The size of the cutting gas channel is determined by the gas flow and the pressure conditions in front of and behind the nozzle, and the gas flow is determined, in turn, by the thickness of the material to be cut. It is to advantage to maintain the two oxygen pressure (cutting and heating oxygen) as equal as possible.

The heating oxygen flows via symmetrically arranged jets (the number of which may vary) into an annular expansion chamber. The uniform spacing of the jets provides for an extremely uniform, circumferentially distributed expansion with a high cooling effect. The gas leaves the jets at a high velocity (approx. 1 Mach) and when expanding cools the whole nozzle. The gas is passed at the bottom of the expansion chamber, via the annular chamber, uniformly distributed into the burning channels, where it is mixed with the burner gas present therein and, as a result of the twisting of the slots relative to the nozzle axis, flows towards the outlet in a rotary path, whereby a very good mixing effect is obtained. Tests have shown that the cooling effect obtained is fully satisfactory. After running the nozzle for several hours with solely the heating flame ignited, the temperature of the nozzle was still at room temperature, while subsequent to carrying out a cutting operation, the temperature of the nozzle was found to be still lower (approx. 15° C) owing to the cooling effect provided by the cutting oxygen.

When cutting steel it is necessary to heat the steel locally, for example to about 1,100° C, whereafter the cutting oxygen can be supplied to the nozzle and cutting commenced. When using nozzles hitherto known to the art, the task of heating the steel takes a relatively long time. Owing to the nature of the flame obtained with the nozzle of the present invention, however, the material to be cut can be heated locally much more rapidly than with conventional nozzles. For the purpose of providing a stable, uniform heating flame which is directed towards a central focus point, the burning gas

channels have been inclined to the long axis of the nozzle. It has been discovered that the best results are obtained with an angle of inclination of about 6°–7° and an inclination of the slot to the long axis of the nozzle of about 1°–5°. One necessary requirement if the heating flame is to burn uniformly and regularly is that a suitable mixing ratio between heating gas (oxygen) and burning gas (acetylene) suitable for cutting purposes is obtained, this ratio when acetylene is used preferably being about 1:3. The mixing ratio is highly dependent on the height of the annular chamber intersecting the burner gas channels and the accuracy of the construction of the chamber is of great importance to the uniform burning of the flame, since the quantity of heating gas used should be equally as great for each burning gas channel. Other requirements for obtaining the desired mixing ratio are that the total jet area for the heating oxygen is in a certain relationship to the total oxygen outflow area where the oxygen meets the burning gas, and that the jet area also stands in certain relationship to the total area of the outlet. The size of the outlet is of great importance to the exiting speed of the gas, which speed should not be of such magnitude that the flame burns too far from the nozzle, but nevertheless sufficiently high to prevent the flame from burning within the slots. The length of the common outflow distance of the gases in the burner gas channels is also significant to the stability of the flame (the combining effect of the flame). Owing to the fact that the outflow distance is short and the channels are narrow, the volume of the gas mixture in an operating burner is small (roughly 1–2 mm^3) and hence the risk of explosion is practically non-existent.

The nozzle of the present invention will now be described with reference to the accompanying drawings, in which

FIG. 1 illustrates a preferred embodiment of the nozzles according to the invention in an assembled condition,

FIG. 2 illustrates the outer sleeve of the nozzle illustrated in FIG. 1,

FIG. 3 illustrates the outer sleeve seen towards its outlet end along the arrows A—A in FIG. 2,

FIG. 4 illustrates the inner sleeve of the nozzle shown in FIG. 1,

FIG. 5 illustrates the inner sleeve as seen towards its outlet end in the direction of arrows B—B in FIG. 4,

FIG. 6 is a sectional view through the cutting gas pipe of the nozzle according to FIG. 1,

FIG. 7 illustrates a modified embodiment of the nozzle sleeves,

FIG. 8 illustrates the modified embodiment as seen towards its outlet end as shown by the arrows C—C in FIG. 7,

FIG. 9 is a section taken through the line D—D in FIG. 7 and

FIG. 10 illustrates a modification of the outlet end of the nozzle illustrated in FIG. 1.

The nozzle illustrated in FIG. 1 comprises a cutting gas pipe 1 having an inlet head 2. Arranged around the cutting gas pipe is a first inner sleeve 3 while between the outer wall of the cutting gas pipe 1 and the inner wall of the first sleeve 3 is located an annular heating gas channel 4, which is terminated with an annular chamber 5. A portion of the outer cylindrical surface of the first sleeve 3 is provided with burner gas channels 6 in the form of slots, while a second, outer sleeve 7, having disposed at the outlet end thereof a number of slots 8, is placed around the first sleeve 3.

FIGS. 2 and 3 illustrates the second sleeve 7 dismantled from the nozzle, FIG. 3 showing the sleeve 7 when seen from the outlet end in the direction of the arrows A—A (FIG. 2). The second sleeve 7 has an upper cylindrical portion 9 and a lower, slightly conical portion 10. The conical portion 10 is terminated with the slots 8 disposed in the outlet opening, and the cylindrical portion 9 is provided at the inlet opening with a flange 11, which is intended to co-act with an attachment means (not shown) affixed to the torch.

The first sleeve 3 is illustrated in a dismantled condition in FIGS. 4 and 5, FIG. 5 showing the sleeve 3 when seen from the outlet end in the direction of arrows B—B (FIG. 4). When dismantled, the first sleeve 3 has a through passing inner chamber 12, of varying cross sectional area. As a result of its varying cross section, the chamber 12 in co-operation with the cutting gas pipe 1 (FIGS. 1 and 6) when the nozzle is assembled is divided into different part chambers, each of which has a different function. At the inlet end of the first sleeve 3, the chamber 12 presents a portion 13 for connection to the inlet head 2, which will be described more fully hereinafter with reference to FIG. 6. Beneath the connecting portion 13 the chamber 12 forms an expansion chamber 14 for the heating gas, the expansion chamber 14 merging with the annular heating gas channel 4. The heating gas channel 4 is terminated with the annular chamber 5, the lower portion of which is sealed by engaging an outwardly inclined surface 15 (FIG. 6) on the cutting gas pipe 1, the outwardly inclined surface resting in a conical recess 16 in the chamber 12. The lowermost portion of the chamber 12 at the outlet opening of the first sleeve 3 is comprised of a guide portion 17 intended for the cutting gas pipe 1.

As mentioned above, a portion of the outer cylindrical surface of the first sleeve 3 is provided with slots 6. The cylindrical surface located nearest the inlet opening of the sleeve 3, however, forms together with the inner surface of the second sleeve 7 a burner gas chamber which imparts to the burner gas a practically static condition, without the formation of eddies or other disturbing activities, before being fed to the slot-like burner gas channels 6. As illustrated in FIGS. 4 and 5, the burner gas channels 6 are inclined or disposed in a helical path and have a through flow area which decreases towards the outlet orifice of the nozzle. It is, however, possible to increase the through flow area of the burner gas channel 6 beneath the annular chamber 5. As will be seen from FIGS. 1 and 4, the annular chamber 5 is in communication with the slots 6, this communication being of great importance to the appearance of the heating flame and the mixing conditions. Thus, it is important that all the slots 6 communicate with the chamber 5 to the same extent. Furthermore, height of the annular chamber, as shown by the letter L in the drawing, is highly important to the mixing ratio of the heating and burner gases. The burner gas channels 6 are directed towards a focus point located outside the nozzle orifice, in a manner to obtain a concentrated heating flame enveloped around the burner gas.

FIG. 6 illustrates the burner gas pipe 1 with the inlet head 2 mounted thereon. The inlet head 2 is provided in a known manner with a conical attachment means adapted to receive the supply lines for three gases. Ar-

ranged centrally in the inlet head **2** is a cutter gas inlet **18**, which extends down the cutter gas pipe **1**, in which is arranged a constriction **19** for the cutter gas. A number of uniformly distributed jets **20** serve as a means for feeding the heating gas into the nozzle, the jets opening out below the connecting portion **13** (FIG. **4**) of the first sleeve **3**. Subsequent to issuing from the jets **20**, the heating gas follows the outer wall of the cutting gas pipe **1** down to the annular chamber **5**, in which the walls of the cutting gas pipe is provided with an upper conical portion **21**, the base of which faces downwardly in a manner to direct the heating gas out into the burning gas channels **6** (FIG. **1** and **4**). The conical portion **21** merges into an outwardly projection portion **15**, discussed above with reference to FIG. **4**, in a manner to form a double cone. Arranged in the extreme periphery of the inlet head **2** are channels **22** for the burner gas, the channels **22** opening out between the first and the second sleeve **3** and **7** resp.

FIGS. **7**, **8** and **9** illustrate a modified embodiment of the first and second sleeves **3** and **7** illustrated in FIGS. **1** to **4**. The modification consists of a combination of the sleeve **3** and **7**, which are combined into a sleeve-like body **23** provided with a centrally positioned chamber **12**, which is constructed in the same manner as the chamber **12** in the first sleeve **3** of the embodiment of FIGS. **1–6** and which co-act with the cutting gas pipe **1** shown in FIG. **6**. In the modified embodiment, the burning gas chamber comprises a cylindrical chamber or separate bores **24** which is or are disposed in the annular wall of the body **3**. The burning gas chamber **24** merge with fine, hollow burning gas channels **25** which, in the same manner as that with the embodiment described with reference to FIGS. **1–6**, are inclined to perpendiculars which extend parallel to the long axis of the nozzle towards a common point located below the nozzle outlet. The hollow burning gas channels **25** communicate with the annular chamber **5** in the same manner as the slots **6** described above. As with the embodiment according to FIGS. **2**, **3**, **4** and **5**, the embodiment illustrated in FIGS. **7**, **8** and **9** is also provided with a flange **11** and slots **8**.

FIG. **8** illustrates the modified embodiment when seen towards the outlet opening as shown by arrows C—C in FIG. **7**, and FIG. **9** illustrates a section taken through the line D—D in FIG. **7**.

In FIG. **10** is illustrated a modification of the outlet portion of the nozzle according to FIG. **1**. In this modified embodiment, the portions forming the nozzle are terminated in a spherical zone in a manner whereby the cutting gas pipe **1** forms a portion of the zone, the first sleeve **3** with the slots **6** forming other portions of the zone and the second sleeve **7** a further portion of the zone. This embodiment enables the slots **8** to be omitted.

Tests carried out on nozzles constructed in accordance with the present invention show the nozzles to have good performances, as will be seen from the following table, in which heading I refers to comparison tests made with conventional torches provided with conventional nozzles and II refers to corresponding tests made with torches provided with nozzles constructed in accordance with the invention and made from 200 mm alloyed steel

	Starting time (seconds)	Cutting speed (mm/min)	Quantity of cutting O_2 (l/tim)	Quantity of heating O_2 (l/tim)	Quantity of H_2C_2 (l/tim)
I	39.6	162	26 500	1 600	1 550
II	10.2	173	22 400	1 800	1 350

As will be seen from the table, the starting time is greatly reduced when using the burner nozzle according to the invention, while the cutting speed is also slightly increased. The quality of the cut surface was the same in both instances.

The nozzle of the present invention has also been found capable of withstanding harsh thermal treatment and is fully explosion safe. Thus, when carrying out tests with nozzles constructed in accordance with the principle illustrated in FIG. **1**, no explosion or flashback occurred when the nozzle orifice became blocked with foreign matter, such as a wooden block. Each test was continued for a duration of one hour, whereafter it was observed that the lower portion of the nozzle had only melted down to approx. **5** mm from the annular chamber. It was found that the flame was unable to melt the nozzle to a greater extent owing to the cooling effect obtained from the cutting and heating gases. It was possible to grasp the nozzle portions and to dismantle said portion without the use of tools immediately upon terminating the tests. With corresponding tests using conventional cutting torches (to the extent that such tests were possible) it was observed that flashback occurred when the orifice of the conventional nozzle became blocked, whereupon it was necessary to extinguish the flame and to cool the nozzle before reigniting the same. Thus, it was not possible to permit the conventional nozzle to remain blocked for any length of time. Subsequent to making a number of tests on the conventional nozzle, it was discovered that the nozzle was no longer usable owing to the fact that the nozzle had fused under the heat.

The nozzles shown in the drawings merely illustrate the principle of advantageous embodiments of the invention, within the purview of which different modifications are possible. Thus, it is possible to vary the length, slope or inclination and the number of the burning gas channels. It is also possible within the purview of the invention to provide the nozzle with two or more cutting gas channels opening out within the heating flame, it being possible to vary the mutual relative position of the cutting gas channels. The illustrated and described embodiment can also be readily adapted for use with deseaming and grooving burners. Consequently it will be evident that the invention is not restricted to the described and illustrated embodiments, but can be modified within the scope of the claimed invention.

I claim:

1. A burner nozzle for cutting purposes, provided with separate channels for cutting gas, burning gas and heating gas respectively, said channel for the cutting gas extending substantially rectilinearly through the entire nozzle and said channels for the burning and heating gases being connected with a chamber, the channel for either the burning gas or the heating gas being annularly formed around the cutting gas channel and being ended by said chamber near the outermost outlet end of the nozzle, said chamber being of annular form, the channels intended for that one of the burning and heating gases respectively not conducted via said annular channel being formed as a number of relatively narrow channels inclined relative to and about the axis of the nozzle so as not to share a common plane therewith and so as to impart a twist to the gas flow therein relative to the cutting gas flow, so that the heating gas is

mixed in that short portion of said inclined channels connecting the annularly formed chamber to the outlet of the nozzle, said gas mixture being arranged to flow annularly out around the jet of cutting gas and form a heating flame.

2. A nozzle according to claim **1,** wherein said annular channel comprises the heating gas channel and is terminated with the annular chamber, said narrow channels which are inclined in relation to the axis of the nozzle being intended for the supply of burner gas, which is mixed with the heating gas as said heating gas flows out from the annular chamber.

3. A nozzle according to claim **2,** wherein the interior of the annular chamber facing the wall of the cutting gas channel is provided with a raised portion which is arranged to direct the heating gas out towards the burning gas channel.

4. A nozzle according to claim **3,** characterized in that the raised portion comprises a conical ring arranged on the wall of the cutting gas channel, the base of said ring lying near the outlet end of the nozzle.

5. A nozzle according to claim **2** wherein the cutting gas channel is arranged in a separate tubular portion which is surrounded by a first sleeve, between the inner wall of which first sleeve and the cylindrical surface of the cutting gas tube is formed the annular heating gas channel, and the outer wall of which first sleeve is provided with a number of slots which together with a second sleeve surrounding the first sleeve form the burning gas channels, the annular chamber being in the form of a flared portion located at the inner wall of the first sleeve.

6. A nozzle according to claim **2** wherein the cutting gas channel is arranged in a separate tubular portion which is surrounded by a sleeve-like body, between the inner wall of which body and the cylindrical surface of the cutting gas tube is formed the annular heating gas channel and in the wall of which body is disposed a number of openings for forming the burning gas channels, said openings communicating with the heating gas channel via the annular chamber, which is in the form of a flared portion located adjacent the inner wall of the sleevelike body.

7. A nozzle according to claim **5** wherein the inlet end of the cutting gas tube is provided with an inlet head for all gases, the supply of cutting gas being effected centrally therein via an upper sealing cone, there being provided around the stream of cutting gas a number of jets for supplying heating gas via an intermediate sealing cone, and a number of supply channels to supply burning gas to the nozzle via a lower sealing cone.

8. A nozzle according to claim **2** wherein the burner gas channels are conically aligned with a focus point located externally of the nozzle orifice.

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