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- (72) **Inventors; and**
- (71) **Applicants :** BORISOV, Borislav, Stefanov [BG/BG];
j.k. "Ovcha Kupel" 1, bl. 416, vh.A, ap.2, Sofia 1632 (BG).
TRENCHEV, Konstantin, Dimitrov [BG/BG]; kv. "lujen
park" 24, ET.2, AP.7, Sofia 1408 (BG).
- (74) **Agent:** TRENCHEV, Konstantin, Dimitrov; "Angel
Kanchev" str. No. 2, BG 1000 Sofia (BG).

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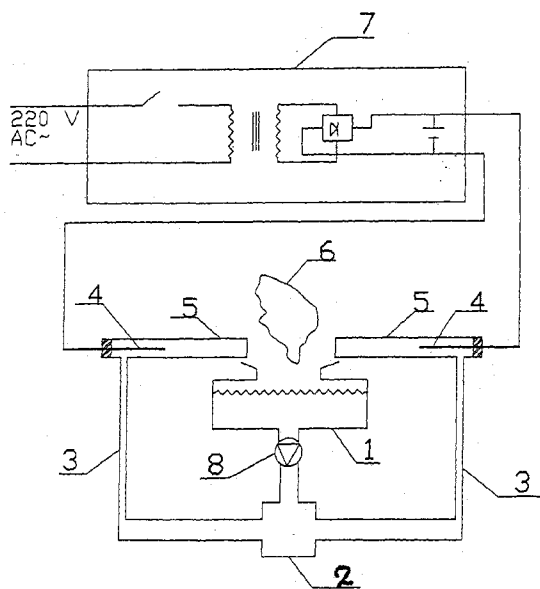
(54) **Title:** METHOD AND A DEVICE FOR PRODUCTION OF PLASMA

FIG 1

(57) **Abstract:** The invention relates to a method and device for production of plasma and finds its application in heat engineering, for destruction of any kind of waste, for gasification of carbon- containing solid and liquid materials, for melting and soldering of metal and non-metal materials. In this method for plasma production, water is supplied under pressure from a water tank (1) by a water pump (8) to a distributor (2), wherefrom the water is divided into two water streams, both of which pass through flexible pipe connections (3) and each one separately goes into a pair of pipes with one of their ends open (5), with each of the pipes accommodating one electrode (4), where under the influence of high voltage direct current applied in the clearance between the two flowing-out water streams plasma (6) is produced with temperature exceeding 4000 °C, while the unused part of the water, flowing freely throughout the open ends of the pipes (5) via the funnel-like collector goes back to the water tank (1). The plasma producing device comprises at least one pair of pipes (5), made of heat- resistant insulation material, in which water is supplied from a water tank (1), by a water pump (8) installed on it, feeding pressurized water to distributor (2), and by means of flexible pipe connections (3) the water is supplied to the pipes (5), inside which at least one pair of electrodes (4) are installed, each pipe accommodating one of them, connected to the opposite poles of high voltage direct current (7) source.

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- of inventorship (Rule 4.17(iv))

- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

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- with international search report (Art. 21(3))

METHOD AND A DEVICE FOR PRODUCTION OF PLASMA**FIELD OF THE INVENTION**

The present invention relates to a method for production of plasma and a mixture of the gases hydrogen and oxygen known as Broun's gas which burns in plasma, and a device for implementation of the said method. They may be used in the heat engineering for heating; for harmful waste treatment, for gasification of hydrogen-containing hard materials, for melting and soldering metal and non-metal materials.

BACKGROUND OF THE INVENTION

1. Methods are known for production of plasma between two hard electrodes, most often made of graphite, connected to a direct current voltage source and with an opposite polarity. Plasma is produced after initiating a plasma formation process by initial touching the electrodes followed by their mechanical moving apart to a definite critical distance, or by heating one of the electrodes so as to initiate an electron emission under the effect of the high temperature.
2. A process called electrolysis is known, during which a direct current voltage is applied to electrodes with an opposite polarity which are submerged in a water solution of an electrolyte. Gas, resp. oxygen and hydrogen, start to release on the positive electrode (cathode) and the negative electrode (anode). They may be used either separately, or may be mixed in a definite manner into a gas mixture known as Broun's gas.
3. A process is known, during which water is heated to a high temperature so as to initiate a reversible reaction where the water molecule is decomposed to its constituents - oxygen and hydrogen. This process starts at a temperature above 1000 °C, and above 3000° C, substantially all water molecules are already decomposed to their constituents. When the temperature lowers, hydrogen and oxygen again bond to each other to form a water molecule, while a big amount of thermal power is released during this synthesis.

SUMMARY OF THE INVENTION

The purpose of the invention is to provide for a method for production of plasma which is more efficient, cheaper, environmentally friendly and safe, as well as a device for easy and efficient implementation of the said method.

The problem is solved using the method proposed for production of plasma and the device for implementation of the said method.

According to the method proposed, two or more water streams are created by means of a distributor in which water under pressure enters from a circulation pump which draws the water from a water tank. These water streams, through connection joints, reach one or more pairs of pipes made of a heat-resistant material. Each of the pipes accommodates a metal electrode which is connected to a direct current high voltage source, while both electrodes are with an opposite polarity. When the voltage is applied, plasma is produced in the gap between the openings of said pair of pipes through which the water flows. The voltage is applied simultaneously to the electrodes, when they are only two, and when they are more than two, it can be supplied at various times to the different pairs of electrodes.

The voltage supplied to the electrodes exceeds 1000 V. In one particular embodiment of the invention, the direct current high voltage supplied is between 3000 V and 5000 V.

Plasma produced within the gap between the openings of each pair of pipes is with a temperature above 4000° C.

The amount of pressure of the water streams and the supply voltage of the source are determined depending of the size of the plasma area to be obtained.

The device proposed for plasma production comprises at least one pair of electrodes with an opposite polarity which are accommodated in pipes through which water flows and are connected to a high direct current voltage source. Water enters from a water tank, and by means of a circulation pump under a definite pressure goes to a distributor where it is divided into at least two or more even water streams which, through flexible connection, pass into the pipes of a heat-resistant insulation material. These pipes accommodate also the electrodes. The electric current passes from the electrodes into the water streams and charges them with opposite charges. Plasma is produced in the space between the water streams flowing out from the pipe ends, whereby gas bubbles start to release on the surfaces of the electrodes accommodated in the pipes at a definite distance from their outlet, resp. oxygen – at the positive electrode, and hydrogen – at the negative electrode. The gases are carried away by the water stream and, leaving the pipe end, they fall into the plasma where they burn in a common plasma-gas flame.

Particular embodiments of the invention are possible, wherein the pipes are made

of a quartz glass or ceramics and may be arranged horizontally, one opposite the other, or at a definite angle in relation to each other.

The gap between the pipe openings through which the water streams flow may be various, while in one of the embodiments according to the invention, it exceeds 5 mm.

According to a particular embodiment of the invention the pipes and the electrodes accommodated therein are two, and according other embodiments, they may be " N ", where N is an even number.

A part of the water of the water streams passing through the pipes is used for production of plasma, and another part which is not used, returns back to the water tank. Thus, a closed loop is created in which the water pumped out of the tank, passing through the circulation pump, divided by the distributor into two or more water streams used for production of plasma, is partially returned back into the tank which, on its part, should be topped-up as required.

The advantages of the method and the device proposed for plasma production consist in that they are environmentally friendly, do not release harmful emissions, and consume a small amount of power. The plasma obtained is with a temperature exceeding 4000° C, and available and cheap materials are used for their production.

With view to intensification of plasma formation, an electrolyte solution at a low concentration may be used, and with view to increasing the process energy yield, small amounts of water-soluble fuels or water-oil emulsions may be added.

DESCRIPTION OF THE DRAWING

Fig. 1 – Device for implementation of the method

1. Water tank
2. Distributor
3. Flexible pipe connections
4. Electrodes
5. Pipe of a heat-resistant material

6. Plasma

7. Direct current high voltage source

8. Water pump

EXAMPLES OF EMBODIMENTS OF THE INVENTION

In the particular embodiment shown in fig. 1 of the plasma production device, water under pressure is fed from a water tank (1) using a circulation pump (8) into a distributor which outlets are connected by means of flexible connections (3) to a pair of pipes (5) made of a quartz glass, of ceramics or another heat-resistant insulation material. Each one of the pipes (5) accommodates one electrode (4) which is connected to a direct current high voltage source (7). One of the electrodes is with a positive charge (anode), and the other is with a negative charge (cathode). The pipes are open in their one end and the water entering them flows freely out through this said end, falling through a funnel-like collector again into the water tank. A clearance (gap) of at least 5 mm exists between both water streams which freely flow out through the open pipe ends, whereby in the clearance between them, after applying a direct current high voltage to the electrodes, a process of plasma formation is initiated.

The clearance between the water streams may be varied within definite limits which influences the intensity of the plasma formation process. Both electrodes are completely submersed under the water passing through the pipes and do not reach the pipe free opening, while the water column between the electrode end and the pipe open end is 20 mm in this particular embodiment, but may vary within definite critical limits. Both pipes, resp. their openings, may be arranged horizontally, one opposite the other, or at a definite angle which may vary according to our desire to make the plasma formation process either less, or more intensive.

Small amounts of hydrogen and oxygen gases start to be added to the plasma torch with a temperature exceeding 4000° C obtained in the gap, which gases start to be discharged on the electrode surfaces, resp. hydrogen – on the anode, and oxygen – on the cathode. They are carried in the form of small bubbles by the water passing and, going out through the free pipe openings, they fall into the plasma torch, where hydrogen burns-up, and oxygen intensifies the process of burning. Due to the fact that the plasma torch contacts directly with the water streams and is formed between them, an intensive process of evaporation from the water surface starts. The water molecules evaporated, falling into the plasma area and due to the extremely high temperature of the medium, decompose to hydrogen and oxygen which move in height, and when the ambient temperature starts to lower, a reversible reaction of a water molecule synthesis is initiated. Said reaction gets more intensive with increase of the distance to

the active plasma formation area; and a big amount of energy is also released during said synthesis.

In another particular embodiment of the invention, the pairs of water streams, resp. the electrodes accommodated therein, are more than one, the direct current high voltage may be applied at various times to the electrodes, and the order of switching on the different pairs of electrodes depends on the desired process. 1, 2, 3, 4 up to N pairs of electrodes may be comprised, which, on its turn, leads to creation of 1, 2, 3, 4 up to N separate plasma formation processes.

APPLICATION (USE) OF THE INVENTION

The invention may be used for production of DHW /domestic hot water/, of steam to be used for production of electric energy, as an external heat source for a Stirling engine, for combustion of waste /including medical and radioactive/, for gasification of hydrogen-containing hard materials, for melting and welding metal and non-metal materials.

claims

- 1 Method for production of plasma, **characterized in that** at least one pair of water streams moving under pressure, situated at a definite distance opposite each other, are charged with opposite polarity by means of electrodes (4), installed inside the water streams and connected to the two opposite poles of direct current electricity source (7) of high voltage, whereby between the two water streams is formed an area where plasma (6) with temperature exceeding 4 000 °C is produced.
- 2 A method for production of plasma according to claim No.1, **characterized in that** the high voltage direct current is supplied simultaneously to all pairs of electrodes (4).
- 3 A method for production of plasma according to claim No.1, **characterized in that** the high voltage direct current is supplied at various times to the pairs of electrodes (4).
- 4 A method for production of plasma according to claims No.1 - 3, **characterized in that** the high voltage direct current supplied to the electrodes (4) exceeds 1000 V.
- 5 Device for production of plasma, **characterized in that** it comprises at least one pair of electrodes connected to the opposite poles of a source of high voltage direct current, and each of the electrodes (4) is accommodated inside a pipe (5) made of heat-resistant insulation material, and they are supplied with water by means of flexible pipe connections (3) from a distributor (2), into which the water is fed under pressure by a water pump (8) from a water tank (1).
- 6 A device for production of plasma according to claim No.5, **characterized in that** the pipes (5) are made of a quartz glass or ceramics.
- 7 A device for production of plasma according to claims No.5 and 6, **characterized in that** the open pipe ends (5) are arranged horizontally or at an angle, opposite each other.
- 8 A device for production of plasma according to claims No.5 - 7, **characterized in that** the clearance between open ends of the pipes (5) exceeds 5 mm.

- 9 A device for production of plasma according to claims No.5 - 8, **characterized in that** the number of the pipes (5) and the electrodes accommodated in them (4) are from two up to "N", where N is an even number.

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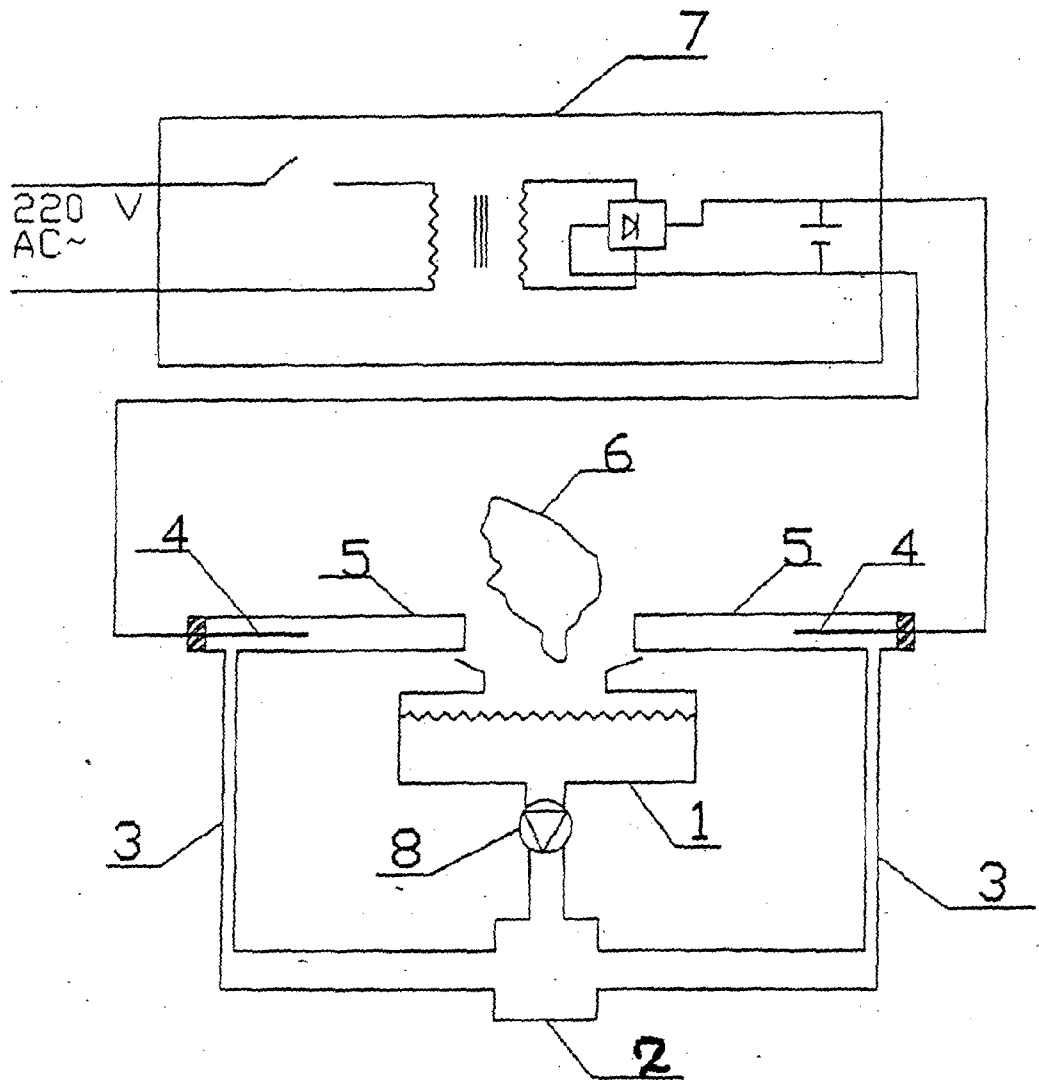


FIG 1

INTERNATIONAL SEARCH REPORT

International application No

PCT/BG2012/000020

A. CLASSIFICATION OF SUBJECT MATTER
 INV. H05H1/48 C02F1/467
 ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 H05H C02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2007/105885 A1 (KIM OKSOON [KR]; KIM ANDERSON H [US]) 20 September 2007 (2007-09-20) paragraph [0087] - paragraph [0100] figure 1	1-9
Y	----- CN 101 254 960 A (FENG WANG [CN]) 3 September 2008 (2008-09-03) page 6, paragraph 1 - paragraph 4 figures	1-9
Y	----- WO 95/05263 A1 (REFRANCO CORP [US]) 23 February 1995 (1995-02-23) page 8, line 8 - line 20 page 10, line 19 - page 11, line 20 figure 2	3
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Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

14 March 2013

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21/03/2013

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040,
 Fax: (+31-70) 340-3016

Authorized officer

Capostagno, Eros

INTERNATIONAL SEARCH REPORT

International application No

PCT/BG2012/000020

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2010/144923 A2 (QUANTUM ENERGY DEV INC [US]; ENOS MICHAEL L [US]; MORGAN W LOWELL [US]) 16 December 2010 (2010-12-16) paragraph [0103]; figure 16 -----	1,5

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/BG2012/000020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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CN 101254960	A	03-09-2008	NONE

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		WO 9505263 A1	23-02-1995

WO 2010144923	A2	16-12-2010	NONE
