

(51) International Patent Classification:  
*F23D 14/32* (2006.01)

(21) International Application Number:

PCT/GB2012/050892

(22) International Filing Date:

23 April 2012 (23.04.2012)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

|           |                              |    |
|-----------|------------------------------|----|
| 1106826.9 | 21 April 2011 (21.04.2011)   | GB |
| 1110399.1 | 20 June 2011 (20.06.2011)    | GB |
| 1118771.3 | 31 October 2011 (31.10.2011) | GB |

(71) Applicant (for all designated States except US): **ITM POWER (RESEARCH) LIMITED** [GB/GB]; 22 Atlas Way, Sheffield, South Yorkshire S4 7QQ (GB).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **NEWBOROUGH, Marcus** [GB/GB]; ITM Power Plc, Unit H, Sheffield Business Park, Europa Link, Sheffield South Yorkshire S9 1XU (GB). **ELLIS, Andrew** [GB/GB]; ITM Power Plc, Unit H, Sheffield Business Park, Europa Link, Sheffield South Yorkshire S9 1XU (GB). **DAVIES, Derek** [GB/GB]; 7 Ragley Close, Poynton, Cheshire SK12 1DW (GB).(74) Agent: **STEVENS, Fiona**; Gill Jennings & Every LLP, The Broadgate Tower, 20 Primrose Street, London, Greater London EC2A 2ES (GB).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

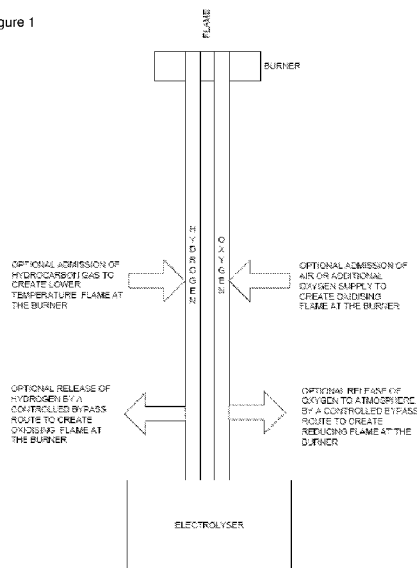
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) Title: BURNER SYSTEM

Figure 1



(57) Abstract: A system comprises a burner having orifices where a flame can be generated, and a water electrolyser producing oxygen and hydrogen streams, which each flow to the burner, and are either completely separate when they leave the electrolyser, or are separated after leaving the electrolyser and before reaching the burner, and wherein the system is adapted to mix the hydrogen and an oxidant together, at, or downstream of the burner orifices. Further, a method of supplying hydrogen and oxidant to a burner, comprises supplying the hydrogen and oxidant separately and mixing them either at, or downstream of the burner orifices wherein the hydrogen is supplied directly from the output of an electrolyser, and the oxidant is preferably oxygen, preferably supplied directly from the output of the same electrolyser.



WO 2012/143738 A2

## BURNER SYSTEM

### Field of the Invention

The present invention relates to a method of supplying fuel and oxidant to a burner.

### Background of the Invention

Flame processes are employed widely for heating, brazing, melting and joining materials. Flame shape, temperature and rate of heat transfer are key to a successful operation. Operator skill is usually required to ensure the heating process occurs over a sufficient surface area in a sufficiently uniform manner to achieve a good outcome (e.g. without unwanted burning, melting or distortion effects). Hydrogen/oxygen flames are employed in several applications where high flame temperatures are essential. This can be facilitated by using flame torches connected to hydrogen and oxygen gas cylinders, or to a water electrolyser.

If they are pre-mixed the gases need to be combusted in a pre-mix burner, but if they are delivered separately to the surface of a burner surface-mix combustion takes place. For pre-mix combustion the flow velocity exiting a burner orifice must be maintained above the limiting hydrogen flame velocity to ensure the flame will not burn back down the supply pipe causing a dangerous situation, usually referred to as "flashback". Pre-mixed flames therefore tend to be high velocity, turbulent, noisy and of high aspect ratio (height:width). This limits their controllability and hence application in many thermal processes where heat needs to be applied uniformly across a wide area. Conversely, a surface mix flame cannot flashback and so can be arranged to be laminar across a range of aspect ratios. A surface mix hydrogen/oxygen flame therefore permits more uniform heating and affords the operator easier control of the flame heating process. It is inherently safer and also provides a much more visible flame than a pre-mixed burner.

In most flame processes pre-mixed gases are employed (e.g. natural gas flowing through a Bunsen burner entrains air by the venturi effect and so a gas/air mix exits the burner orifice). Where electrolyzers are employed to generate oxygen and hydrogen for combustion, it is conventional to premix the gases at the stack or before reaching the burner.

### Summary of the Invention

The present invention is based on the realisation that when a burner employing a surface-mix combustion system is used together with a water electrolyser, there are important safety benefits, such as elimination of “flashback”, which is a problem in pre-mix burners. An added benefit is that the flame height and/or the flame velocity can be controlled by means of adjusting the power input to the electrolyser, therefore providing a much greater degree of precision than otherwise achievable in flame processes employing bottled gas or pre-mix burners. A further benefit is that surface mix combustion permits a laminar hydrogen/oxygen flame to be produced, which ‘laps’ the surface being heated and thus transfers heat more effectively than an equivalent pre-mixed hydrogen/oxygen flame, which is turbulent.

The present invention is the combination of a surface mix burner and a water electrolyser. A surface mix burner is characterised by the mixing of fuel and oxidant at, or downstream of, a burner orifice, i.e. the point at which the fluids exit the burner, and the point of flame generation.

Therefore, according to a first aspect, the present invention is a system comprising a burner having orifices where a flame can be generated, and a water electrolyser producing oxygen and hydrogen streams, which each flow to the burner, and are either completely separate when they leave the electrolyser, or are separated after leaving the electrolyser and before reaching the burner, and wherein the system is adapted to mix the hydrogen and an oxidant together, at, or downstream of, the burner orifices.

According to a second aspect, the present invention is a surface mix burner having two sets of one or more orifices, wherein the first set is adapted to be connected to a hydrogen output of an electrolyser and the second set is adapted to be connected to an oxidant stream.

According to the third aspect, a method of supplying hydrogen and oxidant to a burner having orifices at the point of flame generation, comprises supplying the hydrogen and oxidant separately and mixing them either at, or downstream of the burner orifices wherein the hydrogen is supplied directly from the output of an electrolyser, and the oxidant is preferably oxygen, supplied directly from the output of the same electrolyser.

### Description of the Drawings

Figure 1 shows an embodiment of a system according to the invention.

### Description of the preferred embodiments

As used herein, the term “burner” means any device that includes a flame. In the present invention, the burner is a surface-mix burner. Surface-mix burners are known in the art.

As used herein, the “burner orifice” means the exit area for fuel and/or oxidant, and is the surface through which a fuel exits the burner, and where ignition occurs. The surface of the burner, or burner orifice is very close to the point of flame generation. The surface of the burner preferably comprises a set of one or more orifices through which hydrogen can flow. The surface of the burner preferably also comprises a set of one of more orifices, through which an oxidant can flow. The fuel (e.g. hydrogen) and oxidant (e.g. oxygen) are preferably mixed together as they exit from their respective orifices.

The orifices, i.e. holes are preferably small circular holes. There are at least two orifices in a burner of the invention (two sets of one or more orifices). The orifices are preferably adjacent to each other, such that gases that flow through adjacent orifices will mix downstream of the orifice surface. A burner of the invention preferably comprises two sets of one or more orifices. A first set is for hydrogen flow, and a second set is for oxidant, e.g. oxygen flow. Each set may comprise any number of orifices. For example, a set comprising one, two, three, four, five or six orifices is included within the scope of the invention. Preferably, all the burner orifices are in close proximity, such that gases flowing through the orifices mix downstream of the orifice to produce a surface-mix laminar flame.

A system of the invention includes a water electrolyser. The electrolyser may produce oxygen and hydrogen mixed in a single stream (outlet), or the streams may be completely separate. Preferably, the hydrogen and oxygen streams (outlets) are completely separate, to enable them to be attached directly to a burner, to enable surface-mix combustion. However, in the embodiment where the oxygen and hydrogen are produced as single gases, the streams can be separated, for example by means of a filter, before reaching the burner. The key feature of this invention is that the hydrogen/oxidant stream is only mixed

together for a very short distance, if it all, to avoid the disadvantages of pre-mix systems. Preferably, the hydrogen stream that flows between the electrolyser and the burner flows substantially separate from the oxidant stream. In the embodiment, where both the hydrogen and oxygen streams feed to the burner, preferably the hydrogen and oxygen streams flow substantially separate from each other. They are only mixed together at, or downstream of, the burner orifices.

In a preferred embodiment, the hydrogen and oxygen streams are separate from leaving the electrolyser. They do not mix until downstream of the burner orifice(s).

As used herein, the term “stream”, i.e. oxygen stream or hydrogen stream, means the area of oxygen or gas flow. In one embodiment, it may be a line/pipe, which links the electrolyser to the burner. Preferably, a system of the invention includes a pipe which connects the hydrogen output of the electrolyser to an orifice, and a pipe which separately connects the oxygen output of the electrolyser to a different orifice (to allow surface-mixing).

In a preferred embodiment, a system comprises a burner having orifices where a flame can be generated, and a water electrolyser having oxygen and hydrogen outputs, which are each connected to the burner, via a pipe, wherein there are either separate hydrogen and oxygen pipes connecting the electrolyser to the burner, or the hydrogen and oxygen outputs are initially mixed, but are subsequently separated, such that there are separate hydrogen and oxygen inputs to the burner, and wherein the system is adapted to mix the hydrogen and an oxidant together, at, or downstream of the burner orifices.

The oxygen stream (and by “stream”, it is meant “fluid/gas flow”), may be additionally connected via a venturi mixer, to aspirate atmospheric air or compressed air, so that an oxygen and air mixture is delivered to the surface of the burner.

In an embodiment of the present invention, only the hydrogen stream is delivered to the surface of the burner, and the oxygen stream is safely vented. This allows hydrogen to be used as a neat diffusion flame or allows it to mix with air at the surface of the burner.

The oxidant may be atmospheric air, compressed air, or air supplied from a fan. In a preferred embodiment the oxidant is oxygen that is supplied directly from the electrolyser oxygen stream. It may also be a mixture of both of these things.

The hydrogen and oxygen are generated by the electrolyser in a stoichiometric ratio. Preferably, the burner is designed to combust the gases in these proportions, such that no waste oxygen or hydrogen are produced, allowing for additional safety benefits.

In an embodiment, at least some of the oxygen stream is diverted away from the burner, such that an excess of hydrogen is delivered to the burner and a reducing flame can be produced.

In an embodiment, at least some of the hydrogen stream is diverted away from the burner, such that an excess of oxygen is delivered to the burner and an oxidising flame can be produced.

In a system of the invention, the height of the flame and/or the velocity of the flame is controlled by the rate of power input to the electrolyser.

In a system of the invention, the flow rate of fuel and/or oxidant are adjusted for each orifice to maintain one or more of the following criteria: (i) substantially equal hydrogen and oxidant flow velocities; (ii) substantially equal hydrogen and oxidant flow momentum; (iii) substantially equal hydrogen and oxidant flow Reynolds numbers; and (iv) substantially equal hydrogen and oxidant kinetic energies.

A system of the invention may comprise low pressure electrolyser (<10 bar gauge), and a gas conveyance arrangement which ensures the burner consumes each gas at a rate identical to its generation rate. Such balanced flow rates permit stoichiometric combustion and eliminate the requirement for gas storage within the system, so reducing costs and safety hazards. In some applications, it is desirable to move away from stoichiometric combustion to achieve a reducing or oxidising flame. A system of the invention therefore permits some oxygen or hydrogen to be bled away safely so as to permit the required flame characteristic to be achieved, or for air to be fed into the system.

A system of the invention requires a burner design which facilitates the required flame shape. A suitable burner design will be known to a person skilled

in the art. Usually this is achieved by arranging a distribution of orifice for each gas so as to ensure the plumes interact mainly with each other rather than with the adjacent air. There are several logical geometrical configurations, which can be applied for general purpose heating or for more effective heating of a given work piece geometry (e.g. radial heating of a brazed pipe joint). In some cases, it may be desirable to bias the flow of oxygen to the central region of the burner (e.g. for metal cutting processes). It is important to consider the flow properties of each gas as they emerge from the burner to ensure effective design integration of the electrolyser and burner. This amounts to designing the burner so as to keep one or some combination of the following parameters substantially identical for each gas: velocity, momentum, Reynolds number and kinetic energy. In a preferred embodiment a number of burner attachments may be employed to facilitate different flame characteristics as required by different applications. As a function of the burner design, the required hole sizes for the respective gases require the electrolyser to be capable of operation at differential pressure.

Preferably, a system of the invention comprises means for adjusting the flow rate of hydrogen and/or oxidant through the burner orifices in order to maintain one or more of the following criteria: (i) substantially equal hydrogen and oxidant flow velocities; (ii) substantially equal hydrogen and oxygen momentum; (iii) substantially equal hydrogen and oxidant flow Reynolds numbers; and (iv) substantially equal hydrogen and oxidant kinetic energy. Preferably, the oxidant is oxygen. Preferably, the oxygen is produced solely from the attached electrolyser.

Preferably, the term substantially equal to means within 10% of, more preferably within 5% of. For example, when used in the context of the present invention, the Reynolds number of the hydrogen flow in the orifice should be within 10% of the Reynolds number of the oxidant flow (plus or minus). Reynolds number is known in the art and is a dimensionless number that gives a measurement of inertial forces to viscous forces. The equation for calculating Re is

$$\text{Re} = \frac{\rho v D}{\mu}$$

where  $\rho$  = density of fluid ( $\text{kg/m}^3$ )

$\nu$  = kinetic viscosity ( $\nu = \mu/\rho$ ) ( $\text{m}^2/\text{s}$ )

$D$  = diameter of the orifice (or the sum of the diameters of each orifice)

$\mu$  = dynamic viscosity of fluid ( $\text{Pa}\cdot\text{s}$ )

Preferably, the Reynolds number is adjusted so that the flow is laminar, rather than turbulent.

Surface mix combustion permits the use of laminar oxy-hydrogen flames, rather than the turbulent flames (which occur when air or oxygen and fuel gas are pre-mixed prior to combustion and require high burner velocities to ensure the flame remains external to the burner). Unlike a turbulent flame, a laminar flame will to some extent wrap around the joint being heated, which is most advantageous in common brazing and flame heating applications. The design of surface mix burners is well established, but the design of a burner to match the outputs from an electrolyser is a new concept. The orifice areas and geometrical arrangement of the burner must account for the widely different physical properties (density, viscosity) of oxygen and hydrogen in relation to a range of flow rates in stoichiometric ratio as generated by the electrolyser. The burner must be designed to match the electrolyser (upstream) while ensuring laminar flow for both gases and effective gas mixing (downstream). Therefore this electrolyser-based approach for flame heating processes presents a distinct set of requirements for burner design.

With a conventional burner, the orifice sizes are not critical, as the discharge pressure of the gas cylinders that supply the burner can be adjusted to get adequate velocities through the fuel and oxidant orifices. By contrast, the flow rates and flame properties in a burner of the invention should be controlled by the orifice exit area (and preferably also the power input to the electrolyser).

By analysis and experimentation preferred sizing arrangements for the burner orifices as a function of flow rate have been identified. The ratio of oxygen orifice exit area to hydrogen orifice exit area,  $\alpha$ , is of critical importance. This ratio should be held within the range  $2.6 < \alpha < 3.0$ .

Adhering to the above ratio ensures that an optimal flame is produced. It also ensures efficiency of heat transfer for a given rate of gas production, and minimises pressure differential across the electrolyser, which minimises hazard

for the operator. This ratio has been extensively tested and holds for any size electrolyser and for any number of orifices. A typical burner design may involve two adjacent holes for hydrogen and oxygen, but any number of adjacent orifices of various shapes can be used provided that the ratio of the aggregate areas is adhered to. Typical embodiments are where two holes, preferably circular, are adjacent or where the oxidant issues from an annulus concentric with a central hydrogen hole.

One pair of oxygen and hydrogen holes conforming to the stated  $\alpha$  value will be suitable for creating a laminar flame for a range of gas generation rates emerging from the electrolyser. At the lower limit of this range, the user may deem the flame to be too small or so laminar as to be of no practical use. If flow rates below this limit are to be used, a pair of smaller oxygen and hydrogen holes (according with  $\alpha$ ) will be required to produce an effective flame. At the upper limit of the range, the flame will be of a length the user may consider to be excessive or become turbulent. In this case, either two pairs of exit holes, or one pair of larger holes (according with  $\alpha$ ) will be required. The useful ranges of Reynolds numbers for the oxygen and hydrogen streams for pipe flow through the burner have been found to be  $300 < Re < 1300$  for oxygen and  $300 < Re < 1300$  for hydrogen. In a preferred embodiment,  $Re$  for oxygen and  $Re$  for hydrogen are substantially equal.

By knowing the preferred values of  $\alpha$  and  $Re$ , a burner design and a flow rate range can be established for any given electrolyser. For example, an electrolyser-based burner with a hydrogen hole of 1.194 mm diameter surrounded by an oxygen annulus of 1.65 mm inner diameter and 2.55 mm outer diameter (i.e.  $\alpha = 2.65$ ), has been shown to be most effective across the range  $374 < Re(H_2) < 1197$  and  $394 < Re(O_2) < 1260$ .

A system of the invention may be sized for use as a portable device serving one flame torch, or be sized to serve a number of burners. Because of its key feature of easy flame control, a system of the invention may be automated by arranging for a control system to vary the applied power input to the electrolyser during the heating process to achieve an optimal outcome. This precise flame control is particularly advantageous in industrial brazing operations, relative to the use of conventional gas cylinders, and in boilers where

automated control of input heat fluxes are desirable as a function of thermal demand.

There are several safety benefits associated with utilising the defined system, relative to the inherent danger of using high pressure cylinders of hydrocarbon fuels (e.g. propane and acetylene) and oxygen. This invention seeks to circumvent the weaknesses of such conventional heating processes which are well documented elsewhere.

Figure 1 shows a typical system of the invention. The hydrogen and oxygen streams are supplied separately to separate orifices on the burner surface, such that they are only mixed downstream of the burner surface. This results in a laminar flame and flashback is avoided.

The following Example illustrates the invention

#### Example

An electrolyser stack was built which was able to provide separated streams of hydrogen and oxygen. The electrolyser stack was connected to a controllable power supply unit, the output of which determines the rate of gas production from the electrolyser. The hydrogen and oxygen streams from the electrolyser were connected to a surface-mix burner so that each gas exited the burner through separate holes (orifices) on the burner surface.

The hydrogen and oxygen holes in the burner had an area ratio within the range stated in the preferred embodiments described above, i.e. oxygen: hydrogen area,  $\alpha$ ,  $2.6 < \alpha < 3.0$ , giving gas flow with a Reynolds number  $300 < Re < 1300$ .

For this experiment, the electrolyser was set to provide hydrogen at 4.5 litres per minute and oxygen at a rate of 2.25 litres per minute. The burner used for the test had a hole for the hydrogen to exit through with an area of  $1.12 \text{ mm}^2$  and a hole for the oxygen with an area of  $3.17 \text{ mm}^2$ . This gives an area ratio of 2.78 for the  $\text{O}_2$  and  $\text{H}_2$  exit holes. The gasses exiting the burner would have velocities of  $66.98 \text{ m/s}$  for the hydrogen and  $11.84 \text{ m/s}$  for the oxygen. These gas flows would have Reynolds numbers of 748 for the hydrogen and 778 for the oxygen.

The electrolyser was powered up and the gasses exiting the burner were ignited. This was observed to give a stable laminar flame.

Varying the power to the electrolyser resulted in a change to the gas production rates and was seen to change the size of the flame from the burner. Increasing the power to the electrolyser resulted in an increase to the flame size and decreasing the power led to the flame reducing in size.

CLAIMS

1. A system comprising a burner having orifices where a flame can be generated, and a water electrolyser producing oxygen and hydrogen streams, which each flow to the burner, and are either completely separate when they leave the electrolyser, or are separated after leaving the electrolyser and before reaching the burner, and wherein the system is adapted to mix the hydrogen and an oxidant together, at, or downstream of the burner orifices.
2. A system according to claim 1, wherein the burner surface comprises two sets of one or more orifices through which gas can exit, wherein a first set is connected to the hydrogen stream from the electrolyser and a second set is connected to an oxidant stream, wherein the hydrogen and oxidant streams are separate.
3. A system according to claim 1 of claim 2, wherein the oxygen and hydrogen streams are completely separate on leaving the electrolyser, and preferably separate for the whole distance between the electrolyser and the burner orifices.
4. A system according to any preceding claim wherein the oxidant stream is air, the oxygen that is produced by the electrolyser, or a mixture thereof.
5. A system according to claim 4, wherein the oxidant is the oxygen that is produced by the electrolyser.
6. A system according to any preceding claim, wherein the first set of orifice(s) is connected to the hydrogen stream from the electrolyser and the second set of orifice(s) is connected to the oxygen stream from the electrolyser.
7. A system according to claim 4, wherein the air is either at atmospheric pressure or at higher than atmospheric pressure, such as from a compressed air source.
8. A system according to any preceding claim, comprising means for varying the ratio of hydrogen to oxidant, or the ratio of hydrogen to oxygen, that flows to the burner orifices.
9. A system according to any preceding claim, adapted to supply the hydrogen and oxidant to the burner in a stoichiometric ratio, such that no waste oxidant/hydrogen is produced.

10. A system according to any preceding claim, adapted to divert at least some of the oxygen that flows from the electrolyser to the burner, away from the burner, such that an excess of hydrogen is delivered to the burner surface and a reducing flame can be produced.

11. A system according to any preceding claim, adapted to divert at least some of the hydrogen that flows from the electrolyser to the burner, away from the burner, such that an excess of oxygen is delivered to the burner surface and an oxidising flame can be produced.

12. A system according to any preceding claim, comprising means for controlling the height of the flame and/or the flow rate of the hydrogen or oxidant, dependent upon the rate of power input to the electrolyser.

13. A system according to any preceding claim, comprising means for adjusting the flow rate of hydrogen and/or oxidant through the burner orifices in order to maintain one or more of the following criteria: (i) substantially equal hydrogen and oxidant flow velocities; (ii) substantially equal hydrogen and oxidant flow momentum; (iii) substantially equal hydrogen and oxidant flow Reynolds numbers; and (iv) substantially equal hydrogen and oxidant kinetic energies.

14. A system according to claim 13, wherein the Reynolds number for the hydrogen and/or oxidant is maintained in the range of 300 to 1300.

15. A system according to any preceding claim, wherein the ratio of the total orifice exit area of the second set of orifice(s) (oxidant stream) to the total orifice exit area of the first set of orifice(s) (hydrogen stream) is from 2.6 to 3.0.

16. A surface-mix burner having two sets of one or more orifices, wherein the first set of orifice(s) is adapted to be connected to a hydrogen output of an electrolyser and the second set of orifice(s) is adapted to be connected to an oxidant stream.

17. A burner according to claim 16, wherein the oxidant stream is an oxygen output from the electrolyser.

18. A surface mix burner according to claim 16 or claim 17, which is connected to an electrolyser.

19. A surface mix burner according to any of claims 16 to 18, which has any one of the additional features of claims 5 to 15.

20. A method of supplying hydrogen and oxidant to a burner having orifices at the point of flame generation, comprising supplying the hydrogen and oxidant separately and mixing them either at, or downstream of the burner orifices wherein the hydrogen is supplied directly from the output of an electrolyser, and the oxidant is preferably oxygen supplied directly from the output of the same electrolyser.

21. A method according to claim 19, wherein the height of the flame produced by the burner can be controlled by the power input to the electrolyser.

22. A method according to any of claims 20 to 21, which uses a system according to any of claims 1 to 15, or a burner according to claim 19.

1/1

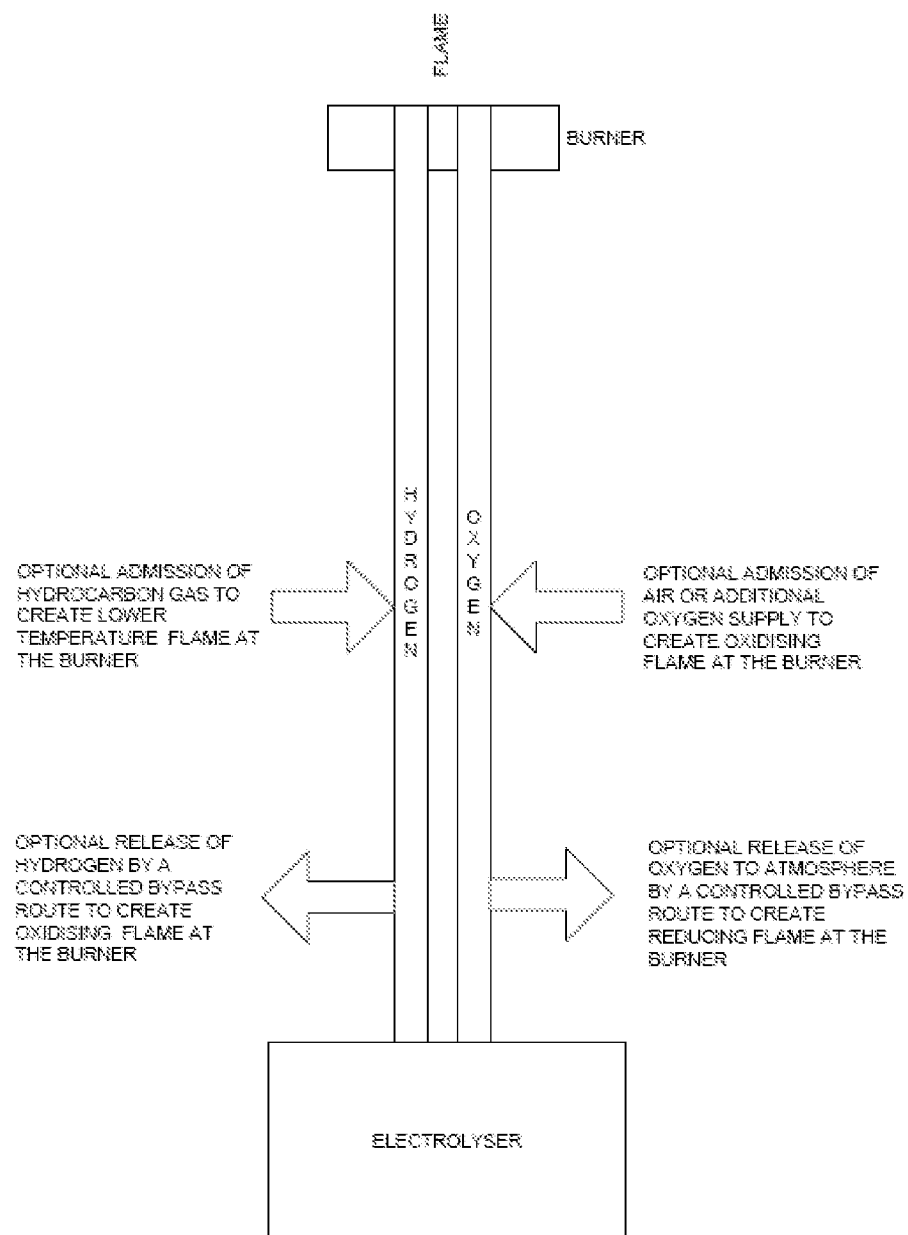


Figure 1