April 22, 1969 J. HANCOCK ET AL 3,439,877

POST-AERATED GAS JETS

Filed Oct. 14, 1966 Sheet 1 of 2

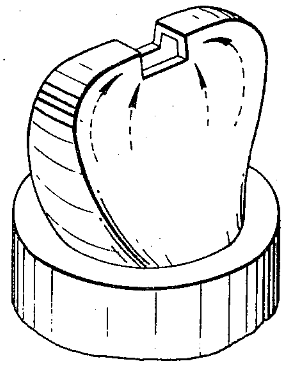

FIG. 1.

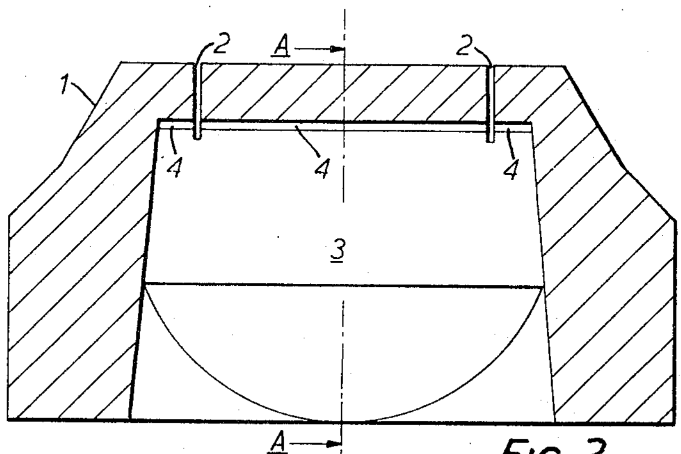

FIG. 2.

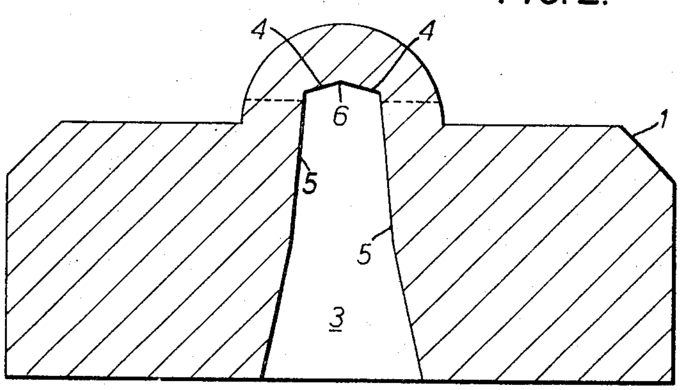

FIG. 3.

INVENTORS
JOHN HANCOCK
ALBERT WESTERMAN
Holcombe, Wetherill & Brisebois
ATTORNEYS

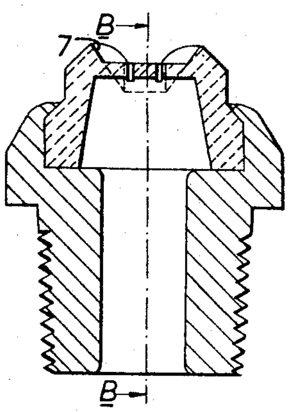

FIG. 4

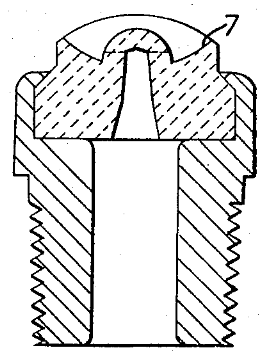

FIG. 5

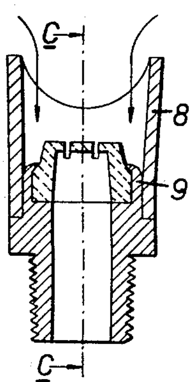

FIG. 6

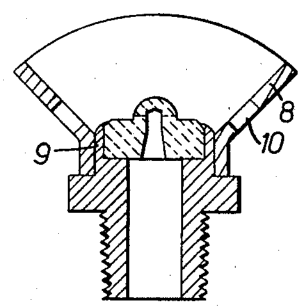

FIG. 7

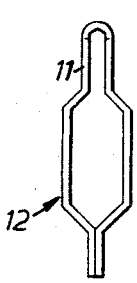

FIG. 9

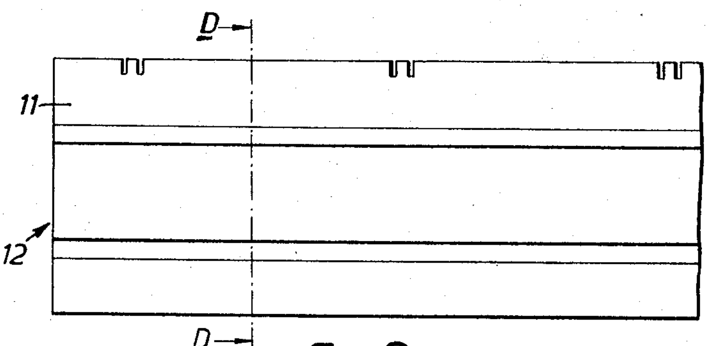

FIG. 8

INVENTORS
JOHN HANCOCK
ALBERT WESTERMA
Holcombe, Wetherill & Brisebois
ATTORNEYS

United States Patent Office 3,439,877
Patented Apr. 22, 1969

3,439,877
POST-AERATED GAS JETS

John Hancock, Leeds, and Albert Westerman, Normanton, England, assignors to Geo. Bray & Company Limited, Leeds, England, a British company

Filed Oct. 14, 1966, Ser. No. 586,832
Claims priority, application Great Britain, Oct. 26, 1965, 45,330/65
Int. Cl. F23d *15/02;* B05b *1/14*
U.S. Cl. 239—419.5 7 Claims

ABSTRACT OF THE DISCLOSURE

A post-aerated gas jet which is constructed to work with slow-burning gases such as natural gas at operating pressures of 1½–3 ins. water gauge. The jet works on a principle similar to known non-aerated jets used for fast burning manufactured gas where two converging gas streams impinge at the gas orifice to give a laminar flame, but the single slot orifice is replaced by two or more closely spaced slot orifices each of which produces a divergent laminar gas stream or streams. The length of each orifice at right angles to the plane of its corresponding gas stream is made small in comparison with the width of the slot, so that the momentum of the two converging gas streams at each orifice is increased at the point of impingement.

This invention relates to a post-aerated jet for use with natural gas and other gases having similar combustion characteristics.

Known types of post-aerated jet, so called because mixing of gas and air takes place after the point of ignition, are widely used with fast burning manufactured gases at operating pressures of 1½–3 inches water gauge pressure but are unsuitable for use with slow burning natural gas because the flame lifts below ½ inch water gauge pressure.

A well known type of post-aerated jet used for manufactured gas is the one having a flat, fan-shaped flame produced as a result of the impingement of two converging gas streams. Such a jet is shown schematically in FIGURE 1 of the accompanying drawing. The two shoulders, at either end of the major axis of the orifice, are the main feature, and cause two streams of gas to turn sharply and emerge from the two vertical and diametrically opposed parts of the orifice. The two streams impinge upon each other and produce a flat fan-shaped flame at right angles to the major axis of the orifice. The air required for combustion diffuses into the gas stream and its movement, because of the momentum of the gas stream and of the convection current produced by the flame, is largely in the direction of the flame. This air movement tends to lift the flame away from the orifice but is countered by the burning velocity of the flame which acts towards the orifice. In practice a balance is obtained between the upward velocities of the gas and air streams and the downward burning velocity of the flame, so that the flame is stable and sits on the orifice at the required operating pressure which is usually in the order of 1½–3 inches w.g. The burning velocity of natural gas is, however, only about one quarter that of manufactured gas and the flame lifts at ½ inch w.g. pressure or less.

There is another factor which is partially responsible for the stability of the flame. Near the orifice, at the base of the flame, there is an air movement counter to that of the emergent gas stream and the main body of the surrounding air. This counter current of air, which is caused by the sudden expansion of the emerging gas stream, acts in the same direction as the burning velocity and helps to stabilise the flame.

The present invention facilitates enhancement of the aforementioned counter current of air at the base of the flame, thereby producing a jet having a stable flame with natural gas at pressures of 1½–3 ins. water gauge.

In conventional jets the length of the orifice at right angles to the plane of the flame is large in comparison with the width of the orifice and at the point of impingement the two converging gas streams have lost some of their momentum and the subsequent expansion of the streams is not as great as if the sources of the impinging streams are placed closer together.

According to the present invention a post-aerated jet for use with natural gas at operating pressures of 1½–3 inches water gauge includes in combination a hollow body portion of which one end is open and serves as a gas input whilst the other end is formed with a terminal portion provided with at least two closely spaced parallel slot orifices, said terminal portion also being formed with gas directing means for ensuring the emergence of a fan-shaped laminar gas stream at each orifice, said gas directing means being provided by the surfaces of at least one pair of inclined walls formed on the underside of said terminal portion and at either side of each of said slot orifices, each of said gas streams lying in a plane containing the major axis of its respective slot orifice, and the length of each of said slot orifices at right angles to the plane of its corresponding gas stream being small in comparison with the width of the said slot orifice.

If only one slot orifice were provided whose length at right angles to the plane of the gas stream is small in comparison with the width of the orifice, the sudden expansion of the impinging gas streams would be sufficient to produce an area of reduced pressure near the slot and air would flow into this region, which, after ignition would help to stabilise the flame. However, one such slot is insufficient in itself to allow the required operating pressures to be obtained, and it is for this reason that at least two such slot orifices are used, preferably in close proximity to each other. Two distinct gas streams emerge from these slots but on ignition coalesce, as a result of the movement of the surrounding air, to produce one flat fan-shaped flame. The air moving into the low pressure area produced by the sudden expansion of each emergent gas stream causes, in particular, the flame to form a bridge immediately above and between the two orifices. This area of the flame then exists in a stagnant region out of the disturbing influence of the movement of both air and gas, and is therefore very stable. At pressures at which either of the flames produced by each individual slot orifice would lift, the part of the flame bridging the two orifices exerts a stabilising influence and the coalesced flame as a whole is restrained from lifting with natural gas at pressures of the order of 1½–3 inches water gauge pressure.

Ignition of a natural gas flame is also a problem because of the tendency for an ignition flame situated some distance from the slot not to be transmitted to the stable region.

It has been found beneficial in this respect to arrange for the gas-stream from each orifice to be broken up into divergent sections or fingers when again the principle of countercurrent air flow applies in that air is drawn towards the point of divergence. By arranging for some or all of the points of divergence to be in the vicinity of the slot the air flow between the fingerlike gas stream encourages the ignition flame to move towards the region of maximum stability which when ignited stabilises the flame as a whole. The low pressure regions existing at the points of divergence are situated above the stabilising part of the flame bridging the two orifices, and the countercurrent air flow into these areas assists still further in maintaining the flame base near to the orifices, thus further inhibiting the tendency to lift.

A particular embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings of which:

FIGURE 1 is a perspective view of the invention,

FIGURE 2 is a sectional elevation of a gas jet taken in a plane perpendicular to the plane containing one of the slot orifices,

FIGURE 3 is a section of the jet shown in FIGURE 2 taken on the line A—A,

FIGURE 4 is a sectional elevation of a gas jet taken in a plane perpendicular to the plane containing one of the slot orifices,

FIGURE 5 is a section of the jet shown in FIG. 4 taken on the line B—B,

FIGURE 6 is a sectional elevation of a gas jet taken in a plane perpendicular to the plane containing one of the slot orifices,

FIGURE 7 is a section of the jet shown in FIG. 6 taken on the line C—C,

FIGURE 8 is a sectional elevation of a ribbon burner taken in a plane perpendicular to the plane containing one of the slot orifices,

FIGURE 9 is a section of the burner shown in FIGURE 8 taken on the line D—D.

FIGURE 2 shows the body portion **1** of the jet which may be made in ceramic or in metal and which is normally mounted in a holder having a means of attachment to a gas pipe.

Two parallel slot orifices **2**, are formed in the upper wall of the body and break through into the internal cavity **3**. The shoulders **4** formed on either side of each slot orifice on the underside of the upper wall cause the gas entering the cavity **3** to converge towards each slot orifice and to impinge so that on emergence from the slot orifice two fan-shaped streams of gas are formed. On ignition these coalesce to form a single flame the small stabilising portion of which develops in the stagnant region immediately above and between the two slot orifices.

The internal cavity **3** is wedge shaped with the major axis at right angles to the slots and, as shown in FIGURE 3, has two walls **5** which taper inwards slightly towards the triangular apex **6** of the cavity.

The slots **2** break through the upper wall of the cavity and the lower edges of the slot orifices are situated at a point below the junctions of the triangular faces of the apex **6** and the inwardly sloping walls **5**.

A divergent or finger-like gas stream is formed by each flat face of the underside of the slot orifice so that in this particular example four divergent gas-streams coalesce to form each major flame. The degree of divergence can be controlled by the angular disposition of the faces relative to one another. Thus an angle between faces of 160° results in a flat, fan-shaped flame with only a slight depression in its upper perimeter, whereas an angle of 90° results in two separate flames with the point of divergence immediately above the orifice. The lengths of the divergent flames can be controlled by the relative dimensions of the faces. Thus if the slot orifice extends down the inwardly sloping walls **5** of the cavity to an extent greater than the length of the triangular faces **6** of the apex, the two outer flames will be longer than the two inner ones. Conversely the two inner flames can be made longer than the two outer ones.

The apex of the cavity may have more than two faces and the number of divergent flames depends on the number of faces exposed by the slot orifice at the point of breakthrough.

The stability of the flame can be controlled further by the distance between the two slots orifices, that is by varying the length of the stagnant region between the slot orifices. In some cases it may prove beneficial to use three slot orifices and hence have two stagnant zones.

In one preferred form of jet, there are two 0.004 in. wide slot orifices at 0.18 in. centres. The included angle of the triangular apex is 150° and the included angle between one of these faces and one of the inwardly sloping walls is 110°. The length of each of the faces of the triangular apex is 0.030 in. and the slot orifices extend down the inwardly sloping walls to a distance of 0.007 in.

The stability of the flame can be improved still further by situating the orifices at the base of a recess **7**, as shown in FIGS. 4 and 5 the sides of which flare away from the ends of each orifice as described in more detail in co-pending application No. 1982/63. Flames which are stable above 4 ins. water gauge pressure are then obtained.

Another way of shrouding the base of the flame is shown in FIGS. 6 and 7. The shroud, which is in the form of a metal cup **8** is attached to a metal socket **9** formed on the jet. The walls of the cup are of generally elliptical cross-section, and flare away from the ends of the slot orifices so that the plane containing the major axes of each elliptical cross-section is parallel to the planes containing each slot orifice. Orifices **10** formed in the flared walls of the cup allow air to flow to the base of the flame appearing across the two slot orifices. The stability of the flame is improved by air flowing over the rim of the cup, as shown by the arrows in FIG. 7, in reverse direction to that of the flame. This reverse air flow thereby inhibits flame lift.

Although the invention has been described in relation to a single jet, it will be understood that it is also applicable to so called ribbon burners an example of which is shown in FIGS. 8 and 9 in which orifices are provided in the ridge **11** of a continuous metal channel indicated generally at **12** with flames being formed at right angles to the channel. In applying the invention to such burners, pairs of orifices are formed in the ridge of the channel, the inside form of which is similar to that of the internal cavity **3** shown in FIGS. 2 and 3 of the accompanying drawing. The pairs of orifices are arranged along the length of the channel at centres which allow air flow between the flame produced by each pair of orifices, and which are also such to allow interlighting of the flames one from another.

We claim:

1. A post-aerated jet for use with natural gas at operating pressures of 1½–3 inches water gauge including in combination a hollow body portion having a lower end which is open and serves as a gas input and an upper end which is formed with a terminal portion provided with at least two closely spaced parallel slot orifices, said terminal portion also being formed with gas directing means for ensuring the emergence of a fan-shaped laminar gas stream at each orifice, said gas directing means being provided by the surfaces of two pairs of inclined walls formed on the underside of said terminal portion and at either side of each of said slot orifices, each of said gas streams lying in a plane containing the major axis of its respective slot orifice, and the length of each of said slot orifices at right angles to the plane of its corresponding gas stream being small in comparison with the width the said slot orifice, said pairs of walls being positioned one above the other and sloping inwardly as they approach said upper end, the upper pair of said walls meeting in a line lying at right angles to the major axis of each slot orifice.

2. A post-aerated jet according to claim **1** in which the portion of each of said surface exposed by its corresponding slot orifice produces a divergent laminar gas stream.

3. A post-aerated jet according to claim **2** in which the length of the exposed portion of each of said surfaces defines the length of its corresponding divergent gas stream.

4. A post-aerated jet according to claim **1** in which the slot orifices are situated at the base of a recess the sides of which flare upwardly and away from the ends of each slot orifice.

5. A post-aerated jet according to claim **1** in which a cup-like member is mounted on the jet the walls of said member flaring away from the ends of each slot orifice.

6. A post-aerated jet according to claim **5** in which air inlet means are formed in the flared portion of said walls allowing air to flow to the base of the flame.

7. A gas burner including a plurality of aligned gas jets according to claim **1**, said jets being provided in the ridge of a continuous channel-like member.

References Cited

UNITED STATES PATENTS

50,075	9/1865	McAvoy	239—568 X
140,164	6/1873	Richardson et al.	239—567 X
692,254	2/1902	Dolan	239—543 X
1,601,863	10/1926	Leins.	
1,631,771	6/1927	Sheather	239—543 X
2,515,845	7/1950	Van Den Bussche	158—116 X
2,573,144	10/1951	Jaye	239—566

FOREIGN PATENTS

500,351	12/1919	France.
14,322	of 1852	Great Britain.

EVERETT W. KIRBY, *Primary Examiner.*

U.S. Cl. X.R.

239—543, 566, 568, 594