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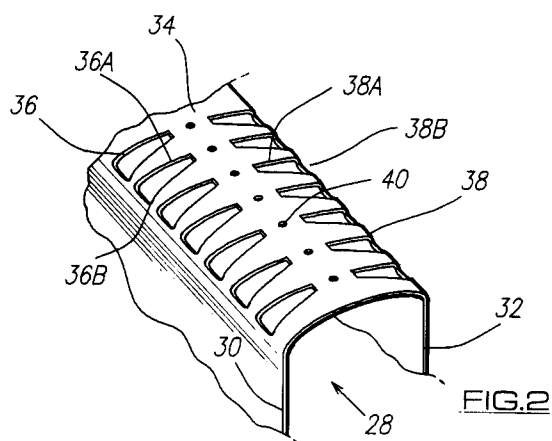
(11) Publication number:

0 661 496 A2

(12)

EUROPEAN PATENT APPLICATION(21) Application number: **94120642.7**(51) Int. Cl.⁶: **F23D 14/58, F23D 14/26,
F23D 14/04**(22) Date of filing: **24.12.94**(30) Priority: **04.01.94 GB 9400007**(43) Date of publication of application:
05.07.95 Bulletin 95/27(84) Designated Contracting States:
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Yorkshire (GB)(54) **Improvements relating to gas burners and flamestrips therefor.**

(57) The invention provides a gas burner comprising an elongated burner body (12, 14) including a flame strip (34) which has spaced slotted flame ports (36, 38) of tapered geometry. The flame ports (36, 38) lie with their narrow ends (36A, 38A) adjacent the centre (42) of the flame strip (34) and extend transversely and in opposite directions from said flame strip centre (42). This provides the advantage of a semi-lifted flame into which secondary air can be induced to produce reduced NOX emissions. Flame retention ports (40) can be provided in the flame strip (34) adjacent the narrow ends (36, 38) of the flame ports (36, 38) to give support adhesion of the flame root to the flame strip surface.

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This invention relates to gas burners, particularly but not exclusively to those gas burners which are termed atmospheric burners and are used in, for example, cookers, boilers and central heating systems. The invention also extends to flamestrips for such burners.

The gas burners to which the invention relates mainly consume gaseous fuel which may be methane, butane, propane, ethane or others, and also blends thereof, but more rarely can consume liquid fuel and the fuel is mixed with air to provide a combustible mixture which can support the burner flame. The expression "gas burner" is used herein to cover all forms of useable fuels.

A perennial difficulty with gas burners is that they create toxic emissions and much work and development has been done in an effort to reduce these emissions which principally are in the form of nitrogen oxides (referred to generally in the art and hereinafter as NOx). Some carbon monoxide is also created but this tends to be in lesser concentrations than NOx. Examples of technological developments which have been proposed for the reduction of NOx emissions from gas burners are set forth in European Patent Applications Nos. 0521024 and 0494888 and International Patent Application No. WO92/01196, but there still remains room for improvement.

Thus, investigations have included the understanding of the harmful effects of the toxic emissions of gas burners on the environment and as environmental awareness amongst the public has considerably increased, continuing investigation into methods of reducing these toxic emissions is taking place.

It is known that conventional atmospheric gas burners generally emit in excess of 100 parts per million (ppm) NOx when functioning under normal conditions and the burners have a "bunsen" type flame which is high in toxic emissions as the fuel/air mixture embodies what is termed "primary air" only, which is 30-50% of the theoretical air requirement for complete combustion.

In these gas burners, "primary air" is so called because it is the first air which is mixed with the fuel to produce the mixture which is fed to flame ports at which the flame is sustained. Secondary air on the other hand is that air which is induced and/or forced into the flame to assist in the combustion of unburnt fuel. The gas burners according to the invention utilise primary and secondary air for the support of the combustion of the fuel.

The present invention is a proposal for gas burner flame port design whereby the conventional gas burners can be caused to run at reduced NOx emission levels compared to the current in excess of 100ppm levels.

More specifically, the invention envisages providing gas burners which run at NOx emission levels of 60ppm or less.

5 The invention furthermore envisages achievement of the reduction in NOx emission levels without substantial increase in the cost of the burner.

10 According to the present invention there is provided a gas burner comprising a burner body defining at least one elongated strip which has flame slots spaced along the length of the strip and on which the burner flame in use is supported, characterised in that the said flame slots, lie transversely of the strip and have narrow and wide partitions to produce a semi-lifted flame.

15 The said slots are preferably evenly spaced along the length of said strip and preferably are parallel to one another.

20 The said slots furthermore preferably are arranged to lie transverse to said strip length with the narrow portions lying at or closer to the centre of the strip than the wide portions.

The slots preferably are of tapered configuration to define the narrow and wide portions.

25 The said slots preferably extend from the centre of the strip, widening to where the strip edges meet the burner body sides and preferably extending marginally into said sides. Adoption of a flame port whose width varies along its length and especially the tapered slot flameport produces a non-uniform discharge velocity profile of the gas/air mixture along the port, the velocity being greater at the wider end of the taper compared with the narrow end which is as a result of the increase in flow resistance through the port from the wider to the narrower end of the taper, resulting from the tapered nature of the port.

30 It has been established that given sufficient flow of fuel (gas)/primary air mixture to the port and providing that a sufficient primary aeration can be achieved, the flame will take up a semi-lifted position with regard to the burner strip surface, the flame being totally lifted from the burner strip surface at the wider end of the taper, whilst showing a greater degree of attachment towards the narrower end of the taper. Preferably, an additional retention port may also be provided in a position adjacent the narrow end of each tapered port to give supporting adhesion of the flame root to the burner strip surface.

35 40 45 50 55 The semi-lifted flame benefits in terms of reduced NOx emission from a greater degree of interaction with secondary air passing up around the outside of the burner body. This has the effect of enhanced cooling of the combustion reactions, and improved mixing of the secondary air to complete the combustion process. These effects reduce the residence time at high temperatures of the materials responsible for NOx formation, thus

lowering the NOx emission levels. The invention, therefore, has considerable environmental advantage.

It is envisaged that a wide range of gas burner designs may embody the present invention. Thus bar burners, as well as the bladed variety referred to above may be perforated with varying width, especially tapered, slots to provide the desired flame profile and the commensurate reduced NOx emission level may embody the invention. The invention may be embodied in any and all suitable new and existing burners.

The invention also has an advantage economically in that it provides a means of adapting existing burners with the minimum amount of modification such that they can function within the same apparatus more effectively and desirably.

In its more usual form of application, the invention will be preferably embodied in multiple bar or blade burners wherein the bars or blades are arranged in parallel to provide a plurality of parallel flamestrips which together make up a flame area.

The invention can be applied where the burner is of a different configuration e.g. it may be annular or cylindrical, depending upon the application.

The invention also provides flamestrips with the appropriate slot pattern, for use in gas burners as aforesaid.

An embodiment of the invention, and various modifications, will now be described, by way of example, with reference to the accompanying drawings, wherein:-

Fig. 1 is a perspective view of a portion of an atmospheric gas burner of the bladed type, but embodying the present invention;

Fig. 2 is an enlarged view of a portion of the top edge (flame strip) of one of the bladed elements of the burner shown in Fig. 1;

Fig. 3 is a developed view showing the configuration and layout of the flame ports and retention ports;

Figs. 4 and 5 are views similar to Fig. 3 but showing modified flame port arrangements;

Fig. 6 is a sectional elevation taken through the top edges of a pair of the burner elements shown in Fig. 1 and illustrate the gas burner when in use;

Fig. 7 is a view similar to Fig. 6, but showing a burner element of slightly different configuration; and

Fig. 8 shows an elevation similar to Fig. 2, an alternative arrangement according to the invention.

Referring to the drawings, in Fig. 1 is shown a portion of a gas burner 10 which is an atmospheric gas burner of the bladed type in that it has a plurality of flat blade elements or bodies 12, 14, 16, 18, and so on which are arranged in parallel planes

as shown, and are mounted on a common plenum chamber 20 so as to be in fluid communication with chamber 20. Chamber 20 receives a mixture of the gaseous fuel and primary air through chamber end 22, and the coupling pipe 24 and gas injector 26 provide that the gas is introduced and the primary air is caused by a venturi effect to be drawn into the chamber 20 where it mixes with the gas. This mixture then passes into the bladed elements 12 to 18, such elements being hollow, and the mixture then issues through the top edges or flamestrips 12A, 14A and so on through flame ports therein. The flame ports are shown in detail in Fig. 2, and referring to Fig. 2 the hollow interior 28 of each bladed element is bounded at the top by blade element sides 30 and 32 and blade element top edge 34. This edge 34 as shown is slightly curved, so as to radius smoothly into the sides 30 and 32 as shown in Fig. 2.

The top edge 34 is provided with a plurality of flame ports 36 to one side of the centre of the edge 34, and a further plurality 38 of said ports to the opposite side of the edge. The ports 36 and 38 are parallel and are aligned as shown, and each of the ports 36, 38 is in the form of an elongated slot having a narrow inner end 36A, and a wider outer end 36B. Reference numerals 38A and 38B indicate the narrow and wide portions of the slots 38.

Between each pair of aligned slots 36 and 38 is a flame retention port 40 which is of circular configuration.

The slots 36 and 38 lie as shown in Fig. 2 transverse to the length direction of the edge 34, and the wide portions 36B and 38B in fact are turned over slightly into the sides 30 and 32.

The making of the slots 36 and 38 so as to have a narrow portion and a wide portion is important to the operation of the burner in accordance with the present invention, as will be explained in more detail hereinafter, but if reference is now made to Fig. 3, the exact development configuration of the slots 36 and 38 is shown. In a practical example, the dimensions indicated in Fig. 3 which are in millimetres apply to the slot configurations. The spacing of adjacent slots is also given. Providing a burner element of Fig. 2 with the slot arrangement of Fig. 3 has been shown to give an extremely effective gas burner.

It is possible to vary the arrangement of the slots 36 and 38 and two modifications are shown in Figs. 4 and 5. In Fig. 4, it is shown that the slots 36 and 38 are not aligned transversely of the edge 34, but are offset and interspaced. The gas retention ports 40 remain on the centre line 42 of edge 34, but in the arrangement of Fig. 5, not only are the slots 36 and 38 offset and interspaced in a manner similar to the arrangement of Fig. 4, but each slot 36 and 38 and its aligned retention port 40 are

overlapped so that the ports 40 are displaced to opposite sides of the centre line 42. With the configuration shown in Fig. 5, slightly different dimensional arrangements are adopted for the slots, and in this connection it may well be necessary to vary the slot configurations and dimensions depending upon the slot arrangement and distribution, provided that the slots are provided with wide and narrow portions.

If reference is made to Fig. 6, this figure indicates the advantageous effect of providing the tapered slots shown in Figs. 2 and 3. As the gas/air mixture 44 is supplied to the interior 28 of each blade element, so that mixture is forced through the slots 36 and 38, but because each of the said slots is of tapered configuration, the mixture issuing from these slots 36 and 38 will have a velocity distribution along the length of the slot. The velocity of the mixture issuing from the narrowest part of the slot will be smaller than that issuing from the widest portion of the slot due to the increased resistance caused by the slot edge. The vectors 46, 48, 50 and 52 are intended to be representative of the respective velocities of the different portions of the mixture which issues from the slots 36 and 38. This means that the flame front indicated for example by reference 54 will take up a lifted configuration in relation to the wide end of the slot, but will be nearer the blade element edge 34 at the narrower end of the slot. This lifted configuration enables secondary air indicated by arrows 56 to be entrained and induced into the flame to assist in further combustion of unburned gas, with a view to reducing noxious emissions.

The retention ports 40 serve in known manner to stabilize the flame 54. By the induction and flow of the secondary air 56 into the flame 54, so the flames of adjacent burner bar elements can be restrained from impinging upon one another which creates undesirable carbon monoxide production.

It has to be appreciated that in indicating a particular set of dimensions to enable the semi lifted flame operation as described in relation to Fig. 6 to be achieved, there has to be adequate provision for satisfactory ignition and cross-lighting of the gas/air mixture. Furthermore adequate flame stability margins must be included to accommodate the requirements of relevant combustion and safety standards, especially those relating to flash back or light back of flame into the gas/air mixture within the burner plenum chamber 20.

Fig. 8 shows an alternative embodiment of the invention and indicates that a plurality of flamestrips 34 can be formed on a single body having sides 30 and 32 corresponding to the sides of the body shown in Fig. 2. The flamestrips 34 extend transversely of the length of the body, and are spaced by air induction grooves or gaps 33 so

that to the edges of each flamestrip 34 there are groove sides 33A and 33B. Secondary air is induced up these sides during the functioning of the burner, and the flamestrip 34 in each case is provided with the slot pattern according to any of the embodiments referred to herein. Specifically, the illustration of Fig. 8 shows the slot pattern similar to that of Fig. 2. The slots and retention apertures 36, 38 and 40 referred to in the previous figures carry the same reference numerals in Fig. 8. Each strip 34 does have a length direction, and the slots 36 and 38 are again arranged transversely to this direction. It would be appreciated that other modified forms of construction may be provided.

Several configurations of tapered ports have been described herein, but others are feasible and can produce the desired result of providing a semi-lifted flame with NO_x reduction, but the practical constraints of meeting the required burner performance criteria must be taken into account.

In the arrangement of Figs. 1, 2, 6 and 8 the burner element edges are shown as being slightly curved, with the slots 36 and 38 extending slightly into the burner sides 30 and 32. It is not necessary that this arrangement should apply, and Fig. 7 shows a modified form wherein the slots 36 and 38 are in a flat edge 34, and do not extend into the sides 30 and 32 of the blade element.

It is to be repeated that the injection arrangement for injecting the fuel and primary air into the plenum chamber or burner if burner bars are used, may be of any appropriate design.

Claims

1. A gas burner comprising a burner body (12) defining at least one elongated strip (34) which has flame slots (36, 38) spaced along the length of the strip and on which the burner flame (54) in use is supported, characterised in that the said flame slots (36, 38) lie transversely of the strip (34) and have narrow (36A, 38A) and wide (36B, 38B) partitions to produce a semi-lifted flame.
2. A gas burner according to claim 1, characterised in that each of said flame slots (36, 38) tapers from a narrow end (36A, 38A) to a wide end (36B, 38B).
3. A gas burner according to claim 2, characterised in that each of said slots extend from the central region (42) of said strip (34) outwardly to an edge region (30, 32) of said strip (34).
4. A gas burner according to claim 3, characterised in that the narrow end (36A, 38A) of

each flame slot is closer to said central region (42) than said wide end (36B, 38B).

5. A gas burner according to any one of the claims 2 to 4, characterised by a gas retention port (40) in said strip (34) adjacent the narrow end (36A, 38A) of each flame slot (36, 38). 5
6. A gas burner according to claim 5, characterised in that the gas retention ports (40) are aligned in a row which lies on the central region of the strip (34). 10
7. A gas burner according to claim 6, characterised in that the gas retention ports (40) are arranged along the strip (34) so that alternate ports (40) lie to opposite sides of the central region (42) of the strip (34). 15
8. A gas burner according to any preceding claim, characterised in that the flame slots (36,38) are arranged in pairs on opposite sides of the central region (42) of the strip (34). 20
9. A gas burner according to claim 8, characterised in that the flame slots (36, 38) of each pair are aligned transversely of the strip (34). 25
10. A gas burner according to claim 8, characterised in that the flame slots (36,38) of each pair are offset lengthwise of the strip (34). 30
11. A gas burner according to any preceding claim, characterised in that the strip (34) is defined by a metal sheet having the flame slots (36, 38) and the retention ports (40) (when provided) therein. 35
12. A gas burner according to claim 11, characterised in that the metal sheet is bent so that the strip (34) is a top edge which curves into two side walls (30, 32) and said flame slots extend partially into said side walls (30, 32). 40
13. A gas burner according to any preceding claim, characterised in that the burner body (12) is elongated and the strip (34) extends in the length direction of the burner body (12). 45
14. A gas burner according to any preceding claim 1 to 12 characterised in that the burner body (12) is elongate and has a plurality of said strips (34) extending transverse to the length direction of the burner body (12). 50
15. A gas burner according to any preceding claim, characterised by a plurality of said burner bodies (12, 14, 16, 18) arranged side by 55

side.

16. A flamestrip for a burner body according to any of claims 1 to 15.

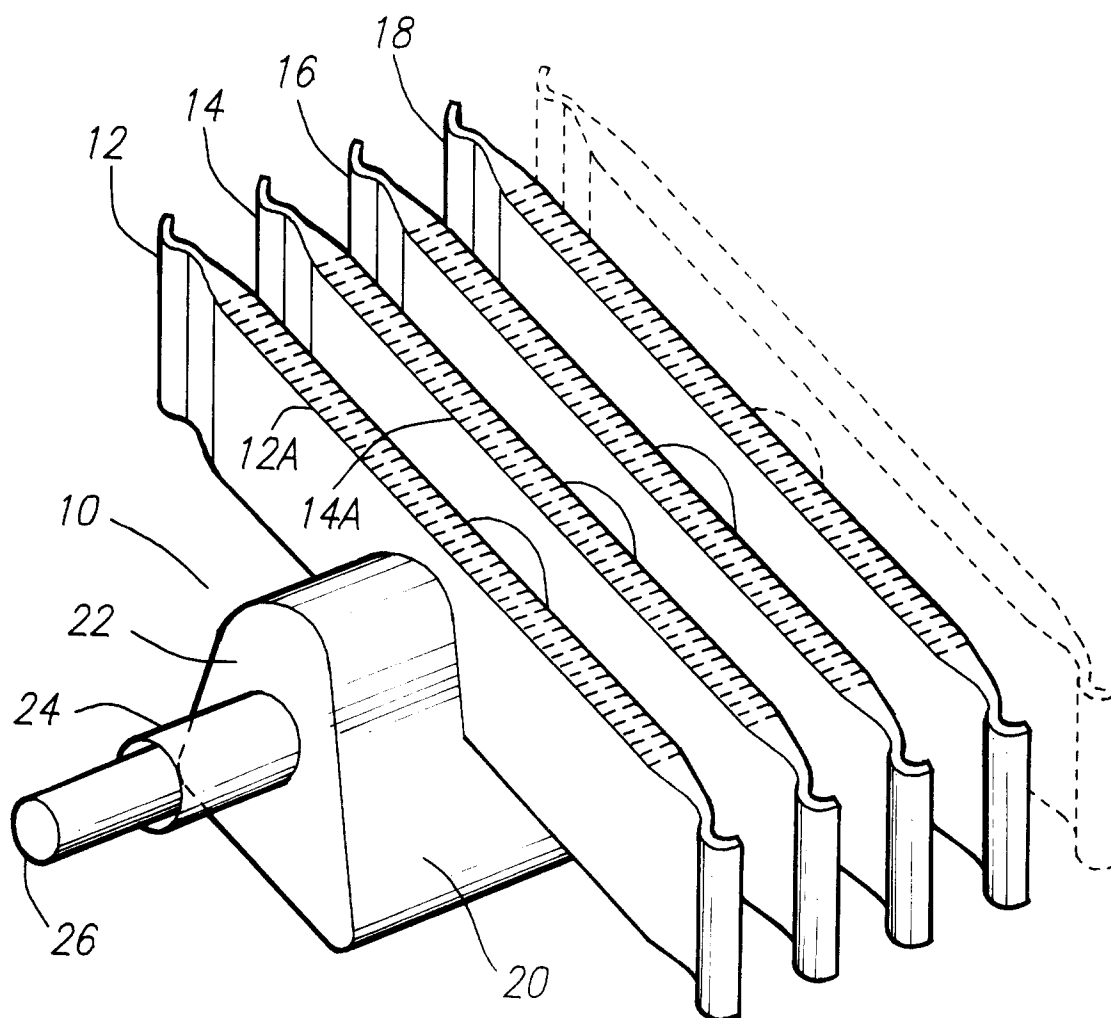


FIG.1

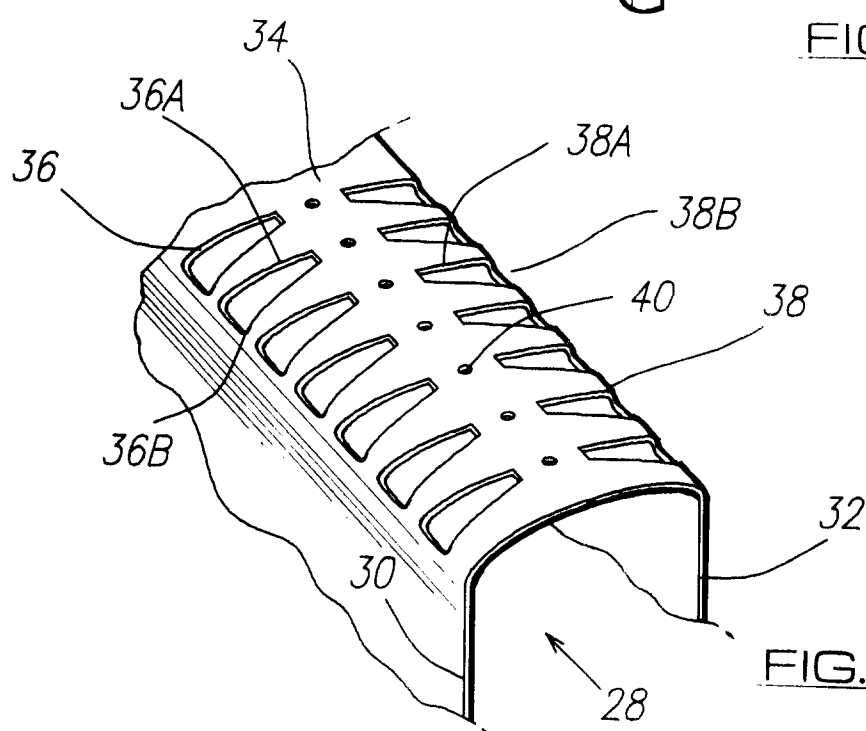
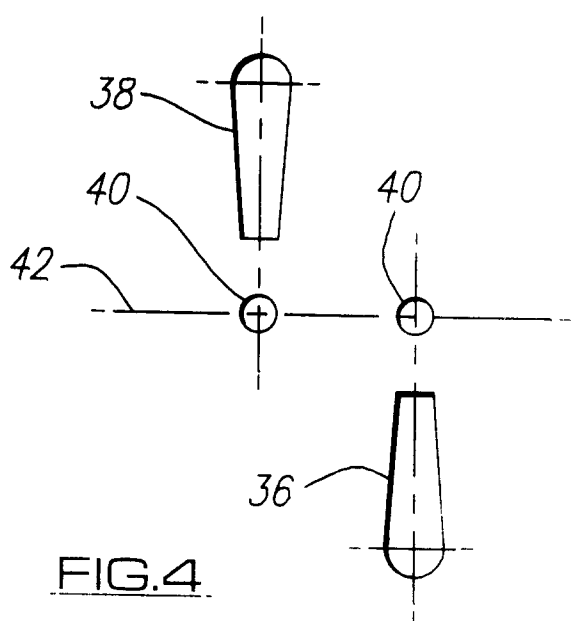
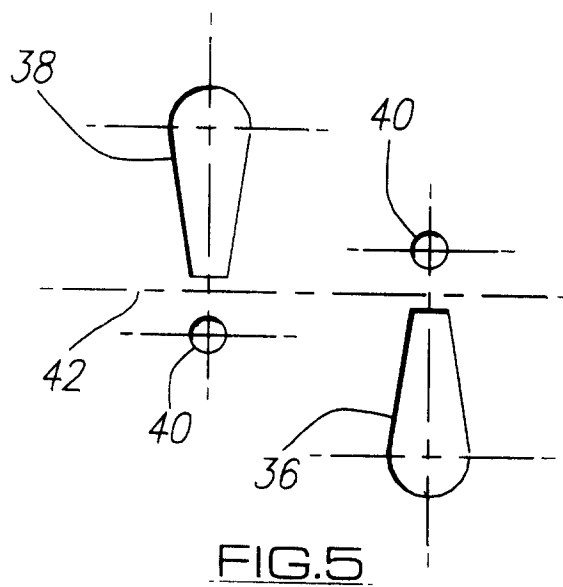
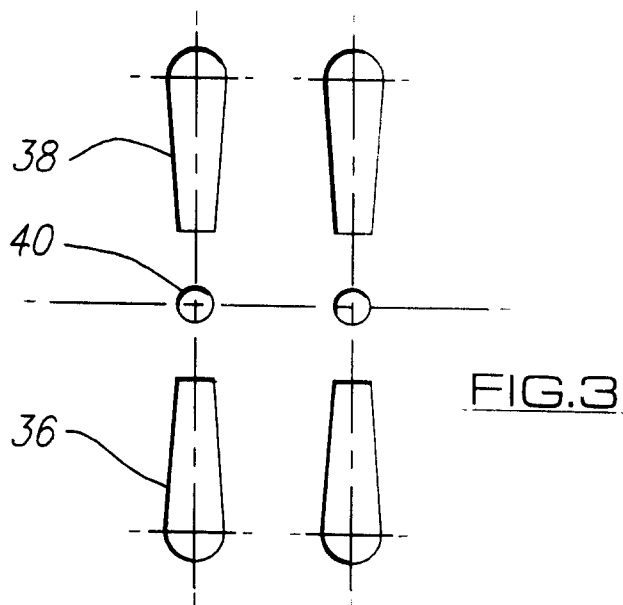


FIG.2



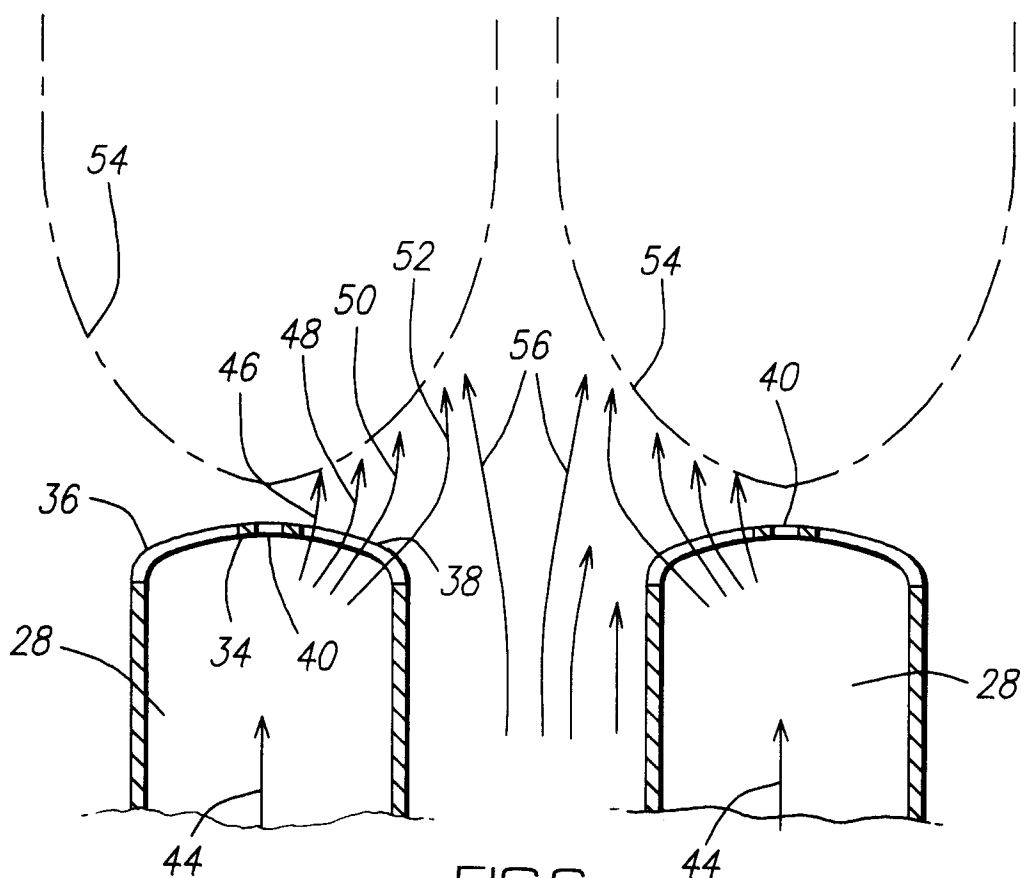


FIG. 6

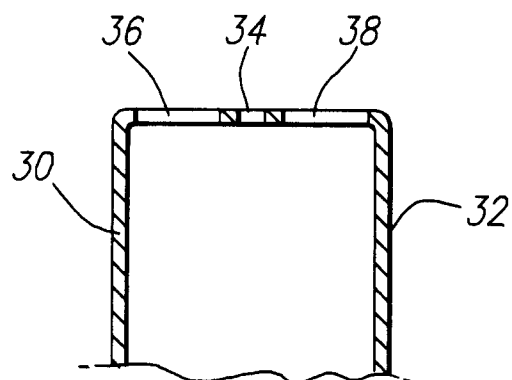


FIG. 7

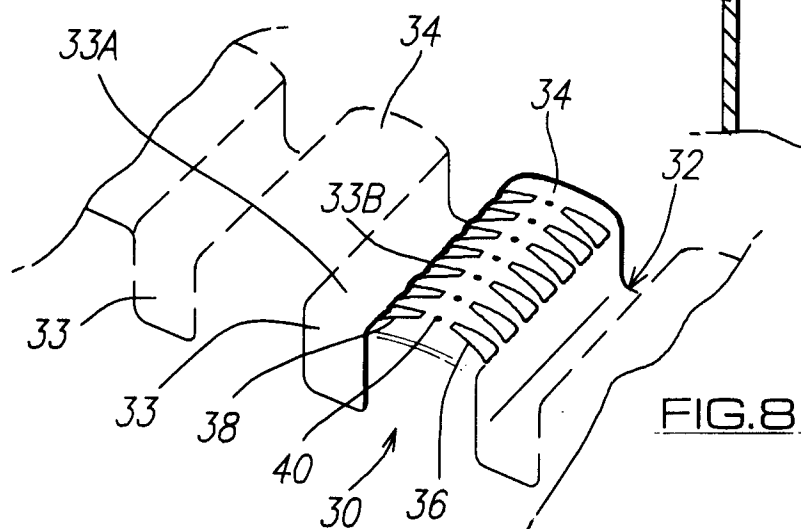


FIG. 8