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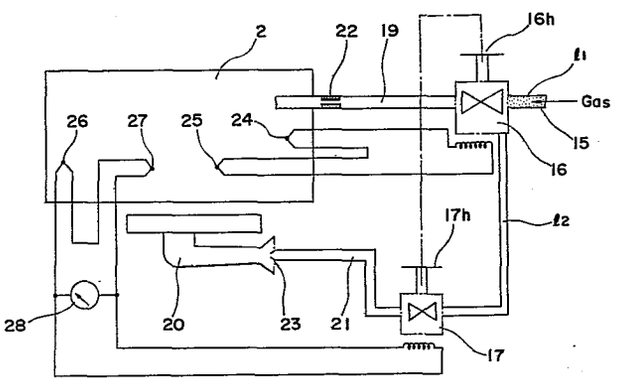
(54) Catalytic combustion arrangement.

(57) The disclosure is directed to an improved catalytic combustion arrangement for use, for example, in a gas stove or the like, which is so arranged that a heat insulation diffusion layer is provided in a catalytic mat layer for the improvement of combustion rate around the catalytic mat (2), and, through employment of two sets of thermo-couples (24, 25, 26, 27) a heating burner (20) for the catalytic mat (2) is adapted to burn only during starting of combustion, and to be automatically extinguished upon arrival at a steady combustion state for continuous combustion only by the catalytic mat (2), with a simultaneous indication of such combustion.



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CATALYTIC COMBUSTION ARRANGEMENT

BACKGROUND OF THE INVENTION

The present invention generally relates to a combustion apparatus and more particularly, to a catalytic combustion arrangement for use in a gas stove and the like or other industrial combustion equipment in general.

In a conventional catalytic burner, it has been so arranged, for example as shown in Fig. 1, that a heat-resistant wire netting or wire mesh W, a catalytic mat M supporting a catalyst, a diffusion heat insulation layer DH, and a supporting plate S having through-holes h formed therein, are piled one upon another in that order from above into one unit, while the catalytic mat layer L on the whole thus constructed is accommodated in a casing H, with the entire peripheral edge of said heat-resistant wire mesh W being depressed from above by a cover member C for fixing. In the known construction as described above, however, since the catalytic mat M directly contacts a flange portion Ha of the casing H, heat at the contact portion of the mat M is absorbed by the flange portion Ha, with a consequent reduction of combustion rate or combustion and hydrocarbon emission rate (which may be represented by: volume of hydrocarbon discharged from the mat M/total volume of

hydrocarbon supplied to a combustion apparatus) during a steady combustion at said portion.

Meanwhile, in a known igniting construction of the catalytic mat M as shown in Fig. 2, upon opening of a cock K, gas is fed through a gas pipe P to a mat M through a gas nozzle N, while simultaneously, a pilot flame burner F is ignited, and thus, the raw gas within the mat M is gradually ignited from its portion surrounding the pilot burner F for combustion of the mat M on the whole. However, in the conventional arrangement as described above, the combustion rate at an early stage of combustion is extremely low, since the combustion of the gas is started from one point, and unburnt gas (i.e. raw gas) is discharged from other portions which have not reached the ignition temperature.

Subsequently, in another conventional catalytic mat arrangement as shown in Fig. 3, an electric heater element E is embedded within the catalytic mat M, and the heater element E is energized in association with opening of the cock K so as to be kept energized during combustion, or to be de-energized upon arrival at the steady combustion state. In the prior art arrangement as described above, however, an electric circuit including the electric heater element is required in addition to the gas line, and thus, the construction is undesirably complicated, with a consequent rise in cost.

SUMMARY OF THE INVENTION

Accordingly, an essential object of the present invention is to provide an improved catalytic combustion arrangement in which combustion rate has been improved particularly at an early stage of combustion and during steady combustion, with a reduction of No_x generation during such steady combustion.

Another important object of the present invention is to provide a catalytic combustion arrangement of the above described type, which makes it possible to effect the process ranging from ignition to combustion only through operation of a gas cock without employment of any electrical heating means for a higher operating efficiency.

A further object of the present invention is to provide a catalytic combustion arrangement of the above described type, which is arranged to automatically cut off the gas in case of mis-fire for improved safety.

Another object of the present invention is to provide a catalytic combustion arrangement of the above described type, which is capable of displaying that combustion is taking place, for preventing dangerous states resulting, for example, from the burner not extinguished inadvertently.

In accomplishing these and other objects, according to one preferred embodiment of the present invention, there is provided a catalytic combustion

arrangement which includes a catalytic mat layer having a catalytic mat which supports a catalyst, a casing for accommodating the catalytic mat layer therein, mean for supplying a fuel into the casing through a gas cock, a heating burner for heating the catalytic mat, means for feeding the fuel to the heating burner through a safety valve, a first set of thermo-couples which are disposed close to the catalytic mat so that one of the thermo-couples in said first set is disposed adjacent to the heating burner, and are connected in series to each other so as to be coupled with an opening means of said gas cock and a second set of thermo-couples which are also disposed close to the catalytic mat so that one of the thermo-couples in said second set is disposed adjacent to the heating burner, and are connected in series to each other so as to be coupled with an opening means of said safety valve.

By the arrangement according to the present invention as described above, an improved catalytic combustion arrangement has been advantageously provided through a simple construction, with substantial elimination of disadvantages inherent in the conventional arrangements of this kind.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and features of the present invention will become apparent from the following description taken in conjunction with the preferred

embodiment thereof with reference to the accompanying drawings, in which;

Fig. 1 is a fragmentary side sectional view showing a construction of a catalytic mat layer portion for a conventional catalytic combustion arrangement,

Figs. 2 and 3 are schematic diagrams explanatory of constructions of conventional catalytic combustion arrangements,

Fig. 4 is a fragmentary side sectional view showing a construction of a catalytic mat layer portion for an improved catalytic combustion arrangement according to the present invention,

Fig. 5 is a perspective exploded view of the catalytic mat portion of Fig. 4,

Fig. 6 is a schematic diagram showing a construction of the catalytic combustion arrangement according to one preferred embodiment of the present invention,

Figs. 7 and 8 are diagrams similar to Fig. 6, which are particularly explanatory of functionings thereof, and

Figs. 9 and 10 are graphs showing characteristics of thermo-couples employed in the arrangement of Fig. 6.

DETAILED DESCRIPTION OF THE INVENTION

Before the description of the present invention proceeds, it is to be noted that like parts are designated

by like reference numerals throughout the accompanying drawings.

Referring now to the drawings, there is shown in Figs. 4 and 5, the construction of a catalytic mat layer portion employed in a catalytic combustion arrangement (Fig. 6) according to one preferred embodiment of the present invention. In Figs. 4 and 5, the catalytic mat layer portion 13 includes a heat-resistant wire mesh 1, a catalytic mat 2 which supports a catalyst (not particularly shown), a heat insulation diffusing layer 12, a diffusion heat insulating layer 3, and a backing or supporting plate 5 having through-holes 5h formed therein, all of which are piled up one upon another in that order from above into one unit, while the entire catalytic mat layer 13 thus piled up are accommodated in a casing 6, with the heat-resistant wire mesh 1 being fixed by a cover member 14 provided to depress the whole peripheral edge of said wire mesh 1.

The catalytic mat 2 as described above is constituted by causing a material having a strong catalytic effect over combustible gases such as platinum, palladium, rhodium or the like, to be supported on a cotton-like heat-resistant mat having a predetermined thickness and made of, for example, fibers of alumina, silica, and the like, so as to achieve combustion reaction through a catalytic effect by the combustible gas and a secondary air on the surface and inner layer of said catalytic mat 2. In the above

construction, the combustible gas passes, from the interior of the casing 6, through the mat layer 13 in the order of the supporting plate 5, diffusion heat insulation layer 3, heat insulation diffusion layer 12, catalytic mat 2, and heat-resistant wire mesh 1, and is subjected to perfect combustion while passing through the catalytic mat 2. Therefore, since activity of the catalyst is reduced upon lowering of the temperature, combustion heat is retained by the diffusion heat insulation layer 3 and heat insulation diffusion layer 12 for uniform diffusion.

Meanwhile, owing to the fact that the peripheral portion of the catalytic mat layer 13 fixed to a flange portion 6a, etc. of the casing 6 for contact therewith, is inevitably more readily cooled than a central portion thereof, it is so arranged that such peripheral portion contacting the casing 6 is particularly raised in the density for dilution of the combustion gas, while direct contact of the catalytic mat layer 13 with such cooling portion is avoided as far as possible.

The heat insulation diffusion layer 12 has for its main object to insulate heat, and has a thickness approximately 1/2 that of the diffusion heat insulation layer 3, with a density about two times that of said layer 3, while said diffusion heat insulation layer 3 is mainly intended for the diffusion.

As is seen from the foregoing description, in the construction of the catalytic mat layer portion according to the embodiment of the present invention as explained so far, owing to various layers provided therein, uniform diffusion of combustion gas is advantageously achieved, without a possibility that the catalytic mat 2 is cooled by the casing 6. Moreover, since the contacting portion of the catalytic mat 2 is arranged to be high in density and small in thickness, not only erroneous work may be eliminated during assembly, but also, the catalytic mat 2 may be efficiently utilized without being cooled excessively, particularly for appliances used during cold winters such as gas stoves and the like.

Referring also to Figs. 6 to 8, a gas line circuit and a gas combustion construction for the catalytic combustion arrangement according to the present invention will be described hereinbelow.

In Fig. 6, the catalytic combustion arrangement of the present invention generally includes a gas line $\ell 1$ having, at its one end, a gas introduction port 15, and connected, at its other end, to a gas cock 16 having a control knob 16h and further connected to a gas passage 19 which is provided with an orifice 22 and led to the catalytic mat 2, another gas line $\ell 2$ connecting said gas cock 16 to a safety valve 17 which has a control knob 17h and is further connected to a gas passage 21 reaching a heating burner 20 through its gas nozzle 23, a set of thermo-couples

24 and 25 connected in series with a coil of the gas cock 16 and disposed close to the catalytic mat 2, another set of thermo-couples 26 and 27 connected in series with a coil of the safety valve 17 and also disposed adjacent to the catalytic mat 2, and an indicating meter 28 connected in parallel to the thermo-couples 26 and 27. By operating the knobs 16h and 17h of the gas cock 16 and the safety valve 17, the combustible gas introduced through the gas introduction port 15 passes through the gas passage 19 for main gas and gas for a pilot flame, and reaches the catalytic mat 2 through the orifice 22 on one hand, and on the other hand, passes through the gas passage 21 and the gas nozzle 23, into the heating burner 20, which is necessary for activating the surface of the catalytic mat 2 during ignition thereof.

Referring also to Figs. 7 and 8, functionings of the catalytic combustion arrangement of Fig. 6 will be explained hereinbelow.

In Fig. 6, since the gas cock 16 is in the closed state, the combustible gas is fed only up to said gas cock 16.

Subsequently, as shown in Fig. 7, the combustible gas is fed into the gas passages 19 and 21 through rotation of the knobs 16h and 17h for the gas cock 16 and safety valve 17, while simultaneously, the heating burner 20 is

ignited by an igniting device (not shown) associated with the gas cock 16. Upon heating of the catalytic mat 2 by the heating burner 20, combustion is started over the entire surface of said catalytic mat 2. Meanwhile, since the thermo-couples 25 and 27 are heated, the gas cock 16 and the safety valve 17 are maintained in the opened state by electromotive forces from said thermo-couples.

In Fig. 8, although combustion is started on the catalytic mat 2 activated by the heating, such combustion has not yet extended over the entire surface thereof, and combustion reaction takes place over the whole surface as time elapses, with electromotive forces being produced in the thermo-couples 24 and 26. Since the thermo-couple 24 is connected in such a direction that the electromotive force thereof increases with that of the thermo-couple 25, while the thermo-couple 26 is connected in a direction to decrease the electromotive force of the thermo-couple 27, the safety valve 17 finally reaches the state where it can not electrically maintain its opened state, and thus, the heating burner 20 is extinguished. Thereafter, the electromotive force of the thermo-couple 25 is rapidly decreased, but owing to the fact that the thermo-couple 24 is already producing electromotive force sufficient to electrically maintain the opened state of the safety valve 16, the combustion is continued.

It should be noted here that a needle pointer of the indicating meter 28 connected in parallel with the thermo-couples 26 and 27 is moved or deflected further towards the left side than in the combustion suspension period (Fig. 6), when the heating burner 20 is ignited and electromotive force is produced in the thermo-couple 27, while it is deflected to the rightmost position, when the heating burner 20 is extinguished, i.e. when a sufficient electromotive force is produced in the thermo-couple 26, and thus, the state of combustion may be ensured by the positions of the pointer needle of said indicating meter 28.

In a diagram of Fig. 9, the state of electromotive forces of thermo-couples 24 and 25 and a composite electromotive force thereof is shown, while Fig. 10 illustrates the state of electromotive forces of thermo-couples 26 and 27 and a composite electromotive force thereof.

As is clear from the foregoing description, according to the embodiment of the present invention as explained so far, since the heating burner 20 continues to burn until the preheating of the catalytic mat 2 has been completely terminated, positive combustion may be safely achieved. Moreover, owing to the arrangement that, only the heating burner 20 continues to burn during non-functioning period of the catalytic mat 2, any unusual state may be ensured at a glance so as to prevent raw gas from being

discharged in advance. Furthermore, the arrangement that starting of perfect combustion by the catalytic mat 2 is indicated upon extinguishment of the heating burner 20, may be utilized for confirmation of combustion.

Although the present invention has been fully described by way of example with reference to the accompanying drawings, it is to be noted here that various changes and modifications will be apparent to those skilled in the art. Therefore, unless otherwise such changes and modifications depart from the scope of the present invention, they should be construed as included therein.

What is claimed is:

1. A catalytic combustion arrangement which comprises a catalytic mat layer having a catalytic mat which supports a catalyst, a casing for accommodating said catalytic mat layer therein, mean for supplying a fuel into said casing through a gas cock, a heating burner for heating said catalytic mat, means for feeding the fuel to said heating burner through a safety valve, a first set of thermo-couples which are disposed close to said catalytic mat so that one of the thermo-couples in said first set is disposed adjacent to said heating burner, and are connected in series to each other so as to be coupled with an opening means of said gas cock, and a second set of thermo-couples which are also disposed close to said catalytic mat so that one of the thermo-couples in said second set is disposed adjacent to said heating burner, and are connected in series to each other so as to be coupled with an opening means of said safety valve.

2. A catalytic combustion arrangement as claimed in Claim 1, wherein said catalytic mat layer includes a heat resistant wire mesh, said catalytic mat which supports the catalyst, a heat insulation diffusion layer, a diffusion heat insulation layer, and a supporting plate, all of which are piled one upon another into one unit and accommodated in said casing.

3. A catalytic combustion arrangement as claimed in Claim 1, wherein at least either one set of said first and

second sets of the thermo-couples is provided with an indicating means for indicating the state of combustion.

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Fig. 1

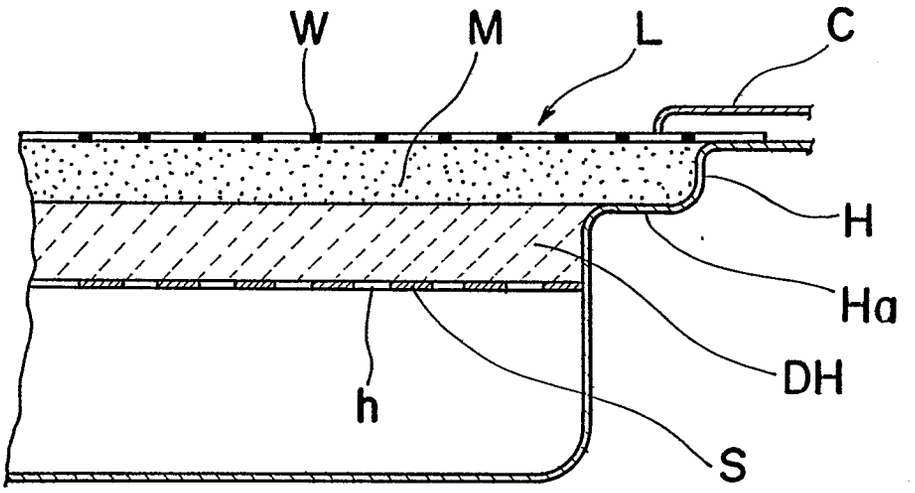

Fig. 2

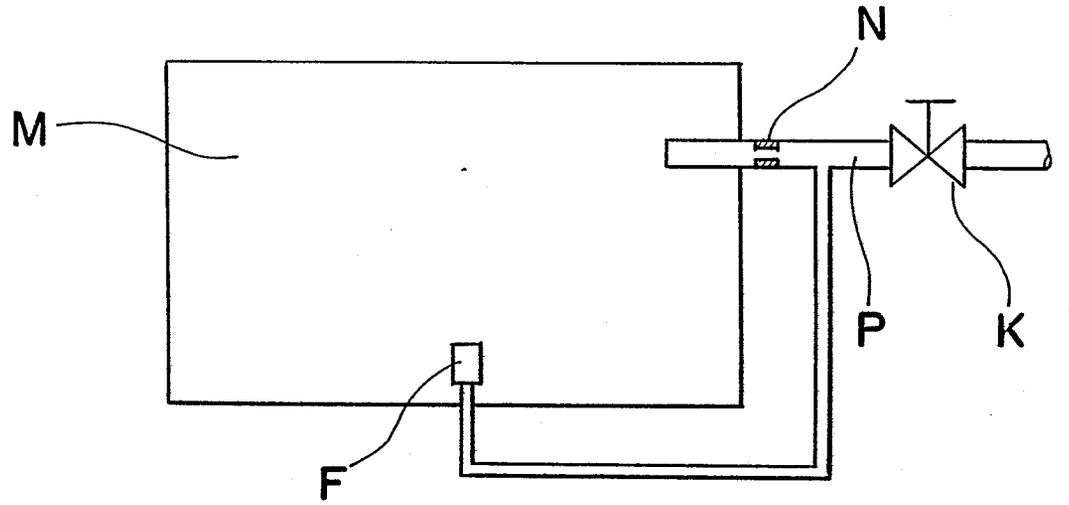

Fig. 3

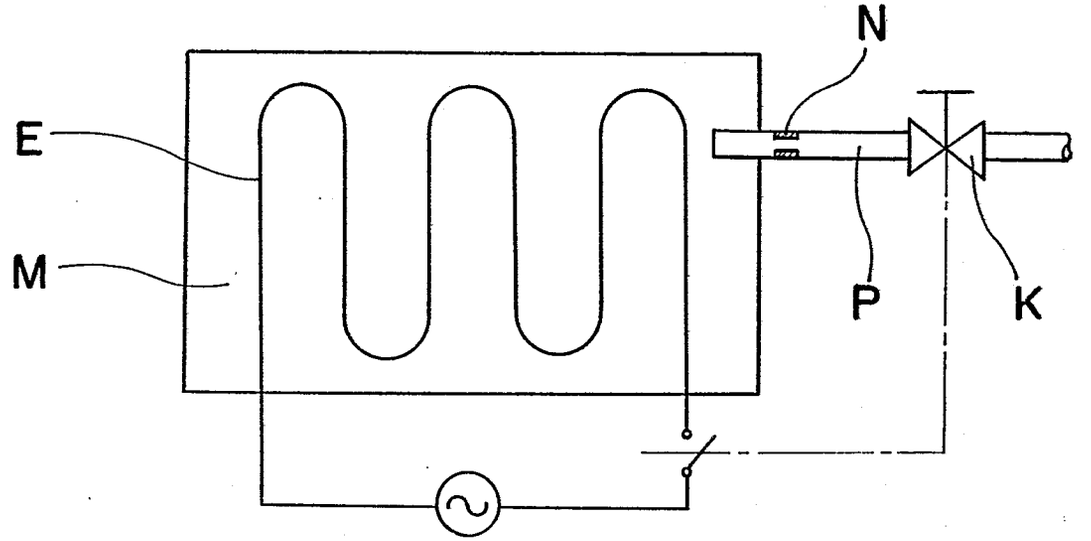

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Fig. 4

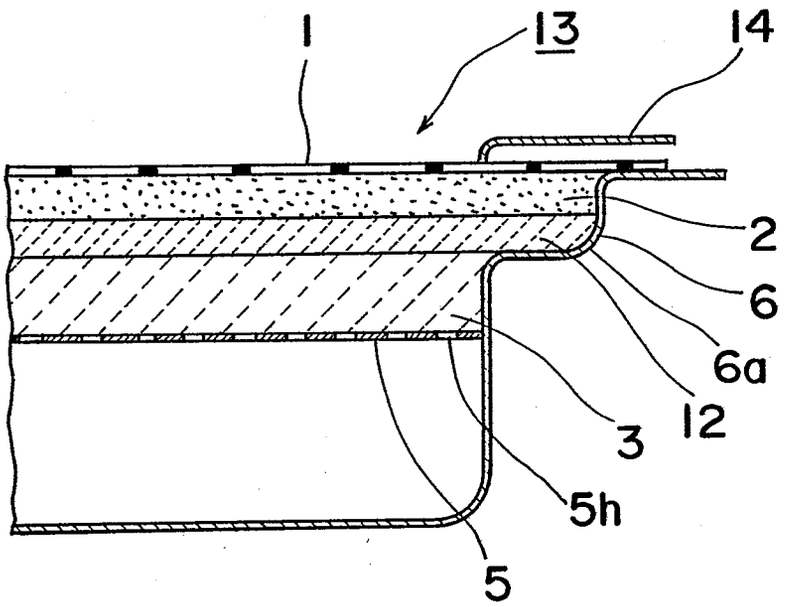
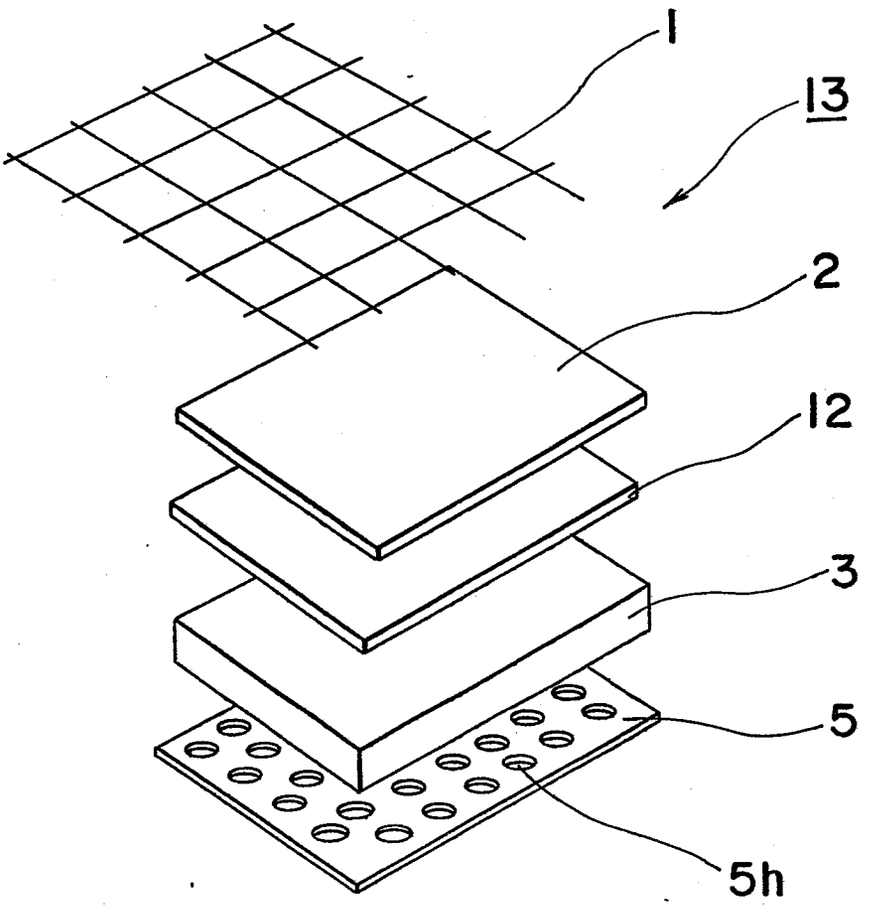


Fig. 5



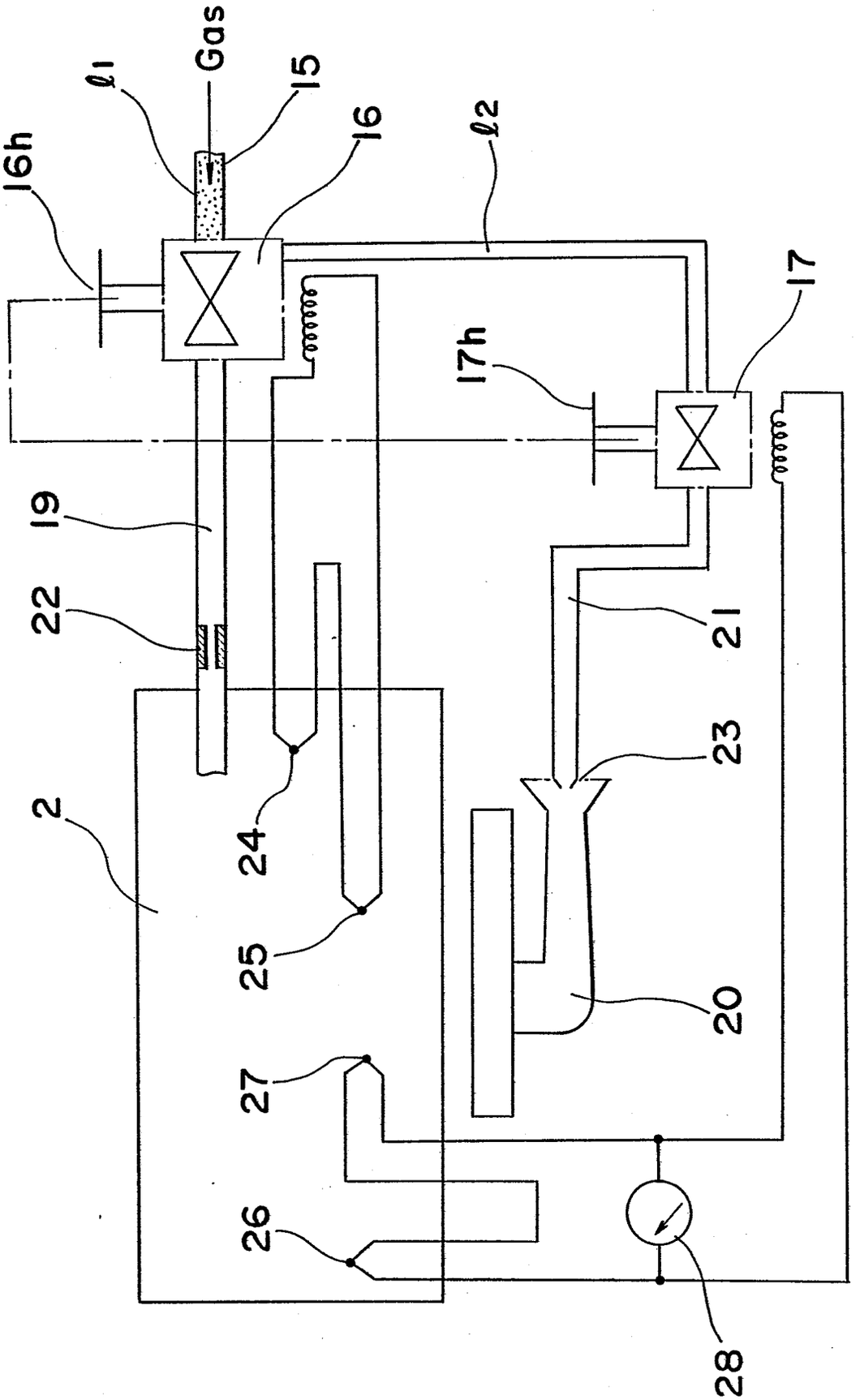


Fig. 6

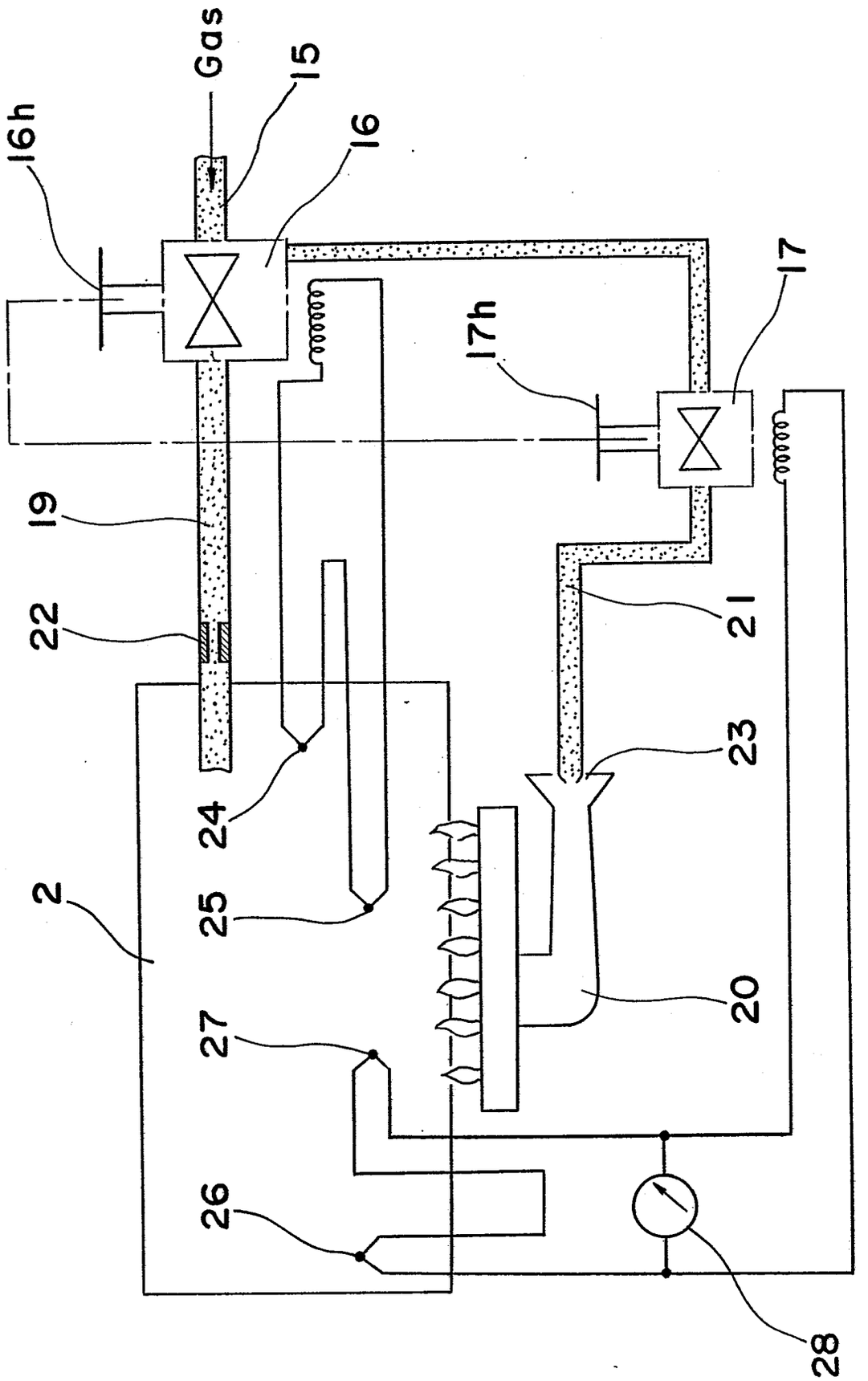


Fig. 7

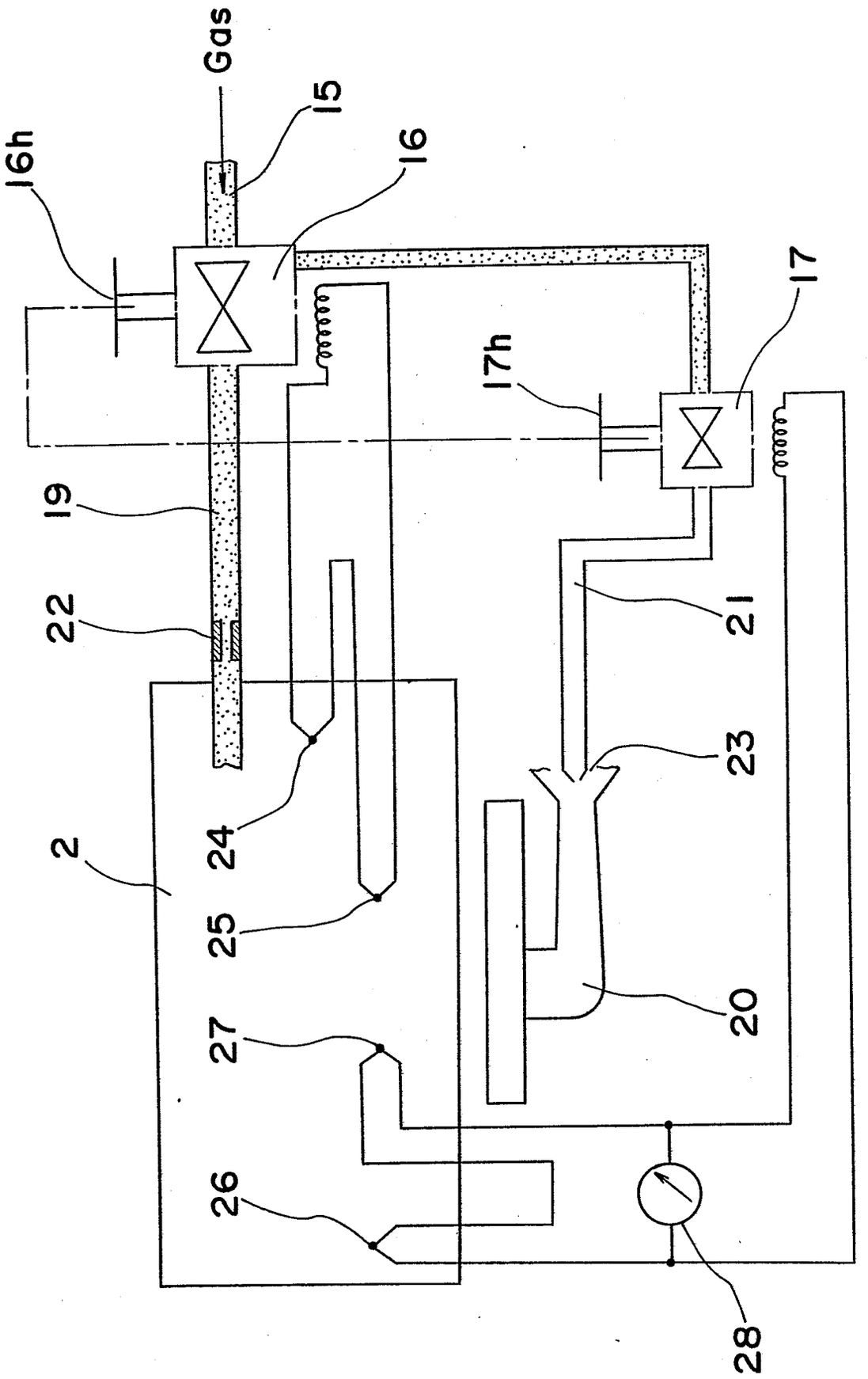


Fig. 8

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Fig. 9

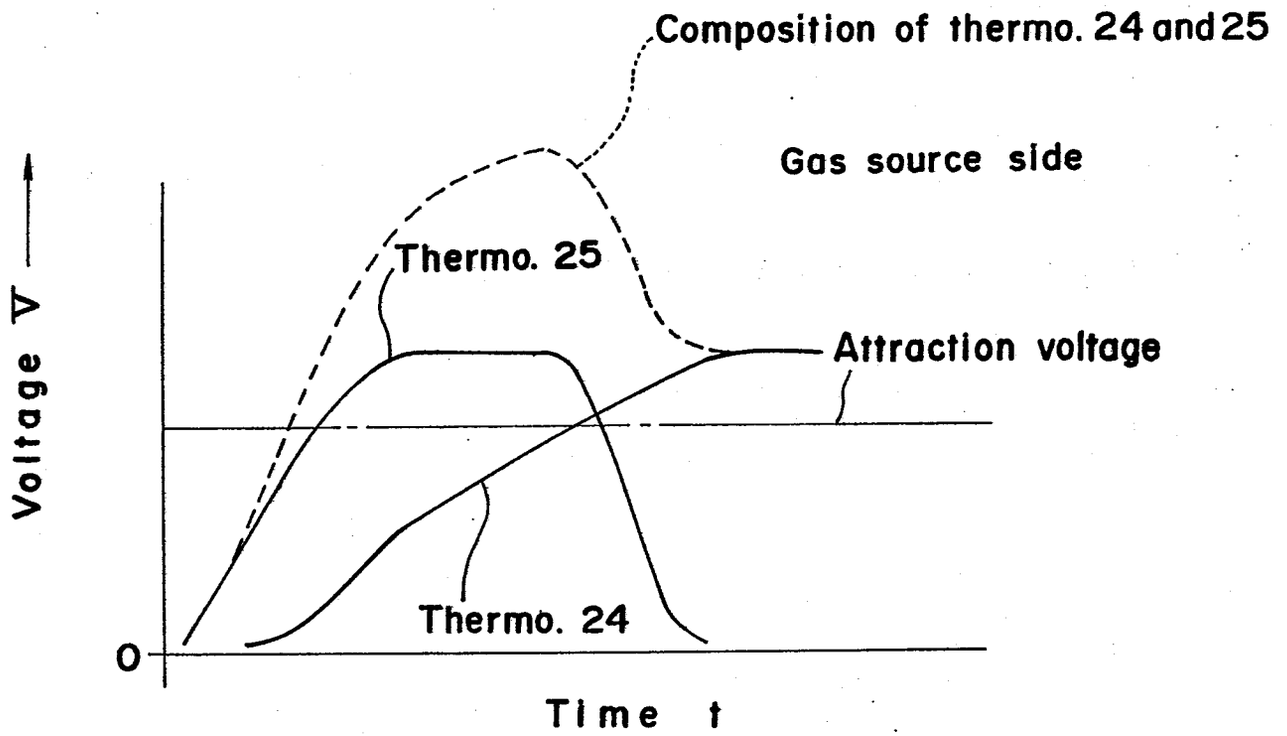
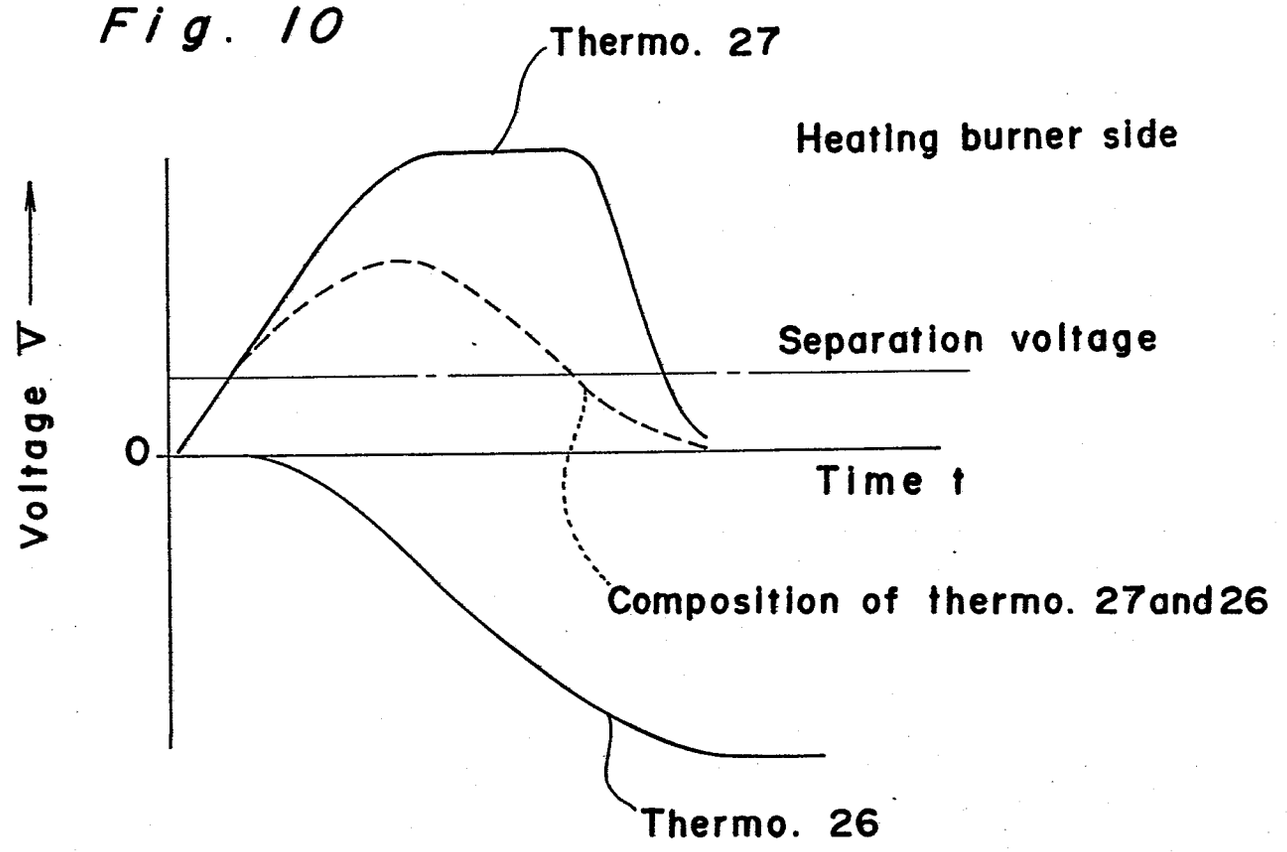


Fig. 10



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EUROPEAN SEARCH REPORT

0119279
Application number

EP 83 10 2379

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Y	FR-A-1 095 865 (MIROUZE) * Page 3, left-hand column, line 29 - right-hand column, line 7; figures 26,29 *	1	F 23 D 13/18
Y	DE-A-1 779 572 (KÜPPERSBUSCH) * Page 3, lines 13-27; figures *	1	
A	FR-A-1 228 434 (AMERICAN THERMOCATALYTIC CORP.) * Page 3, left-hand column, lines 5-35; figure 2 *	1	
A	US-A-3 270 798 (RUFF) * Column 5, line 59 - column 6, line 31; column 6, line 62 - column 7, line 6; figures 1,2 *	1,2	TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
A	DE-A-1 679 259 (STRACHE) * Page 4; figure 2 *	3	F 23 D F 23 C F 23 G F 24 C
A	FR-A-1 514 493 (MOSGAZPROEKT)		
A	FR-A-2 504 648 (SOCIETE LYONNAISE)		
A	FR-A-2 434 339 (CAFAP)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	07-11-1983	COMEL E.

CATEGORY OF CITED DOCUMENTS

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