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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :
F23C 11/04, F23M 13/00
F24H 1/28

A1

(11) International Publication Number: **WO 92/08928**

(43) International Publication Date: 29 May 1992 (29.05.92)

(21) International Application Number: PCT/NL91/00231

(22) International Filing Date: 19 November 1991 (19.11.91)

(30) Priority data:
9002525 19 November 1990 (19.11.90) NL

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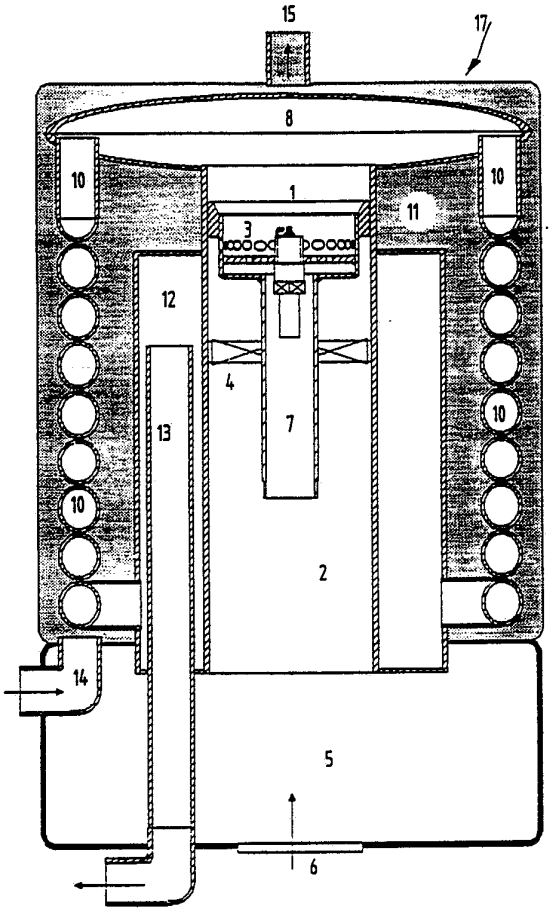
(81) Designated States: AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH (European patent), CI (OAPI patent), CM (OAPI patent), CS, DE (European patent), DK (European patent), ES (European patent), FI, FR (European patent), GA (OAPI patent), GB (European patent), GN (OAPI patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU (European patent), MC, MG, ML (OAPI patent), MN, MR (OAPI patent), MW, NL (European patent), NO, PL, RO, SD, SE (European patent), SN (OAPI patent), SU+,TD (OAPI patent), TG (OAPI patent), US.

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.
In English translation (filed in Dutch).

(54) Title: BURNER FOR PULSATING COMBUSTION

(57) Abstract

A burner for pulsating combustion comprises an explosion chamber (1) which on the inlet side connects onto a supply tube (2) for combustion air and a supply tube (7) for fuel and on the outlet side is connected to one or more discharge tubes (10) for the combustion gases. The invention has for its object to provide a burner for pulsating combustion which produces considerably less noise than the known devices. According to the invention this object is achieved by providing the explosion chamber with a widening (8) on the outlet side and connecting the discharge tube(s) to this widening at or close to the periphery thereof.



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+ DESIGNATIONS OF "SU"

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BURNER FOR PULSATING COMBUSTION

The invention relates to a burner for pulsating combustion with an explosion chamber which on the inlet side connects to a supply tube for combustion air and a supply tube for fuel and on the outlet side is connected to one or more discharge tubes for the combustion gases, as described in the Netherlands patent application NL-A-89 01416 of applicant.

In such a burner the explosion chamber and the supply and discharge tubes serving as resonance tubes are dimensioned such that the frequency of the periodic ignitions of the combustible mixture in the explosion chamber corresponds with the natural frequency of the gas mass in these tubes and the explosion chamber.

Due to the inertia of the gases flowing in the discharge tube there results an underpressure in the explosion chamber after combustion, whereby on the one side fuel and air are drawn in and on the other side hot combustion gases flow back to the explosion chamber which ignite the combustible mixture that has flowed in. A cyclic process hereby results which pulsates with a frequency substantially dependent on the dimensions of the explosion chamber, the supply and discharge tubes and the nature of the fuel.

Such devices are employed for heating, drying, concentration by evaporation, driving gas turbines, etc. and have the advantage of a high heat transfer coefficient, whereby the device can take a compact form while a practically complete combustion is obtained at an air factor 1 with almost no emission of CO and very little formation of NO_x.

In non-damped embodiments the explosion of the fuel produces a great deal of noise (between 90 and 140 db(A)), which produces a nuisance for the surrounding area.

The invention has for its object to provide a burner for pulsating combustion which produces considerably less noise than the known devices.

According to the invention this object is achieved by providing the explosion chamber with a widening on the outlet side and connecting the discharge tube(s) to this widening at or close to the periphery thereof. In this widening, which preferably extends perpendicularly of the centre line of the explosion chamber, explosion waves are reflected back and forth between the walls of this widening whereby the noise emission is markedly decreased.

The widening preferably has a shape such that the sound waves of successive explosions are shifted a half phase or an odd number of half phases relative to each other. The explosion noise is hereby suppressed by antinoise in counter phase. Use of the invention results in a noise reduction of 15 to 20 db(A).

Further advantages of the invention lie in the enlargement of the heat transfer surface in the high temperature zone, whereby less heating surface can suffice and it is possible to embody the outlet tubes shorter than in the known constructions without this widening.

The invention is further elucidated with reference to the embodiments shown in the drawings, wherein:

figure 1 shows a longitudinal section of a boiler for heating liquid, which is provided with a burner according to the invention;

figure 2 shows a longitudinal section through a boiler wherein the outlet tubes of the burner form part of the widening and the device is further provided with inspection windows for observing the explosive combustion that occurs;

figure 3 shows a cut away perspective view of a further embodiment of the boiler according to the invention;

figure 4 shows a burner head in cross section; and

figure 5 shows another embodiment of a burner head in cross section.

For the sake of clarity functionally equivalent components are designated as far as possible in all the figures with the same reference numerals.

The boilers 17 and 18 respectively shown in figures 1 and 2 contain an explosion chamber 1 which forms part of an air feed tube 2 but is separated therefrom by a burner head

3. Situated in the air feed tube 2 is a schematically depicted check valve section 4. The air feed tube 2 communicates with an air chamber 5 into which combustion air is supplied via an opening 6. Fuel is supplied to the explosion chamber via a tube 7 arranged centrally in the air feed tube 2. The tube 7 is connected to a fuel supply not shown in the drawing. The explosion chamber 1 is provided on the outlet side with a widening 8 which extends substantially perpendicularly of the centre line of the explosion chamber, so that the explosion chamber 1, 8 is mushroom-shaped. The widening is connected close to the outer periphery onto four discharge tubes 10.

The combustion takes place in the explosion chamber 1 and the widening 8 from which the combustion gases flow via the widening 8 and the discharge tubes 10, which extend helically in a liquid jacket 11, to a decoupling chamber 12.

The decoupling chamber 12 has the function of acoustically decoupling the resonance system 1, 8 from any other tubes (outlet systems and the like) that may be coupled to the device. Any condensate that may have been carried along can be drawn off in the decoupling chamber 12. The combustion gases then pass to the outside via flue discharge tube 13. The liquid for heating 11 flows inside via an opening 14 in the liquid jacket 11 and leaves this at the top via an opening 15.

In the embodiment 17 drawn in figure 1 the widening 8 is lens-shaped. The shape of the widening 8 can however be chosen at random within certain margins. The diameter of the widening 8 is so large that the sound wave returning after the collision with the peripheral wall is shifted a half phase or a number of odd half phases relative to the wave front of the explosion wave.

The diameter/height ratio of the widening 8 is further preferably such that the sound waves reflect back and forth between the walls of the widening. A part of the sound energy is hereby absorbed.

With use of the adjustable burner chamber as described in the Netherlands patent application NL-A-89 01416 of applicant the frequency can be adapted in simple manner

whereby the sound waves of successive explosions can be shifted a half phase or an odd number of half phases relative to each other in simple manner without constructional operations being necessary.

In the embodiment drawn in figure 2 the widening 8 has a box-like form and the discharge tubes 10 are formed integrally with the widening 8. Inspection windows 16 are further arranged in the wall of the widening 8 and of the liquid jacket 11 for observing the combustion.

This is possible because the discharge tubes 10 connect to the explosion chamber 1 on the peripheral edge of the widening 8.

Figure 3 shows a boiler 19. The technical embodiment is substantially the same as that of the boiler 17 according to figure 1. It will be apparent that this boiler 19 comprises four discharge tubes 10 which are positioned helically in interleaving relationship with small clearance. This ensures a large heat exchanging surface in the liquid jacket 11.

Figures 4 and 5 show burner heads 20 and 21 respectively.

Gas-form fuel is supplied via a gas feed tube 22. This connects to a cylinder casing-like buffer space 23 which is communicates via an annular arrangement of openings 24 with a central tube 25 in which is situated a check valve section 26. This latter prevents flow-back of gas or combustion gases as a result of the combustion occurring in the explosion chamber.

Via the check valve section 4 combustion air can enter a mixing chamber 27 which is provided for this purpose with an annular arrangement of air supply openings. In the embodiment according to figure 4 the openings 28 are placed on the underside of the mixing chamber 27, while in the embodiment according to figure 5 they are arranged higher. The fuel is admitted into the mixing chamber 27 via the respective fuel supply openings 30 (figure 4) and 31 (figure 5).

A spark plug 32 receiving voltage from an external connection 33 is situated in the mixing chamber 27 for initiating the combustion.

The burner heads 20, 21 are sealingly received in the air feed tube 2 shown in figure 1 and are provided therefor with a sealing ring 34.

Attention is drawn to the fact that the noise reduction to be achieved with the invention greatly depends on the dimensioning of the boiler.

The burner heads according to figures 4 and 5 are very easily replaceable. This is of great importance, since due to the nature of the boilers according to the invention repairs have to be carried out by specialized personnel.

The structure according to the invention offers a very considerable noise reduction due to the decoupling chamber 12 and the flue discharge tube 13 (see figure 1), which together can form a suitable resonance system which is tuned such that an additional noise reduction is also obtained. The air chamber 5 moreover also contributes as intake buffer to a reduction in the noise production.

If desired, use can also be made of per se known acoustic damping material.

In a manner per se known for instance from motor technique, use could also be made of exhaust damping systems which can be based on noise suppression by destructive interference, damping using acoustic damping material or combinations thereof.

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CLAIMS

1. Burner for pulsating combustion with an explosion chamber which on the inlet side connects onto a supply tube for combustion air and a supply tube for fuel and on the outlet side is connected to at least one discharge tube for combustion gases, **characterized in that** the explosion chamber is provided on the outlet side with a widening and the or each discharge tube is connected onto this widening on or close to the periphery thereof.

2. Burner as claimed in claim 1, **characterized in that** the widening has a form such that the sound waves of successive explosions are shifted a half phase or an odd number of half phases relative to each other.

3. Burner as claimed in claim 1, **characterized in that** the widening extends substantially perpendicularly of the centre line of the explosion chamber.

4. Burner as claimed in claim 1, **characterized in that** the or each discharge tube is formed integrally with the widening of the explosion chamber.

5. Burner as claimed in claim 1, **characterized in that** an inspection window is arranged in the end wall of the widening.

6. Burner as claimed in claim 1, **characterized in that** the discharge of combustion gases takes place via a decoupling space.

7. Burner as claimed in claim 1, **characterized in that** the intake of combustion air takes place via a decoupling space.

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FIG.1

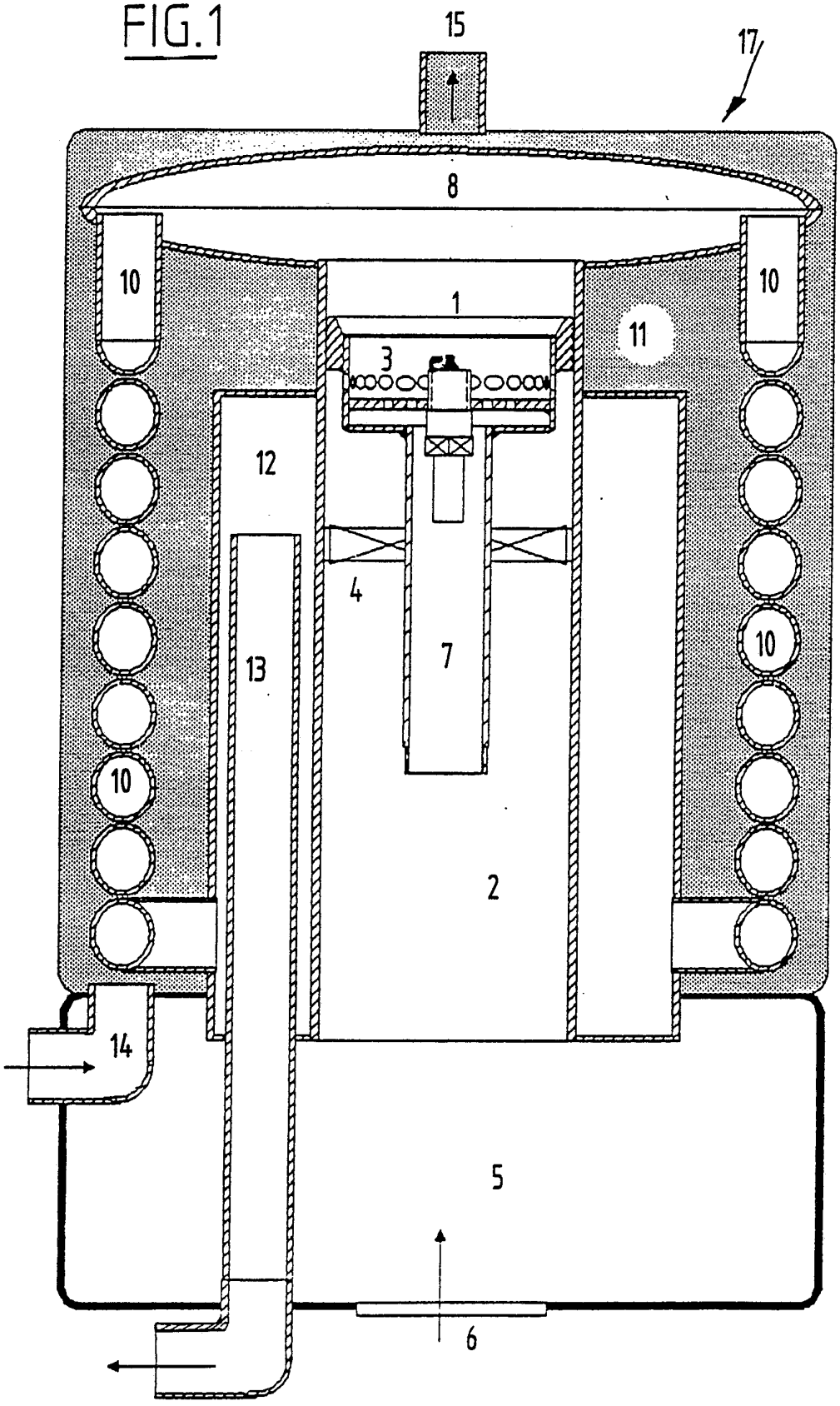

FIG.2

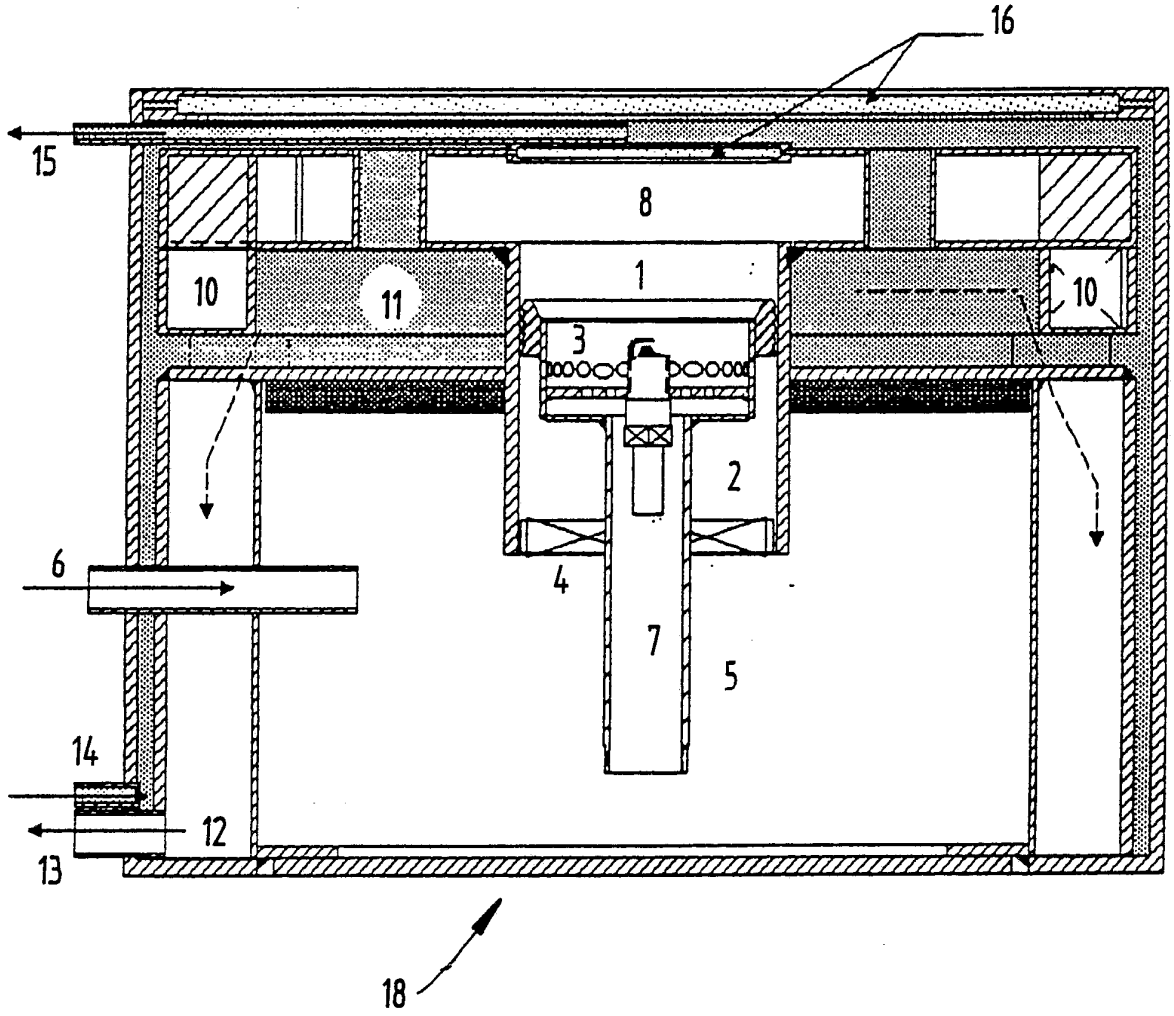

FIG.3

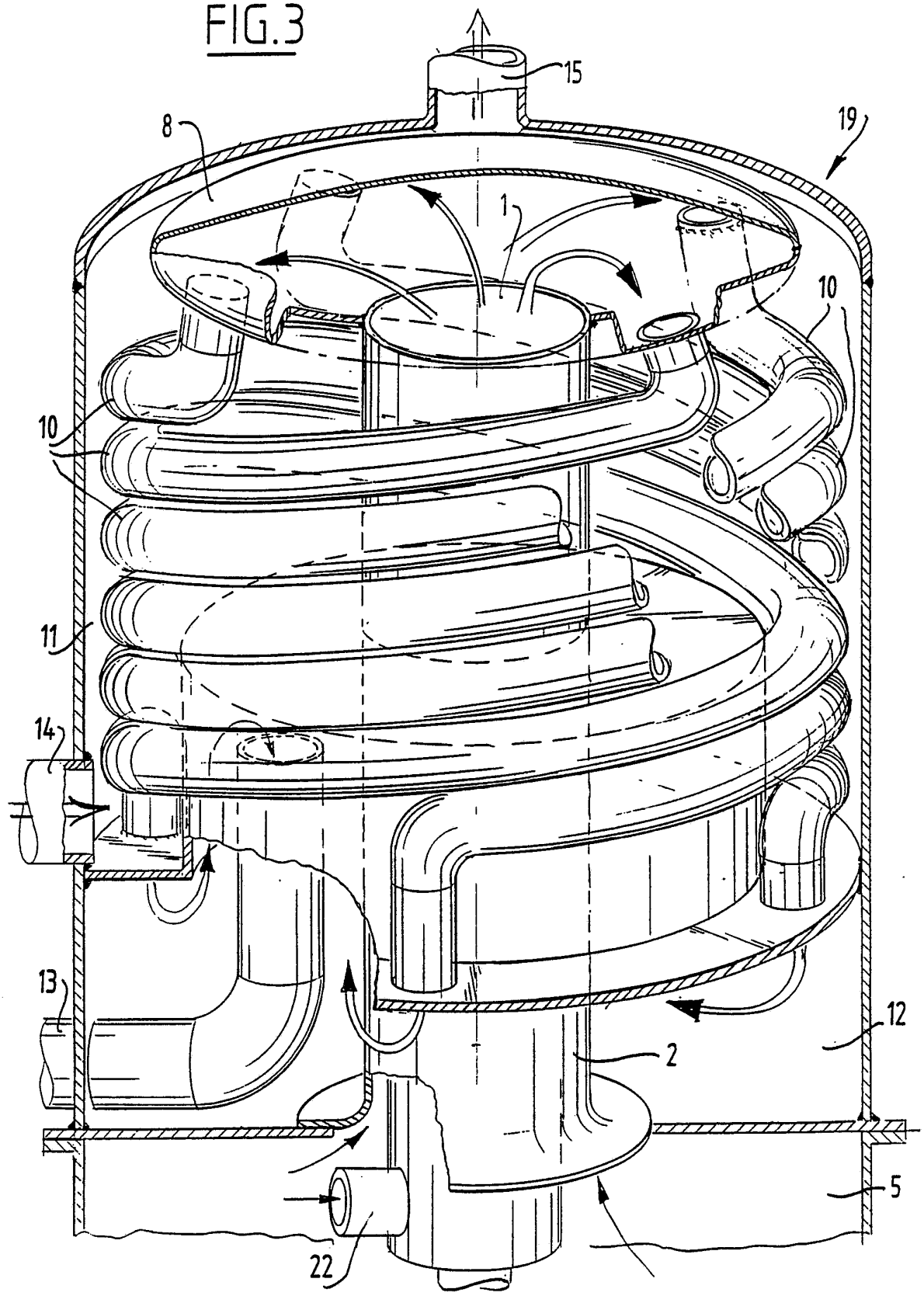

FIG.4

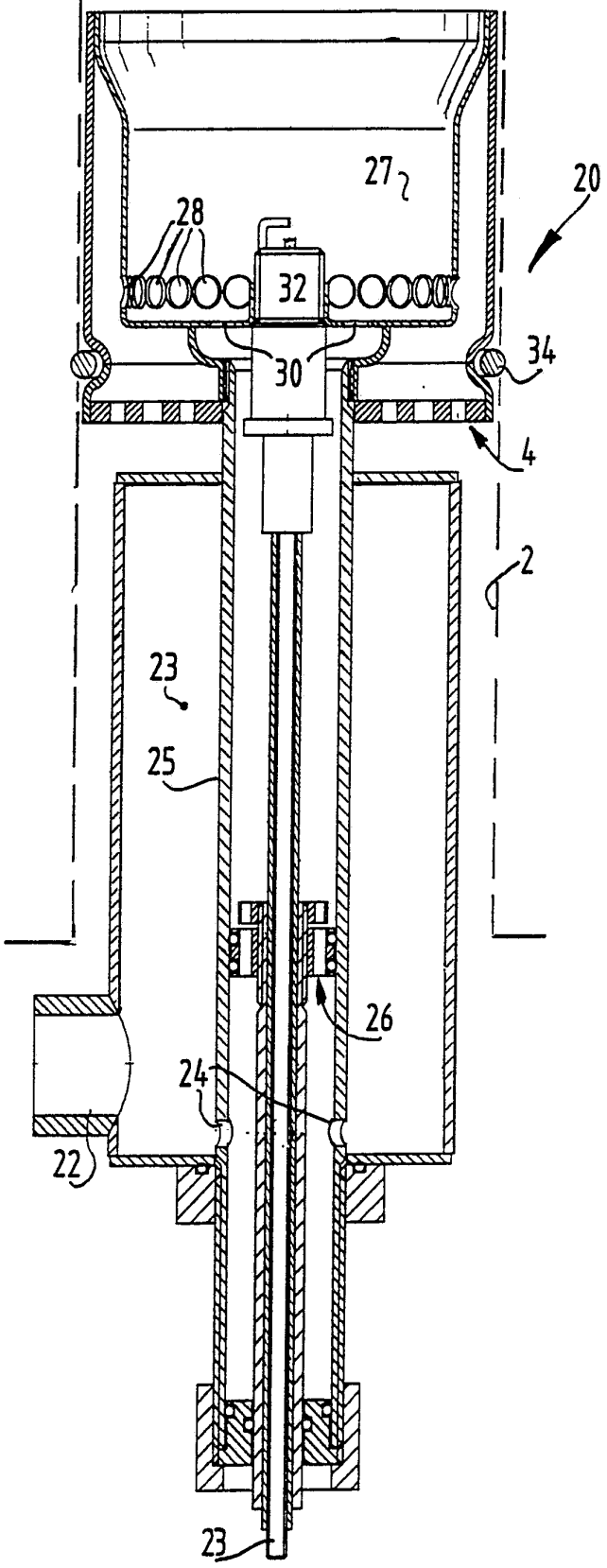
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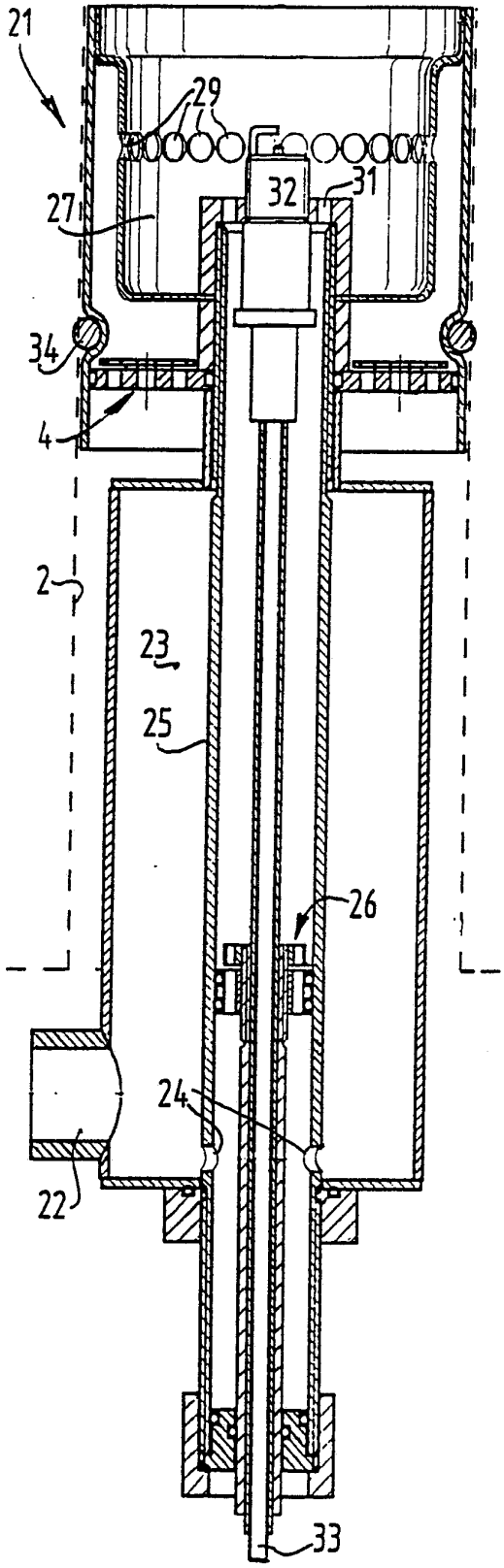
FIG.5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INTERNATIONAL SEARCH REPORT

International Application No PCT/NL 91/00231

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 F23C11/04; F23M13/00; F24H1/28

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	F23C ; F23M ; F23R ; F24H

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	US,A,4 568 264 (MULLEN) 4 February 1986 * see column 1, lines 24 - 36, 53 - 60 * * see column 2, lines 12 - 17, 30 - 38 * * see column 3, lines 4 - 36, 55 - 65 * * see column 5, lines 49 - 52 ; figures 2,5 *	1,6,7
A	GB,A,757 852 (MOTAN) 26 September 1956	
A	US,A,4 919 085 (ISHIGURO) 24 April 1990	
A	FR,A,2 404 811 (MOTAN) 27 April 1979	
A	GB,A,1 292 605 (YGNIS) 11 October 1972	

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
20 FEBRUARY 1992	20. 03. 92
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	PHOA Y.E.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. NL 9100231 SA 53741

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
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GB-A-757852		None		
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