

(19)



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11)

EP 0 779 415 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
23.05.2001 Bulletin 2001/21

(51) Int Cl. 7: **F01N 1/02, F01N 3/20**

(21) Application number: **96850186.6**

(22) Date of filing: **06.11.1996**

(54) Reactor chamber for catalytic cleaning of combustion exhausts

Reaktionskammer für die katalytische Reinigung von Verbrennungsgasen

Chambre de réaction pour le nettoyage catalytique d'échappements de combustion

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI NL PT SE

(30) Priority: **11.12.1995 SE 9504439**

(43) Date of publication of application:
18.06.1997 Bulletin 1997/25

(73) Proprietor: **ABB FLÄKT AKTIEBOLAG
120 86 Stockholm (SE)**

(72) Inventors:
• **Götmalm, Örjan
430 41 Kullavik (SE)**

• **Holmström, Per
426 79 Västra Frölunda (SE)**

(74) Representative: **Roth, Ernst Adolf Michael et al
GÖTEBORGS PATENTBYRA DAHLS
Sjöporten 4
417 64 Göteborg (SE)**

(56) References cited:

EP-A- 0 158 625	EP-A- 0 615 777
DE-A- 1 476 629	DE-A- 4 327 562
US-A- 3 348 629	US-A- 3 495 680
US-A- 3 648 803	US-A- 3 780 826
US-A- 5 321 215	US-A- 5 355 973

EP 0 779 415 B1

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description**FIELD OF THE INVENTION**

[0001] The present invention refers to an exhaust conduit for cleaning exhausts of a Diesel engine in a vessel, including a system for injection of a reagent into the combustion exhausts of the engine, at least one reactor chamber for catalytic cleaning of said exhausts, and at least one reactive silencer in communication with said exhaust conduit.

BACKGROUND OF THE INVENTION

[0002] When installing a reactor chamber according to above in a vessel, usually accommodations must be made in order to clear the limited amount of available installation space. It is known that a catalytic reactor having a number of layers of ceramic honeycomb monolith blocks, display good sound absorbing properties, especially with regard to high frequency sound. Thus, it is sometimes possible to dismount the conventional silencer from the funnel shaft and replace it with a reactor chamber. However, you risk the creation of interference within the exhaust system, for certain installation applications and for certain operational conditions, so that certain sound frequencies are increased instead of dampened. Thus, sound damping requirements result in that an additional damper perhaps nevertheless has to be installed.

[0003] An exhaust conduit of the type described in the introductory part above is known from EP 0 617 777A.

[0004] This publication discloses an apparatus for damping noise at an exhaust conduit belonging to a Diesel engine, which conduit comprises a system for injection of a reagent into the combustion exhausts of the engine, at least one reactor chamber for catalytic cleaning of said exhausts, and at least one reactive silencer in communication with said exhaust conduit, whereby the silencer comprises at least one resonance chamber which is arranged concentric to a straight segment of the exhaust conduit and which is connected to said said channel via at least one opening.

[0005] It is known to use a reactive silencer in the form of a quarter wave resonator, a so called Helmholtz resonator, in exhaust systems in order to dampen a certain low frequency noise, e.g. within the range of 35-150 Hz. A conventionally designed quarter wave resonator is however comparatively space consuming and involve a clear risk for collection of soot particles which may cause fire in the exhaust system and a gradual deterioration of the function of the resonator.

[0006] An other type of reactive silencer is known from DE 14 76629A.

This publication discloses an apparatus for damping noise at an exhaust conduit, which conduit comprises at least one reactive silencer in communication with said exhaust conduit, whereby the silencer comprises at

least one resonance chamber which is arranged concentric to a straight segment of the exhaust conduit and which is connected to the straight segment via at least one opening.

5

THE TECHNICAL PROBLEM

[0007] The object of the present invention is therefore to provide an apparatus for sound damping which does not exhibit the above mentioned drawbacks, and which is simple to integrate into an exhaust system comprising a catalytic reactor.

THE SOLUTION

15

[0008] For this object the invention is characterized in that the length of said silencer being acoustically adapted to the wave length of the sound waves which are going to be damped within a specific frequency range, the silencer comprises at least one resonance chamber which is arranged concentric to a straight segment of the exhaust conduit and which is connected to said exhaust conduit via at least one opening, and that the at least one opening is located upstream to the reactor chamber.

25

[0009] Preferably, the opening is located so that it continually drains occurring soot particles into the exhaust conduit. Alternatively, the opening may be provided with an acoustically permeable filter which prevents soot particles from entering the resonance chamber.

[0010] According to a preferable embodiment of the invention, the resonance chamber is located upstream the reactor chamber. This makes it possible to integrate the resonance chamber, e.g. by means of a gasification unit for injection of the reagent, or a reagent mixer unit.

[0011] Suitably, the radially inner wall of the resonance chamber is formed by the outer wall of the exhaust conduit. This wall may be provided with a channel segment which diverges conically downstream, said segment opening out into the reactor chamber and causing a reduction in the pressure drop through the reactor.

[0012] Two or more resonance chambers may be coaxially located around the straight segment with different lengths that are acoustically adapted to the wave length of the sound waves which are going to be damped within different specific frequency ranges.

DESCRIPTION OF THE DRAWINGS

50

[0013] The invention will be described hereinafter with reference to embodiments that are shown in the enclosed drawings, wherein

55

Fig. 1 schematically shows a Diesel engine with an exhaust system equipped with a silencer apparatus according to the invention,
Fig. 2 shows in a larger scale a section through a

- silencer apparatus according to the invention, along the line II-II in Fig. 3,
Fig. 3 shows a section along the line III-III in Fig. 2
Fig. 4 shows in a corresponding way as Fig. 2 a second embodiment of the silencer apparatus according to the invention,
Fig. 5 schematically shows a gasification unit with a silencer apparatus according to a third embodiment of the invention, and
Fig. 6 schematically shows a reactor chamber with a silencer apparatus according to a fourth embodiment of the invention.

DESCRIPTION OF EMBODIMENTS

[0014] In the description, the expression "concentrically arranged" is used in order to illustrate the location of the silencer apparatus with reference to the exhaust conduit and the components included in the exhaust conduit: gasification unit, mixer unit and reactor chamber. The expression "concentric" also include other sections than circular, e.g. quadratic and triangular.

[0015] The installation diagrammatically shown in Fig. 1 comprises a Diesel engine 10 with an exhaust conduit 11 which is connected to a gasification unit 12 for injection and gasification of urea or some other reagent into the exhausts of the engine. The exhausts are conducted from the gasification unit via a first mixer unit 13 and a second mixer unit 14 which mixer units are arranged for providing an even distribution of the reagent in the exhausts.

[0016] The mixer unit 14 is connected to a reactor chamber 15 which according to prior art is provided with internal support surfaces for not shown honeycomb monoliths of a ceramic material, which contribute to reduce for example contents of nitric oxide in the exhausts. An outlet 16 from the reactor chamber 15 lead directly out into the atmosphere.

[0017] As is illustrated by Fig. 2 and 3, the mixer unit 14 is built into a straight segment 17 of the pipe of the exhaust conduit which is provided with a number of openings 18 opening out into an otherwise closed resonance chamber 19 which is arranged concentrically to the straight segment 17. The resonance chamber 19 forms by means of its outer walls 20 a reactive silencer the length of which is acoustically adapted to the wavelength of those sound waves which are going to be damped within a specific frequency range, e.g. 50-150 Hz. The relations between the section areas for the resonance chamber 19 and the straight segment 17 determines the capacity for damping sound.

[0018] The openings 18 are located at the same level as the bottom edge of the resonance chamber 19, so that they are able to drain occurring soot particles being transported by the exhaust stream, back into the straight segment 17. By adapting the height of the openings, the silencer frequency range may be broadened or concentrated.

[0019] Because the resonance chamber encloses the mixer unit 14, the chamber does not lead to any actual lengthening of the exhaust system of the engine 10.

[0020] Because the radially inner wall of the resonance chamber is the same as the outer wall 17 of the exhaust conduit, the gas in the resonance chamber will have substantially the same temperature as the gas stream in the exhaust conduit, which is acoustically advantageous. Besides, the design leads to a low level of material stress resulting from thermal expansion.

[0021] Each honeycomb monolith is provided with a stocking 13 which extends along the vertical sides and forms a seal against the adjacent blocks and the side walls 10.

[0022] Tests have proven that a silencer designed according to Fig. 2 and 3 provide a dampening of about 10-20 dB(A) at a flow speed of 25-40 m/sec and a temperature range of 150-500 C°.

[0023] The exhaust conduit 17 displays a segment 17' which diverges in the direction of flow, which segment opens out into the reactor chamber and provides a reduction of the pressure fall through the reactor chamber.

[0024] Fig. 4 shows an embodiment of the invention where a further resonance chamber 21 is coaxially arranged around the exhaust conduit 17 inside the resonance chamber 19, and communicates acoustically with the exhaust conduit 17 via openings 22 being located downstream the openings 18. These openings 22 are also located so that they drain soot particles back to the conduit 17. The resonance chamber 21 display a shorter length than the resonance chamber 19 and is in that way acoustically adapted to wave lengths of sound waves which are to be damped within another specific frequency range than that which the resonance chamber 19 is designed for.

[0025] Fig. 5 shows a gasification unit 12 with spray nozzle 23 which is equipped with two in series located resonance chambers 19, 21, essentially displaying the same sectional area and length. Because the height of the openings 18 of the resonance chamber 19, as seen in the direction of flow, are larger than the hight of the openings 22 of the resonance chamber 21, the two resonance chambers 19, 21 may dampen sound within different ranges of frequency.

[0026] Fig. 6 shows a reactor chamber 15 having four outer walls together forming a rectangular chamber section. The reactor chamber comprises three levels of honeycomb monolith blocks 24. Every one of the outer walls of the reactor chamber is so designed that it forms a resonance chamber 19 which is connected via openings 18 to the exhaust channel 11, which openings are located upstream the actual reactor chamber. Because the individual resonance chambers 19 are identically designed, they may work together as a single large resonance chamber. This means that the resonance chambers may be made very small, so that they do not add to the dimensions of the reactor chamber appreciably. Also, the resonance chambers 19 have an insulating ef-

fect around the reactor chamber, so that the heat radiation to the environment may be reduced. Because of this effect, the dimensions of the normal thermal insulation 25 of the reactor chamber may be reduced, which also contributes to reducing the outer dimensions of the reactor chamber. One of the four wall elements of the reactor chamber is preferably dismountable, so that the honeycomb monolith blocks 24 may be exchanged.

[0027] By means of the apparatus according to the invention, a silencer unit is provided which to a large extent facilitate installation of a plant catalytic reduction of the exhausts from a Diesel engine, in particular within the limited amounts of space which prevail within a vessel.

[0028] The invention is not limited to the above described embodiment. For example, the resonance chamber may be located at another segment of the exhaust system than shown, e.g. centrally around the gasification unit 12. It is possible to provide the apparatus according to the invention with more than two resonance chambers.

Claims

1. An exhaust conduit (11) for cleaning exhausts of a Diesel engine in a vessel, including a system (23, 12) for injection of a reagent into the combustion exhausts of the engine, at least one reactor chamber (15) for catalytic cleaning of said exhausts, and at least one reactive silencer (19-20/21; 22) in communication with said exhaust conduit, **characterized** in that the length of said silencer (19-20; 21; 22) being acoustically adapted to the wave length of the sound waves which are going to be damped within a specific frequency range, the silencer (19-20; 21, 22) comprises at least one resonance chamber (19; 21) which is arranged concentric to a straight segment (17) of the exhaust conduit (11) and which is connected to said exhaust conduit (11) via at least one opening (18; 22), and that the at least one opening is located upstream to the reactor chamber.
2. Exhaust conduit according to claim 1, **characterized** in that a second straight segment of the exhaust conduit (11) is enclosed by a second resonance chamber (19) and that the system for injection of the reagent is a gasification unit (12).
3. Exhaust conduit according to claim 1, **characterized** in that the opening (18; 22) is located so that it continually drains occurring soot particles into the exhaust conduit (11).
4. Exhaust conduit according to claim 1, **characterized** in that the straight segment of the exhaust conduit (11) which is enclosed by the res-

onance chamber (19) comprises a reagent mixer unit (14).

5. Exhaust conduit according to any one of the preceding claims, **characterized** in that the straight segment (17) of the firstmentioned resonance chamber (19) is provided with a channel segment (17') which diverges conically downstream, said segment opening out into the reactor chamber (15).
6. Exhaust conduit according to claim 5, **characterized** in that the straight segment of the resonance chamber (19) is formed by the outer wall (17) of the exhaust conduit.
7. Exhaust conduit according to claim 1, **characterized** in that two or more resonance chambers (19, 21) are coaxially located around the straight segment (17) and having different lengths and being acoustically adapted to the wave length of the sound waves which are going to be damped within different specific frequency ranges.
8. Exhaust conduit according to claim 1, **characterized** in that the opening (18, 22) is provided with an acoustically permeable filter.

Patentansprüche

- 30 1. Abgasleitung (11) für das Reinigen von Abgasen eines Dieselmotors in einem Hohlgefäß, einschließend ein System (23; 12) für das Einspritzen eines Reagens in die Verbrennungsabgase des Motors, zumindest einen Reaktionsraum (15) für das katalytische Reinigen der Abgase und zumindest einen Reaktionsschalldämpfer (19-20; 21; 22), der mit der Abgasleitung in Verbindung steht, **dadurch gekennzeichnet**, daß die Länge des Schalldämpfers (19-20; 21; 22) schalltechnisch der Wellenlänge der Schallwellen angepaßt ist, die innerhalb eines bestimmten Frequenzbereiches gedämpft werden sollen, der Schalldämpfer (19-20; 21; 22) zumindest einen Resonanzraum (19, 21) umfaßt, der konzentrisch zu einem geraden Abschnitt (17) der Abgasleitung (11) angeordnet ist und mit der Abgasleitung (11) über zumindest eine Öffnung (18; 22) verbunden ist, und daß die zumindest eine Öffnung oberhalb des Reaktionsraumes angeordnet ist.
- 40 2. Abgasleitung nach Anspruch 1, **dadurch gekennzeichnet**, daß ein zweiter gerader Abschnitt der Abgasleitung (11) von einem zweiten Resonanzraum (19) umschlossen wird und daß das System für das Einspritzen des Reagens eine Vergasungseinheit (12) ist.
- 50
- 55

3. Abgasleitung nach Anspruch 1,
dadurch gekennzeichnet, daß die Öffnung (18; 22) so angeordnet ist, daß sie anfallende Rußpartikel fortlaufend in die Abgasleitung (11) ableitet.
4. Abgasleitung nach Anspruch 1,
dadurch gekennzeichnet, daß der gerade Abschnitt der Abgasleitung (11), der von dem Resonanzraum (19) umschlossen wird, eine Reagensmixereinheit (14) umfaßt.
5. Abgasleitung nach einem der vorhergehenden Ansprüche,
dadurch gekennzeichnet, daß der gerade Abschnitt (17) des erstgenannten Resonanzraumes (19) mit einem Kanalabschnitt (17') versehen ist, der sich nach unten konisch erweitert, wobei der Abschnitt in den Reaktionsraum (15) mündet.
6. Abgasleitung nach Anspruch 5,
dadurch gekennzeichnet, daß der gerade Abschnitt des Resonanzraumes (19) von der Außenwand (17) der Abgasleitung gebildet wird.
7. Abgasleitung nach Anspruch 1,
dadurch gekennzeichnet, daß zwei oder mehr Resonanzräume (19,21) koaxial um den geraden Abschnitt (17) herum angeordnet sind und verschiedene Längen aufweisen und schalltechnisch der Wellenlänge der Schallwellen angepaßt sind, die innerhalb verschiedener bestimmter Frequenzbereiche gedämpft werden sollen.
8. Abgasleitung nach Anspruch 1,
dadurch gekennzeichnet, daß die Öffnung (18, 22) mit einem schalldurchlässigen Filter versehen ist.

Revendications

1. Conduite d'échappement (11) pour épurer les gaz d'échappement d'un moteur Diesel sur un navire, comprenant un système (23, 12) pour l'injection d'un réactif dans les gaz de combustion du moteur, au moins une chambre (15) de réacteur pour l'épuration catalytique desdits gaz d'échappement, et au moins un silencieux à réaction (19-20/21 ; 22) en communication avec ladite conduite d'échappement,
caractérisée en ce que, la longueur dudit silencieux (19-20 ; 21 ; 22) étant acoustiquement adaptée à la longueur d'onde des ondes sonores qui vont être amorties dans une gamme de fréquences spécifique, le silencieux (19-20 ; 21, 22) comprend au moins une chambre de résonance (19 ; 21) qui est disposée de manière concentrique par rapport à un segment droit (17) de la conduite

- 5 d'échappement (11) et qui est raccordée à ladite conduite d'échappement (11) par au moins une ouverture (18 ; 22), et **en ce que** ladite au moins une ouverture est située en amont de la chambre de réacteur.
- 10 2. Conduite d'échappement selon la Revendication 1, **caractérisée en ce qu'** un second segment droit de la conduite d'échappement (11) est entouré par une seconde chambre de résonance (19) et **en ce que** le système d'injection du réactif est une unité de gazéification (12).
- 15 3. Conduite d'échappement selon la Revendication 1, **caractérisée en ce que** l'ouverture (18 ; 22) est située de telle sorte qu'elle draine en continu les particules de suie se formant dans la conduite d'échappement (11).
- 20 4. Conduite d'échappement selon la Revendication 1, **caractérisée en ce que** le segment droit de la conduite d'échappement (11) qui est entouré par la chambre de résonance (19) comprend une unité (14) de mélange du réactif.
- 25 5. Conduite d'échappement selon l'une quelconque des Revendications précédentes, **caractérisée en ce que** le segment droit (17) de la première chambre de résonance (19) mentionnée est muni d'un segment de canal (17') qui diverge de manière conique en aval, ledit segment débouchant dans la chambre de réacteur (15).
- 30 6. Conduite d'échappement selon la Revendication 5, **caractérisée en ce que** le segment droit de la chambre de résonance (19) est formé par la paroi extérieure (17) de la conduite d'échappement.
- 35 7. Conduite d'échappement selon la Revendication 1, **caractérisée en ce que** deux chambres de résonance (19, 21) ou plus sont placées de manière coaxiale autour du segment droit (17), qui ont des longueurs différentes et sont acoustiquement adaptées à la longueur d'onde des ondes sonores qui vont être amorties dans des gammes de fréquences spécifiques différentes.
- 40 8. Conduite d'échappement selon la Revendication 1, **caractérisée en ce que** l'ouverture (18, 22) est munie d'un filtre perméable aux sons.
- 45
- 50
- 55

FIG. 1

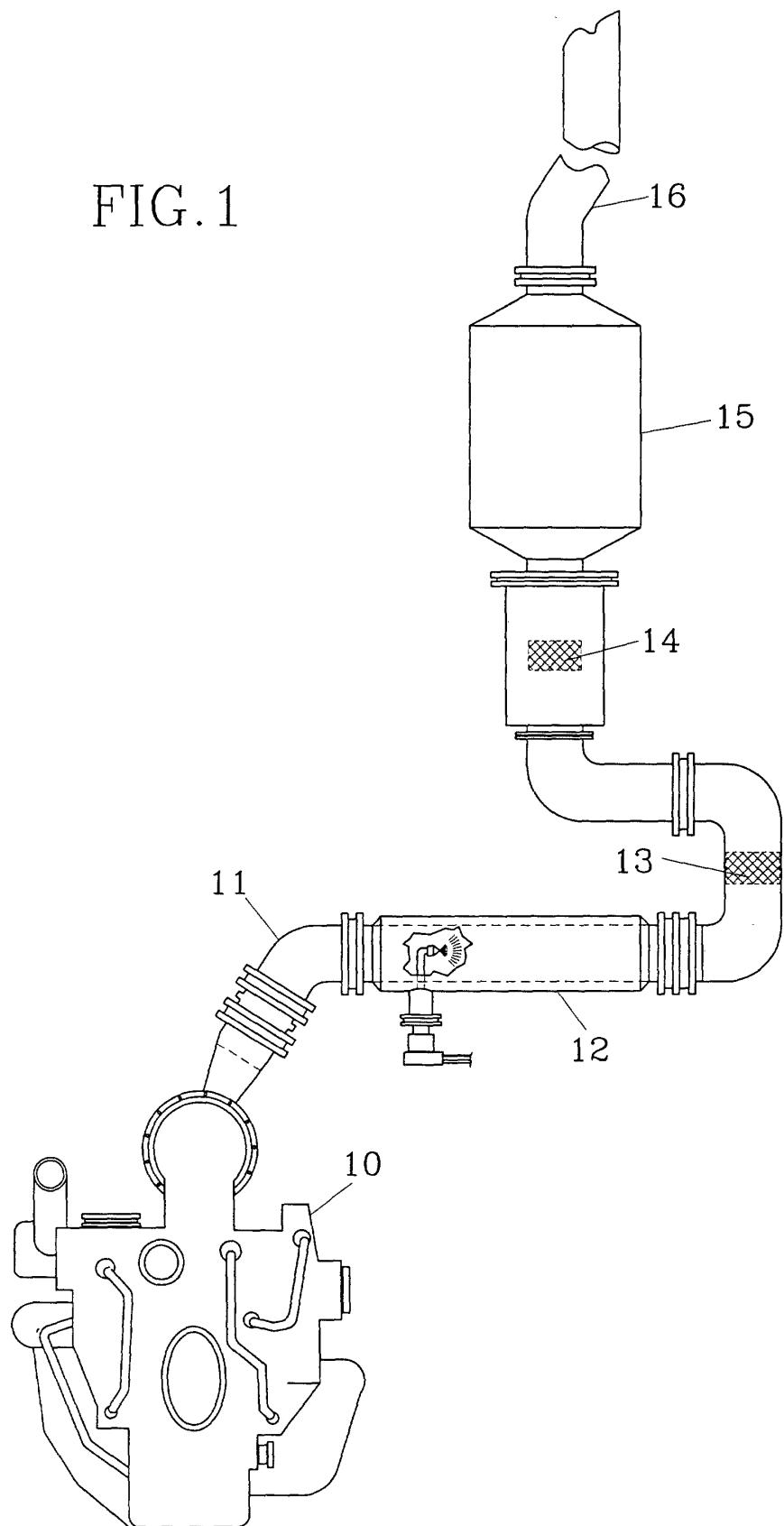


FIG.2

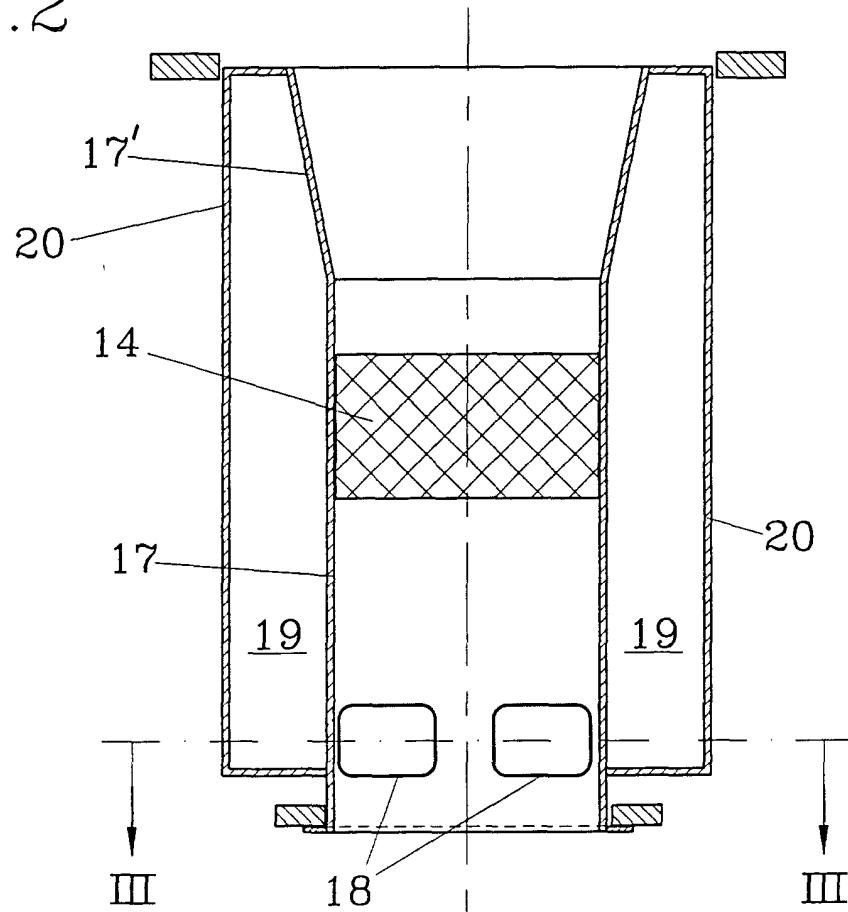


FIG.3

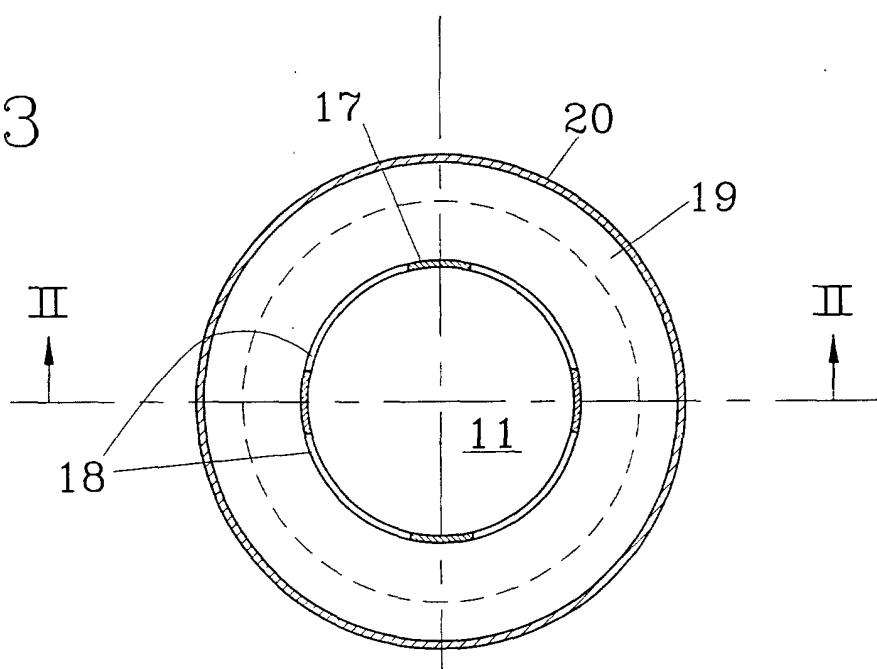
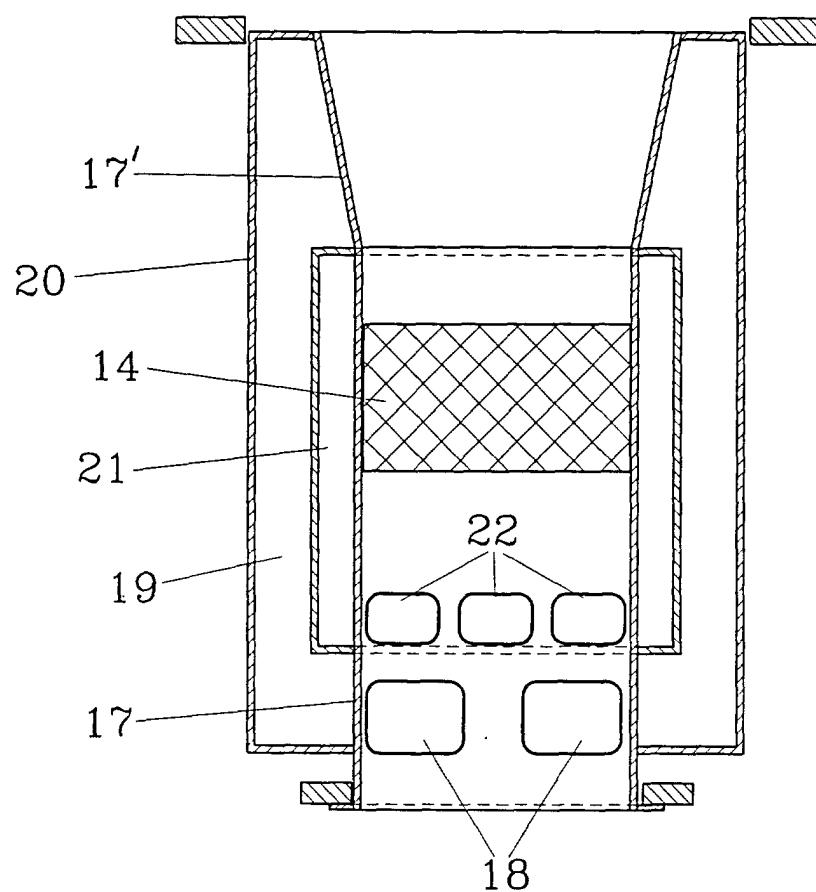


FIG.4



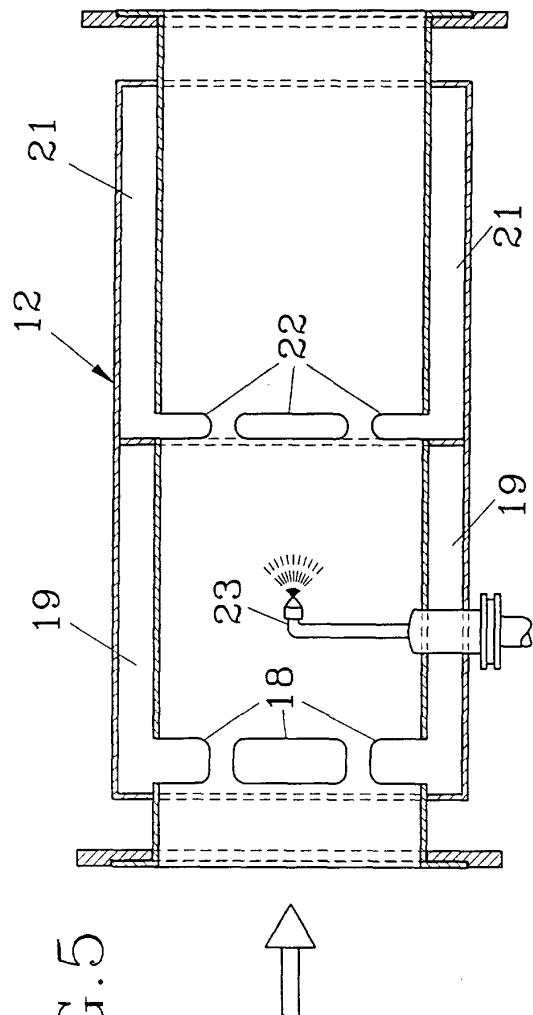


FIG. 5

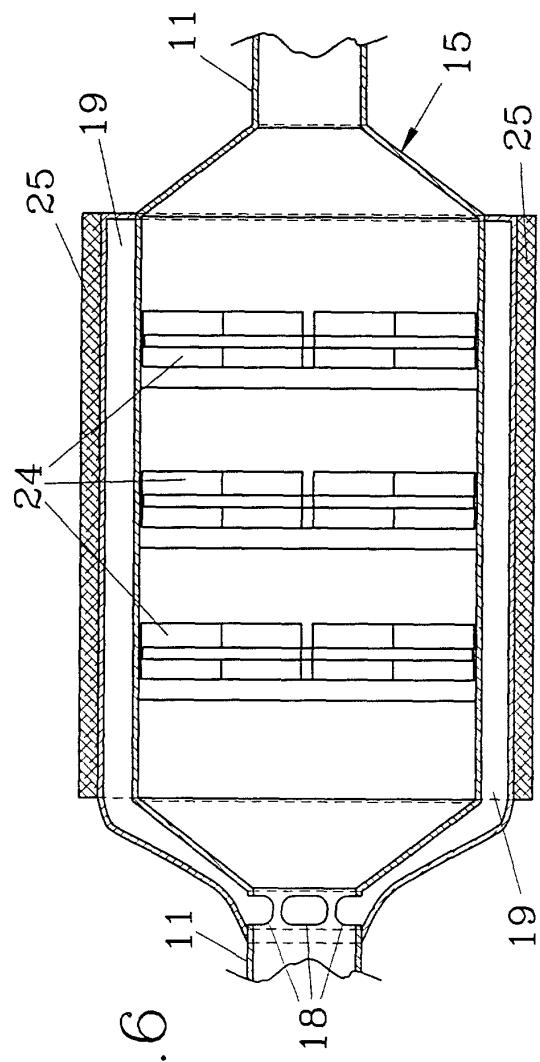


FIG. 6