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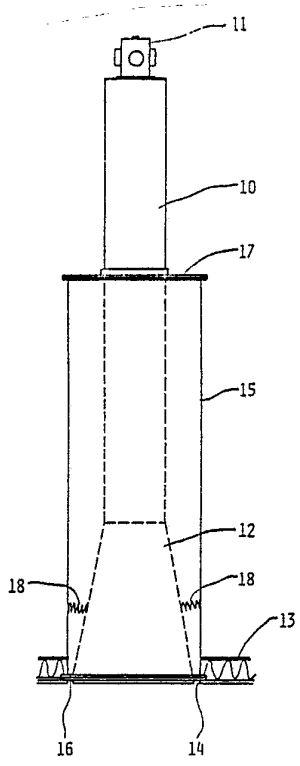
(54) Title: AN ARRANGEMENT IN AN INFRASOUND GENERATOR

(57) Abstract

An arrangement in an infrasound generator with a resonator tube (10) open at one end thereof and having a substantially uniform diameter. At said end the resonator tube is provided with a conical diffuser (12), and the resonator tube is disposed with the opening of the diffuser in an aperture (14) in a wall (13) of a space containing heat exchange surfaces of a boiler installation, in order to communicate with said space at the open end of the tube.



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AN ARRANGEMENT IN AN INFRASOUND GENERATOR

The invention relates to an arrangement in an infrasound generator with a resonator tube open at one end thereof and having a substantially uniform diameter, which communicates at the open end thereof with a space containing heat exchange surfaces of a boiler installation, through an aperture in a wall of said space. Such infrasound generators are used for cleaning the heat exchange surfaces by exposing said surfaces to the influence of infrasound.

When low-frequency sound (infrasound) is used for sooting large industrial boilers and equipment for industrial boilers such as economizers and air preheaters, it has been found that the required acoustic power is of the order of 100 W or more. In the generation of high acoustic power at low frequencies it is always necessary to use some type of resonator. A tube resonator of the quarter-wave type has been found to be particularly suitable. Such a resonator has a length which corresponds to one forth of the wave length of the sound to be generated. When sound of the frequency 20 cps is being generated, the wave length in air of room temperature is 340/20 = 17 m and accordingly the length of the resonator tube then will be about 4 m.

In the opening of the resonator tube, the air movement is at maximum. Deeper in the resonator tube, the amplitude of the air movement decreases. However, the sound pressure is at maximum at the closed end of the resonator tube and decreases with increasing distance from the closed end. The losses in the sound generator to a great extent consist of flow losses at the oscillation of the air at the open end. In order to minimize this loss the open end of the resonator tube should be sufficiently large.

One method of generating high acoustic power is to feed pulses of pressurized air into the closed end of the resonator tube. The power developed by the pulses of pressurized air is determined by the product of the flow of pressurized air and the pressure encountered by the pulses of pressurized air, viz. the sound pressure at the closed end of the resonator tube. The sound pressure in the resonator tube is dependent on the diameter of the resonator tube. At a large diameter at the closed end the sound pressure will be low for which must be compensated by a large flow of pressurized air. At a small diameter the sound pressure will be high. However, in practical constructions, the amplitude of the sound pressure at the closed end must be less than the atmospheric pressure.

In order to obtain optimum conditions the resonator tube accordingly should have different diameters at the open and closed ends, respectively. When acoustic power of the order of 100 W or more is to be generated it has proved suitable to choose a diameter at the open end of the resonator tube of about 0.8 m and a diameter at the closed end of about 0.4 m. This difference in diameters can be obtained by providing a conical resonator tube. However, having conical form the resonator tube must be made longer than a cylindrical tube at the same frequency of the sound to be generated. Moreover, a conical tube is unpractical considering manufacture as well as mounting.

One solution of the problem is to make the resonator tube cylindrical with the diameter which is the optimum diameter considering the conditions at the closed end, and to provide the tube with a diffuser at the open end. A conical diffuser provides a good function and is simple to manufacture. E.g. at a diameter of 0.4 m of the resonator tube, a conical diffuser having the length of

1 m and the opening diameter of 0.8 m is suitable. In some cases it may be desired (due to lack of space) to have a smaller diffuser. However, the conical diffuser should not have a conicity which is too large.

The purpose of the invention is to provide an arrangement in an infrasound generator of the kind referred to above which makes possible to combine with the space containing the heat exchanger surfaces, a resonator tube which by utilization of the diffuser effect described provides optimum conditions as to the generation of sound in the space.

This purpose is achieved by the arrangement having obtained the characteristics according to claim 1.

In order to explain further the invention an embodiment thereof will be described in more detail below with reference to the accompanying drawing in which the figure is a side view of an infrasound generator arranged according to the invention.

The infrasound generator can be of the type which is described in the Swedish patent application No. 7905616-4. The generator comprises a cylindrical resonator tube 10 which is closed at one end thereof and at said end is provided with valve means 11 for the supply of pulses of pressurized air. The resonator tube is provided with a conical diffuser 12 at the other end thereof. The resonator tube and the diffuser are dimensioned for the desired frequency and power as described above.

The sound generator is mounted on a boiler wall 13 which may be a top wall or a side wall, the diffuser 12 being inserted into an aperture 14 in the wall such that the open end of the resonator tube communicates with the interior of the boiler (the furnace) and the opening of the diffuser is substantially flush with the inner surface of the boiler wall.

The sound generator is mounted by means of a cylindrical socket or tunnel 15 which is connected at a flange 16 with the marginal portion of the aperture 14 and projects outwardly from the boiler wall 13. The tunnel has an inner diameter which is sufficiently large to allow the diffuser to be slid therethrough, and thus surrounds the rest of the resonator tube with an annular space between the outside of the resonator tube and the inside of the tunnel. The resonator tube is resiliently suspended in the tunnel by means of an annular diaphragm 17 of steel sheet, which has a thickness of some millimeters and is sealingly mounted at the outer end of the tunnel, the diaphragm being connected at the outer periphery thereof to the tunnel and at the inner periphery thereof to the resonator tube.

The resonator tube and the diaphragm form a resilient system which has a natural frequency that should be considerably higher than the frequency of the sound generator such that a fraction only of the mass forces from the vibrations of the resonator tube is propagated to the boiler via the tunnel.

The diaphragm can take up axial forces only. Springs 18 are mounted between the outside of the diffuser and the inside of the tunnel, said springs being suitably distributed circumferentially, in order to avoid that the cone hits the inside of the tunnel.

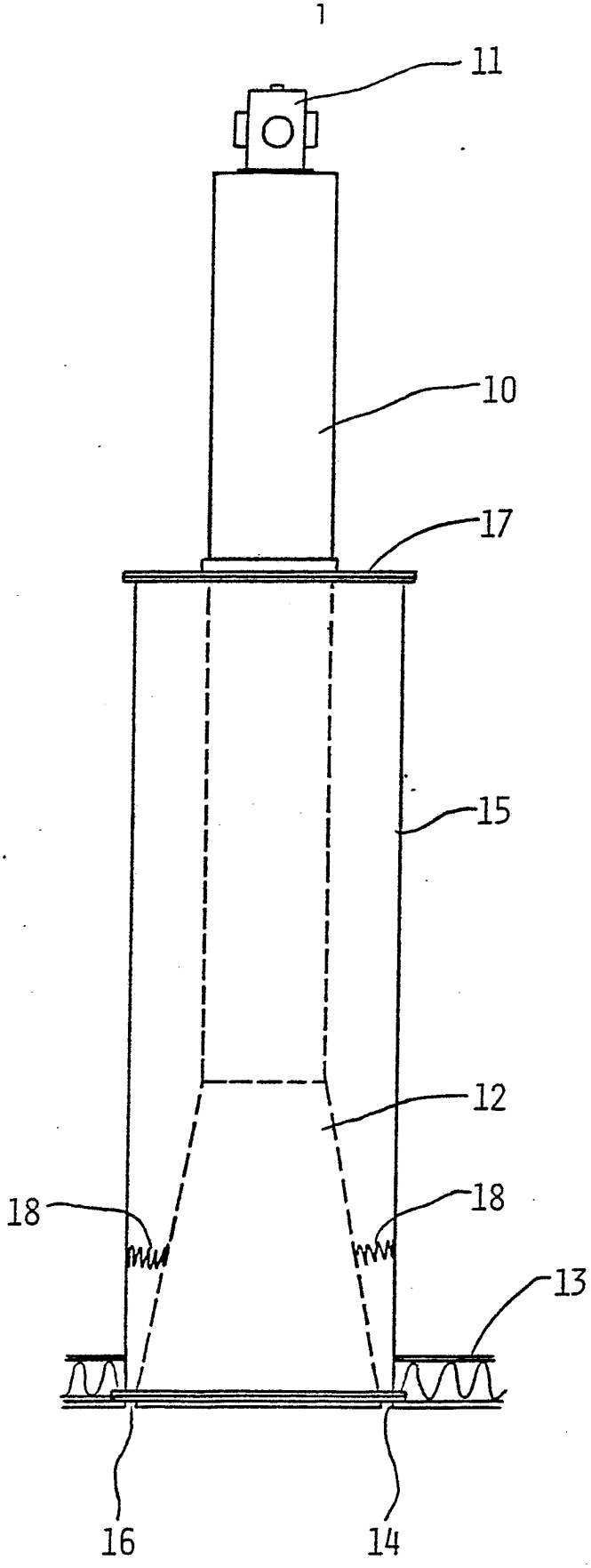
CLAIMS

1. An arrangement in an infrasound generator with a resonator tube (10) open at one end thereof and having a substantially uniform diameter, which communicates at the open end thereof with a space containing heat exchange surfaces of a boiler installation, through an aperture (14) in a wall (13) of said space, c h a r a c t e r i z e d in that the resonator (10) at the open end thereof is provided with a conical diffuser (12) and is disposed with the opening of the diffuser in the aperture (14) in the wall (13), preferably substantially flush with the inside of said wall.

2. An arrangement as claimed in claim 1, c h a r a c t e r i z e d in that the resonator tube by means of an elastic annular element (17) is sealingly mounted to a socket (15) connected with the marginal portion of the aperture (14), which projects outwardly from the wall (13) and surrounds the resonator tube (10) spaced therefrom over at least part of the length of the resonator tube.

3. An arrangement as claimed in claim 2, c h a r a c t e r i z e d in that said element comprises an annular diaphragm (17) which is connected at the inner periphery thereof to the resonator tube (10) and at the outer periphery thereof to the socket (15) at the outer end of the socket.

4. An arrangement as claimed in claim 2 or 3, c h a r a c t e r i z e d in that resilient support members (18) are provided between the diffuser (12) and the socket (15).



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE82/00143

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC [3]

B 06 B 3/00, F.23 J 3/00, H 04 R 1/00

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC 3	B 06 B 1/20,3/00-/04, B 08 B 3/10,5/00-/02,7/00-/02, F 02 M 27/08, F 16 L 5/00-/02, F 23 J 3/00-/02,13/00-/08, F 23 M 7/00-/02, F 28 G 7/00, G 10 K 11/00-/02,11/18,11/26

.../.

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
Y	SE, A, 7905616-4 (MATS OLSSON KONSULT AB) 4 January 1980 see especially page 1, lines 1-14 and page 5, lines 33-34	
Y	Lilla Uppslagsboken, second revised and extended edition from 1964-67, published 1969 by Förlagshuset Nordens Boktryckeri (Malmö, Sweden), Vol 2, col 906 under the headword "Diffusor"	1
Y	DE, B2, 2 822 680 (K TSUKAMOTO) 29 November 1979	1
Y	DE, B2, 2 437 538 (K TSUKAMOTO) 6 May 1976 see especially figure 1 and col. 7, lines 20-25	1
Y	US, A, 1 814 554 (MR HUTCHISON) 14 July 1931 see especially figure 1 and page 1, line 93 - page 2, line 10	1
A	US, A, 1 984 542 (H F OLSON) 18 December 1934	1

.../...

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [1]	Date of Mailing of this International Search Report [2]
1982-07-16	1982 -07- 20
International Searching Authority [1]	Signature of Authorized Officer [20]
Swedish Patent Office	Rune Larsson

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

II Fields Searched (cont)

IPC 3 11/32,13/00, H 04 R 1/00-/02,1/20, 1/28-/38

National Cl 21a^2:14/01,14/02; 74d:3/10,3/11, 6/07-/09

US Cl 116:137; 165:84; 181:0.5, 0.5 AG, ED, J,141,142,148,150-153,159,160,175,177, 179,182,183,192,195,196,198,199

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers ..... because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers ....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

Invention 1: Claim 1

Invention 2: Claims 2-4

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☒ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No [18]
Y	US, A, 1 361 164 (E A LEET) 7 December 1920	
Y	US, A, 1 477 614 (J H WEBER) 18 December 1923	
A	US, A, 1 869 178 (A L THURAS) 26 July 1932 see especially figures 7 and 8	
A	SE, B, 406 970 (IFÖ ELECTRIC LÅGSPÄNNING AB) 5 March 1979	