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(54) Sound generating system.

(57) A sound generating system, suitable among other purposes for keeping boilers and the like free of soot, comprises a sound generator (13), for example a rotary sound generator, which functions by interrupting an air or gas supply at predetermined frequent intervals, at least one resonance tube (18, 19, 20) connected to receive sound pulses produced by the sound generator (13), and, disposed in the connecting line between the sound generator (13) and the or each resonance tube (18, 19, 20), a valve (21, 22, 23) having a straight-through flow passage closable by rotation of a rotary valve member. The system makes it possible to operate several such resonance tubes (18, 19, 20) from a single sound generator (13).

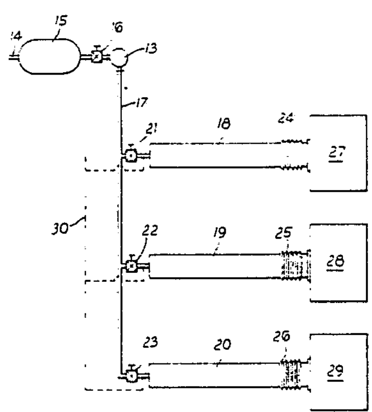

Fig. 1

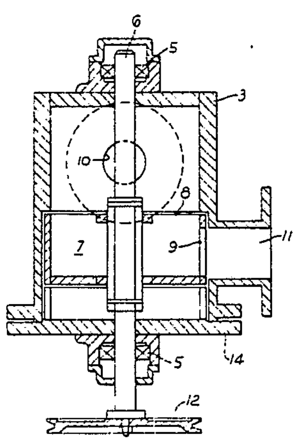

Fig. 2

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SOUND GENERATING SYSTEM

The present invention is concerned with the generating of sound, especially of low-frequency sound, and the use of that sound in a resonator for, among other possible purposes, keeping clean boilers, economisers and other units in which dust and/or soot may otherwise be deposited.

Sound at relatively low frequencies, for example of the order of 20 Hz or much lower, has proved to be very successful in preventing or discouraging the build-up of deposits of dust and/or soot in, for example, the boilers of ships. In a typical installation for this purpose, a rotating member located in a line conveying air (or gas) under pressure interrupts the air flow at regular intervals and thereby generates impulses of low-frequency sound, which are passed to a resonator which is in communication with the boiler or the like to be kept clean. The resonator is typically a tube of which the length is of the order of one quarter of the wavelength of the sound it receives from the sound generator.

A cleaning system of the foregoing type is operated at frequent intervals, say every ten or twenty minutes or so, and it is therefore usual to keep the sound generator and the resonator, and therefore the boiler itself, in permanent communication, both while sound is being generated and throughout the time in between cleaning operations. While the sound generator is operating there is a positive flow of air through the system but in the intervening intervals hot air and also dust may pass back from the boiler to the sound generator, with the risk of damaging or blocking the latter. To counteract this effect, it has been proposed to keep the sound generator operating continuously at a reduced air flow rate. However it is then necessary to keep the bearings of the rotary member cool by, for example, diverting a part of the reduced air flow towards the bearings. This approach to the problem may necessitate designing rotary sound generators which are unduly expensive and of course there is the further disadvantage that running the sound generator continuously gives rise to continuous wear of the moving parts.

It is an object of the present invention to provide a sound generating system, suitable among other purposes for reducing or preventing deposition in boilers and the like, wherein some at least of the disadvantages of prior such systems are reduced or eliminated.

The sound generating system according to the present invention comprises a sound generator, preferably a rotary generator of sound, which functions by interrupting at predetermined frequent intervals a supply of air or gas under pressure, at least on resonance tube connected to receive sound pulses produced by said sound generator, and, disposed in the connecting line between the sound generator and the or each resonance tube, a valve having a straight-through flow passage therein which can be closed by rotation of a rotary valve member.

The sound generator may be any such generator, preferably a rotary generator, which functions by interrupting the air flow therethrough. In such rotary generators one or more apertures in a fixed member may be designed to move into and out of register with one or more apertures in the rotary member as the latter member rotates. The frequency of the sound generated is a function of the relative numbers of fixed and rotary apertures and of the frequency of rotation of the rotary member. The positions of the apertures in the relatively movable members may be such that the air flow is interrupted by a rotating disc as it flows axially through the device or by a rotating cylindrical member as the air flows radially through the latter. A less preferred sound generator is one in which a radial air flow is interrupted by relative axial movement of fixed and movable coaxial cylindrical members.

The resonance tube is a tube suspended so as to be able to vibrate with a minimum of restriction. To a first, closed end of the tube the relatively low-intensity sound pulses from the sound generator are supplied and the other end of the tube is open and is located within, or in direct communication with, the space in which deposition is to be discouraged. Thus, for example, the tube may hang free within a boiler or may be linked with an economiser via a bellows.

The valve is disposed between the sound generator and the resonance tube and, when closed, completely cuts off any flow of air or gas from the sound generator and also prevents any backflow of exhaust or other hot gases from the boiler or the like to the sound generator. It is a feature of the invention that the valve should be of the type wherein the flow through the valve is via a straight-through flow passage therein and that the passage should be closable by rotation of a rotary valve member. Suitable valves meeting these criteria are butterfly valves and ball valves, of which the former are particularly preferred.

Because the rotary valve very effectively prevents hot gases penetrating back to the sound generator, it is not necessary to keep the latter operating continuously nor to provide it with a continuous air flow to cool its bearings. However, in order to protect the rotary valve itself from harm attributable to the hot gases, it is preferred to provide a continuous low-volume flow of air to the downstream side of the rotary valve, that is to that side of the valve which is nearer to the resonance tube.

The type of valve specified in general terms above has the particular advantage that, when the sound generator is in operation and producing sound impulses, the valve allows the pulsed air to pass through without restriction or otherwise distorting the impulses and thus reducing the efficiency of the generated sound.

An important advantage of the sound generating system according to the present invention is that, for what is believed to be the first time in the use of such systems for preventing deposition, it becomes possible to operate two or more resonance tubes from a single sound generator. Thus the invention includes a system wherein two or more resonance tubes are connected to receive sound pulses produced by a single generator, a valve of the above-defined type being included in each of the connecting lines from the sound generator to one of the resonance tubes. This is a major aspect of the invention since sound generating systems of the known type are relatively expensive and it has hitherto been necessary to provide a complete system for each boiler. Using the sound generating system according to the present invention, while the cost of the system for a first boiler may be comparable to the cost of prior systems, the additional cost for second and subsequent boilers may be as little as one third of the cost for the first boiler.

The present system may be used for more than two boilers. Two factors determine the maximum number of boilers to which the system may be applied. Firstly, it is important that the sound generator should not be too distant from any boiler since otherwise any loss of sound intensity between the sound generator and the respective resonance tube may be excessive. It is preferred that the distance apart of the sound generator and any associated resonance tube should not exceed about eight metres. Secondly, since it may be desired to obtain a compressed air supply to the sound generator from a source such as a ship's compressor and it may therefore be necessary to build up the pressure of the supply between cleaning operations, the total desired lapsed time between successive operations of any one resonance tube may limit the number of cleaning operations which can take place. Nonetheless, within the two foregoing constraints, it has proved possible to envisage as many as seven economisers being cleaned at 20-minute intervals with a single sound generating system according to the invention.

The invention will now be further described, by way of example, with reference to the accompanying drawings, wherein:-

Fig. 1 represents schematically one preferred embodiment of the sound generating system according to the present invention, as applied to the cleaning of three economiser units; and

Fig. 2 is an axial sectional view through a sound generator suitable for use in the system of Fig. 1.

Referring firstly to Fig. 2, the illustrated sound generator comprises a generally cylindrical housing 3 closed by an end plate 4. Supported on bearings 5, 5 and within the housing 3 is a shaft 6 to which is secured a generally cylindrical rotor 7. The rotor 7 is open at one end 8 and has in its cylindrical side wall a circular aperture 9. An air inlet 10 is provided in the cylindrical wall of the housing 3 and an air outlet 11, also in the cylindrical wall of the housing 3, is disposed with its axis in a plane at right angles to that of the axis of the inlet 10.

The rotor 7 is aligned with the air outlet 11 such that, in each rotation of the rotor 7, the aperture 9 coincides once with the air outlet 11. Thus air introduced at the air inlet 10 is expelled at the air outlet 11 in pulses at a frequency directly corresponding to the frequency of rotation of the rotor 7.

The shaft 6 is driven by a belt drive (not shown) applied to a pulley 12 and driven by an electric motor (also not shown). If the motor is rotated at, say, 1200 revolutions per minute, infrasonic pulses are delivered from the air outlet 11 at a frequency of 1200 per minute, which corresponds to a sound at 20 Hz frequency.

Referring now to Fig. 1 of the drawings, the sound generator is designated by the reference numeral 13. Air from the ship's compressor is introduced via a supply line 14, at a pressure of the order of 7 - 8 bar,to an air receiver 15. A master valve 16 controls the flow of air into the sound producer. From the sound producer 13, sound pulses generated therein are conveyed by air supply line 17 to resonance tubes 18, 19 and 20 respectively. Butterfly valves 21, 22 and 23 are interposed in the lines to the respective resonance tubes. The respective resonance tubes are linked by bellows 24, 25 and 26 to economisers 27, 28 and 29. An air cooling line 30 bypasses master valve 16 and butterfly valves 21, 22 and 23 and provides a continuous low-volume supply of air to the resonance tubes. Since the internal diameter of the air cooling line 30 may be as little as, say, 3 mm, the continuous air consumption is at a very low level.

The operation of the sound producing system, and in particular of the various valves and of the sound producer 13 itself. may be controlled automatically by a control box. The following is a typical operational cycle of the system:-

A. Butterfly valve 21 is opened.

B. The sound generator 13 is started up.

C. When the sound producer 13 has achieved the desired operating speed, for example 20 Hz, master valve 16 is opened.

D. After a short operating spell, typically within the range from 5 - 10 seconds, the master valve 16 is closed and the sound producer 13 is stopped.

E. After an interval which may be as little as perhaps two minutes but may, in the illustrated embodiment, amount to approximately one third of the value of the desired interval of cleaning of each economiser, the butterfly valve 22 is opened, the sound producer 13 is again started up and the above sequence is repeated for resonance tube 19.

F. The procedure is further repeated for resonance tube 20 whereafter, after the lapse of the desired interval, the whole cycle is repeated.

The illustrated embodiment has been described specifically as applied to three economisers but it may, as already described, be applied to a larger number of economisers subject to the limitations set forth above. However, the sound producing system according to the present invention is envisaged as having application in other situations where infrasonic air is required, for example for airing clothes on a commercial scale or for encouraging the flow of pulverulent products such as dried cement in hoppers and/or delivery pipes.

Claims

1. A sound generating system which comprises a sound generator (13) which functions by interrupting at predetermined frequent intervals a supply of air or gas under pressure and at least one resonance tube (18, 19, 20) connected to receive sound pulses produced by said sound generator, characterised in that a valve (21, 22, 23) is disposed in the connecting line between the sound generator (13) and the or each resonance tube (18, 19, 20) and in that said valve (21, 22, 23) has a straight-through flow passage therein which is adapted to be closable by rotation of a rotary valve member.

2. A sound generating system according to claim 1, characterised in that said sound generator (13) is a rotary sound generator.

3. A sound generating system according to claim 2, characterised in that said rotary sound generator (13) comprises a rotary disc which interrupts an axial air flow therethrough.

4. A sound generating system according to claim 2, characterised in that said rotary sound generator (13) comprises a rotary cylindrical member (7) which interrupts a radial air flow therethrough.

5. A sound generating system according to any of the preceding claims, characterised in that the valve (21, 22, 23) is a butterfly valve or a ball valve.

6. A sound generating system according to any of the preceding claims, characterised in that a continuous low-volume flow of air is provided to that side of the valve (21, 22, 23) which is nearer to the resonance tube (18, 19,20).

7. A sound generating system according to any of the preceding claims, characterised in that it comprises two or more said resonance tubes (18, 19, 20) connected to receive sound pulses produced by a single said generator (13), a said valve (21, 22, 23) being included in each of the connecting lines from the sound generator (13) to one of the resonance tubes (18, 19, 20).

8. A sound generating system according to claim 7, characterised in that the operation of the valves (21, 22, 23) and of the sound generator (13) is controlled automatically by a control box.

9. A sound generating system according to any of the preceding claims, characterised in that the distance apart of the sound generator (13) and the or each resonance tube (18, 19, 20) is not greater than about eight metres.

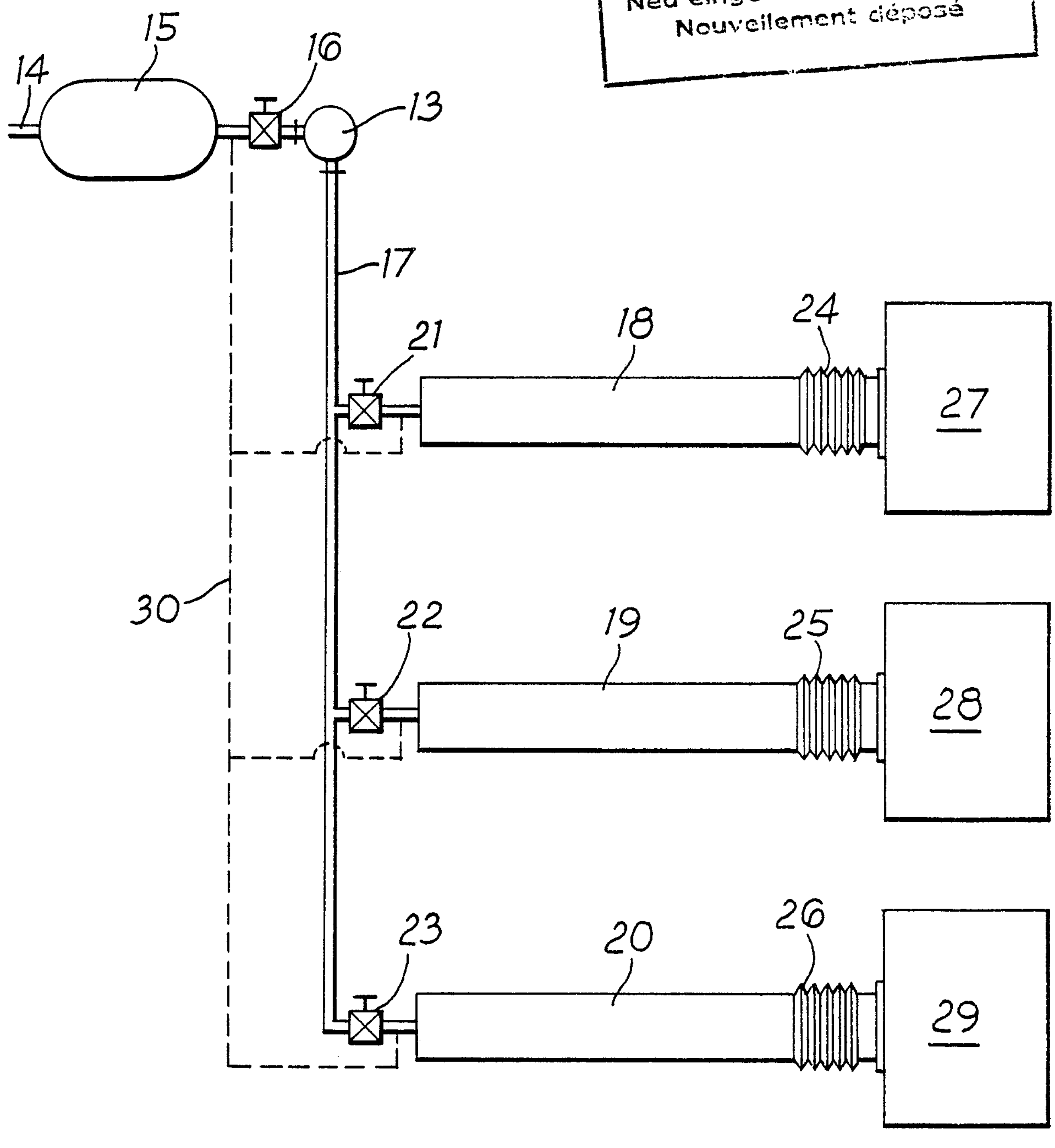

Fig. 1

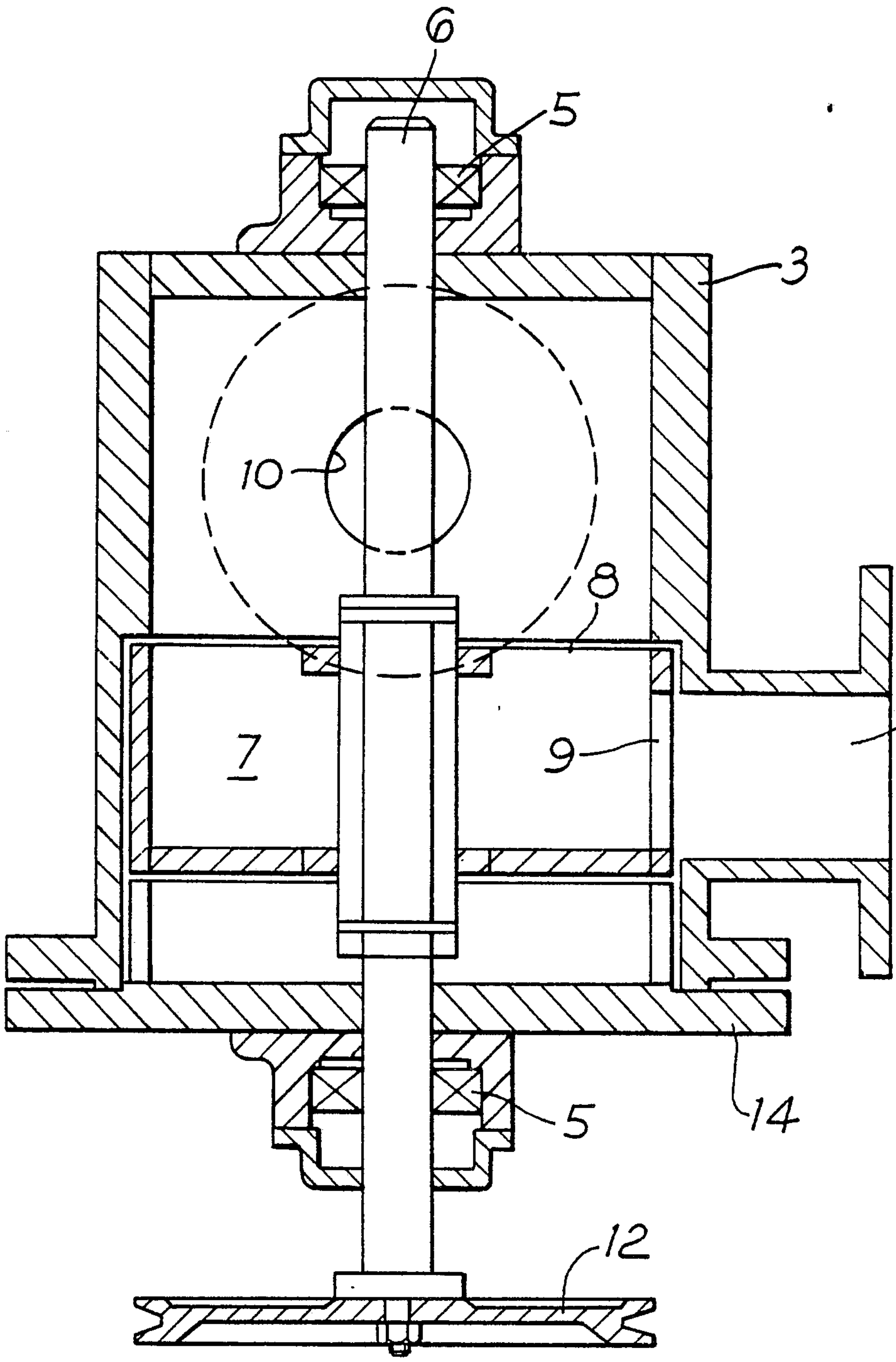

Fig. 2