June 16, 1953 E. R. DEARING 2,642,147

BAFFLE TYPE SILENCER WITH A BUFFER CHAMBER

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FIG. 1.

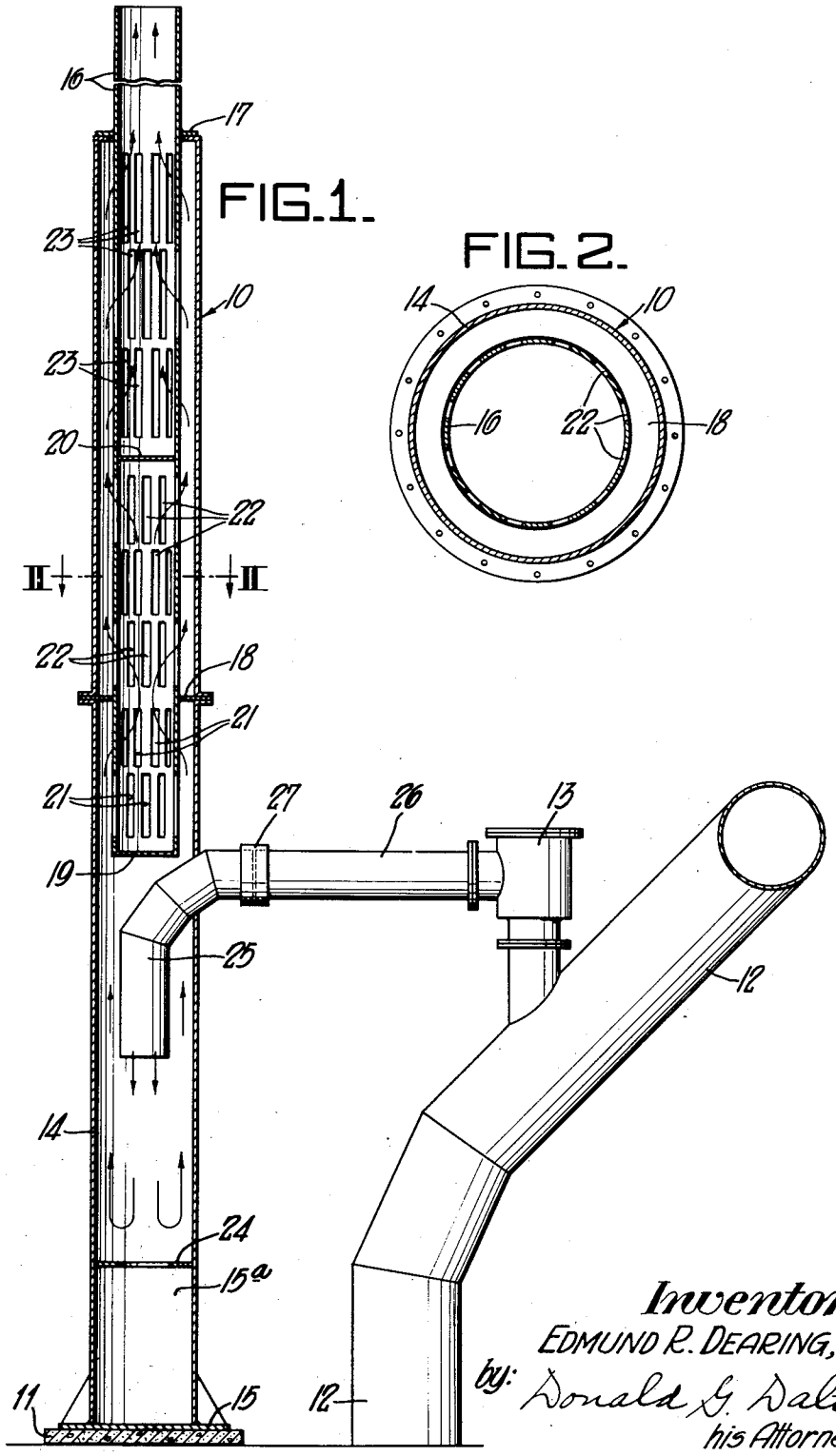


FIG. 2.

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BAFFLE TYPE SILENCER WITH A BUFFER CHAMBER

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8 Claims. (Cl. 181—54)

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This invention relates to a silencer or noise suppressor for the pressure-relief outlet of an air-blast system of large capacity.

In certain industrial installations, such as iron blast-furnaces, large volumes of air are required at moderate pressure. Turbo-blowers are usually employed to supply the air and the blast main connected thereto is always equipped with a pressure-relief valve. The opening of such valve, upon an increase in the pressure in the main above the safe limit, quickly releases a large quantity of compressed air which instantaneously creates a level of noise utterly intolerable to persons in the vicinity, continuing so long as the valve remains open. In fact, the noise may reach a level as high as twenty decibels whereas a level of sixteen decibels is generally considered to be about the maximum for human tolerance. A faint indication of the seriousness of the nuisance may be obtained by recalling the noise attributable to the relief of the pressure line of the ordinary portable compressor used in street and highway maintenance which, of course, has only a minute fraction of the air capacity required for a blast furnace.

The noise condition referred to is aggravated by the induced vibration of adjacent non-rigid members such as duct or pipe lines and the reverberation between buildings or other objects likely to be found in the highly congested mill area in which the valve is usually located. The problem of reducing the noise level is complicated by the fact that, when the relief valve opens, one long continuous air blast of large volume occurs. The valve opens only infrequently, furthermore, under ordinary conditions, and the terrifying effect of such great noise at relatively long intervals may easily be imagined. The only solution for this problem offered by the outstanding specialists in the silencer field involved a structure of prohibitive size and weight for the particular installation contemplated.

It is accordingly the chief object of my invention to provide means for damping or reducing the level of the noise caused by the opening of a pressure-relief valve in a large-capacity blast main, to a value below the maximum which can be tolerated without discomfort or nervous fatigue, i. e., sixteen decibels. Further objects are to provide a silencer of low cost and high efficiency which is self-supporting and takes up but little ground area. In a preferred embodiment, I utilize a combination of partitions and baffles defining a series of expansion chambers effective

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to relieve the pressure of the air gradually without excessive noise or vibration. More specifically, I provide a housing tube closed at one end and an outlet tube extending coaxially part way into the other end. An inlet pipe enters the housing tube and discharges toward the closed end thereof where a buffer chamber is provided. Ports spaced along the outlet tube, in combination with a baffle and partitions therein, cause the air to escape by a circuitous course whereby its pressure is reduced and its energy is gradually consumed and it is eventually released to the atmosphere at a relatively low pressure and velocity.

A complete understanding of the invention may be obtained from the following detailed description and explanation which refer to the accompanying drawings illustrating the present preferred embodiment. In the drawings,

Figure 1 is a vertical axial section showing parts in elevation; and

Figure 2 is a transverse section taken along the plane of line II—II of Figure 1.

Referring now in detail to the drawings, a silencer indicated generally at 10 stands on a foundation 11 adjacent a cold-blast main 12 such as that extending from the blower house to the stoves of a blast-furnace. The main is equipped with a relief valve 13. The silencer 10 comprises a housing tube 14 having a base plate 15 closing the lower end thereof and an outlet tube 16 open at the top, extending coaxially part way into the upper end of tube 14 and having a peripheral flange 17 resting thereon. The lower end of tube 16 extends through a baffle or partition 18 carried by tube 14, with a sliding fit therein, and has a transverse wall or closure 19 adjacent its extremity. A transverse wall or partition 20 is disposed in tube 16 between the baffle 18 and the upper end of tube 14. Tube 16 should extend to a height greater than that of adjacent buldings or other structures.

Ports in the form of elongated slots 21 are spaced circumferentially and longitudinally of the wall of tube 16 below baffle 18. Similar ports 22 but of greater aggregate area are located between baffle 18 and partition 20. Similar ports 23 of still greater aggregate area are located between partition 20 and the upper end of tube 14. All the ports are of about the same width but the length and number of ports in the successive groups increase upwardly. Baffle 18 and walls 19 and 20 define successive expansion stages

for the compressed air, each stage comprising one of the groups of ports 21, 22 and 23.

An orifice plate 24 is disposed in tube 14 adjacent the lower end thereof but spaced above plate 15, defining a capacitance or buffer chamber 15a at the bottom of the tube. An inlet pipe 25 enters tube 14 from one side, at about the level of the lower end of tube 16, and includes an elbow whereby it discharges directly toward the orifice in plate 24. Pipe 25 is connected to an outlet pipe 26 from valve 13 through a non-metallic sleeve 27 which is flexible and yieldable so as to prevent vibrations from being transmitted from the valve to silencer 10.

In explaining the operation of the invention, it will be assumed that valve 13 opens in response to excess blast-main pressure which may be caused by the closing or throttling of air valves at the furnace or some other reason. The excess air escapes from main 12 through the valve and its outlet pipe 26 to silencer inlet 25 and is discharged toward the capacitance or buffer chamber 15a. The air expands in tube 14 and pipe 25 directs a jet through the orifice in plate 24. The space below the latter functions as an acoustical capacitance chamber which has the effect of a low-pass filter. The air in chamber 15a, furthermore, acts as a buffer or cushion to air pulses from inlet 25. When the pressure on opposite sides of plate 24 is equalized, the entering air is diverted upwardly as shown by the arrows, and flows outside the entering jet and in countercurrent relation thereto.

Air ascending through tube 14 passes around the entering jet, enters outlet tube 16 through ports 21 and is there permitted to expand further. The shape and distribution of the ports subdivides the hollow ascending air stream into a multiplicity, say eighteen, of wide, thin streams. These are further subdivided on flowing out through ports 22 for further expansion in the space between tubes 14 and 16 above baffle 18. Ports 22 may number twenty-six, for example. The air then re-enters tube 16 through ports 23 of which there may be twenty-eight, for final expansion to atmospheric pressure and discharge through the upper open end of the tube.

Tube 16 is dimensioned to have a fundamental resonant frequency of 16 cycles per second or below so that the escaping air produces only a low-pitched rumble. The intensity thereof is reduced to a level below sixteen decibels (actually around eleven decibels) ind so causes practically no annoyance to those in the vicinity. The reduction in the energy content of the escaping air results from its gradual expansion and repeated passage around the sharp edges of the ports in tube 16 caused by baffle 18 and walls 19 and 20. The progressive increase in the size and number of the ports in the several groups scatters the frequencies of the sound waves produced, tending to cause multiple interference rather than reinforcement of any particular frequency. The capacitance chamber tends to trap high-frequency vibrations while permitting low-frequency sounds to escape.

It will be apparent that the invention is characterized by many important advantages. It is remarkably effective in reducing the noise of a large volume of escaping compressed air, from an overpowering, nerve-wracking and deafening intensity to a level well below that which can comfortably be tolerated and further to a level which is not even disturbing. Such sound as is produced is directed upwardly and is readily dissipated. The structure is simple, compact, self-supporting and relatively inexpensive. When once installed, it requires no maintenance beyond that of any steel structure exposed to the weather. The device can easily be incorporated in existing plants without major alterations.

While the invention has been disclosed with particular reference to the relief valve of a blast main for a blast-furnace, it will be understood that it is applicable generally to a compressor, receiver or any installation where large volumes of gas under pressure are released suddenly to the atmosphere.

Although I have disclosed herein the preferred embodiment of my invention, I intend to cover as well any change or modification therein which may be made without departing from the spirit and scope of the invention.

I claim:

1. A silencer comprising a housing tube, a closure at one end thereof, an outlet tube smaller in diameter than the housing tube extending coaxially into the other end of the latter but terminating short of the closed end thereof, an inlet pipe entering said housing tube from one side adjacent the inner end of the outlet tube and discharging toward the closed end of the housing tube, the portion of the outlet tube within the housing tube having ports spaced therealong, a baffle spaced from the inner end of the outlet tube closing the space between the tubes and transverse walls in the outlet tube spaced axially in both directions from said baffle whereby gas entering the housing tube is caused to execute successive passes through said ports into and out of said outlet tube.

2. The apparatus defined by claim 1 characterized by said outlet tube being secured to said other end of the housing tube and free to slide through said baffle.

3. The apparatus defined by claim 1 characterized by an orifice plate in said housing tube adjacent the closed end but spaced therefrom.

4. A silencer comprising a housing tube, a closure at one end thereof, an inlet entering said tube from one side and discharging toward said closure, an outlet tube smaller in diameter than the housing tube extending coaxially into the other end of the latter but terminating short of the closed end thereof, a closure on the inner end of said outlet tube, a partition in said outlet tube disposed inwardly of said other end of the housing tube and spaced from said closure, ports spaced circumferentially and longitudinally of the outlet tube and a baffle closing the space between the housing tube and the outlet tube at a point between the closure and partition of the outlet tube.

5. A silencer comprising a housing tube having a closure at one end, an inlet entering said tube from one side and discharging toward said closure, an outlet tube smaller in diameter than the housing tube extending coaxially into the other end of the latter, a closure on the inner end of the outlet tube, a baffle closing the space between the outlet tube and the housing tube adjacent the inner end of the outlet tube, a transverse partition in said outlet tube between said baffle and said other end of the housing tube and ports in said outlet tube on both sides of said baffle and said partition.

6. The apparatus defined by claim 5 characterized by said outlet tube having a sliding fit in said baffle.

7. The apparatus defined by claim 5 characterized by means defining a buffer chamber in the closed end of said housing tube.

8. The apparatus defined by claim 7 characterized by said means being an orifice plate.

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