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2,869,671

GAS TURBINE MUFFLER

Filed Aug. 31, 1953

2 Sheets-Sheet 1

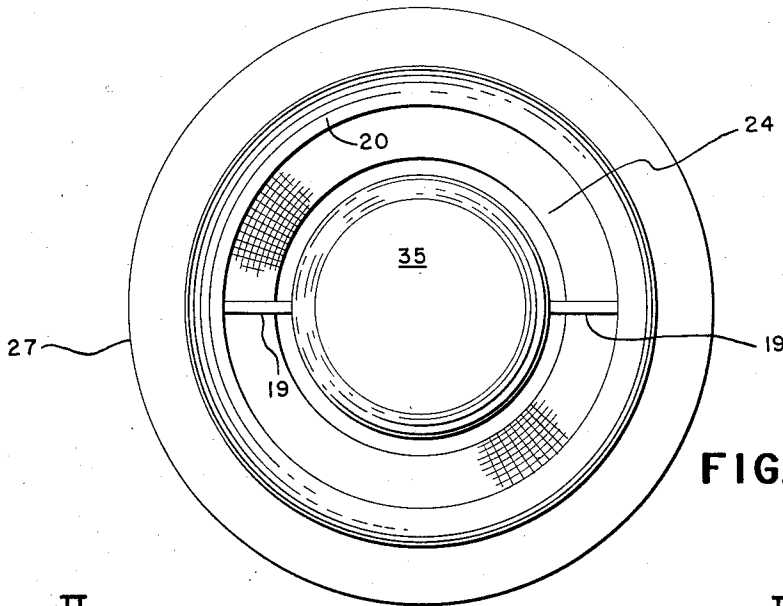


FIG. 2.

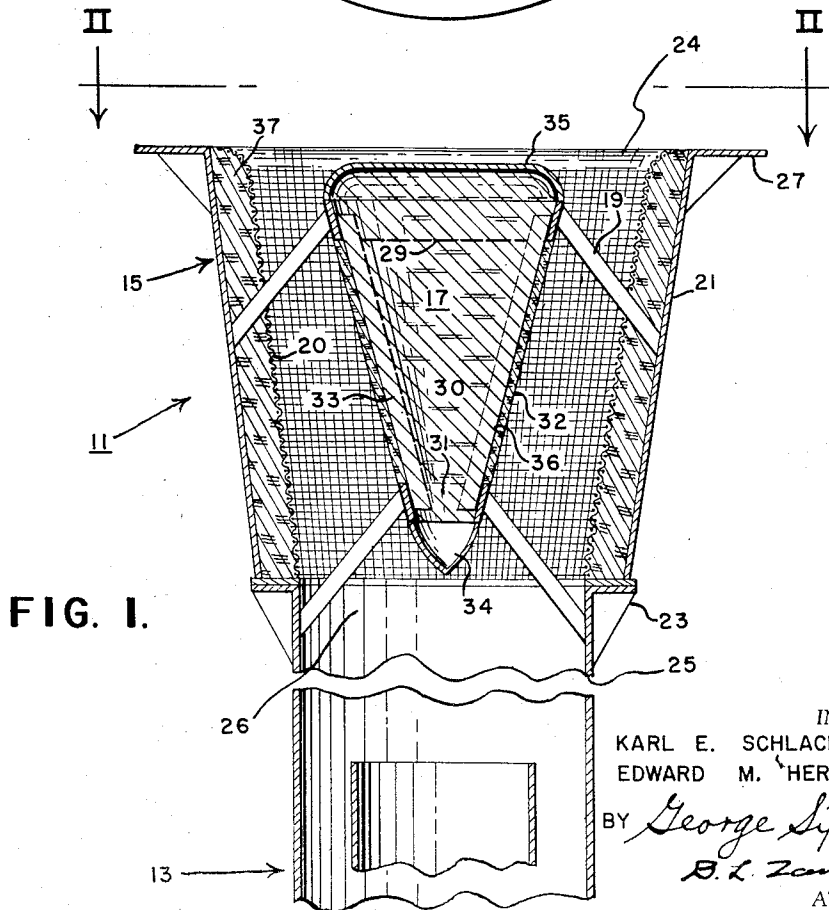


FIG. 1.

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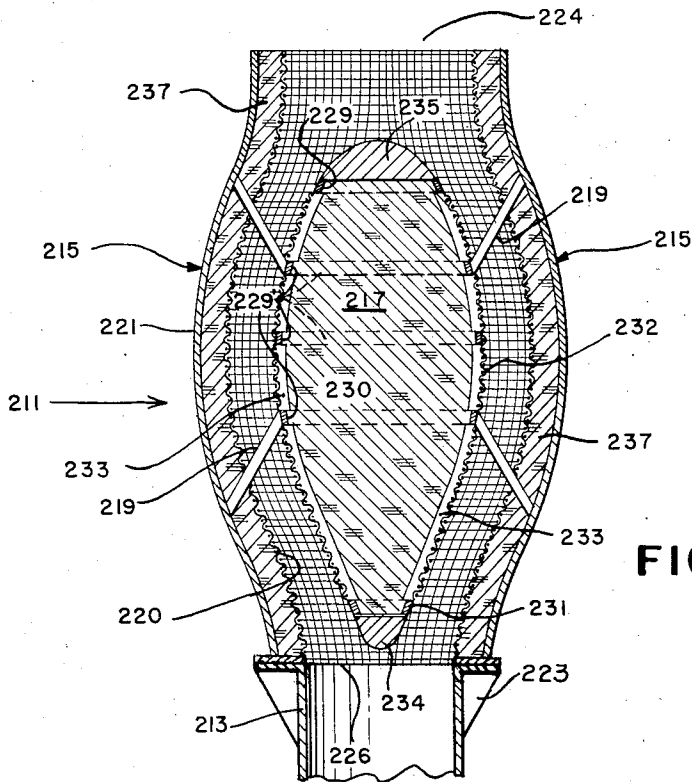


FIG. 4.

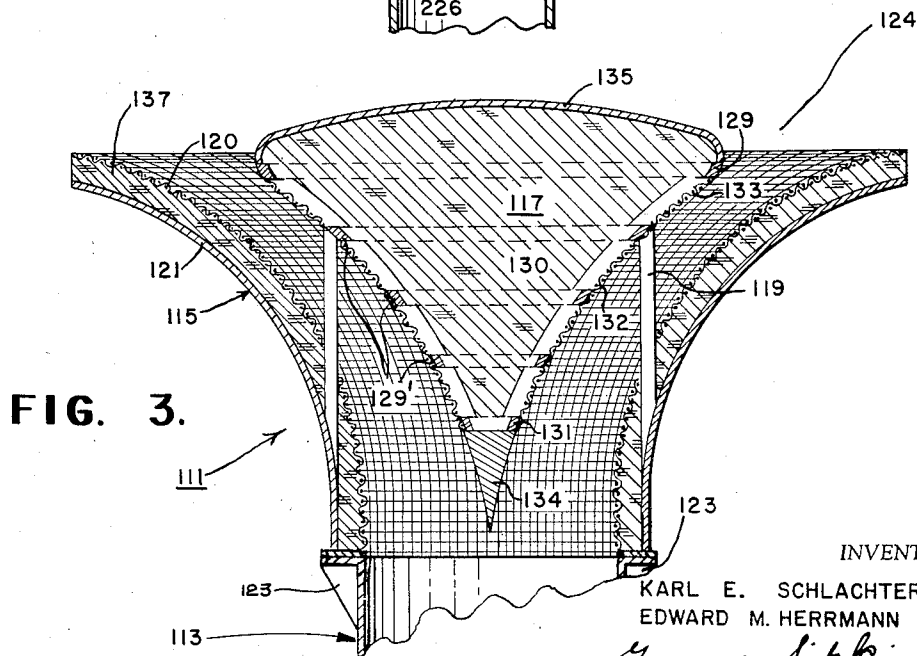


FIG. 3.

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GAS TURBINE MUFFLER

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2 Claims. (Cl. 181—50)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without payment of any royalties thereon or therefor.

The present invention relates to gas turbine mufflers and more particularly to gas turbine mufflers for silencing noises caused by or carried by a gas in its movement through or from a conduit.

Generally, present day mufflers for use with gas turbines are composed of a series of connected chambers having their inner surfaces covered with a porous material which absorbs sound energy, the volume of the chambers being properly proportioned to the size of the engine. Such structures are large, and also produce undesirable back pressures against which the engine must work, and for these reasons are not suitable for installations where space and efficiency are critical.

A muffler for small installations, where space is at a premium, must be compact with high sound absorption properties. Also, such a muffler must be constructed so that the back pressures of the exhaust gasses is not increased and so that the normal eductor action of the conduit, through which the gas is exhausted, is not disturbed. For example, such a light weight muffler, having high sound absorption properties, is desirable in ships wherein the space consideration is of the utmost importance.

In such ships, a plurality of gas turbines are sometimes used to drive a number of generators used to power various equipments and accessories aboard the vessel. The exhaust of these gas turbines is preferably expelled through a stack, resulting in loud exhaust noises in the vicinity of the stack and in an area which may include the operating portions of the ship, which exhaust noises prohibit normal conversation and the operation of some types of equipment.

The present invention provides greater sound absorption of the noises present in the exhaust gasses passing through a stack or conduit, with less structural weight and complexity of construction than previous types known, and does not increase back pressure in the gas turbines nor interfere with the normal eductor action of the stack. The muffler comprises a structural configuration consisting of an outer member containing sound absorption material and a radially spaced center member also containing sound absorbing matter, so that sound waves are reflected back and forth from one absorbing surface to the other. The muffler is directly secured to the stack or conduit so that the exhaust gasses must pass through the muffler before being expelled into the atmosphere. Consequently, it can be seen that only two structural components, an outer tubular member and a concentric internal member spaced therefrom, will muffle exhaust noises of gas turbines to a large degree within the vicinity of the stack or conduit.

2

An object of the present invention is the provision of a muffler to reduce the sound energy present in exhaust gasses of a gas turbine.

Another object is to provide a muffler whereby exhaust noises are reduced without increasing the back pressure to the gas turbine.

A further object of the invention is the provision of a muffler providing good sound absorption with minimum mass without interference with the normal eductor action of the stack.

Another object of the present invention is the provision of an inexpensive muffler to reduce the exhaust noises from gas turbines.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings in which like reference numerals designate like parts throughout the figures thereof and wherein:

Fig. 1 is a vertical sectional view of a preferred embodiment of the invention;

Fig. 2 is a plan view of the device taken on the line II—II of Fig. 1, looking in the direction of the arrow;

Fig. 3 is a vertical sectional view of a modification of the invention showing a flare type muffler; and

Fig. 4 is a vertical sectional view of another modification of the invention showing a balloon type muffler.

Referring now to the drawings, there is illustrated in Fig. 1 a preferred embodiment comprising a muffler 11 rigidly secured to an exhaust gas stack or conduit 13 and having a tubular outer member 15 with an inner body of revolution 17, hereinafter referred to as a splitter, axially spaced therefrom. Members 15 and 17 are provided with sound absorbing material and arranged in such a manner that sound waves are reflected from one absorbing surface to the other, as hereinafter described. The splitter 17 is supported through a plurality of airfoil type struts 19 to the outer member 15.

The outer member 15 is formed in the shape of a truncated cone section having an exterior frusto-conical metal shell 21 and a plurality of interior layers of suitable sound absorbing material 37, for example, a material made of a refractory fiber, or the like. The absorbing material 37 is preferably covered with a retaining perforated metallic mesh 20 of stainless steel, copper, or the like, secured to the shell 21 by suitable securing means. The member 21 is also provided with an outlet ring flange 27 secured thereto at the upper exhaust end 24 by suitable attaching means, such as welding or the like. The member 21 is secured at its inlet end 26 to a flange 23, by welding or the like, said flange being integral with an auxiliary stack 25 securely fixed by suitable means to the existing stack 13.

The splitter 17 is formed in substantially the shape of a right circular cone having an upper ring 29 and a lower ring 31, with said rings being axially spaced and secured to each other by a plurality of circumferentially spaced stays 33. The conical splitter 17 is filled with a sound absorbing material 30 which is preferably the same as material 37, and may be of any suitable material, such as for example, a glass fiber composition or an asbestos-containing fibrous filling, and is maintained within said cone by a metallic mesh 32, such as stainless steel, copper, or the like, wrapped about the cone's external surface. A non-metallic refractory fiber 36 is provided between mesh 32 and the sound absorbing material 30 to prevent the high temperatures of the exhaust gases from

firing the material 30 and changing its absorbing characteristics.

The apex of the splitter 17 consists of a streamlined nose section 34 of suitable metal, for example, stainless steel, while the upper end is provided with a septum or wall 35 of suitable metal plate, as for example, stainless steel or copper. This septum 35 on top of the splitter 17 reflects the sound impinging thereon back into the sound absorbing material 30 and thus provides attenuation of low frequencies of sound in the exhaust gases leaving the muffler 11. The nose section 34 serves as a distributor for the gas stream emanating through the stack 13, so that the exhaust gases will flow uniformly around the nose 34 into the sound absorbing portion of the muffler 11 between the splitter 17 and the outer member 15.

The muffler 11 has two inherent mechanical design features. First, the angle of the surfaces of the metal shell 21, and hence the inside of member 15, relative to the axis of the stack 13 is limited to approximately 7°, and secondly, the cross-sectional area for gas-flow in the muffler 11 from the inlet end 26 to the exhaust end 24 must not be less than the cross-sectional area for gas-flow of the stack 13. The first limitation is necessary to prevent excess turbulence of the exhaust gas stream, and the second to prevent back pressure on the turbine power plant.

In operation, the muffler 11 serves as an extension of the existing stack 13 and effects a deadening of the sound waves found in the exhaust gases. The structural configuration of the muffler 11 is such that the soundwaves in the exhaust gases are alternately partially reflected from the cover of the materials 37 and 30, while maintaining a low back pressure and a non-turbulent flow through the muffler. In this manner, a large quantity of the exhaust noises of the gas turbines is absorbed to the extent that normal conversation can be conducted in the vicinity of the stack 13. Also, the ring 27, located at the exhaust end 24 of the muffler 11, will prevent any sound waves remaining in the exhaust, after passing through the major portion of the muffler, from bending or radiating down near the vicinity of the stack 13. The septum 35, on top of the splitter 17, functions to reflect the sound waves impinging thereon to further attenuate low frequency sound waves emanating from the muffler 11 and also to prevent the sound from passing out of the splitter 17 at this point.

Fig. 3 illustrates a modification of the preferred embodiment shown in Fig. 1. The flare type muffler 111 is formed in the shape of a flared tubular section 115 having an exterior metal shell 121 of metal, such as steel or the like, and with coaxial splitter 117 therein. The metal shell or ring 121 is securely fixed, such as by welding or the like, to flanges 123 which are fixed to the normal stack 113. The inside surface of section 115 is provided with absorbing material 137, such as a plurality of layers of a material made of refractory fiber or the like, with a suitable retaining metal mesh 120, such as stainless steel, copper, or the like, secured to the ring 121 by suitable securing means.

The splitter 117 is formed with an upper ring 129, a plurality of intermediate retaining rings 129', and a lower ring 131. The rings are interconnected by a plurality of stays 133 equally spaced about said splitter 117. The upper end of the splitter is formed with a solid damped septum or wall 135, of stainless steel, copper, or the like, and the lower apex of the pear-shaped splitter 117 is provided with a solid metal splitter tip 134. The damped septum 135 may be of a sandwich type construction wherein an asbestos filler is utilized between adjacent metal plates to dampen any ringing or vibration of the septum by a turbulent movement of air. The volume of the splitter 117 is filled with absorbing material 130, such as a material made of a refractory fiber or the like, with a perforated metal mesh 132, such as stainless steel, copper, or the like, wrapped about the splitter to maintain the absorbing material therein. The splitter 117 is maintained

in a coaxial position relative to the section 115 by a plurality of metal struts 119 secured to the shell 121 and to one of the intermediate rings 129' of the splitter 117.

In the modification shown in Fig. 3, the cross-sectional area of stack 113 must be smaller than the cross-sectional area of the passage through the muffler 111 at its upper or outlet end 124. As in the preferred embodiment of Fig. 1, the material utilized in the construction of muffler 111 is determined by the temperature of the exhaust gases from the power plant, such as gas turbines or the like. In this manner, safe operation of the muffler at operational temperatures will be insured with a constant rate of absorption of the sound waves in the exhaust, since the characteristics of the absorbing material will not be changed or affected by the heat of said exhaust.

The operation of the flare type muffler 111 in relation with stack 113 is similar to the operation of muffler 11 in the preferred embodiment of Fig. 1.

Fig. 4 shows another modification of the preferred embodiment of Fig. 1. The muffler 211 is formed of an egg-shaped section 215 provided with an external metal section 221 of steel, or the like, with a splitter 217 coaxial therewith. Section 221 is secured at its inlet end 226 to flanges 223 by welding or the like, with said flanges integrally secured by suitable means to the stack 213. Section 215 is lined on the interior surface with a plurality of layers of absorbing material 237, maintained in its juxtaposed position to the section 221 by a perforated metal mesh 220, such as stainless steel, copper, or the like.

The splitter 217 is formed with an upper ring 229, intermediate rings 229', and a lower ring 231 interconnected by stays 233. Stiffener rings 229' are provided intermediate the upper and lower rings to maintain the splitter 217 in the required shape shown in Fig. 4. The splitter 217 is maintained in its coaxial position, relative to the egg-shaped section 215, by a plurality of airfoil type struts 219 fixed to the metal section 221 and to several of the intermediate stiffening rings 229', as shown in Fig. 4. Splitter 217 is formed with a septum 235 of suitable metal at its upper end near the exhaust end 224 and with a solid metal tip 234 at its lower end near inlet end 226.

The inside portion of member 217 is filled with absorbing material 230, such as a material made of a refractory fiber, or the like, maintained therein by a metallic mesh 232, such as stainless steel, copper or the like, wrapped about the surface of the splitter 217. The exhaust gases emitted through stack 213 will be divided by the member 234 to thereby provide a uniform flow between the members 217 and 215. The exhaust noises present in the exhaust of gas turbines or the like, will be reduced to a minimum as the flow passes through the muffler 211, since the sound waves are alternately partially reflected from the cover of materials 237 and 230, as discussed in the operation of the preferred embodiment shown in Fig. 1.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood, that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A muffler for exhaust gas noise suppression comprising a tubular substantially egg-shaped outer member formed of an imperforate outer wall, a perforate inner wall arranged in spaced parallel relation with said outer wall and a layer of sound-absorbing material between said walls, a substantially egg-shaped splitter mounted entirely within the tubular member in spaced parallel relation with the perforate inner wall thereof, a plurality of uniformly-spaced airfoil type struts mounting the splitter within the tubular member, said splitter being streamlined of substantially the same curvature as that of the perforate inner wall of the tubular member to thereby provide substantially streamline flow of exhaust gas between the inner wall of the tubular member and the out-

er surface of the splitter, said splitter including a relatively small nose section located at the inlet end of the muffler, a relatively large septum located within the tubular member near the outlet end thereof in spaced relation to the nose section of the splitter, an outer perforate wall between the nose section and the septum and forming therewith a volume for the reception of sound absorbing material, and sound absorbing material filling said volume.

2. A muffler as set forth in claim 1 wherein the perforate inner wall of the tubular member and the perforate wall of the splitter are each formed of wire mesh for substantially uninhibited flow of sound waves to the sound absorbing material contained by such wire mesh.

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