

April 6, 1954

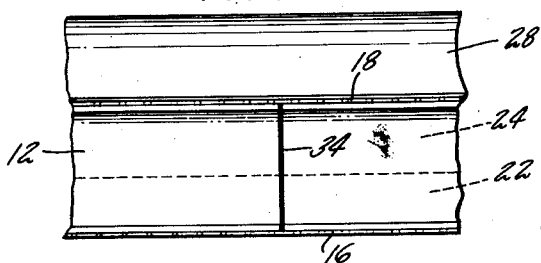
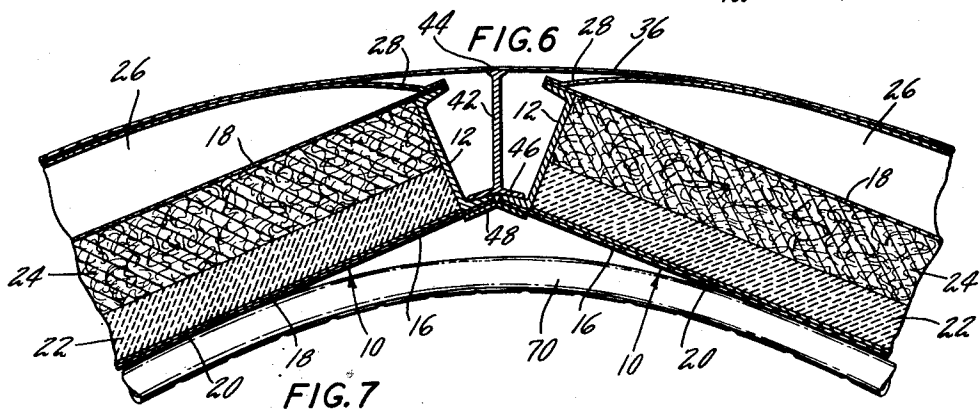
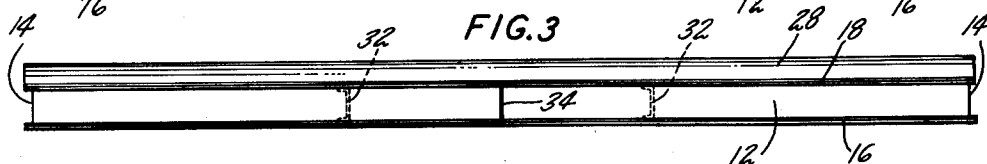
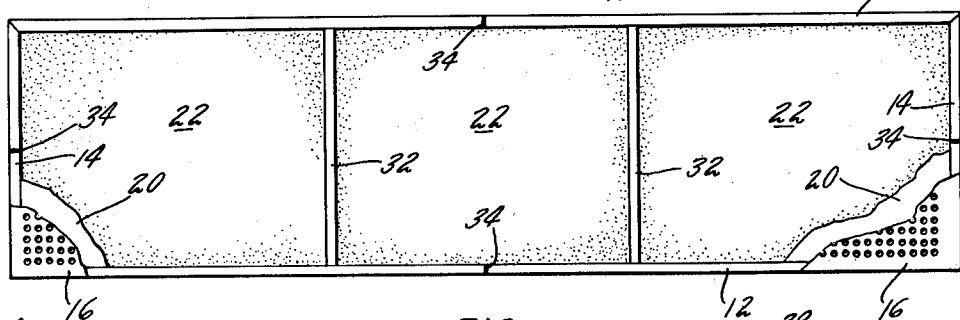
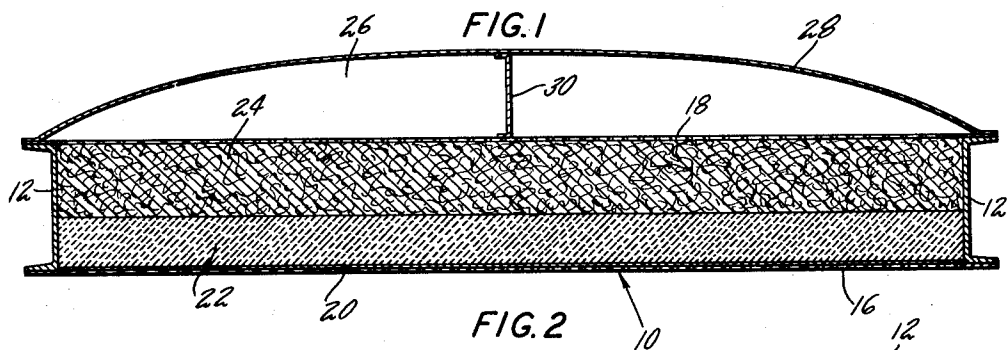
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2,674,335

MUFFLER CONSTRUCTION

Filed Jan. 31, 1950

2 Sheets-Sheet 1



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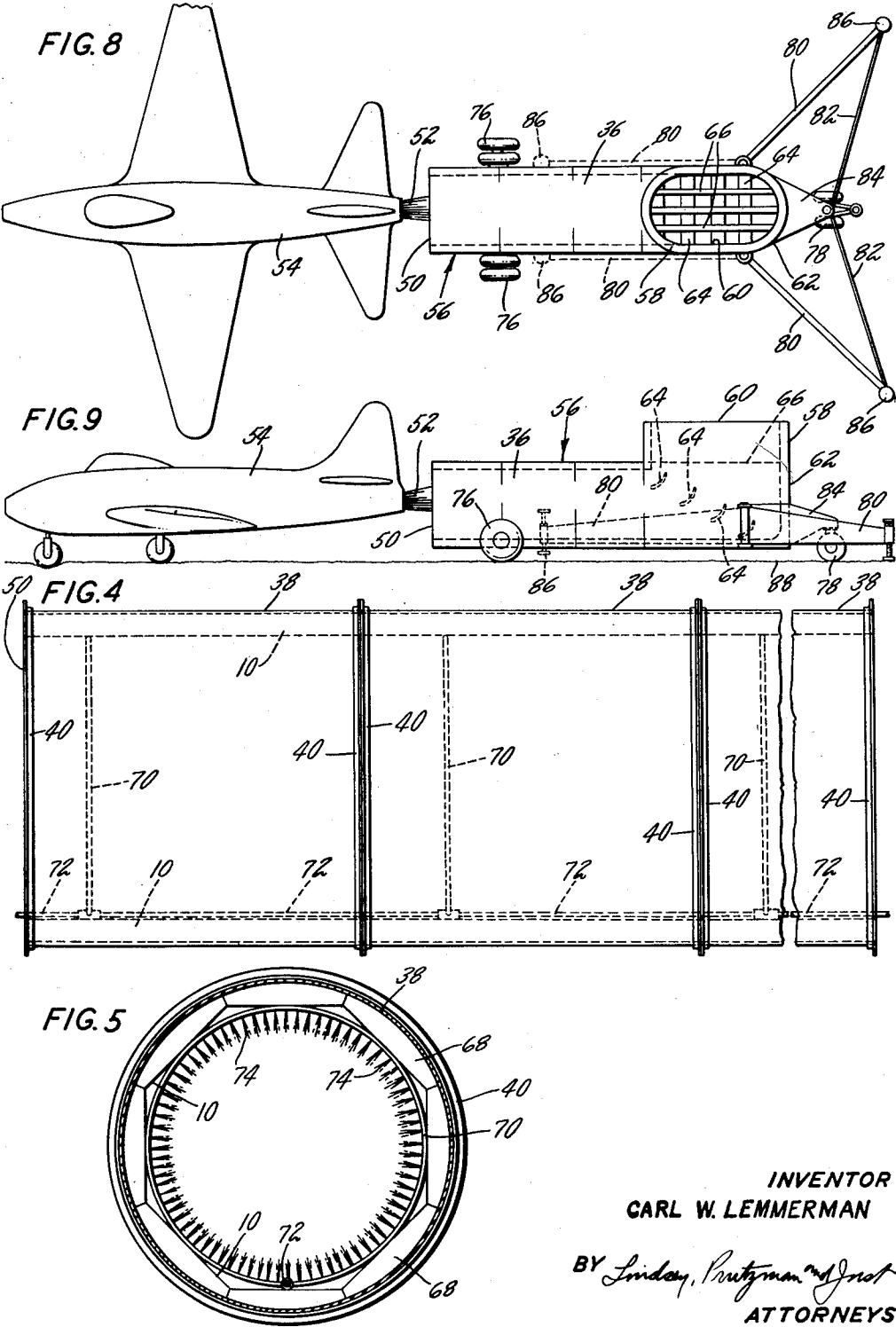
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

2,674,335

MUFFLER CONSTRUCTION

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14 Claims. (Cl. 181—42)

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This invention relates to a muffler construction and, more particularly, but without restriction thereto, to a muffler construction adapted to muffle sound accompanied by high temperatures such as produced by the exhaust of a jet engine.

The development of jet engines has posed a number of problems relative to designing mufflers capable of withstanding high temperatures and muffling the sound produced by the exhaust of such engines, such problems generally not being encountered in designing conventional mufflers in present use. Not only do the exhausts of jet engines develop a wide range of mingled frequencies, but much higher temperature ranges are encountered than those developed by exhausts of conventional gasoline and other types of gas engines. Conventional mufflers, such as those used to muffle the exhausts of automobile engines, are not subjected to temperatures within the ranges developed by the exhausts of jet engines and thus the basic construction embodied in general in automobile type mufflers are not suitable for use in jet engines.

It is an object of the present invention to provide an acoustical panel capable of muffling a relatively wide range of frequencies of sound waves imposed thereagainst and also capable of withstanding relatively high temperatures.

Another object of the invention is to provide a muffler duct constructed to support a plurality of such panels in a manner to muffle and dissipate sound, and also capable of withstanding the relatively high temperature of gases introduced into the muffler.

A further object of the invention is to provide means in such muffler operable to lower the temperature of a stream of exhaust gases, for example, introduced into the muffler and break the shock waves surrounding said stream of exhaust gases so as more readily to permit the absorption and dissipation of the sound waves produced by such exhaust gases.

Still another object of the invention is to provide such muffler duct with a horizontal section terminating in an exhaust extending vertically and including means operable to change the direction of the flow of exhaust gases from said horizontal section into said vertical exhaust.

A still further object of the invention is to construct said muffler duct so as to be mobile, said mobile duct also including means to effectively anchor the duct relative to an exhaust of a jet engine so as to resist the thrust imposed against the duct by such exhaust.

Details of these objects and of the invention, as

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well as other objects thereof, are set forth in the following specification and illustrated in the accompanying drawings forming a part thereof.

In the drawings—

Figure 1 is a transverse sectional view through an acoustical panel comprising part of the present invention.

Figure 2 is a plan view of a panel similar to that illustrated in Figure 1, as viewed from the bottom thereof, part of one cover plate of said panel being broken away to illustrate certain details of the panel, and Figure 2 being on a smaller scale than Figure 1.

Figure 3 is a side elevation of the panel shown in Figure 1, but illustrated on a scale similar to that used in Figure 2.

Figure 4 is a fore-shortened side elevation of a cylindrical duct comprising a muffler embodying the present invention.

Figure 5 is an end view of the muffler duct shown in Figure 4.

Figure 6 is an enlarged, fragmentary, sectional view of part of the duct shown in Figures 4 and 5 and illustrated on a larger scale than in said figures so as to illustrate in greater detail certain features of the construction.

Figure 7 is a fragmentary side elevation of a portion of the acoustical panel shown in Figure 3 and illustrating certain details thereof on a larger scale than in Figure 3.

Figure 8 is a top-plan view illustrating the muffler duct shown in Figure 4, but on a smaller scale, said duct being mobile and positioned adjacent the exhaust of a jet plane.

Figure 9 is a side elevation of the arrangement shown in Figure 8.

Referring to the drawings, the present invention comprises an acoustical panel 10 constructed and arranged to absorb a relatively wide range of frequencies of sound and also capable of withstanding relatively high temperatures. The panel 10 comprises a frame including side channel members 12 and end channel members 14. The ends of said side and end channel members may be secured together in any suitable manner such as welding, the channels of said members preferably opening outward. Extending across one open surface of the frame of the channel 10 is a perforated cover plate 16, the edge portion thereof being secured to the flanges of the side and end channel members by any suitable means, such as a series of spot welds.

The cover plate 16 is considered the operative face of the panel 10, since it is disposed in a position to be subjected to sound waves for purposes

of absorbing and dissipating the same. Said cover plate will also be subjected to heat accompanying said sound waves and must withstand relatively high temperatures. Accordingly, when relatively high temperatures in ranges approaching 4,000° F. are involved, the cover plate is preferably formed from stainless steel of a gauge adequate to withstand deformation when subjected, for example, to the exhaust gases of a jet engine. If the acoustical channel 10 is to be subjected to gases of temperatures under 1,000 degrees F., for example, galvanized steel is adequate in lieu of stainless steel for forming the cover plate 16. When temperatures considerably below 1,000° F. are to be encountered, aluminum will be satisfactory as a cover plate. As is illustrated in the various figures, and particularly Figures 1, 2 and 6, the cover plate 16 is highly perforated for purposes of readily permitting the transmission of certain frequencies of sound therethrough.

The opposite open face of frame of channel 10 is also covered by a cover plate 18 preferably perforated similarly to and of similar material to the cover plate 16. The edges of cover plate 18 may be secured to the flanges of the side and end of channel members by welding or otherwise, as in regard to the joining of cover plate 16 to said frame.

The space between the cover plates 16 and 18 contains sound absorption material of several different forms and additional material as follows. Immediately adjacent the inner surface of cover plate 16, a layer of heat resistant fabric or a thin sheet of matted heat resisting fibers 20 is disposed. The sheet 20 may comprise matted glass fibers or fiber glass fabric, or it may also comprise a sheet of asbestos fabric, or a thin sheet of matted asbestos fibers, the purpose of which is to be described.

Adjacent the sheet 20 is a flat substantially rigid sound block 22 of porous mineral wool. Said block is capable of withstanding high temperatures such as those developed by exhausts of jet type engines. Said block 22 is not only substantially rigid, but is preferably imperforate and formed from mineral wool which is inherently water-proof. It is not necessary that said sound block 22 withstand the maximum temperatures developed by jet engines since the exhaust gases of such engines are rarely discharged directly against panel 10. However the sound block 22 is capable of withstanding relatively high temperatures of the order, for example, of 2,500° F. In the preferred construction, the sound block 22 consumes less than half the space between the cover plates 16 and 18.

Mounted between the sound block 22 and cover plate 18 is a layer 24 of mineral wool felt which is preferably matted, spun wool that is somewhat compressible and is preferably inherently water-proof. The layer of felt 24 should also be capable of withstanding relatively high temperatures, but need not necessarily withstand temperatures greater than of the order of 1,200° F., for example, when used in muffler panels subjected to the exhaust gases of jet engines.

The panel 10 is provided adjacent the cover plate 18 with a resonating chamber 26 formed by a transversely curved sheet of metal 28, said sheet being joined at its side edges to the side edges of cover plate 18. In the preferred construction, the panel 10 is made rectangular and the sheet 28 is curved transversely of the rectangular panel 10. Since the curved sheet 28 is only connected at its side edges to the side edges

of the cover plate 18, the sheet is otherwise spaced from the cover plate 18 to form the resonating chamber 26 referred to above. The spacing of the curved sheet 28 from cover plate 18 may also be insured by providing intermediately of the side edges thereof a brace 30 in the nature of a channel member or otherwise secured at its edges to the inner surface of sheet 28 and the outer surface of cover plate 18.

Extending between the side members 12 of the frame of panel 10 are a plurality of supporting members 32 which may be in the nature of channel members similar to end members 14. The supporting members are fixed at their ends, for example, to the inner surfaces of side chamber members 12 by welding or otherwise. The cover plate 16 is secured to the supporting members 32 by a series of spaced spot welds so as rigidly to anchor said cover plate to the supporting members. In the preferred embodiment of the invention, the cover plate 18 is also similarly anchored to the supporting members 32. Thus, the cover plates 16 and 18 are divided into a series of adjoining areas comprising diaphragms which are vibratable transversely to the plane of the panel 10.

In order to insure against buckling or warping of the panel 10 when mounted in operative position and subjected to high temperature gases, the side panel members 12 are intersected intermediately of the ends thereof by transverse slots 34, said slots preferably entirely intersecting said side channel members 12 but the continuity of the cover plates 16 and 18, which are rigidly connected to the side channel members, will serve to hold the severed sections of the side channel members in elongated alignment as illustrated in Figure 3. The side channel members 12 may be provided with more than one slot 34 intermediately of the ends thereof if desired. More details of the function of the slots 34 are set forth hereinafter.

In adapting the panels 10 for use in muffling and dissipating the sound produced by the exhaust of a jet engine, for example, a series of panels 10 are mounted in edge abutting relationship within a cylindrical duct 36. The duct 36 is made sufficiently long to be adequate to dissipate at least the major portion of the sound accompanying the exhaust of a jet engine and said duct may be formed by connecting in end abutting relationship a series of cylindrical duct sections 38, the ends of said ducts being connected, for example, by welding or by interconnected annular end flanges 40 secured to the opposite ends of each duct section 38.

Extending radially inward from the inner surface of the duct 36 are a plurality of elongated T-shaped beam-like members 42, the edges 44 of the stem flanges of the T-shaped members 42 being secured to the duct 36 by any suitable means such as welding. The side portions of the head flange 46 of each T-shaped member 42 extend in opposite directions and are angularly disposed relative to each other as shown in Figure 6 for purposes of engaging the inner surfaces of the side flanges adjacent one edge of the side channel 12 of adjacent panels 10 when disposed within the duct 36.

A securing plate 48, having angularly related sides as shown in Figure 6, may be either permanently or detachably connected in spaced relationship to the head flange 46 of each T-shaped member 42 for purposes of engaging the side edges of the cover plates 16 of the adjacent panels 10 when mounted within the duct 36. Preferably,

the engagement of the edge flanges of the side channel members 12 between each head flange 46 and the securing plate 48 is such as to permit limited sliding movement of the panels 10 relative to each other and the T-shaped members 42. The duct 36 is provided with one T-shaped member 42 between each adjacent pair of panels 10 and the spaces between members 42 and the side channel members 12 of the panels 10 are preferably filled with mineral wool to prevent the ready transmission of heat through said spaces. The curved sheet 28 of each panel which defines the resonating chamber 26 preferably generally conforms to the contour of the inner surface of duct 36 and is disposed in slidable engagement with said inner surface of the duct, thus cooperating with T-shaped members 42 to position the panels 10 within the duct 36.

The duct 36 has an entrance 50 into which, for example, the exhaust 52 of a jet plane 54 is introduced to the muffler 56 comprising the horizontal duct 36 and exit duct 58 connected thereto. The exit duct preferably extends at a right angle to the duct 36 and the vertical exit duct 58 terminates in an exit 60. An elbow 62 connects the duct 36 with the exit duct 58. The duct 36, elbow 62, and exit duct 58 are lined with panels or sections of panels 10 disposed in edge and end abutting relationship, whereby the entire muffler 56 is lined with acoustic panels capable of absorbing and dissipating the sound produced by the exhaust 52 of a jet engine of the jet plane 54.

In order to facilitate changing the direction of the exhaust gases 52 from a horizontal direction within duct 36 to a vertical direction within exit duct 58, a plurality of spaced, deflecting vanes 64 are mounted within the elbow 62 so as to extend thereacross in parallel and spaced relationship to each other. The deflecting vanes 64 are positioned so as to cooperate with each other and change the direction of substantially the entire horizontal gas stream as it passes through duct 36 so as to direct said gas stream vertically and cause the same to be discharged to the atmosphere from exit 60 of the vertically extending exit duct 58.

Further to facilitate the muffling effect of the muffler 56, the exit duct 58 is provided with a plurality of muffling or sound-absorbing panels 66 which extend across the exit duct 58 and are secured at their ends to the side walls of said exit duct by any suitable means. The various muffling panels 66 are similar to panels 10 in structure and are disposed in parallel, spaced relationship to each other as clearly shown in Figure 8.

The longitudinal cavity defined by the cover plates 16 of the panels assembled within the duct 36 has a diameter at least several times larger than the diameter of the exhaust 52 which enters the entrance 50 of the duct 36. The entrance 50 is positioned preferably concentrically of the exhaust 52. The exhaust enters the duct 36 at high velocity and, accordingly, creates a very extensive draft effect by drawing atmospheric air into the entrance 50 of the duct, said air surrounding the exhaust 52 and thereby serving to a great extent as a buffer or insulating shield between the exhaust 52 and the cover plates 16 of the panels 10, at least in regard to the panels adjacent the entrance 50. The contact of the relatively cool atmospheric air with the high temperature exhaust gases 52 immediately greatly reduces the temperature of said gases within a comparatively short distance inside the duct 36. Nevertheless,

the panels 10 will be subjected to relatively high temperatures notwithstanding the cooling effect produced by the draft of atmospheric air surrounding the exhaust gases 52.

Inasmuch as the cover plates 16 will be the first element of each panel to be contacted by the hot gases, said cover plates 16 will expand and such expansion will occur before any material expansion of cover plate 18 of each panel will take place. Accordingly, were suitable means not provided to prevent warping of the panels 10 due to the initial expansion of cover plates 16 thereof, the panels would warp in a direction longitudinally thereof. However, the side panel members 12 of each of said panels are provided with slots 34 extending transversely therethrough, as described hereinabove, whereby expansion of the web of the side channel members 12 secured to the cover plate 16 is prevented or counteracted to a material extent. Further, the positioning of said flanges of side channel members 12 and the edges of plates 16 connected thereto between head flanges 46 and securing plates 48 of the T-shaped members 42 will also aid in preventing or counteracting any tendency of the panels 10 to buckle or warp longitudinally when engaged by the hot gases of exhaust 52.

Due to the slidable manner in which the panels are supported within the duct 36 by T-shaped members 42 the panels may expand longitudinally a limited amount within the duct 36. Such mounting of the panels also facilitates the mounting thereof within the duct by sliding the panels into the duct from the entrance 50 and between the supporting T-shaped members 42. In order to suitably finish the entrance 50 of the duct 36 and the exit 50 of the exit duct 58 after mounting the panels 10 or sections thereof therein, end plates 58, shaped to conform to the ends of the panels 10 including the resonating chambers 36, are secured by welding or otherwise to the outermost ends of the panels 10 within the ducts 36 and 58. If for any purpose it is desired to remove panels 10 from the muffler 56 after they are mounted therein as described above, such removal may be facilitated by making the T-shaped members 42 removable from the interior of the muffler by removably securing said members to the muffler shell by stainless steel bolts extending through the members 42 and said shell.

The aforementioned description has referred to the plates 16 and 18 being anchored by welding or otherwise at their edges to the side and end channel members of the panels 10 and also to supporting members 32 extending between the side channel members of each panel so as to divide the cover plates into a plurality of adjoining diaphragm-like areas which are independently vibratable when engaged by sound waves. The muffler embodying the present invention, to a certain extent, will have to be custom designed to suit each individual situation requiring such muffler for purposes of providing vibratable diaphragm-like areas in the cover plates 16 and 18 of suitable size that they may readily be vibrated by the sound waves, or shock waves surrounding the sound waves, and such vibrations will be transmitted to the sound blocks 22 and layers 24 of mineral wool felt behind the various cover plates 16. The size of said areas will vary in accordance with the frequency and wave length of the sound waves, the velocity of the gas, and also in accordance with the thickness of cover plates 16 and 18.

The sound waves produced by an exhaust

from a jet engine are of a number of different frequencies and wave lengths. The relatively short waves of high frequency are driven against the vibratable diaphragm-like areas into which the cover plates 16 are divided and are driven through the perforations therein into the sound blocks 22 and layers 24 of wool felt which absorb said high frequency, relatively short waves.

The lower frequency and longer wave length sound and shock waves directly engage the diaphragm-like areas of the adjoining cover plates 16 and cause said areas to be vibrated. The vibrations thereof are absorbed by the sound blocks 22 and layers 24 of the wool felt therebehind. Any sound waves which completely traverse the thickness of the panels between cover plates 16 and 18 will cause some vibration of the vibratable diaphragm-like areas in cover plate 18, or pass through the perforations therein and be expended within the resonating chambers 26 of the panels 10.

The substantially rigid construction of each panel and the relatively rigid mounting of each panel within the ducts 36 and 58 readily lends the vibratable areas of the cover plates 16 and 18 to being vibrated effectively so as to dissipate the sound waves in addition to certain of the sound waves passing through the perforations in the plates 16, whereby the vibrations of the plates 16, as well as the sound waves passing therethrough, are readily absorbed by the sound blocks 22 and the layers 24 of mineral wool felt behind cover plates 16. All of the construction is also such as to withstand readily the relatively high temperatures to which the muffler is subjected.

The sheets 20 of heat resisting fabric, or matted fibers, which are disposed directly behind the cover plates 16, serve to prevent any appreciable amount of shattered particles of the sound blocks 22 or layers 24 of mineral wool felt from passing from the interior of the panels 10 into the passage through the muffler 56 in the event said sound blocks or layers of felt should become more or less shattered due to the vibrations of the aforementioned areas of plates 16 beating against said sound blocks and layers of felt.

The gases of the exhaust 52 which enter the entrance 50 of the duct 36 or the muffler 56 are cooled by the draft effect of atmospheric air rushing into the duct 36 and surrounding the exhaust 52 as has been stated above. Such cooling effect is also supplemented by the provision of a water-spray arrangement comprising a plurality of rings 70 of pipe, preferably formed from stainless steel, and perforated at regularly spaced intervals throughout the length thereof, such perforations extending radially from said pipe toward the center of the ring of pipe. A plurality of rings 70 are disposed in regularly spaced relationship to each other within the interior of duct 36, as is clearly shown in Figures 4 and 5. The rings 70 are interconnected by pipes 72 and the outer end of outermost pipe 72 may be connected to a suitable source of water supply, preferably under pressure.

When water is flowing from the pipes 72 to the perforations of the pipe rings 70, a series of sprays 74 thereof are directed toward each other so as to intersect the entering stream of exhaust gases and thereby perform the dual function of cooling the gases and coincidentally breaking the sound waves surrounding the exhaust 52. The water sprays will, to a large extent, be flashed into steam due to the relatively high temperatures of the exhaust 52, and the

vapor atmosphere produced will also tend to dampen the sound waves of the exhaust, as well as operating to break the shock waves surrounding the exhaust.

The exhaust from a jet engine also has a tendency to spiral. If such spiral exhaust engaged a cylindrically flat inner surface in duct 36, the spiraling gases will tend to shear off the inner surface of said duct and present less possibility of engaging said gases and sound waves for absorbing and dissipating the same by the panels 10. However, the shape of the inner surface of the duct 36 is polygonal in cross section due to the edge abutting relationship of the plurality of substantially flat panels 10 disposed longitudinally within the shield of duct 36. The dihedral angle between each adjoining row of panels 10 provides cavities within which the spiraling exhaust gases become somewhat trapped and retarded while spiraling and thus produces an irregular surface with which the spiraling gases engage. The contact of the spiraling gases with the surfaces defining the dihedral angles therefore tends to retard and break up the spiraling movement of the gases, whereby the gases move through the interior of the duct 36 at a rate sufficiently slow that the same may be readily dissipated or absorbed by the panels 10 in the several manners described hereinabove.

Mufflers such as the muffler 56 described hereinabove may be used in a number of different installations which require the muffling of sound accompanied by relatively high temperatures. For example, such mufflers may be used with highly satisfactory results while testing jet engines mounted on a stationary test stand and operated for testing purposes. The mufflers 56 may be stationarily mounted with the entrance 50 thereof adjacent and concentric with the exhaust of the jet engine so as to muffle satisfactorily the sound of the exhaust and also to reduce the temperatures thereof before the same is discharged to the atmosphere.

A muffler of the type described hereinabove may also be used to muffle the sound of jet engines of planes while, for example, on an airfield prior to a take-off or immediately following a landing so as to muffle the extensive roar produced by such jet engines. To this end the present invention contemplates the mounting of wheels 76 and 78 adjacent opposite ends of the muffler 36, as shown in Figures 8 and 9. The wheels 78 may be pivotally mounted so as to permit steering the muffler while being transported and positioned relative to a jet plane 54. A mobile muffler of this type may be positioned readily by a small truck or tractor and thus easily be moved into operative position relative to exhaust of jet plane.

In order to brace the muffler 36 so as to withstand the thrust imposed thereagainst by the exhaust 52, the muffler 56 is provided at opposite sides with a pair of bracing legs 80 which are pivotally connected at one end to opposite sides of the elbow 62, for example. When the muffler is being transported, the legs 80 are folded against the sides of the duct 36 as shown in dotted lines in the Figure 8. In operative bracing position, the legs 80 are disposed in full line positions thereof illustrated in Figures 8 and 9, and the same may be held in this position by any suitable means such as a pair of struts 82 which may be secured at one end to the outer ends of the legs 80 and, for example, to the member 84 extending from elbow 62 and which supports the wheels 78.

The outer ends of legs 80 may also be provided

with friction feet 86, engageable with the ground or any other supporting surface on which the muffler may be disposed. The feet 86 are connected to the outer ends of legs 80 by threaded rods, or any other suitable means by which the feet may be elevated away from and moved into engagement with the ground surface 88.

From the foregoing it would seem that the present invention provides a muffler comprising a plurality of acoustical panels disposed so as to provide a lining for a duct into which heated gases are discharged and such gases are not only muffled, but the temperature thereof is reduced materially before the gases are discharged to the atmosphere. A muffler of this nature is adapted to muffle the sound produced by and reduce the temperature of a stream of gases of various types and particularly those issuing from the exhaust of a jet type engine. The muffler panels of the muffler are capable of absorbing and dissipating sounds of a relatively wide range of frequencies and wave lengths.

The materials from which the muffler is formed are readily capable of withstanding the relatively high temperatures generated by the exhaust of jet type engines and the absorption and dissipation of the sound produced by such exhaust is facilitated by providing water spray means to break the shock waves surrounding the exhaust and thus rendering the sound waves more susceptible to absorption and dissipation by the muffler. The muffler is also constructed so as to reduce the spiraling movement and thereby reduce the speed of gases from the exhaust of jet type engines, whereby the sound waves produced by the exhaust are somewhat trapped and thus rendered more easily absorbed and dissipated by the muffler.

While the invention has been illustrated and described in its preferred embodiment and has included certain details, it should be understood that the invention is not to be limited to the precise details herein illustrated and described, since the same may be carried out in other ways, falling within the scope of the invention as claimed.

I claim as my invention:

1. An acoustical panel capable of withstanding high temperatures of the order encountered in the exhaust stream of a jet engine or the like and comprising, in combination, a frame defining the sides and ends of said panel, perforated metallic cover plates fixed at the edges thereof to and supported by said frame in spaced parallel relation to each other, said plates being of adequate gauge to withstand said high temperatures and defining the rigid outer surfaces of said panel, one of said cover plates being disposed toward a source of sound and heat, a layer of non-shatterable and incombustible fabric adjacent the inner surface of said one cover plate, a relatively thick layer of sound absorbing mineral wool between said fabric and other perforated cover plate, supporting means extending across said frame and anchored to said one cover plate to rigidly support it intermediately of its edges, and an imperforate metal sheet curved transversely between the side edges of said other cover plate and secured at its edges to said edges of said plate, said sheet being spaced intermediately of its edges from the outer surface of said cover plate to provide a resonating chamber of varying depth adjacent said plate.

2. An acoustical panel capable of withstanding high temperatures of the order encountered

in the exhaust stream of a jet engine or the like and comprising, in combination, a frame comprising channel members joined at the ends thereof to define the sides and ends of said panel, perforated metallic cover plates of relatively heavy gauge welded at the edges thereof to the spaced flanges of said channel members of said frame and the side channels of said frame being divided transversely intermediately of the ends thereof to permit said panel to expand when subjected to high temperatures, said plates being in spaced parallel relation to each other and defining the rigid outer surfaces of said panel and one of said cover plates being disposable toward a source of sound and heat, a layer of non-shatterable and incombustible fabric adjacent the inner surface of said one cover plate, a relatively thick layer of sound absorbing mineral wool between said fabric and other perforated cover plate, and resonator attached to said other cover plate comprising an imperforate rectangular sheet curved about a central axis and having its edges secured to the edges of the plate.

3. A sound muffler for use in connection with the exhaust stream of a jet engine or the like comprising a substantially cylindrical shell, and a plurality of flat rectangular acoustical panels secured at the side edges thereof against the inner surface of said shell and in edge abutting relation to each other to form a polygonal passageway; each of said panels being held by said shell against movement radially of said shell and each panel comprising a frame defining the sides and ends thereof, perforated metallic cover plates of relatively heavy gauge attached at the edges thereof to said frame in spaced parallel relation to each other, a layer of incombustible fabric adjacent the inner surface of the cover plate farthest from said shell, sound absorbing mineral wool between said fabric and the other perforated cover plate, and supporting means extending between the sides of said frame and secured to said cover plate farthest from said shell intermediately of the edges of said plate to divide said plate into diaphragm-like areas supported at the edges thereof rigidly relative to the shell of said muffler.

4. An acoustical duct comprising a substantially cylindrical shell, a plurality of flat rectangular acoustical panels forming a polygonal passageway through the cell, and means secured to the inner surface of said shell and extending radially inward therefrom and longitudinally of said shell, said means engaging the sides of said panels and slidably supporting said panels in edge to edge relationship for relative expansible movement longitudinally of said shell, each of said panels being supported by said means against movement radially of said shell and each panel comprising a frame defining the sides and ends thereof, perforated metallic cover plates of relatively heavy gauge attached at the edges thereof to said frame in spaced parallel relation to each other, a layer of incombustible fabric adjacent the inner surface of the cover plate farthest from said shell, sound absorbing mineral wool between said fabric and the other perforated cover plate, and supporting means extending between the sides of said frame and secured to said cover plate farthest from said shell intermediately of the edges of said plate to divide said plate into diaphragm-like areas supported at the edges thereof rigidly relative to the shell of said duct.

5. An acoustical duct comprising a substantially cylindrical shell, a plurality of flat rectangular acoustical panels and elongated T-shaped members secured at the outer edges of the webs thereof to the inner surface of said shell and extending radially inward therefrom and longitudinally of said shell, the top portions of said T-shaped members slidably engaging the side edges of said panels and supporting said panels in edge to edge relationship around the interior of said shell for expansible movement longitudinally thereof and providing spaces between the central portions of said panels and said shell comprising resonating chambers; each of said panels being supported by said T-shaped members against movement radially of said shell and each panel comprising a frame defining the sides and ends thereof, perforated metallic cover plates attached at the edges thereof to said frame in spaced parallel relation to each other, sound absorbing mineral wool between said cover plates, and supporting means extending between the sides of said frame and secured to said cover plate farthest from said shell intermediately of the edges of said plate to divide said plate into diaphragm-like areas supported at the edges thereof rigidly relative to the shell of said duct.

6. An acoustical duct comprising a substantially cylindrical shell, a plurality of flat rectangular acoustical panels secured at the side edges thereof against the inner surface of said shell and in edge abutting relation to each other to define an interior gas conducting channel within said shell; each of said panels being held by said shell against movement radially of said shell and each panel comprising a frame defining the sides and ends thereof, perforated metallic cover plates attached at the edges thereof to said frame in spaced parallel relation to each other, a layer of incombustible fabric adjacent the inner surface of the cover plate farthest from said shell, sound absorbing mineral wool between said fabric and the other perforated cover plate, and supporting means extending between the sides of said frame and secured to said cover plate farthest from said shell intermediately of the edges of said plate to divide said plate into diaphragm-like areas supported at the edges thereof rigidly relative to the shell of said duct; and water spray means positioned within said channel and comprising a plurality of perforated pipe rings spaced apart longitudinally of said channel, and interconnecting said rings and connectible with a water supply.

7. A sound muffler for use in connection with the exhaust stream of a jet engine or the like comprising a substantially cylindrical outer shell and having a passageway extending longitudinally therethrough, said passageway being polygonal in cross-section and defined by a plurality of flat rectangular acoustical panels extending longitudinally of said shell and secured at the side edges thereof to said shell and substantially in edge abutting angular relationship to each other; each of said panels being held by said shell against movement radially of said shell and each panel comprising a frame defining the sides and ends thereof, perforated metallic cover plates of relatively heavy gauge attached at the edges thereof to said frame in spaced parallel relation to each other, a layer of incombustible fabric adjacent the inner surface of the cover plate farthest from said shell,

sound absorbing mineral wool between said fabric and the other perforated cover plate, and supporting means extending between the sides of said frame and secured to said cover plates intermediately of the edges thereof to define diaphragm-like areas of said plate rigidly supported at the edges thereof relative to the shell of said muffler.

8. An acoustical duct comprising a substantially cylindrical shell open at one end to provide an entrance and provided at the other end with a substantially right-angled elbow and exit shell extending upward from said elbow, wheels rotatably supported by said duct adjacent the opposite end thereof to render the duct mobile, bracing means connected to said duct and engageable with the surface supporting said duct in a manner to resist movement of said duct in a direction from the entrance to the exit end thereof, and a plurality of acoustical panels secured at the side edges thereof against the inner surface of said shell and in edge abutting relation to each other to provide a lining for said shell from the entrance to the exit thereof; each of said panels being held by said shell against movement radially of said shell and each panel comprising a perforated metallic cover plate interconnected at the edges thereof to said shell and in spaced relation thereto, sound absorbing mineral wool between said cover plate and said shell, and supporting means interconnected to said shell and extending between the edges of and connected to said cover plate to divide said plate into diaphragm-like areas rigidly supported at the edges thereof and vibratable radially relative to said shell of said duct.

9. An acoustical duct comprising a substantially cylindrical shell open at one end to provide an entrance and provided at the other end with a substantially right-angled elbow and exit shell extending upward from said elbow, wheels rotatably supported by said duct adjacent the opposite ends thereof to render the duct mobile, a pair of bracing legs pivotally connected at one end to opposite sides of said duct adjacent the exit end thereof and extendable outward from said opposite sides of said duct and engageable with the surface supporting said duct to resist movement of said duct in a direction from the entrance to the exit thereof, said legs being foldable against the sides of said duct for support thereby during mobile movement thereof, and a plurality of acoustical panels secured at the side edges thereof against the inner surface of said shell and in edge abutting relation to each other to provide a lining for said shell from the entrance to the exit thereof; each of said panels being held by said shell against movement radially of said shell and each panel comprising a perforated metallic cover plate interconnected at the edges thereof to said shell and in spaced relation thereto, sound absorbing mineral wool between said cover plate and said shell, and supporting means interconnected to said shell and extending between the edges of and connected to said cover plate to divide said plate into diaphragm-like areas rigidly supported at the edges thereof and vibratable radially relative to said shell of said duct.

10. A sound muffler for use in connection with the exhaust stream of a jet engine or the like comprising a substantially cylindrical shell, a plurality of flat rectangular acoustical panels secured at the side edges thereof against the inner surface of said shell in edge-abutting rela-

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tion to each other to define a gas passageway of polygonal cross section, each of said panels comprising a frame defining the sides and ends thereof, perforated metallic cover plates of relatively heavy gauge attached at their marginal portions to said frame in spaced parallel relation to each other, a sheet of incombustible fabric adjacent the inner surface of the cover plate farthest from said shell, a sound absorbing pack between said fabric and the other cover plate, and impervious means curved transversely between the side edges of said other cover plate and secured thereto with its intermediate portion in spaced relation to the intermediate portion of said other cover plate to define a resonating chamber therewith, said panels being arranged within said shell with the intermediate portions of said impervious means adjacent the surface of said shell.

11. A sound muffler for use in connection with the exhaust stream of a jet engine comprising a tubular shell curvilinear in cross-section and open at one end for receiving the exhaust stream, and a lining for said shell forming an exhaust passageway through the muffler of polygonal cross-section comprising a plurality of flat rectangular acoustical panels secured at the side edges thereof against the inner surface of the shell in edge-abutting relation to each other and in chordal relationship with the shell to form resonator spaces therebetween, each of said panels comprising a frame defining the sides and ends thereof, rigid metallic plates attached at their marginal portions to said frame in spaced parallel relation to each other to form front and back cover plates for the panels, said plates having spaced apart perforations therein and a relatively thick layer of sound absorbing material between said plates.

12. A sound muffler for use in connection with the exhaust stream of a jet engine comprising a tubular shell curvilinear in cross-section and open at one end for receiving the exhaust stream, and a lining for said shell forming an exhaust passageway through the muffler of polygonal cross-section comprising a plurality of flat rectangular acoustical panels secured at the side edges thereof against the inner surface of the shell in edge-abutting relation to each other and in chordal relationship with the shell to form resonator spaces therebetween, each of said panels comprising a frame defining the sides and ends thereof, rigid metallic plates attached at their marginal portions to said frame in spaced parallel relation to each other to form front and back cover plates for the panels, said plates having spaced apart perforations therein, means forming a resonating chamber associated with each panel comprising a curved imperforate metallic sheet secured at opposite edges of the back cover plate and accommodated between the back cover plate and the muffler shell, and a relatively thick layer of sound absorbing material between said plates.

13. An acoustical panel capable of withstanding the velocity and temperature conditions encountered in the exhaust stream of a jet engine and effective for attenuating sound varying over a wide frequency range comprising a rectangular

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frame, a pair of flat and rigid metallic plates of relatively heavy gauge for withstanding said velocity and temperature conditions fixed at the side edges thereof to opposite sides of the frame in parallel spaced apart relation to form front and back cover plates, both of said plates having spaced apart perforations therein for the passage of sound waves therethrough, a first layer of mineral material capable of withstanding said velocity and temperature conditions, a relatively thick second layer of mineral sound absorbing material disposed between the plates, said first layer being situated adjacent the perforated front cover plate and the second layer being situated adjacent the perforated back cover plate, and means forming a resonating chamber of varying depth behind the back cover plate comprising a curved imperforate metallic sheet secured at opposite edges of the back cover plate.

14. An acoustical duct comprising a substantially cylindrical shell open at one end to provide an entrance and provided at the other end with a substantially right-angled elbow and exit shell extending upward from said elbow, a plurality of curved deflector vanes spaced from each other and extending transversely across said elbow, said vanes being engageable by gases and operable to change the direction of flow thereof to direct them upward into said exit shell, and a plurality of acoustical panels secured at the side edges thereof against the inner surface of said shell and in edge abutting relation to each other to provide a lining for said shell from the entrance to the exit thereof; each of said panels being held by said shell against movement radially of said shell and each panel comprising a perforated metallic cover plate interconnected at the edges thereof to said shell and in spaced relation thereto, a layer of incombustible fabric adjacent the inner surface of the cover plate, sound absorbing mineral wool between said fabric and said shell, and supporting means interconnected to said shell and extending between the edges of and connected to said cover plates to divide said plate into diaphragm-like areas rigidly supported at the edges thereof and vibratable radially relative to said shell of said duct.

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