

June 4, 1968

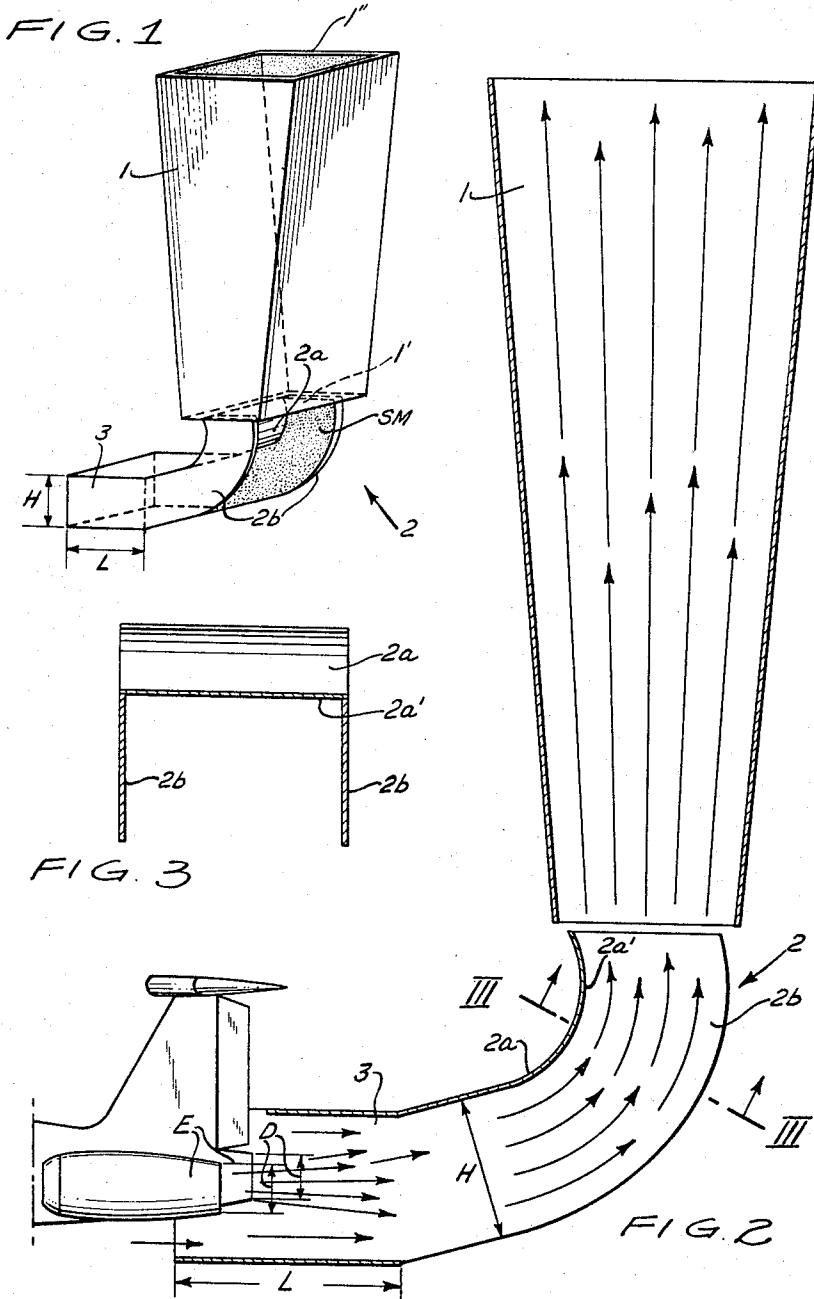
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3,386,528

JET ENGINE SOUND SUPPRESSOR WITH COANDA EFFECT DEFLECTOR

Filed July 5, 1967

4 Sheets-Sheet 1



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JET ENGINE SOUND SUPPRESSOR WITH COANDA EFFECT DEFLECTOR

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FIG. 4

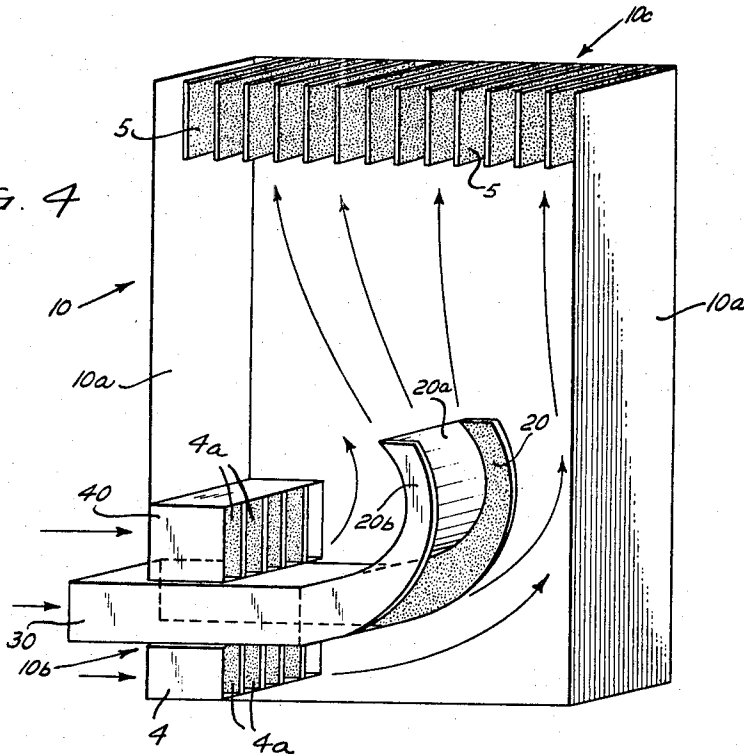


FIG. 5

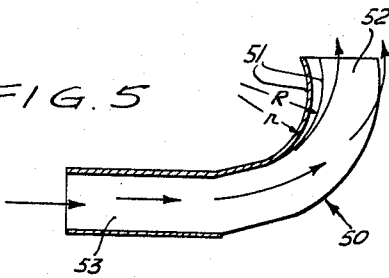


FIG. 6

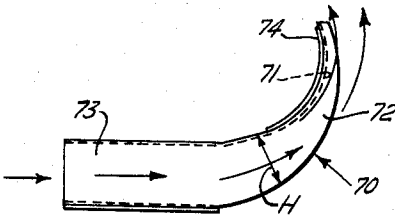
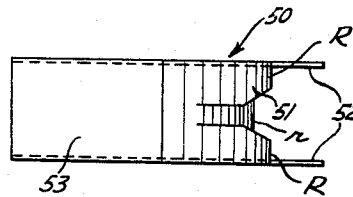


FIG. 7

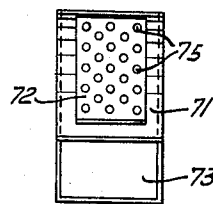


FIG. 8

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FIG. 9

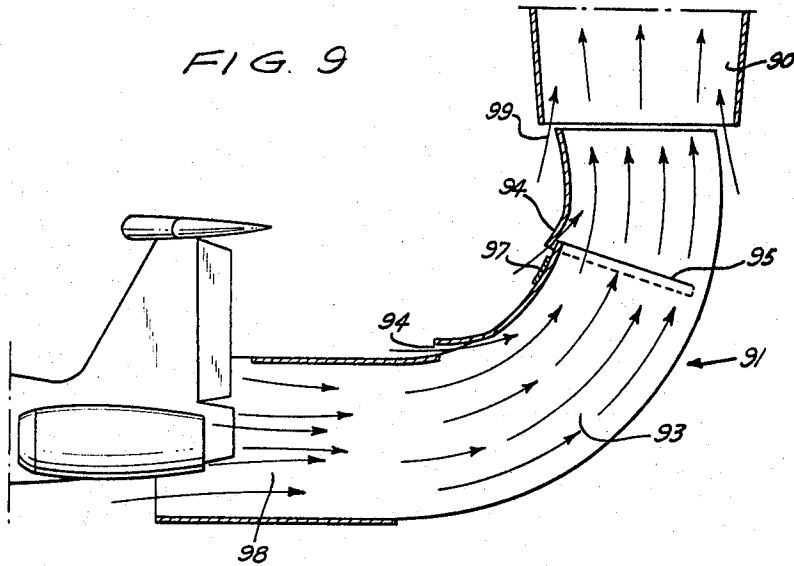
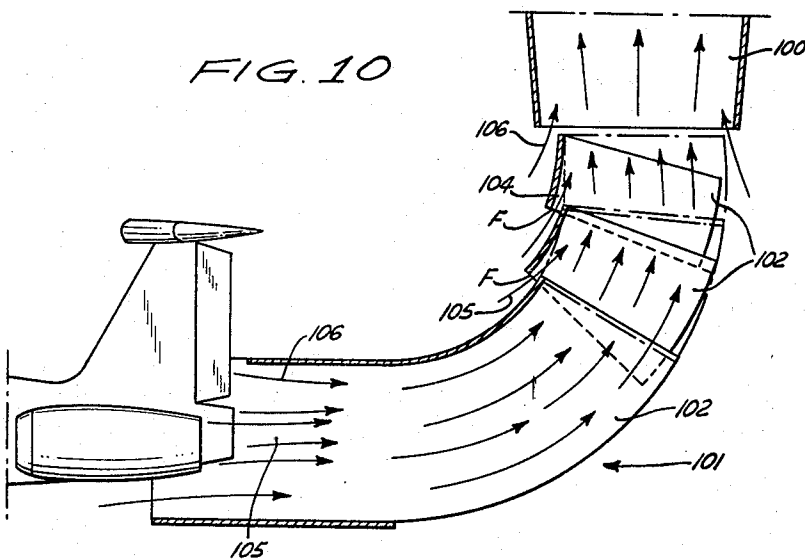


FIG. 10



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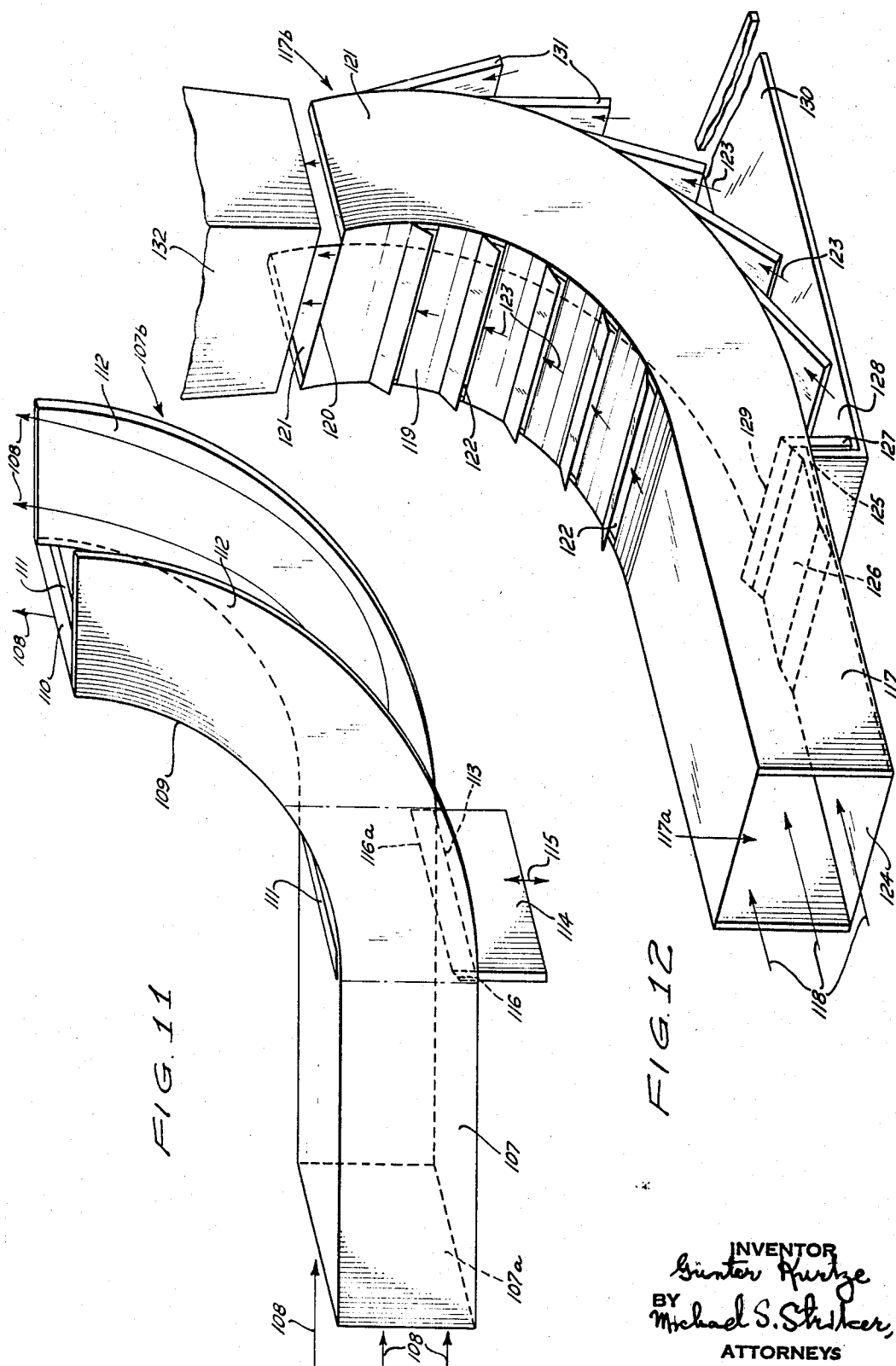
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3,386,528

JET ENGINE SOUND SUPPRESSOR WITH COANDA EFFECT DEFLECTOR

Filed July 5, 1967

4 Sheets-Sheet 4



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3,386,528

JET ENGINE SOUND SUPPRESSOR WITH COANDA EFFECT DEFLECTOR

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Continuation-in-part of application Ser. No. 423,647,
Jan. 4, 1965. This application July 5, 1967, Ser.
No. 651,330

Claims priority, application Germany, Jan. 4, 1964,
G 39,538; Aug. 1, 1964, G 41,243
21 Claims. (Cl. 181-51)

ABSTRACT OF THE DISCLOSURE

A deflector for streams of hot gases issuing from a jet engine. An elongated channel has a substantially horizontal first portion provided with an inlet, and a substantially vertical portion communicating with the first portion and provided with a substantially vertically directed outlet. Deflector means is arranged in the channel intermediate the inlet and the outlet so as to deflect a horizontal gas stream, entering the channel through the inlet, in vertical direction for passage toward and outwardly beyond the outlet.

Cross-reference to related applications

This application is a continuation-in-part of my earlier application, Ser. No. 423,647, filed on Jan. 4, 1965, under the title, "Sound Suppressor." and now abandoned.

Background of the invention

The present invention relates to deflectors in general, and more specifically to deflectors for use in deflecting the stream of gas issuing from a jet engine. Still more particularly, it relates to deflectors which are also adapted for use in suppressing the sound of jet engines.

In developmental testing of jet engines, and in the testing for maintenance purposes of jet engines installed in grounded aircraft, it is necessary to use sound suppressors to mitigate the extremely loud noise resulting from operation of such engines. This is necessary in consideration of the welfare of personnel working with such engines and, in certain areas of localities where an airport or testing facilities for jet engines are located close to human habitations, it is even required by law.

Sound suppressors presently used for the purpose of suppressing the sound of jet engines which latter, it will be understood, may or may not include an after-burner, are horizontally extending elongated tubular structures lined with sound-absorbing material. The outlet end of such ducts is generally directed at an angle to the axis of the duct, usually normal thereto, so that the gases passing through the duct are directed upwardly into the atmosphere.

The dimensions of the sound suppressors hitherto known are governed by the maximum volume of exhaust gas and coolant which must flow through them, as well as by the velocity of flow and the temperature of the gas. Taking all of these considerations into account, the length and the free cross-sectional interior area of the duct must be at least large enough to prevent the walls of the duct, particularly in the region where the duct is upwardly curved, from becoming damaged.

As a result of these considerations the cross-section of sound suppressors of the type set forth above is necessarily quite large and such sound suppressors are heavy and very difficult to transport. They also are generally very long and require large amounts of floor space, a

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requirement which often makes it difficult or even impossible to install them.

Summary of the invention

The present invention provides a deflector for the gas stream of jet engines which avoids the above-mentioned drawbacks of the known art.

The deflector according to the present invention is relatively light in its construction and requires comparatively little floor space.

In accordance with the invention my novel deflector has its major extension in a vertical plane.

My novel deflector includes a vertical sound suppressor provided with a means for deflecting a horizontal stream of exhaust gases emanating from a jet engine or the like upwardly into the sound suppressor, and assures the prevention or any damage to the suppressor from the heat of the impinging gases.

In the novel deflector and sound suppressor according to the invention the cross-sectional dimensions of the gas stream can be so varied that the ratio of length to width of the outlet of the structure can be comparatively large, whereby the sound suppressing capacity of the structure is enhanced.

The flow of gases in my novel deflector is controlled, in accordance with the invention by the principles of the Coanda effect.

In accordance with one feature of my invention I provide in a deflector adapted to be used with a jet engine, in combination, an elongated channel having a substantially horizontal first portion of substantially constant cross-section and provided with an inlet adapted to receive a stream of gas discharged in horizontal direction from the outlet of a jet engine, and a substantially vertical second portion communicating with the first portion and provided with a substantially vertically directed outlet spaced from the inlet, and deflecting means arranged intermediate the inlet and the outlet, for vertically deflecting the gas stream toward and outwardly beyond the outlet of the second portion.

Provision of a substantially vertical channel will of course reduce the amount of floor space required for the device. However, since it is not generally possible to so arrange the engines to be tested that their outlet nozzles point upwardly—this may be possible in rare cases in development work, but is normally impossible with engines installed in an aircraft—the horizontally directed stream of exhaust gases must somehow be deflected so that it will traverse the height of the vertical channel.

This is accomplished, in accordance with the invention, by providing a deflector means at the inlet, that is the lower end, of the vertical channel. Of course, various kinds of deflector means could be used. However, the ones customarily proposed for such purposes are disposed in the path of the gases so that the latter must impinge on the deflector means and be deflected thereby. Since the gases are exceedingly hot, even the best deflector means heretofore proposed is subject to relatively speedy damage and final destruction. In some cases, damage to the actual sound-absorbing duct structure may also result.

To overcome this I provide a deflector means utilizing the well-known Coanda effect, that is the phenomenon according to which a stream of gas traveling at high speed will hug a convexly curved surface and will be guided thereby in the desired direction.

Of course, it should advantageously be possible to influence the gas stream in some manner, if, as set forth earlier, a change in its normal cross-sectional area will permit construction of a more efficient sound-suppressing channel. For this reason the invention includes provision for enabling aspiration of cooling air by the gas stream.

The addition of such air will not only help to cool the deflector means and thus guard it against damage, but will also counteract the suction on which the Coanda effect is based, thus enabling the stream of gas to fan out in one transverse direction, that is, to become thinner. The same result can also be achieved by making the radius of curvature of the convex surface greater along its edge portions than in the center. However, this is not the embodiment I prefer to use.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

Brief description of the drawing

FIG. 1 is a perspective view of one possible embodiment of a deflector constructed in accordance with the invention;

FIG. 2 is a sectional elevation of the device shown in FIG. 1;

FIG. 3 is a sectional elevation of the deflector member taken on the line III—III of FIG. 2;

FIG. 4 is a perspective view of another embodiment constructed in accordance with the invention;

FIG. 5 is a sectional elevation of a particular embodiment of the deflecting member;

FIG. 6 is a plan view of the embodiment shown in FIG. 5;

FIG. 7 is another embodiment of a deflecting member in a view similar to that of FIG. 5;

FIG. 8 is a front view of the embodiment shown in FIG. 7;

FIG. 9 is a sectional elevational view of another embodiment of the inventive deflector;

FIG. 10 is yet another embodiment of the inventive deflector in a view similar to that of FIG. 9;

FIG. 11 illustrates an additional embodiment of the invention in a perspective view; and

FIG. 12, in another perspective view, illustrates still a further embodiment of the invention.

Description of the preferred embodiments

Referring now to the drawings, and firstly to FIGS. 1-3, the inventive deflector will be seen to comprise a substantially vertical elongated channel portion 1, which will advantageously be provided in its interior with suitable sound-absorbing means SM, and which has at its bottom end an inlet 1' and at its top end an outlet 1''. A deflecting member 2 in the form of a convexly curved deflecting plate 2a and a pair of side walls 2b, which extend from opposite longitudinal edge portions of plate 2a normal thereto, is suitably connected to the inlet 1' of portion 1. The side walls 2b which can be, but need not be provided, have a height H which is preferably three times the diameter D of the outlet of a jet engine E whose sound is to be suppressed. To facilitate communication between the inventive device and the jet engine E the deflecting member 2 is provided with a linear horizontal channel portion 3, and such an extension may have a length L which is preferably equal to approximately 2.5-3 times the height H of the side walls 2b. While the deflecting member itself should have at least one open side, that is, have no more than three wall surfaces, the horizontal portion 3 may be constructed as a duct, as a tube, etc. As clearly shown in the drawings, the plate 2a is upwardly convex, that is, it curves from the horizontal upwardly to a vertical direction.

The construction shown in FIGS. 1-3 is based on the well-known Coanda effect, that is the phenomenon according to which a stream of gas will hug and flow along a convexly curved guide surface such as the inner convex

surface 2a' of the plate 2a, and may thus be deflected into a given direction.

In operation of the device, the discharge nozzle of a jet engine E is placed into communication with the horizontal channel portion 3 which, of course, in effect constitutes an extension of the deflecting member. As the engine E is started and a stream of hot gases begins to emanate from the discharge nozzle, the convex plate 2a will guide the stream of gas from the horizontal into a vertical direction so that it is forced to traverse the length of channel 1 and to leave the latter through the outlet 1'' thereof. It will thus be seen that, contrary to the practice hitherto common, the exhaust gases leave the device at a point well upwardly of their point of origin so that the major portion of the noise which manages to pass through the suppressor is directed upwardly, and that amount of noise which inevitably radiates in lateral direction will do so at a considerable distance above the ground, thus creating less of a nuisance at ground level.

It will be understood that the deflecting member 2 should directly precede the vertical portion 1. However, as clearly shown in FIG. 4, it may be so constructed as to project with its discharge end directly into this vertical portion, rather than being merely connected to the inlet thereof. In the embodiment shown in FIG. 4 the vertical channel portion 10 comprises the side walls 10a and is provided at its upwardly directed outlet 10c with a plurality of sound-suppressing baffles 5. Such baffles may be arranged in any suitable manner to obtain maximum suppression of noise; in FIG. 4 they are shown in parallel relationship extending across the width of the channel portion 10. However, since the baffles form no part of the invention they will not be further described. The deflecting member 20 is partially positioned within portion 10, that is, its convexly curved plate 20a and the side walls 20b cooperating therewith are disposed within the portion 10, together with a section of the horizontal channel portion 30, while the free end of the horizontal portion 30 extends outwardly through the inlet 10b of portion 10 and therebeyond. Directly above and below the inlet 10b the vertical portion 10 is provided with openings 40 for permitting the entry of air. Such openings may also be provided with sound suppressing baffles 40a. In positioning the curved plate 20a within vertical channel portion 10 care must be taken that the stream of gases entering through inlet 10b, cannot impinge upon the walls 10a of portion 10 until deflection by plate 10a has taken place. Otherwise the gases would not be properly conducted through the portion 10 and, moreover, direct impinging of the hot gases on the wall 10a at right angles thereto would very quickly cause severe damage to the wall.

FIGS. 5-8 illustrate two embodiments of the deflecting member, having in common the provision of means for controlling the flow of the stream of gas discharged by the jet engine. Discussing firstly the embodiment shown in FIG. 5, it will be seen that the deflecting member shown here is identified with reference numeral 50 and comprises a curved deflecting plate 51 which is formed along opposite longitudinal edge portions with respective radii R which are larger than the radius of curvature r at the center portion of the plate. Since the centrifugal forces acting on that part of the stream of gases which passes along the center portion of the plate are thus larger than those acting on the portions passing along the edges of the plate, the stream of gases is thus caused to fan out in transverse direction. At the same time, a pressure differential is created between the gas portions and that at the center of plate 51 so that a flow of gas from the edge portions toward the center, and a consequent aspiration of cooling air into the gas stream, takes place. The aspiration of cooling air serves to prevent overheating and damage to the deflecting member 50, whereas fanning-out of the gas stream permits a relatively large ratio of length to width of the outlet of the vertical portion, a fact which

enhances the sound-suppressing efficiency of the device. Such a configuration is not possible if the gas stream were to be left alone and permitted to expand freely.

In the further embodiment of the deflecting member shown in FIGS. 7 and 8, additional means for promoting and controlling this fanning-out of the gas stream are provided. The convexly curved deflection plate 71 of the deflecting member 70 shown in these figures is provided with a plurality of apertures 75 through which cooling air can be aspirated into the interior of the deflecting member 70. A sliding member 74, which may also be provided with apertures, is so arranged that the apertures 75 of plate 71 may be completely or partially closed for regulating the amount of air being drawn into the member 70. It will be understood that similar provisions may also be made on the side walls 72 of member 70. Since the Coanda effect achieved with deflector 70 is based on the suction principle, the aspiration of air through such apertures results in local reduction of the suction effect, thereby enabling the stream of gases to fan out to a greater or lesser degree, depending upon the amount of air aspirated and the positioning of the various apertures.

A similar effect can be achieved by decreasing the height of at least one side wall 71 of the deflecting member 70 in the direction of flow, if the deflecting member is indeed provided with such side wall. The amount of air being aspirated into member 70 increases with the decrease in height of the side wall. It is therefore possible to achieve a desired degree of break-away of the gas stream from the convex inner surface of the plate 71, and consequent fanning-out of the stream, by suitably reducing the height of the side wall in the direction of flow of the stream. This is clearly shown in FIG. 7 of the drawing.

Yet another way of causing the gas stream to fan out is to decrease the radius of curvature of the deflecting plate in the direction of flow. In a preferred embodiment of this concept the radius of curvature of the deflecting plate will decrease at a uniform and linear rate (see FIG. 2); however, it is possible also to provide different constructions in which the curvature will decrease progressively or non-uniformly, for example in a series of steps (compare FIG. 9). However, this will not aid in protecting the deflecting member from the detrimental effects of the heat of the stream of gases although it will as already pointed out, serve to reduce the thickness of the gas stream in one transverse direction before the stream enters the vertical channel portion. Thus, any one of the constructions discussed herebefore permits the use of a vertical channel portion which need be widened only in the plane of curvature and in the direction of flow of the gas, this being the most efficient configuration for the vertical portion.

Still other, and preferred embodiments of the inventive device are shown in FIGS. 9 and 10. Firstly, in FIG. 9, the curved plate 92 will be seen to be provided with injector-type openings 94, that is openings which extend through the plate 92 and communicate with the interior of member 91 in the direction of flow of the stream of gases emanating from the jet engine E. Such openings, of which one or more may be provided, will preferably extend across the entire width of the plate 92. Similar openings may also be provided in one or both of the side walls 93 and are indicated in FIG. 9 with reference numeral 95. The advantage of injector-type openings over the apertures described earlier with reference to FIG. 7 is that a stream of air, indicated by the arrow 99, is drawn through the openings 94 in the direction of flow of the gas stream 98 and forms a relatively cohesive film or layer of air between the stream 98 of gases and the convexly curved inner surface of deflector plate 92. This film serves to prevent direct contact of the very hot gases 98 with the plate 92 and thus prevents damage to the latter. Because of the injector effect provided by the openings 94 the air aspirated therethrough will tend to cling to the aforementioned convex inner surface of plate 92 im-

mediately upon entering into member 95 without promoting any significant turbulence in the gas stream 98, and without becoming admixed with the same. At the same time it will, however, reduce adherence of the gas stream 98 to the plate 92, so that the gas can fan out in the desired way. To permit control of the fanning-out process adjustable flaps 96, slides 97, or like means may be provided for partially or completely closing any or all of the openings 94 or 95.

FIG. 10 shows an embodiment in which the plate 92 is replaced with a plurality of convexly shaped deflecting members 102, 103, etc. These members are so arranged, as seen in the direction of flow of gas stream 105, that the rearward edge portion of each member overlaps the forward edge portion of the member directly preceding it so that there are created in this manner injector-type openings whose cross sections F may be varied at will by adjusting of the members 102, 103, etc. It will be understood, of course, that it is possible to effect such adjustments by servo means (not shown), for instance via remote control from a central control panel to permit increasing or decreasing of the cross sections F while the device is in operation.

An important aspect of the embodiments of the invention shown in FIGS. 9 and 10 is the fact that the film of air drawn through the injector-type openings separates the stream of gas from the convexly curved deflecting plate and forms a highly efficient thermally insulating layer therebetween. As a result of this the plate may be constructed of a less heat-resistant material than would otherwise be necessary, for example, commercially available sheet metal. It will be clear that the possibility of using such material, which is cheaper to manufacture, reduces the cost of the finished device and thereby provides an important economy.

The desirability of being able to protect the deflecting member from the damaging heat of the gas stream, which may reach temperatures of up to 2,000° centigrade, has already been indicated. The face that suitable apertures can be provided through which the suction created by the gas stream aspirates cooling air, has been discussed with reference to some of the preceding figures, and in FIG. 8 such apertures have been shown as foramina although it should in this context be understood that it may be sufficient if the deflecting member and/or the side walls consist of a material which is porous enough to permit the entry of an adequate amount of air.

Under certain circumstances, however, the aspiration of cooling air may create problems in my novel device. This is the case, specifically if the radius of curvature of the deflecting member—or, more precisely, the radius of curvature of the path into which the gas stream is forced by the deflecting member—is very small. In such a construction, which it may be necessary to employ if the horizontal space available for the device is very small, so that upward deflection of the gas stream must be accomplished very quickly, the lift-off effect of the aspirated cooling air would normally be strong enough to overcome the tendency of the gas stream to adhere to the curved deflecting member, and would result in complete break-away of the gas stream, making upward deflection of the latter impossible.

The embodiments illustrated in FIGS. 11 and 12 overcome this problem.

Discussing firstly the embodiment illustrated in FIG. 11, it will be seen that the device shown there is somewhat reminiscent of FIGS. 9 and 10. The horizontal portion of the gas-receiving channel is designated in FIG. 11 with reference numeral 107 and comprises an inlet 107a (shown in dashed lines) which in the afore-described manner is adapted to receive a stream of gas 108 which enters the inlet 107a in the direction of the arrow. The substantially vertical channel portion is generally identified with reference numeral 107b, and the deflecting means 109—which can be a single member or a plurality

of members according to the disclosure in FIGS. 9 and 10—is so arranged that its continuous or composite inner guide surface 110 is exposed to the gas stream 108 and curves convexly upwardly in the direction of the substantially vertically facing outlet of the channel portion 107b.

The deflecting means 109 is provided with apertures which may be of the various types and/or configurations discussed earlier, and of which the slots 111 in FIG. 11 are only intended to be illustrative. Side walls 112 may be provided, in which case the cross-section of the channel portion 107b is substantially U-shaped.

At the inner end 113 of the horizontal channel portion, that is at the point where the upward deflection of the gas stream is to begin, I provide auxiliary deflecting means which is located at the side of the channel opposite the guide surface 110 and which serves to impart to the gas stream a component of movement transversely of the channel and in the direction toward the guide surface 110.

In the embodiment of FIG. 11 this auxiliary deflecting means is constituted by a plate-shaped member 114, an edge portion of which projects into the channel and is provided with an edge face 116 inclined upwardly toward the surface 110 and forwardly in the direction of gas flow. Thus, the gas stream is forced to flow over this edge face 116 and is thereby given a component of movement toward the guide surface 110. To assure a clean breaking-away of the gas stream from the edge face 116, the downstream edge 116a of the latter is configured sharp and knife-like from which the gas stream breaks loose for travel in forward and upward direction. Without this configuration of the edge 116a there is the danger that the gas stream might deflect downwardly away from the guide surface 110.

The member 114 is preferably, but not necessarily, movable in the direction of the double-headed arrow 115 to influence the gas stream at the will of an operator, and instrumentalities suitable for effecting such movement are well known in the art and require no discussion.

The embodiment of FIG. 12 is relatively similar to that of FIG. 11. Again, the channel has a horizontal portion which here is identified with reference numeral 117, as well as a substantially vertical portion 117b. The horizontal portion is provided with an inlet 117a for a stream of gas 118, and the guide member 119 curves upwardly toward the outlet of the portion 117b. Side walls 121 are provided, and the guide member 119 is formed with apertures which here are illustrated as transversely extending slots 122 through which cooling air is aspirated by the suction of the gas stream, as shown by the arrows 123. The slots 122 have been—somewhat schematically—illustrated as being provided with covers or flaps because it is desirable that the cross-sectional area of the openings be adjustable to permit regulation of the amount of cooling air which is being aspirated; evidently, too little aspirated air could result in heat damage to the deflecting member 119 under certain conditions, and too much air could provide excessive lift-off of the gas stream. By providing such adjustability I make it possible to regulate the amount of cooling air in accordance with prevailing conditions, particularly the speed of the gas stream.

As in the embodiment of FIG. 11 I again provide auxiliary deflecting means which here comprises a plate member 127 corresponding to the plate member 114 in FIG. 11, and an insert 126, which overlies a part of the bottom wall 124 of the horizontal channel portion 117 immediately upstream of the plate member 127 and is provided, as shown in dashed lines, with one or more stepped surface portions which effect a step-wise deflection of the gas stream toward the inclined edge face of the member 127, from where the gas stream proceeds as discussed with reference to FIG. 11. A member 128 is arranged downstream, i.e., behind the plate member 127 to aid in counteracting any tendency of the gas stream to move

away from the guide member 119. This member 128 may be adjustable in direction of the arrow 115 in FIG. 11 and comprises, as visible in FIG. 12, a portion which is interposed between insert 126 and member 127 and which serves to guide the gas stream from the former to the latter, and an exposed surface 130 which, together with the inner surfaces of the side walls 121, can be covered with suitable sound-circulating means as discussed earlier.

Unlike FIG. 11, where the side opposite the deflecting member is open, the embodiment of FIG. 12 illustrates that sound-deadening means, for example in form of overlapping elements 131, can be provided at this side. Arrows 123 show that air is then also aspirated through the spaces between these elements 131. Reference numeral 132 indicates a vertical tubular extension which communicates with the outlet of vertical channel portion 117b and which may be provided with sound-insulating means.

While the invention has been illustrated and described as embodied in a substantially vertical sound suppressor, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

1. In a deflector, adapted to be used with a jet engine, in combination, an elongated channel having a substantially horizontal first portion of substantially constant cross-section and provided with an inlet adapted to receive a stream of gas discharged in horizontal direction from a jet engine, and a substantially vertical second portion communicating with said first portion and provided with a substantially vertically directed outlet spaced from said inlet; and deflecting means, arranged intermediate said inlet and said outlet and defining an upwardly curved and downwardly open guide channel, for vertically deflecting said gas stream toward and outwardly beyond said outlet of said second portion.

2. In a deflector as defined in claim 1, wherein said horizontal first portion comprises opposed side walls of a predetermined height, said first portion having a length equal to 2.5–3 times said predetermined height.

3. In a deflector as defined in claim 1, wherein said deflecting means comprises a section projecting into said second portion of said channel.

4. In a deflector as defined in claim 1, wherein said deflecting means comprises a deflecting plate upwardly curved in the direction of flow of said gas stream and toward said outlet of said second portions, said deflecting plate having a convex surface facing the interior of said channel so that said gas stream will cling to said surface and be upwardly deflected into said second portion.

5. In a deflector as defined in claim 4, wherein said convex surface has a radius of curvature decreasing in the direction from said inlet toward said outlet.

6. In a deflector as defined in claim 5, wherein the decrease in the radius of curvature of said convex surface is a linear decrease.

7. In a deflector as defined in claim 5, wherein the decrease in the radius of curvature of said convex surface is a progressive decrease.

8. In a deflector as defined in claim 5, wherein the decrease in the radius of curvature of said convex surface is a stepped decrease.

9. In a deflector as defined in claim 5, wherein the

radius of curvature of said convex surface is larger at the edges of said plate than at the middle thereof, whereby the center part of said stream of gas is subjected to centrifugal forces greater than those acting on the parts of the stream which are on either side of the center part, resulting in a pressure-differential between such parts of the stream of gas and in consequent flow of gas between such parts with attendant aspiration of cooling air into the stream.

10. In a deflector as defined in claim 4, and further comprising opposite lateral walls extending along opposite edge portions of said deflecting plate transversely thereto.

11. In a deflector as defined in claim 10, wherein at least one of said lateral walls decreases in height in the direction of flow of the stream of gas so that a progressively greater amount of cooling air can be aspirated into said channel by the suction effect of the stream of gas whereby such suction effect, which causes the stream of gas to cling to said convex surface of said deflecting plate is at least locally reduced so that the stream of gas is caused to fan out transversely of its direction of flow.

12. In a deflector as defined in claim 10, further comprising air-aspirating aperture means including at least one aperture provided in at least said deflecting plate for permitting aspiration of cooling air through said aperture and into the stream of gas.

13. In a deflector as defined in claim 12, wherein said aperture means further comprises at least one additional aperture provided in at least one of said lateral walls.

14. In a deflector as defined in claim 13, and further comprising closure means for closing at least one of said apertures.

15. In a deflector as defined in claim 12, wherein said aperture in said deflecting plate extends transversely of the direction of flow of the gas stream substantially across the entire width of said plate, said aperture being inclined so as to open into said channel in the direction of flow of the stream, whereby cooling air aspirated through said aperture will form a substantially cohesive film intermediate said convex surface and said stream of gas but will not promote turbulence in the latter.

16. In a deflector as defined in claim 4, wherein said

deflecting plate comprises a plurality of sections overlapping one another in the direction of flow of the stream of gas and forming at the joints at which they overlap respective apertures extending transversely of said direction of flow and opening into said channel substantially parallel to said direction of flow.

17. In a deflector as defined in claim 1, and further comprising sound-absorbent means having sound-absorbent surface portions facing the stream of gas in said channel.

18. In a deflector as defined in claim 1, and further comprising auxiliary deflecting means arranged in said channel opposite said convex surface for imparting to the stream of gas a component of movement in the direction toward said convex surface.

19. In a deflector as defined in claim 18, said auxiliary deflecting means comprising a plate member having an edge portion extending transversely of the elongation of said channel and projecting into the same toward said convex surface, said edge portion having an edge face upwardly inclined toward said convex surface and in the direction of flow of the gas stream.

20. In a deflector as defined in claim 18, wherein said auxiliary deflecting means is arranged in the region of the upstream end of said deflecting plate.

21. In a deflector as defined in claim 19, wherein said auxiliary deflecting means further comprises an insert in said channel immediately upstream of said plate member and oppositely said deflecting plate, said insert having guide surfaces deflecting the stream of gas in direction toward said edge face of said plate member.

References Cited

UNITED STATES PATENTS

3,011,584 12/1961 Lemmerman et al. 181—33

FOREIGN PATENTS

1,187,245 3/1959 France.
1,199,789 6/1959 France.
890,106 2/1962 Great Britain.

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