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JET NOISE SUPPRESSOR NOZZLE

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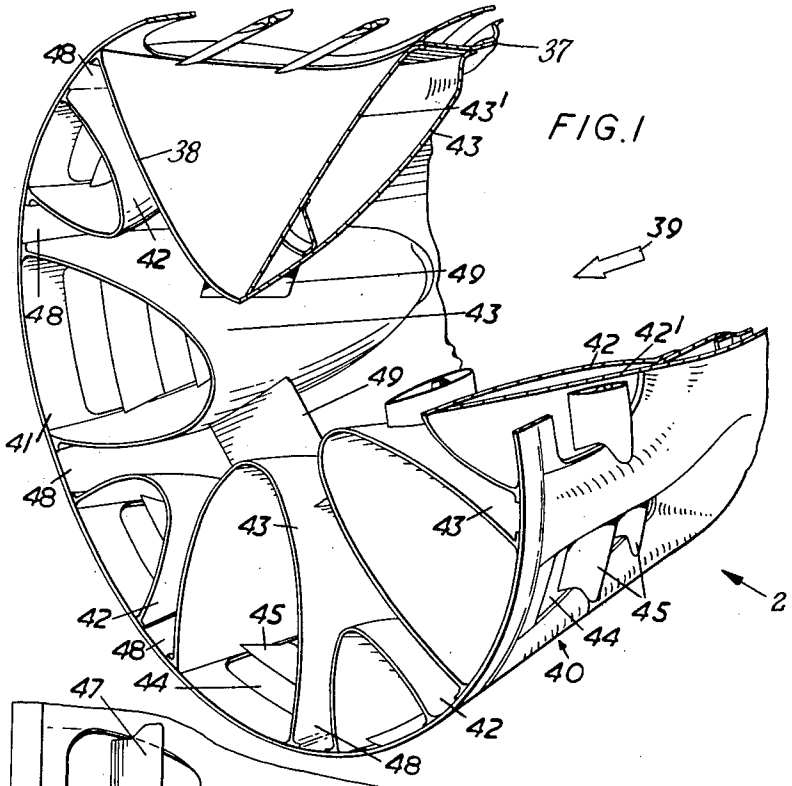


FIG. 1

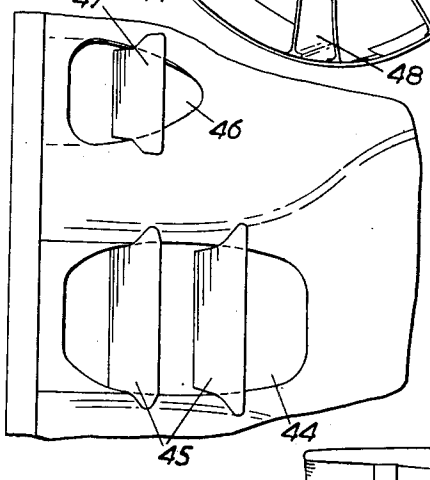


FIG. 2

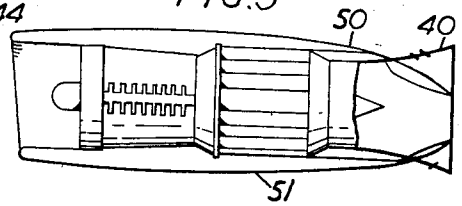


FIG. 3

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JET NOISE SUPPRESSOR NOZZLE

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This invention relates to a jet noise suppressor nozzle.

According to the present invention there is provided a jet noise suppressor nozzle comprising a tubular member having a plurality of hollow, flow-dividing members which are closed at their upstream ends and open at their downstream ends and which extend radially into the jet path, the flow-dividing members being separated from each other by longitudinal passages adapted for the flow of jet gases therethrough, alternate flow-dividing members extending radially inwardly to greater and lesser extents.

Means are preferably provided for entraining atmospheric air, flowing externally of the nozzle, into and through the interior of at least some of the flow-dividing members.

The means for entraining atmospheric air can comprise apertures in the tubular wall of the nozzle and guide vanes positioned across the apertures and shaped so as to direct atmospheric air into the flow-dividing members so that the air passes through the members and out of their downstream ends.

Preferably it is arranged that, at the downstream end of the nozzle, the ratio of the two cross-sectional areas within the nozzle which are respectively disposed externally and internally of the flow-dividing members are within the range 1:1.75 to 1:2.0.

If desired, the flow dividing members which extend furthest radially can be braced by aerofoil struts interconnecting adjacent members.

Each flow-dividing member preferably increases in radial extent in a downstream direction.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:

FIGURE 1 is a perspective view looking at the rear of a practical embodiment of the nozzle according to the present invention, part of the nozzle being broken away to illustrate the construction more clearly;

FIGURE 2 is an elevation of a broken away part of the exterior of the nozzle of FIGURE 1 as seen in the direction of the arrow 2 of FIGURE 1 and on the same scale; and

FIGURE 3 is a smaller scale diagrammatic side elevation of a gas turbine engine incorporating the nozzle of FIGURES 1 and 2.

The present invention is based upon the discovery that silencing is affected by: (*a*) the ratio of the "gas nozzle area" to the "atmospheric mixing air area." The first is the total of the cross-sectional areas (at the downstream end of the nozzle) of the interiors of the flow dividing members, and the second being the whole cross-sectional area of the nozzle at its downstream end less the first area, and (*b*) the diameter of the widest unobstructed outlet for the hot gases from the jet pipe.

As regards (*a*) it can be shown that the ratio should preferably be from 1:1.75 to 1:2.0.

FIGURE 1 illustrates a nozzle which is in accordance with the present invention and which is designed to take account of the factors *a* and *b* listed above. It will be seen that the nozzle has alternate flow dividing members 42, 43 which extend radially inwardly to greater and lesser extents. The arrangement of this figure is made such that the ratio referred to in (*a*) above

is held within the range 1:1.75 to 1:2.0. At the same time the dimension of the widest unobstructed outlet for hot gases is held to the minimum practicable value.

It will also be noted from FIGURE 1 that two inscribed circles could be drawn which respectively touch the radially innermost portions of the alternate flow-dividing members 42, 43. This arrangement, thus provides in effect, a nozzle having a series of alternate deep and shallow corrugations and therefore provides a very large total peripheral mixing area about which mixing of the hot gases and atmospheric air occurs without increasing the diameter of the smaller inscribed circle which defines the periphery of the "hard core" of hot gases which are the last to mingle with atmospheric air and which, therefore, must be reduced to the minimum. This circle also defines the widest unobstructed outlet for the gases.

It has been found that the nozzle formation shown in FIGURE 1 enables the nozzle to be given a light, though rigid construction.

Referring now to FIGURE 1 as a practical embodiment of the invention, there is shown a jet noise suppressor nozzle 40 having an external casing 41 through which flow hot gases from a jet pipe 50 (see FIGURE 3), the direction of flow of the hot gases being indicated by the arrow 39. Mounted within the external casing 41 are a number of hollow flow-dividing members 42, 43 which are closed at their upstream ends 37 and open at their downstream ends 38 and which extend radially into the jet path. The members 42 and 43 alternate, the members 43 being of considerably greater radial extent than the members 42.

Corresponding to each member 43 there is an aperture 44 (FIGURES 1 and 2) in the casing 41 of the nozzle. Each aperture 44 has a pair of guide vanes 45 across it, the guide vanes being arranged to direct atmospheric air into the interior of the member 43 so that the air will flow out of the downstream end of the member 43. Apart from the apertures 44 and the open downstream end, each member 43 is closed and increases in radial extent in a downstream direction.

Corresponding to each smaller member 42 there is, in the casing 41 of the nozzle, an aperture 46 and across each aperture 46 is a guide vane 47 shaped to direct atmospheric air into the interior of the smaller members 42, so that the air flows out through the open downstream ends of the members 42. The members 42 also increase in radial extent in a downstream direction.

Between the members 42 and 43 are formed channels 48, through which the jet gases flow in the direction of the arrow 39.

The members 43 are braced by aerofoil struts 49, which are made fast in the adjacent exterior surfaces of the members 43.

The flow-dividing members 42, 43 are of a semi-elliptical shape which has been found especially suitable for resisting the loading applied to the said members by the pressure of the hot gases. The semi-elliptical shape also provides the exteriors of the members 42, 43, in longitudinal section, with a good streamline form such as is adapted to the gas flow and therefore such as to keep the thrust loss low.

It will be noted from FIGURE 1 that the flow-dividing members 42, 43 are provided with inner skins 42', 43' respectively which are shaped to suit the flow of atmospheric air, the shape of the members 42, 43 being such that only relatively minor alteration of their interiors is required to make them suitably shaped for atmospheric air flow therethrough. The shaping of the members 42, 43, 42', 43' shown in FIGURE 1 is designed to result in low external drag.

The jet nozzle 40 can be attached, as shown in FIGURE 3, to the jet pipe 50 of a gas turbine engine 51.

In operation, gases flowing through the jet pipe 50 will pass out of the jet nozzle 40 through the channels 48 formed between adjacent members 42 and 43, and also through the central space between the members 43.

Air will be entrained by the guide vanes 45 to enter the apertures 44 and flow through the interior of members 43. Similarly, air will be entrained through guide vanes 47 to enter apertures 46 and flow out through the open downstream ends of members 42. Atmospheric air will mix with the jet gases at the boundaries formed by the downstream ends of members 42 and 43.

We claim:

1. A jet noise suppressor nozzle comprising a tubular casing member having a plurality of hollow, first flow-dividing members on the interior of said tubular member and arranged about the interior thereof, each of said members having a closed upstream end merging with said tubular member and the downstream end extending inwardly and being open, and having communication with an opening in said tubular member upstream from said open end, and said tubular member having at least one second flow-dividing member between adjacent first flow-dividing members, said last named dividing members being similar to but of smaller dimensions than said first flow-dividing members, and circumferentially spaced therefrom for the flow of jet gases therebetween.

2. The jet noise suppressor nozzle as defined in claim 1 in which the ratio, at the downstream end of the nozzle of the two cross-sectional areas within the nozzle casing which are respectively disposed externally and internally of the flow-dividing members being within the range of 1:1.75 to 1:2.0.

3. The jet noise suppressor nozzle as defined in claim 1 having means on said casing for entraining atmospheric air, flowing externally of the nozzle casing through said openings and into the interior of at least some of said flow-dividing members.

4. The jet noise suppressor nozzle as defined in claim 3 in which said means comprise guide vanes carried by the casing and positioned across the openings to direct said air into and through the flow-dividing members to mingle with the jet gases downstream of the nozzle.

5. The jet noise suppressor nozzle as defined in claim 1 in which said flow-dividing members are uniformly circumferentially spaced about the nozzle casing, extend radially inwardly therefrom to increasing depth from upstream to downstream ends and increase similarly in width, the spaces between said flow-dividing members extending radially inwardly to merge with an unobstructed central axial passage through said nozzle.

6. The jet noise suppressor nozzle as defined in claim 1 in which air foil section struts interconnect adjacent flow-dividing members which extend fartherest radially inwardly and pass over and clear of the intervening members of smaller dimensions.

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