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DIRECTING NOZZLE FOR DISCHARGING GAS
ALONG THE SURFACE OF THE GROUND

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3 Sheets-Sheet 3

FIG. 7

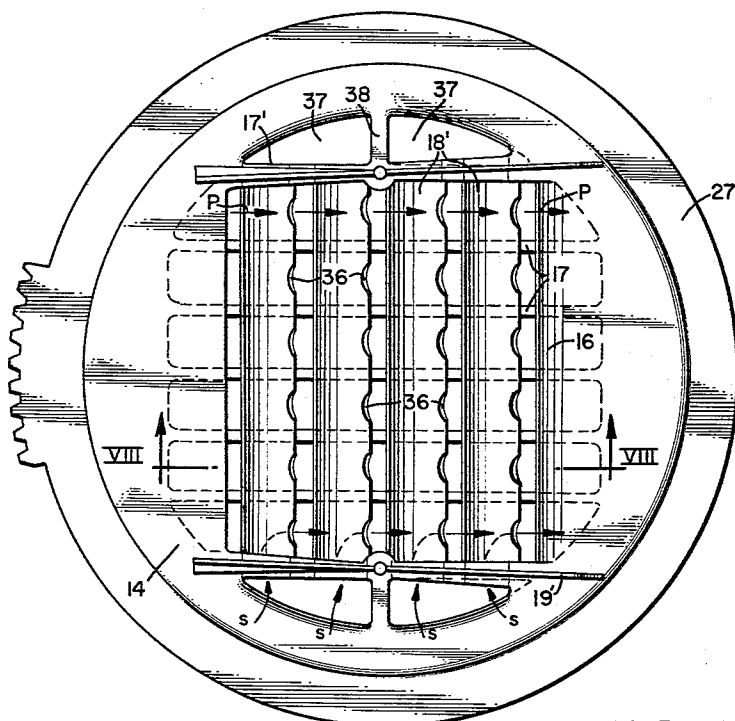


FIG. 8

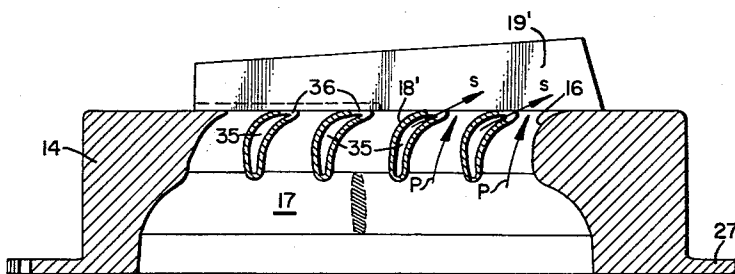
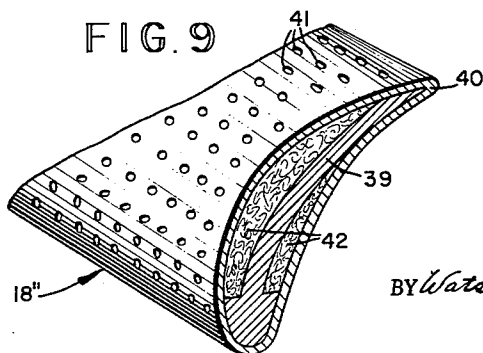


FIG. 9



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1

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DIRECTING NOZZLE FOR DISCHARGING GAS ALONG THE SURFACE OF THE GROUND

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7 Claims. (Cl. 239-14)

This invention relates to a nozzle designed to be embedded flush with the ground surface, that allows for directing, about an axis perpendicular to the ground, a gas stream which is generated for instance by the prior dilution in an extractor of a primary flow at higher pressure, said nozzle constraining the gas stream to hug the surface of the ground.

Various applications can be found for such a nozzle, examples being insect destruction and especially fog dispersal over runways. These examples, however, are by no means restrictive applications.

In a preferred embodiment, the nozzle proper is supported on an external circular rolling track surmounting the vertical terminal portion of the gas delivery duct. Said nozzle is fitted with vanes the upstream portions of which are substantially vertical and the downstream portions slightly inclined to the horizontal. The angle of exit from said vanes relative to the ground surface is preferably less than 20°.

Said vanes are associated to a rounded convex deflecting edge which forms the forward side of the nozzle, i.e. the side towards which the vane trailing edges are directed.

The gas orienting device referred to hereinabove is completed by lateral barriers which easily give way when run over by a wheel and which prevent the surrounding air from penetrating between the ground and the gas jet and thereby causing the latter to separate from the ground surface.

Like the nozzle orientation, said lateral barriers may be remote-controlled in order that the degree of splay imparted to them permit the spread, as well the orientation of the jet to be adjusted.

In addition, said vanes can be cooled by an extractor effect, and to this end consist of hollow airfoils which are provided for instance with apertures near their trailing edges that debouch into gills open to the surrounding air. Passage of the gas stream through the nozzle creates a local depression along the vanes, which suffices to entrain into the same a certain quantity of the surrounding air which serves to cool them before it mingles with said stream.

In this way, the nozzle temperature remains moderate and the vane strength high. In the event of an aircraft leaving the runway and its wheels running over said nozzle, the ensuing damage would be confined to bending of said lateral barriers, which could easily be replaced.

Lastly, the noise due to the gas efflux from the nozzle can be notably reduced by equipping the vanes with a suitable lining. By way of example, said vanes could consist of a central reinforcement and a perforated sheet-metal envelope, between which could be provided a good noise-damping material such as fibre-glass.

The description which follows with reference to the accompanying drawings, which are given by way of example only and not of limitation, will give a clear understanding of the various particularities of this invention and of the art of carrying them into practice.

In the drawings filed herewith:

FIGURE 1 is a schematic sectional view in side elevation

2

tion of an embedded device according to this invention, usable for fog dispersal purposes for instance;

FIGURE 2 is a highly diagrammatic plan view of a preferred distribution of nozzles according to this invention, in the approach zone to and along a runway;

FIGURE 3 is an axial section on line III—III of FIGURE 4 through a gas delivery duct, showing in more detailed fashion the method of fitting a nozzle to the extremity of said duct and one possible embodiment of the nozzle remote-control system;

FIGURE 4 is a sectional view on line IV—IV of FIGURE 3, with fragmentary sections taken through different levels in order to better bring out the relevant details of the remote-control system;

FIGURES 5 and 6 are smaller-scale views similar to FIGURE 4 showing alternative embodiments;

FIGURE 7 is a plan view of a nozzle, the vanes of which are hollow and cooled by induced ambient air;

FIGURE 8 is a sectional view taken on line VIII—VIII of FIGURE 7; and

FIGURE 9 is a fragmentary perspective view of a soundproofed vane.

Referring first to FIGURE 1, there is illustrated thereon the basic component parts of an embedded installation which is designed, say, for fog dispersal over an airfield. A turbojet comprising a compressor 1, a combustion chamber 2 and a turbine 3 is disposed within a trench or underground chamber 4 covered by a grid 5. Complementary air intakes serve to supply induced air to an extractor 6 which is positioned downstream of the turbojet tailpipe 7 and feeds into a duct 8.

Said duct, which is made as short as possible in order to reduce calorific losses, can be provided with multiple ramifications, but supplies at least one nozzle such as that denoted by reference numeral 9. It is of course to be understood that said duct must have an appropriate cross-section throughout its length if valves are disposed at the point of ramification to permit selective directing of the stream into any of a plurality of nozzles.

Reference is now had to FIGURE 2, whereon is shown the planwise disposition of said nozzles close to an aircraft runway. Nozzles 10 are placed at intervals along the length of a runway 11, while others, bearing the reference numeral 12, form a two-dimensional network in the approach zone that immediately precedes the touch-down end 13 of the runway.

FIGURES 3 and 4 are detailed illustrations of the manner of execution of each nozzle. The nozzle proper is embodied within a turntable 14 which is supported through the medium of a circular rolling-rim 27 inserted between two rows of balls such as 15 which also ensure correct centering. Said nozzle is provided with a reflecting edge 16, guide-vanes and expansion vanes 17 and 18, and lateral barriers 19. A resilient seal 21 reduces gas mixture leakages.

The guide-vanes 17 have a straight profile and are represented by a fragmentary "folded-down" sectional view. They serve not only to oppose any rotation of the gas stream but also to support the expansion vanes 18 which are arranged substantially perpendicular to them as well as any loads that the latter may be called upon to withstand.

Said expansion vanes have a curved profile; their lower portion is vertical and their upper trailing portion directed at a small angle α of about 15° to the horizontal.

On passing through expansion vanes 18, the gas is accelerated and at the same time deflected towards the ground. The presence of a rounded deflecting edge 16 causes the bottom gas layer to hug the surface of said deflecting edge, and subsequently also that of the ground by reason of the phenomenon known as the Young effect or Coanda effect. Since the successive top layers adhere

to said bottom retarded and ground-hugging layer, their total deflection exceeds the geometrical deflection corresponding to the angle of exit from vanes 18, and the entirety of the gas efflux is spread over the ground. This spreading effect is enhanced when said nozzles are used in conjunction with lateral barriers 19, which barriers are of low height and at least as long as the diameter of turntable 14, beyond which turntable their downstream extremities project. Said barriers are designed so as to retract by bending when run over by a wheel. This bending can be either temporary if said barriers are resilient, mounted on hinges or biased by return springs, or final if they are made of a light material and designed to be replaced. The actions which said barriers will have to sustain from the gas will in any event never be other than of very small magnitude.

Said lateral barriers can be remote-controlled to permit adjustment of the jet spread. One embodiment of a remote-control system, given by way of example only and not of limitation, is shown in FIGURES 3 and 4. Each barrier 19 is fulcrumed about a vertical pivot 28 positioned midway along its length. One of these pivots is connected by a lever 29 to a nut 30 which co-operates with the threaded shaft of an electric motor 31 which is pivotally mounted as at 32. A link 33 synchronizes the motions of the barriers 19. A flexible lead 34 supplies motor 31 and said barriers 19 are each provided with a horizontal portion which ensures lateral leak-tightness when the barriers are oriented.

The presence of the lateral barriers and the possibility of adjusting them improve the adhesion effect and prevent fresh air from entering at the sides of the gas jet, as such air penetration would reduce the ground hugging effect of the individual jets and hamper intermingling between adjacent jets. The barriers 19 divide the individual jet-damping primary zones and also foster the creation of a continuous layer by the use of multiple spaced-out nozzles, this being due to the fact that, a few diameters only from the vane outlets, the individual layers intermingle to form a single layer which is uninterrupted for all practical purposes.

It is of course to be understood that the disposition in plan view of the barriers shown in FIGURE 4 is by no means an exclusive one. FIGURES 5 and 6 illustrate alternative embodiments wherein the entire surface of turntable 14 is taken up by expansion nozzles, which nozzles in FIGURE 6, are shown as being more specifically nozzles of revolution designed to initiate the areawise spread of the gas.

A plurality of nozzles distributed near the touchdown end and near the edges of a runway will consequently enable a continuous, thin layer of hot gas to be directed towards said runway at high velocity, and, on mingling with the surrounding air, said layer will dissipate the fog with which the air is laden. Notwithstanding the fact that winds are usually low in foggy weather and despite the relatively high penetration force possessed by the gas jet issuing from a turbojet, it may be of advantage for the nozzle orientation as well as the degree of splay of the lateral barriers to be instantly remote-controllable.

One possible remote-control system has been illustrated in highly diagrammatic fashion in FIGURES 3 and 4. It comprises an electric motor which is placed in the housing 25 designed to receive the nozzle and which orients the latter through the medium of a screw 23 which meshes in driving relation with a toothed sector rigid with the rolling-rim 27 upon which said nozzle reposes. The elbow of hot gas delivery duct 26 is provided with deflecting vanes 24 (see FIGURE 1) and its extremity is so designed that said orienting mechanism be sheltered against harmful weather effects. The most harmful of these effects is icing, which could jam the nozzles solid. However, the rapid rise in temperature of the nozzles once the turbojet has been started up would very quickly restore their mobility.

Since the nozzles may require to be positioned in the immediate vicinity of the runway, they must comply with the norms relating to the presence of ground obstacles and to the ground resistance, on the runway approach zones. Although, as stated precedingly, the lateral barriers will retract when run over by a wheel, it is also necessary for the vanes to be sufficiently strong to withstand the weight of a heavily loaded wheel and neither to sag nor damage the tire because of their high temperature.

This requirement can be met by utilizing hollow vanes as illustrated in FIGURES 7 and 8. Such vanes 18' have their extremities secured to two solid partitions 17' which are surmounted by the lateral barriers 19' and supported by lower vanes 17 which are substantially perpendicular to them. Passageways 35 extend through them and debouch through partitions 17' and out of barriers 19' into gills 37 which open upwardly into the surrounding atmosphere. When necessary, additional partitions 38 are provided to brace the partitions 17' and to divide said gills into separate compartments.

The vanes preferably consist of formed and welded sheet-metal and their trailing edges at least are provided with apertures 36 through which escapes the surrounding air *s* induced by the gas stream *p* issuing from the nozzle.

Said surrounding air increases the volume of gas discharged, but, above all, cools the vanes 18' internally. Said vanes are thereby more easily able to withstand heavy loads since their strength is higher at low temperatures; consequently they are no longer in danger of damaging the tires of an aircraft that has left the runway.

In addition, it is desirable to reduce the operating noise of the nozzle, and this can be achieved by resorting to a special vane design, one possible embodiment of which is generally designated by the reference numeral 18'' and illustrated in FIGURE 9.

Each vane 18'' accordingly consists of a reinforcement 39 which can be conveniently shaped if desired and which is sufficiently thick to impart the required strength to the vane as a whole. (In FIGURE 9, said reinforcement 39 is provided with a strengthened and rounded leading edge, a curved middle section and a chamfered trailing edge.) A sheet metal skin 40, perforated as at 41, surrounds said reinforcement with a suitable sound-proof material 42, for example fibre-glass, is inserted therebetween.

While there has been shown and described, the presently preferred embodiments of the jet directing nozzle of this invention, it will be well understood by those skilled in the art that various changes and modifications may be made to these embodiments. By way of example, other vanes of smaller height provided with a sound-proof skin could be interleaved with the cooled vanes; similarly, the nozzle could be caused to co-operate with a wall inclined at any convenient angle to the horizontal.

What we claim is:

1. A nozzle which is flush with a surface and discharges a gas stream over the same, comprising, in combination, vanes which at their leading edges form a very small angle of incidence relative to the perpendicular to said surface and at their trailing edges an angle of exit of not more than 20° relative to said surface; a rounded deflecting edge on that side of the nozzle toward which the trailing edges of said vanes are directed; barriers of low height perpendicular to said surface and possibly bordering both sides of said nozzle; and means for orienting said nozzle about an axis perpendicular to said surface.

2. A nozzle adapted to be imbedded flush with the surface of the ground and to discharge a gas stream over the same, comprising, in combination, vanes which at their leading edges form a very small angle of incidence relative to the perpendicular to said ground surface and at their trailing edges an angle of exit of not more than 20° relative to said ground surface; a rounded deflecting edge on that side of the nozzle toward which the trailing edges of said vanes are directed; barriers of low height

5

perpendicular to said ground surface and possibly bordering both sides of said nozzle; and means for orienting said nozzle about an axis perpendicular to said ground surface.

3. A nozzle as claimed in claim 2, wherein said vanes are rigid with partitions set perpendicularly to the ground surface, said partitions supporting said vanes and being substantially perpendicular thereto in plan view.

4. A nozzle as claimed in claim 2, wherein said lateral barriers are respectively fulcrumed about a pivot perpendicular to the ground surface and are associated to means whereby their positions and the degree of spread of the issuing jet can be remote-controlled.

5. A nozzle as claimed in claim 2, wherein the nozzle orienting means comprise a circular rolling track equipped with a resilient seal; guiding and supporting balls, rollers or like means; a toothed sector coaxial with said rolling track, with which it is rigid; and a remote-controlled motor for driving an endless screw meshing in driving relation with said sector.

6. A nozzle as claimed in claim 2, wherein said vanes

6

consist of hollow airfoils which are provided with apertures positioned near their trailing edges, for example, and the interiors of which communicate with upwardly opening gills located externally to said barriers, thereby enabling the gas stream flowing through said nozzle to entrain cooling air through said vanes.

7. A nozzle as claimed in claim 2, wherein some of the vanes consist of a reinforcing core and a surrounding envelope made of perforated sheet-metal, with a good soundproofing material such as fibre-glass placed therebetween.

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