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[33]		**Sweden**
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[54] **DEVICE FOR FORCED MIXING OF PARALLEL FLUID FLOWS**
2 Claims, 3 Drawing Figs.

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[50] **Field of Search** 137/604; 259/4; 60/262

[56] **References Cited**

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ABSTRACT: A device for forced mixing of parallel fluid flows by means of guide vanes such as for mixing hot and cold gaseous flows in turbine-jet engines, said guide vanes consisting of a plurality of triangular discs turned with a corner opposite the direction of flow and having the base as trailing edge and located with said corner spaced from a partition between said flows, at the end edge of which partition said discs are mounted at such angle of attack to the direction of flow that they are approaching the border area between said flows as seen from said corner towards said trailing edge, the side edges of said triangular discs being located each in a side plane disc disposed in the direction of flow and by means of which said triangular disc is supported from said partition.

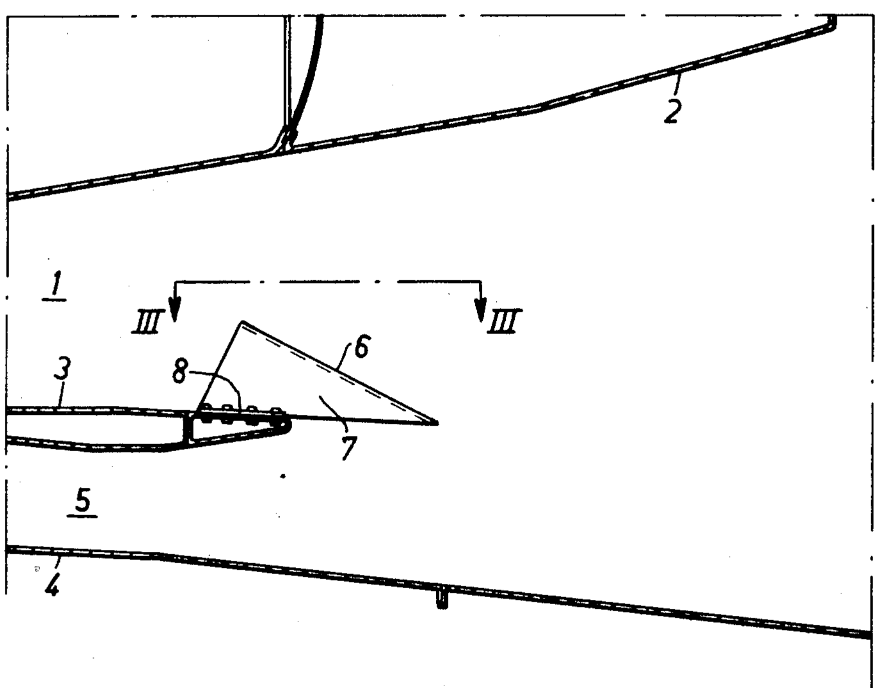
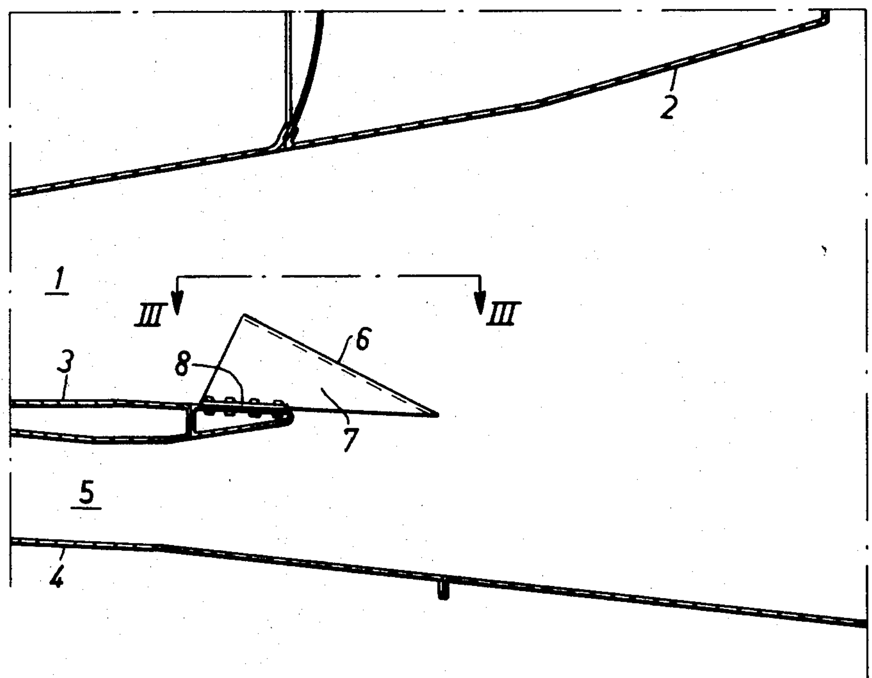


FIG.1



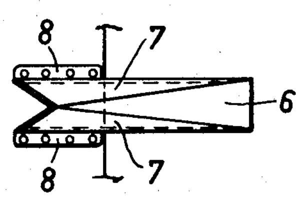


FIG. 3

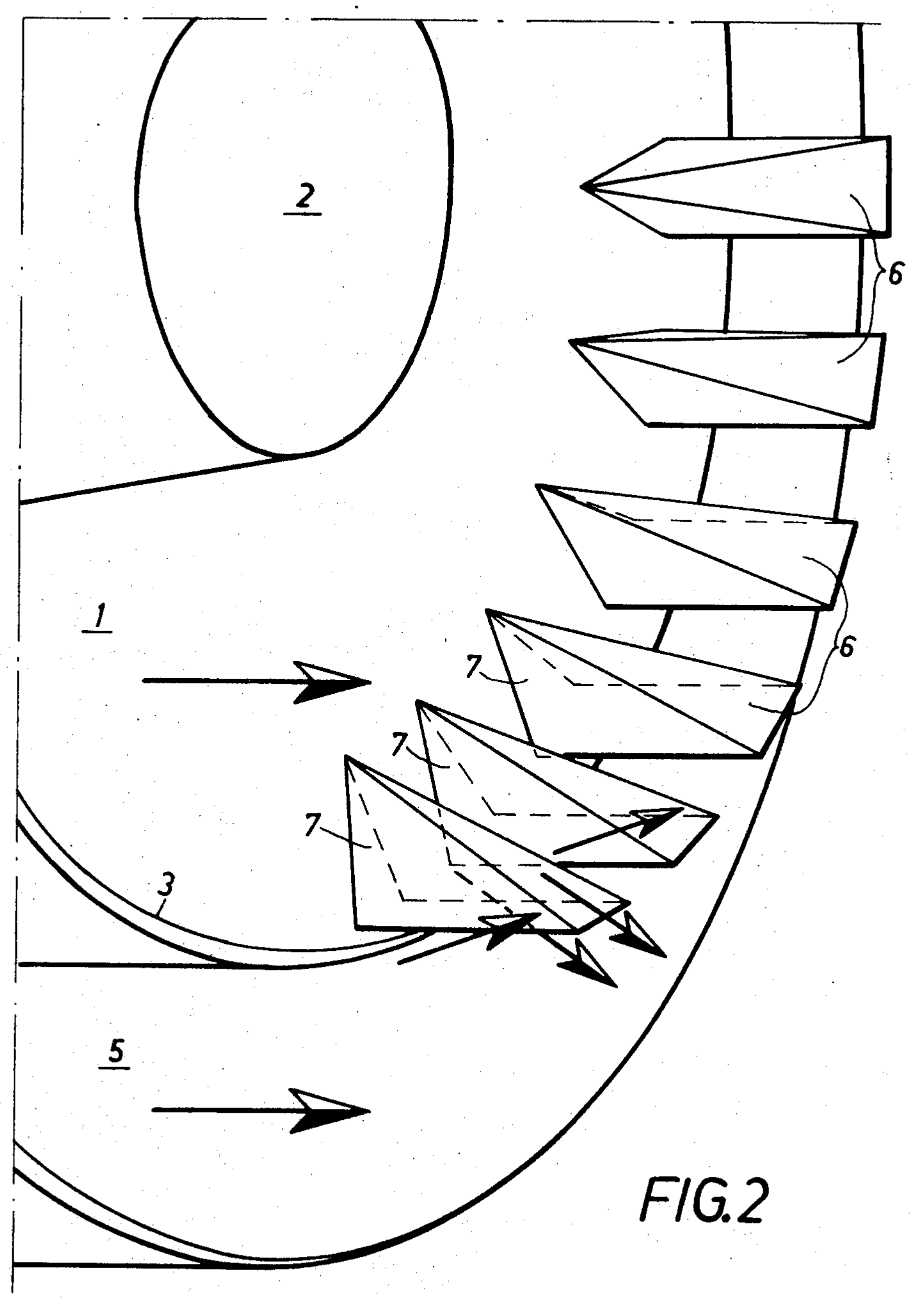


FIG.2

DEVICE FOR FORCED MIXING OF PARALLEL FLUID FLOWS

The present invention concerns a device for forced mixing of parallel fluid flows by means of guide vanes, such as for mixing hot and cold gaseous flows in turbine-jet engines.

When mixing flowing fluids the general rule is that two flows of gas or liquid separated by a partition but then in parallel relationship entering into a common passage, have approximately the same static pressure but may have different temperatures, velocity and density. Said flows are intermixed in the border area therebetween substantially due to viscous effects.

If it is desired to speed up the mixing operation the contact area between the two flows must be increased. This is obtained by means of various kinds of deflecting devices which force parts of each flow into the other. Said deflection can be achieved by substantially two ways. One of them is by extending the partition between the inlet channels of the gas flows, as is known in prior art, e.g. to the peripheral wall of the intermixing length and is provided with apertures or nozzles for inlet of one of the flowing fluids into the other with a velocity component at right angles to the direction of flow of the latter. This kind of deflecting device can provide a rapid mixing but then at the expense of high pressure loss. Furthermore the arrangement is heavy, which is a substantial drawback in aeronautical applications.

The second way is to fold said flows at the end of the partition by local deflection and thus increase the mixing area therebetween. Said deflection can be provided by folding the final portion of the partition or by guide vanes immediately downstream the same.

The change of the direction of flow or the angle the flow is deflected is the parameter best distinguishing how difficult this process actually is. The possibility of achieving an effective deflection of the flows and thus a good mixing is limited in this last-mentioned kind of deflection device by the circumstance that already at a relatively small deflection angle of about 15° the boundary layer increase on the downstream side of the guide vane, i.e. the side turned opposite the direction of flow, results in a flow separation. Said flow separation involves pressure losses and reduced deflection.

The only measures hitherto known for achieving a greater deflection has been either to utilize long vanes with small curvature or grids of shorter vanes. However, such guide vane devices are complicated and thus expensive to manufacture.

Therefore, the main object of the present invention is to eliminate the above-mentioned difficulties and the invention is based on the aerodynamic discovery now well known in the aeronautical field, viz that a plane triangular disclike body with a corner or peak directed opposite the direction of flow and having the base at trailing edge gives raise to a vortex flow if said body is mounted at an angle of incidence relative to said direction of flow. Said vortex flow is formed on the downstream side of said disc and consists of two counterrotating vortexes. Due to their high speed of rotation, said vortexes create a high flow velocity adjacent the downstream surface or the suction surface.

If said discovery is converted into practice according to the invention and a guide vane is made as a triangle, preferably with two equal sides and the base as trailing edge, it turns out that much greater deflection can be achieved than with prior guide vanes and thereby many advantages can be obtained. Said high flow velocity adjacent the downstream surface or suction surface namely eliminates the risk for flow separation even at great angles of attack resulting in such deflection angle which would have caused flow separation in guide vanes hitherto known. With a device according to the invention there can thus be achieved a deflection up to an angle which is more than twice as great as the maximum angle achievable with previously known single guide vanes. In fact, however, said vortex flow involves a pressure loss per se but the latter can be limited to its extent in a surprisingly simple way by arranging side plane discs in the direction of flow along the side edges of the triangle. The reason for said limiting effect of said side discs is that they prevent an overflow from the pressure side of said guide vane to the suction side thereof, and thereby the vortex intensity is limited.

Therefore, the invention is substantially distinguished in that the guide vanes consist of a plurality of triangular discs, preferably with two equal sides and mounted equally spaced along the end edge of a partition between said flows, said triangular discs being turned with the corner or peak opposite the direction of flow and the base as trailing edge and located with said peak or corner spaced from that partition, said discs furthermore being mounted at an angle to the direction of flow so that they, as seen from the corner towards the trailing edge, are approaching the border area between said flows, said two equal edges of the triangular disc being situated each in a side plane disc, which is located in the direction of flow and by means of which said triangular disc is supported from said partition between the flows.

With the device according to the invention a plurality of advantages is achieved, i.a. that the angle of deflection of the flow can be increased without any risks for flow separation of the flowing fluid from the downstream surface of the guide vane. In its turn this involves that the very mixing process occurs within a substantially shorter length. The suggested shape of the guide vane also involves that the mixing device is simple and light and inexpensive in manufacture, particularly due to the fact that each guide vane can be produced in one single piece of sheet material. A favorable secondary effect of the two vortexes created on the downstream surface of the disc also is that they vigorously contribute to the very mixing and in its turn this involves that less numerous guide vane units in principle must be used for achieving the same desired mixing effect as hitherto for a certain given passage length.

The invention will be described by way of example in the following while referring to the accompanying drawings, in which: FIG. 1 illustrates an embodiment, partially in section, through a turbine-jet engine in the portion thereof, where a cold fan flow is mixed with the hot gas flow from the turbine in parallel relationship and where said two flows are to be mixed as fast and completely as possible; FIG. 2 illustrates the arrangement of a plurality of guide vanes according to the invention along the end edge of a partition between the gas flows; and FIG. 3 is a plane view in detail of a guide vane according to the invention.

Already in this connection it is to be pointed out that the exemplifying embodiment now choosen wherein the invention is applied in the outlet portion of a turbine-jet engine of bypass type in no way restricts the invention but only is meant as a good illustration thereof. Of course the invention also can be applied in other cases. Nor is the invention restricted only to the use of air and other gaseous fluids but ought also to be used with advantages for liquids.

It can also be mentioned that in principle the angle of attack between the direction of flow and the leading edge of a conventional guide vane of course is no measure of the ability of the guide vane to deflect the flow. Invariably, said angle of attack is much smaller than the angle between the original direction of the flow and the direction thereof after deflection. When it comes to the type of guide vane now suggested the angle of attack and the angle of deflection are approximately equal. It is appreciated that it is impossible to compare the angle of attack of conventional guide vanes and of this new type of guide vanes.

The essential character of each type of guide vane is the ability thereof to change the direction of flow of the fluid, and therefore comparisons if made must concern said deflection angle. A guide vane of previously known type with an extension in the direction of flow comparable with the guide vane according to the present invention can give a maximum deflection angle of about 15° in the exemplifying embodiment mentioned in the following.

On the contrary, with a guide vane according to the present invention a deflection angle twice as great can be obtained.

However, it is impossible to state a maximum possible deflection angle since said angle varies with the sweep angle of the triangular disc sides. The slimmer the triangle, the greater the angle of attack which can be used without any flow separation occurring and thus the greater the deflection angle will be. Structural reasons, however, make extremely slim guide vanes less suitable, but no limits for the choose of sweep angle can be stated for various application alternatives.

In the drawings there is illustrated a portion of the rear part of a turbine-jet engine of bypass type. In an internal channel **1** surrounding a central outlet cone **2** hot combustion gases are discharged from the turbine portion of the jet engine. In the actual portion of the engine said gases are to be mixed with a cold fan air flow passing in an external and concentrically surrounding channel **5** defined by a partition **3** and an external wall **4**. It is obvious that it is of greatest importance particularly in a turbine-jet engine of the present kind for airplane propulsion that said mixing can be carried out with as simple, light and inexpensive measures and as short a length as possible, which induces substantial economical and structural advantages.

According to the invention, at the rear edge of the partition **3** now are arranged along the channel periphery suitably spaced guide vanes consisting of triangular discs **6**, preferably having two equal sides and the base as trailing edge. Owing to said shape and for previously mentioned reasons said discs cause an exceptionally great deflection of the direction of flow.

Suitably, the two side edges of the discs **6** are located each in a side plane disc **7**, disposed in the direction of flow and by means of which the triangular disc **6** is supported from the partition **3**. As already mentioned said side plane discs **7** at the same time provide an obstacle for preventing the overflow from the pressure side of the guide vane to the suction side thereof and thus limit the extent of the unavoidable pressure losses. For facilitating the manufacture of the guide vanes it is suitable to make them together with the side plane discs in one single piece of any suitable sheet material. It is also suitable to form attaching flanges **8** at the front portion of the free edges of the side plane discs **7** in the direction of flow for securing the guide vanes to the rear edge of the partition **3**.

I claim:

1. A device for forced mixing of parallel fluid flows by means of guide vanes such as for mixing hot and cold gas flows in turbine-jet engines, characterized in that said guide vanes consist of a plurality of triangular discs spaced along the end edge of a partition between said flows and having two equal sides turned with a corner or peak opposite the direction of flow and the base as trailing edge and disposed with said corner or peak spaced from said partition, said discs being arranged at an angle of attack to the direction of flow so that they are, as seen from the corner or peak towards the base, approaching or getting closer to the border area between said flows, the two side edges of the triangular disc each are located in a side plane disc which is disposed in the direction of flow and by means of which said triangular disc is supported from the partition between the flows.

2. A device according to claim **1**, characterized in that said triangular disc and said side plane discs are made integrally of sheet metal and that at the front portion of the free edge of the side plane discs extending in the direction of flow is formed an attachment flange for the securing of the guide vane to the partition.