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(54) SUPERSONIC AIR INTAKE DIFFUSER FOR AIR–BREATHING PROPULSION UNITS

(71) We, MESSERSCHMITT-BÖLKOW-BLOHM Gesellschaft mit beschränkter Haftung, of 8000 Munchen, German Federal Republic a Company organised and existing under the laws of the German Federal Republic, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:–

This invention relates to a supersonic air intake diffuser for an air-breathing aerial propulsion unit, such as a ramjet, having an aerodynamically profiled central body consisting of two components positioned in succession, the rearward one being fixed and the forward one being longitudinally displaceable to alter the intake geometry whilst at the same time retaining an aerodynamically favourable over-all profile for the central body.

The adjusting devices used in known diffusers and which alter the intake geometry are complex and this invention seeks to provide a diffuser in which the front component of the central body can be displaced longitudinally to alter the admission geometry using a simplified apparatus.

According to this invention there is provided a supersonic air intake diffuser for an air-breathing aerial propulsion unit having an aerodynamically profiled central body consisting of two components position in succession, the rearward one being fixed and the forward one being longitudinally displaceable to alter the intake geometry whilst at the same time retaining an aerodynamically favourable over-all profile for the central body which has an internal chamber extending in the longitudinal direction of the diffuser, the chamber having a front end wall formed by a surface of the forward component of the central body and a rear end wall formed by a surface of the fixed rearward component of the central body, the chamber being defined in part by a casing affording relative movement between the said end walls, there being conduits with associated valves for selectively connecting the interior of the chamber with the exhaust zone of the diffuser or with the exterior of the diffuser in the zone of static ambient pressure, the effective area of the front end wall of the chamber being such that the product thereof with the static pressure in the diffuser exhaust zone is greater than, and the product of said area and the static ambient pressure is less than, the product of the projected area of the central body on a plane normal to the axis and the ramp pressure.

The invention provides a supersonic intake diffuser in which the high pressure differences occurring in the diffuser zones in the event of high Mach numbers are used to displace the front component of the central body in a longitudinal direction in order to adjust the admission geometry to the prevailing flight conditions. Thus it is possible to dispense with external power hitherto necessary for this specific purpose. This is particularly advantageous in air-breathing missile propulsion units designed for operating speeds in the supersonic range. For with such missiles the comparatively small amount of space available renders the installation of supplementary power sources difficult as compared with aircraft.

An embodiment of the invention is described by way of example with reference to the accompanying drawings wherein:–

Figure 1 shows a front view of a missile with supersonic air intake diffusers, one being sectioned across the zone of supersonic compression at I–I of Figure 2, the missile having a ramjet propulsion drive,

Figure 2 shows a section II–II of Figure 1, and,

Figure 3 shows a section on III–III of Figure 2.

The propulsion means for a missile 1 is a ramjet designed for Mach numbers (M_0) of between 2 and 3.5. In the present case four supersonic intake diffusers 2 are provided, distributed evenly around the body 3. The shape of the intake zone is rotationally symmetrical over half the circumference. Each of the diffusers 2 has a casing 4 which forms with a baffle 5 (see especially Fig. 2) and an aerodynamically profiled central body 6 an air duct marked 7 (see Fig. 1). The baffle 5 is spaced from the missile body 3 by a boundary air dam 8. The baffle 5 defines the limit of the duct 7 on the side adja-

cent projectile body.

As shown in Figure 2, the body 6 has an intake ramp formed by a part conical surface 6*a* extending forward of the tapered lip 9 of the casing 4. The central body 6 has two components 6*b* and 6*c* situated in succession. The forward component 6*b* has the ramp 6*a* and dam 8 and forms a movable unit which can be displaced in the longitudinal direction of the diffuser while at the same time preserving an aerodynamically favourable overall profile of the body 6. The purpose of the dam 8, or boundary layer diverter, is to keep the inlet diffuser out of the zone of the boundary layer. The displacement is to regulate the throughput of air over the intended range of operation by adjusting the position of the narrowest part of the air duct throat. The rear component 6*c* of the central body 6 is fixed.

The longitudinally movable unit 6*a*, 6*b* and 8 is provided at the points where the front component 6*b* of the central body 6 forms the dam 8 with channels 10 (Figure 1) which slidingly engage the edges of baffles 5. Support and guide rollers 11, 12, 13 are adjustably connected with the moving component.

The lateral guiding is effected by two pairs of rollers 11 which bear on the two side flanks of a rail 14 fixed to the missile body 3. The body 3 serves as a support and guide surface for the pair of rollers 12 to the rear of the longitudinally movable unit 6*a*, 6*b* and 8. In order to ensure a better guide the rollers are adapted in position to the external shape of the body. The longitudinally movable unit 6*a*, 6*b* and 8 is laterally supported by the pair of rollers 13 bearing on the lateral flanks of rail 14 and directed towards the projectile body 3 and engaging beneath a rack 14*a* of T profile and forming part of the rail 14.

To enable the ramp 6*a* to be positioned more accurately, the front component 6*b* of the body 6 contains a brake or holding device 15. This comprises a gearwheel 16 coacting with the toothed rack 14*a*. The mounting of the gearwheel in the component 6*b* is by a device 17, having an electro-magnet 18 of which the armature 19 is fitted with a brake device 20 acting on the wheel 16. The locking power for this brake is provided by a spring 21. The brake 20 is released when the electromagnet 18 is energised and the arrangement is operated intermittently in the manner of a trembler so that the moving component 6*b* of the body 6 can be longitudinally displaced in very small steps and held in a particular position without under or overshoot.

For the longitudinal displacement of the moving component, an adjusting device is provided which obtains the adjusting forces directly from the different pressure zones in the diffuser. The adjusting system has a chamber 22 which extends inside the central body in the longitudinal direction of the diffuser and which has a forward end wall 23 formed by the displaceable component 6*b* and a rear end wall 24 formed by the fixed component 6*c*. A longitudinally extensible casing defines in part a chamber 22 and interconnects the two components 6*b* and 6*c*. The casing may be formed by a bellows unit 25. With the chamber 22 are associated conduits 26 and 27 with respective electro-magnetic valves 28 and 29 which serve for the optional connection of the interior of the chamber to the diffuser exhaust zone at the point marked 30 or with the exterior, of the diffuser in the zone 31 (Figure 3) of static ambient pressure $P_{amb.(min)}$. The product of the effective area A_{eff} and the static pressure P_{exh} in the diffuser exhaust zone 30 is greater than, and the product of said area A_{eff} and the static ambient pressure $P_{amb.(min)}$ is less than, the product of the projected area of the ramp 6*a* on a plane normal to the axis A_{app} and the ramp pressure P_{ext} exerted thereon i.e. $A_{eff}.P_{exh} > A_{app}.P_{ext} > A_{eff}.P_{amb.(min.)}$. The forward component 6*b* of the central body 6 therefore moves forwards in the direction of flight together with the admission ramp 6*a* and the boundary layer dam 8, as soon as the magnetic valve 28 which closes the conduit 26 effects an opening movement and the brake 20 is released. All that is required in order to stop the movement is to re-apply the brake 20 and close the magnetic valve 28. This occurs, for example, at the moment when the admission ramp 6*a*, after moving distance *x*, has taken-up the position shown in chain dot lines in Figure 2. This results in the throttling of the air throughput. The reverse effect is obtained when the component 6*b* of the central body 6 performs a movement in the opposite direction. Such a movement occurs when the brake 20 is released and the magnetic valve 29 in the conduit 27 is opened. This reverse movement can be stopped by actuating the brake 20 and closing the magnetic valve 28 in the conduit 21.

WHAT WE CLAIM IS:—

1. A supersonic air intake diffuser for an air-breathing aerial propulsion unit having an aerodynamically profiled central body consisting of two components positioned in succession, the rearward one being fixed and the forward one being longitudinally displaceable to alter the intake geometry whilst at the same time retaining an aerodynamically favourable over-all profile for the central body which has an internal chamber extending in the longitudinal direction of the diffuser, the chamber having a front end wall formed by a surface of the forward component of the central body and a rear end wall formed by a surface of the fixed rearward component of the central body, the chamber being defined in part by a casing affording relative movement between the said end walls, there being conduits with associated valves for selectively connecting the interior of the chamber with the exhaust zone of the diffuser or with the exterior of the diffuser in the zone of static ambient pressure, the effective area of the front

end wall of the chamber being such that the product thereof with the static pressure in the diffuser exhaust zone is greater than, and the product of said area and the static ambient pressure is less than, the product of the projected area of the centre body on a plane normale to the axis and the ramp pressure.

2. An air intake diffuser in accordance with Claim 1, wherein the casing extending between the two end walls comprises a pressure resistant bellows.

3. An air intake diffuser according to Claim 1 or 2, wherein a brake device is provided to hold or release the displaceable forward component.

4. An air intake diffuser substantially as herein described with reference to and as shown in Figures 1, 2 and 3 of the accompanying drawings.

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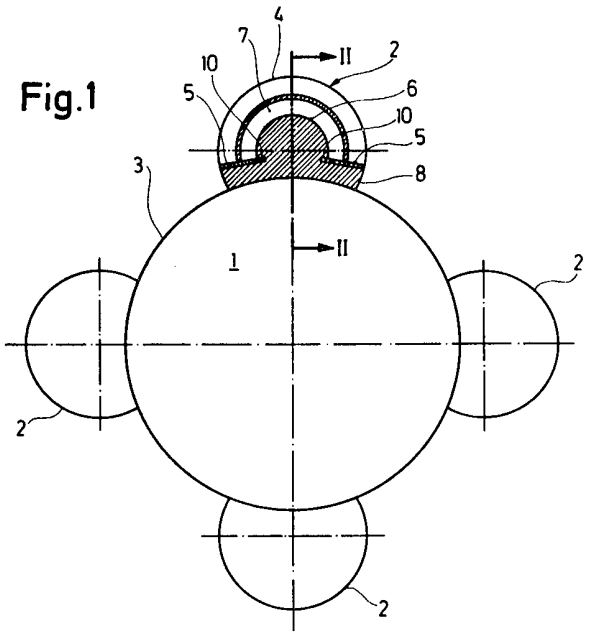
Sheet 1

Fig.1



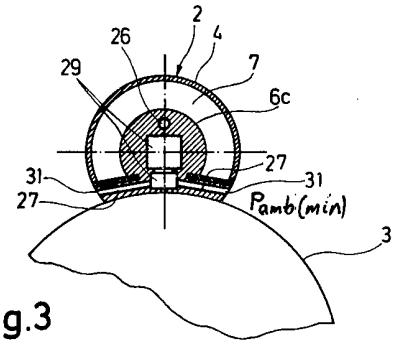


Fig.3

1591994 COMPLETE SPECIFICATION
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Sheet 2

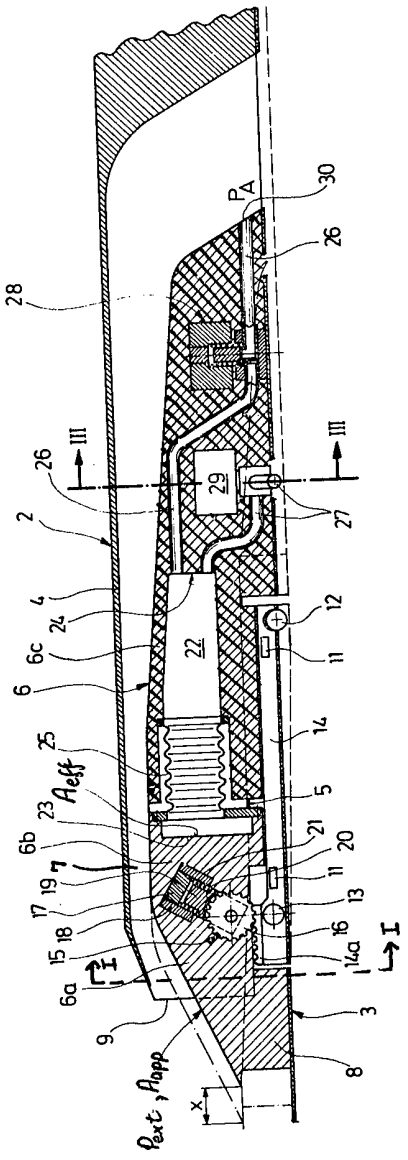

Fig.2