Aug. 29, 1961 D. M. BROWN 2,998,092

JET PROPULSION NOZZLE WITH NOISE REDUCING MEANS

Filed Oct. 14, 1957 2 Sheets-Sheet 1

Fig. 1.

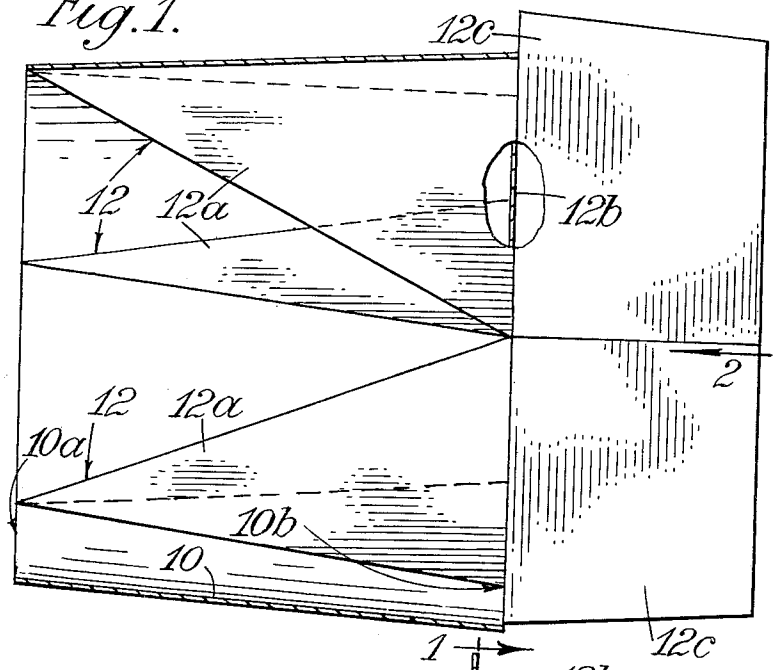


Fig. 2.

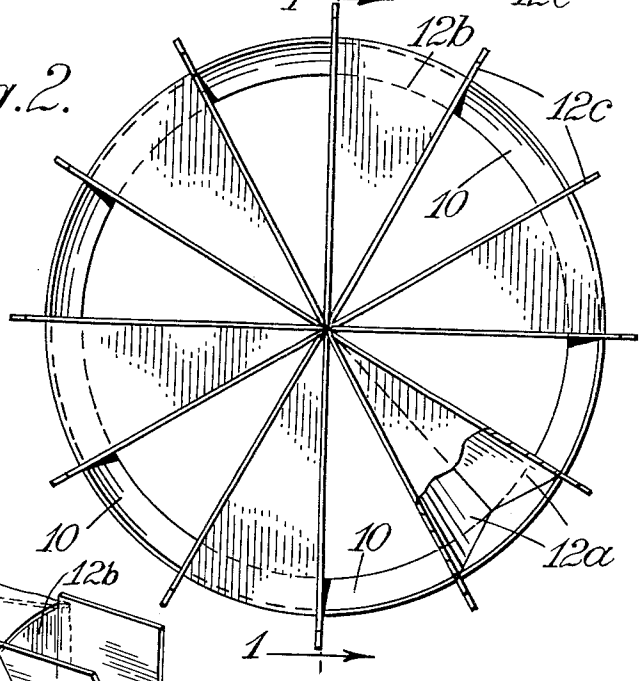
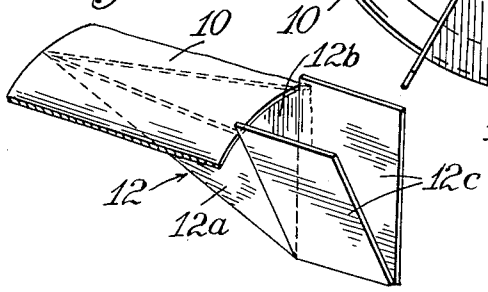


Fig. 1a.



Aug. 29, 1961 D. M. BROWN 2,998,092

JET PROPULSION NOZZLE WITH NOISE REDUCING MEANS

Filed Oct. 14, 1957 2 Sheets-Sheet 2

Fig. 3.

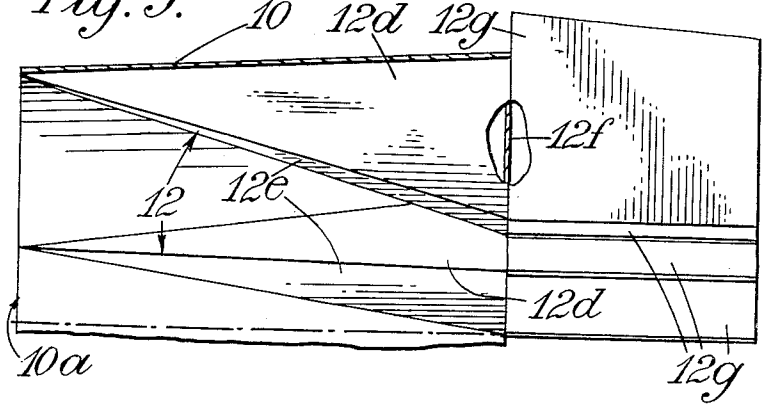
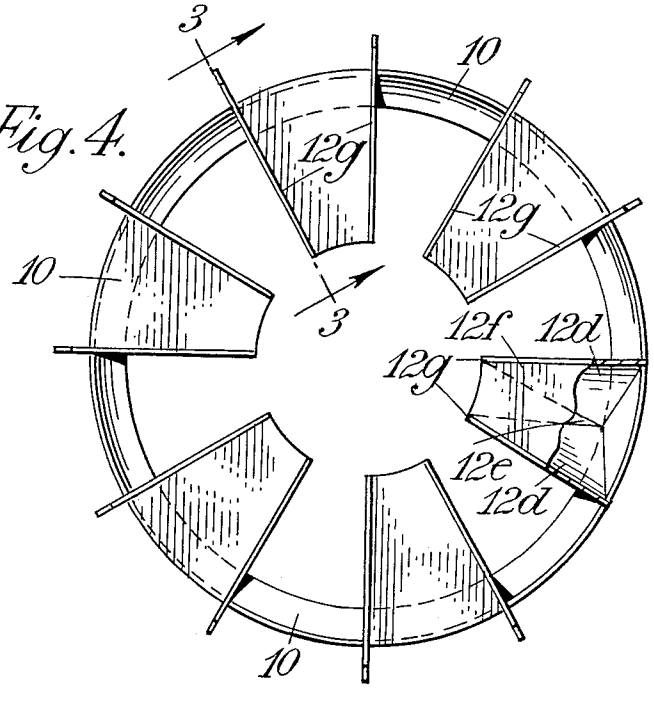


Fig. 4.



United States Patent Office 2,998,092 Patented Aug. 29, 1961

2,998,092

JET PROPULSION NOZZLE WITH NOISE REDUCING MEANS

David Morris Brown, Alvaston, England, assignor to Rolls-Royce Limited, Derby, England, a British company

Filed Oct. 14, 1957, Ser. No. 689,921
Claims priority, application Great Britain Oct. 18, 1956
5 Claims. (Cl. 181—41)

This invention comprises improvements in or relating to jet propulsion nozzles.

This invention is concerned with jet propulsion nozzles, for example as set forth in U.S. Patent No. 2,982,092, issued May 2, 1961, to John Michael Storer Keen, constructed to afford from adjacent the nozzle inlet at least to the throat thereof a plurality of paths for the hot gas flowing through the nozzle, the number of such paths being selected to reduce the noise level in operation of the nozzle as compared with an equivalent nozzle of common construction which for example in the case of a convergent nozzle is a frusto-conical tube. The paths are conveniently formed by attaching elements which taper in the upstream direction, to the inner surface of a tubular wall; such elements at their downstream ends extend radially inwardly either to the nozzle axis in which case the paths have sector-shaped outlets, or only part way towards the nozzle axis in which case the periphery of the outlet appears corrugated.

According to the present invention, in a nozzle as set forth, each of the elements defining the gas paths includes a pair of circumferentially-facing walls bounding the adjacent gas paths and an axially-facing wall joining the downstream ends of the circumferentially-facing walls, so that at the outlet of the nozzle the gas paths alternate with the axially-facing walls around the nozzle, and the circumferentially-facing walls have axial extensions beyond the outlet of the nozzle to delay mixing of hot gases leaving the nozzle and air flowing into the zones behind the axially-facing walls.

Preferably the extensions extend in the radial direction outwardly beyond the perimeter of the nozzle.

Two constructions of jet propulsion nozzle according to this invention will now be described with reference to the accompanying drawings in which:

FIGURE 1 is an axial section through one construction,

FIGURE 1A is a perspective view showing the construction of one of the members **12** of FIGURE 1.

FIGURE 2 is a view in the direction of arrow **2** on FIGURE 1 and shows the section line **1—1** for FIGURE 1, and

FIGURES 3 and 4 are corresponding views of the second construction.

Referring to FIGURES 1 and 2, the nozzle illustrated is a convergent nozzle and comprises an outer tubular wall **10** of frusto-conical form and a series of elements **12** (in this case six) attached to the inner surface of the wall **10** to define a corresponding series of trough-like paths for the hot gases leading from adjacent the inlet **10***a* of the nozzle to the outlet **10***b*. Each of the elements **12** has a pair of circumferentially-facing walls **12***a* bounding the trough-like gas paths and an axially-facing end wall **12***b*, so that the end walls **12***b* alternate with the ends of the trough-like paths at the outlet **10***b*. The elements **12** are of tetrahedron form and are of such dimensions that the total cross-sectional area for gas flow through the nozzle decreases gradually from the inlet **10***a* to provide a throat at the outlet **10***b*. Also at their downstream ends the elements **12** extend to the nozzle axis. Such a nozzle has a lower noise level as compared with an equivalent simple frusto-conical nozzle.

In order to delay mixing of the hot gas issuing from the nozzle with air flowing into the zones behind the walls **12***b*, the walls **12***a* are provided with extensions **12***c* beyond the outlet **10***b* of the nozzle. The extension walls **12***c* are contained in axial planes and extend radially from the nozzle axis to beyond the perimeter of the nozzle at its outlet.

Referring now to FIGURES 3 and 4, there is shown a construction of nozzle in which the elements **12** forming the trough-like paths leading to the throat at the nozzle outlet **10***b* do not extend to the nozzle axis at their downstream ends. Each element has a pair of circumferentially-facing walls **12***d*, and inwardly-facing wall **12***e* joining the inner edges of the walls **12***d* and an axially-facing end wall **12***f* joining the downstream ends of the walls **12***d*, and **12***e*.

In this construction, there are provided axial extensions **12***g* of the walls **12***d* to delay mixing of the hot gas issuing from the nozzle and air entering the zones behind the walls **12***f*. The extension walls **12***g* are contained in axial planes and extend radially from the inner edges of the walls **12***d* to beyond the perimeter of the nozzle at its outlet.

The invention is applicable not only to convergent nozzles but also to convergent/divergent nozzles having trough-like paths running through both sections of the nozzle and in this case the extension walls will be downstream of the outlet from the divergent section of the nozzle.

It is thought that by delaying the mixing of the hot gas and the air entering the zones behind the axially-facing end walls, the drag of the nozzle will be reduced.

I claim:

1. A jet propulsion nozzle comprising a tubular outer wall and a series of angularly-spaced elements extending radially inwards from the inner surface of the tubular outer wall to define from adjacent the nozzle inlet at least to the throat thereof a plurality of paths for the hot gas flowing through the nozzle, the number of such paths being selected to reduce the noise level in operation of the nozzle, wherein each of the elements defining the gas paths includes a pair of angularly-spaced circumferentially-facing walls bounding the adjacent gas paths and an axially-facing wall joining the downstream ends of the circumferentially-facing walls, so that at the outlet of the nozzle the gas paths alternate with the axially-facing walls around the nozzle, and the circumferentially-facing walls have axial extensions beyond the outlet of the nozzle to delay mixing of hot gases leaving the nozzle and air flowing into the zones behind the axially-facing walls.

2. A jet propulsion nozzle according to claim 1, wherein the extensions extend in the radial direction outwardly beyond the perimeter of the nozzle.

3. A jet propulsion nozzle according to claim 1, wherein said elements at their downstream ends extend radially to the axis of the nozzle and the axial extensions are walls contained in axial planes and extend radially from the nozzle axis to beyond the perimeter of the nozzle.

4. A jet propulsion nozzle according to claim 1, wherein the said elements at their downstream ends project radially part way along towards the nozzle axis and the extensions are walls contained in axial planes and extending radially from the inner edges of the circumferentially-facing walls to beyond the perimeter of the nozzle.

5. A jet propulsion nozzle comprising a tubular outer wall and a series of angularly-spaced elements extending radially inwards from the inner surface of the tubular outer wall to define from adjacent the nozzle inlet at least to the throat thereof a plurality of paths for the hot gas flowing through the nozzle, the number of such paths being selected to reduce the noise level in opera-

tion of the nozzle, wherein each of the elements defining the gas paths includes a pair of angularly-spaced circumferentially-facing walls bounding the adjacent gas paths, the angular spacing of said pair of walls of each of the angularly-spaced elements being substantially equal to the angular spacing of the angularly-spaced elements, and each of the elements further comprising an axially-facing wall joining the downstream ends of the circumferentially-facing walls, so that at the outlet of the nozzle the gas paths alternate with the axially-facing walls around the nozzle, and the circumferentially-facing walls have axial extensions beyond the outlet of the nozzle to delay mixing of hot gases leaving the nozzle and air flowing into the zones behind the axially-facing walls.

References Cited in the file of this patent

UNITED STATES PATENTS

2,382,386	Arms	Aug. 14, 1945
2,648,192	Lee	Aug. 11, 1953
2,664,700	Benoit	Jan. 5, 1954
2,685,936	Brenneman et al.	Aug. 10, 1954

FOREIGN PATENTS

507,357	Italy	Dec. 29, 1954

OTHER REFERENCES

Flight, "Reduction of Jet Noise," July 8, 1955, volume 68, No. 2424, p. 57–60.