WO 2014/174163

Description

Orientable rocket-motor system

The present invention relates to an orientable rocket motor system for an airborne vehicle.

Though not exclusively, this invention is particularly suitable for being used for a space plane, that is to say an aircraft that is equipped both with aerobic propulsion means such as turboshaft engines and anaerobic propulsion means such as a rocket motor, which is capable of taking off from the ground in the usual manner for an aircraft, of reaching an altitude of at least one hundred kilometres, of flying at a transonic or even supersonic speed, and then of landing also in the usual manner for an aircraft.

It is known that a rocket motor comprises a combustion chamber and a nozzle connected by a nozzle neck and that, in order to orient in flight an airborne vehicle equipped with a rocket motor, it is advantageous to control said rocket motor for orientation. To do this, in a known manner, the end of the combustion chamber opposite to the nozzle neck is articulated, for example by means of a universal joint, on the structure of the airborne vehicle, and actuation means, such as actuators, are provided to pivot said rocket motor with respect to this articulated end of the combustion chamber.

This way of proceeding has the drawback that, since the orifice for ejecting gases from the nozzle is separated from said articulated end of the combustion chamber by the entire length of the rocket motor, the movement of said orifice for ejecting gases from the nozzle is significant in the transverse direction. Consequently the cowling of the airborne vehicle enclosing the rocket motor must have a large diameter to allow the transverse movement of the orifice for ejecting gases from the nozzle.

The result of this is that this large cowling is the source of high aerodynamic drag which impairs the performance of said airborne vehicle.

The object of the present invention is to remedy these drawbacks.

For this purpose, according to the invention, the orientable rocket motor system for an airborne vehicle, said rocket motor comprising a combustion chamber and a nozzle connected by a neck of said nozzle, and said system making it possible to orient said rocket motor with respect to a reference position defining a reference axis which, when said rocket motor is in said reference position, is orthogonal to the orifice for ejecting gases from the nozzle and passes through the centre of said gas-ejection orifice, is distinctive in that it comprises tilting means:

- by which said rocket motor is rigidly connected to said nozzle neck by the adjacent part of said nozzle, and
- which are able to tilt said nozzle and said combustion chamber in opposite directions so that said rocket motor adopts, with respect to said reference position, tilted positions in which the centre of said orifice for ejecting gases from the nozzle is situated at least approximately on said reference axis.

Thus, by virtue of the present invention, the transverse movement of the orifice for ejecting gas from the nozzle is reduced since the tilting radius thereof is also reduced and since the centre of said orifice remains in the vicinity of the reference axis. The cowling of the rocket motor can therefore have a smaller diameter and give rise only to a lower aerodynamic drag.

In an advantageous embodiment, said tilting means comprise a hollow support structure having a truncated pyramid shape:

- that is deformable in both directions of a first deformation direction, under the action of first actuation means,
- which carries said rocket motor by the small base thereof, and
- inside which said combustion chamber is housed.

Preferably, said hollow deformable support structure is formed by a lattice of articulated bars and said first actuation means are actuators articulated on at least one articulated bar of said lattice.

To allow tilting of the rocket motor in any orientation in space, it is advantageous that said tilting means comprise in addition a hollow base structure, having a truncated pyramid shape:

- that is mounted by the large base thereof on said vehicle,

- that is deformable in both directions of a second deformation direction orthogonal to said first deformation direction, under the action of second actuation means, and
- that carries said hollow deformable support structure by the small base thereof.

As with the support structure, the hollow deformable base structure may be formed by a lattice of articulated bars and said second actuation means may be actuators articulated on at least one articulated bar of said lattice.

The articulated lattices of said base structure and of said support structure are advantageously placed one above the other in order to form a hollow truncated-pyramid framework for said tilting means. Said means may comprise an intermediate frame for assembling the lattices of said base structure and of said support structure, an intermediate frame on which:

- the bars of said support structure are articulated about first rotation axes orthogonal to said first deformation direction, and
- the bars of said base structure are articulated about second rotation axes orthogonal to said second deformation direction.

Preferably, said first actuation means for deformation of said support structure bear on said intermediate frame.

Said tilting means may in addition comprise a base frame for assembling the lattice of said base structure on the airborne vehicle, the bars of the lattice of said base structure being articulated on said base frame about such second rotation axes orthogonal to said second deformation direction. Furthermore, it is advantageous that said second actuation means for deformation of said base structure bear on said base frame.

Said tilting means may comprise an end plate for attaching said rocket motor to said support structure, the bars of said support structure being articulated on said end plate about such rotation axes orthogonal to said first deformation direction.

The present invention also relates to an airborne vehicle, in particular a space plane, comprising an orientable rocket motor system as specified above.

The figures of the accompanying drawing will give a clear understanding of how the invention can be implemented. In these figures, identical reference signs designate similar elements.

Fig. 1 shows, in perspective, a space plane equipped with an orientable rocket motor according to the present invention.

Fig. 2 shows, also in perspective, the means for tilting the rocket motor in accordance with the present invention, this rocket motor being in the reference position thereof, neutral in orientation.

Fig. 3 is a plan view of the tilting means of Fig. 2.

Fig. 4 is a side view from the left of the tilting means of Fig. 2.

Fig. 5 is a side view from below of the tilting means of Fig. 2.

Fig. 6 shows, by comparison with Fig. 4, the tilting of the rocket motor in a first deformation direction.

Fig. 7 shows, by comparison with Fig. 5, the tilting of the rocket motor in a second deformation direction orthogonal to said first deformation direction.

Fig. 8 shows, in comparison with Fig. 2, the combined tilting of the rocket motor resulting from the simultaneous tiltings in said first and second orthogonal deformation directions.

The space plane 1, according to the present invention and shown in Fig. 1, comprises only one stage and is capable of making transonic and/or supersonic flights.

This space plane 1, having a longitudinal axis L-L, comprises two lateral turboshaft engines 2 and 3 and a rocket motor 4, arranged at the rear of said space plane inside a base cowling 5, provided with a gas-discharge orifice 6. As shown by Fig. 2 to 8, the rocket motor 4 comprises a combustion chamber 7 and a nozzle 8 connected by a nozzle neck 9. The nozzle 8 comprises a gas-ejection orifice 10 arranged opposite the outlet orifice 6 of the base cowling 5 (shown schematically in dot-and-dash lines in Fig. 4 to 7).

The rocket motor 4 is mounted (in the base cowling 5) on tilting means 11 capable of deforming in both directions 12.1 and 12.2 and 13.1 and 13.2 of each of the two orthogonal deformation directions 12 and 13. The tilting means 11 comprise, firstly, a truncated pyramid framework 14 in a lattice of articulated bars and, secondly, actuators 15 and 16.

The truncated pyramid framework 14 comprises a supporting truncated pyramid structure 14A carrying the rocket motor 4 by the small base thereof, and a base truncated pyramid structure 14B carrying the supporting truncated pyramid structure 14A by the small base thereof. The large base of the truncated pyramid structure 14A is connected to the small base of the truncated pyramid structure 14B by means of an intermediate frame 17, on which the articulated bars 18 of the base structure 14B are articulated about axes 19 orthogonal to the deformation direction 13 and the articulated bars 20 of the support structure 14A are articulated about axes 21 orthogonal to the deformation direction 12.

The truncated pyramid framework 14 also comprises, on the side of the large base of the structure 14B, a base frame 22 making it possible to connect said framework to the structure of the space plane 1. The articulated bars 18 of the base structure 14B are articulated on the base frame 22 about axes 23 orthogonal to the deformation direction 13. The actuator 16 is articulated both on the base frame 22 on which it bears and on an articulated bar 18, so as to be able to tilt the truncated pyramid structure 4B in both directions 13.1 and 13.2 of the deformation direction 13, by rotation about axes 19 and 23 orthogonal to said deformation direction.

On the small base thereof opposite to the base structure 14B, the support structure 14A carries the rocket motor 4 in a rigidly connected manner. For this purpose, this small base is an end plate 24, to which said rocket motor is rigidly connected by means of the part of the nozzle 8 adjacent to the nozzle neck 9, so that the combustion chamber 7 is situated inside the framework 14. The articulated bars 20 of the support structure 14A are articulated on the end plate 24 about axes 25 orthogonal to said deformation direction 12. The actuator 15 is articulated both on the intermediate frame 17 on which it bears and on an articulated bar 20 so as to be able to tilt the truncated pyramid structure 4A in both directions 12.1 and 12.2 of the deformation direction 12 by rotation about axes 21 and 25 orthogonal to said tilting direction.

Thus, by controlling the actuators 15 and 16, it is possible to orient the rocket motor 4 in space.

In the neutral orientation position P_o serving as a reference position (see Fig. 2, 4 and 5), the axis of the rocket motor 4 occupies a position $m_o - m_o$ that is orthogonal to the gas-ejection orifice 10 of the nozzle 8 and passes through the centre C of said orifice. This position $m_o - m_o$ serves as a reference axis with respect to which the rocket motor 4 tilts.

As shown by Fig. 6, by extending or shortening, the actuator 15 deforms the truncated pyramid support structure 14A in one or the other direction 12.1, 12.2 of the deformation direction 12. Such deformations of the support structure 14A cause the tilting of the end plate 24 so that the rocket motor 4 adopts tilted positions P_1 in the directions 12.1, 12.2 of the direction 12, in which the axis thereof adopts positions $m_{12} - m_{12}$ inclined with respect to the reference axis $m_o - m_o$. In these tilted positions P_1, the combustion chamber 7 and the nozzle 8 tilt in opposite directions because the fixed motor 4 is rigidly connected to the end plate 24 by the part of the nozzle 8 adjacent to the nozzle neck 9. By virtue of this fact and the formation of the support structure 14A, the centre C of the gas-ejection orifice of the nozzle 10 can, in these positions P_1 tilted in the deformation direction 12, remain in the vicinity of the reference axis $m_o - m_o$, if not on said axis. The movement of the nozzle 10 in the deformation direction 12 can thus be small.

In a similar manner, as shown in Fig. 7, by extending or shortening, the actuator 16 deforms the truncated pyramid base structure 14B in one or the other direction 13.1, 13.2 of the deformation direction 13. Such deformations of the base structure 14B cause the tilting of the intermediate plate 17 so that the rocket motor 4 adopts tilted positions P_2 in the direction 13.1, 13.2 of the deformation direction 13, in which the axis thereof adopts positions $m_{13} - m_{13}$ inclined with respect to the reference axis $m_o - m_o$. In these tilted positions P_2, the combustion chamber 7 and the nozzle 8 also tilt in opposite directions because the fixed motor 4 is rigidly connected to the end plate 24 by the part of the nozzle 8 adjacent to the nozzle neck 9. By virtue of this fact and the formation of the base structure 14B, the centre C of the gas-ejection orifice of the nozzle 10 can, in these positions P_2 tilted in the deformation direction 13, remain in the vicinity of the reference axis $m_o - m_o$, if not on said axis. The movement of the nozzle 10 in the deformation direction 13 can therefore be small.

Naturally, as shown in Fig. 8, the actuators 15 and 16 can act simultaneously in order to provide the rocket motor 4 with positions P_3, tilted both in the deformation direction12 and in the deformation direction 13.

Claims

1. Orientable rocket motor system for an airborne vehicle, said rocket motor (4) comprising a combustion chamber (7) and a nozzle (8) connected by a neck (9) of said nozzle, and said system making it possible to orient said rocket motor (4) with respect to a reference position (P_o) defining a reference axis ($m_o - m_o$) which, when said rocket motor (4) is in said reference position (P_o), is orthogonal to the orifice (10) for ejecting gases from the nozzle and passes through the centre (C) of said gas-ejection orifice (10), characterised in that it comprises tilting means (11):

- by which said rocket motor (4) is rigidly connected to said nozzle neck (9) by the adjacent part of said nozzle (8), and
- which tilt said nozzle (8) and said combustion chamber (7) in opposite directions so that said rocket motor adopts, with respect to said reference position (P_o), tilted positions (P_1, P_2, P_3) in which the centre (C) of said orifice (10) for ejecting gases from the nozzle (8) is situated at least approximately on said reference axis ($m_o - m_o$).

2. System according to claim 1, characterised in that said tilting means (11) comprise a hollow support structure (14A), having a truncated pyramid shape:

- that is deformable in both directions (12.1, 12.2) of a first deformation direction (12), under the action of first actuation means (15),
- which carries said rocket motor (4) by the small base (24) thereof, and
- inside which said combustion chamber (7) is housed.

3. System according to claim 2, characterised in that said hollow deformable support structure (14A) is formed by a lattice of articulated bars (20).

4. System according to either claim 2 or claim 3, characterised in that said tilting means (11) comprise in addition a hollow base structure (14B), having a truncated pyramid shape:

- that is mounted by the large base (22) thereof on said vehicle,
- that is deformable in both directions (13.1 and 13.2) of a second deformation direction (13) orthogonal to said first deformation direction (12), under the action of second actuation means (16), and
- that carries said hollow deformable support structure (14A) by the small base (17) thereof.

5. System according to claim 4, characterised in that said hollow deformable base structure (14B) is formed by a lattice of articulated bars (18).

6. System according claim 3 and claim 5, characterised in that the lattices of said base structure (14B) and of said support structure (14A) are placed one above the other in order to form a hollow truncated pyramid framework (14) for said tilting means (11).

7. System according to claim 6, characterised in that said tilting means (11) comprise an intermediate frame (17) for assembling the lattices of said base structure (14B) and of said support structure (14A), an intermediate frame (17) on which:

- the bars (20) of said support structure (14A) are articulated about first rotation axes (21) orthogonal to said first deformation direction (12), and
- the bars (18) of said base structure (14B) are articulated about second rotation axes (19) orthogonal to said second deformation direction (13).

8. System according to claim 7, characterised in that said first actuation means (15) for deforming said support structure bear on said intermediate frame (17).

9. System according to any of claims 5 to 8, characterised in that said tilting means (11) comprise a base frame (22) for assembling the lattice of said base structure (14B) on the airborne vehicle, the lattice bars (18) of said base structure being articulated on said base frame (22) about second rotation axes (23) orthogonal to said second deformation direction.

10. System according to claim 9, characterised in that said second actuation means (16) for deforming said base structure (14B) bear on said base frame (22).

11. System according to any of claims 4 to 9, characterised in that said tilting means (11) comprise an end plate (24) for attaching said rocket motor (4) to said support structure (4A), the bars (20) of said support structure being articulated on said end plate (24) about first rotation axes (25) orthogonal to said first deformation direction.

12. Airborne vehicle, characterised in that it comprises an orientable rocket motor system as specified in any of claims 1 to 11.