TURBINE ENGINE NOZZLE

U.S. GOVERNMENT RIGHTS

The invention was made with U.S. Government support under contract no. N00019-02-C-3003 awarded by the U.S. Navy. The U.S. Government has certain rights in the invention.

BACKGROUND OF THE INVENTION

(1) Field of the Invention

The invention relates to turbine engines. More particularly, the invention relates to variable throat turbine engine exhaust nozzles.

(2) Description of the Related Art

There is well developed field in turbine engine exhaust nozzles. A number of nozzle configurations involve pairs of relatively hinged flaps: a convergent flap upstream; and a divergent flap downstream. Axisymmetric nozzles may feature a circular array of such flap pairs. Exemplary nozzles are shown in U.S. Pat. Nos. 3,730,436, 5,797,544, and 6,398,129.

SUMMARY OF THE INVENTION

Accordingly, one aspect of the invention involves a turbine engine nozzle subassembly. A downstream flap is pivotally coupled to an upstream flap for relative rotation about a hinge axis. An actuator linkage is coupled to the downstream flap along a forward half thereof for actuating the upstream and downstream flaps between a number of throat area conditions.

In various implementations, an external flap may be pivotally coupled to the downstream flap and to an environmental structure. A span between respective coupling locations with the downstream flap and environmental structure may be extensible and contractable responsive to aerodynamic forces. Means may restrict an extensibility range of the external flap. The means may include a secondary link having a first pivotal coupling location to the environmental structure and a second pivotal coupling location to the divergent flap. The second pivotal coupling location may be intermediate coupling location of the downstream flap to the external flap and a coupling location of the actuator linkage to the downstream flap. The secondary link may have a restricted free float range relative to the downstream flap.

Another aspect of the invention involves a turbine engine nozzle having a number of flap subassemblies coupled to a static structure. The subassemblies each include an upstream flap pivotally coupled to the static structure for relative rotation about an axis essentially fixed relative to the static structure. Each subassembly further includes a downstream flap pivotally coupled to the associated upstream flap for relative rotation about a hinge axis. Means actuate articulation of the upstream and downstream flaps within a range of areas of the throat while minimizing mode change-induced throat area changes at a given design point.

In various implementations, the subassemblies may be axisymmetrically arranged about an engine centerline. The articulation may be simultaneous for each of the subassemblies. Each of the subassemblies may further include an external flap pivotally coupled to the associated downstream flap.

Another aspect of the invention involves a means for retrofitting a turbine engine or reengineering a turbine engine configuration which has or has previously had a first nozzle subassembly having a convergent flap, a divergent flap, an external flap and an actuation linkage coupled to the convergent flap. A second subassembly is installed or engineered. The second subassembly has a second convergent flap, a second divergent flap, and a second actuation linkage, optionally sharing one or more components with the actuation linkage of the first nozzle subassembly. The second actuation linkage is coupled to the second divergent flap so as to permit an aerodynamically-induced mode change articulation of the second divergent flap to rotate the second divergent flap about a non-fixed instantaneous center of rotation while simultaneously rotating the second divergent flap relative to the second convergent flap about a non-fixed hinge axis.

In various implementations, the second subassembly may provide an aerodynamic throat which has a throat area that is less sensitive to changes associated with said mode change articulation than was an area of a throat of the first nozzle subassembly. The method may entail replacing a circumferential array of such first nozzle subassemblies with a circumferential array of such second nozzle subassemblies.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cutaway longitudinal view of a turbine engine nozzle in a first condition.

FIG. **2** is a view of the nozzle of FIG. **1** in a second condition.

FIG. **3** is a view of the nozzle of FIG. **1** in a third condition.

FIG. **4** is a view of the nozzle of FIG. **1** in a fourth condition.

FIG. **5** is a schematic view of the nozzle of FIG. **1**.

Like reference numbers and designations in the various drawings indicate like elements.

DETAILED DESCRIPTION

FIG. **1** shows a turbine engine nozzle **20**. The exemplary nozzle comprises an axisymmetric circular array (FIG. **5**) of convergent/divergent flap pairs about a nozzle axis or centerline **500**. A given flap pair has a convergent flap **22** upstream/forward extending from an upstream end **23** to a downstream end **24** and a divergent flap **26** downstream/aft extending from an upstream end **27** to a downs end **28**. The flaps are hinged relative to each other by a hinge mechanism **30** for relative movement about a hinge axis **502** proximate the convergent flap downstream end and divergent flap upstream end. The inboard surface of the divergent flap **26** has a longitudinally convex surface portion **40** near its upstream end for forming an aerodynamic throat (i.e., the location of smallest passageway cross-section) of the nozzle of instantaneous throat radius R_T and an essentially longitudinally straight portion **42** extending aft therefrom toward the downstream end for forming an exhaust outlet of instantaneous outlet radius R_O. For each convergent/divergent flap pair, the nozzle further includes an external flap **50**, the outboard surface **52** of which forms an exterior contour of the nozzle exposed to external airflow passing around the aircraft fuselage.