is not choked upstream of the fan exhaust nozzle **30'**. A number of intermediate deployed positions between the fully stowed position and fully deployed position for the translating sleeve are possible with the hydraulic actuators being activated gradually.

After aircraft touch down, the thrust reverser **36** may be positioned at its engaged position to produce reverse thrust. For the thrust reverser **36** to be activated and effective, the translating sleeve **38** must first be translated aftwardly to expose the turning vanes **56** to the gases in the duct **28** and to enable aftward movement of the reverser. The translating sleeve **38** is activated and translates downstream in the same manner as described above. The thrust reverser **36** is moved axially downstream when the hydraulic pressure builds up in the thrust reverser cylinders **66** and extends the moveable rods **68** axially downstream. The thrust reverser **36** then slidingly moves downstream as the thrust reverser T-slides **96** slide downstream in the tracks **97**. The reverser door **50** pivots radially inwardly to block the gases in duct **28** from exiting through the fan exhaust nozzle throat **30'**, thereby diverting the gases through the guide vanes **60**.

The gas turbine engines that employ the present invention can achieve higher propulsive efficiency with a lower pressure ratio and high mass flow without sacrificing engine thrust and without fan stability problems. At cruise, as the translating sleeve is in the fully stowed position, the gas turbine engines with lower pressure ratios enjoy higher thrust, reduced noise levels and improved fuel consumption. At takeoff, climb, and approach, as the translating sleeve is in one of the deployed positions, the increased area of the fan exhaust nozzle **30'** allows the additional air flow generated by the fan to exit the engine **10** without causing excessive back pressure on the fan blades and thus without stalling the fan **14**. Moreover, gradually and continuously varying area of the fan exhaust nozzle allows further optimization of the performance by reducing the overall weight of the gas turbine engine and improving fuel consumption.

Furthermore, the combination of the lower fan pressure ratio and the higher fan mass flow reduces noise levels at approach, takeoff and climb. The noise reduction is a result of two factors. First, the fan rotating at lower speeds thereby producing less noise. Second, the extended downstream translating sleeve affords an additional attenuation path that reduces noise levels. Moreover, the combination of the lower fan pressure ratio and the higher fan mass flow improves fuel consumption at cruise.

The variable area fan exhaust nozzle having the translating sleeve **38** of the present invention allows an increase in the area of the nozzle throat in excess of 40%. The translating sleeve **38** achieves a significant increase in the area of the nozzle **30'** without a significant weight penalty to the gas turbine engine **10**. Furthermore, the two semi-cylinders **90**, **91** of the translating sleeve **38** form a continuous inner surface **74** of the fan exhaust nozzle. The continuous surface **74** allows the nozzle to withstand the internal pressure of the airflow without excessive weight and to avoid air leakage.

The variable area fan nozzle of the present invention overcomes the major shortcomings of the prior art. The increase in throat area is achieved exclusively as a result of a downstream translation of the translating sleeve. Thus, the present invention avoids implementation of an auxiliary nozzle which introduces a radial velocity component to the nozzle efflux. When the engine is installed under the wing, this radial velocity component will adversely effect the basic wing lift generation at all speeds and degrade the effect of wing leading edge high lift devices at low speed operations. The present invention also avoids the adverse effect of an auxiliary nozzle to the propulsion system and to the internal aerodynamic performance of the engine.

The invention is also less susceptible to uncommanded engagement of the reverser. The mechanical independence of the reverser and sleeve actuation systems guarantees that a malfunction of either system alone cannot cause uncommanded reverser engagement. Instead, such uncommanded engagement can only occur following a far less probable malfunction of both systems.

Finally, the invention ensures stable fan operation since the reverser is engageable with the area modulating sleeve in its aftmost, maximum throat area position. Unlike the apparatus disclosed in U.S. Pat. No. 4,922,713, the present invention does not require that engagement of the reverser be preceded by a potentially destabilizing reduction in the nozzle discharge area.

The present invention is also acoustically superior to the prior art in general, and to U.S. Pat. No. 4,922,713 in particular. All of the airflow exiting through the nozzle is acoustically treated and attenuated.

Although the invention has been shown and described with respect to exemplary embodiments thereof, it should be understood by those skilled in the art that various changes, omissions, and additions may be made thereto, without departing from the spirit and scope of the invention. For example, this invention can be used with a thrust reverser having translating turning vanes, rather than stationary turning vanes **56**, as described in the preferred embodiment.

We claim:

1. A variable area exhaust nozzle for a gas turbine engine having a longitudinally extending axis, comprising:

an aerodynamically streamlined outer nacelle having an upstream portion and a downstream portion, the downstream portion including:

a thrust reverser having a moveable body and a plurality of blocker doors radially spaced apart from the moveable body, the thrust reverser being positionable at an engaged position and a disengaged position, and

a fixed geometry translatable sleeve having a trailing edge aft of the moveable body, the sleeve being translatable between and deployable at a stowed position, a fully deployed position and a plurality of intermediate positions, the sleeve in its stowed position being nested radially intermediate the moveable body and the blocker doors so that the sleeve inhibits movement of the thrust reverser to its engaged position;

a fixed geometry, aftwardly convergent core cowl radially spaced from the outer nacelle and cooperating therewith to define a longitudinally extending annular exhaust duct the exhaust duct having a throat defined by the core cowl and the trailing edge of the sleeve, the throat being the exclusive outlet for discharging a quantity of working medium gases from the duct for producing forward thrust, the duct having, for all positions of the sleeve, an aftwardly generally diminishing annular area including a throat area, the throat area being the minimum area of the duct;

a sleeve actuation system including a plurality of sleeve actuators for effecting translatory movement of the sleeve, the translatory movement being the exclusive means for varying the throat area and the quantity of forward thrust producing gases discharged from the duct, aftward movement of the sleeve causing an