1

8.3.

$$F = \dot{m}_9 u_9 - \dot{m}_0 u_0 + (P_9 - P_0) A_9$$

assume

$$\dot{m}_9 = \dot{m}_0 = \dot{m} \qquad P_9 = P_0$$

$$\frac{F}{\dot{m}} = u_9 - u_0 = u_0 \left(\frac{u_9}{u_0} - 1 \right)$$

$$u = aM$$

$$\frac{u_9}{u_0} = \frac{a_9 M_9}{a_0 M_0} = \sqrt{\frac{\gamma R T_9}{\gamma R T_0}} \frac{M_9}{M_0} = \sqrt{\frac{T_9}{T_0}} \frac{M_9}{M_0}$$

$$\frac{F}{\dot{m}} = a_0 M_0 \left(\sqrt{\frac{T_9}{T_0}} \frac{M_9}{M_0} - 1 \right)$$

or

$$\frac{F}{\dot{m}} = a_0 \left\{ \sqrt{\frac{T_9}{T_0}} M_9 - M_0 \right\}$$

Expect pressure portion to be the same as the normal derivation.

$$P_{t9} = \cancel{P_9}^{\,P_0} \left(1 + \frac{\gamma - 1}{2} M_9^2 \right)^{\frac{\gamma}{\gamma - 1}} = \frac{P_{t9}}{P_{t5}} \frac{P_{t5}}{P_{t4}} \frac{P_{t4}}{P_{t3}} \frac{P_{t3}}{P_{t2}} \frac{P_{t2}}{P_{t0}} \frac{P_{t0}}{P_0}$$

since

$$\frac{T_{t9}}{T_9} = 1 + \frac{\gamma - 1}{2} M_9^2 \qquad \frac{P_{t9}}{P_9} = \left(\frac{T_{t9}}{T_9} \right)^{\frac{\gamma}{\gamma - 1}}$$