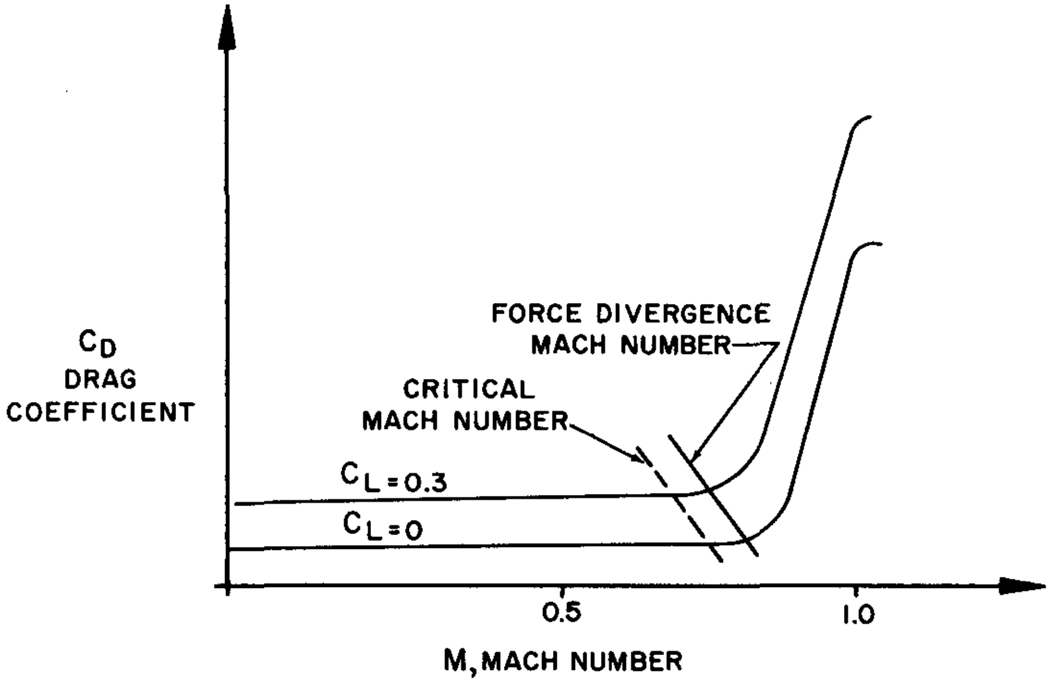

Figure 3.10. Compressibility Drag Rise

shock wave formation, there will be a loss of lift and subsequent loss of downwash aft of the affected area. If the wings shock unevenly due to physical shape differences or sideslip, a rolling moment will be created in the direction of the initial loss of lift and contribute to control difficulty ("wing drop"). If the shock induced separation occurs symmetrically near the wing root, a decrease in downwash behind this area is a corollary of the loss of lift. A decrease in downwash on the horizontal tail will create a diving moment and the aircraft will "tuck under." If these conditions occur on a swept wing planform, the wing center of pressure shift contributes to the trim change—root shock first moves the wing center of pressure aft and adds to the diving moment; shock formation at the wing tips first moves the center of pressure forward and the resulting climbing moment and tail downwash change can contribute to "pitch up."

Since most of the difficulties of transonic flight are associated with shock wave induced flow separation, any means of delaying or alleviating the shock induced separation will improve the aerodynamic characteristics. An aircraft configuration may utilize thin surfaces of low aspect ratio with sweepback to delay and reduce the magnitude of transonic force divergence. In addition, various methods of boundary layer control, high lift devices, vortex generators, etc., may be applied to improve transonic characteristics. For example, the application of vortex generators to a surface can produce higher local surface velocities and increase the kinetic energy of the boundary layer. Thus, a more severe pressure gradient (stronger shock wave) will be necessary to produce airflow separation.