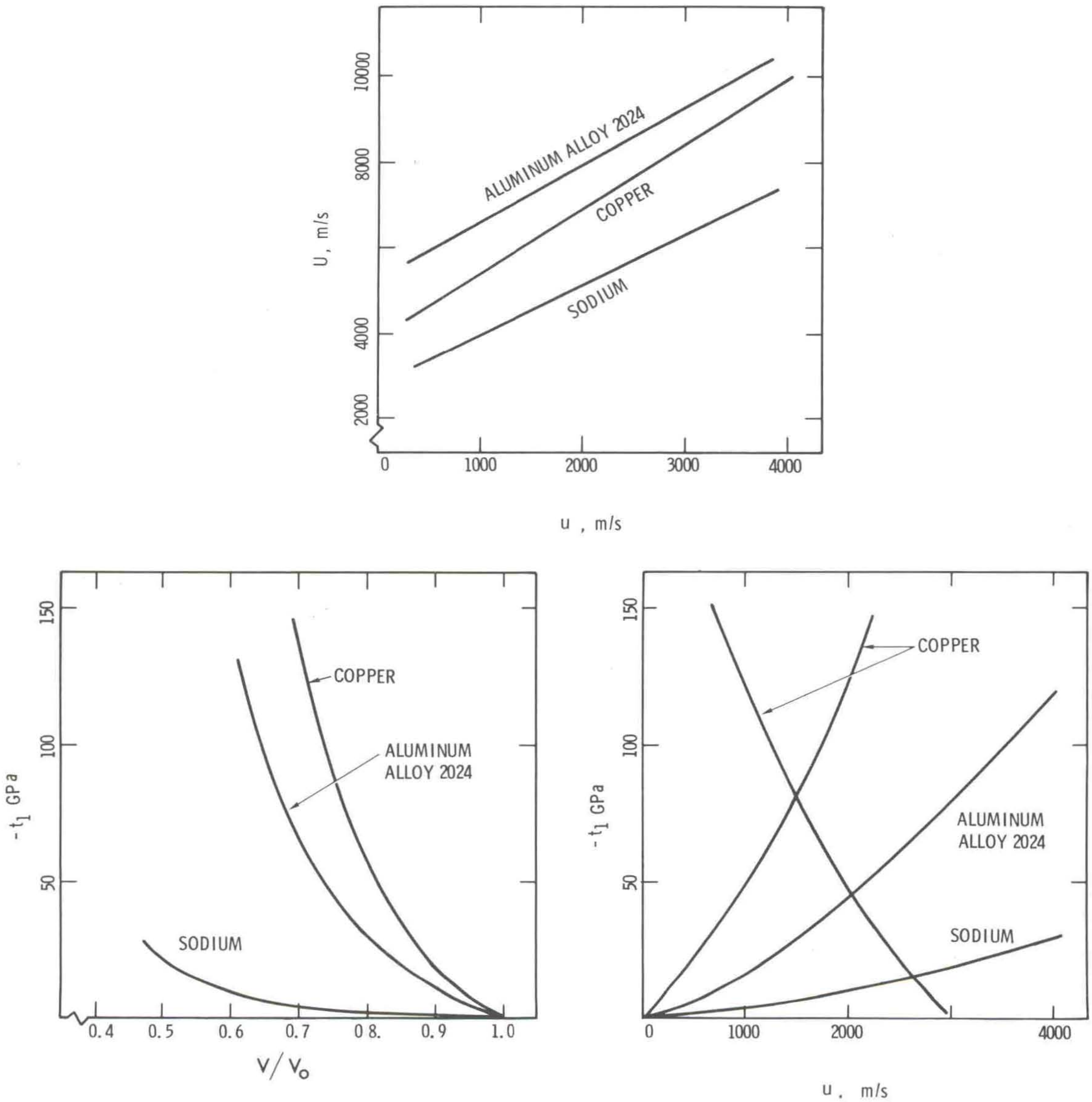

Fig. 2.1. Hugoniot curves in the (U, u), $(-t_1, v/v_0)$ and $(-t_1, u)$ planes are shown for three metals. Sodium is one of the most compressible of the solids normally studied, the aluminum alloy is an intermediate case, and the copper is less compressible, but comparable to nickel, chromium and stainless steels. Materials such as platinum, tungsten and gold are among the least compressible solids. The two $(-t_1, u)$ curves shown for copper illustrate the fact that reflection and translation in u is permissible.

centered on the point (p^+, v^+) has the same slope and curvature as the isentrope through this point.

Stability of shocks. One important problem that must be mentioned is that of stability of shocks. It will suffice for our purpose to present heuristic arguments and to point out two important cases where a stable shock transition between given states is not possible. Consider first the Hugoniot curve (A) in fig. 2.2a. A shock transition from the state $\mathscr{S}^+$ to the state $\mathscr{S}^-$ will propagate at a

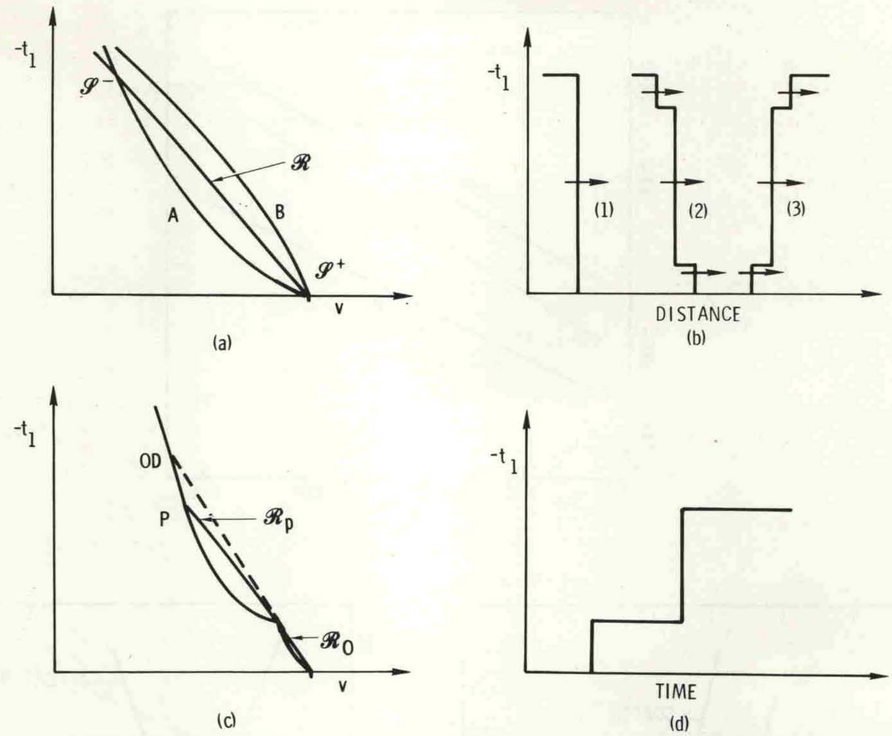

Fig. 2.2. Elementary considerations of the stability of shocks involve resolving the question of whether a small perturbation (see part (b) of the figure) advancing ahead of the shock, or falling behind, will propagate at a velocity that allows it to merge with the shock or at one that causes it to disperse further. In the former case the shock is stable, while in the latter it is unstable. As discussed in the text, this analysis shows that compression shocks are stable in material having a Hugoniot curve of the form of curve A in part (a) of the figure, and are unstable for Hugioniot curves of the form B. The reverse situation obtains for decompression waves. Parts (c) and (d) of the figure illustrate the Hugoniot curve and the corresponding stress history of a propagated compressive disturbance for a case where an elastic-plastic transition or collapse to a dense phase produces a discontinuity in the slope of a Hugoniot.

velocity proportional to the negative square root of the slope of the Rayleigh line $\mathscr{R}$. It can be expected to be a step in stress that advances in time as suggested by waveform (1) of fig. 2.2b. Suppose the shock were to exhibit a tendency to increase in thickness by virtue of small high-pressure wavelets falling behind and/or small low-pressure wavelets advancing ahead of the shock as illustrated by waveform (2) of the figure. These weak shocks will propagate at velocities essentially proportional to the slope of the Hugoniot curve at the maximum shock pressure and at its foot, respectively. By examination of the relative slopes of the Rayleigh line and these two tangents, we see that a waveform perturbed to look like (2) will tend to restore itself to form (1). We conclude that the shock is stable. The opposite conclusion would follow if we consider a decompression wave for this material or a compression wave for a material governed by the curve B in fig. 2.2a; the shock is not a stable solution to these problems (this issue can also be discussed in terms of an entropy production requirement and eq. (2.19)). The nature of the instability suggests that a smooth, spreading wave will form. Such a disturbance would have to satisfy the differential equations of motion (2.12), not the shock jump conditions, and such solutions do exist and have been studied extensively (see, for example, the classical treatment of Courant and Friedrichs [48C1]).