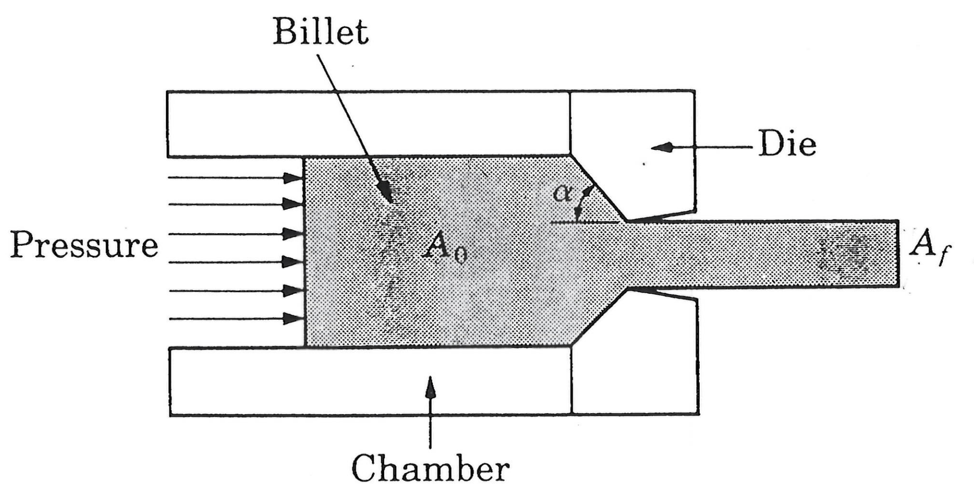

- Die Angle α
- Extrusion Ratio R
- Billet Temp.
- Ram Velocity
- Lubricant used.

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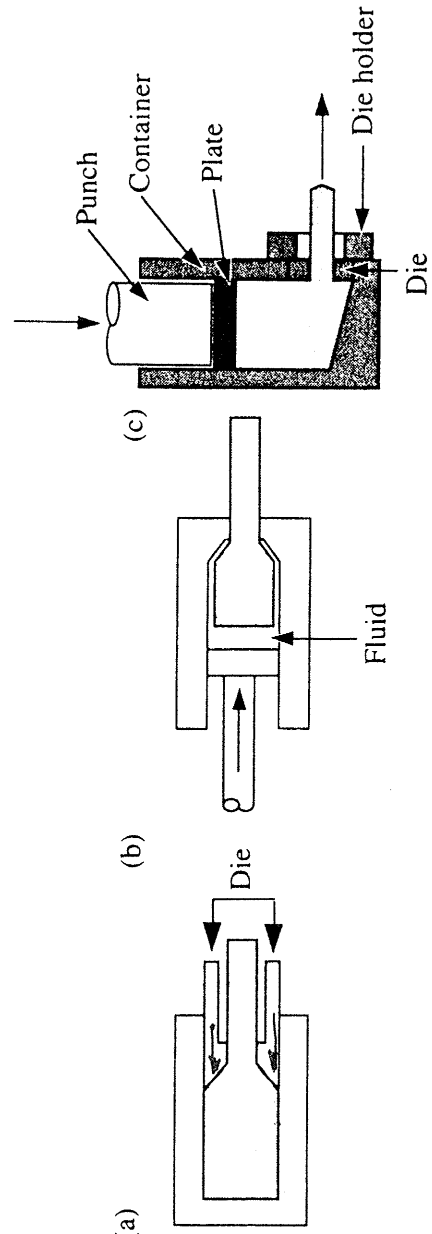
Types of extrusion: (a) indirect; (b) hydrostatic and (c) lateral

Figure 15.3 (page 419)



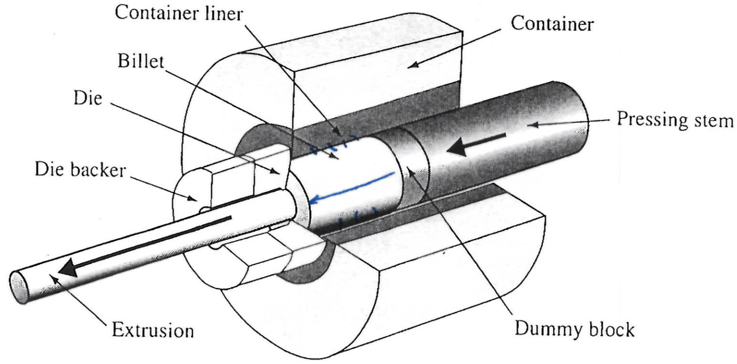


FIGURE 15.1 Schematic illustration of the direct extrusion process.

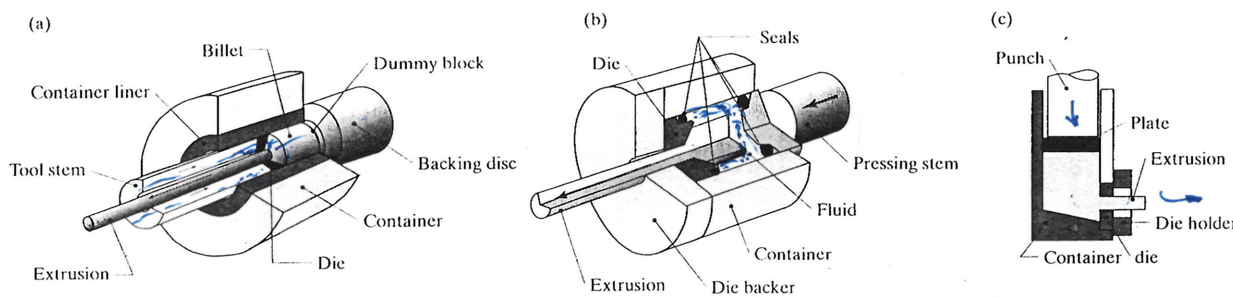


FIGURE 15.3 Types of extrusion: (a) indirect; (b) hydrostatic; (c) lateral.

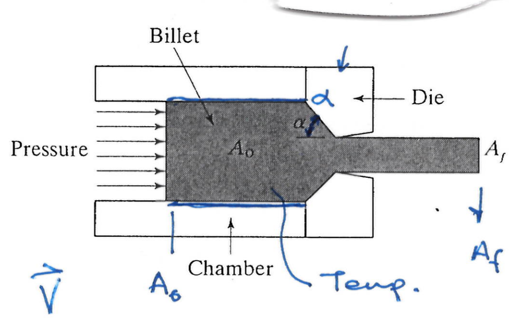


FIGURE 15.4 Process variables in direct extrusion. The die angle, reduction in cross-section, extrusion speed, billet temperature, and lubrication all affect the extrusion pressure.

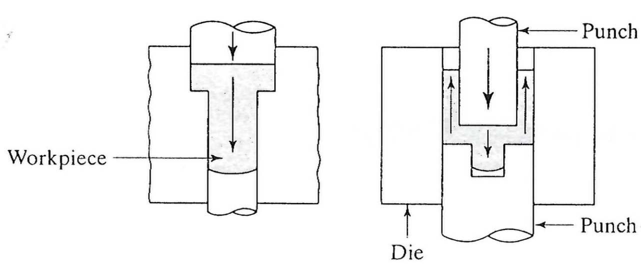
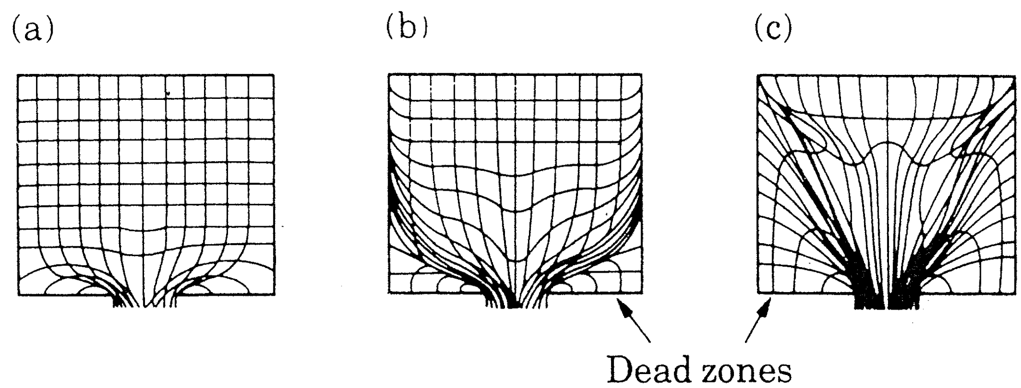


FIGURE 15.11 Two examples of cold extrusion. Thin arrows indicate the direction of metal flow during extrusion.

Types of metal flow in extruding with square dies



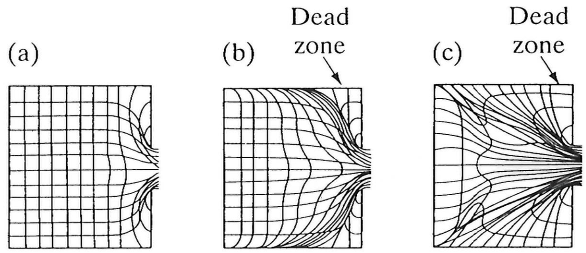


FIGURE 15.7 Types of metal flow in extruding with square dies. (a) Flow pattern obtained at low friction, or in indirect extrusion. (b) Pattern obtained with high friction at the billet–chamber interfaces. (c) Pattern obtained at high friction, or with cooling of the outer regions of the billet in the chamber. This type of pattern, observed in metals whose strength increases rapidly with decreasing temperature, leads to a defect known as pipe, or extrusion defect.

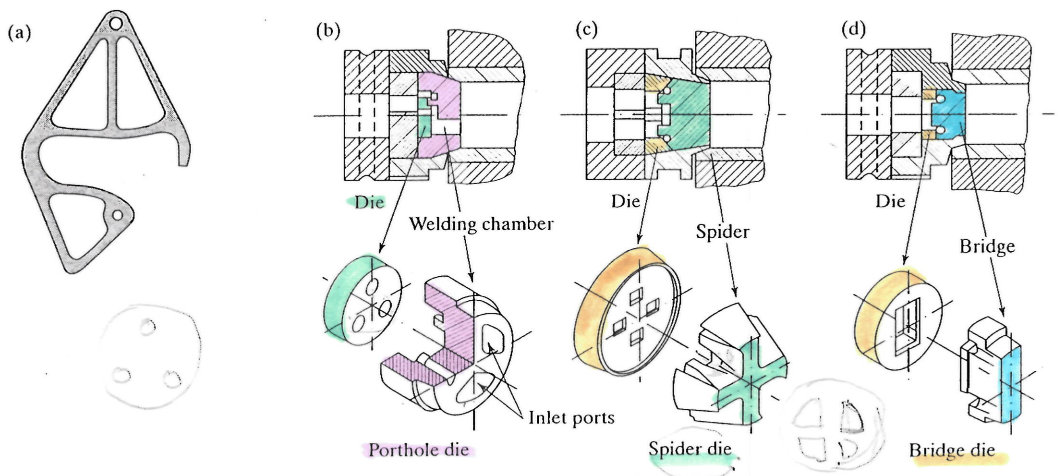
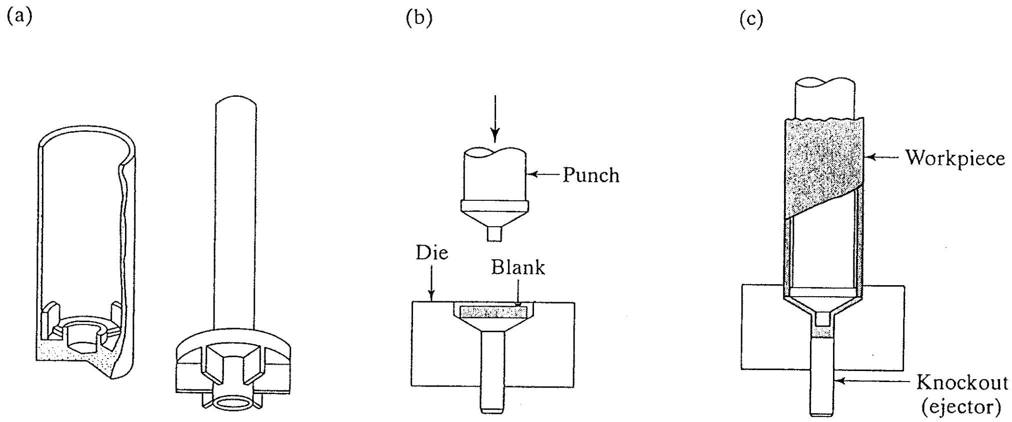


FIGURE 15.9 (a) An extruded 6063-T6 aluminum ladder lock for aluminum extension ladders. This part is 8 mm (5/16 in.) thick and is sawed from the extrusion (see Fig. 15.2). (b)-(d) Components of various dies for extruding intricate hollow shapes. *Source* for (b)-(d): K. Laue and H. Stenger, *Extrusion—Processes, Machinery, Tooling*. American Society for Metals, Metals Park, Ohio, 1981. Used with permission.

FIGURE 15.15 (a) Two examples of products made by impact extrusion. These parts may also be made by casting, by forging, or by machining; the choice of process depends on the dimensions and the materials involved and on the properties desired. Economic considerations are also important in final process selection. (b) and (c) Impact extrusion of a collapsible tube by the *Hooker process*. (5)



(6)

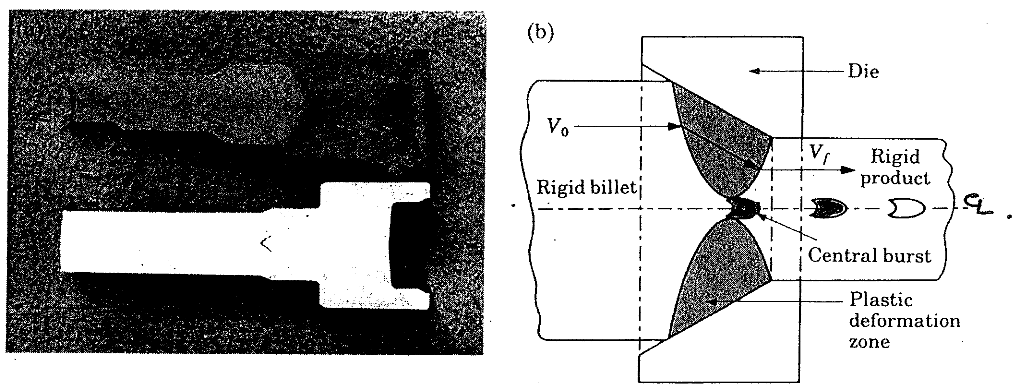


FIGURE 15.16 (a) Chevron cracking (central burst) in extruded round steel bars. Unless the products are inspected, such internal defects may remain undetected, and later cause failure of the part in service. This defect can also develop in the drawing of rod, of wire, and of tubes. (b) Schematic illustration of rigid and plastic zones in extrusion. The tendency toward chevron cracking increases if the two plastic zones do not meet. Note that the plastic zone can be made larger either by decreasing the die angle or by increasing the reduction in cross-section (or both). *Source*: B. Avitzur.

(7)

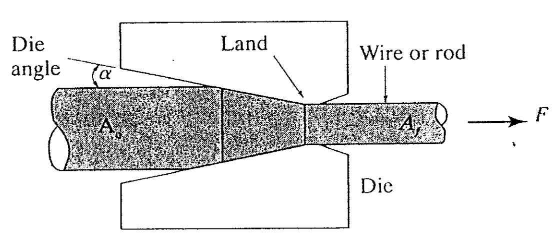
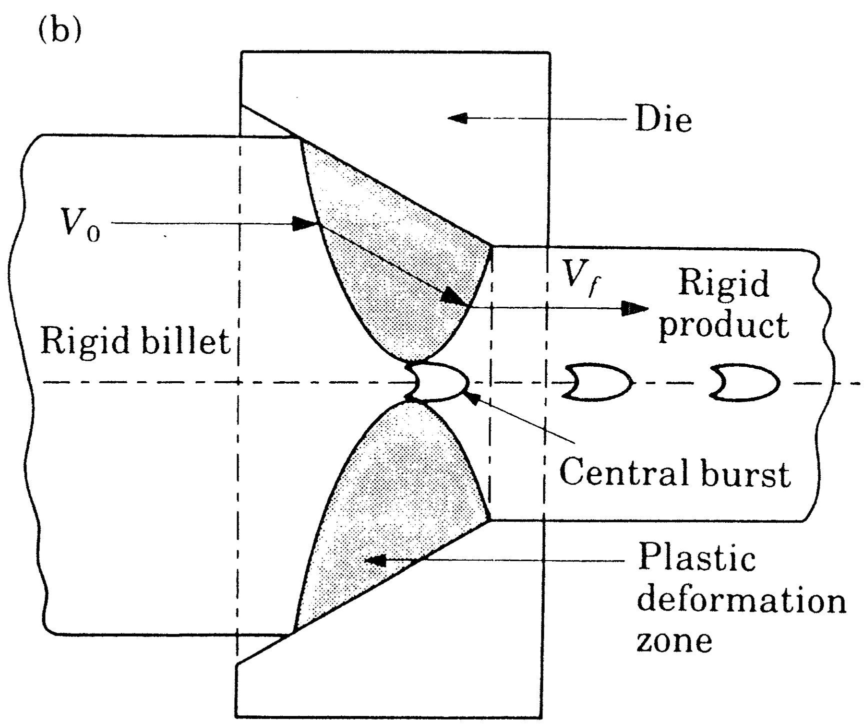


FIGURE 15.18 Process variables in wire drawing. The die angle, the reduction in cross-sectional area per pass, the speed of drawing, the temperature, and the lubrication all affect the drawing force, *F*.

Figure 15.19 (page 432) (b) Schematic illustration of rigid and plastic zones in extrusion. The tendency for chevron cracking increases if the two plastic zones do not meet.



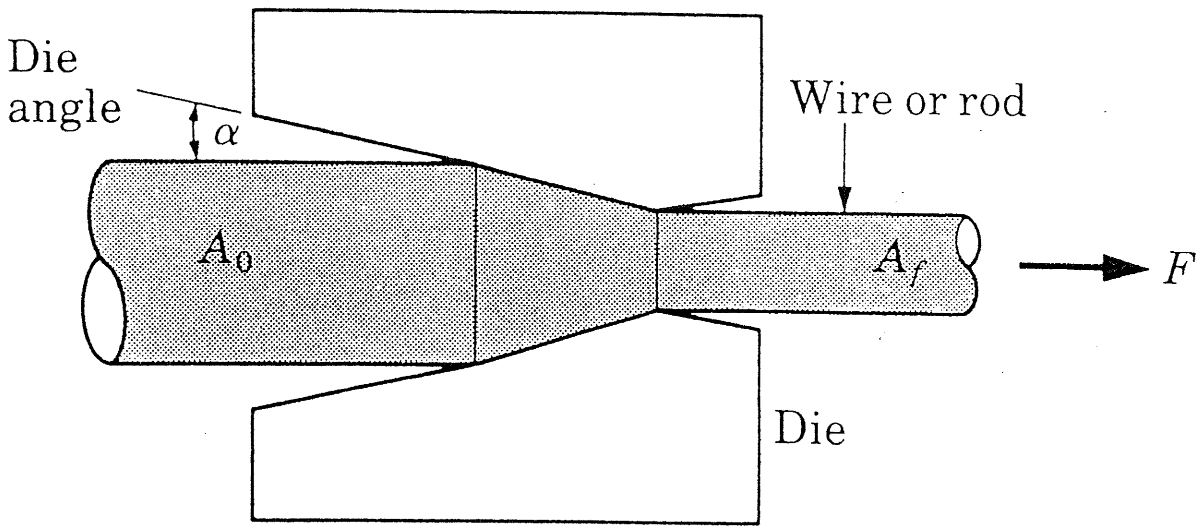

Die
angle
α
Wire or rod
A_0
A_f
F
Die

Figure 15.23 (page 435) **Examples of tube-drawing operations, with or without an internal mandrel** **Master 43**