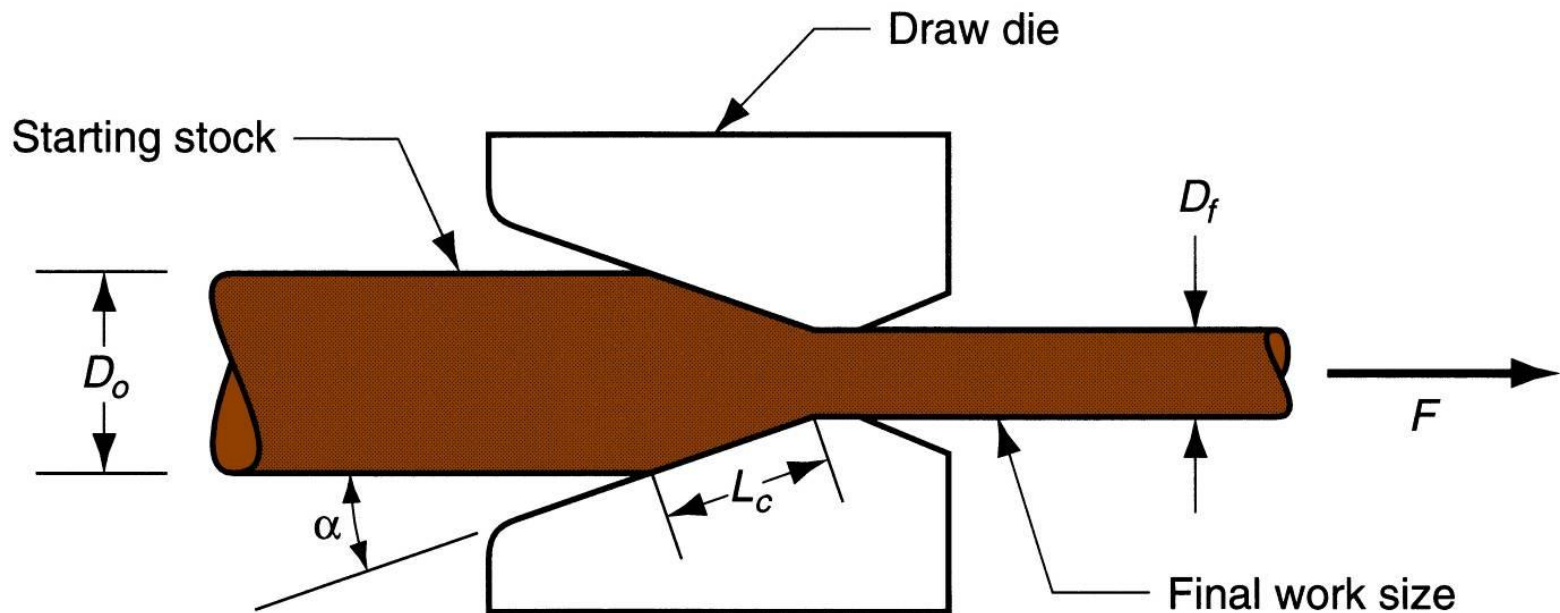


WIRE AND BAR DRAWING

- Drawing is an operation in which the cross-section of a bar, rod, or wire is reduced by pulling it through a die opening, as in Figure .
- The general features of the process are similar to those of extrusion .
- The difference is that the work is pulled through the die in drawing, where as it is pushed through the die in extrusion.

WIRE AND BAR DRAWING

- Although drawing applies tensile stress, compression also plays a significant role since metal is squeezed as it passes through die opening.



WIRE AND BAR DRAWING

- Change in size of work is usually given by area reduction:

$$r = \frac{A_o - A_f}{A_o}$$

where r = area reduction in drawing; A_o = original area of work; and A_f = final work

- The draft is simply the difference between original and final stock diameters = $D_o - D_f$

WIRE AND BAR DRAWING

$$\text{Elongation} = \frac{L_f - L_o}{L_o}$$

$$\text{Drawing Force} = \sigma_{avg} A_f \ln (A_o / A_f)$$

σ_{avg} = average true stress of the material in the die gap

WIRE AND BAR DRAWING

Alternative Formula

$$\text{Drawing Force} = c \sigma_t \ln (A_o - A_f)$$

c = constant whose value ranges from 1.5 to 3.0
(lower value for higher percentage reduction)

σ_t = tensile strength of the material before
drawing

Wire Drawing vs. Bar Drawing

- Difference between bar drawing and wire drawing is stock size
 - Bar drawing - large diameter bar and rod stock
 - Wire drawing - small diameter stock - wire sizes down to 0.03 mm are possible
- Although the mechanics are the same, the methods, equipment, and even terminology are different

Drawing Practice and Products

- ***Drawing practice:***

- Usually performed as cold working
- Most frequently used for round cross sections

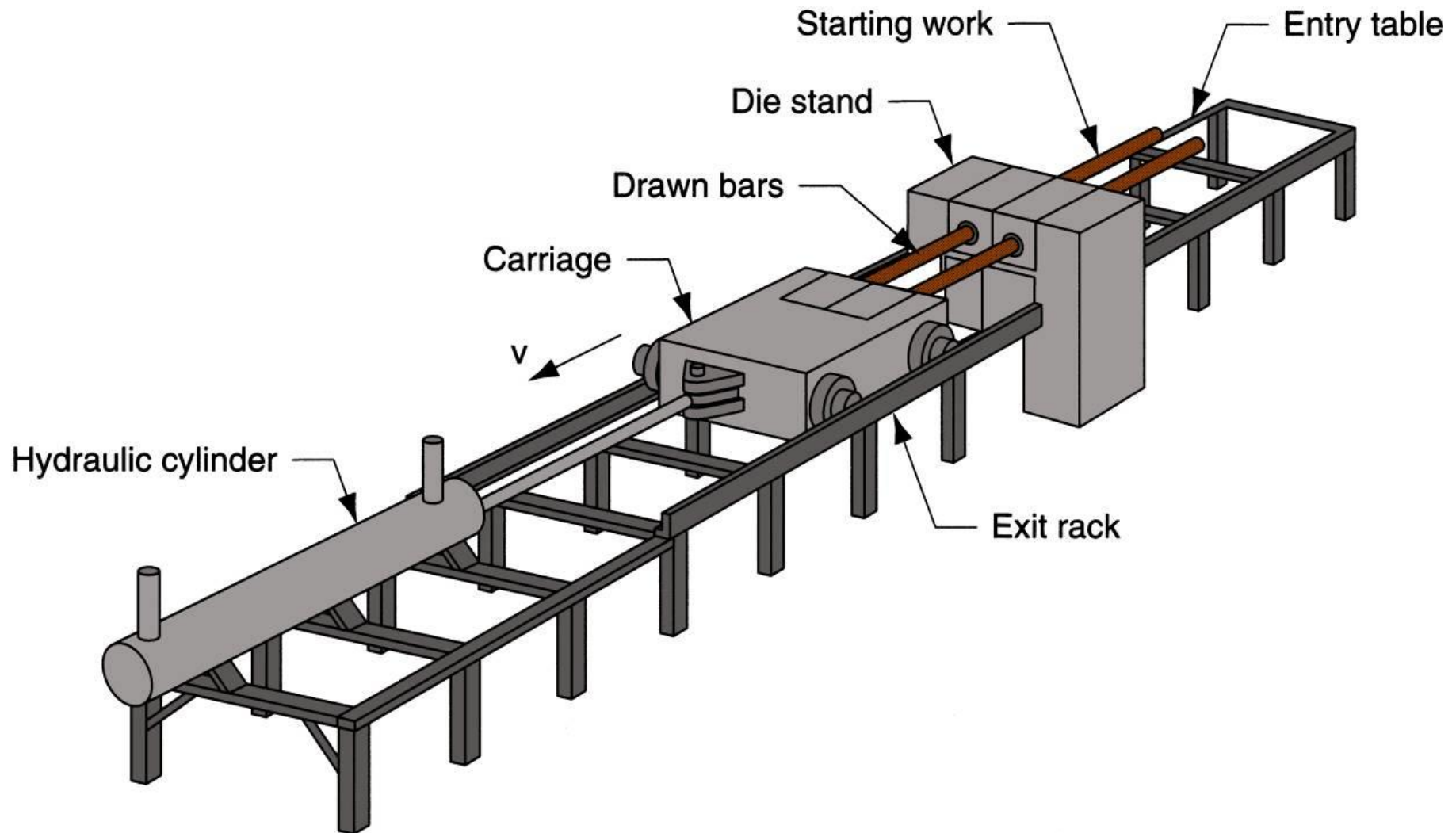
- ***Products:***

- Wire: electrical wire; wire stock for fences, coat hangers, and shopping carts
- Rod stock for nails, screws, rivets, and springs
- Bar stock: metal bars for machining, forging, and other processes

Bar Drawing

- Accomplished as a *single-draft* operation - the stock is pulled through one die opening
- Beginning stock has large diameter and is a straight cylinder

Hydraulically operated draw bench for drawing metal bars.



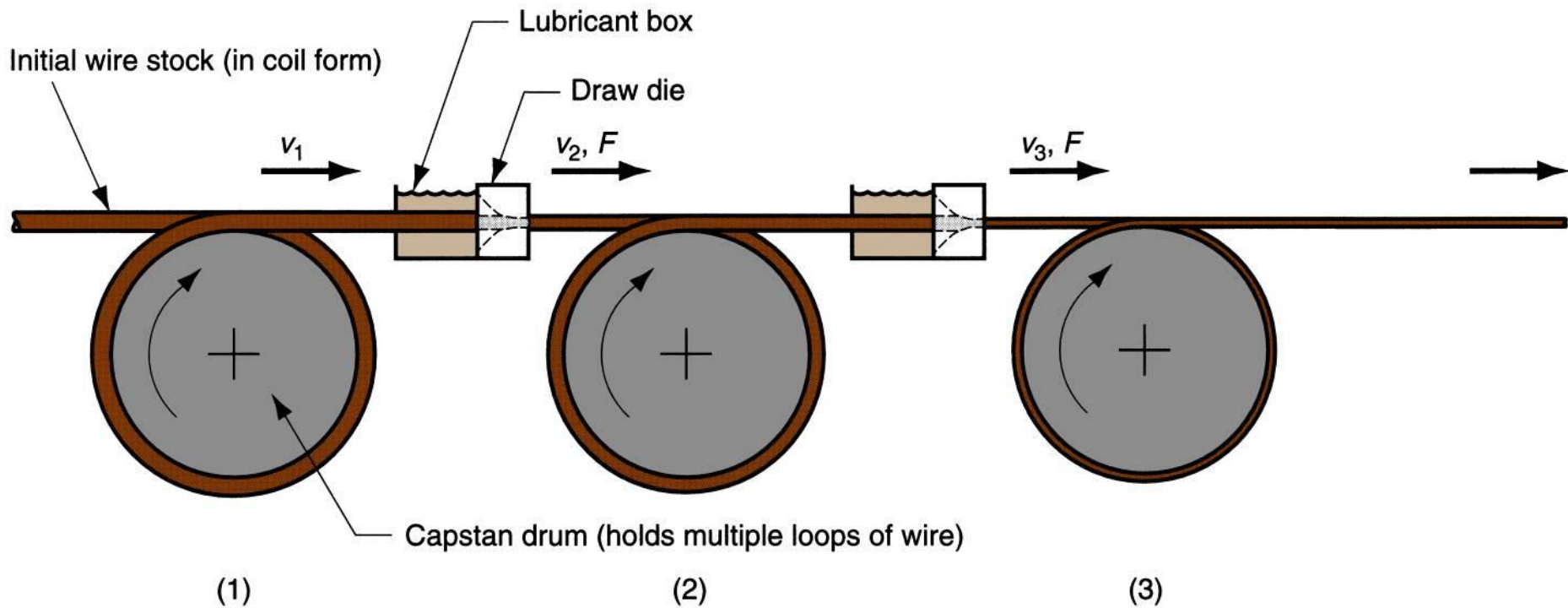
Bar Drawing

- Bar drawing is accomplished on a machine called a draw bench, consisting of an entry table, die stand (which contains the draw die), carriage, and exit rack.
- The carriage is used to pull the stock through the draw die. It is powered by hydraulic cylinders or motor-driven chains.
- The die stand is often designed to hold more than one die, so that several bars can be pulled simultaneously through their respective dies.

Wire Drawing

- Continuous drawing machines consisting of multiple draw dies (typically 4 to 12) separated by accumulating drums
 - Each drum (*capstan*) provides proper force to draw wire stock through upstream die
 - Each die provides a small reduction, so desired total reduction is achieved by the series
 - Annealing sometimes required between dies to relieve work hardening

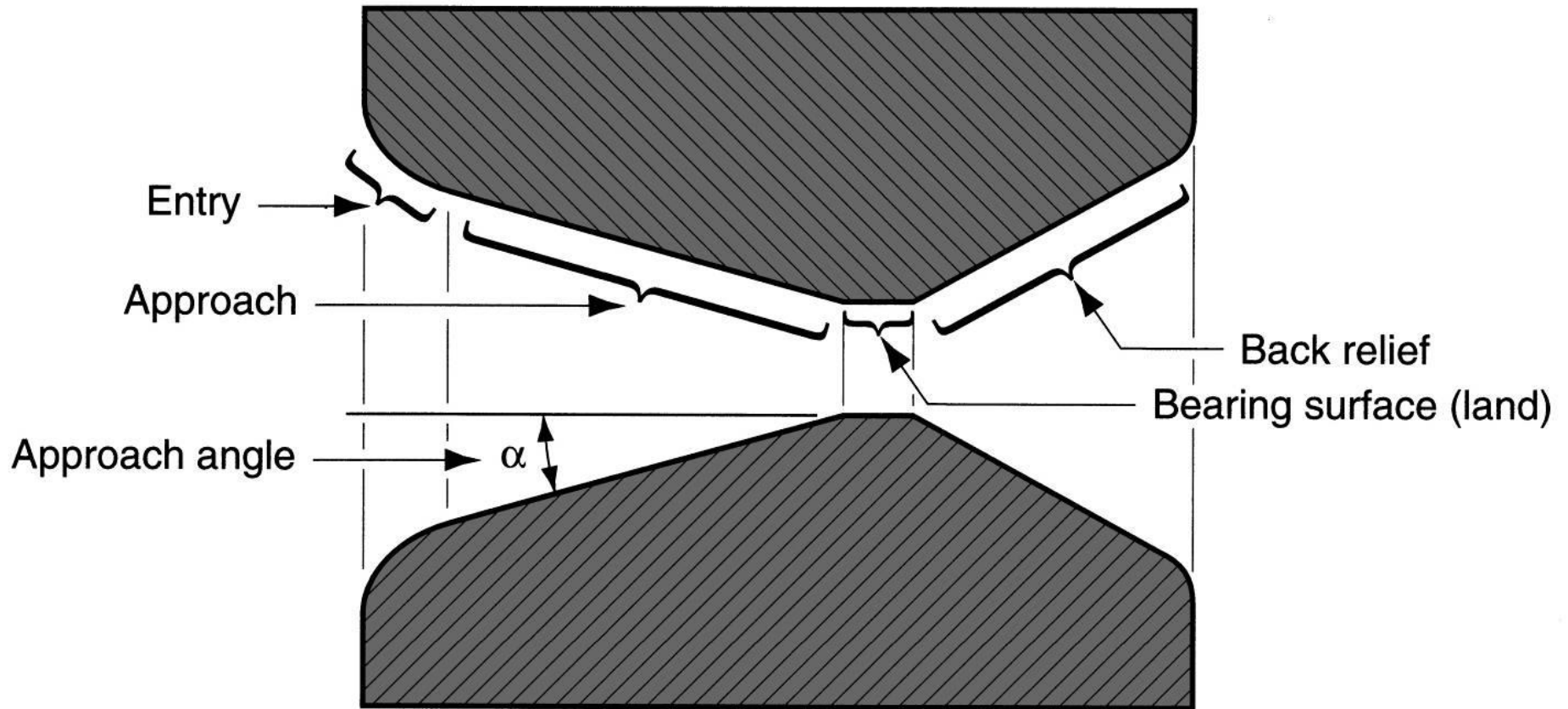
Wire Drawing



Features of a Draw Die

- Entry region - funnels lubricant into the die to prevent scoring of work and die
- Approach - cone-shaped region where drawing occurs
- Bearing surface - determines final stock size
- Back relief - exit zone - provided with a back relief angle (half-angle) of about 30°
- Die materials: tool steels or cemented carbides

Draw Die Details



Preparation of Work for Drawing

- Annealing – to increase ductility of stock
- Cleaning - to prevent damage to work surface and draw die
- Pointing – to reduce diameter of starting end to allow insertion through draw die