Drawing processes

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Contents:

- Introduction
- Wire Drawing
- Rod Drawing
- Tube Drawing
- Lubrication
- Drawing Die
- Deep Drawing
- Defects

Introduction to Drawing

- Drawing is a cold working process in which the work piece is pulled through a tapered hole in a die so as to reduce its diameter.
- Accurate Dimensions ,specified cross-section and clean and excellent quality of surface to work.
- Appreciably increases strength and hardness of metal.

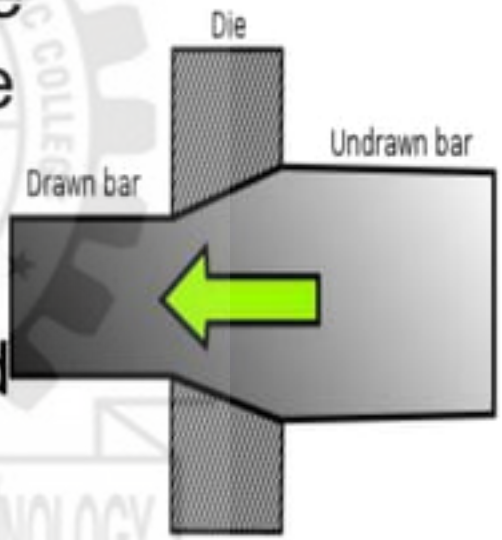


Fig 1

Contd…

- The starting materials for drawing are in the form of rolled or extruded rods , rolled sections
- Large quantities of wires, rods, tubes and other sections are produced by drawing process
- The plastic flow is caused by compression force, arising from the reaction of the metal with the die.

Contd…

- Material should have high ductility and good tensile strength
- Reduction of the diameter through plastic deformation while the volume remains the same.
- Same principals for drawing bars, rods, and wire but equipment is different in sizes depending on products.

Shapes produced by Drawing:

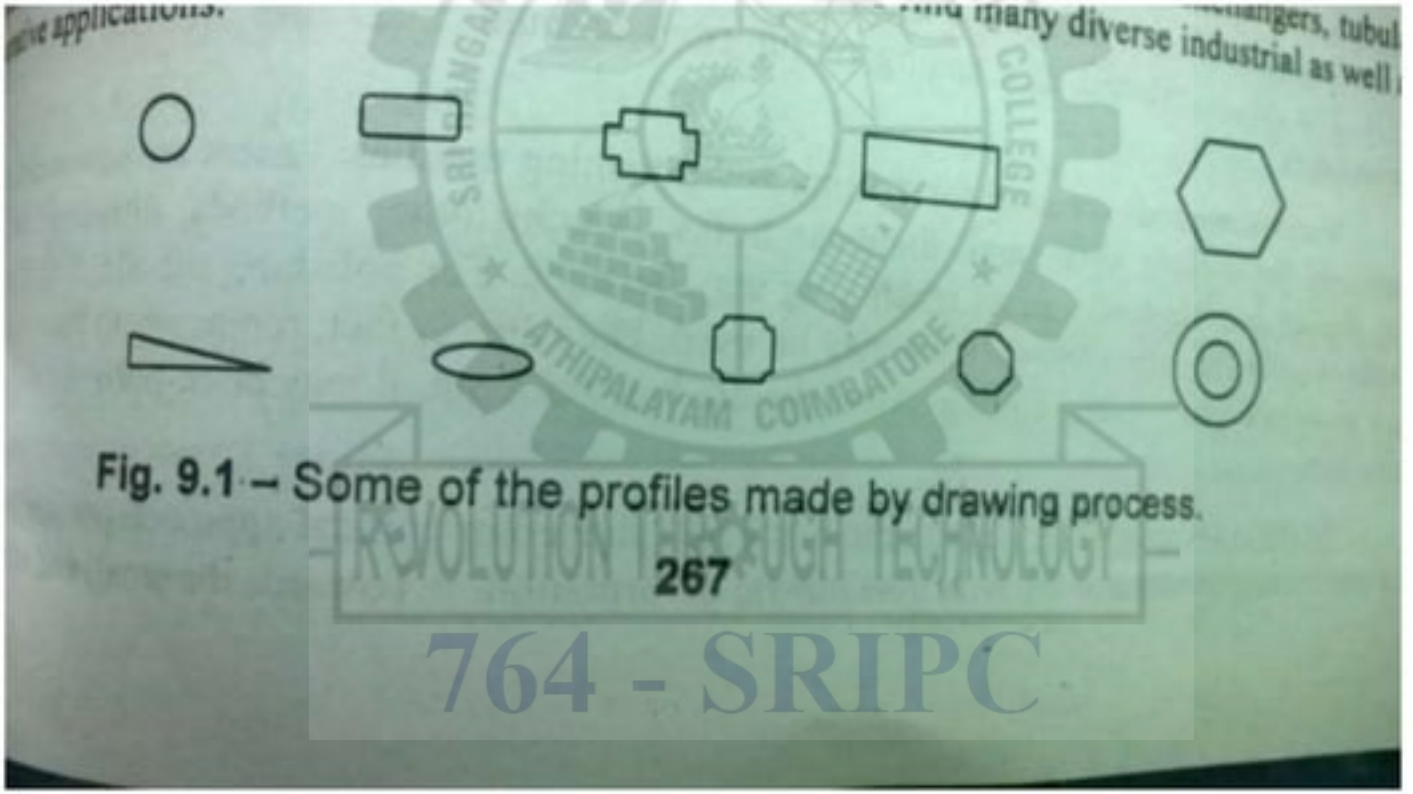
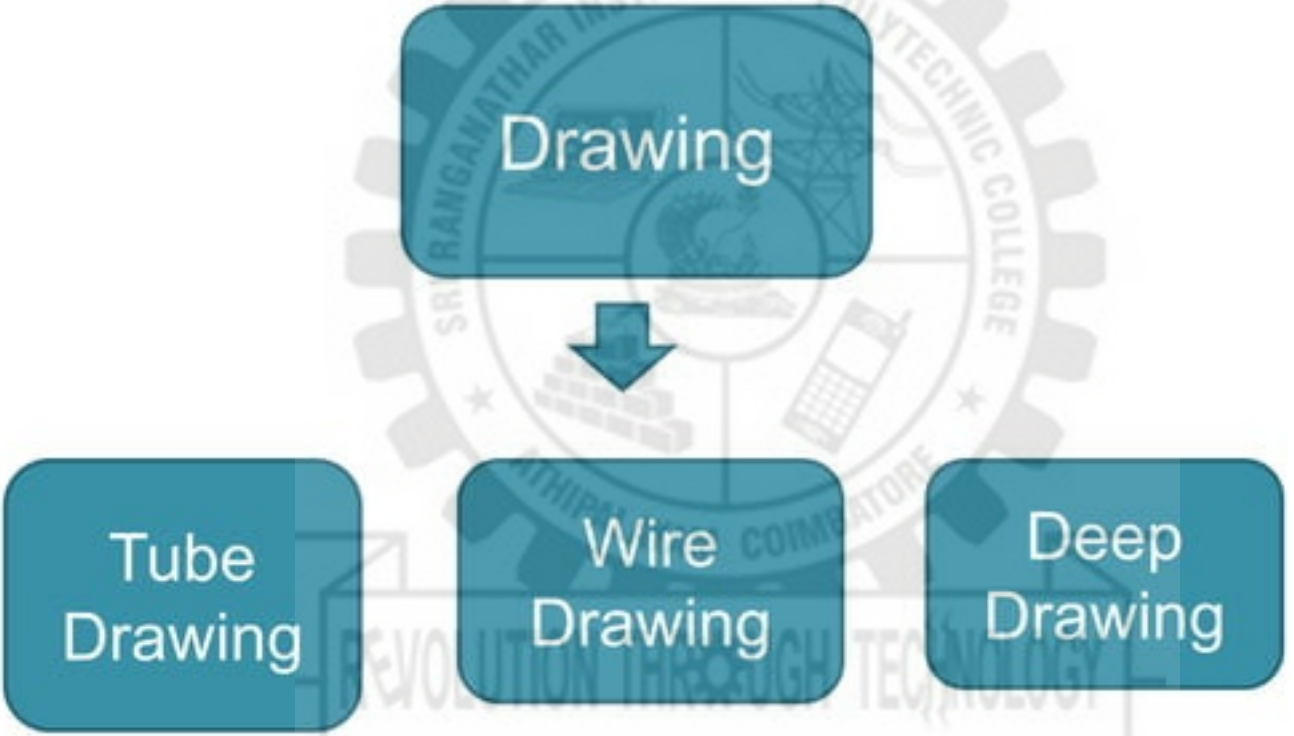


Fig 2



Wire Drawing:

- In a typical wire drawing operation, once end of the wire is reduced and passed through the opening of the die, gripped and pulled to reduce its diameter.
- By successive drawing operation through dies of reducing diameter wires can be reduced to very small diameters

Fig 3

Bull Block Draw Bench

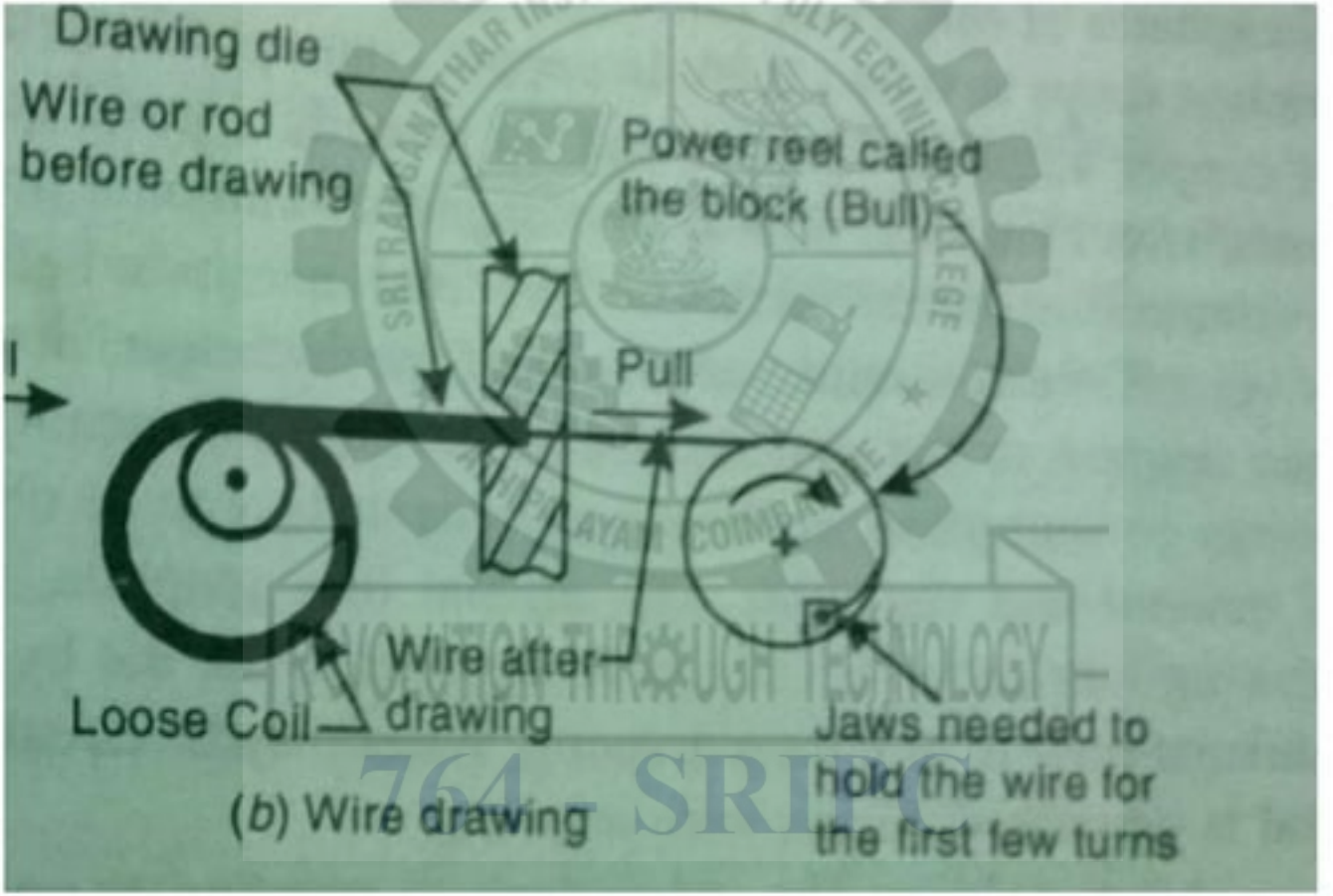
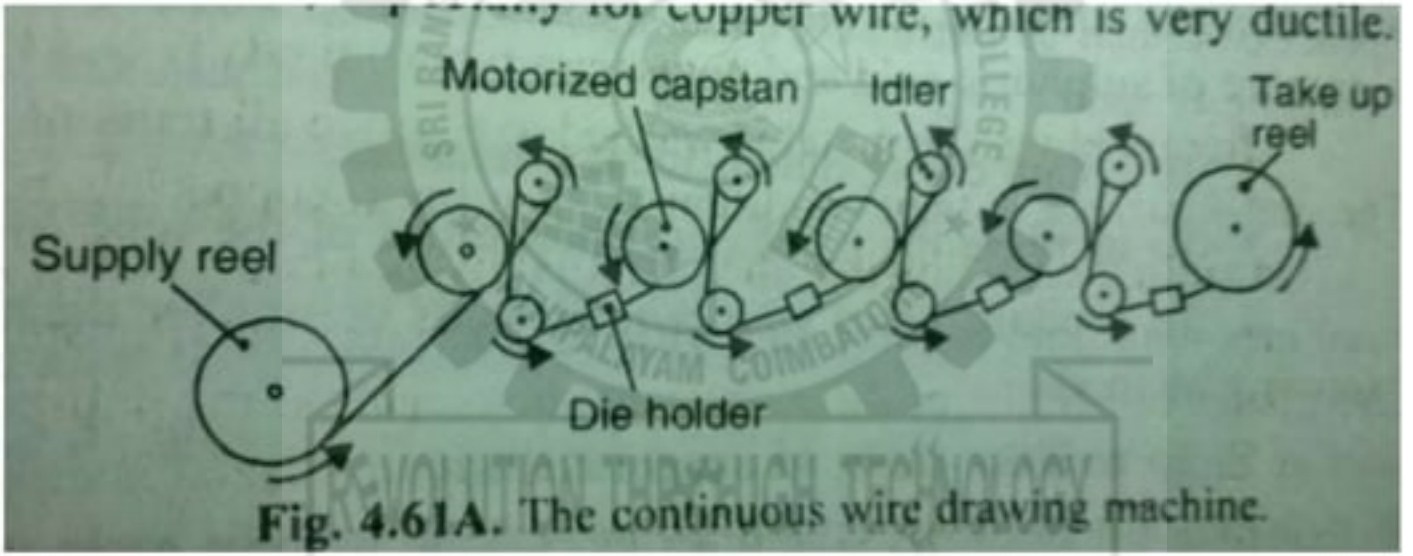


Fig 4

Tandem wire Drawing



...copper wire, which is very ductile.

Fig. 4.61A. The continuous wire drawing machine.

Fig 5

Rod Drawing:

- Rods -relatively larger diameter products.
- Wires- smaller diameter products, usually <10 mm
- In rod drawing the product must remain straight
- Due to the size of the work, rod and bar drawing involves much more finite lengths of material than wire drawing.
- Chain Drawbench are used for

Chain Drawbench :

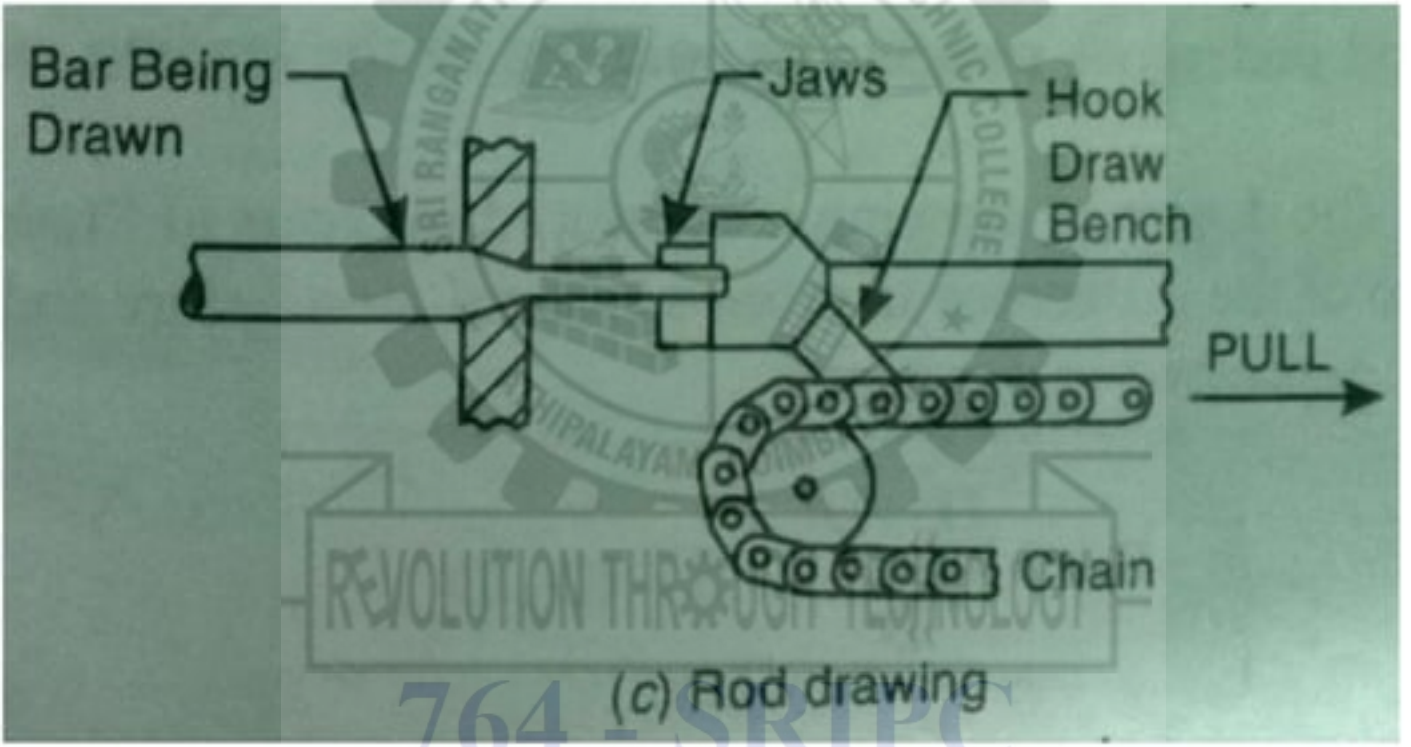
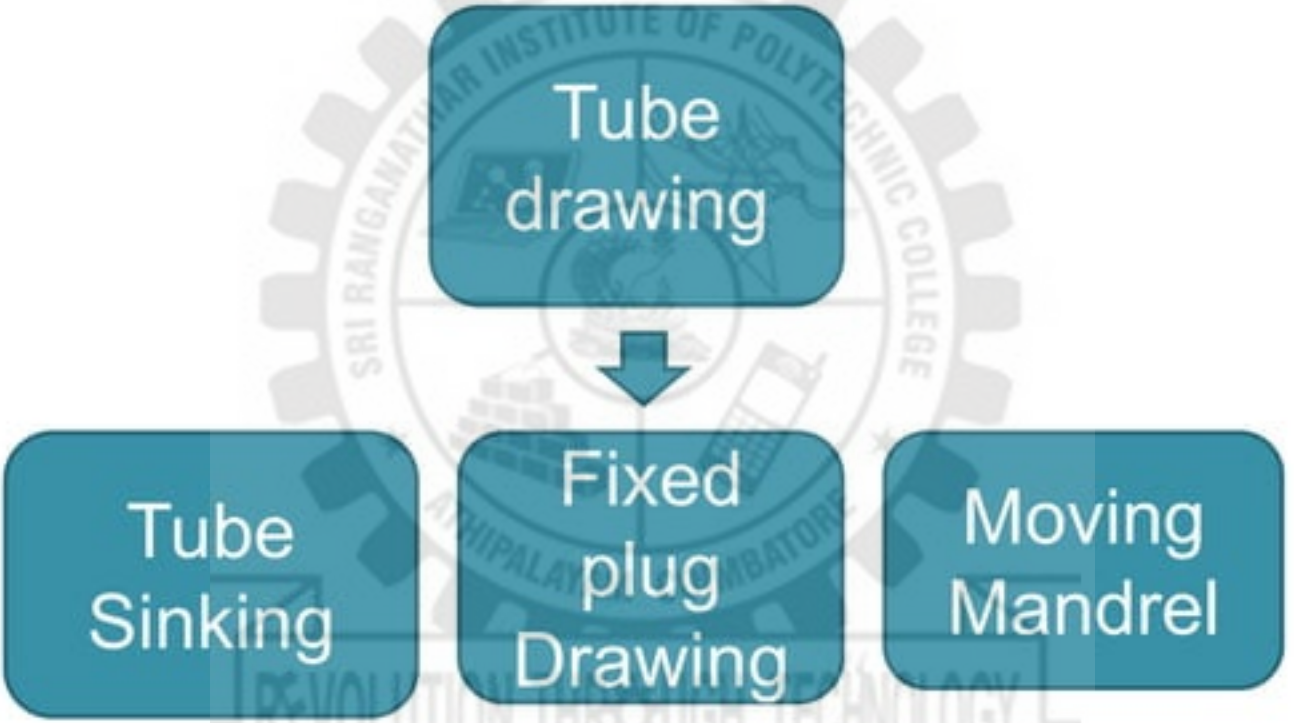


Fig 6

Tube Drawing

- Tube drawing involves reducing the cross section and wall thickness through a draw die.
- The cross section can be circular, square hexagonal or in any shapes.


Tube drawing
Tube Sinking
Fixed plug Drawing
Moving Mandrel

Tube Sinking

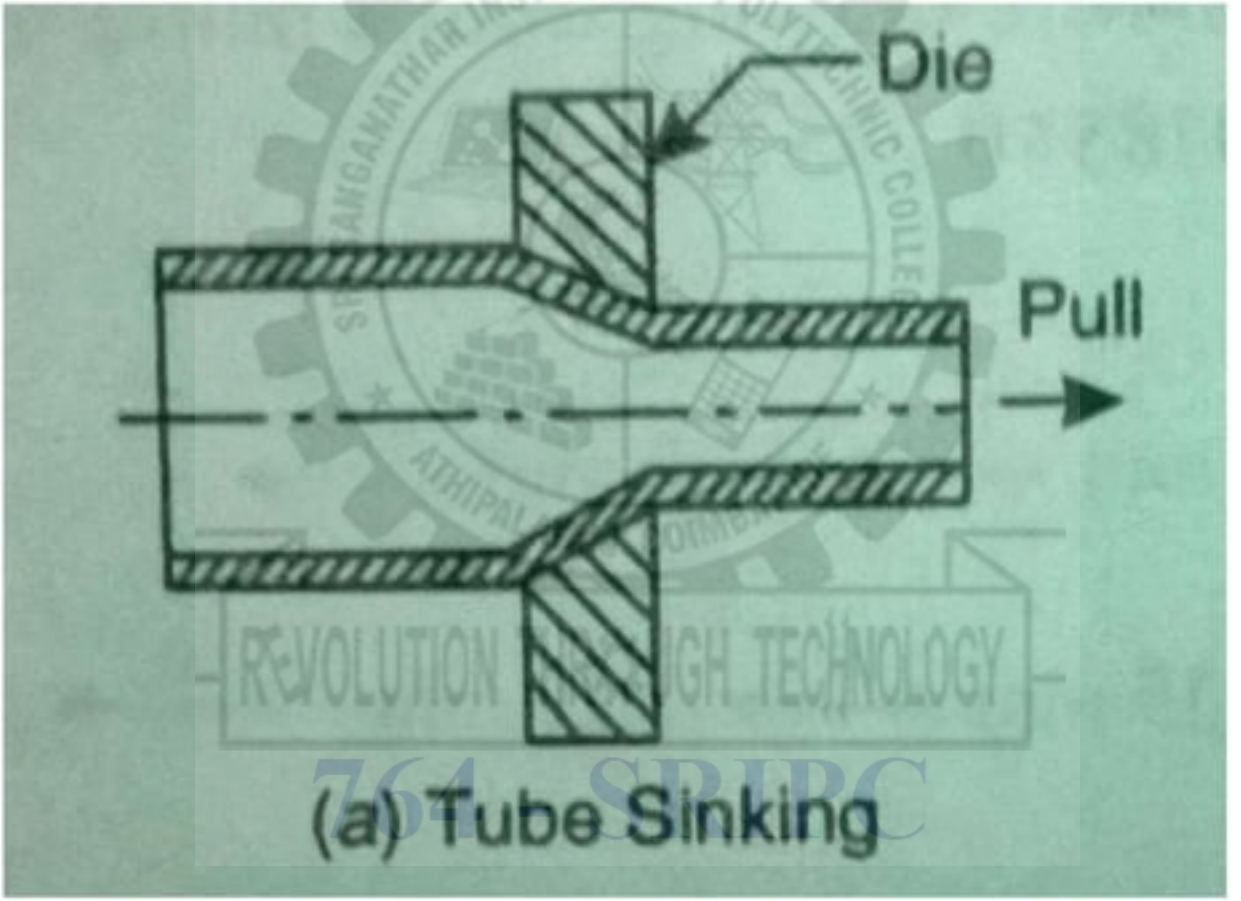


Fig 6

Fixed Plug

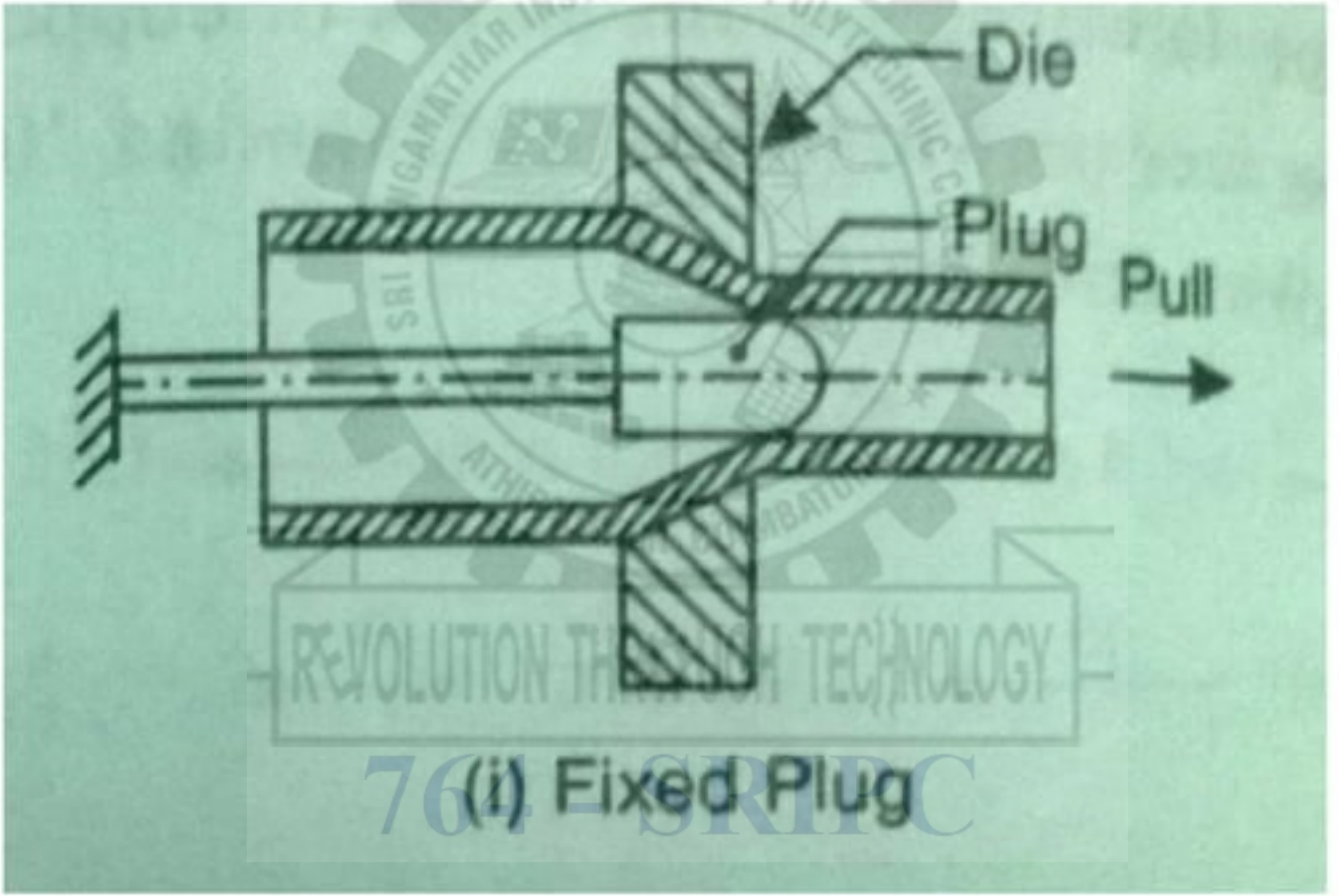


Fig 7

Moving Mandrel

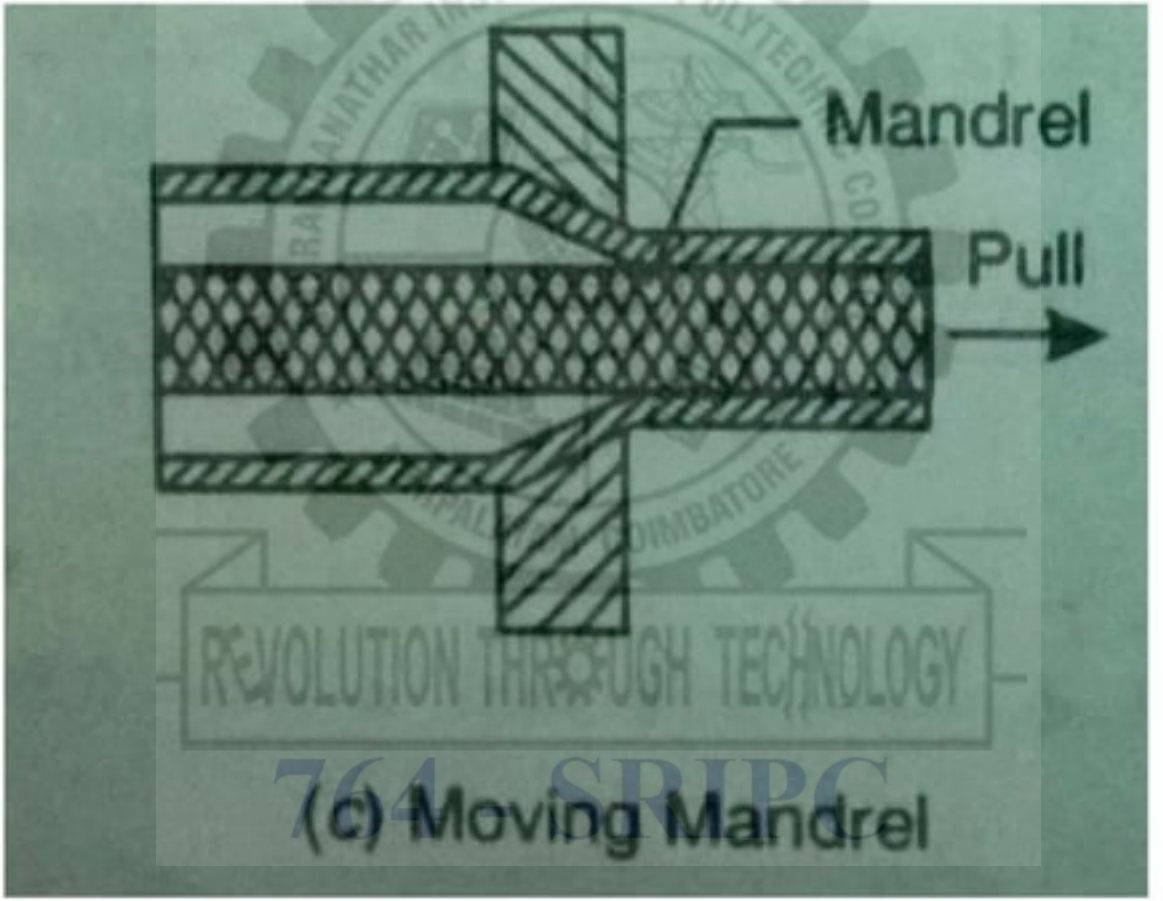


Fig 8

Purpose of tube Drawing

- To regulate the outer diameter
- To regulate outer diameter and to have good surface finish on the inner diameter
- To regulater outer and inner diameter
- To carryout a heavy reduction in thickness of tube

Lubrication for drawing

- Proper lubrication is essential in order to improve die life, reduce drawing forces, reduce temperature, and to improve surface finish.
- These can be of three types

✓ Wet drawing lubrication

✓ Dry drawing lubrication

✓ coating

- Types of Lubricants
  - Oil
  - Copper Sulphate Solution
  - With difficult to draw metals, polymers or soft materials may also be used as lubricants

Wire Drawing Machines

Single Step Machine

Continuous wire drawin Machine

Drawing Die

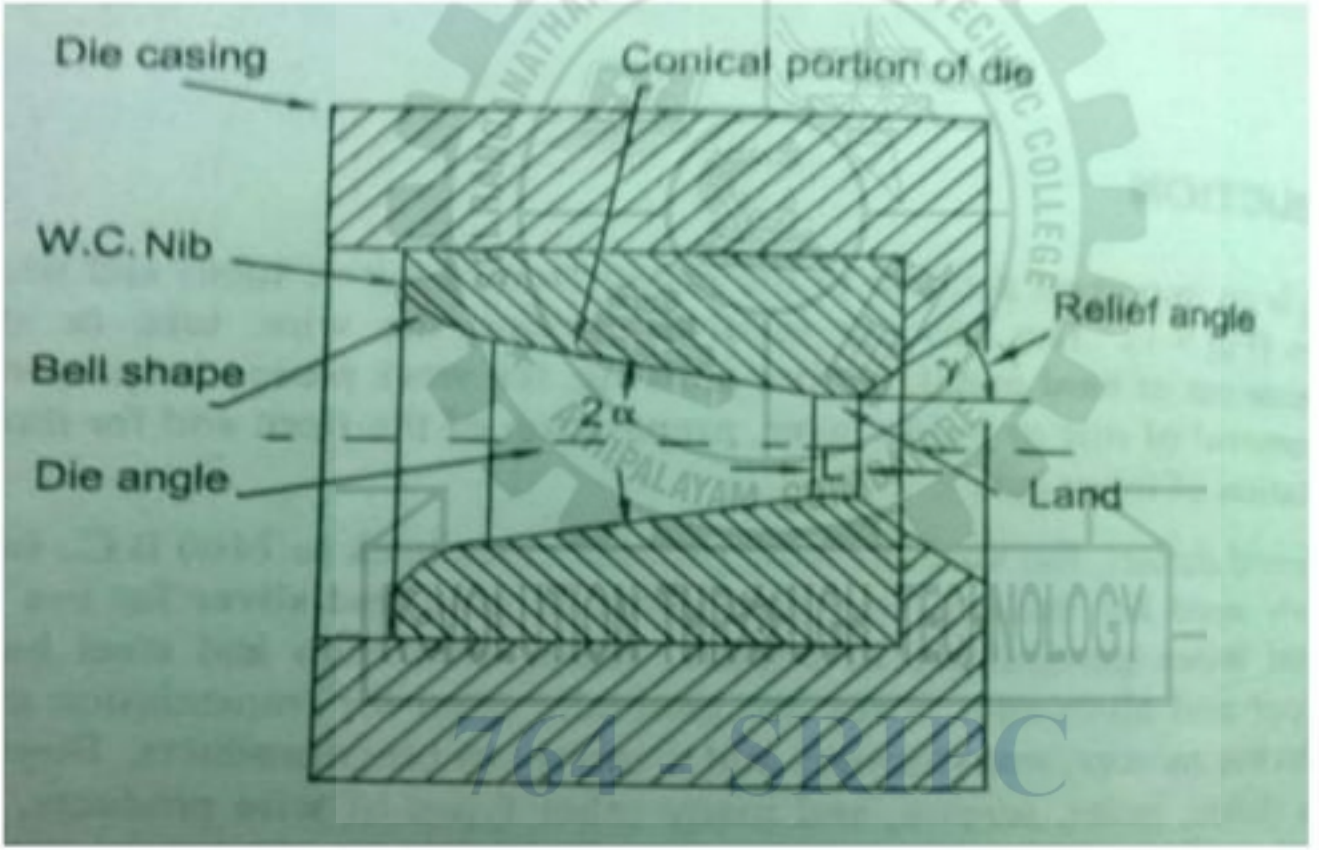


Fig 9

Die Materials

- Steel and carbides
- Chromium plated steel
- Titanium nitride coated carbide
- Dimond

Deep Drawing

Deep Drawing is a sheet metal forming operation used to make cup-shaped, box-shaped, or other complex-curved, hollow-shaped parts. It is performed by placing a piece of sheet metal over a die cavity and then pushing the sheet into the opening with a punch. The blank is held down flat against the die by a blank holder

Mechanics Of Deep Drawing

A blank of diameter D_b is drawn into the die by means of a punch of diameter D_p. The punch and die have corner radii R_p and R_d, respectively. The sides of the die and punch are separated by a clearance, c, which is about 10% greater than the sheet thickness. The punch applies a downward force, F, to deform the metal while the downward holding force, F_h, is applied by the blank holder.

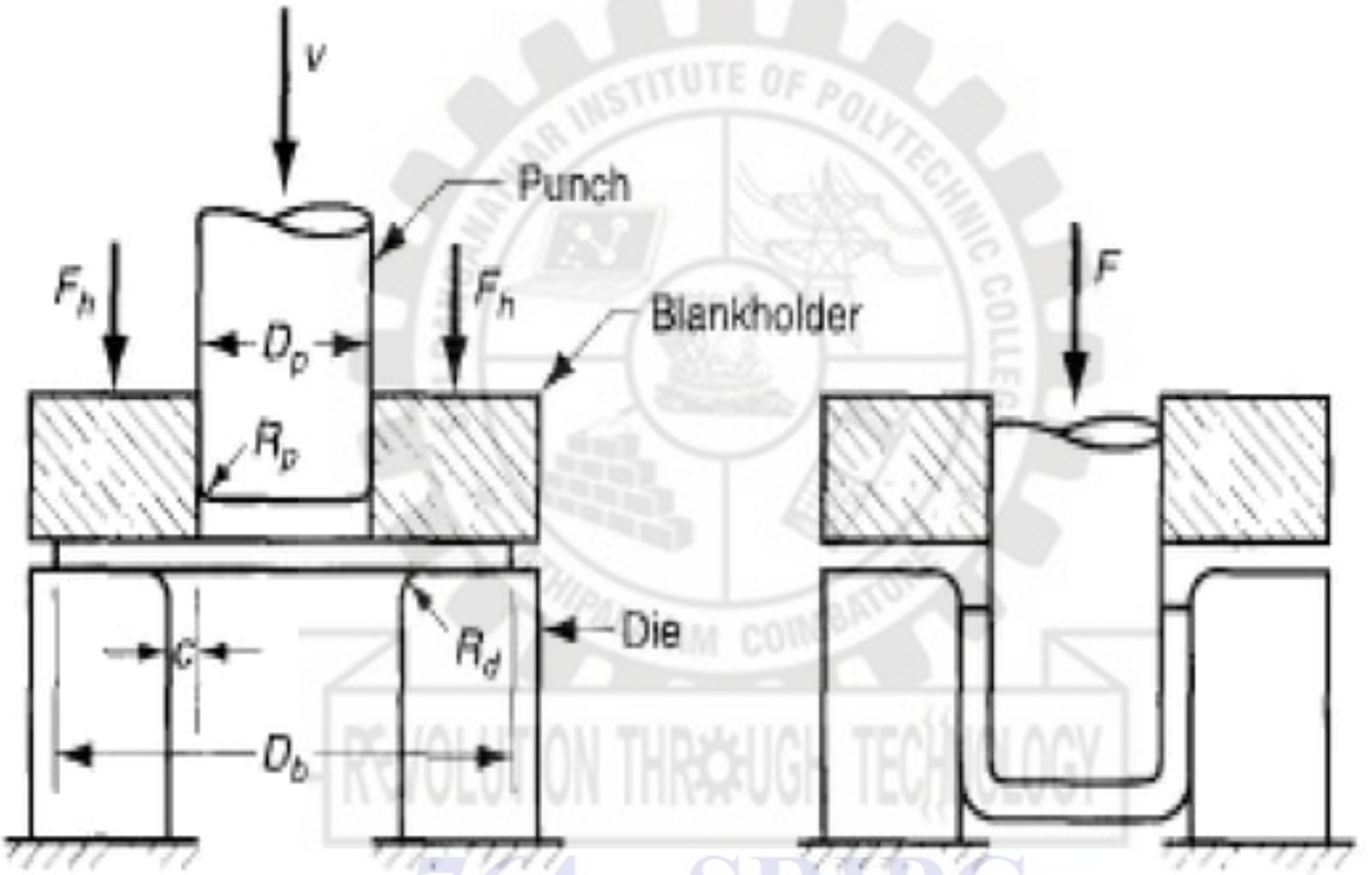


Fig 10

- As the punch proceeds towards its final position, the work piece experiences a complex sequence of stresses and strains as it is formed into its final shape

- The blank holder force, F_h, is applied and the punch begins to move towards the sheet material.

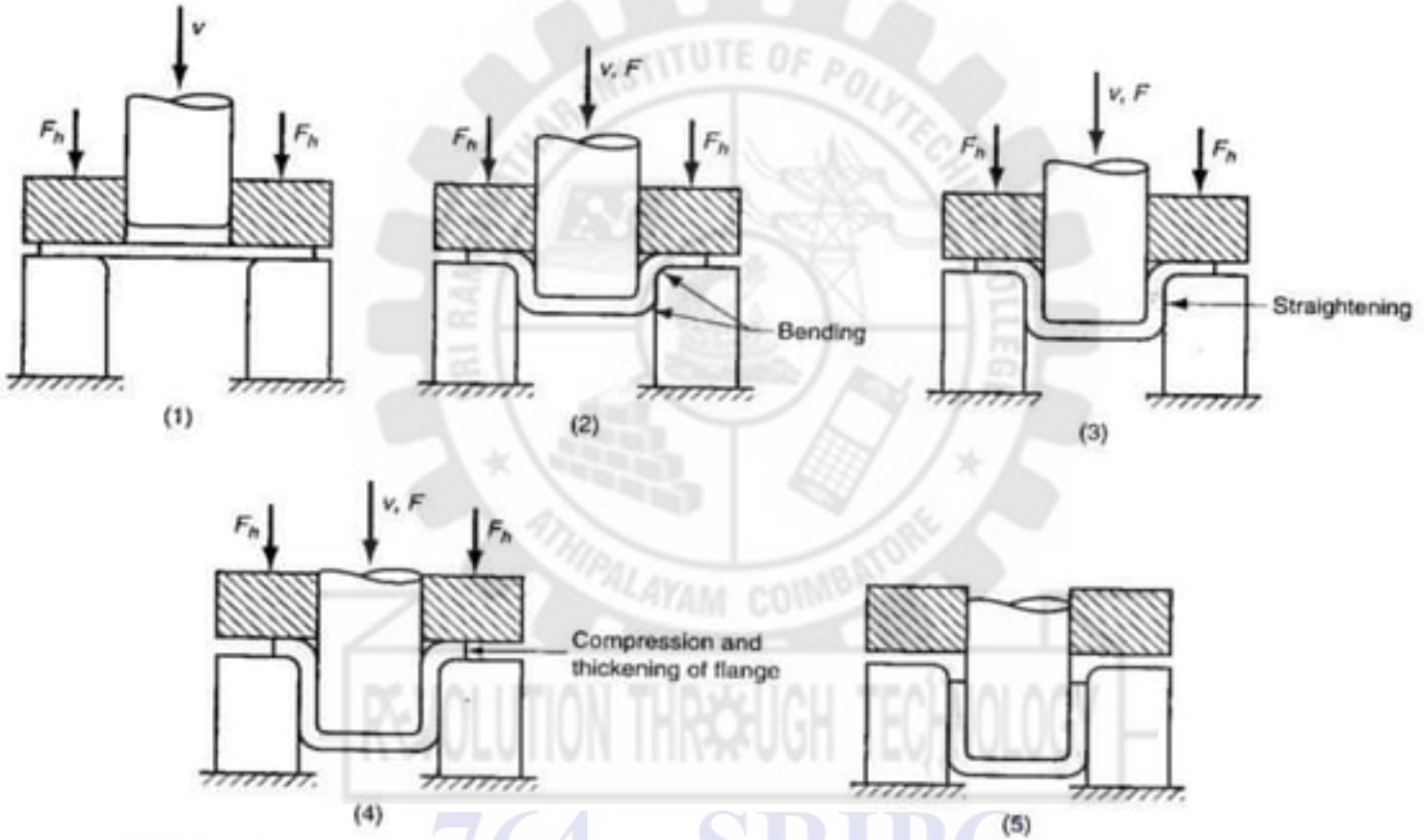


FIGURE 22.20 Stages in deformation of the work in deep drawing: (1) punch makes initial contact with work, (2) bending, (3) straightening, (4) friction and compression, and (5) final cup shape showing effects of thinning in the cup walls. Symbols v = motion of punch, F = punch force, F_h = blankholder force.

Fig 11

- The sheet material is subjected to a *bending* operation. The sheet is bent over the corner of the punch and the corner of the die.

- As the punch continues moving down, a *straightening* action occurs in the metal that was previously bent over the die radius. Metal from the flange is drawn into the die opening to form the cylinder wall.

As the metal in the flange moves toward the center, it is subjected to the following state of stress:

1- Compression in the circumferential direction (the outer perimeter becomes smaller)
2- Tension in the radial direction
3- A relatively small compression in the thickness direction

In order for the material to be drawn:

1- Friction between the sheet material and surfaces of the blank holder and die must be overcome.
2- Deformation energy should be provided

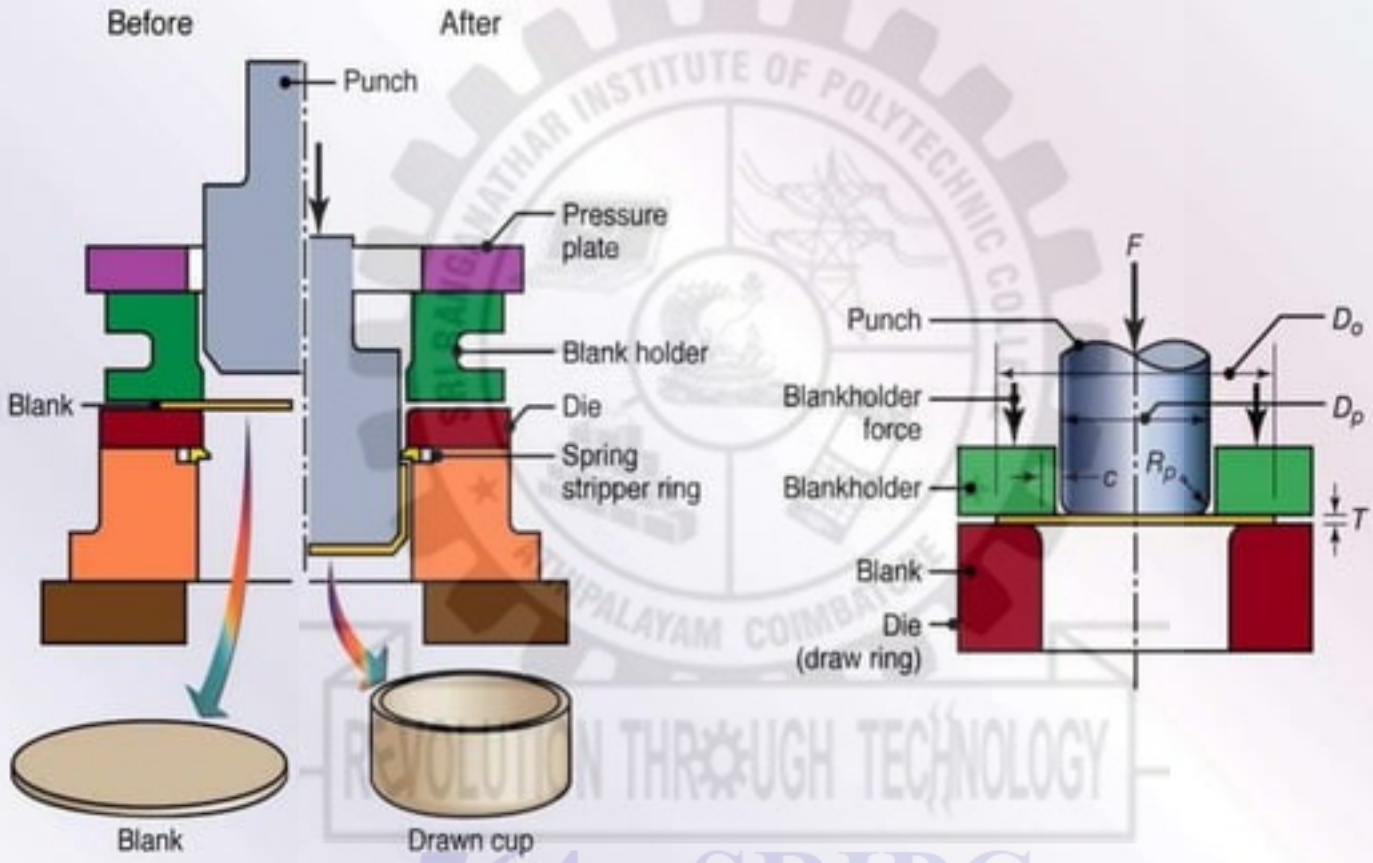
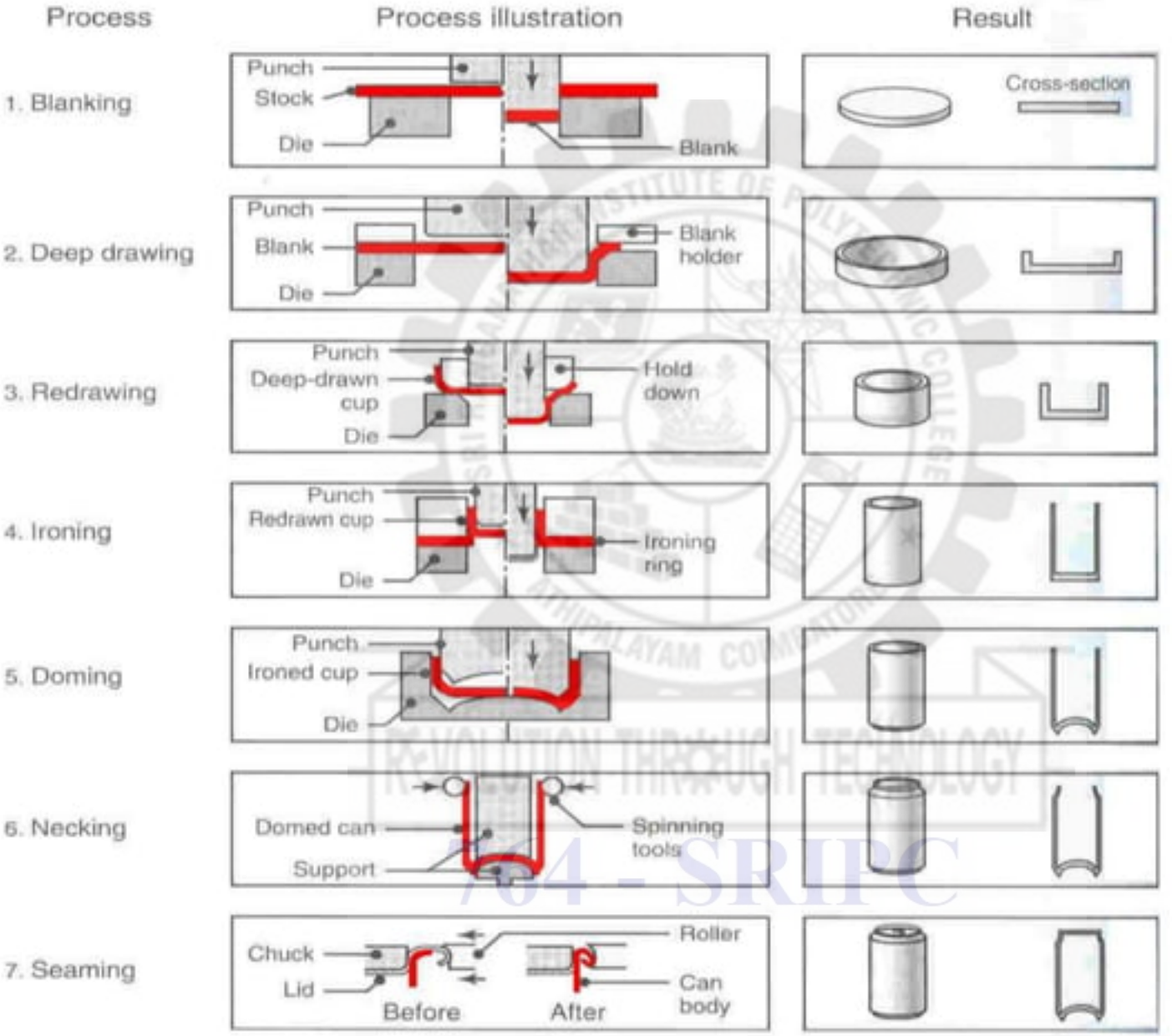
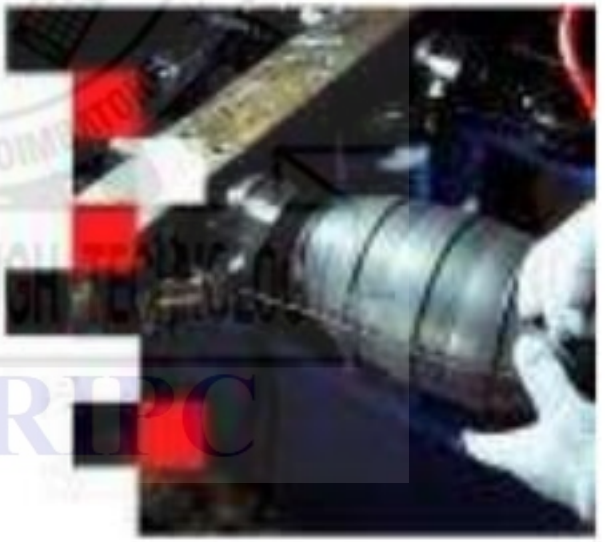


Fig 12


Process
Process illustration
Result
1. Blanking
Punch
Stock
Die
Blank
Cross-section
2. Deep drawing
Punch
Blank
Die
Blank holder
3. Redrawing
Punch
Deep-drawn cup
Die
Hold down
4. Ironing
Punch
Redrawn cup
Die
Ironing ring
5. Doming
Punch
Ironed cup
Die
6. Necking
Domed can
Support
Spinning tools
7. Seaming
Chuck
Lid
Before
After
Roller
Can body

Examples of Deep Drawing



Applications

Manufacturing of

- Pots and pans for cooking
- Containers
- Sinks
- Automobile parts such as panels, gas tanks

Defects

- Centre burst
- Surface cracking
- Internal cracks
- Corrosion induced cracking
- Hot shortness

Defects

- Wrinkles at flange
- Wrinkles at wall
- Tearing
- Earing
- Surface scratches

Defects In Deep Drawing

Fig 13

Wrinkles

Fig 14

Wrinkles

During drawing operation, the movement of the blank into the die cavity induces compressive circumferential stresses in the flange, which tend to cause the flange to wrinkle during drawing.

WRINKLING

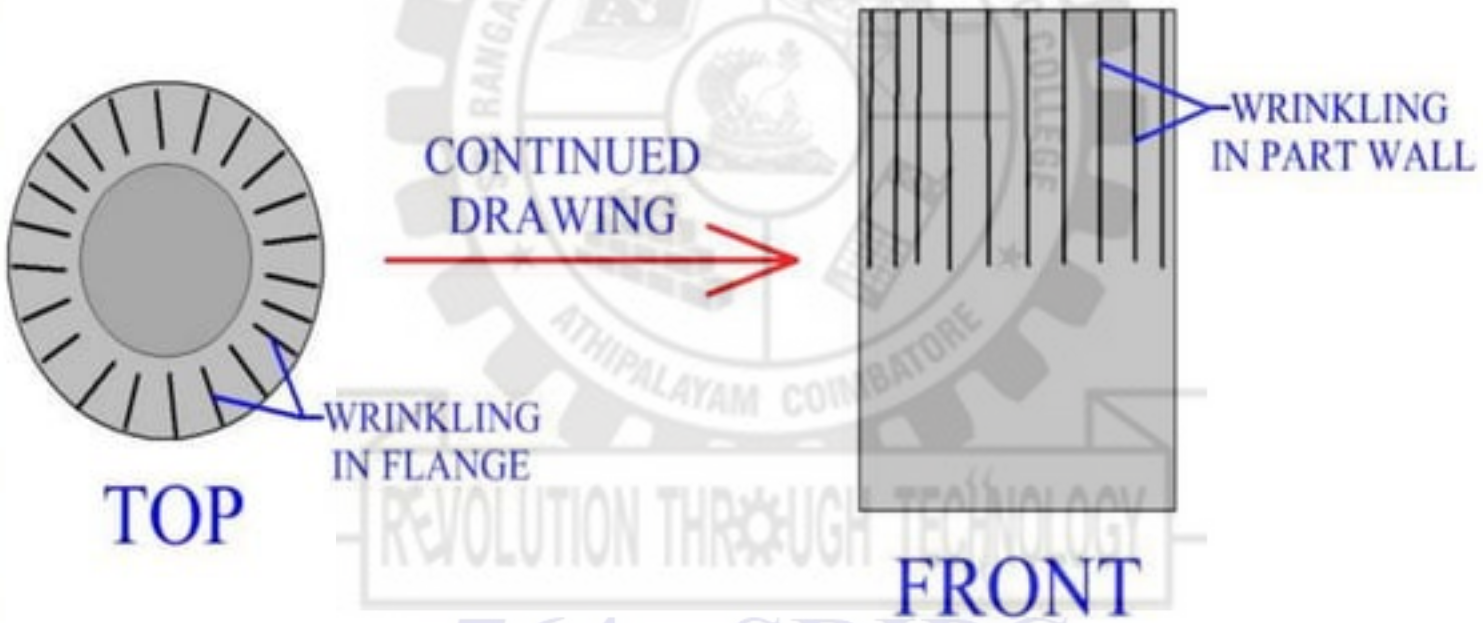


Fig 15

Various Parameters Affecting Wrinkling

- Blank holding force
- Deep drawing depth
- Die edge radius
- Punch edge radius
- Friction

Tearing

The cup wall, which is already formed, is subjected principally to a longitudinal stress. Elongation causes the cup wall to thin; if excessive; it causes tearing

Lueders Bands

Lueders bands, also known as slip bands are localized bands of plastic deformation in metals experiencing tensile stresses, commonly to low carbon steels.

Fig 16

References:

- Books:
  - Fundamentals of Metal Forming Process- Juneja B L
  - Production Technology- P C Sharma
- Websites:
  - http://en.wikipedia.org/wiki/Drawing_%28manufacturing%29
  - http://thelibraryofmanufacturing.com/metal_drawing.html
  - Journals :
    - *International Journal of Engineering Trends and Technology- Volume3*

THANK YOU

Sheet Metal Forming Processes

Manufacturing Processes

Outline

- Introduction
- Shearing
- Blanking
- Bending
- Deep Drawing
- Stamping Dies
- Progressive Dies
- Transfer Dies
- Spinning

Sheet Metal Working

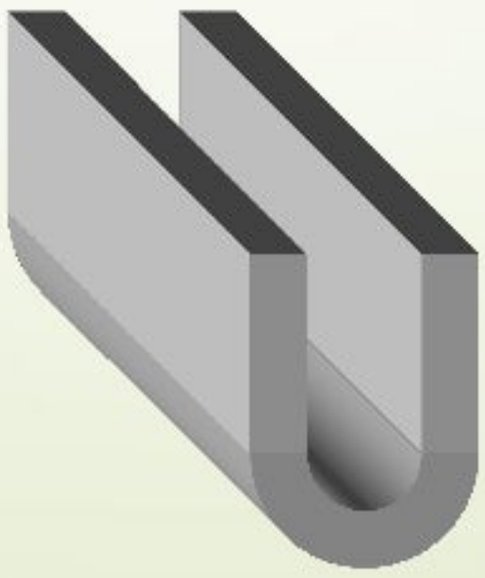
Products:

automotive fenders

washers

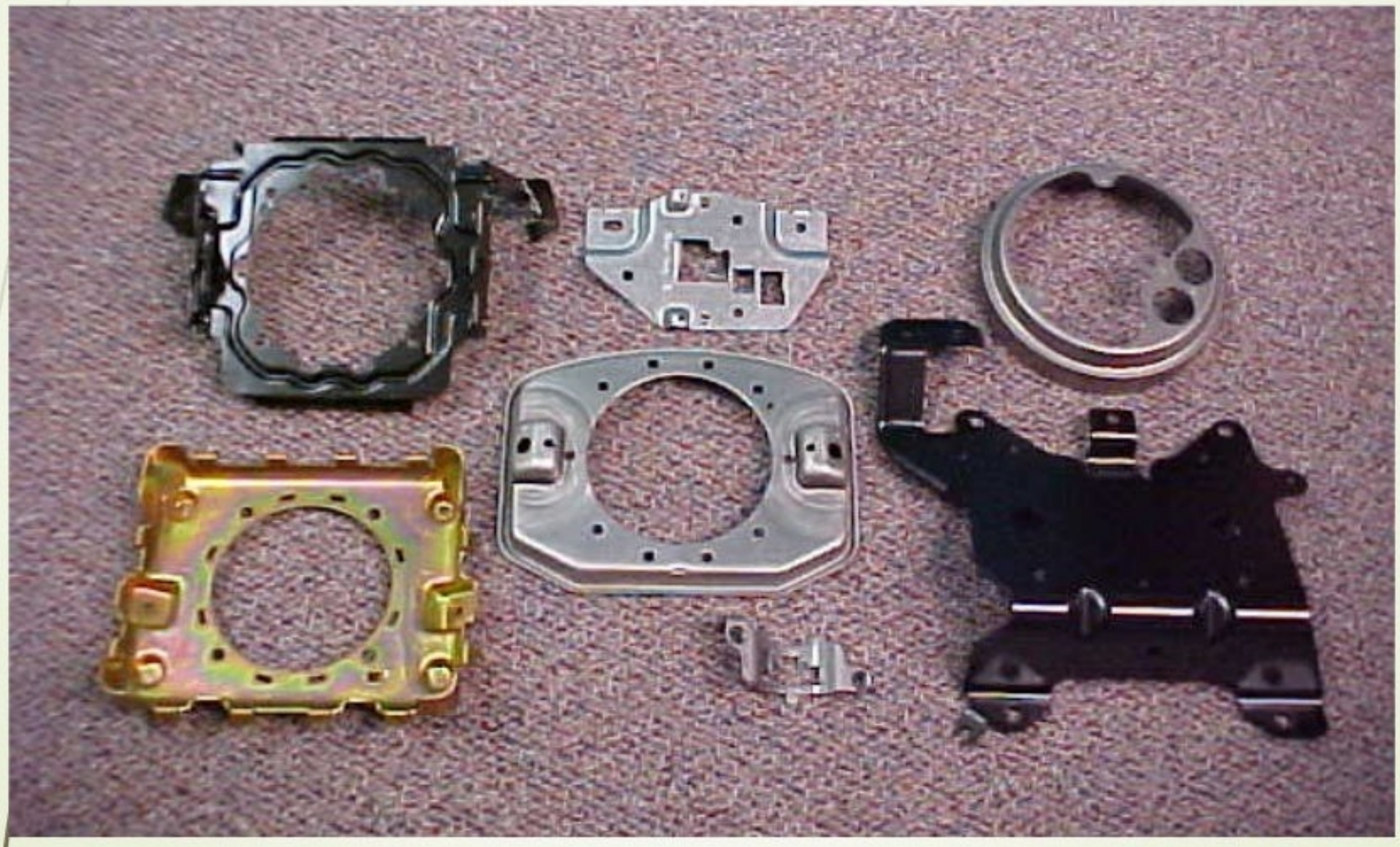
stamped parts

channels



Examples of Stamped Parts

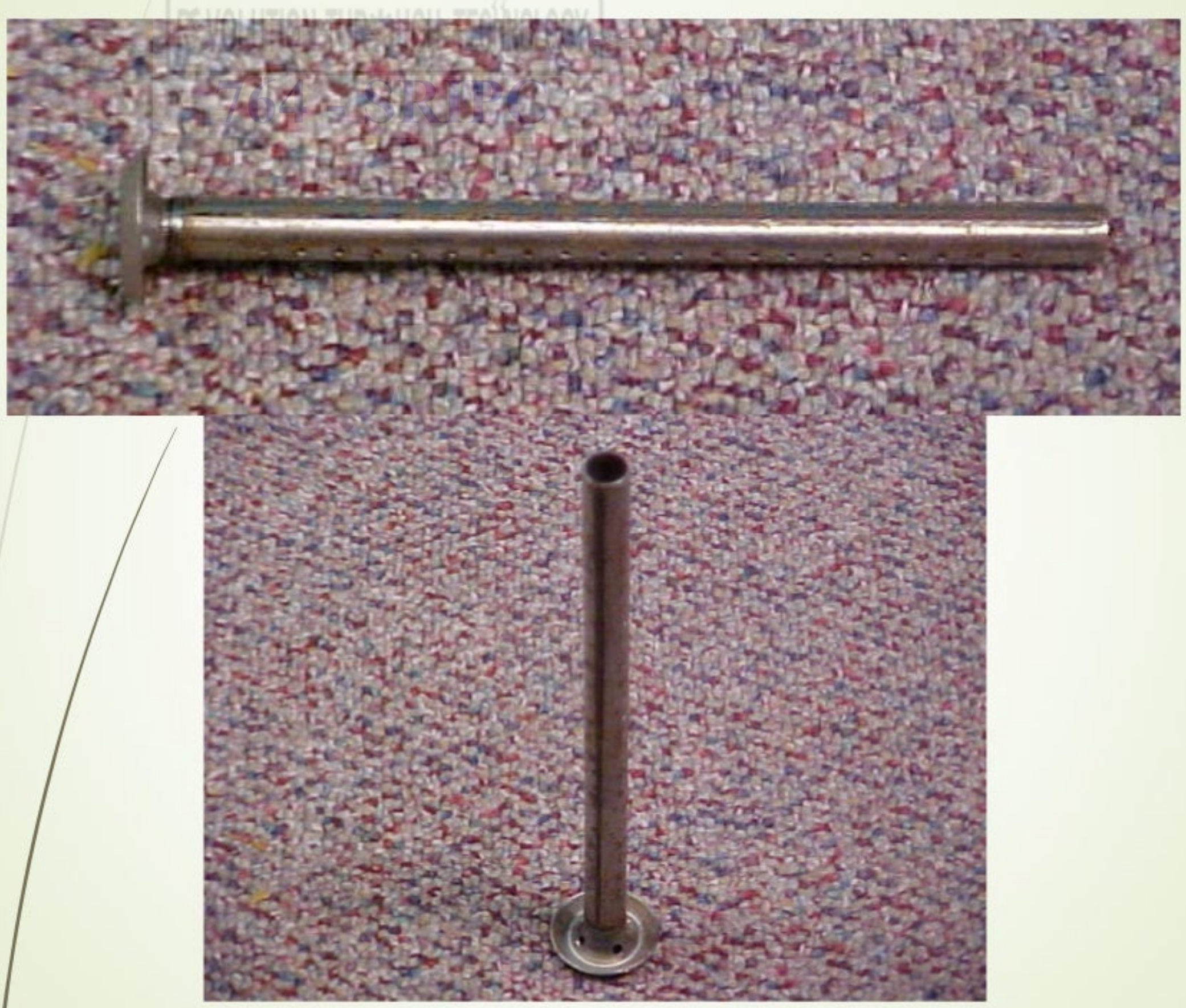
Examples of Stamped Parts



Examples of Stamped Parts

This part was made from several stamped parts plus a nut, which were stamped again to seal them together

Examples of Stamped Parts



This part was made from a sheet that was stamped, bent, and welded into a tube, plus a separate stamped end piece

Examples of Stamped Parts

Shearing

A sheet-metal cutting operation along a straight line between two cutting edges

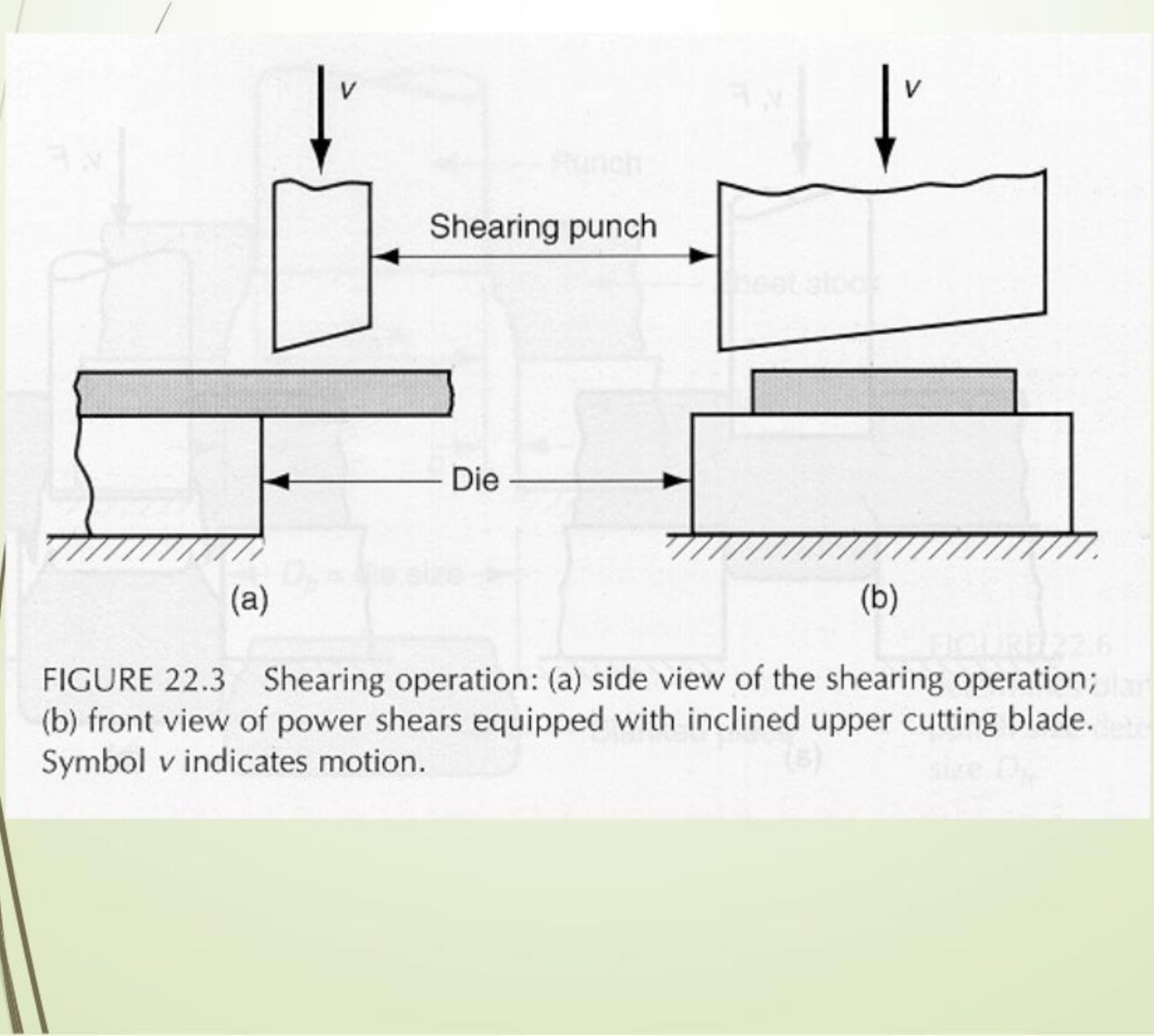


FIGURE 22.3 Shearing operation: (a) side view of the shearing operation; (b) front view of power shears equipped with inclined upper cutting blade. Symbol *v* indicates motion.

Shearing of Metal Between Cutting Edges

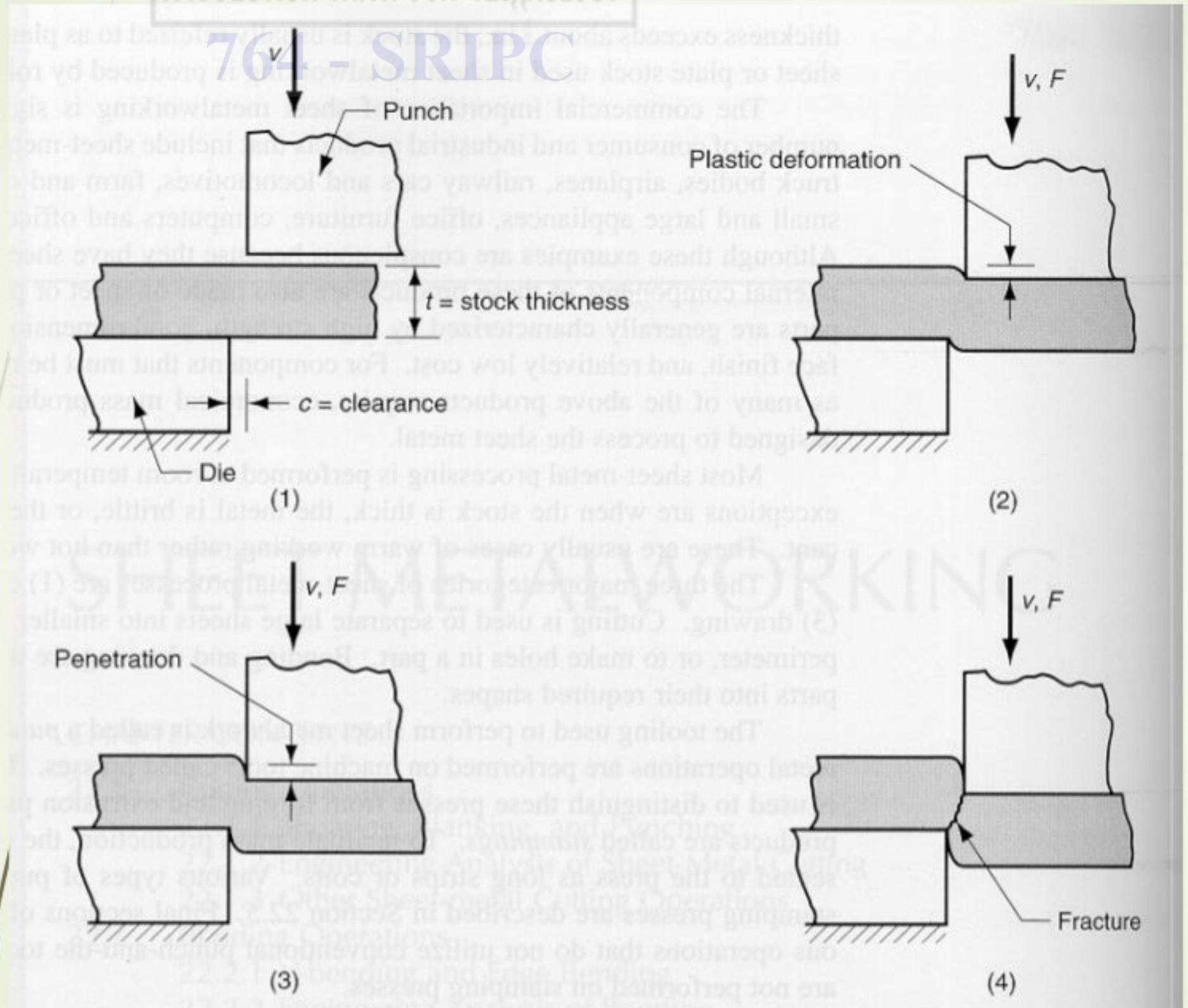


FIGURE 22.1 Shearing of sheet metal between two cutting edges: (1) just before the punch contacts work; (2) punch begins to push into work, causing plastic deformation; (3) punch compresses and penetrates into work, causing a smooth cut surface; and (4) fracture is initiated at the opposing cutting edges that separate the sheet. Symbols v and F indicate motion and applied force, respectively.

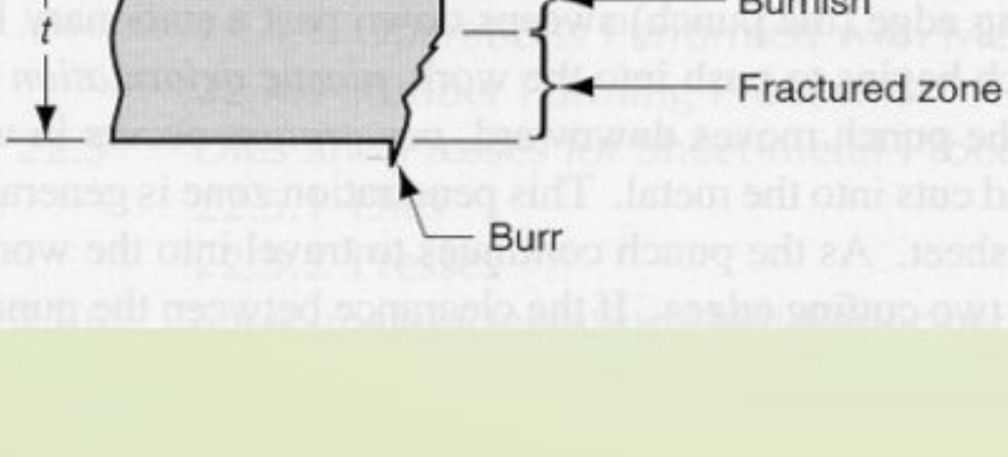


FIGURE 22.2 Characteristic sheared edges of the work.

Shearing of Metal Between Cutting Edges

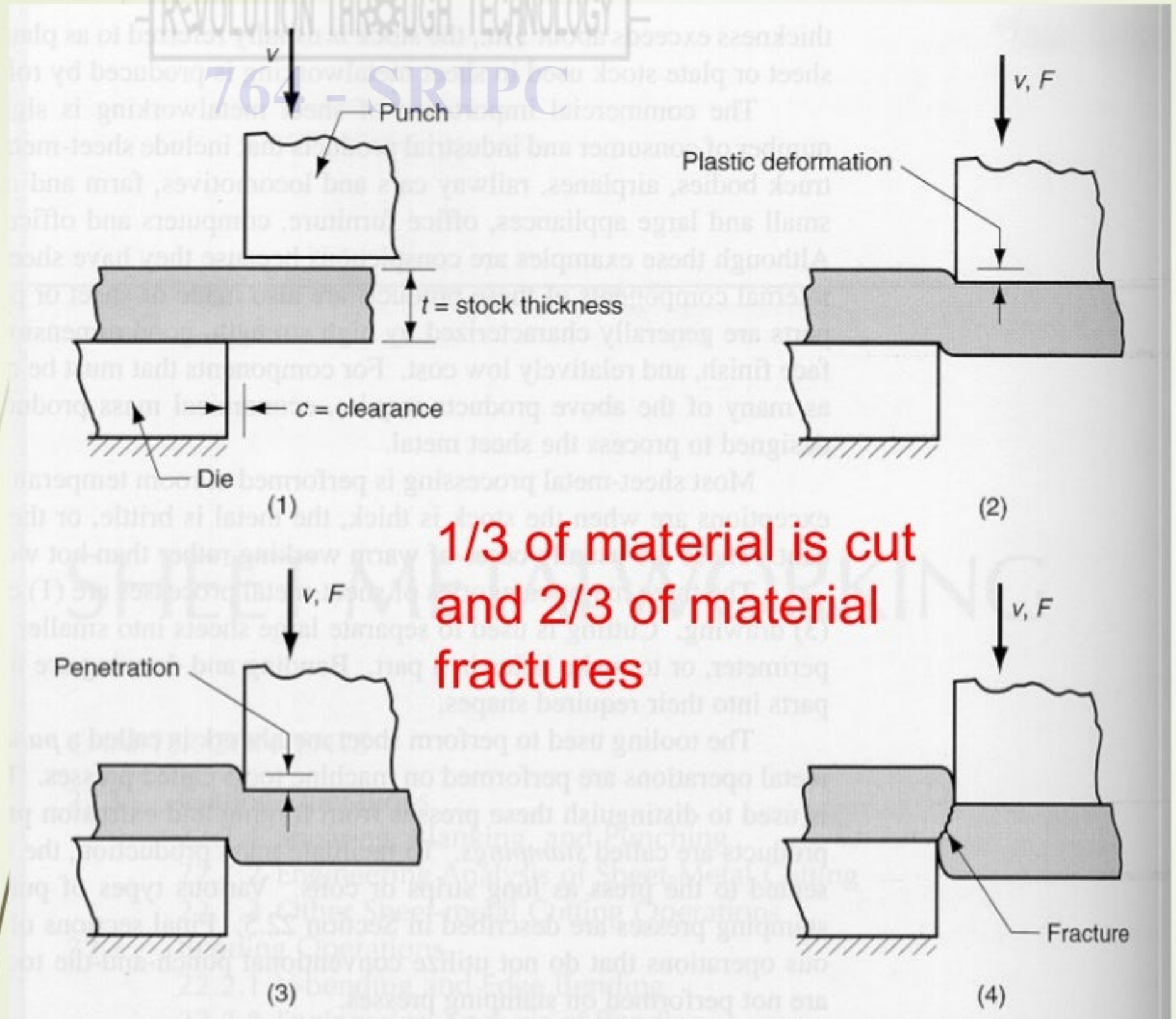


FIGURE 22.1 Shearing of sheet metal between two cutting edges: (1) just before the punch contacts work; (2) punch begins to push into work, causing plastic deformation; (3) punch compresses and penetrates into work, causing a smooth cut surface; and (4) fracture is initiated at the opposing cutting edges that separate the sheet. Symbols *v* and *F* indicate motion and applied force, respectively.

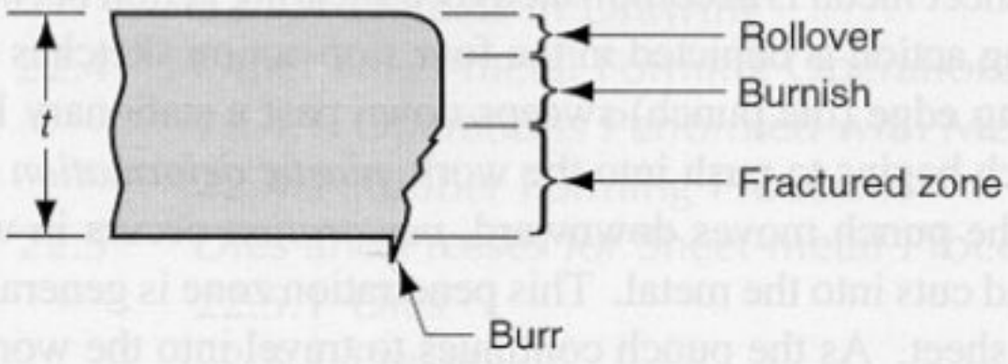


FIGURE 22.2 Characteristic sheared edges of the work.

Blanking

Involves cutting the sheet metal along a closed outline

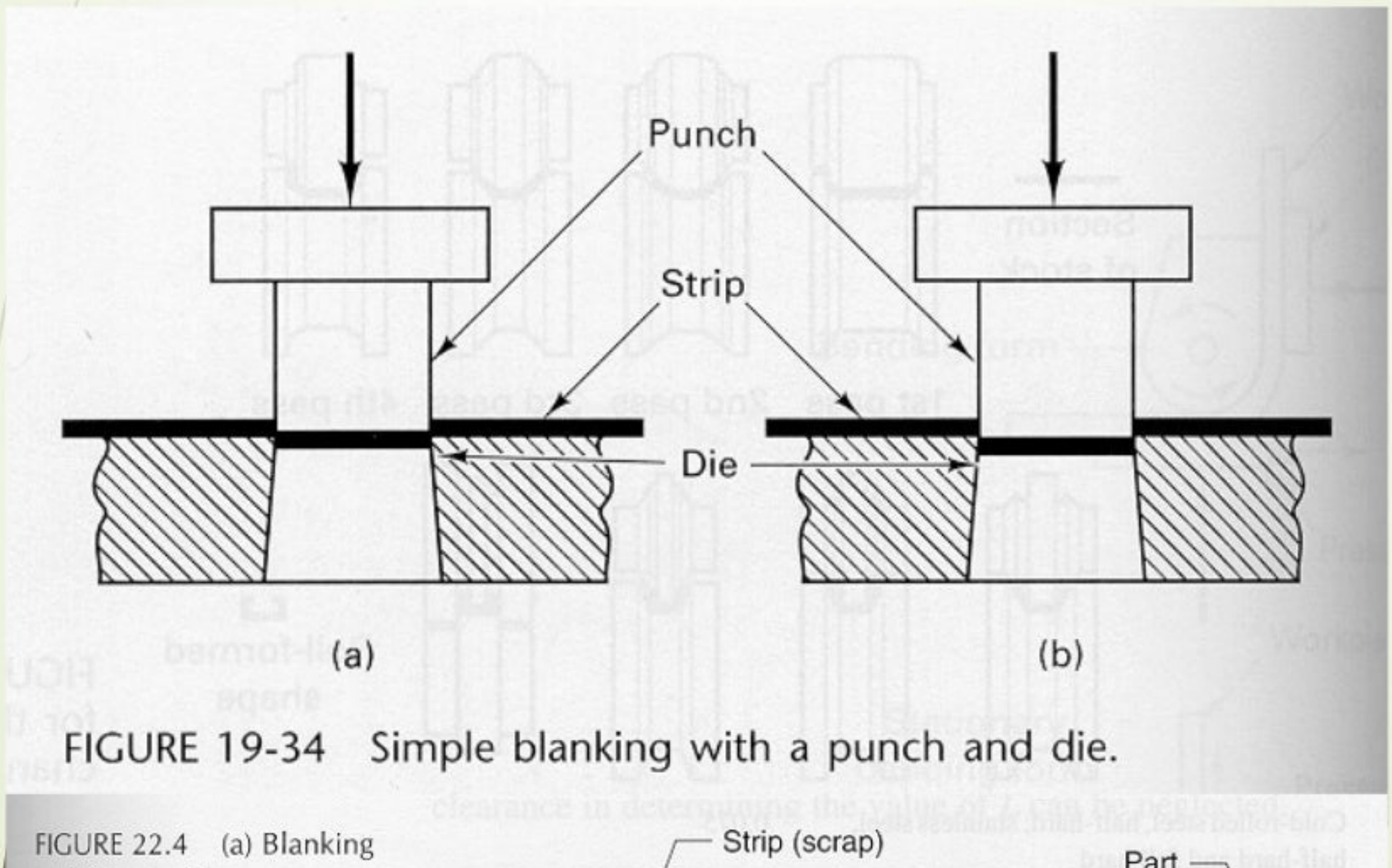


FIGURE 19-34 Simple blanking with a punch and die.

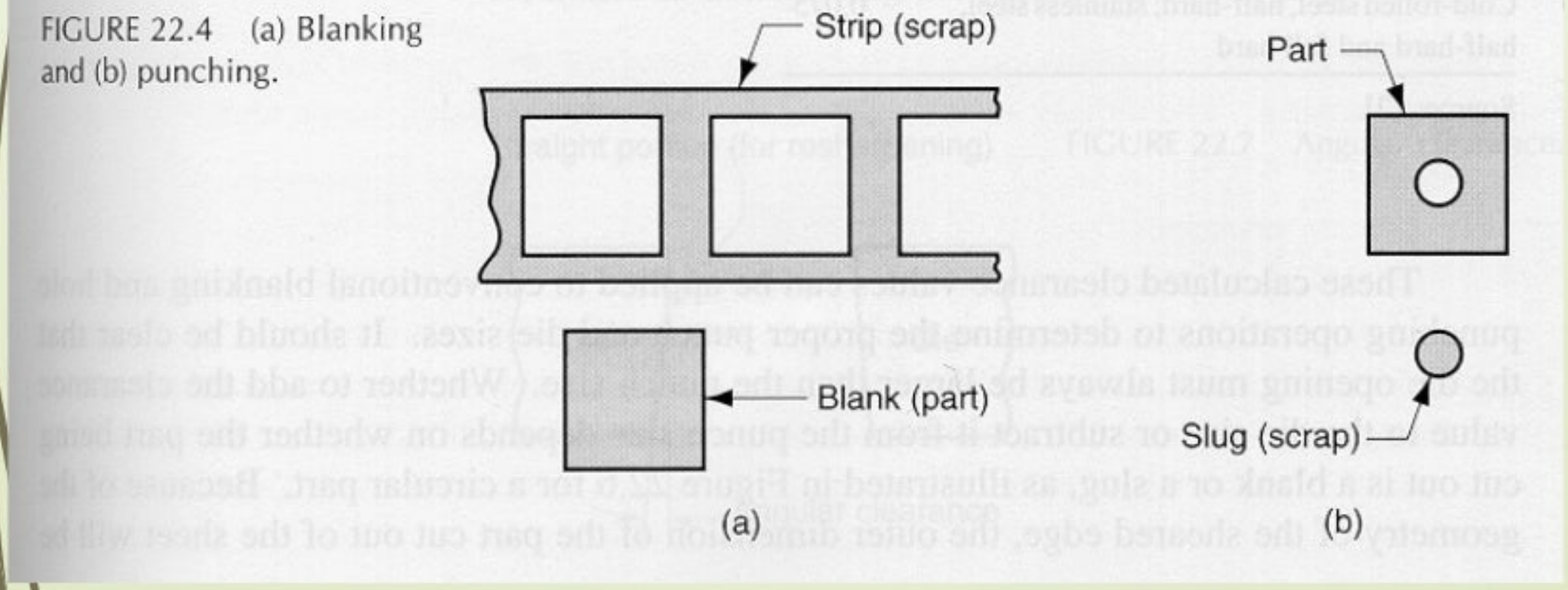


FIGURE 22.4 (a) Blanking and (b) punching.

Piercing and Blanking

Shearing operations in which the shear blades are closed, curved lines along the edges of the punch and die

In blanking, the piece punched out is the workpiece; in piercing, the remaining strip is the workpiece

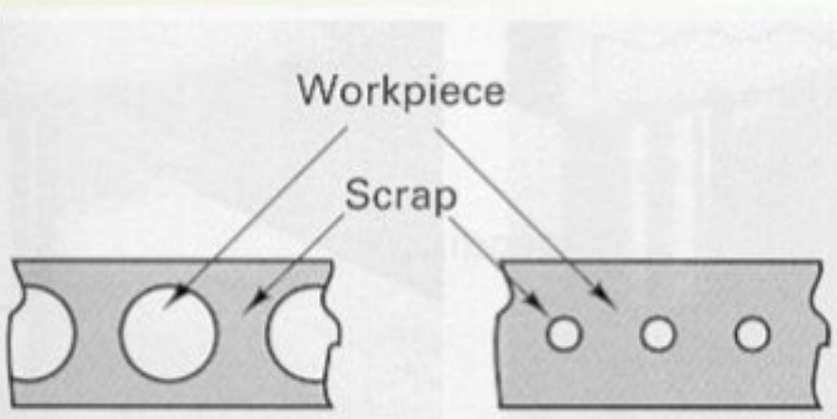


FIGURE 19-40 Schematic showing the difference between piercing and blanking.

Punch and Die

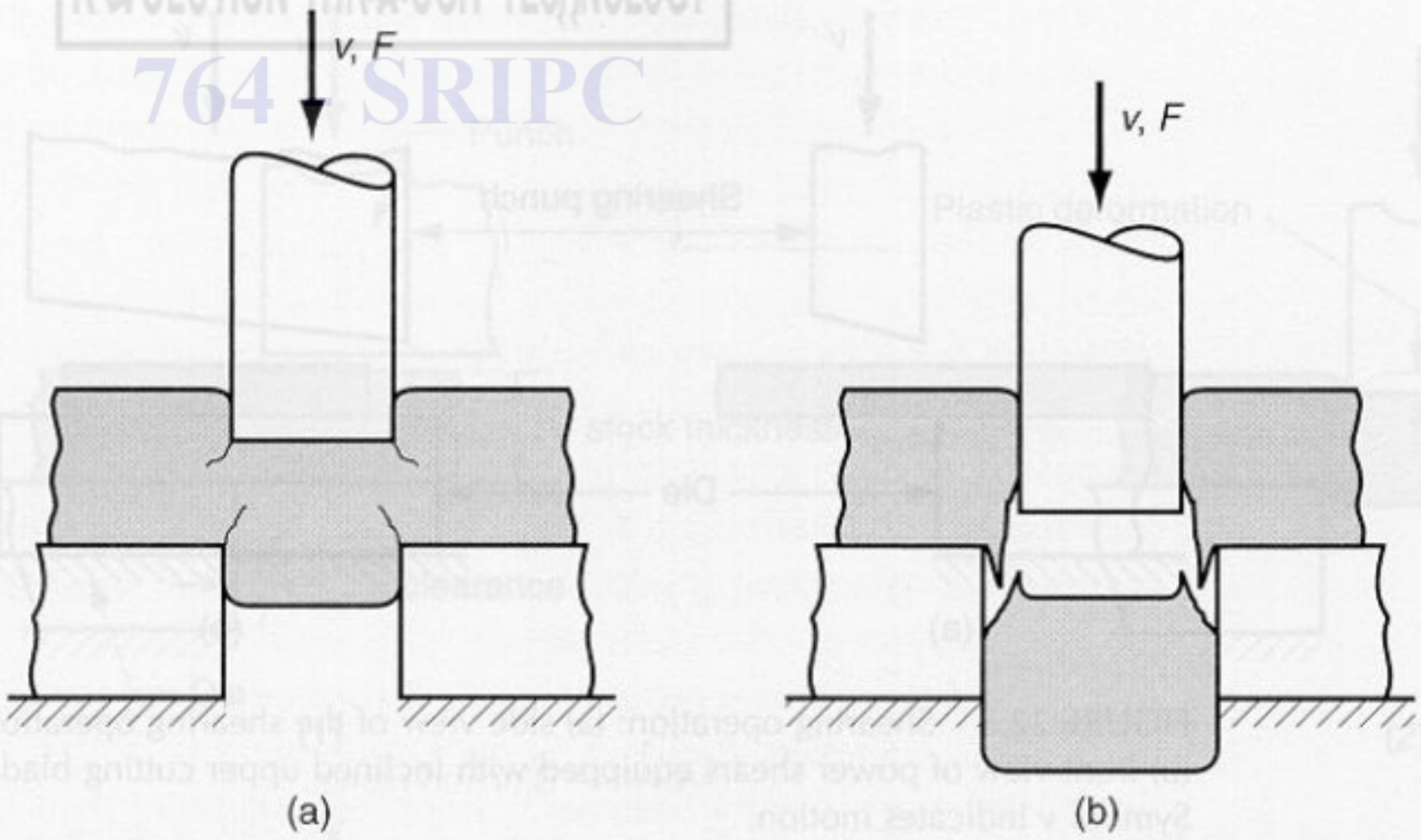


FIGURE 22.5 Effect of clearance: (a) clearance too small causes less than optimal fracture and excessive forces and (b) clearance too large causes oversized burr. Symbols *v* and *F* indicate motion and applied force, respectively.

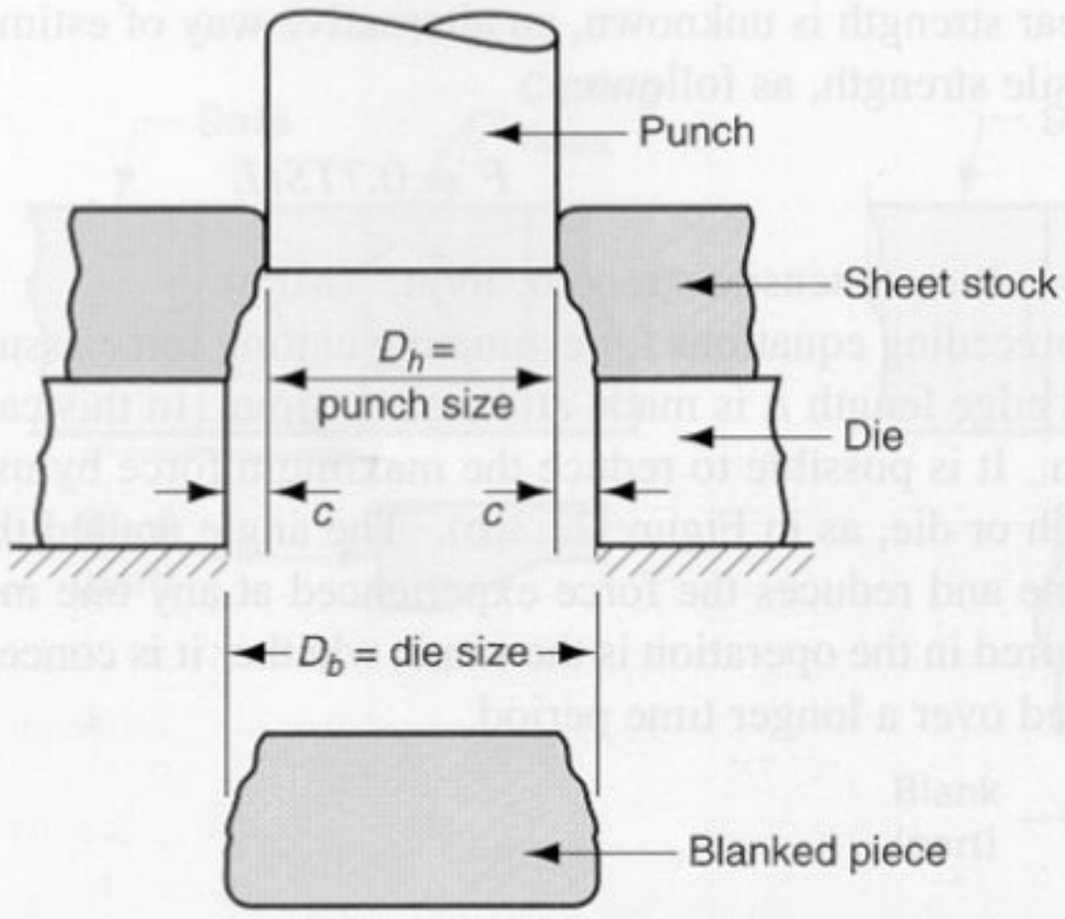


FIGURE 22.6 Die size determines blank size D_b; punch size determines hole size D_h.

Bending

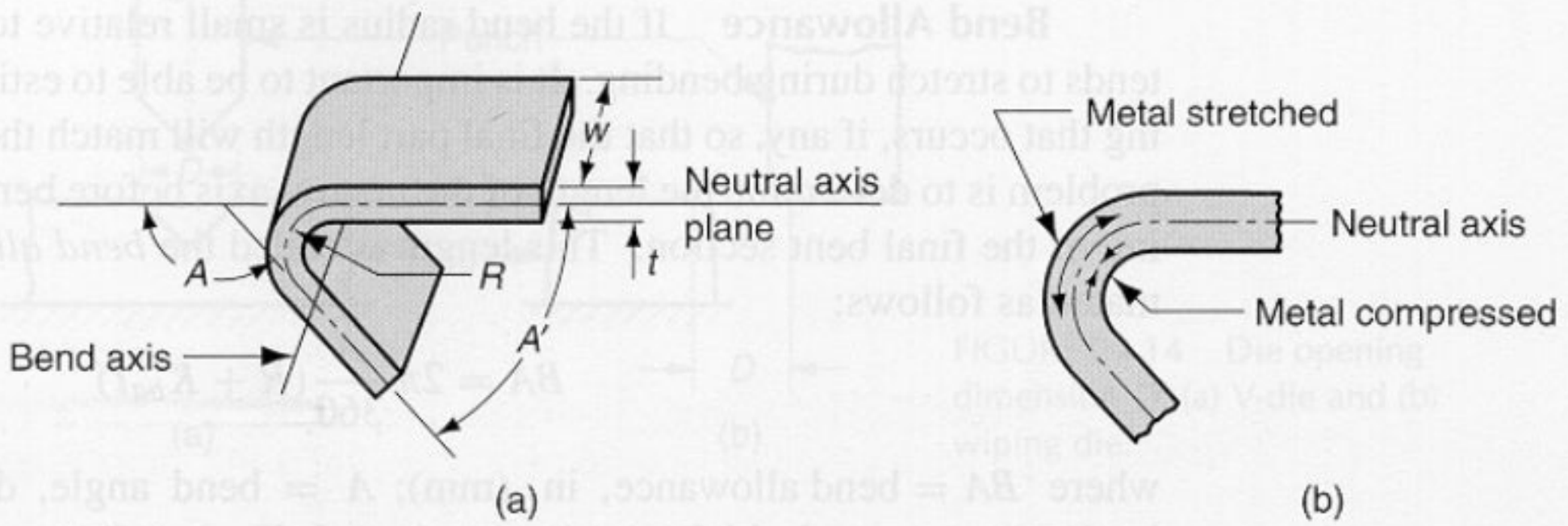


FIGURE 22.11 (a) Bending of sheet metal; (b) both compression and tensile elongation of the metal occur in bending.

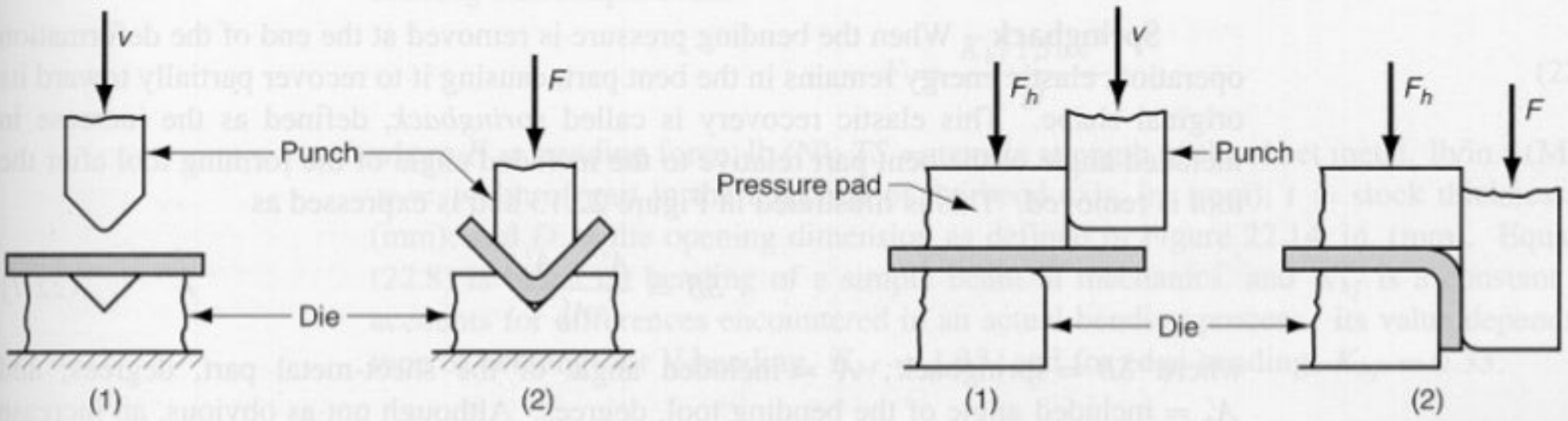


FIGURE 22.12 Two common bending methods: (a) V-bending and (b) edge bending; (1) before and (2) after bending. Symbols v = motion, F = applied bending force, F_h = holding force.

Bending

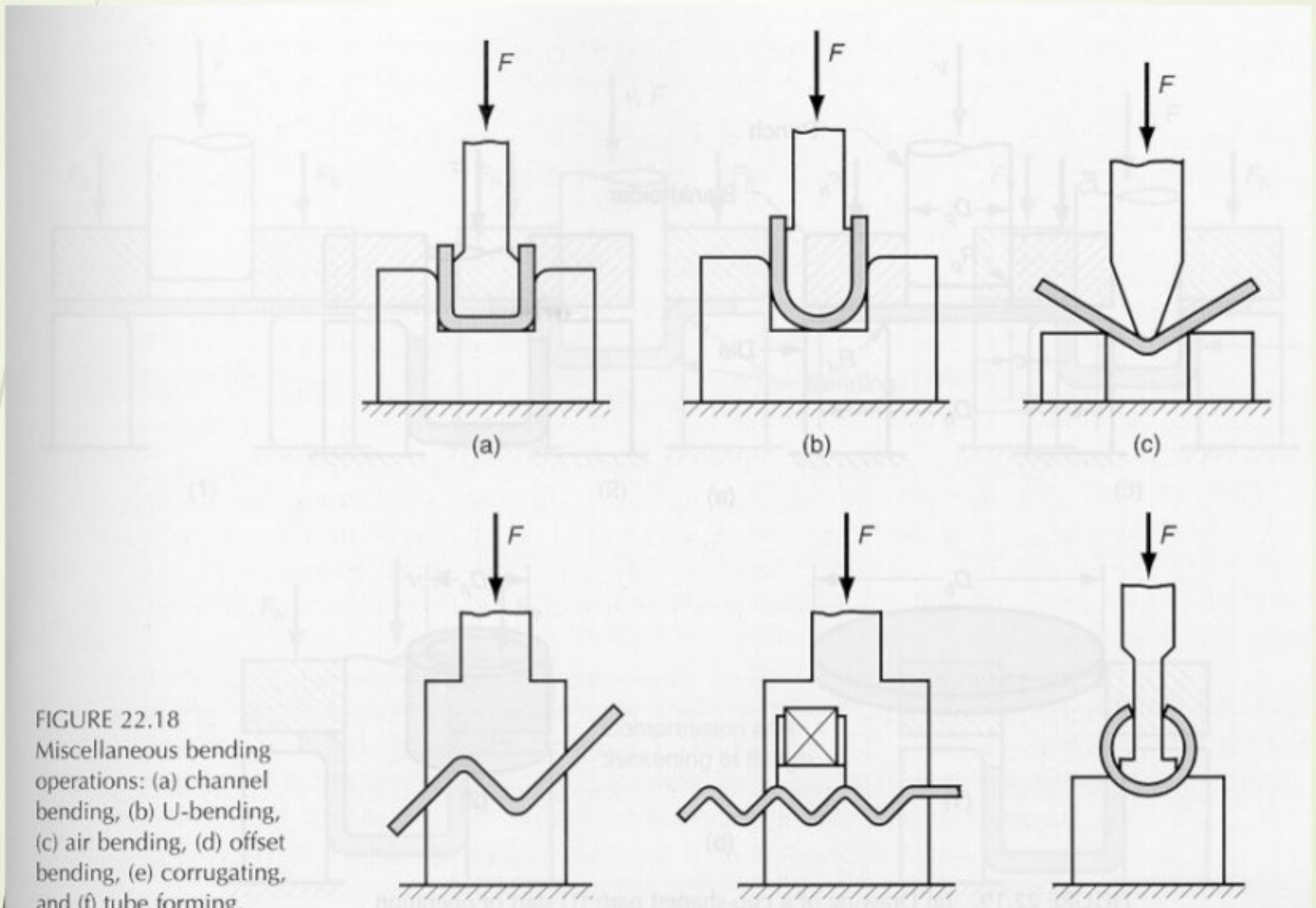
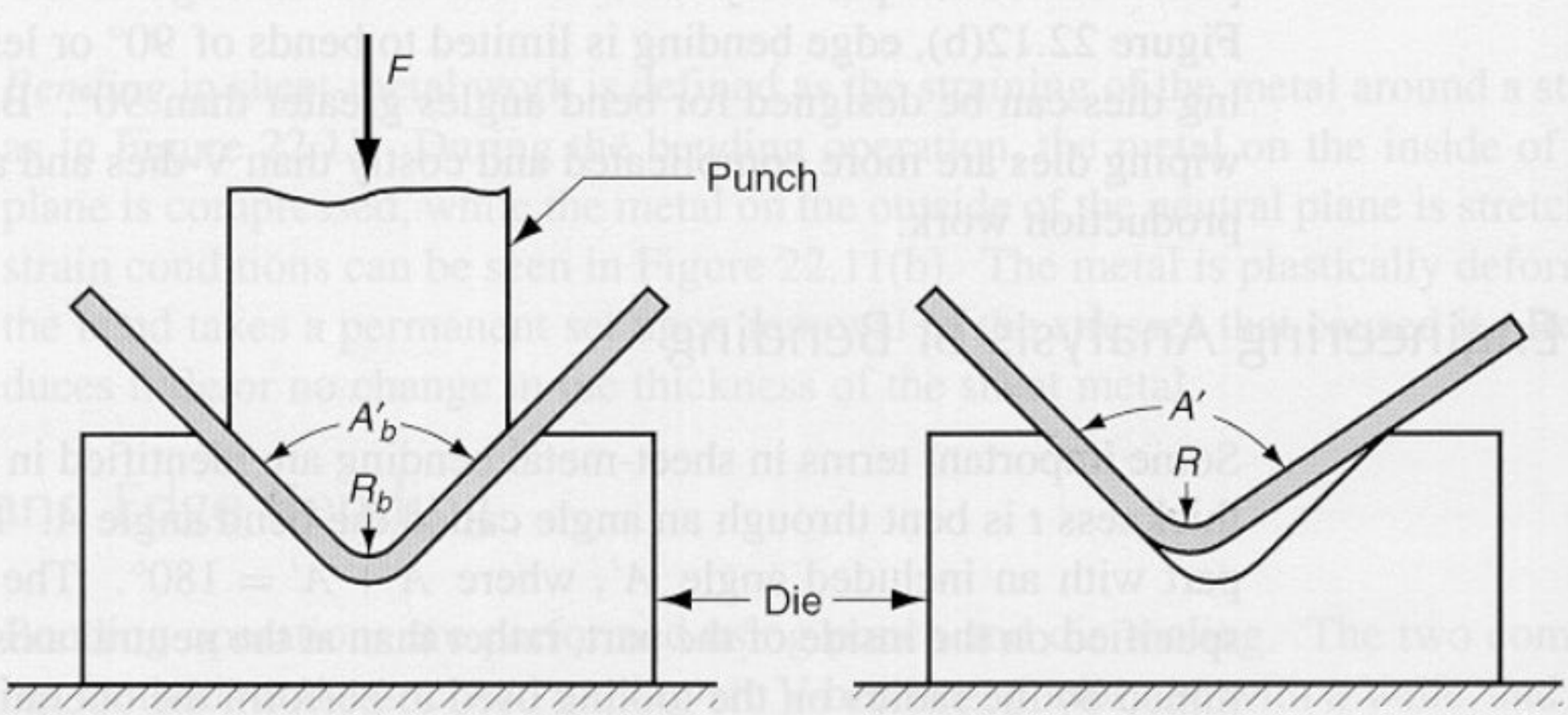


FIGURE 22.18
Miscellaneous bending operations: (a) channel bending, (b) U-bending, (c) air bending, (d) offset bending, (e) corrugating, and (f) tube forming. Symbol F = applied force.

Bending Springback

FIGURE 22.13 Springback in bending shows itself as a decrease in bend angle and an increase in bend radius: (1) during the operation, the work is forced to take the radius R_b and included angle A'_b determined by the bending tool (punch in V-bending); (2) after the punch is removed, the work springs back to radius R and included angle A'. Symbol F = applied bending force.



Deep Drawing

A sheet metal forming operation used to make hollow-shaped parts

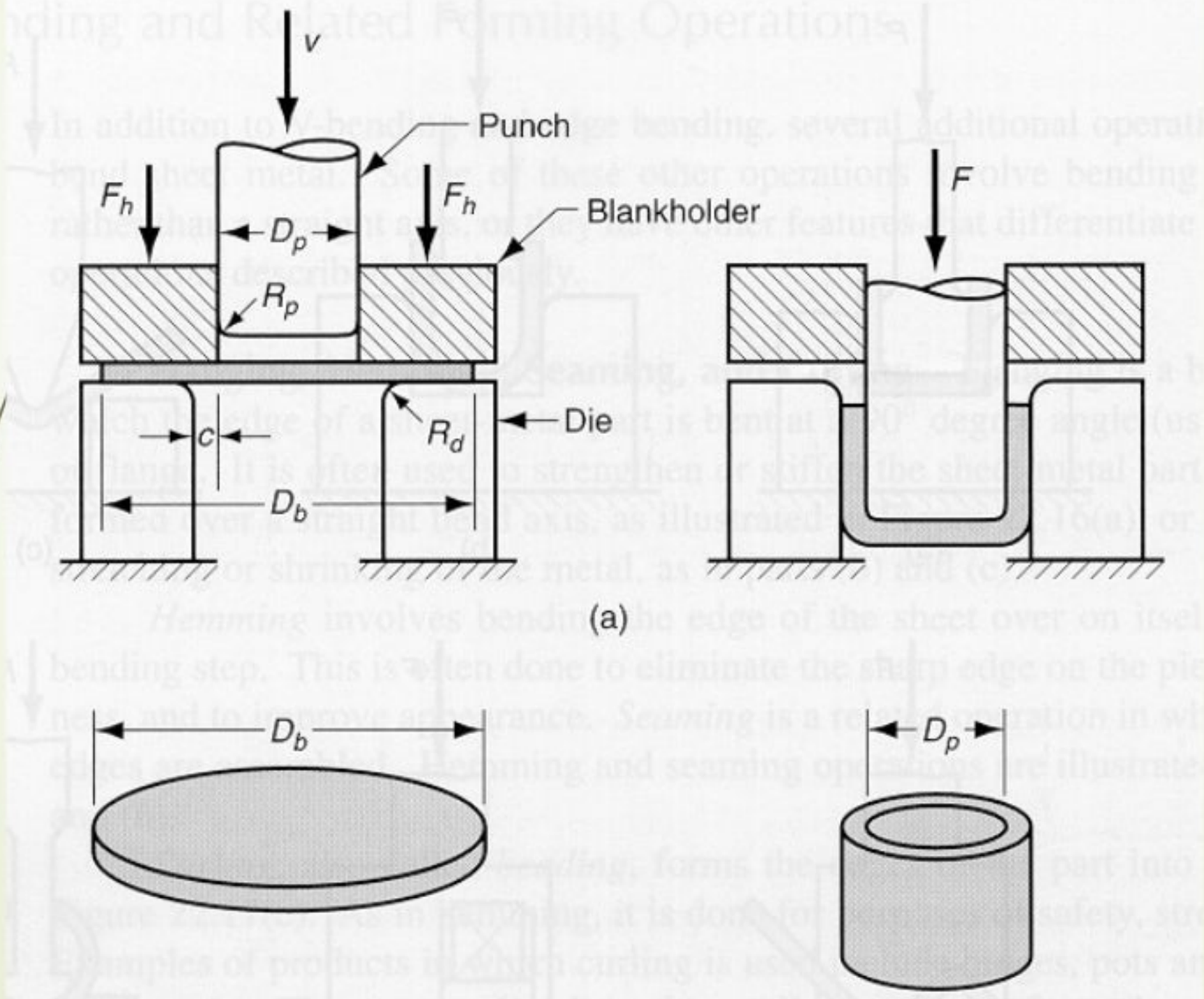


FIGURE 22.19 (a) Drawing of a cup-shaped part: (1) start of operation before punch contacts work and (2) near end of stroke; and (b) corresponding workpart: (1) starting blank and (2) drawn part. Symbols c = clearance, D_b = blank diameter, D_p = punch diameter, R_d = die corner radius, R_p = punch corner radius, F = drawing force, F_h = holding force.

Deep Drawing

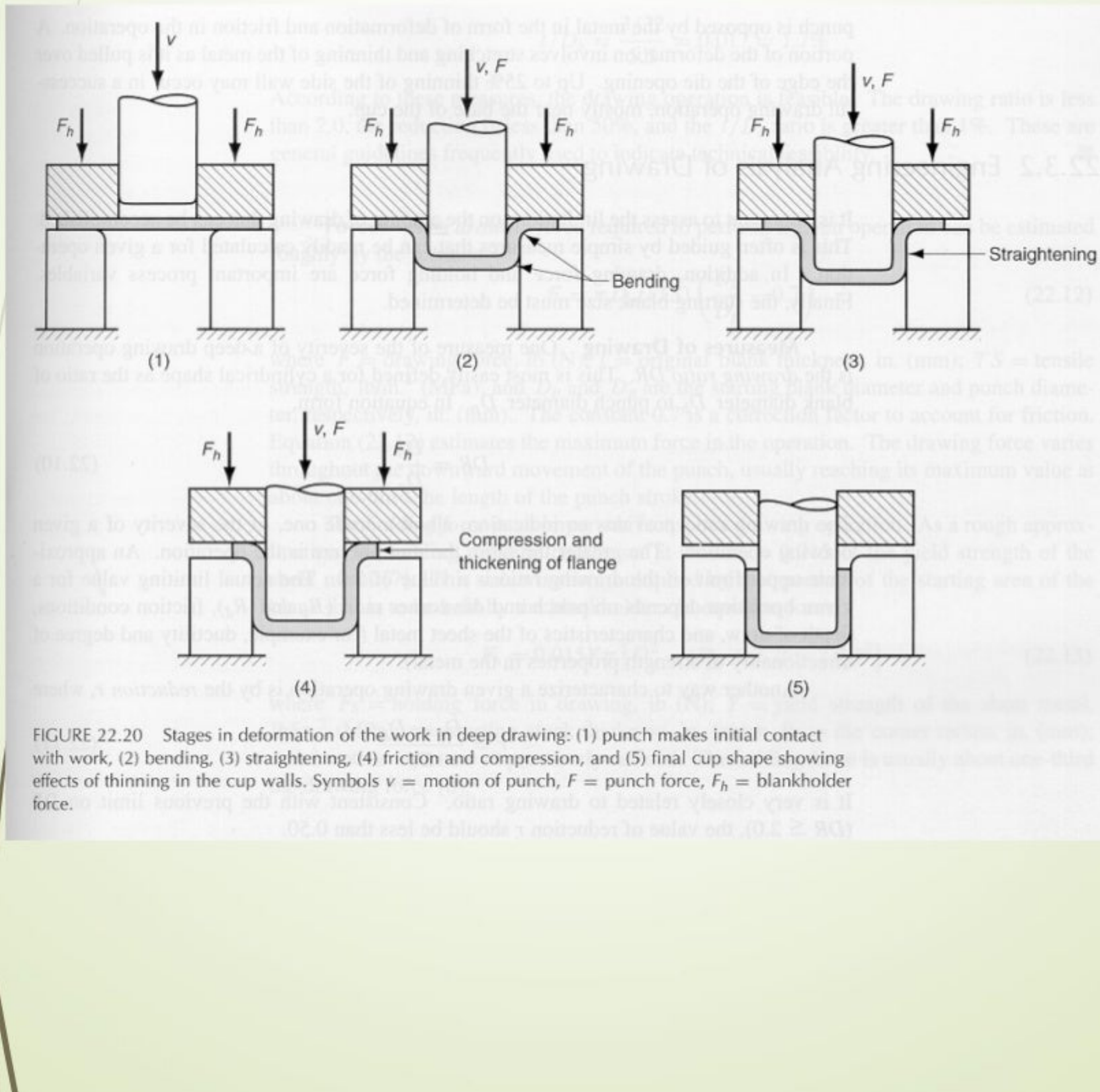
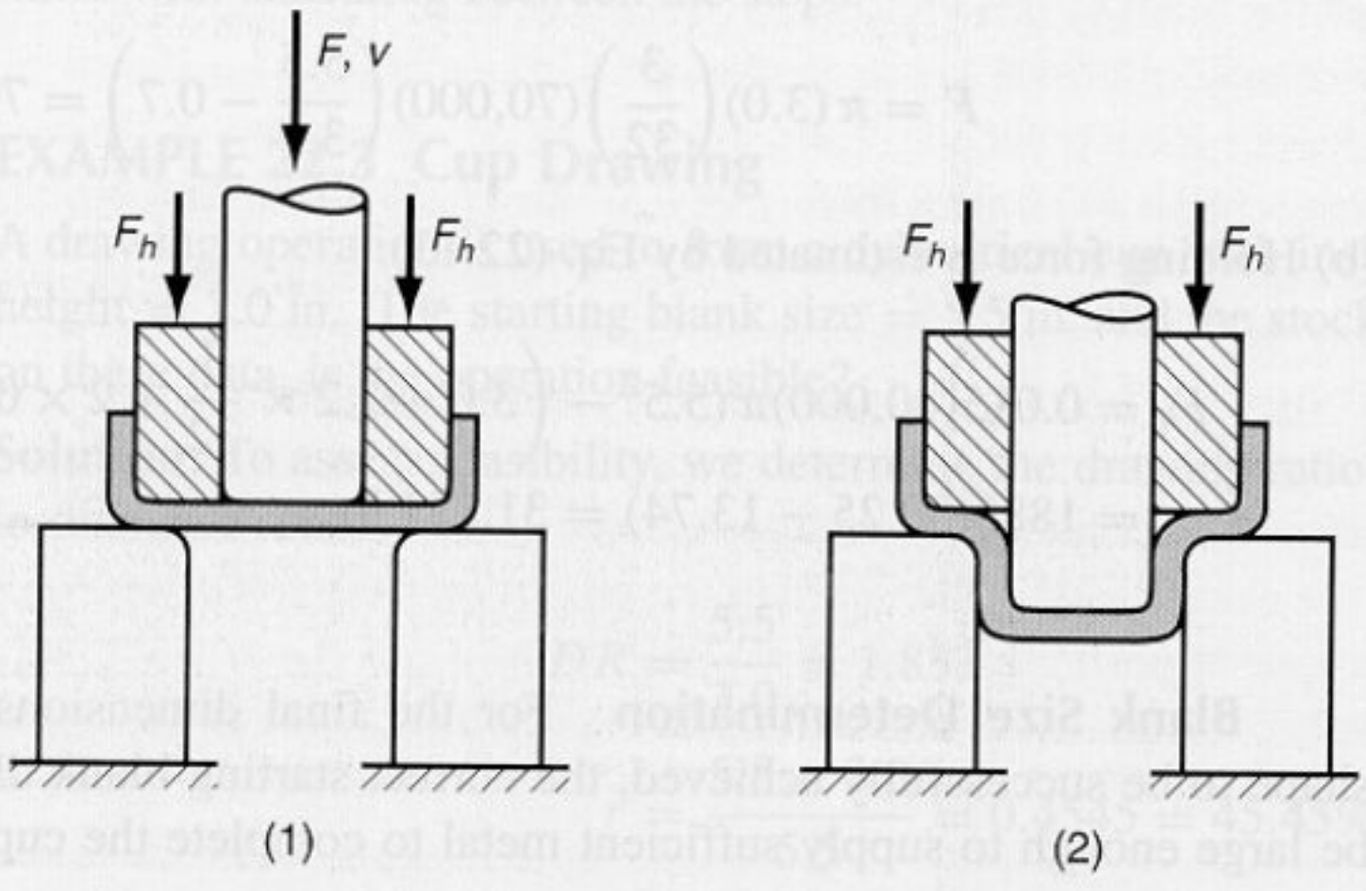


FIGURE 22.20 Stages in deformation of the work in deep drawing: (1) punch makes initial contact with work, (2) bending, (3) straightening, (4) friction and compression, and (5) final cup shape showing effects of thinning in the cup walls. Symbols v = motion of punch, F = punch force, F_h = blankholder force.

Redrawing

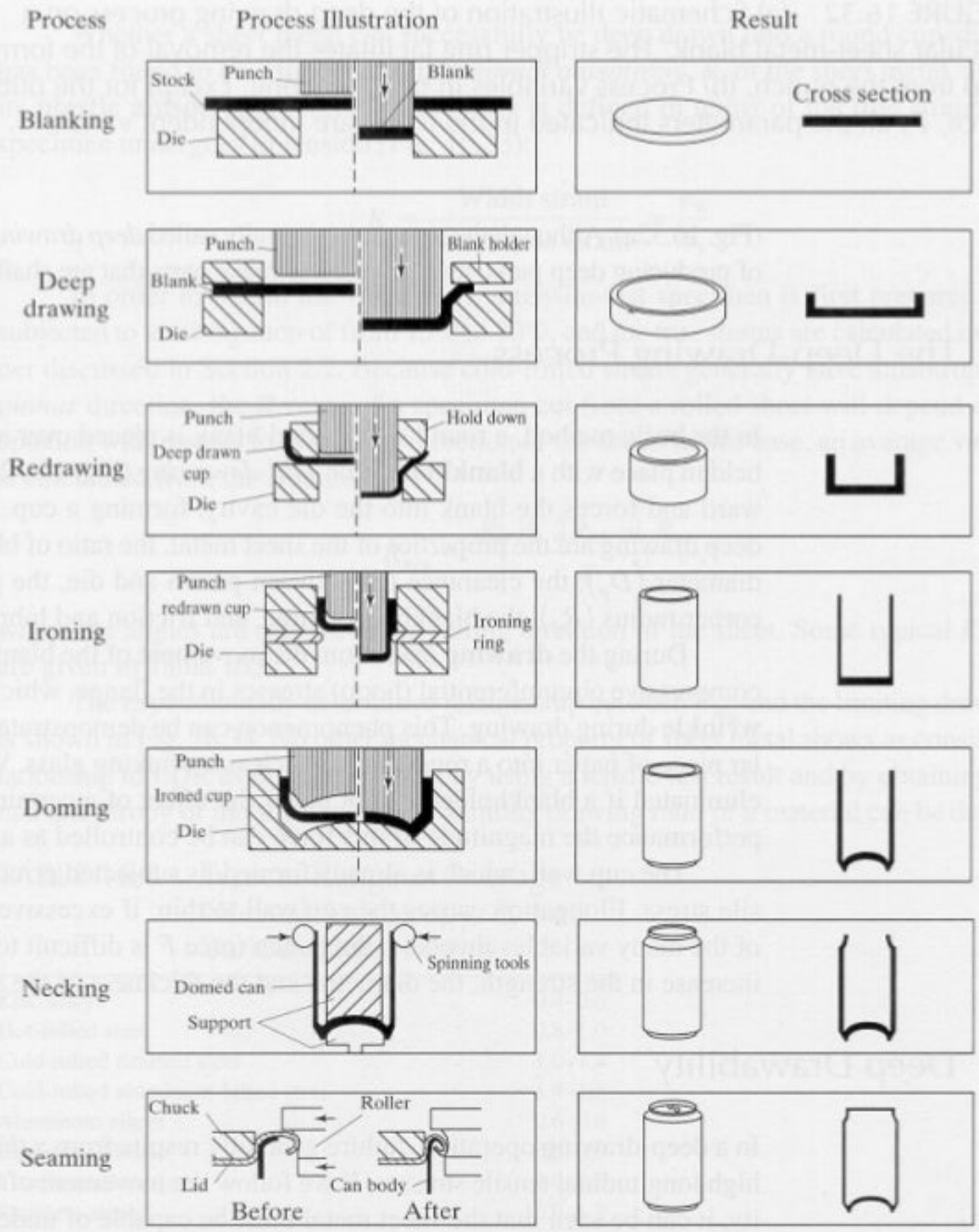
Additional drawing steps (redrawing) may be required if the shape change of the material is too severe

FIGURE 22.21
Redrawing of a cup: (1) start of redraw and (2) end of stroke. Symbols v = punch velocity, F = applied punch force, F_h = blankholder force.



Example of a Drawn Part

FIGURE 16.31 The metal-forming processes involved in manufacturing a two-piece aluminum beverage can.



Example of a Deep Drawing Press

Stamping Die

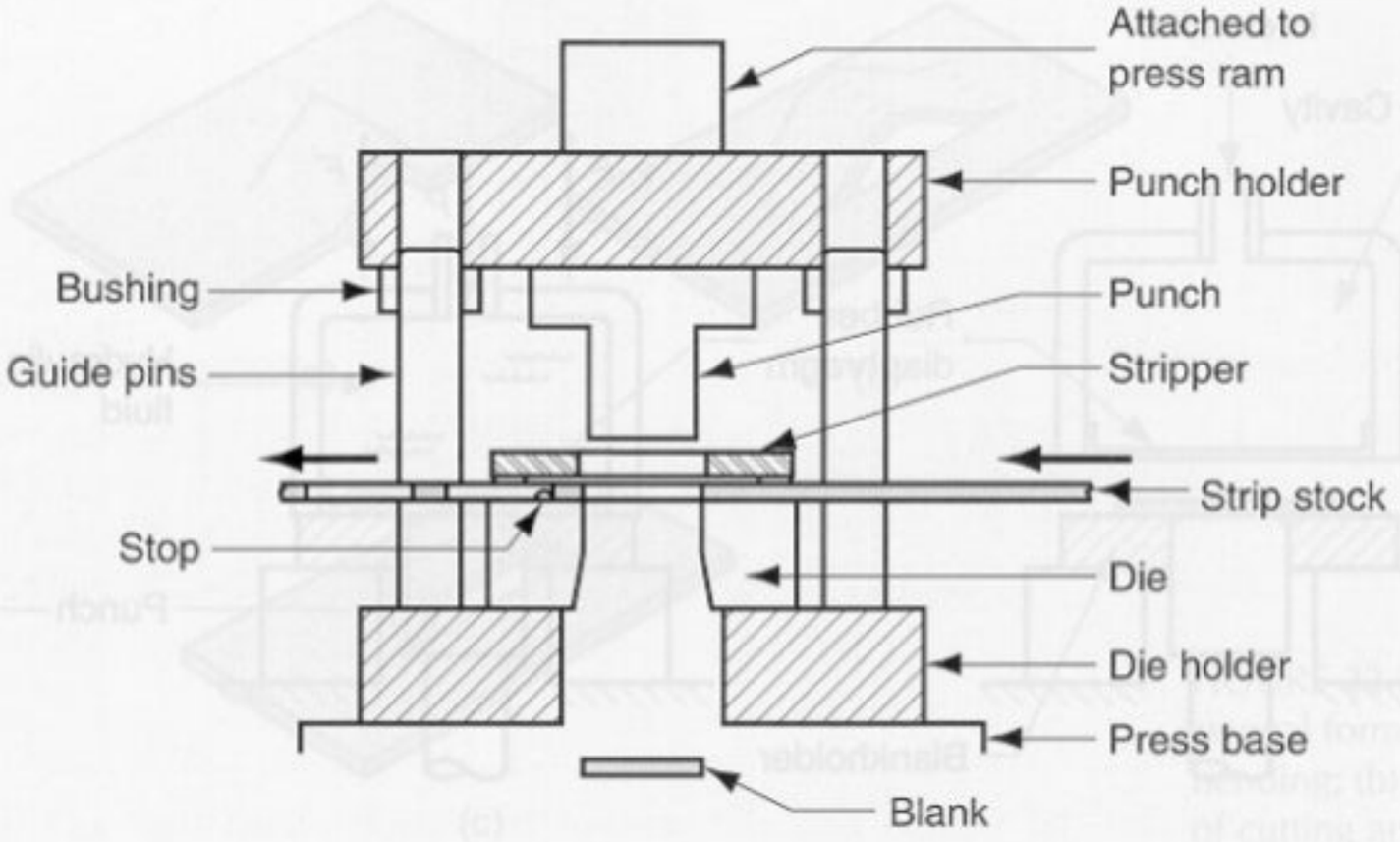
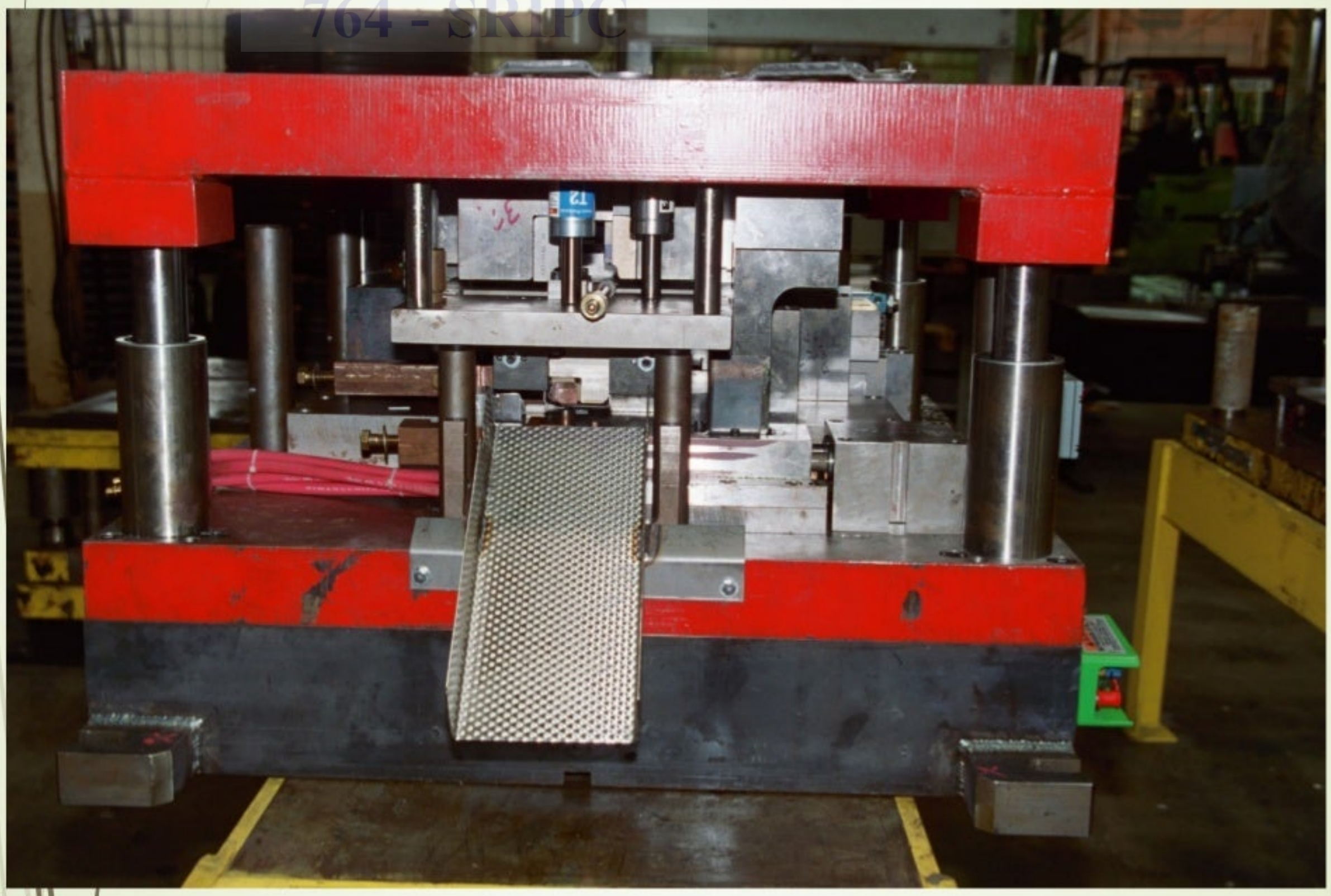


FIGURE 22.30
Components of a punch and die for a blanking operation.

Stamping Die



Progressive Die

Performs multiple operations at different stations with every press stroke

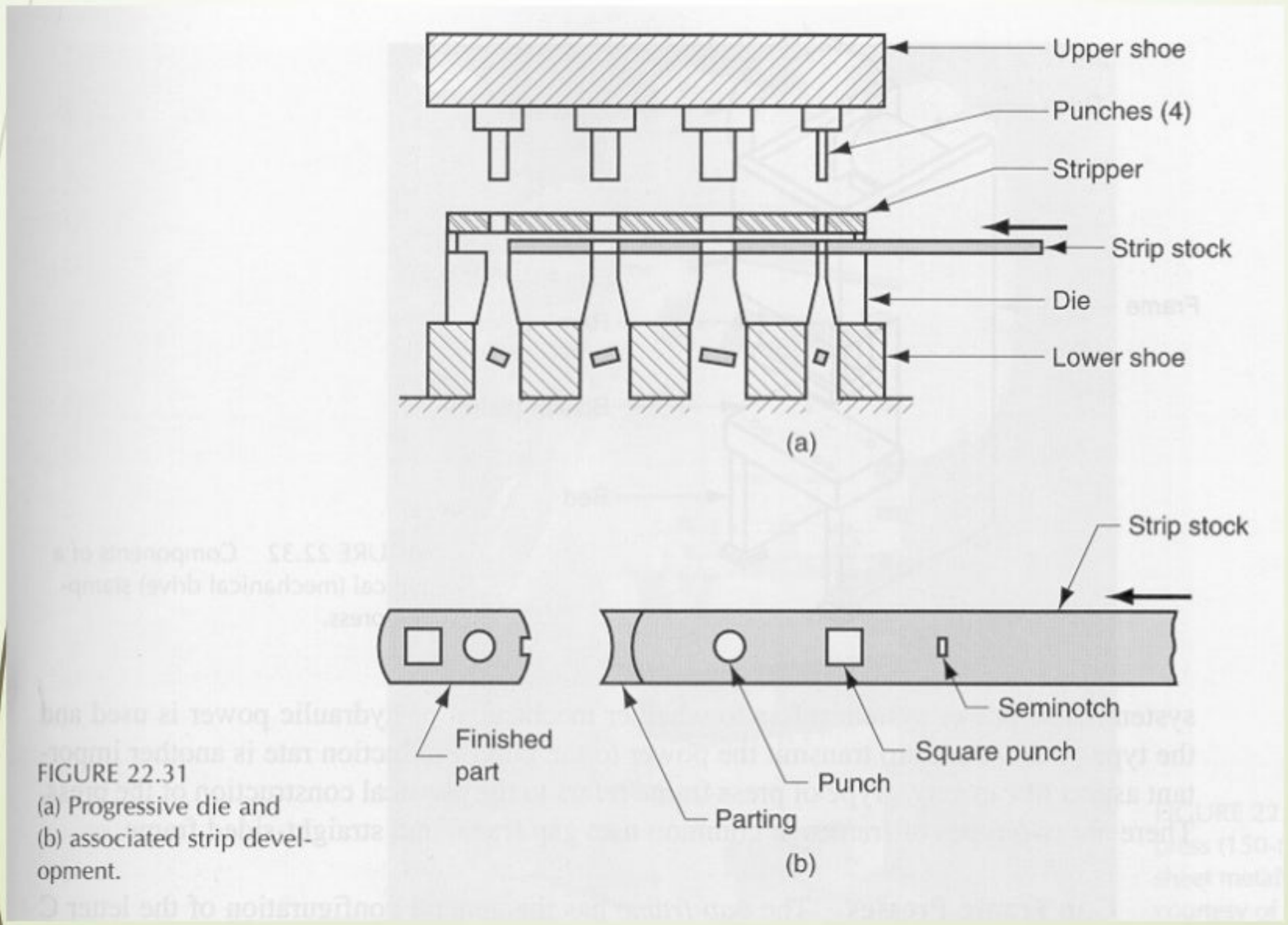
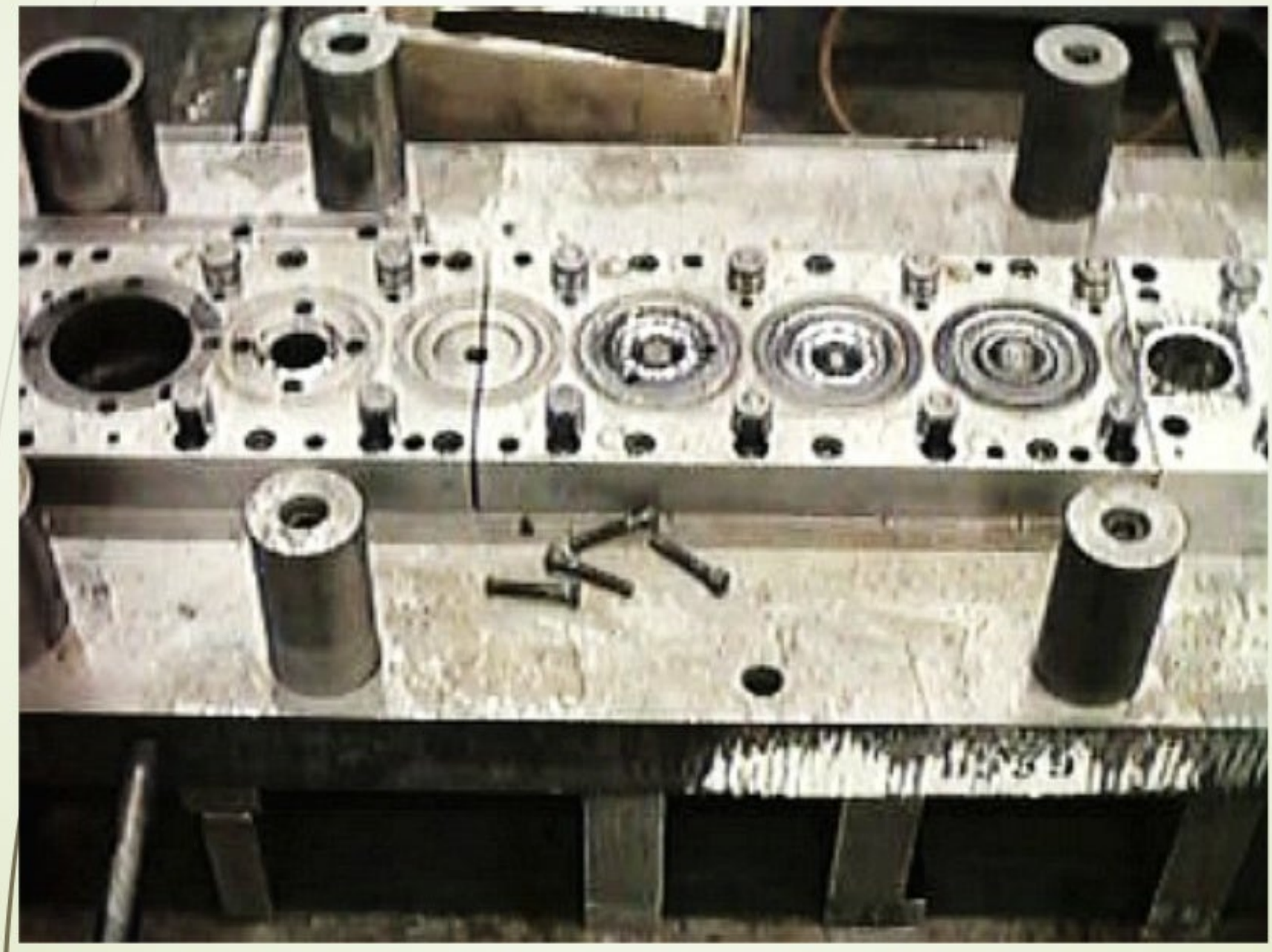
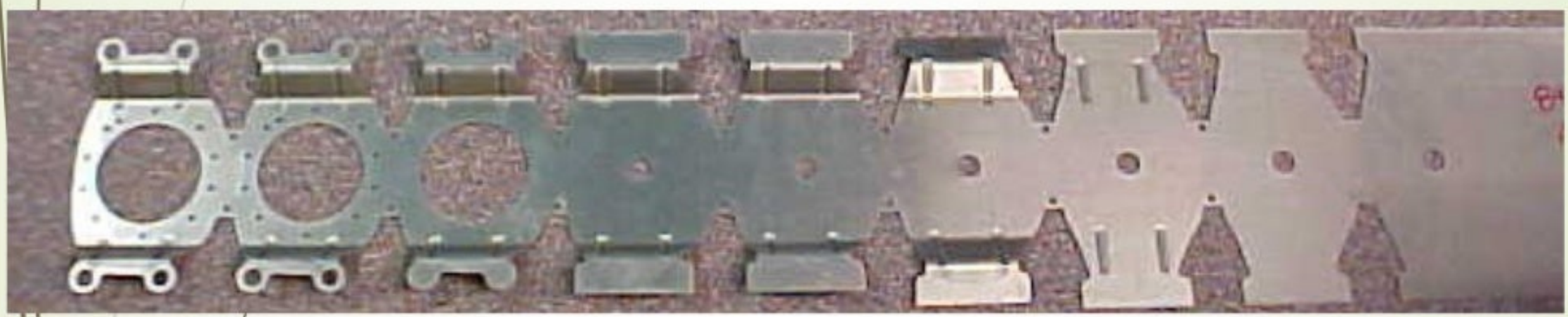


FIGURE 22.31
(a) Progressive die and
(b) associated strip development.

Progressive Die



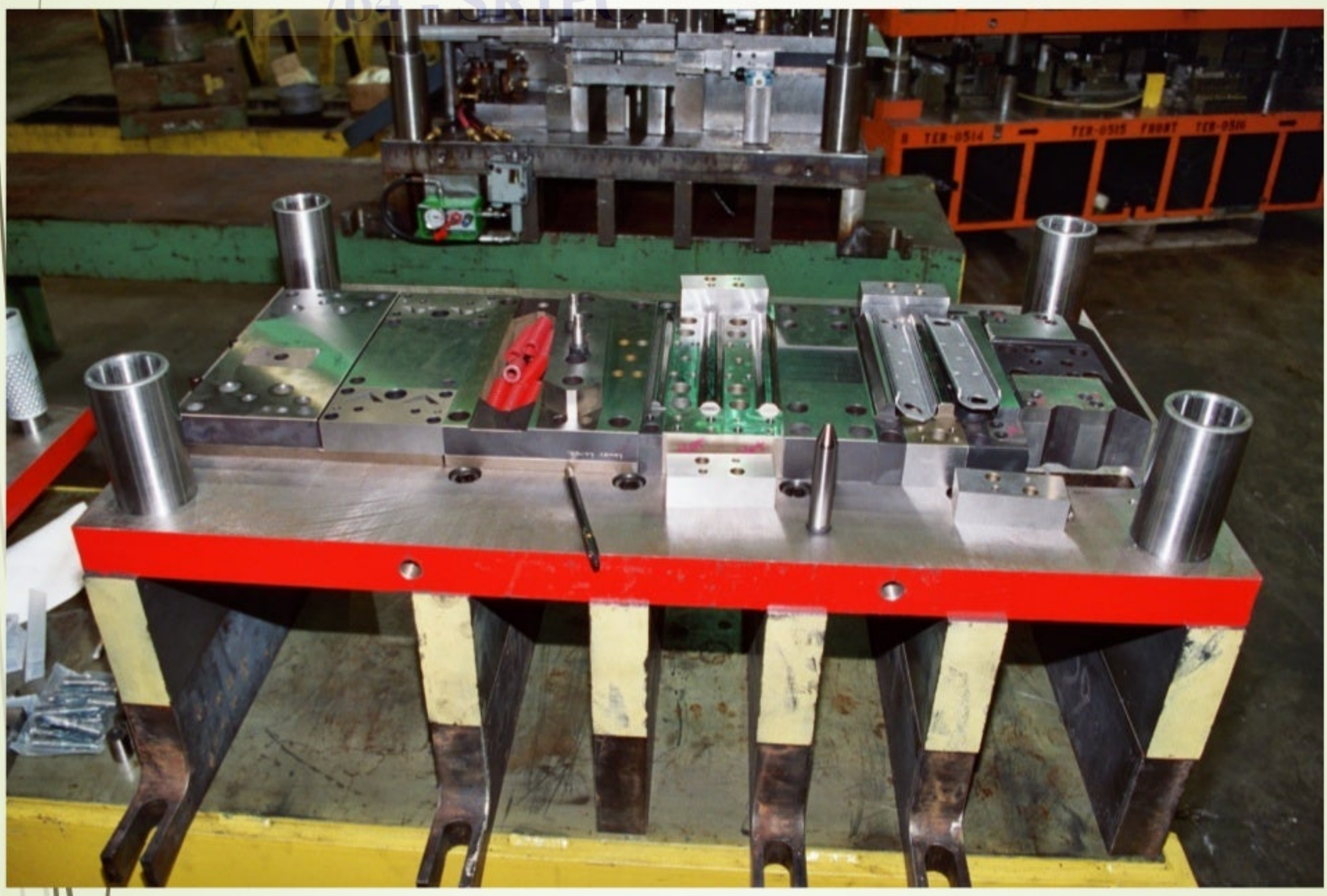
Example of Progressively Stamped Parts



This sheet has been stamped by a progressive die, showing the series of operations from right to left

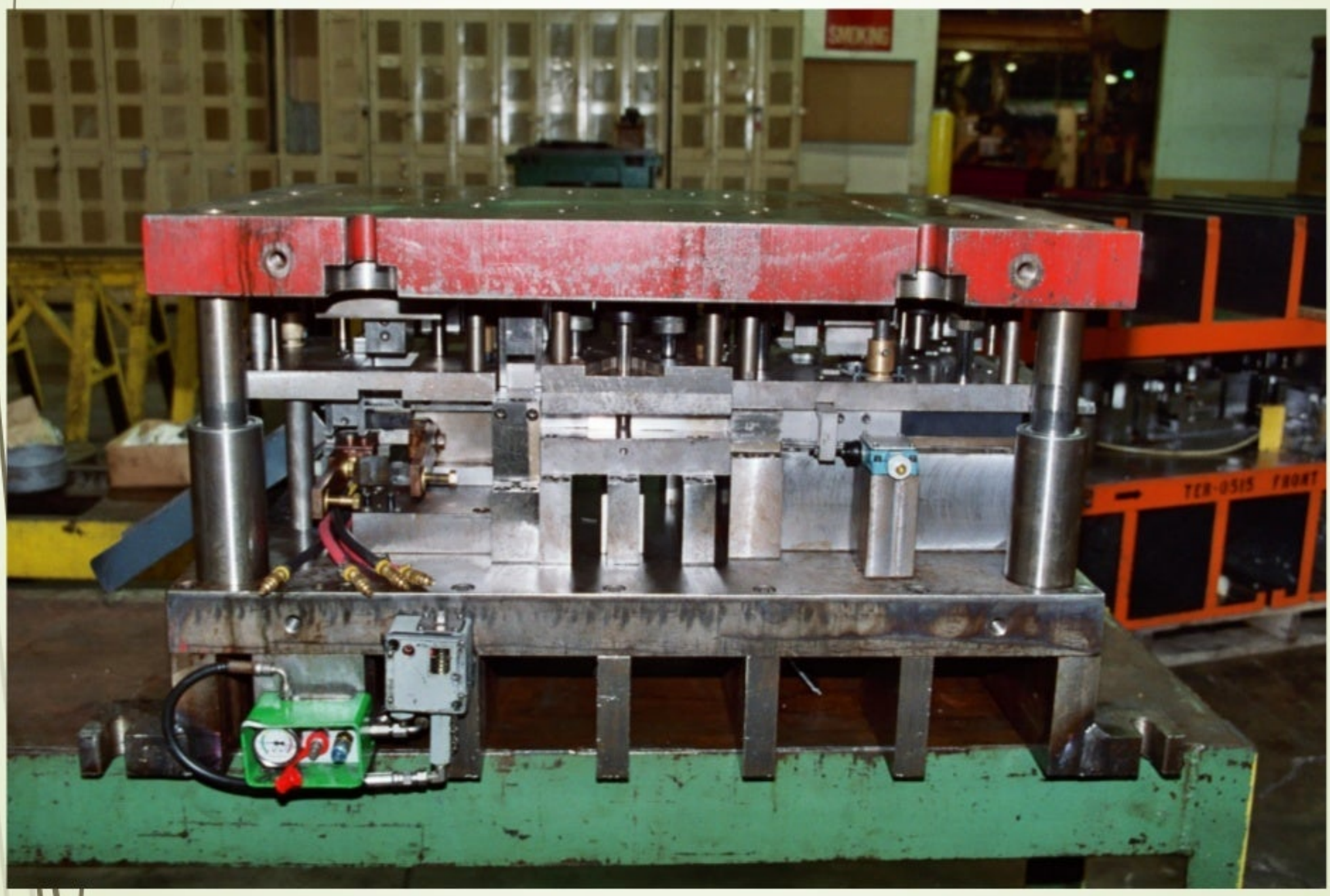
Progressive Die

Progressive Die

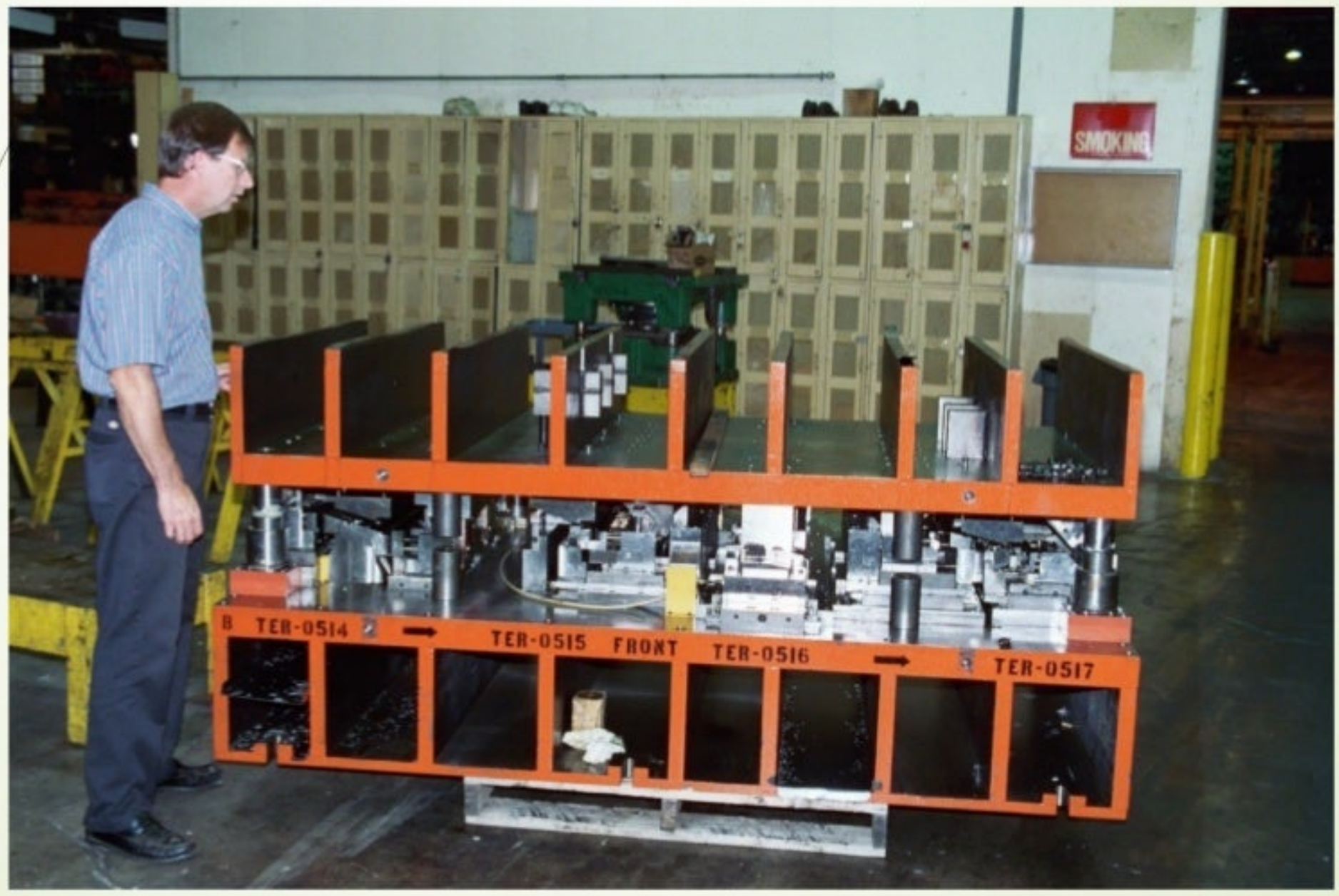


Progressive Die

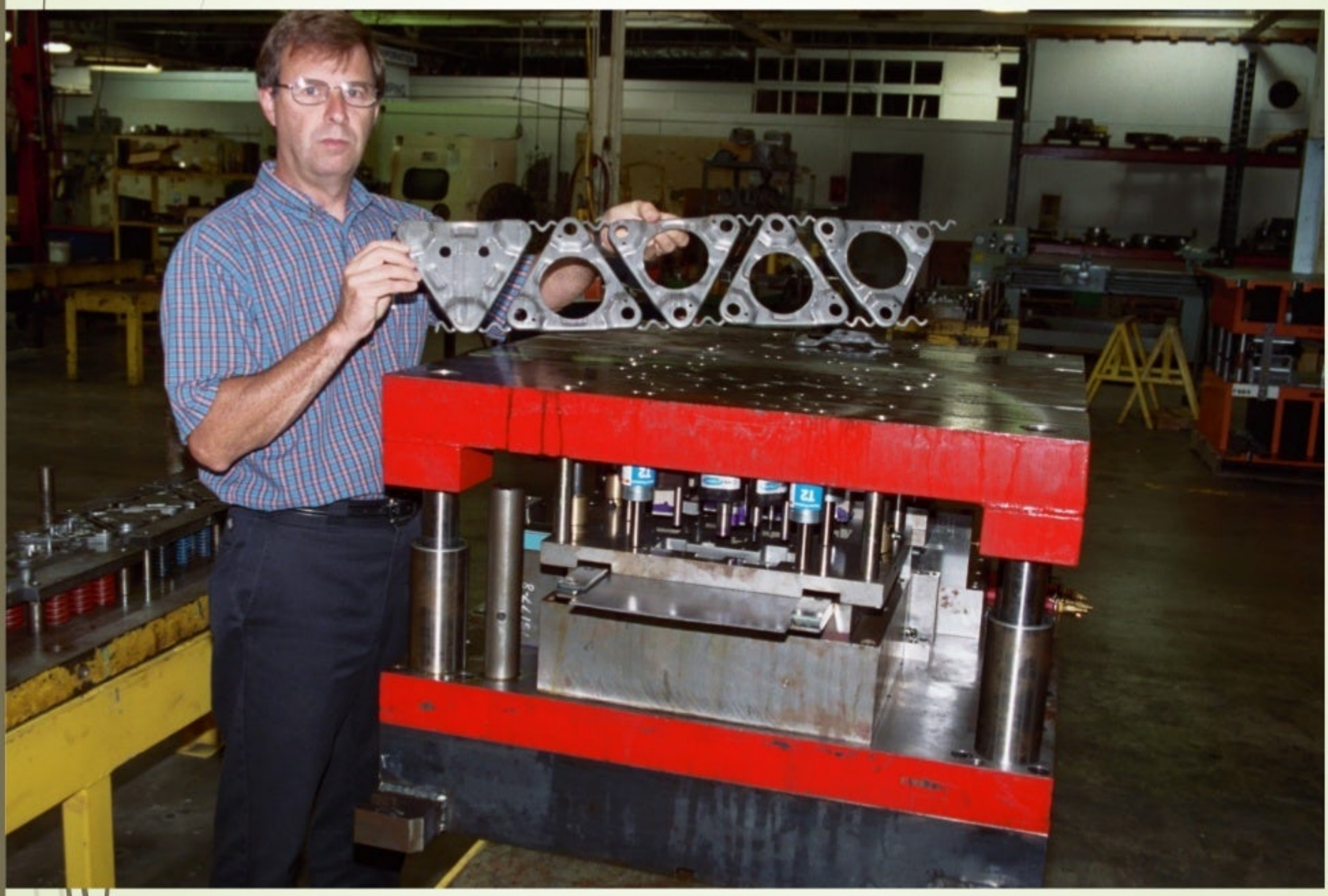
Progressive Die



Progressive Die



Progressive Die



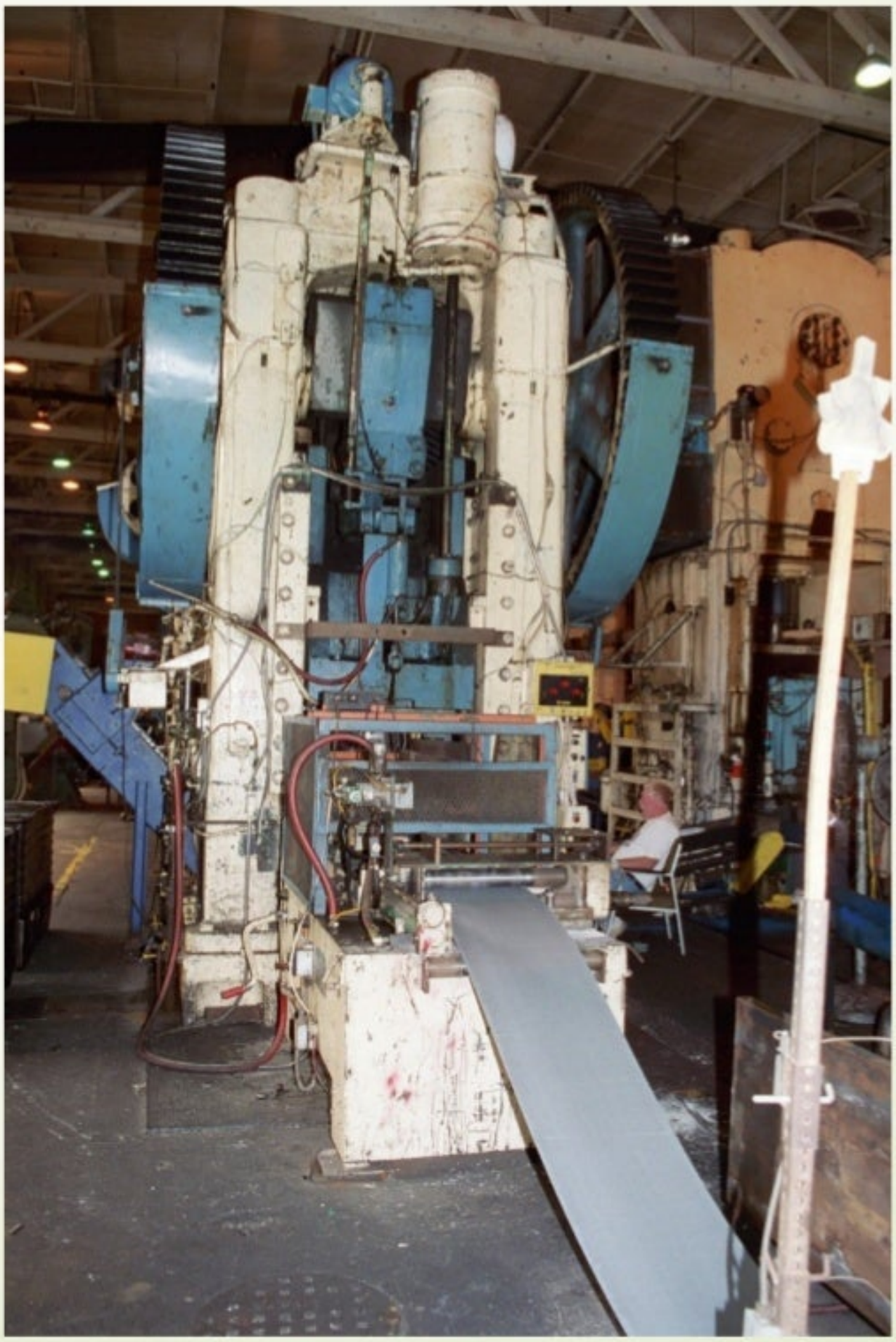
Examples of Stamping Machines

Progressive Die in Stamping Press

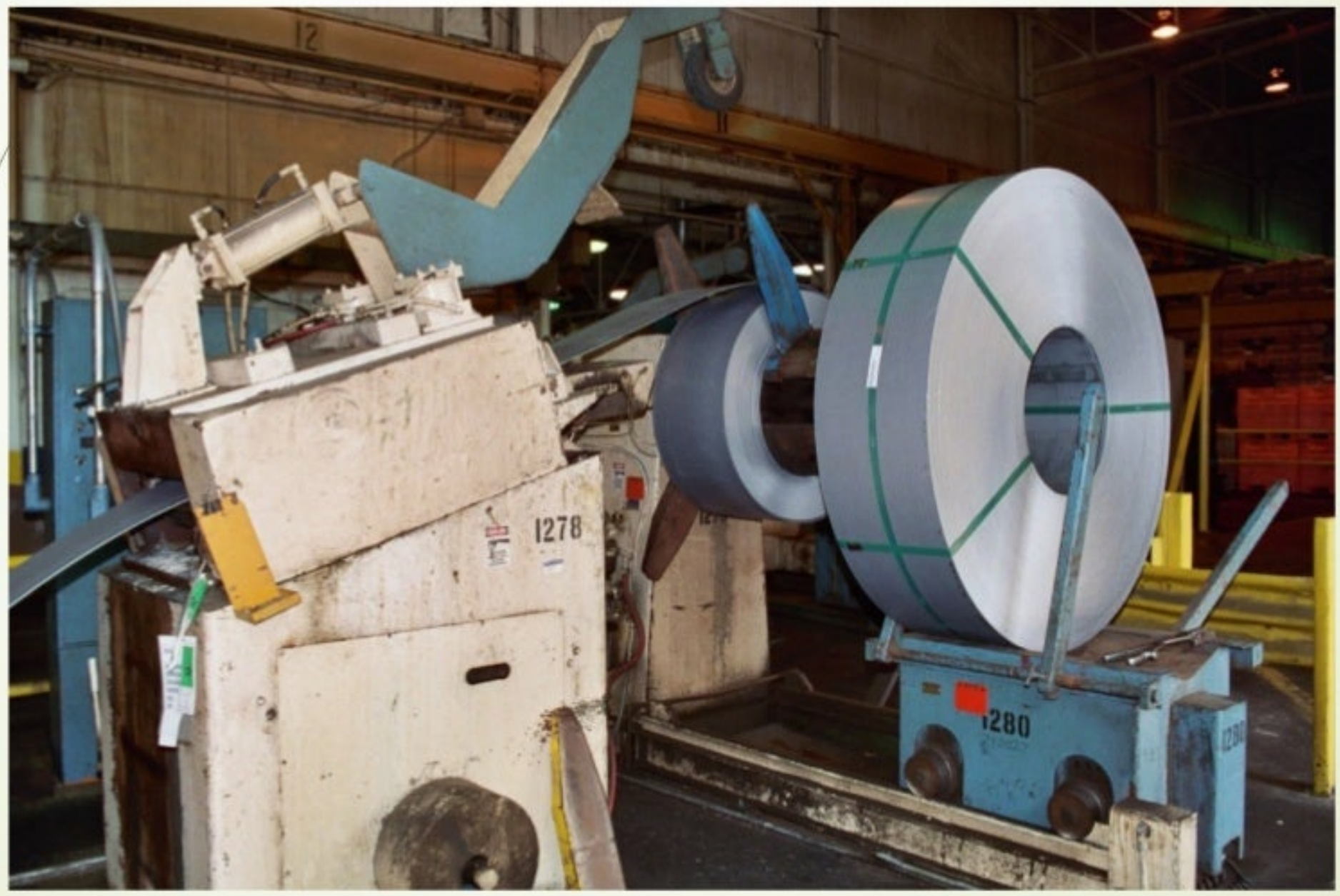
Progressive Die

Material Coils

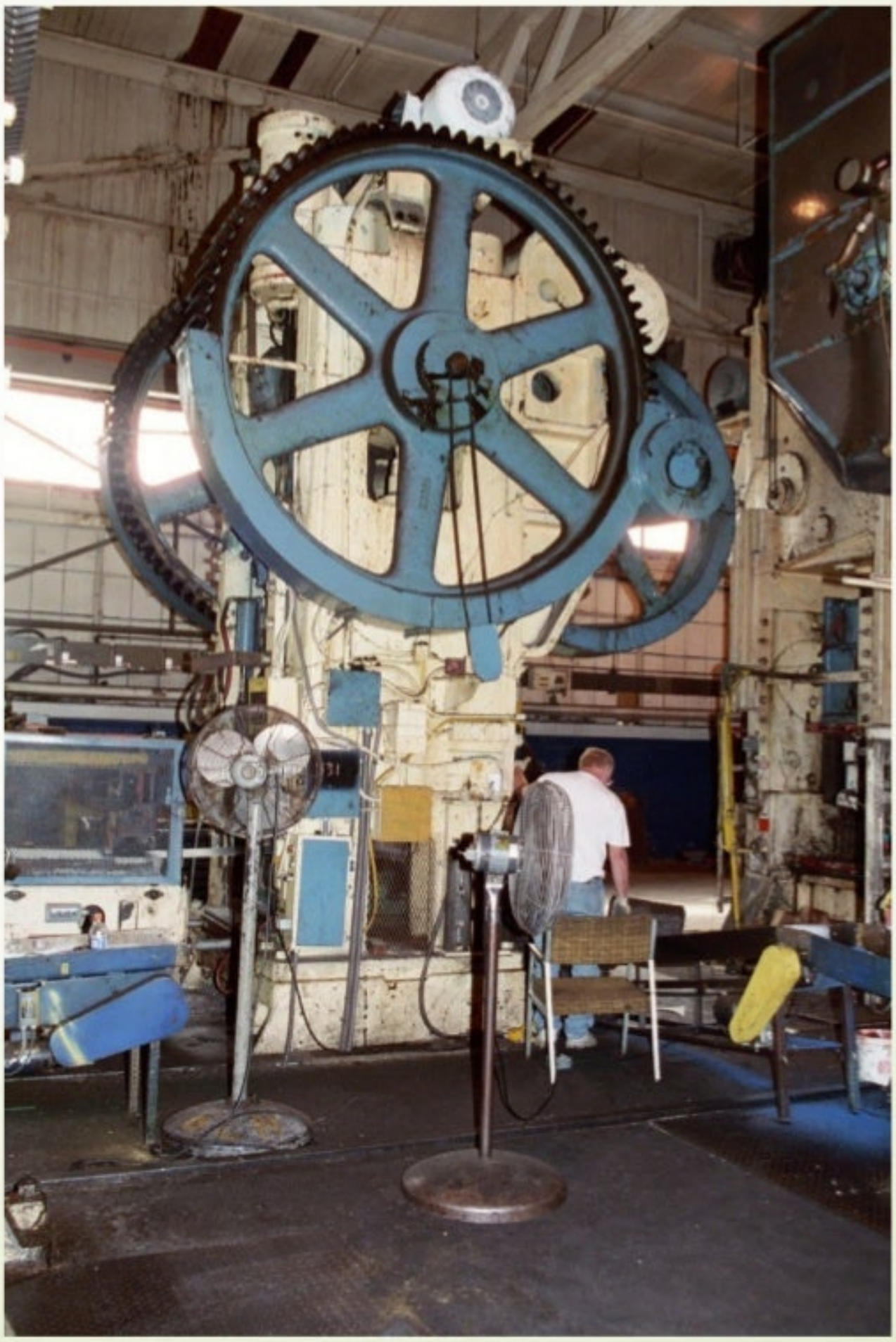
Material Feed



Material Feed

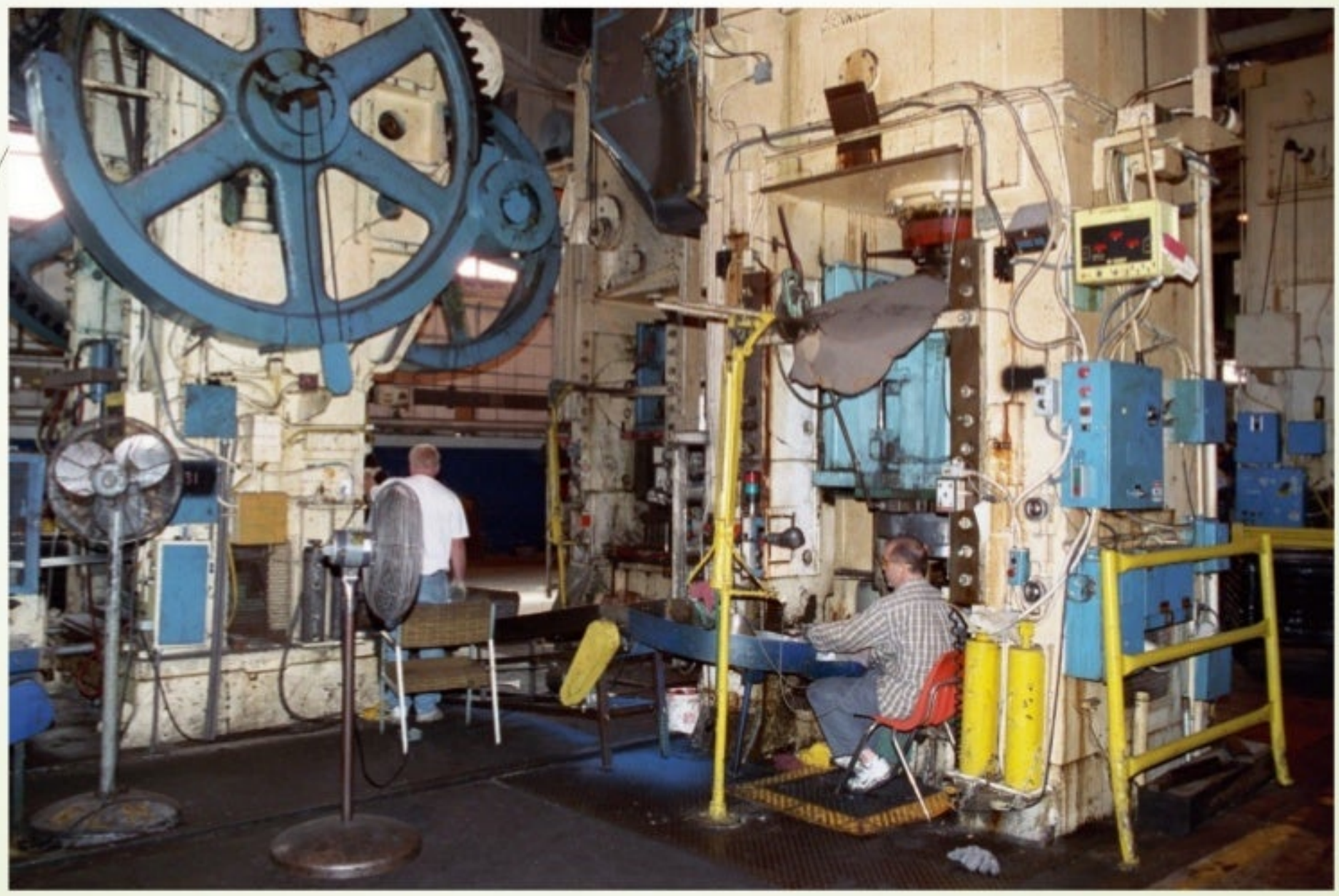


Transfer Line



Transfer Line

Transfer Line



Transfer Line

Transfer Press

Transfer Press

Transfer Die

Spinning

Uses a spinning mandrel and a roller to form sheet metal into a radially symmetrical part

FIGURE 22.42 Conventional spinning: (1) setup at start of process, (2) during spinning, and (3) completion of process.

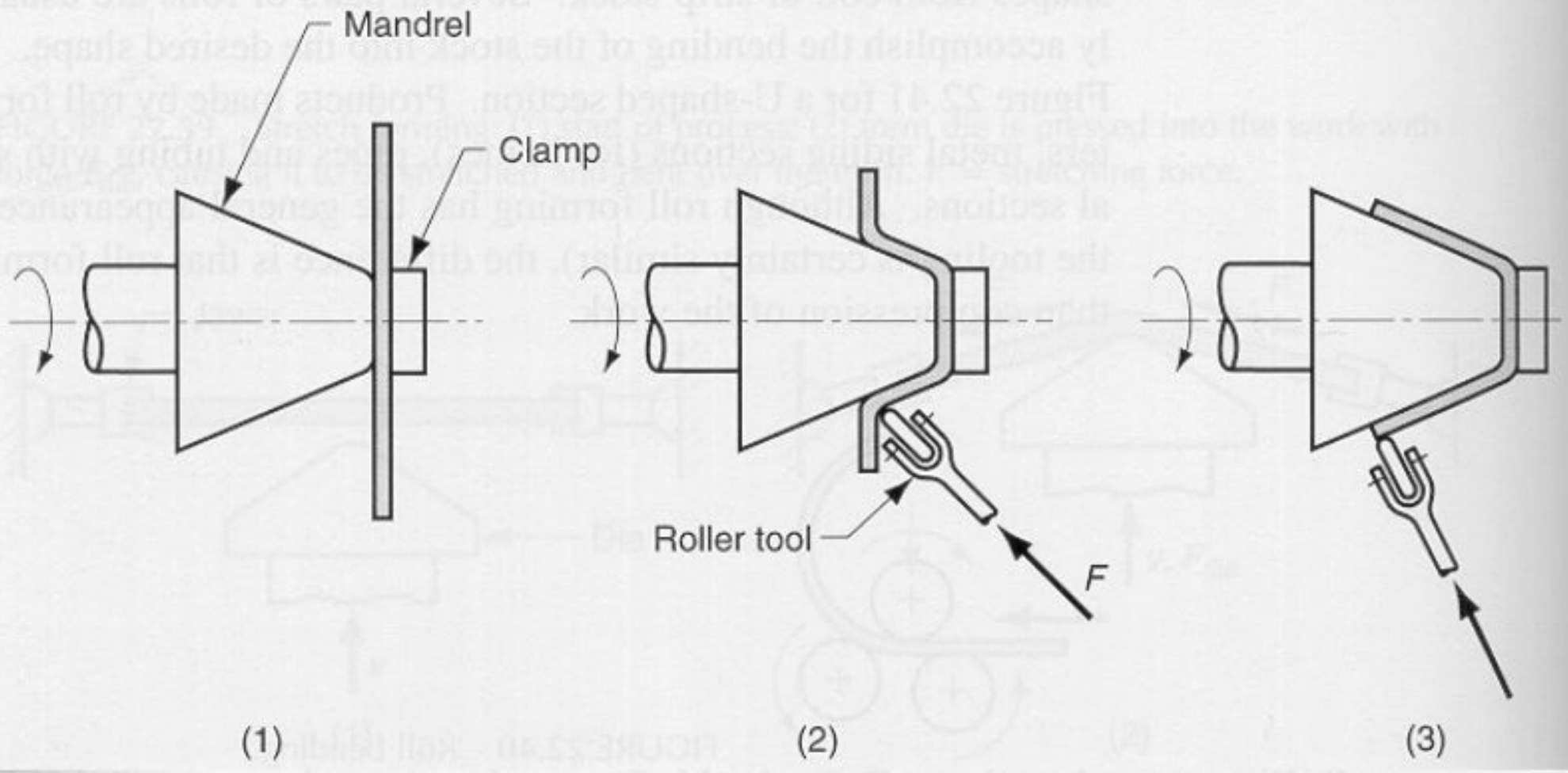
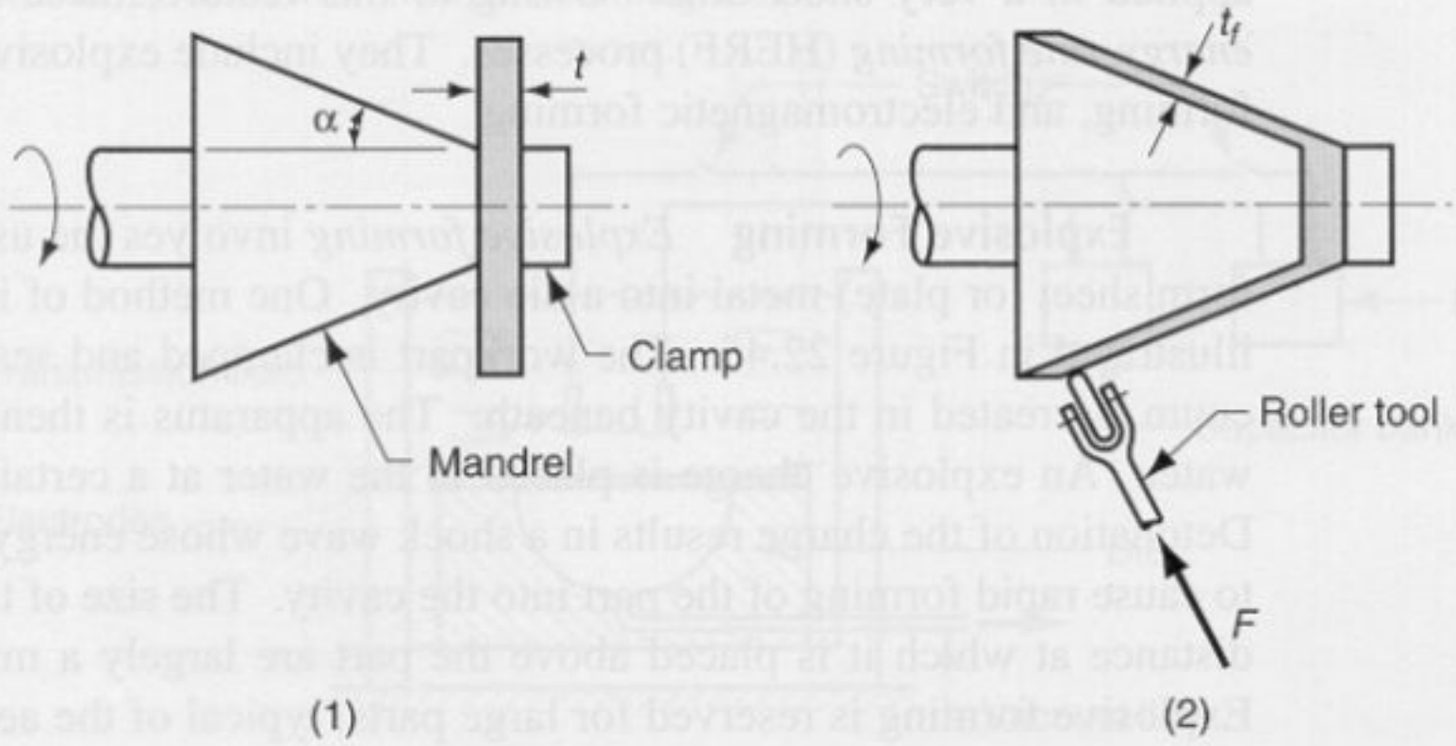
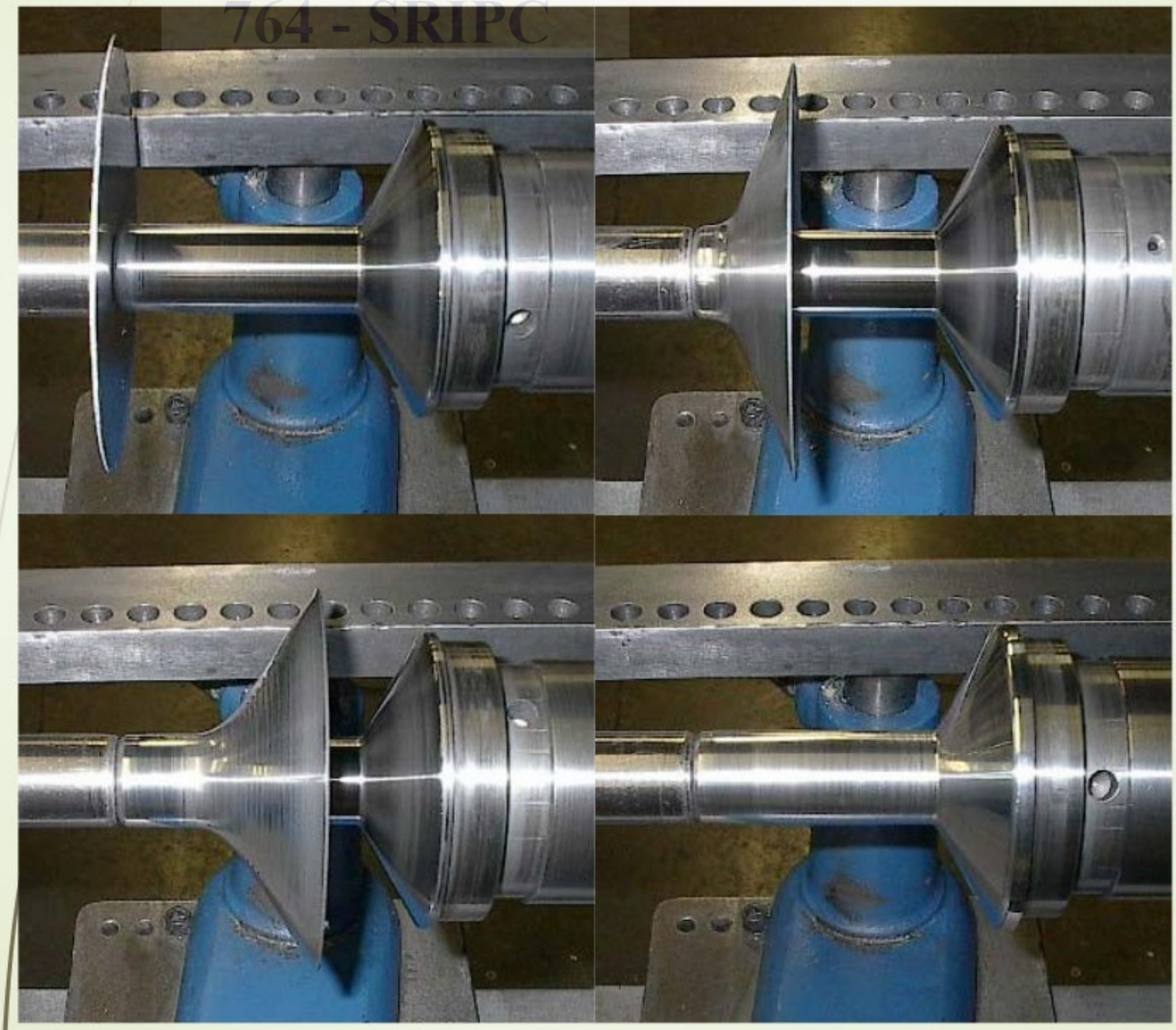


FIGURE 22.43 Shear spinning: (1) setup and (2) completion of process.



Spinning



Courtesy Koch Metal Spinning

Tube Spinning

Uses a spinning mandrel and a roller to reduce the wall thickness and increase the length of a tube

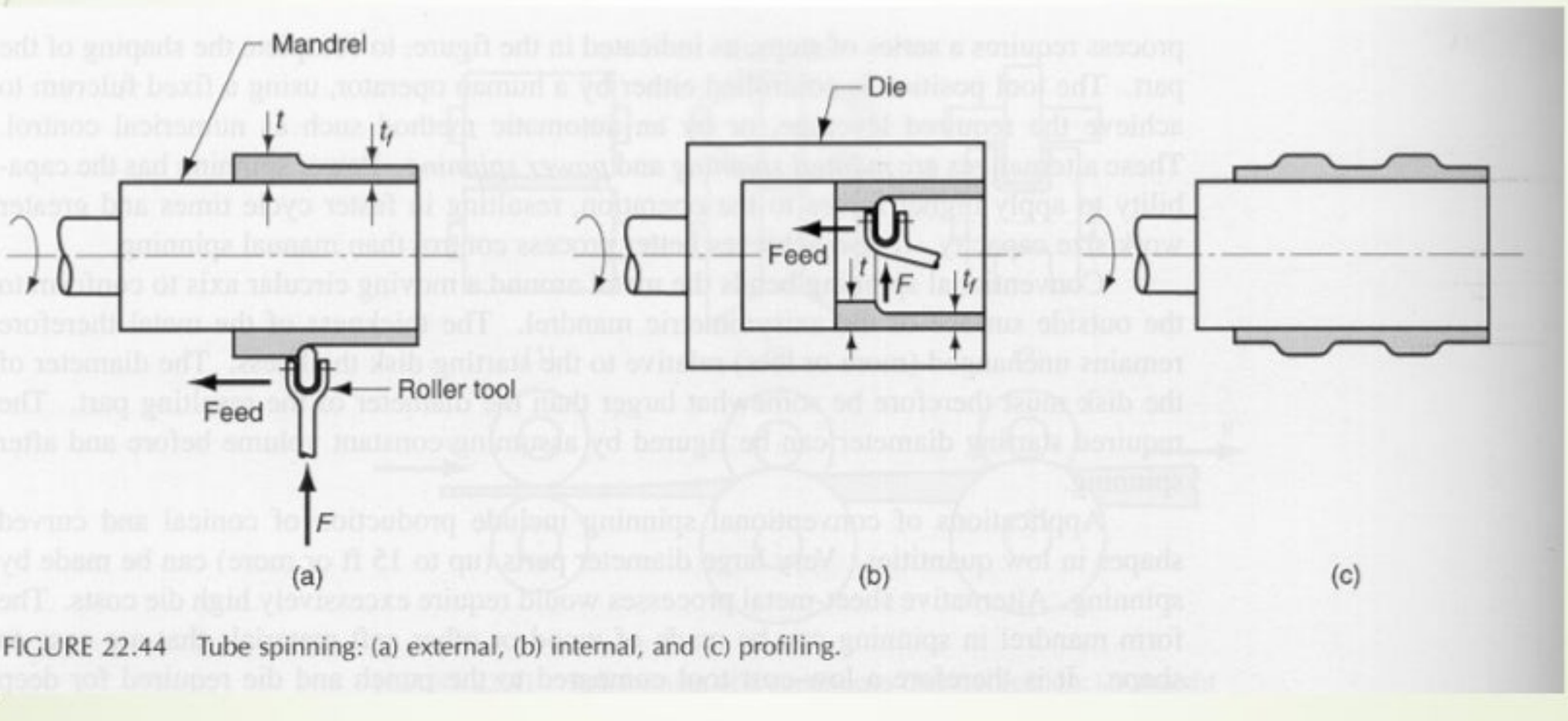


FIGURE 22.44 Tube spinning: (a) external, (b) internal, and (c) profiling.

Summary

Blanking, bending, and deep drawing are capable of producing an immense variety of thin metal parts

Progressive dies can produce parts at high production rates by performing multiple operations simultaneously