The bending and forming of metals are cold working operations which involve plastic deformation of the workpiece. The metal has to be stretched beyond the elastic limit, but not so far that it cracks or fractures. Only some metals and alloys have sufficient ductility to be used in this way. Low carbon steels, killed steels, and alloys of copper and aluminium are widely used for the manufacture of metal pressings.

Bending

Many metal components are formed by bending a sheet of metal in one or more places. Short lengths of metal can be bent by using die sets in mechanical presses. Longer lengths require special presses with long beds called press brakes. The kind of die set used in a press brake is shown in Fig 15.1. Complex shapes can be formed by repeated bending as shown in Fig 15.2. Complex profiles can also be formed by passing metal sheets or strips through successive sets of rollers.

Stretch forming and stretch drawing

In pure stretch forming, the metal sheet is completely clamped round its circumference and the change in shape is achieved at the expense of sheet thickness. Stretching the metal causes it to become thinner. The advantage of such a process is that only a single punch needs to be used to stretch a sheet which is clamped using a number of clamps as shown in Fig 15.3.

An example of stretch drawing is shown in Fig 15.4. The metal blank is clamped round its circumference by a blank holder. The punch moves downwards, stretching and drawing the metal into the cavity in the die.

Deep drawing

In the deep drawing process, the metal blank is not clamped but allowed to draw into the die. Deep drawing is usually done in a number of stages. The first stage which is also called cupping is shown in Fig 15.5.

Initially the blank is held firmly on the die by the pressure pad. The punch moves downwards, and pushes the blank into the cavity. The metal is made to bend and
flow plastically while it is drawn over the edges of hole to form a cup. The thickness is very little changed. The pressure pad has the function of ironing out any wrinkles formed during the drawing process. It does not however prevent the metal from being drawn into the cavity. Deeper objects can be produced by redrawing several times.

**Combination dies** can be used to carry out blanking and drawing simultaneously.

**Some other press forming operations**

- **Beading** is an operation in which the edge of a metal sheet is folded over to improve its strength, stiffness, safety, and appearance (Fig 15.6).

- **Plunging** is an operation in which a punch is pressed through a hole in a metal sheet, bending it into the shape required to take the head of a screw (Fig 15.7).

- **Flanging** is an operation which produces edges of various widths and angles on flat or curved metal sheets and tubes (Fig 15.8).

- **Coining** is a process in which a a very high pressure is applied from both sides on a piece of metal placed between a punch and a die. The metal flows in the cold state and fills up the cavity between the punch and the die.

- **Embossing** is similar to coining, and involves plastic flow of the metal. It is an operation in which figures, letters, or designs are formed on sheet metal parts.

**Spinning**

In the spinning process, a thin sheet of metal is formed into the required shape by revolving it at high speed, and pressing it against a former attached to the headstock spindle of a lathe. The metal is also supported at the tailstock. Pressure is applied by a special tool, forcing it to acquire the shape of the former (Fig 15.9).