of steps have to be made, and recesses, or flanges, or other features produced. Out of the demands for this more complicated work, as well as for plain bolts and studs, has arisen the great group of *turret* or *capstan lathes* (fig. 31) and the automatics or *automatic screw machines* which are a high development of the turret lathes.

*Turret Lathes.—*The turret or capstan (fig. 32) is a device for grip­ping as many separate tools as there are distinct operations to be performed on a piece of work; the number ranges from four to as many as twenty in some highly elaborated machines, but five or six is the usual number of holes. These tools are brought round

in due succession, each one doing its little share of work, until the cycle of operations required to produce the object is complete, the cycle including such operations as turning and screwing, rough- ing and finishing cuts, drilling and boring. Severance of the finished piece is generally done by a tool or tools held by a *cross-slide* between the headstock and turret, so termed because its movements take place at right angles with the axis of the machine. This also often performs the duty of “ forming,” by which is meant the shap- ing of the exterior portion of an object of irregular outline, by a tool the edge of which is an exact counterpart of the profile required. The exterior of a cycle hub is shaped thus, as also are numerous handles and other objects involving various curves and shoulders, &c. The tool is fed perpendicularly to the axis of the rotat­ing work and completes outlines at once: if this were done in ordinary lathes much tedious manipulation of separate tools would be involved.

*Automatics.—*But the marvel of the modem automatics (fig. 33) lies in the mechanism by which the cycle of operations is rendered absolutely independent of attendance, beyond the first adjustments and the insertion of a fresh bar as often as the previous one becomes used up. The movements of the rotating turret and of the cross-slide, and the feeding of the bar through the hollow spindle, take place within a second, at the conclusion of the operation preceding. These movements are effected by a set of mechanism independent of that by which the headstock spindle is rotated, viz. by cams or cam arums on a horizontal cam shaft, or other equivalent device, differing much in arrangement, but not principle. Move- ments are hastened or retarded, or pauses of some moments may ensue, according to the cam arrangements devised, which of course have to be varied for pieces of different proportions and dimensions. But when the machines with their tools are once set up, they will run for days or weeks, repeating precisely the same cycle of opera- tions; they are self-lubricating, and only require to be fed with fresh lengths of bar and to have their tools resharpened occasionally. Of these automatics alone there are something like a dozen distinct types, some with their turrets vertical, others horizontal. Not only so but the use of a single spindle is not always deemed suffciently economical, and some of these designs now have two, three and four separate work spindles grouped in one head.