Chapter 6

SOME OPERATIONS WITH A GLASS-WORKING MACHINE

WE have mentioned (p. 2) the difficulty of holding and rotating a piece of glass tube in each hand and operating on a semi-molten mass between the two pieces. A very satisfactory way of resolving this problem is to use a machine—the *Edwards Model G 3 Glass-Working Machine* (made by Edwards High Vacuum Ltd) is of great value. The glass to be worked is held in two chucks which grip the tubing and rotate it synchronously at a speed which is variable over a considerable range (120–500 rev/min). One of the chucks can be moved towards or away from the other. The glass may also be held in only one chuck.

The glass can be worked both by blowing into it as it rotates and by the use of tools which can be mounted in various ways or held in the hand. Thus operations involving the production of articles with circular symmetry can be carried out with great ease, and a skilled operator is by no means necessary. The advantages of using this machine, when possible, for work involving tubing exceeding 3–4 cm in diameter are, we think, particularly manifest. The operation of putting a spindle in a large tube, for example, is done by hand only with difficulty, whereas with the machine it can be done rapidly and effectively. In this Chapter we attempt to give merely a general idea of how such a machine can be used; the detailed manipulations involved soon become clear after a little practice. The machine is valuable either for the production of special parts in research and development work or for continuous operation on repetition work by unskilled personnel.

General Description

Two views of the glass-working machine are shown in FIGURES 34 and 35. It consists of a substantial cast base fitted with a fixed headstock and a movable tailstock. This can be moved towards or away from the headstock by operating the tailstock traverse control. Rotating mandrels in the headstock and tailstock are synchronously driven; the tailstock mandrel drive can be disconnected and locked in position so that the mandrel does not rotate, and it can then be employed as a tool holder for tools used to work single lengths of tubing held in the headstock chuck. The tool can be moved towards or away from the glass using the tailstock traverse as usual.

In the front of the machine there is a burner mounting bar which normally carries either a cannon burner, operating with gas and air or gas–air–oxygen mixtures, or a crossfire burner, operating with gas–oxygen mixtures. Both burners can be used together and their flames directed on the same region. The burner mounting bar has a

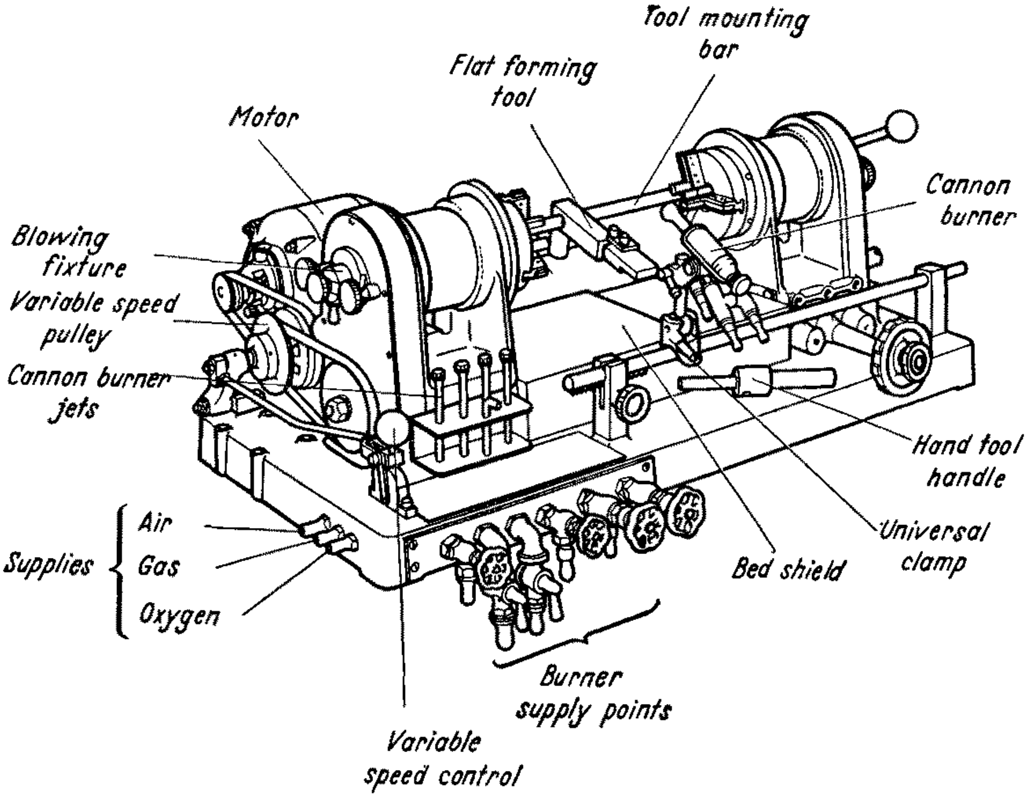

FIGURE 34. A glass-working machine

rack-and-pinion mechanism so that the burner or burners can be traversed a limited distance along the glass and be made to follow up the work.

At the rear of the machine there is a tool mounting bar. A flat forming tool can be fixed to this, as shown in FIGURE 34; and by using the operating lever (FIGURE 35), the tool is brought into contact with the lower side of the rotating tubing, which, softened in a flame, is pushed into shape. A socket for a cone-and-socket joint is easily made by setting up the flat forming tool at the proper angle. The tool mounting bar is fitted with an adjustable mechanical stop which is also an electrical contact for giving visual indication on a lamp when pre-set limits are reached. This arrangement is useful for repetition work. Generally, when constructing specialized apparatus for research work, operations with tools are performed by holding them in the tailstock chuck (not rotating), or in the hand tool holder (FIGURE 34), which is held in the hand.

The mandrel bore size is 32 mm, so that tubing of this size will pass right through the headstock and tailstock. The maximum jaw opening is 63 mm with the jaws in their normal position; but they are

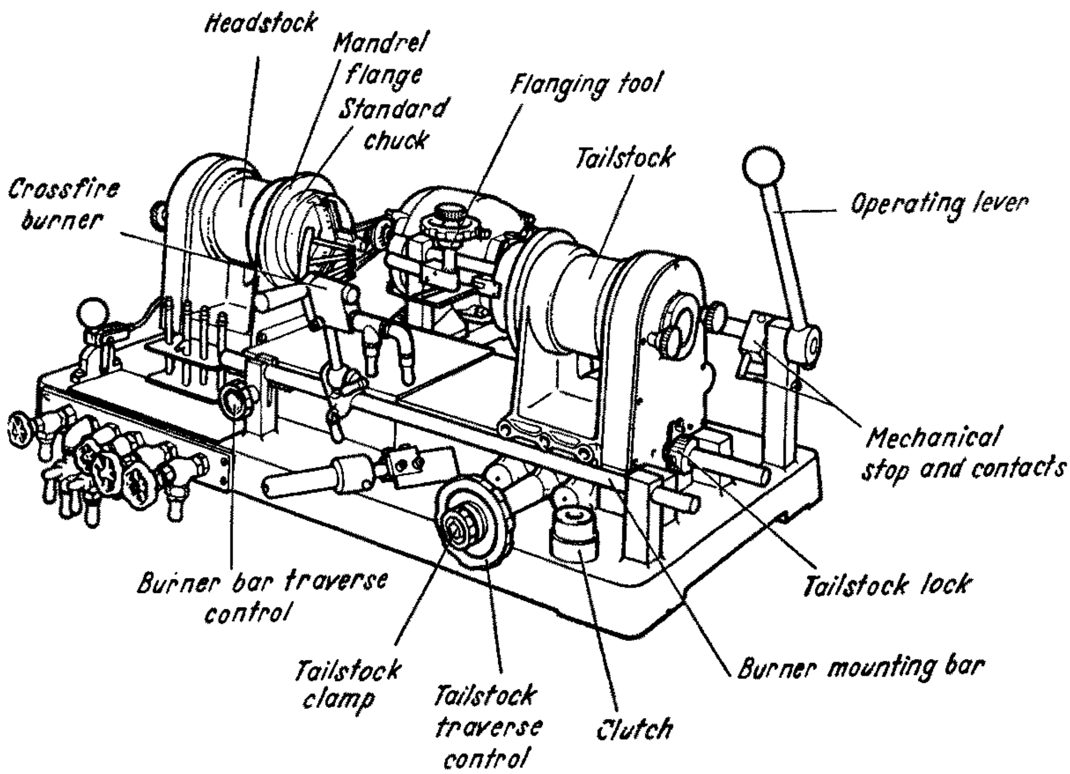

FIGURE 35. Another view of the glass-working machine

reversible, and by reversing them tubing up to 115 mm diameter may be held.

There are various ways of blowing into the rotating work. If the tube, or a portion of it, is long enough and less than 32 mm diameter it may be passed right through the headstock and blown into using a glass-blower's swivel (p. 42). Otherwise spindles or rubber stoppers carrying glass tubes may be used in conjunction with a swivel. The machine itself can be used to put a short spindle in a tube, using, in principle, the method described on p. 56. A blowing fixture can also be fitted to the headstock or tailstock mandrel (see FIGURE 34); this remains stationary while the work rotates, and so it is only necessary to prepare a sufficiently air-tight joint between the tubing to be used and the mandrel with the help of tape or rubber stoppers, or stoppers and tape together.

Sketch of Some Possible Operations

A tube held in the headstock chuck can be flared by any of the methods previously described (p. 72). Flares can be made very easily with a cylindrical carbon rod attached to a special holder fitting into the tailstock chuck, which is not rotated during the operation. The flare is made by pushing the carbon rod, held at the desired angle, into the end of the rotating and heated glass tube, for which purpose the tailstock traverse is used. With this method the end of the tube can be opened out until it resembles a funnel.

To put a spindle in a tube (p. 57), both ends are held in the rotating chucks. It may be desirable to straighten the tube, by heating it in a gas–air flame as it rotates, if it is so bent that it is not held well in both chucks. A spindle is put into the tube by the method described on p. 56, except that the operator's hands are replaced by the two chucks. The length of the spindle which can be obtained is limited by the length of the tailstock traverse.

A tube with a spindle in it can be worked to a tube with a round end by removing the spindle just beyond the shoulder (see p. 57) with a small flame, and then shrinking down and blowing out the end. The blowing can be done while the glass is in the flame. A hole can be blown in the end of the closed tube by heating the extreme end in a small flame. The hole can then be opened out with a tool, using an ordinary flaring method. Two tubes with holes of the same size in their ends can be joined very easily by bringing their hot ends together as they are both rotated, one tube being in each chuck. The joint is finished as described on p. 61. To join big tubes it may be convenient to grind the two ends flat; no holes need then be blown, since the tubes will meet well enough.

To blow a bulb in the middle of a tube, it is held in both chucks; glass is accumulated by pushing the tailstock to the headstock as the glass rotates, and the tube is blown into gently at the same time. The bulb is blown as the glass accumulates; an elegant bulb can be obtained very easily.

An internal seal can be made by Method 1 of p. 73. The hole in the outer tube and the ridge or bulge on the inner tube are both put in on the machine. The ridge can be put in by heating a small portion of the tube as it rotates in both chucks, and quickly pushing one end towards the other with the tailstock traverse. Alternatively, a small bulge can be blown until it is the required size. This is conveniently done with the help of a calliper gauge. When making the final internal seal, the inner tube of the seal can be supported in the outer tube with corrugated cardboard. An internal seal can also be made by Method 4 of p. 76. The correct size flange or flare is put on the inner tube with a tool, and a calliper gauge is again used to check the size of the hot glass.

A *Dewar* seal (p. 122) can be made without blowing by flaring the smaller tube outwards until it will nicely meet the larger tube (as in FIGURE 50, *III*). The smaller tube is mounted in the larger tube with the help of corrugated cardboard, and the final joint is made by pushing the flare of the inner tube on to the outer tube with a tool as the glass rotates in the flame. If the tubes are first ground flat at the ends to be sealed, an elegant joint can be obtained very easily.

Graded seals must be used for joining together glasses of such different thermal expansions that a direct seal cannot be made (p. 25). The best way of making a graded seal with the machine is to use the various intermediate glasses as rod. The first piece of glass tubing is held in the headstock chuck, and the first intermediate glass is held in the tailstock chuck; both are rotated. The end of the tube is closed with the rod, which is then drawn off just beyond the closure. The closed tube remaining then has its end worked to a rounded shape. The next glass is attached as a globule on the extremity of the hemispherical end and is worked to another hemispherical end; the process is repeated with the next intermediate glass, and so on. The final tube is joined as a tube.

A graded seal can also be made by fusing together rings of the intermediate glasses, or by fusing on each intermediate glass in the form of tubing, then drawing a spindle, making a round end, and blowing a hole.

The making of glass bellows is an operation which is very greatly facilitated by the machine. The glass is rotated in a small hot flame and blown out to give a thin protruding portion of glass. More of these thin portions are then introduced. Practice is necessary to make bellows with the required degree of flexibility. The flexibility of course increases with the number of thin portions of glass; the fragility likewise increases.

Tapering can be carried out by the methods described on p. 79. When a precise angle is required the flat forming tool on the tool mounting bar (FIGURE 34) can be used.