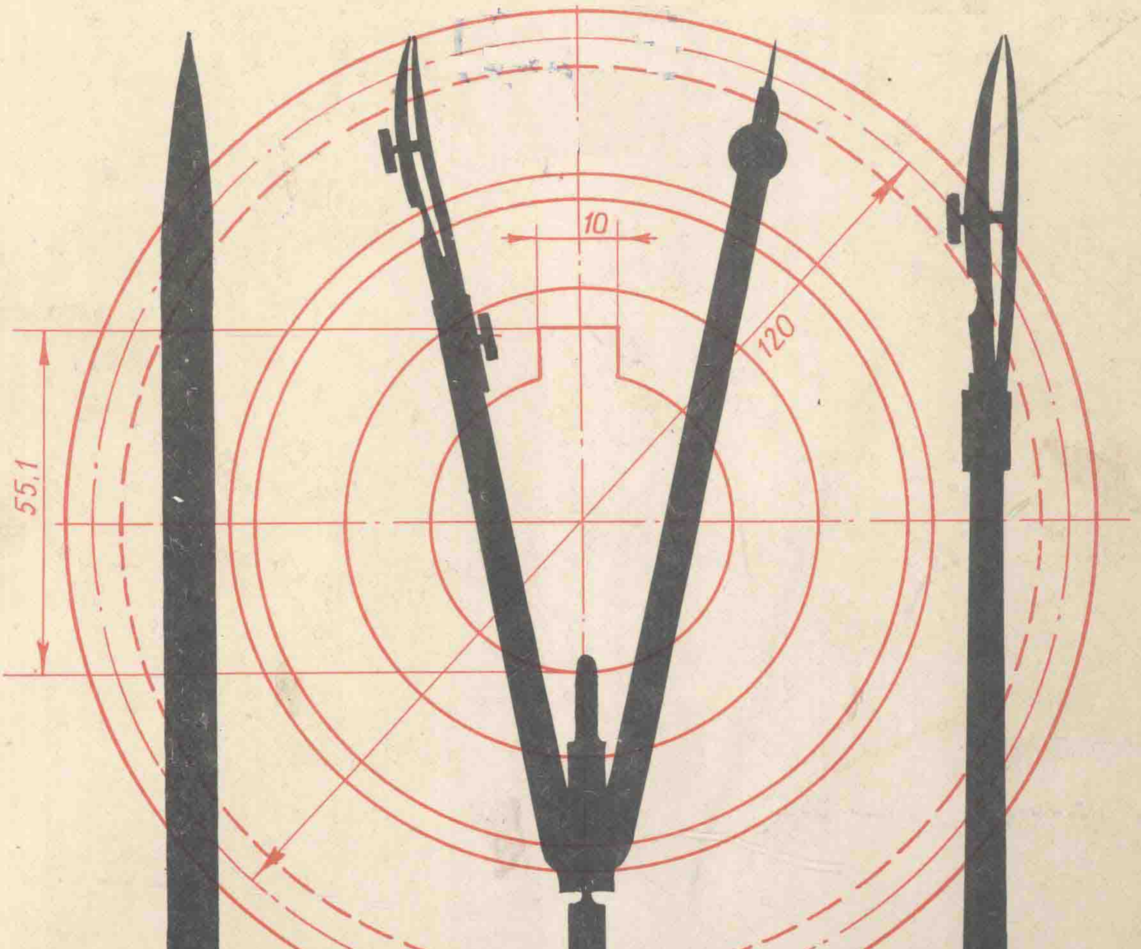
ENGINEERING DRAWING



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ENGINEERING DRAWING

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КУРС ТЕХНИЧЕСКОГО ЧЕРЧЕНИЯ

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ENGINEERING DRAWING

A

Course

for

Technical Schools

of

Mechanical Engineering

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Translated from the Russian

by

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and

NICHOLAS WEINSTEIN

ИЗДАТЕЛЬСТВО • МИР •

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CONTENTS

PREFACE

The continuous development of industry and the flood of new machine tools, machinery and equipment utilizing pneumatic, hydraulic and electronic devices for the complete mechanization and automation of production processes impose ever greater demands on the training of engineering draftsmen and technicians.

The course in technical drawing for technical schools and colleges therefore requires examples from the design and construction of such equipment, and this textbook aims to provide the student with extensive graphic material of just this kind, drawn from the latest industrial technology.

The authors' many years of teaching engineering drawing have convinced them that explanations based on the use of machine parts and components encourage the linking-up of theory and practice, develop the student's range of understanding and spatial visualization, acquaint them with technical terminology, and train them in the solution of drawing problems.

Illustrations have been selected from the latest technical literature and industrial practice; and to facilitate understanding of machine parts and components, drawings have been supplemented by photographs and axonometric representations.

Explanatory texts are brief, the aim being to teach the student to comprehend drawings and not simply to read accompanying explanations.

INTRODUCTION

A drawing is a graphic representation of an object, or a part of it, and is the result of creative thought by an engineer or technician. Modern engineering produces enormous numbers of articles, each first designed and presented in the form of a technical drawing, and each manufactured on the basis of this drawing. Designing an item involves making sketches and technical drawings, and the appropriate calculations. Sometimes a number of alternative designs are represented in drawings, and the best then selected.

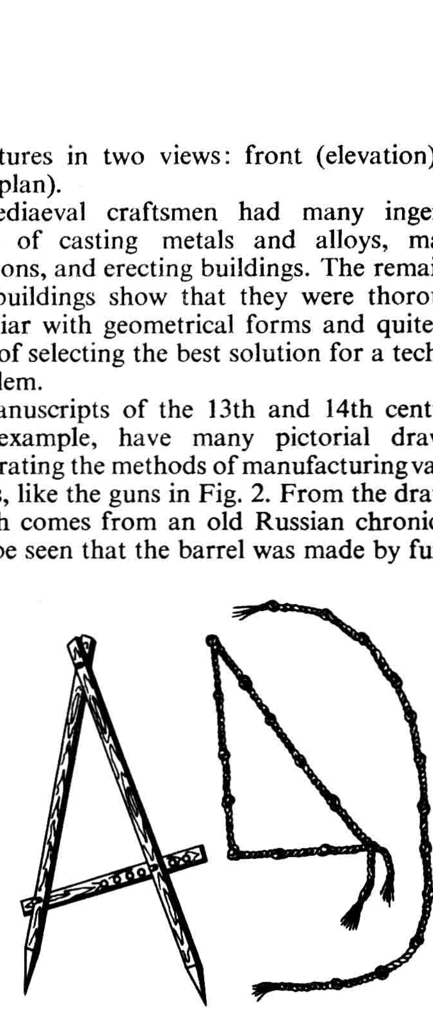
Technical drawing has a history of its own. Articles have been represented in the form of drawings since ancient times, and drawing in general was a means of communication between people long before systems of writing emerged.

The first real technical drawings, known as "plans", appeared when it became necessary not only to depict an existing object, but to create new things, when whole structures had to be built: fortresses, houses, and the like. Ordinarily, these drawings were executed full size right on the ground on the site of the future structure, which required specialized instruments like the large wooden measuring device shown in Fig. 1*a* and the right-angled triangle made of rope depicted in Fig. 1*b*.

Later, these plan drawings were made on papyrus, parchment, wood, or canvas on reduced scales, and attempted to reflect the shape and dimensions of the objects themselves. Early Egyptian papyri already depicted buildings and structures in two views: front (elevation) and top (plan).

Mediaeval craftsmen had many ingenious ways of casting metals and alloys, making weapons, and erecting buildings. The remains of old buildings show that they were thoroughly familiar with geometrical forms and quite capable of selecting the best solution for a technical problem.

Manuscripts of the 13th and 14th centuries, for example, have many pictorial drawings illustrating the methods of manufacturing various items, like the guns in Fig. 2. From the drawing, which comes from an old Russian chronicle, it can be seen that the barrel was made by furnace



(*a*) (*b*)

Fig. 1

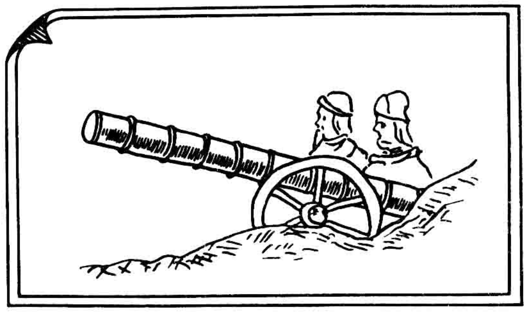


Fig. 2

or forge welding, and was reinforced by mounted hoops.

Very often a single representation would include a combined plan (top view) and elevation (front or side view) of some structure, like the bridge in Fig. 3. This was inconvenient, however, and so the two views came to be separated, thus initiating projection drawing, in which two, and even three, planes of projection were used.

During the 16th and early 17th centuries orders for articles from metal-working factories were usually based on models rather than drawings; but in the 17th century drawings began to predominate. At first they were not made to any kind of scale, but dimensions were always indicated.

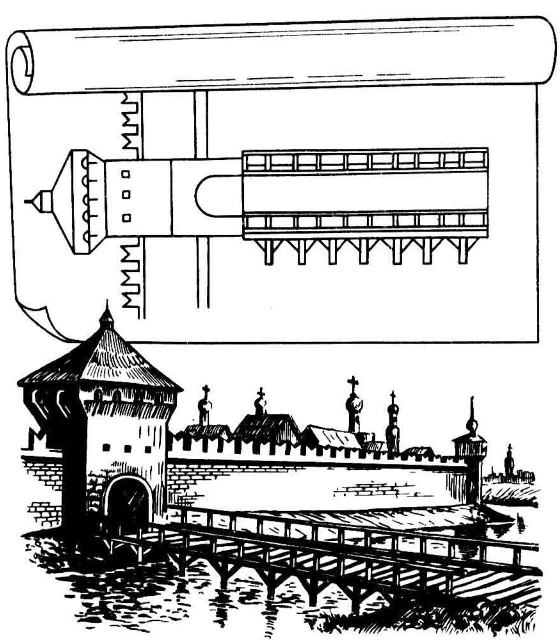


Fig. 3

As shipbuilding, for example, developed, more exact drawings were required, made to a strict scale. The drawings made by shipwrights and their helpers by the beginning of the 18th century were of a very advanced character and utilized three projections, in which all three dimensions of the ship — length, beam, and height were indicated (Fig. 4).

In 1798 the French engineer Gaspar Monge published his *Descriptive Geometry*, a book that laid the foundation for projection drawing as we know it today. Important as his contribution was, however (he generalized the method of rectangular projection of objects onto two mutually perpendicular planes), it is important to remember that long before the appearance of descriptive geometry, craftsmen were producing drawings that posed and solved problems theoretically treated by him. Certain Russian drawings of the 18th century, for example, were executed with extreme care and drawn in various coloured inks. They indicated cutaway portions of hollow articles, with the cutaway coloured according to the type of material.

The drawings of the Russian inventors I. Polzunov and I. Kulibin (Fig. 5*a* and *b*) clearly show that they well knew how to make exact projection drawings long before the end of the 18th century.

Descriptive geometry was further developed during the 19th century and right up to the present, Russian and Soviet specialists making their own valuable contribution to the theory of representation, the elaboration of standards, and the methodology of teaching mechanical drawing. Modern projection drawing is used in every field of technology, and underlies the manufacture of all mass-produced articles and components, and assembly work.

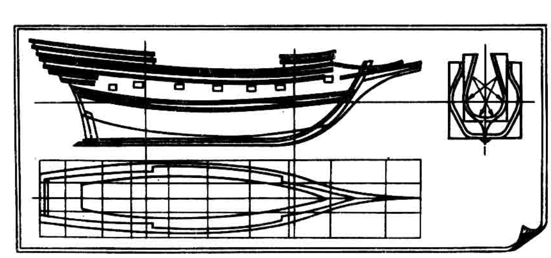
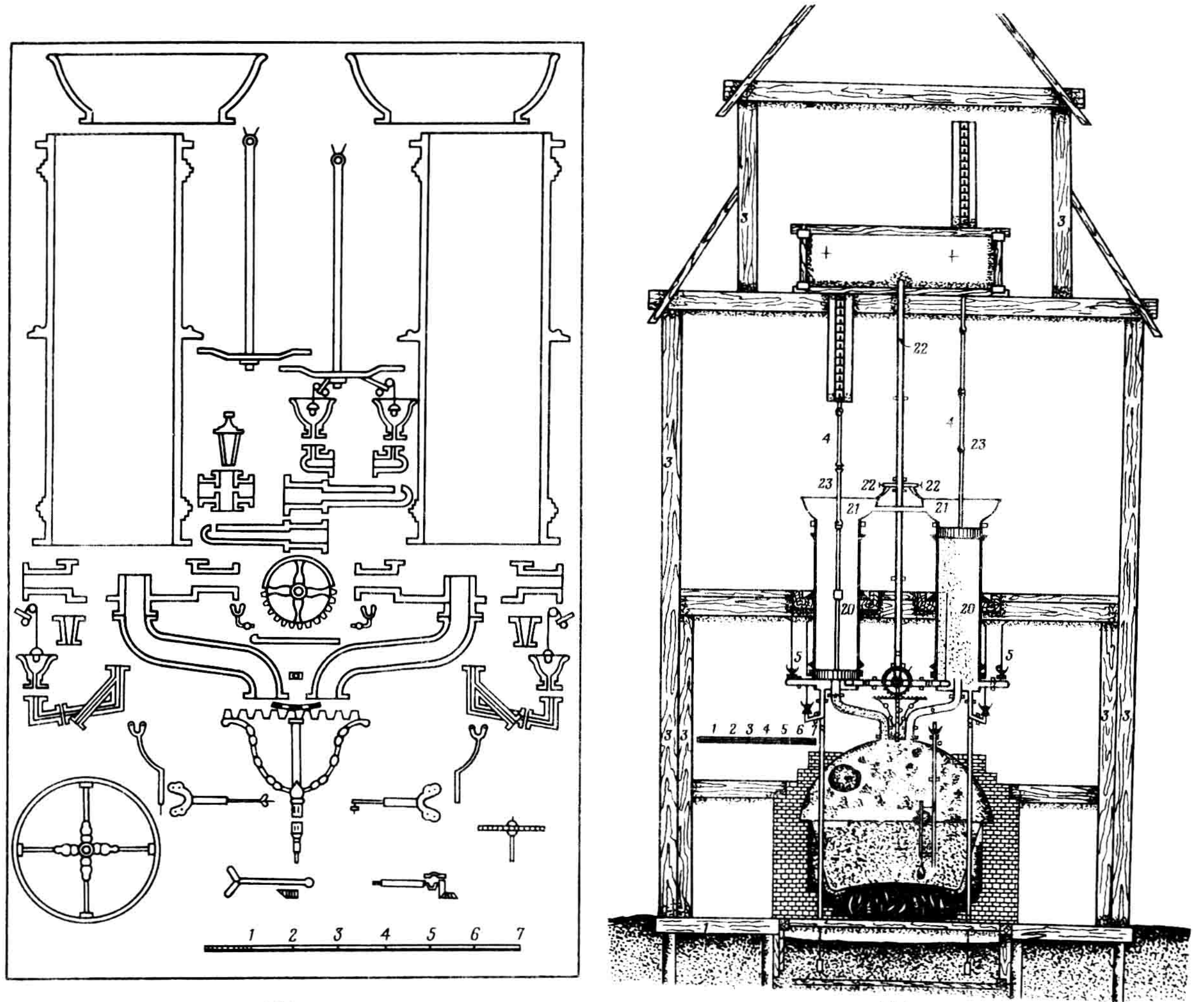


Fig. 4



(a) (b)

Fig. 5

I
DRAWING TECHNIQUE

CHAPTER 1

INSTRUMENTS AND MATERIALS OF DRAWING

All drawings are made by means of various instruments. The quality of a drawing depends to a large extent on the quality, adjustment and care of the instruments.

Each student must have a set of drawing instruments and materials (see Fig. 6).

1. **Drawing Board.** The paper, on which a drawing is to be made, is fixed with thumbtacks to a specially designed drawing board (Fig. 6*c*). Drawing boards are usually made of linden because thumbtacks readily penetrate its soft wood. The thumbtacks are unpinned with the aid of a remover specially designed for this purpose (Fig. 6*o*). The size of the drawing board should be such as to provide enough space for a standard sheet of drawing paper Size 24 measuring 594×841 mm (according to the USSR Standard).

2. **Triangles.** Two types of triangles are used for drawing purposes: 45°-45° and 60°-30° (Fig. 6*a* and *b*). Triangles must be tested for accuracy of their angles each time they are to be used. Proceed as follows: put the triangle with one of its legs against the straight edge of a tested ruler and draw a straight line along the other side with a well sharpened pencil (Fig. 7). Then turn the triangle through 180° and draw another line as before. The two pencil lines must coincide (Fig. 7*a*), if not, the angle between the adjacent sides is not equal to 90°, and such a triangle should not be used in drawing as it is inaccurate (Fig. 7*b*).

3. **T-square.** The common T-square consists of two parts, a long ruler (or blade) and a cross-piece (or head) at one end fitted at right angles to the blade (Fig. 6*e*). When using the T-square its head should be tightly pressed against the left-hand edge of the drawing board.

The T-square head, in turn, consists of two parts, one fixed and the other hinged. The latter can be fastened at any angle by means of a wing nut. The hinged part of the head is turned to draw parallel lines at any angles to the edges of the drawing board (Fig. 8*b*). To keep the T-square in good condition, careful handling is required. After use it should be hung on a nail to prevent it from warping.

With the aid of triangles and a T-square parallel and perpendicular lines are drawn (Fig. 8*a*). Vertical lines are drawn along the long leg of the triangle, its short leg sliding against the T-square blade. Lines at angles of 45, 60 and 30 degrees with the horizontal are drawn along the hypotenuse of the respective triangle.

It is very convenient to use a T-square fitted with rollers and a cord (Fig. 8*c*).

4. **French Curve.** French curves are used to draw irregular curves (Fig. 6*g*). It is desirable to have several French curves of different curvature. The edges of a French curve must be absolutely smooth. The French curve is one of the most difficult instruments to use skilfully. Its shape should comprise curves most widely used in drawings and gradually merging into each other.

5. **Protractor.** This instrument is employed for laying out and measuring angles (Fig. 6*d*).

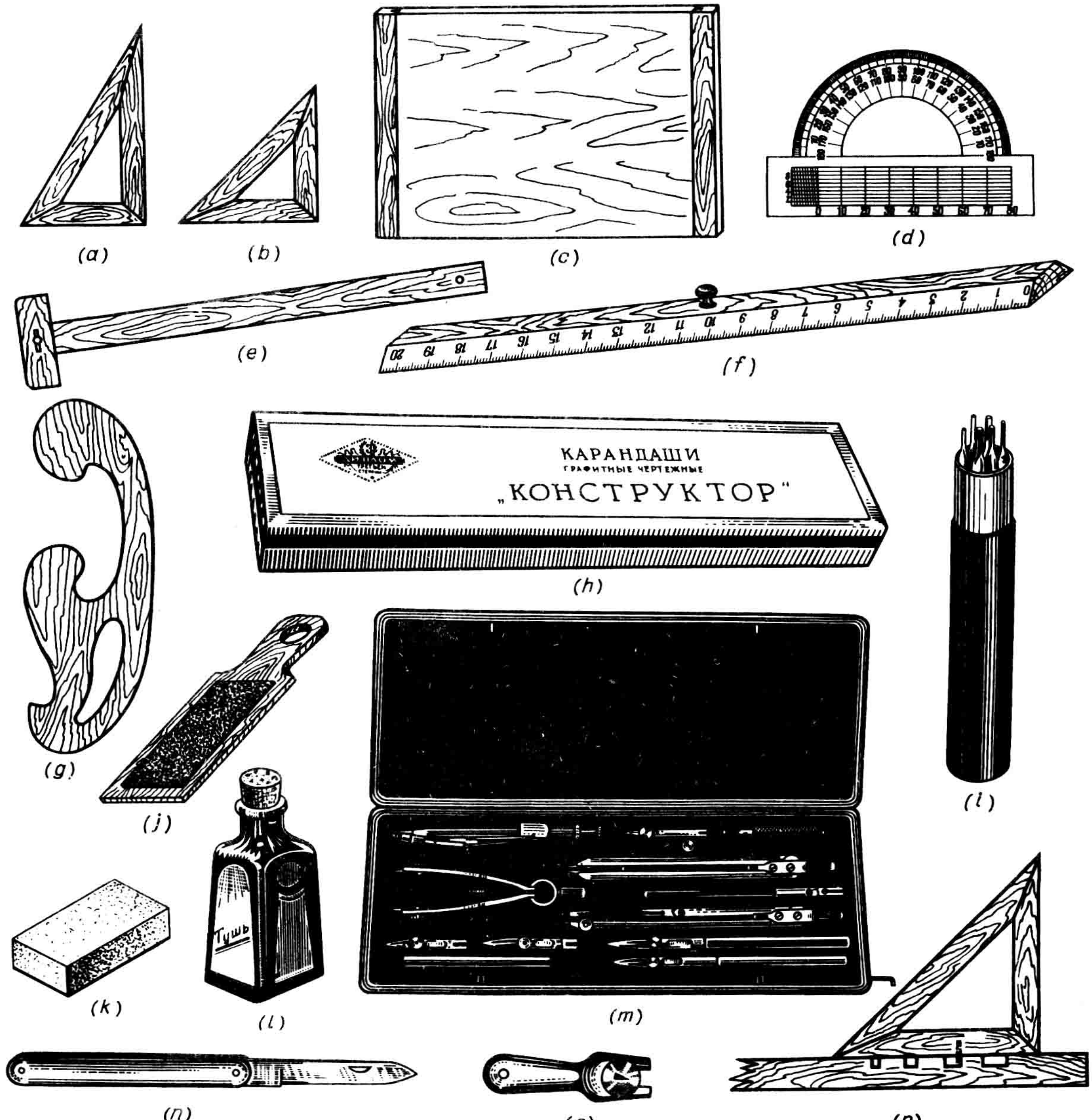

(a)
(b)
(c)
(d)
(e)
(f)
КАРАНДАШИ
ГРАФИТНЫЕ ЧЕРТЕЖНЫЕ
„КОНСТРУКТОР"
(g)
(h)
(i)
(j)
Тушь
(k)
(l)
(m)
(n)
(o)
(p)

Fig. 6

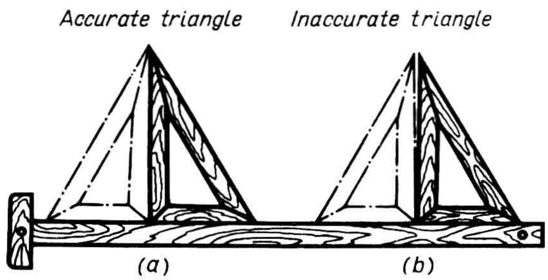


Fig. 7

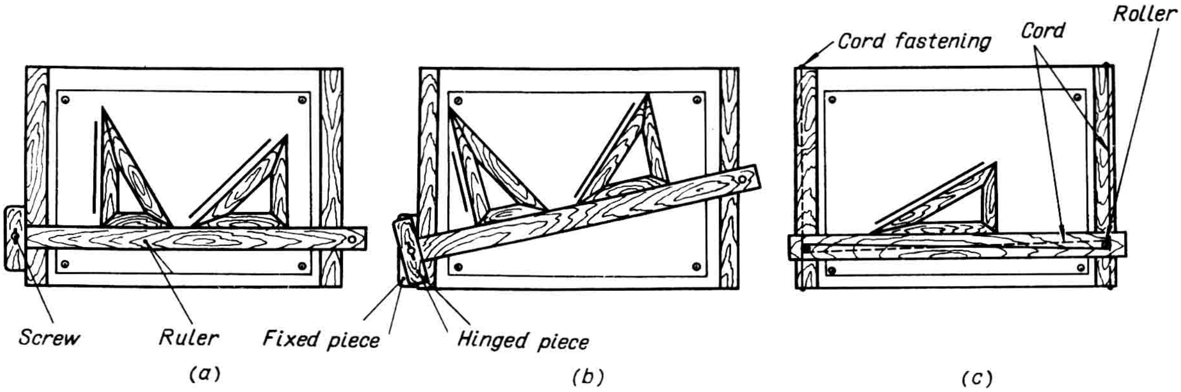


Fig. 8

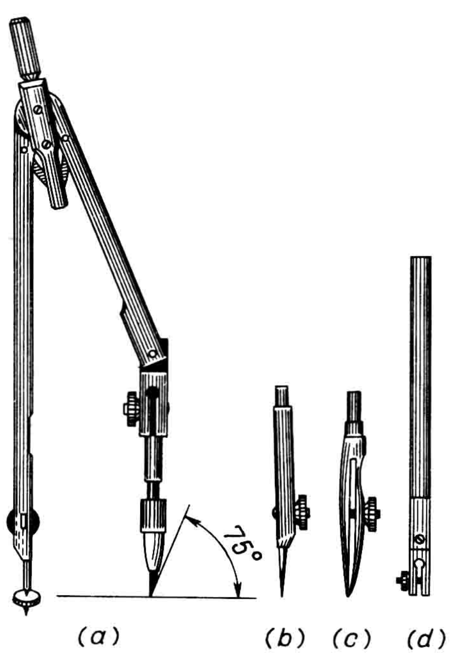


Fig. 9

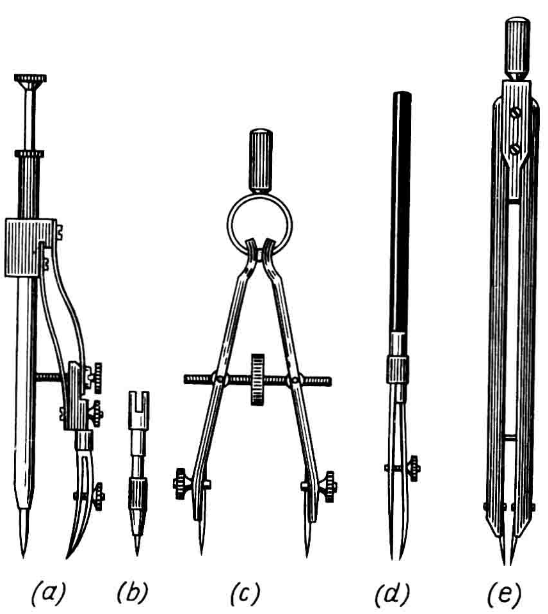


Fig. 10

6. **Scale.** Scales with bevelled edges graduated in millimetres are usually used (Fig. 6*f*).

7. **Section Liner.** This device is employed for the rapid and even spacing of cross-hatching lines at an angle of 45 degrees with the horizontal. Such instruments are usually made by students themselves. The one shown in Fig. 6*p* may serve as an illustration. A short metal pin (say, a headless nail) is inserted into one of the legs of a triangle and the blade is indented with rectangular cuts of different width. The depth of the cuts should somewhat exceed the projecting length of the pin. In this device the spacing of cross-hatching lines is determined by the width of the cuts.

In section lining the blade and the triangle are shifted in turn after each individual cross-hatching line is drawn. Be sure that at the moment of drawing, the metal pin is held tightly against the edge of the cut.

Without such a device it is very difficult to attain even spacing of cross-hatching lines, and, most important of all, the eyes will soon get tired. Moreover, even the slightest difference in spacing is clearly noticeable and ruins the drawing.

8. **Case of Instruments** — a set of compasses, ruling pens and other drawing instruments arranged in a specially designed case (Fig. 6*m*).

(a) *Compass* (Fig. 9*a*). The compass is used to draw circles and arcs both in pencil and in ink. It consists of two legs pivoted at the top. One leg is equipped with a steel needle attached with a screw, the other, shorter, leg is provided with a socket for detachable inserts (furnished with a lead for drawing circles in pencil), Fig. 9*a*, with a ruling pen for ink (Fig. 9*c*), and, finally, with another steel needle (Fig. 9*b*) to be used as dividers, i.e., for transferring measurements

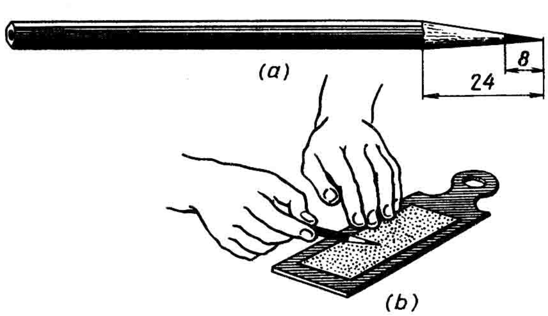


Fig. 11

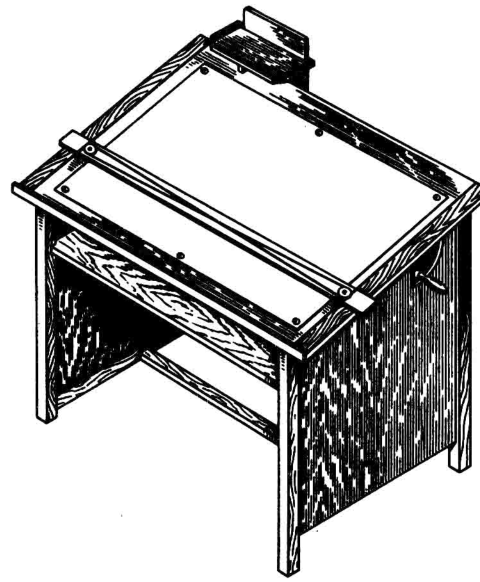


Fig. 12

and for dividing lines into any number of equal parts. In drawing circles of larger radii a lengthening bar (Fig. 9*d*) should be used. When a large number of concentric circles are to be drawn the needle of the compass should be put in a metal centre which has the shape of a thumbtack.

(b) *Drop pen.* The drop pen, as shown in Fig. 10*a* and *b*, is used for drawing very small circles. The pencil or pen point spins around the central axis and can be raised and lowered.

(c) *Ruling pen.* This instrument is designed for inking drawings. The distance between the nibs of the pen can be adjusted by means of a screw (Fig. 10*d*) to obtain lines of various thickness.

(d) *Dividers.* The dividers (shown in Fig. 10*c* and *e*) are used chiefly for transferring distances and occasionally for dividing spaces into equal parts.

9. **Pencil.** Uniform quality and appropriate hardness determine the selection of pencils.

The importance of a correctly prepared pencil point cannot be overstressed. Fig. 11*a* shows a properly sharpened pencil, Fig. 11*b* pointing the lead with fine sandpaper pasted up on a small wooden board.

10. **Drafting Desk.** It is good practice to place the drawing board on a drafting desk. Such a