MECHANICAL DRAWING

CHAPTER I

The scope of mechanical drawing is not necessarily confined to the delineation of machinery, as it is both useful and necessary in any branch of constructional art where accuracy is required.

The principal aim of the student of this branch of engineering craft should be absolute accuracy in position of his lines, and clear and full description by dimensions and notes of what the lines represent. Nothing at all should be left to the imagination of the workman, whose business is solely to carry out the shewing of the drawing in the materials of construction. The drawing should be measurable at every point by a scale corresponding, and the dimensioning should correspond to the drawing both locally and collectively; the dimensioning should be regarded more as a convenience in reading off sizes and distances than as any substitute for inaccuracies of drawing. The drawing should be a check on the dimensions, and the dimensions a check on the drawing.

For the attainment of that manipulative exactness which is needed, all the apparatus and implements

which are used should be of the best quality obtainable and of such patterns and make as will make the production of exact work a possibility, with ordinary care and commercial expedition. Patterns which are difficult to handle, or which require both hands instead of one for adjustment in working, or in any way are less convenient than such things can be made, are quite inadmissible and are not in any circumstances to be used, as they are eventually a handicap on the draughtsman's means of getting a living, and are dear at any price. Inferior implements tend to produce bad habits in manipulation which are difficult to get rid of when once acquired. The apparatus and instruments are the tools of his craft, and the cost of the best is a negligible item in the value of the work which is produced by their use. No man in competition can afford to work under any heavier handicap than his competitor.

All mechanical drawings, or nearly all, contain work of a great variety of difficulty, some parts being relatively easy to the beginner, and other parts of a degree of difficulty sufficient to tax the skill of an accomplished draughtsman. This variety has always prevented the student from making any satisfactory progress in his work of copying drawings of mechanical objects for practice for a considerable length of time, as nothing collectively passable could be done until the more difficult minutiæ were mastered; and these occurring only seldom in the figures, and therefore affording relatively little practice, a very large amount of waste labour has had to be expended in repetitions under the old system of teaching before sufficient proficiency for practical purposes could be attained. In order to get over these difficulties and expedite the rate of progress in the early stages of

study, the author some years ago devised a series of progressive exercises in the use of scales and instruments which have invariably shortened the time for acquiring manipulative skill, from twelve months to three months, and in cases of exceptional aptitude to even much less than the latter time. This is a very important matter in many ways. The saving of time is great, and especially valuable at a student's time of life; but the saving of patience and avoiding of vexatious and repeated failures to execute the more difficult parts of an ordinary object drawing, and thus repeatedly wasting the whole, are perhaps even more important. Many students under the old system have given up the attempt to become good draughtsmen, and many more have lapsed into loose ways of finish which have never left them.

Line Exercises.

The Exercises, which form part of this work, are arranged to give a large amount of practice in each stage on small sheets of paper, so that those containing irremediable "slips" can be destroyed and a fresh start made without much loss of either time, patience, or material. They develop a sufficient skill for object drawing before such work is attempted, and at the same time a skill in the minutiæ which is altogether superior to that which is usually acquired under the old system. Also these exercises entail no mental effort in the understanding of the figures, and so leave the whole mental energy available for concentration on the manipulation. This is important, and adds to the rate of progress in skill. The repetitions also provide opportunity for the student to "experiment" with the instruments, and so to find out what they will do and what they will not do. The teacher's

work in the opening stages of this study is very much less than under the old system, as the simple use of the scale and an examination of the quality of the lines are all that it is necessary for him to do while work on the exercises is going on, and he can consequently give efficient supervision to larger classes.

CHAPTER II

APPARATUS AND MATERIALS FOR DRAWING

Drawing Board.

Among the apparatus and instruments which are employed in mechanical drawing, the drawing-board is the first to be considered. This is a perfectly rectangular board, made of the best yellow pine, about 1 inch in thickness. It is grooved at the back and stayed with oak or mahogany cross-pieces or clamps for preventing skellering or twisting from damp and changes of temperature, which would spoil the flatness of the working side. The sizes are such as are required for the paper drawn upon; but in drawing offices the most common size in use is that which corresponds with the "double elephant" size of paper, which is 40 inches long by 27 inches wide, the boards being made 42 inches by 28 inches. This size is as large as the draughtsman can reach over comfortably, but in some offices 60 by 30-inch boards are used. For special purposes some are even larger.

Wherever there is room for its use, it is advisable that all drawing practice should be done on the regular

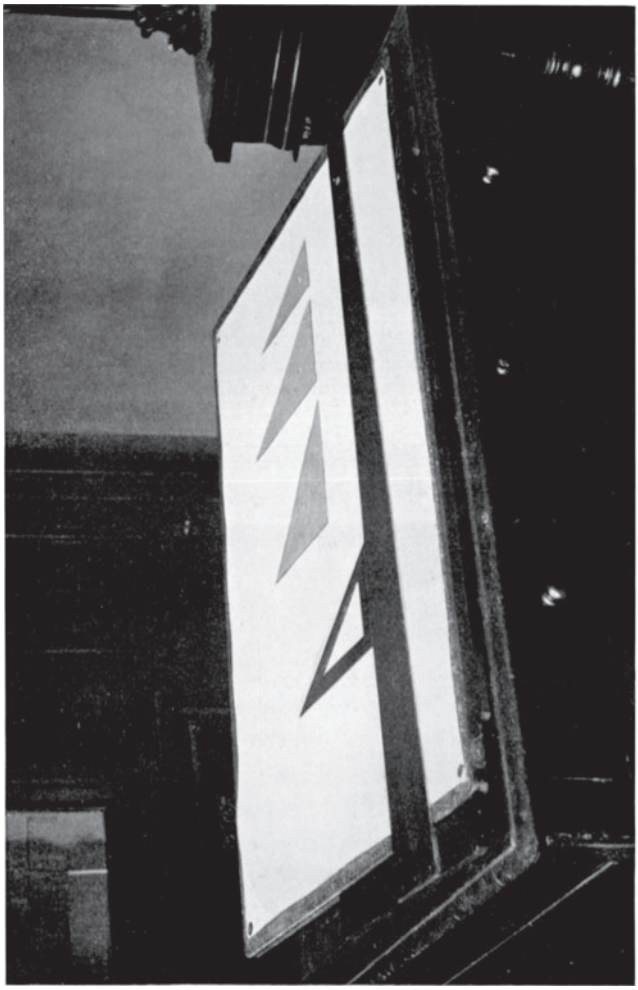

Fig. 1. Drawing-board, T-square and Set-squares.

drawing office size of board, in order that the pupil may become accustomed to handling the ordinary commercial apparatus. The drawing paper is fixed on the drawing-board by means of short pins with large heads, the pins being pressed through the paper at the corners into the soft wood of the board. Formerly drawing paper was damped at the back, which expanded it, and then it was glued to the board all round its edges When dried the contraction stretched the paper very tight and straight. But in those days more time was spent on drawing, and often artistic work and colouring was indulged in, while in the present utility and expedition are the desiderata only. It is very seldom that any costs are incurred which can be avoided. Moreover, elaborate mechanical drawings are sufficiently expensive even when they are produced in the cheapest possible way.

A drawing-board as described is shewn by Fig. 1.

T-Squares and Set-Squares.

The next, and very important item in the equipment, is the T-square. This is a perfect straight-edge, having a T end which slides against the edge of the board when in use. The T end being held in close contact with the edge of the board, maintains the drawing edge of the T-square at right angles to the edge of the board, and the draughtsman is thus enabled to draw across the drawing paper, lines of any length which are square to the edge of the board and perfectly parallel to each other For drawing rectangular figures it only remains to provide a similar method of making lines "square" to the T-square edge as the T-square lines are to the edge of the board. This is accomplished by the use of a "set-square," which is usually a triangular sheet of thin material (wood or

vulcanite), which has two sides at right angles, the angles being usually 45°, 30° and 60°, or 22½° and 67½°, each pair of angles, of course, making 90°. The T-square and set-squares (of which latter it is usual to have a set) are shown in position on the board in Fig. 1.

The T-square and set-squares are manipulated by the left hand of the draughtsman, the friction of the fingers maintaining a slight pull on the blade or straight-edge for the purpose of preserving close contact of the "butt" or T end with the edge of the board, while the set-square is placed in the position which the work requires by the right hand, and is held there by the forefinger of the left hand. The left hand is thus fully occupied, while the right hand is free to use the pencil. Horizontal lines or lines across the board are usually drawn from left to right, but it is always necessary to *see* the point of the pencil at the finish or "joining up" of a line, and the end of a line is often drawn back from right to left and "joined up" so that it may not be necessary to rub out "over-drawn" lines—lines which pass the "set-out" marks. In some cases it may be convenient to "over-draw" one or both sets of lines (vertical and horizontal) very lightly, and then go over the "correct figure" portions with a heavier line. The fine "over-drawn" lines are a guide to the exact finishing points of the ink lines, where the finishing points are difficult to see by reason of the hand or ruling edges coming into the line of sight.

The holding of the T-square and set-square is an important matter, and is shewn by Fig. 2. It is usual and the regulation method for the student to learn to "rule," or draw the lines, from bottom to top—to rule *away* from the T-square when using the set-square. But this is not imperative, though generally convenient and

Fig. 2. Holding T-square and Set-square.