CHAPTER II.

TOOLS AND INSTRUMENTS.

TOOLS.

Tool kits.

47. The standard tool kit for metal riggers, as enumerated in Air Publication 830, Vol. III, contains all the hand tools normally required. In addition to these, occasional use will be found for other tools, all of which are available and can be obtained from the flight or headquarters lock-up, and which are also enumerated in the above publication. With a few exceptions, the tools need no explanation and will present no more difficulty in use than practice in the proper handling will overcome. Amongst the exceptions are the measuring tools employing the vernier principle, such as the vernier and micrometer calipers which are illustrated in figs. 7 and 8. The micrometer is normally used for measuring the diameter of cylindrical parts, whilst the vernier is generally used for measuring flatter objects. As instruments and tools employing the vernier principle are often used, the system should be thoroughly understood.

Vernier.

48. The principle of the vernier, which can be applied to any units of measurement, is as follows :—Referring to fig. 7, the long scale is stationary, while the short vernier is capable

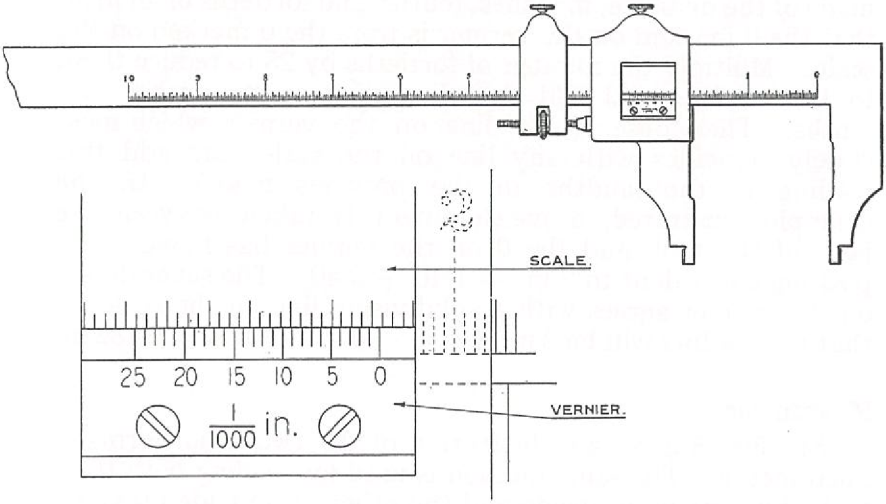

FIG. 7.—Vernier.

of being moved along the scale. Both the scale and the vernier are marked in regular divisions, but it will be noted that the vernier divisions are slightly shorter than the scale divisions.

49. Suppose, as is generally the case for the type of instrument illustrated, that each division of the scale is equal to 1/40th of an inch, and the vernier is equal in length to 24 of the scale divisions, but is divided up into 25 parts. If the vernier is so placed that the end lines of the vernier exactly coincide with the end lines of 24 divisions of the scale, then the first division line of the vernier will not be exactly opposite the first division line of the scale, but will be out of line to the extent of 1/25th of 1/40th, which equals 1/1000th of an inch. The second division will be twice this, or 2/1000ths out of line, and so on to the end of the vernier, when the difference will be 25/1000ths or one complete division of the vernier. So, obviously, if the vernier is moved until the first subdvivision line is opposite the first on the scale, then the vernier will have moved 1/1000th in. or ·001 in. If the vernier is progressively moved along the scale in the same direction, it will be noted that each subdivision of the vernier will in succession agree with the next subdivision on the scale, but none of the other vernier lines will coincide with any of the lines on the scale. Therefore, when making a measurement, it is necessary to observe the lines which coincide in order to determine the thousandths.

50. Now, referring to the complete tool in fig. 7, it will be seen that both the scale and the vernier are marked 0 at one end. When taking the measurement of an article, a note is made of the distance, in inches, tenths, and fortieths of an inch, that the 0 marked on the vernier is from the 0 marked on the scale. Multiply the number of fortieths by 25 to reduce them to thousandths and add this dimension to the inches and tenths. Then observe the line on the vernier which most closely coincides with any line on the scale, and add this reading in thousandths to the previous figures. In the example illustrated, a measurement is taken between the jaws of the tool, and the 0 on the vernier has moved to a position equivalent to 2 in. + 1/10 + 3/40. The seventh line on the vernier agrees with a subdivision line on the scale, so that the reading will be 2 in. + ·1 + ·075 + ·007 = 2·182 in.

Micrometer.

51. Fig. 8 gives an illustration of the two usual forms of micrometer. The same method is used for reading both these tools, but one is for inside and the other for outside measurements. The movement of a micrometer is rotary, and the

measurements are made between the anvil and an extensible screwed spindle. To the spindle is attached the rotating sleeve or thimble. The pitch of the thread on the spindle is

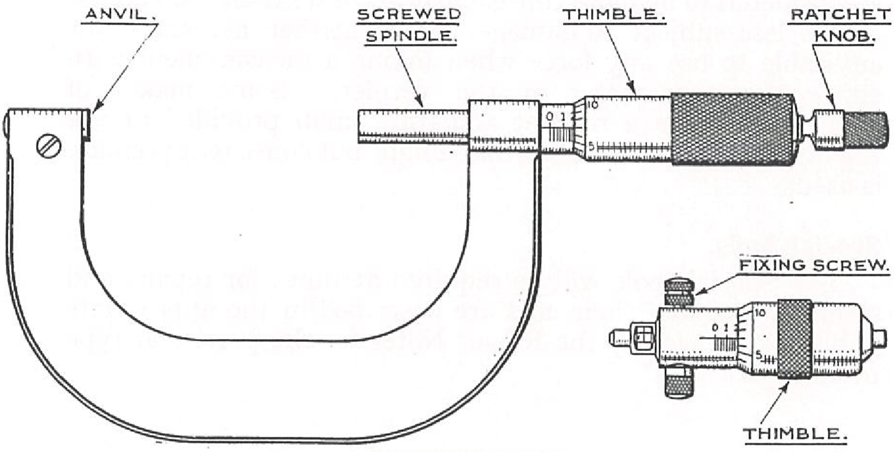

FIG. 8.—Micrometers.

40 to the inch, so that one complete turn of the rotating thimble is equal to an axial movement of 1/40th in. = ·025 in. The number of turns given to the spindle is indicated on the graduated scale marked on the inner stationary sleeve. This scale is marked off in fortieths of an inch, each fourth division mark being elongated to represent the 1/10th. The bevelled edge of the rotating thimble has 25 divisions, each fifth line being marked progressively from 0 to 25.

52. If the thimble is rotated one subdivision, this is obviously equal to an axial movement of 1/25th of 1/40th, which is equal to 1/1000th or ·001 in. When taking a reading, the size of the micrometer is noted and the minimum dimension to which it will measure is taken. The number of 1/10ths visible on the stationary spindle is also noted. Then the number of subdivisions, or fortieths, of the last incomplete tenth are multiplied by 25 to reduce them to thousandths, and to these dimensions are added the number of subdivisions on the thimble, from the 0 to the line which coincides with the horizontal line on the stationary sleeve, all the figures added together giving a dimension to the nearest 1/1000th of an inch. As an example, if the micrometer is a 2 in. to 3 in. size and the position of the spindle is such that 1/10th division and three subdivisions are shown on the sleeve, and the 7th division on the thimble agrees with the horizontal line, then the measurement will be 2 in. + ·1 + ·075 + ·007 = 2·182 in. With practice, a still finer reading may be taken, by judging the

position of the horizontal graduated line, when this line is between two marks on the thimble.

53. Of the two types of calipers described, the micrometer is considered to be more consistently accurate than the vernier, and is less subject to damage. It is neither necessary nor advisable to use any force when taking a measurement with either the micrometer or the vernier. Some makes of micrometer have a ratchet actuating knob provided at the top of the thimble to ensure that a light but consistent pressure is used.

Special tools.

54. Special tools will be required at times for repairs and similar work, and their uses are described in the appropriate publications, such as the Repair Notes for the particular type of aircraft.

INSTRUMENTS.

Straightedge.

55. The best form of straightedge which can be relied upon to keep reasonably true is made of solid metal, usually steel, and is available in lengths up to 6 ft. In the largest sizes, their cost and weight make them unsuitable for rigging purposes; therefore hardwood straightedges are generally employed. If this form of straightedge has been carefully made in the first instance and frequently tested during use, it is sufficiently accurate for all rigging purposes.

56. Care must be exercised in storage and in use, and, if not used for some while the straightedge must be tested for accuracy. Teak and mahogany are amongst the best materials from which to make wooden straightedges, but brass protection strips should be placed on the ends, and in other positions where excessive wear or damage is anticipated.

57. It is not possible to use straightedges on all occasions when the function of a straightedge is required. Under these conditions it is usual to employ a length of thin strong balloon cord or similar material tightly stretched between the objects to be levelled, or between the points of reference. The sag or dip can be quite appreciable, and it is advisable, if comparatively long distances are involved, to try the cord first by tying one end to some fixture, and holding the other end in the hand at a distance approximating to that required, and sighting along the cord for sag. By this means, the tension required on the cord is ascertained. For the smaller aeroplanes greater accuracy can be obtained by using No. 18 white thread, Stores Reference 32B/451, than by using cord.

Trammels, truing. Stores Ref. 1c/2593.

58. A set of trammels is an almost indispensable part of the rigger's equipment. As shown in fig. 9, trammels are simply metal fingers arranged to slide easily but without shake along a wooden bar with a screw by which the trammel can be fixed in any desired position. A pair of trammels is used

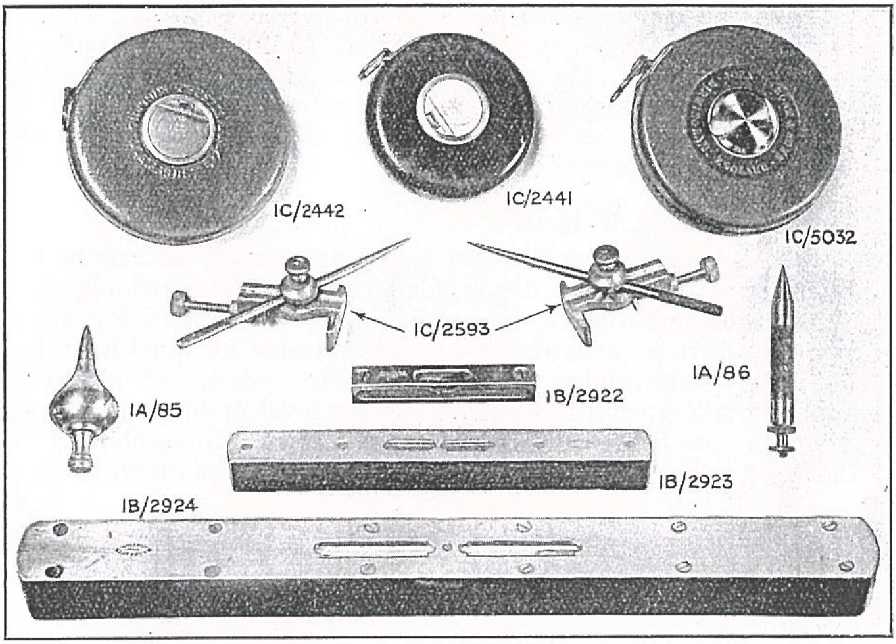

FIG. 9.—Rigging instruments.

chiefly to compare two or more distances which should be equal, such as the cross bracing wires of an undercarriage or fuselage, but is also useful to measure distances which are inaccessible to the usual steel measuring tape. It is not unusual to have two or three beams of varying lengths, made to fit the same trammels.

Bobs, plumb (8 oz. and 3½ oz.). Stores Ref. 1A/85 and 86.

59. A plumb bob is used by the rigger as the special form of weight at the end of a cord to form a plumbline. Plumblines are used to ascertain by visual comparison if the object to be lined up is truly vertical. A plumb bob is provided with a point at the lower end by means of which the plumbline can be placed directly over a point or line. A plumbline will always give a truly vertical line from its last point of contact. The two forms of plumb bob issued are shown in fig. 9; the

heavier of the two is made of brass and weighs 8 oz.; the other is mercury-filled and weighs 3½ oz.

Levels, spirit, 4 in., 10 in. and 18 in. Stores Ref. Nos. 1B/2922, 2923 and 2924.

60. A spirit level is an essential part of a rigger's equipment, as by its use an object can be made truly horizontal. One or more of the types shown in fig. 9 will normally be available for the rigger. It is generally advisable to use a straightedge in conjunction with the shorter types of spirit level if the part to be levelled is long, or the points of reference are far apart. Spirit levels must be treated with care, as otherwise the glass bulb will be displaced or broken.

Level, adjustable, 0° to 10°.

61. Incidence and dihedral angles are usually ascertained by means of special boards provided for each type of aeroplane. When these boards are not available, it is necessary for the rigger to have an instrument which is suitable for quickly and accurately determining these angles. The instrument usually supplied is a special form of adjustable level or inclinometer. There is now being developed a new type of adjustable level designed to measure from 0° to 10°. This instrument, which is

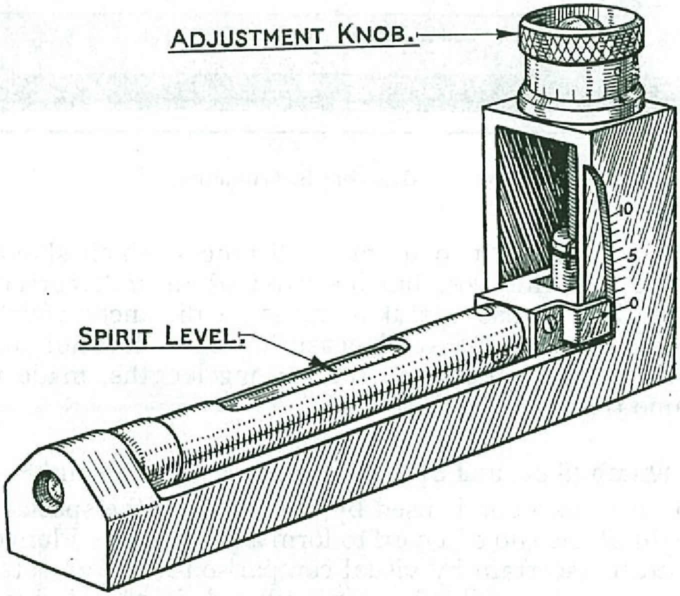

FIG. 10.—Adjustable level.

shown in fig. 10, consists of a base with a bridge piece at one end, a levelling arm which contains a spirit level, and a knurled drum which is rotated to raise or lower the levelling arm. Attached to the levelling arm is a pointer, which registers with graduations marked in degrees on the outside of the bridge piece. The knurled actuating drum is marked off into 12 divisions, and, as each division is equal to five minutes, one complete turn of the drum is equal to one degree.

62. In order to measure an angle (of 10° or less), the instrument should be used in conjunction with a straightedge in the usual manner, and the knurled actuating knob rotated until the bubble of the spirit level is central. The degrees are then read from the side graduations, as indicated by the levelling arm pointer, and the minutes from the actuating drum as given by the arrow marked on the collar immediately below it.