# CHAPTER X.

## TRUING UP ON BOARD SHIP.

308. On board ship where a level and steady platform is not available, or the aeroplane cannot be held dead still, the normal operations for rigging cannot be used. In these circumstances special methods must be adopted. Unless the aeroplane has been damaged or dismantled for any purpose, it is not likely that many rigging adjustments will be required for modern all-metal aeroplanes under normal service conditions.

309. The usual method of checking the rigging of an aircraft on board ship is to check the length of wires and other parts against a list of dimensions previously obtained. This will necessitate a record being made on shore of all the important dimensions when the aeroplane is correctly rigged. The dimensions recorded will be mainly connected with the length of wires between pin centres, or preferably the diagonal distances of the bracing between definite marks on the fittings. The dimensions recorded should be as accurate as possible, say to the nearest $\frac{1}{16}$ in., as otherwise it will be impossible, at times, to determine the smaller variations in lengths. It will be difficult to measure to as fine a degree as this for some parts, therefore it may be advisable to inset in the fabric, or attach to struts, small light alloy plates or clips which have been marked with a centre punch. On occasion, such as when a new plane has been fitted, it will not be possible by the above method to get the aircraft correctly rigged at the first attempt, and it may be necessary to give the new wing a little "wash in" or "wash out" in order to rectify the flying defect reported.

310. Where the method of checking by measurement is not applicable, the following methods can be used:—

**Ship plane fuselage.**

311. Similar methods of truing up the side frames of a stripped fuselage can be used on board ship as are used on shore. These methods are described in para. 217 (i) to (v) and illustrated in fig. 72, and consist of stretching cords (or preferably lengths of No. 18 white thread) along each side of the fuselage at datum line height, just clear of the side members. The threads or cords are tied to horizontally disposed straightedges, which project from either side of the fuselage, attached to the front and rear struts. A carpenter's square is then used, to ascertain if the top longerons are the correct distance from the threads, as given in the rigging notes. The transverse panels are then roughly trued up by measuring the diagonals at each vertical strut. As plumb lines cannot be used, the top and bottom frames of the fuselage

are trued up in a similar manner to the side frames, that is by means of threads or cords above and below the fuselage, stretched between vertically disposed straightedges or laths clamped to the centre of the front and rear cross struts as shown at A, fig. 84. The side lines should be maintained in position during this operation, as the truth of the side frames will probably be disturbed by the adjustments made to the top and bottom frames. The top and bottom lines must be so disposed that, as ascertained by using a carpenter's square, they are at 90° to the centre marks made on the front and rear cross struts. Adjustments are then made until the top and bottom longerons are equidistant from the threads on either side, or the centre marks made on all the cross struts are in line with the threads.

312. In those cases where it is merely required to check the truth of the fuselage of a completed airframe, the procedure will be similar to that already described for landplanes in para. 213 with the exception that, of course, spirit levels cannot be used. Two straightedges are used, laid across the longerons, one as far forward as possible and the other positioned at a number of different points, and the top edges are viewed from the front or rear to check for parallelism. Symmetrical rigging is checked as given in para. 275 and shown at A and D, fig. 79. During all checking operations it is essential that the bracing wires should be at the correct tension.

**Ship plane undercarriage.**

313. The truth in front view of an undercarriage can be ascertained by measuring from similar points on the axle extremities to similar points on fittings on the opposite side of the fuselage, or by measuring the diagonal distances in line with the cross bracing wires or cables as shown at B, fig. 84. This operation will probably involve detaching the

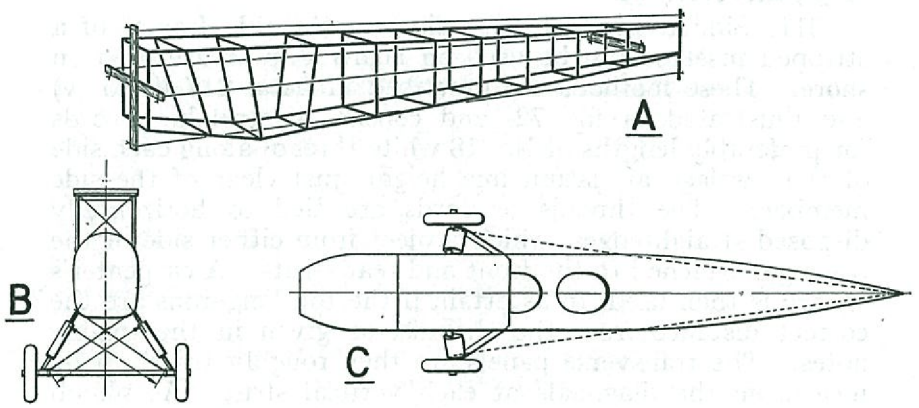


FIG. 84.—Truing ship plane fuselage and undercarriage.

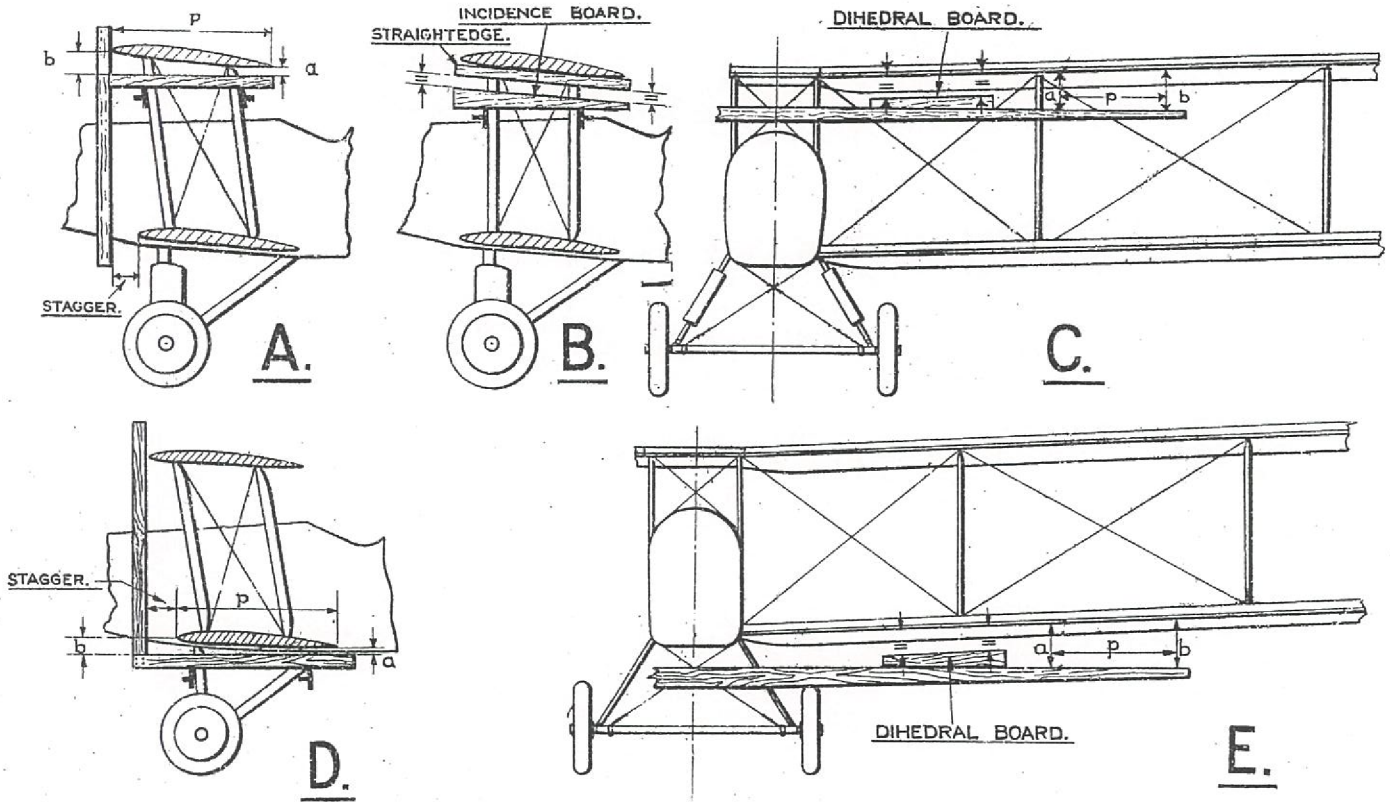


FIG. 85. TRUING SHIP PLANE MAIN PLANES.

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undershield or bottom engine fairing. The correctness of the undercarriage in plan view can be checked by measuring from the same or similar points on either end of the axle to the sternpost, as shown at C, fig. 84. In both checks given above, the measurements on either side should be equal.

**Ship-plane main planes.**

314. An artificial marking-off platform should be built up from some datum line, e.g., the top of the fuselage rails, the top or bottom of the main wing spar roots, or from the datum line as transferred from the levelling plates or pegs provided. In the latter case the fuselage must be checked for truth before the main planes are checked.

315. The skeleton platform may consist of two long straightedges of a length equal to about half the span of the aircraft, plus half the length of the landing chassis, the top edges of these platform straightedges being square and true, and the sides braced against warping. The platform straightedges are held by special clamps to the top longerons, the top centre section struts, or the bottom main wing root spars. When the straightedges are held to the bottom main wing roots, they are attached to the undercarriage struts or other suitable parts, as indicated at E, fig. 85. In this case, accurately made distance pieces are placed between the top edges of the platform straightedges and the extremities of the bottom centre section. The distance pieces should preferably be made of metal and so constructed that they register up against definite fixed points, such as the front and rear spars, or the spar end fittings, for which purpose it may be necessary to cut the fabric or detach fairings. When so attached, the top surfaces of the straightedges should be transversely and longitudinally true with the fuselage, and would represent two lines on a horizontal truing-up board.

316. In many instances it will be difficult to attach the platform straightedges to the undercarriage struts or the bottom longerons, and so work from the underside of the lower planes. In these circumstances it will be necessary to make arrangements to work from the underside of the upper planes as shown at C, fig. 85. It may be possible to use distance pieces in this position also, in which case the operation is similar to that just described, with the addition that the top centre section must first be checked for truth. Where distance pieces cannot be used, or where it is necessary to check the alignment of the platform straightedges, the procedure given below is recommended :—

(i) Check the front and rear diagonals of the top centre section struts.

(ii) Temporarily clamp the two platform straightedges in position on the top longerons or the top centre section struts, in as near the final position as possible.

(iii) Measure from similar points at the top of the front centre section struts to points marked on the front straightedge which are equidistant from the centre line of the fuselage, and also from the same points on the front straightedge to the extremities of the bottom centre section, and adjust this straightedge until the distances measured on either side are equal. The front straightedge should now be transversely true with the fuselage.

(iv) Strip the covering from the fuselage, and place a straightedge, long enough to cover two bays if possible, on the levelling plates or parallel with the scribed datum line and clamp in position.

(v) Place two straightedges or round bars through the fuselage, resting them on the longitudinal straightedge, and clamp to adjacent struts. Ensure parallelism and transverse truth by measuring the height of the straight edges from similar points on the longerons to each straightedge on either side, and sight from the rear to check. The transverse straightedges should be as far apart as possible.

(vi) Tie a length of cord or No. 18 white thread to the rear transverse straightedge, and bring the line over this straightedge and the one in front. The line is then taken to the front of the fuselage so as to touch the fuselage fairing at a distance a little beyond the leading edge of the lower centre section stub planes, and raised or lowered until it just touches both of the rear transverse straightedges. A mark is then made on the fuselage side at the same height as the cord. It is advisable to do this several times, and select a mean position midway between the marks so made. Then, placing the line on a level with the selected mark, make a series of dots on the fuselage fairing, at the height of the thread, for a length somewhat greater than the cord of the main planes, and scribe a pencil line through the dots. A similar line should be made on the other side of the fuselage. These pencil lines will then represent the datum line of the fuselage.

(vii) Measure the vertical height from the pencil lines to the upper surfaces of the platform straightedges and adjust the rear straightedge until it is at the same height from the pencil lines as the front straightedge. The top surfaces of the two straightedges should then be parallel when viewed from the front or rear.

(viii) Sight from the rear across the platform straightedges and the rear transverse straightedges to ensure parallelism.

317. In some cases, cords tied to the outer interplane struts could be used instead of the platform straightedges. The alignment of the cords, and the rigging of the aeroplane, should be checked by measurement, as described for the platform straightedges.

**Dihedral.**

318. The best method of checking dihedral, when using the platform straightedges, is to use a dihedral board tapered to the same angle as the dihedral angle, and measure vertically from each end of the top surfaces of the dihedral board to the underside of the planes, at about the spar positions, with the board resting on one of the platform straightedges as shown at C and E, fig. 85. The distances so measured should, of course, be equal.

319. If dihedral boards are not available, the dihedral angle can be measured by taking the distance between the spars and the two platform straightedges, as shown in fig. 85, at points " a " and " b " at a distance from one another " p," and subtracting " a " from " b." The dimension so found, in conjunction with the distance equivalent to " p," thus forms the perpendicular and the base lines of a right-angled triangle. The actual position and distance apart of the points taken does not matter greatly ; but the further apart they are the better. Having these two dimensions, and referring to fig. 107, the angle can be ascertained directly. The angle can be easily found otherwise by referring to trigonometrical tables, as the tangent of the angle being measured is equal to $\frac{b - a}{p}$; all distances to be in inches. Take, as an example, the measuring of the dihedral of a plane where the perpendicular distances are 7·3 in. and 4 in., measured on a base line of 5 ft. 3 in. or 63 in. Then $\frac{7 \cdot 3 - 4}{63} = \cdot 0524$. By referring to trigonometrical tables, it is found that ·0524 is the tangent of 3°, which is the angle required.

320. The dihedral can also be checked by joining the tops of the wings by a thread held taut, measuring the distance between the thread and the top of the main plane spars, as indicated at F, fig. 79, and proceeding as given above.

**Symmetrical rigging.**

321. This can be checked as already described in para. 275, and as shown in fig. 79 for landplanes. The check is made by

measuring the distances from the sternpost to similar points on either side of the aeroplane at each lower and upper wing extremities, such as the rear interplane strut fittings.

**Incidence.**

322. An incidence board should be provided, tapered to the same angle as the angle of incidence of the main planes when the aircraft is in rigging position. When the incidence is measured from a line tangential to the underside of the plane, the incidence board and a straightedge are disposed as shown at B, fig. 85, and the vertical distances at about the leading and trailing edges are measured from the top of the incidence board to the underside of the straightedge. The incidence of the plane will be correct when these distances are equal. When the incidence is measured from the chord line taken through the centre of the leading and trailing edges, the incidence board is used alone and measurements are taken from the leading and trailing edges to the board. These distances also should be equal if the incidence is correct. Another method which can be adopted, should an incidence board not be available, is to place a straightedge across the platform straightedges at right angles to the spars, as indicated at A, fig. 85, and measure the vertical distances between the top surface of the straightedge and the chord line at the leading and trailing edges. The method employed to find the angle is then similar to that employed for dihedral.

**Stagger.**

323. A large 90° or T-square is necessary to measure the stagger. By putting the bottom edge of the square on top of the two platform straightedges and placing the inner vertical edge of the square against the leading edge of the top centre section, the stagger can be measured by ascertaining the horizontal distance between the nose of the lower plane and the inner vertical edge of the square, as indicated at A and D, fig. 85.

324. If the top and bottom planes are parallel, the stagger must be checked in at least two positions along each wing. If the top wing only possesses sweepback, then the stagger can be measured at the centre section only.

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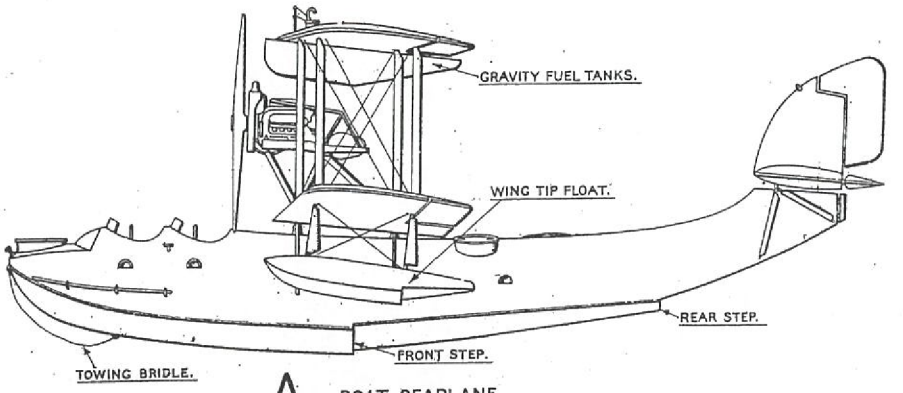
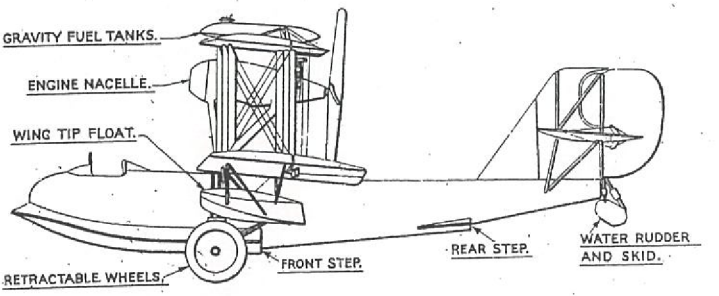
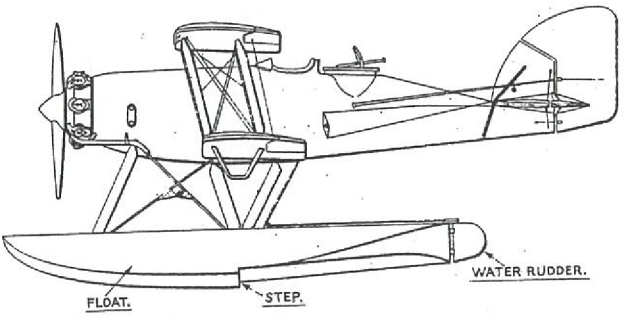



A — BOAT SEAPLANE.




B — AMPHIBIAN.




C — FLOAT SEAPLANE.

FIG. 86. BOAT AND FLOAT SEAPLANE AND AMPHIBIAN.