CHAPTER VII.

ASSEMBLING AND TRUING OF A STRIPPED FUSELAGE.

Fuselage Assembling.

209. In the design of modern all-metal aircraft for service use, where the general and performance requirements are constantly increasing, there is of necessity a strong tendency towards making the fuselages rigid structures, using fixed-ended struts and very few or no bracing wires. The actual form of any fuselage structure varies with each aircraft in accordance with the general arrangement and design, but it is not uncommon for single-engined tractor aeroplanes to have the fuselage divided into three sections, the engine mounting as fore part, the middle section, in which is placed the pilot's cockpit and to which are attached the flying and alighting structures, and the tail portion which extends back to the fin and rudder post, and carries the tail unit and skid. Each part may differ somewhat in construction.

210. The types of construction may take either of two forms, monocoque as shown at figs. 42 and 61, or braced girder, as indicated in figs. 40, 43, 59 and 60. In the former, the skin takes the major portion of the loads from the tail and requires no rigging adjustments. In the latter, the struts and ties are placed in certain fixed positions, each taking its own definite load, and may or may not require truing up after assembly, depending upon type of design. The types of braced girders used for aircraft fuselages are the " N " which has vertical posts and diagonal struts, the double " N " or " Pratt," with vertical posts and cross bracing ties, and the " Warren " or inclined struts only. These types are indicated in fig. 71.

211. In the assembling of modern fuselages it is often necessary to have jigs in which to build up certain sections. The part so treated is generally the middle section, as this part is in most cases of very solid construction, often embodying the lower plane centre section spars, the attachments for the undercarriage and top centre section struts, and a considerable number of internal and external fittings. A middle section of a fuselage which is jig built should be correct to fine limits in every important detail, because all the various parts are usually secured together with a fixed relationship to one another, and form the basis on which the remainder of the structure is erected. In some forms of fuselage, notably the fixed-ended strut type, it is not unusual for the complete side frame to be built up in a jig, and then assembled together by the insertion of cross struts and transverse bracing wires or struts. In other types, particularly the larger kinds, the fuselage is built up

in two or more complete sections which are subsequently bolted together at the longerons.

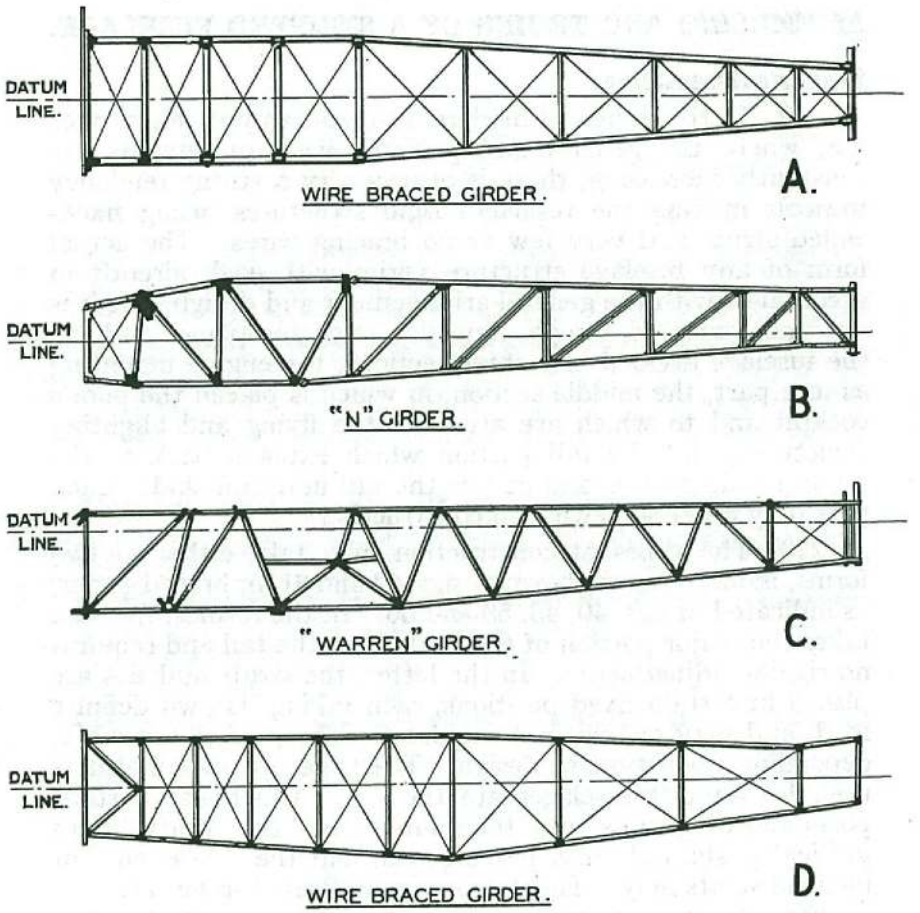

FIG. 71.—Types of braced fuselages.

212. With the fixed-ended strut types of fuselage, that is the " N " or " Warren " varieties shown at B and C, fig. 71, it is not possible to make many adjustments when rigging, because all the struts and component parts have been made and built up together in jigs in the first place, and therefore little more than correct assembling is required to obtain true alignment. Obviously, the amount of rigging needed depends upon the number of bracing struts employed. The more numerous the diagonal struts are, the less will be the rigging required.

Fuselage truing.

213. In those cases where it is merely required to check the truth of the fuselage of an aeroplane, the coverings and fairings are detached as found necessary, and the fuselage

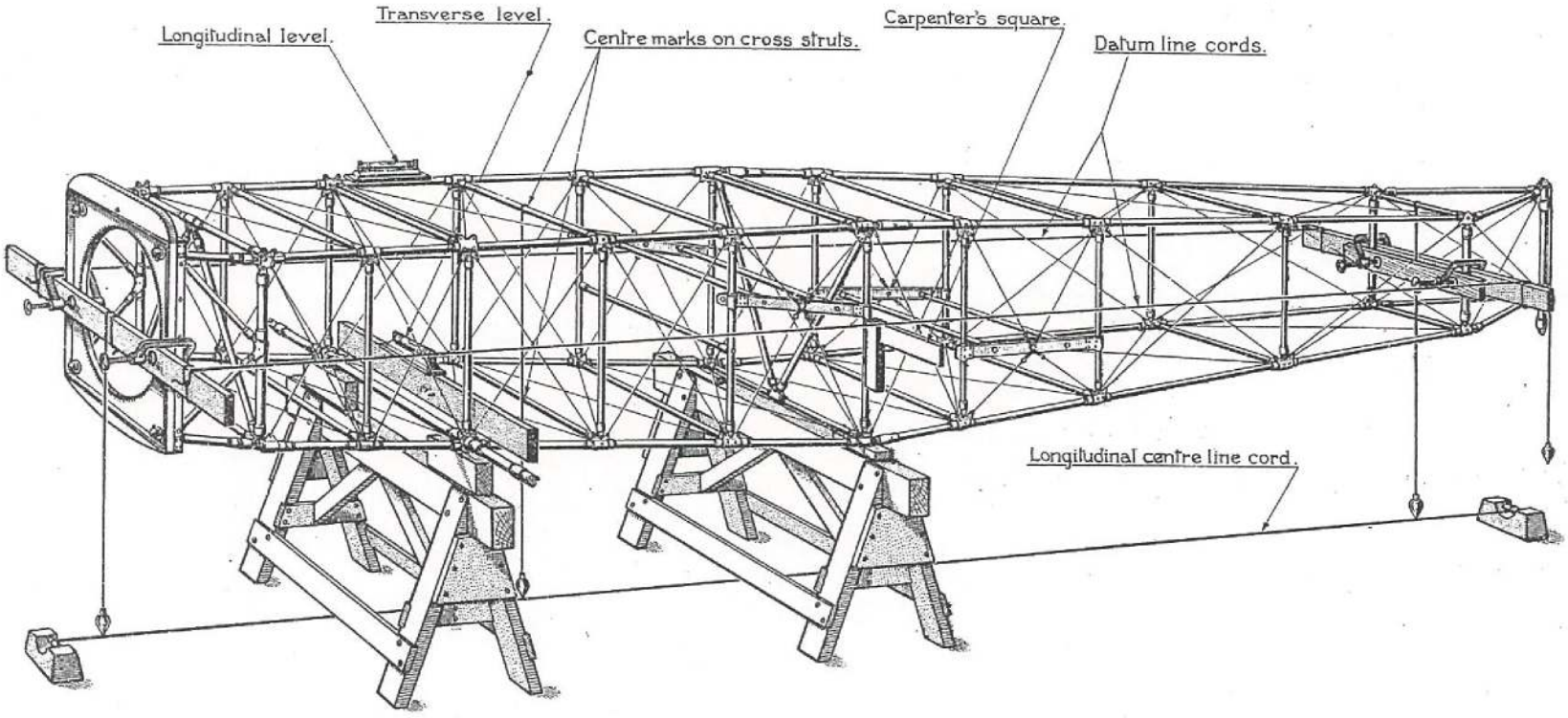

FIG.72. TRUING A FUSELAGE.

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arranged on trestles, or suitably jacked up, until the datum line is horizontal and until it is also transversely horizontal, as ascertained by placing spirit levels on the longitudinal and transverse levelling plates. If levelling plates are not provided, then spirit levels are placed on those parts of the top longerons which are parallel with the datum line, and also on straightedges placed across the fuselage. Two straightedges are then laid across the longerons, one as far forward as possible and the other positioned at a number of different points in turn, and the top edges are viewed from the front or rear to check for parallelism. Unless trammels can be effectively used, it is difficult to check properly the side frames in a completed airframe, but the method of checking by straightedges given above will show if one side is out compared with the other. During all checking operations it is essential that the bracing wires should be at the correct tension, as described in para. 222.

214. Before a fuselage can be trued up, it is usually essential to know the position of the horizontal datum line, that is, the line in side elevation of the fuselage which will cut the side struts at certain known points. Generally, this line will be made horizontal when the fuselage is placed in rigging position. It is sometimes found that the situation of this line is marked on the side struts of the fuselage frame during manufacture, or levelling plates or pegs are provided for the same purpose. If no indications are given on the structure, it is important that the drawings of the fuselage or the handbook should be consulted before definitely adopting any position for the datum line.

215. The most difficult form of fuselage to true up is that of the double " N," shown at A and D, fig. 71, where pin-jointed struts are used in conjunction with diagonal cross bracing wires ; the following description of the method of truing up a fuselage deals with this type. The procedure outlined is intended as a guide only, and is not identical with the methods adopted for all similar types of fuselage. It will not be always possible to make all the adjustments enumerated, the tendency being for the correct rigging of a fuselage to become more and more a matter of assembly. For particular aircraft, reference should be made to the aircraft handbooks where mention is made of the normal methods to be used for the type. The form of the typical body generally agrees with one of the shapes shown in fig. 71, that is where the fuselage is symmetrical in side view as at A, or where the top longerons are horizontal as at C, or partly so as at B and D.

216. In the following paragraphs the truing up of a fuselage which has been entirely dismantled and reassembled is described, but partial truing up would be carried out on the same lines. The amount of truing up to be done, and the extent

to which the fuselage must be dismantled, would depend upon the degree of distortion, or the extent of the repair or replacement, if such has been effected.

217. The general method of truing up a fuselage of the type shown at D, fig. 71, is first roughly to true up the structure, then set up the fuselage accurately on the trestles, and complete the truing. The procedure is as follows :—

(i) As shown in fig. 72, the fuselage is supported on two trestles, at points which have been pre-determined by the provision of jacking pads, or in the positions given in the handbook. Except in those cases where the top longeron acts in this capacity, the datum line must be marked off and cords stretched along at datum line height on each side of the fuselage parallel with the side frames.*

(ii) To do this, select suitable transverse panels at the front and rear, and true up by adjusting the cross bracing wires until the diagonal distances are equal, as determined by measurement or by using trammels. If an engine plate acts as the front panel, this can be used, and will, of course, require no truing up. The front pair of struts, or engine mounting plate, and also the rear pair of struts, are then marked off at the heights which are given as representing the datum line, and straightedges clamped on in the manner shown in fig. 72 with their top edges at exactly the same height as the marks. One or more of the centre struts on each side of the fuselage, (strut No. 7 in the instance given in fig. 72) are also marked at the height given for the datum line. Cords, or threads, are then tied to the straightedges and stretched tightly over them, so that the under surface of the cords is on a level with the marks on the front and rear struts. The cords must not touch the side of the fuselage, nor have any perceptible sag.

(iii) The next operation is to true up the transverse panels, by adjusting the wires until both diagonals are of equal length, and check with trammels.

(iv) The top and bottom bracings should then be treated in a similar way, checking the diagonal bracings with trammels as before, and adjusting the wires as necessary.

(v) The next procedure is to true up the fuselage side frames roughly by holding a carpenter's square against one of the marked centre side struts, and making adjustments to the diagonal bracing wires until, when the blade of the square just touches a cord, it also touches the mark

* The use of No. 18 white thread, Stores Ref. No. 32/B/451 is recommended.

on the strut. The longerons must not be allowed to sag or bow during these adjustments, and occasional visual checks must be made by sighting along the straight portions. It is essential, when adjusting wires, that the rigger does not attempt to pull the structure true by tightening the wires only. If an adjustment has to be made, the impeding wires must first be slackened off before adjusting the selected wire.

(vi) After this, the fuselage will be roughly true, and the final work of checking and making small adjustments may be proceeded with. To do this the front and rear trestles should be adjusted until the fuselage is longitudinally and transversely horizontal. If fixed trestles are being used, the adjustments for height should be made with wooden packing pieces. The longitudinal level of the fuselage can be checked by resting a spirit level on any part, such as the front portion of the longerons, which is parallel to the datum line, and the transverse level by laying a straightedge and spirit level across the fuselage at right angles to its plan centre line at a number of different points. The side cords must be left in position, as a check will be required if any adjustments are made to any transverse upper or lower panels, owing to the possibility of subsequent adjustments upsetting those already made.

(vii) The middle points of all upper and lower cross struts are then marked, midway between the inner faces of the longerons, and a plumbline tied to the front upper strut, or engine mounting plate, at the marked point, and to the rear cross strut also at the marked point. Next tie the ends of a cord to heavy weights, or over trestles, and arrange the cord underneath the centre line of the fuselage, so that, when tightly stretched, it is just clear of both plumb-bobs.

(viii) Now hold or tie a plumbline to each upper cross strut in turn, and adjust the bracing until the plumbline touches the marked middle points of the corresponding upper and lower cross struts, and the plumb-bob is directly over the line stretched beneath the fuselage.

(ix) Check the side frames as outlined in (iv) and make any necessary adjustments.

(x) The rigger should finally test each bracing wire to see that all are properly locked and are at the correct tension. (See para. 222.)

218. If the fuselage possesses a stern post, or it is possible to erect one temporarily, it is advisable to check continually the truth of the stern post with a plumbline during the truing

up operations. It is of assistance in many cases to check by sighting that the upper surfaces of two straightedges, placed across the top and bottom longerons at various positions, are parallel. When the checks enumerated have been satisfied, the fuselage may be considered fully trued up.

219. When adjusting the wires of the side, top, and bottom frames, it should be remembered that these are interconnected with the wires of the transverse panels, and must, therefore, all be "kept going" together. As an instance, when adjusting the side bays to bring the side strut datum line marks into alignment, the transverse cross bracing must also be adjusted, and checked by trammelling. In addition, the other side of the fuselage will probably need adjustment. Otherwise it would be possible to true one side until it was true as a whole, but after truing the transverse panels it would probably be found that the side was out of truth again.

220. A fuselage of the type shown at A, fig. 71, can be trued up on the same principle as the one already described, but is somewhat simpler, as greater use can be made of trammels in the initial rough truing up and subsequent checking, because the diagonal cross bracing wires in the side frames are of equal length when correctly rigged. Also datum line marks can be made on all struts, as this point is situated at the centres of their lengths.

221. If the fuselage is of the shape shown at C, fig. 71, but has cross bracing wires instead of diagonal struts, the procedure given can be applied, but as the longerons are straight and are horizontal when the fuselage is in rigging position, they may be used instead of the side cords for the truing up of the side frames.

Bracing wires and attachments.

222. Before a fuselage is left, all the bracing wires must be as near the correct tension as possible. Various instruments have been devised to measure the tension of wires, but few are actually in use, and it is seldom that the rigger has anything except his own judgment to guide him. The cultivation of this judgment is largely a matter of experience, and riggers should lose no opportunity of testing the tautness of wires that are passed by experienced men as correct in tension. It is important that the wire should not be too tight, as this naturally places an initial stress on compression members, and may even bend them. On the other hand, a wire that is too slack will, when under load, fail to perform its proper function, and may throw extra stress on other parts of the structure. As a general guide it can be assumed that all wires are sufficiently tight if, after the slack has been taken up, they are

given from half to one turn, depending upon the size and length of wire, and the solidity of the surrounding structure.

223. With streamline wires it is not possible to turn the wire less than half a turn; therefore if a quarter-turn is required, the wire is slackened off and the pin extracted from one of the fork ends, which is then detached from the wiring lug. The fork end which has been detached is then rotated on the wire half a turn and replaced on the lug. Referring to fig. 73, it must be noted that the screw threads on the ends of

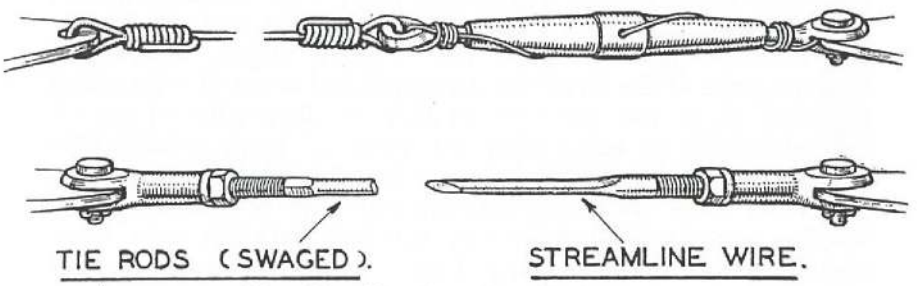

FIG. 73.—Bracing wire attachments.

the wires, either streamline or the circular-section swaged tie rod, are cut right- and left-handed, so that in rotating the wire one turn it has shortened the distance between the pin centres by the equivalent of not one thread, but two. It must also be noted that the locking nuts are made of soft material, either brass or cast iron. The object of this is to prevent any stripping of threads or over stressing of the wires when tightening the locknuts.

224. A fork end invariably has a small hole drilled about half-way along the barrel. The distance which this hole is from the end of the barrel is equivalent to the minimum amount of thread which should be in engagement, and is placed in this position to allow the point of a scriber or a small piece of wire to be inserted as a feeler.

225. It is of great assistance sometimes, especially during the repair of a fuselage, to use some form of temporary bracing. This is usually arranged with piano wire and turnbuckles, shown in fig. 73, which are attached to specially prepared wrapper plates or clips fitted round the parts to be braced. If turnbuckles are used on the permanent structure, they are locked with soft iron wire in the manner shown.

226. All split pins used must be of correct size and length, and well spread and turned over. A split pin must on no account be used a second time. If it is necessary to detach a split pin when dismantling, it must be thrown away and a new one used upon re-assembly.