CHAPTER VIII.

ASSEMBLING AND TRUING AND COVERING OF PLANES, CONTROL SURFACES, AND UNDERCARRIAGES.

Assembling of planes.

227. Initially, most manufacturers assemble the component parts of a wing together in jigs. This method ensures that the planes are true when completed, and that like parts are interchangeable. With the wooden types, where the various parts of the structure are glued and screwed or bradded together, it is not an easy matter to dismantle wings for reconditioning or other purposes without doing considerable damage to parts which it may be desirable to preserve. Generally, the complete dismantling and re-assembling of wooden wings is undertaken by the manufacturer, and, even under these conditions, only a few parts, such as the metal fittings and occasionally a spar, are salvaged from a wing which is unserviceable to the extent warranting reconditioning. Where the reconditioning of wings is undertaken by the service, the structures are usually re-built in accordance with the drawings provided for the purpose.

228. With metal construction, on the other hand, there is a possibility, if great care is exercised, of partly or completely dismantling a wing with little or no damage to the various parts, but this work is usually done at depots or at the manufacturer's works, where the special sections, component parts, drawings and jigs are available. The necessary repairs of a minor nature which are undertaken by service units are carried out in accordance with the repair scheme which is issued officially for each type of aircraft.

229. In the assembling of a metal wing, the ribs are usually threaded on to the spars and placed in their approximate positions before the drag struts and cross bracing wires are fitted. The ribs are then attached in their definite positions, and the leading and trailing edges assembled in the manner suited to the type of design.

Fabric covering.

230. The re-covering of a wing with fabric is an important item in the reconditioning or repair, and the methods employed must be strictly in accordance with the official instructions on the matter, and, unless instructions are issued to the contrary, will be in accordance with the standard methods described below. The fabric covering normally used for planes is of

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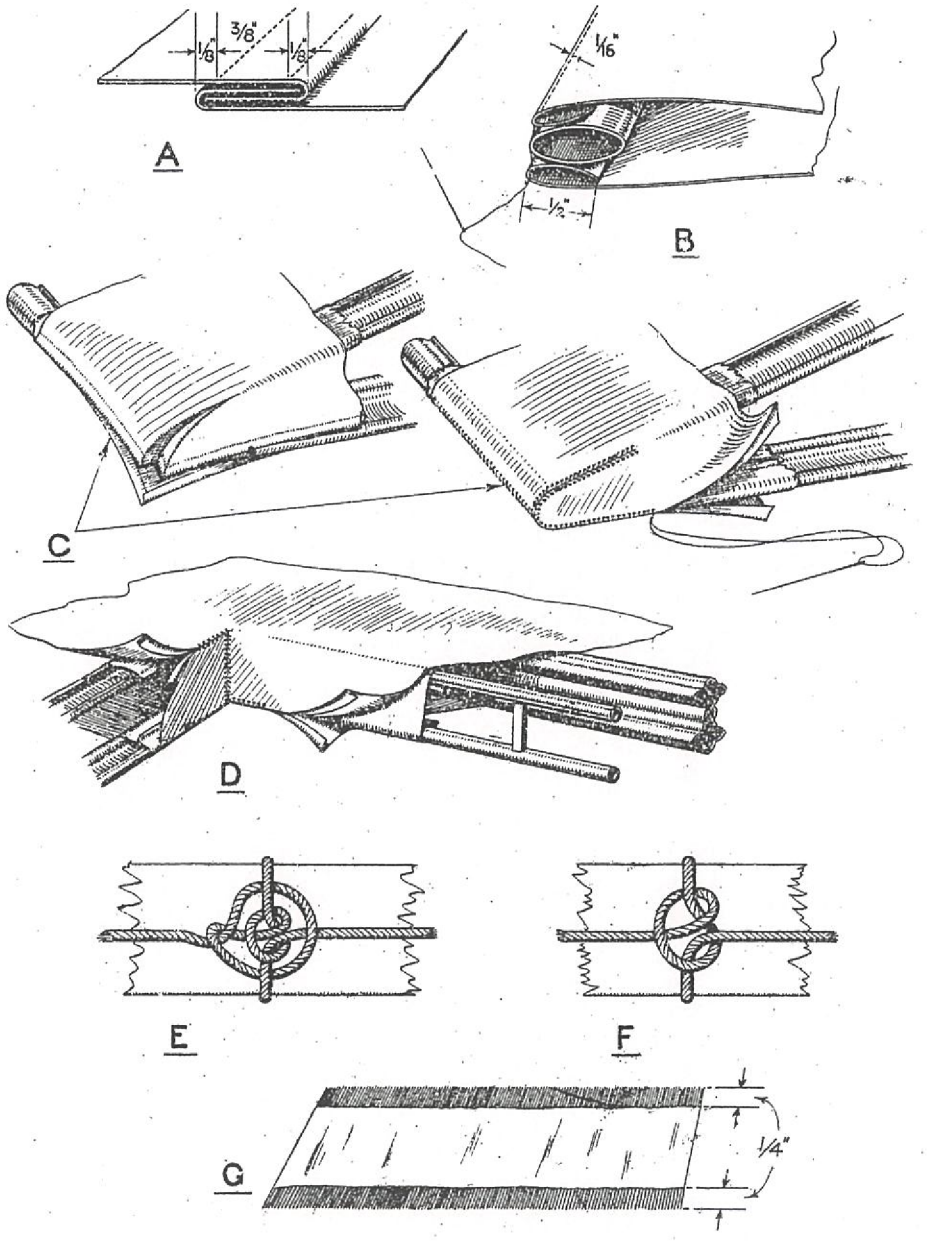

FIG. 74. FABRIC ATTACHMENT BY SEWING.

the best quality linen to B.E.S.A. Specification 4F.1, Stores Ref. 32B/147. The fabric is usually attached to the planes by sewing with braided cord to B.E.S.A. Specification 2F.25, Section II, Stores Ref. 32A/94.

231. The types of seams used when covering planes are shown at A and B, fig. 74. The seam shown at A is the double balloon seam, and should be made as indicated. The seam at B is used to tighten the fabric at the trailing edge and other parts, and is arranged so that the edges of both portions of the fabric are inturned to form folds of about $\frac{3}{8}$ in. to $\frac{1}{2}$ in. in depth, and are located parallel with the edge of the structure along which the seam is to be made. The lines of the seams should be from $\frac{3}{16}$ in. to $\frac{1}{4}$ in. distant from the edge to allow for pulling up. Hand-sewn seams are lockstitched approximately eight stitches per inch and double-lockstitched every 6 in., using single 18S or double 40S linen thread to B.E.S.A. Specification F.34, Stores Ref. 32B/451 and 32B/413 respectively. Machined seams should have approximately nine stitches per inch, using single 40S linen thread of similar specification. At C and D, fig. 74, are indicated the methods used for covering the corners formed at the trailing edge of the end ribs and in the aileron gap respectively. In the latter case it will be noted that the seams are made along the lower edge of the former parallel with the main spar, and at the upper edge of the end rib. The forward seams should always be sewn before the other seams are made.

232. Before the fabric is placed in position on the planes, all the corners where the fabric is likely to touch and chafe must have a strip of fabric doped, glued or sewn on. This applies also to the ribs and the leading and trailing edges. The linen or Egyptian tape which is used on wooden ribs, has normally a width sufficient to give an overlap at the edges of from $\frac{1}{4}$ in. to $\frac{3}{8}$ in. and is attached by a line of glue down the centre of each rib flange. The tape is usually sewn to metal ribs by the methods indicated at A, fig. 75. After the preliminary taping has been accomplished, the fabric is secured to the framework of the plane by sewing or stringing to the ribs with the braided cord (which is waxed to prevent slackening), as shown at A, fig. 75. The usual pitch of stitches is 3 in., and the knots are made on the upper surface of the plane at each stitch. The stitching is double-knotted at approximately every 18 in. on the upper surface of each rib. At E, fig. 74, is illustrated the method of knotting the cord at the forward end of the rib, and also at the points at which it is double-knotted. All the intermediate single knots are made as indicated at F, and the sewing is finished off by the double knot shown at E.

233. In order to reinforce the fabric over the ribs and also to prevent it from tearing away from the stitching, linen webbing or Egyptian tape is laid on the fabric over each rib before sewing. The ends of the tapes may be temporarily secured by being tacked to the fabric. After the string sewing, the stitching is covered with the frayed-edge linen tape shown at G, fig. 74 ; this tape is doped in place after the first coat of dope has been applied to the plane. The leading edge, the upper and lower edges of the inner ribs and the members bounding the aileron gap, and all similar corners where the fabric is likely to be subjected to friction or hard usage should be covered externally with a strip of fabric doped on. Where plywood is used as a reinforcement to the fabric, or to give the correct contour in such positions as the nose of the plane, it may not be necessary to adopt the method of stringing given above, provided the fabric is properly attached to the plywood by doping. When this method of attachment is used at the nose of the plane, the upper fabric must be frayed at the edge and taken well round the nose, and must overlap the lower fabric by some inches.

234. In those aeroplanes which are fitted with engines of over 400 H.P., special precautions must be taken with the fabric in the region of the airscrew slipstream. Considerable trouble has been, and is still being experienced with the fabric attachment in this position, due no doubt to the rapidly fluctuating pressures imparted by the airscrew slipstream. The normal method of attachment in these positions is to halve the pitch of the stitches, making them every $1\frac{1}{2}$ in. instead of 3 in. This method will give satisfaction for a reasonable period, but it is most important that the rigger should very carefully examine the fabric attachment of any planes in the region subjected to the slipstream. It is not sufficient merely to ascertain that the fabric has a satisfactory appearance ; investigations must be made to ensure that the stitching cord has not become frayed or chafed inside the plane.

235. Some variations of the method of attachment given above are allowed for certain aircraft. On those rib booms which present a sufficiently rounded surface, the stringing is arranged round the boom as shown at B, fig. 75, instead of being taken right through the plane. This method is particularly adaptable for deep wing sections. Another method is to thread a metal wire through the tape and the fabric and also through eyelets, or bridge pieces, formed in the rib booms, as indicated at C, fig. 75.

236. It is not always essential to tape the ribs under as well as over the fabric covering ; the tape on top of the covering is all that is necessary if the rib presents a sufficiently

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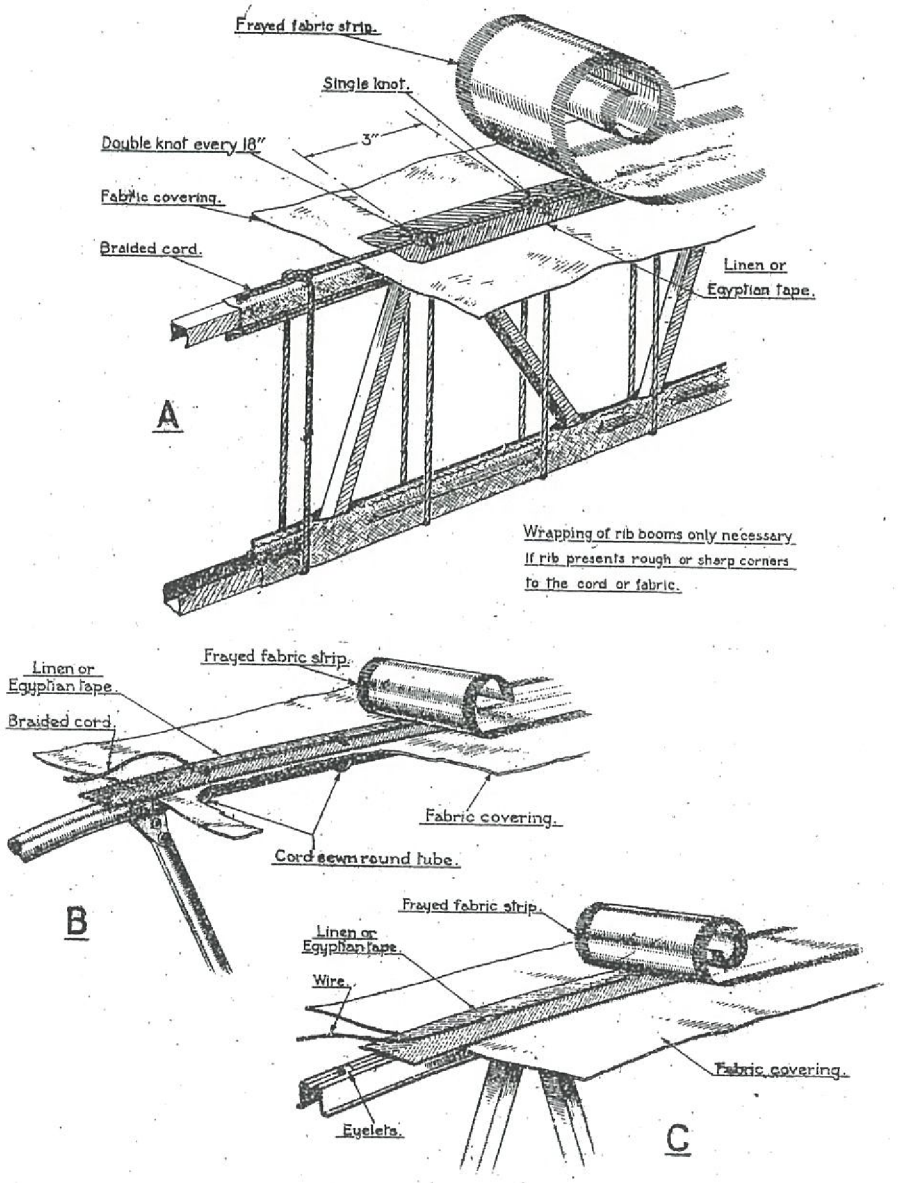
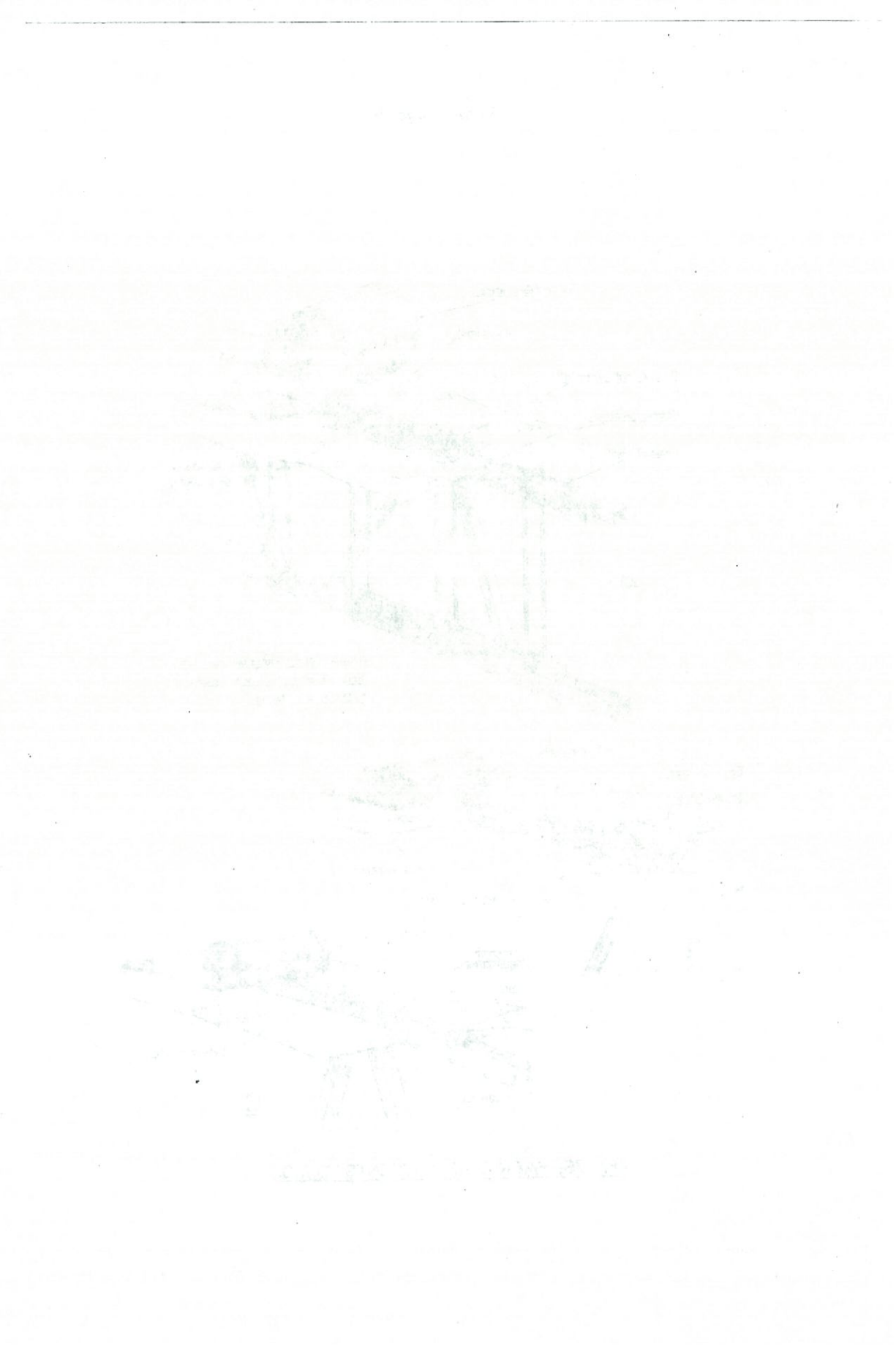


FIG. 75. FABRIC ATTACHMENTS TO RIBS.



smooth surface. When re-covering wings, care should be taken to adopt exactly the method of attachment approved for the type of aircraft, as is ascertained when stripping down the wing.

237. Before being used, fabric should be stored for as long as possible at a fairly high temperature, 73° F. being suitable. This will thoroughly evaporate all moisture which would prevent satisfactory doping. Before gluing fabric on to wood, the fabric should always be thoroughly washed, as otherwise the presence of the dressing substance in the linen makes it difficult to obtain good results. Where the fabric is attached to wood and has to be subsequently doped, glue is not, as a rule, used as an adhesive, as not only is there a danger of the fabric rotting, but the glue has a detrimental effect on the applied dope. In these circumstances, dope is the best adhesive, and for smoothing down, wads of doped fabric should be used. After the wing covering is completed, the fabric is given several coats of dope, the final coats being pigmented, that is, with a colouring matter added.

238. It is important that no aircraft should be flown with openings in the wing covering, other than those designed to be there, as the effect may be to alter the static pressure within the wing to such an extent that the normal rib loading is considerably exceeded.

Truing up of planes.

239. The truing up of planes after re-assembly or repair is a comparatively simple matter and is similar for either wood or metal structures. The framework of the normal form of plane is similar to that illustrated in figs. 32 and 52, and described in paras. 139 and 180, and as will be seen, consists of two spars, generally parallel, which are the main strength members and which are braced together by the usual form of lattice bracing; that is, the spars are separated by drift struts and the open panels formed by the spars and the struts are cross braced with the usual form of tie rods, the strength of which gradually decreases from the wing root to the tip. The remaining parts, such as the ribs and the leading and trailing edges, act as formers, and are provided to give the shape of the wing, and to transfer the air loads from the fabric on to the main strength members.

240. To true up the planes, lay the structure across two trestles, placing packing blocks on the tops of the trestles so that the weaker parts of the plane are clear of the trestles, and, commencing at the wing root, adjust the diagonal bracing until trammelling indicates that the diagonal distances are equal in each bay. The planes of a biplane are usually thin

compared with their length and breadth, and will in most cases deflect considerably if inadequately or incorrectly supported. Care should therefore be taken to ensure that the structure is securely supported and that the spars are at the same level. When the bays are small, minor inaccuracies are hard to detect ; therefore, it is advisable to mark off equal distances, say 5 ft., along each spar from similar points on the root fittings and trammel the diagonal distances between the points marked and the fittings, and adjust the bracings until these distances are equal. When completed, the plane should be checked by taking diagonal measurements from the outer end of each spar to the root fittings on the opposite spar, and each spar should be checked for bowing by using a long straightedge or a tightly stretched cord.

241. When the plane has sweepback, and consequently the end rib at the root of the plane is not at right angles with the spars, the method outlined cannot always be employed. When the plane is so constructed that, with the exception of the strut between the spar root fittings, the drift struts are placed at right angles to the spars, the end bay may be ignored for truing up purposes and the procedure for truing up is then similar to that already given. When the drift struts are all parallel to the line of flight and therefore not at right angles with the spars, the truth of the plane must be judged by the angular displacement of the front spar root fitting in relation to the rear spar root fitting. Taking a line through similar points on the spar root fittings, the bracings are adjusted until the angle formed by this line and a line taken at right angles to the rear spar, from the same point on the rear spar fitting, is equal to the angular sweepback on the planes.

Truing up control surfaces.

242. The truing up of tail planes follows the general lines laid down for the truing up of the main planes, special attention being paid to the lining up of the hinge points. Normally, elevators, ailerons, fins and rudders cannot be trued up in the ordinary way, as these components are usually rigidly built. Therefore, if these parts become seriously out of truth, then replacement or repair will be necessary.

243. Before passing any main plane or control surface as ready for re-covering, it is necessary that a very thorough inspection should be made to ensure that the structure is in a safe and serviceable condition, that all wires are locked, and that no fatigue failures, actual or incipient, are evident, and that no chafing of the wires or other parts through vibration is possible.

Truing up of undercarriages.

244. Undercarriages vary in design and construction, but are as a rule fairly simple to rig correctly provided the component parts are properly assembled. In all cases undercarriages should be, as far as possible, assembled on the floor and then lifted into position.

245. Undercarriages are invariably rigged so as to be symmetrical about the centre line of the fuselage in front and plan views. In the assembling of the undercarriage to the fuselage, the first problem to be met is the supporting of the fuselage at the correct height. When preparing the fuselage for the reception of the undercarriage, it should be jacked up into rigging position, allowing sufficient room for the wheels to be free of the floor when the undercarriage is fitted. Jacking pads are usually provided for this purpose on the underside of the fuselage, but if pads are not actually provided, there is usually a point indicated as that correct for jacking up. Should no indication be given, choose a position on a fitting as close up to the front undercarriage strut attachments as is convenient. If an adjustable trestle is not available and ordinary jacks are used on trestles, then care must be taken that the heads of the jacks do not damage the fittings or structure. A way can always be found of supporting the fuselage without placing undue stress on the fuselage or engine mounting, and, where special equipment is necessary, it is as a rule available to the unit. If it becomes essential, it is always possible to improvise safe methods, provided attention is paid to the fuselage construction and to the design of the undercarriage, so that the supports may be well clear of the landing gear during the necessary assembling operations.

246. The type of undercarriage commonly in use for the smaller aeroplanes is shown in fig. 67 and consists in side view of two struts forming a V, the top ends of the struts being attached to the fuselage and the lower ends connected together with a universal joint at the axle. One of these struts usually incorporates some form of shock absorber and is telescopic, and the other acts as a radius rod. In front view, an undercarriage of this type is usually cross braced, with flexible cables, in the panel formed by the radius rods. The truing up of this type of undercarriage is done in a similar manner to that described in para. 248 below.

247. Where a split axle undercarriage is used, similar to that shown in fig. 68, no rigging will be required, as all the parts are made to a fixed length and correct assembly should ensure a symmetrical undercarriage. If a check for alignment is required for this type of undercarriage, it should be carried out as for a wire-braced undercarriage. If, as a result of the

check, it is found to be out of alignment, then all fittings should be carefully examined and a comparative check made between the pin centres of all corresponding members, and the damaged or faulty part removed and substituted by a new part.

248. When a type of undercarriage similar to that shown in fig. 76 has to be trued up, the cross bracing shown at BB and CC should be adjusted to be equal in length, checking by trammel. The undercarriage should then be true, but to verify, drop plumb lines from the fuselage lower longerons on to the centre lines of the axle tubing, and measure along

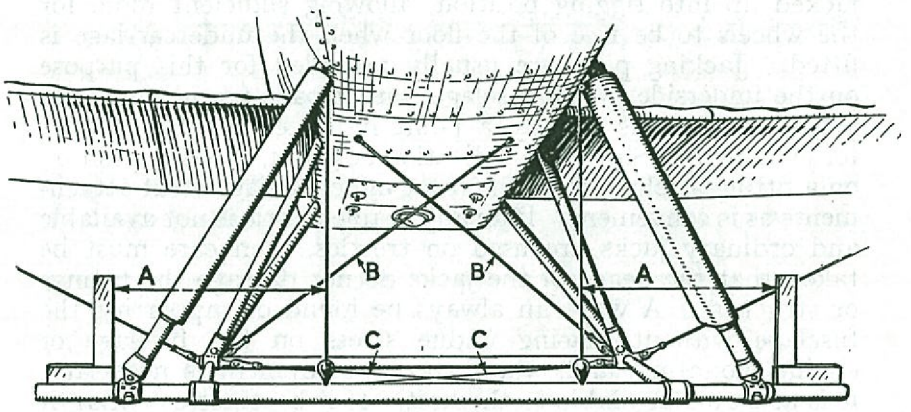
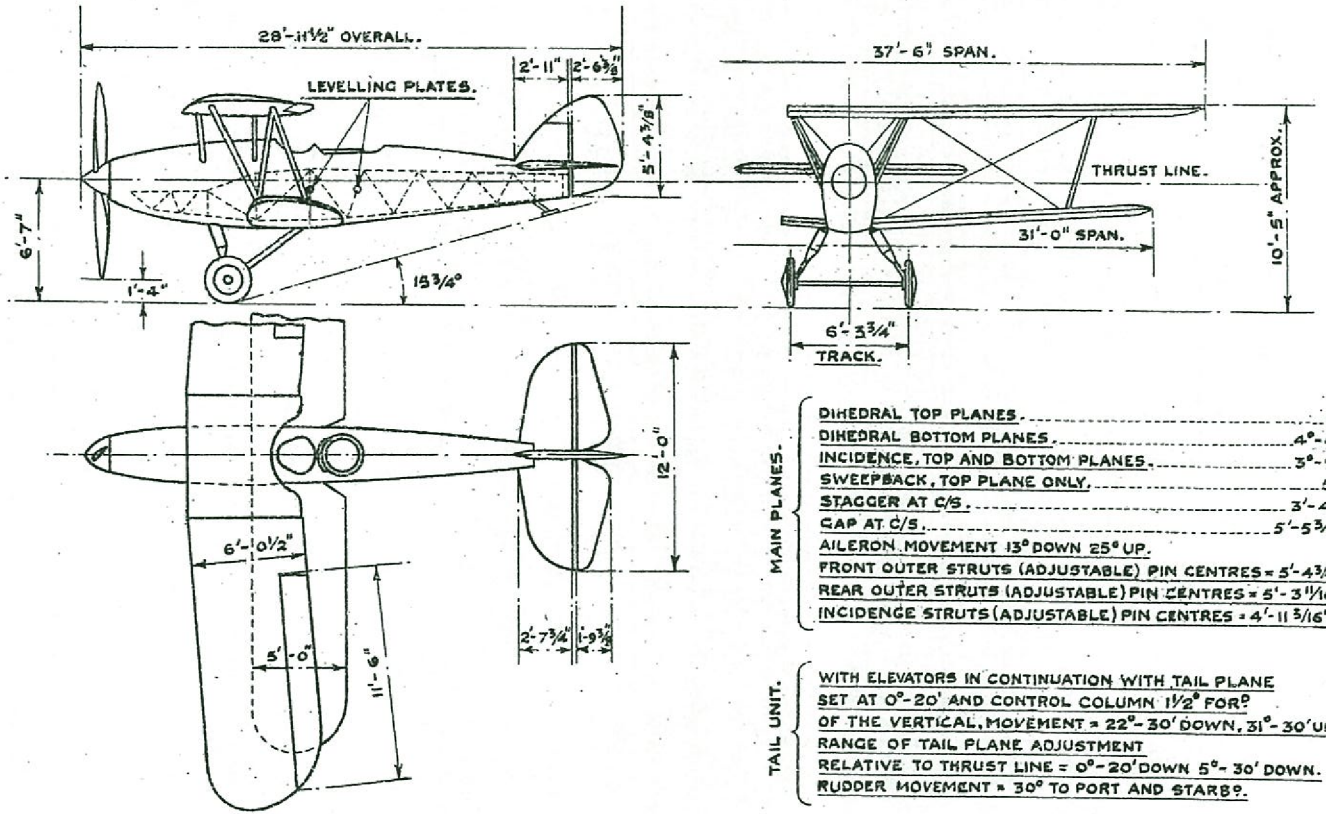


FIG. 76.—Truing an undercarriage.

the axle from these points to the inner flanges at the wheel hubs, A and A in fig. 76. When the axle is central with the fuselage, the distances will be equal on each side. A check for symmetrical rigging in plan view can be made by comparing the distances from the axle extremities to some fixed point on the centre line of the aeroplane near the sternpost.

249. Rigging adjustments to an undercarriage must be made with the aeroplane jacked up so that the weight is taken off the wheels. In this way, errors due to inequalities in the lengths of the shock absorber legs are obviated, as is also the danger of the undercarriage collapsing sideways should one of the wires become detached accidentally.



MAIN PLANES.

DIHEDRAL TOP PLANES	1°
DIHEDRAL BOTTOM PLANES	4°-0'
INCIDENCE, TOP AND BOTTOM PLANES	3°-9'
SWEEPBACK, TOP PLANE ONLY	5°
STAGGER AT C/S	3'-4"
GAP AT C/S	5'-5¾"

AILERON MOVEMENT 13° DOWN 25° UP.
FRONT OUTER STRUTS (ADJUSTABLE) PIN CENTRES = 5'-4¾"
REAR OUTER STRUTS (ADJUSTABLE) PIN CENTRES = 5'-3 11/16"
INCIDENCE STRUTS (ADJUSTABLE) PIN CENTRES = 4'-11 3/16"

TAIL UNIT.

WITH ELEVATORS IN CONTINUATION WITH TAIL PLANE SET AT 0°-20' AND CONTROL COLUMN 1½" FOR 0° OF THE VERTICAL, MOVEMENT = 22°-30' DOWN, 31°-30' UP.
RANGE OF TAIL PLANE ADJUSTMENT RELATIVE TO THRUST LINE = 0°-20' DOWN 5°-30' DOWN.
RUDDER MOVEMENT = 30° TO PORT AND STARB'D.

FIG. 77. TYPICAL RIGGING DIAGRAM.

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