CHAPTER IX.

ASSEMBLING AND TRUING UP A COMPLETE TRACTOR BIPLANE.

250. It is very difficult to lay down a definite procedure for the assembly and truing up of complete air-frames which would cover all types, as each particular type has usually some peculiarity of its own. The instances and methods given below should provide sufficient information to act as a guide for all types normally encountered.

251. An airframe is usually issued in components, that is, a complete fuselage, a complete undercarriage (which for the smaller aeroplanes is usually attached to the fuselage), centre sections, upper and lower, port and starboard main planes, tail plane or planes, ailerons, elevators, fin and rudder. To facilitate transport, some of the larger types of aeroplanes have the fuselage and also the main planes built in two or three sections, but in the following descriptions the components are considered as a whole, as the assembling of these parts is peculiar to the type, and for any necessary instructions regarding these parts reference should be made to the handbook of the type.

252. The difference between the assembling and truing up of a wooden airframe and that of a corresponding all-metal structure is usually not very great, but, as a general rule, the assembly of the latter type is somewhat easier than that of the former. This is owing to the fact that the interplane struts and other parts are made to a jig, and should therefore require little or no fitting, and also that struts, both fixed and pin-jointed, are used to a greater extent for bracing purposes.

253. A rigger is generally given all the particulars required when dealing with a particular type of aeroplane. Fig. 77 shows in diagrammatic form the information normally supplied. In addition to this, it is usual to provide any special information or warnings regarding the assembly, rigging or maintenance peculiar to the type.

Setting up the fuselage.

254. The first component to be handled in the assembly of an airframe is the fuselage, and it is assumed here that it is correctly rigged. If there is any doubt about the correctness of the rigging of a fuselage it should be checked as enumerated in Chapter VII. The fuselage should be placed on trestles, and arranged longitudinally and transversely level. If the undercarriage has not been attached, the height of the fuselage should be sufficient to allow the undercarriage to be placed in position.

255. The attitude of the fuselage, when correctly positioned for the assembly of the supporting and controlling surfaces, is termed the "rigging position," and is not necessarily the same as that used for the truing of the fuselage. The rigging position is usually clearly indicated in the rigging notes or the aeroplane handbooks. The provision on the aircraft for determining this position usually takes the form of a horizontal line painted on the side of the fuselage or levelling blocks or plates are attached to the members, so that the rigger may know that the fuselage is in rigging position longitudinally when a line taken through these points is horizontal. If clear instructions are not given for finding the rigging position, then the correct attitude for the fuselage can be obtained by arranging the fuselage so that the incidence of the lower centre section is at the correct angle. The transverse level can be ensured, if levelling blocks are not provided, by placing a spirit level on one of the fuselage cross members.

256. The method of supporting the fuselage varies to some degree, as the jacking points are in slightly different positions for each type of aeroplane. The jacking points are usually situated at, or forward of, the front undercarriage struts, and also at the rear of the fuselage in the neighbourhood of the tail skid. If adjustable trestles are available, the smaller types of fuselage can be jacked up directly at these points by placing the trestles across the underside of the fuselage as shown in fig. 79. If suitable adjustable trestles are not available, then the ordinary lifting jacks must be used, placed on fixed trestles or a similar form of rigid support. Packing blocks are often used when jacking up a fuselage, and care must be taken to ensure that the blocks are substantial and are securely positioned so that the weight is taken on the pads provided. If there are no clearly defined places for the supporting trestles, the greatest care should be taken in choosing these positions. It is always safe to place the front trestles at the front undercarriage strut fittings, as a strong bulkhead or strut is invariably placed in this position, and to choose a position for the rear trestle where the fuselage is strengthened to take the stresses due to the tail plane and tail skid.

257. If the fuselage has the undercarriage already attached it is not necessary to raise the front of the fuselage very much, only sufficient to take the weight of the fuselage off the wheels. Occasionally, special jury struts are supplied by the manufacturers, or wooden blocks are suitably disposed, so that, when these parts are used, the oleo leg strut is given a fixed length. In these circumstances, it is possible to raise the front part of the fuselage into the rigging position by jacking up the undercarriage only. If some form of jury strut is not

employed, it is obvious that, owing to the shock-absorbers, the undercarriage alone will not provide a sufficiently steady support for rigging purposes.

258. The normal method of levelling a fuselage or an airframe is first to level the fuselage longitudinally, and when this is roughly correct the transverse levelling is proceeded with. When the transverse levelling is correct, the longitudinal levelling is again checked, and any necessary adjustments made until the fuselage is securely supported and is level transversely and longitudinally.

Attaching undercarriage.

259. If the undercarriage is not already attached, this part should at this stage be fitted, and trued up as already described in paras. 244 to 249.

Attaching tail unit.

260. After the fuselage has been securely positioned in the rigging attitude, the tail planes, fin, and rudder can be fitted and roughly trued up, and the control cables or rods connected. The final truing up of the tail unit is better left to a later stage.

Attaching centre section.

261. The upper centre section is usually the next component to be erected. One method of doing this is to place the upper centre section plane upside-down on a piece of felt or similar material on the ground, and to fit the four centre section struts ; the bracing wires should then be attached, and the whole unit lifted into position. The loose ends of the struts are next attached to their respective fittings on the fuselage, and the ends of the bracing wires or struts connected up.

Truing up centre section.

262. To true up the centre section, trammel the front and rear diagonals until the leading edge of the upper centre section plane is horizontal, and is symmetrical about the vertical centre line of the aeroplane. If the planes possess any degree of stagger, and this is not fixed by side bracing struts, the side cross bracing wires must be adjusted until this is correct.

263. Cross bracing wires must never be used to pull a plane into its correct position or incidence. In all cases impeding wires must be definitely slackened off and the plane moved, or allowed to move sufficiently, and then the wires re-tightened.

264. The method of checking is as follows :—Drop plumblines from the extremities of the top front and rear centre section spar end fittings, as shown in fig. 78, and measure the gaps "A" and " B," which should be the same on each side

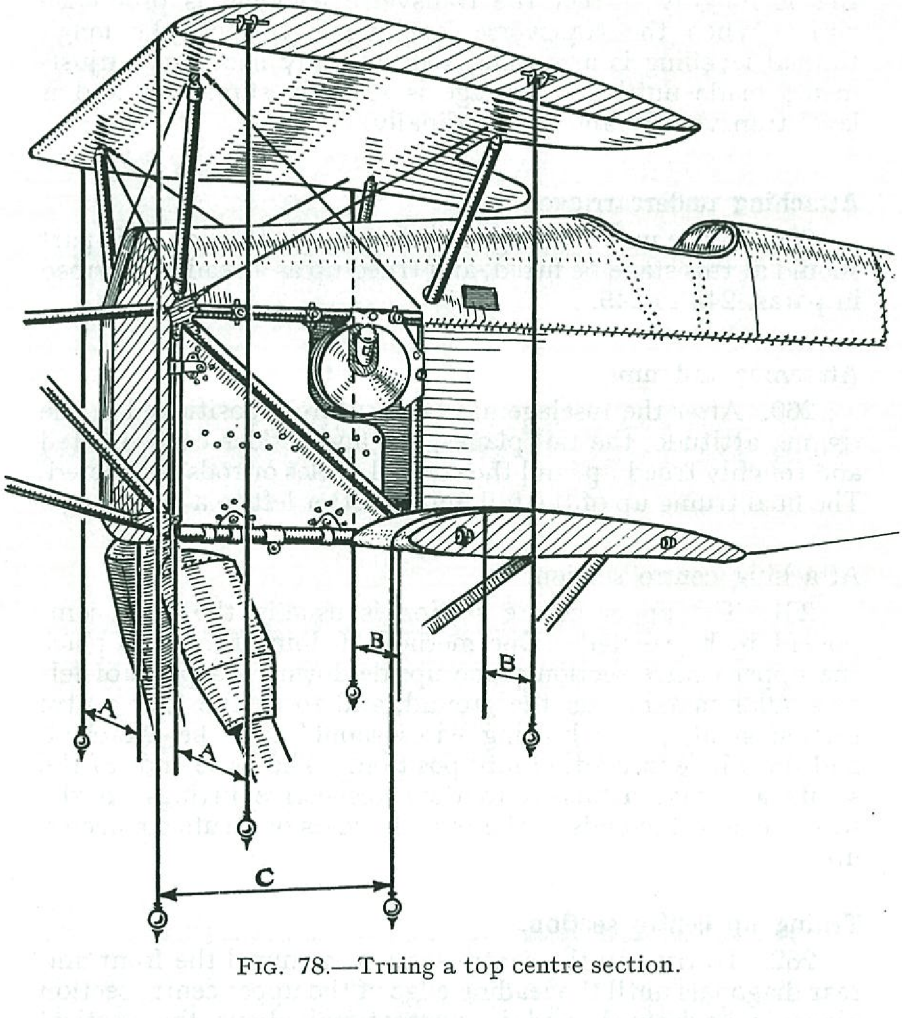

FIG. 78.—Truing a top centre section.

of the fuselage. To check the stagger, drop plumblines over the leading edge and measure the distance " C." This should also be the same on both sides, and should be in accordance with the instructions issued.

265. In some cases there will not be a separate top centre section, but the roots of the top main planes will meet at a point over the centre line of the fuselage. In this event, there will be some form of pylon or triangulated strut formation over the fuselage for the attachment of the planes. After this

has been erected it can be checked by dropping plumblines from the centre of the top fittings, and measuring from the plumblines to each side of the fuselage fittings. These distances should be equal. Sighting from the front across the two plumblines towards the fin post will prove whether the fittings are in alignment with the fuselage centre line.

Attaching main planes.

266. There are two commonly used methods of mounting the main planes on the fuselage, the choice between these two methods being decided chiefly by the size, weight, and design of these components.

267. In the first method, which is more applicable to the smaller types of aeroplanes fitted with two sets of struts, one of the lower main planes is placed with its chord vertical, and the leading edge resting on some protective material on the ground. The protective material is required to prevent injury to the leading edge, and should consist of felt placed in shallow wooden troughs. The interplane struts should next be fitted to their respective attachments, and the upper main plane brought into its proper position in relation to the lower, so that the interplane struts can be attached to this plane also. The bracing wires, which are supplied in their correct lengths and identifiable by tags, should then be joined to their respective fork ends (taking care that the same number of threads on each end of the wire are in engagement) and attached to the wiring lugs. In this way the complete cellule of the planes for one side will have been boxed up into a fairly rigid structure, which can be easily handled provided sufficient lifting power is available. After ascertaining that all control cables, chains, or rods are free, and in a fit condition to connect up, the planes should be hoisted into position and the spar attachments made to the upper and lower centre section. As soon as the plane spar attachments are made, the bracing wires for the inner bay should be connected up, starting with the inner anti-lift wires running from the upper centre section to the bottom of the inner pair of interplane struts. The same action should be taken on the other side of the aircraft to complete the assembly of the main planes.

268. The second method, generally adopted for small aeroplanes with a single set of struts and also for the larger multi-bay aeroplanes, is to erect each main plane separately. The order in which the planes should be fitted is usually determined for each type of aeroplane, and is generally given in the handbook. If the bottom plane is attached first, the bottom main plane spar attachments are fitted to their companion fittings on the fuselage or on the bottom centre

section stub plane, the outer end of the plane being meanwhile supported on a trestle at approximately the correct dihedral and incidence. The inner anti-lift wires should be attached as soon as possible.

269. The top main plane is then laid flat on a special felt-lined cradle and slung clear of the ground, and the interplane struts attached to the fittings provided on the underside. The next operation is to sling the plane into its correct position and to join the spars of the top main plane to the spars of the top centre section. A suitable form of lifting gear or crane should be provided for each type of aircraft, but if this is not available, temporary gear must be devised. Unless special sanction has been obtained, the roof of the shed or hangar should never be used. The interplane struts should next be fitted to the bottom plane, taking care that each strut mates correctly with its fitting as the plane is lowered. The bracing wires are then attached, and tightened sufficiently to make the structure reasonably rigid. The planes on the other side should be erected in a similar manner. When the main planes have been assembled, the transverse and longitudinal levelling of the fuselage should again be checked, and any necessary adjustments made. The centre section must be absolutely correct in rigging before any attempt is made to true up the main planes.

270. The engine may be fitted at any time during, or after the assembly of an airframe, but before doing so care should be taken to tie down the tail end of the fuselage to heavy weights resting on the ground, or to an eye-bolt or ring securely fixed in the floor, as otherwise the fuselage may tend to fall over on its nose. The tying down of the tail end is a wise precaution whether the engine is fitted or not. Care should be taken to see that the tying down does not put any strain on the fuselage. The rope should not be tighter than is necessary to take up the slack.

271. The attachment of the ailerons to the planes is usually undertaken before the planes are erected. During this process, some means must be taken to prevent damage due to the free movement of the ailerons, and a device such as that shown in fig. 106, and described in para. 466, should be used.

Truing up main planes.

272. The rigging notes for the particular type of aircraft being trued up will state the exact dihedral angle, and also the angular incidence of the planes and whether there is any "wash in" or "wash out." A typical rigging diagram is shown in fig. 77. In nearly all cases, specially prepared boards are provided to enable a rapid and accurate check to be made

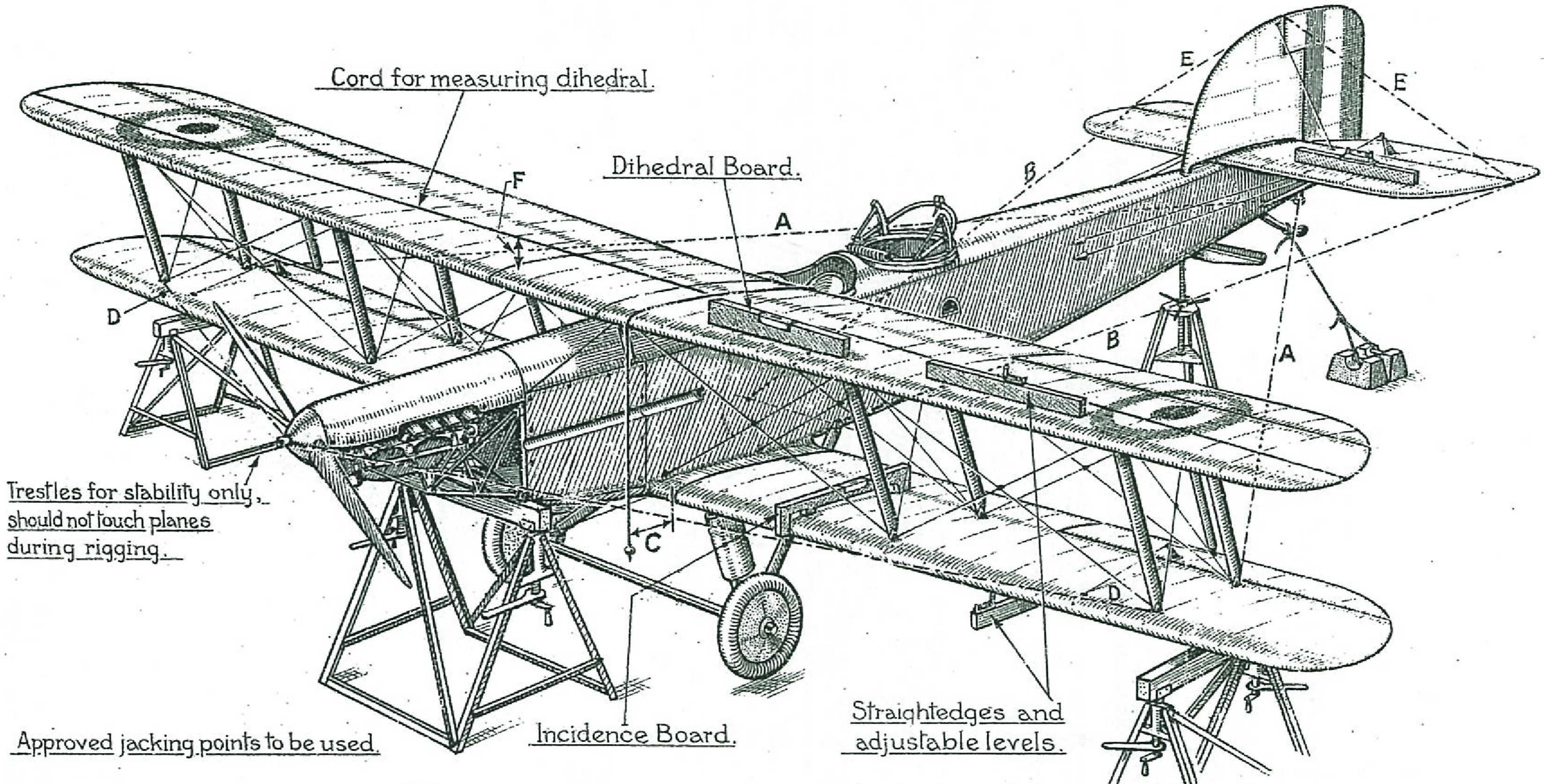

FIG. 79. TRUING UP A COMPLETE TRACTOR BIPLANE.

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of the incidence and dihedral angles. Where these are not provided, the incidence and dihedral of a plane should be ascertained by using a straightedge and a clinometer. In those cases where dihedral is present as well as " wash in " or " wash out," the dihedral angle must be taken as that represented by the front spar.

273. In some types of aircraft, struts are employed instead of the interplane cross bracing wires, and in these instances little or no adjustment can be made unless the struts are made adjustable for length, which is not often the case. Normally, the dihedral of the lower main planes is fixed by the adjustment of the front landing wires, and is checked by means of the special dihedral board placed approximately over the front spar positions, as shown in fig. 79, or by using a straightedge and clinometer placed in a similar position. The dihedral angle may also be checked by using a cord stretched tightly over the tips of the top main planes and measuring the vertical height (F, fig. 79) from the cord to the plane and proceeding as given in para. 319. The stagger is adjusted by the cross bracing between the front and rear interplane struts, and is checked by measuring horizontally the fore-and-aft distance between a plumbline dropped from the leading edge of the upper main plane to the leading edge of the lower main plane. When an aircraft has a different degree of dihedral on the upper and lower planes, the stagger will not be constant throughout the span, because a plane which possesses a dihedral angle pivots about a line inclined to the horizontal at an angle which is governed by the angle of incidence. Thus an increasing set-back is given to the plane as it moves from a position of no dihedral to a limiting position of 90° dihedral angle, the circle described by the tip to the leading edge not being in a vertical plane. The set-back is rarely of any great magnitude and is only found when upper and lower planes have different dihedral angles. As an example, if a 5° dihedral angle is given to the planes of a biplane which are twenty feet from root to tip and have 5° angles of incidence, the wing tip of the lower planes would be set-back about 1·8 in. behind a plumb line dropped from a corresponding point on the upper plane.

274. The incidence of the main planes, as defined in para. 19, is adjusted mainly by means of the rear landing wires, but the incidence bracing between the front and rear pairs of interplane struts must be adjusted at the same time as the landing and flying wires. The incidence is checked by means of a clinometer resting on a straightedge which is pressed against the lower surface of the plane along one of the ribs, or by means of the special incidence boards which are prepared for the purpose, as shown in fig. 79. The usual procedure with

many of the smaller types of aeroplanes is to get the dihedral right first and, provided that the centre section has been properly rigged, the incidence and stagger should then be correct, or require but little adjustment. The correct rigging of a large aeroplane is often only achieved after repeated adjustments and continual checking. If the appropriate instruments are not available, it is possible to check the incidence and dihedral angles by using a straightedge and spirit level. With the aircraft in rigging position, the straightedge is suitably disposed beneath the plane (on trestles or by clamping to struts) and levelled with the spirit level. The angle is then ascertained by measurement as indicated in para. 322.

275. Before leaving the wings, they can be finally checked to see that they are symmetrical with the fuselage by measuring the distance on each side from some convenient pair of fixed points near the tips of the planes to a fixed point on the centre line of the fuselage near the tail skid, and also that the incidence, dihedral and stagger on each side of the aircraft are equal and correct. It is probably best to check symmetrical erection of the main planes by measuring from the top and bottom of the rear outer strut fittings to the stern post, and also from the centre of airscrew shaft to the outer front strut fittings, as shown at A and D, fig. 79.

276. There is a tendency towards the restriction of the use of the datum line to the truing up of the fuselage only, and to the referring of the angles of incidence of the tail plane to the incidence of one of the main planes. In this case the incidence of the lower plane centre section should generally be taken as the key to which the other angles, including the angle of the tail plane and that of the remaining main planes, would be referred, but the rigging diagram or the handbook will give all the information required in this respect.

Truing up tail unit.

277. Normally, the stern post (sometimes called the fin post) is vertical. The longitudinal centre line of the fin generally coincides with the centre line of the fuselage, whilst the tail plane is laterally horizontal and also symmetrical about the centre line of the fuselage. If the tail plane spars are not tapered, this component is very easily checked transversely with a straightedge and spirit level. If the spars are tapered, it is necessary to know the height of the packing blocks which must be inserted between the straightedge and the tail plane tip, and the position of these blocks, before the straightedge and spirit level can be used. It would be advisable to make up a tapered board for use with the spirit level if tail

planes of this type have to be checked frequently. If packing blocks are to be made up, it is always possible to obtain the correct height by trial and error.

278. The tail plane must be symmetrical on either side of the fuselage, and this may be checked by taking measurements on each side from the tips of the tail plane spars to some convenient pair of fixed points on the fuselage or lower centre section, as, for instance, the rear undercarriage strut attachments, or the rear spar attachments of the lower main planes. If the measurements taken are equal and the tail plane spar is in one straight line, this spar will be at right angles to the centre line of the fuselage.

279. The method of measuring tail plane incidence is indicated in fig. 80. The height of the packing blocks may be given to the rigger, or it may be necessary to make these up by the process of trial and error, the relative heights being correct when the distances marked A are equal at front and

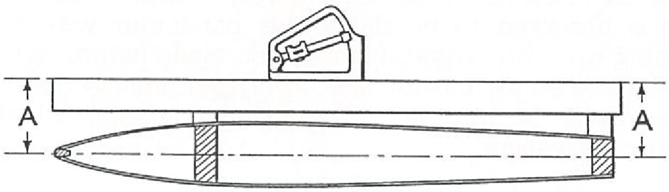

FIG. 80.—Measuring tail plane incidence.

rear. If the tail plane incidence has to be measured often, it would be advisable to make up an incidence board on the lines of the incidence boards for the main planes. Before proceeding to measure the incidence of the tail plane, care must be taken to place the tail adjusting gear in the normal position, as indicated in the rigging instructions.

280. Occasionally, for single-engined aeroplanes, the designer will have made the fin offset from the centre line of the fuselage in order to counteract the rotary effect of the airscrew slipstream. When this is done, the rigging instructions will generally specify the amount of offset, usually the distance in inches, between the longitudinal centre line of the fuselage and the centre line of the leading edge of the fin.

Locking bracing wires.

281. All bracing wires must be definitely locked, the usual method of doing this being by means of locknuts made of cast iron or brass. The nuts are composed of this material so that, if too great a pressure is used the nuts will split or the threads strip before the bracing wire is over-stressed at this

point. In addition to the locking of the wires they must be prevented from vibrating excessively, as otherwise wires which cross one another, and are in contact or are in close proximity, will suffer considerable damage. Also, from the wireless reception point of view, intermittent contact must be avoided. (This point is mentioned later in connection with bonding and screening). The usual method for internal wiring is to use a flat disc of red fibre, attached by soft iron wire or cord, between bracing wires where they cross, as shown at A and B, fig. 83. A grooved disc is also used as shown at C. Where duplicate wires are used externally, "acorns" are generally employed as shown at E, but sometimes the front and rear lift and anti-lift wires are connected as shown at D. Where the effects of vibration are very severe, twin bracing wires are attached to one another about midway between the intersection of the wires and the fork ends, by a fitting of the type shown at F.

282. It must never be immediately assumed that because a wire is observed to be slack, this particular wire requires tightening up. Investigations must be made before tightening up a slack wire to ensure that the slackness is not due to over-tightness of another wire, or to damage which has escaped observation.

Flying controls.

283. The flying control system of modern small aeroplanes is usually very simple, and an example of a common arrangement is given in figs. 81 and 82. In the larger aeroplanes the

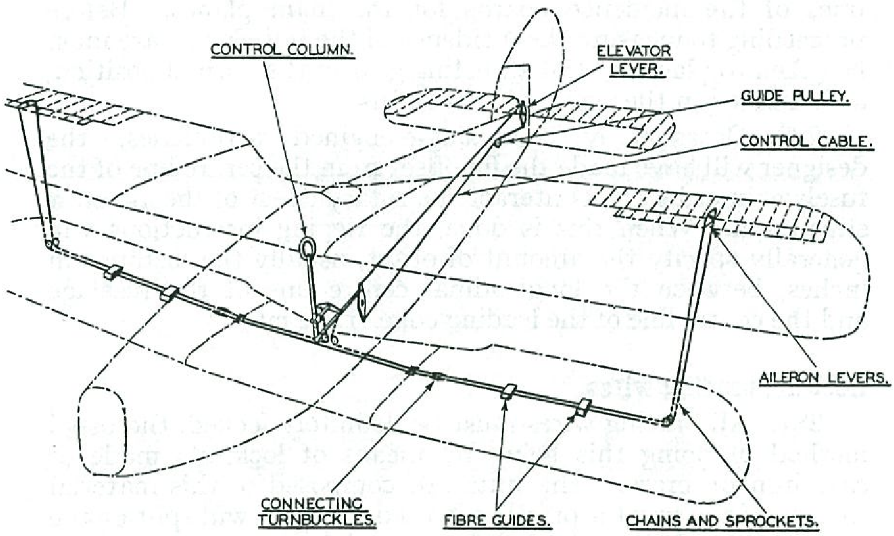

FIG. 81.—Control system—aileron and elevator.

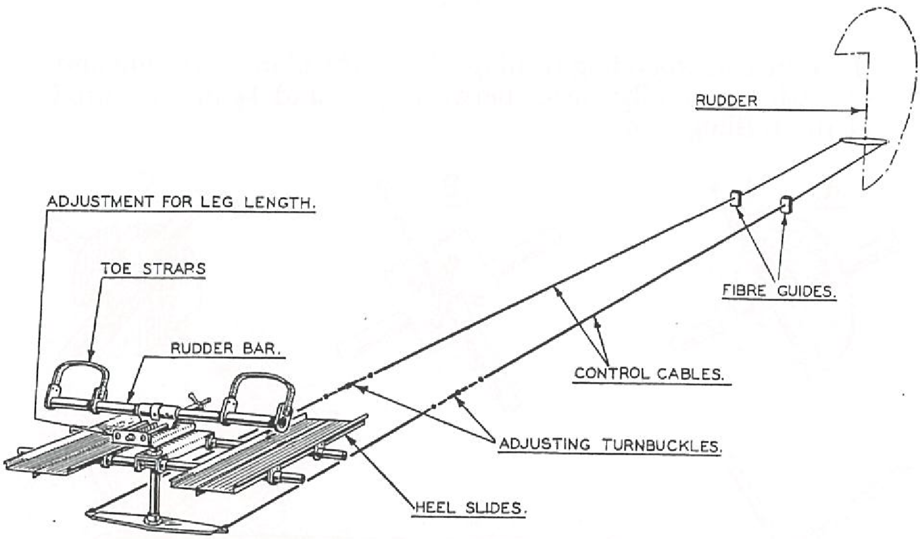

FIG. 82.—Control system—rudder.

control system is of necessity rather more complex, but the principle is the same as that illustrated. Before assembling the supporting and control surfaces, care should be taken to see that all control cables, chains, rods and levers are in a fit condition to connect up.

After assembling the aerofoils and coupling up the controls, adjustments should be made so that the cables and other parts are fairly taut, but work without undue stiffness, and that all control surfaces when in their neutral position are symmetrical about the centre line of the aeroplane. The control column is not always vertical when the elevators are in line with the tail plane, but is not infrequently inclined forward when in the neutral position. The rigger will always have specific instructions on these points. After connecting up the controls, the rigger should sit in the pilot's seat and operate all the controls one at a time, to see that the full range of movement is obtained, that the controls are not stiff in action and that the control surfaces move in the right direction following a corresponding movement of the rudder bar or control column. It is vitally important to check that a forward movement of the control column drops the elevators, that a movement to the right drops the left or port aileron and raises the right or starboard, and that a movement to the left reverses this motion.

Ailerons, setting of.

284. In order to allow for the stretch of the cables when under load, ailerons are sometimes given an initial droop, that is, the trailing edge of the aileron is set a little lower

than the corresponding trailing edge of the plane. The amount of setting generally varies between $\frac{1}{2}$ in. and $1\frac{1}{2}$ in. measured at the trailing edge.

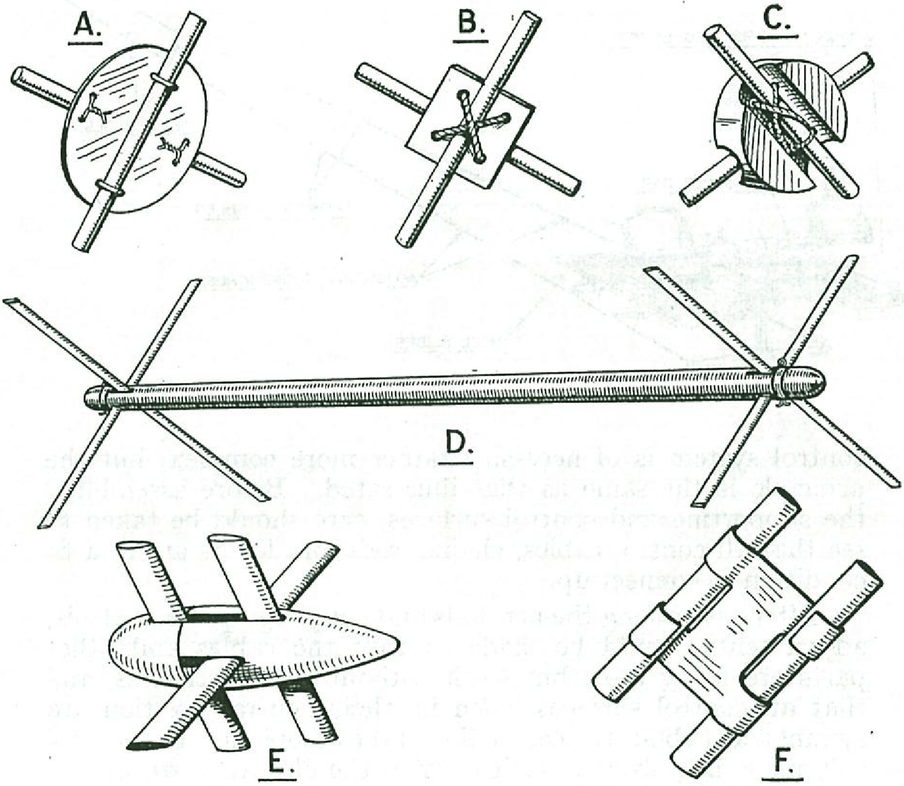

FIG. 83.—Vibration preventers on bracing wires.

Run of cables.

285. In the system illustrated in figs. 81 and 82 cables are used throughout, except at those points where the cables are deflected greatly out of their normal run. In positions such as these, chains and sprockets are adopted to obviate the rapid wear of cables, which is inevitable if plain standard pulleys are used. Where the wire is only slightly deflected (less than 5°), fibre fairleads are usually employed, generally split to facilitate the renewal of cables. In those instances where the cable is deflected more than 5°, it is normal practice to introduce a pulley and so obviate any unnecessary friction. Although the instances are getting rarer, there are still many aeroplanes in which plain control cables are used throughout the complete system. In many cases on these aircraft, comparatively small pulleys are used and there is often a deflection of the cable from its normal run of about 90°. In these cases,

the examination and renewal of the cables is an important item in the maintenance programme. The cable used is always extra flexible steel to B.E.S.A. Specification W.2, and it is specially manufactured and tested for this particular work, but in spite of this, it is not possible to make a cable which will last indefinitely if, in its working position, it is bent round a comparatively small diameter pulley.

286. For service aircraft it is usual to duplicate all control cables running to the rudder, and to the elevator also if they are interconnected in accordance with the general requirement. This duplication is a safeguard against loss of control should one of the cables become shot away or broken.

Control rods.

287. In many aeroplanes, especially of the larger types, single push-and-pull rods are used for the controls instead of flexible cables, as it is found that this form of actuating gear requires considerably less attention and fewer renewals. In this type of control mechanism the rods are usually composed of small diameter tubing, with suitable end fittings, connected to bell-crank or other forms of lever. When possible, the rods are supported at intervals throughout their length by small pulleys or similar devices, and are usually adjustable for length.

Adjustment of elevators.

288. In all the tail plane incidence control systems commonly in use, actuation of the incidence gear will to some extent affect the elevators in all positions except the normal flight setting. This makes it essential for the rigger to adjust the elevator controls only when the tail plane incidence is at the normal. The mid-position is always taken as the normal unless otherwise stated. The elevator control should be tested to see that it works smoothly at all positions of the tail plane incidence gear.

Variable camber gear.

289. For the purpose of giving a wider speed range to an aeroplane, the designer sometimes provides additional flaps which are hinged to the rear spars and situated usually inboard of the ailerons. The pilot is given a separate control by means of which he may depress these flaps and so virtually alter the camber and incidence of the wings. In practice, the variable camber is normally used only when it is desired to land at as low a speed as possible. When this gear is fitted, any specific instructions required for adjustments are usually included in the rigging notes of the aeroplane.

Auto control slots.

290. Where automatic slots are fitted, these are usually built up with the wing and should need very little attention other than lubrication of the bearings. When for any reason it has been necessary to dismantle a slot, there should be no trouble with its functioning after reassembly, provided that the setting of the gap at the trailing edge of the slot is as stated for the type, or is arranged as it was before dismantling. Fig. 54 shows a typical arrangement of an automatic slot. In this case the links and other parts are made to a fixed length, which precludes any adjustments being made, and definitely fixes the gap. Where adjustment is provided, care should be taken to get the setting correct, as otherwise the slot will not open at the correct time. Automatic slots are inclined to open sooner than is required if the trailing edge gap is too small.

Rudder bias gear.

291. Some aeroplanes are fitted with an arrangement by which the rudder is given an initial setting to one side. This gear is usually operable from the pilot's seat. The object is to allow the pilot to set the rudder during a long straight flight for the purpose of counteracting uneven engine thrust or similar defects, thereby obviating the tiring effects of continual pressure on the rudder bar. It is only necessary to see that the bias gear operates correctly, and that no bias is applied during the time that the rudder control cables are being adjusted.

Auilixary rudder control.

292. An auxiliary rudder control is usually only fitted to those aeroplanes provided with a bomber's slot in the bottom of the fuselage. The auxiliary control is usually coupled up to the rudder bar or to the rudder control cables, and needs little attention other than to see that it functions correctly and in no way impedes the action of the rudder bar.

Servo rudder.

293. A servo rudder is an auxiliary control surface, operable by the pilot, which actuates the main rudder, thereby making the aeroplane less tiring to fly. A servo rudder usually takes the form of either a narrow flap along the trailing edge of the main rudder, or a small, square auxiliary surface, placed 2 or 3 ft. behind the main rudder and attached thereto by outriggers. The control is usually very effective, and therefore in order to provide the pilot with some resistance

when operating the rudder bar, it is common practice to give the servo rudder some form of spring loading. Another device connected with servo rudders is called " follow up," and consists of the provision of some mechanical arrangement whereby the main rudder comes into direct operation by the rudder bar after the servo has been moved over to the full extent allowed by the stops.

294. The adjustment and lining up of a servo rudder is quite simple, as it is only necessary to see that the servo rudder and the main rudder are in line with one another and also in line with the plan centre line of the aeroplane when the rudder bar is transversely square with the fuselage.

Lubrication of controls.

295. One of the chief difficulties in the maintenance of control systems is the adequate lubrication of the bearings in the planes. Not only is the lubrication of these parts difficult, but even when lubricated care must be taken that the lubricant does not solidify or freeze during the extreme cold encountered at high altitudes and lock the controls, or make them exceedingly difficult to operate.

296. It is usual to employ anti-freezing oil, Stores Reference 34/43 and 46, and grease in any form should be avoided for the bearings of flying controls. (*See* Air Ministry Technical Order 143 of 1930). This means that parts which would normally be packed with grease and left an indefinite period will need attention a little more frequently when oiled with anti-freezing oil. Fibre fairleads should not be lubricated. Protection against corrosion will be dealt with in detail later, but cables or wires must not be covered over with paint or any substance which prevents immediate inspection of the part.

Examination of controls.

297. All well-designed control systems provide ample opportunities for examination of all the joints, connections and bearings, usually by means of tear-off patches or small sliding light alloy doors in the planes, and easily detachable fairings on the fuselage. The types of tear-off patches used are shown in fig. 105. Adequate arrangements are generally made for renewal of cables, and where the cables are long, such as in the interior of some of the larger planes, it is not unusual for the cables to be built up in sections, so that if only a small portion is defective the whole length need not be replaced. Where no definite arrangements are made for the renewal of cables in planes, a new cable can generally be introduced in the manner described in para. 459.

298. The control mechanism should be frequently inspected for corrosion, wear, frayed cables and incipient fractures or cracks, and also to see that all the locking devices, such as split pins, are in position and are secure. Where turnbuckles are used these must be securely locked with soft iron wire as shown in fig. 73.

Inspection.

299. The necessity for accurate, intelligent and systematic inspection of aeroplanes cannot be too greatly emphasised. It is of vital importance that all aeroplanes in service should be very thoroughly examined and that these examinations should be made in accordance with a set routine. The routine is usually detailed in the maintenance schedules for the type (*see* Air Ministry Weekly Order 25 of 1929), and the schedule, including any amendments made, should be strictly adhered to.

300. If an aeroplane has been subjected to a heavy landing or to any treatment which may adversely affect the structure, all the parts affected, or likely to be affected, should be examined in minute detail, in order to ascertain the exact extent of the damage.

301. After re-assembly, necessitated by repairs, the aeroplane should be completely inspected before it is passed as fit for flying. The inspection should be made methodically and in accordance with a system. The system usually adopted is to divide the aeroplane into a number of logical and convenient groups, and deal with each group in a definite order. The grouping normally employed is :—undercarriage, fuselage, tail unit, cockpits, mainplanes, airscrew and general. During the inspection of each group the inspector should, as far as the group lends itself to such procedure, always go round it in an anti-clockwise direction, examining each individual part in detail as it is encountered.

302. Every airframe has a log book which accompanies it throughout its service life. In the log book are recorded all matters bearing upon the life or serviceability of the airframe. In addition to the log books, there are Weekly Aircraft Maintenance Forms in which are recorded all matters dealing with the routine inspection and maintenance of the aeroplane.

Rigging defects and remedies.

303. The following list of faults, with their possible causes and remedies, is given only as a guide to the rigger when ascertaining the reason for a defect which has been reported after flight. In all cases the rigging notes and instructions

for the particular aeroplanes, contained in the handbook or elsewhere, should be rigidly adhered to.

Symptoms.—Tendency to yaw, i.e., does not fly straight.

Cause.—Resistance not the same on both sides ; may be caused by one of the following :—

(*a*) Fin not in alignment, giving the effect of slight rudder.

(*b*) Fuselage not in correct alignment, giving an effect as in (*a*).

(*c*) Resistance greater on one side than the other, due to such causes as wires or struts not being in true line of flight, distorted surface, bombs, generators, etc.

(*d*) Elevators not in alignment with tail plane on one side, giving slight torsional effects and greater resistance on one side.

Symptoms.—Tendency to roll, i.e., inclined to fly one wing down.

Cause.—Lift greater on one side than the other, which may be caused by one of the following :—

(*e*) Incidence of the main planes greater on one side than the other.

(*f*) Ailerons out of alignment with control column central.

(*g*) Dihedral greater on one side than the other.

(*h*) Surfaces distorted, giving greater or less lift on one side.

(*i*) Unequal distribution of the load due to wing tanks, bombs, etc., giving, in effect, unequal wing loading.

Symptoms.—Nose or tail heavy.

Cause.—(*j*) Stagger incorrect.

(*k*) Incidence of tail plane incorrect.

(*l*) Incidence of main planes the same on both sides, but incorrect.

(*m*) Loading incorrect. (This should never occur, as the correct loadings between the limits of the C.G. position are always given).

304. In addition to the above, it is possible for certain rigging defects, such as the incidence of the main planes or tail plane not being the same on both sides, to give a slight tendency to yaw during flight as a secondary effect (as at (*c*)), the primary having been corrected by the pilot.

305. It should be noted that there will probably be a tendency to yaw with the engine off, due to the offset fin or "wash-in" of the planes. This must not be confused with the tendency to yaw in steady level flight.

Rigging allowances.

306. Rigging notes and instructions generally give the angles and dimensions in exact figures, but in practice it is seldom possible to work to the exact dimensions given. A tolerance is therefore permissible on all dimensions.

307. The allowances to be made vary with different aircraft, obviously depending mainly on the type and size of the aeroplane and the magnitude of the dimension. Table V may be taken as a guide as to what limits may reasonably be allowed, under good conditions, for a small high-performance tractor biplane of the Siskin or Bulldog type. *It must be distinctly understood that the tolerances on a larger aeroplane or on an equal-sized aeroplane of a different type (Avro 504.K. or Moth, for example) may be very different. The utmost care must be taken to avoid damage to the structure owing to an attempt to work to too strict a tolerance; on the other hand, no effort should be spared to obtain the closest approximation to the rigging dimensions that the normal adjustments will allow.*

TABLE V.

(NOTE.—This table must be used strictly in the light of para. 307.

Checks.	Limit.	Remarks.
Top centre section for being central.	± 1/16 in. ..	"A" and "B," fig. 78.
Top centre section for incidence	± 10 mins. ..	See fig. 4.
Main planes, dihedral ..	± 15 mins. ..	See fig. 4.
Main planes, incidence ..	± 15 mins. ..	See fig. 4.
Main planes, stagger	± 1/8 in.	"C," fig. 79.
Main planes, gap variation throughout span.	± 1/16 in. (1/32 in. in 3 ft.).	
Symmetrical rigging, rear diagonals.	± 3/4 in.	"A," fig. 79.
Symmetrical rigging, front diagonals.	± 1/2 in.	"D," fig. 79.
Tail plane alignment, lateral	± 1/4 in.	"B," fig. 79.
Undercarriage alignment, lateral.	± 1/4 in.	"A," fig. 76.
Undercarriage alignment, longitudinal.	± 1/4 in. ..	"C," fig. 84.
Rudder post alignment, vertical	± 1/8 in.	"E," fig. 79.


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