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BLOCTUBE CONTROL SYSTEM

GENERAL AND TECHNICAL INFORMATION

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Introduction

1. The Bloctube control system consists of an assembly of levers in a control box or boxes and a transmission line, which provides positive mechanical operation from a position convenient to the pilot. Control levers, grouped together and easily identified and made accessible by their being of different lengths, are coupled through the medium of tubular rods and levers to such engine details as throttle, mixture, hot and cold air-intake, the two-speed operating lever of the supercharger, and the propeller pitch or speed control. One lever in the control box may control one of these items so that on twin-engined aircraft such controls as mixture, throttle and fuel cocks may be coupled in pairs to a single control lever, while two control levers, e.g. one

for each propeller on twin-engined aircraft, may be coupled together. The detail arrangement of the control system varies with each type of aircraft but the components and functioning are common to all systems, irrespective of the layout detail.

List of major components

2. The major components of the control system are as follows:-

(i) The control box, in which the control levers are mounted (see fig. 1 and 2).

(ii) The locking box, in which any necessary inter-coupling between two controls is effected - e.g. throttle and mixture (see fig. 3).

(iii) The transmission line, consisting of straight tubes, guide blocks, crank levers and shafts, through the medium of which movement of a control lever is conveyed to the operating lever on the component controlled (see fig. 4 to 7).

DESCRIPTION OF COMPONENTS

Control box

3. The control box is peculiar in the lever arrangement, to each type of aircraft, therefore a general description cannot cover all designs. The following information is however generally applicable and, in conjunction with the illustrations fig. 1 and 2, explains the constructional and operational principles. The control box consists of two side plates of aluminium-alloy approximately triangular and connected by threaded studs that keep the plates rigid, parallel and at the correct distance apart. Two lugs are riveted on the lower corners of the plates to serve as attachments to the airframe, with a single bolt passing through each lug to provide four-point attachment, though other means of mounting may be employed in accordance with design requirements. The control levers are mounted on spindles, the levers being located thereon by distance pieces and shims. The spindles are threaded internally at each end into which setscrews are fitted to hold them rigidly in the side plates. Each lever is a single-piece stamping drilled for lightness and terminating in a central disc fitted with an oilite bush to provide a self-lubricating bearing on the spindle. Screwed radially into the periphery of the disc is a ball with a stop-pin to which the socket of the first tube of the transmission line is connected. The upper end of each lever is capped by a spherical knob which is generally a fixture, but in the case of levers which require to be locked in the extreme positions, the knob serves to operate a spring-loaded locking plunger. All control levers are of the same pattern and cut to individual lengths; some throttle levers, however, have a curved tubular extension fitted, to increase their length beyond that of the standard stamping, so increasing their sensitivity and accessibility.

4. At a convenient radial distance from the axis of the lever spindle are two long studs held in the side plates by nuts at each end; these studs serve also to hold the quadrants, along the arc of which the control levers travel and on which adjustable stops are attached in order that the travel of the levers can be limited as required. In addition, the studs support the ends of spring flanges which are used in some control boxes to apply frictional load on the lever discs, the load being adjustable by tightening the nuts on the studs to increase or diminish the pressure of the flanges against the lever discs. These spring flanges are not used in instances where throttle levers require variable and frequent frictional loading; instead, a readily accessible external

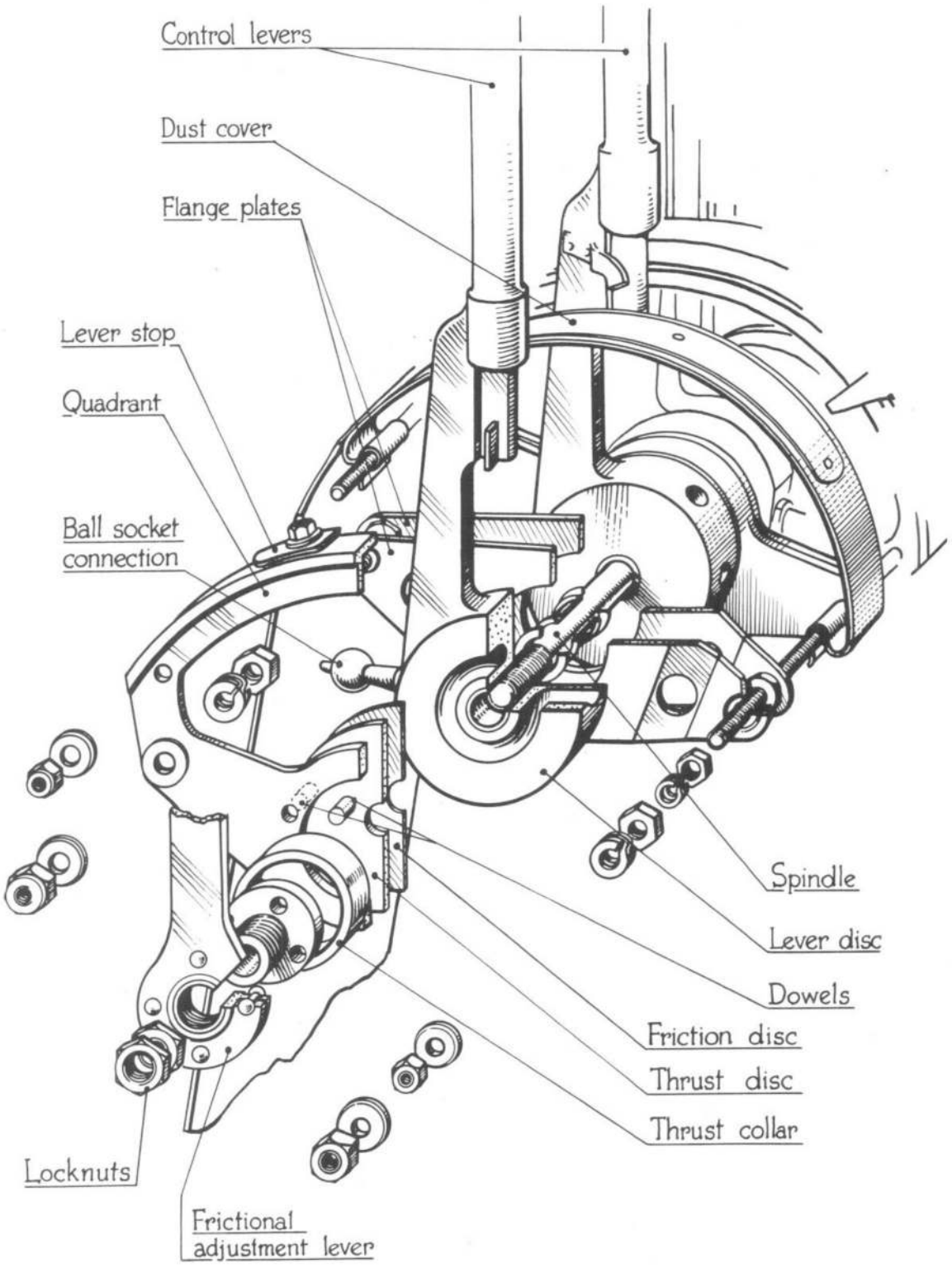

Fig. 1 Typical arrangement of control levers and frictional discs

lever or hand-nut is incorporated in the box giving immediate adjustment between the free and the locked positions of the control lever; in such cases the spring flanges mentioned above are retained in the control box for constructional reasons and not to provide friction on the lever. Dust covers carrying name-plates for the relevant levers are held on the control boxes by steel spring clips engaging at each end with the studs between the side plates.

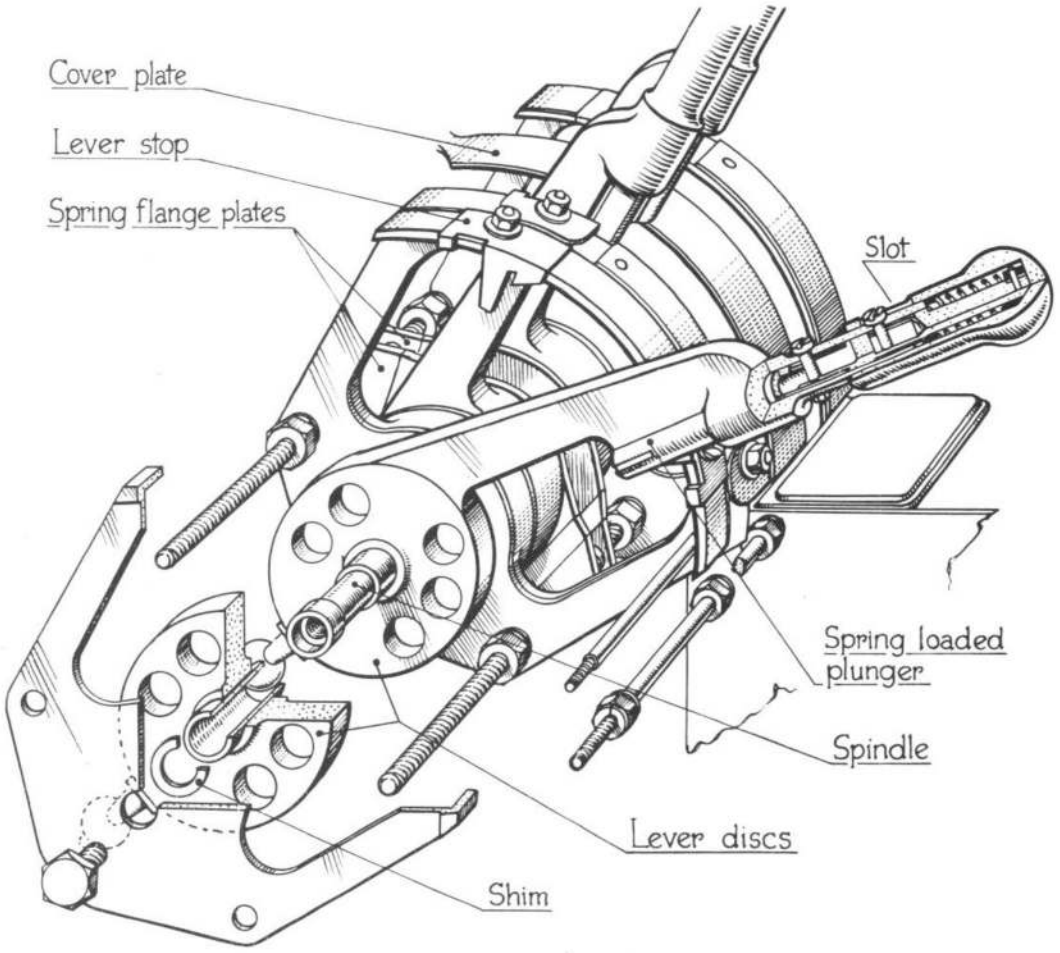

Fig. 2 Bloctube controls - 4-lever assembly

5. Throttle levers are usually provided with the hand-nut or lever adjustment, whilst propeller control levers have constant loading, applied by means of the spring flanges; levers may also be entirely free from any friction loading. Levers that require to be locked in the extreme positions, e.g. those controlling fuel cocks or two-speed superchargers, have a spring-loaded plunger fixed in the handle, operated by lifting or depressing the hand knob to engage with stops at each end of the quadrant. On all other levers instead of this plunger a fixed blade is fitted which comes into contact with a stop on the quadrant and while limiting the travel of the lever does not provide any positive locking, so that the lever may be positioned in use anywhere within the limits of its travel, in contrast with the levers which are locked only at one end or the other of their quadrants.

6. There are usually four control levers on each spindle of a control box, though there may be only two; the number of spindles in the box may be one, two or three; when more than three spindles are required in a control system they are usually included in separate boxes, each spindle having two or four control levers, the boxes being arranged in tiers within reach of the pilot. On twin-engined aircraft, such primary controls as throttle, mixture, airscrew, hot and cold air-intake and supercharger, are incorporated in the main control box; others, such as carburettor cut-off and fuel cocks, may be included in the same box or separately mounted. On four-engined aircraft, separate control boxes may be provided for the throttle and other controls for which four levers

are necessary, while the transmission lines to components operated by a single lever (e.g. mixture controls) may be coupled together at some convenient point or points in the transmission line from which a single tube leads to one control lever. Normally, levers are pivoted on the spindle to give a movement for-and-aft along their quadrants, but in some instances, such as carburettor cut-off and fuel cock controls, a handle for direct push-pull action may be fitted. The grouping of the levers varies with different types of aircraft, a typical arrangement being two throttle and two mixture levers on one spindle with the control levers for the superchargers, air intakes and propellers on another spindle at a lower level in the box, fuel cock control levers, etc. being at a still lower level in the same or in a separate control box.

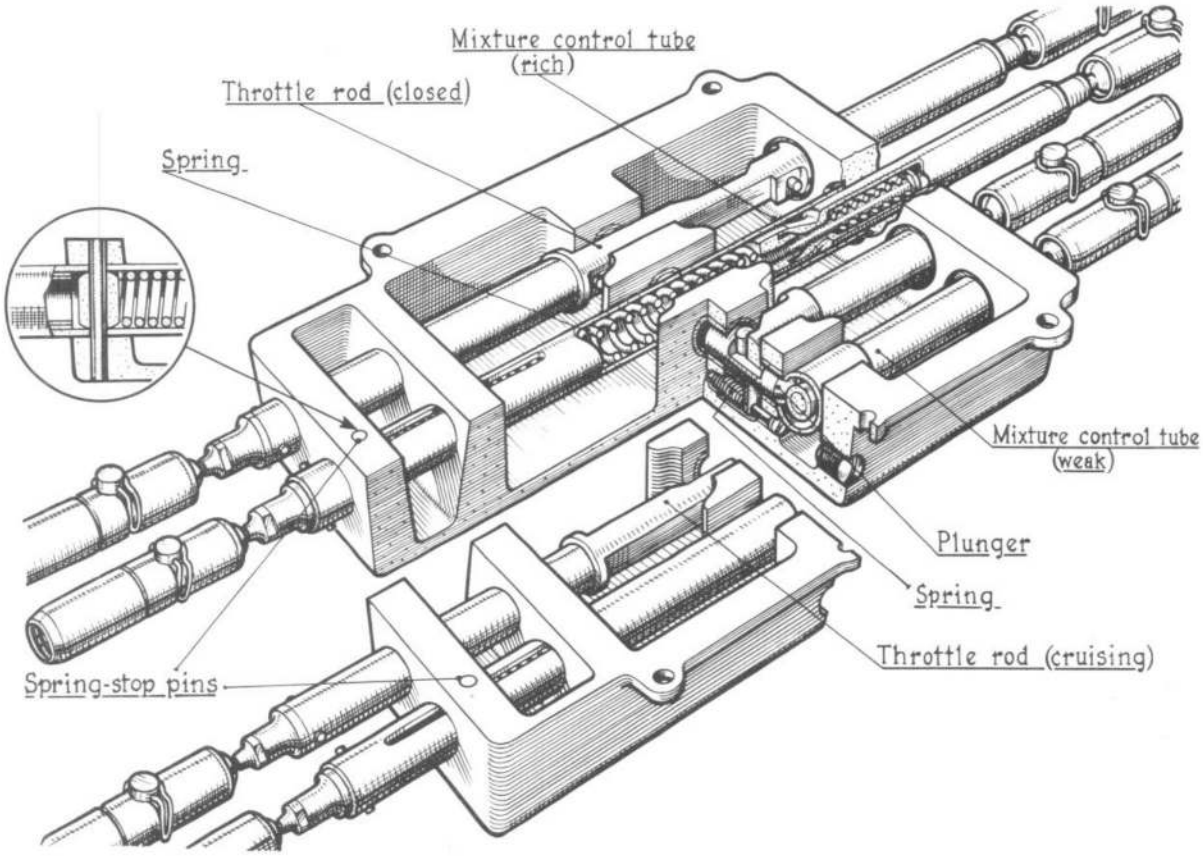

Fig. 3 Bloctube controls - locking box

Frictional loading of control box levers

7. The constant frictional loading arrangement consists of a Ferodo disc interposed between the disc of the lever and the spring flange plate, the frictional contact depending on the positions of the spring flanges as determined by their adjusting nuts. When the handnut adjustment is fitted, the spring flanges are not in frictional contact with the levers, the load being applied externally, as required by the pilot. It is always of the greatest importance, however, to ensure that the spring flanges are at right angles to the studs and parallel to the control-lever discs. The handnut adjustment consists of a device for bringing the lever discs and friction discs on the spindle into contact by compressing them against a fixed collar fitted in a groove in the spindle. When all the levers on a spindle are to be affected by the adjustment the collar is mounted at the remote end of the

spindle to the lever or handnut adjuster; if only some of the levers are to be loaded, generally two in a four-lever assembly, the collar is fixed at the centre of the spindle, the levers between the collar and the handnut thus being controlled while those on the other half of the spindle are not affected. The handnut may be fitted with a lever, depending primarily on the position of the control box in the aircraft, a lever usually being provided when it is accessible from above the control box, though the handnut gives finer adjustment when easy access to the side of the box is possible; for descriptive purposes the term handnut will be used.

8. The handnut screws on to a flanged and threaded bush, surrounded by a thrust collar and retained on the end of the control lever spindle by two locknuts, this part of the assembly being to the exterior of the side plate of the control box. On the control lever spindle inside the side plate is a thrust disc in which four dowel pins are fitted, two of which engage with the fixed quadrant and the other two engage in holes in the flange of the screwed bush to prevent it rotating. The thrust collar bears against the thrust disc which is in contact with the first friction disc on the spindle, the actual pressure depending on the amount of adjustment given to the handnut. When this is tightened, the outer collar, the thrust disc, the friction discs and lever discs are forced into closer contact with each other against the inner collar which is fixed in a groove in the spindle; the inner collar is also pinned to one of the quadrants to hold the spindle. The hand adjustment thus regulates the effort necessary to move the control levers and may also be used to lock them in any intermediate position along the arc of movement.

Locking box

9. The control levers are coupled to the first countershaft in the transmission line, and the locking box is coupled, next in the line, as close as convenient to the first countershaft. The throttle and mixture controls pass through the locking box in which they are inter-coupled by a system of cams and spring-loaded plungers so that the mixture can be set to stay at 'weak' over a required range of throttle setting - i.e. cruising. The mixture lever cannot be fixed in the 'weak' position until the throttle lever is within the 'cruising' range and as soon as the throttle lever is moved out of this range, either backward (towards closing) or forwards for wider opening, the mixture lever is immediately and automatically returned to the normal or 'rich' position. The mixture-control lever then cannot be locked in the 'weak' position until the throttle is returned to the 'cruising' position, although it may be held by hand in the 'weak' position. For description purposes it will be convenient to consider a locking box in which one throttle and one mixture-control tube in the system are interconnected, though there may be more than one of each in a given locking box, also, one mixture tube may be connected with more than one throttle tube, as for example when the mixture settings of multi-engined aircraft are controlled by a single lever in the control box.

10. The locking box (see fig. 3) is rectangular in shape, having bearings in each end through which the control tubes slide, one end being webbed and fitted with taper pins which act as stops for the coil spring within the mixture tube. Inside the box, which is closed by a cover plate or lid held by two screws, is a transverse boss in which the spring-loaded plungers which effect the interlocking between the throttle and mixture tubes are arranged. Sliding within the locking box is a square section steel rod, one face of which is machined to form a cam profile; the rod is screwed into the ends of the throttle tube of which it forms a part and is secured by split pins. Inside the mixture tube, in the control box section, is a spring-loaded telescopic assembly. The larger of two coil springs is positioned by the spring stop at

one end of the locking box as mentioned above, and at the opposite end bears against the end of the inner tube. The end of the tube is machined to form a tapered groove which registers with a hole in the outer tube. The spring-loaded plunger, sliding in the boss inside the box, has a vertical pin, fitted in a slot across which the throttle rod slides. The head of the plunger normally bears against the mixture tube so that the vertical pin is held away from the square-section rod of the throttle control. If, however, the mixture tube is operated by the control lever to give weak setting at the carburettor, a hole in the tube will be brought opposite to the plunger, the head of which will tend to enter the hole in the mixture tube and hold it against the spring pressure. Before the plunger head can enter the hole, however, the pin in the plunger slot contacts with the throttle rod and so the plunger movement is restrained and the head cannot enter the hole. When the cam recess in the throttle rod is opposite to the plunger pin the plunger head may enter the hole and lock the mixture tube; the positions in which the cam recess is opposite the pin of the plunger corresponds to the cruising range setting of the throttle so that it is only within this range of throttle setting that the mixture control can be locked at 'weak'. As soon as the throttle is moved out of the cruising range the cam bears against the plunger pin and withdraws the plunger from the hole in the mixture tube, after which the mixture tube is returned to the normal or 'rich' setting by the reaction of the coil spring in the tube, the plunger head again bearing on the side of the mixture tube. If the mixture control is moved to 'weak' while the throttle is not within the 'cruising' range it may be held there by hand only and will return to the 'rich' setting under the reaction of the spring in the tube as soon as the control is released.

Transmission line

11. Transmission of movement from the levers in the control box to those on the operated components is effected by means of light tubular rods, connected together by ball and socket joints and, in addition, where a change in direction is involved, by bell-crank levers on a countershaft. The ball sockets are secured to the ends of the tubes either by a sleeve secured by taper pins or by screw threads and a locknut, the screw connection being generally used when adjustment is required. The tubes may be of 7/16 in. external diameter for internal fitting or $\frac{3}{4}$ in. x 20 s.w.g. for external fitting, into or onto the end of the ball socket respectively. The permissible maximum unsupported length of tube in the transmission line is 20 in. for the smaller and 48 in. for the larger sizes. Support may be provided either by an intermediate lever or by means of guides.

12. The detail layout of the transmission system varies with the type of aircraft, but the various components and their functions are common to all. Normally a group of short tubes connect the control-box levers to crank levers on a countershaft from which tubes lead off in different directions to other countershafts en route to the various terminal levers. The primary function of the countershaft is to provide a change in the direction of the tubes, the levers being provided at any required angles between 62 deg. and 180 deg., the latter giving a reversal of direction of movement; in addition, the countershaft also serves to support the tubes. This function is alternatively provided by guides or by single levers pivoted on a spindle when no change in direction is required; the single arm terminates in a ball which engages in a ball socket forming part of a joint between two tubes. For a change in angular direction of less than 62 deg., two levers may be mounted on a splined shaft which is bushed to fit a fixed spindle.

Levers

13. The levers are light alloy stampings of different dimensions and weights to meet varying requirements, and are made as light as possible for the load they have to transmit. The lighter types of levers, which may be regarded as the standard, have strengthening webs within the angle and the heavier types are drilled for lightness but have no strengthening webs. Where provision for adjustment is required and where steel balls are used - i.e. in front of the engine bulkhead - the ball connecting the lever to the tube is screwed into the end of the lever arm and is locked by a washer and locknut; otherwise, the ball is an integral part of the lever stamping, machined to dimensions as required. ◄All levers, irrespective of their detail functions, have spindles pivoting in oilite bushes - the exceptions are of course, the single levers which are splined in pairs on to a hollow shaft, in which cases the hollow shaft is bushed. To ensure free working of the levers, all bushes should be lubricated periodically with Oil, OX-14, NATO Code No. O-147.►

Ball joints

14. A feature of the whole control system is the ball joints which in different forms are used to connect the tubes to each other and to the levers (see fig.4 and 5). The balls have a tapering neck and those on the lever discs have the ball-end formed into a stop-pin which engages in a slot cut in the socket housing. The function of the stop-pin is to limit side movement throughout the range of movement between the lever and the tube, the maximum permissible angle of which is 70 deg., though this is as far as possible reduced to 50 deg. in practice.

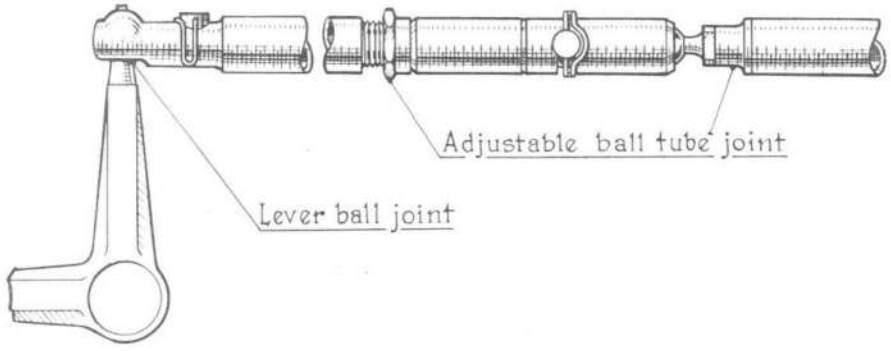

Fig.4 Application of ball joints

15. The ball socket in which the ball engages is fitted at the end of a tubular housing incorporating a spring-loaded internal cup that is forced against the ball by means of a small cam or key. A wire clip is provided through the head of the key and when turned across the socket housing and pressed downwards, where it is held by its spring action, the clip locks the key. The spring and inner cup are fitted by selective assembly and any damage sustained will entail the replacement of the complete ball socket by a new one. Socket for the lever balls are attached to the transmission tube ends by two taper pins at right angles to each other; cups that form part of a joint between the transmission tubes and from which the balls are not normally to be disengaged are fitted at one end of a divided socket housing, the other end of which forms a bayonet-type fitting. Separation of the two ends is effected by unlocking the bayonet joint, there being no locking key.

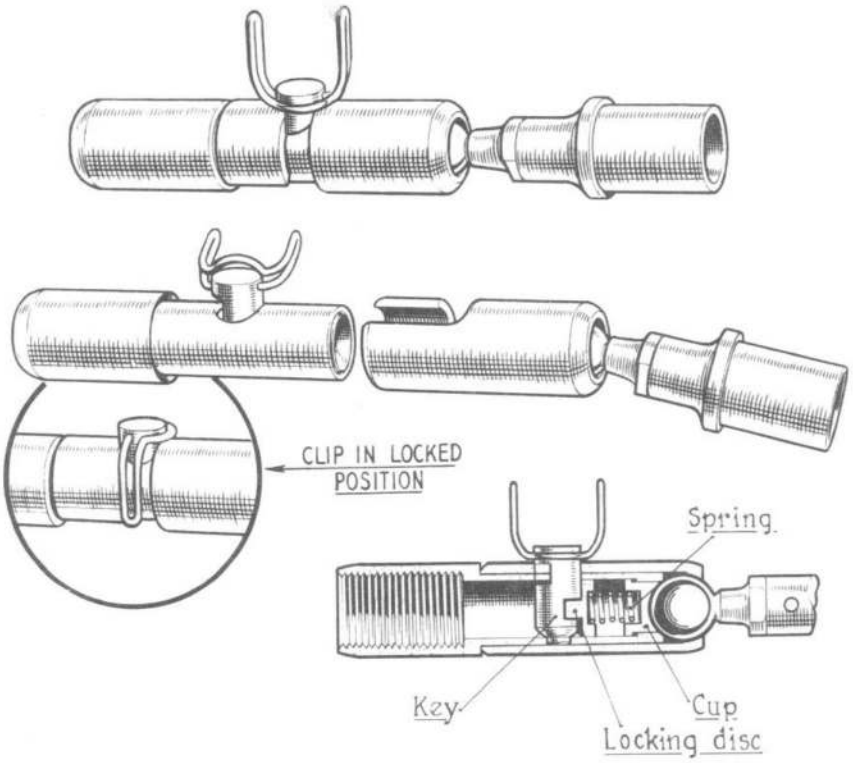

Fig.5 Locking arrangements for ball joints

Tube supports and guides

16. Light transmission tubes are supported by levers or by guide blocks. The guide levers may be either on the countershaft or lever assemblies or they may be single levers pivoted vertically on a horizontal spindle, with the ball in the end of the lever engaged in a ball-socket joint between two lengths of transmission tube. The guide blocks are of different types (see fig.6), the simplest being a Tufnol block, bolted to the airframe and having holes drilled through it to accommodate each tube; this type of guide block is usually divided horizontally across the centre line of each hole and held together at the ends by a hinge and clips. In some instances the holes in the Tufnol blocks each have a metal bush that provides a bearing for the tube and the block is then undivided so that the tube can only be fitted by being inserted through the bush. These bushes may be self-aligning, consisting of a metal sleeve of spherical section, held between two metal plates that are spaced by a felt washer and distance pieces and attached to the Tufnol block by screws. Another type of guide comprises a bushed metal block which is screwed directly on to an airframe member.

SERVICING

Control box

17. ◄ Control levers are fitted with oilite bushes and lubrication should normally not be required; if, however, it is found necessary, it is advisable to dismantle the control box, lubricate the bushes with Oil, OX-14, NATO Code No. O-147, and lightly coat the spindle bearing surfaces with Grease, XG-287, NATO Code No. G-354, prior to assembly. Ensure that the lubricant does not contaminate the friction or lever disc surfaces. The ball and socket joints between levers and tubes should be lubricated with Grease XG-287.► The whole control box should be kept clean and inspected periodically for signs of

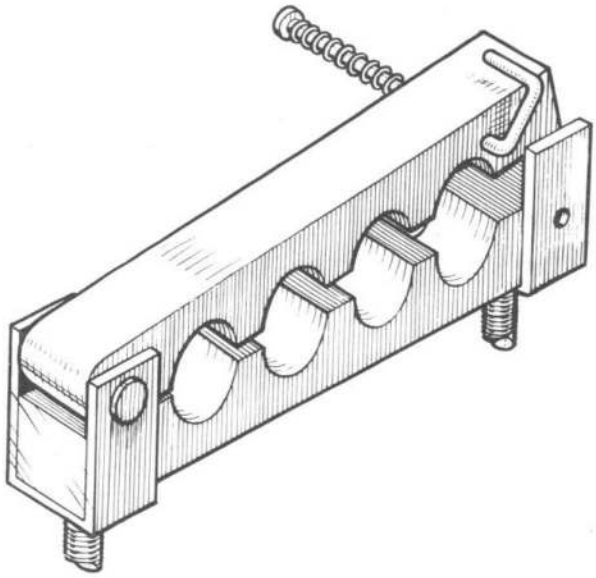

Fig.6 Guide block

corrosion and for any looseness of nuts and bolts. The adjustable stops on the quadrants do not normally require alteration but they should be checked after any disturbance of the transmission lines. Primary adjustment of the controls should preferably be effected at the engine end, the lever on the control box being in the mid-way position. Loss of movement in the control box should be immediately investigated and rectified, the control box being removed completely from the aircraft if necessary for access to bolts and adjusting nuts. Frequent inspection should be made to ensure that the spring-on cover plates are secure and their steel clips free from corrosion. Adjustment to the friction-loading spring flanges can be made after the cover plates have been removed, care being taken to ensure that the nuts on the studs are adjusted equally and that the flange plates are kept parallel to the lever discs.

Dismantling the control box and spindle

18. Provided that access to the control box is easy, it may be dismantled in situ on the aircraft, though if more than one spindle is to be removed it will generally be found advisable to remove the control box completely. In either case the transmission tubes must first be disconnected from the control-lever ball-joints (see para.24). Details for removing the control box from the aircraft are given in the relevant aircraft handbook, Vol.I. In all instances the dismantling operations should be conducted systematically, each component being retained in the correct relative position as removed. Such items as washers, distance pieces, etc. should not be reversed or exchanged and operations will be facilitated if the parts are placed on dummy spindles as they are removed. The following is a typical example of the dismantling operations required for a particular type of control box:-

(1) Remove the control-box cover plates by springing them off at each end.

(2) Remove all nuts and studs on the side plate remote from the hand-nut adjuster.

(3) Lift the side plate off the studs and spindle ends, easing it as necessary, leaving the spindles with their levers on the remaining side-plate, which if removed from the aircraft should now be laid flat on the bench.

(4) Lift the upper quadrant from the threaded studs and remove the nuts and spring washers from them.

(5) The nuts holding the spindle assembly to be removed should now be released from the control box including the hand-nut adjustment, then lift the spindle assembly with the studs from the side-plate.

(6) Remove the friction disc and outer throttle lever from the spindle and then the distance tube shims at each end.

(7) Remove the nuts from the studs after which the spring flanges should be removed together with their adjusting nuts.

(8) Remove the inner throttle lever and friction disc, followed by the outer mixture lever and distance piece which will free the inner mixture lever.

(9) Withdraw the spindle complete with collar from the quadrant assembly. The collar may be removed from the spindle after its two retaining bolts have been unscrewed.

Assembling the spindle and control box

19. Assembling is the reverse of the dismantling operations described in the preceding para., attention being paid to the following points:-

(1) The spindle collar must be fitted with its pin towards the threaded end of the spindle and care must be taken to tighten the two retaining bolts evenly.

(2) The pin of the collar must be engaged in the hole in the centre quadrant.

(3) On the throttle side of the spindle the following is the correct order of assembling - friction disc next to the collar, inner throttle lever (in this instance the starboard throttle lever), spring flange plate with bowed side inwards towards centre of spindle, two spring-flange adjusting nuts with their shoulders next to the flanges on the threaded rods, spring-flange plate with bowed side outwards towards the threaded end of spindle outer (port) throttle lever, friction disc and outer quadrant.

(4) On the mixture side of the spindle fit the inner (port) lever first; this has a bush protruding on one side only, against which the distance tube, to be fitted next, abuts. The outer (starboard) mixture lever which is fitted next has a bush protruding on each side.

(5) When offering the spindle assembly on to the side-plates ensure that the studs are evenly entered in the holes in the quadrants.

(6) When the control box is assembled, the distance from the centre of the centre quadrant to the inside of the side plates must conform to the correct dimension for the box concerned and all quadrants and indicator plates must be adjusted to ensure free travel for all levers, without interference.

(7) When adjusting the spring plates ensure that they are at right angles to the threaded rods and parallel to the lever discs.

(8) To adjust the frictional loading tighten the spindle locknuts until resistance can be felt on the throttle levers, then lock the nuts together; it should now be possible to lock the control levers by tightening the handnut. The face of the threaded bush should be 9·5 mm. from the face of the handnut, ensuring that the thrust collar extends beyond the bush by the correct amount.

Servicing the locking box

20. The mixture tube and the lever in the control box should return from the 'weak' to the 'rich' position without hesitation or delay and when the throttle lever is moved out of the cruising range the mixture tube should become automatically locked. Cleaning and re-greasing operations should be effected periodically and the box should be kept about half-filled with anti-freezing grease.

Dismantling the locking box

21. During dismantling, the locking box components should be marked or placed so that they may be re-assembled in their original positions. The components are not interchangeable and damage to any part involves several other components of which the part is a working unit. The locking box should generally be removed from the aircraft for dismantling though in some installations dismantling in situ is possible. The sequence of operations given below for dismantling a box having one throttle and one mixture tube are also applicable to boxes having groups of similar controls irrespective of the number of such controls:-

(1) Undo the two retaining screws, one on each side, and remove the top cover plate. Dismantling will be facilitated by cleaning the interior of the box although this is not essential.

(2) Uncouple the mixture tube ball joints.

(3) Using a flat-nosed pin punch, knock out the mixture tube spring-stop pin.

(4) Place the throttle tube in the closed position and slide the mixture tube out of the box.

(5) Uncouple the throttle tube ball joints, then remove the split pin from each end of the square-section throttle rod and unscrew the throttle tubes from the rod, holding the latter with a spanner if necessary.

(6) Remove the rod from the box and assemble the three parts together immediately to ensure that they shall be replaced correctly when subsequently re-assembled.

(7) Unscrew the nut and remove the bolt and the plunger spring.

(8) Unscrew and remove the spring screw eye from the plunger.

(9) Remove the burrs, made by centre punching, from the retaining cap at the inside of the box, then tap out the plunger and cap. A screw plug must be removed before the plunger can be tapped out.

Dismantling the mixture tube

22. The mixture tube should be dismantled as follows:-

(1) Insert a temporary spring stop-pin between the outer end of the slots in the tube and the spring, then knock out the two taper pins and withdraw the ball end from the end of the tube.

(2) Using a rod held in a vice to compress the coil spring, remove the temporary pin from the slot, then remove the spring and its stop from the tube.

(3) Drive out the 5/32 in. taper pin from the opposite end of the slotted tube and withdraw the sliding end of the tube.

(4) Drive out the two 5/32 in. taper pins and remove the other ball end.

(5) Holding the end plug of the sliding tube in a vice, and pulling against the spring, knock out the taper locking pin from the spring screw; assistance will be needed for this operation.

(6) Remove the spring screw by means of a screwdriver (the end of which will enter the tube), thereby releasing the spring.

Assembling the mixture tube and locking box

23. Assembling the mixture tube and locking box is the reverse of the operations described in para. 21 and 22, but the following notes on the locking box should be observed:-

(1) Before assembling see that the locking box and all components are clean.

(2) Ensure that each part is replaced in its original position.

(3) Screw the eye bolt into the inner side of the plunger and insert the 4 BA screw and ensure that the eye bolt is correctly adjusted to allow the plunger to slide freely.

(4) Grease and fit the plunger spring on its bolts, fit the spring washer and tighten the Simmonds 4 BA nut.

(5) First ensuring that the plunger works freely, centre-punch the eye bolt at the end of the threads to prevent any tendency to rotate.

(6) Uncouple the square-section rod from the end throttle tubes, and assemble them in position in the box.

(7) Ensure that the throttle tube travels freely and that the cam rod is correctly positioned in the plunger slot, then insert the locking pins.

(8) Insert the assembled mixture tube and see that it travels freely while the pressure of the plunger is temporarily relieved from the tube.

(9) Fit the spring stop-pin through the locking box and the slot in the mixture tube, holding the stop in position and the spring clear of the pin by means of a screwdriver.

Frequent and accurate adjustment is necessary as, if this is neglected it is possible that in extreme cases a ball may be broken off its lever, and the particular control affected would be put completely out of action. Lesser faults in adjustment may result in a control not having full travel and may also prevent the correct functioning of the locking box which, as a result, will fail to preserve the necessary interaction between the mixture and the throttle controls. Lost motion or backlash in the system causing general inaccuracy of control may be due to wear in joints or balls, improperly fitted joint keys or end float in the lever bushes.

Lubrication

27. ◄ Notwithstanding that all levers have oil impregnated bushes, these bushes should be lubricated with Oil, OX-14, NATO Code No. O-147, at convenient intervals and, whenever the spindles are dismantled, they should be thinly coated with Grease, XG-287, NATO Code No. G-354, before being assembled. Control box levers should not normally be lubricated, but if the necessity does arise, refer to para. 17. All joints and those parts of the tubes which slide in guides should also be lubricated with Grease, XG-287. ► Working parts of the system must be kept clean and free from grit, this applying particularly to the balls and sockets where the presence of grit may cause rapid wear, for which the only remedy is complete renewal of the joint. When excessive wear has taken place at a joint, both the ball and socket should be replaced by new ones and no attempt should be made to effect a repair by the replacement of a ball or a socket alone.

Adjustment

28. General information on the adjustment of the transmission line is given in para. 25 in which the control system is described as being in correct adjustment when, with the control lever in its mid-way position, the stop-pins on the balls are central in their slots; full travel is thus obtained at the operated lever on the engine by full movement of the operating lever in the control box, and the locking box can function correctly. A fault in any one of these respects may be remedied by correction at an adjustable joint in the tube line or at an adjustable ball-end. In addition to the correct adjustment of an adjustable joint to give the correct length, it must be ensured that each end of the joint is screwed into the ends of the tube until the inner end has passed the inspection hole; this should be checked by means of a piece of wire. When correctly adjusted, the levers in the control box should bring the associated lever on the engine or other controlled mechanism to the limit of its travel when they are within a maximum distance of $\frac{1}{8}$ in. from the stops on the control box quadrant. This $\frac{1}{8}$ in. clearance is necessary to allow for spring in the transmission line, but any excess over $\frac{1}{8}$ in. is to be avoided, because it may bring the stop-pins on the lever balls to the extreme end of their slots and in extreme cases may ultimately lead to the breakage of a ball-end off the lever, thus putting the control-line out of action. All adjustment should be begun at the control-box end of the system.

29. If any ball stop-pins are seen to be fouling the end of the joint slots the tube line will be found to be in need of adjustment, which should be effected by locking the control lever opposite the mid-point marked on the quadrant, and then adjusting the length of the control tube until the stop-pin is brought to a central position and the levers are at right angles to the tube. If any lever fails to give full travel at the operating end, the balls on the lever assembly nearest to the controlled mechanism should be adjusted by being screwed inwards to increase, and outwards to decrease, the travel of the lever when the adjustable ball-end is on the opposite side of the lever to the operating tube. When the adjustable ball-end is nearest the engine the adjustment required is

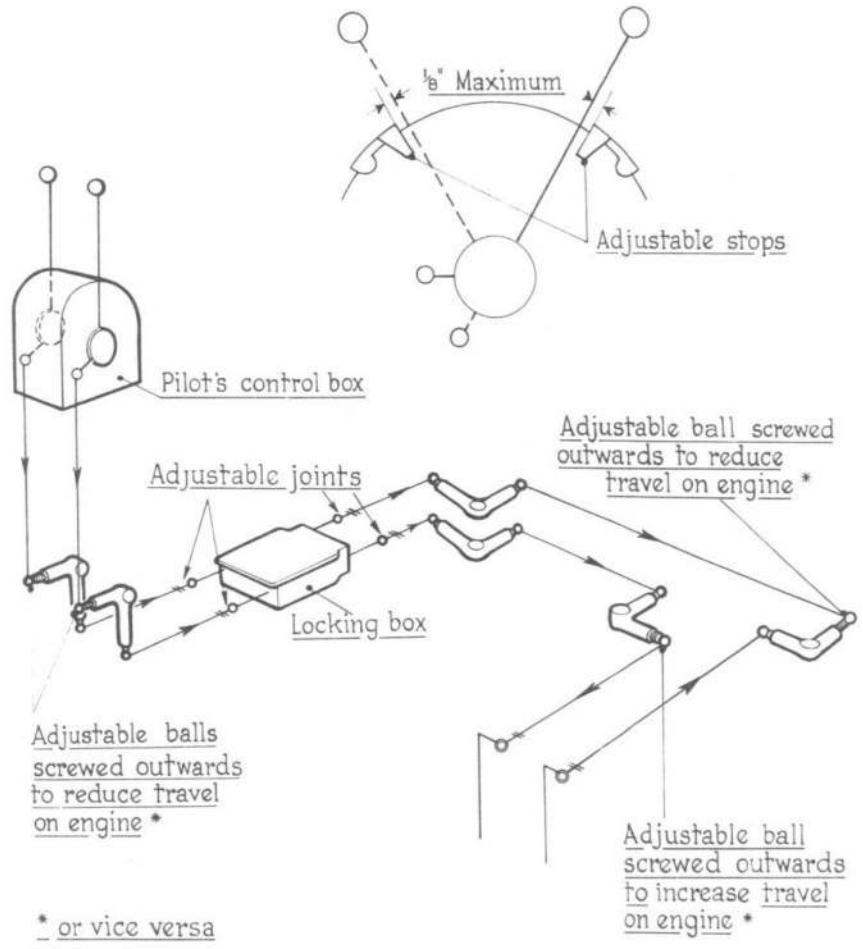

Fig.8 Diagram of control system

opposite to that just described (see fig. 9). Adjustment of the length of the tubes will not affect the amount of travel of the levers, provided that the levers themselves are correctly set.

Backlash

30. Backlash found to be due to wear in the joints or balls should be cured only by renewal of the complete joint, i.e. a new ball and socket assembly, and not by renewal of the ball or socket alone. If backlash is found to be due to end float or play in lever bushes the levers should be renewed.

Modifications

31. New types of ball-joint have now been introduced in the Bloctube control system; these are an improvement on those shown in previous illustrations in this chapter. As an example, the new type of joint illustrated in fig. 8 is a modification of that shown in fig. 4. It will be seen from this modification that the bayonet type socket and sleeve illustrated in fig. 5 are eliminated, the ball fitting into a cup which is an integral part of the joint and locking mechanism. The ball is inserted into the joint from underneath and turned through a slot into its working position where it is secured by the locking mechanism. It should be noted that the locking mechanism provides a positive lock and that the ball-joint is not spring loaded to compensate for wear as might appear, the function of the spring being to retain the locking key within its housing when the key is in the open position. The straight type of locking clip that was used with the bayonet joint is now obsolescent, because there is

no slot provided in the new type of joint into which the straight arms of the locking clips can be engaged and consequently all locking clips now provided are curved to enable them to be sprung over the tube and thus retained in position.

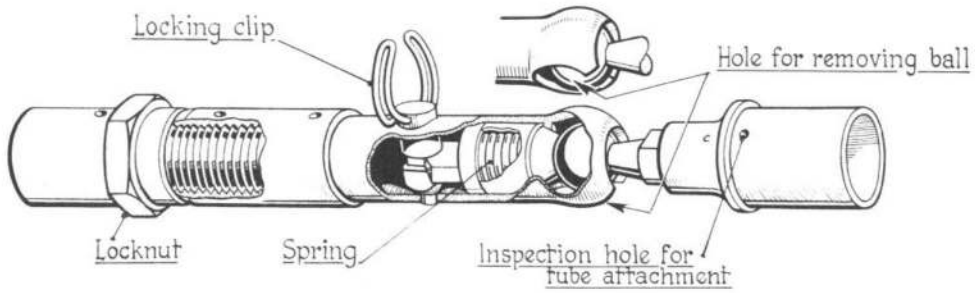

Fig.9 New type ball joint

Correcting faults

32. The following information is given as a result of faults which have arisen in service, caused by errors in adjustment. The items mentioned are covered in the preceding text but are repeated here in a more concise form to stress the importance of the need for careful attention to maintainance details:-

(1) Cleanliness - Joints must be kept clean and free from grit and dirt, particular care being taken when assembling.

◄(2) Lubrication -

(a) Ball joints, guides and those parts of the tubes which slide in guides must be lubricated periodically with Grease, XG-287, NATO Code No. G-354.

(b) Lever spindle bushes (except those in control boxes - refer to para. 17) must be lubricated periodically with Oil, OX-14, NATO Code No. O-147.►

(3) Adjustment - Adjustments should always be made from the control-box end, working towards the engines as the work proceeds (see fig. 8 and 10 for effects of adjustment).

(4) Undue friction - When assembling bell-crank lever assemblies, ensure that the levers are as free in action when rigged as they were before. When adjusting the friction brake, it should be ascertained that the lever has about $\frac{1}{8}$ in. slack in the unlocked position to avoid undue friction being applied to the control levers.

(5) Locking adjustable joint - When locking the nuts on adjustable joints, do not use the ball in either joint as a tommy-bar; undue pressure is not necessary. A $\frac{1}{8}$ in. hole in which a small C-spanner or piece of $\frac{1}{8}$ in. dia. steel rod can be engaged is now provided in joint cases to relieve the ball of a strain which is often the cause of fractured balls on levers.

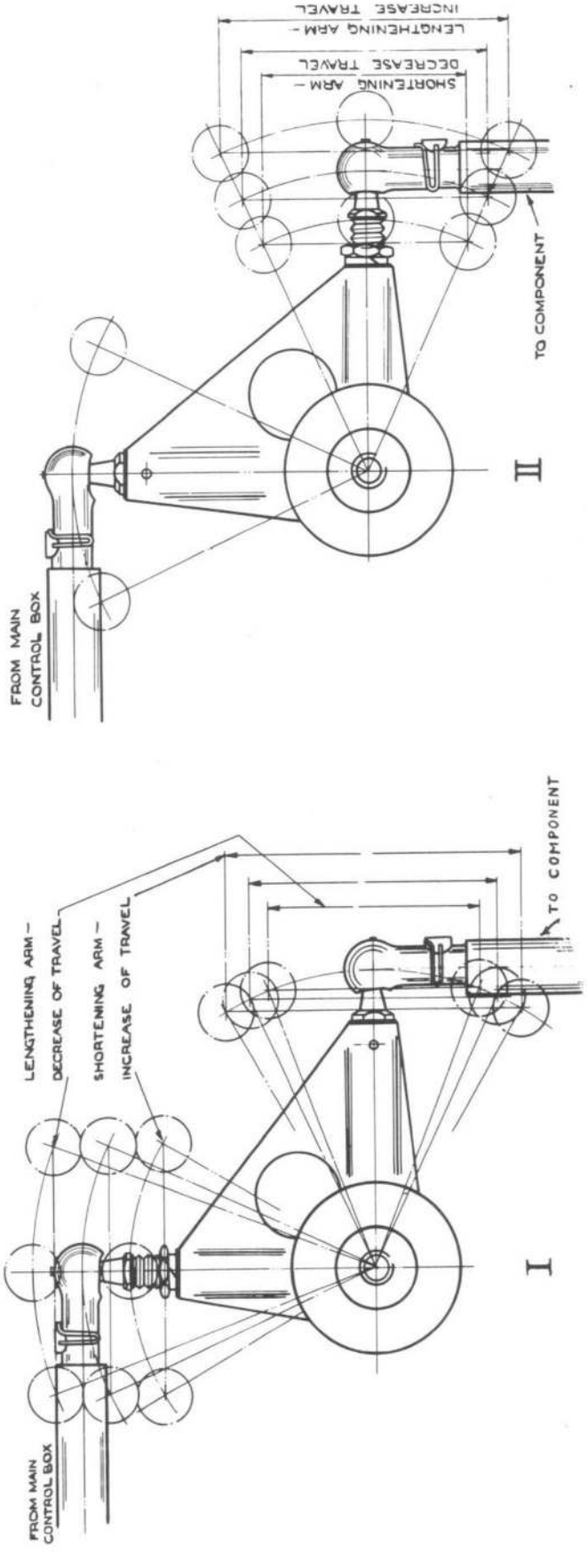

Fig. 10 Showing effect of adjustment to arms in different relative positions