

DESCRIPTION

General information

1. Each aileron is power operated by two hydraulically-powered flying-control units (p.f.c.u.) supplied from separate hydraulic systems, but operating simultaneously in response to lateral control column movement. Because it is power operated there is no natural 'feel' in the control system and artificial 'feel' is provided by a torsion unit built into a torque tube, connecting the control column to the control run. A non-linear gearing assembly modifies aileron response to control column movement.

Centring unit (fig.1)

General information

2. This unit transforms lateral movement of the control handle into linear movement of the control run, provides artificial 'feel' and centring forces for lateral movement of the control column, and transmits trim effects to the control column and ailerons. The main components are a torque tube assembly, connected to the control column and aileron lever, and a torsion bar splined into the torque tube and trim actuator lever. The assembly is connected to the control column by a joint which allows universal movement of the upper member and handle of the control column.

Centring and artificial 'feel'

3. Centring forces and artificial feel result from torsion bar resistance to lateral control column movement from the trimmed position, the torsion bar being held at its forward end by the

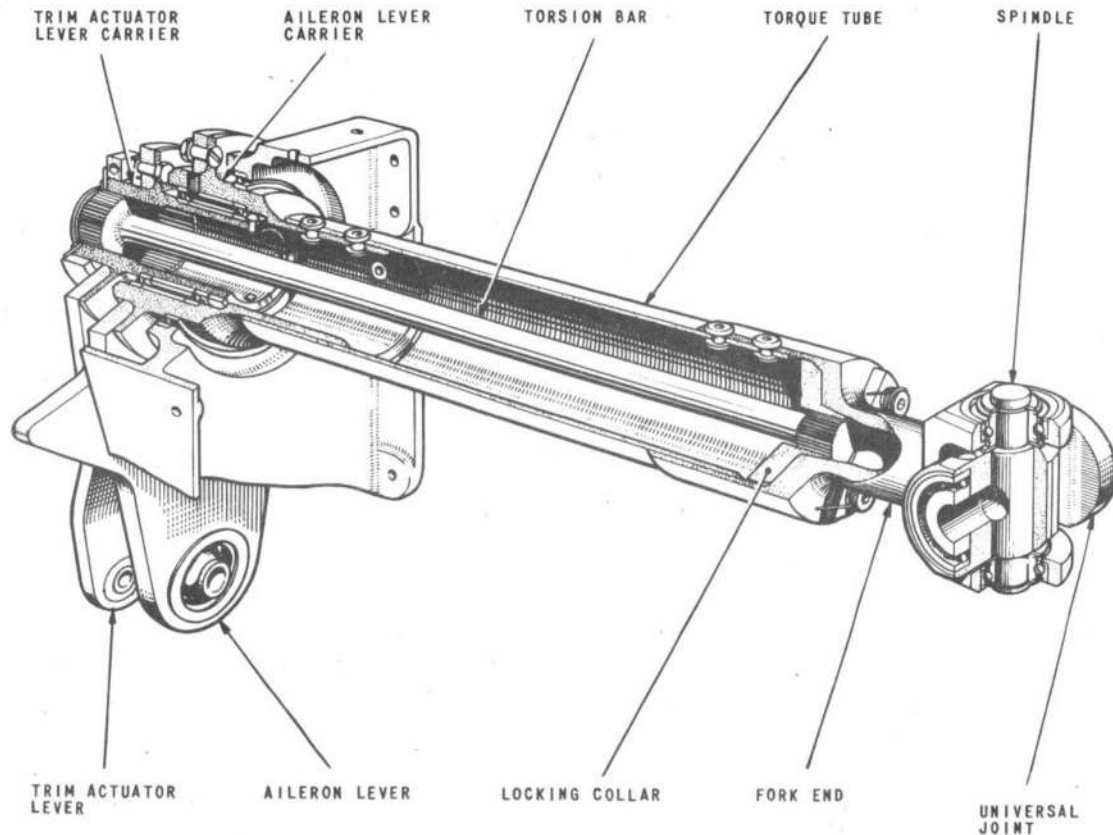


Fig.1. Centring unit

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trim actuator ram. Feel force is directly proportional to control column movement. When the load on the control column is removed the torsion bar returns the control column and the ailerons to the trimmed position.

Trimming

4. Trimming is controlled by a four-position switch on the control handle. Lateral operation of the switch controls aileron trim by extending or retracting the trim actuator ram with consequent

rotation of the torsion bar and torque tube. This moves the ailerons and control column to the selected trim position.

Non-linear gearing mechanism (fig.2)

5. The non-linear gearing corrects over-sensitivity of the aileron control at high speed by reducing aileron response to control column movement. The gearing is designed to effect this reduction principally over the small deflection range. A bracket on the lower

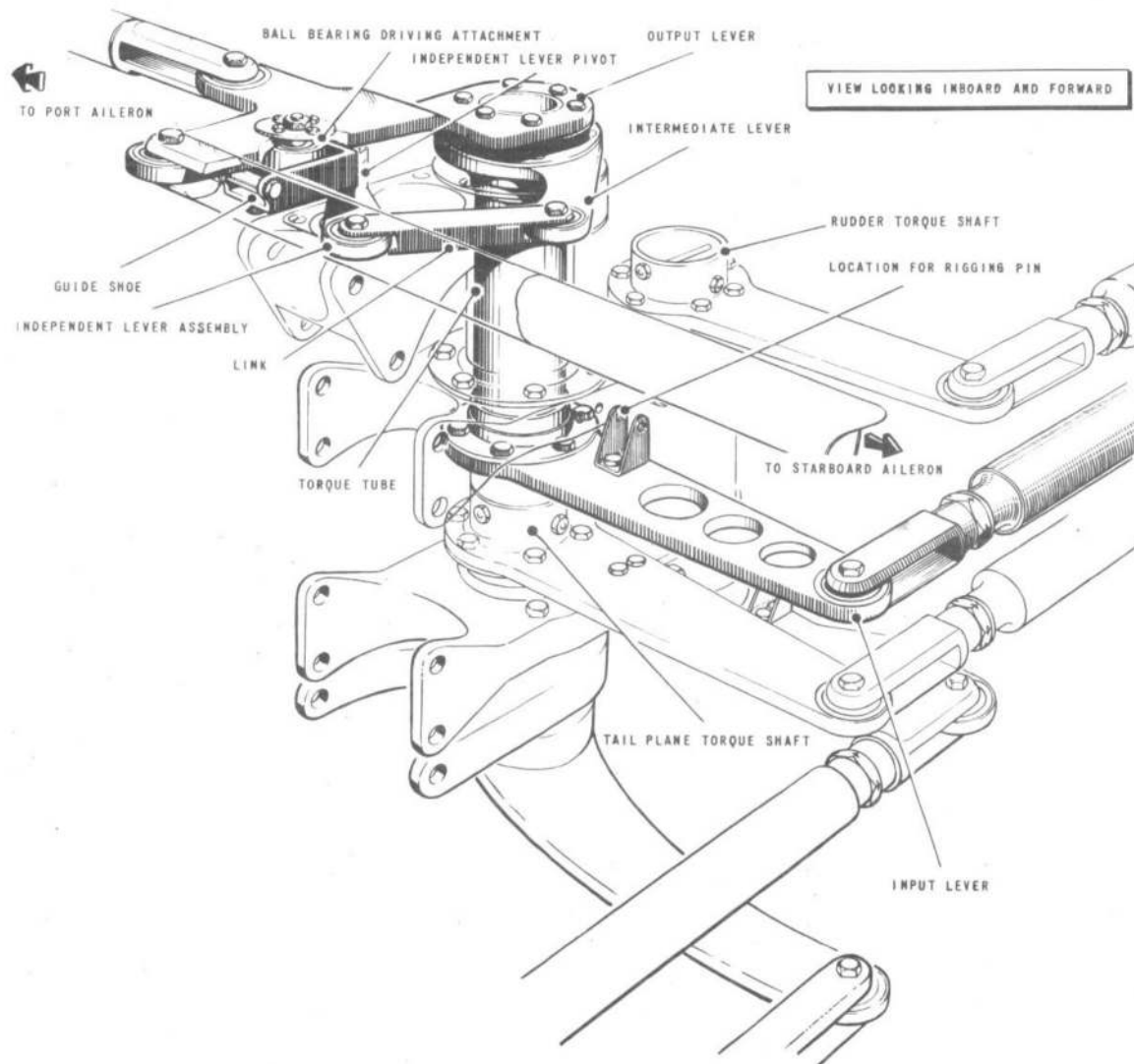


Fig.2. Non-linear gearing mechanism

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lever enables the levers to be held in the neutral position by a locating pin when rigging the controls. The gearing assembly is mounted on the starboard main plane front spar (access panel 26S).

Autostabilizer actuators (fig.3)

6. The autostabilizer actuators, powered by the hydraulic services system (Chap.6), are linked into both aileron control runs to operate the p.f.c.u. at the dictation of amplified electrical signals from the flight control system. The connection into the control run is designed to allow the autostabilizer to move the ailerons without moving the control column.

P.f.c.u.

7. Each aileron is operated by two flying control units each powered by independent hydraulic systems (Chap.6) but simultaneously controlled from the cockpit. Should the hydraulic supply to one control unit fail, the other unit will continue to operate the aileron at a reduced rate. The control units are installed with the body extension attached to the aileron and the fixed piston anchored to the main plane structure.

Aileron travel restriction (post Mod. 2145) (fig.6)

General information

8. To ensure that rolling limitations are not exceeded in flight (while allowing full aileron movement for take-off and landing manoeuvres) a mechanical restrictor, which limits aileron movement to 8 deg is fitted into the con-

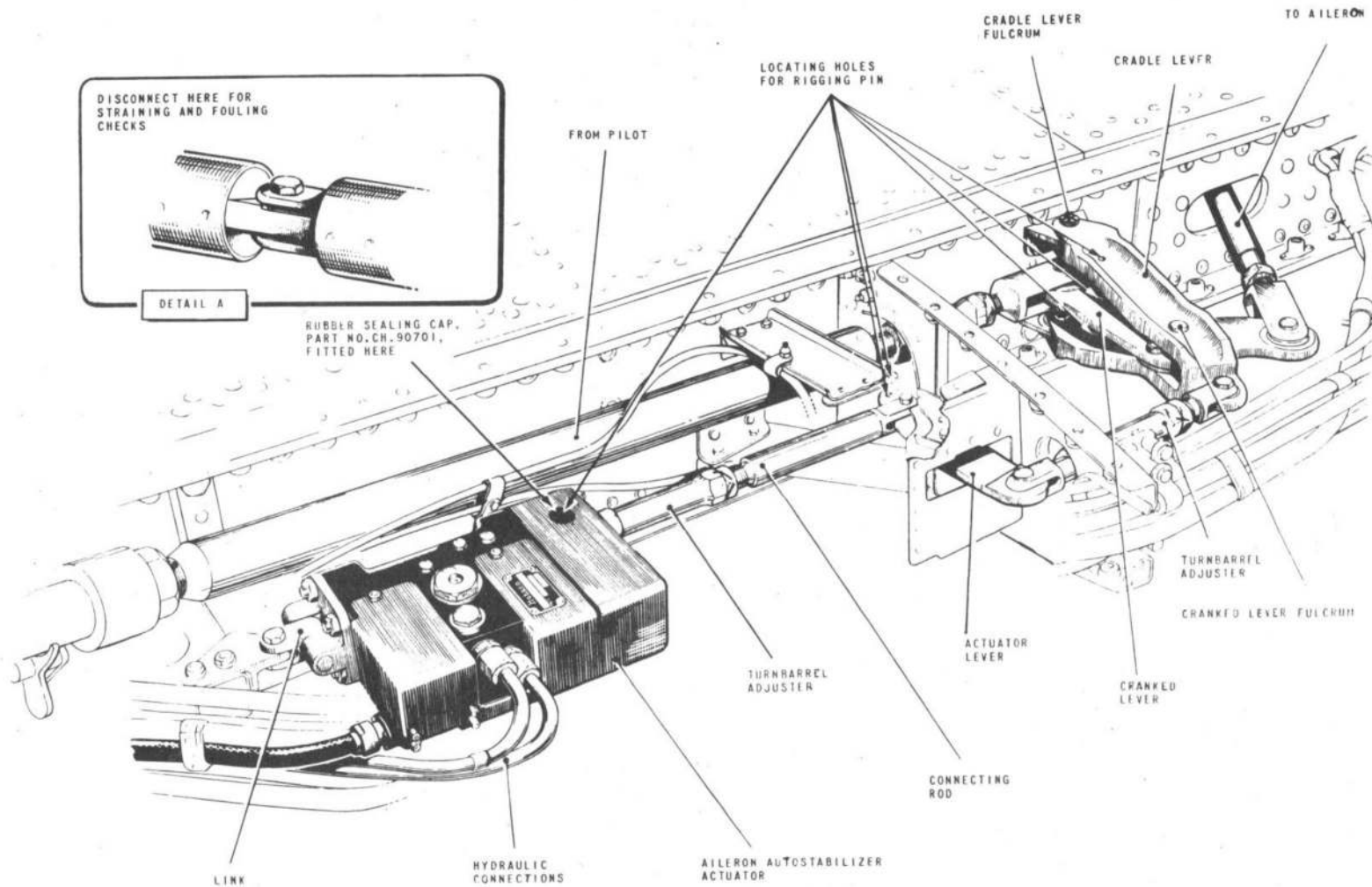


FIG. 3. AUTOSTABILIZER ACTUATOR INSTALLATION

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◀ (DETAIL A REFRANK) ▶

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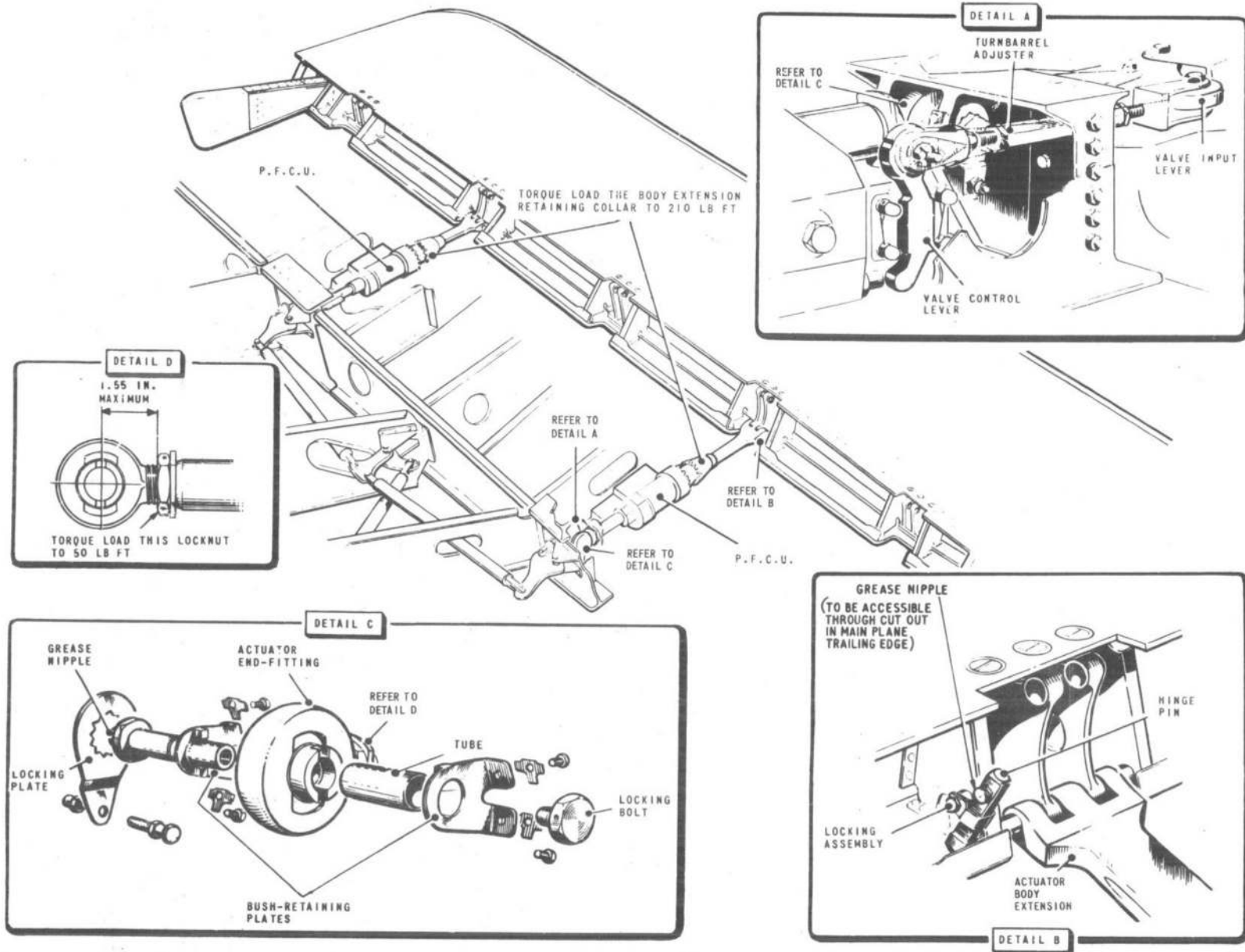


FIG. 4. P.F.C.U. INSTALLATION

◀NOTE ADDED IN DETAIL B▶

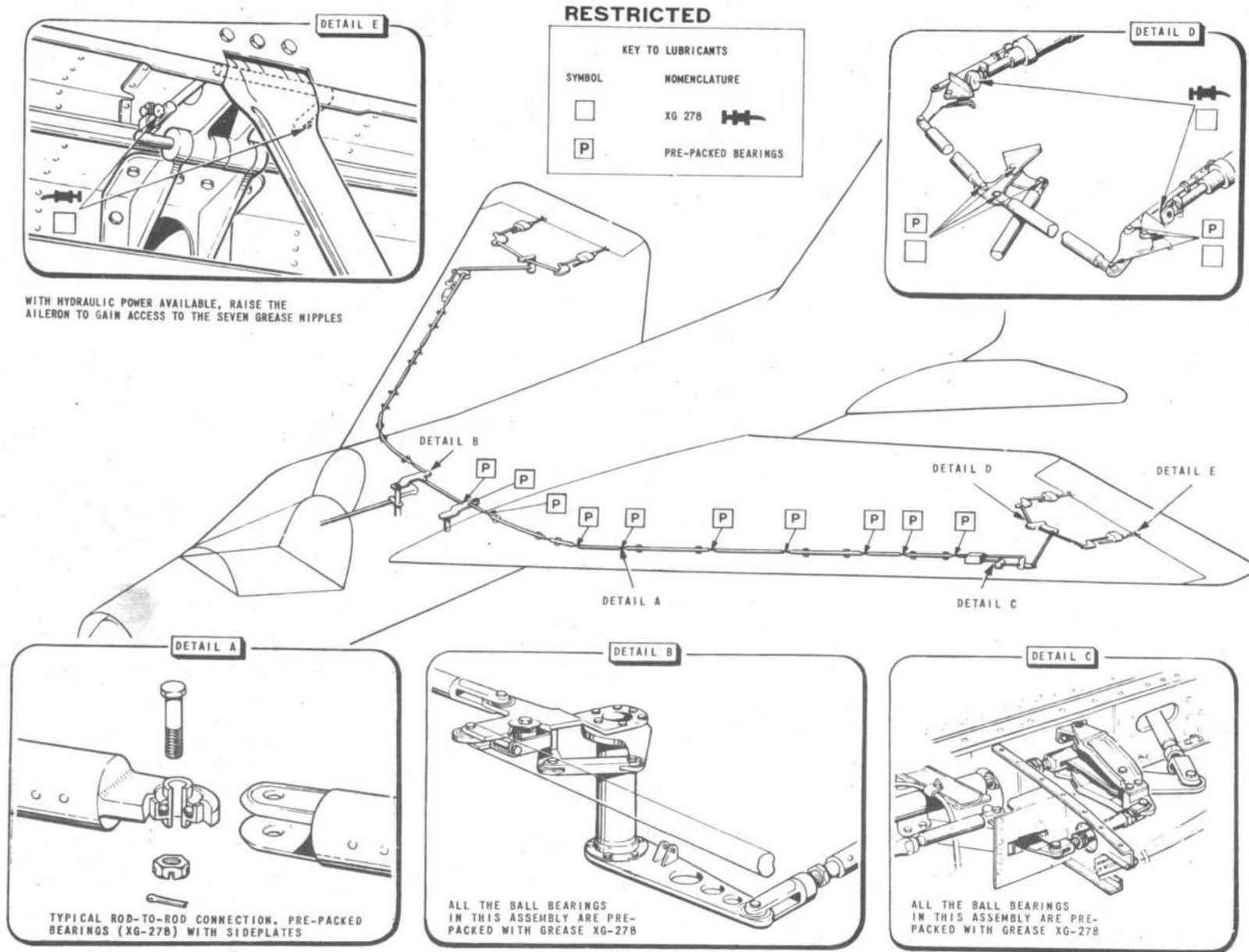
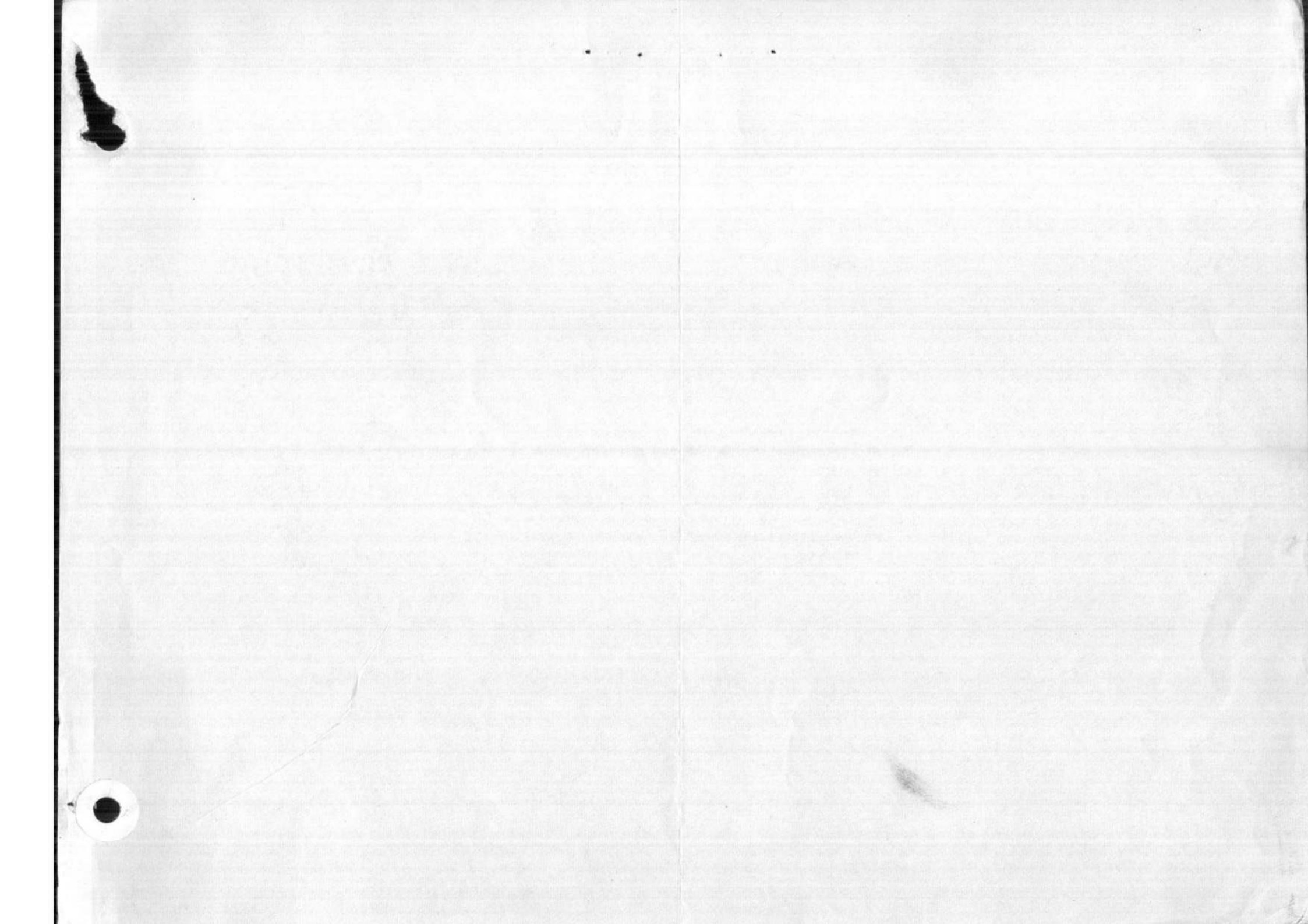


FIG. 5. LUBRICATION OF CONTROLS

◀ REVISED SYMBOLS ▶

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July, 1973

LIGHTNING F MK.1/1A AIRCRAFT

GENERAL AND TECHNICAL INFORMATION

ADVANCE INFORMATION LEAFLET NO.1/73

INSERT this leaflet in A.P.101B-1001-1A, Sect.3, Chap.3, facing para.19.

Rudder damper

WARNING

Ensure that the special nut and bolt securing the rudder top hinge to the rudder damper assembly are locked together (fig.5, detail A) prior to fitting the rudder to the aircraft.

Note...

1. Information contained in this leaflet will be incorporated by normal amendment list action in due course.
2. If, after receipt of this leaflet, an amendment list with a prior date and conflicting information is received, the information in the leaflet is to take precedence.

trol run in the main plane. When the alighting gear is down a spring-loaded connecting rod withdraws a lever from a spacing collar, allowing full movement of the aileron control run. When the alighting gear is up, the wheel-well door operates the door-lever which moves the connecting rod, and engages the stop-lever with the spacing collar, to restrict the movement of the control run.

Restrictor mechanism

9. The restrictor mechanism is a simple mechanical device comprising two levers, a connecting rod and a spacing collar. The levers, which are joined by the connecting rod are (a) the door-lever in the wheel well, and (b) the stop-lever on the main plane spar, the latter contacting the spacing collar to effect aileron restriction. The door-lever consists of a vertical arm attached to the connecting rod, and a horizontal arm which, as the wheel-well door closes, contacts a striker plate on the door. The connecting rod comprises an outer and an inner rod, the latter being attached to the stop-lever on the main plane spar: the inner rod is inserted in the outer rod and is spring-loaded by a compression spring. The two rods are secured by means of a shear-pin and a split-pin. The inner rod is slotted to receive the shear-pin, the spring loading and slot catering for possible maladjustment of the assembly. The outer rod is connected to the door-lever, and two tension springs hold the complete assembly in the unrestricted position until the spring tension is overcome by the wheel-well door operating the door-

lever. The stop-lever on the main plane spar pivots in a bracket; the upper arm of the lever intruding between the two end-stops of the spacing collar to restrict movement. The spacing collar is of dumb-bell form, the larger diameter end-pieces acting as stops for the lever, and is part of a control rod assembly. For information on setting the restrictor mechanism refer to fig.6.

SERVICING

WARNING

The relevant safety precautions detailed on the LETHAL WARNING marker card must always be observed before entering the cockpit or performing any operations upon the aircraft.

Note...

Whenever servicing trolleys are being used to operate hydraulic systems, air pressure of 16-18 lb/in² must be applied to the associated reservoirs.

Lubrication

10. The key to the lubricant symbols is given in fig.5. The nomenclature and reference and N.A.T.O. code numbers of the lubricants are given on the back of the contents marker card at the front of this book. Ball-bearings in the assemblies are pre-packed with grease and do not normally require attention. Where oil is specified it is to be used sparingly. Control rods are designed to run dry in their roller guides and should not be lubricated.

Controls rigging (Table 1)

Preparation

11. Remove the associated access panels and cockpit floor panels (Sect.2, Chap.4, Table 3 and fig.8).

Servicing checks

12. For normal servicing checks refer to Table 1 and carry out checks 1A and B, 5A, 6A and B, 7 and 8. If any of the conditions in these checks cannot be satisfied carry out the complete set of checks 1 to 8. Check for security, freedom of movement without noticeable backlash, lubrication and cleanliness.

Control run breakdowns

13. If it is necessary to break down the control system, fit the neutral setting rig (control column only) and/or rigging pins at points both sides of the breakdown area. Upon completion of the work carry out checks for fouling or straining, freedom of movement; range of movement and security.

Complete rigging checks

14. To carry out full rigging checks, refer to Table 1 and execute all the listed operations.

Trim range checks

15. Refer to Table 1 and carry out checks and any necessary adjustments detailed in check 7B.

Autostabilizer actuators - neutral setting

16. Before the aileron controls are rigged for neutral position, the autostabilizers in the main planes must be

**TABLE I
CONTROLS RIGGING**

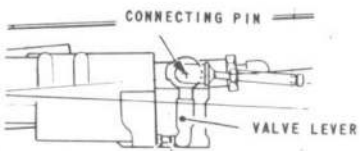
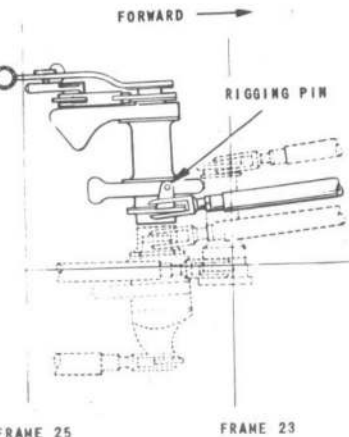
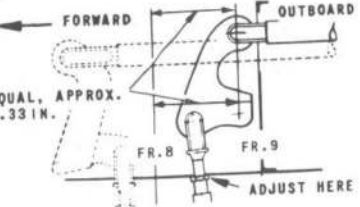
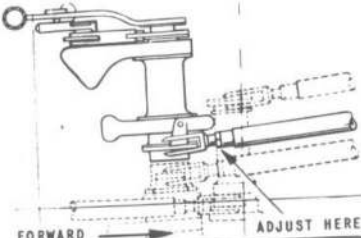
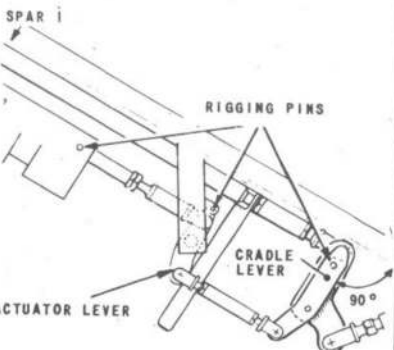
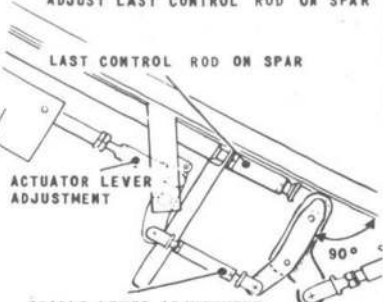
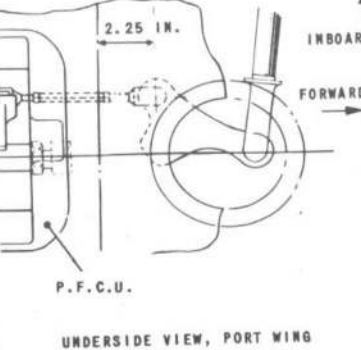
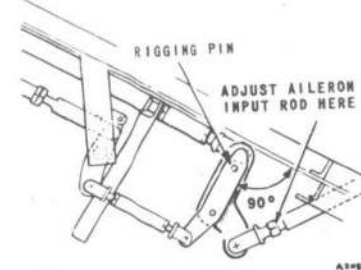
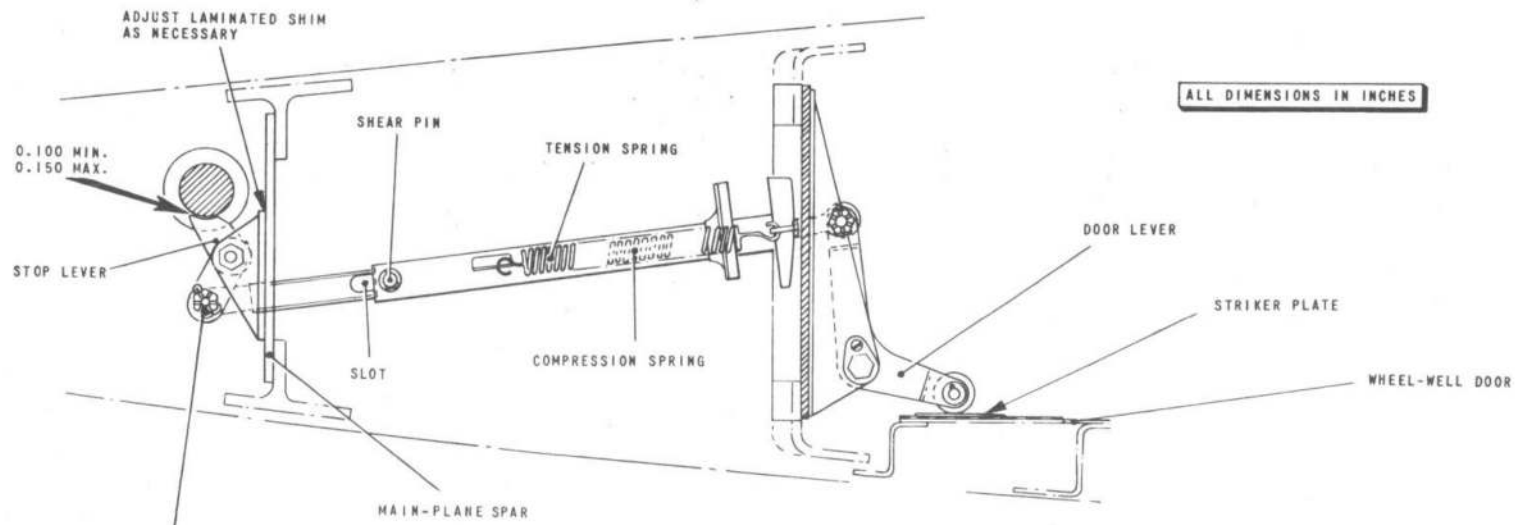
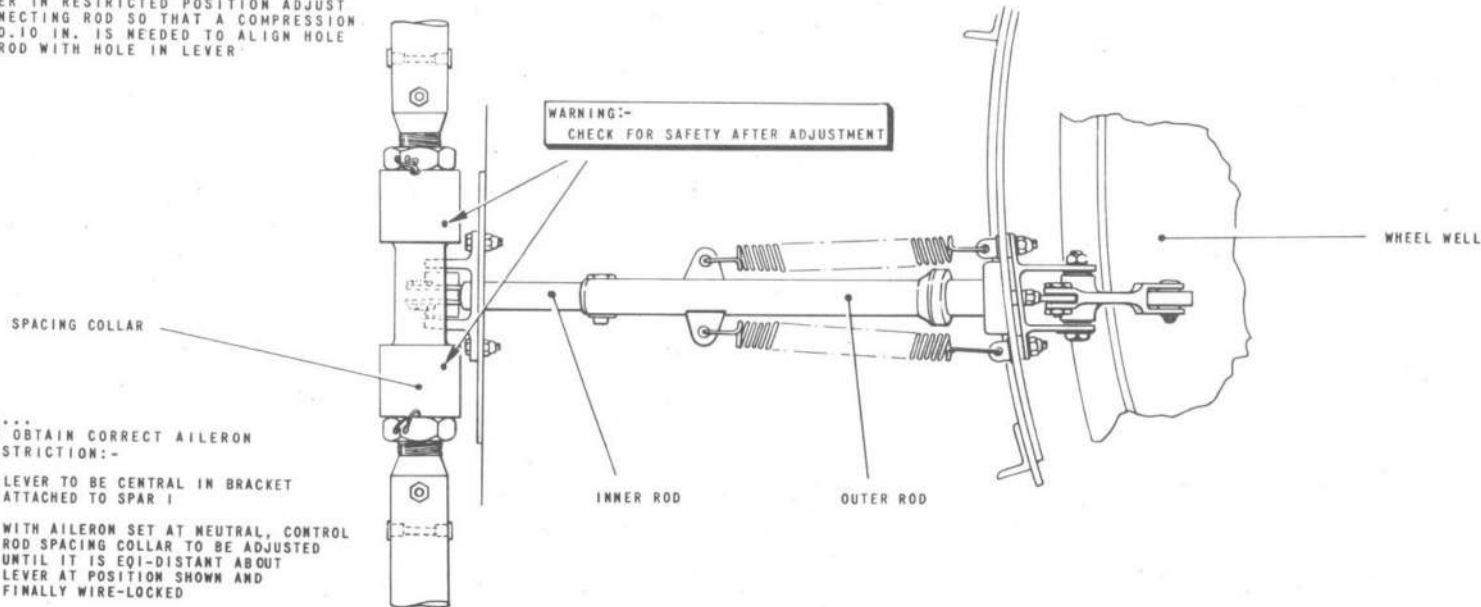
CHECKS	ADJUSTMENTS IF NECESSARY	CHECKS	ADJUSTMENTS IF NECESSARY
<p>CONNECT HYDRAULIC SERVICING TROLLEY, REF.NO.4F/3603 AND ELECTRICAL SERVICING TROLLEY, REF.NO.4F/3761 OR 4F/3786 AND WITH POWER ON</p> <p>(A) SET TRIM TO NEUTRAL BY COCKPIT INDICATOR</p> <p>(B) FIT THE NEUTRAL SETTING RIG (REF.NO.26DK/95503) AND CLINO</p> <p>(C) STOP TROLLEYS</p> <p>(D) ON ALL FOUR P.F.C.U. REMOVE THE PIN CONNECTING THE TURN-BARREL TO THE VALVE INPUT LEVER</p> 	<p>(B) IF THE CONTROL COLUMN IS OUT OF NEUTRAL POSITION, OPERATE THE TRIM SWITCH TO CORRECT THIS. THE TRIM INDICATOR MUST BE RESET AFTER THE FLYING CONTROLS CHECKS HAVE BEEN COMPLETED.</p>	<p>FIT THE RIGGING PIN IN THE NON-LINEAR GEARING MECHANISM (ACCESS PANEL 26S)</p> 	<p>IF PIN WILL NOT ENTER, CHECK LEVER SETTING AT FR.8-9</p>  <p>EQUAL, APPROX. 6.33 IN.</p> <p>IF PIN WILL STILL NOT ENTER, ADJUST CONTROL ROD AT NON-LINEAR GEARING</p> 
<p>IN BOTH MAIN PLANES INSERT RIGGING PINS AT</p> <p>(A) THE AUTOSTABILIZER ACTUATOR</p> <p>(B) THE ACTUATOR LEVER</p> <p>(C) THE CRADLE LEVER ASSEMBLY</p> <p>THE RIGGING PIN MUST NOT BE LEFT IN THE AUTOSTABILIZER ACTUATOR</p> 	<p>(A) IF PIN WILL NOT ENTER AUTOSTABILIZER ACTUATOR, REFER TO PARA. 16</p> <p>(B) IF PIN WILL NOT ENTER ACTUATOR LEVER, ADJUST TURNBARREL AT ACTUATOR</p> <p>(C) IF PIN WILL NOT ENTER CRADLE LEVER ASSEMBLY, CHECK THAT CRADLE LEVER IS 90° TO SPAR FACE ADJUSTING ON TURNBARREL IF NECESSARY</p> <p>IF PIN STILL DOES NOT ENTER, ADJUST LAST CONTROL ROD ON SPAR</p> 	<p>CHECK THE SETTING OF THE AILERON INPUT LEVERS (ACCESS PANEL 101A AND C. PORT AND STARBOARD)</p>  <p>UNDERSIDE VIEW, PORT WING</p>	<p>IF THE SETTING IS INCORRECT, ADJUST THE INPUT ROD AT THE END WHICH PROJECTS THROUGH SPAR 1</p> <p>PLAN VIEW ON PORT WING OUTBOARD</p> 

TABLE I- CONTINUED

CHECKS	ADJUSTMENTS IF NECESSARY	CHECKS	ADJUSTMENTS IF NECESSARY
<p>(A) CHECK THE AILERONS FOR NEUTRAL POSITION AT THE INBOARD TIP</p> <p>(B) SET THE AILERON P.F.C.U. TO NEUTRAL USING THE SETTING GAUGE</p> <p>(C) CONNECT THE TURNBARRELS TO THE AILERON P.F.C.U. BY INSERTING THE PINS</p>	<p>(C) IF NECESSARY ADJUST THE TURNBARRELS UNTIL THE PINS CAN BE INSERTED WITHOUT DISTURBING AILERON OR P.F.C.U. SETTINGS</p>	<p>(A) REMOVE THE NEUTRAL SETTING RIG AND ALL RIGGING PINS</p> <p>(B) FIT AILERON CHECKING GAUGES (REF.NO.26DK/95074 PORT AND 26DK/95164 STBD.) AT THE AILERON INBOARD TIPS</p> <p>(C) DISCONNECT THE INBOARD END OF THE LAST CONTROL ROD ON SPAR ON BOTH MAIN PLANES</p> <p>(D) START HYDRAULIC TROLLEYS</p> <p>(E) OPERATE EACH CONTROL ROD MANUALLY AND CHECK THE AILERONS FOR FOULING, TWISTING OR STRAINING OVER THE FULL RANGE OF MOVEMENT</p> <p>(F) CONNECT THE CONTROL RODS</p>	<p>NOTE:- THE MAXIMUM TRAVEL OF 17° MAY BE EXCEEDED PROVIDED THAT IT IS EVENLY DISTRIBUTED UP AND DOWN AND NO FOULING OR STRAINING TAKES PLACE</p>
		<p>MEASURED AT AILERON INBOARD EDGE, UPPER FACE</p> <p>MEASURED AT AILERON INBOARD EDGE, LOWER FACE</p>	
<p>(A) CHECK THE OPERATIONAL TRAVEL ON BOTH AILERONS ENSURING EVEN MOVEMENT BOTH SIDES</p>	<p>(A) IF OPERATIONAL TRAVEL IS INCORRECT, ADJUST CONTROL COLUMN STOPS.</p>	<p>8</p>	<p>INSPECT ALL LIMIT STOPS, CONTROL ROD ADJUSTERS AND TURNBARRELS FOR CORRECT LOCKING AND, WHERE APPLICABLE, CORRECT THREAD ENGAGEMENT.</p>
<p>F.M.K. 1 16° = 4.42 ± 0.00 / -0.25</p> <p>F.M.K. 1A 15° 18' = 4.22 ± 0.00 / -0.25 CHORDAL</p>	<p>NOTE:- IF CONTROL COLUMN FOULS THE CONSOLE, ADJUST THE APPROPRIATE STOP TO CLEAR THE FOUL</p>		
<p>NEUTRAL ± 0.050</p>			
<p>F.M.K. 1 16° = 4.45 ± 0.00 / -0.25</p> <p>F.M.K. 1A 15° 18' = 4.25 ± 0.00 / -0.25 CHORDAL</p> <p>MEASURED AT AILERON INBOARD EDGE LOWER FACE</p>			
<p>(B) CHECK THE TRIM RANGE WHICH SHOULD BE NOT LESS THAN 4° OF AILERON MOVEMENT UP AND DOWN AND EQUAL PORT AND STARBOARD</p>	<p>(B) IF TRIM RANGE IS NOT EQUAL, ADJUST THE LENGTH OF THE TRIM-ACTUATOR RAM UNTIL BALANCE IS ACHIEVED AND RESET THE TRIM INDICATOR TO CORRESPOND</p>		
<p>AILERON UP - 1.107 ± 0.25 / -0.00 MEASURED AT AILERON UPPER FACE</p>			
<p>AILERON DOWN - 1.117 ± 0.25 / -0.00 MEASURED AT AILERON INBOARD LOWER FACE</p>			



WITH U/C DOOR IN CLOSED POSITION AND LEVER IN RESTRICTED POSITION ADJUST CONNECTING ROD SO THAT A COMPRESSION OF 0.10 IN. IS NEEDED TO ALIGN HOLE IN ROD WITH HOLE IN LEVER.



NOTE...
TO OBTAIN CORRECT AILERON RESTRICTION:-

- (1) LEVER TO BE CENTRAL IN BRACKET ATTACHED TO SPAR I
- (2) WITH AILERON SET AT NEUTRAL, CONTROL ROD SPACING COLLAR TO BE ADJUSTED UNTIL IT IS EQUIDISTANT ABOUT LEVER AT POSITION SHOWN AND FINALLY WIRE-LOCKED

FIG.6. AILERON TRAVEL RESTRICTOR

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RESTRICTED

set to the neutral position as follows:-

(1) Check that the complete flight control system is installed and serviceable.

(2) Connect a.c. and d.c. electrical supplies to the aircraft (Sect.2, Chap. 2, fig.1).

(3) Set the following switches:-

Flight control switch on control column handle OFF

PITCH and ROLL/YAW switches on control unit OFF

Instrument master switch ON

Master switch on control unit ON

(4) Remove the hydraulic system hand pump handle from its stowage in the port leg well, fit it to the pump (access panel 79P) and operate the pump to provide pressure for centring the actuator.

(5) Switch OFF the master switch on the control unit, and the instrument master switch.

(6) Check for centre position using rigging pin Ref.No. 26DK/95134, through the hole in the body of the actuator (fig.3). If the pin will not enter the actuator is unserviceable.

Note...

Do not leave the pin in position.

Smoothness, friction and centring checks
17. The following checks must be made whenever a replacement p.f.c.u., centring unit or torsion bar has been fitted:-

(1) Connect hydraulic servicing trolleys Ref.No.4F/3603 to the No.1 and No.2 controls systems (access panels 45P and 67P respectively).

(2) Operate the trim switch until neutral position is indicated on the gauge and check that the control column and ailerons are in the neutral position.

(3) Check carefully that, when the control column is moved through its full arc of movement, consistent smoothness is felt throughout the range. If perceptible harshness is felt, its source must be traced and remedied before any further checks are carried out.

(4) Using spring balance Ref.No.1H/118 check for friction by slowly applying sufficient force to the control column, at a point 15.5 in. from the column pivot, to initiate aileron movement from neutral. The force required must not exceed:-

12 oz. port or starboard

(5) Check for centring by displacing the control column to one extreme and allowing it to return slowly, under restraint, to the neutral position. Note the final 'hands off' position. Repeat the check, taking the control column to the opposite extreme, and

note the final position. In both cases the final out-of-centre must not exceed ± 2 deg.

Artificial 'feel' check

18. This check, in addition to those given in para.17, must be made whenever a replacement centring unit or torsion bar has been fitted.

(1) Connect hydraulic servicing trolleys, Ref.No.4F/3603, to the No.1 and No.2 controls systems (access panels 45P and 67P respectively).

(2) Using spring balance Ref.No.1H/4225, check that the force required to displace the control column agrees with the following table:-

TABLE 2
Artificial 'feel' check

CONTROL COLUMN ANGLE			
Port		Starboard	
5°	15°	5°	15°
7 ± 1.5 lb	21 ± 2 lb	7 ± 1.5 lb	21 ± 2 lb

Checking aileron travel restriction (post Mod.2145)

19. To check the functioning of the aileron travel restrictor:-

(1) Jack and trestle the aircraft so that the wheels are clear of the ground.

(2) Connect, and run, hydraulic servicing trolleys Ref.No.4F/3603 to the services and both controls systems.

(3) Apply a pitot pressure of not less than 150 knots and retract the alighting gear.

(4) Operate the control column fully to port and starboard.

(5) Move the control column fully to port and check that aileron travel at port and starboard main planes does not exceed $8 \text{ deg} \pm \frac{1}{4} \text{ deg}$.

(6) Repeat (5) with the control column fully to starboard.

(7) Lower the alighting gear and fit the ground locks.

(8) Check the ailerons for full unrestricted travel (Table 1).

(9) Remove the servicing trolleys and the pitot pressure rig. Lower the aircraft to the ground.

Note...

Do not use undue force when the control column has reached the extent of its travel in the restricted position.

REMOVAL AND ASSEMBLY

P. f. c. u.

Removal

20. To remove a p. f. c. u.:-

(1) Remove access panels 101A and C, and 102A and B from the appropriate main plane, and the outboard section of the leading edge covering the cradle lever assembly.

(2) Release hydraulic pressure from the aileron accumulators by operating the control handle (rate not to exceed one stroke between stops in five seconds).

(3) Connect a hydraulic servicing trolley Ref.No. 4F/3603 to the ground connection couplings of the controls system serving the serviceable control unit, i.e., No.1 controls system for outboard control unit; No.2 for inboard control units.

(4) Centre the autostabilizer actuators (para.16) and, using the trolley hand pump, set the controls in the neutral position.

(5) Disconnect the inboard end of the last control tube on spar 1.

(6) Release the air pressure from the hydraulic fluid reservoirs and disconnect the hydraulic connections to the control units. Blank off the pipe ends and the control unit connections.

(7) Using torque spanner Ref.No. 27KC/2779 to overcome the initial tightness, unscrew the control unit body extension retaining nut. If the nut is more than hand-tight, use C-spanner Ref.No. 26DK/95114 (when using this spanner the aileron must be in the down position).

(8) Repeat (7) on the other control unit in the same main plane.

(9) Lift the aileron and disconnect the control unit body extension from the hinge bracket of the aileron (fig.4, detail B). The hinge pin is locked by

clips secured by a 2 B.A. bolt, distance piece, slotted nut and split pin; keep these items together to avoid difficulty on reassembly. Withdraw the body extension forward.

(10) Remove the turnbarrel adjuster connecting the valve lever to the input lever (fig.4, detail A).

(11) Disconnect the control unit ram end-fitting from its attachment to the diaphragm in the main plane as follows:-

(a) Remove the 2 B.A. stiffnut securing the hinge-pin locking plate and remove the locking plate.

(b) Remove the hinge-pin locking bolt.

(c) Remove the two 4 B.A. bolts and tab washers securing each bush retaining plate.

(d) Extract the hinge pin and remove the control unit.

(e) Clean, and examine for serviceability, the hinge pin, tube, and the bush-retaining plates (fig.4, detail C).

Installation

21. To install a replacement control unit:-

(1) On a hydraulic test rig, fully prime the control unit and extend the ram until its position is identical with that of the unit removed.

(2) Adjust the eye-end to the same

dimension as that on the unit removed. Tighten the locknut to 50 lb ft using torque spanner Ref.No. 27KC/2780. The dimension between the outer face of the locknut and the attachment pin centre must not exceed that given in fig.4, detail D.

(3) Move the aileron to its maximum up position and fit the control unit body extension to the aileron. Lock the pin by fitting the clips and securing them with the 2 B.A. bolt, distance piece and slotted nut. Split pin the nut.

◀ Note...

The hinge pin is to be positioned so that the grease nipple is accessible through the cut-out in the main plane trailing edge. ▶

(4) Position the tube through the bushes of the eye-end of the control unit and locate the two bush-retaining plates (fig.4, detail C). Position the unit in the main-plane box and fit the hinge pin. Fit the locking plate to the hexagon head and the locking bolt to the tapped end of the hinge pin. Wire-lock the locking bolt. Secure the bush retaining plates with the 4 B.A. special bolts, using new tab washers Ref.No. 26DK/6230.

(5) Lubricate the control unit hinge pins.

(6) Connect the body extension to the control unit, ensuring that the locating pegs are engaged in the slots. With the aileron in the down position, screw up the retaining nut using C-spanner Ref. No. 26DK/95114. Torque load the nut to 210 lb ft using torque wrench Ref.No. 27KC/2779. Wire-lock the collar.

(7) Repeat (6) on the other control unit.

(8) Set the ailerons in the neutral position, displacing the relay valve of the serviceable control unit by moving the control tube at the wing spar in the appropriate direction.

(9) Set the relay valve on the replacement control unit to the neutral position, using the gauge as a feeler.

(10) Reconnect the turnbarrel adjuster to the valve lever and input lever.

(11) Prime and bleed the hydraulic pressure line, and fit and wire-lock the pipes.

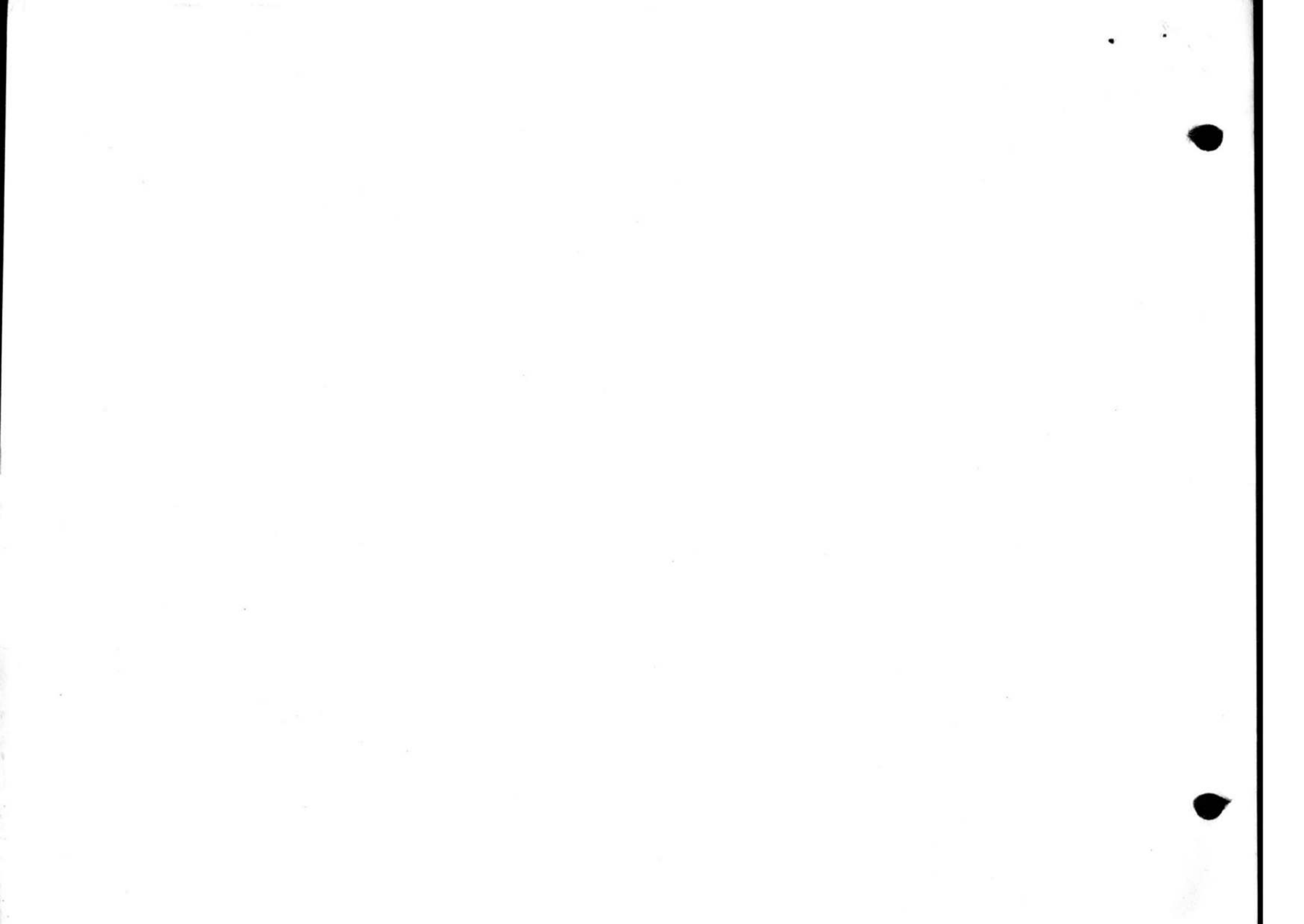
(12) Connect a hydraulic servicing trolley to the controls system serving the replacement control unit. Operate the trolley hand pump and check at the inboard tip and outboard horn, that no movement or distortion of the aileron occurs. If necessary correct by adjustment on the turnbarrel. Wire-lock the turnbarrel.

(13) Connect a hydraulic servicing trolley to both controls system and an external air supply to the reservoir air release valve (panel 63P). Start the trolleys, and slowly operate the control tube on the wing spar to check maximum aileron up and down movement (Table 1, check 6). Check carefully that no straining or fouling occurs.

(14) Set the ailerons to the neutral position and reconnect the last control tube on spar 1.

(15) Operate the control column handle and check for correct operational movement of the ailerons (Table 1, check 7).

(16) Carry out the smoothness and friction checks (para.17) and the hydraulic pressure and accumulator checks (Sect.3, Chap.6).



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