

Chapter I POWER UNIT

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SERVICING

REMOVAL AND ASSEMBLY

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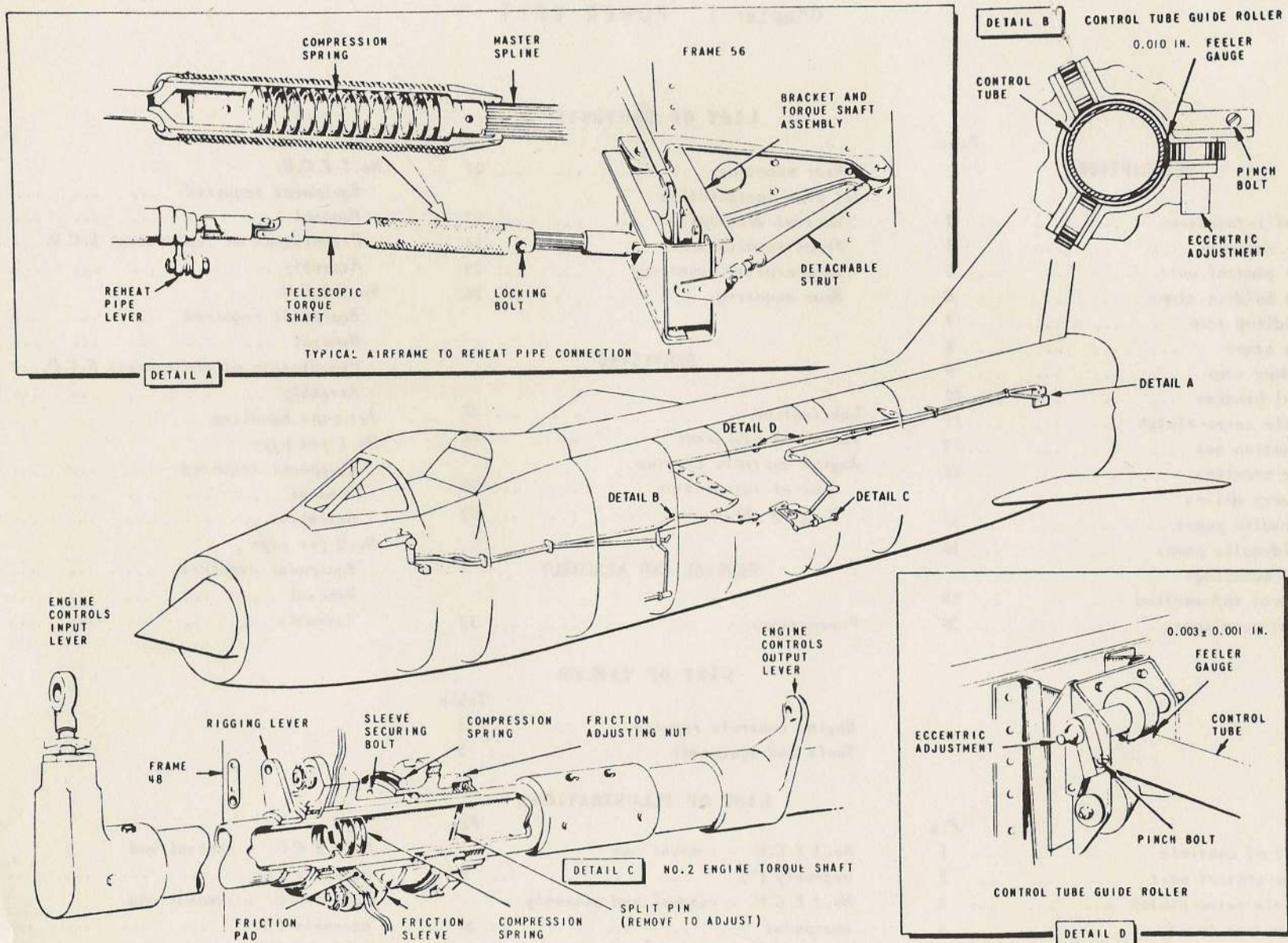


FIG. 1. LAYOUT OF CONTROLS

◀DETAIL C AND CONTROL LAYOUT AMENDED▶

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DESCRIPTION

General information

1. The aircraft is powered by two straight-flow turbo-jet engines mounted one above the other in the fuselage, No.1 engine being installed below and forward of No.2. The jet pipe of each engine is in two sections, a reheat section incorporating a fully-variable nozzle and a reheat burner, and an intermediate section coupling the reheat section to the engine exhaust unit. The intermediate sections are of different lengths due to their respective engine positions.

2. An air-turbine-driven gearbox, sited remotely from the engines and using air bled from the engine compressors, drives the d.c. generator and a.c. alternator which provide the aircraft electrical power. A stand-by generator, similarly driven, provides a d.c. supply should the main air turbine or generator fail.

3. Each engine and reheat system is controlled by a throttle handle. Movement of each handle is divided by a gate into two sections and is transmitted to the combined H.P. fuel cock and throttle valve, and to the reheat system, through a lost motion linkage. Within the throttle range each handle controls the cold power of the appropriate engine, and initiates reheat light-up when rocked through the gate and moved to the reheat section; movement of each handle in the reheat range is transmitted through mechanical linkage, via an air motor control unit (A.M.C.U.) to an air

motor to control the associated jet-pipe nozzle position. Excessive jet-pipe temperature (J.P.T.) is prevented by a jet pipe temperature control system. Once maximum J.P.T. is attained the controller trims the fuel flow, preventing a rise in temperature above the maximum value. Reheat is automatically cancelled if the maximum J.P.T. is exceeded, or if the reheat fuel system, or the fueldraulic system should fail. Once reheat has been automatically cancelled it cannot be reselected until the associated throttle handle has been moved back through the gate and rocked to open the gate switch. For flight director/automatic I.L.S. approach automatic throttle control is limited to a short range of rev/min and is effective only subject to throttle presetting within that range. For details of the engine and reheat systems refer to A.P.102C-1523-16A.

Engine controls (fig. 1)

4. Engine and reheat thrust are controlled manually from the cockpit through conventional mechanical linkages. From each throttle handle a single control linkage runs to a lost-motion box, mounted on the airframe near the fuel flow control unit of its associated engine, whence the run divides into two separate linkages, one for engine and one for reheat control. Reheat is electrically initiated and cancelled by a microswitch operated by the control handle. Initiation can be effected only at maximum engine speed, but when reducing thrust, manipulation of the throttle handle allows reheat to be retained in the cold range down to the reheat hold-in

stop. During flight director/automatic I.L.S. approaches air speed can be controlled, to a limited degree, by an electric servo-actuator which is connected to the controls through a manually-operated clutch. In emergency, the clutch can be overridden by direct movement of the control handles.

Engine control unit (fig. 2)

5. The engine control unit is mounted on the port console and combines the control of the H.P. cocks, engine throttles and reheat, through sliding handles. The handles are moved forward to increase engine power output. The slots which guide the handles are cranked at the maximum throttle position to prevent inadvertent selection of reheat; this is the only impediment to forward movement but, when throttling back, the handles are arrested at certain positions by adjustable limit stops. The reheat microswitches are operated by hinged plates which are moved by the handles as they are rocked to port. The length of the plates is such that the handles will, if held over to port, maintain contact when being withdrawn beyond the reheat gate, so providing the facility of reheat hold-in (para. 6).

Reheat hold-in stops

6. As each handle is withdrawn from the reheat range and held over to port, it strikes a spring-loaded masking plate at the reheat gate. Continued movement of the handle pushes the plate backwards until it contacts an adjustable stop at the rear of the unit; this stop determines the minimum engine speed at which reheat may be retained. When the handle

is rocked to starboard, the microswitch operating plate is released, and the masking plate springs forward to the reheat gate preventing reheat from being reselected until the handle is once again moved forward to the gate.

Fast-idling stop

7. This is an adjustable stop secured to the control unit casing by three screws. When No.2 engine control handle is moved aft, a spring-loaded trigger on the handle abuts the stop and further aft movement is possible only by depressing the trigger to withdraw it from engagement. The stop ensures a sufficient flow of compressor air to the turbine for a.c. and d.c. supplies.

Idling stops

8. The control handles move in the unit on ball bearing carriages. Backward movement of each handle brings its carriage on to adjustable idling stops in the aft end of the unit. A lever on the side of the box, when pushed forward, allows the handles to pass the stops for engine shut-down purposes. The idling stops adjustments are accessible at the rear end of the unit.

Shut-down stop

9. The No.2 control handle is held in the shut-down position by engagement of the fast-idling stop release trigger with a fixed stop mounted on the unit face plate.

Control handles

10. The outboard of the two handles

controls No.1 engine and the inboard handle No.2. The No.2 engine control handle incorporates the air-brakes selector and R/T transmitter switches.

Throttle servo-clutch (fig.3)

11. The clutch comprises three separate levers and a manual operating device, all mounted on a common shaft supported in a bracket, the complete assembly being secured in the structure of the port console. Two of the levers, one

for each engine, are connected in the airframe throttle linkage and each carries one of two male clutch components. The third lever is interposed between the engine levers, and is connected to the servo actuator; this lever incorporates the female component of the clutch.

12. When the clutch is disengaged, the engine levers are free to pivot on the shaft during normal operation of the

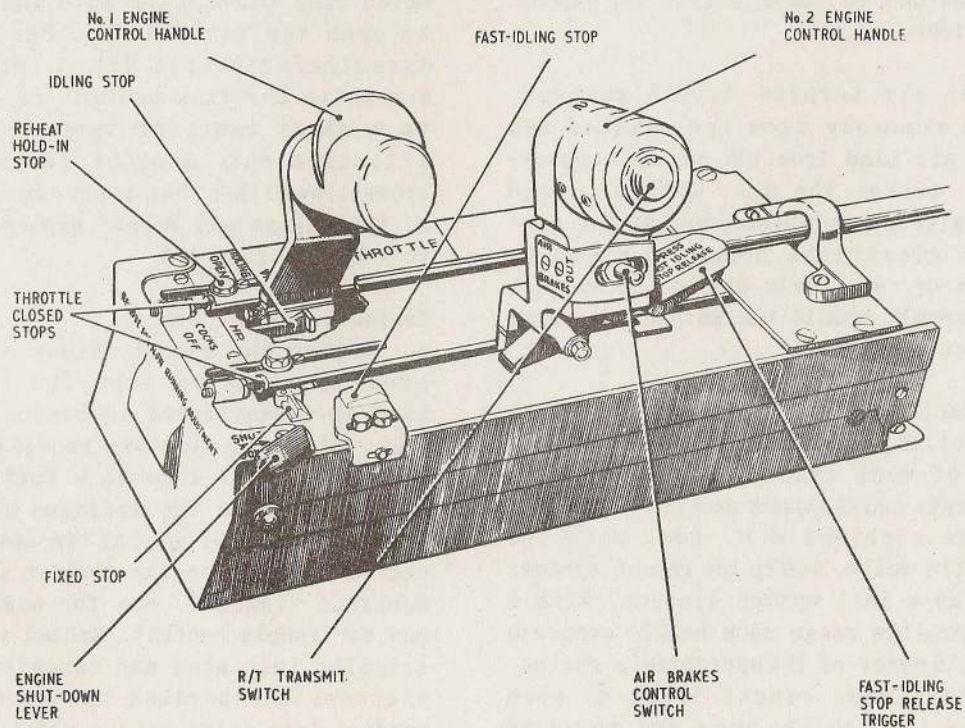


Fig. 2. Engine control unit

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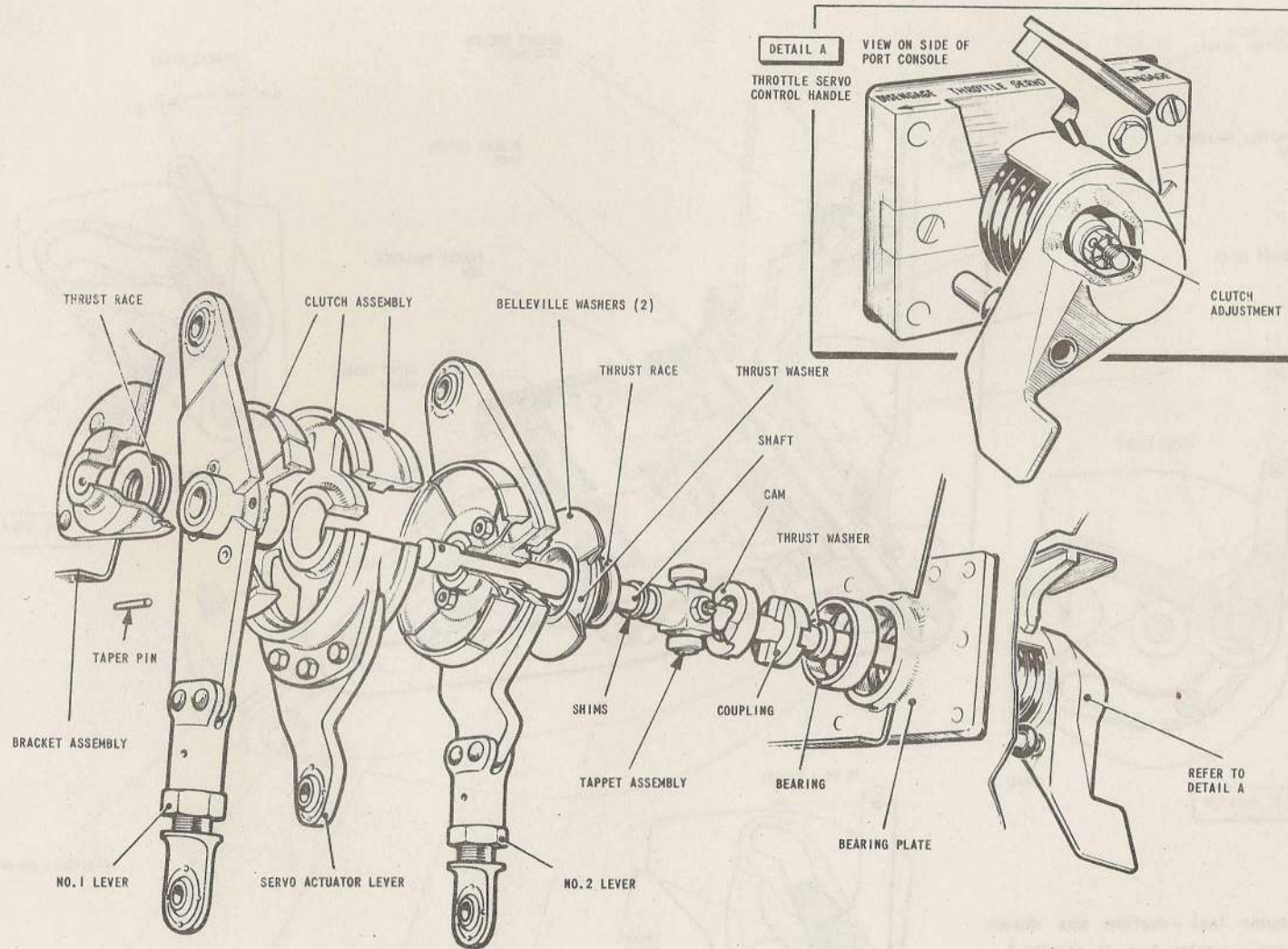
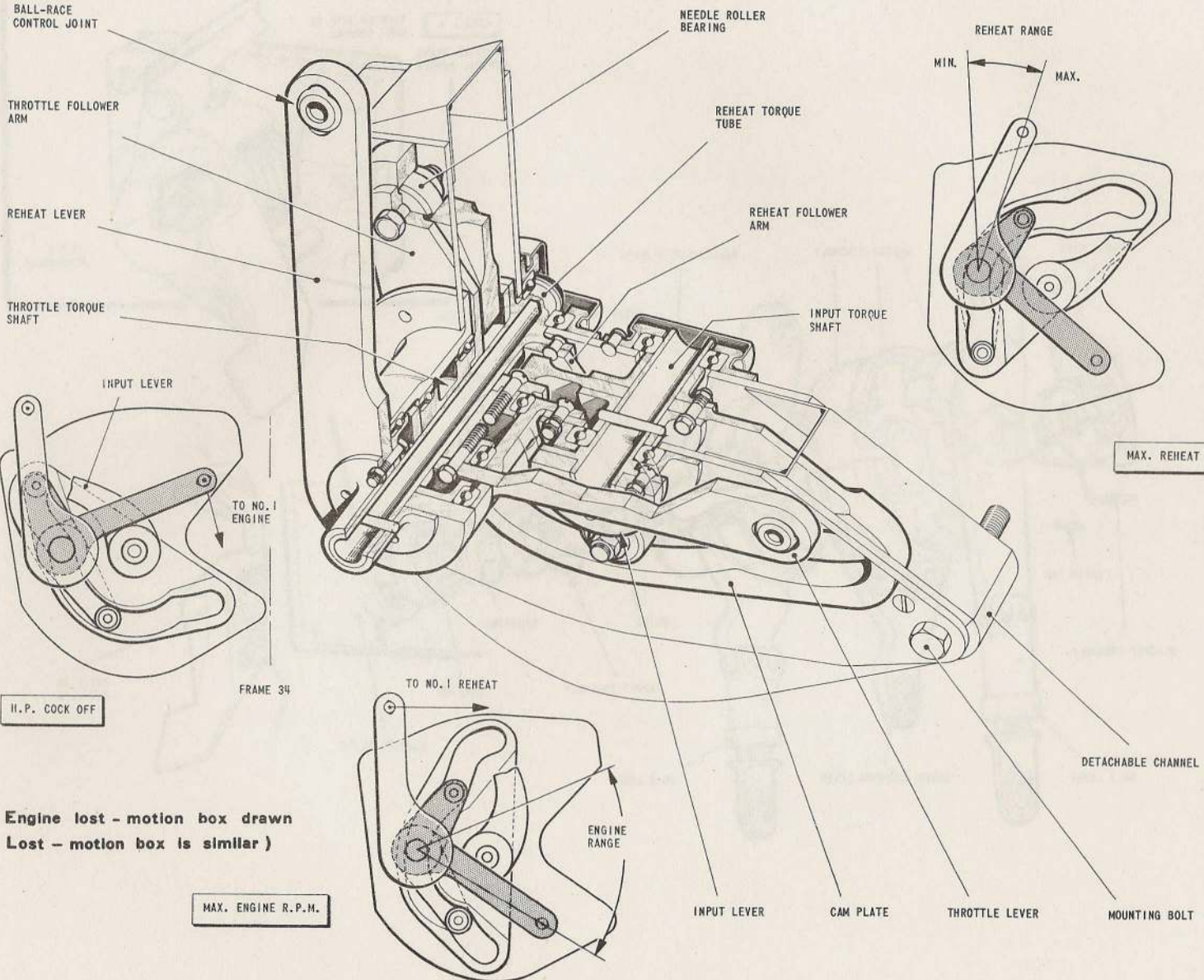


FIG. 3. THROTTLE SERVO - CLUTCH

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No. 1. Engine lost - motion box drawn
(No. 2 Lost - motion box is similar)

FIG. 4. LOST - MOTION BOXES

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engine control handles. Clutch engagement is effected by rotating the control lever in a clockwise direction; this rotates a cam to bring the clutch faces into contact with each other, thus linking the servo actuator to the throttle levers on the engine. Belleville washers govern the overriding force required on the throttle control handles. The clutch is released by depressing the switch on the lever to allow the lever to return to the disengaged position.

Lost-motion box (fig. 4)

13. The lost-motion box, one in each engine linkage, comprises two side plates enclosing a cam plate and two cam levers, one for engine control and the other for reheat control. The levers are attached to an engine spool and reheat shaft, respectively. The shafts rotate independently and concentrically about the same axis in bearing housings attached to the side plates. The shaft and spool extend beyond the side plates at one side and each carries an output lever for transmitting movement to its associated control linkage. The cam plate is attached to a shaft which extends beyond the side plates on the same side as the output levers and is connected by a lever to the throttle handle linkage.

14. Needle bearings attached to the ends of the cam levers run in a profile slot in the cam-plate. The slot is so formed that the centre section is concentric to the cam-plate shaft, the opposing end sections being eccentric. Angular displacement of the throttle and reheat output levers is effected by

movement of the corresponding cam levers within the opposing end sections of the cam-plate slot. When a cam-lever moves within the centre section the corresponding output lever remains stationary. At any instant one cam lever lies in the appropriate end section with the other in the centre section.

15. With the throttle handle in the H.P. COCKS OFF position the throttle control cam lever will be at the appropriate end of the cam-plate slot and the reheat cam lever will be in the centre portion. As the throttle handle is moved to the OPEN position the throttle control cam lever will move in relation to the cam-plate slot and hence transmit the throttle handle movement to the engine H.P. cock. During this phase there is no movement of the reheat lever. As the throttle cam lever moves into the centre portion of the slot, continued movement of the throttle handle into the reheat range will cause the reheat cam lever to move out of the centre portion and into the end section, moving in relation to the profile of the slot and hence transmitting throttle handle movement to the reheat system.

Engine starting

- ◀ 16. Engine starting is effected by the Plessey system of starting using isopropyl-nitrate fuel in conjunction with high energy ignition. Details of this system are given in Chap. 1A which should be read in conjunction with A.P. 103D-0208-16. Further information can be found in Sect. 6, Chap. 7 of this publication along with the relevant circuit and routing diagrams. ▶

Accessory drives

Hydraulic pumps

17. Hydraulic pressure for the flying controls and services is supplied by four pumps, two on each engine. The pumps are mounted on the external wheel-case on the port side of the compressor casing, and are secured by quick-release clamps supplied with the engine.

Fueldraulic pumps

18. An engine driven fueldraulic pressure pump is fitted on the starboard side of each engine. These pumps supply fuel pressure to drive the motors of the fueldraulic booster pumps in the aircraft fuel system. The No. 1 engine pressure pump drives the booster pump in the port wing fuel system and the pump on No. 2 engine drives the booster pump in the starboard wing.

Engine mountings

General information

19. Each engine is supported by two front and two rear mountings which provide for engine alignment and expansion. To gain access to the No. 2 engine front mountings the engine hatch must be removed; all other mountings are accessible beneath detachable panels (Sect. 2, Chap. 4, Table 3).

Front mountings (fig. 6)

20. A self-aligning mounting linkage, traversing the top of each engine compressor casing, is connected on each side to reinforced structure in the fuselage by a turnbuckle adjuster. The connection is made by quick-release pins in the No. 1 engine installation, and by bolts in the No. 2. Restraining

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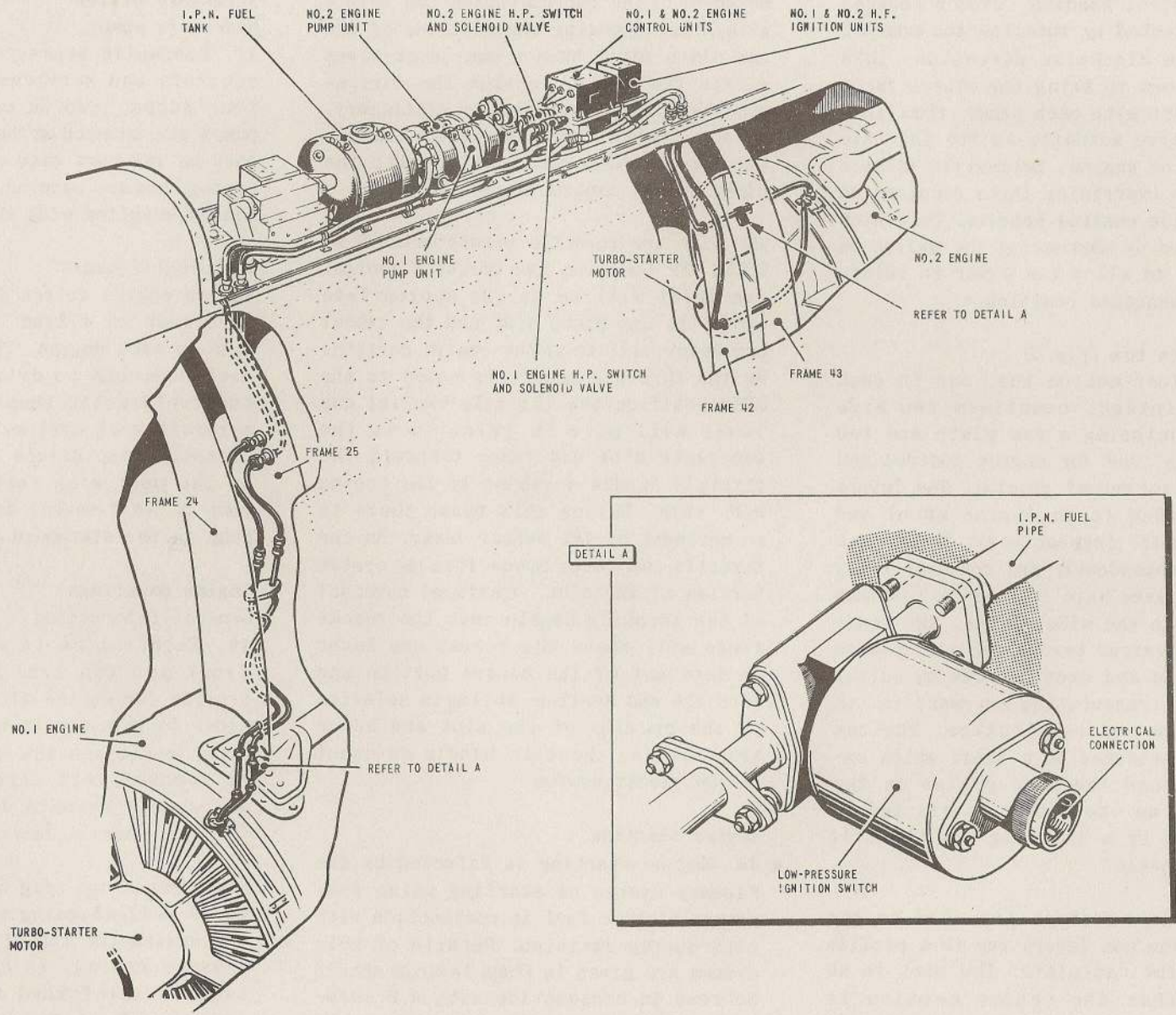


FIG. 5. ENGINE-STARTING INSTALLATION

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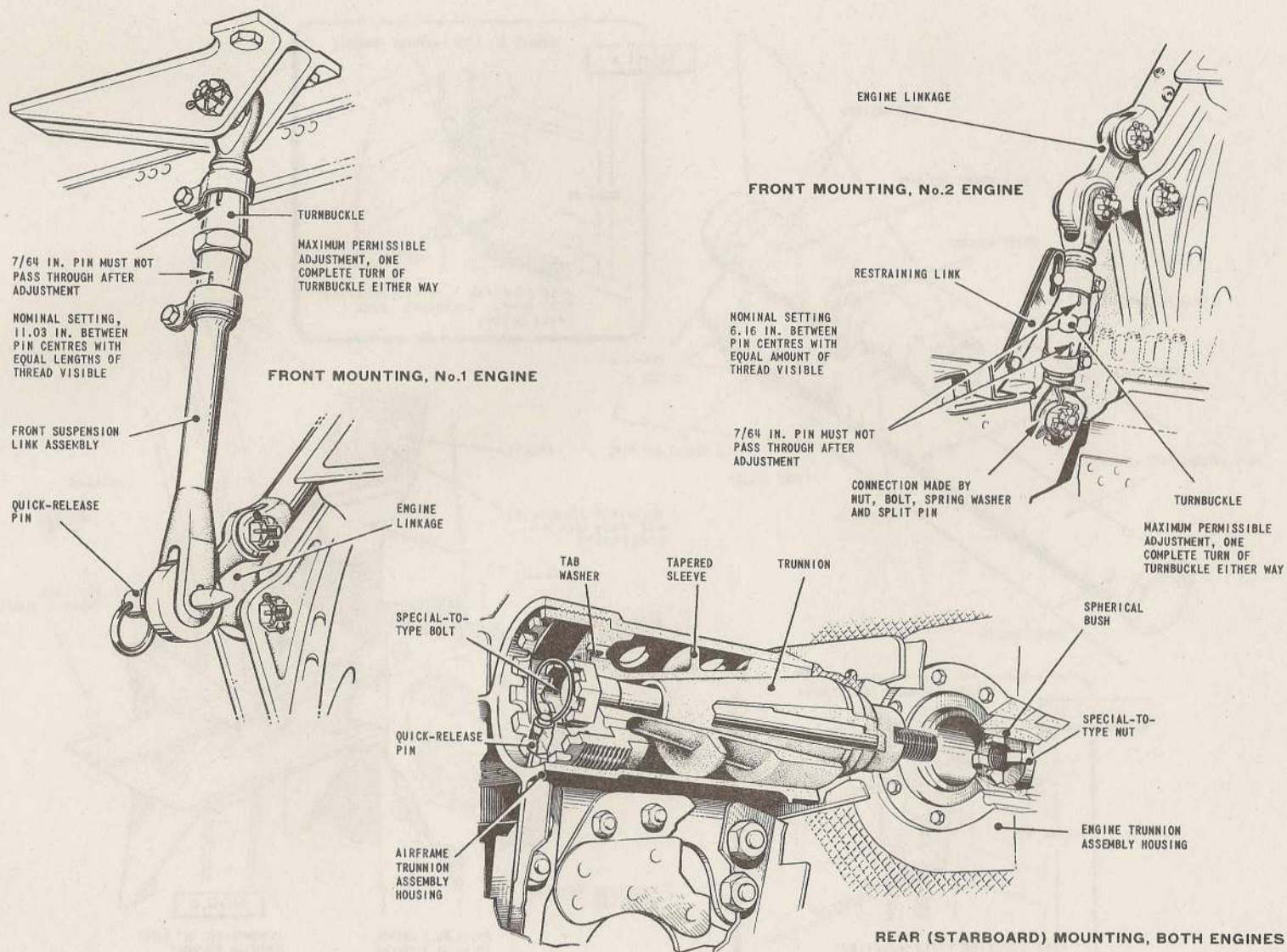


FIG.6. ENGINE-MOUNTING DETAILS

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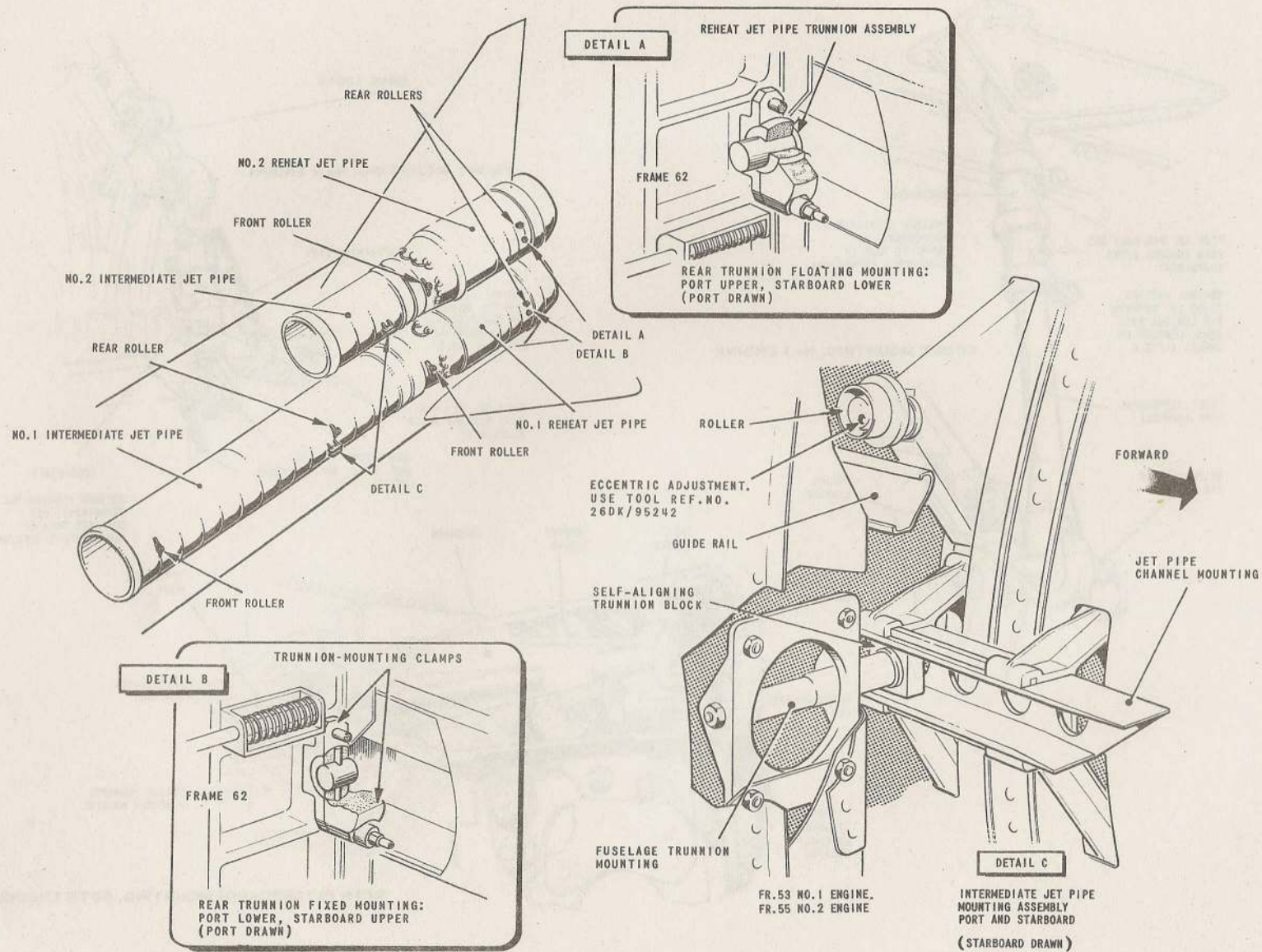


FIG.7. JET PIPE MOUNTINGS

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links on No.2 engine front mountings prevent the turnbuckles falling and damaging the structure during engine removal.

Rear mountings (fig.6)

21. The rear engine mountings are trunnion assemblies, supported in housings in the fuselage structure, port and starboard. The trunnion assemblies comprise a hollow tapered trunnion with cruciform slots at the small diameter, a tapered sleeve, and a special-to-type bolt. The trunnion is centralized in the housing by the sleeve and supports the engine by engaging a spherical bush located inside the horizontal web of the nozzle box. The bolt securing the assembly passes through the hollow tapered sleeve and trunnion and screws into a special pegged nut which is fitted in the spherical bush; this nut is free to turn and move slightly about its axis until engaged by the cruciform slots of the trunnion, when it is held at the correct angle for a thread start of the bolt. Thread start is also aided by the hole through the trunnion being reduced to bolt diameter for only a short distance at the inboard end; this permits rocking of the bolt before the assembly is drawn tightly together. A tab washer locks the bolt to the sleeve.

22. The starboard trunnion assembly positions the engine, the sleeve being threaded externally to screw into the airframe housing. The sleeve is locked by a quick-release pin which passes through one of the fifteen radial slots in the head of the sleeve and one of two holes in the housing. Engine expansion

is allowed for in the port trunnion assembly by the sleeve being free to move axially in its housing. The spherical design of the bush permits movement about the horizontal axis in the engine housing; this movement provides for any slight engine misalignment.

Jet pipe installation

General description

23. In each installation, the intermediate and reheat jet pipes form one complete unit when assembled to the aircraft, with seals between the two sections and between the intermediate pipe and the engine. At the engine-to-intermediate jet pipe joint of both engine installations, an annular shroud is fitted to vent hot gas leaks overboard. The gases flow through two pipes communicating with holes in the port and starboard fuselage skin. The jet pipes are supported at the engine and at two further points on each side, the mountings allowing for axial and radial expansion. Although similar, the reheat pipes are not interchangeable.

Front mountings (fig.7)

24. The forward ends of the intermediate pipes are supported by the exhaust units of their associated engines. The items are secured together by keep plates (*fig.20, detail C*), two to each installation, which grip overlapping flanges on the engine and jet pipe by pressure applied with a castellated nut on each plate. Clearance within the joint permits axial expansion.

Intermediate mountings (fig.7)

25. At frame 53 (No.1 jet pipe) and

frame 55 (No.2 jet pipe), port and starboard trunnions support the aft ends of the intermediate pipes and take the weight of the forward ends of the reheat pipes when they are assembled. Each trunnion carries a rectangular steel block mounted on a spherical bush; the block engages a short channel section supported by brackets on the intermediate pipe. Clearance within the joint provides for radial expansion of the pipe.

Rear mountings (fig.7)

26. Trunnions, integral with the reheat pipes, carry spherical bushes which are gripped by clamps bolted on the aft face of frame 62. No.1 jet pipe starboard trunnion and No.2 jet pipe port trunnion are of increased length and permit radial expansion of the jet pipe by being free to move through the spherical bush.

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.

Lubrication

27. The full designations of lubricants referred to throughout this chapter can be found in Leading Particulars. Ball bearings in the assemblies are pre-packed with lubricant and do not normally require attention. Oil where

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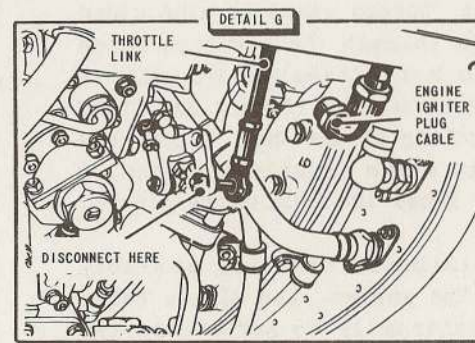
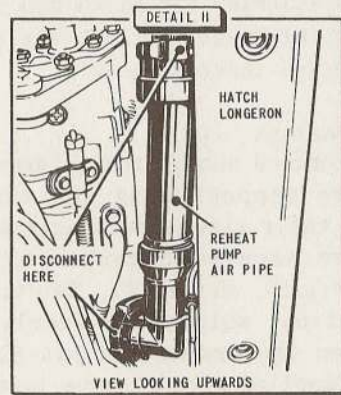
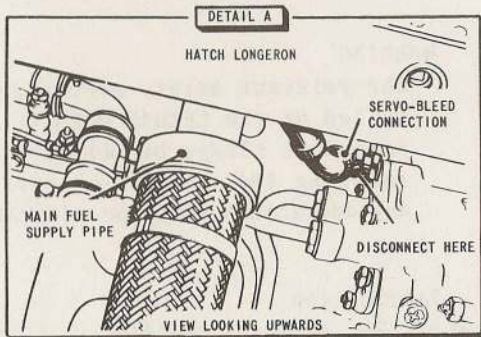
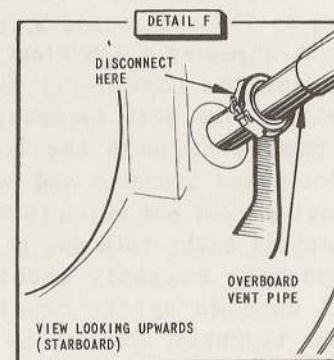
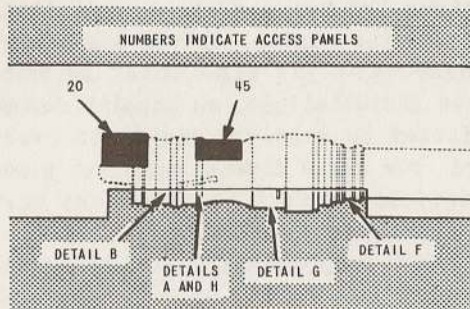
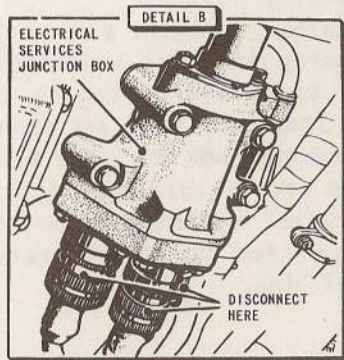
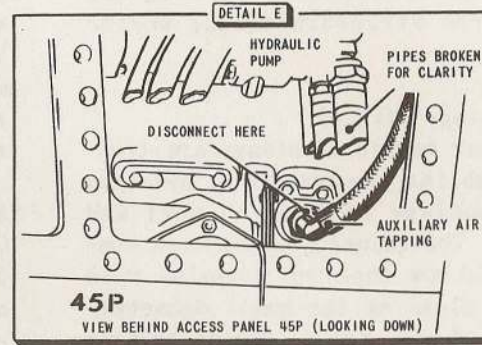
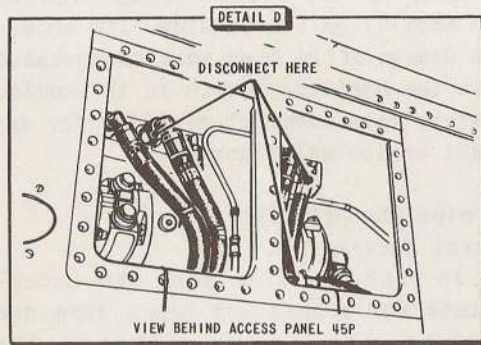
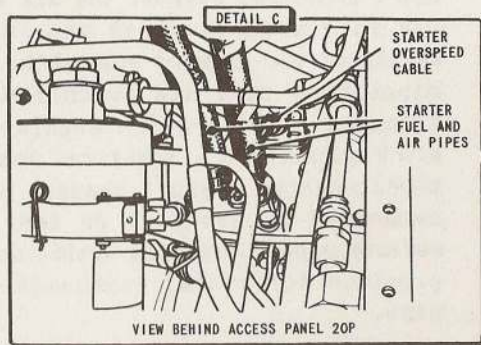


FIG. 8. NO.1 E.C.U. - REMOVAL AND ASSEMBLY (1)

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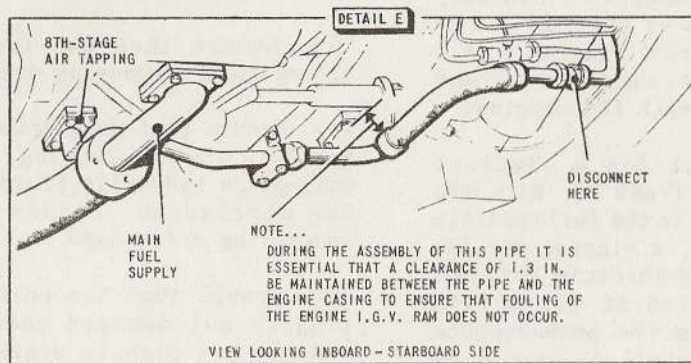
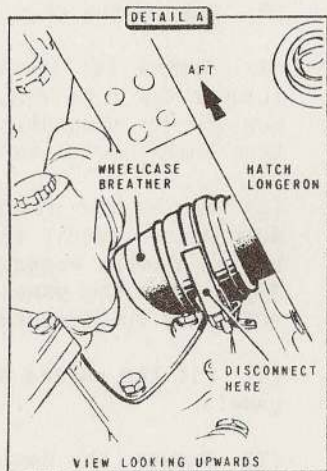
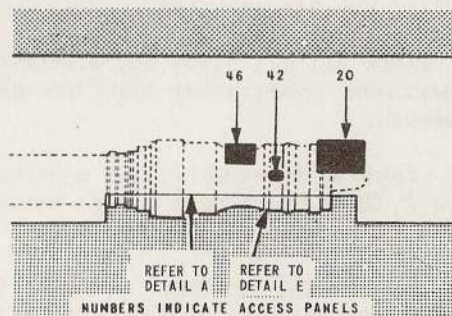
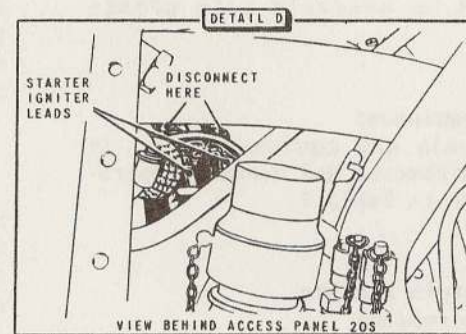
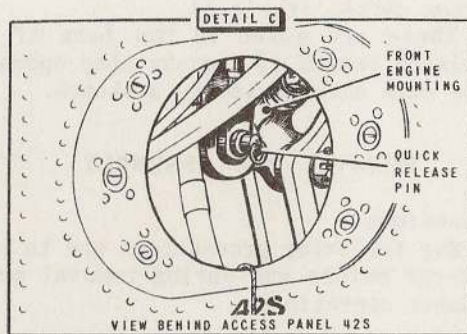
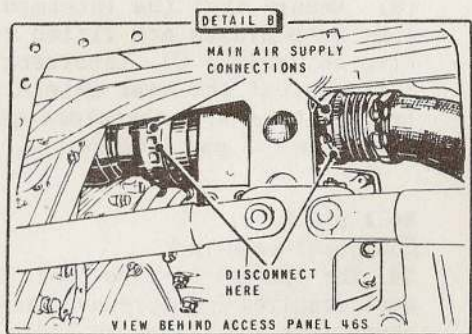


FIG.9. No.1.E.C.U. -REMOVAL AND ASSEMBLY (2)

specified is to be used sparingly. All control rods are designed to run dry in their roller guides and are not to be lubricated. The Teleflex controls are lubricated on assembly with grease XG-315.

Tools and equipment

28. For tools and equipment used in servicing or removal and assembly operations, refer to Table 2.

Engine controls rigging

General information

28. A full rigging of the engine control linkages is carried out with the use of rigging pins inserted at various points in the linkage, coupled with dead length measurements. Once the initial rigging has been done it is seldom, if ever, that a complete rigging check would be required. Should this occasion arise, both engines and associated jet pipes are removed and the engine controls rigging checks done step-by-step as detailed in Table 1.

30. If a control rod, lever, or part of the linkage become damaged or suspect, the affected section of the run can be locked at the two nearest rigging points and the damaged portion renewed and adjusted to conform with the original.

31. The datum point for a complete rigging check is at frame 25. With the port throttle levers in the full throttle (100% cold) position, a rigging pin inserted in the forward throttle box, and rigging pins inserted at all points throughout the system the measurements given in Table 1 (detail A) should be obtained. Before commencing rigging ensure that all control rod bearings are correctly adjusted by setting the appropriate clearance between the control

rods and eccentric rollers of each type of bearing assembly, as detailed in fig.1, detail B and D.

Rigging checks (Table 1)

32. These are given in the form of a tabulated series of step-by-step operations each accompanied by a sketch.

REMOVAL AND ASSEMBLY

Precautions

33. The following precautions are to be observed before and during removal and assembly operations:-

(1) Ensure that the aircraft battery is disconnected and that all external supplies are disconnected.

(2) Blank off all pipes and electrical connections immediately they are disconnected.

(3) Jack and trestle the aircraft (Sect.2, Chap.4), if both engine hatches are to be removed.

(4) Trestle the aircraft at frame 59, before removing No.1 E.C.U. or fitting the jet pipe cradle.

(5) Ensure that the fuel cocks are closed before removing either E.C.U.

(6) Ensure that the hydraulic servicing trolleys are not running, and that the tail-plane hydraulic fluid accumulators are discharged, before removing or assembling a jet pipe.

(7) Ensure that the bulkhead sealing ring is not damaged when the intermediate jet pipe is separated from or connected to the ECU exhaust unit. If the joint in the sealing ring is conveniently positioned (at 6 o'clock, No.1 installation, & 12 o'clock No.2

installation) a locally manufactured seal joint guard can be interposed between the seal joint and the jet pipe.

(8) Ensure that the intermediate jet pipe keep plates are fitted correctly (fig.20, detail C). Incorrect fitting will prevent the heat shield sections from seating on the braided seals, and result in hot gas leakage.

No.1 E.C.U.

Equipment required

34. The special-to-type tools and equipment required during removal and assembly operations are listed in Table 2.

Removal (fig.8, 9 and 10)

35. To remove No.1 E.C.U.:-

(1) Remove the No.1 engine hatch (Sect.3, Chap.1).

(2) Disconnect the 24-volt and high-energy ignition leads from the ignition boxes on the duct access panel.

(3) Remove the starter exhaust pipe.

(4) Remove the lower half of the air-intake duct-to-engine sealing ring housing by unscrewing the special-to-type bolts, using the key provided.

(5) Remove the six bolts securing the duct access panel; the panel is located by two dowels engaging holes in frame 22. Remove the panel, first moving it rearwards to disengage the dowels.

(6) Fit the engine air-intake blanking panels.

(7) Remove the domed starter fairing by unscrewing the six securing bolts, rotating the fairing through a few degrees counter-clockwise and drawing it forward.

- (8) Disconnect the sleeved vent pipes between the overboard vented heat shield at the exhaust unit and fuselage skin adapters by unfastening the two quick-release clamps and retracting the inner sleeves, using the tools provided.
- (9) Release the four fasteners securing the two sections of the overboard vented heat shield and detach the bottom section.
- (10) Using the roller key, lower the intermediate jet pipe rollers on to the fuselage rails. Push the key inwards before turning to release the locking device.
- (11) Remove the two keep-plates.
- ◀ (12) Fit the jet pipe divorcing tools, positioning them so that the flanged ends of the tool travellers abut the aft face of the engine exhaust unit flange.
- (13) Rotate the pinions of the tools to separate the jet pipe from the engine and slide the intermediate jet pipe as far as possible to the rear.
- (14) Remove the top section of the overboard vented heat shield. ▶
- (15) Disconnect the two Firewire connections on the exhaust unit.
- (16) Disconnect the three electrical services plugs from the engine.
- (17) Disconnect the servo-bleed pipe from the reheat control unit.
- (18) Disconnect the air supply pipe for the reheat pump at the engine and pump connections and remove the pipe.
- (19) Disconnect the engine throttle control rod at the engine fuel flow control unit.
- (20) Disconnect the port and starboard engine igniter plug leads.
- (21) Disconnect the wheelcase breather pipe.
- (22) Disconnect the starter igniter leads from the igniter boxes in the spine and then, at the engine end, from the bracket on the starboard hatch longeron at frame 25.
- (23) Remove the engine fuel supply flexible hose by disconnecting at the engine and fuselage duct.
- Note...
Fuel will drain out of the supply pipe when the hose is disconnected.
- (24) Disconnect the guided-weapon hot-air supply line from the 8th compressor-stage tapping at the flexible connection rearward of frame 22.
- (25) Remove access panel 26P and disconnect the starter fuel and air pipes from the engine and airframe.
- (26) Disconnect the starter overspeed cable.
- (27) Remove access panel 45P and disconnect the six flexible hydraulic hoses and the drainpipes at the two hydraulic pumps using the special-to-type spanners.
- Note...
Refer to Sect.3, Chap.6, SERVICING for instructions regarding P.T.F.E. hoses.
- (28) Remove the lower cover from the No.1 lost-motion box.
- (29) Remove the two hydraulic pumps. When removing the aft (controls) pump, tilt the rear end downwards and withdraw through the access panel, splined shaft leading.
- (30) Disconnect the auxiliary-air system pipe from the engine adapter.
- (31) Remove access panel 46S and disconnect the fuel hydraulic supply pipe from the engine bracket.
- (32) Disconnect the fuel supply pipe to the hot-shot relay.
- (33) Disconnect the air ducts to and from the engine non-return valve.
- (34) Position the buffer strips on the bottom aft surface of the air-intake duct.
- (35) Secure the forward and aft hoist support beams to the hatch fastener nuts at frame 27 and 31 and frames 36 and 39 respectively, on each hatch longeron (*fig.10*).
- (36) Mount the engine hoisting cradle

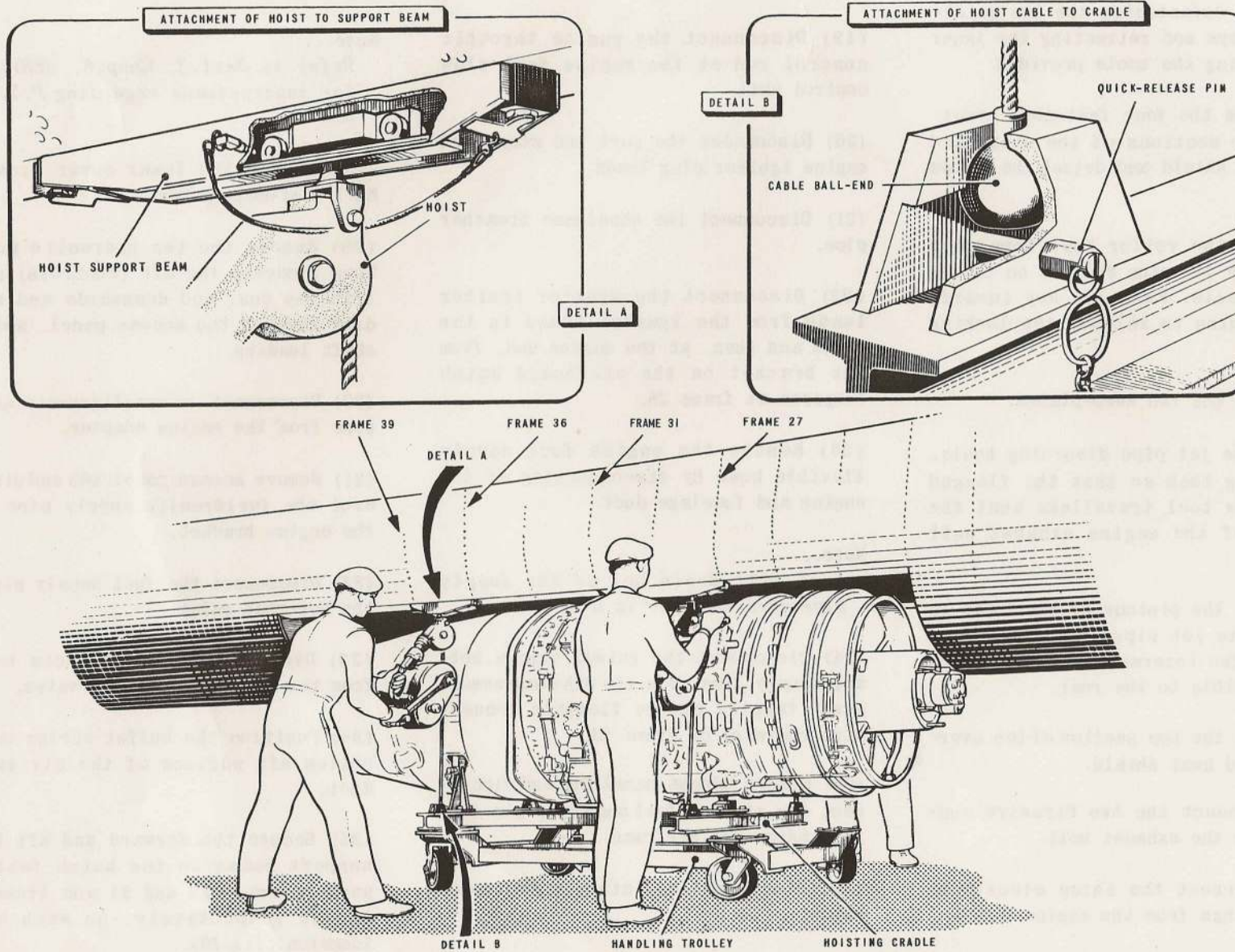


FIG. 10. NO. 1 E.C.U. - REMOVAL AND ASSEMBLY EQUIPMENT

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on the engine handling trolley and position the assembly beneath the engine.

(37) Fit a hoist to each support beam and enter the ball-ends of each cable into the appropriate cradle attachment; move the ball-ends to the forward end of each slot in the attachments and lock with the quick-release pins (fig. 10).

(38) Raise the cradle to the engine and secure it, at the aft end, to the brackets located below the rear engine mountings. Fit the winch handles to the upper drive dogs and continue winding until the clutch on each hoist slips.

(39) Remove the quick-release pins from the forward engine mountings (fig. 6).

(40) Dismantle the rear mountings (fig. 6).

(a) Remove the locking pin from the starboard trunnion.

(b) Straighten the tab washers locking the mounting bolts and remove the bolts using a box spanner.

(c) Withdraw the tapered sleeves using, on the starboard mounting only, the hexagon key provided.

(d) Withdraw the trunnions using the extractor provided.

(41) Lower evenly on each hoist until engine N.R.V. clears main air-supply pipes. On rear hoists lower rear end of engine (fig. 12). Ensure starter assembly

does not foul air-intake duct. Continue lowering on rear hoists, moving engine aft until exhaust unit extension is beneath the fuselage at frame 44 and starter is clear of the duct. Lower on front hoists to a level position, then lower evenly on to trolley. Remove hoists.

*Preparation of replacement E.C.U.
(fig. 11)*

36. To prepare the replacement E.C.U. for installation the following items are transferred from the removed E.C.U.

(1) Main air system non-return valve; assemble, using new locking strips (for lubrication of threads and joints refer to Sect. 3, Chap. 8A).

(2) Hydraulic pumps (after applying grease XG-284 to the drive splines (detail B)). The hydraulic pumps clamp fasteners must be tightened to a torque loading of 135 lb in.

Note...

If it is necessary to fit replacement P.T.F.E. hoses:-

1. Refer to Sect. 3, Chap. 6, Servicing Note 3.

2. Fit the pump or pumps in the position marked on the presetting jig provided and connect each hose hand-tight to the pump connections.

3. Carefully set each hose until the correct lie is obtained and connection to the appropriate point on the jig can be made.

4. Tighten and wire-lock each pump/hose connection, disconnect the pump/jig connection and remove the pump from the jig ensuring that the set of the hoses is maintained.

(3) Fit auxiliary air system supply pipe adapter (detail C) on port side of engine compressor housing (for lubrication of threads and joints refer to Sect. 3, Chap. 8A).

(4) Compressor seal vent outlet adapter (detail D).

(5) Fuel flow control unit drain (detail E).

(6) Oil cooler drain (detail F).

(7) Combustion chamber drain (detail G).

(8) Jet pipe joint drain; use bolts and spring washers on replacement E.C.U. (detail H).

(9) Fuel hydraulic pump (detail J) renewing the sealing rings and the gasket at the fuel inlet elbow joint.

(10) Fuel hydraulic supply pipe and mounting bracket (details A and J); use existing nuts on pump and N.R.V. housing.

(11) Starter exhaust pipe; remove starter fairing, lift locking tab, and release ring nut using a 'C' spanner. Replace tab washer when transferring to replacement E.C.U.

(12) 8th compressor-stage tapping (fig. 9 detail E); transfer pipe assembly and

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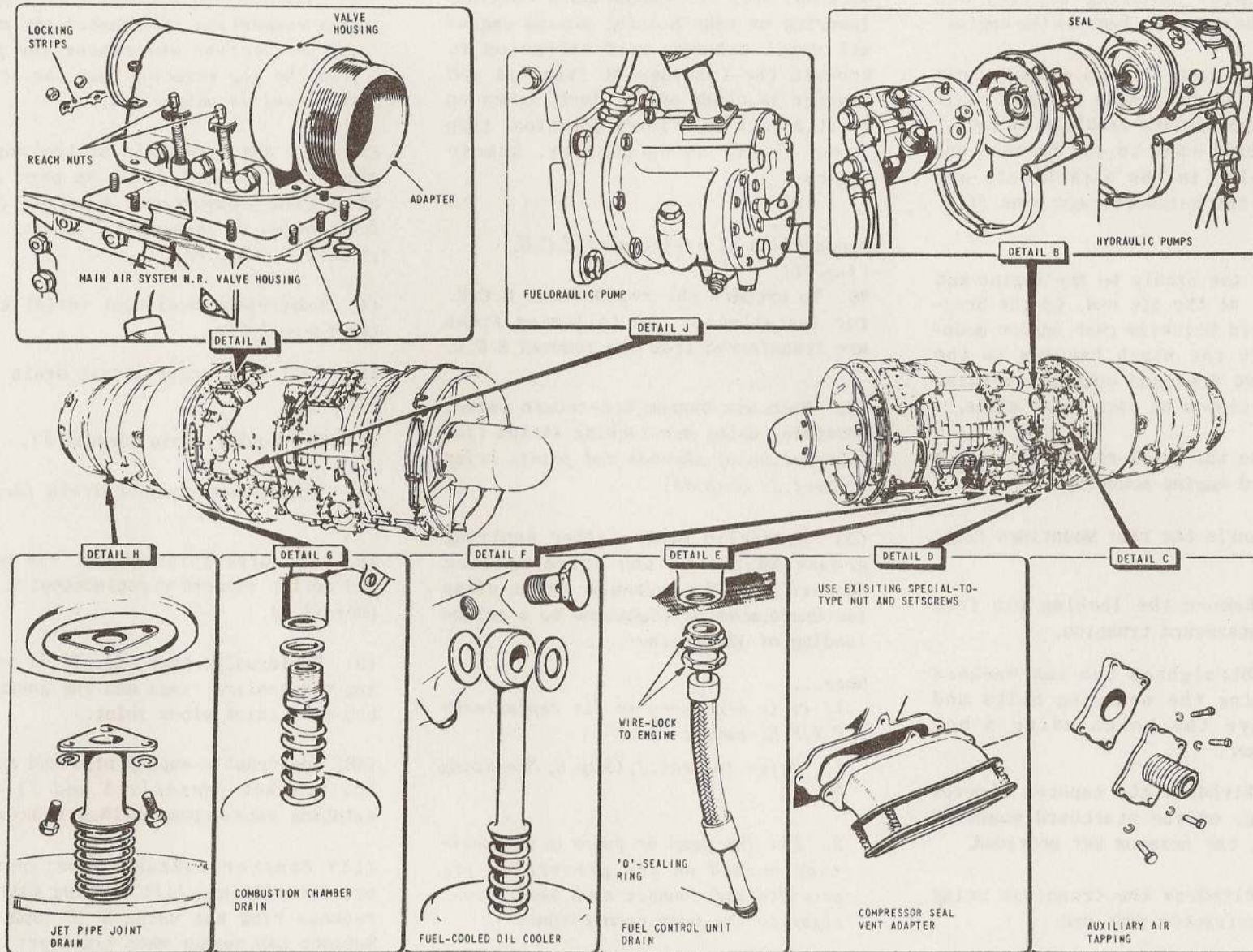


FIG.11. NO.1 E.C.U. - PREPARATION

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fairlead using nuts, joint and brackets on replacement E.C.U.

(13) Engine air-intake blanking panels.

Note...

In preparation for the installation of the replacement E.C.U.:-

◀ 1. Apply grease ZX-38 lubricant to the trunnion sleeves at the shaded area indicated in fig.14.

2. Apply the lubricant to the trunnion housing bores over a length of 4 in. inboard from the fuselage skin. Leave to dry for not less than 30 min.

Assembly (fig.8, 9 and 10)

37. With the engine in the complete state of preparation (para.36) and mounted in the handling trolley:-

(1) Ensure that the precautions detailed in para.33 are observed.

(2) Tie back loose electrical leads and flexible hoses in the engine bay and examine the bay for cleanliness.

(3) Place the starter domed-fairing in the air intake in readiness for connection.

(4) Position the engine and cradle beneath the engine bay, position hoist trolleys aft in their support beams, and connect the hoist adapters to the cradle.

(5) Raise the engine and cradle, adjusting the trim as necessary (fig.12)

to avoid fouling and align the rear mounting trunnion housings.

(6) Assemble the rear mountings (*lubricated as detailed in the note following para.36 operation (13)*).

(a) Insert each trunnion into its fuselage housing and, using the trunnion spanner, engage the slots in the trunnion with the nut in the engine housing.

(b) Fit the starboard tapered sleeve over the trunnion and tighten. Align one of the notches in the sleeve with a corresponding hole in the housing (fig.6). The sleeve may be unscrewed just sufficiently to achieve this.

(c) Fit the sleeve over the port trunnion.

(d) Fit the port and starboard trunnion bolts, flanged bolt to port, using new tab washers; tighten the bolts with the special spanner and lock with the tab washers.

(e) Check for correct engagement of the trunnions (fig.14) and lock the starboard trunnion with the quick-release pin.

Note...

The starboard trunnion sleeves for No.1 and No.2 engine installations are not interchangeable. The sleeve for No.1 engine is modified by the removal of a collar before the threads.

(7) Insert the quick-release pins in the front mountings.

(8) Check the engine/air intake alignment (fig.13). If necessary adjust the front mountings by slackening the clamps and adjusting the turnbuckles (fig.6). The adjustment must not exceed one full turn. Check safety holes with 7/64 in. dia. wire and reclamp.

(9) Remove the quick-release pins securing the cradle and lower the cradle on to the trolley. Dismantle the hoists. Remove the support beams from the hatch longerons and stow them on the trolley.

(10) Through access panel 46S, lubricate the threads of the air system non-return valve housing (Sect.3, Chap.8A), refit the washers, and connect and lock the ducts.

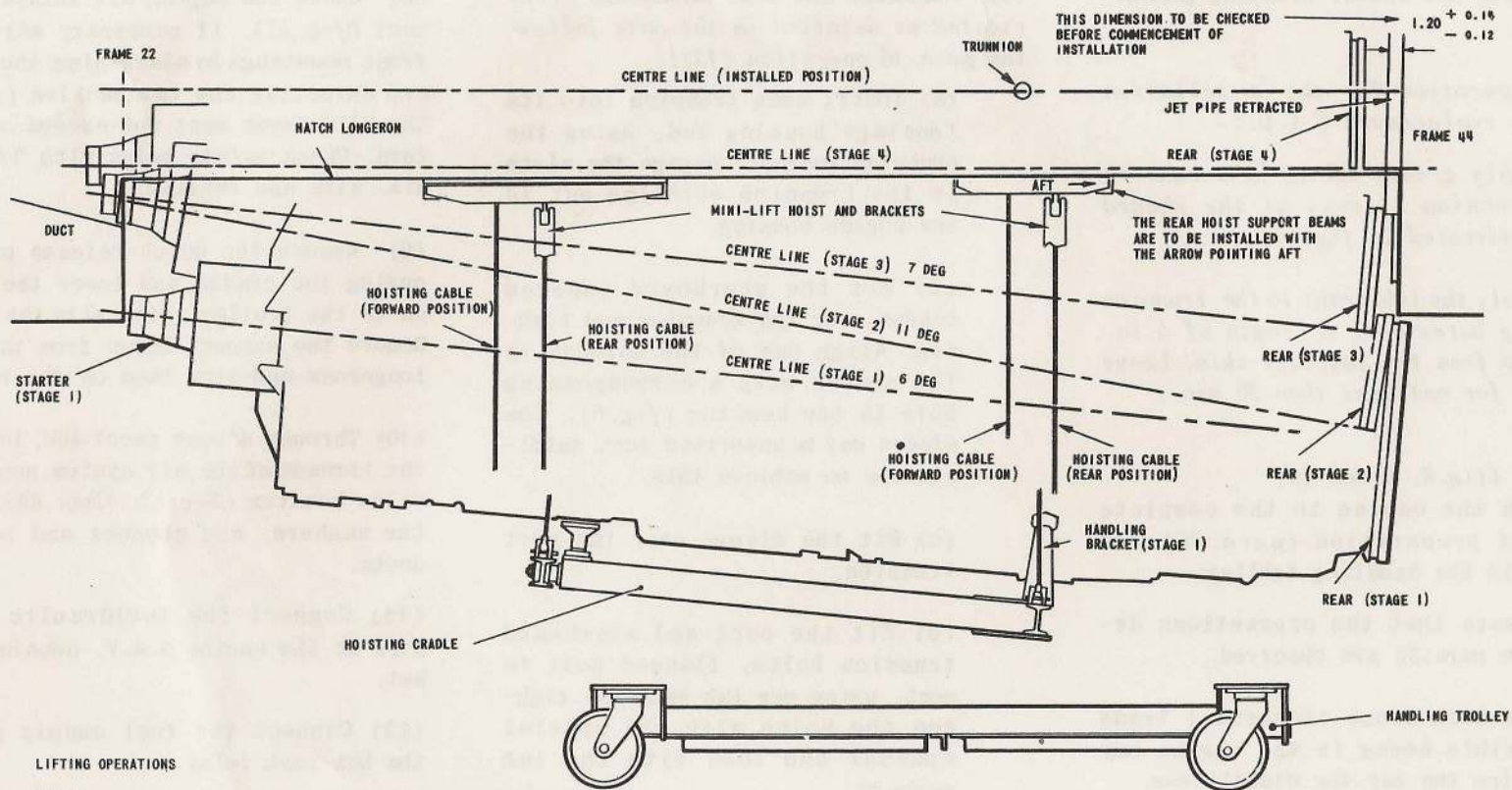
(11) Connect the fueldraulic supply pipe at the engine N.R.V. housing bracket.

(12) Connect the fuel supply pipe to the hot-shot relay.

(13) In the engine bay, connect the 8th stage compressor tapping for weapon pack heating. Ensure that the stated engine casing/pipe clearance is maintained (fig.9, detail E).

(14) Connect the starter igniter leads to their respective adapters on the starboard hatch longerons.

(15) Connect the engine fuel supply hose, ensuring that the seal is correctly seated in the engine connection flange.



LIFTING OPERATIONS

Note...

1. Prior to e.c.u. installation, check that the jet pipe has been retracted to the dimension shown at Fr.44 between the forward face of the jet pipe and the frame.
2. Aircraft profile is shown with ventral pack removed. With aircraft in this position the engine can be changed without lifting the aircraft with jacks, providing the handling trolley is removed before engine is tilted as shown at Stage 1.
3. When installing or removing engine on aircraft with centre and rear section of ventral pack fitted, the aircraft must be jacked and trestled. Maximum angle of inclination of engine will be 25 deg.

STAGE 1

Position the e.c.u. as shown with the starter motor assembly inside the e.c.u. bay, and the rear of the e.c.u. under the aircraft at fr.44 inclined at approximately 6 deg.

STAGE 2

Lift the e.c.u. at the front end and move it forward, putting the starter motor housing in the air intake duct. The rest of the e.c.u. should now be within the e.c.u. bay and inclined at approximately 11 deg.

STAGE 3

Move the e.c.u. forward and lift the rear end (inclination approximately 7 deg).

STAGE 4

Move the e.c.u. forward and lift it until it lies parallel with its installed position. From here it is a straight lift.

FIG.12. No.1. E.C.U. ASSEMBLY PROCEDURE

E2180-1

(16) Fit the wheelcase breather pipe into its fuselage compartment and connect it to the engine.

(17) Connect the high-tension leads to the engine igniter plugs and to the high-energy ignition units.

(18) Connect the reheat fuel pump air supply pipe ensuring that the seal is correctly seated.

(19) Connect the servo-bleed pipe to the reheat control unit.

(20) Connect the engine electrical cables to the junction box.

(21) Through access panel 20P aperture connect the starter motor fuel and air pipes, using new tab washers.

(22) Connect the starter motor over-speed cables.

(23) Through access panel 45P aperture carefully insert the services and controls systems hydraulic pumps in turn, ensuring that the lie of each hose is not disturbed and that the hoses are not used to support the weight of the pump. Fit the pumps ensuring that the clamp fasteners are positioned at the bottom of the flange with the nut out-board. A torque load of 75 lb in. must be applied to the nut and repeated at least three times. Connect the hoses from the pumps to the associated fuselage connection and the drainpipes to the pumps. For pump bleeding instructions refer to Sect.3, Chap.6.

(24) Refit the lost-motion box cover.

(25) Connect the auxiliary-air supply pipe.

Note...

Before connecting the jet-pipe assembly, secure the exhaust unit/intermediate jet pipe sealing ring in the unexpanded position by securing the joint with a short length of transparent adhesive tape, to prevent displacement of the sealing ring whilst the jet pipes are being installed. If the joint is of the overlap type, the broader section must be to the rear.

(26) Attach the jet pipe divorcing tools to the keep plate attachment flanges, with the flanged ends of the travellers hooked around the front face of the exhaust unit flange. Rotate the pinnions of the tools to pull the jet pipe forward until it surrounds the exhaust unit. Remove the tools, replace the upper half of the ventilated heat shroud, and fit and secure the keep plates.

(27) Raise the intermediate jet pipe forward rollers, using the roller key provided.

(28) Fit the lower half of the heat shroud, connect the overboard vent pipes, tighten the quick-release clamps, and fit the locking pins.

(29) Connect the two Firewires, ensuring that the longer one is connected to the forward engine connection, and wire-lock them together.

(30) Fit the starter motor domed fairing, ensuring positive engagement of the locating pin. Tighten the six securing bolts.

(31) Remove the buffer strips.

(32) Remove the air-intake blanking panels.

(33) Refit the duct access panel.

(34) Fit the lower half of the air-intake sealing ring housing, using the key provided.

Note...

One flange on the channel section of the housing is thinner than the other. The thin flange must face-forward and engage the groove in the duct access panel rib.

(35) Connect the 24-volt and high energy leads to the high-energy ignition units.

(36) Check the engine control rigging (Table 1, operation 3).

(37) Carry out the starter system priming and 'fail safe' check detailed in A.P.1181B, Vol.1, Part 1, Sect.1, Chap.3.

(38) Refit the No.1 engine hatch (Sect. 3, Chap.1).

No. 2 E. C. U.

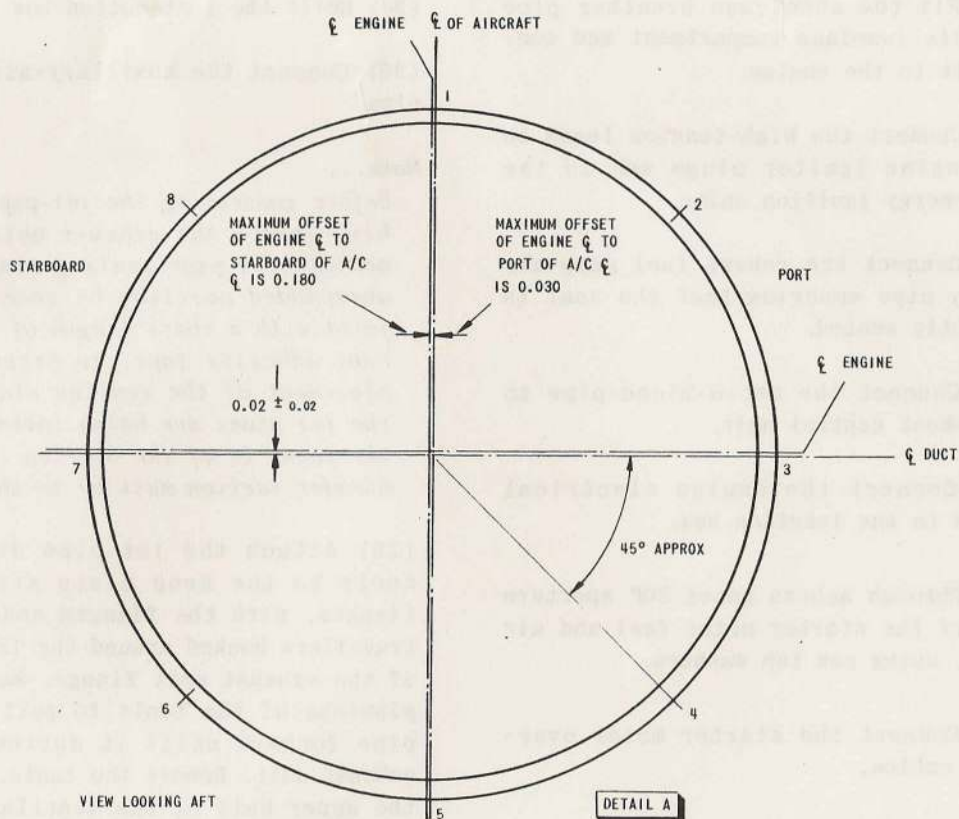
Equipment required

38. The special-to-type tools and equipment required during removal and assembly operations are listed in Table 2.

Removal (fig.15 and 16)

39. To remove No.2 E.C.U.:-

- (1) Ensure that the precautions detailed in para.30 are being observed.
 - (2) Remove No.2 engine hatch (Sect.3, Chap.1).
 - (3) Remove the upper half of the air-intake duct sealing ring housing, using the special key provided.
 - (4) Remove the stand-by generator air supply pipe.
 - (5) Remove the six bolts securing the duct access panel and detach the panel.
 - (6) Fit the air intake blanking panels.
 - (7) Remove the domed starter fairing.
 - (8) Disconnect the starter exhaust pipe.
 - (9) Release the four fasteners securing the two sections of the overboard vented heat shield and remove the top half of the shield.
 - (10) Disconnect and retract the shield vent pipes, using the retracting tools. Disconnect the drainpipe.
- ▶◀
- (11) Remove the panel in frame 53 giving access to the rail on stringer No.1 and attach the jet pipe handling link to the rail and to the intermediate jet pipe lug.



TO DETERMINE POSITION OF CL OF ENGINE RELATIVE TO DUCT

ON INSTALLATION OF ENGINE, THE DIMENSION "X" SHOWN IN DETAIL B IS TO BE MEASURED AT 8 POINTS AROUND THE CIRCUMFERENCE OF THE SEALING RING AT THE POSITIONS SHOWN IN DETAIL A. THEN THESE POINTS ARE TO BE PLOTTED GRAPHICALLY BY DRAWING THE OUTER CIRCLE, MARKING OFF THE 8 POINTS AROUND THE CIRCUMFERENCE AND THEN MEASURING OFF THE DIMENSIONS "X" AT EACH POINT. SET A PAIR OF COMPASSES AT OR A LITTLE OVER THE RADIUS OF THE INNER CIRCLE. THEN FROM THE 8 NEW POINTS SCRIBE AN ARC AT THE POSITION AT THE CENTRE OF THE INNER CIRCLE. FROM THIS DETERMINE THE POSITION OF THE CENTRE OF THE INNER CIRCLE RELATIVE TO THE CENTRE OF THE OUTER CIRCLE. THE DIMENSIONS AND TOLERANCES FOR THE RELATIONSHIP OF THESE CENTRES ARE SHOWN IN DETAIL A.

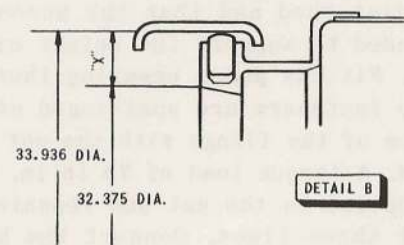


Fig. 13. Engine/intake duct alignment

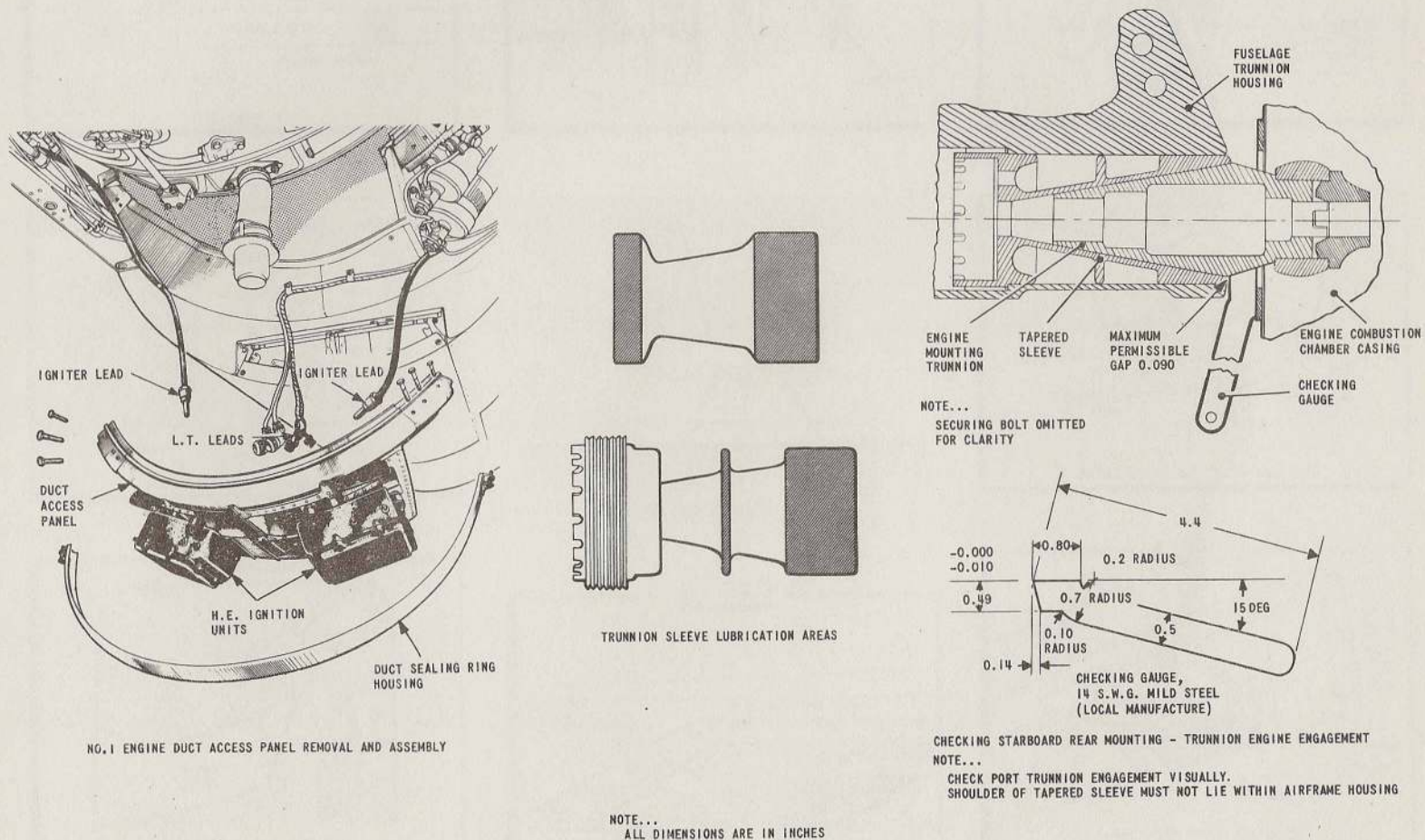


FIG.14. ENGINE REMOVAL AND ASSEMBLY DETAILS

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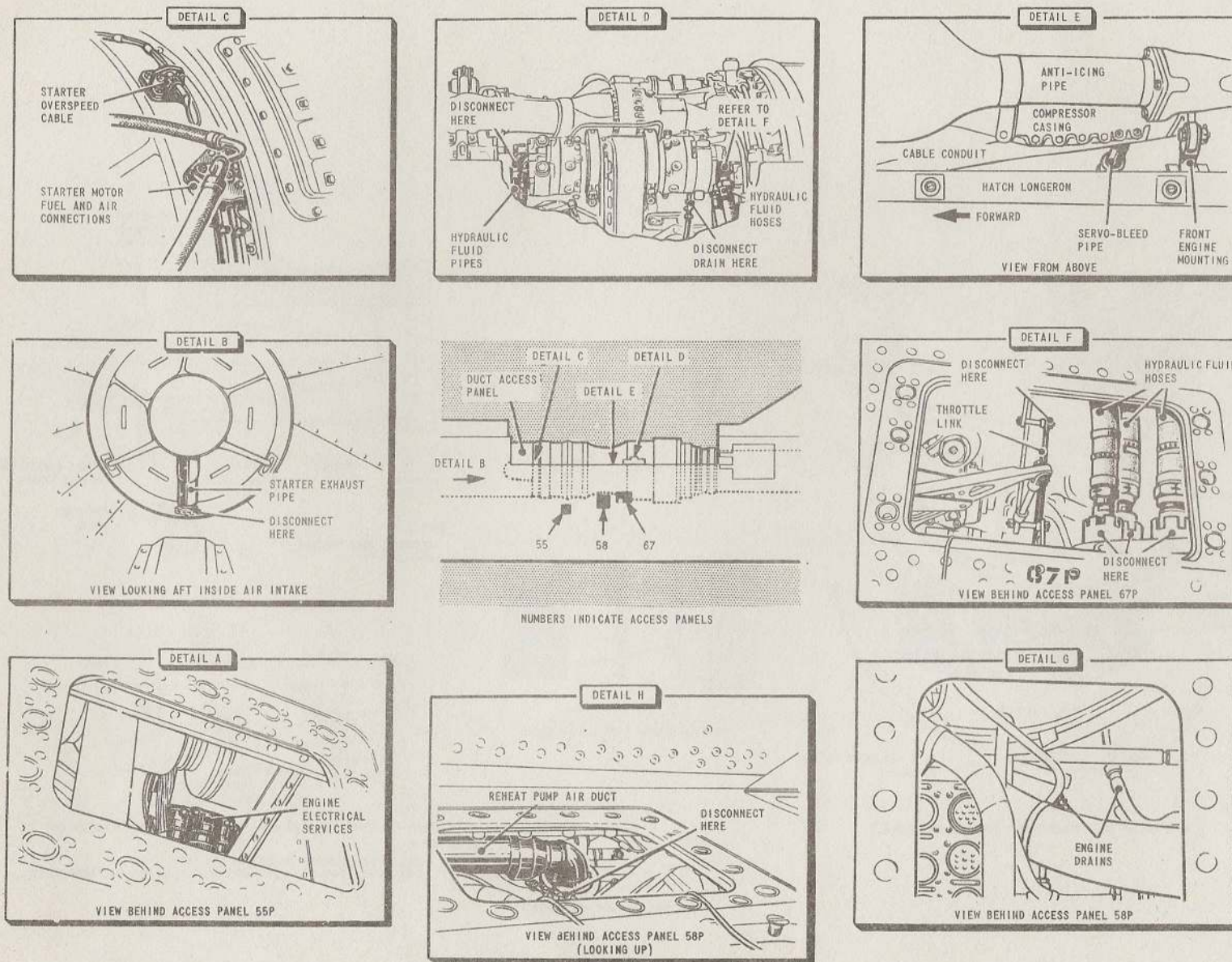


FIG.15. NO.2 E.C.U. - REMOVAL AND ASSEMBLY (1)

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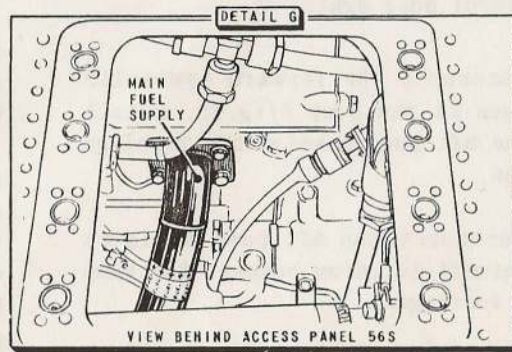
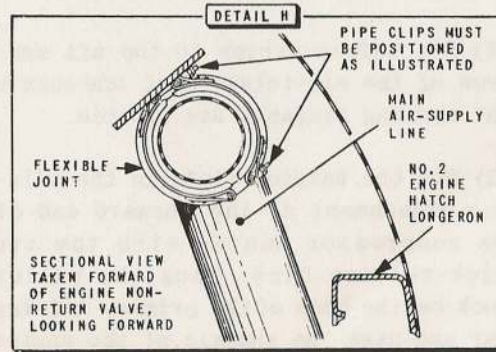
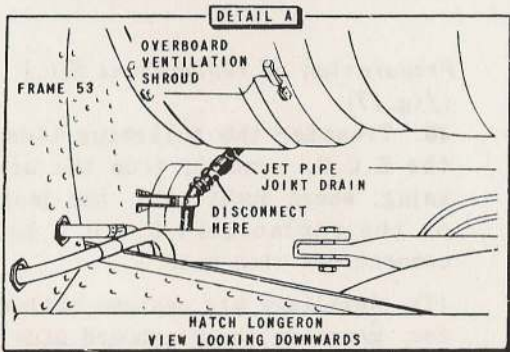
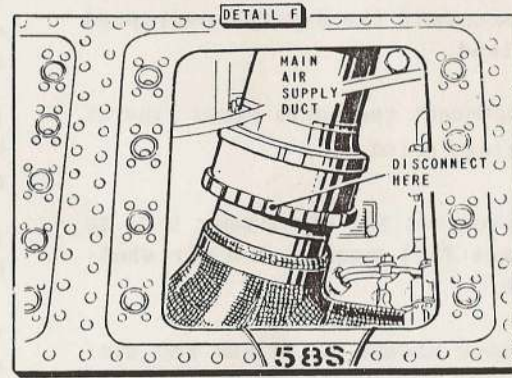
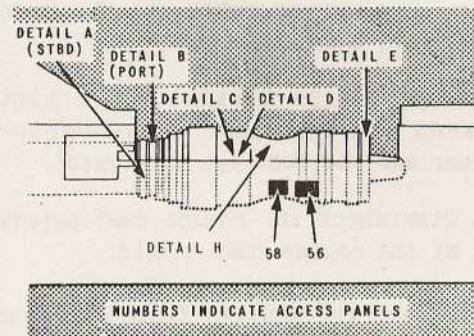
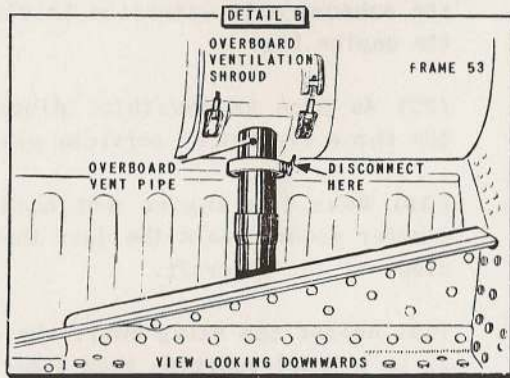
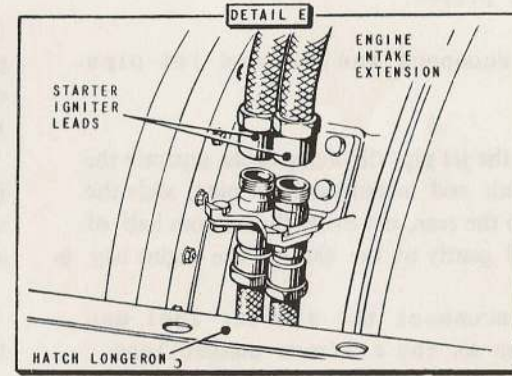
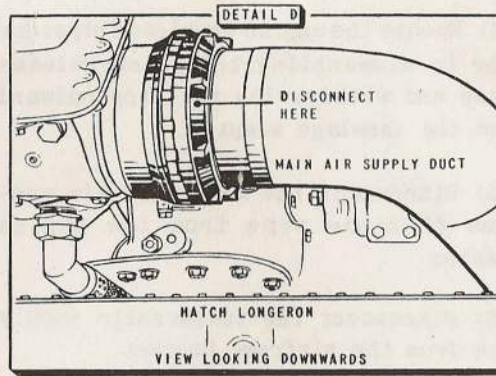
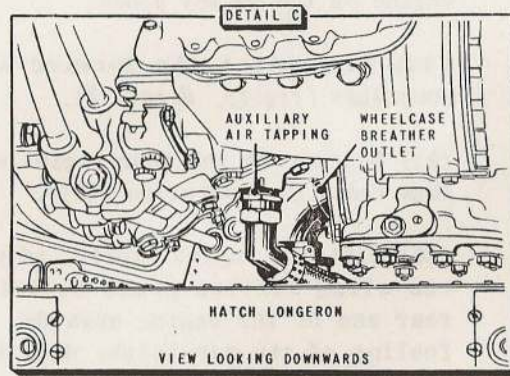


FIG.16. NO.2 E.C.U. - REMOVAL AND ASSEMBLY (2)

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(12) Remove access panels 74P and S, unscrew the clamp bolts and remove the two keep plates.

(13) Disconnect the forward jet-pipe drain.

(14) Fit the jet pipe divorcing tools, separate the exhaust unit and intermediate jet pipe, slide the jet pipe to the rear, and lower the bottom half of the shield gently to the floor of the engine bay. ►

(15) Disconnect the starter fuel and air lines at the airframe connections.

(16) Disconnect the starter overspeed switch lead.

(17) Disconnect the servo bleed pipe at the fuselage union.

(18) Disconnect the air supply pipe to the reheat fuel pump at the air shut-off cock.

(19) Remove access panel 58P and disconnect the oil cooler drain and the fuel control unit drain.

(20) Disconnect the forward hydraulic pump hoses at the pump (*fig.15, detail F*) and the aft pump hoses at the fuselage couplings.

(21) Disconnect the aft pump drain at the intermediate union between the pump and the fuselage.

(22) Disconnect the final control link at the engine fuel flow control unit valve lever.

(23) Ensure that the starboard high-energy igniter lead is disconnected.

(24) Remove the engine wheelcase breather pipe by dismantling the quick-release clamp and withdrawing the pipe outward from the fuselage adapter.

(25) Disconnect the auxiliary air systems flexible pipe from the engine adapter.

(26) Disconnect the fuelraulic supply pipe from the airframe bracket.

(27) Remove the air pipe between the engine non-return valve and the main air duct of the starboard floor.

(28) Remove the flexible fuel pipe between the hot-shot relay engine adapter and the fuselage attachment.

(29) Disconnect the engine fuel supply hose at the engine fuel filter.

(30) Remove the knurled leads from the starter igniter boxes in the spine and disconnect the leads from the engine.

(31) Fit buffer strips to top aft surfaces of the air-intake duct, and ensure that warning pennants are visible.

(32) Fit the adapter plate to the slinging attachment at the forward end of the compressor casing with the two quick-release pins. Hang the pulley block on the hook of the primary lifting gear and pass the shackle of the engine sling over the hook of the pulley block.

(33) Position the sling over the engine

and secure it fore-and-aft with quick-release pins. Take the weight of the engine on the pulley block.

(34) Disconnect the forward engine mountings (*fig.15, detail E*).

(35) Disconnect the rear engine mountings (*para.35, operation (40)*).

(36) Lift the engine slowly, adjusting the sling lifting point to tilt the rear end of the engine upwards. Avoid fouling of the air-intake duct by the starter motor. Continue tilting until the exhaust unit extension is clear of the engine bay.

(37) As soon as possible, disconnect the three electrical services plugs.

(38) Move the engine aft until the starter motor clears the duct then lift clear of the aircraft.

(39) Adjust the sling until the engine is in a level position then lower it on to the transportation stand.

Preparation of replacement E.C.U. (fig.17)

40. Transfer the following items from the E.C.U. removed from the aircraft using, where applicable, the fastenings on the replacement E.C.U.; lock all connections when made:-

(1) Auxiliary air systems outlet adapter; mount on the starboard side of the engine.

(2) Compressor seal vent adapter.

(3) Fuel control unit drain adapter, washer and flexible pipe.

(4) Oil cooler drain, adapter, washers and flexible pipe.

(5) Combustion chamber drain, cover and washer.

(6) Servo-bleed flexible hose.

(7) Hydraulic pumps (after applying grease XG-284 to the drive splines).

Note...

The clamp fasteners must be positioned at the bottom of the flange with the nut outboard, and must be tightened to a torque loading of 135 lb in. Repeat the operation at least three times.

(8) The fuel hydraulic pump and drive pipe.

(9) The main air system non-return valve. Assemble using new locking strips.

(10) Engine air-intake blanking panels.

(11) Engine throttle-lever crank pin.

Assembly (fig. 15 and 16)

41. With the E.C.U. prepared as in para. 40.

(1) Ensure that the precautions detailed in para. 33 are being observed.

(2) Tie back all electrical leads and examine the bay for cleanliness.

(3) Place the starter domed-fairing in the engine intake prior to lowering the engine.

(4) Assemble the slinging and hoisting equipment to the engine.

(5) Lift and position the E.C.U. over the engine bay and, by sling adjustment, tilt the front end downwards. Lower as necessary to position the starter motor behind the duct, then move forward and lower the rear end to level the engine and align the trunnion mountings.

Note...

Ensure that the engine is not lowered beyond the mounting level to avoid damaging the starter exhaust pipe.

(6) As soon as possible connect the three electrical services plugs to the engine and the starter exhaust pipe to the intake connection.

(7) Assemble the rear trunnion mountings and connect the front mountings with the bolt heads facing aft.

(8) Dismantle and remove slinging and hoisting equipment.

(9) Fit the starter motor domed fairing, remove the buffer strips and air intake blanking panels.

Note...

Before connecting the jet pipe assembly, secure the exhaust unit/intermediate jet pipe sealing ring in the unexpanded position by securing the joint with a short length of trans-

parent adhesive tape, to prevent displacement of the sealing ring whilst the jet pipes are being installed. If the joint is of the overlap type, the broader section must be fitted to the rear.

(10) Position the bottom half of the overboard-vented heat shield beneath the exhaust unit.

(11) Attach the divorcing tools to the keep plate attachment flanges with the flanged ends of the travellers hooked around the front face of the engine exhaust flange. Rotate the pinions of the tools to pull the jet pipe forward until it surrounds the exhaust unit, and fit and secure the keep plates.

Note...

If the jet pipe will not pass easily over the flange, slacken the starboard engine mounting, fit the jet pipe and retighten the mounting.

(12) Fit the top half of the overboard vented heat shield.

Note...

Before finally engaging the heat shield toggle fasteners, check the alignment of the sleeved vent pipes and, if necessary, rotate the shield to ensure correct alignment of the pipe flanges.

(13) Fit the gaskets and quick-release clamps to the vent pipes.

(14) Disengage and remove the jet pipe handling link and refit the access panel in frame 53.

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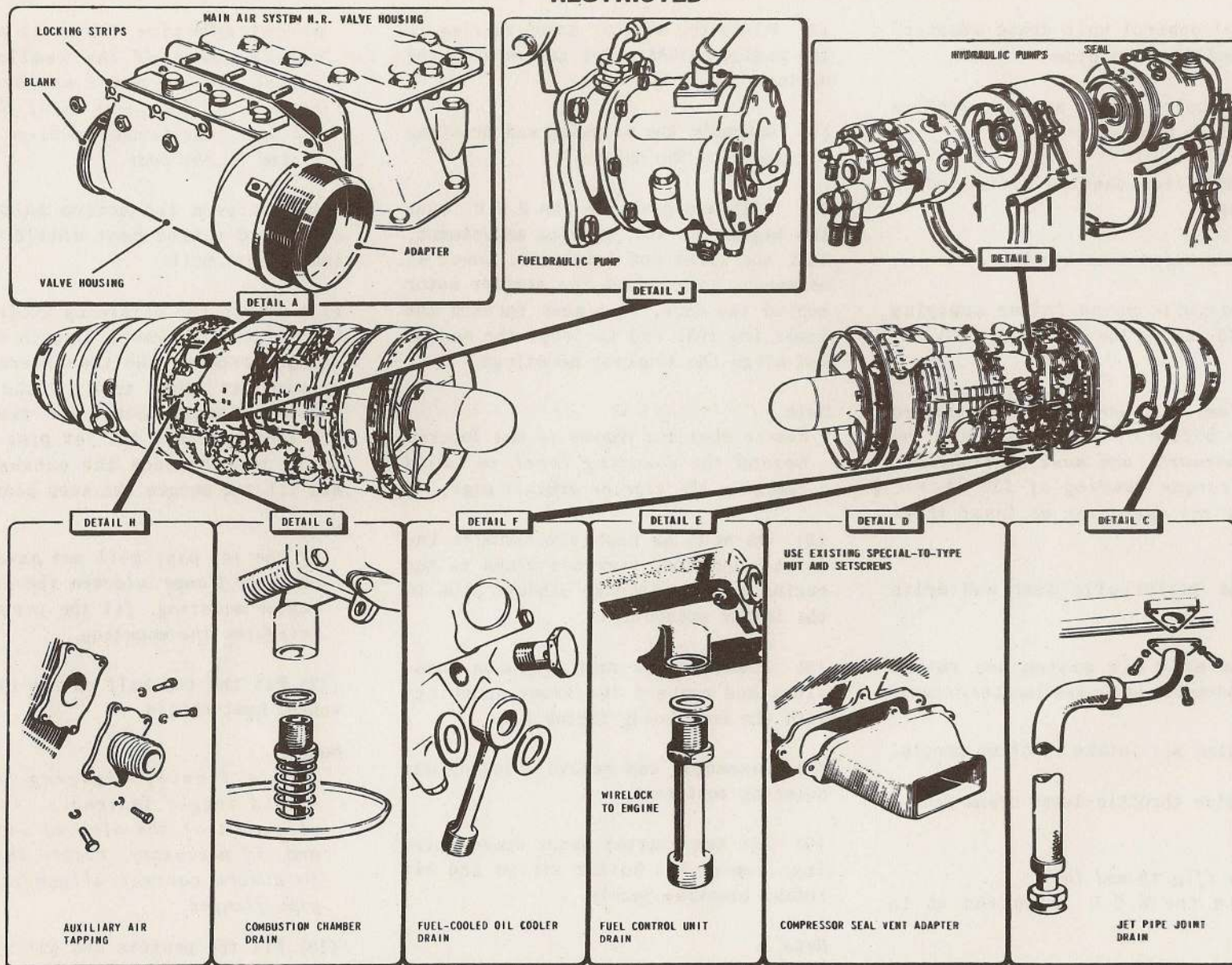


FIG.17. NO.2 E.C.U. - PREPARATION

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- (15) Connect the fuel flow control unit flexible drainpipe.
- (16) Connect the oil cooler flexible drainpipe.
- (17) Connect the reheat fuel pump air pipe to the air shut-off cock.
- (18) Connect the starter fuel and air pipes.
- (19) Connect the starter overspeed cable.
- (20) Connect the servo bleed pipe to the fuselage union.
- (21) Couple the hydraulic fluid pump drainpipe to its fuselage component and connect the flexible hoses.
- (22) Connect the hydraulic fluid hoses and the drainpipe to the forward pump.
- (23) Connect the starter igniter leads at the bracket on the engine intake extension.
- (24) Connect the auxiliary air supply pipe between its adapters.
- (25) Connect the engine wheelcase breather pipe.
- ◀(26) Fit the flexible fuel pipe between the fuselage attachment and the hot-shot relay engine adapter. ▶
- (27) Fit the air pipe between the engine non-return valve and the main air duct. Tighten and lock the upper end first.
- (28) Connect the fuel hydraulic drive pipe
- between the pump and airframe connections.
- (29) Connect the engine fuel supply hose.
- (30) Fit the duct access panel.
- (31) Fit the upper half of the air-intake sealing ring housing using the special tool.
- Note...**
One flange of the channel section of the housing is thinner than the other. The thin flange should face forward and engage the groove in the duct access panel rib.
- (32) Fit the stand-by generator air pipe.
- (33) Check engine alignment (fig.13).
- (34) Check engine control rigging (Table 1, operation 3).
- (35) Carry out the starter system priming and 'fail safe' check described in A.P.1181B, Vol.1, Part 1, Sect.1, Chap.3.
- (36) Refit the engine hatch (Sect.3, Chap.1).
- Jet-pipe handling**
42. To remove either an engine or jet pipe from the aircraft, the associated intermediate jet pipe must be disconnected from the engine; conversely, reconnection of the intermediate jet pipe is a final assembly operation practicable only with both items in position in the aircraft. The reheat pipes of the two installations are of the same

overall dimensions and are clamped in position by their rear trunnions, at frame 62; the engines also are of identical dimensions but No.1 is sited forward of No.2 and the resultant difference in the lengths of the intermediate pipes has necessitated the fitting of individual handling aids in the fuselage. On the No.1 intermediate and reheat pipes eccentrically mounted rollers are fitted on the port and starboard sides, front and rear; these rollers can be lowered to register with rails which are fitted to the fuselage frames and run practically the full length of the jet-pipe installation. The No.1 intermediate and reheat pipes are removed and installed as separate units. In the case of the No.2 jet-pipe installation the length of the rail is restricted by the position of equipment in the aircraft so that it is possible to provide rails and rollers only for the reheat pipe; to facilitate aligning the No.2 intermediate pipe with the engine, therefore, a short rail in the fuselage upper structure is used with a ground-handling link to support the forward end of the pipe during removal and assembly. The No.2 reheat pipe may be removed and installed as a separate unit but if it is necessary to remove or install the No.2 intermediate pipe, it should remain attached to the reheat pipe and the assembly handled as a single unit.

No.1 jet pipe

Equipment required

43. The special-to-type tools and equipment required during removal and assembly operations are listed in Table 2.

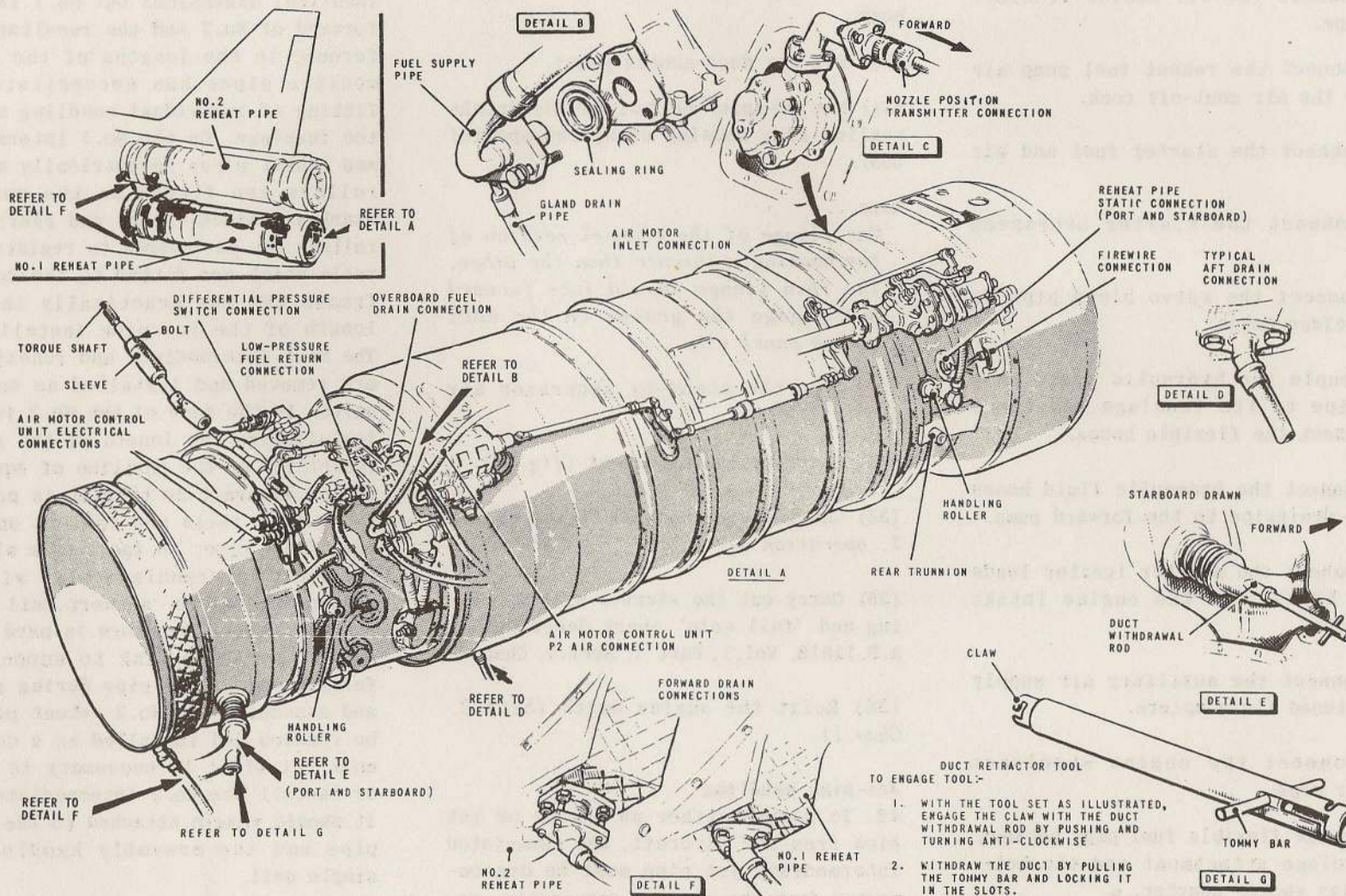


FIG. 18. CONNECTIONS TO JET PIPE

Removal (fig.19, 20 and 21)

WARNING

The intermediate jet pipe must not be manhandled out of the aircraft.

44. To remove No.1 intermediate and reheat pipes:-

(1) Ensure that the necessary precautions (para.33) are observed.

◀ (2) Remove the No.1 engine hatch (Sect.3, Chap.1). ▶

(3) Disconnect the forward and aft fuel drain hoses from the reheat pipe (fig.18, detail D and F; access panels 85P and 94P).

(4) Disconnect the fuel supply, low-pressure return and drainpipes, and the air pressure pipe from the A.M.C.U. (access panel 76P).

(5) Disconnect the electrical cables to the jet pipe thermocouple terminal block.

(6) Disconnect the electrical cables from the bracket at the forward end of the reheat pipe (access panel 76P) (fig.18).

(7) Disconnect the electrical cable to the differential-pressure switch (access panel 76S).

◀ (8) Remove the split pin and nut then withdraw the locking bolt from the engine controls torque shaft and tele-

scope the shaft in order to release it from the jet pipe and airframe splines.

(9) Withdraw the port and starboard cooling ducts using the retractor tools (fig.18, detail E and G; access panels 105P and 105S).

(10) Withdraw the hot gas exhaust duct using the retractor tool in the aperture immediately forward of access panel 76P.

(11) Unlock access panels 88P and 88S; hinge them back and secure them by inserting the quick-release pins provided through the holes in the lower edge of the panels and the fuselage skin.

(12) Disconnect the electrical cable from the nozzle position transmitter (fig.18, detail C).

(13) Disconnect the electrical cable from the Firewire system connection on the nozzle cowling (fig.18).

(14) Disconnect the compressor-air-delivery pipe at the air motor (fig.18).

(15) Lower the front and rear rollers on the intermediate pipe to the fuselage rails, using the roller key. The front rollers are accessible behind access panels 53P and 53S and the rear rollers behind access panels 77P and 47S.

Note...

Push the key inward before turning to release the locking device.

(16) Lower the front rollers on the

reheat pipe to the fuselage rails (access panels 76P and 76S).

(17) Fit the jet-pipe-cradle pick-up brackets to frame 62 (fig.21, detail A).

(18) Adapt the cradle to receive a No.1 pipe (fig.19). Set the rails to the wide position, i.e. cradle rail adjustment quick-release pins through the inner holes (fig.21, detail B). Lift the cradle to the fuselage and secure it to the attachment brackets; align the cradle rails with the fuselage rails.

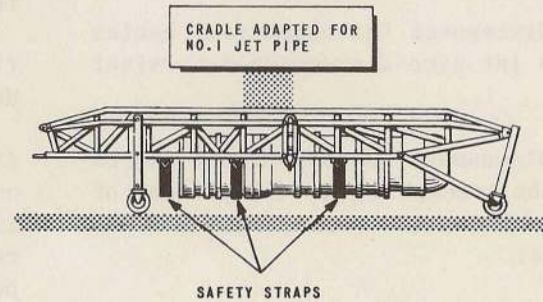
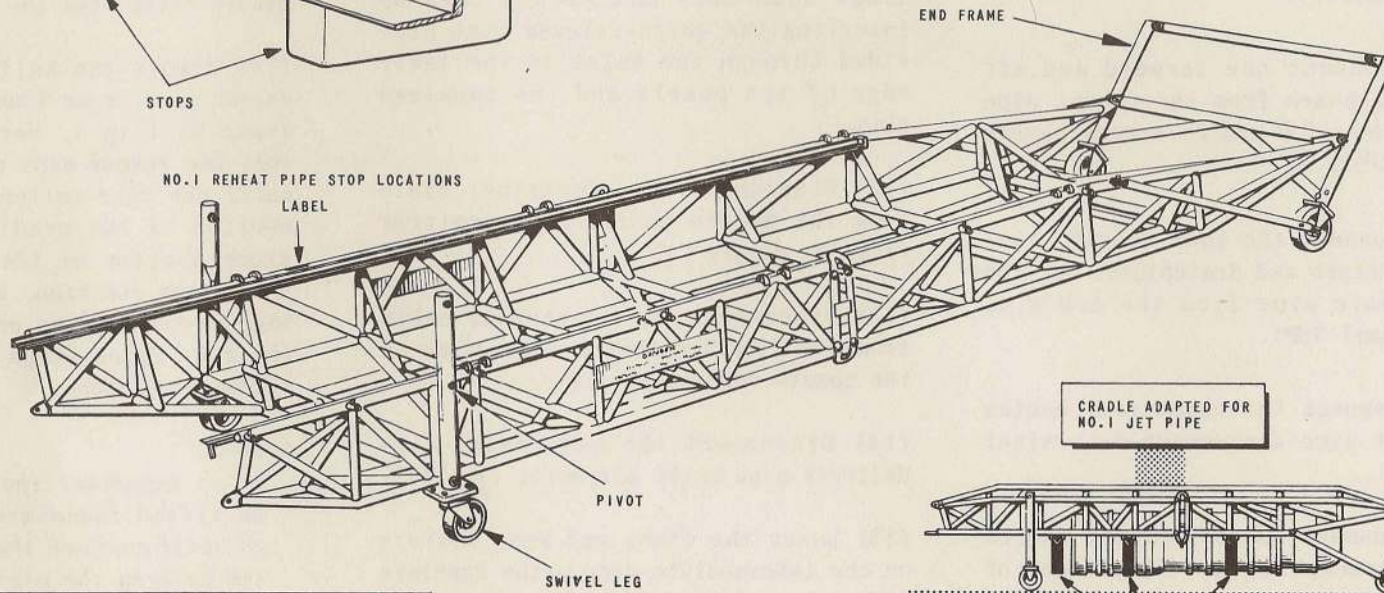
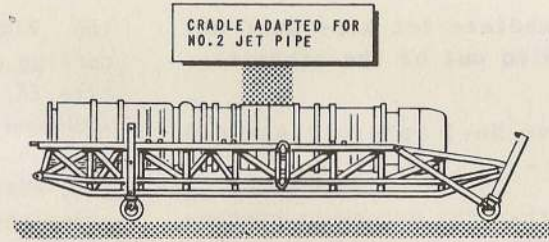
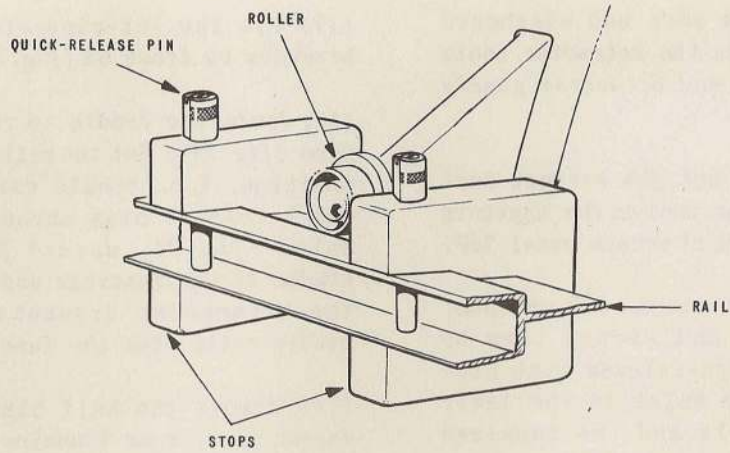
(19) Remove the half clamps from the reheat pipes rear trunnion mountings on frame 62 (fig.7, detail A and B) and roll the reheat pipe out into the cradle until the rear rollers are on the rear section of the cradle rails; set the front section of the cradle rails to the narrow position, and continue rolling the reheat pipe until it is against the rear fixed stops. Fit the forward reheat pipe stops.

Note...

It is important that the reheat pipe be tilted immediately after removal to spill any fuel that may have collected between the pipe and its casing.

(20) Disconnect the cradle from the attachment brackets and, supporting it at the rear end, lower the reheat pipe and cradle on to a transportation stand. Remove the stops and roll the cradle off the pipe, then lift the cradle and connect it to the fuselage brackets. Set both sections of cradle rails to the narrow position.

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NOTE...

- (1) WHEN USING THE CRADLE FOR NO.2 JET PIPE, FIT THE CRADLE WALKWAY
- (2) WHEN USING THE CRADLE FOR NO.1 JET PIPE, FIT THE SAFETY STRAPS

FIG.19. JET PIPE HANDLING EQUIPMENT

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(21) Refer to para.35(9) to (14) and separate the intermediate jet pipe from the engine.

(22) Roll the intermediate pipe along the fuselage on to the cradle until it is up against the rear fixed stops; fit the forward intermediate pipe stops. Disconnect the cradle at the attachment brackets, and lower the pipe and cradle on to a transportation stand. Remove the stops and roll the cradle off the pipe.

Assembly (fig.19, 20 and 21)

WARNING

The intermediate jet pipe must not be manhandled into the aircraft.

45. To assemble No.1 intermediate jet reheat pipes:-

Note...

Before connecting the jet-pipe assembly, secure the sealing rings of the exhaust unit/intermediate and the intermediate/reheat unit jet pipes, in the unexpanded position with a short length of transparent adhesive tape, to prevent displacement of the rings during installation.

(1) Ensure that the necessary precautions (para.33) are being observed.

(2) Adapt the jet-pipe cradle to receive a No.1 jet pipe (fig.19); set the cradle rails to the narrow position (fig.21, detail B) and, with the intermediate pipe on a transportation stand, draw the cradle over the aft end of the pipe.

Fit the forward intermediate pipe stops and set the pipe rollers to their lowest position.

(3) Lift the cradle and pipe to the fuselage, and secure the cradle to the pick-up brackets on frame 62 (fig.21, detail A). Align the cradle rails with the fuselage rails.

(4) Remove the stops and roll the pipe into the fuselage; guide the self-aligning trunnion blocks into the jet pipe channels, and align the jet-pipe flange with the engine exhaust unit flange. Refer to para.37(26) and secure the intermediate jet pipe to the engine and fit the overboard vented heat shield.

(5) Remove the cradle and adjust the rails to the wide position. With the reheat pipe on a transportation stand, draw the cradle over the rear end of the pipe until the rear rollers are running on the rear section of rails; adjust the forward section of rails to the narrow position to receive the front rollers. Fit the forward reheat pipe stops.

(6) Lift the cradle to the fuselage and attach it to the brackets on frame 62. Align the cradle rails with the fuselage rails and remove the forward stops.

(7) Roll the reheat pipe forward until the front rollers are on the fuselage rails, reposition the forward section of the cradle rails to the wide position and continue rolling the reheat pipe until the rear trunnions are positioned firmly on their mountings on frame 62.

Do not use the half-clamps (sub-para.(8)) to force a difficult reheat pipe into this position.

(8) Reassemble the rear trunnion mounting half-clamps (fig.7) applying oil to the studs and torque loading the nut to $120 \pm 2\%$ lb in.

(9) Raise the intermediate pipe rollers and the reheat pipe front rollers (fig.7).

(10) Remove the cradle and the cradle attachment brackets.

(11) Connect the fuel, air and drain-pipes to the a.m.c.u. Connect the appropriate electrical cables to the thermocouple terminal box and reheat pipe brackets (fig.18; access panel 76P).

(12) Connect the torque shaft to the airframe and jet-pipe splines, fit the locking bolt and nut (access panel 76S) and secure using a new split pin. ▶

Note...

If a replacement jet pipe is fitted the reheat setting must be checked (Table 1, operation 4).

(13) Connect both forward and aft reheat fuel drain connections (fig.18, detail D and F; access panels 72S and 76S).

(14) Connect the electrical cable to the differential pressure switch (access panel 76S).

(15) Release the hot-gas exhaust duct and remove the retractor. Ensure that the telescopic duct moves freely and seats correctly on the jet pipe. ▶

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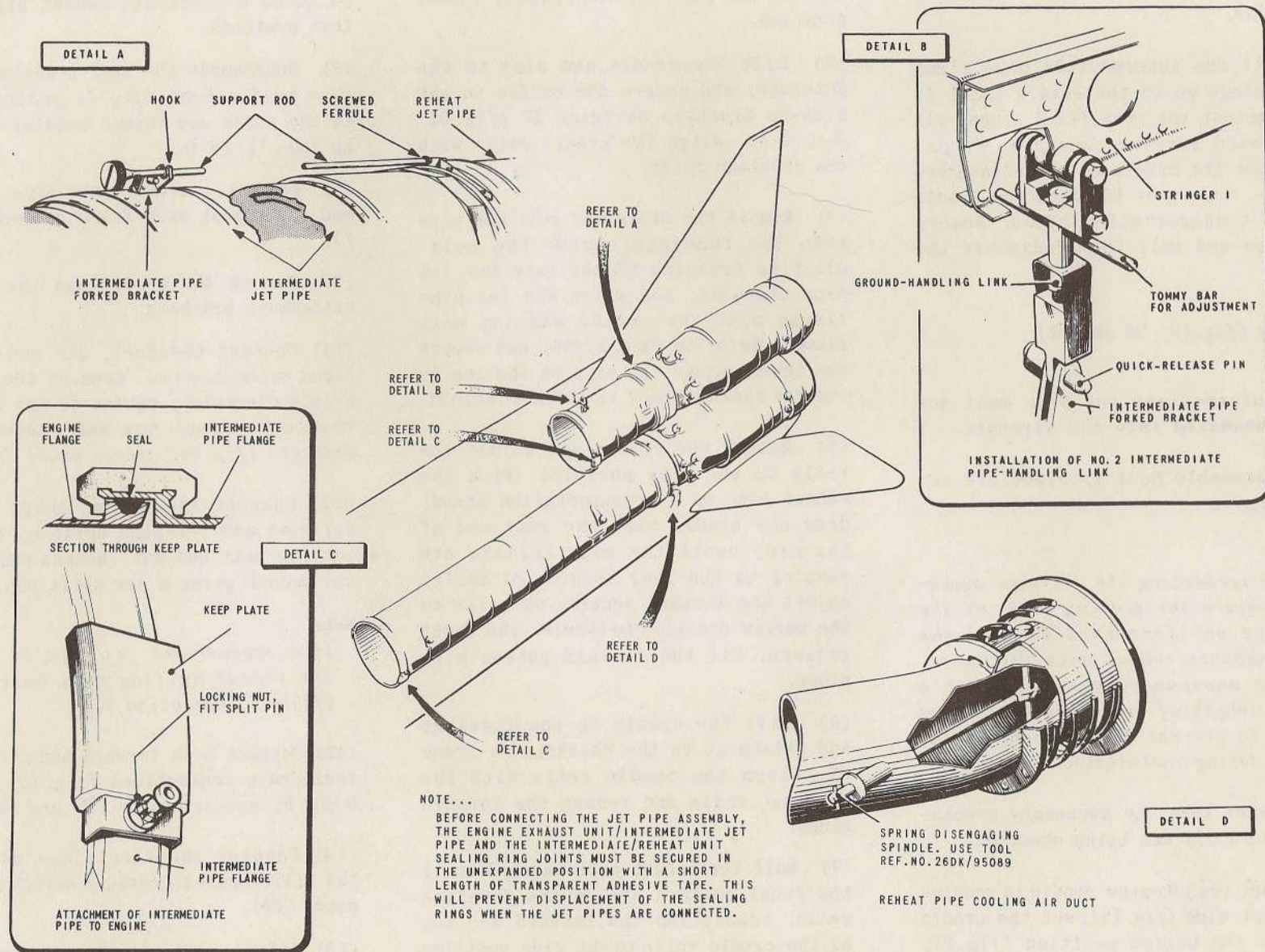


FIG. 20. JET PIPE - REMOVAL AND ASSEMBLY (1)

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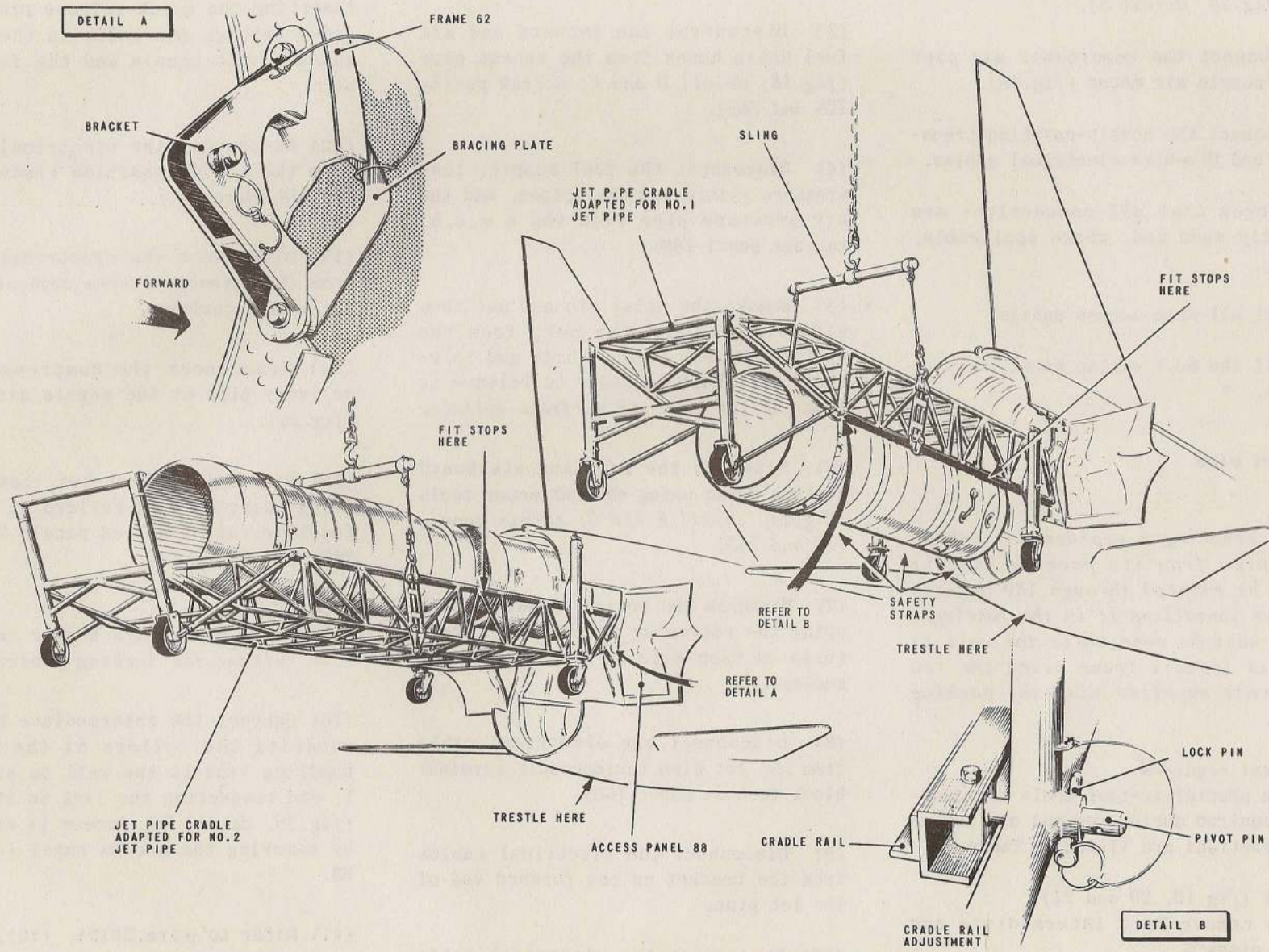


FIG. 21. JET PIPE - REMOVAL AND ASSEMBLY(2)

(16) Release the port and starboard cooling air ducts and remove the retractors (fig.20, detail D).

(17) Connect the compressor air pipe to the nozzle air motor (fig.18).

(18) Connect the nozzle-position transmitter and Firewire electrical cables.

(19) Check that all connections are correctly made and, where applicable, locked.

(20) Fit all skin access panels.

◀ (21) Fit the No.1 engine hatch (Sect.3, Chap.1). ▶

No.2 jet pipe

Note...

When removing a replacement reheat jet pipe from its packing case it must be rotated through 180 degrees before installing it in the fuselage. This must be done while the unit is in its transit frame using the two segments supplied with the packing case.

Equipment required

46. The special-to-type tools and equipment required during removal and assembly operations are listed in Table 2.

Removal (fig.19, 20 and 21)

47. To remove No.2 intermediate and reheat pipes:-

(1) Ensure that the necessary precautions (para.33) are being observed.

(2) Remove No.2 engine hatch (Sect.3, Chap.1).

(3) Disconnect the forward and aft fuel drain hoses from the reheat pipe (fig.18, detail D and F; access panels 72S and 76S).

(4) Disconnect the fuel supply, low-pressure return and drainpipes, and the air pressure pipe from the a.m.c.u. (access panel 76S).

◀ (5) Remove the split pin and nut then withdraw the locking bolt from the engine controls torque shaft and telescope the shaft in order to release it from the jet pipe and airframe splines.

(6) Withdraw the port and starboard cooling ducts using the retractor tools (fig.18, detail E and G; access panels 74P and 74S).

(7) Withdraw the hot-gas exhaust ducts using the retractor tools in the apertures on each side of the forward fin section.

(8) Disconnect the electrical cable from the jet pipe thermocouple terminal block (access panel 76S).

(9) Disconnect the electrical cables from the bracket on the forward end of the jet pipe.

(10) Disconnect the electrical cable from the differential pressure switch (fig.18).

(11) Unlock access panels 88P and 88S, hinge them back, and secure them by inserting the quick-release pins provided through the holes in the lower edges of the panels and the fuselage skin.

(12) Disconnect the electrical cable from the nozzle position transmitter (fig.18, detail C).

(13) Disconnect the electrical cable from the Firewire system connection on the nozzle cowling.

(14) Disconnect the compressor air delivery pipe at the nozzle air motor (fig.18).

(15) Using the roller key, lower the reheat pipe forward rollers on to the fuselage rails (access panels 76P and 76S).

Note...

Push the key inward before turning, to release the locking device.

(16) Support the intermediate pipe by mounting the rollers of the ground handling link to the rail on stringer 1, and connecting the link to the pipe (fig.20, detail B). Access is obtained by removing the access panel in frame 53.

(17) Refer to para.39(9), (10), (12), (14) and release the intermediate jet pipe from the engine. Slide the intermediate pipe aft to engage the locking

device (fig. 20, detail A) and disengage the handling link.

(18) Fit the cradle pick-up brackets to frame 62 (para. 44(17)).

(19) Remove the half-clamps at the rear trunnion mountings on frame 62.

(20) Adapt the handling cradle to receive a No. 2 jet pipe (fig. 19). Fit the sling to the lifting eyes, lift the cradle into position and secure it to its attachment brackets. Align the cradle rails with the fuselage rails.

(21) Set the cradle to the wide position, i.e. with the cradle rail adjustment quick-release pins through the inner holes (fig. 21, detail B).

(22) Roll the jet pipe on to the cradle until the rear reheat pipe rollers are running on the cradle rear rails; set the cradle front rails to the narrow position, i.e. quick-release pins through the outer holes, and continue rolling the jet pipe until it is against the rear fixed stops. Fit the forward stops, using quick release pins.

Note...

It is important that the reheat pipe be tilted immediately after removal to spill any fuel that may have collected between pipe and casing.

(23) Disengage the cradle from the fuselage brackets, and lower it to the ground. Lift the jet pipes from the cradle and store them in a transportation stand.

Assembly (fig. 19, 20 and 21)

48. To assemble No. 2 intermediate and reheat pipes:-

Note...

Before connecting the jet pipe assembly, secure the sealing rings of the exhaust unit/intermediate and the intermediate/reheat unit jet pipes, in the unexpanded position, with a short length of transparent adhesive tape, to prevent displacement of the rings during installation.

(1) Ensure that the necessary precautions (para. 33) are being observed.

(2) Adapt the cradle to receive a No. 2 jet pipe, and set the aft section of the rails to the wide position, and the front section to the narrow position (fig. 21, detail B). Lift the reheat pipe on to the rear section and the intermediate pipe on to the front, ensuring that the coupling device is securely locked. Adjust the forward rollers to their lowest position, and fit the reheat pipe stops to the rails. Attach the sling to the cradle.

(3) Lift the cradle and jet pipes to the fuselage, and secure the cradle to the brackets on frame 62. Align the cradle rails with the fuselage rails.

(4) Remove the cradle rail stops, and roll the jet pipe into the fuselage until the front rollers are on the fuselage rails. Reset the forward section of cradle rails to the wide position, and continue rolling until the

rear trunnions are positioned firmly in their mountings. Do not use the half-clamps (sub-para. (5)) to force a difficult reheat pipe into this position.

(5) Reassemble the rear trunnion mounting half-clamps (fig. 7), applying oil to the studs and torque loading the nuts to 120_{-0}^{+20} lb in.

(6) Connect the ground handling link to the bracket on the intermediate pipe (fig. 20, detail B), and adjust on the link to align the pipe with the engine exhaust unit.

(7) Release the locking device by lifting the forward end of the reheat jet pipe and pull the intermediate pipe forward until supported by the self-aligning trunnions in the channel sections. Align the intermediate pipe flange with the engine exhaust unit flange. Referring to para. 41 (10), (11), (12) and (13) connect the jet pipe to the engine and fit the overboard vented heat shield.

(8) Lift the reheat pipe rollers clear of the fuselage rails, using the roller key (access panels 76P and 76S).

(9) Remove the cradle, the cradle attachment brackets and the ground handling link. Fit the half-clamps at the rear trunnion mountings.

(10) Connect the fuel, air and drain-pipes to the a.m.c.u. (fig. 18; access panel 76S).

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(11) Connect the torque shaft to the airframe and jet-pipe splines. Fit the locking bolt and nut (access panel 76S) and secure using a new split pin. ▶

Note...

If a replacement jet pipe is fitted the reheat settings must be checked. (Table 1, operation 4).

(12) Release the hot-gas exhaust ducts and remove the retractors. Ensure that

the telescopic duct moves freely and seats correctly on the jet pipe. ▶

(13) Release the port and starboard cooling air ducts and remove the retractors (*fig.18, detail E and G*).

(14) Connect the electrical cable to the differential-pressure switch, (access panel 76P).

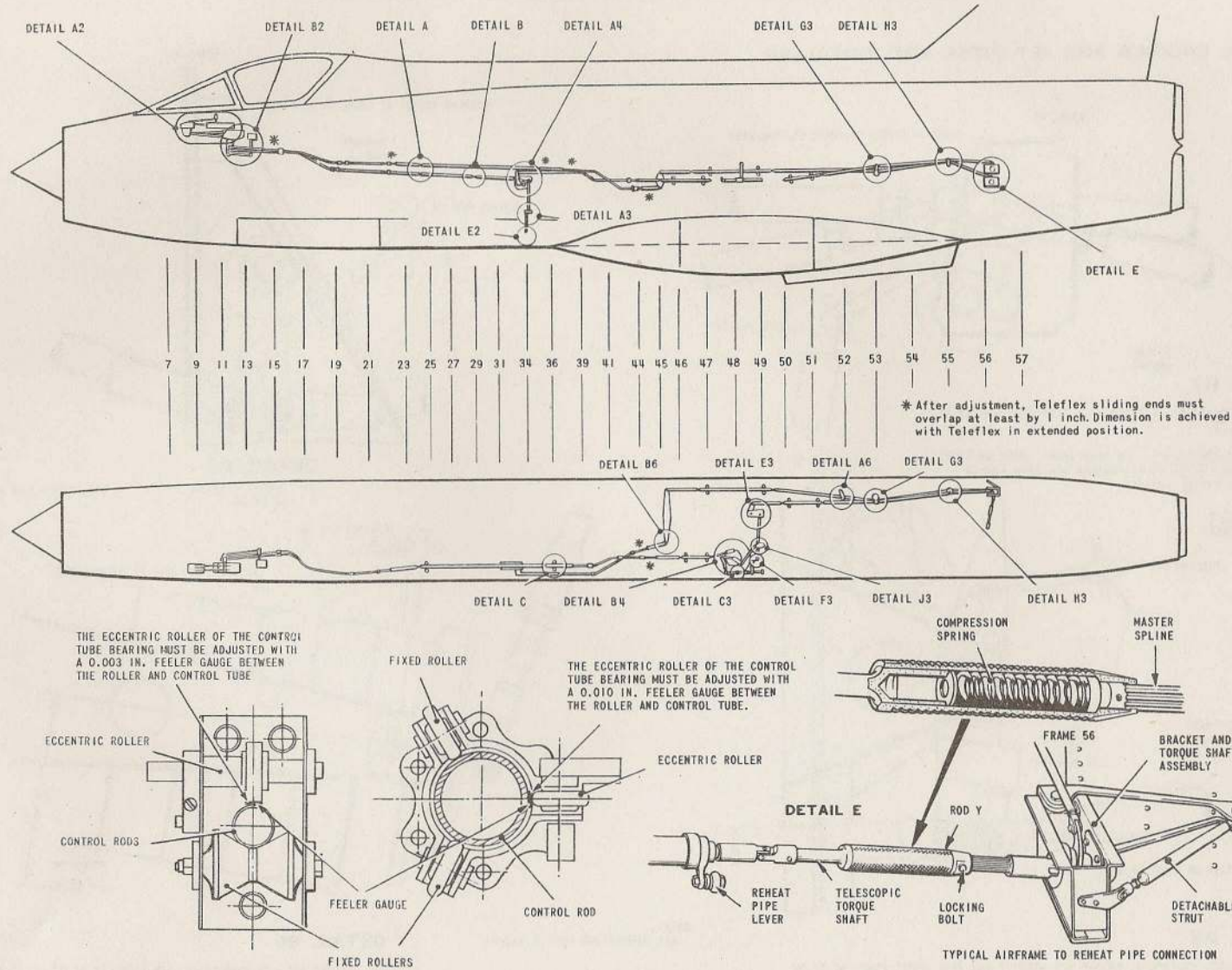
(15) Connect the electrical cables to the thermocouple terminal box and to the forward bracket (access panel 76S).

(16) Connect the compressor air pipe to the A.M.C.U. (*fig.18*).

(17) Connect the nozzle-position transmitter and Firewire electrical cables.

(18) Check that all connections are correctly made, and, where applicable locked. Fit the panel in frame 53, the skin access panels and No.2 engine hatch.

TABLE 1. ENGINE CONTROLS RIGGING - GENERAL ARRANGEMENT

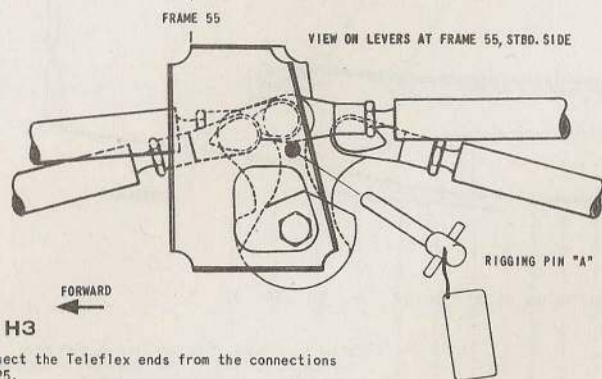


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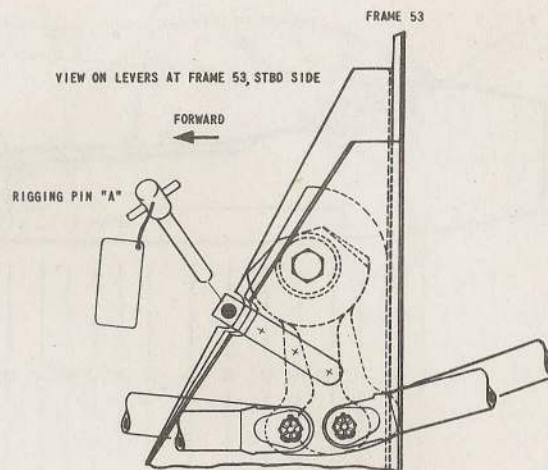
TABLE 1. ENGINE CONTROLS RIGGING - OPERATION 1

BEFORE ENGINES AND JET PIPES ARE INSTALLED



DETAIL H3

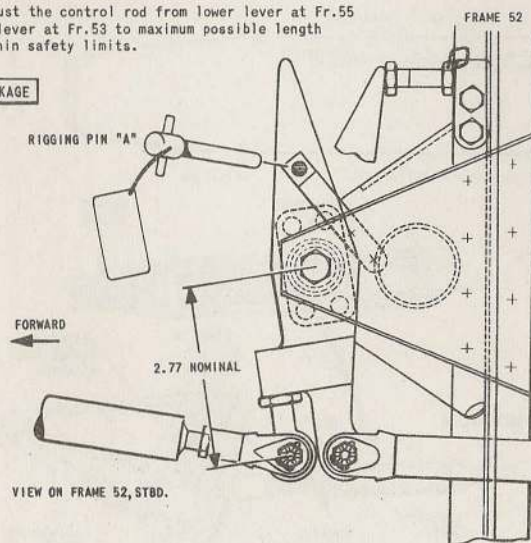
- (1) Disconnect the Teleflex ends from the connections at Fr.25.
- (2) Adjust the control rod from lower lever at Fr.55 to lever at Fr.53 to maximum possible length within safety limits.



DETAIL G3

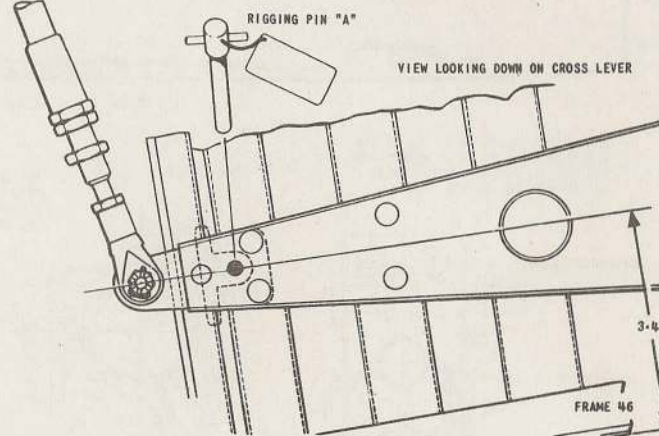
- (3) Insert rigging pin "A" in the levers and brackets at Fr.53.

NO. 1 LINKAGE



DETAIL A6

- (4) At Fr.52, starboard, adjust the control rod from lower lever at Fr.53 until rigging pin "A" can be inserted through lever and bracket.



DETAIL B6

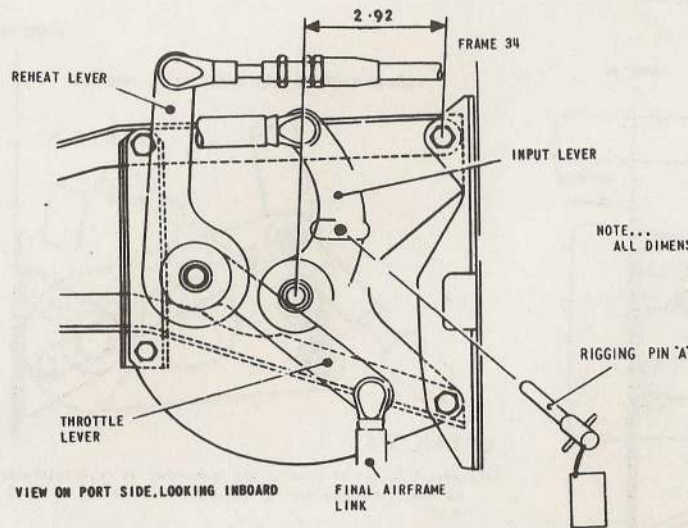
- (5) Adjust the rod forward of the lever at Fr.52 until rigging pin "A" can be inserted through the lever arm.

NOTE... ALL DIMENSIONS ARE IN INCHES

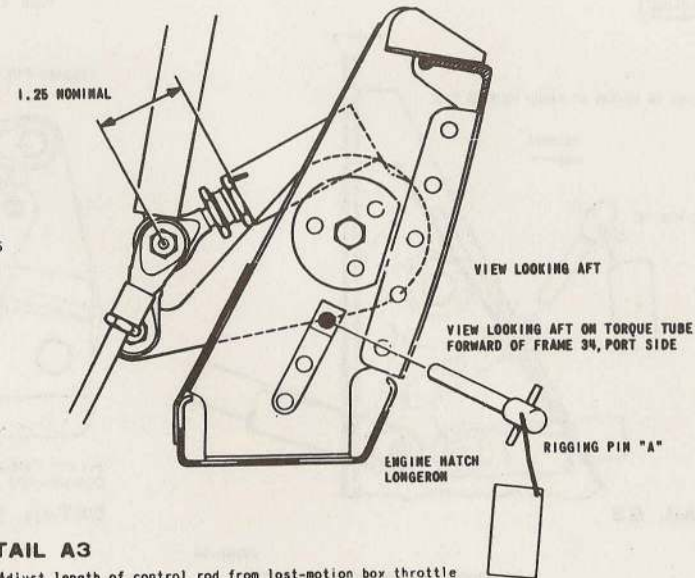
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TABLE 1. ENGINE CONTROLS RIGGING - OPERATION 1 (CONTINUED)



NOTE...
ALL DIMENSIONS ARE IN INCHES

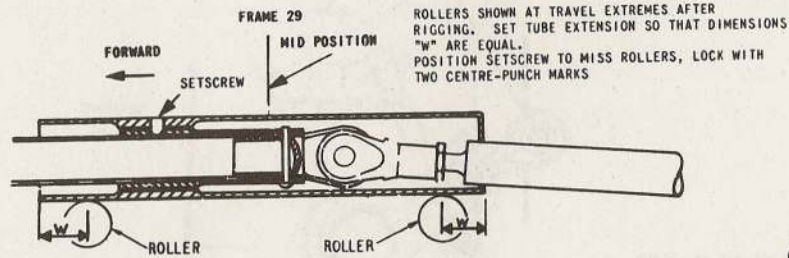


DETAIL A4

(6) Adjust Teleflex ends on the run from cross-lever arm to insert rigging pin "A" in the input lever and rigging plate on No.1 lost-motion box at Frame 34.

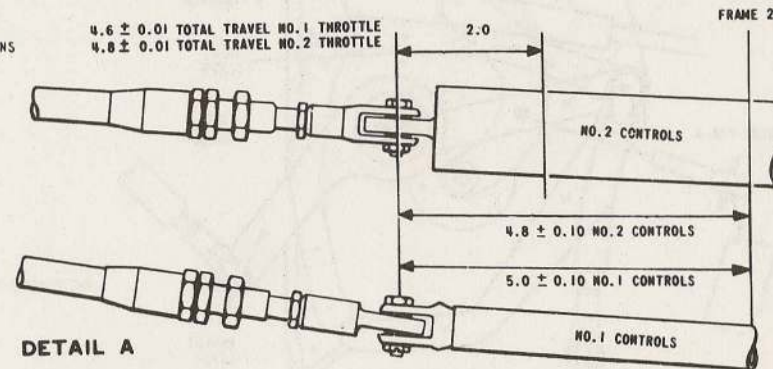
DETAIL A3

(7) Adjust length of control rod from lost-motion box throttle lever to insert rigging pin "A" in rigging arm of torque Shaft at Frame 34.



DETAIL B

(8) Adjust length of control rod from lost-motion box throttle lever in the tube extension at Frame 29 to obtain dimensions given in Detail A for No.1 controls rod at Frame 25.

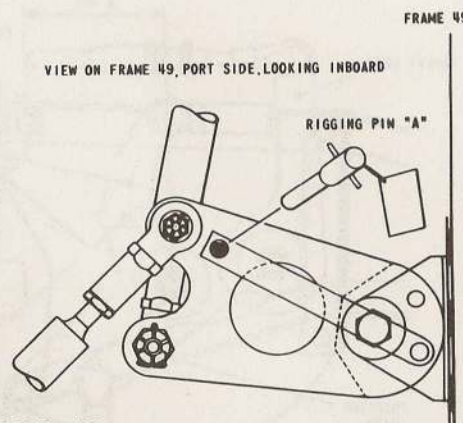
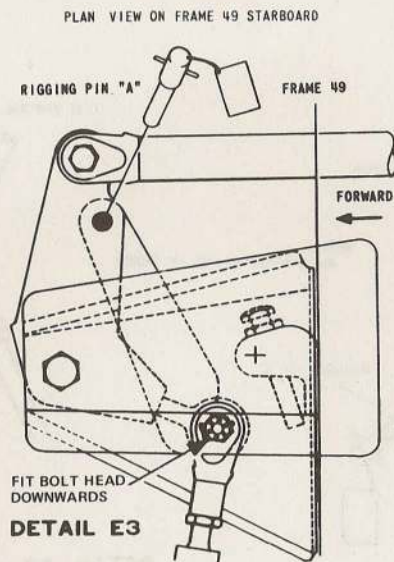
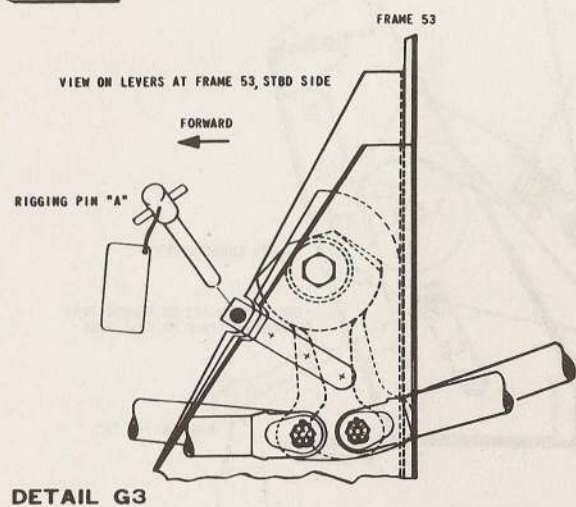


DETAIL A

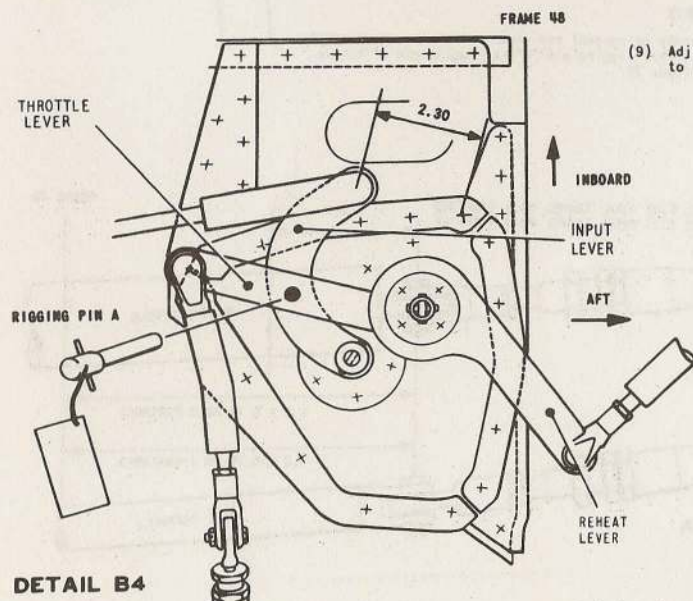
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TABLE 1. ENGINE CONTROLS RIGGING - OPERATION 1 (CONTINUED)

NO. 2 LINKAGE



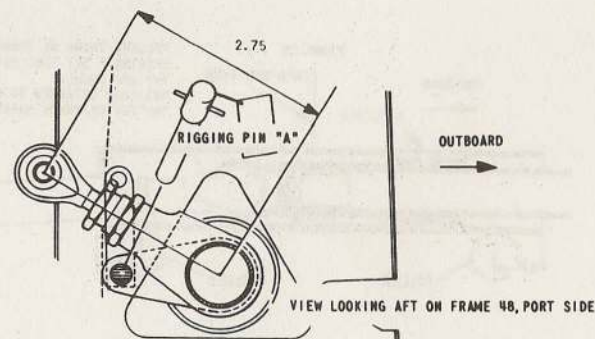
(10) Adjust length of control rod from lever at Fr.49 starboard to insert rigging pin "A" through lever and lug at Fr.49 port.



(11) Adjust length of control rod from lever at Fr. 49 port to insert rigging pin "A" through input and throttle levers on lost-motion box at Fr.48.

(9) Adjust length of control rods on run from upper lever at Fr.53 to insert rigging pin "A" in lever and lug at Fr.49 starboard.

NOTE... ALL DIMENSIONS ARE IN INCHES

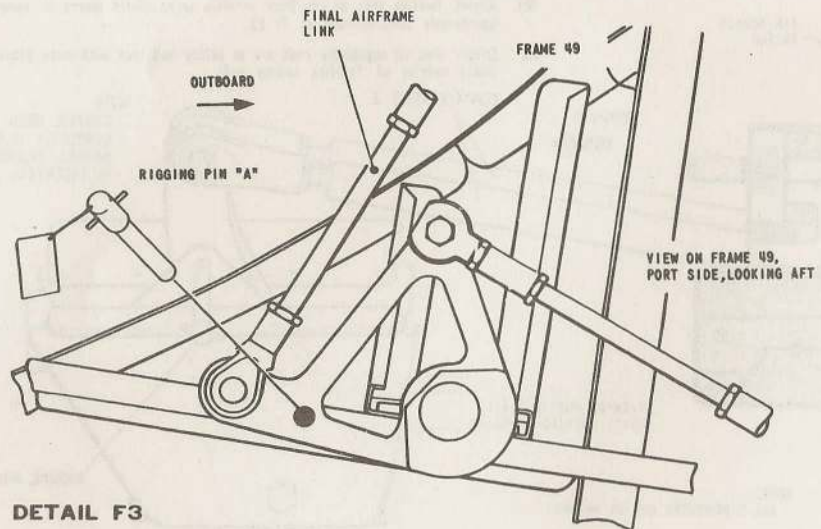


(12) Adjust length of control rod from throttle lever on lost-motion box at Fr.48 to insert rigging pin "A" in rigging arm of torque shaft at Fr.48.

◀ DETAIL E3 AMENDED ▶

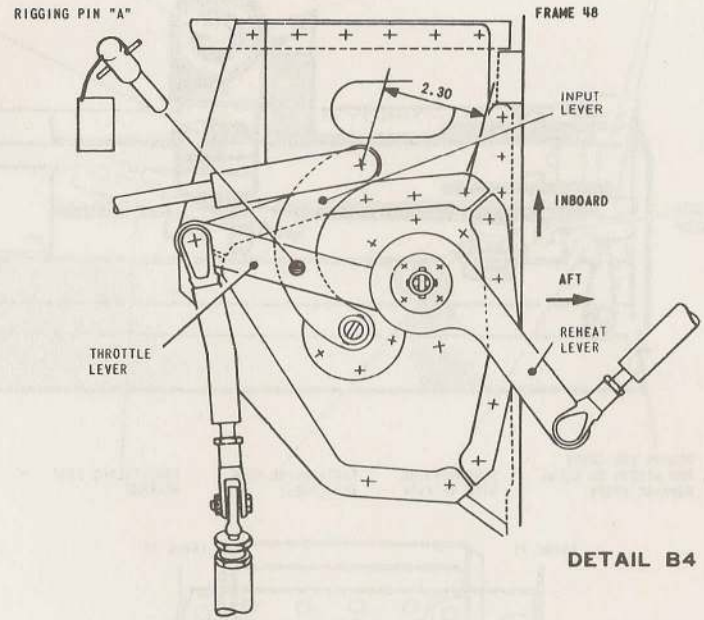
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TABLE 1. ENGINE CONTROLS RIGGING - OPERATION 1 (CONTINUED)

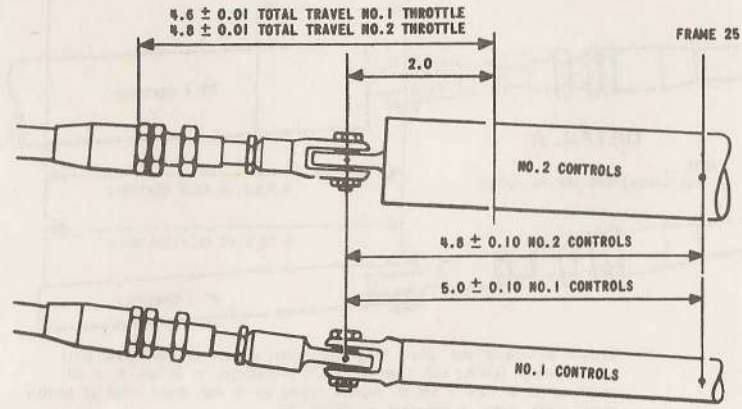


DETAIL F3

(13) Adjust length of control rod from torque shaft at Fr.48 to insert rigging pin "A" in lever and bracket at Fr.49.

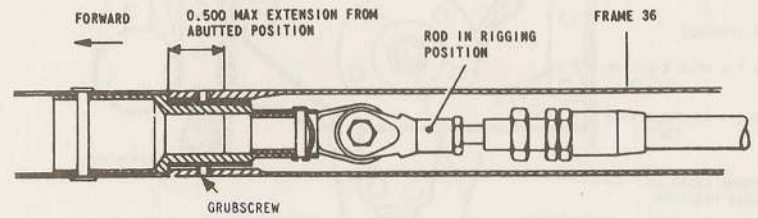


DETAIL B4



DETAIL A

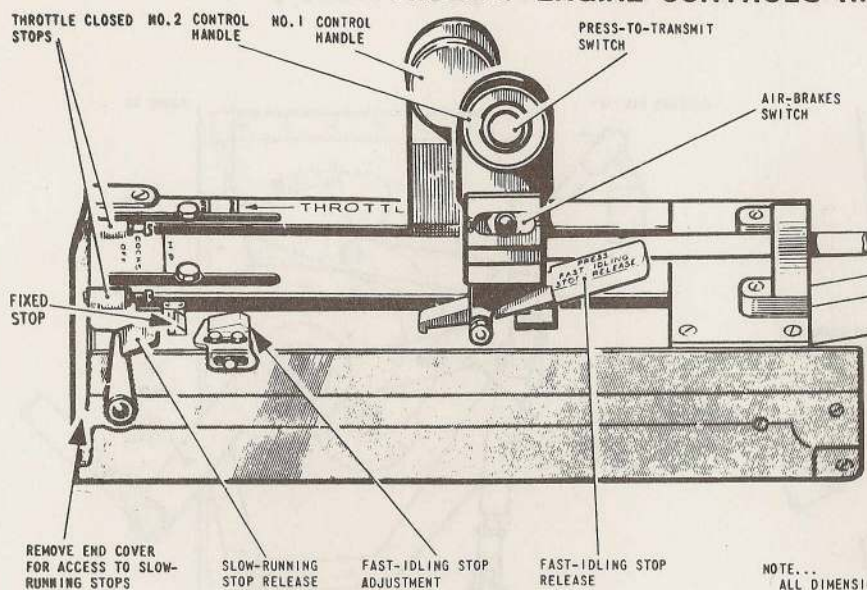
NOTE... ALL DIMENSIONS ARE IN INCHES



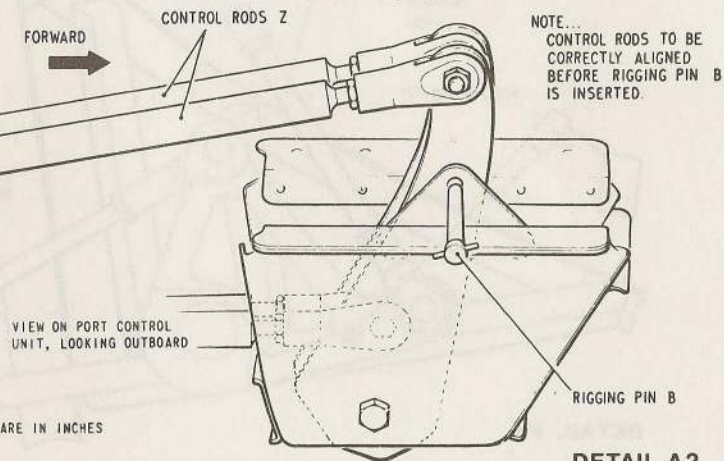
DETAIL C

(14) Adjust the Teleflex ends at Fr.46 and Fr.36 on run from the lost-motion box input lever to obtain No.2 controls dimension at Fr.25.

TABLE 1. ENGINE CONTROLS RIGGING - OPERATION 2

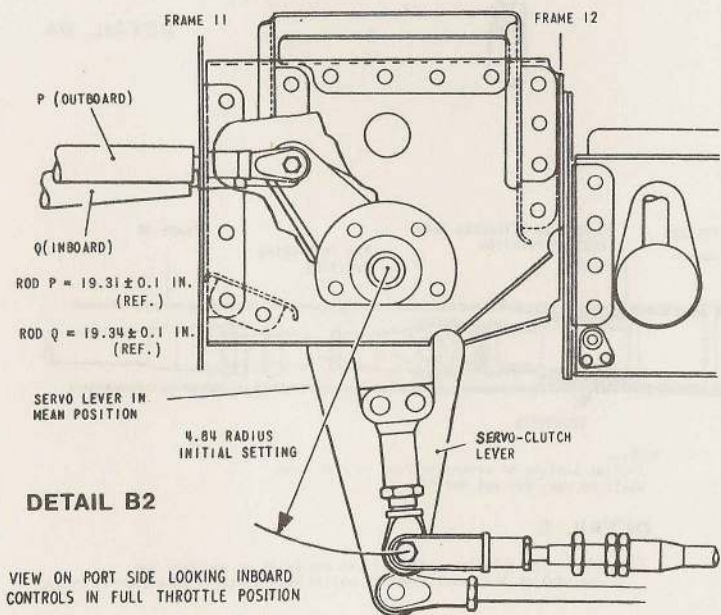


- (1) Set handles at full-throttle stops (100% COLD), adjust control rods 'Z' to insert rigging pin B in forward lever box.
- (2) Adjust Teleflex ends on run from throttle servo-clutch levers to connect with appropriate control rods at Fr. 25.
- (3) Ensure that all adjustable ends are in safety and lock with nuts provided. Check overlap of Teleflex sliding ends.



NOTE... ALL DIMENSIONS ARE IN INCHES

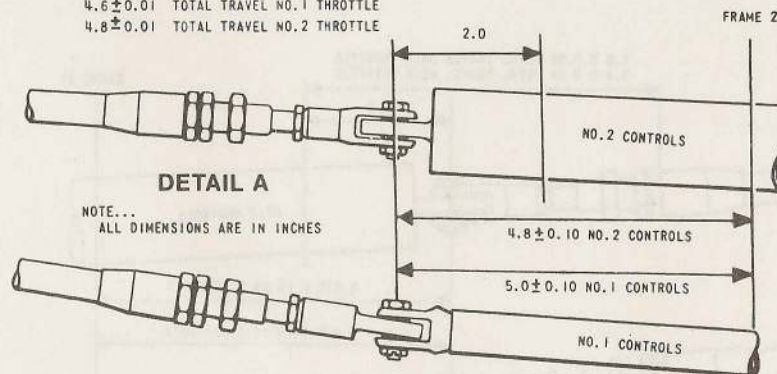
DETAIL A2



DETAIL B2

VIEW ON PORT SIDE LOOKING INBOARD CONTROLS IN FULL THROTTLE POSITION

4.6 ± 0.01 TOTAL TRAVEL NO. 1 THROTTLE
4.8 ± 0.01 TOTAL TRAVEL NO. 2 THROTTLE

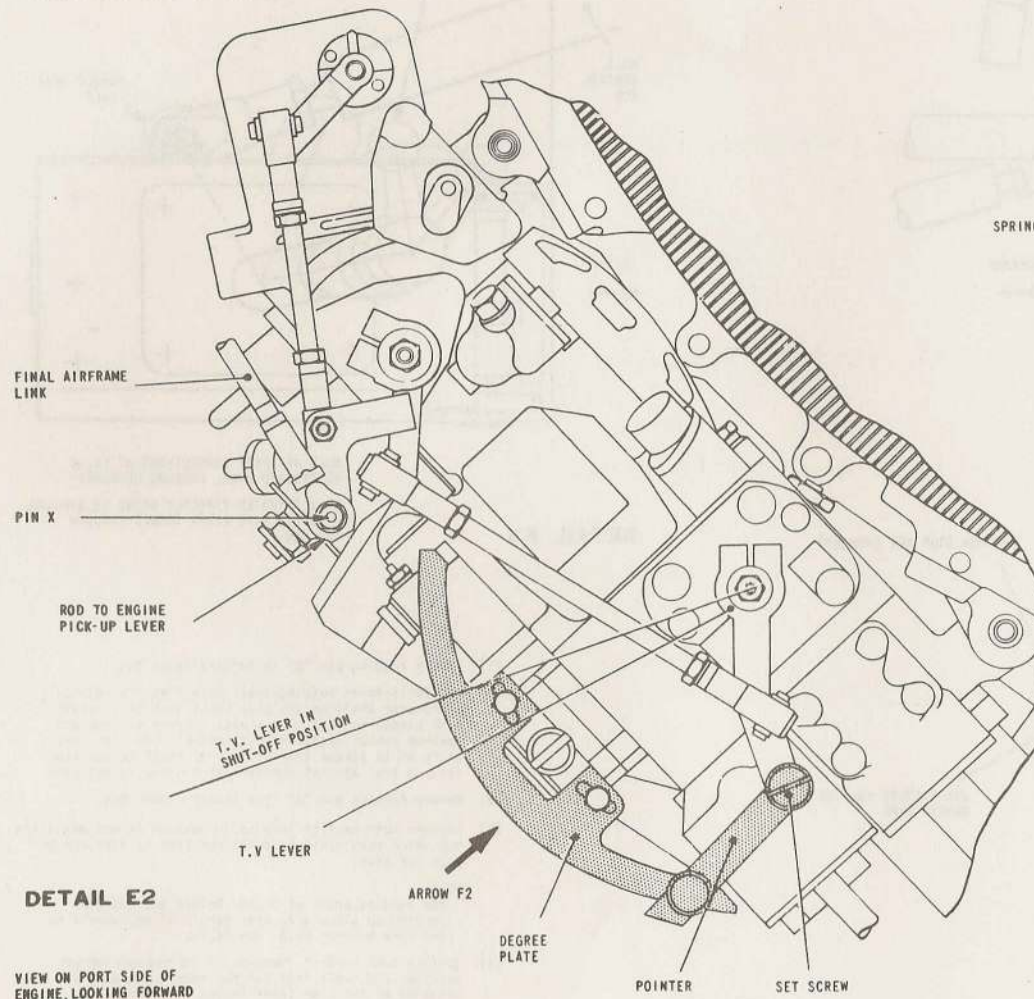


DETAIL A
NOTE... ALL DIMENSIONS ARE IN INCHES

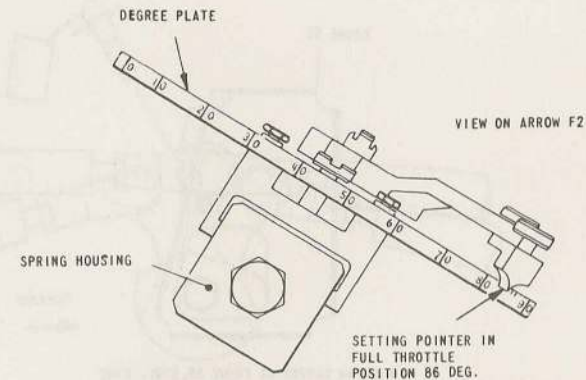
- (4) Remove all rigging pins. Check that total travel of each control handle gives corresponding Teleflex end travel at Fr. 25 as indicated in DETAIL A, if not check length of rods 'P' and 'Q'. Replace rigging pin 'B' and adjust length of throttle servo-clutch levers as indicated in DETAIL B2.
- (5) With servo-clutch lever in mid-position adjust horizontal rod from servo-clutch lever to bell-crank lever on Fr. 13 to position centre line of vertical lever of bell-crank parallel to Fr. 13. Set throttle servo actuating plunger in mid-travel and lock.

TABLE 1. ENGINE CONTROLS RIGGING - OPERATION 3

RIGGING ON ENGINE



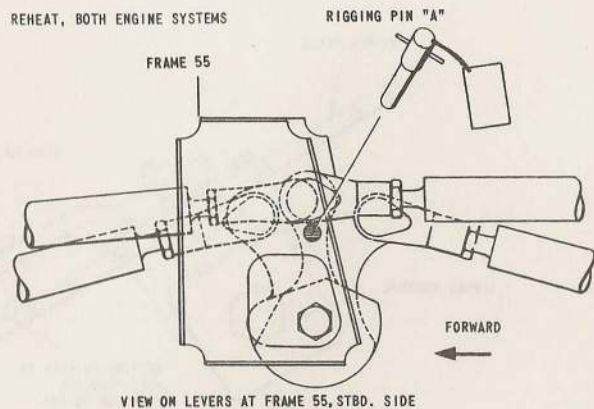
DETAIL E2

VIEW ON PORT SIDE OF
ENGINE, LOOKING FORWARD

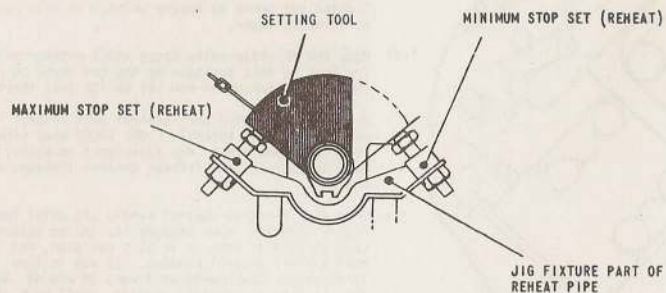
- (1) Attach the degree plate to the spring housing of the engine, by means of the bracket and set screws.
- (2) Operate the throttle valve (T.V.) lever to its shut-off position.
- (3) Attach the pointer assembly by its plate to the back of the throttle lever and secure by inserting set screw into the top hole of the throttle lever and screwing it into the tapped hole of the pointer. Set pointer to 0 deg. on scale. Tighten set screw to ensure pointer is held rigidly on end of throttle lever.
- (4) Move the throttle valve lever until pointer registers 86 deg. and lock in this position by the set screw on degree plate. The engine linkage is now set to its full throttle position.
- (5) With the associated port control unit control handle set against its full throttle (100% COLD) open stop, attach the final airframe link. Any adjustment necessary to do this must be done at the airframe control linkage, and not on the engine.
- (6) Move each throttle control handle aft until the appropriate engine throttle lever engages its idling detent. If both control handles line up in this position, set idling stops to butt against control handles. If not in line, adjust the torque-shaft lever arms at frames 34 and 48, and the control rods to them to maintain rigging, until both control handles line up in "idling" and "full-throttle" positions.
- (7) With both control handles in "idling" position, check that the tube extensions at frames 29 and 36 conform to the dimensions given in details B (operation 1 (B)) and C (operation 1 (14)) respectively.
- (8) Move both control handles fully aft and set "H.P. cock off" stops.
- (9) Check throttle levers positions against the degree-plate reading as follows:-
0 DEG. - "H.P. COCK OFF" position
22 DEG. TO 26 DEG. - "GROUND IDLING"
86 DEG. TO 90 DEG. - "FULL THROTTLE" (100% COLD) position
- (10) Remove degree plate and pointer and lock all controls.

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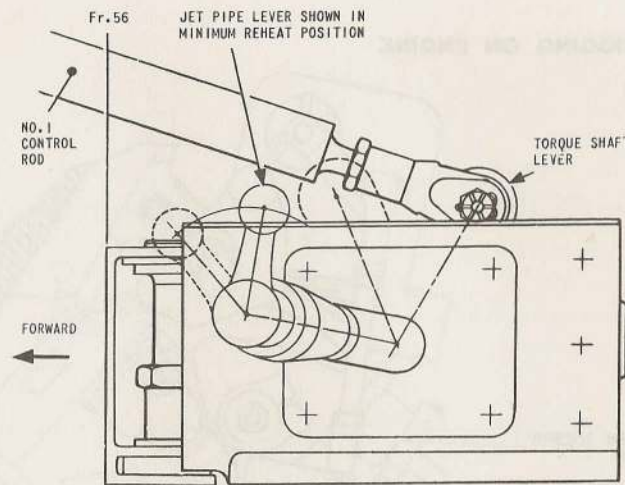
TABLE 1. ENGINE CONTROLS RIGGING - OPERATION 4



DETAIL H3



DETAIL W5



DETAIL K3

NO. 1 JET PIPE CONNECTIONS AT FR.56 (STARBOARD SIDE, LOOKING OUTBOARD)

NO. 2 SITUATED DIRECTLY ABOVE IS SIMILAR, WITH JET PIPE LEVER TURNED THROUGH 180 DEG

- (1) Insert rigging pin "B" in forward lever box.
- (2) Fit Rolls-Royce setting tool, Detail W5, to splines of transverse shaft on jet pipe (port side of aircraft in both cases) so that it operates between minimum and maximum reheat stops. Adjust control rods from levers at Fr.55 to torque shaft levers at Fr.56 to position setting tool against appropriate minimum reheat stop.
- (3) Remove rigging pin "B" from forward lever box.
- (4) Operate both control handles to maximum reheat positions and check that maximum reheat position is attained on each jet pipe.

NOTE...

The rigging point at Fr.55, Detail H3, has been ignored to allow a further margin of adjustment on the rods between Fr.53 and Fr.55.

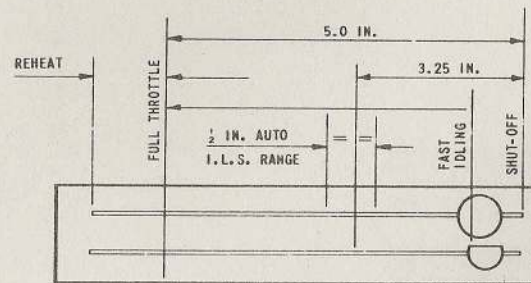
- (5) Operate both control handles aft to minimum reheat position and check that minimum reheat position is attained at jet pipe (over travel is permitted).
- (6) Remove setting tool; lock all controls.

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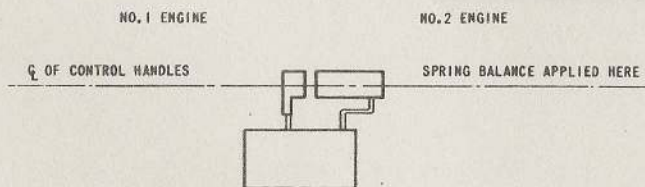
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TABLE 1. ENGINE CONTROLS RIGGING - OPERATION 5



DIAGRAMMATIC PLAN VIEW ON CONTROL UNIT



THROTTLE LOADINGS

NOTE...

- (1) Measure all throttle-handle loads in both directions, i.e. push and pull.

BEFORE ENGINE INSTALLATION

- (1) Adjust friction dampers on torque shafts at fr. 36 and 48 to give 2 to 4.5 lb. No. 1 engine, 2 to 6 lb. No. 2 engine, in the I.L.S. range and 2 to 6.5 lb. in the "fast-idle" to "full-throttle" range.
- (2) Adjust servo-clutch (fig. 3) so that, with clutch engaged, override load in I.L.S. range is $(2 \times \text{I.L.S.} + 6)$ lb. No. 1 engine, $(2 \times \text{I.L.S.} + 5)$ lb. No. 2 engine.
- (3) These loads ensure that with engines installed (friction load 3 lb. maximum) throttle loads will not exceed 20 lb.

AFTER ENGINE INSTALLATION

- (4) Measure each control-handle load through reheat range; this must not exceed 10 lb. Breakout load from maximum reheat must not exceed 13 lb. and pull aft must be smooth with steadily decreasing load.
- (5) Check that minimum load in the reheat range is not less than 4 lb. and difference between maximum-cold setting and minimum reheat is not more than 2 lb. The load required to move handles outboard into reheat and inboard into cold range must be $4 \pm \frac{1}{4}$ lb.
- (6) Check that, when moving control handles from maximum reheat to maximum cold, a travel of 0.50 in. (measured at the control unit slots) is not exceeded without movement of lost-motion box output levers and reheat control rods.
- (7) With throttle servo-clutch engaged, check that override load is not less than $(2 \times \text{I.L.S.} + 3)$ lb. No. 1 engine, $(2 \times \text{I.L.S.} + 2)$ lb. No. 2 engine.
- (8) Measure clutch override of both handles together, this must be $40 + 10$ lb. anywhere in the range. The difference between each handle, measured separately, must not exceed 6 lb.
- (9) With servo-clutch disengaged, maximum load at throttles must be 9.5 lb. No. 1 engine, 11.0 lb. No. 2 engine.

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TABLE 1. ENGINE CONTROLS RIGGING - OPERATION 6

CHECKING THE REHEAT GATE MICROSWITCHES

- (1) With a 28-volt ground supply attached to the aircraft, connect a test lamp across terminals KF111 and KF112 at the terminal block, located aft of the port console. Operate No.1 throttle-control lever up to the maximum engine rev. position, the lamp should not light.
- (2) Rock the lever outboard through the reheat gate. The lamp should light and stay lit for full travel of the lever to its maximum reheat position and then back to the extent of the reheat sector.
- (3) Rock the lever inboard into the normal running position and the light should go out.
- (4) Repeat (1), (2) and (3) using No.2 throttle control lever and with the test lamp connected to terminals KF211 and KF212. The indications should be the same.

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TABLE 1. ENGINE CONTROLS RIGGING - OPERATION 7

SETTING THE FAST - IDLE STOP

The fast-idling stop arrests the rearward travel of No.2 engine control handle to ensure that sufficient air is available to provide a.c. and d.c. supplies

- (1) Fit the debris guard.
- (2) Start No.1 engine to slow idle.
- (3) Start No.2 engine to slow idle. Increase rev/min on No.2 slowly to about 80%. Note rev/min at which a.c. comes on line (this should be below 63%).
- (4) With No.1 engine at about 60% set 'fast-idle' stop on No.2 so that engine idles at 58% when handle is moved slowly back from 80% to fast-idling position. Lock stop in this position.
- (5) Increase No.2 rev/min to 102%, check on slam deceleration to fast-idling position that rev/min do not fall below $58 \pm \frac{1}{2}\%$.
- (6) Repeat the deceleration test slowly and confirm that at fast-idling position No.2 rev/min are still $58 \pm \frac{1}{2}\%$.
- (7) With No.1 engine at slow-idling position check that a.c. does not come off line above 58%.

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TABLE 2

Tools and equipment

Ref. No.	Item	Purpose
	Engine controls rigging	
26DK/95127	Rigging pin A	Locking of control runs as necessary
26DK/95457	Rigging pin B	Locking of control runs as necessary
64VV/3113	Minimum/maximum reheat setting tool	Setting of controls on engine
64VV/890	Degree adjustment plate	Setting of controls on engine
	No. 1 E. C. U.	
4GC/5752	Hoist	Installation and removal of E.C.U.
4GC/6093	Extension tube, 12-inch	For use with hoist
4GC/6099	Top sheath ball, 1 1/16-inch	For use with hoist
4GC/6100	Ball end cable, 1 1/16-inch	For use with hoist
4GC/5743	Handle, 9-inch	For use with hoist
26DK/95794	Hoist support beam (fwd.)	For securing hoist to airframe
26DK/95793	Hoist support beam (rear)	For securing hoist to airframe
26DK/95792	Hoisting cradle	Supporting E.C.U. during assembly and removal operations
26DK/95397	Spanner	Engine trunnion
26DK/95094	Spanner, box	Trunnion bolt
26DK/95095	Key, hexagon	Trunnion cone (starboard mounting only)
26DK/95297	Extractor tool	Engine trunnion
26DK/95403	Spanner	Auxiliary air connection
26DK/95904	Spanner	N.R.V. air connection
64VV/3055	Divorcing tool	Engine jet pipe joint
26DK/95745	Key	Air intake sealing ring
26DK/95351	Blanking panels	Air intake
26DK/95761	Box	Stowage of buffer strips and warning pennants
◀ EF3. 88. 691 ▶	Buffer strips, No.1 engine	Installation of E.C.U.
26DK/95800	Pennants, warning	Installation of buffer strips
26DK/95242	Key	Jet pipe rollers
26DK/95781	Rig, setting	Hydraulic pump hose setting
	No. 2 E. C. U.	
◀ 4GC/4232223 ▶	Plate, adapter	

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TABLE 2 Tools and equipment - continued

Ref. No.	Item	Purpose
No. 2 E. C. U. - continued		
26DK/95765	Sling	Installation and removal of E.C.U.
26DK/95397	Spanner	Engine trunnion
26DK/95094	Spanner, box	Trunnion bolt
26DK/95095	Key, hexagon	Trunnion cone (starboard mounting only)
26DK/95297	Extractor tool	Engine trunnion
26DK/95420	Spanner	Igniter plug lead
26DK/95745	Key	Air intake sealing ring
26DK/95761	Box	Stowage of buffer strips and pennants
◀ EF3. 88. 695 ▶	Buffer strips, No.2 engine	Installation of E.C.U.
26DK/95800	Pennants, warning	Installation of buffer strips
26DK/95242	Key	Jet pipe rollers
No. 1 jet pipe		
26DK/95430	Cradle	Removal and installation of jet pipe
26DK/95431	Sling	Used with cradle
26DK/95697	Pin	Used for locking rear fuselage doors in the open position
26DK/95242	Key	Jet pipe rollers
26DK/95089	Retractor tool	Cooling ducts
26DK/95762	Withdrawal tool	Exhaust gas outlet
26DK/95455	Pick-up bracket (port)	Used with cradle
26DK/95456	Pick-up bracket (stbd.)	Used with cradle
No. 2 jet pipe		
26DK/95430	Cradle	Removal and installation of jet pipe
26DK/95431	Sling	Used with cradle
26DK/95455	Pick-up bracket (port)	Used with cradle
26DK/95456	Pick-up bracket (stbd.)	Used with cradle
26DK/95014	Handling link	Removal and installation of jet pipe
26DK/95089	Retractor tool	Cooling ducts
26DK/95697	Pin	Used for locking back rear fuselage doors in open position
26DK/95242	Key	Jet pipe rollers
26DK/95763	Retractor tool	Exhaust gas outlets
◀ 26DK/1439915	Calibration equipment	Checking of jet pipes ▶

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