

TECHNICAL TRAINING SCHOOL
(SA) WARTON

AIRCREW EGRESS SYSTEM SPECIALIST

CHAPTER ONE

LIGHTNING MK 53 CANOPY

CHAPTER ONE

LIGHTNING MK 53 CANOPY

CONTENTS

PARAS. 1 - 4	CANOPY - GENERAL INFORMATION
PARA. 5	CONTROLS FROM OUTSIDE THE COCKPIT
PARA. 6	CONTROLS FROM INSIDE THE COCKPIT
PARA. 7	OPENING IN POWER FAILURE CONDITIONS
PARA. 8	OPENING
PARA. 9	JETTISONING
PARA. 10	JACK END-FITTING RELEASE
PARAS. 11 - 14	LOCKING MECHANISMS
PARAS. 15 - 17	ACTUATING MECHANISM
PARAS. 18 - 23	JETTISONING MECHANISM
PARA. 24	STANDBY OPENING

ILLUSTRATIONS

FIG. 1	GENERAL ARRANGEMENT OF CANOPY MECHANISM
FIG. 2	CANOPY SEAL
FIG. 3	CANOPY EXTERNAL CONTROL
FIG. 4	JACK END FITTING RELEASE
FIG. 5	TORQUE SHAFT
FIG. 6	TORQUE SHAFT LINKAGE
FIG. 7	CANOPY LOCKING INTERNAL HANDLE
FIG. 8	DIAGRAMTIC LAYOUT OF JETTISON SYSTEM
FIG. 9	ACTION OF HINGE RELEASE MECHANISM

CHAPTER ONE

CANOPY

General Information

1. The canopy, which is hinged to the rear on bolts secured in the spine structure, is mechanically locked, hydraulically actuated, and can be jettisoned by a cartridge-operated firing unit. Provision is also made for standby opening of the canopy, without resorting to jettison action, in hydraulic or electrical failure. Safety features incorporated in the design of the operating mechanism ensure that the canopy is unlocked before the hydraulic control can be operated. Cockpit pressurization is maintained by a hollow rubber seal around the windscreen arch and the cockpit sill which, when the canopy is locked, is inflated with air ducted from the main air system. For descriptive purposes the operating mechanism is subdivided into locking, actuating, and jettisoning mechanisms.

Canopy

2. The canopy consists of a metal frame containing two double skinned transparent side-panels and, at the top, a glass clear-vision panel. Two hinge arms bolted to the canopy top member, extend aft and incorporate built in release mechanisms. Each release mechanism consists of a hook which grips the canopy hinge bolt steel bush under pressure applied from an eccentrically mounted catch. The adjustment is locked by a tab on the eccentric engaging one of seven radial slots in the hinge arm.
3. Two rollers carried by bolts passing through the rear side-castings are engaged by locking hooks on the fuselage structure to lock the canopy. Additional locking facilities are provided by shoot bolts carried on control rods extending along each canopy side member. These rods, which are spring loaded towards the unlocked position, have yokes at the aft end which are engaged by the locking hooks to cause the shoot bolts to enter, or withdraw from, holes in brackets on the windscreen arch.
4. Striking blocks, formed on the rear side castings, are contacted by the canopy jettisoning jack pistons to lift the canopy during jettisoning.

CANOPY CONTROLS

Canopy Controls from Outside the Cockpit

5. The canopy external controls are behind a small detachable panel in the port side of the spine immediately aft of the cockpit. The canopy is opened (after removing the access panel) by first pulling the black coloured locking handle outboard then operating the adjacent switch controlling the canopy jack; the locking handle also controls canopy seal inflation. A warning buzzer sounds whenever the canopy switch is operated and a CANOPY warning indicator on the auxiliary warnings panel is illuminated while the canopy is unlocked. The canopy can also be closed and locked by the external controls.

- 1 REDUCTION LEVER
- 2 INTERNAL JETTISONING HANDLE
- 3 INTERNAL STAND-BY HANDLE
- 4 JETTISONING CABLE
- 5 GAS TUBES
- 6 CANOPY JETTISONING JACK (STBD.)
- 7 LOCKING HOOK (STARBOARD)
- 8 LOCKING LINK (STARBOARD)
- 9 MICROSWITCH
- 10 CANOPY FIRING UNIT
- 11 DAMPER UNIT
- 11A DAMPER UNIT LEVER
- 12 CANOPY HINGE RELEASE CAUSHAFT
- 13 CANOPY HINGE ARM
- 14 PULLEY GUARD
- 15 CANOPY JACK
- 16 LEVER SPOOL
- 17 CRANKED LEVER
- 18 EXTERNAL LOCKING HANDLE
- 19 EXTERNAL SWITCH
- 20 EXTERNAL STAND-BY HANDLE
- 21 EXTERNAL OPERATING LINK
- 22 TORQUE SHAFT (FIG. 5)
- 23 MICROSWITCH
- 24 LOCKING LINK (PORT)
- 25 INTERNAL OPERATING LINK (UPPER)
- 26 LOCKING HOOK (PORT)
- 27 DISTANCE TUBE ON HOOK SHAFT
- 28 CANOPY JETTISONING JACK (PORT)
- 29 INTERNAL OPERATING LINK (LOWER)
- 30 INTERNAL CONTROL HANDLE
- 31 EXTERNAL JETTISONING CABLE

NOTE:-
THE MECHANISM IS
DEPICTED IN THE
LOCKED POSITION

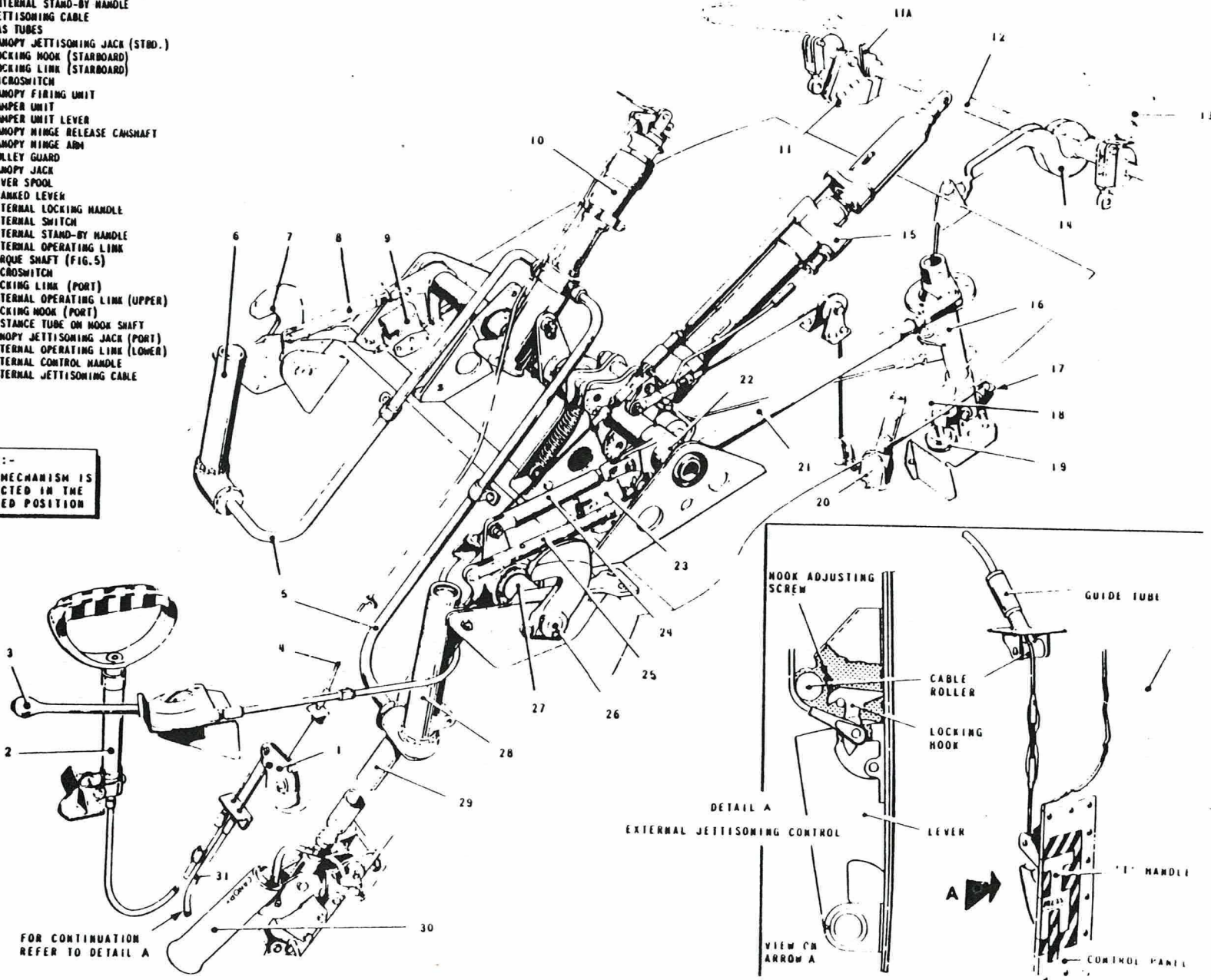


FIG.1 GENERAL ARRANGEMENT OF CANOPY MECHANISM

TECHNICAL TRAINING SCHOOL
(SA) WARTON

Canopy Control from Inside the Cockpit

6. The occupant of the cockpit opens or closes the canopy by operating the internal control handle and its integral canopy jack control switch. The controls are inter-connected with the external controls so that the 'Canopy unlocked' and 'Canopy moving' warning is given in the appropriate circumstances. The control switch can be operated only when the control handle is in the unlocked (up) position.

NOTE: If the canopy fails to open when the control switch is operated, the probable cause is low pressure in the services hydraulic system. The pressure can be restored by use of the hand pump. If, after this, the canopy still fails to open refer to the emergency exit procedure (para. 7 - 8).

Canopy Opening in Power Failure Conditions

7. If electrical or hydraulic failure prevents the canopy being opened normally when the aircraft is on the ground it can be opened manually. It is essential that the canopy remains in the closed and locked position until the canopy jack end fitting has been released by operating either of the two EMERGENCY CANOPY JACK RELEASE levers, one mounted below the top longeron forward of the windscreen arch and the other near the external canopy locking handle. With the canopy jack end fitting free, the canopy can be unlocked in the normal manner and pushed or lifted open.

Partial Opening

8. If an attempt is made to open the canopy in the normal way in conditions of hydraulic or electrical failure, it may open slightly and render the stand-by and canopy jettisoning systems ineffective. In this case:-
 - (1) If the failure is hydraulic, close it (manual assistance may be necessary) by selecting, and holding CLOSED, the OPEN/CLOSE switch. If the failure is electrical, close it by manual means.
 - (2) Lock it by pushing down the CANOPY control handle.
 - (3) Operate the EMERGENCY CANOPY JACK RELEASE handle.
 - (4) Pull the CANOPY control handle upwards, but do not operate the OPEN/CLOSE switch.
 - (5) With external assistance, manually raise the canopy.

Canopy Jettisoning

9. The canopy can be jettisoned without actuating the seat ejecting mechanism by pulling either of two handles, one a spade grip type mounted on the cockpit floor to the left of the pilot's seat and the other a T-shaped handle connected to a lever on the external jettisoning control panel. After depressing the section marked PRESS the external handle must be pulled outboard.

Canopy jettisoning is operated in conjunction with the seat ejecting system by pulling either of the two seat firing handles.

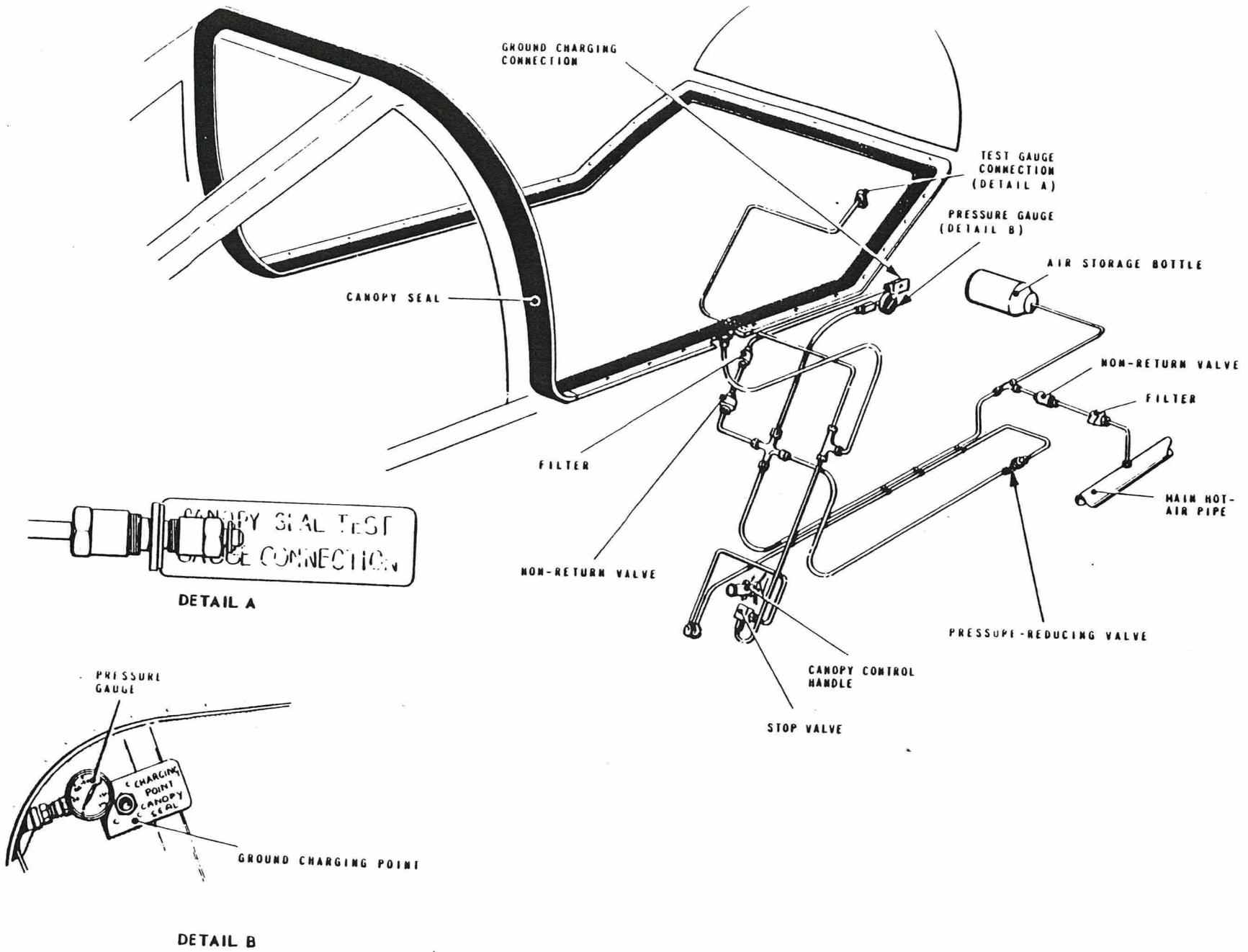


FIG.2 CANOPY SEAL

EC/2/7

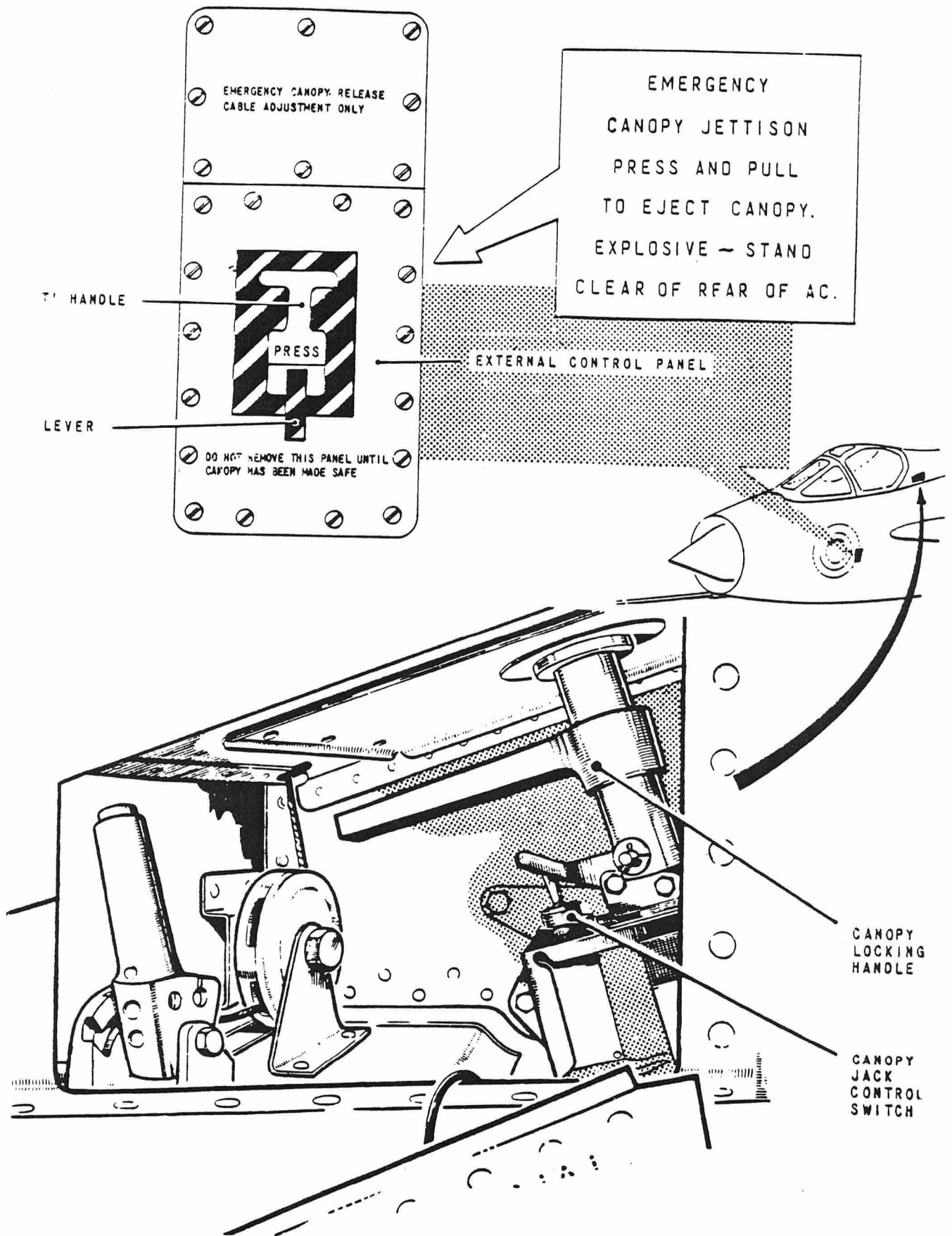


FIG.3 CANOPY EXTERNAL CONTROL

Canopy Jack End-fitting Release

10. The mechanism is operated by pulling either the internal handle (beneath the port cockpit sill) or the external handle (access panel in port side of the spine). Releasing the jack-end fitting enables the canopy to be opened manually in the case of electrical or hydraulic failure. It is essential that the canopy remains in the closed-and-locked position until the jack end-fitting is released.

CANOPY OPERATION

Locking Mechanism

General Information

11. The locking mechanism is based on a torque shaft to which rotary motion can be imparted by the canopy firing unit or, through rod and lever linkages, by either of two interconnected handles, one inside and one outside the cockpit. This motion is used, through additional levers and linkage, to turn the hook shafts and engage or disengage the canopy locking hooks. Visual indication that the canopy is unlocked is given by an illuminated CANOPY indicator on the auxiliary warnings panel and controlled by two microswitches near the torque shaft. Two mechanical indicators, one on each inside face of the lower canopy frame, are marked CANOPY-FREE-LOCKED to show the position of the shoot bolts.

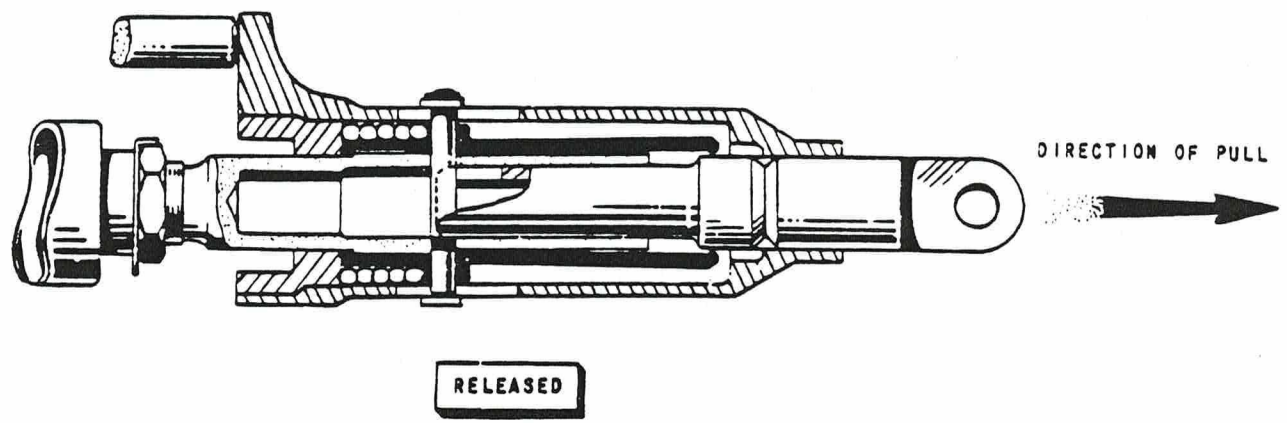
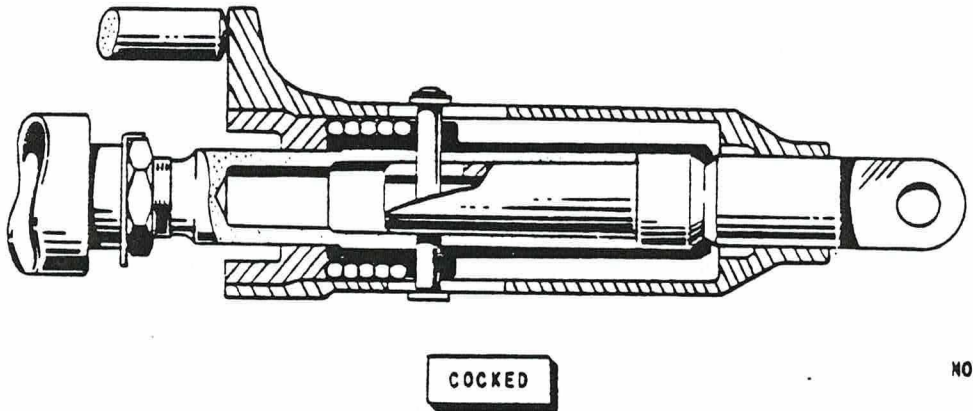
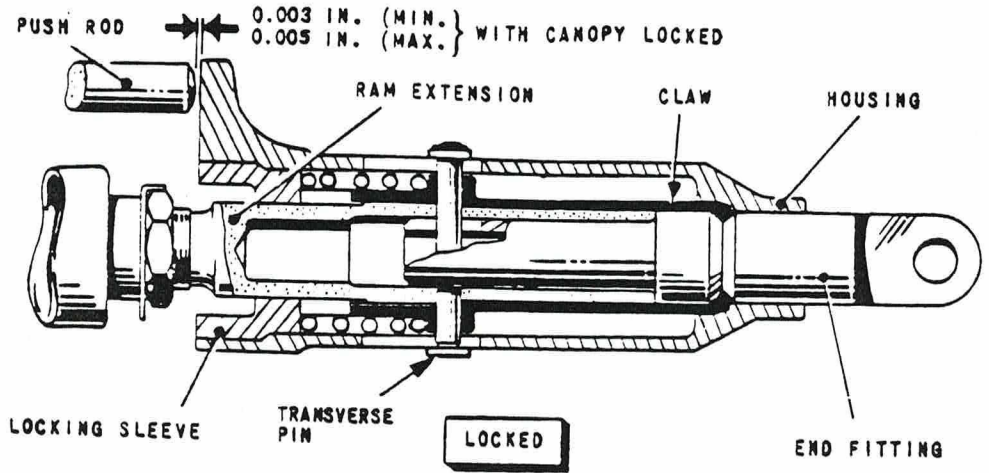
Torque Shaft

12. The torque shaft is supported in four ball-bearing brackets bolted to the rear pressure bulkhead, and is rotated, during normal operation of the canopy lock mechanism, by movement of either of the two control handles; these are linked to separate control levers formed on a fixed sleeve at the port end of the shaft. The same sleeve also carries a lock lever and a microswitch striker arm, both of which are duplicated on a second sleeve secured to the starboard end of the shaft. Each lock lever is connected to the associated locking hook shaft, and the two striker arms operate the 'Canopy unlocked' warning microswitches. During canopy jettisoning sequence the torque shaft is rotated by the firing unit through a jettisoning lever formed on a third fixed sleeve disposed centrally on the shaft.

Movement of the shaft is restricted by two adjustable limit stops in the port inner bearing bracket, which are contacted by a stop lever on the shaft. Connected between the stop lever and a pin passing through the port inner bearing bracket, is a springloaded locking-plunger which is in full compression when the torque shaft is mid-way between the limit stops, thus ensuring positive location of the shaft in either the locked or unlocked positions. At each side of the jettisoning lever is a jettisoning sleeve freely supported on the shaft and having no operational effect on it.

Internal Controls

13. The canopy controls inside the cockpit consist of a handle for the locking mechanism and a three position switch for the hydraulic system. The hollow handle, mounted in a bracket bolted to the rear pressure bulkhead between the ejection seat and the port console, contains a retractable



NOTE...
THE CANOPY JACKS AND
JACK END FITTINGS ARE
MATCHED PAIRS AND MUST BE
KEPT AS SUCH

FIG.4 JACK END FITTING RELEASE

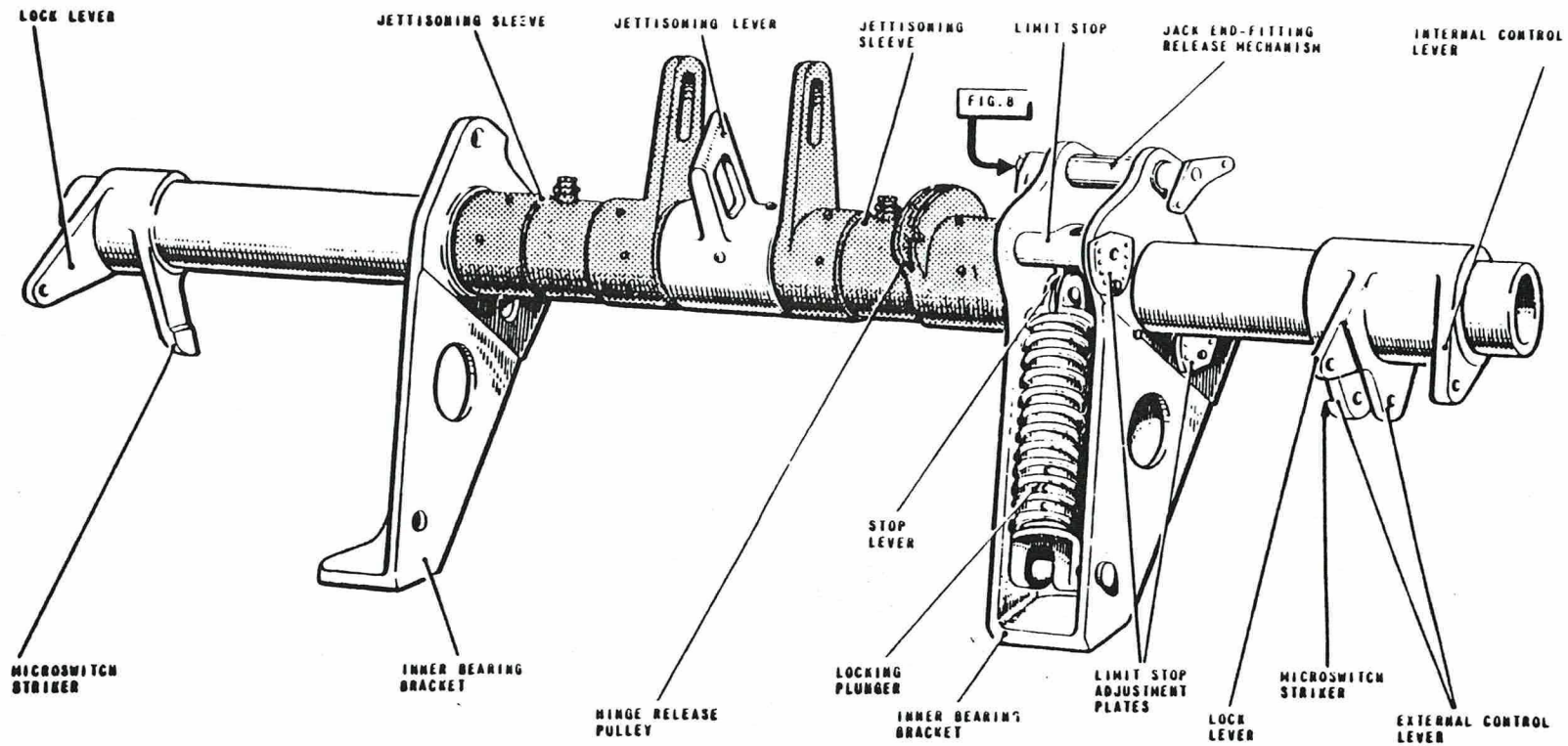


FIG.5 TORQUE SHAFT

Eq/2/11

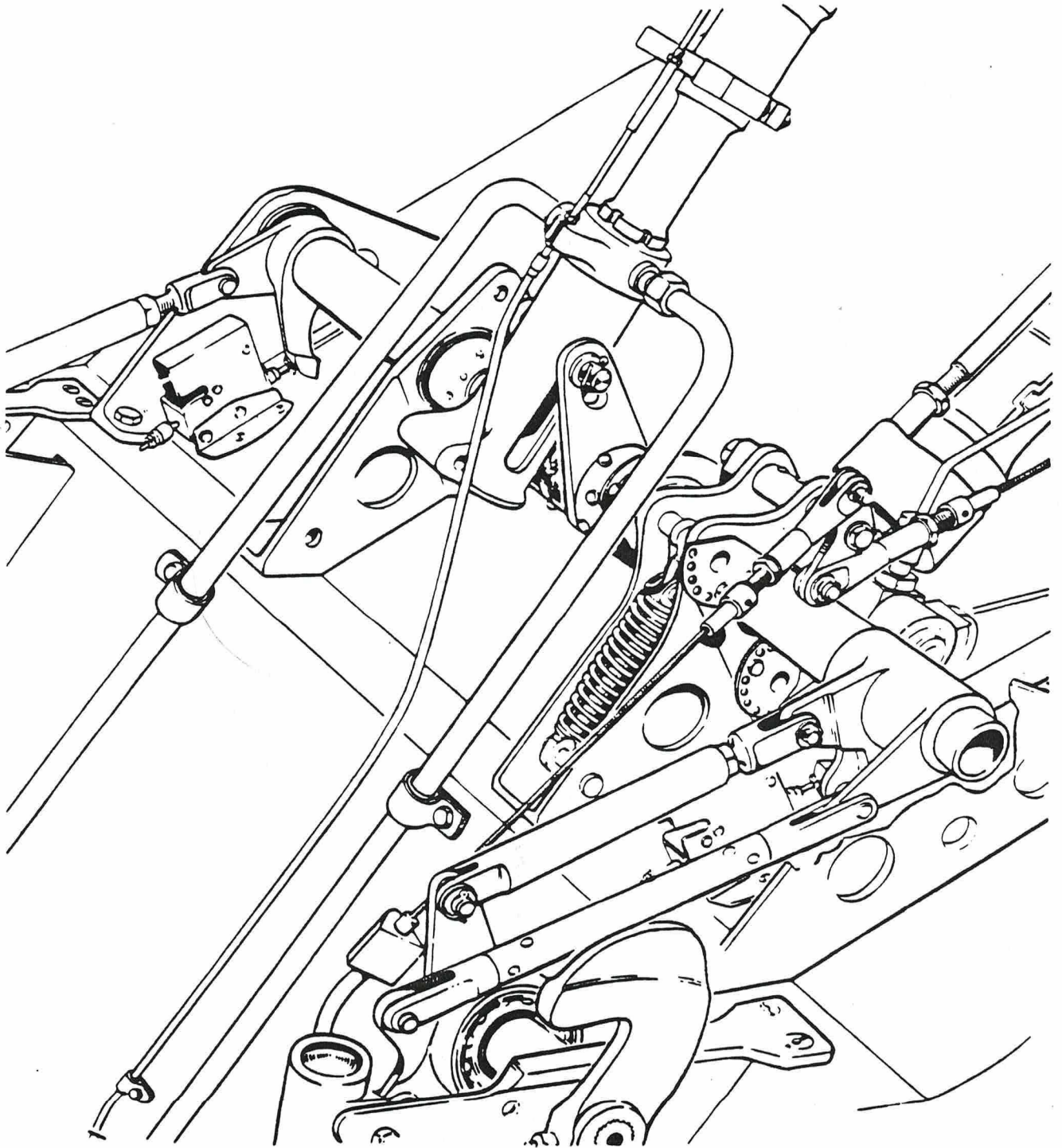


FIG.6 TORQUE SHAFT LINKAGE

TECHNICAL TRAINING SCHOOL
(SA) WARTON

sleeve which carries the switch. The sleeve is actuated by a cranked lever which transmits motion from a cam follower, bearing on the machined profile of the handle mounting bracket. The sleeve is extended and the switch exposed only when the canopy is unlocked. A sprung protection flap attached to the mounting bracket below the limit stop prevents ingress of dirt to the control mechanism.

External Controls

14. The external controls are accessible through a detachable panel in the port side of the spine, immediately behind the cockpit. They consist of a handle fixed to the lower end of a shaft passing through the pressure bulkhead, and a control switch for the hydraulic selector. The upper end of the shaft carries a lever and link by which rotary motion applied to the handle is transmitted to the external control lever on the torque shaft. The switch is mounted on the structure near the lower end of the shaft, with the switch dolly between the fork arms of a spring-loaded cranked lever. Operation of the cranked lever is controlled by a pin in the shaft, and is such that the switch can be operated only when the canopy is unlocked.

Actuating Mechanism

General Information

15. The canopy is raised or lowered by a hydraulic jack connected between the torque-shaft port inner bearing bracket and a bracket on the canopy. The jack is powered by the services system, through an electro-hydraulic selector controlled by either of two switches. The control switches are spring-loaded to the 'off' position so that any intermediate position of the canopy, between fully open and fully closed, may be selected. When a selection is made, an electric buzzer, mounted on the d.c. relay box, is energized so that any movement of the canopy is accompanied by an audible warning. For jettisoning or stand-by opening, the jack incorporates a device by which the end-fitting may be detached.

Jack

16. Hydraulic pressure is admitted to the jack through a swivel coupling embodying two attachment plates through which the jack is bolted to the torque shaft bracket. Guides formed on the jack body carry a pushrod for cocking the end-fitting release mechanism. The end-fitting has a reduced diameter, which slides inside the ram extension, and a peripheral groove in the large diameter. A four-segment spring-claw, screwed to the ram extension, engages the groove and is held in engagement by a spring-loaded housing, preventing the end-fitting being withdrawn. A pin through the ram extension engages two slots in the housing and fastens the two components together. The slots permit limited axial movement of the housing relative to the ram.

Jack End-fitting Release

17. A cam in the torque shaft bearing bracket is rotated, by the jettisoning system or stand-by system, to lift the pushrod, which contacts the housing and slides it up the end-fitting against spring pressure. After sufficient movement of the housing, the spring claw is freed of restraint. If an

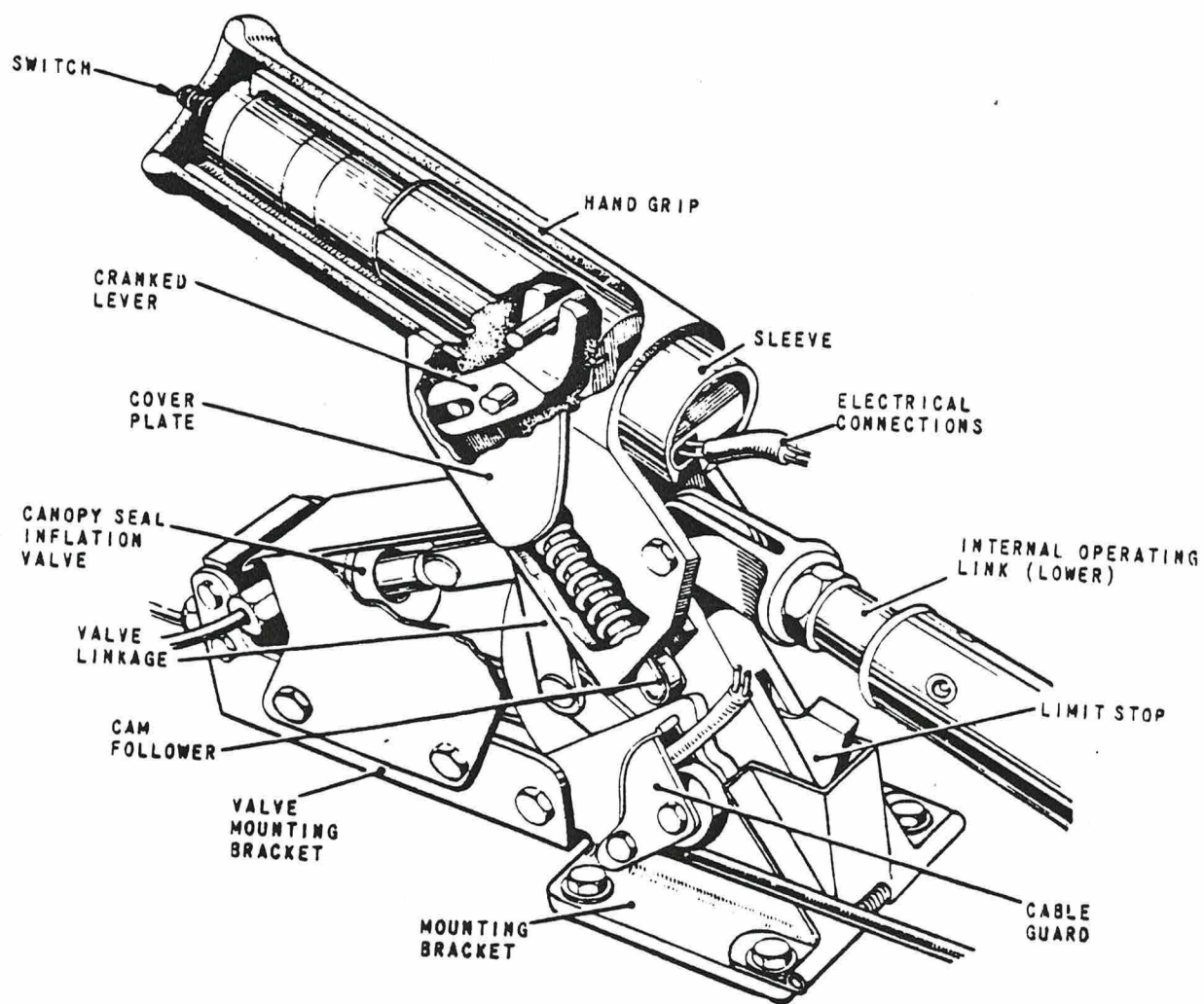


FIG.7 CANOPY LOCKING INTERNAL HANDLE

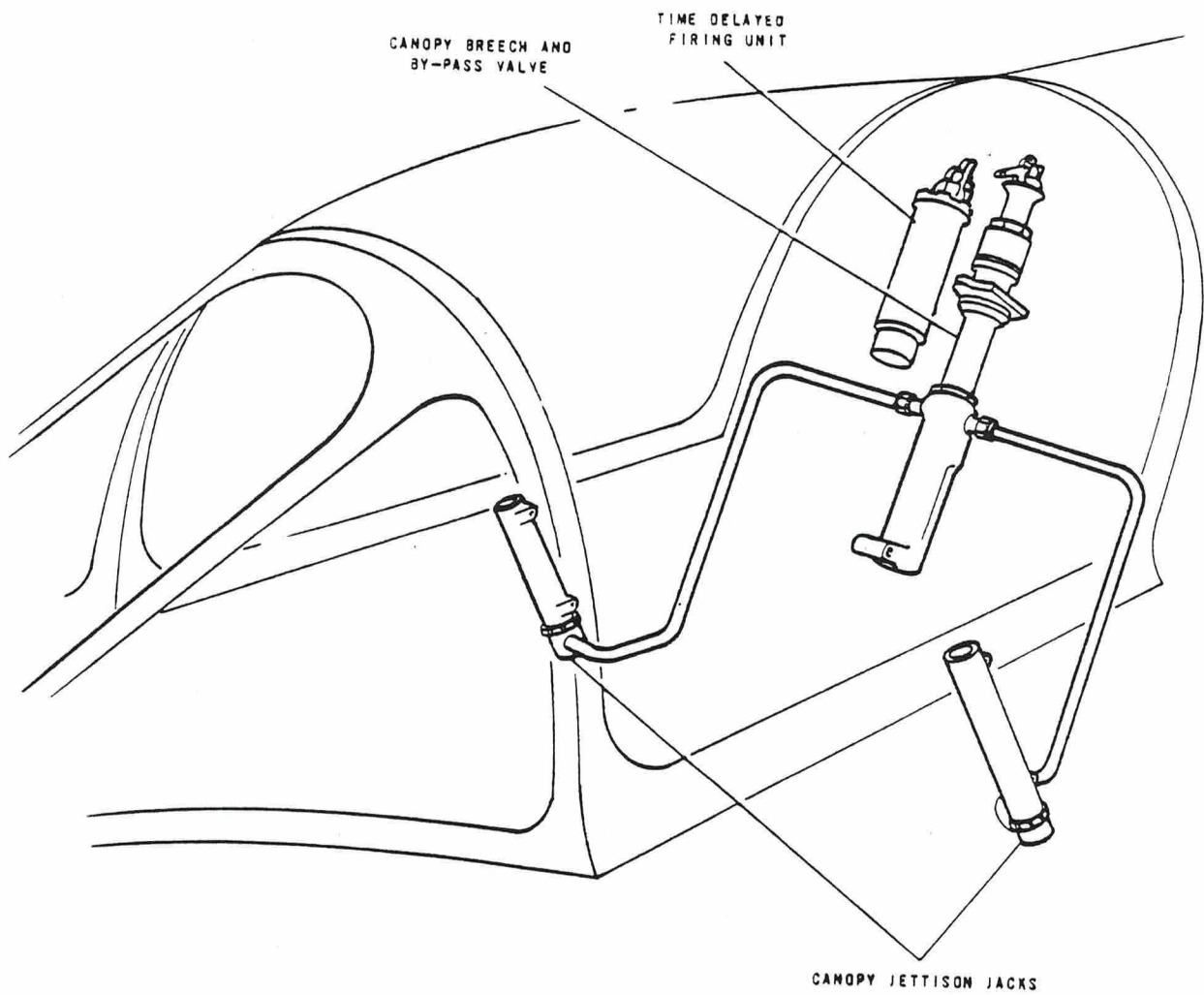


FIG.8 DIAGRAMTIC LAYOUT OF JETTISON SYSTEM

TECHNICAL TRAINING SCHOOL
(SA) WARTON

axial load is then applied to the end-fitting from the canopy, either manually or by the jettisoning jacks, the claw segments are deflected outward by the sloping faces of the peripheral groove, releasing the end-fitting from the ram. The claw recovers its shape after the end-fitting has left the jack.

Jettisoning Mechanism

General Information

18. The canopy is jettisoned by a firing unit, bolted to the ejection seat gun, which acts through mechanical linkages to unlock the canopy, release the jack end-fitting, and cock the canopy hinge release mechanism. The firing unit also extends two jettisoning jacks which lift the canopy to a position where the airstream can carry it clear of the aircraft.

Internal Controls

19. The canopy jettisoning controls inside the cockpit consist of a spade-grip handle interconnected, by two Bowden-type cables and a reduction lever, to the firing unit sear. The handle is mounted on the cockpit floor to the left of the pilot's seat and the lever located on the pressure bulkhead. Movement of the lever is restricted to 90 deg. by a limit stop in the base.

External Controls

20. The controls consist of an external jettisoning control interconnected by a Bowden type cable to the outboard pin of two in the reduction lever. The control panel, located on the port side of the fuselage between frames 13 and 14, incorporates a lever connected to a 'T'-shaped handle and a locking device to retain both the lever and handle in the unoperated position. Depressing the section of the 'T' marked PRESS, unlocks the lever and handle by tripping a hook engaging a catch on the inner face, and simultaneously cocking the handle outboard enabling it to be gripped manually. The cable from the lever passes over two rollers, located on the panel and the lower face of the fuselage upper-web respectively, then enters the cockpit pressurized area through a flanged guide-tube incorporating an air-tight seal.

Firing Unit

21. The firing unit embodies a chamber containing a piston, a percussion cartridge, and a removable spring-loaded firing pin assembly. The firing pin is held in the cocked position by a sear, connected by cables to the ejection seat firing handles and to the internal and external canopy jettisoning handles. An extension of the piston passes through the lower end of the firing chamber, into a slotted sleeve, and almost touches the jettisoning lever of the torque shaft when the canopy is locked. A transverse pin in the end of the piston extension passes through the slots of the sleeve to engage the jettisoning sleeves on the torque shaft. Two ports in the firing chamber wall are connected by pipes to the port and starboard canopy jettisoning jacks mounted on the cockpit sides.

Hinge Release Mechanism

22. The release mechanism consists of two spring-loaded links, mounted in the spine structure aft of the cockpit, which are in contact with the cams of a camshaft fitted transversely in two diaphragms in the spine. The camshaft embodies a fixed pulley which is connected, by cables via a lever spool on the external control shaft and fairlead pulleys, to a similar pulley on the torque-shaft port jettisoning sleeve. A small lever on the camshaft prevents it overriding by engaging a damper unit bolted to the starboard diaphragm. The spring-loaded links are set during assembly of the mechanism to allow a 12 deg. release angle, and should not be altered.

Operation

23. When the firing unit sear is withdrawn, the cartridge is fired and expanding gases drive the piston down the firing chamber. The end of the piston, acting on the jettisoning lever, rotates the torque shaft to unlock the canopy, and at the same time the jettisoning sleeves are rotated by the transverse pin. The port jettisoning sleeve applies a pull to the cables to rotate the hinge camshaft, pushing the release links into contact with the canopy hook catches and also, through a cam and lever rotates the cam of the jack end-fitting release mechanism. When the piston has travelled sufficiently to perform these operations, it uncovers the ports in the cylinder walls and the remaining gas pressure passes to the canopy jettisoning jacks. The jack pistons are then driven upwards against the canopy striking blocks, lifting the canopy to a position where the airstream becomes effective. When the canopy has pivoted through 12 deg. the links of the hinge-release mechanism withdraw the hook catches and free the hinges from the aircraft allowing the canopy to be carried away by the airstream.

Standby Opening

24. In a case of hydraulic or electrical failure the canopy may be opened by operating either of the two EMERGENCY CANOPY JACK RELEASE levers which are connected by cables to the canopy jack end-fitting release mechanism to free the canopy from the jack. It is essential that the canopy remains in the closed-and-locked position until the canopy jack end-fitting has been released, then subsequent operation of either of the two canopy control handles withdraws the shoot bolts and the canopy may be pushed or pulled open as the case may be. The handles, situated one beneath the port cockpit sill, and one near the external locking handle, are prevented from returning to normal after operating by spring-loaded pawls, which may be released by depressing a plunger in the end of each handle. The external stand-by handle is secured to the structure with thin locking wire to provide an indication if the handle has been operated. The jack end-fitting must be reset before subsequent flight and before resetting a control handle.

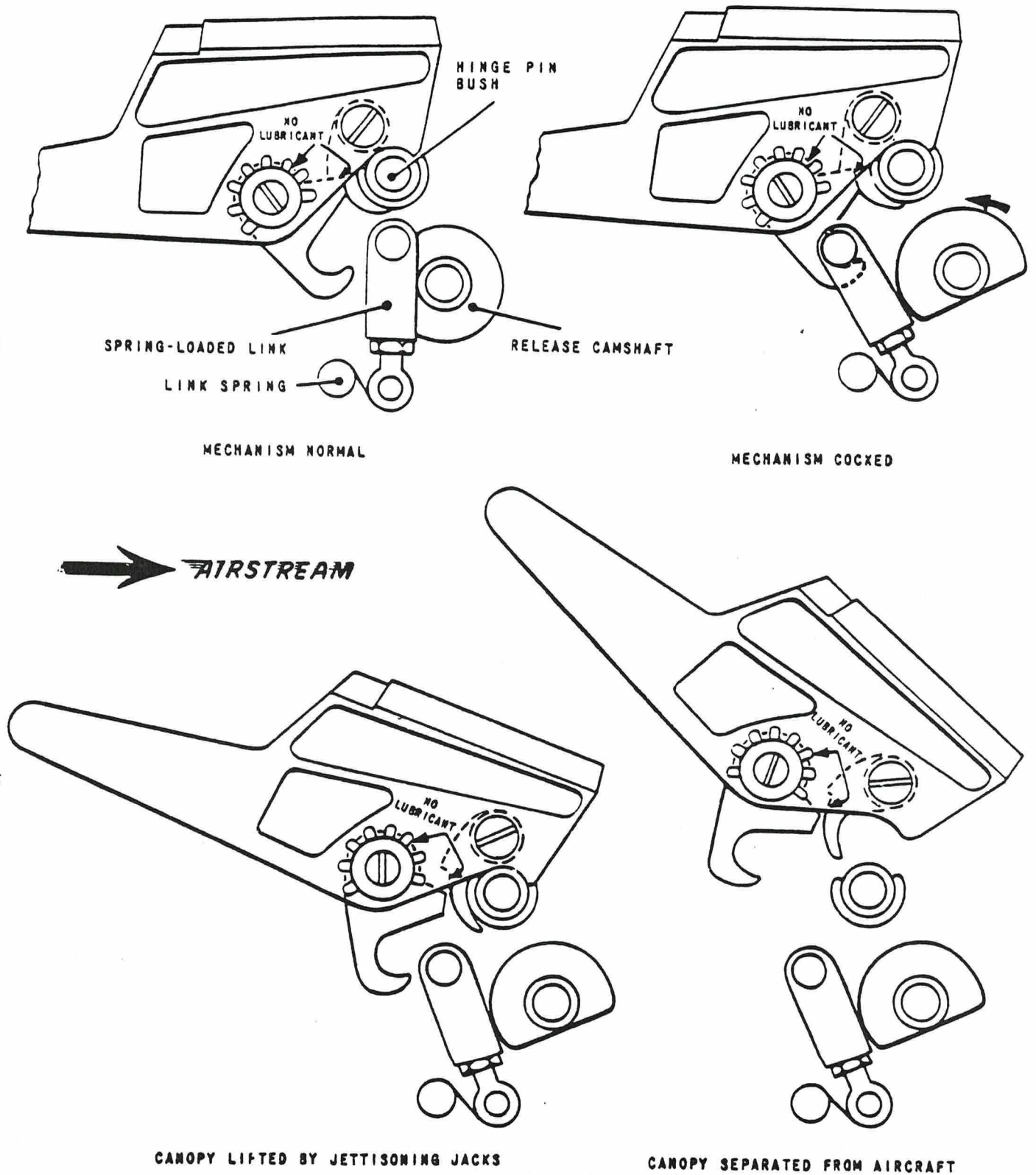


FIG.9 ACTION OF HINGE RELEASE MECHANISM