BRISTOL SIDDELEY ENGINES LTD.

AERO ENGINE SCHOOL

SECTION 8

CONTENTS

OLYMPUS

DEFECT INVESTIGATION TABLE

SYMPTON	POSSIBLE FAULT	ACTION 1
	ENGINE FAILS TO START	
Starter button fails to remain in engagement. (Compressor will not rotate)	Open-circuited 24 volt supply to master starter switch.	Check fuses.
	Starter motor does not rotate	Check for open circuit in electrical supply to starter motor.
	Starter motor rotates but the starter drive shaft is sheared.	Remove starter and withdraw the defective drive shaft and fit a new drive shaft. Check that the H.P. compressor rotates freely. If so check the starter panel operation. If both are satisfactory, re-fit the starter. If the compressor is tight remove the engine.
Engine rotates but does not reach sufficient speed to start.	Low output from power supply	Check ground supply; if satisfactory, check plug contacts from supply to aircraft connections. If satisfactory, check aircraft connections to starter panel bus-bar in power supply compartment.
	Last stage of starting cycle does not come into operation; fault in last stage of starter panel.	Change the starter panel.

SYMPTON	POSSIBLE FAULT	ACTION 2
Engine rotates and reaches full motoring speed.	Starter motor defective.	Change starter motor.
	Compressor(s) partially seized.	Change engine.
	Igniter plugs not firing.	Check high energy ignition system.
	H.T. leads defective.	H.T. Harness and continuity check. Change leads.
	Plugs defective.	Clean and check.
	No fuel supply.	Check fuel tank contents.
	Obstruction in supply lines.	Check aircraft fuel system.
	L.P. cock failure.	Check operation.
	Engine fuel system H.P. cock not fully operating.	Change F.R.F.C.
	Incorrect setting of throttle linkage.	Re-set.
	Fuel pump not functioning.	Change pump.

SYMPTON	POSSIBLE FAULT	ACTION
	POOR STARTING	
Engine lights up but fades out.	Restricted fuel supply (L.P.W.indicator shows low pressure)	Check fuel filter.
	L.P. cock failure	Check Operation.
	Air in the fuel system	Bleed system.
High jet pipe temperature	Throttle too far open	Check setting.
	Electrical supply to starter at a low voltage.	Check voltage.
	Combustion chamber and exhaust cone drain obstructed or drain valve sticking.	Check for obstruction.
	INABILITY TO OBTAIN FULL SPEED	
Inability to obtain full speed.	Throttle control not operating correctly.	Check and reset controls.
	L.P. overspeed governor set too low.	Make necessary adjustment
	Defective F.R.F.C.	Change F.R.F.C.
	Main fuel supply to pump restricted (L.P.W. indicator shows low pressure)	
	Engine filter choked.	Change filter element.

SYMPTON	POSSIBLE FAULT	ACTION
	L.P. fuel cock not fully open.	Check.
	Excessive ineffective throttle lever movement at T.O. end of range.	Re-adjust governor.
	UNABLE TO OPEN UP	
	Leaking servo line	Replace servo line pipes if necessary.
	Compressor pressure delivery pipe to A.F.R.C. fractured or leaking.	Change pipe.
	Defective air fuel ratio control. Servo ball valve not seating correctly.	Change A.F.R.C.
	Pump defective.	Change fuel pump.
	GENERAL RUNNING FAULTS	
Low jet pipe temperature.	Instrumentation fault.	Check.
	Defective thermocouple or leads.	Change.
	Dirty compressor.	Clean compressor.
	Split jet nozzle	Change jet nozzle.
	Oversize nozzle.	Change jet nozzle.

SYMPTON	POSSIBLE FAULT	ACTION
High jet pipe temperature.	Instrumentation fault.	Check.
	Fractured turbine or compressor blades.	Change engine.
	H.P. turbine stators restricted.	Change engine.
	Jet pipe nozzle damaged or distorted.	Change jet nozzle.
Engine stalls when accelerated or is sluggish opening up.	H.P. turbine stators restricted.	Change engine.
	A.F.R.C. defective	Change unit.
	F.R.F.C. defective.	Change unit.
	Fuel pump servo system defective.	Change unit.
Engine will not respond to throttle control.	Linkage defective.	Check throttle controls.
	Defective A.F.R.C.	Change unit.
	Defective F.R.F.C.	Change unit.
Low thrust	Jet pipe temperature low	
	Compressor dirty	Clean compressor
	Split nozzle	Change nozzle

SYMPTON	POSSIBLE FAULT	ACTION
Low oil pressure	High oil inlet temperature (above +65°C.). Low oil pressure will occur if anti-icing is in use.	Re-check with oil temperature normal.
	Pressure gauge faulty.	Change gauge.
	Pressure transmitter faulty.	Re-calibrate.
	Oil pressure filter choked.	Clean filter.
	Oil pressure relief valve jammed.	Remove valve assembly
	Oil tank level low.	Replenish tank and re-check.
	Internal oil leak. Note:- Oil temperature gauge not fitted to engine. Make check with gauge fitted for ground run.	Check scavenge oil filter for evidence of internal engine failure.
High oil pressure	Pressure gauge faulty	Change gauge.
	Oil pressure relief valve. Incorrectly adjusted.	Re-adjust.
	Oil pressure transmitter. Defective calibration.	Re-calibrate.

SYMPTON	POSSIBLE FAULT	ACTION
High oil inlet temperature	Oil by-passing cooler Defective valve in cooler.	Check cooler with valve inoperative, if defect still occurs - change cooler.
	Internal failure	Change engine.
Engine vibration	Engine mountings defective	Check installation.
	Damaged compressor or turbine. Only likely if a foreign body has passed through the engine.	Change engine.

ANALYSIS AND CORRECTION OF FAULTS

ENGINE FAILS TO START

It is assumed that the correct starting procedure has been carried out and that a fully charged ground starter unit has been employed.

Starter Motor Rotates

Should the starter motor rotate without turning the H.P. compressor, it can be assumed that the starter drive shaft has sheared. Remove the starter motor and the defective drive shaft, fit the replacement drive shaft and check that the H.P. compressor rotates freely. If the compressor is satisfactory refit the starter motor. If the compressor is tight - remove the engine.

Starter Motor does not Rotate

Remove the starter motor, examine the drive shaft for condition and check that the H.P. compressor rotates freely. If both are satisfactory, check the starter motor in the following manner. With the starter motor detached from the engine, apply the appropriate operating voltage to its terminals. If the motor rotates in this condition it is defective, i.e. weak, if the motor does not rotate, a motor breakdown is evident. In either case replace the starter motor.

Igniter Plugs

Carry out the following checks to ascertain that both igniter plugs are firing in the appropriate engine:-

(a) Ensure that the fuel cocks are turned "OFF"

Check that .....

(b) Check that the throttle lever is in the "H.P. cock shut" position.

(c) Set the engine selector switch to the appropriate engine.

(d) Set the igniter isolation switch to "ON".

(e) Set the starting master switch to "ON".

(f) Press the starter button (this will hold for 30 seconds). The sparking of the igniter plugs will be clearly audible; if one plug is sparking only, sparking will be regular at between 1 to 2 per second. If both plugs are operating, the sparking will be irregular.

(g) At the conclusion, re-set the controls to the "OFF" positions.

CAUTION .....

The H.T. side of the high-energy ignition system can be dangerous if mishandled. Disconnect the L.T. supply and wait one minute before handling the equipment.

Ignition Leads

Check the ignition leads for continuity, insulation and the security of the end connections. Make sure that the end connections are clean to ensure a good electrical contact. Replace defective cables.

H.P. Cock (not operating).

If the throttle lever, when moved to the "H.P. cock Open or Shut" gate position, is in-operative, it can be assumed that H.P. cock has jammed. Replace the F.R.F.C.

Fuel Pump

To check the function of the fuel pump, carry out one

Deliberate .....

"Deliberate False Start" as detailed. At the conclusion of the "False Start", fuel will flow from the drains and also collect in the jet pipe if the pump is functioning correctly. If no fuel, or only a very small quantity of fuel flows from the drains or if the jet pipe is dry, it can be assumed that the pump drive shaft has failed or that the pump is defective. In either case, change the pump. If the pump functions satisfactorily, carry out a "Motoring Cycle" to clear excess fuel from the engine and jet-pipe.

NOTE

Always bleed the fuel system after changing the fuel pump or disconnecting fuel pipes.

POOR STARTING. (ENGINE LIGHTS UP BUT FADES OUT).

Air Lock in Fuel System

Air locks in the fuel system should only occur if the engine is newly installed, or if any of the components or fuel pipes have been disturbed. Bleed the fuel system. The absence of fuel from the drains and in the jet pipe subsequent to an attempt to run, is an indication of fuel starvation.

Combustion chamber and exhaust cone drain obstruction or drain valve sticking.

Release the two drain pipe support bracket clips, then cut the locking wire and release the six union nuts and remove the drain pipes. Next, release the banjo nut and remove the banjo. Check the valve for freedom of movement and possible obstruction. Flush out the drain pipes with kerosine. Refit the banjo and its washers to the banjo post then fit and tighten the banjo nut. Re-assemble the drain pipes and tighten

their union nuts, then secure the pipe support clips. Finally wire-lock all union nuts.

Defective A.F.R.C.

To determine whether or not the A.F.R.C. is defective, it is necessary to isolate the unit. To do this, disconnect the main fuel feed pipe from the fuel pump to the A.F.R.C. and the pipe from the A.F.R.C. to the F.R.F.C. Connect and secure a slave pipe of suitable length, to the fuel pump fuel outlet and to the fuel inlet connection of the F.R.F.C. Disconnect the servo and suction pipes from the A.F.R.C. and blank off the pipes. Blank off all open union connections on the A.F.R.C., run the engine, but take care not to open up too rapidly or the engine will stall. If the engine run is now satisfactory it can be assumed that the A.F.R.C. is defective. If the defect still persists change the fuel pump.

UNABILITY TO OBTAIN FULL SPEED

L.P. compressor overspeed governor set too low.

This defect is indicated by excessive ineffective throttle lever movement at the T.O. end of the range. With the engine running, release the governor adjusting screw locknut and, using a screw-driver, turn the adjusting screw clockwise to increase the governing speed of the unit. Run the engine throughout its operating range and carry out adjustments until satisfactory governing is obtained. Finally, tighten the locknut and secure it with lock-wire in the approved manner.

UNABLE TO OPEN UP

The defect may be caused by a leaking or fractured P.3 Pressure Delivery pipe to the A.F.R.C. Carefully examine the pipe

at its banjo .....

at its banjo and union connections. If a defect is noted, cut the locking wire and release the union connection nuts and remove the pipe. Fit a new pipe, tighten the nuts securely and retain them with locking wire in the approved manner.

OIL BY-PASSING COOLER.

The relief valve is located on the rear port side of the oil cooler and is incorporated in the banjo post. To verify that the valve is defective it is necessary to blank the oil passage to the valve and carry out an engine run to check the oil inlet temperature. Do this in the following manner :-

(a) Cut the locking wire and remove the starboard cap nut from its banjo post.

(b) Fit the blanking tool into position in the banjo post in place of the cap nut.

(c) Carry out a further engine run and check the oil inlet temperature.

(d) If the temperature is now satisfactory, change the valve as follows.

(e) Cut the locking wire on the port cap nut and remove the cap nut.

(f) Remove the blanking tool from the starboard banjo post.

(g) Remove the sealing washers and remove the pipe complete with the banjos.

(h) Remove the port banjo post, complete with its integral valve.

(j) Fit a replacement banjo post and its integral valve, interposing the sealing washer.

(k) Re-fit the pipe and banjos, interposing the sealing washers and fit the cap nuts. Tighten the cap nuts and retain them with lock-wire.

(l) Carry out a further engine run to ascertain that the oil temperature is now satisfactory.

High Energy Ignition

The High energy ignition system has been developed to ensure ignition of fuel in gas turbine engine combustion chambers under conditions where normal booster coil ignition is ineffective. The most difficult condition is to re-light at high altitudes and speed.

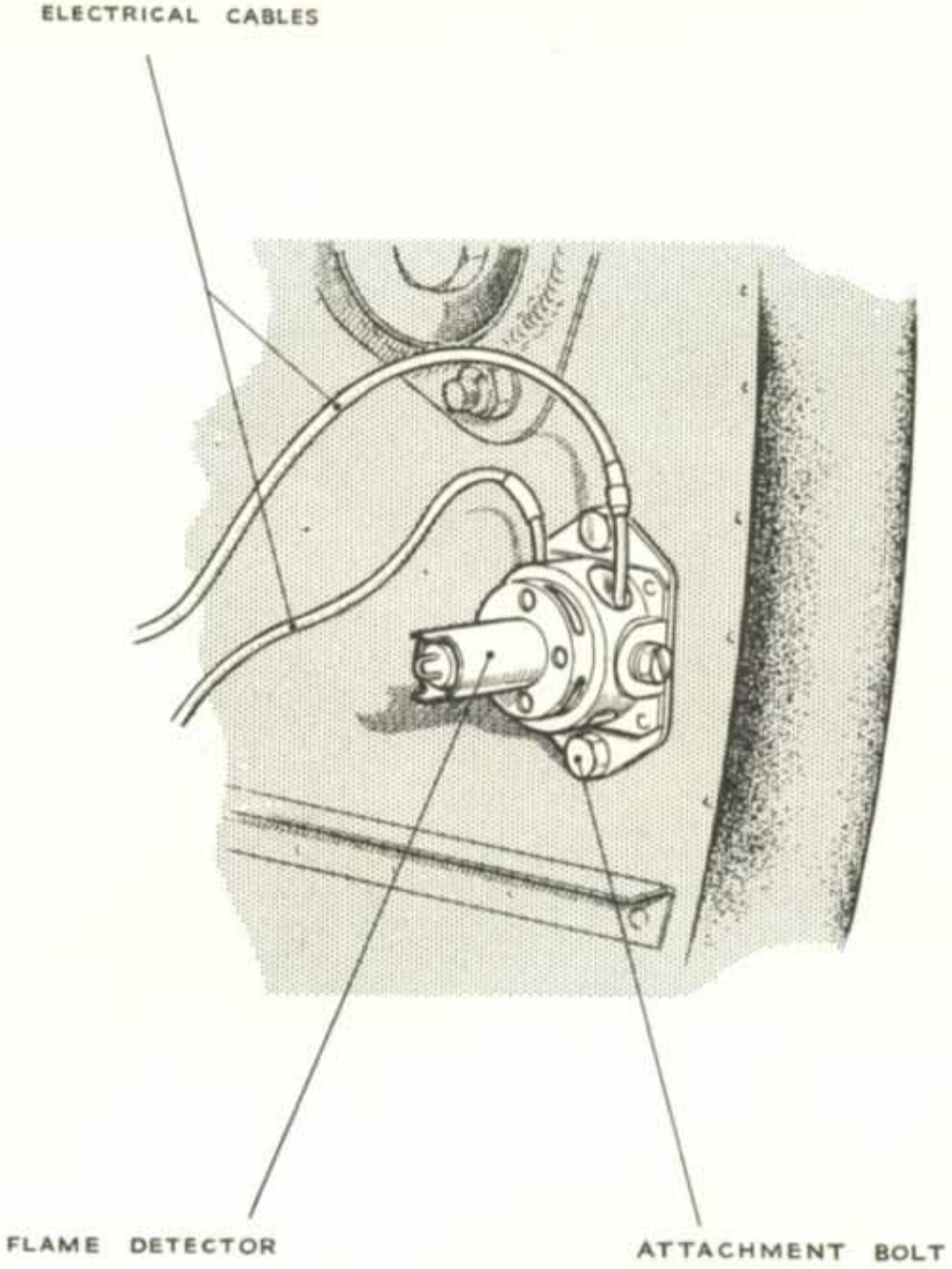
In order to re-light at high altitudes and high air mass flow, it has been found that a different form of discharge than that dissipated in a short time at a rate of approximately 60 discharges per minute is required.

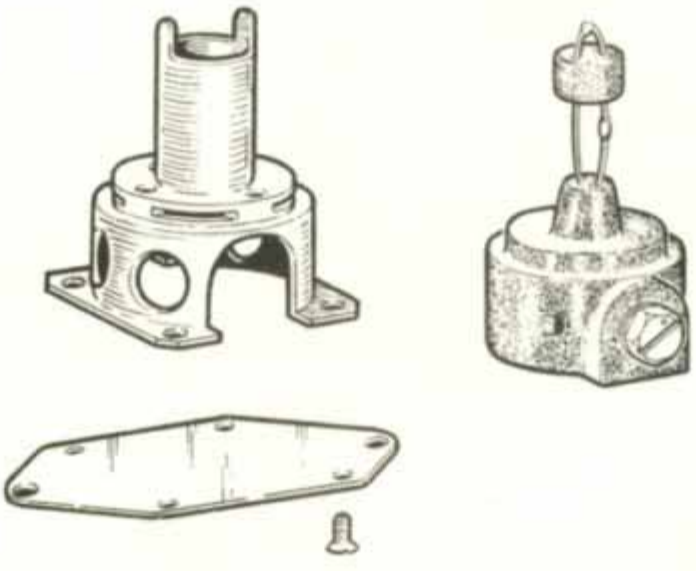
The principle of operation is as follows: a 24 volt D.C. induction coil, operated by a trembler, charges a condenser through a high voltage rectifier. When the rising voltage increase to a value of approximately 2,000 volts the sealed discharge gap breaks down and the condenser discharges across the gap, through an inductance to the engine surface discharge plug.

The condenser is then re-charged and the process repeated.

Resisters are fitted to the unit to protect the unit in the event of failure of the sealed gap or open circuit of the external high tension lead.

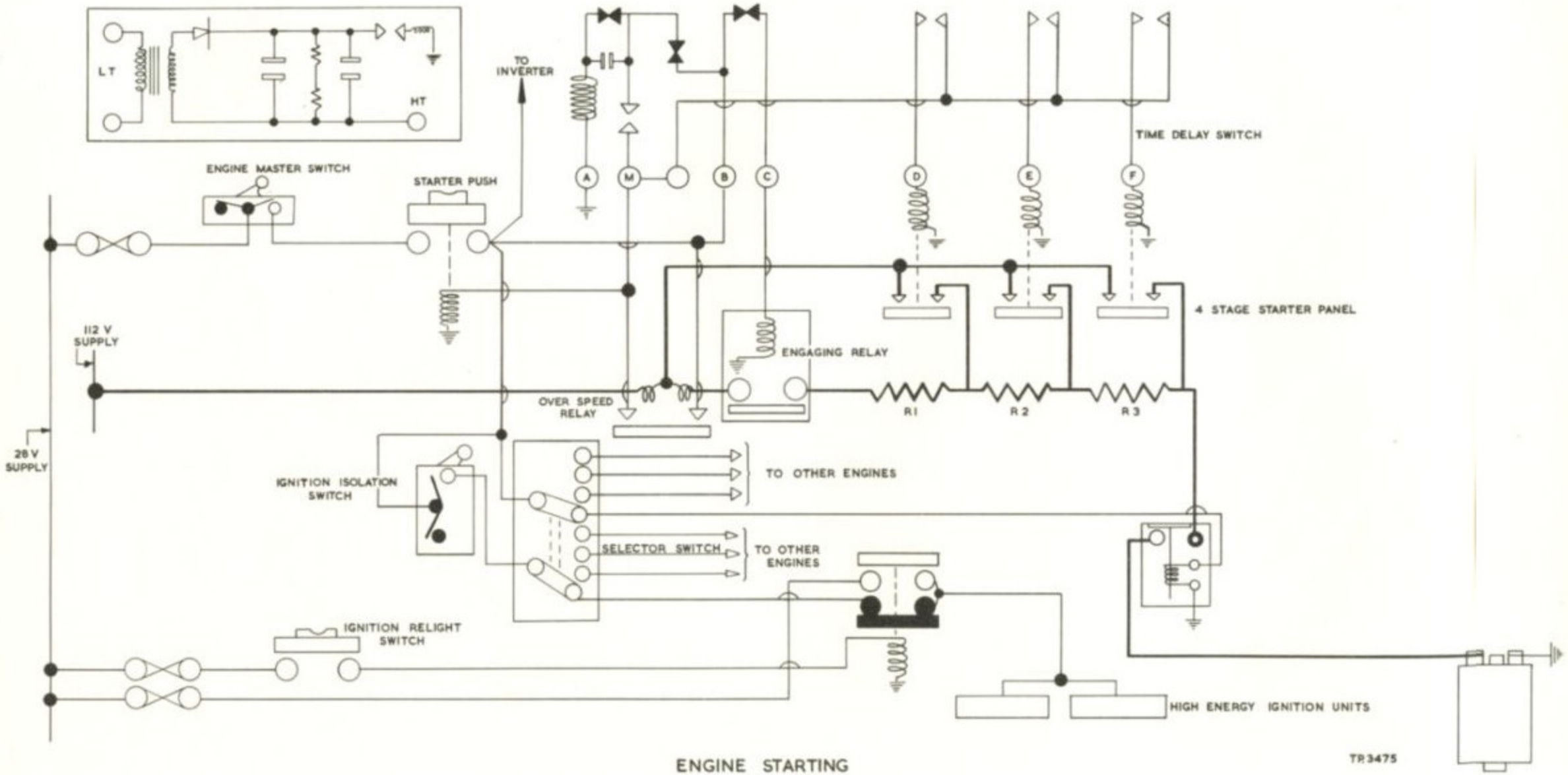
Warning: It cannot be emphasised toogreatly that these units are lethal.



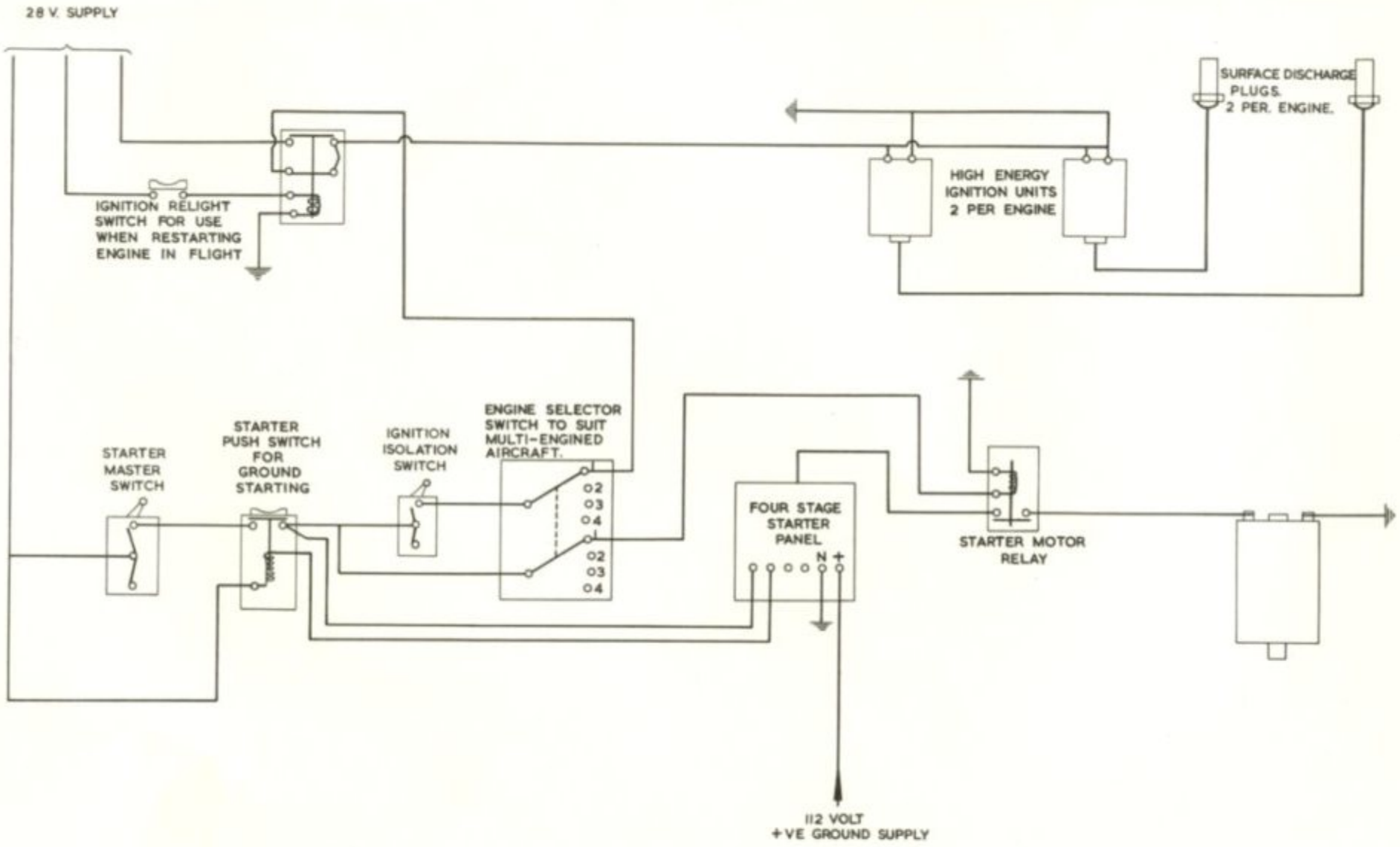


DETAILS OF FLAME DETECTOR

FLAME DETECTOR. INSTALLATION.



ENGINE STARTING



OLYMPUS 101 ENGINE

DIAGRAM OF STARTER SYSTEM

TP. 2954.

INHIBITING OF THE ENGINE FUEL SYSTEM WITH AN ENGINE THAT CANNOT BE RUN.

1. Remove the two blanks from the fuel drain system located at the base of the fuel filter.
2. Blank off the engine main L.P. fuel feed connection.
3. Engage the starter mechanism and look the H.P. system to prevent rotation of the engine.
4. Retain the throttle valve in the fully open position.
5. Drain the fuel filter by opening the drain valve at the base of the filter housing. Then open the following bleeds:-
   - (a) Fuel Filter.
   - (b) Fuel Pump.
   - (c) Cruise governor
   - (d) L.P. max. R.P.M. governor.
6. Remove the blanking plug in the cruise governor diaphragm cover. Drain the fuel and refit the plug.
7. Connect the rig delivery pipe to the engine fuel pump delivery connection.
8. Connect a pipe to the $\frac{1}{8}$ B.S.P. pump inlet pressure tapping in the pump body and arrange it to return the spill flow back to the inhibiting rig tank with the least possible restriction. This is essential in order to avoid high pressure building up in the low pressure side of the system.
9. Connect the "Pressure tapping" on the rig to the primary burner connection on the engine.
10. When the filter has drained close the drain valve.

11. Close all the air bleeds "finger tight" only, except the L.P. max. governor bleed which must be left open.

12. Ensure that the rig delivery cock is in the closed positions. Then move the two way cock to select "pressurise".

13. Start the rig, holding the button in until a pressure is indicated on the gauge; set the pressure control so that the gauge indicates 400 P.S.I. Shut down the rig holding in the button until the pressure falls to zero.

14. Select "inhibit" by means of the two way cock, open the delivery cock and restart the rig. The pressure gauge will indicate the rig delivery pressure required to cause the flow of inhibiting oil through the system sufficient to give a pressure difference across the primary burners of 400 P.S.I. The indicated pressure will be in the order of 800 P.S.I.

15. Continue until the inhibitor flows from both the turbine drain and L.P. governor bleed. During this operation inhibiting oil should leak past the four bleed valves. When this is observed open the bleeds then relighten including the L.P. governor bleed.

16. Stop the rig, re-connect pipe lines and release starter.

INHIBITING THE OLYMPUS FUEL SYSTEM

The preferred method is by running the engine using inhibiting oil as fuel. When an engine cannot be run a special rig must be used.

When to Inhibit

The fuel system should be inhibited if it is to remain idle for more than seven days.

Re-inhibiting should be carried out every twelve months.

A cocooned engine should have its fuel system re-inhibited every three years.

PROCEDURE TO INHIBIT A SERVICEABLE ENGINE INSTALLED IN AN AIRCRAFT

Items required:

(1) A gravity tank capacity approximately five gallons and fitted with an efficient tank filter.

(2) A change over cock to shut off the normal fuel supply from the Aircraft tanks, and open the inhibitor supply to the fuel system. This cock is to be in the L.P. supply line at a suitable point up stream of the engine low pressure filter.

Method

Connect inhibitor supply pipe to change over cock in the L.P. pipe line and prime to this point by bleeding the cock.

With the engine running at "IDLING" condition, operate the change over cock to deliver inhibitor into the fuel system.

Bleed off any trapped fuel from the governor system by opening the necessary bleed valves.

Make normal "SHUT-DOWN" when inhibitor has passed through the system denoted by the issuing of white smoke from the jet pipe.

FUEL RIG

To facilitate inhibiting of engines which cannot be run, a rig is provided. It comprises a tank designed to hold six gallons of approved inhibiting fluid, which is connected via an engine type filter to an electrically driven engine type pump, the delivery pressure from this pump being controlled by a B.P.C. from which the capsule has been removed. Fuel from the pump outlet is taken via a pressurising valve and isolation cock, to a connection on the outlet side of the engine pump, a two way cock in the system can be positioned to "Pressure" or "Inhibit." A further connection is made from the rig to the primary burner line, and when the cock is set to "inhibit" the pressure in this line is connected through the cock to the B.P.C. piston, when "pressurise" is selected this line is isolated and pump delivery press is applied to the B.P.C. Piston.

To obtain the desired burner line pressure for inhibiting, close the rig isolation cock so that there is no supply to the engine pump, and set the two way cock to "pressurise," start the rig, and make the necessary adjustment on the B.P.C. to give the required pressure reading on the rig gauge.

Setting in this manner ensures that the stroke of the rig pump is not limited until this pressure is raised at the B.P.C. piston.

Having set the pressure in this manner if the isolation cock is now opened and the two way cock set to "inhibit," the rig pump delivery pressure will rise by an amount equal to the pressure difference between the engine pump outlet, and the primary burner line pressure which will rise to the original setting.

Example

1. With no flow to the engine and the two way cock at "pressurise," adjust B.P.C. until gauge reads 400 p.s.i.

2. Open rig.....

2. Open rig isolation cock and set two way cock to "inhibit", burner line pressure will rise up to 400 p.s.i.. If the pressure drop between the outlet of the engine pump and burner line equals 600 p.s.i., the rig gauge will read 400 + 600 = 1,600 p.s.i.