SECTION 1

RUNNING DEFECTS

Dmd 3956 44685 375 12/53 AB539/3 7495

Section 1

RUNNING DEFECTS

Note.—*This section applies to Avon Mk. 10801 and 11401 Engine Change Units and associated Reheat Jet Pipe Avon J.P.101*

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

General

1. This section has been compiled to assist in the tracing of faults which affect the correct and efficient running of the engine and reheat system and contains instructions for investigating suspected defects and the necessary precautions to be taken during investigation. It has been assumed throughout that the aircraft systems which serve the engine are fully serviceable, that all control settings are correct and that the correct handling drill has been followed as described in Vol. 1, Part 1, Sect. 2. If further information on the reheat system is required, reference should be made to A.P.4282 and 4282A.

2. When defects are indicated by gauge readings, it is imperative that the gauges should be checked before investigating further and when electrical equipment is suspected, the supply voltage should be checked. If a fuse has blown, the cause must be traced and rectified before renewing the fuse. If checks of the engine fuel system involve removing a unit or disconnecting a pipe, the system must be bled as described in Vol. 6, Part 1, Sect. 2, Chapter 6, failure to bleed the system will result in erratic running. Reference should also be made to Vol. 6, Part 1, Sect. 2 when a defective unit has to be changed.

3. It should be noted, particularly during fault diagnosis, that the j.p.t. and r.p.m. may vary with the ambient temperature. Under low temperature conditions governed engine speed, as quoted in Operating Limitations, may not be obtainable on the ground and the engine may underspeed to as low as 7,800 r.p.m. at full throttle, but maximum thrust will be maintained.

ENGINE

4. The following chart tabulates a list of possible running defects against alternative possibilities. Each possibility is cross referenced with subsequent paragraphs in this section, which give more detailed information on how to diagnose and rectify the defect.

Defect	Location	Refer to to Para.
FAILURE TO START		5
	Starter system	6
	Ignition system	8
	L.P. fuel system	10
	Fuel servo system	12
INCORRECT R.P.M.		13
	H.P. fuel system	13
FAULTY ACCELERATION AND SURGE		16
	Air bleed control	16
	Acceleration control	16
	Intake guide-vane servo system	16
	Intake anti-icing system	20
ROUGH RUNNING		21
	Compressor or turbine	21
	Accessory gearbox	22
	Installational clearances and mountings	21
INCORRECT JET PIPE TEMPERATURE		23
	Pyrometer system	25
	Air-intake	23
	Acceleration control	23
LOW OIL PRESSURE		26
	Pressure relief valves	27
	Oil leakage	26
EXCESSIVE OIL CONSUMPTION		28
	External or internal leakage	28
EXCESSIVE FUEL DRAINAGE OR INCREASE IN SUMP OIL LEVEL		30
	H.P. fuel pump seals	30
	Fuel control unit seals	30
	Blockage of fuel drains	30
	Intake guide-vane governor pump seals	30
	Oil cooler	30
FAILURE TO RELIGHT IN FLIGHT		32
	Ignition system	32
	Fuel servo system	32
	L.P. fuel system	32

FAILURE TO START

5. A satisfactory start is achieved only when the engine reaches idling speed and runs at a jet pipe temperature consistent with operating limitations. Starting faults may therefore be placed in three categories:—

(1) Failure to motor over after the starter button has been pressed.

(2) Failure to light up, indicated by r.p.m. increasing to approximately 2,000 with no accompanying rise in j.p.t.

(3) Failure to reach idling speed which is indicated by low r.p.m. and a rapid rise in j.p.t.

Failure to motor over

6. Failure to motor over when the starter button is pressed indicates a defect in the starter system and is due to either the failure of a cartridge to fire or a mechanical defect, the former being caused by a breakdown in the electrical supply or a faulty cartridge. If, on three consecutive attempts to start, the cartridge fails to fire, check the electrical supply to the starter.

WARNING

Before attempting to diagnose turbo-starter faults, turn off the electrical supply at the master switch and disconnect the electrical lead to the starter. The cartridges may then be removed and, if faulty, disposed of in accordance with the safety

precautions laid down for the handling of high explosives.

7. If the cartridge fires but the engine does not motor over, a defect in the turbo-starter or starter drive is indicated. Check that the engine is free to turn and that the engaging mechanism is satisfactory by turning the engine through the starter drive. If no engine defect is discovered, change the starter.

Failure to light up

8. Failure to light up may be due to a fault in either the igniter or fuel systems. To ascertain if the igniters are functioning satisfactorily, press the relight button and listen for the pronounced "cracks" of the electrical discharge across each plug.

WARNING

The energy stored in the igniter unit may, under certain circumstances, be lethal. It is essential therefore, after disconnecting the L.T. supply, to wait at least one minute to permit the stored energy to dissipate before handling the unit, H.T. cable, plug or high-energy unit.

9. If one of the plugs is silent, check the L.T. supply to the igniter unit and, if this is satisfactory, remove the H.T. lead to the plug and check that the contacts are clean and the insulation is free from damage. If, after cleaning and carefully reconnecting the lead, the failure to light up persists, change the plug; it is not necessary to clean the plug. If the failure still persists, change the ignition unit. No attempt to test the plug by earthing it to the engine should be made, as this would result in damage to the engine.

10. An inadequate L.P. fuel supply will cause failure to light up and will be indicated by the pressure warning unit. If this unit flickers, even after engine light up, check the unit and fit a temporary pressure gauge. If the pressure is found to be unsatisfactory, disconnect the fuel inlet pipe to the L.P. filter and make a flow check as described in the relevant aircraft Air Publication. If the flow is satisfactory, change the L.P. fuel filter.

Failure to reach idling r.p.m.

11. Failure to reach idling speed is indicated by a rapid rise in j.p.t., due to insufficient power or torque and resultant low air flow. Check the voltage supply and, after observing the warning, examine the cartridges and turbo-starter as described in para. 7. If the turbo-starter is satisfactory, check the L.P. fuel supply as described in the relevant aircraft Air Publication.

12. A leak or excessive bleed from the fuel servo system may also result in failure to start, due to an inadequate supply of fuel reaching the burners; this will also reduce r.p.m. over the whole throttle range. Excessive servo system bleed may be due to faults in the B.P.C., the A.C.U. or the H.P. fuel pump and each unit should be checked in turn. To do this, isolate the B.P.C., by disconnecting the servo pressure pipe at the fuel pump end, and fit

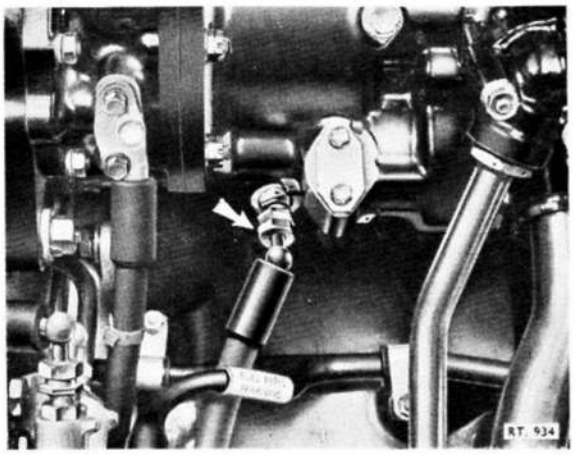

Fig. 1. B.P.C. blanking point

pressure blanks to the pipe and pump connection (*fig.* 1). Attempt to start the engine and, if idling r.p.m. is obtained, the B.P.C. is faulty. Change the fuel control unit. If the fault still persists, isolate the A.C.U. by disconnecting the servo pressure line to the unit and fit pressure blanks (*fig.* 2). Extreme care must then be taken when opening the throttle during the subsequent run and at no period must the throttle lever movement be in advance of engine response, or the jet pipe temperature be near maximum. If idling r.p.m. are now obtained, change the A.C.U. and metering valve, but if the foregoing checks do not effect a cure, change the fuel pump.

INCORRECT R.P.M.

13. When it is confirmed that the r.p.m. indicating system is reading correctly, incorrect idling speed can only be caused by a defect within the fuel system. Check the low pressure supply in accordance with the relevant aircraft Air Publication,

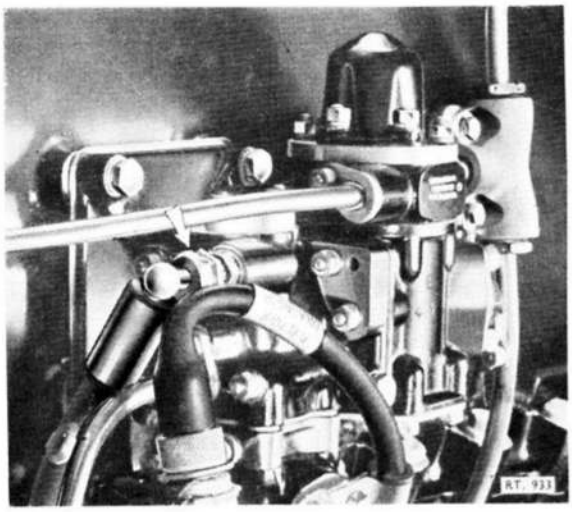

Fig. 2. A.C.U. blanking point

and the fuel servo system as described in para. 12.

14. Erratic r.p.m. may be due to vapour locks caused by inadvertently closing the L.P. cock while the engine is still running, or to the presence of air in the system, through the delayed change-over from an empty fuel tank. Bleed the fuel system as described in Vol. 6, Part 1, Sect. 2. Chap. 6, and if erratic running continues, change the fuel pump.

Note . . .
The fuel pump is fuel lubricated. If for any reason, such as "windmilling" with the L.P. cock closed, the pump is operated without fuel for a period exceeding 3 minutes, it must be changed.

15. Incorrect maximum r.p.m. may be due to the incorrect setting of the fuel pump governor, a defect in the fuel servo system, or a change in the specific gravity of the fuel. Check the idling and maximum r.p.m. If both speeds are below normal and the idling adjustment has not been disturbed, the fuel servo system should be suspected and the defect located as described in para. 12. If, however, idling r.p.m. are satisfactory, reset the fuel pump governor as described in Vol. 6, Part 1, Sect. 2, Chap. 6. A change of fuel, (*Vol.* 1, *Sect.* 1, *Chap.* 2) may also cause incorrect maximum r.p.m. and affect engine speeds over the whole range; the operation of the bleed valves will also be affected. Check the density of the fuel and, if necessary, reset the governor. If adjustment does not effect a cure, change the fuel pump.

FAULTY ACCELERATION AND SURGE

16. If the time taken to accelerate from idling speed to maximum conditions does not correspond with that given in Vol. 1, Part 2, Sect. 2, Chap. 2, check the operation of the air-bleed control and intake guide-vanes as described in the same chapter. Adjust or replace the faulty unit as described in Vol. 6, Part 1, Sect. 2.

Note . . .
If surge is encountered, no repeat or check acceleration must be made before adjusting the A.C.U. This adjustment is most sensitive and the instructions must be closely followed.

17. Surge is due to a disturbance of the air flow in the compressor and is demonstrated by audible indications, varying from a muffled noise to violent and abrupt explosion and vibration. It is usually associated with throttle movement and is further distinguished from ordinary mechanical roughness by its pulsating quality.

18. Surge experienced when opening the throttle is normally indicated by failure to accelerate, together with a rapidly rising j.p.t. accompanied by a 'burbling' note reaching extreme proportions between 3,500 and 4,000 r.p.m. If this occurs, close the throttle immediately and adjust the acceleration control. If still unsatisfactory change the acceleration control and metering unit.

19. Surge which persists when the throttle is opened slowly or when closing the throttle, is likely to be due to a defect in the bleed-valve control system and reference should be made to Vol. 6, Part 1, Sect. 2, Chap. 2. When surge is encountered on closing the throttle, it is often extremely violent and the throttle must be fully closed without hesitation.

20. Surge experienced at altitude, may be due to a defect in the air-intake anti-icing system, resulting in icing of the air-intake and guide-vanes. Check the electrical supply at the gate valve actuator feed plug and check the operation of the valve. To do this turn the cockpit anti-icing switch to ON and, by observing the pointer on the unit, check that the gate valve moves to the fully open position. Turn the switch of OFF and ensure that the valve returns to the closed position. If the unit does not operate in this manner, it must be changed.

ROUGH RUNNING

21. Engine roughness can result from loose mountings or incorrect installational clearances, or from various defects such as failure of the rotating assembly or bearings, defective combustion equipment, or failure of the accessories or gearbox, and should not be confused with surge, the symptoms of which are fully described in Vol. 1 Part 1, Sect. 2. In the preliminary stages of investigation, the possibility of causing further damage to the engine, by running to investigate the defect, should be considered and the engine should be examined before further running is attempted. Evidence of internal failure is generally found in the turbine and nozzle guide-vanes, which should be examined as described in Vol. 1, Part 2, Sect. 3, Chap. 1. If there is any doubt about the serviceability of the turbine or nozzle guide-vanes, the engine should be removed for further examination. If the turbine condition is acceptable, examine the compressor through the air-intake, (*Vol.* 1, *Part* 2, *Sect.* 2, *Chap.* 1). If any defect is found during the above checks, its origin must be traced to establish the cause of the trouble. If no defect is apparent, run the engine at idling speed, close the H.P. cock and, as the engine runs down, feel the compressor casing and exhaust unit for vibration. If vibration can be felt, remove and examine the Purolator oil filter and if metal particles are present, remove the scavenge filters; an unusual deposit of metal particles will indicate bearing failure and the engine must be changed.

22. Roughness and vibration may emanate from an external source such as the accessory gearbox or its associated units and can be traced by disconnecting the gearbox drive coupling and running the engine. Cessation of the roughness would indicate a defect in either the gearbox or its mounted accessories and the appropriate aircraft Air Publication should be consulted.

INCORRECT JET PIPE TEMPERATURE

23. Before investigating incorrect jet pipe temperature, consideration should be given to the possible inaccuracy of instrument readings and to atmospheric conditions which also affect j.p.t., particularly at low r.p.m. High j.p.t. experienced when taxying or ground running may be due to the aircraft facing down wind or to the engine drawing in hot gases from the jet stream of another aircraft.

24. Having eliminated the above possibilities, high j.p.t. can be caused by an obstruction in the air-intake, defective intake guide-vanes or a defect in the acceleration control unit. Examine the compressor through the air-intake then check the operation of the vanes as described in Vol. 1, Part. 2, Sect. 2, Chap. 2. If the intake and guide-vanes are satisfactory, first endeavour to adjust the acceleration control unit (see para. 16) and if this is unsuccessful, change the unit together with the metering valves.

25. Erratic or low j.p.t. may be indicated due to current leakage, caused by moisture or a fault in the thermo-couple equipment. Excessive temperature indication may be caused by a faulty voltage regulator. If low j.p.t. is encountered with reheat in operation, reference should be made to para. 43. If the maximum j.p.t. limits have been exceeded, the pyrometer system should be inspected for damage and the jet pipe and exhaust unit examined for cracks and buckling of the inner skin, (*Vol.* 1, *Part* 2, *Sect.* 3, *Chap.* 1). If there are signs of severe overheating or if there is any doubt about the condition of the turbine, the engine must be removed for further examination. A full description of the pyrometer system together with the diagnosis and rectification procedure, will be found in A.P.1275A, Vol. 1, Sect. 4, Chap. 5.

LOW OIL PRESSURE

26. The most probable cause of this defect is a faulty pressure relief valve but, if low pressure is accompanied by an increase in oil tank level, reference should be made to para. 31.

27. Foreign matter on the relief valve seatings or a damaged seating in either the main relief valve or the oil cooler by-pass valve, may cause low oil pressure; in the latter case an excessive amount of oil would be by-passed from the cooler, resulting in high temperature and consequent loss of pressure The valves should be removed and cleaned as described in Vol. 6, Part 1, Sect. 2, Chap. 8. If this does not rectify the defect, renew the complete assembly.

EXCESSIVE OIL CONSUMPTION

28. Excessive oil consumption can occur only as a result of oil leakage from the system; if external, the leak will be obvious and may be due to a loose or damaged pipe or a faulty joint washer which can be rectified.

29. Internal oil leakage is usually indicated by an oil film in the cooling air outlet ducts on the nozzle box or by blue smoke issuing from the ducts. If oil consumption exceeds the maximum laid down in Leading Particulars and inspection fails to reveal any external leakage, the engine must be changed.

EXCESSIVE FUEL DRAINAGE OR INCREASE IN SUMP OIL LEVEL

30. If the total spill from the engine fuel drain system, while the engine is running exceeds 2,590c.c. per hour, disconnect the drain pipe from each unit in turn and check for individual spill. Run the engine for a minimum period of 3 minutes at 4,500 r.p.m. and allow each drain to spill into a separate container, Carefully check the amount of spill from each unit and if this exceeds the figure laid down in the following table, change the faulty unit as described in Vol. 6, Part 1, Sect. 2.

Unit	Max. permissible spill
Fuel pump	30 c.c. per hr.
Intake guide vane governor pump	60 c.c. per hr.
H.P. cock	2500 c.c. per hr.
Oil cooler	Nil.

31. An apparent increase in sump oil level may be caused by fuel leakage from the H.P. pump, allowing fuel to drain through the wheelcase into the sump, or from defective oil cooler. To diagnose the faulty unit, check the drains as described in para. 30. Before restarting the engine, drain the engine of oil, clean the filters and refill the system with clean oil (*Leading Particulars*).

FAILURE TO RELIGHT IN FLIGHT

32. Failure of one igniter unit may not cause starting difficulties at ground level but may result in failure to relight at altitude. In the event of such a failure, first check the starter panel as detailed in the relevant aircraft Air Publication then proceed as described in para. 8 and 9. If the igniters operate satisfactorily, check the L.P. fuel supply and the fuel servo system as described in para. 10 and 12 respectively.

JET PIPE AND REHEAT SYSTEM

33. A defect in the reheat system will cause partial or total loss of additional thrust and may, under certain circumstances, result in low j.p.t. accompanied by a considerable reduction in normal thrust. In the preliminary stages of investigation, some indication of the location of a defect may be obtained from the following tables. In the first table, faulty units are indicated by the behaviour of the warning indicator in conjunction with certain conditions while in the second table, possible defects are listed in order of convenience for checking and are cross referred to the appropriate paragraphs.

Warning indicator with reheat selected	Conditions	Probable cause of defect
OFF	Reheat not obtained Nozzle remains closed	Electrical supply Throttle switches or relay Time switch (burned out booster coil)

Warning indicator with reheat selected	Conditions	Probable cause of defect
ON	Reheat operates but cancels after 3 secs. Nozzle closes	J.P.T. or Temperature trip switch
ON	Reheat operates but cancels immediately Nozzle remains closed	Nozzle control valve
ON	Reheat not obtained Nozzle remains closed	Air shut-off cock or pressure switch relay
OFF	J.P.T. decreases (150°C.) Loss of power Nozzle open	Main shut-off cock

Note . . .
Before making any electrical check of the various solenoids, ensure that all fuel cocks are CLOSED *and the tank pumps switched* OFF.

34. To check the electrical supply to the solenoids, unscrew the breeze plugs and connect them to test lamps. When reheat is selected the lamps should light in their correct sequence. When checking the supply to the nozzle valve and main shut-off cock, short circuit the pressure switch. To do this disconnect the L.T. supply to the reheat igniter plug, remove the cover plate illustrated in fig. 3, disconnect the two leads from their respective terminals and join them together. To check the operation of the solenoids, listen for the "click" from each one as it is energised.

FAILURE TO LIGHT UP

35. Failure to light up will be apparent from lack of audible indication and, if heavy vapour is emitted from the jet pipe and the eyelids are open, a defect in the igniter sustem is indicated. Switch OFF all fuel cocks and booster pumps and check the operation of the igniter plug by removing the plug and earthing it firmly to a convenient part of the jet pipe, then moving the throttle lever into the reheat segment; continuous sparking should occur across the electrodes.

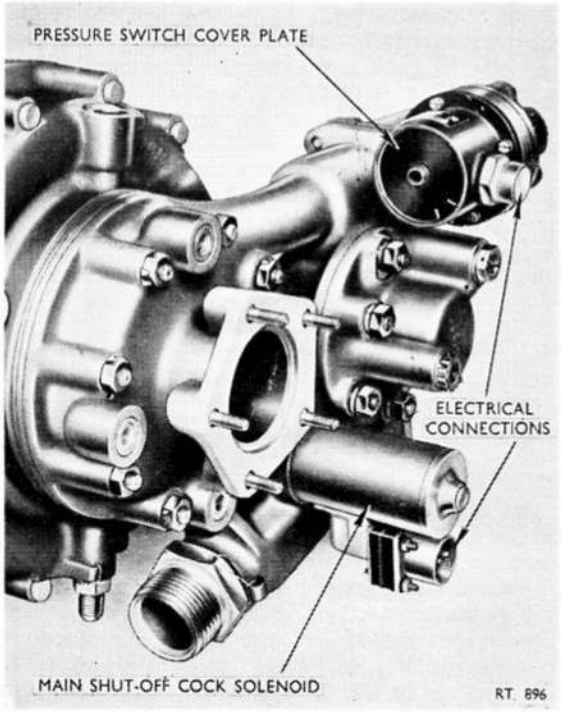

Fig. 3. Reheat-pump electrical connections

Defect	Location	Refer to Para.
FAILURE TO LIGHT UP		35
	Igniter system	35
	Pilot burner	36
	Fuel control unit	36
	Reheat fuel pump	36
	Fuel pressure switch	36
FAILURE TO SUSTAIN LIGHT UP		40
	Temperature trip switch	40
	Nozzle and ram	40
	Air control valve	40
	Fuel pressure switch	40
	P_2 line (compressor outlet pressure)	40
	P_4 line (turbine outlet pressure)	40

Defect	Location	Refer to Para.
DELAYED LIGHT UP		41
	Fuel control unit	41
	Reheat fuel pump	41
REHEAT INCONSISTENT		
	P_2 and P_4 lines	42
	Fuel control unit	42
INCORRECT J.P.T.		43
	P_4 line	
	Fuel control unit	43
	Air control valve	43
	Reheat fuel pump	43

36. If the sparking is unsatisfactory, check the throttle lever micro-switches, the temperature trip switch and the input and output of the booster coils. If the fault persists, change the igniter plug. In the event of continued failure, check that the pilot shut-off cock solenoid is functioning, so allowing fuel to pass to the pilot burner. If this is satisfactory change the pilot burner complete with feed pipe as described in Vol. 6, Part 1, Sect. 2.

37. If the nozzle opens and no vapour is emitted, check the electrical supply to the main shut-off cock solenoid and, if this is satisfactory, change the turbo pump.

38. If the nozzle remains closed, check the flow of air from the exhaust of the turbo pump. If no air is emitted, check the electrical supply to the air and pilot shut-off cocks, if this is satisfactory, change the reheat fuel control unit. If, however, the turbo pump is operating satisfactorily, check the electrical supply to the pressure switch then short circuit the switch, (*para.*34), and if the air control valve operates, change the switch. If this does not effect a cure, examine the "eyelids" and connecting rods for distortion and operate them manually to ensure that the rods move freely. If the fault still persists, check that the air supply line to the air control valve is clear and if satisfactory, change the valve.

39. If the eyelids and rams are difficult to move, distortion should be suspected and the eyelid gap should be checked. To do this disconnect the air control valve feed pipe at the filter inlet union and connect a pressure supply not exceeding 30 lb. per sq. in. Ensure that all fuel cocks and tank pumps are switched OFF, disconnect the L.T. supply to the reheat igniter plug then short circuit the pressure switch (*para.* 34). Select reheat and check that the eyelids operate smoothly and that when closed the gap between the two eyelids is not less than 0·050 in. If the gap is less than 0·050 in. serious distortion is indicated and the jet pipe must be changed. After completing the check, reconnect the electrical services and replace the pressure switch cover.

FAILURE TO SUSTAIN LIGHT UP

40. If reheat cuts out after light up, the fault may be in the temperature control system; check the setting of the resistance in the temperature controller. If this is satisfactory, ensure that the eyelids and rams operate freely and check the operation of the pressure switch relay and air control valve solenoids. If the fault persists, disconnect the electrical supply to the control unit override solenoid and select reheat for one or two seconds. If reheat then operates a restriction in the P_2 or P_4 lines is indicated. Remove and clean the filter in the P_2 line and remove the P_4 line at the bulkhead and clear the pipe.

DELAYED LIGHT UP

41. If, after reheat has been selected the time taken to light up exceeds 5 seconds, a defect in the fuel control unit is indicated. Change the unit. If this does not effect a cure, change the turbo fuel pump.

REHEAT INCONSISTENT

42. If, after light up, reheat weakens off (*low j.p.t.*), the defect may be in either the P_2 or P_4 lines. Check the P_2 line for leakage and if satisfactory, remove and clear the pipes of both lines and clean the filter in the P_2 line. If reheat richens up (*high j.p.t.*), check the P_4 line for leakage.

INCORRECT J.P.T.

43. Some adjustment of j.p.t. can be made at the needle valve on the fuel control unit, (*Vol.* 6, *Part* 1, *Sect.* 2). If however, excessive j.p.t. is indicated check the P_4 line for leakage and if satisfactory check the operation of the control unit override solenoid. If the fault persists, change the control unit. If excessive j.p.t. is apparent on cancellation of reheat, a defect in the main shut-off cock is indicated. Change the reheat pump. It should be noted that in all cases where overheating has taken place, the jet pipe should be examined for cracks and buckling, (*Vol.* 1, *Part* 2, *Sect.* 3, *Chap.* 1).

44. Low j.p.t. may be due to either a restriction in the P_2 and P_4 lines. Clean the P_2 and P_4 pipes and filter.

F.S./4
Dmd 6212 453602 500 11/54 AB539/3 8901