SECTION 6 SYSTEMS LAYOUT, DESCRIPTION AND USE

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6.1 THE ENGINE AND PROPELLER

6.1.1 General Description

The aircraft is powered by a 4 cylinder 4 stroke petrol engine driving a 2 bladed variable pitch propeller which rotates clockwise as viewed by the pilot. The propeller is driven directly from the engine. Fuel is provided to the cylinders by a fuel injector system equipped with throttle and mixture controls; there is provision for oil and fuel supplies to allow sustained power during inverted flight. Engine ignition is provided by twin magnetos.

6.1.2 The Engine

The engine is an Avco-Lycoming AEIO-320-D1B rated at 160 HP at 2700 RPM. A pulley on the propeller drive provides power for the belt-driven alternator; drives from the back of the engine power the vacuum pump, mechanical fuel pump, twin magnetos and engine speed tachometer: a drive from the front of the engine supplies engine speed information to the propeller constant speed unit.

6.1.3 Engine Lubrication System

General The wet sump engine oil system provides for lubrication of the internal bearings under pressure. There are no pilot-operated controls, but indicators show the oil pressure and temperature. Both gauges are marked with yellow (cautionary), green (normal) and red (danger) bands and knowledge of the corresponding temperature/pressure numerical values is unnecessary.

Oil Filler and Sump The oil sump filler is located under a flap on the top right-hand side of the engine cowling, and incorporates a dipstick. The dipstick is marked in US Quarts; the maximum level is the 8 US quart mark and the minimum level is 4 US quarts. The maximum oil consumption is 0.72 US quarts/hour at rated power and 0.37 US quarts/hour at 75% rated power. The oil filler cap should be tightened by hand only.

A procedure for establishing the normal operating level of oil contents for each individual engine is laid out in the Avco-Lycoming Operations Manual and should be followed carefully. The normal operating level may be as low as 7 US quarts and, if the engine is filled above its "normal" level it will immediately dump the excess oil during flight.

Oil Cooler An air-cooled oil cooler is mounted on the left-hand side of the engine. An integral thermostatic valve directs oil through the cooler or bypasses it dependant on oil temperature. Cooling air supply is taken from the back baffle plates on the left-hand pair of cylinders, the air first entering the main intake at the front of the cowling. The air exhausts with the rest of the engine cooling air at the bottom of the lower engine cowling.

Inverted Flight Oil System The engine inverted flight oil system incorporates a pump, a changeover valve and an oil separator. The oil separator allows the top of the engine crankcase to be vented to atmosphere and collects any oil droplets in the vented air for return to the engine sump. In inverted flight the "top" of the engine becomes the sump and the sump becomes the top: to stop the oil from being vented directly to atmosphere a steel ball in the separator moves under gravity to block the vent connection from what is now the bottom of the engine. On return to normal flight the ball falls back again and normal venting takes place. The changeover valve directs oil to the oil pump: in normal flight oil is taken from the sump; in inverted flight oil is taken via the oil breather pipe at the top of the engine (which becomes the sump), the valve changing over automatically under gravity, thus allowing a supply of oil to the pump under both normal and inverted flight. Extreme manoeuvres (eg vertical flight) will rob the pump of all oil supply and this gives rise to the limitations in Section 2.4. During transition from manual to inverted flight or back again the oil pressure may flicker momentarily, dropping by 10 to 30 psi but it should rise again within one second. Due to the longer path for oil from sump to pump in inverted flight, the sustained oil pressure in inverted flight will be 5-10 psi lower than in erect flight. If the oil pressure in inverted flight stabilizes at more than 20 psi below the erect flight figure this signifies a fault in the oil supply system and the aircraft should be righted immediately and the fault investigated on the ground.

On start-up, the oil pressure should rise to the yellow or green sector within thirty seconds; if it does not, the engine should be stopped immediately or severe internal damage may result. The engine is very slow to warm up and care should be taken to observe engine oil temperature and pressure minima and maxima. There are no oil temperature minima for run-up or takeoff but the engine run-up should not be commenced until the engine has been warmed up for four minutes from cold; takeoff should only be continued if the engine accelerates smoothly as the throttle is opened and 2550 RPM is obtainable immediately the throttle is opened fully at the beginning of the takeoff run. Engine life is maximised if the oil is warmed to 40°C before takeoff.

The engine may over-cool during a prolonged glide with the engine throttled fully back and this may lead to very poor and slow engine acceleration when the engine throttle is subsequently opened. This cooling takes place at the engine cylinders and will be apparent on the cylinder head temperature gauge. Prolonged glides are most likely during engine failure practice and, to avoid the problem of over-cooling, the engine should be cleared at least once every 1000 ft by opening the throttle to full power for at least three seconds and closing it again to idle. Additionally the throttle should be opened slowly on the climb out.

6.1.4 Magnetos

Two Bendix magnetos are employed; they are mounted at the back of the engine, the 'left one being at eleven o'clock and the 'right' one at one o'clock. Each of the four engine cylinders has two sparking plugs; both magnetos work together, each one supplying one sparking plug in each cylinder so that for safety, the engine will continue to run if one magneto fails.

> The magneto switch (Item 9 Fig 8.4 and 8.4B) controls both magnetos and is < marked OFF - R - L - BOTH. In the 'OFF' position both magnetos are earthed and so will produce no spark; in the 'R' position the right magneto is made live whilst the left magneto is earthed and thus the right magneto should produce sparks. In the 'L' position the left magneto alone is now live and in the 'BOTH' position, both magnetos are live.

The left magneto is fitted with an impulse and spark retard device which makes the engine easy to start; the device only operates at very low RPM and thus the magneto is providing a normally timed spark at all RPM settings available to the pilot. For starting the engine, the magneto switch should be selected to 'L' and then to 'BOTH' when the engine fires. Prolonged running with one magneto switched off will lead to oiling up of its sparking plugs and a consequently large magneto "drop".

If one magneto becomes dead during engine operation, it may not immediately be apparent as the engine will continue to run. It may also happen that one magneto becomes permanently live; this will not normally be discovered as it is the usual practice to stop the engine by cutting off the fuel. For this reason a "dead/live" magneto check is carried out immediately after starting and immediately before stopping the engine. The purpose of this check is to ensure that there is a drop in engine RPM when a magneto is switched off but that the engine continues to run.

An individual check of the performance of each magneto is carried out before takeoff in the Engine Run, but the 'Dead Cut' check has two purposes as follows:

a. To ensure that each magneto can run the engine.

b. To ensure that either or both can be switched off if required.

Should there be no RPM drop, then the magneto that has been switched off is permanently live and the engine is in a dangerous condition because:

1. If that magneto malfunctioned, it could not be switched off.
2. The engine could not be stopped by switching off the magnetos (eg fire drill).
3. There is a risk of the engine starting when the propeller is turned during engineering work on the ground.

The magneto performance check is done before each flight and is carried out by setting 1800 RPM with 'BOTH' selected; the right magneto is then switched off by selecting 'L' and the RPM is monitored to check that the engine runs smoothly and the RPM drop does not exceed 175 (ie the RPM does not fall below 1625 RPM). The magneto switch is returned to 'BOTH' and the RPM allowed to re-stabilize at 1800 RPM. Then the left magneto is switched off by selecting 'R'; the engine should again continue to run smoothly and the RPM should be above 1625; additionally, the RPM should be within 50 RPM of that achieved with 'L' selected. (If the engine is not within these limits an engineering investigation is required). The magnetos should then be selected to 'BOTH'.

A cėrtain type of magneto failure can occur where one magneto either sparks intermittently or sparks with the wrong timing; this can lead to rough running of the engine. If rough running occurs and cannot be attributed to any other cause (wrong mixture setting, induction icing, oil pressure failure) each magneto can be switched off in turn to check for malfunctioning. Should normal engine running be restored with one magneto switch off the aircraft should not take off and, if already airborne, should land at the nearest safe landing ground as continued engine operation now depends on a single magneto.

6.1.5 Tachometer

A drive from the back of the engine is transmitted by a sleeved cable to a tachometer in the cockpit. The face of the tachometer is graduated from 0 to 3500 RPM and the glass is marked with a red line at the limiting engine RPM of 2700 RPM. The 'hours' figure on the face of the instrument assumes a constant RPM and may therefore under- or over- read against real time; it cannot therefore be used to measure engine operating time.

6.1.6 Manifold Pressure

The manifold pressure gives the operator a direct indication of how hard the engine is working whilst the RPM tells him how fast the engine is going round. As is the case with most piston engines, the engine should not be made to work too hard at low RPM. The manifold pressure gauge shows the pressure of air being fed to the cylinders and hence, the higher the pressure, the harder the engine is working. When the engine is running, opening the throttle admits more air to the manifold and allows the pressure to rise. If the manifold pressure is too high for the RPM being used, detonation and engine damage may result: to avoid this condition the manifold pressure (in inches of mercury) should never be allowed to exceed the RPM (in hundreds) by more than 4, e.g. the maximum manifold pressure allowed at 2200 RPM is 26 inches of mercury. This condition can inadvertently be encountered when increasing or decreasing power settings, so a simple rule to remember is - when increasing power "REV UP" first, when decreasing power "THROTTLE BACK" first.

6.1.7 Starter

The starter is located at the front of the engine under the propeller drive. It is operated by a push-button on the centre console, the button being obstructed when the fuel cock is selected to 'OFF'. Electrical power is available to the starter through the starter button when the master is switched on. A starter warning light illuminates when the starter is engaged; it should light only whilst the starter button is pressed and should it fail to go out when the button is released, the engine must be stopped immediately or mechanical damage will ensue. The starter circuit is not routed through the ammeter and thus the starting current is not shown on the ammeter.

6.1.8 Propeller and Constant Speed Unit

The propeller is a Hoffmann 2 bladed variable-pitch propeller. The leading edges are covered with a replaceable metal strip. In the event of any damage, cracks, chips or surface crazing being detected, reference should be made to the maker's handbook which gives details of acceptable imperfections. The propeller rotates clockwise as seen by the pilot. The propeller hub is hidden by the spinner which is secured to the propeller back plate by screws; thus the hub cannot be inspected on a daily basis.

Propeller pitch is varied by the movement of a piston in the propeller hub: this piston is connected to both propeller blades and moves them simultaneously to vary their pitch from low pitch (fully fine) to high pitch (fully coarse). The blades have counter-weights attached at their roots; when the propeller is turning these counterweights exert a force on the blades to make them move to the fully coarse position. This action is assisted by a spring. Thus, once the engine is running, the blades can only be moved from fully coarse by applying enough pressure to the piston in the hub to overcome the force generated by the spring and counter-weights. The source of pressure is the oil pump and the amount of pressure allowed to go to the piston is controlled by the constant speed unit.

The function of the constant speed unit is to vary the pitch of the propeller blades to keep the propeller RPM at the value selected by the RPM control. It works on the principle that if the pitch of the propeller blades is increased, the blades will develop more lift (thrust) but will also develop more drag; this increase in drag will slow the propeller RPM down. Conversely, if the pitch is decreased, the propeller will speed up. The desired RPM is set in the constant speed unit by movement of the RPM control; the unit then either lets oil in under pressure to decrease the propeller pitch or lets oil out allowing the pitch to increase until the set RPM is reached. If the RPM then varies from the set value the constant speed unit changes the pitch until the correct RPM is regained.

The constant speed unit can only function correctly when the engine is developing enough power to turn the propeller at the RPM set by the RPM control. When the throttle is closed on the ground the engine develops very little power; the constant speed unit will attempt to keep the RPM at the value set by the RPM control and, as the engine slows down, will move the propeller to a lower and lower pitch until it is at minimum pitch (fully fine). At ground idle the engine is not developing enough power to keep the RPM above about 800 - even at minimum pitch. Thus it can be seen that, at low throttle settings, the propeller will be fully fine and the throttle will control the RPM; opening the throttle will increase the RPM until the engine is developing enough power to drive the propeller round at the value set by the RPM control; once the set RPM is reached, the constant speed unit will keep the RPM the same by coarsening the propeller as the throttle is opened further. Conversely, as the throttle is progressively closed from fully open, the constant speed unit progressively reduces the propeller pitch to keep the set RPM. Eventually, at a certain throttle position, the propeller is fully fine, the unit can no longer maintain the set RPM; the RPM will then fall as the throttle is closed beyond this position.

In practice, at normal flight power settings, the RPM control sets the RPM and the throttle controls the manifold pressure. It is only on the ground or when reducing to low throttle settings that the power output of the engine is too low to allow the constant speed unit to work and then the throttle controls the RPM.

Overspeed

Up to 3105 RPM If the propeller overspeeds between 2700 PRM and 3105 RPM (an overspeed of 0% - 15% over the engine takeoff RPM limit of 2700) a normal propeller periodic 100 hour inspection must be carried out.

3105 RPM tp 3375 RPM If the propeller overspeeds between 3105 RPM and 3375 RPM (representing an overspeed of 15% - 25% over the engine takeoff RPM limit of 2700) the propeller must be returned to the manufacturer or authorised agent for inspection. The exact overspeed RPM should be noted.

Above 3375 RPM The propeller should be returned to the manufacturer or authorised agent for inspection and no ferry flight should be made.

6.1.9 Normal Use

The drills for the normal use of the engine are given in Section 3 and in the Flight Reference Cards (FRCs). The limitations are given in Section 2 of this manual and critical limitations are summarised in the FRCs.

Cruising Power During First 50 hrs Engine Life Cruising should be done at 65% - 75% power until 50 hrs engine life has accumulated or oil consumption has stabilised.

6.1.9 Malfunctions

The emergencies are covered in Section 4 and are reproduced in the emergency check lists (red pages) of the FRCs.

6.2 THE AIRFRAME AND ENGINE FUEL SYSTEM

6.2.1 General Description

Fuel is contained in two separate wing tanks, it can be fed from one or other of the tanks, via a left/right selector valve, to the engine through a filter by means of an electric booster pump and an engine driven pump (EDP). The engine is equipped with a continuous flow fuel injection system which incorporates a fuel pressure sensor.

6.2.2 Fuel Tanks (Ref Illustration 8.4 and 8.4B)

The two GRP tanks form integral parts of each wing inboard leading edge structure. The capacity of each tank is 80.7 litres (17.75 Imp Galls) of which 78.7 litres (17.31 Imp Galls) are usable. Fuel type is AVGAS 100LL. The tank fillers are located on the upper surface of the wing leading edge.

Vent pipes from each tank are led separately, from a breather box assy, to vent from under the fuselage inboard of Rib 1 port and starboard. The breather box assembly incorporates a flapper valve to minimise fuel loss during inverted flight. Both filler caps incorporate a positive lock and rubber sealing washer to prevent fuel loss during inverted flight. Each tank contains a float metering unit which supplies information to the electric fuel contents gauges (Items 39 and 40 Fig 8.4) (Items 43 and 44 Fig 8.4B) when the master switch is on.

Fuel drains are fitted to both tanks. In both cases the drain is taken from the lowest point of the tank and this will collect any water that may be present in the fuel from condensation or contamination. The fuel can be sampled before each flight by pressing up on the spring loaded screw and collecting the fuel which flows out in a suitable wide necked glass container.

CAUTION

The spring loaded screw will remain in the up position if it is inadvertently turned, therefore care must be taken to ensure that the fuel has ceased to flow after the sample has been taken.

Fuel to the engine is drawn from the bottom of the inboard side of the tank through a fuel feed pipe. Attached to the fuel feed pipe inside the tank is a flop tube which is fitted with a filter and non-return valve assembly. The flop tube is contained in a collector tank; this ensures adequate supply of fuel to the engine during inverted flight or steep turns. Fuel flows from the tank to a fuel cock (Item 4 Fig 8.4 and Fig 8.4B) mounted on the centre lower instrument panel such that the starter button is obstructed when the fuel is turned off. The fuel cock has 3 settings FUEL OFF/LEFT TANK/RIGHT TANK. From the fuel cock, fuel passes through a filter to an electrically operated booster pump. The pump is controlled by a FUEL PUMP ON/OFF SWITCH (Item 3 Fig 8.4 and Fig 8.4B), mounted on the lower centre console; it is protected by a circuit breaker located on the right of the instrument panel. Pump output is capable of supplying fuel to the engine at maximum power with the EDP failed. In cruising flight the booster pump can be switched off and fuel drawn by the EDP will be drawn through the bypass incorporated into the pump.

The EDP is mounted centrally at the back of the engine forward of the firewall; it incorporates a bypass valve so that fuel can flow when the engine is not turning or the pump has failed. A vent from the EDP emerges under the engine cowling forward of the nosewheel leg. The pilot has no controls for the EDP.

6.2.3 Fuel Contents Gauge (Ref. Illustration 8.4 and 8.4B)

The fuel gauges are mounted at the top of the instrument panel (39 and 40). (43 and 44 Fig 8.9B). They require electrical power which is supplied through the master switch. They have a circuit breaker (44) (48 Fig 8.4B) which also controls the electrical supply to the oil temperature, oil pressure and fuel pressure gauges. The gauges are marked in litres and Imperial Gallons, each full tank containing 78.7 litres (17.31 Imp galls) useable fuel. The contents metering floats are located away from the filler neck and thus the gauges may be used to give an indication of fuel levels during refuelling.

6.2.4 Fuel Pressure Gauge (Ref Illustration 8.4 and 8.4B)

The fuel pressure gauge (Item 36 Fig 8.4) (Item 37 Fig 8.4B) is mounted on the left-hand instrument panel on a gauge shared with the manifold pressure
> indicator. It is calibrated from 0-10 psi. <

The fuel pressure sensor is mounted on the fuel distributor inlet so that the pressure recorded is the same as that being experienced at the injectors. The gauge senses the fuel pressure directly through a pipe and, for this reason, a restrictor is put in the pressure line to the gauge so that fuel is not pumped into the cockpit if the pipe breaks. The fuel pressure supplied to the distributor is controlled by the fuel control unit which responds to throttle demands. The amount of fuel fed to the engine is directly proportional to the fuel pressure and thus the fuel pressure gauge may be expected to read high when the throttle is open and low when the throttle is closed: it should never read zero when the engine is running. The relationship between fuel pressure and fuel flow is given in Section 6.2.5.

In the event of engine malfunction a check of the gauge pressure will confirm whether the problem is caused by a fuel supply problem. If the fuel pressure gauge reads very low the likely rectifiable causes are fuel pump failure or fuel supply failure; the electric pump should be switched on and the fuel control and contents checked.

6.2.5 Fuel Control Unit

The fuel control unit takes the place of the carburettor. It supplies fuel to a fuel distributor which directs fuel to the appropriate cylinder where it is injected directly into the inlet port. The fuel control unit senses the airflow through the manifold into the engine and provides the appropriate amount of fuel to give the correct air/fuel mixture. It actually achieves this by varying the fuel pressure; this changes the fuel flow and gives the correct mixture. Opening the throttle will increase the airflow in the manifold and the fuel control unit schedules a higher fuel flow. At altitude the reduction in density results in a lower manifold airflow being sensed by the unit which automatically schedules a lower fuel flow, avoiding an over-rich mixture. The fuel control unit is set to provide a maximum power (rich) fuel/air mixture throughout the operating range but weakening the mixture to economy cruise settings can be achieved by use of the mixture control.

The fuel control unit depends on the supply of fuel under pressure to function correctly and failure of the pressure supply will result in power failure. Both the engine driven fuel pump and the electric fuel pump can individually provide sufficient pressure for correct fuel supply. Under normal circumstances only the engine driven pump is used. A failure of this pump will result in power loss and low or zero fuel pressure; normal engine performance can be restored by use of the electric fuel pump.

A failure in the fuel control unit or impact icing on the throttle or air pressure sensing pipes will cause reduced fuel or air flow and will lead to loss of power: icing conditions must be avoided as there is no provision for manifold or throttle ice clearance.

> <u>6.2.6 Fuel Distributor</u> (Ref. Illustration 8.4 and 8.4B) <

The fuel distributor is downstream of the fuel control unit and directs fuel to the inlet port of each cylinder in turn as they commence their induction stroke. There are no pilot controls or indicators but the fuel pressure experienced at the indicator is shown on the fuel pressure gauge (Item 36 Fig 8.4) (Item 37 Fig 8.4B) in the cockpit.

> <u>6.2.7 Throttle</u> (Ref. Illustration 8.4 and 8.4B)

A throttle is provided for left-handed use by each pilot. The left-hand throttle (Item 46 Fig 8.4) (Item 51 Fig 8.4B) is of the lever type and is < located on the left cockpit wall, incorporating a spindle friction damper.
> The right-hand throttle (Item 6 Fig 8.4 and Fig 8.4B) is on the centre lower < instrument panel and is of the plunger type. The two throttles are ganged together and thus operate simultaneously. The throttle is fully open when the controls are fully forward.

> <u>6.2.8 Fuel Mixture/Cutoff Control</u> (Ref. Illustration 8.4 and 8.4B)

The mixture/cutoff control (Item 8 Fig 8.4 and Fig 8.4B) is situated on the < centre lower console and is of the plunger type. The mixture is fully rich when the control is fully forward and progressively weakens as the control is pulled back: the fuel is completely cutoff when the control is fully back. The control is of the vernier type and incorporates a central push button to release the vernier. An adjustable friction device is also provided which turns clockwise to increase friction. The friction control should always be set tight as vibration may otherwise cause the setting to 'creep'.

For takeoff, climb and at low levels AMSL fully rich should always be selected and locked. In the cruise it may be weakened to reduce fuel pressure to the value derived from the performance graph at Section 5. Weakening beyond this point will cause rough running and may lead to RPM surging as the constant speed unit attempts to maintain RPM under conditions of fluctuating power. This fuel pressure setting gives the mixture which is the most efficient for that particular RPM, temperature, speed and altitude and will need resetting if any of these conditions change. The mixture should always be set fully rich before changing any throttle setting or commencing any climb or descent. The engine should normally be stopped on the ground by setting the mixture to cutoff so that fuel is not left in the cylinders after the engine has stopped; this stops lubricating oil being washed from the cylinder walls and minimises the chance of the engine firing if the propeller is turned.

Should the engine ever seem to be suffering from power loss with no other symptoms (e.g. mechanical noise, oil system malfunction, induction icing) immediately select the mixture to fully rich in case incorrect mixture was the cause of the trouble.

6.2.9 Normal Use

Before Flight Ensure that there is sufficient fuel for the flight and that the fuel caps are both secure. Check that both vent pipes are clear. Sample fuel for contamination- check if required. (First flight of each day). Once the master switch is on, check fuel gauge indicators, both tanks, leave fuel on and carry out engine starting drill. After take off switch off booster pump.

During Flight Periodically monitor fuel gauge indicators. Switch from one tank to the other from time to time during long flights to maintain the balance of fuel in the tanks. Fuel asymmetry before commencing aerobatics and spinning manoeuvres should not exceed 14 litres (3 Imp Galls).

The effect of asymmetry of fuel greater than 14 litres will not hazard the aircraft but does lead to slight increase in control stick aileron forces and less precise aerobatic manoeuvres.

Switch on booster pump when beginning a landing approach.

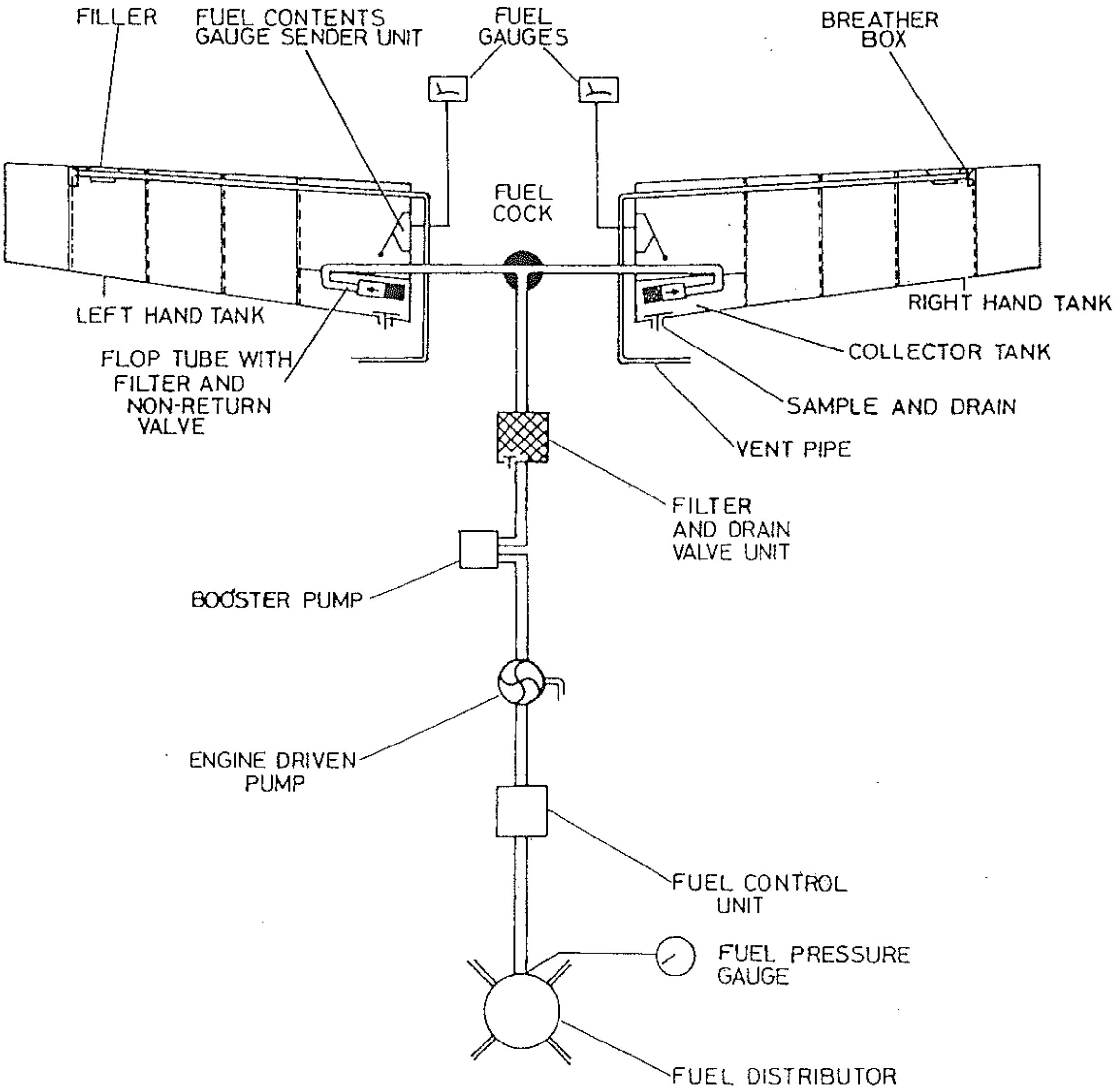
Should a low fuel situation arise, it is advisable to select one tank until the engine begins to falter and then switch to the other tank containing the remaining fuel.

After Flight Set the mixture control to cutoff. When the engine has stopped, switch off the fuel.

6.2.10 Malfunctioning

These are covered in Section 4 and in the FRCs - red section.

6.2.11 Fuel System Diagram



6.3 THE ELECTRICAL SYSTEM

6.3.1 General Description

A battery provides 24V DC for all electrical services. Any equipment requiring AC incorporates its own solid state inverter thus eliminating the need for any separate AC distribution system. An engine-driven alternator charges the battery. All circuits are protected by circuit breakers which are accessible to the pilot in flight.

6.3.2 Battery (Ref Illustration 8.4 and 8.4B)

The 24 volt battery rated at 15 ampere hours is located on the forward side of the firewall to the port side of the engine. It can supply all electrical services but demands on it should be kept to a practicable minimum until alternator output is available; this will retain battery capacity for starting the engine and for use in the air should the alternator fail before it has fully charged the battery. No emergency battery is fitted. An ammeter (Item 42 Fig 8.4) (Item 46 Fig 8.4B) indicates the rate of battery charge or discharge. The battery is connected to the DC busbar by a battery relay which is operated by the master switch (Item 2 Fig 8.4 and Fig 8.4B). No electrical services except the clock will operate until the master switch is on. Once the engine is running, the alternator may be switched on to charge the battery; the master must never be switched off when the alternator is on and the engine running, as alternator damage may occur.

6.3.3 Alternator (Ref Illustration 8.4 and 8.4B)

The 24 volt 70 amp Prestolite alternator is driven by a friction belt from a pulley on the propeller drive shaft; a red warning light marked ALT (Item 26 Fig 8.4) (Item 27 Fig 8.4B) flashes whenever the master is on and the alternator is not giving any output. The flashing can be stopped by pressing the warning button for more than half a second which will cause the light to revert to steady red. Voltage control is regulated by a Lamar regulator, this effectively cuts out the alternator in the event of over voltage. An ammeter is fitted to indicate any excessive charge or discharge.

The alternator requires an excitation current to be applied to its field coils before it will start delivering current even though it is being turned by the engine; this current is supplied from the busbar through the excitation switch (Item 1 Fig 8.4 and 8.4B). Two circuit breakers protect the alternator; one, rated at 5 amps, protects the excitation circuit and the other, rated at 60 amps, (Item 45 Fig 8.4) (Item 49 8.4B) protects the main alternator output. The alternator should be switched on once the engine is running and should be switched off before the engine has been shut down. The ammeter (Item 42 Fig 8.4) (Item 46 Fig 8.4B) indicates the rate of battery charge or discharge and should be carefully monitored when the alternator is switched on; the ammeter should immediately be expected to indicate about +20 amps but should fall to no more than +10 amps after about 60 seconds or the battery is likely to 'boil' and spill acid. The charge rate will steadily fall from about +10 to +2 amps as the battery becomes fully charged. The alternator is capable of full output at ground idle RPM (700 RPM) and will thus retain output at windmill RPM (800 RPM) at gliding speed following an engine failure; it will not produce any output when the propeller has stopped.

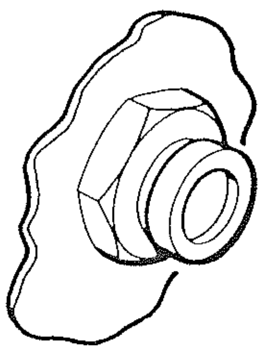
Warning

The master switch should not be switched off when the alternator is switched on with the engine running as this may result in damage to the alternator control components.

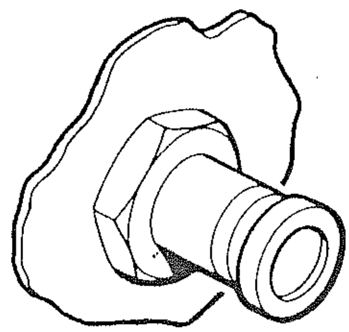
Alternator failure will be indicated by the ALT light flashing and the ammeter indicating a discharge. The alternator excitation should be switched off and the circuit breakers checked and reset if necessary; the alternator may then be switched on but if a circuit breaker trips again the alternator should be switched off and the fault investigated on the ground.

6.3.4 Circuit Breakers (Ref Illustration 8.4 and 8.4B)

The circuit breakers (Item 44 Fig 8.4) (Item 48 Fig 8.4B) are all accessible to the pilot in flight. The ampere ratings are stamped on the head of each one. When a circuit breaker trips is protrudes about half-inch from the panel and a white portion on its stem is clearly visible. The circuit breakers may be tripped by the pilot by pulling out the head of the circuit breaker until the white portion is visible. They may be reset by pushing the head back to the 'set' position.



CIRCUIT BREAKER SET



CIRCUIT BREAKER TRIPPED

If a circuit breaker trips, the circuit which it is protecting should be switched off (if there is a switch) before any attempt is made to reset the circuit breaker; the circuit breaker should be allowed to cool for about 30 seconds and then it may be reset. Under no circumstances should a circuit breaker ever be held pressed in as this can result in an electrical fire. Once a circuit breaker has been reset, the circuit which it was protecting may be switched on again; if the circuit breaker trips a second time the circuit should be switched off and no further attempt made to reset it. Some circuit breakers serve more than one circuit but this is not always indicated on the panel. Details of all circuit breakers, their loadings and the circuits protected by them are given on the diagram of the electrical system in this chapter at 6.3.8.

6.3.5 Normal Use of the System

Before flight: Check electrical services as detailed in the FRCs. Select the master switch on before starting the engine and leave it on until the engine has been shut down. Once the engine is running select the alternator excitation switch to ON and monitor the ammeter readings to ensure that the initial charge rate of about 20 amps falls to 10 amps in 60 seconds and about 2 amps in 5 minutes. Select services as required.

During flight: Monitor the charge rate periodically. Select services as required.

After flight: Switch off the alternator before engine shutdown and switch off the master once the engine has stopped.

Use of Avionics: Avionics should only be switched on and off whilst the alternator is running to protect them from transient voltage fluctuations.

(If avionic ground checks are required, without the engine running, do not operate master or starter switches whilst radios are turned on.)

6.3.6 Malfunctioning (Ref Illustration 8.4 and 8.4B)

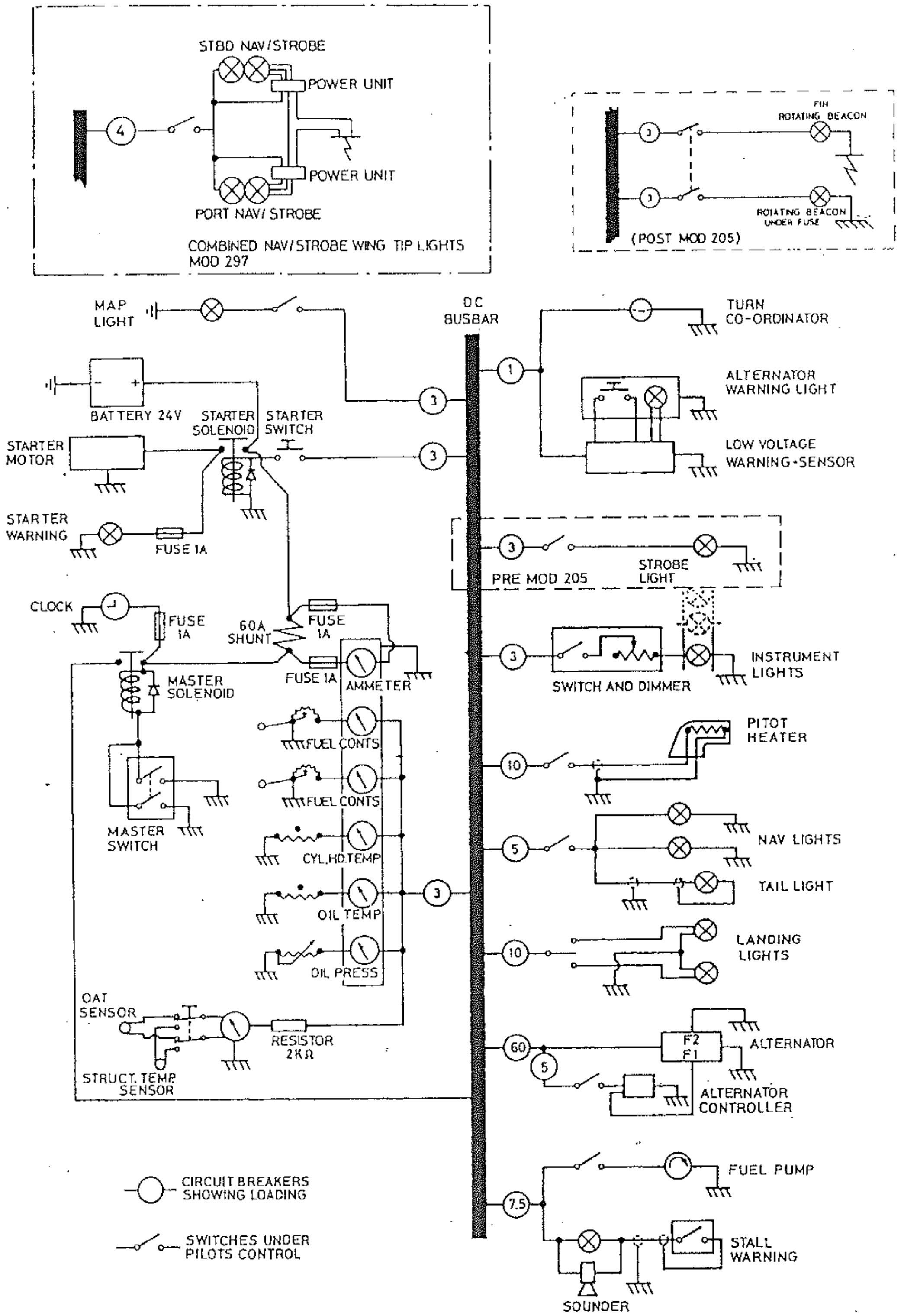
Alternator failure: Failure will be indicated by the red ALT warning (Item 26 Fig 8.4) (Item 27 Fig 8.4B) illuminating and the ammeter (Item 42 Fig 8.4) (Item 46 Fig 8.4B) indicating a discharge. The drill for attempting to restore alternator output is given in the FRC.

Flat battery: Should there be too little power in the battery to start the engine it will be necessary to have the battery changed or to fit a serviceable one. There is no provision for the connection of an external electrical supply.

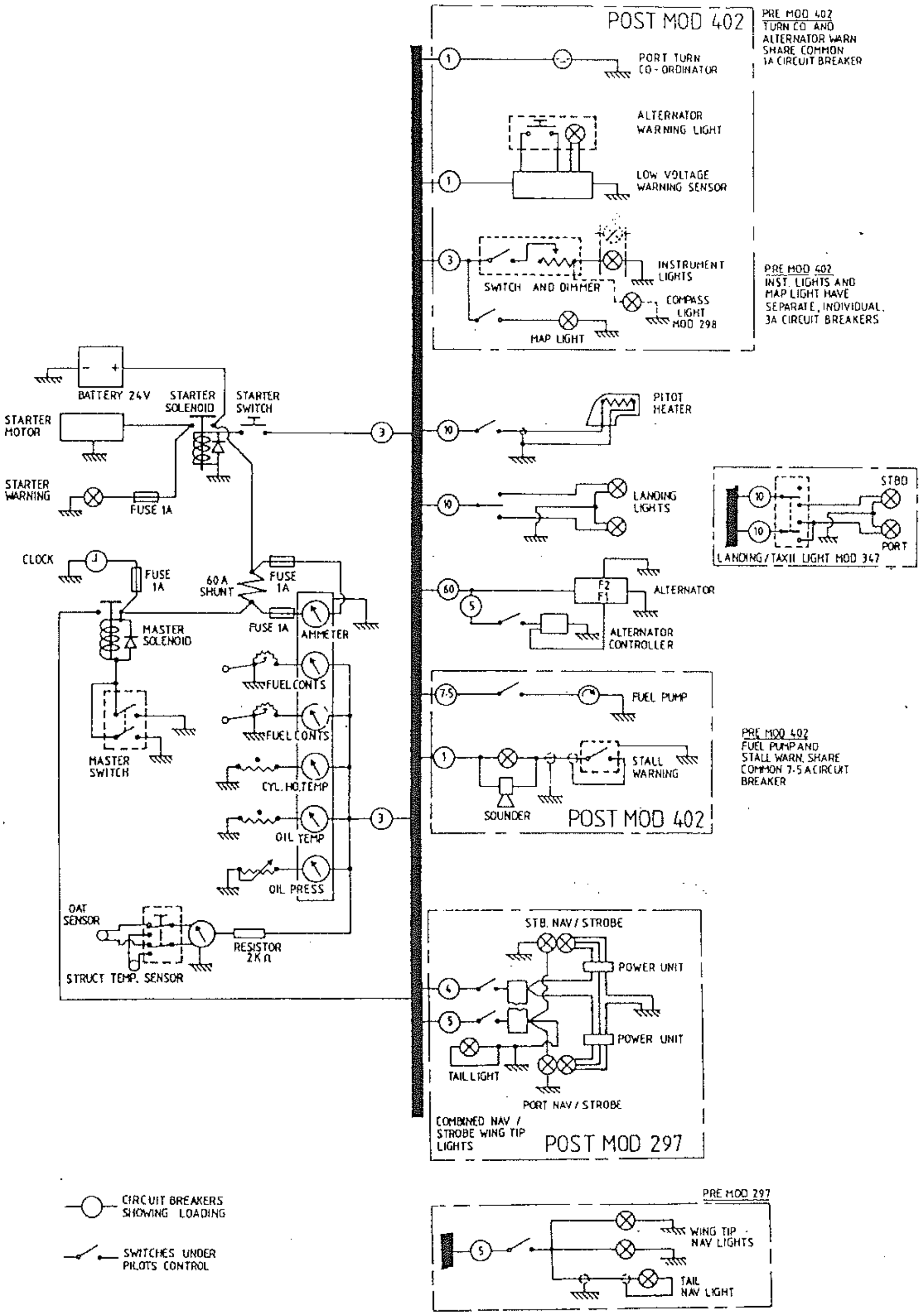
Do not take off with a flat battery. It supplies emergency electrical power in the event of an in flight alternator failure.

Circuit breaker trip: See 6.3.4 in this chapter.

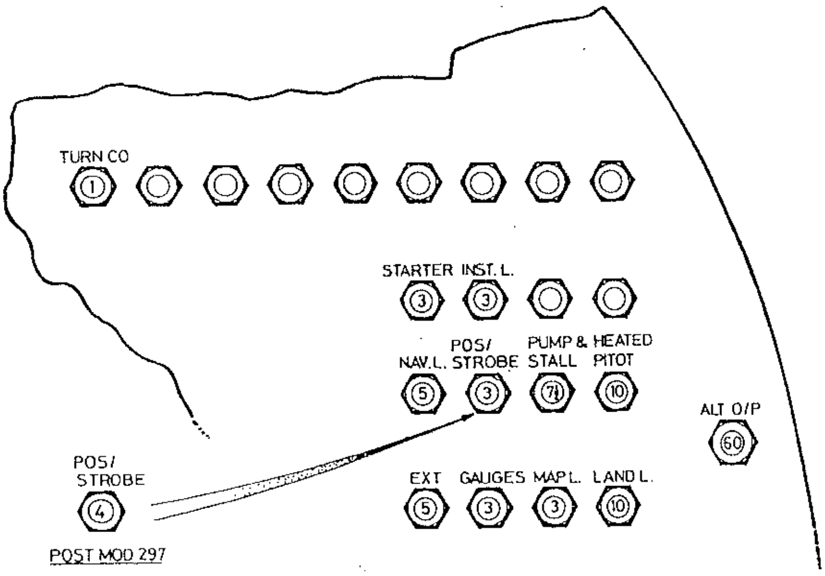
> ## 6.3.7 The Electrical Circuit Diagram (PRE MOD 402) <



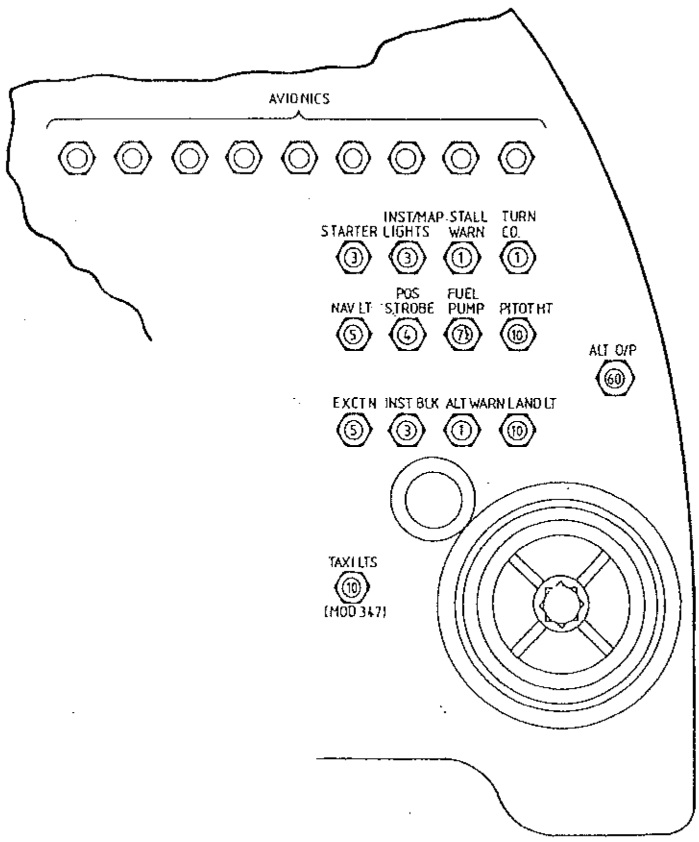
> 6.3.7A The Electrical Circuit Diagram (POST MOD 402)



> 6.3.8 Circuit Breaker Layout (PRE MOD 402) <



> 6.3.9 Circuit Breaker Layout (POST MOD 402)



<

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6.4 GENERAL EQUIPMENT

6.4.1 Safety Equipment

The safety equipment fitted in the aircraft is a fire extinguisher, a first aid kit and a crash axe. The fire extinguisher is filled with BCF and its use should be minimised in a confined space. The extinguisher is mounted on the back wall of the cockpit in a clip that prevents inadvertent operation but allows removal with one hand. The extinguisher is operated by squeezing the trigger on the head of the bottle. There is no provision for engine fire warning or extinction. The first aid kit is stowed on the back of the bulkhead behind the pilots seats and the axe is mounted on the back wall beside the fire extinguisher.

6.4.2 Access to the Cockpit

Access to the cockpit is by a walkway on each wing. A footstep and handhold is provided on each side of the aircraft in order to assist both pilot and co-pilot in stepping up onto the walkways. The walkways go from the trailing edge to level with the cockpit and are surfaced with non-slip material. The areas outboard and in front of the walkway are the flap and wing upper surface and the leading edge; these areas are not stressed for walking on and care must be taken when getting in and out of the cockpit to see that they are not damaged.

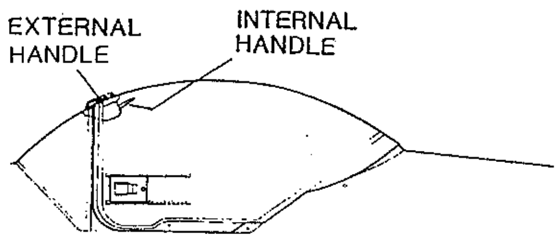
It is a sensible precaution to leave the flaps at fully down when the aircraft is not in use to make it less likely that personnel will inadvertently tread on them.

6.4.3 Aircraft Security

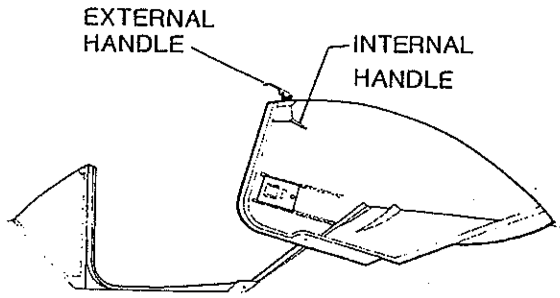
The canopy latch mechanism incorporates a key operated lock; also the engine cannot be started without a key to switch on the magnetos. Therefore the removal of the magneto key and locking of the canopy will totally immobilise the aircraft.

6.4.4 Canopy

The canopy consists of a fixed windscreen separated by a carbon fibre hoop from an upward and backward hinging perspex transparency. A latch mechanism is fitted to the upper forward edge of the transparency and can be operated by handles from either inside or outside the aircraft. The rear of the moveable part of the canopy is fixed to the aircraft by a runner which can slide fore and aft in a track but cannot lift up. When opening the front lifts up, hinging on 2 radius arms attached to the cockpit sill and canopy frame. The canopy is prevented from sliding too far rearwards by a stop incorporated into the track of the rear attachment.



CANOPY CLOSED



CANOPY OPEN

Canopy Lock The canopy is locked by the 2 hooks of the canopy latch assembly, attached to the moveable transparency, which engage on the latch pin part of the latch block assembly, located centrally on the forward hoop. The latch mechanism has been designed so that in the open position both internal and external handles stick out whereas in the closed position they lay flat thereby giving good visual indication as to whether the latch mechanism is open or engaged.

Opening the Canopy To disengage the latch mechanism from inside or outside the cockpit a steady pull on the handle is needed until the mechanism is triggered and the handle snaps into the open position. The canopy may now be opened fully; it should always be moved in a controlled manner and never slammed open or shut. The canopy should never be left in an intermediate position as there is a risk of it falling shut and causing damage. The canopy must always remain closed and latched during flight unless emergency evacuation is intended (see P.2-10).

Post Mod 283 A split canopy slide lock is introduced to retain the canopy in the open position. The lock is operated from a lever inside the cockpit at the rear of the centre console.

Closing the Canopy Pull canopy forward until it cannot move any further ensure that the latch handle is in the open position and thus that the canopy is fully home. Press the handle into the closed position, inside or outside of the cockpit, thereby engaging the 2 hooks onto the latch pin and securing the canopy in the closed position.

6.4.5 Seats and Harnesses

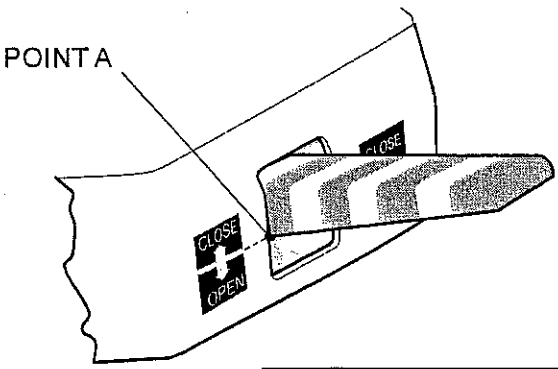
The moulded bucket seats can be used with or without parachutes. Cushions are fitted, being attached with velcro strips, and these may be removed when parachutes are worn. The seats are not adjustable for height but additional cushions can be used to correct pilot head height. Variations in leg length are allowed for by rudder pedal adjustment.

The harness is a 5-piece full body restraint type with a quick-release fitting which releases all straps simultaneously. It comprises two lap straps, two shoulder straps and a negative G restraint strap; the quick release fitting is permanently attached to the outboard lap strap and the other straps have metal tongues which fit into individual slots in the fitting. A cruciform disc on the front of the fitting is spring-loaded to the locked position and

6.4.4 Canopy

Canopy Lock The canopy is locked by the 2 hooks of the canopy latch assembly, attached to the moveable transparency, which engage on the latch pin part of the latch block assembly, located centrally on the forward hoop. The latch mechanism has been designed so that in the open position both internal and external handles stick out whereas in the closed position they lay flat. Positive visual indication as to whether the latch mechanism is locked is provided by witness marks, the white line on the OPEN/CLOSED placard aligning with the bottom of the handle (6.4.4A). The canopy latch mechanism incorporates a key operated lock.

6.4.4A Canopy Latch Witness Marks



NOTE
When latch is properly closed the line on the label will line up with POINT A.

cdata/t67m260/latch.cdr

the locked position and can be rotated about 40° both clockwise and anti-clockwise to unlock the tongues from the fitting. The shoulder straps may be released separately leaving the lap straps and negative G strap still locked; this is done by pushing forward the metal tag that protrudes upwards from the top of the locking box.

The shoulder straps are connected to a central inertia reel strap which is controlled from a locking mechanism located between the seats.

6.4.6 Aircraft External Lighting (Ref Illustration 8.4 and 8.4A)

Navigation Lights The aircraft is fitted with 3 navigation lights, one at each wingtip and one on the rudder trailing edge; an on/off switch (Item 28 Fig 8.4) (Item 32 Fig 8.4B) on the instrument panel controls the lights once the master is on.

Anti-collision Lights A strobe light is fitted under the fuselage and is controlled by an on/off switch (Item 29 Fig 8.4) (Item 33 Fig 8.4A) on the instrument panel once the master is on.

POST MOD 297 Combined nav/strobe wing tip lights are fitted they are controlled by an on/off switch (Fig 8.4A) positioned top centre of the instrument panel between the nav light and the map light switches.

Landing/Taxi Lamp Two single filament landing lamps are fitted on the front of the engine cowling. Both lamps shine straight ahead. The lights are controlled by a single three position switch such that only one lamp can be on at a time.

> POST MOD 347 The wiring is modified to enable either, one only or both landing lights to be selected as follows:

Middle position - OFF Switch up - ONE (TAXI) LIGHT

Switch down - BOTH (LANDING) LIGHTS <

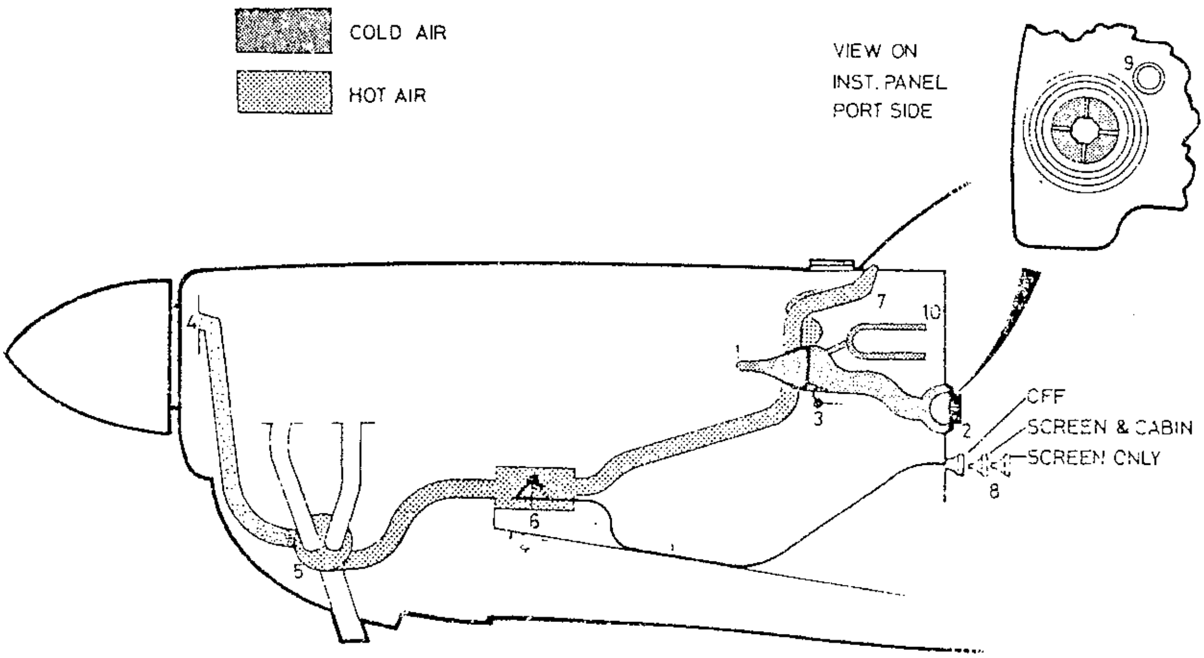
6.4.7 Cockpit Lighting (Ref Illustration 8.4 and 8.4B)

Cockpit lighting consists of pillar lamps for the instrument panel and a map light. The instrument lighting control (Item 43 Fig 8.4) (Item 47 Fig 8.4B) is a combined on/off and dimmer switch, allowing the brilliance level to be adjusted to the desired setting. The map light is mounted on the bulkhead between the pilot's seats. The map light switch (Item 30 Fig 8.4) Item 34 Fig 8.4B) is on the instrument panel left of centre. As no emergency battery lights are fitted it is essential to carry a torch in the cockpit during night flying.

6.4.8 Cockpit Ventilation and Heating (Ref Illustration 8.4 and 8.4B)

Separate cockpit hot and cold air systems are provided. The hot air system can provide for front transparency demist, for cockpit heating or for a combination of both. The control (Item 10 Fig 8.4 and Fig 8.4B) is a push/pull knob; when pulled partly out to the first stop it provides partial hot air to demist the front transparency and hot air to the pilots feet; when pulled fully out it provides full hot air to demist the front transparency

Cockpit Air Conditioning Diagram



No.	ITEM	DESCRIPTION
1	RAM AIR INTAKE (Cold air system)	One on each side of aircraft.
2	ADJUSTABLE LOUVRE	To vary the volume and direction of cold air flow. One for each pilot.
3	COLD AIR DEFLECTOR	Re-directs parts of the cold air flow down to the forward cabin area. One for each pilot.
4	RAM AIR INTAKE (Hot air system)	On engine baffle, fwd left side. Provides supply of warm air to the heat exchanger (ITEM 5).
5	HEAT EXCHANGER	Air from Item 4 is passed through this unit which encircles the exhaust pipe.

6	HOT AIR DISTRIBUTION BOX	Directs the hot air into the cockpit. There are 3 main settings - OFF, SCREEN/CABIN and SCREEN ONLY. Although there are 3 optimum positions any point in between may be selected to give a greater degree of control.
7	SCREEN DE-MIST OUTLET	Positioned forward of the instrument panel. One for each pilot.
8	HOT AIR CONTROL	Positioned on the forward console below the main instrument panel. There are 3 main positions. 1. FULLY IN ...... Heat off 2. HALF OUT ...... Heat to screen and cabin 3. FULLY OUT ..... Heat to screen only.
9	COLD AIR TO CABIN CONTROL	Fitted on instrument panel adjacent to adjustable louvre (ITEM 2). When PUSHED IN air to occupants feet ON, PULLED OUT air to occupants feet OFF. One for each pilot. The control may be turned to lock in any position.

only. The air supply comes from an air intake fitting mounted on the port-side air deflector forward of the engine and goes through an exhaust pipe heat exchanger before entering the control box for direction as dictated by control knob position.

The cold air supply comes from two intakes, one on each side of the fuselage just in front of the canopy. Each pilot has his own supply. The air can be directed to the pilot's face or body by an adjustable louvre (Item 12 Fig 8.4) (Item 14 Fig 8.4B) and to the feet by a push/on, pull/off knob adjacent to the louvre.

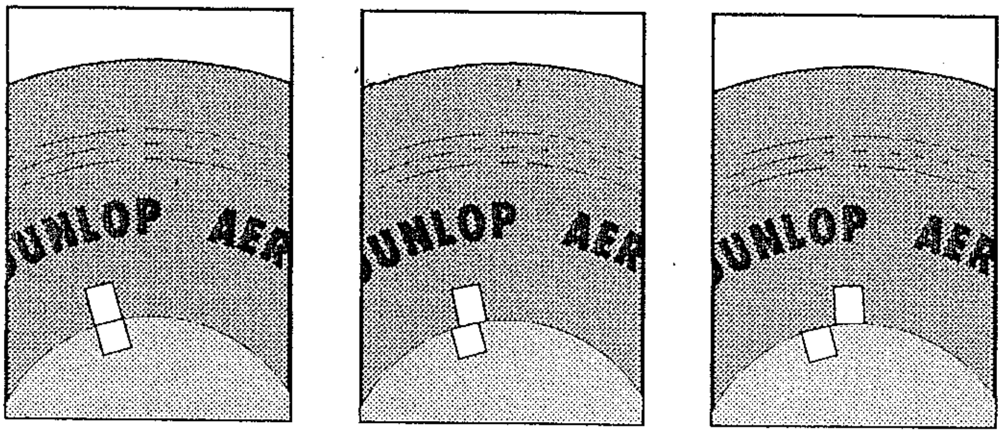
6.5 THE UNDERCARRIAGE

6.5.1 General Description

The fixed tricycle undercarriage is fitted with shock absorbers and pneumatic tyres. The nosewheel is steerable and disc brakes are fitted to the mainwheels.

6.5.2 Tyres

All the tyres are tubed and thus, if the tyre moves round on the hub, there is a danger that the inner tube valve may be torn leading to sudden tyre deflation. For this reason 'creep' marks are painted on the tyre and hub such that, with the tyre, tube and valve in the correct position, the marks on the hub and tyre are lined up. Whilst the two marks are still touching each other the amount of any creep is acceptable but the wheel must be removed for examination when the marks are no longer touching each other.



NO CREEP   ACCEPTABLE CREEP   UNACCEPTABLE CREEP

The tyre should never be used if the wear is such that any part of the tread is no longer visible or if any cut is sufficiently deep to have penetrated the rubber tread to the cords of the tyre carcase. Other tyre damage may include scald marks and flat spots (bald patches); engineering advice should be sought before tyres with this damage are used. The correct inflation pressures for the tyres, as given in the leading particulars, are marked on the undercarriage legs. The tyres are electrically conductive and thus there is no need for any earthing static discharge wires.

6.5.3 The Nosewheel

The nosewheel incorporates an oleo-pneumatic shock absorber strut. A hole in the top of each side of the nosewheel fork allows connection of a ground handling arm. See 6.5.5 for details of the nosewheel steering. Correct oleo-pressures must give a leg extension of about 3 inches as the combination of low oleo-pressure and rough ground could cause the propeller tips to strike the ground. Thus care must be taken when taxying over uneven ground or when braking hard and the control column must be kept in a position that does not tend to force the nose down.

6.5.4 The Mainwheels

The mainwheels each incorporate an oleo-pneumatic shock absorber strut Correct oleo-pressures should give leg extensions of about 3 inches.

6.5.5 Nosewheel Steering

The nosewheel is steerable by the rudder pedals and acts in the same sense as the rudder: when the right rudder pedal is pressed with the aircraft moving the aircraft nose swings to the right. When the aircraft is not moving it takes a lot of force to twist the nosewheel from side to side; for this reason the rudder pedals should not be moved when the aircraft is stationary and the rudder should not be moved during the pre-flight check or excessive strain may be put on the system. The only method of checking the rudder system for full and free movement on the ground is to find a safe area and apply full rudder in each direction whilst the aircraft is moving. The nosewheel is self-centering by a spring-and-cam mechanism and this spring action tends to give the rudders artificial "feel" in the air as the nosewheel always remains connected to the rudder controls.

6.5.6 Wheelbrakes

Independent brakes are fitted to the mainwheels. They are hydraulically operated by pedals on the rudder bars, the left wheel brake being operated by the left rudder pedal and the right brake by the right rudder pedal. The hydraulic reservoir is behind the left-hand seat on the back of the bulkhead. A set of brake pedals is fitted to both sets of rudder bars. Braking action is progressive, more pressure being applied at the discs as the pedals are pushed further. The brakes can be locked in the fully on position by first applying the brakes fully and then moving the parking brake lever back to the ON position: in this position the pressure fed to the brakes is then trapped in the system. The parking brake is released by moving the parking brake lever to OFF. A collar on the parking brake lever has to be pulled up the lever shank before the lever can be moved from ON to OFF or from OFF to ON. Once the parking brake control has been moved to ON the brakes can be applied if they are not already on; once on, they can only be released by moving the control to OFF.

The brakes are very powerful and should be used with caution on wet or slippery surfaces if skidding is to be avoided: under these circumstances it is preferable to apply the brakes with a pumping action so that, if a wheel tends to lock, it is able to start rotating again before any skid develops.

6.5.7 Tail Bumper

A tail bumper is fitted at the rear of the fuselage under the rudder. Mishandling of the controls during takeoff or landing may result in the tail bumper touching the ground. The bumper is there to minimise the damage to the fuselage should the tail touch the ground but if it is known that the tail has touched or if the bumper shows signs of having touched, an engineering investigation should be carried out to ensure that no repairs to the aircraft structure are needed.

6.5.8 Ground Handling Arms

The ground handling arm attaches to the nosewheel fork and allows the nosewheel to be turned whilst the aircraft is being handled on the ground. A larger towing arm can be used to tow the aircraft on the ground. Both arms protrude forward through the propeller disc and cannot be used when the engine is running. Either should be removed by the pilot before entering the cockpit to fly as they cannot be seen by either pilot once they are strapped in. When not in use the ground handling arm can be stowed in the luggage compartment.

6.5.9 Picketing

Three picketing rings are fitted; one is under the tail just in front of the tail bumper and two others are on each wing under surface about 2 ft in from the tips.

6.5.10 Normal Use

Before Flight Inspect the tyres for cuts, tread, creep and damage and inspect the wheelbrakes for damage or leaks. Examine the tail bumper to see if it has been touched on the ground. Check the oleos for the correct extension. Apply the parking brake before starting the engine and test the brakes immediately taxying is commenced. Whilst taxying check that the nosewheel responds fully and correctly to rudder deflection in both directions. Before takeoff and landing positively check that the parking brake is off.

After Flight When leaving the aircraft, ensure that the parking brake is left on unless the mainwheels are chocked to prevent movement. Picket the aircraft if necessary.

6.6 FLIGHT INSTRUMENTS

6.6.1 General Description

One set of flight instruments is provided, on the left of the instrument panel. Conventional pitot and static sources supply airspeed, vertical speed and altitude indicators: an engine-driven vacuum pump powers an artificial horizon and a directional gyro: the aircraft DC electrical system powers the turn co-ordinator, pitot head heater, stall warning, clock, and outside air temperature gauge: a magnetic compass provides heading information: an acclerometer provides 'g' information.

> Post Mod 506A and 506B aircraft are fitted with a Horizontal Situation Indicator (HSI) in place of the Directional Indicator and a Turn and Slip in place of the Turn Coordinator. <

6.6.2 The Pitot and Static Systems (Ref Illustration 8.4 and 8.4B)

Pitot pressure is sensed by a pressure head under the port wing outboard of the mainwheel. The head can be heated by an electrical element for which power is supplied through the pitot heater switch (Item 22 Fig 8.4) (Item 30 Fig 8.4B) when the master is on. The head supplies pitot pressure for the air speed indicator.

Two static sources are fitted, one on each side of the fuselage about half way back. Blanking plugs can be fitted on the ground to prevent the ingress of moisture or insects. These must be removed before flight. The two sources are interconnected and are needed to give a stable source of static pressure under changing aircraft attitude. Static pressure is supplied to the airspeed indicator, altimeter and vertical speed indicator. Pressure error corrections are given in Section 5.

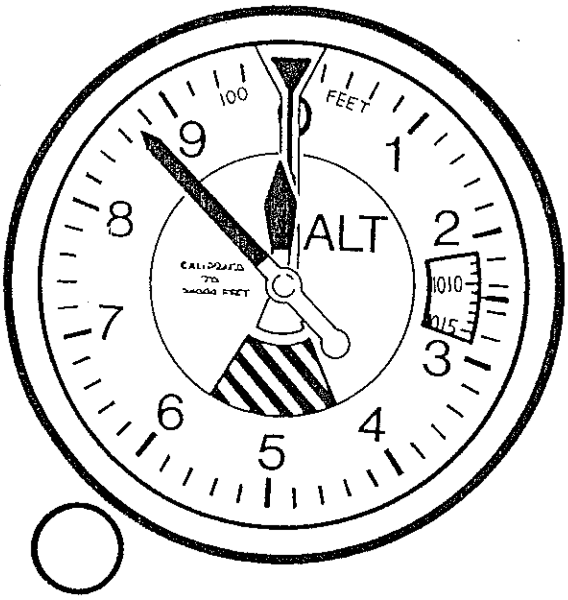
> Mod 485 introduces an alternative static source. This is in the form of a selector cock, mounted on the instrument panel above the LH fresh air louvre, which opens the static system to cockpit in the event of the normal static ports becoming blocked.

CAUTION

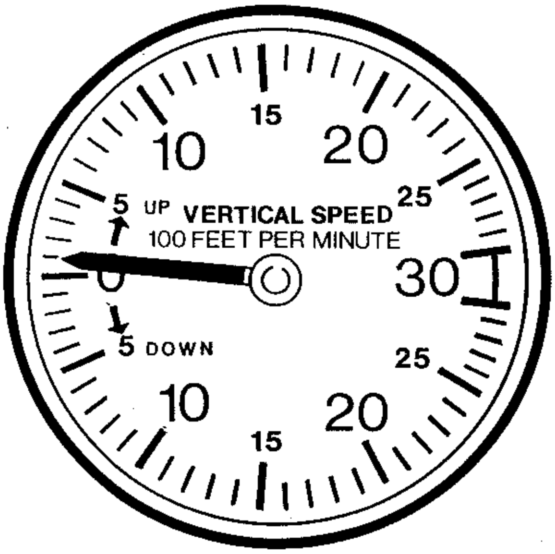
Whilst operating on emergency static source allowance must be made for minor errors on pitot static instruments. <

6.6.3 Pitot and Static Instruments (Ref Illustration 8.4 and 8.4B)

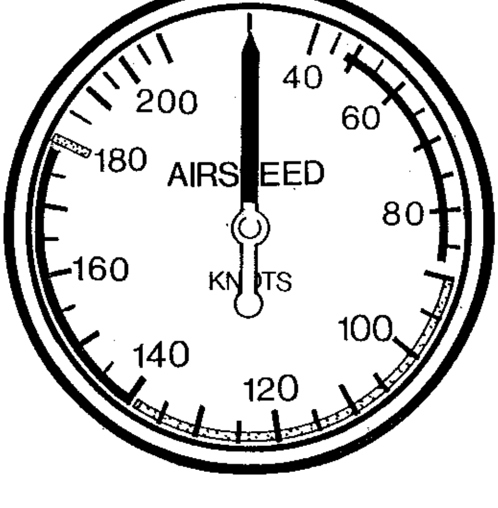
Altimeter The altimeter (Item 19 Fig 8.4) (item 21 Fig 8.4B) and second altimeter where fitted, are standard 3-needle instruments graduated from 0 to 9 with a mark every 1/5th unit; one needle covers 1,000 feet in one revolution and thus the graduations represent 100 feet each with a mark every 20 feet. A smaller needle covers 10,000 feet in one revolution and thus the graduations represent 1,000 feet and the marks 200 feet. The smallest needle covers 100,000 feet, the graduations representing 10,000 feet, the graduations representing 10,000 feet and the marks 2,000 feet. The instruments could thus read up to 99,995 feet, but are in practice only calibrated to 20,000 feet. A sub-scale and rotary setting knob allow for the setting of varying reference pressures; the scale is calibrated in millibars. The instruments should read within 50 feet of a known correct height when the appropriate pressure reading is set and should thus agree with each other within 100 feet. Pressure error corrections are given in Section 5.



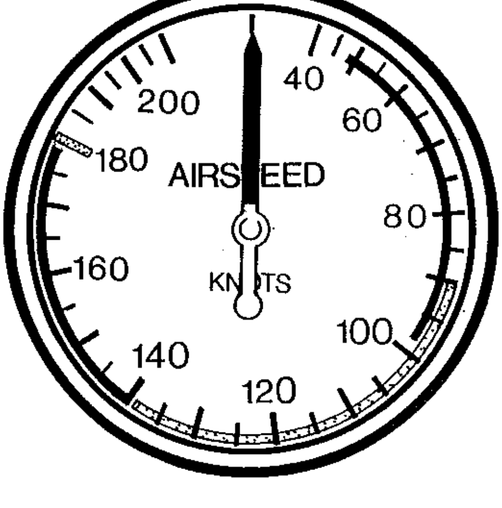
Vertical Speed Indicator The vertical speed indicator (Item 18 Fig 8.4) (Item 20 Fig 8.4B) is calibrated from 3,000 ft/min up to 3,000 ft/min down. It incorporates a mechanical stop which prevents the needle from over-running the end of either scale. There are numbers on the scale every 1,000 ft/min and marks for each 100 ft/min with a larger mark at each 500 ft/min. The instrument should read within 100 ft/min of zero when on the ground.



The Airspeed Indicator The airspeed indicator (Item 21 Fig 8.4) (Item 23 Fig 8.4B) is a single needle instrument with readings from 40 kts to 200 kts. It has standard markings on the face to indicate significant speeds as given in Section 1. Pressure error corrections are given in Section 5.



PRE MOD 656



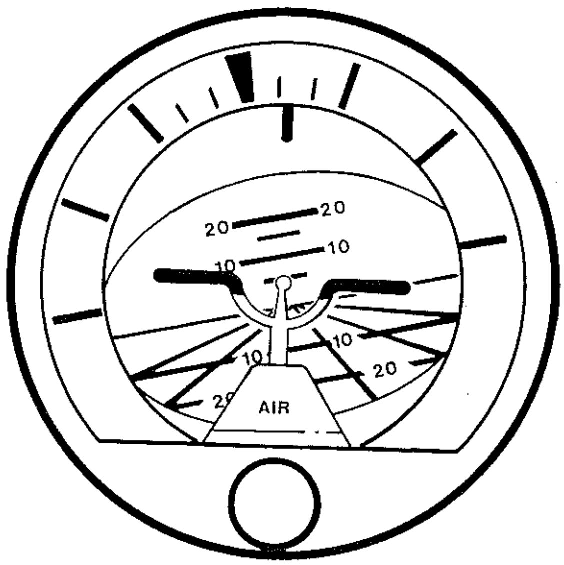
POST MOD 656

6.6.4 The Suction Supply (Ref Illustration 8.4 and 8.4B)

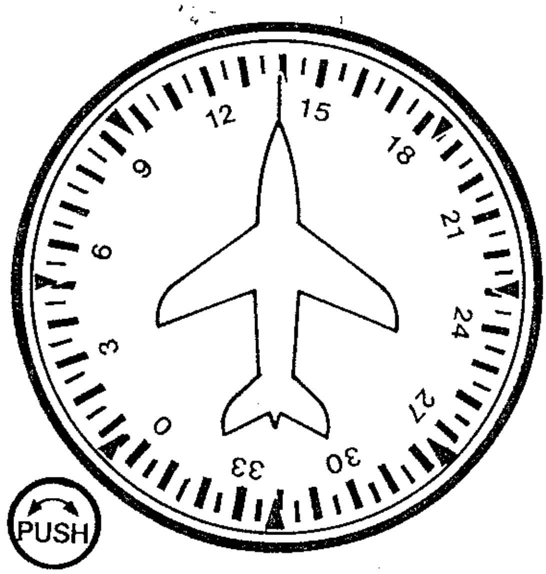
A suction pump is driven by the engine, the amount of suction generated being indicated on a gauge in the cockpit (Item 23 Fig 8.4) (Item 24 Fig 8.4B). For the suction instruments to be reliable, the gauge reading should be in the green sector (4.5 to 5.5 in Hg). The gauge reading will be below the green sector (4.5 to 5.5 in Hg) when the engine RPM are less than about 1500 RPM but the gyros will not slow down enough to affect instrument readings if the RPM is below this figure for short periods. The gyro instruments will take about 2 minutes to reach operating speed after start-up and will remain reliable for about 1 minute after suction failure. A failure of the suction supply is indicated only on the gauge; none of the suction-driven instruments have any sort of failure indicator on them. Thus the suction gauge should be monitored periodically during flight, particularly under instrument flying conditions.

6.6.5 Suction Driven Instruments (Ref Illustration 8.4 and 8.4B)

The Artificial Horizon The artificial horizon (Item 20 Fig 8.4) (Item 22 Fig 8.4B) indicates the pitch and bank angles of the aircraft. An aircraft symbol datum in the centre of the instrument can be adjusted with a knob on the instrument to allow for alignment of the instrument for pilots of different sitting height. The bank indications are calibrated at the top of the instrument and show 10°, 20°, 30°, 60° and 90° of bank.



The Directional Gyro The directional gyro (Item 17 Fig 8.4) is used to give correct heading information during turns when the magnetic compass can be unsteady and unreliable. It is calibrated from 0-360° with numbers, omitting the last digit, every 10°. Thus a heading 290° is shown as 29. There are marks at every intermediate 5° and reading to greater accuracy requires interpolation. The numbers on the scale increase clockwise. To align the indicator with the magnetic compass the setting knob must be pushed in and kept in whilst it is then rotated; this action uncouples the face of the instrument from the gyro and allows it to be turned to give the same reading as the magnetic compass. The knob may then be released, recoupling the face of the instrument to the gyro: the knob should then be twisted to ensure that it has disconnected from the face. As long as the correct suction pressure is maintained and the aircraft altitude is kept within the instrument limits, the direction gyro should maintain accuracy to within 10° per hour. It should be monitored regularly to ensure that it is correctly aligned with the magnetic compass. The gyro will remain accurate following manoeuvres of up to 60° of bank and pitch but its accuracy should always be checked after any violent manoeuvring.



6.6.6 The Stall Warning

Stall warning is given to the pilot by a buzzer and a warning light which come on when the wing angle of attack is approaching the stalling angle; they are set to operate between 5 and 10 kts before the stall. The warning is activated by a vane on the port wing leading edge which is held down by gravity; as the angle of attach of the wing increases, a stage is reached where the airflow is coming from under the vane and lifts it up, activating the warning device. The system is electrically powered through the master switch and a circuit breaker, and can be tested before flight by switching the master on and applying light finger pressure to lift the vane. As the system is gravity controlled and is set for erect flight it cannot be used for inverted flight.

> 6.6.7 The Magnetic Compass (Ref Illustration 8.4 and 8.4B)

The magnetic compass (Item 47 Fig 8.4) (Item 50 Fig 8.4B) is a pendulously suspended permanent magnet with liquid damping; provision is made for correction of errors and a compass error card indicates where residual errors need to be applied to obtain correct headings. The compass correction card lists headings every 30° and gives the indicated compass reading that must be steered to achieve this heading. For example, it may say 'for 120° steer 122°'; this means that if you want to fly a heading of 120°, you must steer 122° on the magnetic compass, ie the error is +2°. Steering an intermediate heading will require interpolation of the errors shown on the card. A sample card is shown below along with some worked examples. The card in your aeroplane will not have the same figures as this example. <

Compass Correction Card

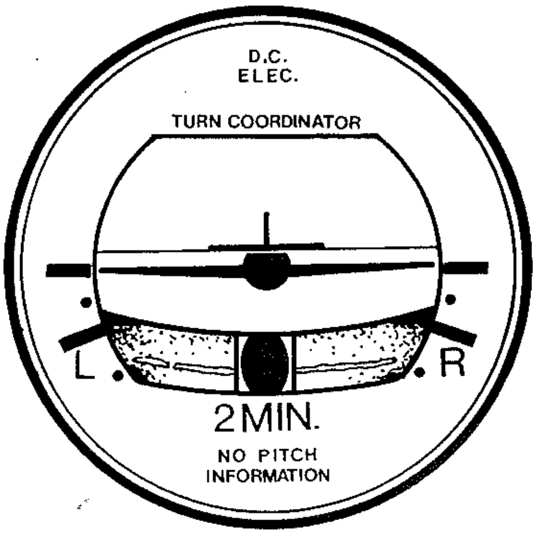
For	N	30	60	E	120	150	DATE 1-6-84
Steer	001	031	061	090	119	148	
For	S	210	240	W	300	330	
Steer	181	210	241	270	302	331	

Examples

1. If you require heading 120°, steer 119° on this compass.
2. If you require heading 160°, steer 158° on this compass.
3. If you require heading 295°, steer 297° on this compass.
4. If you require heading 040°, steer 041° on this compass.

6.6.8 The Turn Co-ordinator (Ref Illustration 8.4 and 8.4B)

The turn co-ordinator (Item 16 Fig 8.4) (Item 18 Fig 8.4B) provides the pilot with turn information only. It is calibrated to show a rate one turn (3° per second) in either direction but is not calibrated beyond this; if the aircraft is turning at more than rate one it is not possible to ascertain the actual rate of turn from this instrument. The turn co-ordinator employs a gyro whose inner gimbal is not quite horizontal; this results in the instrument being responsive to roll as well as yaw, rendering it more direct reading than the conventional turn indicator and making is possible to roll into and out of turns without having to allow for instrument lag. The instrument presentation makes use of an aircraft symbol similar to the artificial horizon but it gives no pitch information; great care must be taken not to be misled by the aircraft symbol which apparently indicates that the aircraft nose is in the level position. The gyro is electrically driven, power being supplied by the master through a circuit breaker; a small red warning flag appears on the face of the instrument when no electrical power is available. Being electrically driven the instruments will not be affected by a suction system failure. In the event of failure of the artificial horizon, the turn co-ordinator becomes a primary flight instrument.

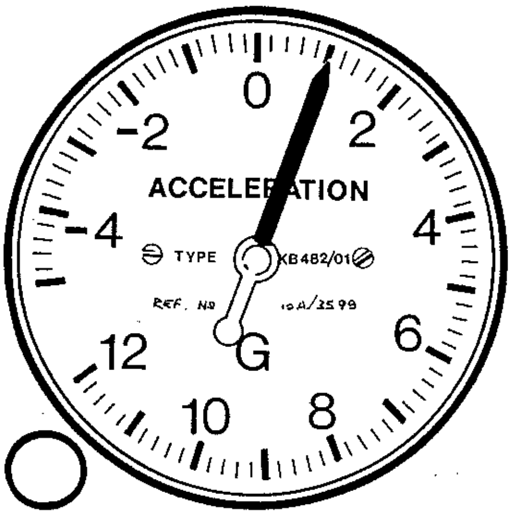


> 6.6.9 Miscellaneous Instruments (Ref Illustrations in Section 8)

The Clock The clock is electrically powered, a small spring being rewound by a solenoid every few minutes. It has a conventional face with full sweep second hand. It is permanently connected to the battery through a fuse not accessible to the pilot.

Mod 305 A battery operated digital clock is fitted in place of the original equipment.

The Accelerometer An accelerometer shows instantaneous 'g' readings and maximum and minimum pointers show the maximum and minimum 'g' experienced since the instrument was last reset. The maximum and minimum pointers can be reset by twisting the resetting knob in a clockwise direction, or by pushing the knob in, dependent on the make of instrument. The instrument requires no power.



The Outside Air Temperature Gauge An electrical outside air temperature gauge gives an instantaneous reading in °C. The temperature probe is mounted on the side of the fuselage just in front of the fresh air louvre intake. Electrical power is supplied by the master through a circuit breaker.

(PRE MOD 734)
A secondary use of the OAT Gauge is obtained by pressing test switch which then indicates temperature of the main GRP structure at the wing/fuselage junction. The sensor is placed inside the port side of the cockpit structure below the instrument panel. A limit of 50°C is placed on the aircraft structure above which aerobatics may not be performed. <

> (POST MOD 734)
A secondary use of the OAT Gauge is obtained by turning a rotary switch located next to the gauge in a left or right direction. The gauge then indicates the temperature of the main GRP structure. The switch is spring loaded to return to the center position when released. Both sensors are placed inside structure against the aft face of the main spar. The left sensor is positioned outboard of rib 6, in the port wing and the right sensor is positioned at the wing root port side. A limit of 50°C is placed on the aircraft structure above which revised "g" limits (Section 2) apply. <

6.6.8A <u>The Turn and Slip (Mod M514)</u> (Ref Illustration 8.4D and 8.4E)

The turn and slip indicator provides turn information. It is calibrated to show a rate of turn of up to 3° per second (two minute turn) in either direction. If the aircraft is turning at more than this rate it is not possible to ascertain the actual rate of turn from this instrument. The turn and slip indicator uses an electrically driven gyro. The instrument is responsive to roll as well as yaw, making it possible to roll into and out of turns without having to allow for instrument lag. Power for the instrument is supplied via a 1 Amp circuit breaker, when the master switch is in the ON position. A small red warning flag appears when no electrical power is available.

the inclinometer part of the instrument, a ball in a liquid filled glass tube, indicates coordination. Gravity and centrifugal force act on the ball. When the aircraft is in coordinated flight, the ball will be centered.

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6.6.10 Normal Use

Before starting the engine, remove the pitot cover and static vent plugs and test the stall warning system. Once the engine has been started, check the vacuum system, align the directional gyro (or HSI) with the magnetic compass and set the datum on the artificial horizon. Check and cross-check the altimeters with a known pressure setting and ensure that the airspeed and vertical speed indicators are within limits. Check that the power failure warning flag is not showing on the turn co-ordinator (or Turn and Slip). Once taxying, check that the compass, directional gyro (or HSI), artificial horizon and turn co-ordinator (or Turn and Slip) give correct indications in turns in both directions. Switch on the pitot head heater before takeoff if required.

In flight, monitor the vacuum and electrical systems for failure. Reset the directional gyro periodically and reset the altimeter sub-scale settings as appropriate. Relate the outside air temperature to conditions outside the aircraft for warning of icing. When manoeuvring, refer to the accelerometer to ensure that the 'g' limits are not exceeded.

6.6.11 Malfunctioning

Electrical Failure In the unlikely event of a total electrical failure (alternator and battery both dead), the pitot head heater, turn co-ordinator, stall warning, clock and outside air temperature gauge will all stop working. If any one of these services fail without signs of any other failure, check its circuit breaker and reset if necessary. The pressure instruments and suction driven instruments will continue to function but a torch would then be needed to read them at night.

Vacuum Failure The vacuum gauge will indicate below the green section and the artificial horizon and directional indicator will become unreliable. The pressure instruments and electrically driven instruments will continue to function.

6.7 FLYING CONTROLS AND FLAPS

6.7.1 General Description

The flying controls comprise conventional elevators, ailerons, rudder and flaps. Elevator trimming is available to the pilot.

6.7.2 Control Columns

The two control columns are linked together so that movement of one always results in identical movement of the other; they cannot be disconnected or removed. The top of each control column incorporates a press-to-transmit button.

6.7.3 The Elevator and Trimmer (Ref Illustration 8.5)

Mass and horn balanced elevators are fitted to both sides of the tailplane trailing edge. Fore and aft movement of the control columns is transmitted to the elevator control surface by rods and bell cranks. The system is balanced fully nose up (control columns fully rear) on the ground with no airspeed or engine airflow.

The left-hand elevator incorporates a trimming tab covering about half the elevator trailing edge. A handwheel (Item 1 Fig. 8.5) in the cockpit operates the trimmer, movement being transmitted by a solid core cable. A trimmer position indicator (Item 2 Fig. 8.5) is fitted in the cockpit just in front of the operating wheel; trim positions are marked U for nose up, N for neutral and D for nose down. About 6mm (1/4 inch) of up-and-down play can be felt at the trimming tab when it is tested for security during the pre-flight inspection; this is acceptable.

6.7.4 Ailerons

Differential Frise ailerons occupy the outboard third of each wing trailing edge. Lateral movement of the control columns is transmitted to the ailerons by control rods and bell cranks. No trimming is possible in flight but the port aileron is fitted with a metal trim tab which can be adjusted on the ground by ground engineers only.

6.7.5 Rudder

The rudder is operated by either pair of linked rudder pedals. The two sets of pedals are interconnected so that movement of one set results in identical movement of the other. Movement is transmitted from the pedals to the rudder by cables and pulleys, the cable tension being maintained by springs which hold the rudder pedals forward. The rudder pedals can be adjusted to allow for leg length. The rudder pedals also provide for nosewheel steering and wheel braking; this is described in this section at 6.5.5 and 6.5.6.

6.7.6 Control Lock

A control lock is introduced by Mod.435. This consists of a transverse bar with sockets which locate on the rear faces of the control columns. At the centre of the bar is a further socket which, when secured by the flap lever in the Flaps Up position, locks the ailerons neutral and the elevator fully down.

There is no stowage for the control lock, which must be removed from the aircraft before flight.

Depending upon the likely wind conditions and the direction in which the aircraft is parked, the controls may be locked by using the right-hand pilot's buckle strap and one of the right-hand shoulder straps, passing them around the left-hand control column and taking up the slack.

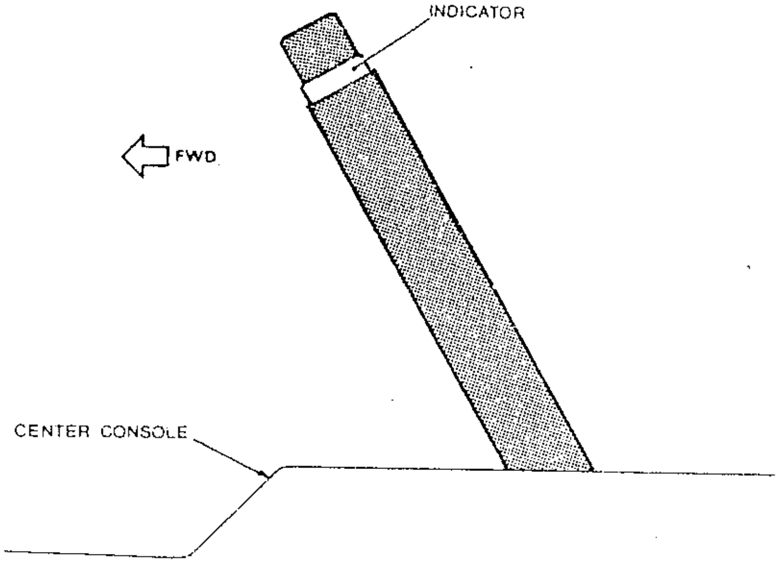
The rudder/nosewheel should be left on full right lock. In this position the nosewheel/ground friction prevents movement of the rudder in windy conditions.

6.7.7 Flaps (Ref Illustration 8.5)

The flaps occupy the inboard two-thirds of each trailing edge, a small portion of the extreme inboard trailing edge not being used so that it can form a walkway. No portion of the flaps is stressed for walking on. The flap control has 3 positions:- UP; 18° (takeoff); and 40° (landing). So that there will be no air loads felt when operating the flaps in the air, a spring is fitted which assists down selection. This results in the flaps being strongly biased in the down direction on the ground, and care must be taken when lowering them on the ground to stop them from slamming to the down position. The control lever (Item 3 Item 8.5) is positioned on the centre console and can be locked in any of the 3 flap positions; when the lock is fully engaged, a dark coloured spring-loaded button in the end of the control lever protrudes far enough to show a white ring at the base of the button. To move the flap from one selection to another, the button must first be pressed in to disengage the lock; the lever is then free to move. As the flaps approach the required position, the button should be released so that it is free to engage the lock at the new position. On the ground, the spring balance tends to pull the flaps down and this makes it difficult to disengage the lock; to achieve this it is necessary to push the flap lever in the UP direction to balance the spring pressure before attempting to press the button in.

The flaps are correctly locked when the button in the end of the selector lever protrudes far enough to enable the white band locking indicator on it to be seen. It is important, particularly when raising the flaps, to check that the locking indicator is visible; if it is not, then the flaps are not correctly locked and may move to a different position without action by the pilot.

There is no flap position indicator as both flaps can easily be seen from either seat.



Flap Lever Locking Indicator

6.7.8 Normal Use

Before flight, check the condition of the control surfaces and tabs and ensure that all drain holes are clear. Once in the aircraft, check the elevators and ailerons for full, free and correct movement. Ensure that the trimmer moves over the full range. Check the correct operation of the flaps at all 3 settings and leave them up for taxying. Once taxying, check the rudder and nosewheel for full, free and correct movement.

After takeoff, raise the flaps at a safe height and speed, ensuring that the locking indicator is then visible. For landing, use the flaps as required. After landing maintain directional control using the combination of the rudder, nosewheel steering and brakes as necessary.

6.7.9 Malfunctioning

If, immediately following flap selection, an undemanded roll occurs, visually check that both flaps are in the same position; if they are not or if difficulty is experienced in holding an out-of-trim roll force, return the flaps to the previous setting. Leave the flaps in this position and land at the nearest suitable airfield.

6.8 RADIO EQUIPMENT

The available radio fits make provision for some or all of the following facilities:

a. Intercommunication between crew members.

b. Single or two VHF communications radios.

c. An audio control panel.

d. A loudspeaker.

e. A hand microphone.

f. VOR.

g. ILS and markers.

h. DME.

i. A transponder with or without height encoding.

j. ADF.

More sophisticated equipment is available subject to special order.

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