



British Rail

TECHNICAL TRAINING NOTE APT/5

A.P.T. TRAILER CARS

CONTENTS:-

1. Exterior Passenger Access Door
2. Trailer Car Air Management System
3. Temperature Ltd. Air Conditioning System
4. Denco-Miller Ltd. Air Conditioning System
5. Toilets

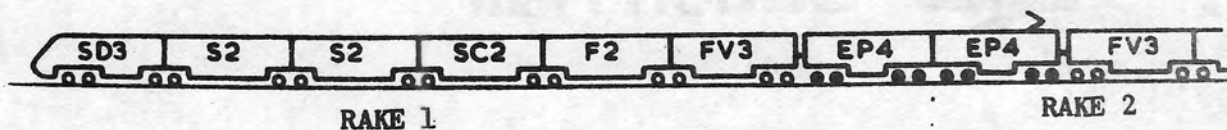
RAILWAY ENGINEERING SCHOOL,
BRITISH RAILWAYS, DERBY.

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APT	5		F2
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APT-P TRAIN FORMATION CODES

250 km/h (2+12) high-powered version (prototype) |



OPERATORS	DTS	TS	TS	TRB	TF	TBF	M	M	TBF
CODE							←	→	

DTS:-	Drg. Trailer Second	or	Second Drg. (3 axles)	SD3
TS :-	Trailer Second	or	Second (2 axles)	S2
TRB:-	Trailer Rest/Buffer	or	Second Catering (2 axles)	SC2
TF :-	Trailer First	or	First (2 axles)	F2
TBF:-	Trailer Brake First	or	First Van (3 axles)	FV3
M :-	Motor	or	Elect Power (4 axles)	EP4

TECHNICAL TRAINING NOTE APT/5AUXILIARY EQUIPMENT TRAILER CARS1. EXTERIOR PASSENGER ACCESS DOOR (See Figs. 1 and 2) end of
handout1.1 INTRODUCTION

The door is a flush-closing sliding plug door with a power operated step which folds flush with the body profile when the door is closed. The door has a power operated lock and an inflatable seal, mechanical position detectors are used to control the operating sequence and also to give indication to the guard when the door is safely closed and locked. A 'safe-edge' fitted to the door leaf will re-open the door if it meets an obstruction during its closing stroke.

1.2 Electrical System (see Figs. 3 and 3a)

The electrical control system takes its power from the 110v d.c. trailer rake supply via main control circuit breaker CF1, control switch CS1 and circuit breaker CCB2. Over-riding control of the doors is exercised by the train crew from either guards van, where the automatic "door-unlock" control is located, passengers can then locally open the access door; passengers may also locally close the door.

(i) Guard's Control

In the guards van is a control panel for passenger access doors and associated functions on that side of the train - either 'A' or 'B'. Each control panel comprises of:-

- (a) A carriage-key operated switch, to control items (b) - (e).
- (b) "Doors Unlock" push button to unlock all doors on that side of the train, which enables the guard to open them, or locally by passengers.
- (c) "Doors Open" push-button opens all doors on the train that have been released.
- (d) "Doors Closed" push-button closes and locks all doors on the train.
- (e) Driver-Guard communication push-button.
- (f) Indicator lamp which lights to show all doors on that side of the train are safely closed and locked.

(ii) Local Controls

Local push-button door controls for the use of passengers are provided at each door, they are

- (a) The internal 'open' push-button is mounted chest high on the door itself.
- (b) The 'Close' push-button is provided on the adjacent vestibule wall and may be operated from within the coach, or without when the door is open.
- (c) The external 'Open' push-button is mounted on the door itself at normal handle height, 'open' control is only available when the guard has 'unlocked' the doors.

1.3 Operating Sequence (See Fig. 4) end of handout

(i) Opening

Door circuits on one side of the train are released by the guard, the guards indicator light will go out, the operation of the local exterior or interior "Open" push-button, or of the guards "open" push-button will cause the following sequence to take place:-

- (a) Door Latch is released by machanical spring, assisted by air pressure, as latch moves door seal deflates, seal pressure is exhausted.
- (b) Step Latch is released by air pressure.
- (c) Step actuating cylinder is vented and step will lower by gravity and air pressure.
- (d) Door actuator starts to move (6 bar).
- (e) Door closed detector senses movement of door and supply pressure to door actuator is reduced to 3 bar.

(ii) Closing

A remote "Close" signal from the guards control panel will cancel the "Unlock" signal to all doors - a local or remote "Close" signal will cause the following sequence to take place:-

- (a) Door actuator starts to move, 3 bar pressure door starts to close.
- (b) Step latch cylinder is vented.
- (c) Door closed detector detects door is virtually closed.
- (d) Door actuator pressure is increased to 6 bar.
- (e) Step actuator moves to raise step.

(ii) Closing (Cont'd)

(f) Door latch actuator is closed by air pressure to lock the door.

(g) Door seal inflates 1 bar.

When the step is raised, being flush with the passenger door a mechanical interlock allows the step-latch to engage by spring force - this is detected electrically.

When all doors are closed on one side of the train the respective indicator lamp for that side is illuminated.

(iii) Safe-Edge operation

The safe-edge is a pneumatic drive, and contact with the safe-edge during the doors closing stroke will activate an air pressure switch, causing the door to re-open for 5 seconds and then re-close.

The safe-edge is however inactive once the door has fully closed and the step has risen.

(iv) Re-opening

If for any reason one or more of the doors fail to close completely, those doors may be re-opened by the guard, without unlocking the remainder again, simply by pressing his "open" control. This will re-open any doors which have not been detected fully closed and locked.

(v) Door Timings

Opening - 4 seconds minimum to 8 seconds maximum.

Closing - 4 seconds minimum to 8 seconds maximum, excluding the seal inflation.

1.4 Emergency Operation

In an emergency any door may be opened from the inside with or without air pressure, electrical power or release by the guard.

An emergency valve with handle is located in vestibule wall at shoulder height, and is protected by a fragile transparent cover. When the emergency valve is operated the step latch will be released (mechanically, bowden-cable), and the air pressure holding the door and step closed will be vented. The step will fall under gravity, so enabling the door to be pulled open.

. . The door latch is released on loss of air pressure by its internal spring.

1.4 Emergency Operation (Cont'd)

NOTE: The pneumatics are supplied with dry filtered air at 7.5 to 9.5 bar.

Loss of Train Supply Air pressure will have no immediate effect on the door, air is held in the door pneumatic system by the non-return characteristics of the supply pressure regulating valves. Should air be lost in the door control system, the door latch will open, the door seal will deflate, and air pressure will be lost from the step actuating cylinder. The step is prevented from falling by it's latch, which can only be released by a positive application of air pressure, or by operation of the manual emergency valve. The presence of the raised step is sufficient to prevent the door from opening.

1.5 Electrical Control Sequence (Figs. 3 and 3a)

Circuit drawn with door closed, all relays de-energised.

NOTE: Relay DR4 is energised under normal running conditions i.e. Door closed and 110v D.C. supply available.

(a) Normal Operation

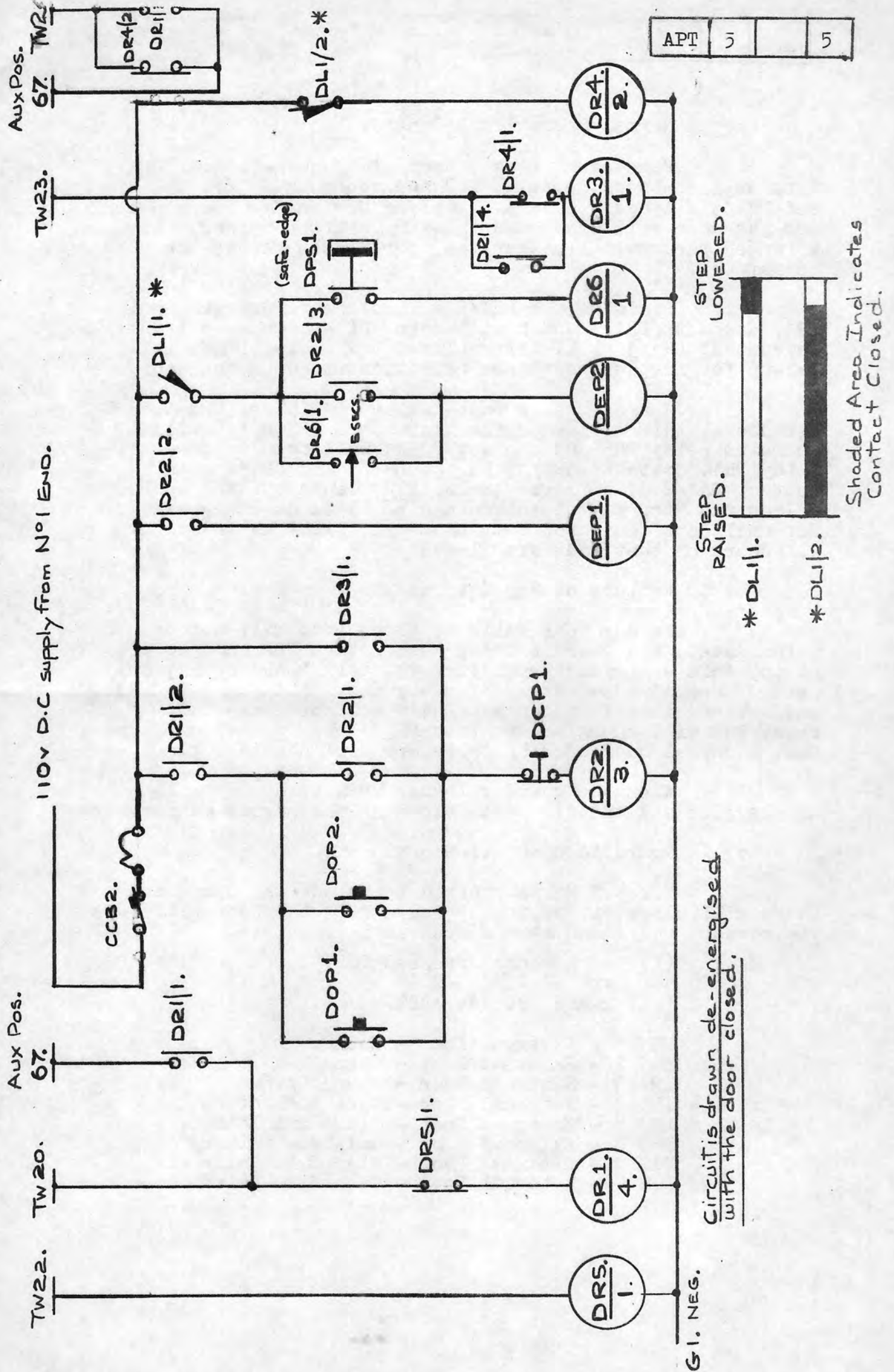
When the guard presses Un-lock push button (TDB1), train wire 20 is pulsed to energise relay DR1, the relay holding itself energised via contact DR1/1, contacts DR1/2, DR1/3 and DR1/4 will also close.

Contact DR1/2 will "set up" the local passenger door open operation circuit, DOP1 and 2, contact DR1/3 will energise Train Wire 24 which in turn will energise relay DR15, contact DR15/1 opens, and the external Door Indicator lamp (LP14) will go out, to indicate doors unlocked.

With either door open push-button pressed (DOP1,2), relay DR2 is energised, contacts DR2/1 DR2/2 and DR2/3 will close. Contact DR2/1 retains the supply to relay DR2, contact DR2/2 closes to energise Step E.P. valve DEP1, this will open the door latch, step latch and allow the step to fall; contact DR2/3 being closed and limit switch DL1/1 closed (step lowered) will energise Door Open E.P. valve DEP2, this will open the door.

Limit switch DL1/2 opens when the step is lowered to de-energise relay DR4, contacts DR4/1 and DR4/2 both close, DR4/2 in parallel with contact DR1/3.

EXTERNAL DOOR CONTROL, TRAILER CAR. - SIDE 'A'. FIG. 3.



(a) Normal Operation (Cont'd)

Passenger presses door close push-button DCP1 this will de-energise relay DR2 and contacts DR2/1, DR2/2 and DR2/3 all open, both E.P. valves DEP1 and 2 are de-energised and the door will close and the step will be raised. (It is arranged pneumatically that the door closes before the step is raised).

Limit switch DL1/2 will close to energise relay DR4, contacts DR4 1 and 2 will open, LP14 remains out due to contact DR1/3 still being closed. The circuit is still set-up for further passenger operations to open the door.

Guard presses push-button TDB2 Close and Lock all doors, this will energise Train Wire 22, which will energise relay DR5 and contact DR5/1 will open to de-energise relay DR1, contacts DR1/1, DR1/2, DR1/3 and DR1/4 open. Contact DR1/2 de-energises relay DR2, Contact DR1/3 opens and as the step is raised Train Wire 24 is de-energised, External Door Indicator Lamp LP14 will light to indicate all doors on that side are closed.

(b) Failure of any Door to close

If any door fails to close LP14 will not be illuminated, the Guard presses push-button TDB3 and holds it in, this energises Train Wire 23, "All Doors Open", as relay DR4 will be de-energised on any door that has not closed and locked, therefore contact DR4/1 will be closed and relay DR3 will energise, contact DR3/1 will close to energise DR2, a normal door opening procedure will now take place.

When the guard releases TDB3 relay DR3 will de-energise and the door will close in the normal manner.

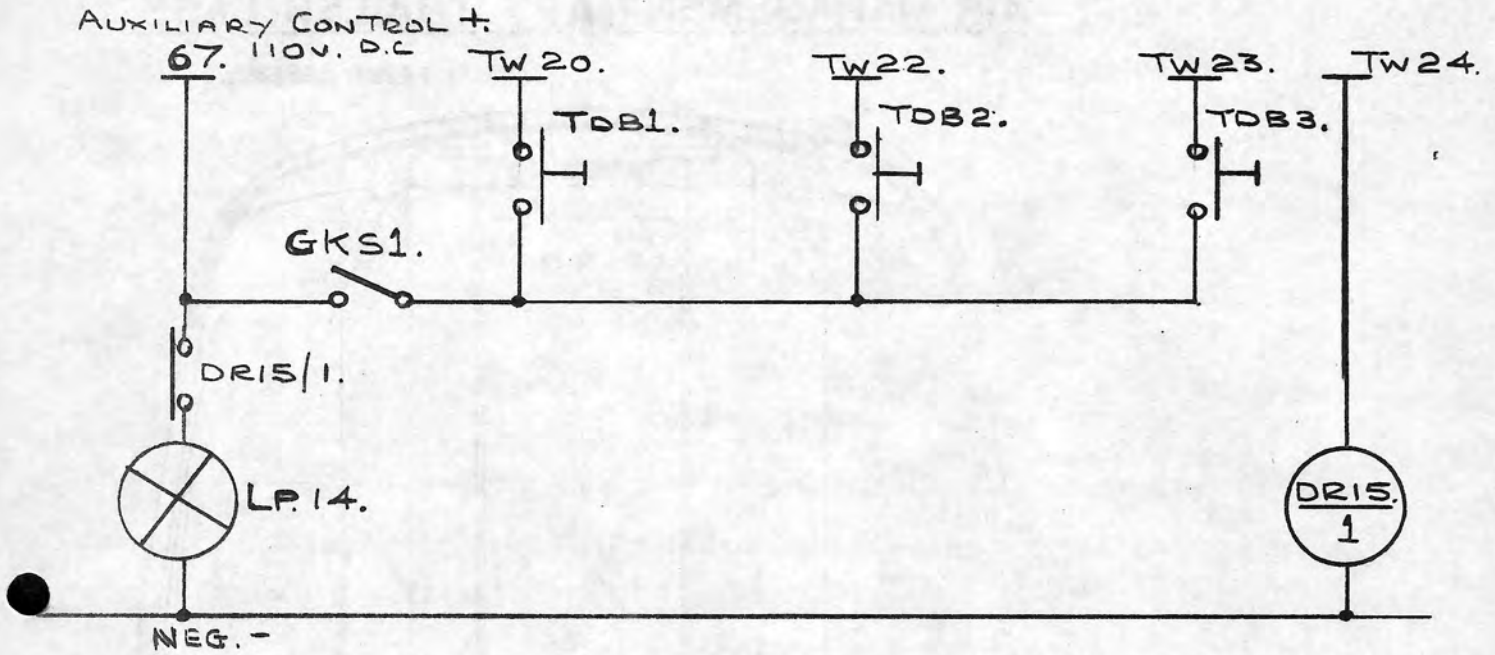
(c) Guard to Open all Doors

First TDB1 is pressed to unlock the doors and DR1/4 will close, if he then presses TDB3 the door will open via contact DR3/1 and remain open until either:-

- (i) a passenger presses DCP1
- or
- (ii) guard presses TDB2.

- DR1 1 - External Door - Unlock
- DR1 2 - External Door - Open
- DR1 3 - External Door - Guard Open
- DR1 4 - External Door - Open Indication
- DR1 5 - External Door - Close and Lock
- DR1 6 - External Door - Safe Edg Timing
- DEP 1 - External Door - Step E.P. Valve
- DEP 2 - External Door - Open E.P. Valve

EXTERNAL DOOR CONTROLS, GUARD'S POSITION 'A' SIDE. FIG 3a



KEY

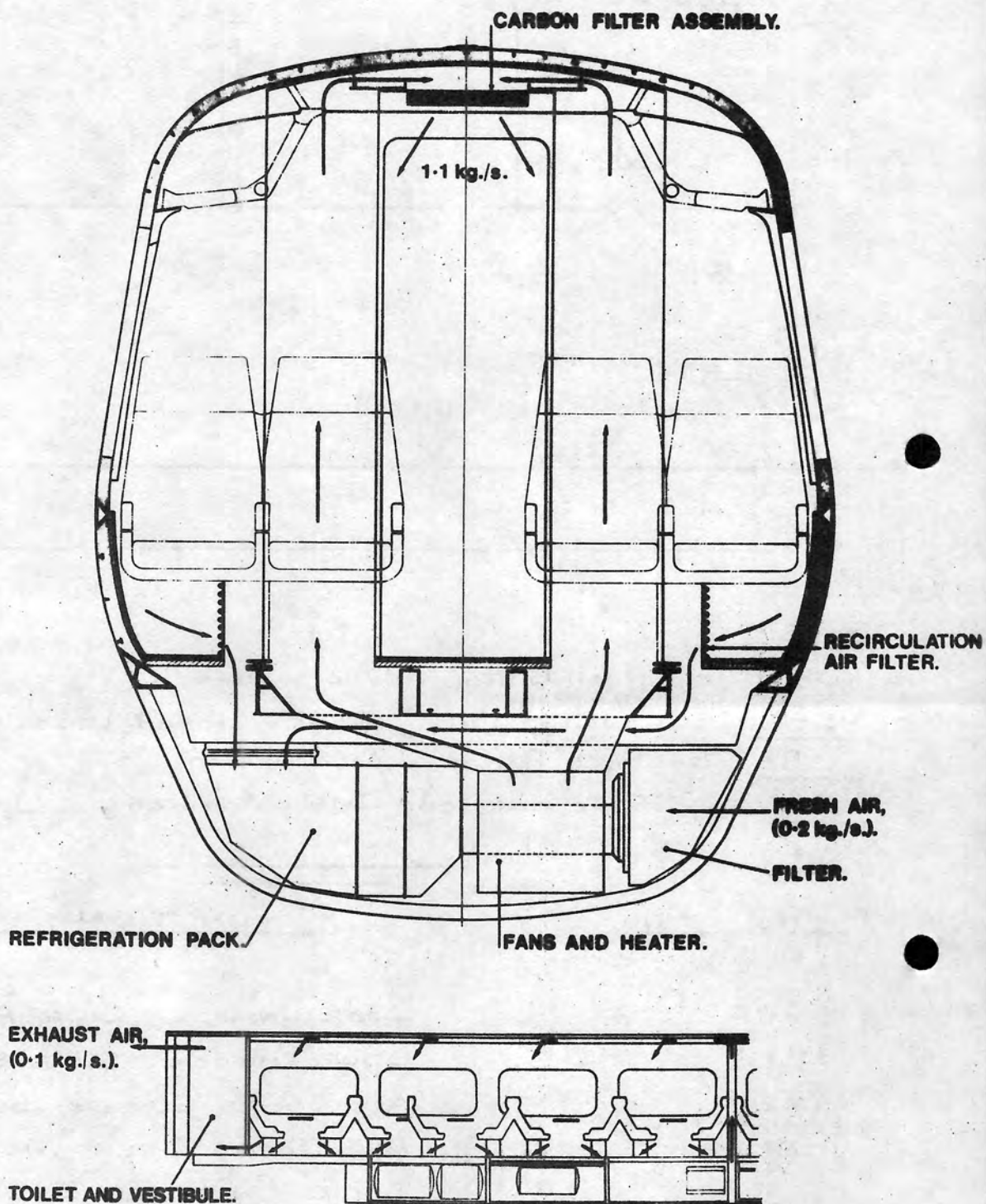
- GKS1. - Guard's Key Switch.
- TDB1. - Push Button - Doors Unlock.
- TDB2. - Push Button - Doors Close & Lock.
- TDB3. - Push Button - Door Open.
- LP14. - External Door Indicator Lamp - 'Unlocked'.

TRAIN WIRE No.

FUNCTION.

- | | |
|-----|-------------------------------------|
| 20. | DOOR UNLOCK SIDE 'A'. |
| 21. | DOOR UNLOCK SIDE 'B'. |
| 22. | ALL DOORS CLOSE & LOCK. |
| 23. | ALL DOORS OPEN. (GUARD) |
| 24. | DOORS UNLOCKED INDICATION 'A' SIDE. |
| 25. | DOORS UNLOCKED INDICATION 'B' SIDE. |
| 67. | AUXILIARY CONTROL POSITIVE. |

FIG

AIR MANAGEMENT. APT TRAILER CARS.

2. TRAILER CAR AIR MANAGEMENT SYSTEM

2.1 Introduction

The A.P.T. train sets are equipped with full air conditioning, maintaining the high environmental standards afforded to B.R. inter-city railway passenger vehicles. Air conditioning came into being through the need to reduce the high noise levels which are associated with opening window lights, once windows are sealed unless air conditioning were employed it would have been technically very difficult to provide the large air flows that are required by an alternative method.

2.2 Objectives

The design coach interior temperature was set at $20^{\circ}\text{--}21^{\circ}\text{C}$, this temperature being allowed to increase linearly to 25°C during ambient temperature change from 20° to 30°C , with maximum passenger loading and full sunshine. Maximum relative humidity levels were set at 65%. Interior noise levels which are primarily a function of vehicle speed track condition and the locality through which the vehicle is passing. The noise levels aimed for are 68 DBA and 76 DBA in open country, when the train is stationary the target is 58 DBA.

Also pressure changes arise which may cause discomfort to passengers, hence on A.P.T. the maximum pressure change which occurs when another train is passed in a tunnel is set at 3KN/m^2 (0.45 lb/in^2), to restrict this rate of pressure change necessitates well sealed vehicles together with a means of closing air conditioning inlets and outlets.

2.3 Thermal Loads

When in the "Heating" mode, the heat input to a passenger vehicle is used to offset conduction and convection losses through the vehicle surface together with the heat required to raise the temperature of the ambient ventilation air to that of the vehicle interior. Heat input to ventilation air is proportional to the fresh air mass flow utilised and it is in this respect that A.P.T. vehicles differ somewhat from B.R. Inter-City Air Conditioned vehicles, as very low fresh air flows are employed in order to effect energy savings. Apart from the steady state requirements the heating capacity has to provide an acceptable pre-heating performance, that the coach internal temperature rises from 0°C to 20°C in 90 minutes, with an ambient temperature of 0°C , the heating capacity is 24KVA per coach.

2.3 Thermal Loads (Cont'd)

When in the "Cooling" mode the heat/thermal loads are varied and numerous when a high ambient is experienced, and are typically as follows:-

- (i) Conduction and Convection (sensible)
- (ii) Solar Heat Load (sensible)
- (iii) Fresh Air Heat Load (sensible and latent)
- (iv) Auxiliary heat loads, lighting fans etc. (sensible)
- (v) Passenger Load (sensible and latent)

In extremes of summer ambient temperatures and humidity coupled with direct sunshine result in the internal temperature of the vehicle rising to a maximum of 25°C, fully loaded.

The cooling capacity gives acceptable "pre-cooling" performance, the requirement being that the coach internal temperature should be reduced to 25°C from a "hot-soaked" condition in an ambient of 30°C in not more than 90 minutes

2.4 Air System (See Fig. 1)

In all air conditioning systems used for passenger comfort flow rates and distribution are the critical factors, ensuring that passengers do not experience draughts, air movement may be detected but the overhaul objective is for the air movement to be sufficient to mix with the air to be conditioned and carry away heat, moisture etc. The velocity of the air to be sufficient not to cause stratification of the air, but to ensure by time the conditioned air has arrived at the "breathing-line" the air has lost its velocity.

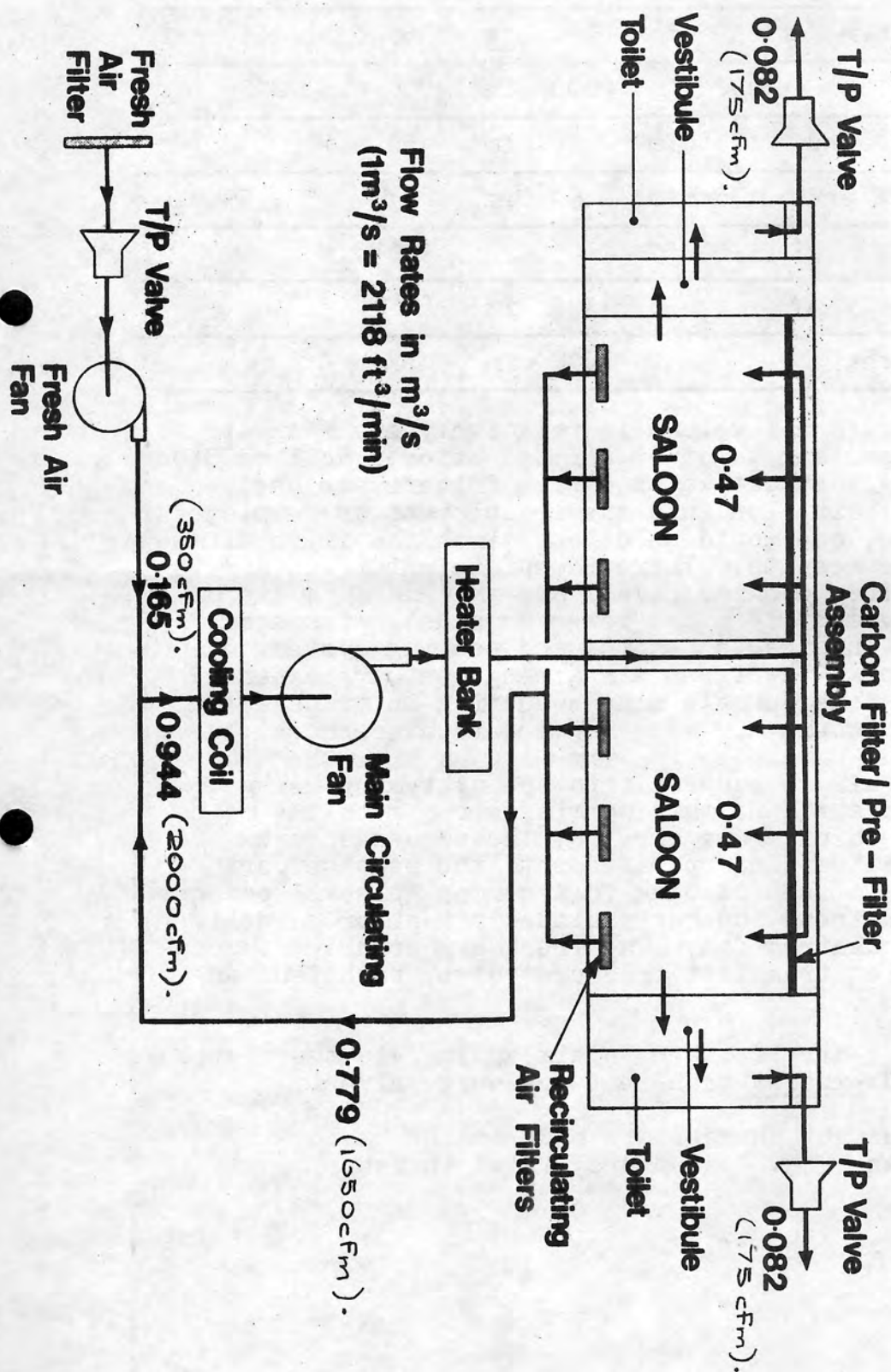
The 4 areas of primary importance are:-

- (i) Recirculation air flow rate (return air).
- (ii) Fresh Air Flow rate.
- (iii) Exhaust Air flow rate.
- (iv) Coach Internal Overpressure.

Total air circulated by the circulation fan is 2000 c.f.m., the exception being the Van Trailer Car which circulates 1700 c.f.m., this comprises of recirculation air and fresh air in the following proportions:-

Fig. 1.

2 AXLE INTERMEDIATE TRAILER CAR



2.4 Air System (Cont'd)

TABLE 1

	I.T.C. SO and FO	I.T.C. Catering	V.T.C.	D.T.C.
Fresh Air	350 cfm	800 cfm	350 cfm	350 cfm
Recirculation Air	1650 cfm	1200 cfm	1350 cfm	1650 cfm
Total Air Flow	2000 cfm	2000 cfm	1700 cfm	2000 cfm
Exhaust Air No 1 end	175 cfm	50 cfm	50 cfm	
Exhaust Air No 2 end	175 cfm	50 cfm		50 cfm
From Van Area			300 cfm	
From Staff Room		300 cfm		
From Kitchen Area		400 cfm		

The fresh air volume is relatively small on A.P.T. vehicles in comparison to other Air Conditioned Rolling Stock, the reason being that activated carbon filters are used to filter the total air flow into the vehicle and are employed to remove odours, one would need four times the fresh air to achieve the same results. There is sufficient fresh air to maintain low carbon dioxide levels and provide adequate oxygen. With this arrangement it makes lower demands in terms of energy consumption on both heating and cooling system. Other benefits of a low fresh air arrangement are extended filter life and considerable size reduction in transient pressure valves (where air is exhausted to atmosphere).

Fresh air is induced into the system by using a separate fresh air fan, this working along with the main circulating fan which draws air from the passenger area via recirculating filters incorporated into the seat support structure where it is lead back to a common 'plenum' chamber which mixes both fresh and recirculated air prior to delivery by the main circulating fan. The fresh air is drawn through a filter and inlet transient pressure valve, both fans are of the 'radial' type.

Exhaust air is taken to atmosphere via the vestibule area, toilet and exhaust transient pressure valves.

Some slight changes are made to the basic air management scheme (Fig. 1) and are listed in Table 1

2.5

Vehicle Insulation

The heat transfer to or from a vehicle structure is determined by insulation and structural details, on A.P.T. vehicles the sidewall and roof are lined with approximately 50 mm of fibreglass insulation, this is increased to 100 mm thickness on the floor area. The sidewall windows are double-glazed with an air gap of 35 mm between panes, the outer pane is treated to reduce solar radiation and only 50% of the incident energy passes via the windows to the vehicle interior.

3. TEMPERATURE LTD. AIR CONDITIONING SYSTEM

Introduction

The air conditioning equipment is mounted in the under belly of each vehicle and is separated (by the longitudinal keel member) into:

- (i) A removable self-contained refrigeration pack including compressor and motor, condensor coils and fan motors, evaporator coils and all the refrigeration controls etc.
- (ii) The air moving and heating equipment, including fliters, recirculation and fresh air fans, heater bank, transient pressure valve and ambient thermostat.

A 'Trafag' 6-stage multistat is used to control the vehicle internal temperature and is mounted in the No. 2 vestibule, its sensing probe being in the return air flow.

3.1 The Power Supply (see Fig. 1)

A.C. power and control supplies are derived from the 415v 50hz 3 phase and neutral via circuit breaker SCB2 (70 amp) located in No. 1 vestibule and change-over switch COS2 located in the under belly contactor panel. The A.C. supply is then taken to the respective compressor and condensor fan motors, circulating and fresh air fan motor and heater bank via circuit breaker switches ACCB1, 2 and 3 located on the under belly contactor panel.

The A.C. control supply at 240v 50hz are taken from the red (A) phase and neutral of the 3 phase supply, the supply is taken to the control circuit via circuit breaker ACCB2 and 4.

The D.C. control supply is derived from the 110v D.C. battery supply via a 40 amp fuse link and control switch located in No. 1 vestibule, batteries are located in both power car and Driving Trailer Car.

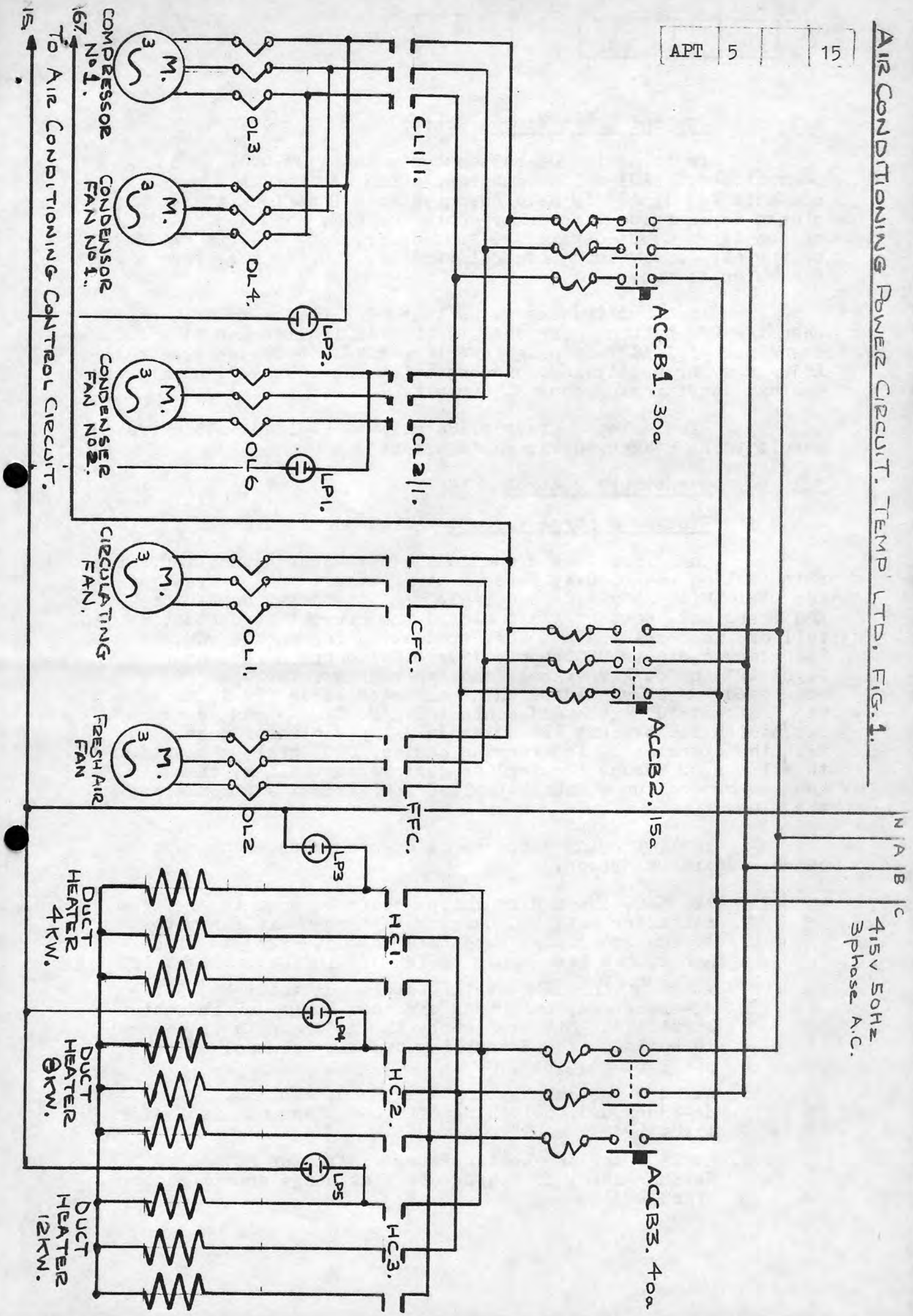
3.2 Control Train Wires (see Fig. 2)

There are four 110v D.C. train lines associated with air conditioning

- TW 14 - Air Conditioning ON.
- TW 15 - Air Conditioning OFF.
- TW 17 - Transient Pressure Valves, CLOSE/OPEN.
- TW 67 - Auxiliary Control Positive.

ON/OFF switching can be done for all air conditioning units by using the Train ON or OFF Air Conditioning Push Buttons in either Van Trailer Cars, providing all control circuit breakers previously mentioned in 3.1 are closed along with the Air Conditioning Isolating Switch AC1S which should be in the ON position.

AIR CONDITIONING POWER CIRCUIT. TEMP LTD. FIG.1.



3.2 Control Train Wires (Cont'd)

Pressing the ON button cause the 110v D.C. to energise contactor coil AC3 which energises contactor coil AC1 via contacts AC3/1, AC1 is held energised via interlock AC1/2, AC1/1 closes to energise time delay contactor ASR, when contact ASR/1 closes after a pre-determined time delay, 250v A.C. is switched to the air conditioning control circuit, causing the circulating fan motor to run.

Air Conditioning is switched OFF in a similar manner, when the OFF button is pressed in the Van Trailer Car 110v D.C. energises coil AC2, opening interlock AC2/1 to de-energise coil AC1 and subsequently ASR, disconnecting the 250v A.C. supply from the air conditioning control circuit.

Time delay contactor ASR allows the load on the train supply to be staggered during 'start up'.

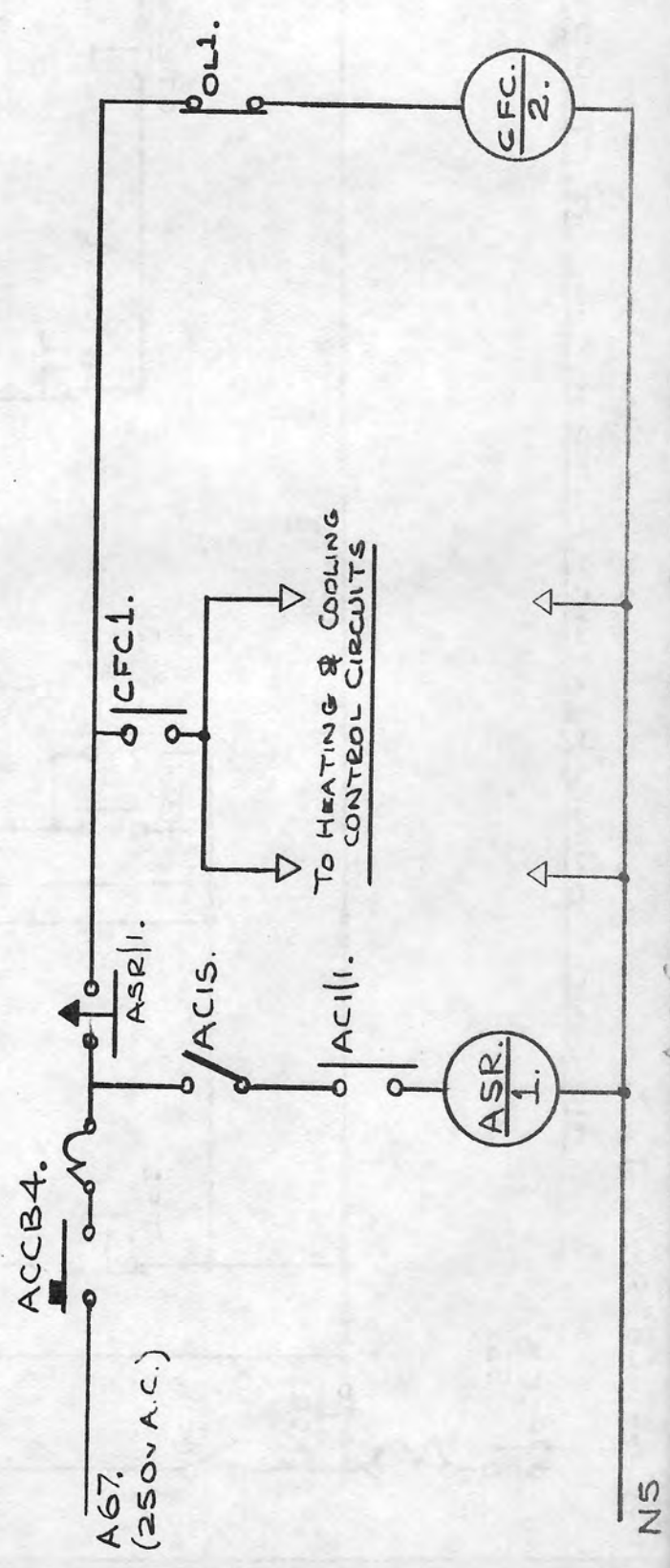
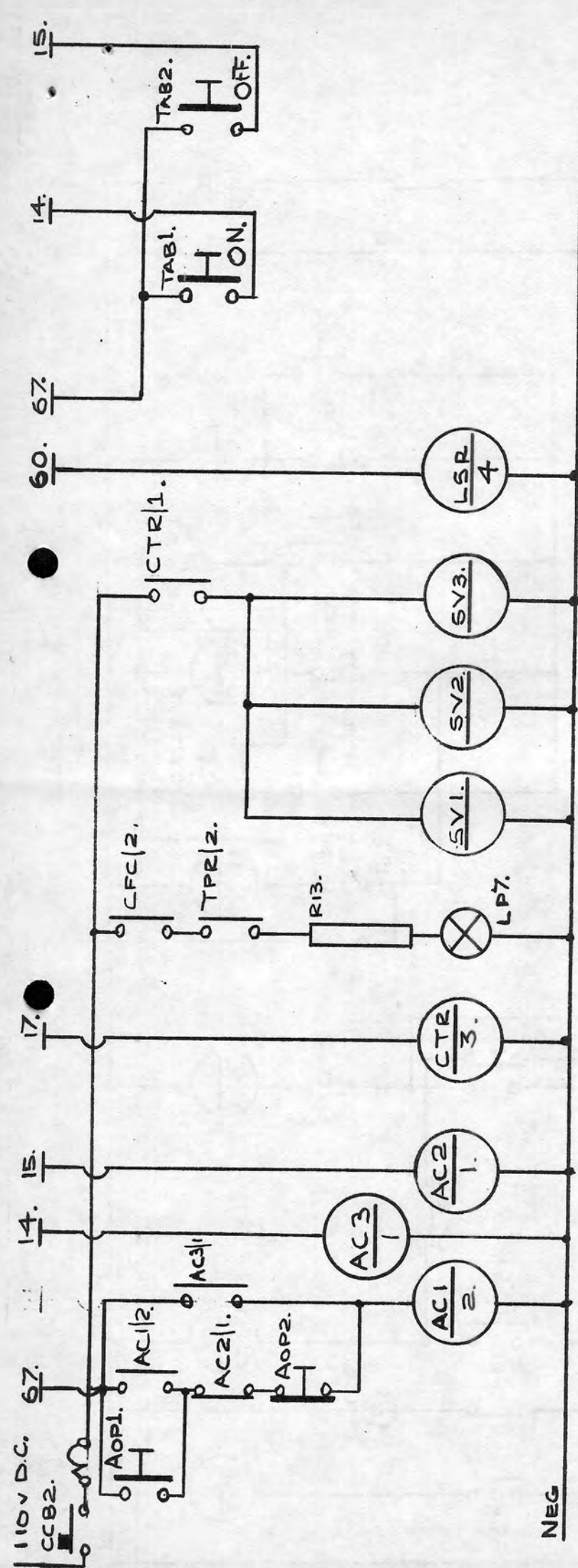
3.3 Temperture Control

Heating Control Circuit (Fig. 3)

The circuit is drawn in the 'pre-heat' condition, with both cooling stages OFF, three heating stages on and fresh air fan OFF. With 250v A.C. available and time delay contactor ASR energised, contact ASR/1 closed the circuit to contactor coil CFC is completed and the circulating fan should run. Secondary contacts CFC2 apply 110v D.C. to green indicator light LP7 in No. 2 vestibule end, providing interlock TPR/2 is closed, as it should be when contactor relay TPR is energised via Trafag 16°C switch and contact CTR/2, TPR1 opens to extinguish fault light LP6 on under belly contactor panel. With the circulating fan running contact CFC1 will be closed to allow A.C. to the 'Trafag' temperture controller, thus heating or cooling cannot be called for without a circulating air flow.

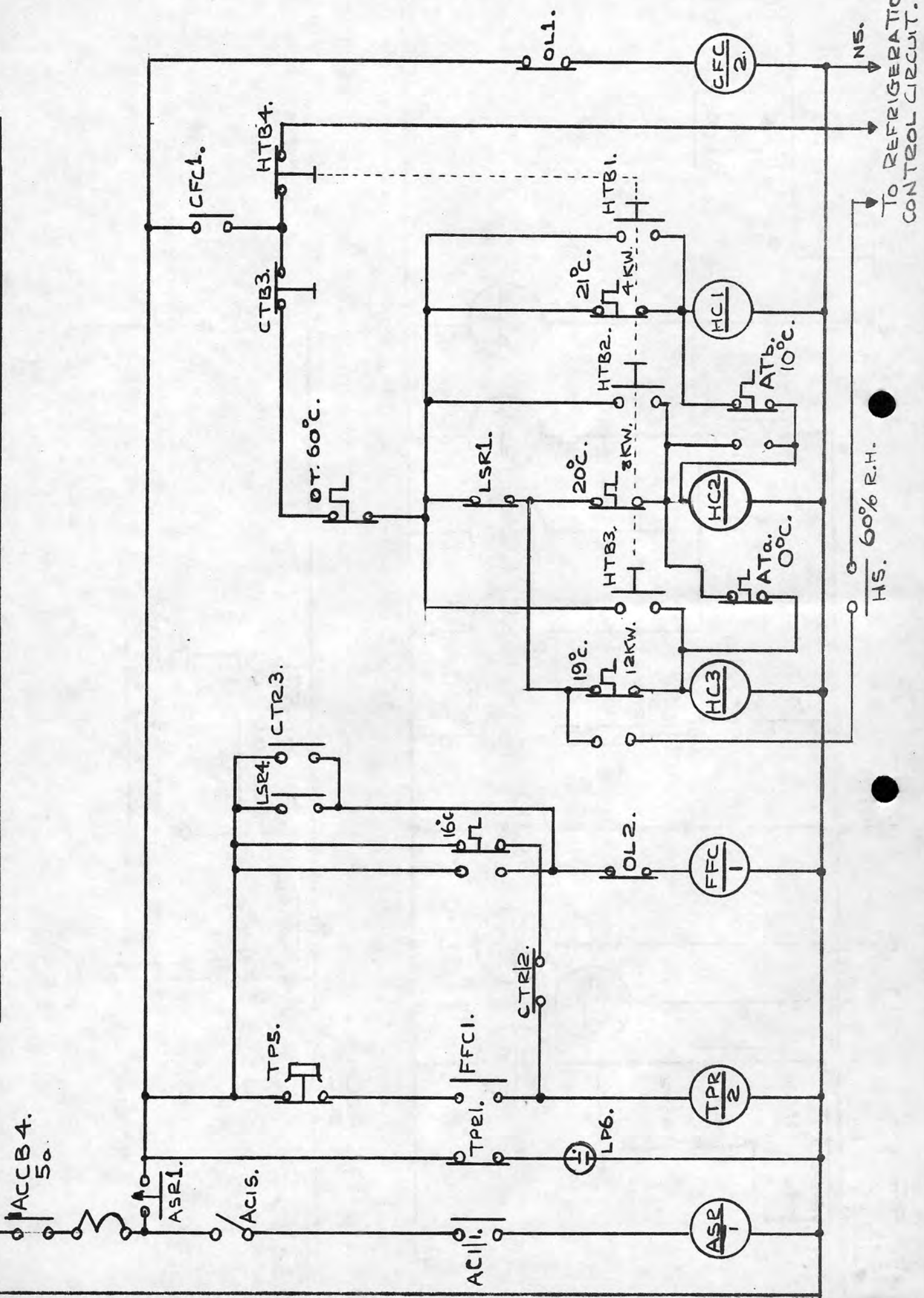
The following sequence of events takes place as the coach temperature rises.

- (i) At 16°C, the recirculation contacts open to energise contactor coil FFC causing the fresh air fan motor to run and closes secondary contact FFC/1 to close and retain the supply to TPR and indicator light LP7
- (ii) At 19°C the 12Kw heating stage contactor HC3 is de-energised, switching off that stage and indicator light LP5. Simultaneously the A.C. supply is connected to humidistat H.S enabling humidity control to take place if required.
- (iii) At 20°C the 8Kw heating stage contactor HC2 is de-energised, switching off that stage and indicator light LP4
- (iv) At 21°C the 4Kw heating stage contactor HC1 is de-energised, switching off that stage and indicator light LP3



AIR CONDITIONING HEATING CONTROL CIRCUIT. TEMP. LTD. FIG. 3.

NS. A67. (250V A.C.)



The vehicle will now assume the ventilation mode until the temperature continues to rise to initiate a cooling stage or falls to initiate a heating stage.

An Ambient Thermostat is necessary because when low ambient temperature conditions are experienced it is necessary to increase the capacity of the heating stages and thus reduce the time for the Coach Temperature to respond to the direction of the Trafag Temperature Controller, this is achieved by the ambient thermostat in the following way:

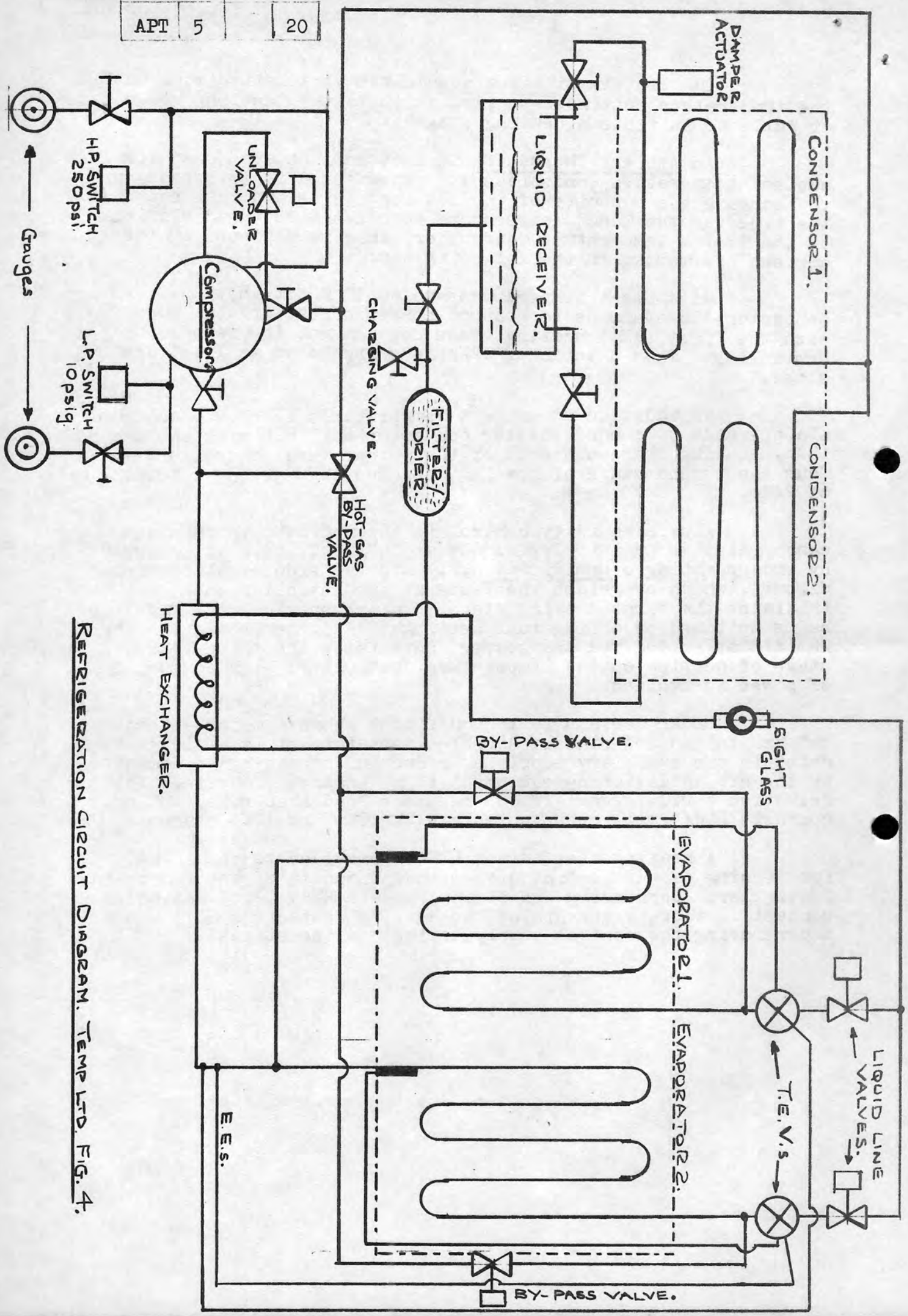
At ambient temperatures below 10°C but above 0°C contactor ATb operates to connect heater contactor coil HC2 with the first (4Kw) heating stage contacts of the temperature controller. Thus a total of 12Kw is switched on as first heating stage.

In addition at ambient temperatures below 0°C contact ATa operates to connect heater contactor coil HCB with the second (8Kw) heating stage contacts of the temperature controller. Thus the second stage of heating becomes 12Kw giving a total of 24Kw.

Also a humidity control is incorporated to maintain coach relative humidity below 60% at $19^{\circ}/20^{\circ}\text{C}$, this is achieved by incorporating a Humidistat H.S. into the electrical control circuit, which overrides the Temperature Controller and initiates the first cooling stage. To prevent the cooling stage being switched on during full heating (24Kw), recirculation the humidistat is fed via changeover contacts on the third (12Kw) stage of heating on the Temperature Controller; high consumption of power is avoided.

Under certain fault conditions where a motor-alternator set has failed and standby diesel-alternator set is employed to maintain the auxiliary supply a reduction of the power demanded by the air conditioning equipment is necessary. To effect this reduction a D.C. signal TW 60 energises load shed relay LSR and contacts LSR/1 will open to isolate the 8Kw and 12Kw stages.

A heating test button HTB is provided to check the functioning of the heating stages independantly of the Temperature Controller. Depressing HTB closes contact HTB1, 2, 3 and opens contact 4, thereby energising the heating contactors HC1, 2 and 3 and removing the control supply to the cooling stages.



REFRIGERATION CIRCUIT DIAGRAM. TEMP LTD. FIG. 4.

Cooling System (Fig. 4)

As in all air conditioning systems, the mechanical compression type of refrigeration is used, the essential equipment used is firstly a compressor which is used to pump the refrigerant (R12) around the system, this being a multi-cylinder reciprocating semi-hermetically sealed type. The compressor raises the temperature and pressure of the refrigerant due to the compression process and then passes the refrigerant to the condenser. The refrigerant arrives at a much higher temperature than the ambient air being forced across the condensor coils by the axial-fan, thus heat from the refrigerant is carried away by the ambient air, this causes the refrigerant temperature to fall causing it to condense to a liquid and pass to the liquid receiver. From the liquid receiver the refrigerant passes through a filter unit, heat-exchanger, sight glass to the expansion valve (T.E.V.), where it meters the liquid refrigerant into the coils of the evaporator. In doing this the pressure and temperature of the refrigerant is lowered as it flows through the evaporator coils, the air being forced over the evaporator coils by the centrifugal-fan being warmer (22°C+) than the refrigerant flowing through the evaporator coils is lowered in its temperature and its moisture content is reduced. The refrigerant leaves the evaporator superheated above its boiling to enter the compressor after passing through the heat-exchanger.

2-stages of cooling are used to give close control and operating efficiency, the first of which leads to the operation of the compressor in the partly unloaded condition, using only one condensor and evaporator, capacity control for both stages is provided for by means of a hot gas by-pass valve situated in the discharge gas by-pass line between the compressor discharge line and evaporator inlets. Also included is a condensor air flow control, which reduces the air flow through the condensor coils when on partial load, thus reducing the power consumption of the respective fan motors.

Cooling Sequence (Fig. 5)

The following sequence of events takes place as coach temperature rises.

(i) At 22°C the first cooling stage contact is closed to energise contactor coil CR1 which in turn via interlock CR1/1 will cause the Compressor and No. 1 Condensor Fan Motors to run, interlock CR1/2 will cause No. 1 Liquid Line Solenoid Valve, No. 1 By-pass Solenoid valve and the Compressor Loading Solenoid valve to energise, giving 50% cooling capacity and energising the indicator light LP2.

(ii) At 23°C the second cooling contact is closed to energise contactor coil CR2 which in turn via interlock CR2/1 will de-energise the Compressor Loading Solenoid valve which will cause the Compressor to pump on all cylinders and after 8 seconds contact CR2/2 will close and cause the No. 2 Condensor Fan Motor to run and the No. 2 Liquid line Solenoid Valve and By-pass Solenoid to energise, making the remaining 50% cooling capacity available and energising the indicator light LP1.

NOTE: When load shedding is taking place only 50% of the Cooling Capacity is available, as the 2nd store of cooling is isolated via interlock LSR/2, see Fig.5.

3.4 Transient Pressure Valves

Operation (Figs 2 and 3)

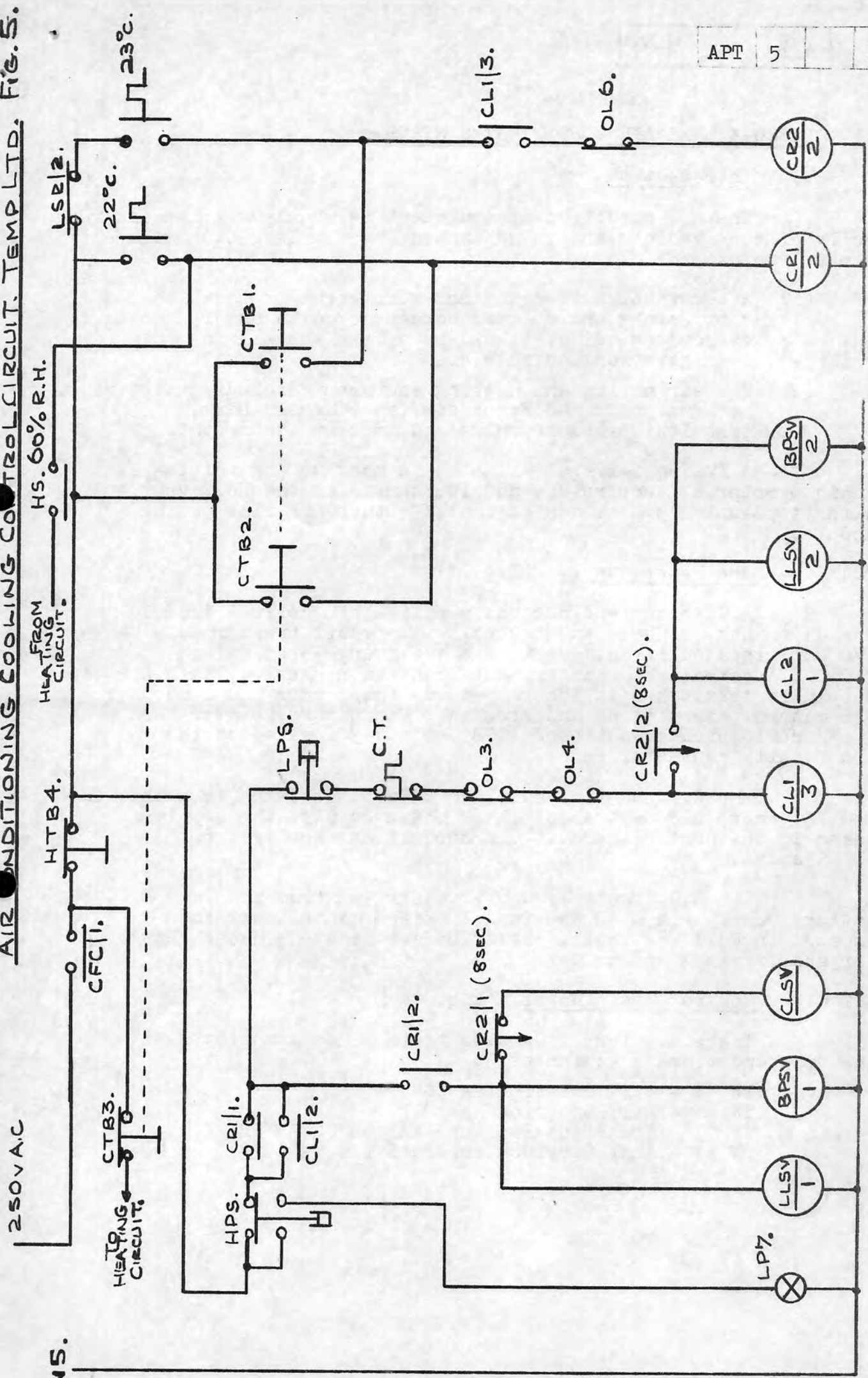
Prior to A.P.T.P entering a tunnel the C.A.P.T. system is activated and applies 100v D.C. to train wire 17 which is held energised for 1 minute, this cause contactor coil CTR3 to energise, contact CTR/1 closes to energise solenoid valve SV1, 2 and 3 operating their respective transient pressure valves to the closed position.

If the fresh air fan is running, the closing of the inlet transient pressure valve causes a depression which opens pressure switch TPS this removes the supply from contactor coil TPR, illuminating red light LP6 and extinguishing LP7.

If the fresh air fan were not running as would be the case in the pre-heat/re-circulation stage secondary contact CTR/3 would close to energise contactor FFC and CRT/2 opens to remove the existing feed to TPR. With the fresh air fan now running LP6 will illuminate and LP7 extinguish indicating that the transient pressure valve is closed.

AIR CONDITIONING COOLING CONTROL CIRCUIT. TEMP LTD. FIG. 5.

N5.



4. DENCO-MILLER AIR CONDITIONING SYSTEM

Introduction

The air conditioning equipment is mounted in the under belly of each vehicle and is separated (by the longitudinal keel member) into:

- (i) A removable self-contained refrigeration pack including compressors and motors, condenser coils and fan motors, evaporator coils, liquid receivers and all the refrigeration controls etc.
- (ii) The air moving and heating equipment including filters, recirculation and fresh air fans, heater bank, transient pressure valve and ambient thermostat.

A Trafag 6-stage multistat is used to control the vehicle internal temperature and is mounted in the No.2 vestibule with its sensing probe located in the return air flow to the module.

4.1 The Power Supply (Fig. 1)

A.C. power and control supplies are derived from the 415v 50hz, 3 phase and neutral via circuit breaker SCB2 (70 amp) located in No.1 vestibule and change-over switch C.O.S.2 located in the under belly contactor panel. The A.C. supply is then taken to the respective compressor and condenser fan motors, circulating and fresh air fan motors, heater bank via circuit breaker switches ACCB1, 2 and 3 located on the under belly contactor panel.

The A.C. control supply at 240v 50 is taken from the red (A) phase and neutral of the 3 phase supply, the supply is taken to the control circuit via circuit breaker switches ACCB2 and 4.

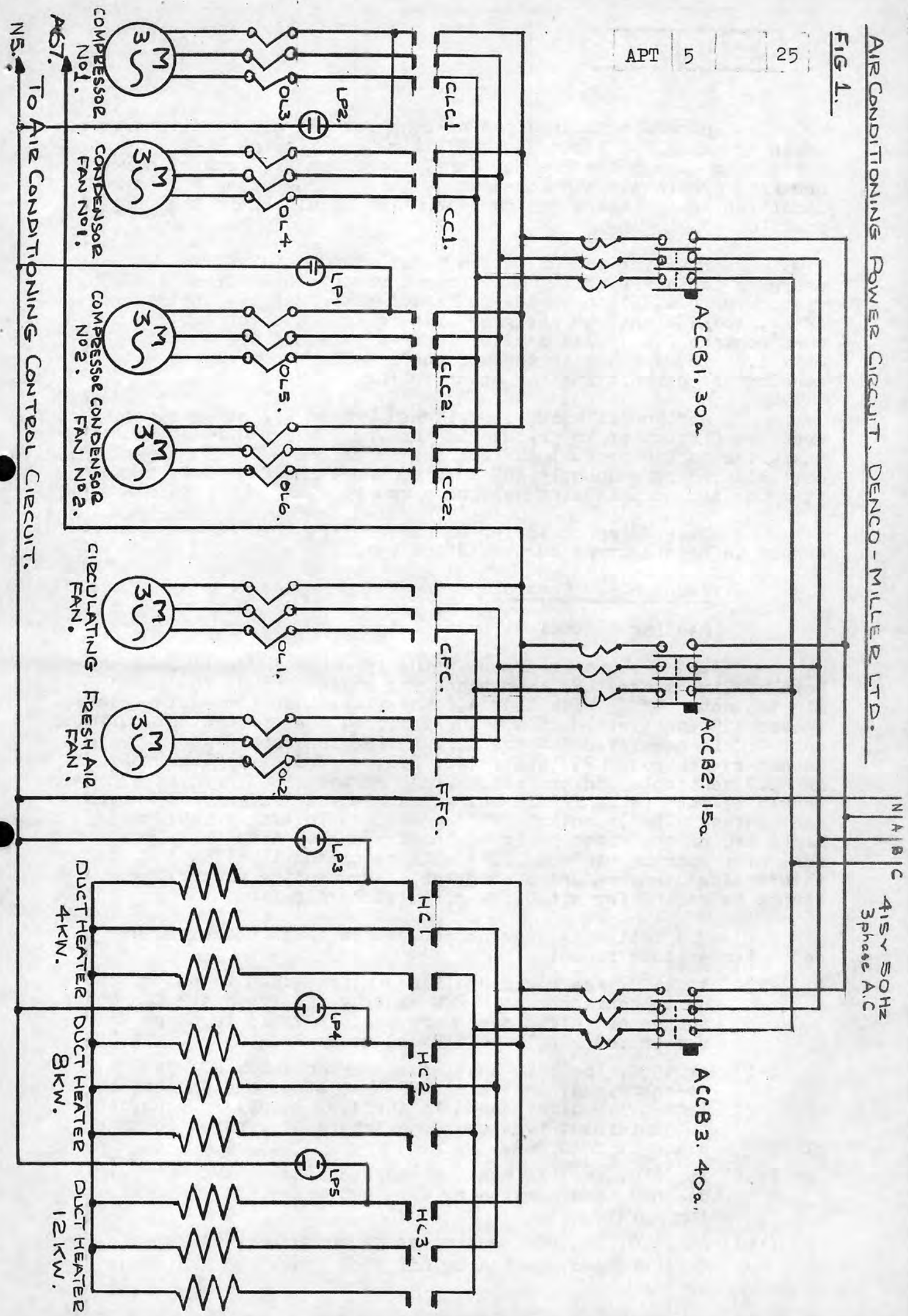
The D.C. control supply is derived from the 110v D.C. battery supply via a 40 amp fuse link and control switch located in No.1 vestibule, batteries are located in both Power Car and Driving Trailer Car

4.2 Control Train Wires (Fig. 2)

There are four 110v D.C. train lines associated with the air conditioning equipment.

- TW 14 - Air Conditioning 'ON'
- TW 15 - Air Conditioning 'OFF'
- TW 17 - Transient Pressure Valves CLOSE/OPEN
- TW 67 - Auxiliary Control Positive

FIG 1.



ON/OFF switching can be done for all air conditioning units by using the Train ON or OFF Air Conditioning Push Buttons in either Van Trailer Cars, providing all control circuit breakers previously mentioned in 3.1 are closed along with Air Conditioning Isolating Switch AC1S which should be in the ON position.

Pressing the ON button causes the 110v D.C. to energise contactor coil AC3 which energises contactor coil AC1 via contacts AC3/1, coil AC1 is 'held' energised via interlock AC1/2, AC1/1 closes to energise time-delay contactor A.S.R. when contact ASR/1 closes after a pre-determined time-delay 250v A.C. is switched to the air conditioning control circuit causing the circulating fan motor to run.

Air Conditioning is switched OFF in a similar manner, when the OFF button is pressed in the Van Trailer Car 110v D.C. energises contactor coil AC2 opening interlock AC2/1 to de-energise coil AC1 and subsequently ASR to disconnect the 250v A.C. supply from the air conditioning control circuit.

Time Delay contactor ASR allows the load on the train supply to be staggered during 'start up'.

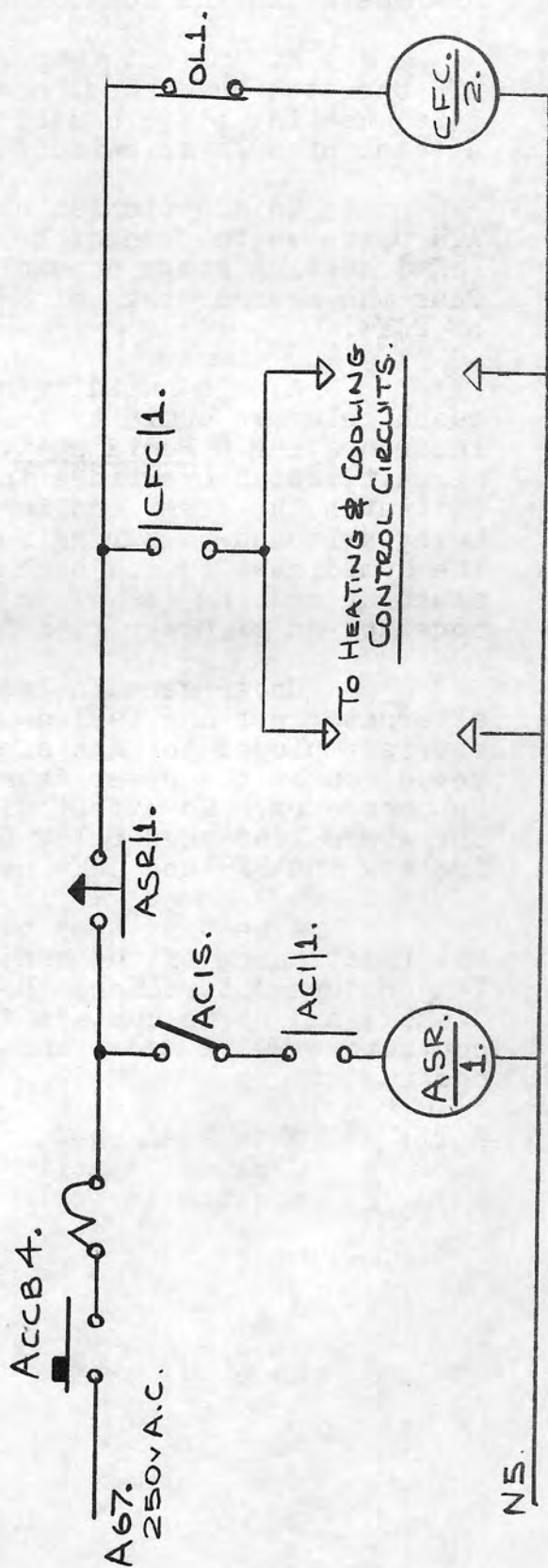
4.3 Temperature Control

Heating Control Circuit (Fig. 3)

The circuit is drawn in the 'pre-heat' condition with both cooling stages OFF, three heating stages on and the fresh air fan motor OFF. With 250v A.C. available and time-delay contactor ASR energised, contact ASR/1 closed the circuit to contactor coil CFC is completed and the circulating fan should run. Secondary contacts CFC2 apply 110v D.C. to indicator light LP7 in No.2 vestibule end providing TPR/2 contact is closed as it should be when relay TPR is energised via the Trafag 16°C switch and contact CTR/2, contact TPR/1 will open to extinguish fault light LP6 on the under belly contactor panel. With the circulating fan motor running contact CFC/1 will be closed to allow A.C. to the 'Trafag' temperature controller, thus heating or cooling cannot be called for without a circulating air flow.

The following sequence of events takes place as the coach temperature rises:

- (i) At 16°C, the recirculation contacts open to put a feed on to contactor coil FFC causing the fresh air fan motor to run and close secondary contact FFC/1 to close and retain the supply to TPR and green indicator light LP7
- (ii) At 19°C, the 12Kw heating stage contactor HC3 is de-energised, switching OFF that stage and indicator lamp LP5. Simultaneously the A.C. supply is connected to humidistat H.S. enabling humidity control to take place if required.
- (iii) At 20°C, the 8Kw heating stage contactor HC2 is de-energised, switching OFF that stage and indicator lamp LP4.
- (iv) At 21°C, the 4Kw heating stage contactor HC1 is de-energised, switching off that stage and indicator lamp LP3.



AIR CONDITIONING TRAINING LOCAL CONTROL FIG. 2.

The vehicle will now assume the ventilation mode until the coach temperature continues to rise to initiate a cooling stage or falls to initiate a heating stage.

An Ambient Thermostat is necessary because when low ambient conditions are experienced it is necessary to increase the capacity of the heating stages and thus reduce the time for the coach Temperature to respond to the direction of the Trafag Temperature Controller, this is achieved by the ambient thermostat in the following way:

At ambient temperatures below 10°C but above 0°C contact ATB operates to connect heater contactor coil HC2 with the first (4Kw) heating stage contacts of the Temperature Controller. Thus a total of 12Kw is switched on as the first heating stage.

In addition at ambient temperatures below 0°C contact ATa operates to connect heater contactor coil HC3 with second (8Kw) heating stage contacts of the Temperature Controller. Thus the second stage of heating becomes 12Kw giving a total of 24Kw.

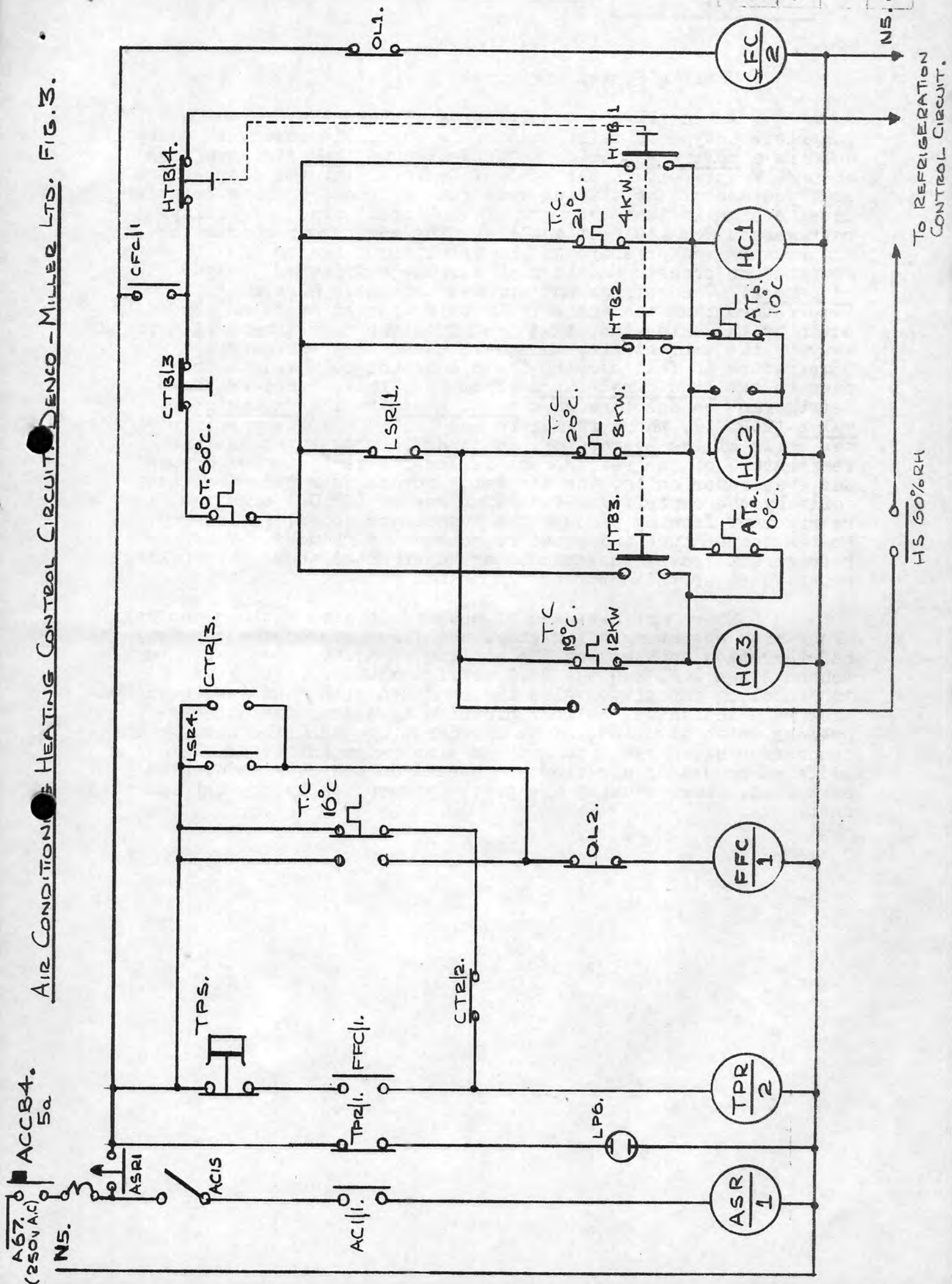
Also a humidity control is incorporated to maintain coach relative humidity below 60% at $19^{\circ}/20^{\circ}\text{C}$, this is achieved by incorporating a Humidistat. H.S. into the electrical control circuit, which overrides the Temperature Controller and initiates the first cooling stage. To prevent the cooling stage being switched on during full heating (24Kw), and recirculation the humidistat is fed by changeover contacts on the third stage of heating (12Kw) on the Temperature Controller; high consumption of power is avoided.

Under certain fault condition where a motor-alternator set has failed and the stand-by diesel-alternator set is employed to maintain the auxiliary supply, a reduction of the power demanded by the air conditioning system is necessary. To effect this reduction a D.C. signal, TW 60 energises load shed relay LSR and contacts LSR/1 will open to isolate the 8Kw and 12Kw heating stages.

A heating test button H.T.B. is provided to check the functioning of the heating stages independantly of the Temperature Controller. Depressing H.T.B. closes contacts HTB1, 2 and 3 and opens contact 4, thereby energising the heating contactors HC1,2 and 3 and removing the control supply to the cooling stages.

NOTE: When load shedding is taking place only 50% of the Cooling Capacity is available, as the 2nd stage of cooling is isolated via interlock LSR/2, see Fig.5.

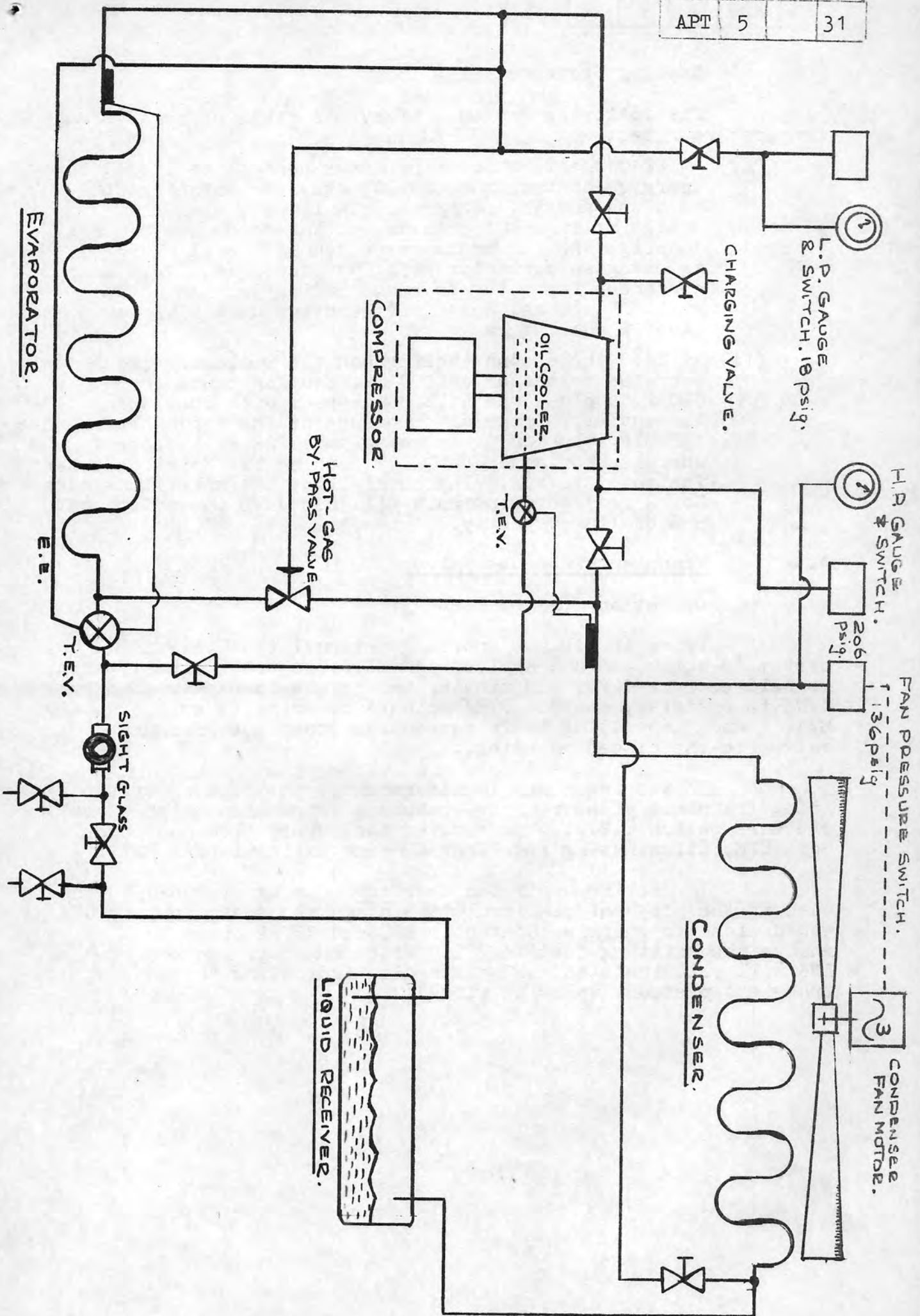
AIR CONDITIONING & HEATING CONTROL CIRCUIT. Denco - Miller Ltd. FIG. 3.



Cooling System (Fig. 4)

As in all air conditioning systems the mechanical compression type of refrigeration is used, the essential equipment used is a compressor which is used to pump the refrigerant (R12) around the system, in the case of Denco-Miller the compressors employed are of the sliding-vane rotary types, being a relatively novel design in that they are of the 'open' type but employ refrigerant for indirect cooling. The compressor raises the temperature and pressure of the refrigerant due to the compression process and then passes the refrigerant to the condenser. The refrigerant arrives at a much higher temperature than the ambient air being forced over the condenser coils by the axial-fan, thus heat from the refrigerant is carried away by the ambient air, this will cause the refrigerant temperature to fall causing it to condense to a liquid and pass to the liquid receiver. From the liquid receiver the refrigerant passes through a sight glass to the expansion-valve (T.E.V.), where it meters the liquid refrigerant into the coils of the evaporator, in doing this the pressure and temperature of the refrigerant is lowered as it flows through the evaporator coils, the air being forced over the evaporator coils by the centrifugal-fan being warmer ($22^{\circ}\text{C}+$) than the refrigerant flowing through the evaporator coils, is lowered in its temperature and moisture content is reduced. The refrigerant leaves the evaporator superheated above its boiling point to enter the compressor.

There are 2-stages of cooling to give a close control along with operating efficiency, the first stage runs the No.1 refrigeration unit giving 50% cooling capacity, a call for the second stage will run the No.2 refrigeration unit to give 100% cooling capacity. Also incorporated with each refrigeration pack is a "capacity control" provided by means of a hot gas by-pass valve situated in the discharge by-pass line between the compressor discharge line and the evaporator inlet. In addition condenser air flow and hence fan power is reduced at part load, thus reducing the power consumption by the refrigeration unit.



REFRIGERATION CIRCUIT DIAGRAM, DENCO-MILLER.

Fig 4.

Cooling Sequence (Fig. 5)

The following sequence of events takes place as coach temperature rises:

- (i) At 22°C the first cooling stage contact is closed to energise contactor coil CLC1 causing contactor CLC/1 to close and No.1 Compressor will run, when the outlet refrigerant pressure of the condenser reaches 136psig, the fan pressure switch CPS1 will close to energise contactor coil CC1 causing the No.1 condenser fan motor to run. Indicator light LP2 will illuminate, No.1 refrigeration unit will now give 50% cooling capacity.
- (ii) At 23°C the second cooling contact will close to energise contactor coil CLC2, causing contactor CLC/2 to close and No.2 Compressor will run, when the outlet refrigerant pressure of the condenser reaches 136psig, the fan pressure switch CPS2 will close to energise contactor coil CC2 causing the No.2 condenser fan motor to run. Indicator light LP1 will illuminate No. 2 refrigeration unit will now give the additional 50% cooling capacity.

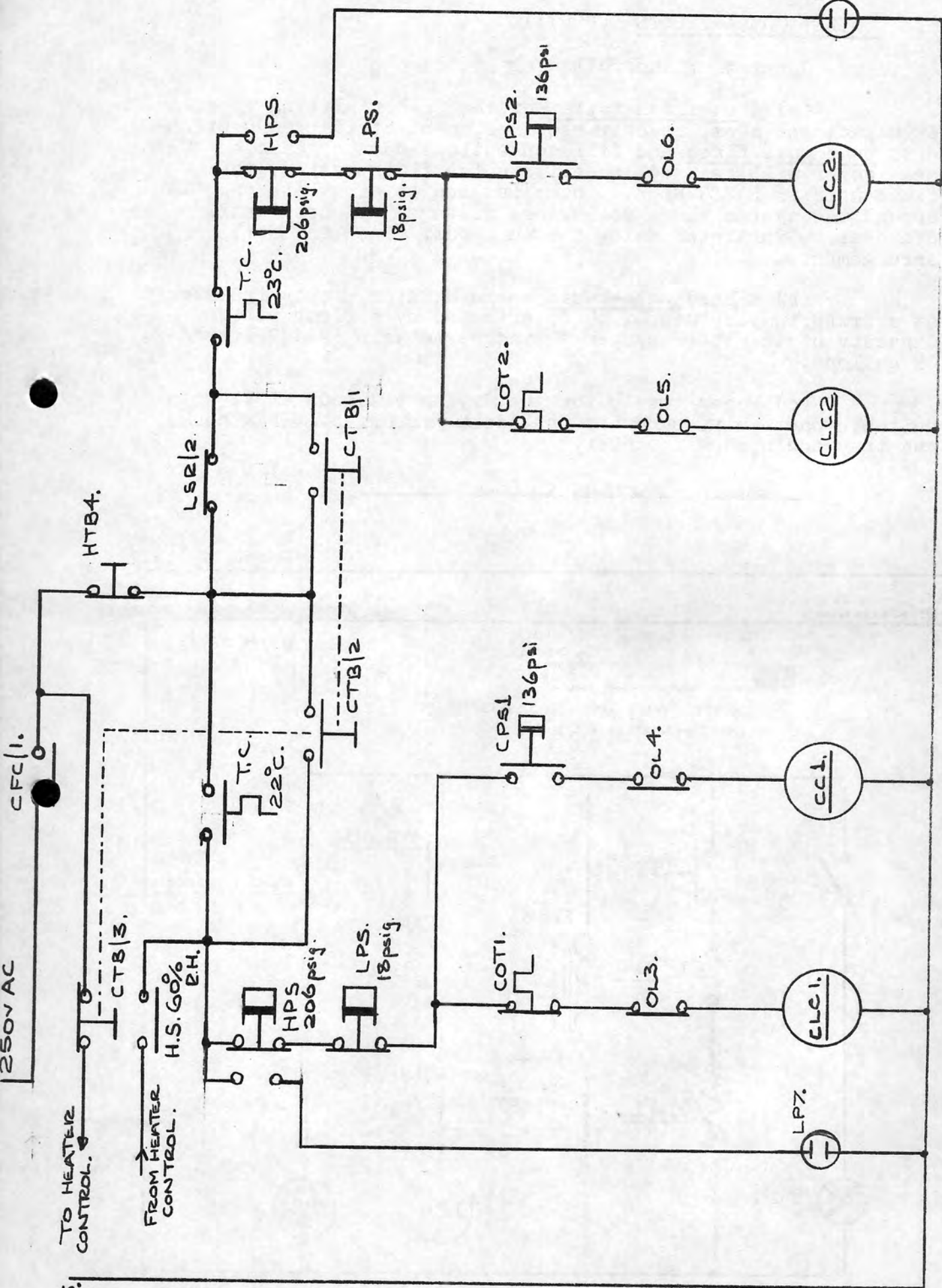
4.4 Transient Pressure Valves

Operation (Figs. 2 and 3)

Prior to A.P.T.P entering a tunnel the C.A.P.T. system is activated and applies 110v D.C. to train wire 17 which is held energised for one minute, this cause contactor coil CTR3 to energise, contact CTR/1 closes to energise solenoid valve SV1, 2 and 3 operating their respective transient pressure valves to the closed position.

If the fresh air fan is running, the closing of the inlet transient pressure valve causes a depression which opens pressure switch T.P.S. this removes the supply from contactor coil TPR, illuminating red light LP6 and extinguishing LP7.

If the fresh air fan were not running as would be the case in the pre-heat/re-circulation stage secondary contact CTR/3 would close to energise contactor FFC and CRT/2 opens to remove the existing feed to TPR. With fresh air fan now running, LP6 will illuminate and LP7 extinguish indicating that the transient pressure valve is closed.



AIR CONDITIONING COOLING CONTROL CIRCUIT. DENCO - MILLER, LTO. FIG. 5.

5. TOILET COMPARTMENTS (Fig.1)

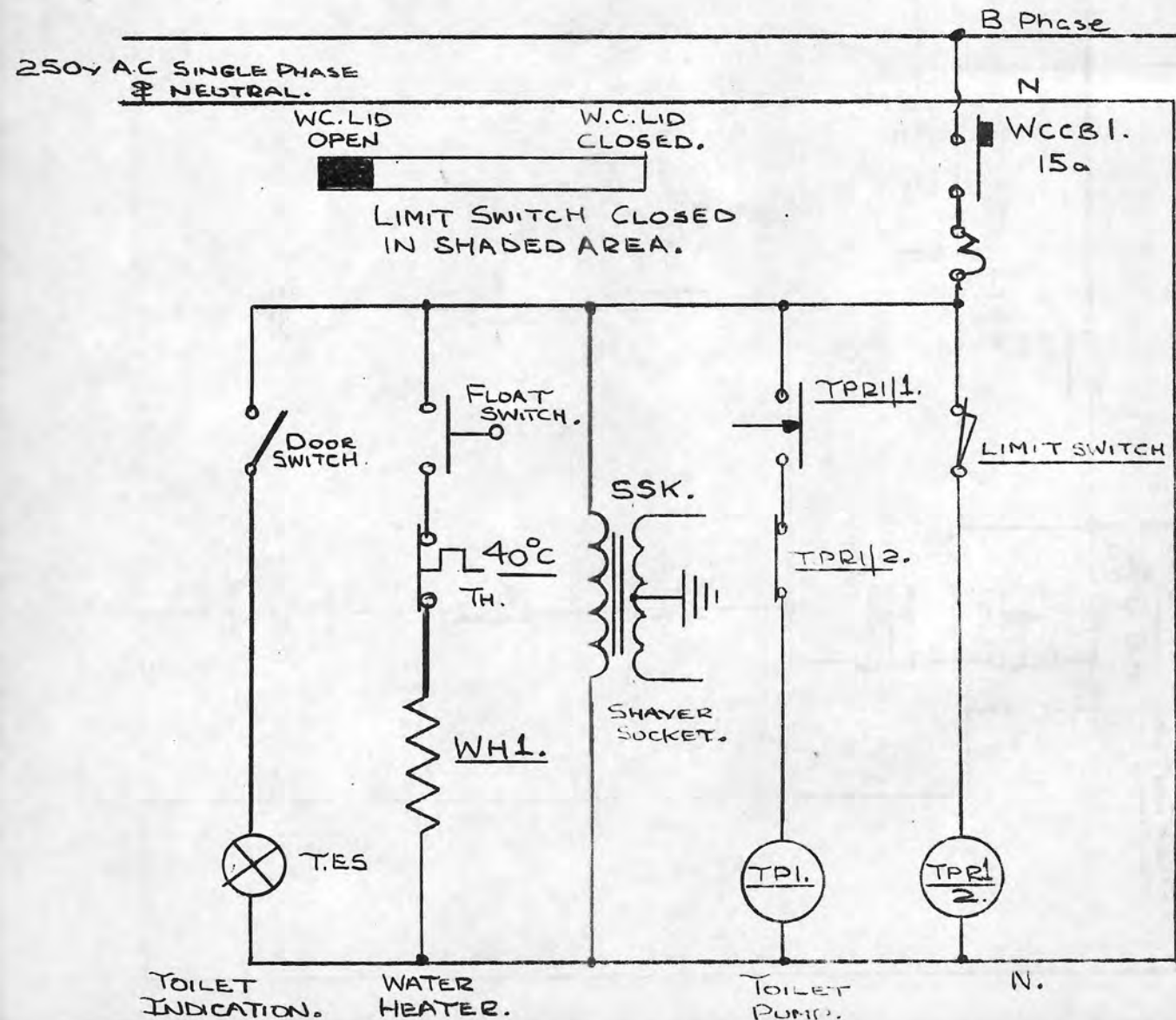
Consist of the following items:

(a) A chemical toilet of the re-circulating type, built as a packaged item, it only requires on electrical connection with pump out, flush and fill connections to the vehicle. The seat cover will be used to activate the flush system, the fluid used is ELSEN BLUE, a pump is used to circulate the fluid around the system where solids are filtered and held until disposal is initiated using the pump out, flush and fill arrangements.

(b) A hand wash-basin where a water supply is metered at a fixed temperature of 45°C , actuated by a floor button. Capacity of the water system to the wash-basin is 170 litre/28 gallons.

(c) Paper towels for the drying of hands etc., with suitable waste bin, sundries include a mirror, coat/bag hook, ash tray and a shaver socket.

TOILET CONTROL CIRCUIT.



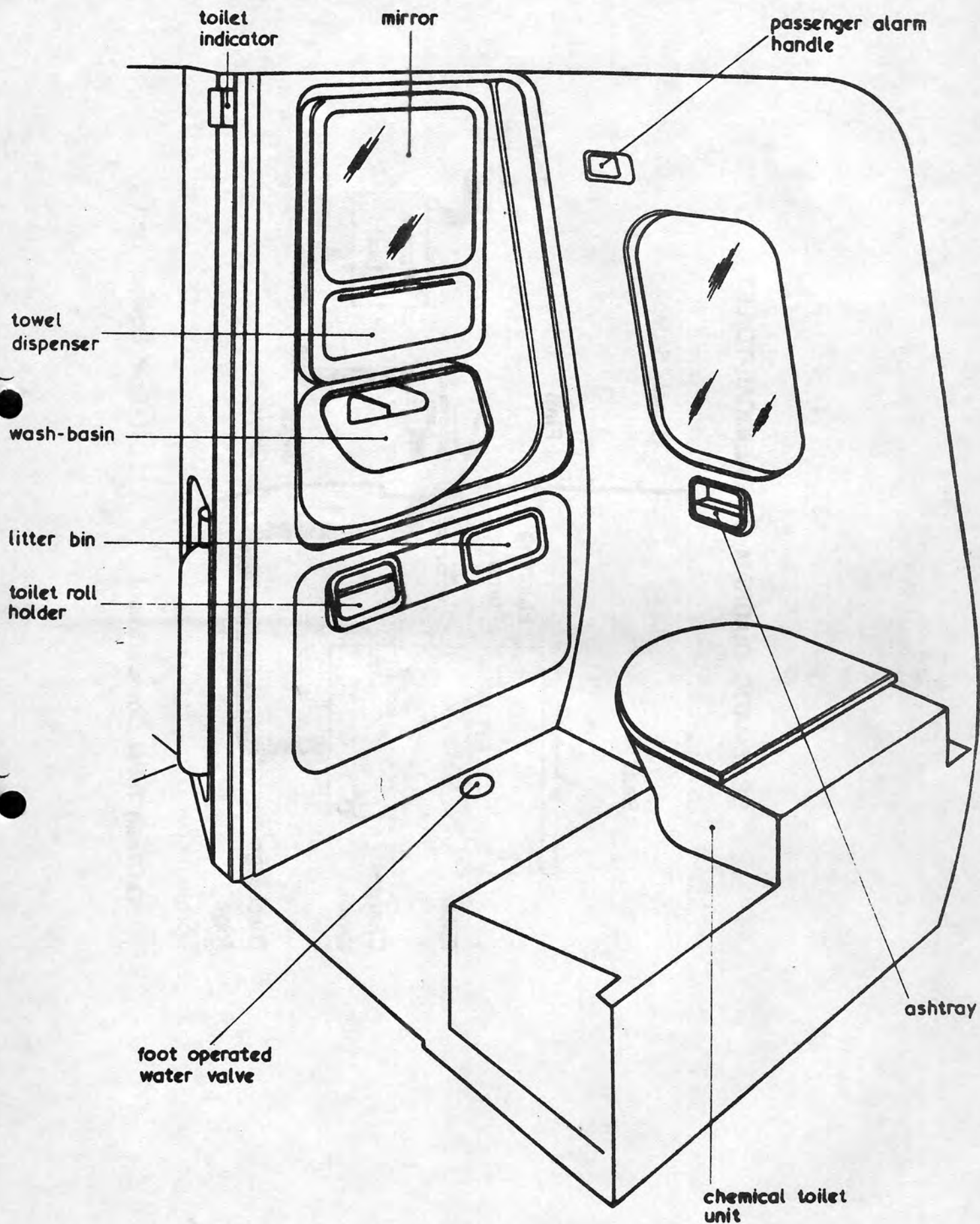
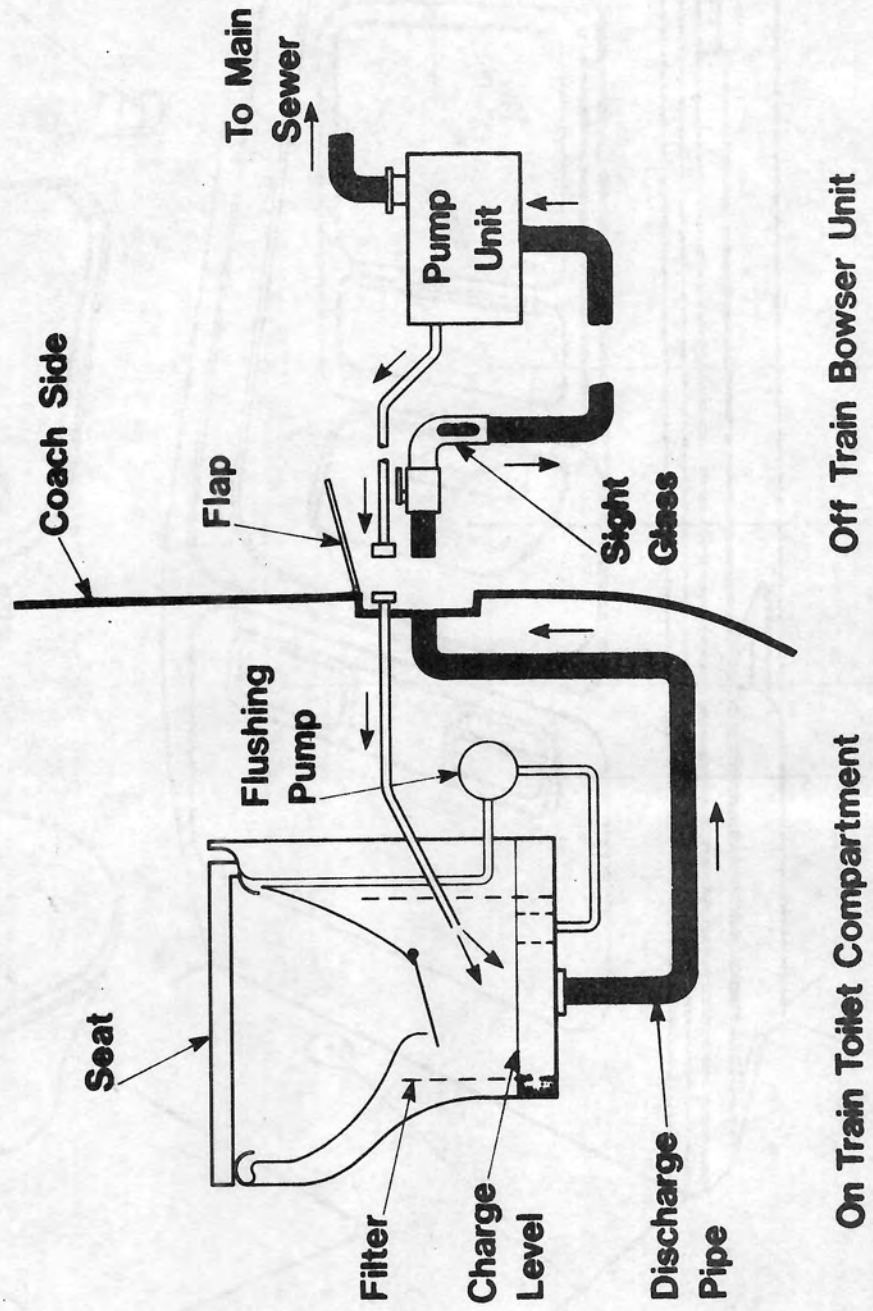
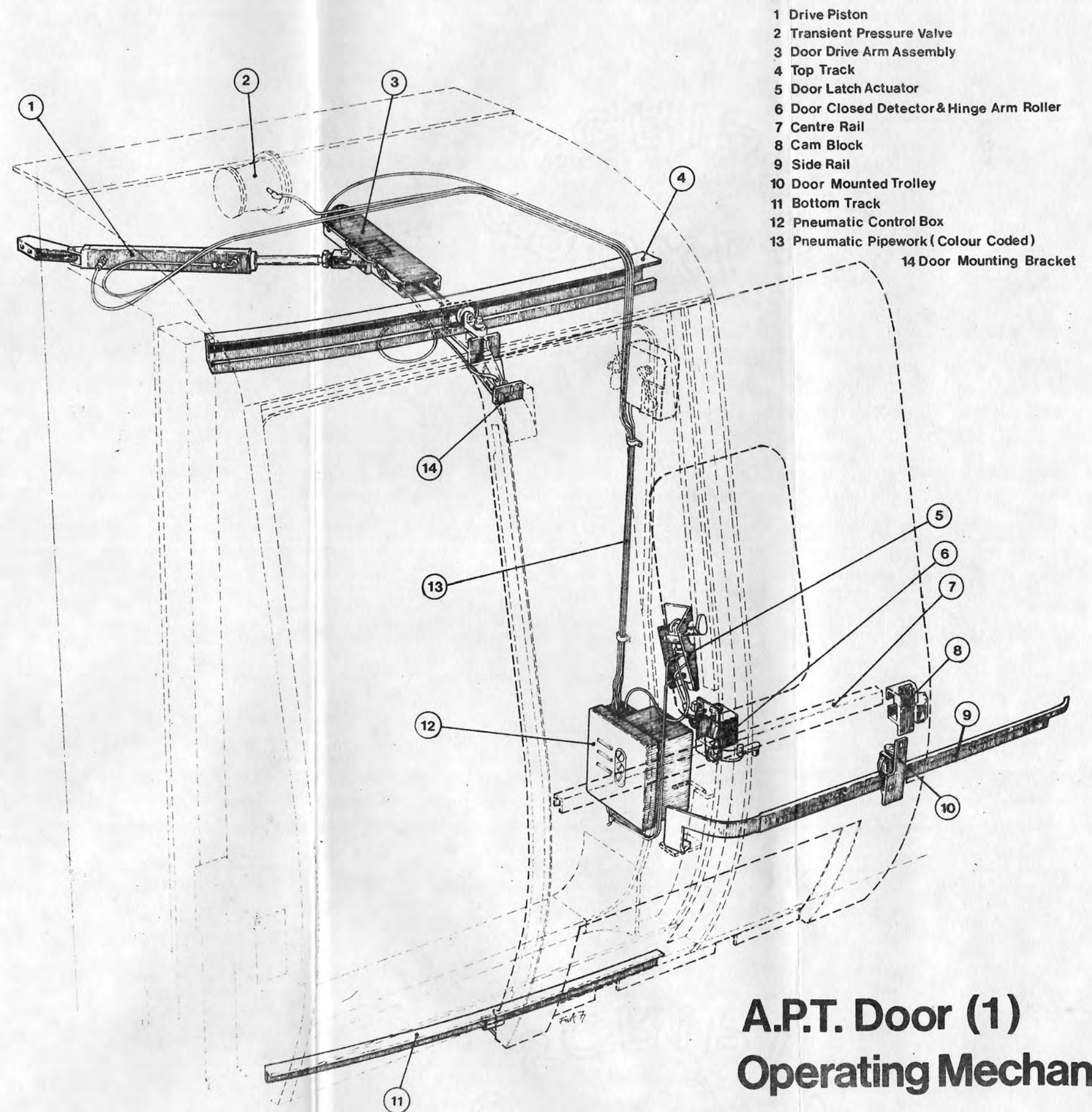


FIG. 1. TOILET COMPARTMENT

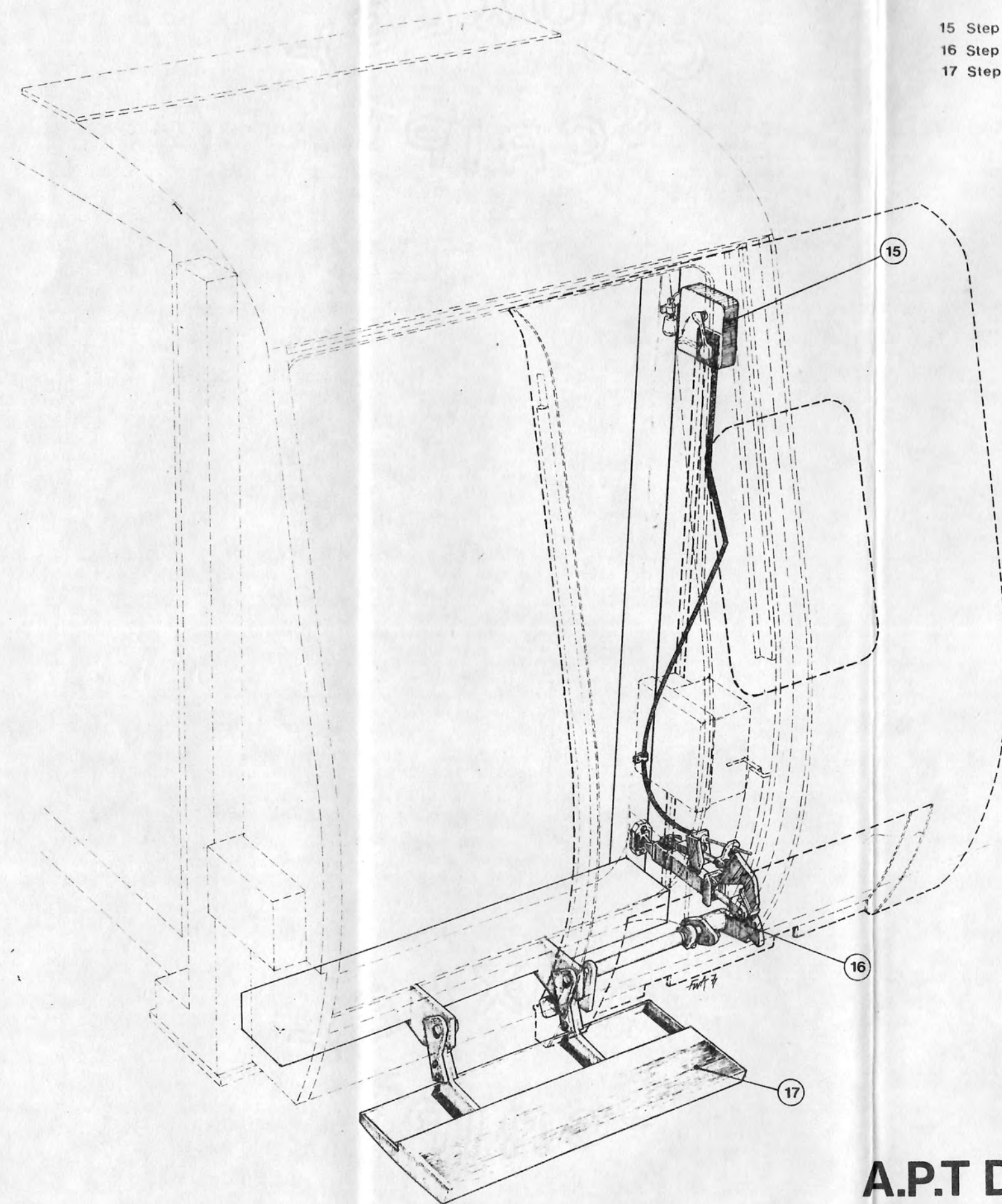
SCHEMATIC DIAGRAM OF CHEMICAL TOILET





**A.P.T. Door (1)
 Operating Mechanism**

- 15 Step Emergency Release
- 16 Step Actuator Assembly
- 17 Step



A.P.T Door (2) Step Mechanism

