British Rail

TECHNICAL TRAINING NOTE APT/4.3

A.P.T. TRAIN AIR SUPPLY SYSTEM

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2. Compressor
3. Vehicle Air Systems

RAILWAY ENGINEERING SCHOOL,
BRITISH RAILWAYS, DERBY.

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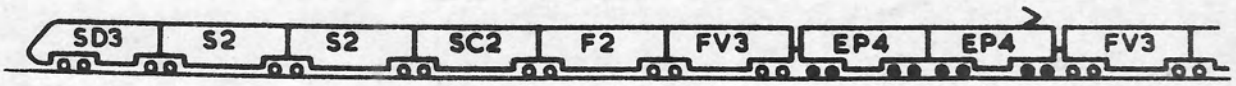
APT-P TRAIN FORMATION CODES

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



RAKE 1 RAKE 2

OPERATORS CODE	DTS	TS	TS	TRB	TF	TBF	M	M	TBF

DTS:-	Drg. Trailer Second	or	Second Drg. (3 axles)	SD3
TS :-	Trailer Second	or	Second (2 axles)	S2
TRB:-	Trailer Rest/Buffet	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

BRITISH RAIL

TECHNICAL TRAINING NOTE APT4

A.P.T.P TRAIN AIR SUPPLY LINE

1. INTRODUCTION

The A.P.T.P. consists of two articulated rakes with power cars located in the middle, both rakes of vehicles and power cars sharing a common train air supply line which runs the whole length of the train, vehicles having end coupling hoses with conventional star (male) connections and isolating cocks at the head stock position.

The train supply line pressure being a nominal 10Bar/140PSIG, the air is supplied from two fluid-Air 2-stage 30 H.P. Air Cooled Compressors, being of the rotary (sliding blade) type, employing a first stage and second stage rotor giving a delivery of 88 c.f.m. at a nominal speed of 1450 r.p.m. The compressors are located respectively in each Van Trailer Car, and are supplied with 415 volt 3 phase A.C. 50 HZ from the respective A.C. supply to that rake of vehicles, an aftercooler (air cooler) is fitted.

2. COMPRESSOR

2.1 Compressor Operation (Fig.1) see end of handout

The first stage rotor (6 slots) has an integral drive shaft which is keyed to the second-stage rotor (8 slots), fitted into the slots are blades which are free to move radially under centrifugal force, the rotors are eccentric within the stator bore and the space formed between them is crescent-shaped and divided into segments.

Filtered air is drawn through the unloader valve into the first-stage rotor, as the rotor revolves the segment volume decreases and air is compressed, the air then passes into the second-stage rotor where another compression cycle takes place to the final discharge pressure.

During first-stage compression, cool filtered oil is injected through nozzles in the stator wall and mixes with the air as it is being compressed, this oil has a three-fold effect.

(a) Absorbing much of the heat of compression
(b) Sealing running clearances
(c) and lubricating all moving parts

The oil is fed to the nozzles by pressure differential from the sump via filters and air cooled cooler. A separate full pressure oil feed is supplied direct to the main shaft bearings from the sump via an oil filter.

The second-stage rotor is lubricated by the compressed air from the first-stage rotor as a large quantity of oil is carried over, this is removed as the air being delivered from the second-stage passes over a series of baffles, any remaining oil is separated in a coalescing-filter and is returned to the air intake via two oil return valves.

2.2 Control

This is a control system which varies the amount of air passing through the compressor from zero to maximum, according to the demand, in this way the air line pressure is maintained within 2-4 psig of the maximum regulated pressure.

The system is fully automatic and is operated by sump oil pressure acting on the servo valve and unloader valve - the sump oil pressure is the same as the pipe line air pressure apart from the negligible drop through the oil separator and discharge valve.

2.3 The Unloader (Fig.2)

This has two functions:-

(i) When the compressor is running it regulates the amount of air entering the compressor by varying the opening of the air intake valve.

(ii) Act as a non-return valve when the compressor stops, preventing a reverse flow of air and oil out of the compressor air intake.

2.4 The Servo Valve (Fig.2) see end of handout

Its function is to regulate both the pressure and amount of oil passing from the sump to the unloader valve to effect the control system (2.2).

When the compressor is running at FULL LOAD as shown in Fig.1, oil is retained in the sump by the servo valve spring. The unloader housing is vented to the suction port via the servo valve, thus the air intake is fully open, allowing full capacity of air into the compressor.

If demand for air falls, it causes a slight increase in the sump oil pressure, this pressure increases until it overcomes the initial servo spring force and moves the servo-valve to the "partially on load" position, sump oil at reduced pressure overcomes the initial unloader spring force and partially closes the air intake thus reducing the volume of air entering the compressor. If sump pressure continues to rise the servo valve moves further against its spring, further restricting the venting passage, thus increasing the oil pressure on the unloader piston spring closing further the air intake.

2.4 The Servo Valve (Cont'd)

This further reduces the volume of air entering the compressor. If demand for air increases the reverse occurs, i.e. the sump pressure falls and the air intake opens and allows a greater volume of air to enter the compressor.

If the air demand is zero, sump pressure increase and moves the servo-valve to the OFF LOAD position, the venting passage is closed and full sump oil pressure acts on the unloader piston spring, this fully closes the air intake valve. The compressor is now fully unloaded and its power requirements are at a minimum.

2.5 Safety Valve

A safety valve is fitted to safeguard the compressor against excessive pressure, it is spring-loaded to a pre-set figure of 11/12 Bar 160/170 psig.

2.6 Excess Temperature Thermostat

This is mounted in the compressor oil sump to moniter the temperature of the sump oil its contact will open to stop the compressor should the oil overheat, it will not reset until the oil has cooled sufficiently and the reset button has been pressed.

3. VEHICLE AIR SYSTEMS (Fig.3)

Air from the Train Air Supply System is provided to the following:-

(a) Driving Trailer Cars

(i) H.K. Brake Air Reservoir
(ii) The Bogie Secondary Suspension (Air Springs)
(iii) The Diesel Alternator Set for - Starting and Resilient Mountings
(iv) The Exterior Door Gear
(v) The Transient Pressure Valves
(vi) The Toilet Washhand Basin Water System

(b) Van Trailer Cars

(i) H.K. Brake Air Reservoir
(ii) The Bogie Secondary Suspension (Air Springs)
(iii) The Motor-Alternator Resilient Mountings
(iv) The Exterior Door Gear (including Van Door)
(v) The Transient Pressure Valves
(vi) The Toilet Washhand Basin Water System

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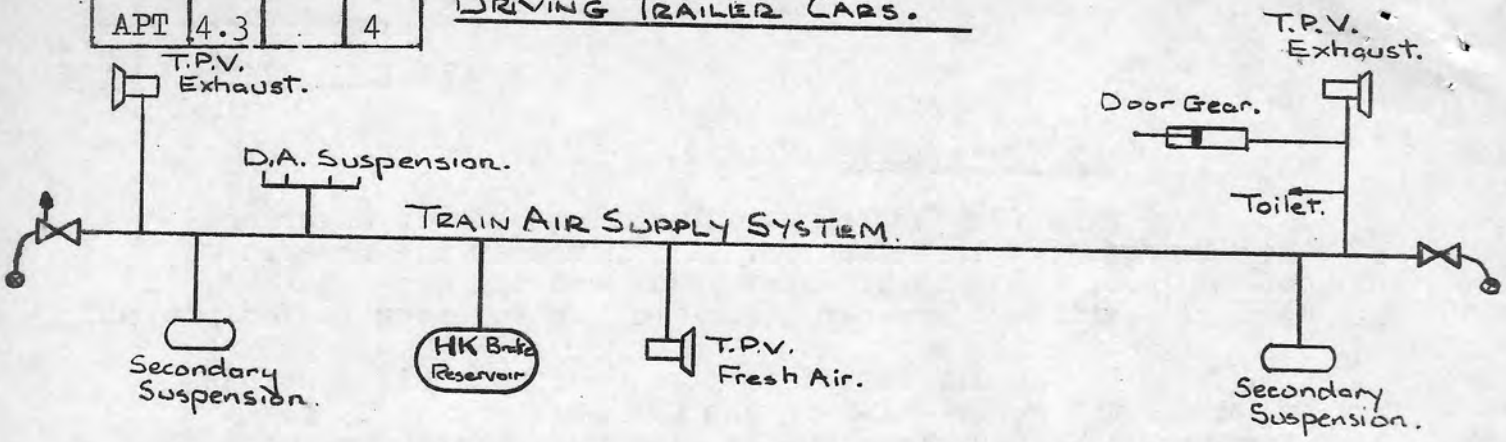
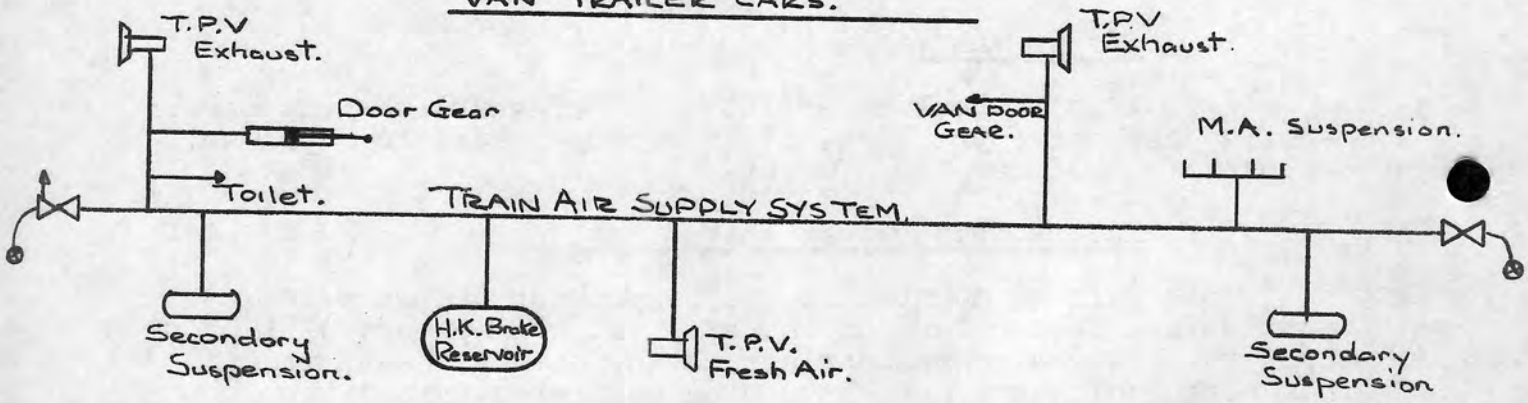
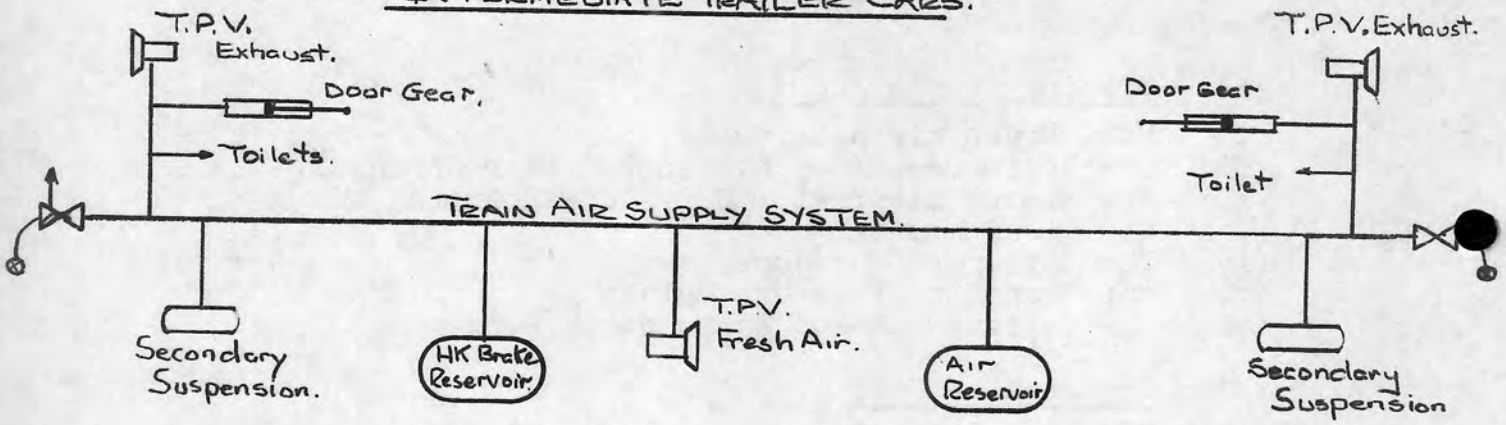
DRIVING TRAILER CARS.



VAN TRAILER CARS.



INTERMEDIATE TRAILER CARS.



POWER CAR.

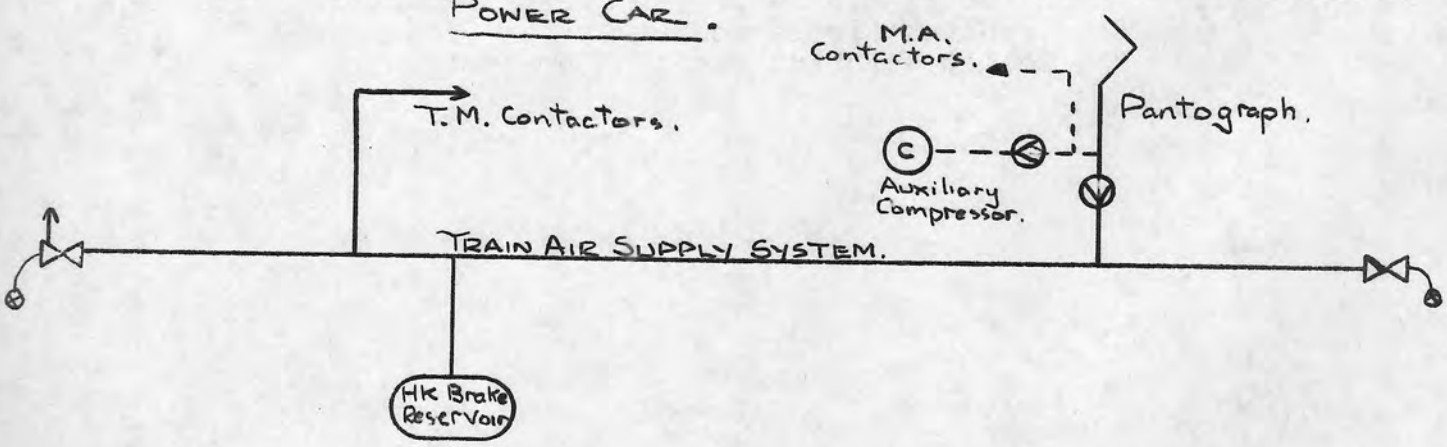


FIG. 3.

(c) Intermediate Trailer Cars

(i) H.K. Brake Air Reservoir
(ii) An Air Supply Reservoir
(iii) The Bogie Secondary Suspension (Air Spring)
(iv) The Exterior Door Gear
(v) The Transient Pressure Valves
(vi) The Toilet Washhand Basin Water System

(d) Power Cars

(i) The Pantograph
(ii) Motor-Alternator Line Contactors
(iii) H.K. Brake Reservoir
(iv) Traction Motor Contactors

3.2 Secondary Air Suspension BT 11 and 12 Bogie (See Fig. 4)

Air from the train supply air system is fed to the secondary air suspension via a regulator set at 5 BAR/72 psig air filter and levelling valve, the levelling feeds both air springs and surge reservoirs. (An onifice plate connects both air springs pneumatically).

The levelling valve will admit air into the air spring as load is increased within the vehicle and exhaust air to atmosphere as the load is decreased within the vehicle, thus maintaining the vehicle at a constant height.

3.3 Cummins Diesel Engine Air Start System (See Fig. 5)

A minimum air pressure of 5 bar/72 psig is required to motor to diesel-engine. When the local or remote start button is pressed in either Driving Trailer Car the air start valve is energised and air will flow to the starter motor and operate the pre-engager which draws the pinion into mesh with the starting-ring, air is then passed to the main-air valve which then rotates the starter motor and hence diesel-engine. The starter motor remains engaged for 15 seconds or until the diesel engine has reached a speed of 600 r.p.m., when it will disengage.

Air is also supplied to an 'ether' start valve so that is cold ambient temperatures $0^{o}C$ or below ether is injected into the air induction manifold.

AIR SYSTEM. SECONDARY SUSPENSION. BT11. Bogie.

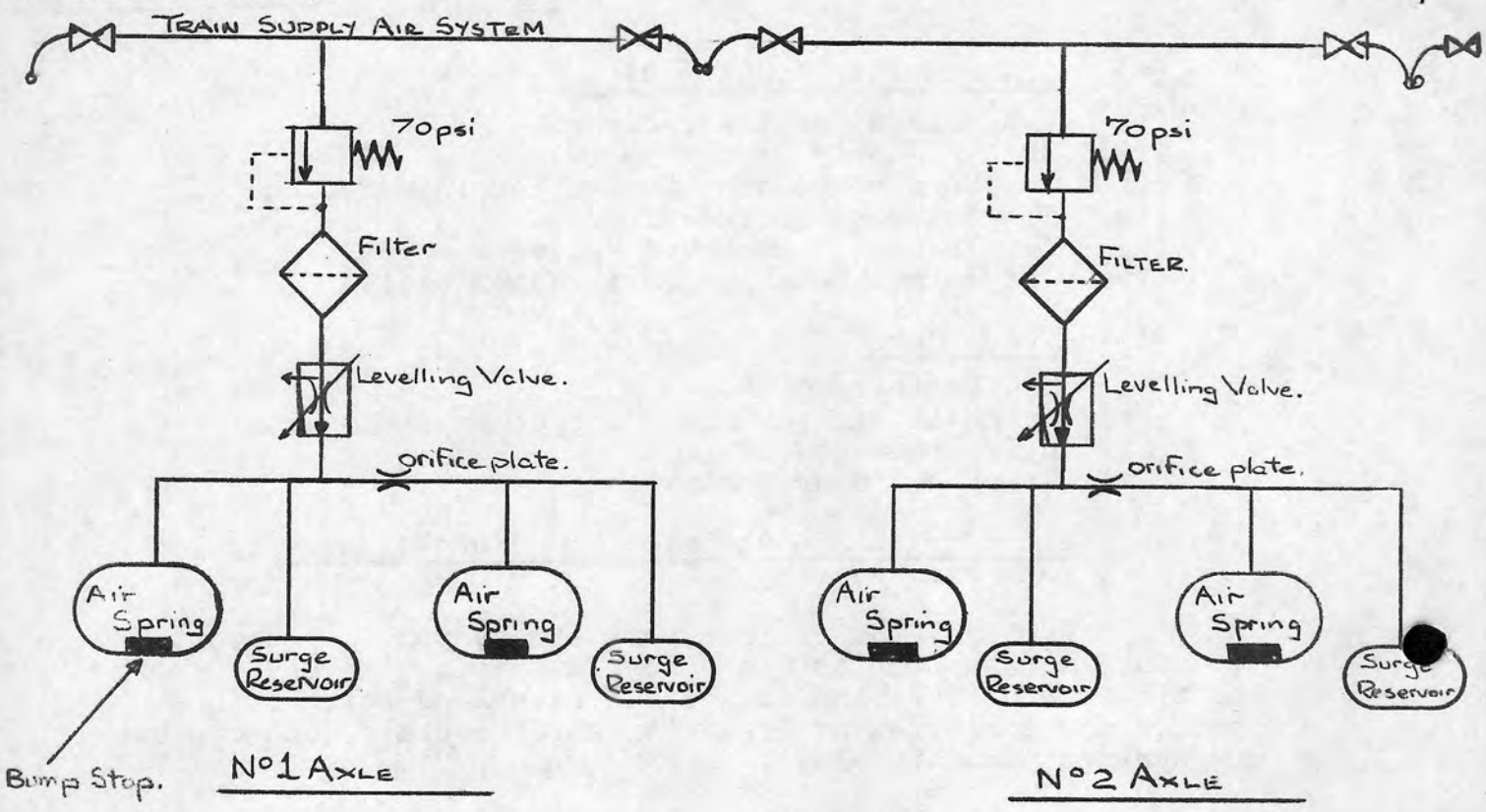


FIG 4.

AIR SYSTEM. DIESEL-ALTERNATOR STARTING.

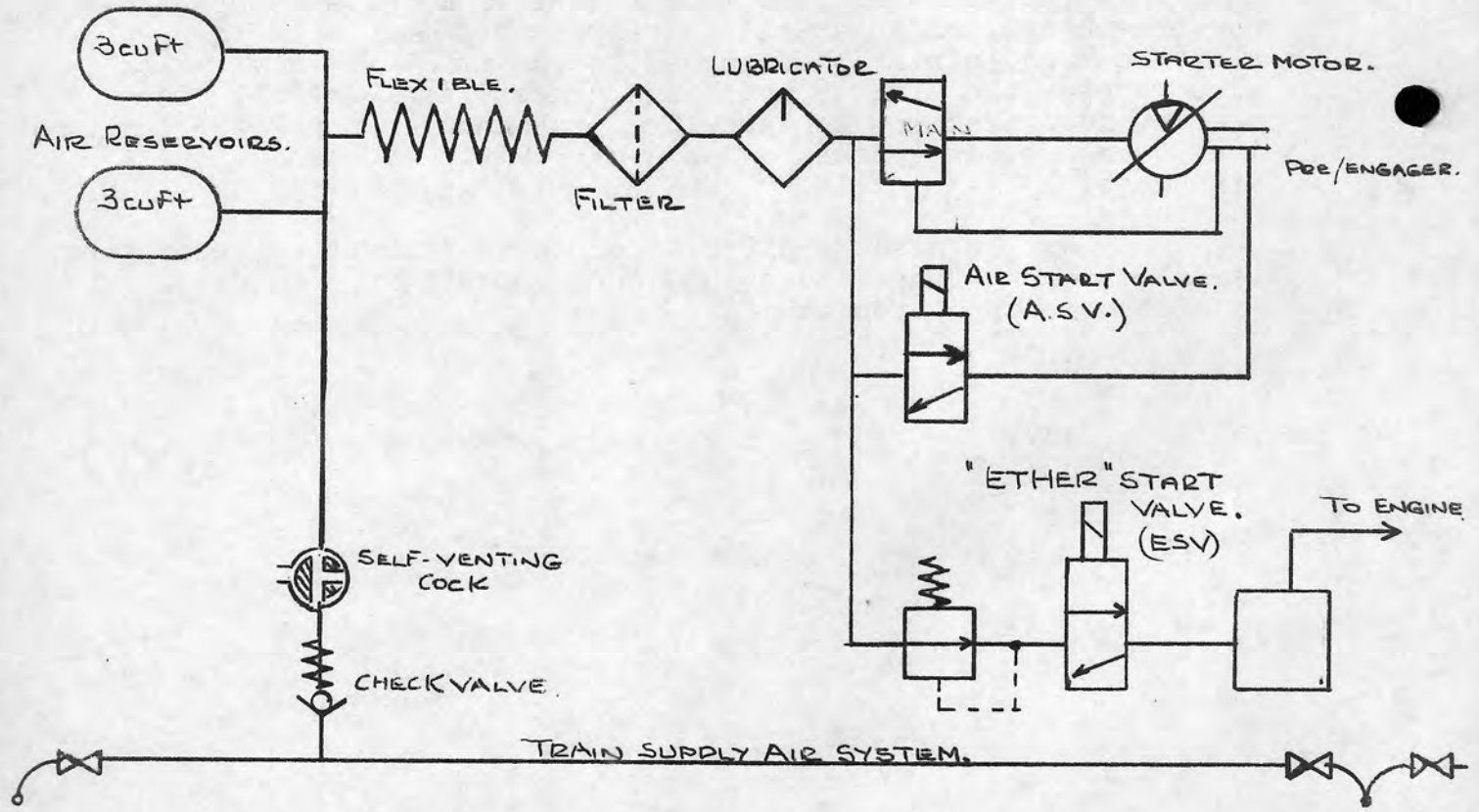
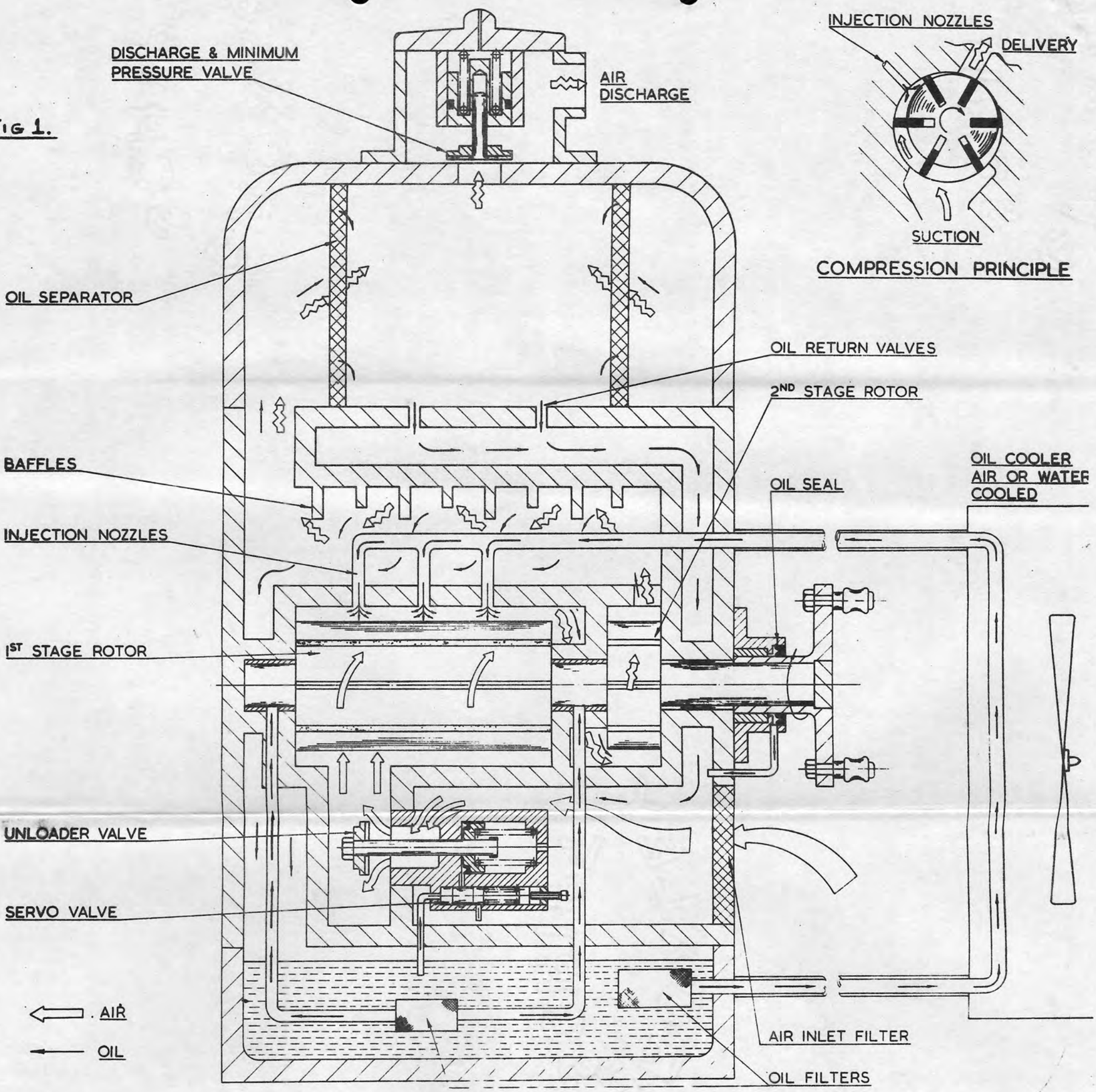


FIG 5.

FIG 1.



OPERATING PRINCIPLE OF TWO STAGE
S2R66 & S2R110 FLUIDAIR COMPRESSORS

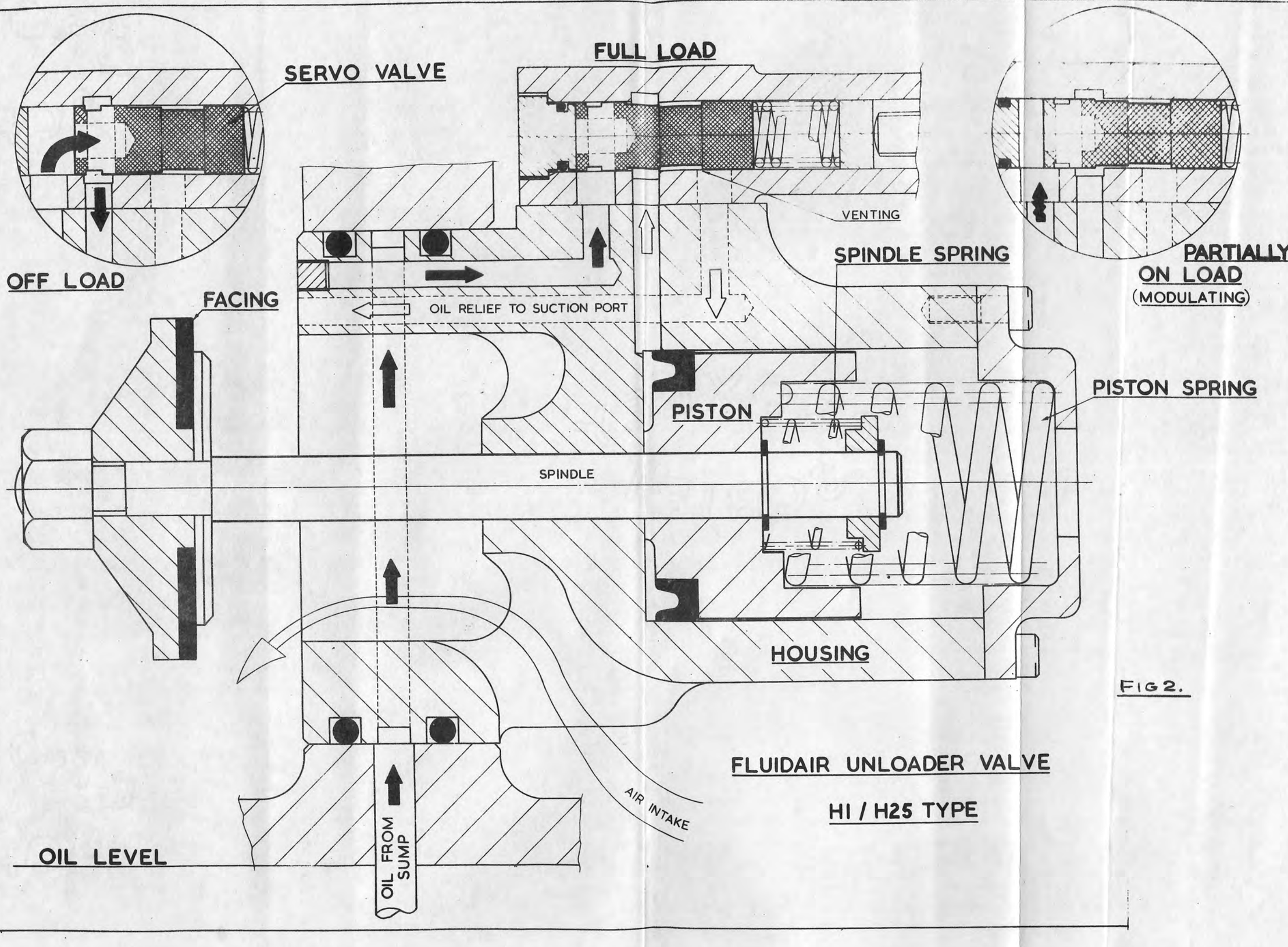


FIG 2.

FLUIDAIR UNLOADER VALVE

H1 / H25 TYPE