Chapter 6

NITROGEN SYSTEM AND FUEL TANK PRESSURISATION

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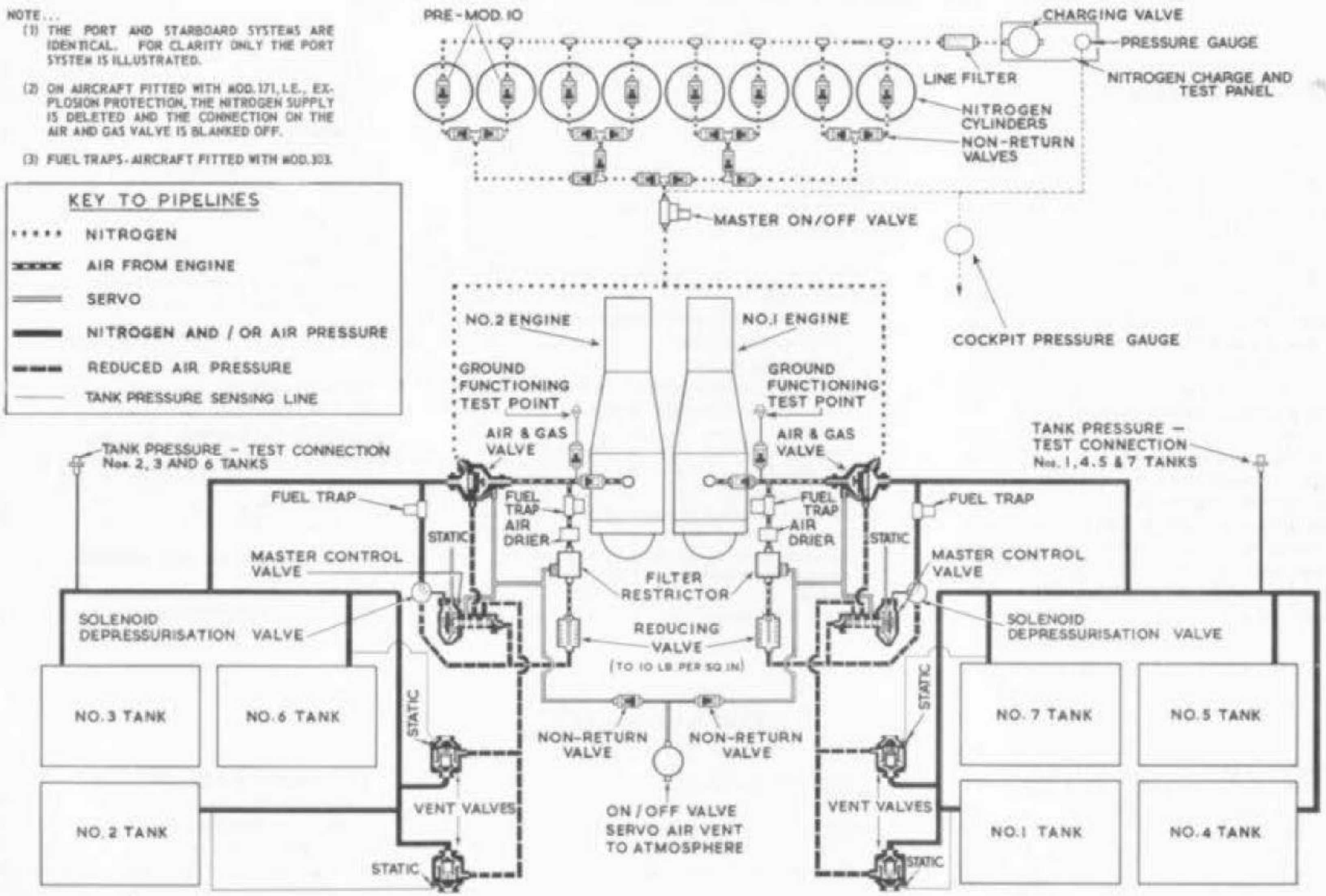


Fig. 1. Nitrogen system and fuel tank pressurisation

DESCRIPTION

Introduction

1. This chapter contains a description of the fuel tank pressurisation system, gives details of servicing operations and recommends the method of removal and assembly of certain components. Should it be necessary to service or bench test a system component, reference should be made to A.P.4303E, (Aircraft Pneumatic Equipment - Teddington Controls). On aircraft with Mod.171, fire and explosion risks are minimised by the introduction of an Explosion Protection system. A description and servicing of this system, which replaces the nitrogen system, are provided in A.P.4505A & C, Vol.1, Book 2. The operation of the fuel tank pressurisation system is as described in this chapter.

General

2. The pressurisation system enables a predetermined nitrogen pressure of approximately 2·02 - 2·5 p.s.i. (or air pressure of 1·82 - 2·3 p.s.i. when the nitrogen supplies are exhausted) above ambient to be maintained in the fuel tanks throughout the altitude range of the aircraft.

3. Primarily the reason for pressurisation is to prevent loss, by boiling off fuel, due to high altitude and high fuel temperature particularly when using fuels of high Reid Vapour Pressure, i.e., AVTAG R.V.P. 3 p.s.i. Note that the Reid Vapour Pressure is the absolute pressure at which fuel at 100 deg.F. begins to boil. For example, should the aircraft be parked in high surrounding temperatures and then rapidly climbed to 38,000 ft., at this altitude the ambient pressure is 3 p.s.i., i.e., incident with the fuel R.V.P., and, without a pressurisation system, under these conditions the fuel would rapidly boil off.

4. In addition, the system prevents negative differential pressure in the tanks which could damage or even collapse the tanks during diving conditions. Fire risks are minimised by the use of nitrogen which prevents the formation of inflammable fuel/air mixtures in the tanks.

5. A diagrammatic arrangement of a system in one side of the aircraft is shown on fig.1; a sequence of operations may be seen on fig.7 and succeeding diagrams. Two separate but identical systems, one on the port side and one on the starboard side of the aircraft, are provided. To prevent total loss of nitrogen should one system be damaged, there is no interconnection between the two systems.

CONTROLS AND INDICATORS

6. Three switches control the nitrogen and fuel tank pressurisation systems. Two control the port and starboard nitrogen ON/OFF valves, and the third, the tank pressurisation switch, operates solenoid depressurisation valves that control the air supply and depressurise the system. On aircraft fitted with Mod.171 only the tank pressurisation switch is fitted.

7. Two 0-2,000 p.s.i. gauges register the pressure in the port and starboard nitrogen systems.

8. On all aircraft the switches are located on the starboard console. The position of the switches varies with the introduction of modifications.

9. The switches and the gauges are part of the tank pressurisation panel at the aft end of the starboard console on aircraft prior to Mod.38 and 171 (fig.1A, Sect.1, Chap.1).

10. On aircraft fitted with Mod.38, i.e., Flight Refuelling, but not Mod.171 i.e., Explosion Protection, the switches are part of the Flight Refuelling panel which is forward of the de-icing panel at the aft end of the starboard console (Sect.4, Chap.2). The nitrogen pressure gauges are below the de-icing control panel.

11. On aircraft fitted with Mod.38 and 171, the nitrogen system is not fitted and the nitrogen switches and gauges are deleted. The tank pressurisation switch is part of the Flight Refuelling panel (Sect.4, Chap.2). Mod.1429 introduces four indicators, one for each tank group, which operate in conjunction with the flight refuelling master switch to indicate that, the groups are depressurised before in flight refuelling commences.

SYSTEM INSTALLATION

12. Reference to fig.1 will show that compressed air from the engines and compressed nitrogen from the storage cylinders are piped, for the operation of the system, to combined air and gas valves; the flow from these valves is regulated by master control valves before being fed directly into all fuel tanks.

13. Compressed air is supplied at pressures, depending upon the engine and aircraft speed, up to 200 p.s.i. from ½ in. tappings at the last stage of each engine high-pressure compressor through non-return valves to the air and gas valves on the control panel (fig.5). An air flow, tapped from the main supply line, passes through an air drier and the filter of a filter restrictor to a pressure reducing valve. After the pressure is reduced to 9-12 p.s.i., the flow is either fed direct to the master control valve to be applied as servo pressure to the system components or through a solenoid depressurisation valve to the master control valve to depressurise the system. From the filter a further servo line supplies restricted air for the operation of the air and gas valve. The functions of the bleed and servo

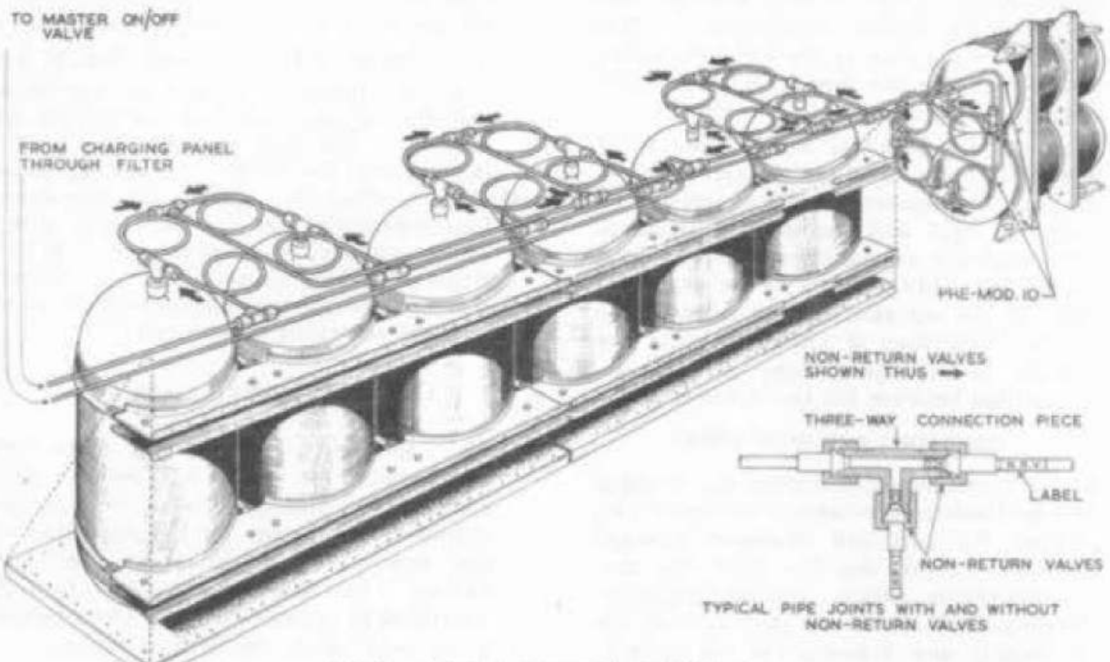


Fig.2 Nitrogen cylinder installation

lines may be seen on fig.7 and succeeding figures.

14. On aircraft fitted with Mod.303, fuel traps are introduced into the system. In each group, one precedes the air drier and another is fitted in the tank pressure line between the tanks and the solenoid depressurisation valve.

15. Nitrogen is stored in twelve 2,250 litre wire-wound steel cylinders charged from an external source to 1,800 p.s.i., six cylinders being mounted in a crate at the rear of each main undercarriage rib (fig.2). For recognition purposes the cylinders are painted grey with the upper half of the hemispherical portion at the outlet end black.

16. Each cylinder is separated from the other by a non-return valve so that damage to one cylinder will not affect delivery of gas from the remainder; similarly each pair of cylinders is isolated so that damage to the delivery pipe will not affect the supply from the remaining pairs.

17. From each bank of cylinders a tungum pipeline leads through an electrically-operated cock labelled MASTER VALVE OPEN-SHUT which is remotely controlled from the cockpit; interposed in this line before the master valve actuator is a pressure transmitter connected to the cockpit cylinder contents gauges. A tapping is also taken to a pressure gauge on the charging panel in the main-wheel bays. After the master valve, the pipeline branches to the two air and gas valves.

18. The servo air piping arrangement between the system components, i.e.,master control valve, air and gas valves and vent valves, is shown on fig.5; the static air supply to the master control valves is taken from a static vent in the No.2 tank bay above the nose wheel.

19. Vent pipes from the fuselage No.1 and No.2 tanks lead to forward-facing outlets in the fuselage roof skin plating one on the port and one on the starboard side of the aircraft. A further outlet for the wing tanks is on the underside of each wing inboard of the elevator centre hinge rib. This outlet is branched, each branch being connected through a vent valve to the associated tank group pressurisation system. The No.1 tank is interconnected to the No.4, 5 and 7 tanks via tank pressurisation lines and to two vent valves. Similarly the No.2 tank is connected to the No.3 and 6 tanks and two further vent valves. Therefore the pressure in all tanks of one group will normally be equal with both vent valves operated together. Should one vent valve in a group become totally inoperative all tanks in the group can vent through the remaining vent valve. For example, under these conditions, it is possible for the No.1 or 2 tanks, in company with the other tanks in the associated group, to vent through the undersurface of the wing.

20. If the emergency fuel level switches failed during the refuelling of No.3, 4 or 5 fuel tanks, overfilling would create a depression in the tanks and their pressurisation lines. Fuel would be siphoned from the tanks and the reduction of the internal pressure acting on the tanks, relative to the external, would tear the tank colletted studs from the bay skin and damage the tank. To prevent this, pipes tapped into

the tank pressurisation lines lead through anti-siphon non-return valves to air vents in the undersurface of the wing. The valves are set to prevent the pressure in the tank pressurisation lines falling below -¼ p.s.i. (i.e. -7 in. water gauge). When the valves open, the pressure will rise to atmospheric and the external and internal forces acting on the tank will again balance.

CHARGING AND TEST PANEL

21. A panel on the outer, forward side of each main-wheel bay houses the nitrogen cylinder charging valve and a 0-2,000 p.s.i. gauge registering the pressure in the bank of cylinders.

TANK PRESSURISATION GROUND TEST PANEL

22. The ground test panel (fig.3), situated on the inner rib in each main-wheel bay, houses the test points to which pressure gauges are attached during ground checks of the system. Four points are provided, two for the compressor air pressure and two for the fuel tank pressure. In addition, an ON-OFF valve is provided to exhaust servo air pressure to atmosphere during ground testing. The function of this servo air pressure is explained in para.13.

SYSTEM COMPONENTS

23. Eight major units are employed in the system. Seven of these are duplicated on the tank pressurisation control panels (fig.5) in the main-wheel bays. They consist of:-

(1) Master control valve (M.C.V.) Type FLE/A/6.

(2) Air and gas valve (A.G.V.) Type FLE/A/4.

(3) Vent valve (V.V.), Type FLB/A/12.

◄ (4) Servo pressure reducing valve, FLD/A/14. ►

(5) Filter/restrictor unit, Type FLC/A/7.

(6) Air drier, Type C/FOD/A5.

(7) Solenoid depressurisation valve, Type ES/A/390.

◄ (8) Fuel trap Ref. No. 26DC/6833. ►

24. Pressure supply to the tanks is provided by the engine compressors and from nitrogen cylinders whose initial charge pressure is 1,800 p.s.i. Servo air supplies are also taken from the engines to the master control valves and the air and gas valves, these supplies being dried and suitably reduced by the reducing valve and filter unit previously mentioned.

25. The major units are composite, e.g., the air and gas valve unit has an air valve and a gas valve. Therefore, to avoid tedious description, components in subsequent paragraphs are referred to by their initial letters, e.g., air valve (A.G.V.) would indicate the air valve of the air and gas valve.

Master control valve (M.C.V.)

26. The master control valve, as the name implies, is the initial controlling influence of the pressure in the fuel tanks, since it governs the opening and closing of the vent valves, the air inlet valve and the gas inlet valve in order to maintain the tank pressure within the accepted limits under all conditions.

27. Referring to fig.7 it will be seen that a spring-loaded diaphragm at one end of the M.C.V. is subject to tank pressure on one side and on the other side, which is open to atmosphere, to static pressure. Variations of tank pressure cause movement of the diaphragm and the landed control spindle to which it is attached.

28. It will be noted that the air, gas and vent valve servo lines are each connected to the central bore of the valve at three different points and immediately opposite these are three exhaust ports communicating directly to atmosphere. Suitable positioning of the lands on the spindle and the placing of restrictions in the servo supply line and inside the M.C.V., enable the latter to release or supply pressure for the various servo lines and thus control the operation of the air, gas and vent valves in strict sequence. The nominal tank pressure setting of the valves, that is the figure at which the vent valve servo pressure is vented as pressure rises is 3 p.s.i. above ambient. It will be appreciated from the description of the valve that a certain travel of the control spindle is required between the point at which the air inlet is closed off and the vent valve is opened as tank pressure rises; in the case of the valve FLE/A/6 the air valve

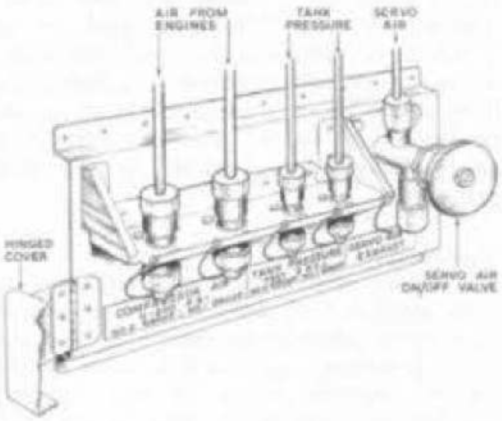


Fig.3. Ground test panel

is open at pressure up to 1·82 - 2·3 p.s.i., at which it is closed, and the vent valve is open at 2·65 - 3 p.s.i., the gas valve being open to 2·02 - 2·5 p.s.i.

Air and gas valve (A.G.V.)

29. Reference to fig.7 will show that the air and gas valve unit consists of two diaphragm operated valves, an air valve in tandem with a controlling diaphragm and a nitrogen inlet valve operated by a pivoted lever.

30. There is a difference to be borne in mind when examining the operation of the two valves. The air valve, of the self-servo type, is lightly spring-loaded to the closed position and held shut by servo pressure on the diaphragm chamber. This pressure is tapped from the engine supply line and is fed through a restrictor in the filter/restrictor unit directly into the diaphragm chamber.

31. Conversely, the gas valve which is normally held closed by a light spring and the nitrogen pressure itself, is opened when an independent air supply is applied to its diaphragm chamber from the master control unit. A differential pressure of 5 p.s.i. is sufficient to open the valve against a nitrogen pressure of 1,800 p.s.i. The actual servo pressure will of course be dependent on the master control unit supply which is governed by the tank pressure.

Vent valve (V.V.)

32. Two vent valves are connected to each group of fuel tanks and are dependent upon servo pressure for their operation; the servo pressure supply is controlled by the master control valve in the system. Operation of the vent valve is governed by the internal bellows chamber upon which the main valve seat with rubber seals is fitted. When the chamber is not pressurised by servo air, the main valve seat is spring-loaded to the open position. Application of servo pressure to the interior of the chamber will close the valve against the compression of the internal spring. The minimum servo pressure required to hold the valve closed is at present 5 p.s.i.

33. Provision is made within the vent valve for emergency inward and outward venting, control of which is by a single diaphragm chamber at the outlet end of the valve. Tank pressure is fed to the upper side of the chamber while the other side is open, through a filter in the valve body, to atmospheric pressure. The emergency pressure settings are 2·75 to 3·25 p.s.i. (outward) and -4·5 in. on a water manometer at 23 deg.C. (inward).

34. When the tank pressure exceeds the emergency setting figure, the emergency diaphragm chamber is expanded downwards against a spring and, through a push rod and ball, opens a cone valve which vents the main bellows chamber to atmosphere; the valve is then immediately opened and excess tank pressure is released.

35. Should the tank pressure fall below ambient atmospheric pressure the emergency diaphragm chamber is moved in the opposite direction against a lightly loaded spring above it, allowing the ball assembly to lift off its seating in the centre of the cone valve and the servo pressure to escape from the main bellows chamber; the main valve is immediately opened and inward venting takes place.

Filter/restrictor unit

36. The unit is provided in the system to filter the servo air supply with a low pressure drop. It has one inlet, from the engine compressor and two outlets. One outlet goes to the servo pressure reducing valve and the other, in which a restrictor is interposed, goes to the operating diaphragm chamber of the air valve, (A.G.V.) and to the M.C.V.

Servo pressure reducing valve

37. This valve is designed to provide 9-12 p.s.i. outlet servo pressure for inlet pressures from the engine compressor varying between 180 to 15 p.s.i. The valve has an emergency relief valve incorporated downstream of the reducing valve seat which relieves at 12 p.s.i. to protect against excessive servo pressure in the event of failure of the reducing valve.

Air drier

38. An air drier is interposed in the servo air bleed line to the system components and consists of a cylindrical fluted body housing a container. Inside the container there is 0·2 lb. of silica gel (Ref.No.33C/1454). The air drier removes moisture from the servo air applied to the the system components and thus prevents malfunctioning.

Solenoid depressurisation valve

39. This electrically-operated two-way valve controls the pressure supply to the tank pressure side of the diaphragm in the master control valve. When the tank pressurisation switch is in the ON position, the tank pressurisation line is connected through the solenoid depressurisation valve to the master control valve, fluctuation of tank pressure will then automatically control the system through the master control valve. If the switch is in the OFF position the tank pressurisation line is isolated from, and air reduced in pressure connected to, the master control valve, and the landed spindle is moved until the air port is closed and the nitrogen and vent valve ports opened. Air and nitrogen supplies are cut off and the vent valves opened to depressurise the system (fig.12).

CYCLE OF OPERATIONS

Static conditions (fig.7)

40. Under static conditions but with the

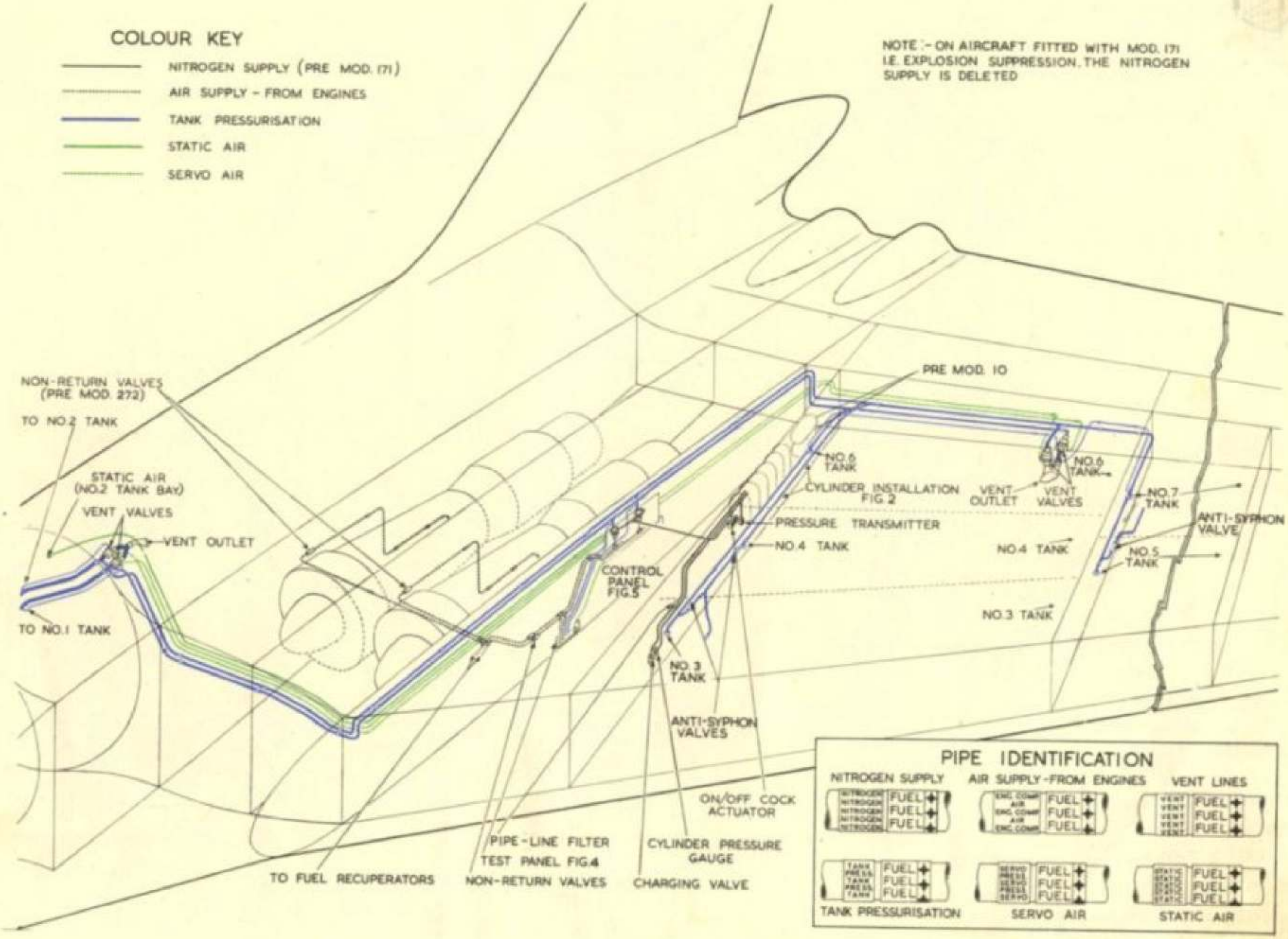


FIG. 4. FUEL TANK PRESSURISATION SYSTEM INSTALLATION

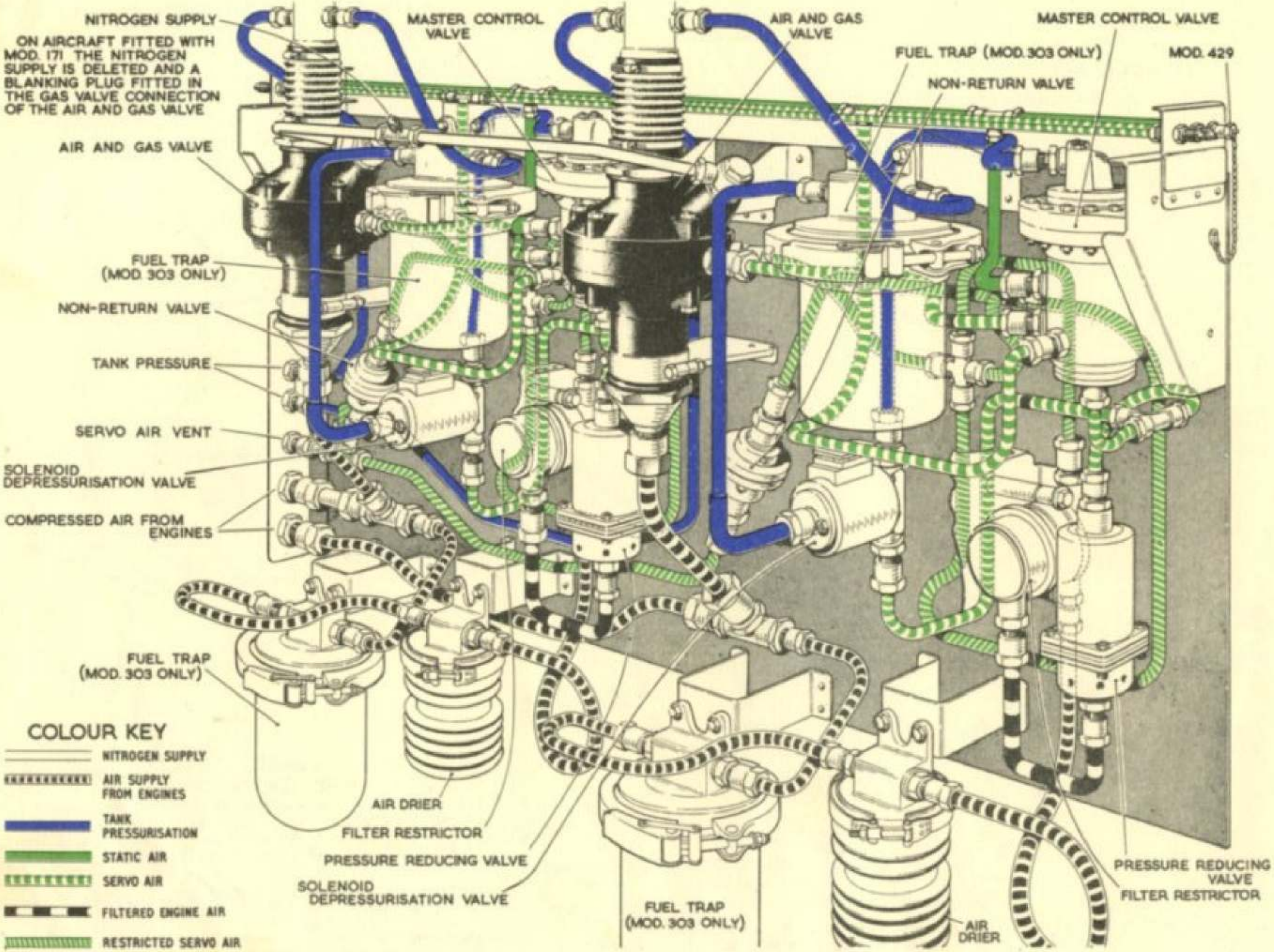


FIG. 5 TANK PRESSURISATION CONTROL PANEL

engines running and nitrogen selected, compressed air is applied directly to the air valve (A.G.V.) which at this stage is lightly spring-loaded to the closed position. The force of the compressed air is sufficient to open the air valve and permit some flow into the tanks.

41. At the same time, air passes through a small diameter pipe line from the main engine supply to the filter/restrictor unit. From the latter unit, restricted air is piped to the air valve diaphragm chamber (A.G.V.) and to the M.C.V. A further line passes from the filter/restrictor unit through the servo pressure-reducing valve (set at 9 - 12 p.s.i.) to the M.C.V.

42. Initially the master control valve air valve port is open, and the vent valve and nitrogen valve ports are closed, due to the position of the M.C.V. spring-loaded diaphragm (set to 3 p.s.i.).

43. Servo air from the filter/restrictor unit will pass through the reducing valve to the vent restrictor orifice (M.C.V.) and, being diverted by the closed port, will pressurise the vent valve bellows to close the main vent valve (V.V.).

44. The nitrogen orifice (M.C.V.) servo supply, diverted in the same way, will pressurise the gas valve diaphragm chamber (A.G.V.) to open the gas valve (A.G.V.) and nitrogen will commence to flow into the tanks. Note that, when the nitrogen supply is exhausted, the air valve diaphragm (A.G.V.) open to atmosphere via the two ports in the M.C.V. sleeve, will allow the air valve to open and permit pressurisation with air only.

Tank pressure rising (fig.8)

45. As tank pressure rises to 1·82 - 2·3 p.s.i. so the pressure on the M.C.V. diaphragm is increased and, since there is a static air supply on the other side of the diaphragm, the differential pressure is sufficient to move the landed spindle attached to the diaphragm within the M.C.V. The movement of the spindle closes the servo air port and the diverted pressure is applied to the air valve diaphragm chamber, closing the air supply to the tanks. The vent valve remains closed, the nitrogen valve (A.G.V.) remains open and a nitrogen pressure is built up in the tanks.

TYPICAL MASTER CONTROL VALVE (TYPE FLE/A/6) PERFORMANCE AND SETTING TOLERANCES FOR M.C.V. AND VENT VALVE (TYPE FLB/A/12)

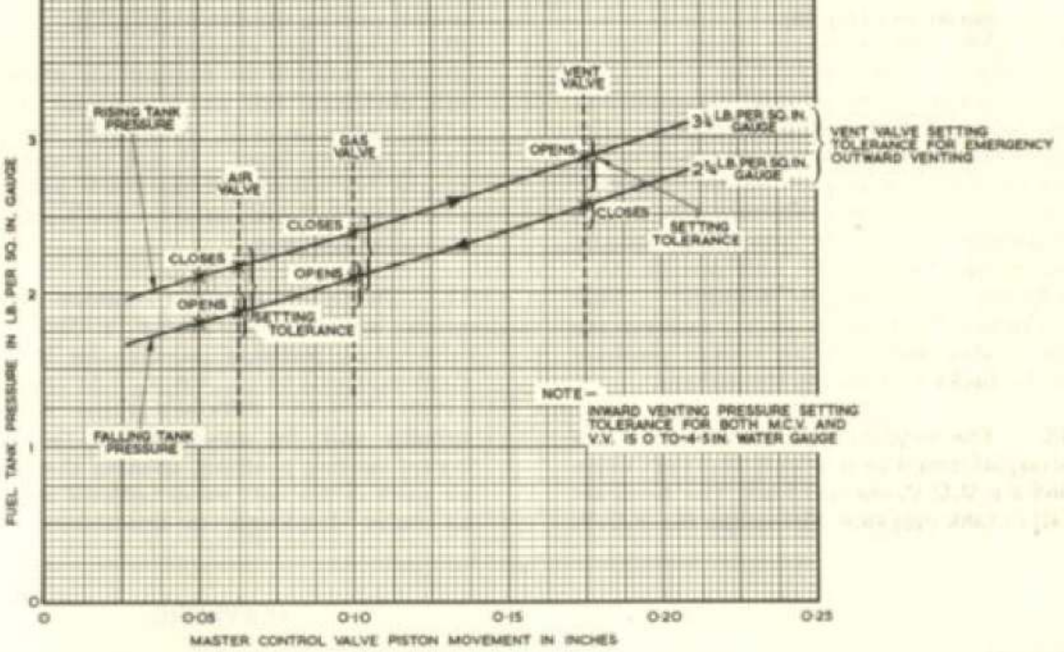


Fig.6. Master control valve settings

Balanced tank pressure (fig.9)

46. Shortly after starting the engines a state of equilibrium is reached with the tank pressure at 2·02 - 2·5 p.s.i. (pre Mod.171) or 1·82 - 2·3 p.s.i. (post Mod. 171). This is achieved by the sensing action of the M.C.V. As tank pressure rises on aircraft without Mod.171 embodied, by the inward flow of nitrogen, so the pressure on the M.C.V. diaphragm is increased, causing the spindle (M.C.V.) to move far enough to open the vent port (M.C.V.) allowing servo air to escape. The gas valve diaphragm is collapsed, the gas valve closed and the system is

◀ balanced with no supply to the tanks. Should the tank pressure fall below 2·02 - 2·5 p.s.i. due to the consumption of fuel or for any other cause, the M.C.V. spindle will be moved by the lowering of pressure on the M.C.V. diaphragm closing the vent port (M.C.V.) and allowing servo air to open the nitrogen valve again. ▶

Climb conditions (fig.10)

47. As tank pressure rises, due to climbing, so the pressure on the M.C.V. diaphragm is increased until the presetting of 3 p.s.i. differential is exceeded. The gas valve is first closed as described in the previous paragraph. At approximately 2·65 - 3 p.s.i. tank pressure the M.C.V. diaphragm will move its associated spindle far enough to open the vent port (M.C.V.) allowing servo air to escape. This collapses the bellows (V.V.) opening the vent valve and allowing excess pressure in the tanks to pass to atmosphere.

48. The sequence of operations is now straightforward in that only the vent valve and the M.C.V. are involved. The resultant fall in tank pressure will cause the M.C.V. diaphragm to return sufficiently to move the spindle and close the servo air vent to atmosphere when the vent valve will close.

49. Any further increase in tank pressure will again open the vent valve and the tanks will vent in a series of pulses if the climb is continued.

Inward venting conditions (fig.11)

50. When the aircraft descends, tank pressure relative to ambient air pressure will obviously fall and a reversal of the climb sequence will occur with the gas valve opening first. Should the nitrogen supply be exhausted the tank pressure will again fall and, at 1·7 - 2.0 p.s.i. the air valve will open.

51. Should the pressure continue to fall which would occur during a dive, the differential pressure across the M.C.V. diaphragm will be increased. At approximately 1 p.s.i. differential the M.C.V. spindle will be moved to the extreme inward venting position, opening the servo air ports of the vent valve bellows and the air valve diaphragm to atmosphere, and sealing off the pressure on the nitrogen valve diaphragm.

52. Removal of the servo air supply from the vent valve bellows will allow the valve to be opened by its light spring-loading, similarly, the air valve diaphragm is deflated and air passes into the tanks whilst the pressure in the gas valve holds the valve open to permit flow.

53. When the differential pressure across the M.C.V. diaphragm has been sufficiently reduced, the M.C.V. spindle will regain its equilibrium position.

Failure of air supply

54. Should the air supply from an engine fail, the emergency valve of the vent valve will operate irrespective of the state of the remainder of the system and open the vent valve when the tank pressure falls to a predetermined pressure below the ambient atmosphere. The preset pressure is - 4·5 in. on a water manometer at 23 deg. C. The outboard venting has been set to 2·75 to 3·5 p.s.i. Reference should be made to para.33 and subsequent paragraphs for an explanation of the emergency operation of the valve.

SERVICING

General

55. Servicing of the pressurisation and nitrogen system consists of making the routine checks at the periods stipulated in the Servicing Schedule. Detailed servicing and descriptive information on the system components is given in A.P.4303E.

CYLINDERS

56. The cylinders are to be periodically checked for the last date of pressure test; the date is stamped on the outlet neck. Cylinders have a life specified in A.P.3158, Vol.2 after which time they must be returned to a Maintenance Unit for examination and pressure testing. If a cylinder has to be removed it should be arranged that the open ends of the broken connections are left unblanked for a minimum length of time.

NOTE . . .

It is dangerous to disconnect a cylinder until it is almost empty.

Blank off the inlet and outlet connections after a cylinder has been removed. Should all cylinders be removed, i.e., the system is not in use, all open ends of pipes and connections must be blanked off with approved blanking caps to prevent the ingress of moisture and foreign matter. All installed cylinders must be properly secured and free from corrosion.

MASTER COCK

57. The master cock must be examined for corrosion, damage and security. Test for leaks by applying soft soap solution with a brush. The presence of bubbles will indicate a leak; tighten up the gland nut as necessary.

INITIAL OPERATION ON STARTING ENGINES

(1) Engine compressor air is fed to the Air and Gas valve, which opens and allows air into the fuel tanks.

(2) Air passes through the filter to the Master Control Valve, allowing the Vent Valve bellows to expand (closing the valve) and the nitrogen side of the Air and Gas Valve to expand (opening the nitrogen supply to the tanks). Air and nitrogen go into the tanks together and pressurisation commences.

(3) Compressor air begins to seep through the restrictor.

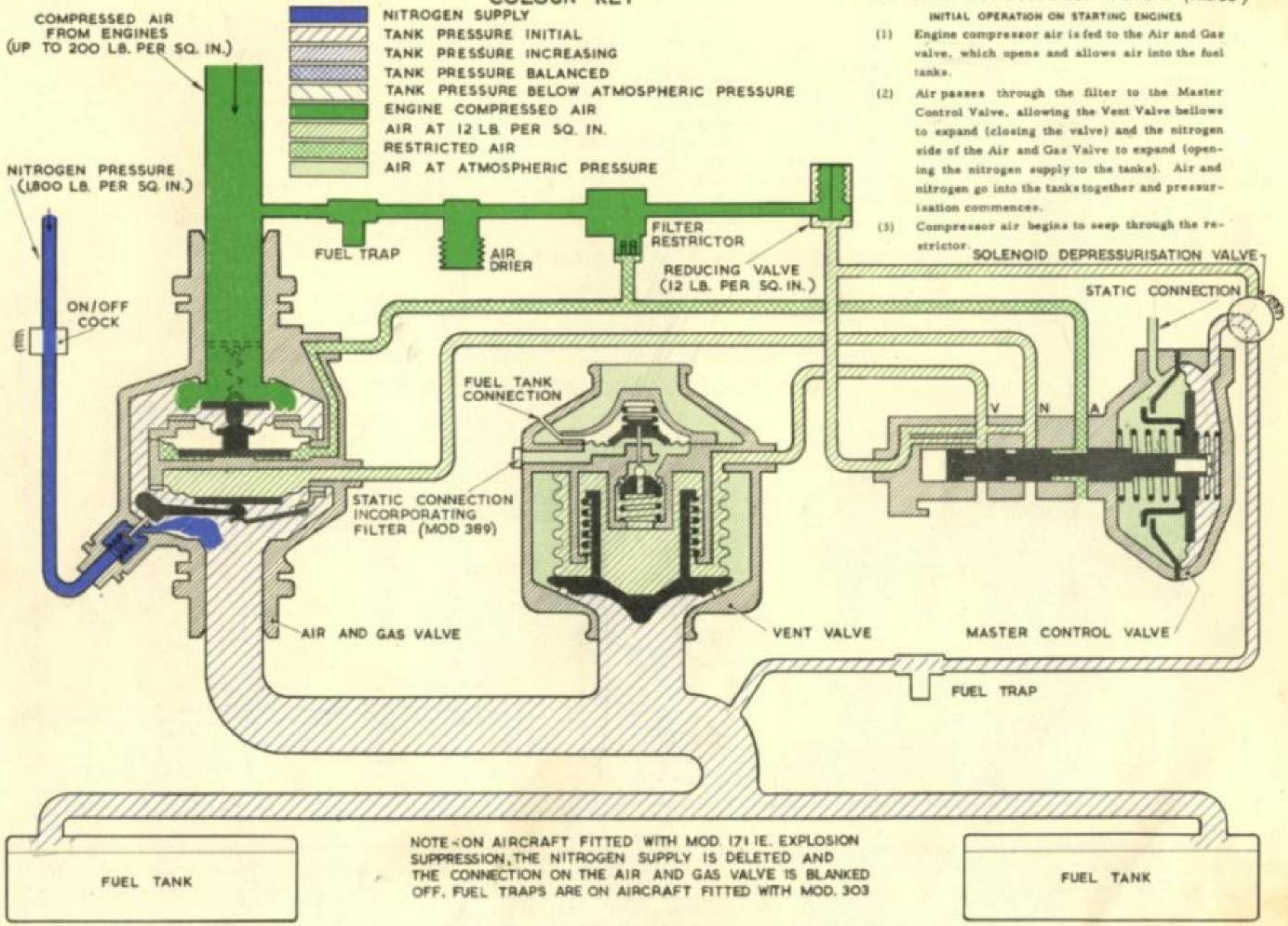


FIG. 7. TANK PRESSURISATION (1)

TANK PRESSURE BUILDING UP

(4) As tank pressure builds up, the Master Control Valve spindle moves to the left, sealing connections A, N and V from static.

(5) Gas valve remains open.

(6) Vent valve remains closed.

(7) Pressure builds up on the underside of the air diaphragm of the Air and Gas Valve, closing off the air supply to the tanks, and allowing nitrogen only into the tanks.

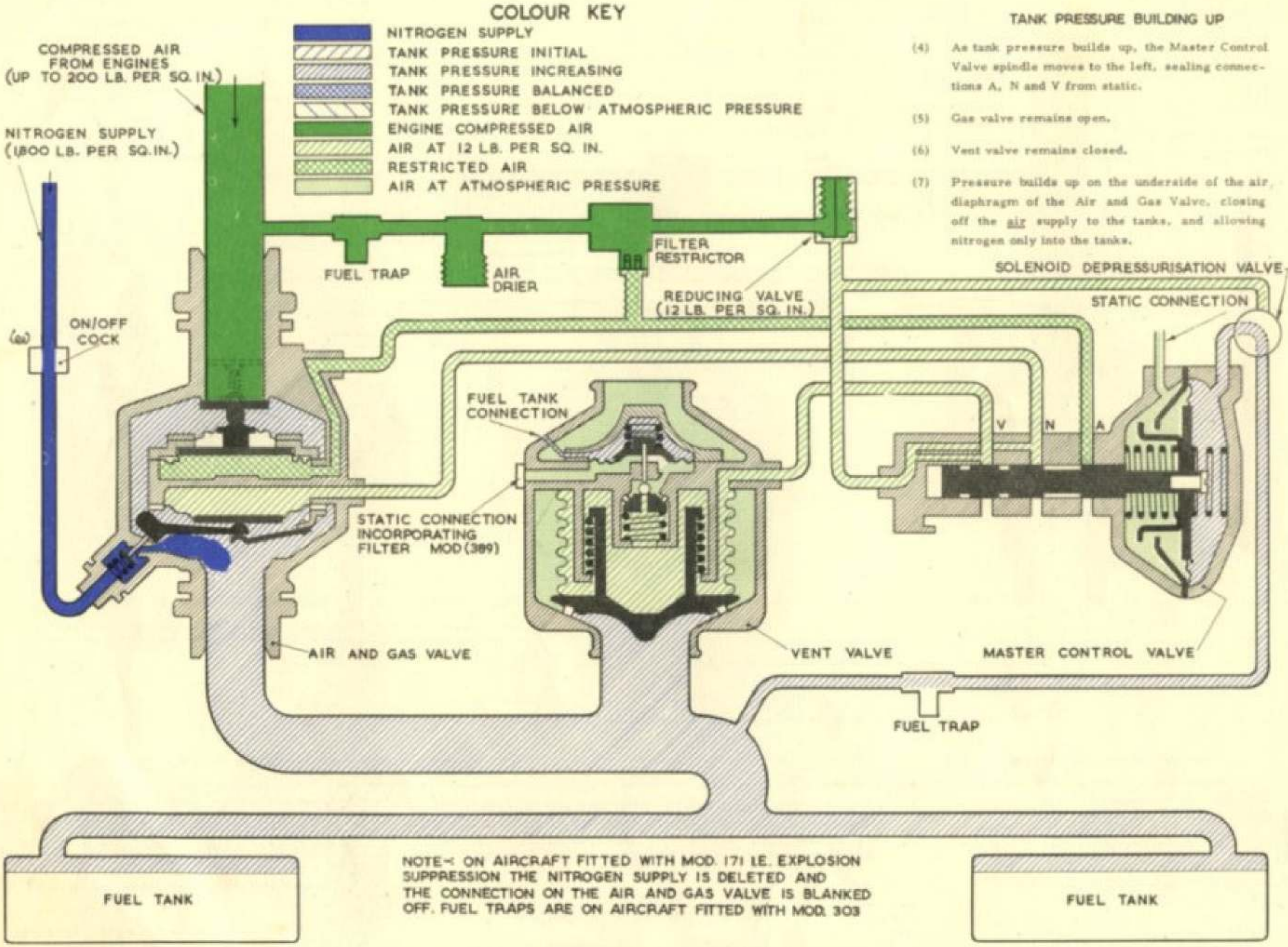


FIG. 8. TANK PRESSURISATION (2)

TANK PRESSURE BALANCED AT 3 LB. PER SQ. IN. WITH AIR AND NITROGEN

(8) As the Master Control Valve moves to the left, on tank pressure reaching 3 lb. per sq. in. connection N is vented to atmosphere which deflates the nitrogen side of the Air and Gas Valve, and shuts off the nitrogen supply.

(9) System remains balanced with no supply to the tanks.

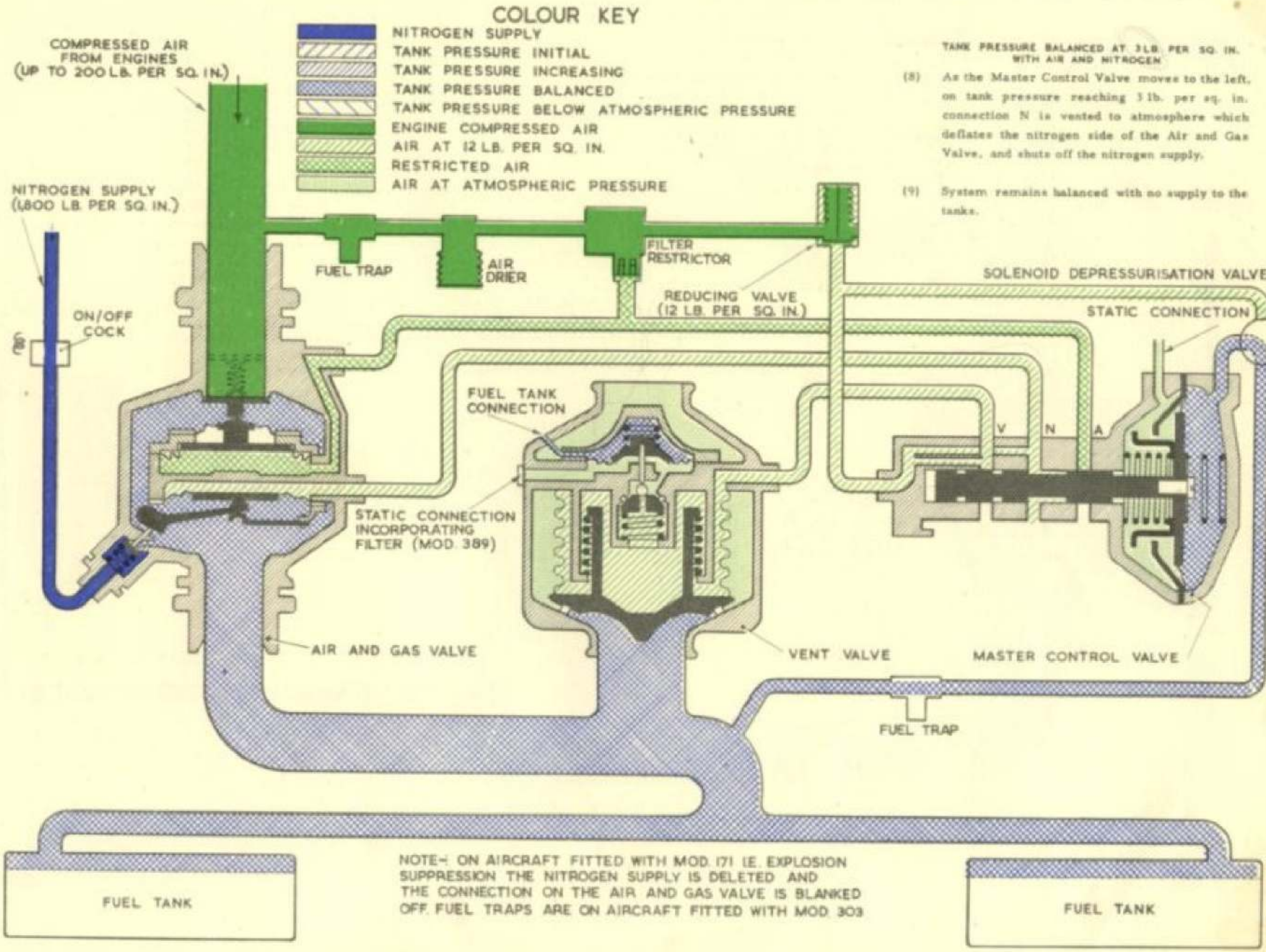
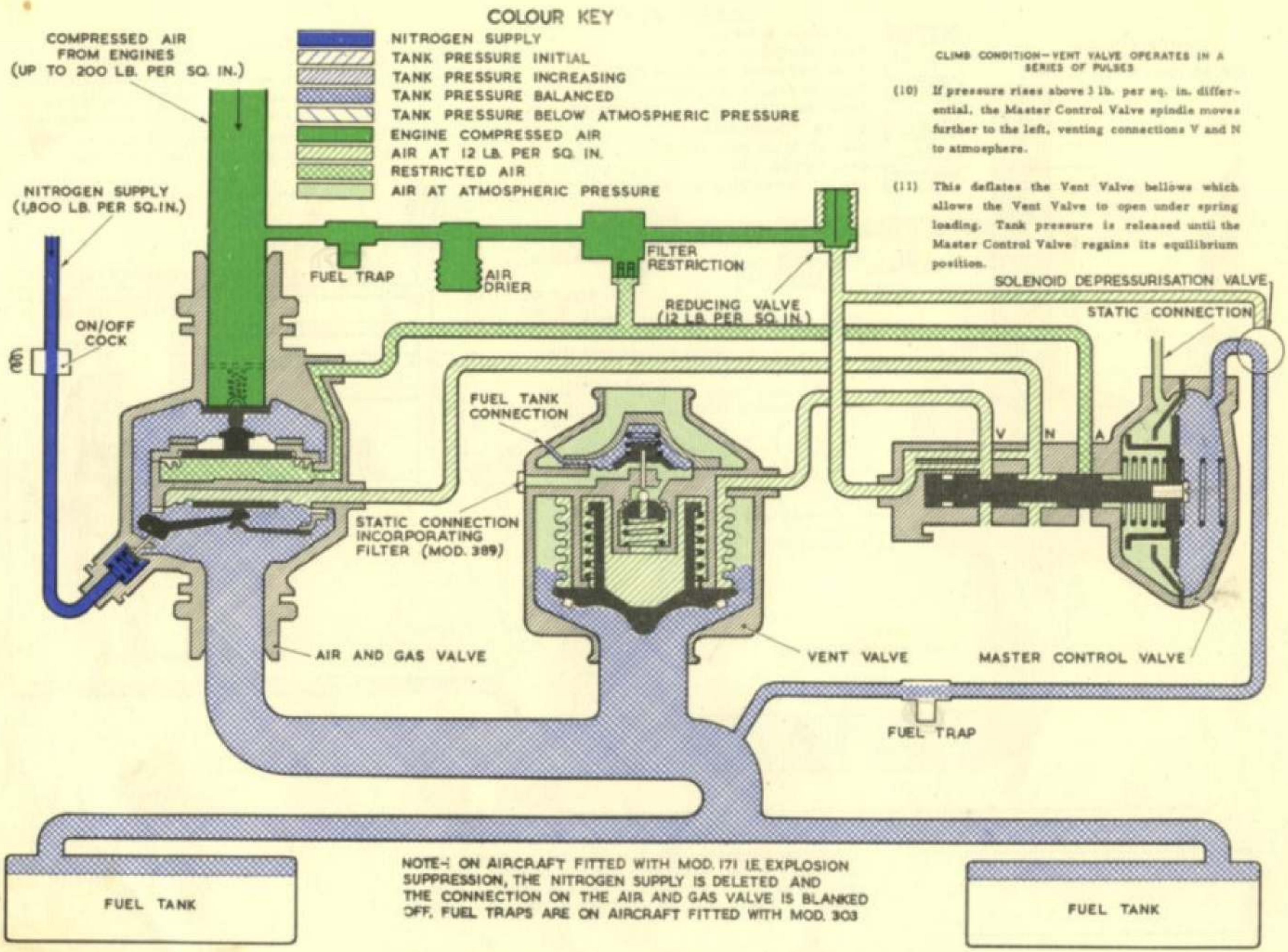


FIG. 9. TANK PRESSURISATION (3)

CLIMB CONDITION—VENT VALVE OPERATES IN A SERIES OF PULSES

(10) If pressure rises above 3 lb. per sq. in. differential, the Master Control Valve spindle moves further to the left, venting connections V and N to atmosphere.

(11) This deflates the Vent Valve bellows which allows the Vent Valve to open under spring loading. Tank pressure is released until the Master Control Valve regains its equilibrium position.



NOTE:- ON AIRCRAFT FITTED WITH MOD. 171 I.E. EXPLOSION SUPPRESSION, THE NITROGEN SUPPLY IS DELETED AND THE CONNECTION ON THE AIR AND GAS VALVE IS BLANKED OFF. FUEL TRAPS ARE ON AIRCRAFT FITTED WITH MOD. 303

FIG. 10. TANK PRESSURISATION (4)

INWARD VENTING OR DIVING CONDITION

(12) If tank pressure is <u>less</u> than atmospheric pressure the Master Control Valve moves over to the extreme right position, venting connections A and V to atmosphere.

(13) The Vent Valve opens (under internal spring loading).

(14) The air diaphragm part of the Air and Gas Valve is deflated, allowing air into the tanks.

(15) At the same time, connection N is sealed off from atmosphere allowing air pressure to inflate the nitrogen side of the Air and Gas Valve, thus opening the gas valve to the tanks.

(16) This deflates the vent valve bellows, which allows the vent valve to open under spring loading. Tank pressure is allowed to increase, until the Master Control Valve regains its equilibrium position.

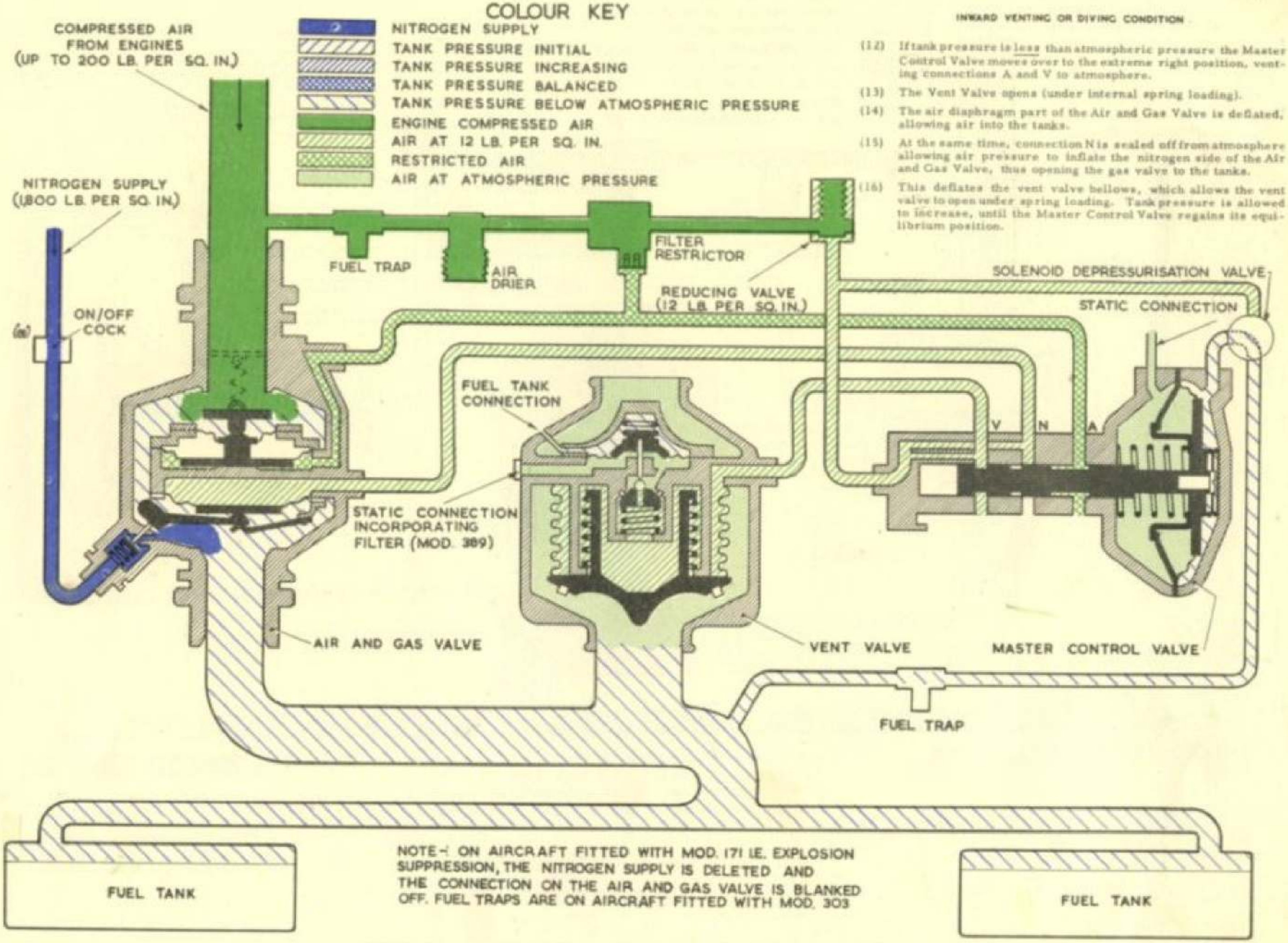
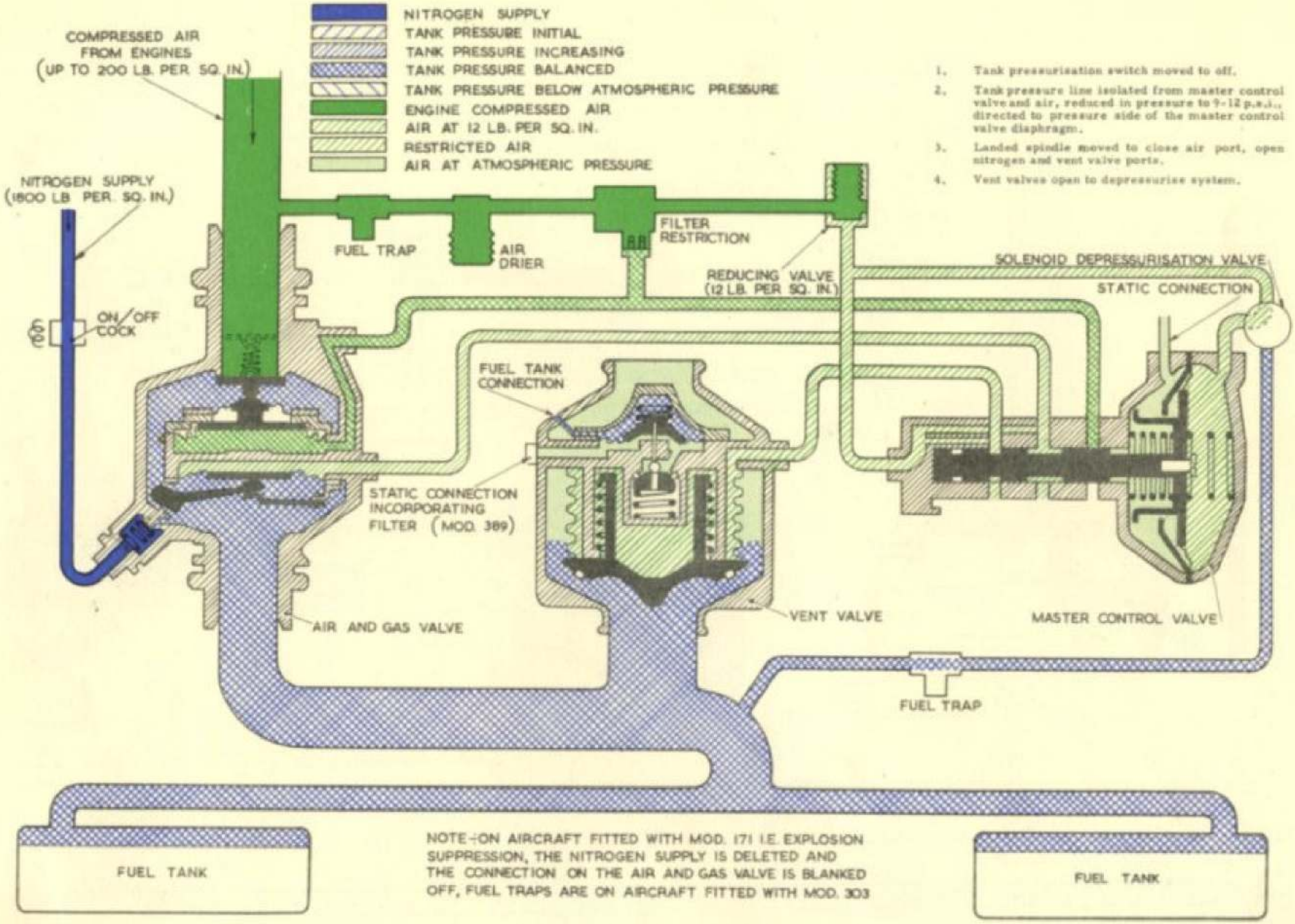


FIG. 11. TANK PRESSURISATION (5)

(A.L.55, Sept. 58)



1. Tank pressurisation switch moved to off.
2. Tank pressure line isolated from master control valve and air, reduced in pressure to 9-12 p.s.i., directed to pressure side of the master control valve diaphragm.
3. Landed spindle moved to close air port, open nitrogen and vent valve ports.
4. Vent valves open to depressurise system.

NOTE:–ON AIRCRAFT FITTED WITH MOD. 171 I.E. EXPLOSION SUPPRESSION, THE NITROGEN SUPPLY IS DELETED AND THE CONNECTION ON THE AIR AND GAS VALVE IS BLANKED OFF, FUEL TRAPS ARE ON AIRCRAFT FITTED WITH MOD. 303

FIG. 12 TANK DEPRESSURISATION

RESTRICTED

FILTERS

58. Filters must be examined for damage and corrosion.

AIR DRIER

59. Periodical examination of the silica gel crystals is the only servicing normally required for the air drier. When the container is removed a check should also be made for signs of internal corrosion and obvious damage. The container is removed by releasing the clamping ring at the upper end. Silica gel shows definite colour changes with various concentrations of moisture. The gel, when free from moisture, is deep blue in colour and changes through bluish purple to reddish purple then to a deep pink colour when saturated. Should a change in colour have taken place the crystals should be renewed using silica gel, Ref.No.33C/1454. Silica gel Ref.33C/790 must not be used as it is unsuitable.

FUEL TRAPS

60. Fuel traps should be checked and emptied when investigating system faults and when required by the Servicing Schedule.

PIPELINES AND CONNECTIONS

61. Pipeline connections are to be periodically checked for leaks using a soap solution, and for security. Except at hose joints the connections should be wire locked with 22 s.w.g. steel wire (D.T.D.189). Before couplings are assembled the threads should be lubricated with anti-seize graphite grease ZX-13 and then tightened to the following instructions:-

Outside diameter of pipe (in.)	Approximate number of turns after finger tightening New Joint	Remade Joint	Approximate clearance between end of outer sleeve and face of hexagon on inner sleeve (in.)
3/16	2/3	1/3	1/16 - 1/8
1/4	1/4	1/6	1/8
5/16	1/4	1/6	1/8
3/8	1/4	1/6	1/8
7/16	1/4	1/6	1/8
1/2	1/4	1/6	1/8
5/8	1/3	1/6	1/4
3/4	1/3	1/6	1/4
7/8	1/3	1/6	1/4
1	1/3	1/6	3/8
1¼	1/3	1/6	3/8
1½	1/3	1/4	3/8

Clearance between the end of the outer sleeve and the face of the hexagon on the inner sleeve should be watched. Excessive tightening and releasing of unions will tend to reduce the clearance and the outer sleeve may be bottoming and failing to pull the pipe up to the nipple. Unions should be tight under the conditions specified above and leaks should not be eliminated by undue tightening of the union. If leaks persist, the union should be released, and the component parts and the pipe flares examined for faults.

CHARGING THE SYSTEM

62. The cylinders can be replenished in situ through a charging valve Mk.8B (Ref.No.6D/796), located in each mainwheel bay, using a ¼ in. B.S.P. connection (Ref.No.6D/801) complete with tubing. Brief details of the procedure for charging the nitrogen cylinders are given in Sect.2, Chap.2 of this Book, full details are given in A.P.1275A, Vol.1, Sect.10, Chap.4.

FUNCTIONING TESTS

WARNING. . .
Should the tank pressure reach 3·35 p.s.i. during tests, all air supplies must be shut off immediately and the tests discontinued otherwise serious damage to the structure may result.

Fuel tank pressurisation switches

63. To permit independent control of air and nitrogen supplies during functioning tests, coupling bars linking the system switches may be removed, but should be refitted as soon as the tests are completed. On aircraft not fitted with Mod.38, i.e., Flight Refuelling, the coupling bar links the nitrogen and the tank pressurisation switches. The two forward switches control the nitrogen supplies to the port and starboard tank groups and the aft switch the air supply and depressurisation of the system. On aircraft fitted with Mod.38, but not Mod.171, i.e., Explosion Protection system, only the nitrogen switches are linked together. The switch order is reversed, the forward switch controlling the air supply and the aft switches the nitrogen supplies. When both modifications are fitted i.e., Mod.38 and 171, the Explosion Protection system replaces the nitrogen system and nitrogen switches are not fitted.

64. All sections of the following tests will be applicable to aircraft fitted with Mod.171 except the check on tank pressure with combined air and gas supplies.

65. The method of in situ testing of the system in the following paragraphs should be applied when demanded by the Servicing Schedule, after the renewal of damaged pipelines or faulty components, or when malfunctioning of the system is suspected. A fault finding chart (Table 1) will assist in the investigation of faults.

66. Air for the system may be supplied either by running an engine, or, when more convenient, by an external ground supply. When the engine used is Olympus 101, 102 or 104 the minimum engine speed required to initiate pressurisation of the system with certainty is 80 per cent r.p.m. Once tank pressure has been built up, it can be maintained by 43 per cent r.p.m.

67. Connections labelled COMPRESSOR AIR, to which an external air supply can be coupled, are provided on the test panels in the main-wheel undercarriage bays. It should be noted, that if these connections are used, the engine and tank pressurisation air feed lines and their associated non-return valves will not be included in the tests and will have to be checked during an engine run.

68. Air should be supplied at pressure up to 200 p.s.i. at the ground connection. However, if this pressure is not available, the system will function satisfactorily at pressures down to 20 p.s.i.

69. The amount of air flow is, of course dependent on the quantity of fuel present in the tanks and the duration of the tests. If storage cylinders are used, approximately 200 lbs. of air must be stored. This is equivalent to 60,000 litres of air at normal temperatures and pressures. Note that the standard charging cylinder Mk.7A (Ref.No.71A/29) has a capacity of 15,850 litres when charged to 3,600 p.s.i. Air flows up to 30 lb. per minute will be required for short periods, this flow decreasing considerably as the tanks become pressurised.

Functioning test with engine running

70. A functioning test of any group of the tank pressurisation system may be carried out as follows:-

(1) Ensure that the tanks are refuelled to a minimum of 80 per cent capacity to conserve nitrogen.

(2) Couple gauge (Ref.No.26DC/95096) to the group tank pressure connection on the test panel in the main-wheel undercarriage bay.

(3) Remove the blank from the servo exhaust cock on the test panel.

(4) Start the required engine.

(5) To check the operation of the vent valves and the air valve (A.G.V.):-

(a) Ensure that the nitrogen switch is in the OFF position.

(b) Select the tank pressurisation switch to ON.

(c) Servo air should close the vent valves and tank pressure build up to 1·82 - 2·3 p.s.i. when a slow hunt should occur as fuel is used.

(d) Switch the tank pressurisation switch to OFF. This should exhaust the vent valve bellows and depressurise the tanks.

(6) The check in item (5) should be carried out three times.

(7) To check the operation of the gas valve (A.G.V.):-

(a) Switch the tank pressure switch to ON and allow the tank pressure to build up to 1·82 - 2·3 p.s.i.

(b) Select the nitrogen switch to ON. Tank pressure should build up to 2·02 - 2·5 p.s.i. and a slow hunt occur as fuel is used. The nitrogen pressure gauge reading should fall indicating a flow of nitrogen into the tanks.

(c) Switch the nitrogen and the tank pressurisation switches OFF. The tanks should depressurise.

(8) Repeat item (7).

(9) Switch ON the nitrogen first and then the tank pressurisation switch. The tanks should pressurise to approximately the same value of 2·02 - 2·5 p.s.i. but the build up of pressure being fed from engine air and nitrogen should be completed in a shorter time.

(10) Depressurise the system.

(11) To check the engine and tank pressurisation air feed lines and their associated non-return valves:-

(a) Select the tank pressurisation switch to ON.

(b) When tank pressure has built up, increase engine speed to take-off r.p.m. for twenty to thirty seconds. Check that tank pressure is unaffected.

(c) Decrease engine speed to 43 per cent r.p.m. check that tank pressure is maintained. Failure to hold tank pressure at 43 per cent r.p.m. indicates a restriction in the engine air-feed line or associated non-return valves.

(12) To check outward venting:-

(a) On aircraft with Mod.38 and 39 embodied pressurise the tank and, with the engines at 40 per cent r.p.m. select the flight refuelling master switch to ON, this will depressurise the tanks. Increase the engine r.p.m. to 80 per cent and select the flight refuelling master switch to OFF, the tanks will again pressurise. Reduce the engine r.p.m. to 43 per cent, check that tank pressure is maintained.

(b) Depressurise the tanks.

(c) Select the tank pressurisation to ON and increase the engine speed to 80 per cent r.p.m. Pressure should build up to 1·82 - 2·3 p.s.i.

(d) Decrease the engine r.p.m. to 60 per cent, open the servo air exhaust cock on the test panel slowly and just a sufficient amount to cause a slow build up of pressure. This will collapse the bellows of the air valve (A.G.V.) and allow a continuous flow of air into the tanks. Tank pressure will rise until at 2·65 - 3 p.s.i. the vent valves open and outward venting occurs. Venting will continue in a series of slow hunts.

NOTES . . .

The servo air exhaust cock must not be opened further than to cause a build up of tank pressure. Full opening of the cock may cause false low readings or entire loss of servo air and tank pressure.

It will not be known in the outward venting check whether the vent valves open under the control of the master control valve or the emergency valves of the vent valves since the limits overlap. If necessary, the independent operation of these valves may be checked by the methods in para. 73 and 75.

(13) The check in item (12) should be carried out three times.

(14) An inward venting check (as detailed in para.72) should be carried out after the completion of the test requiring an engine run.

(15) When all checks are completed:-

(a) Refit the blanks on the servo air exhaust cock.

(b) Remove the tank pressure gauge and refit blanking caps on the test points.

Functioning test with an external air supply

71. The procedure in para.70 is applicable when an external air supply is used instead of engine air but the following points peculiar to checks with an external air supply should be noted:-

(1) The engine and tank pressurisation air feed lines and their associated non-return valves are not checked and must be tested during an engine run.

(2) When a check is made of the operation of the vent valves and the air valve (A.G.V.) (para.70, item (5)) a very slow hunt in tank pressure is permissible. If, however, the tank pressure hunts at rates of more than once in thirty seconds this indicates an excessive air leak from the tanks or piping and it is important that the leak be located and rectified.

(3) On isolated aircraft, it is possible that during the outward venting check the pressure will rise to 2·65 - 3 p.s.i., the vent valve open and the pressure then stabilise somewhere between 2·5 and 3 p.s.i. instead of venting in a series of slow hunts. This is not a matter for concern provided outward venting takes place at the specified pressures when the three checks are carried out.

Inward venting

72. It is very difficult to test the operation of the system on the ground satisfactorily for inward venting as this condition arises only during a rapid aircraft descent. A test to check the inward venting can, however, be made by supplying normal air supply to the servo system with the exception of the air valve (A.G.V.) and creating a depression in the fuel tanks by defuelling the aircraft. To test the operation of normal inward venting.

(1) Blank off the AIR connections to the master control valves.

NOTE . . .

On the port side of the aircraft it will be found more convenient to blank off at the four way union.

(2) Connect a water manometer to the group tank pressurisation test point.

(3) Select the tank pressurisation switch to ON. Tank pressure should remain at atmospheric.

(4) Open the defuelling cock.

(5) Connect a bowser to the refuelling point in the main-wheel undercarriage bay. Commence defuelling with the assistance of the booster pump. A negative pressure will build up and inward venting should take place before it reaches -4·5 in. on a water manometer at 23 deg.C.

NOTE . . .

Defuelling should be stopped immedi-

ately and the tank pressure switch moved to OFF if the negative pressure reaches -5 in. on the water manometer.

Whether inward venting is under the control of the master control valve or the emergency valve in the vent valve will not be determined by this test. The work entailed in adequately testing the individual operation of the vent valves by the master control valve or the emergency valves of the vent valves is considerable and the necessity for this is outweighed by the safety factor of the system. A test rig (Ref.No.26DC/95218) is used to check the tank pressurisation control panel, fitted with the vent valves, prior to its fitment to the aircraft.

(6) Check inward venting three times.

(7) On completion of the tests:-

(a) Remove the blanks from the air connections and reconnect the pipes to the master control valves.

(b) Remove the water manometer from the test connection.

(8) Connect a pressure gauge to the test connections and check the operation of the air valve (A.G.V.) (para.70, item 5). Check the reconnected unions for leaks.

(9) Remove the pressure gauge from the test connection and refit the blanking caps.

Outward venting control by the master control valve

73. If it is necessary to check the operation of the vent valve by the master control valve without the intervention of the emergency valve in the vent valve:-

(1) Disconnect and blank off the tank pressure sensing pipes at wing and fuselage vent valves.

(2) Connect a pressure gauge to the group test point and then pressurise the system to 1·82 - 2·3 p.s.i.

(3) Open the servo exhaust cock slowly and just sufficient to allow tank pressure to build up.

(4) Tank pressure should build up to 2·65 - 3 p.s.i. when the master control valve should operate the vent valves. Pressure will fall to approximately 2·5 p.s.i., rise again, and outward venting then continue in a series of slow hunts.

(5) On completion of the test, reconnect the tank pressure sensing pipes to the wing and fuselage vent valve.

(6) Pressurise the system to 1·82 - 2·3 p.s.i. and check the reconnected couplings for leaks.

(7) Depressurise the system, remove the pressure gauge from the test point, and fit the blanking cap.

Outward venting control by the emergency valve of the vent valve

74. If it is necessary to check the operation of the vent valve by the emergency valve in the vent valve without the intervention of the master control valve.

(1) Disconnect the pipe between the master control valve and the vent valve bellows. Attach an air supply of approximately 15 p.s.i. to the vent valve bellows connection. This isolates the master control valve but allows tank pressure to build up slightly above normal controlled pressure.

(2) Fit a pressure gauge to the group tank pressure test point and then pressurise the system to 1·82 - 2·3 p.s.i.

(3) Open the servo exhaust valve slowly and just sufficient to allow tank pressure to build up. Pressure should rise to 2·75 - 3·25 p.s.i. when the emergency valve should operate the vent valves and release the tank pressure.

(4) Reconnect the pipe between the master control valve and the vent valve bellows.

(5) Pressurise the system to 1·82 - 2·3 p.s.i. and check the reconnected coupling for leaks.

(6) Depressurise the system, remove the pressure gauge from the test point, and refit the blanking cap.

FAULT FINDING

75. Table 1 gives a list of faults which may be detected on the pressurisation system. Such faults as a failed vent valve bellows, seized pressure reducing valve, high control pressure from the pressure reducing valve or a blocked filter restrictor are highly improbable and not included in this table. Prior to application of the table, air driers and fuel traps should be checked for excessive moisture or fuel content. If the content is excessive, moisture or fuel may have passed into the system and caused malfunctioning of components. Easy detection of the faulty component is acquired with experience. If a master control valve has been affected by moisture, droplets may sometimes be seen at the exhaust ports when the system is operated.

NITROGEN PURGE - FLIGHT REFUELLING
(Aircraft fitted with Mod.39)

Introduction

76. Nitrogen, under pressure, forces fuel remaining in the forward pipelines of the flight refuelling system to beyond the four inch non-return valves situated between the front and rear false spars of the centre section wing stubs into the No.2 tanks when refuelling is complete. This removes fuel from the vicinity of the crews nacelle and prevents the formation of inflammable and explosive vapours. Full description and details of servicing of system components are in the following Air Publications:-

Nitrogen cylinder	A.P.1275A, Vol.1
Mk.8B charging valve	A.P.1275A, Vol.1
Hymatic pressure reducing valve	A.P.4303C, Vol.1
Dowty non-return valve	A.P.1803D, Vol.1
Saunders ON/OFF valve	A.P.1464D, Vol.1
Dunlop blow-off valve	A.P.4303B, Vol.1
Hymatic relief valve	A.P.4303C, Vol.1

DESCRIPTION

NITROGEN CYLINDER

77. A Mk.5D 750-litre nitrogen cylinder (Ref.No.6D/9429890) with a T-piece screwed into the head, is strapped to a felt lined cradle bolted to the port, aft face of bulkhead 470 in.F. To identify it, the cylinder is coloured grey with the words NITROGEN and USE NO OIL OR GREASE stencilled on it in black and the upper half of the top hemispherical portion painted black.

CONTROLS

78. A switch labelled NITROGEN PURGE and ON/OFF on the flight refuelling panel, part of the starboard console, operates a Saunders ON/OFF valve (Pt.No.903/AC01/P8) that controls the flow of nitrogen from the cylinder at 1,800 p.s.i. to a Hymatic pressure-reducing valve, and opens the refuelling valves in the No.2 tanks to allow the fuel from the forward pipelines to enter.

LOW PRESSURE COMPONENTS

79. Pressure is reduced from 1,800 p.s.i. to 20 p.s.i. by a Hymatic pressure-reducing valve (Pt.No.PS.82/3) before the nitrogen passes through a Hymatic pressure relief valve (Pt.No.RV.31/5) and a Dowty Mk.C non-return valve (Pt.No.D446Y) and the feed line to the forward end of the probe fuel pipe.

CHARGING AND TEST POINTS

80. Fitted in a ground charging recess, accessible through a panel marked FLIGHT REFUELLING CHARGING on the starboard forward section of the metal nose fairing, are - a Mk.8B charging valve (Ref.No. 6D/796), identified by white and red stripes on the body and a label marked NITROGEN ONLY, NOT TO BE USED FOR OXYGEN on its mounting, a pressure gauge (Ref.No. 6A/2689) and a low pressure test connection. Adjacent to the low-pressure connection is a label marked LOW PRESSURE TEST 20 p.s.i., and to the gauge and charging valve NITROGEN H.P. TEST. The charging valve and pressure gauge are connected by a common line through a high pressure blow-off valve (Pt.No.ACM.15318) set at 2,000 p.s.i., to the T-piece on the cylinder head, and are used for charging and testing. The low pressure test connection is tapped into the main feed line between the low pressure relief valve and the Dowty non-return valve.

HIGH AND LOW PRESSURE PIPES

81. High pressure pipes from the ground charging valve to the pressure reducing valve are either ¼ in. dia. or 3/8 in. dia. 22 s.w.g. tungum.

82. Low pressure pipes from the pressure reducing valve to the probe assembly are either ¼ in. dia. or 3/8 in. dia. light alloy.

SERVICING

General

83. Servicing of the system must be at periods specified in A.P.4505A & C, Vol.4. Servicing instructions for the system components are in the relevant Air Publications given in para.76.

NITROGEN CYLINDER

84. A date, stamped on the outlet neck of the cylinder must be checked periodically. If the time between the date on the cylinder and the date of servicing is as specified in A.P.3158, Vol.2, the cylinder must be returned to a Maintenance Unit for testing. When a cylinder is removed broken connections must be blanked as soon as possible.

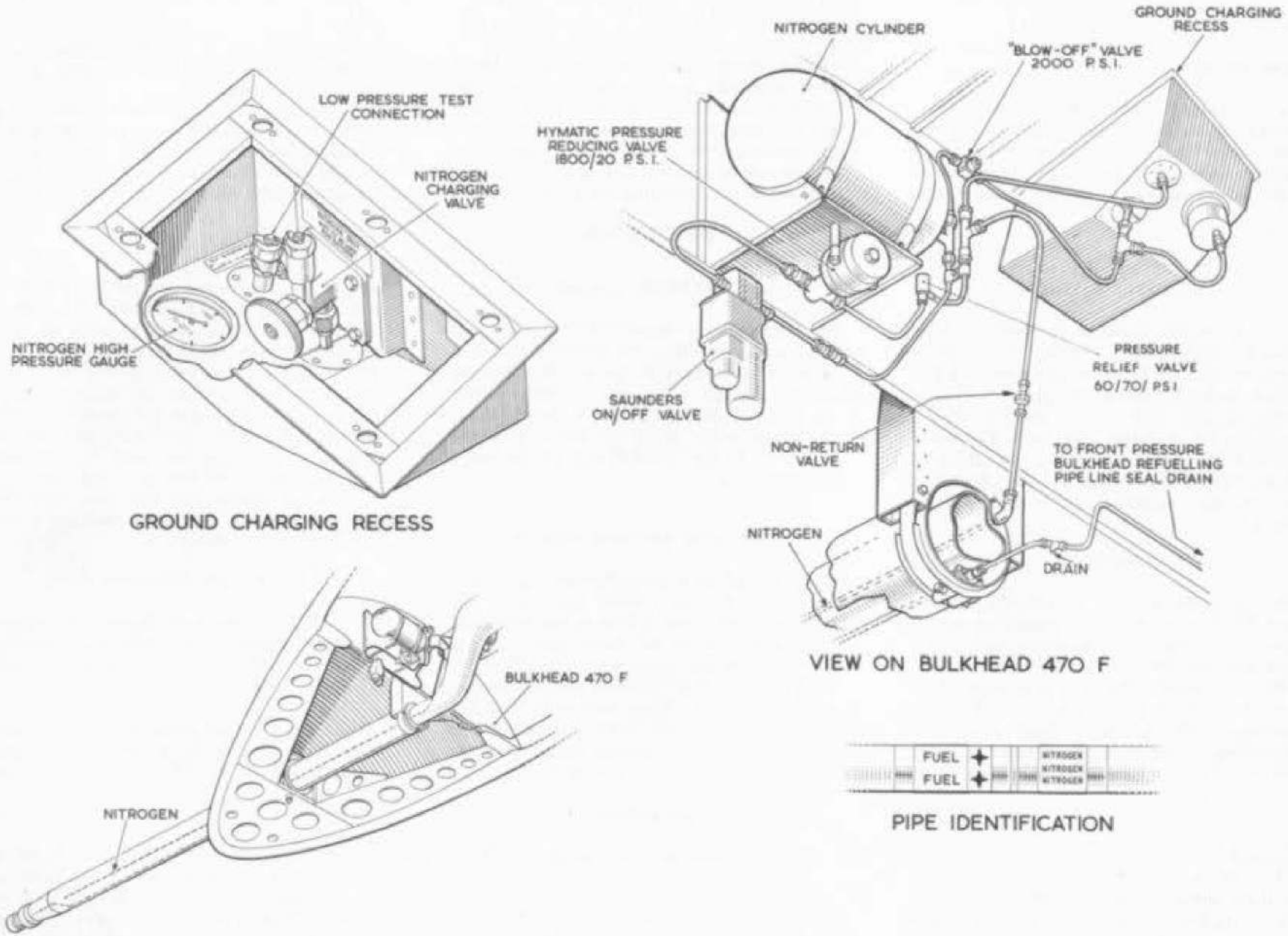


Fig. 13. Nitrogen purge – Flight refuelling

NOTE ...
It is dangerous to disconnect a cylinder before it is almost empty. Nitrogen, oxygen and air cylinders are not interchangeable.

PIPE CONNECTIONS

85. All pipe joints must be wire-locked with 22 s.w.g. non-corrodible steel wire (D.T.D.161 or 189). The thread lubricant and torque loadings specified in para.61 are applicable to couplings in this system.

CHARGING THE SYSTEM

86. The system is charged through a Mk.8B charging valve in the ground charging recess, accessible through a panel marked FLIGHT REFUELLING CHARGING at the starboard forward end of the metal nose fairing. Brief details of charging are identical to these given in Sect.2, Chap.2 of this book and full details in A.P.1275A, Vol.1, Sect.10, Chap.4 or 7.

TESTING

General

87. After installation of the removable flight refuelling equipment, tests as laid down in the following paragraphs, should be carried out. To avoid an unnecessary waste of nitrogen, clean dry compressed air can be used for pressure testing and the system completely exhausted of compressed air and recharged with nitrogen prior to functional testing.

Pressure test

88. To pressure test the nitrogen purge system proceed as follows:-

(1) Ensure that the nitrogen purge switch on the flight refuelling control panel is OFF.

(2) Isolate electrically both No.2 tank refuelling valves.

◀ (3) Fit a 0-100 p.s.i. pressure gauge and a connection for an air supply to the low pressure test point on the nitrogen ground charging panel. Ensure that the air supply connection is blanked. ▶

(4) Connect an air supply to the nitrogen charging point on the nitrogen ground panel and initially charge the nitrogen bottle to 400 p.s.i.

(5) Select the nitrogen purge to ON. Check that the pressure reducing valve is controlling the low pressure at 20 p.s.i. as indicated on the pressure gauge fitted in sub. para.(3).

(6) Select the nitrogen purge switch to OFF.

(7) Continue charging the system and check that the high pressure blow-off valve operates 2,025 ± 10 p.s.i. Shut off the air supply until the blow-off valve closes.

(8) Charge the system to 2,000 p.s.i. and maintain for 30 minutes, examine the high pressure system for leaks and deformation at the bends.

(9) Select the nitrogen purge switch ON. Check that the low pressure side of the system builds up to 20 p.s.i. Maintain this condition for 10 minutes, examine the low pressure side of the system for leaks. Select the nitrogen purge switch OFF.

(10) Disconnect the nitrogen purge pipeline from the rear end of the probe and blank off the pipeline.

(11) Connect an air supply to the connection fitted in sub.para.(3) and slowly build up a pressure in the low pressure side of the system and check that the low pressure relief valve operates at 60 - 70 p.s.i.

(12) Disconnect the air supply and remove the pressure gauge and air connection from the test point. Replace the dust cap on the test point.

(13) Reconnect the nitrogen purge pipeline to the rear end of the probe.

(14) Discharge the air completely from the system.

(15) Reconnect the electrics to the No.2 tank refuelling valves.

Functional test

89. To carry out a nitrogen purge functional test proceed as follows:-

(1) Ensure that the nitrogen purge switch is selected OFF.

(2) Fully charge the nitrogen cylinder with nitrogen.

◀ (3) Using adapter (Ref.No.27E/4819) connect a refuelling tanker hose to the probe and fully charge the flight refuelling pipes with fuel, after which disconnect the tanker hose. ▶

(4) Note and record the contents of the No.2 fuel tanks.

(5) Select nitrogen purge ON for two minutes during which time the probe pressure, as registered on the gauge on the cabin conditioning control

panel, should rise to approximately 7 p.s.i. and gradually fall to approximately zero.

(6) Note the contents of the No.2 fuel tanks which must have increased by 160 lb. in each tank.

(7) Remove the drain plug from the branch pipe immediately to the rear of the probe and collect the residual fuel in a container. The quantity of fuel must not exceed 3 gall.

(8) Replace and lock the drain plug.

REMOVAL AND ASSEMBLY

NITROGEN CYLINDER

90. To remove a cylinder:-

(1) The nitrogen must be released from the storage cylinders before disconnecting pipe connections.

(2) Disconnect the cylinder head connection and blank off as soon as possible. If a new cylinder is to be connected immediately the installation is to be arranged in such a manner that the old cylinder is replaced by the new with as little delay as possible

NOTE . . .
It is dangerous to disconnect a cylinder before it is nearly empty.

(3) Remove the cylinder from its cradle by breaking the turnbuckle locking wire and releasing the turnbuckles that secure the retaining straps.

NITROGEN PURGE FITTINGS

91. Special instructions for the installation and removal of the system fittings are not considered necessary. When the system is not installed the nitrogen ON-OFF valve electrical connection must be stowed in the clip provided on the forward face of former 470F.

TABLE 1 Fault Finding Chart

Symptoms in Flight	Symptoms on Ground Test	Fault and Method of Detection	Remedy
Nitrogen pressure gauge remains constant even when aircraft is diving.	Tanks, do not pressurise and no pressure is recorded on the engine air pressure gauge.	Stoppage of flow from engine compressor due to:-	
		(a) Faulty non-return valve in undercarriage or engine bay.	(a) Renew non-return valve.
		(b) An obstruction in the pipe between the engine compressor and tank pressurisation panel.	(b) Locate and rectify.
Nitrogen pressure gauge remains constant and outward venting audible except when aircraft is in steep dive.	◀ Tanks outward venting continually with tank pressure test gauge reading 2·65 p.s.i. - 3·0 p.s.i. When system is switched to OFF, air continues to issue from vents and engine air pressure test gauge reads lower than maximum supply pressure. ▶	Air valve (A.G.V.) not closing due to:-	
		(a) Air leak in feed line to air valve connection (A.G.V.).	(a) Locate leak and rectify.
		(b) Faulty non-return valve in adjacent group to that being tested on tank pressurisation panel. This fault is only effective when the adjacent group is inoperative and will be denoted by a leak at the master control valve exhaust of the adjacent group.	(b) Renew non-return valve in adjacent group.
		(c) Leaking air valve bellows (A.G.V.) denoted by a leak in the static hole in the centre of A.G.V. body.	(c) Renew A.G.V.
		(d) Faulty air valve seat (A.G.V.). This fault may be confirmed by disconnecting the rubber pipe above the air gas valve and testing for an excessive leak when the system is OFF	(d) Renew A.G.V.

TABLE 1 (Cont'd.)

Symptoms in Flight	Symptoms on Ground Test	Fault and Method of Detection	Remedy
Nitrogen pressure gauge reading remains constant even when aircraft is diving.	Tank pressure test gauge shows low pressure of 2·0 - 2·2 p.s.i. (No nitrogen supply to tanks).	(a) Nitrogen master valve not working.	(a) Check nitrogen valve circuit for appropriate side of aircraft and rectify or renew components where necessary.
		(b) Leak or obstruction in pipe between gas connection (A.G.V.) and M.C.V.	(b) Locate and rectify.
		(c) Leak in gas valve bellows (Only detected during bench test).	(c) Renew A.G.V.
Nitrogen pressure gauge reading falls rapidly during taxying and climb. Outward venting is audible except when aircraft is in steep dive.	Tanks containing outward venting at 2·65 - 3·0 p.s.i. in a series of pulses and nitrogen continually passing through system which is denoted by fall in nitrogen pressure or by sound. On switching OFF, system depressurises satisfactorily.	(a) Nitrogen valve (A.G.V.) remains open due to sticking or faulty seat. Indicated by continued discharge when all air is evacuated from system and pressurisation switch is ON.	(a) Renew A.G.V.
		(b) M.C.V. remaining in gas valve open or air and gas valve open position due to sticking piston or leaking tank sensing line.	(b) Check for leaks in tank sensing line to M.C.V. If none renew M.C.V.
		(c) Punctured diaphragm in M.C.V. Detected by disconnecting static line from M.C.V. and checking for leaks at the M.C.V. static connection when system is switched OFF.	(c) Renew M.C.V.
Nitrogen pressure gauge reading falls rapidly during taxying and climb.	Tanks pressurise. Excessive hunting recorded on tank pressure test gauge and engine air test gauge. Air does not issue through vents.	Leak from tank, vent pipe, engine supply pipe or tank sensing line.	Locate and rectify.

TABLE 1 (cont'd.)

Symptoms in Flight	Symptoms on Ground Test	Fault and Method of Detection	Remedy
Nitrogen pressure gauge reading falls rapidly during taxying and climbing.	Tanks do not pressurise due to vent valve failing to close. Air issues from vents when pressurisation is switched ON.	(a) Emergency inward venting ball valve (V.V.) unseated. This will be denoted by an excessive leak at the static connection.	(a) Renew vent valve.
		(b) Emergency outward venting valve (V.V.) not seating correctly. Indicated by leak as in (a).	(b) Renew vent valve.
		(c) Leak in piping between pressure reducing valve and control connection on the vent valve. This may be checked by removing piping from control connection and fitting 0-20 p.s.i. gauge. Reading should not be less than 9 p.s.i.	(c) Locate leak and rectify.
		(d) M.C.V. remains in inward venting position due to sticking. Denoted by excessive air leaking through exhaust on M.C.V. and may be confirmed by sucking on disconnected static connection (M.C.V.) with the aid of a rubber tube. System should then pressurise.	(d) Renew M.C.V.
Nitrogen pressure gauge continues to fall with tank pressurisation OFF.	Tanks will not depressurise.	Solenoid not operating.	Check electrical circuit and renew solenoid if necessary.
Nitrogen pressure gauge continues to fall with tank pressurisation OFF.	Tanks depressurise.	Leak in nitrogen supply line to panel.	Locate and rectify.

Table 1 Fault Finding Chart

Symptoms in Flight	Symptoms on Ground Test	Fault and Method of Detection	Remedy
Nitrogen pressure gauge remains constant even when aircraft is diving.	Tanks do not pressurise and no pressure is recorded on the engine air pressure gauge.	Stoppage of flow from engine compressor due to:— (a) Faulty non-return valve in undercarriage or engine bays. (b) An obstruction in the pipe between the engine compressor and tank pressurisation panel.	 (a) Renew non-return valve. (b) Locate and rectify.
Nitrogen pressure gauge remains constant and outward venting audible except when aircraft is in steep dive.	Tanks outward venting continually with tank pressure test gauge reading 2·75 p.s.i. – 3·0 p.s.i. When system is switched to OFF, air continues to issue from vents and engine air pressure test gauge reads lower than maximum supply pressure.	Air valve (A.G.V.) not closing due to:— (a) Air leak in feed line to air valve connection (A.G.V.) (b) Faulty non-return valve in adjacent group to that being tested on tank pressurisation panel. This fault is only effective when the adjacent group is inoperative and will be denoted by a leak at the master control valve exhaust of the adjacent group. (c) Leaking air valve bellows (A.G.V.) denoted by a leak in the static hole in the centre of A.G.V. body. (d) Faulty air valve seat (A.G.V.). This fault may be confirmed by disconnecting the rubber pipe above the air gas valve and testing for an excessive leak when the system is OFF.	 (a) Locate leak and rectify (b) Renew non-return valve in adjacent group. (c) Renew A.G.V. (d) Renew A.G.V.
Nitrogen pressure gauge reading remains constant even when aircraft is diving.	Tank pressure test gauge shows low pressure of 2·0-2·2 p.s.i. (No nitrogen supply to tanks).	(a) Nitrogen master valve not working. (b) Leak or obstruction in pipe between gas connection (A.G.V.) and M.C.V. (c) Leak in gas valve bellows (Only detected during bench test).	(a) Check nitrogen valve circuit for appropriate side of aircraft and rectify or renew components where necessary. (b) Locate and rectify. (c) Renew A.G.V.

Table 1 *(Contd.)*

Symptoms in Flight	Symptoms on Ground Test	Fault and Method of Detection	Remedy
Nitrogen pressure gauge reading falls rapidly during taxying and climbing.	Tanks do not pressurise due to vent valve failing to close. Air issues from vents when pressurisation is switched ON.	(a) Emergency inward venting ball valve (V.V.) unseated. This will be denoted by an excessive leak at the static connection.	(a) Renew vent valve.
		(b) Emergency outward venting valve (V.V.) not seating correctly. Indicated by leak as in (a).	(b) Renew vent valve.
		(c) Leak in piping between pressure reducing valve and control connection on the vent valve. This may be checked by removing piping from control connection and fitting 0-20 p.s.i. gauge. Reading should not be less than 9 p.s.i.	(c) Locate leak and rectify.
		(d) M.C.V. remains in inward venting position due to sticking. Denoted by excessive air leaking through exhaust on M.C.V. and may be confirmed by sucking on disconnected static connection (M.C.V.) with the aid of a rubber tube. System should then pressurise.	(d) Renew M.C.V.
Nitrogen pressure gauge reading falls rapidly during taxying and climb. Outward venting is audible except when aircraft is in steep dive.	Tanks containing outward venting at 2·75-3·0 p.s.i. in a series of pulses and nitrogen continually passing through system which is denoted by fall in nitrogen pressure or by sound. On switching OFF, system depressurises satisfactorily.	(a) Nitrogen valve (A.G.V.) remains open due to sticking or faulty seat. Indicated by continued discharge when all air is evacuated from system and pressurisation switch is ON.	(a) Renew A.G.V.
		(b) M.C.V. remaining in gas valve open or air and gas valve open position due to sticking piston or leaking tank sensing line.	(b) Check for leaks in tank sensing line to M.C.V. If none, renew M.C.V.
		(c) Punctured diaphragm in M.C.V. Detected by disconnecting static line from M.C.V. and checking for leaks at the M.C.V. static connection when system is switched OFF.	(c) Renew M.C.V.

Table 1 *(Contd.)*

Symptoms in Flight	Symptoms on Ground Test	Fault and Method of Detection	Remedy
Nitrogen pressure gauge reading falls rapidly during taxying and climb.	Tanks pressurise. Excessive hunting recorded on tank pressure test gauge and engine air test gauge. Air does not issue through vents.	Leak from tank, vent pipe, engine supply pipe or tank sensing line.	Locate and rectify.
Nitrogen pressure gauge continues to fall with tank pressurisation OFF.	Tanks will not depressurise.	Solenoid not operating.	Check electrical circuit and renew solenoid if necessary.
Nitrogen pressure gauge continues to fall with tank pressurisation OFF.	Tanks depressurise.	Leak in nitrogen supply line to panel.	Locate and rectify.