CENTRAL FLYING SCHOOL

TECHNICAL JET

JPT AND RPM LIMITATIONS

Introduction

1. In the last lesson we dealt with the turbine assemblies, their build-up and action and it was seen that their efficiency was dependent among other things on the temperature drop across the turbine, and the degree of heat the turbine could withstand. Up to the present the materials and design of the cooling systems permit turbine operating temperatures of somewhere in the region of 920°C. This high temperature brings about high stresses on the blades; another consideration to be taken into account is Centrifugal Loadings.

Loads

2. At the high rpm necessary for efficient operation, very high loads are imposed on the blades, not only on their attachment to the disc, but on the blade itself. Due to the mass of the blades. We know all metals have a certain limit and when the load is removed it will return to its former size. This ability of the metal to return to its original size is dependent on the amount of the load, the rpm and the temperature. If the rpm and temperatures are low then the material will retain its elasticity for a very long time, if however, the rpm and temperature, particularly the temperature, are increased, then the material will eventually fracture.

3. Now if we consider the condition a turbine in a jet engine is operating under, we will see that both the temperature and rpm vary considerably. The temperature is in direct relation to the fuel burnt, ie, JPT.

Limits

4. The 2 main considerations are, of course, the amount of load and the temperature, because both have obvious limits, which can be exceeded with bad engine handling. The maximum JPT can be exceeded, for instance, during a "Compressor Stall" condition, while the amount of load can be exceeded by exceeding the maximum rpm.

Creep

5. The inability of the turbine blades to return exactly to their original size is termed "Turbine Blade Creep", or the amount the blades will elongate in a given time, under certain temperatures and load. This creep occurs in 3 phases, Primary, Secondary, and Tertiary.

6. The Primary phase takes place in the first few hours of running and is at a fairly high rate.

7. The Secondary phase is at a much reduced rate, while the Tertiary phase is again at a very rapid rate, and some short time during the Tertiary phase the blade will fracture.

8. It follows, therefore, that under no circumstances must a turbine assembly be allowed to enter the Tertiary phase, and to ensure complete safety it is necessary to limit the running time to some portion of the Secondary phase.

9. From what has been said it follows that engine limitations must be strictly adhered to and any increases beyond the limits laid down must be reported and the engine checked.

NB: The life of the Viper engines are: 1850 hours for the 102, and
1400 hours for the 202.

/10. Creep

10. Creep life is affected by:

a. Temperature.

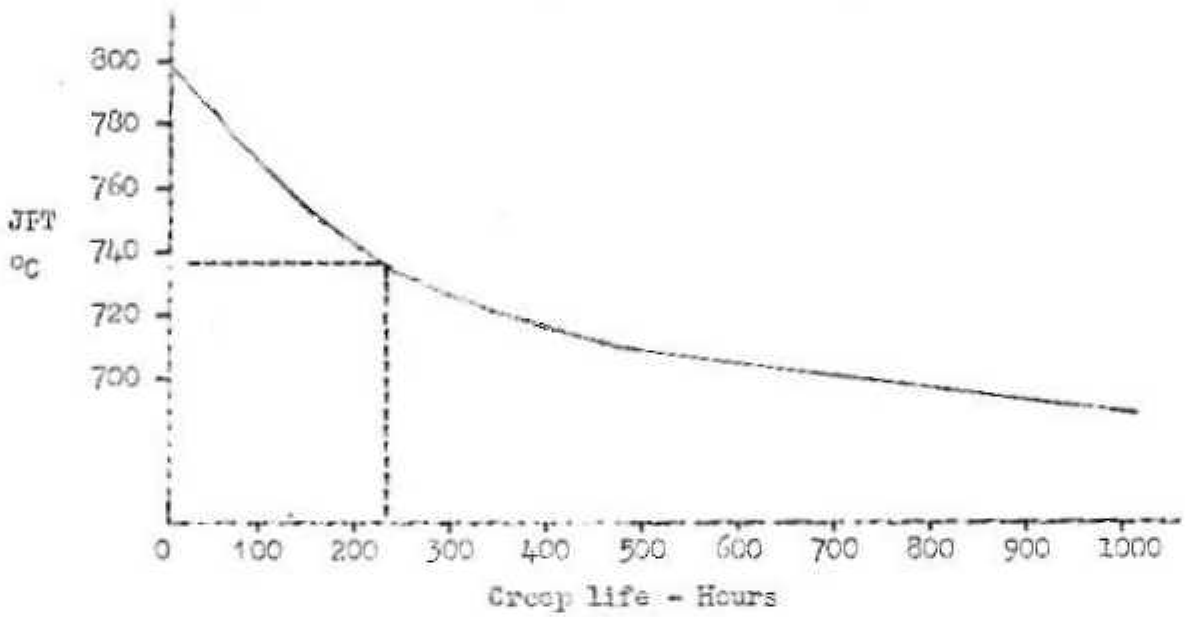
b. Time at that temperature.

c. Load rpm.

d. Material qualities.

11. The material is usually fixed early in the design state and rpm has already been mentioned. The remaining villains are therefore, temperature and time.

Viper 202 Fitted in JP Mk 5 [redacted]



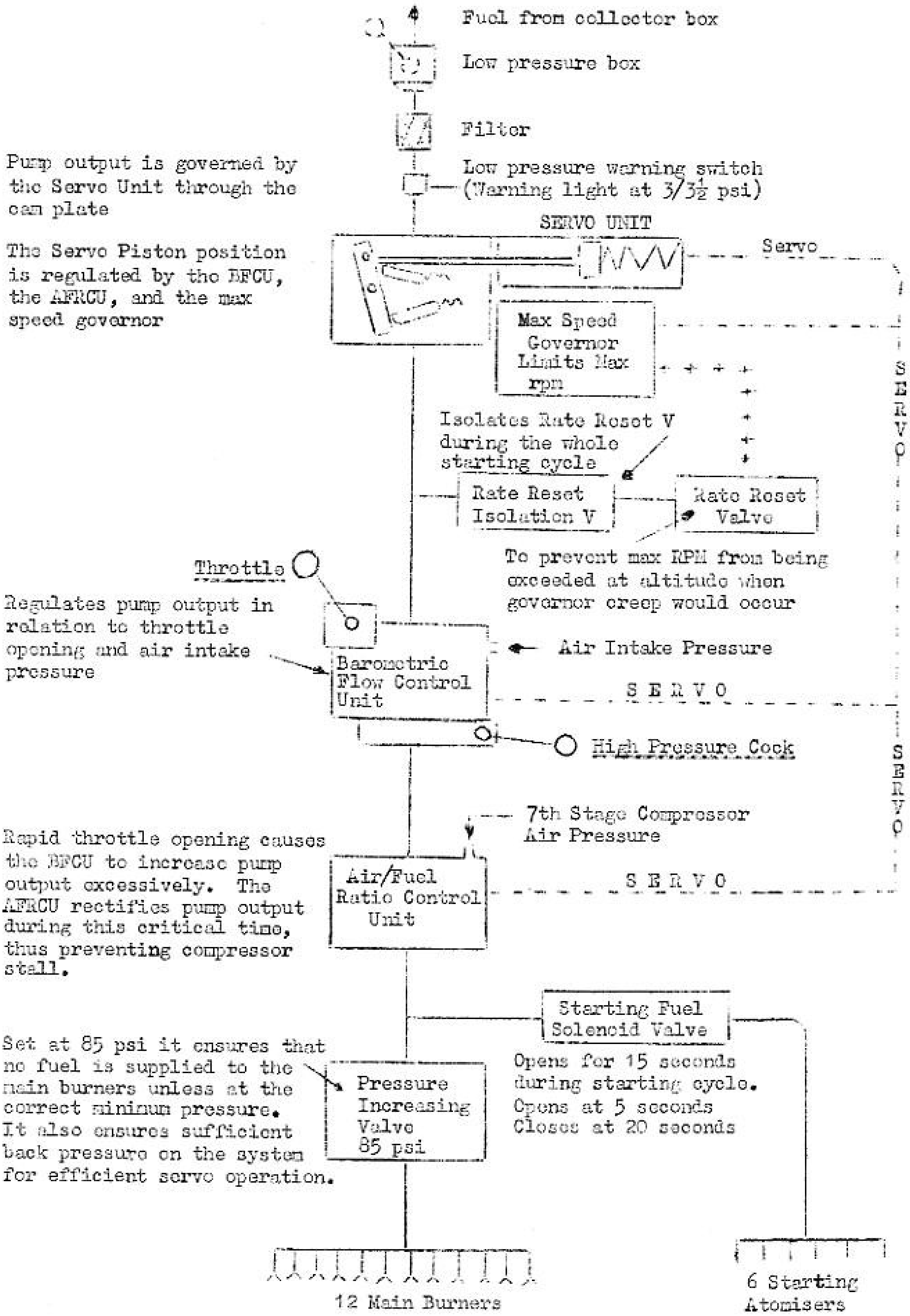
12. The graph shows a plot of turbine creep life against temperature, and it can be seen that continuous running at take-off temperature would give a creep life of 220 hours and at 775° would give a creep life of about 15 hours. A single over-temperature to 790° reduces the creep life to a few minutes and reduction to 700° increases the creep life to over 1,000 hours.

13. In this context engine "life" is quite different from "creep life" because the engine ratings will be such that not more than about ⅓ of the creep life will be used between overhauls, and a large percentage of the total flying time will be spent at relatively low temperatures. In the example shown the Viper in the JP is expected to achieve a life of over 1,000 hours.

14. If we now examine, as an example, the JP Mk 5 limitations:

Power Rating	RPM	Max JPT	Time Limit (per flight)
Take-off	100%	735	20 mins

15. The previous graph has shown that the critical factors are time and temperature, so what does 20 mins per flight mean? Flights of 20 mins at TO and 5 mins for a screaming dive and landing continuously would not be "normal" as 80% at the total life would be at take-off power.



HIGH PRESSURE FUEL SYSTEM VIPER MK 10201

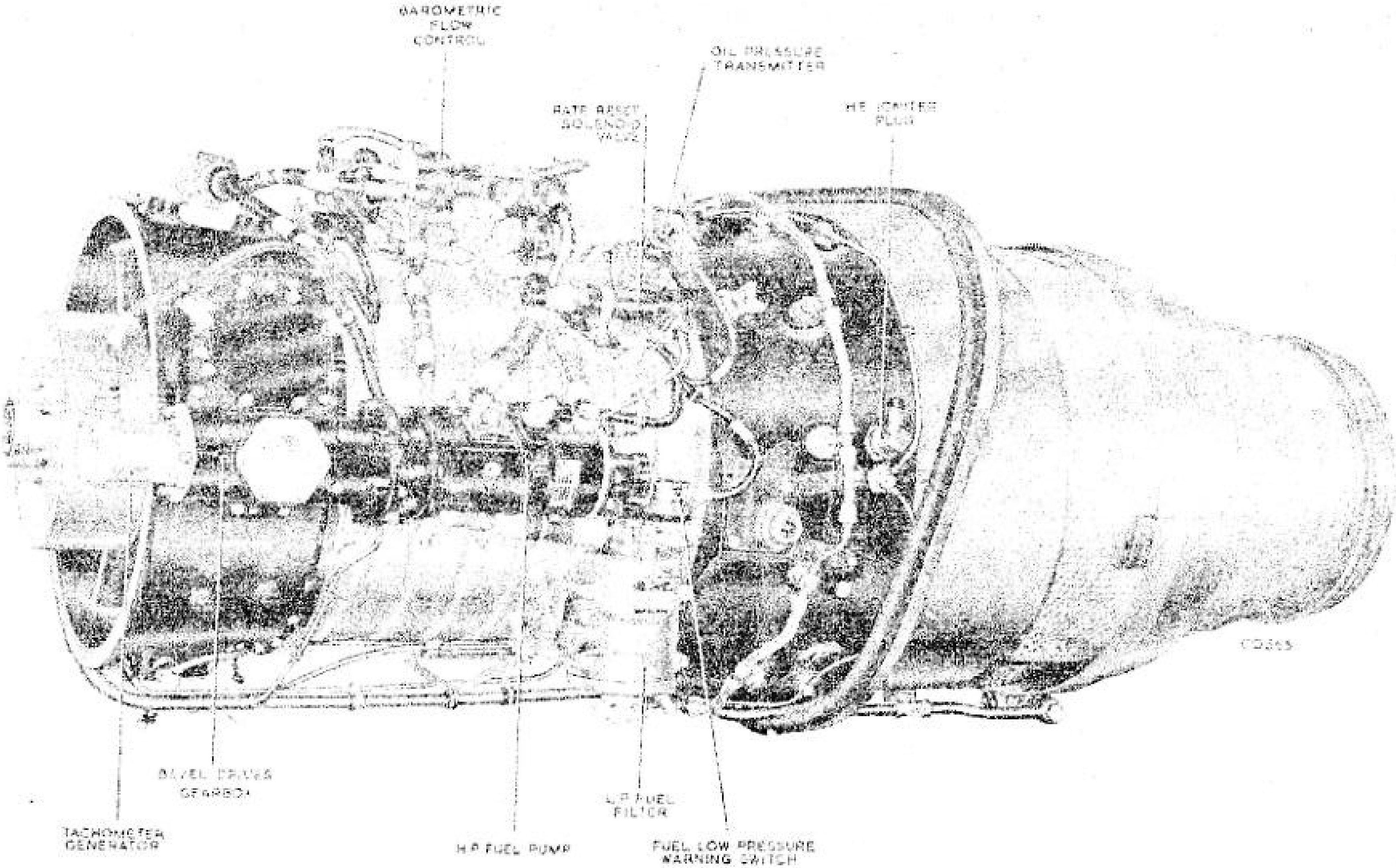


Fig. 1. Viper Mk. 10201 e.c.u. (port side)

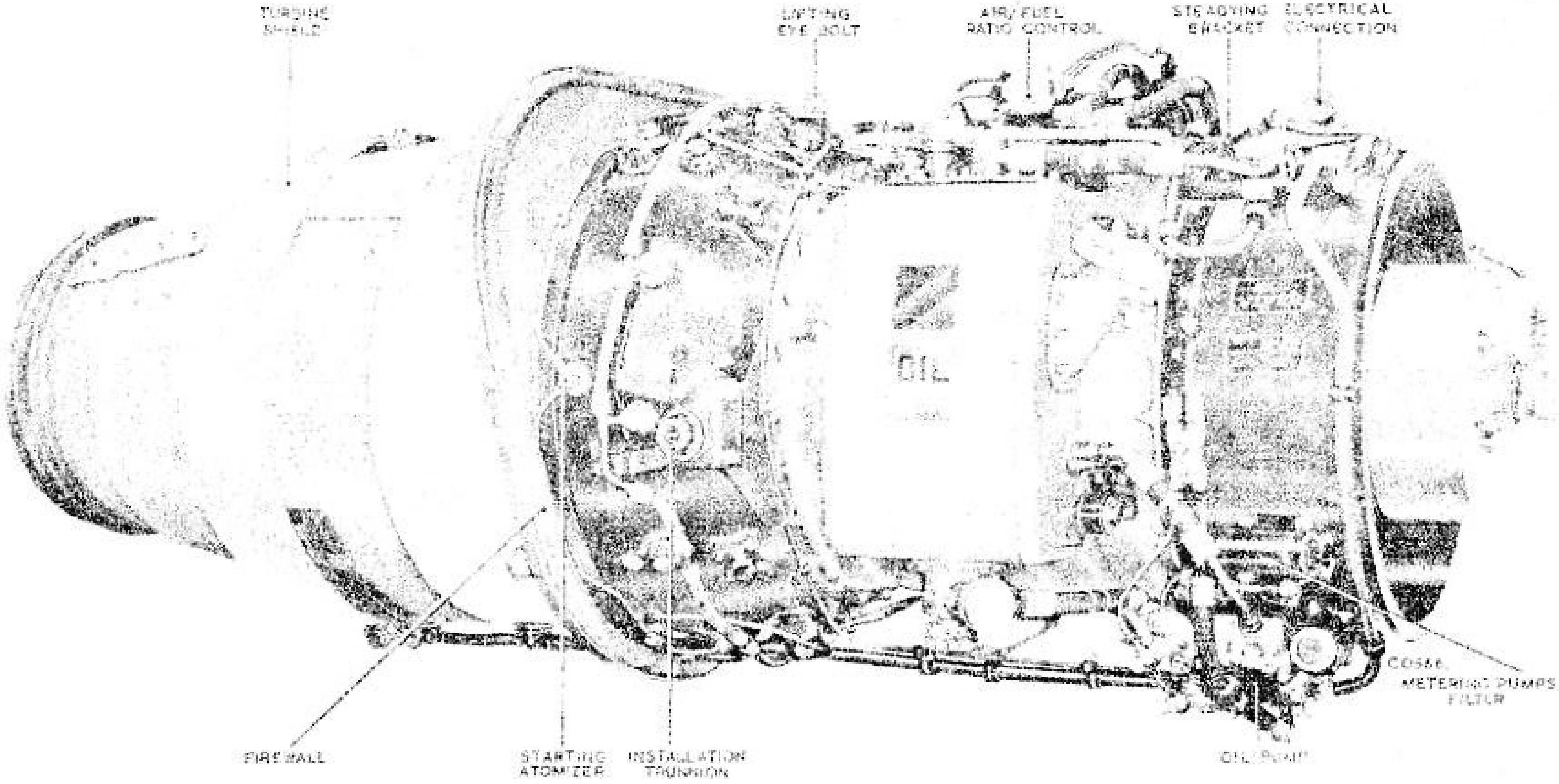


Fig. 2. Viper Mk. 10201 e.c.u. (starboard side)

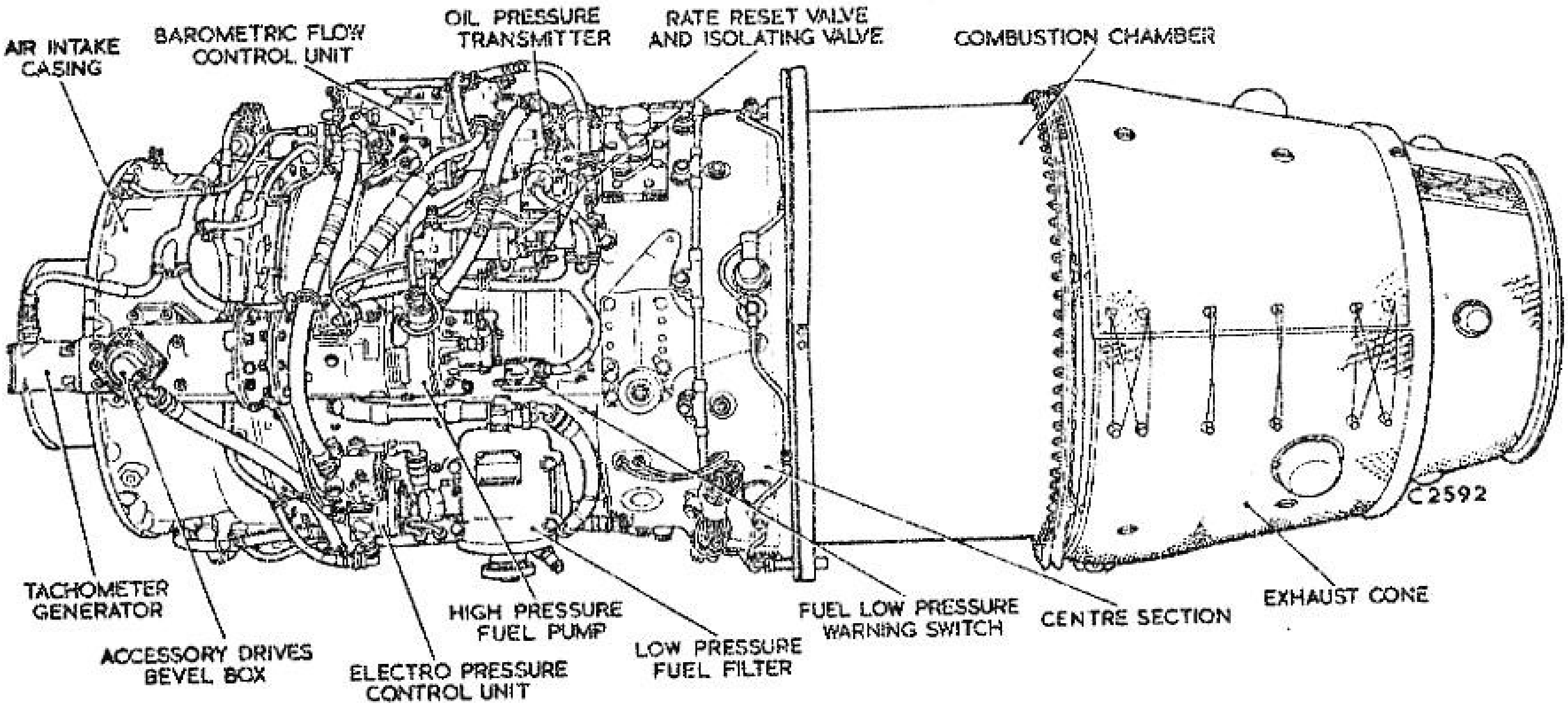


Fig.2A. Viper Mk.20201 Mod. V.3458 and Mk.20401 e.c.u. (port side)

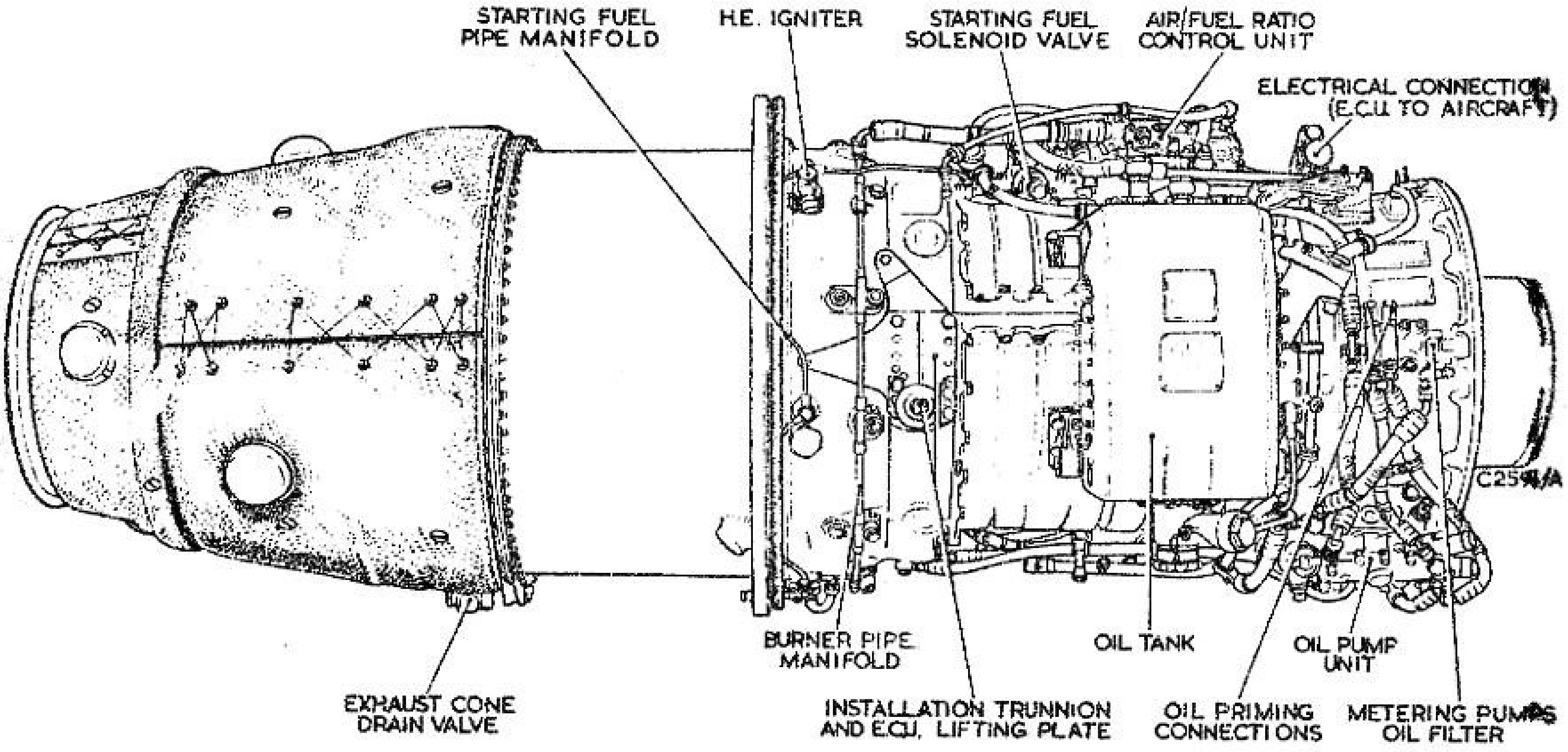
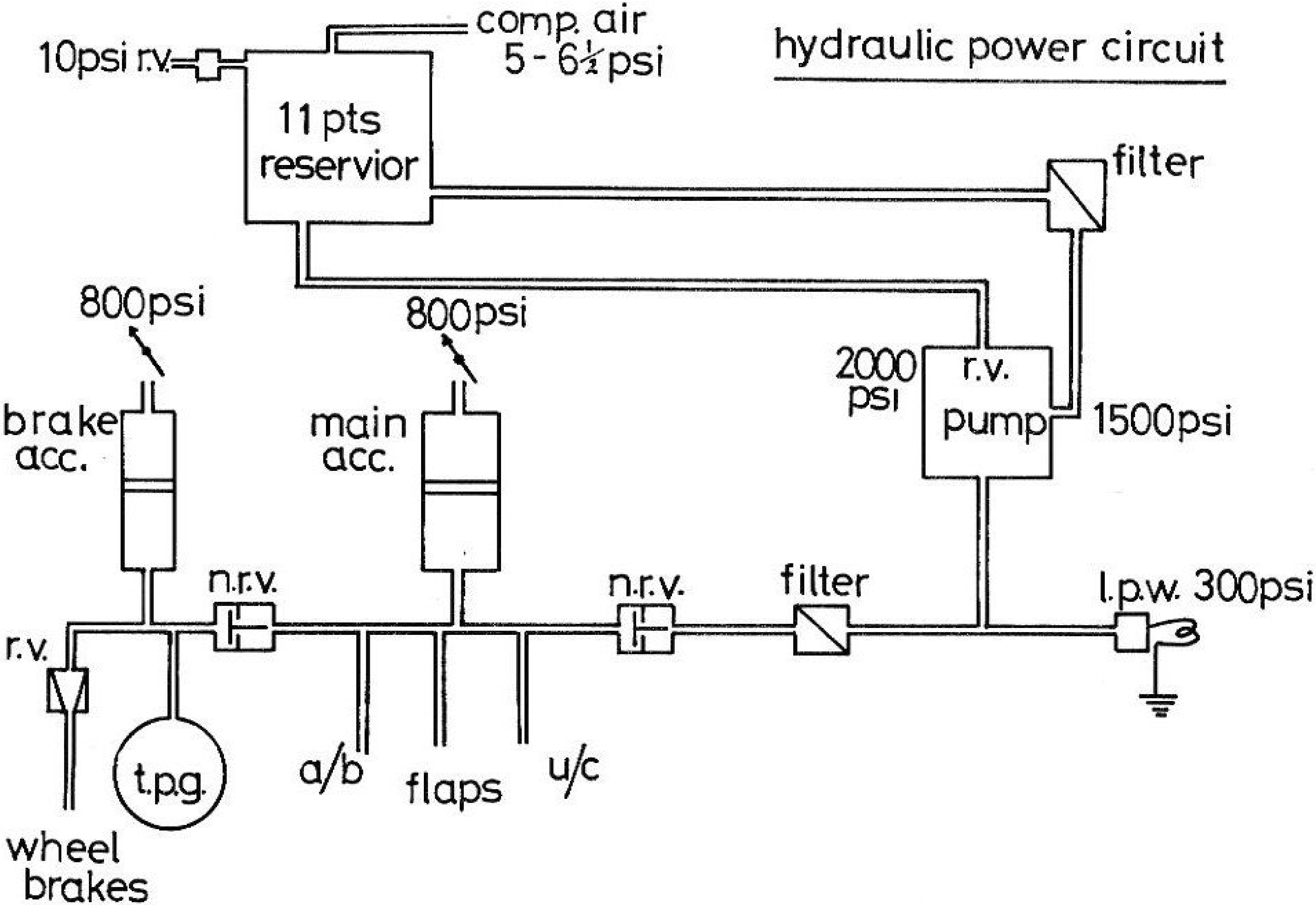
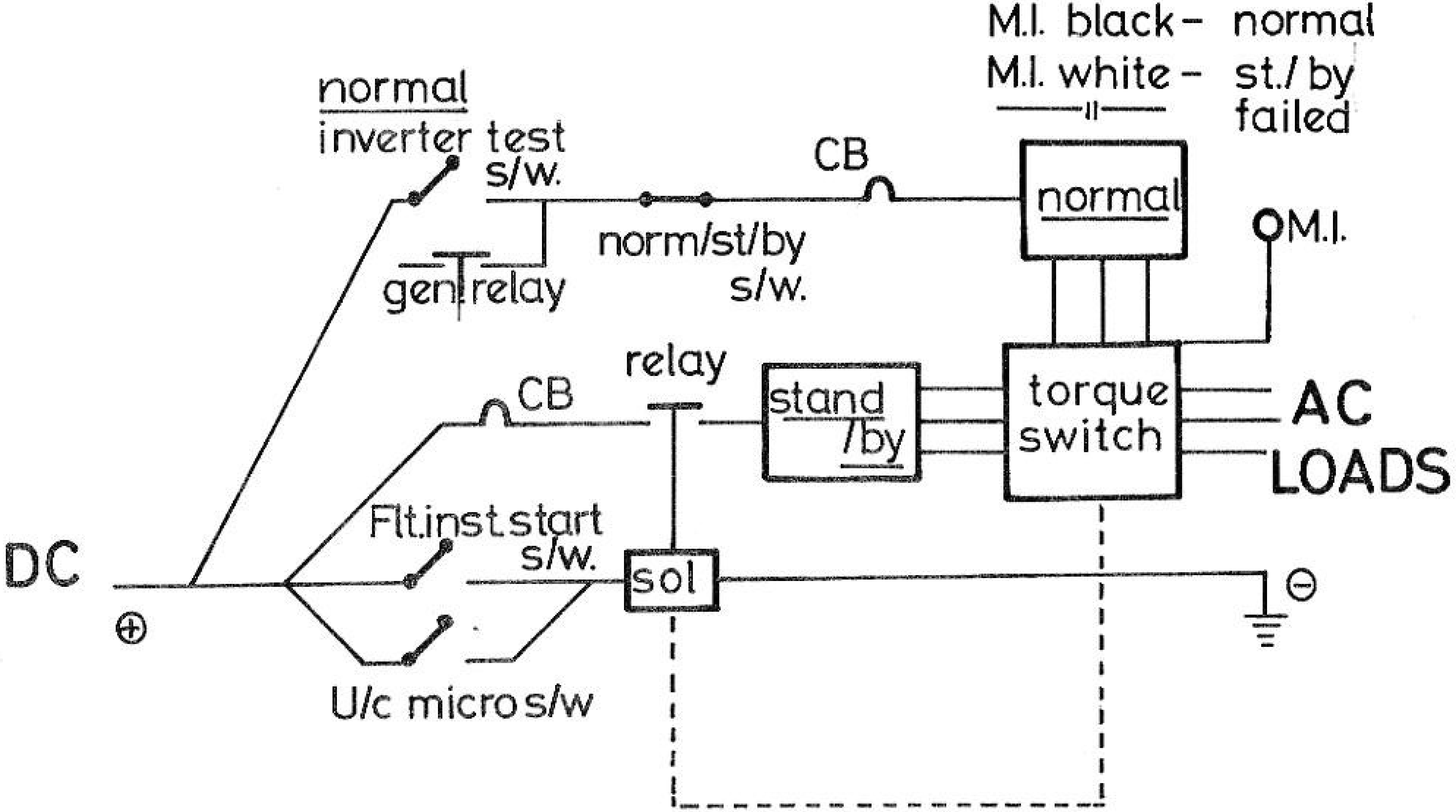


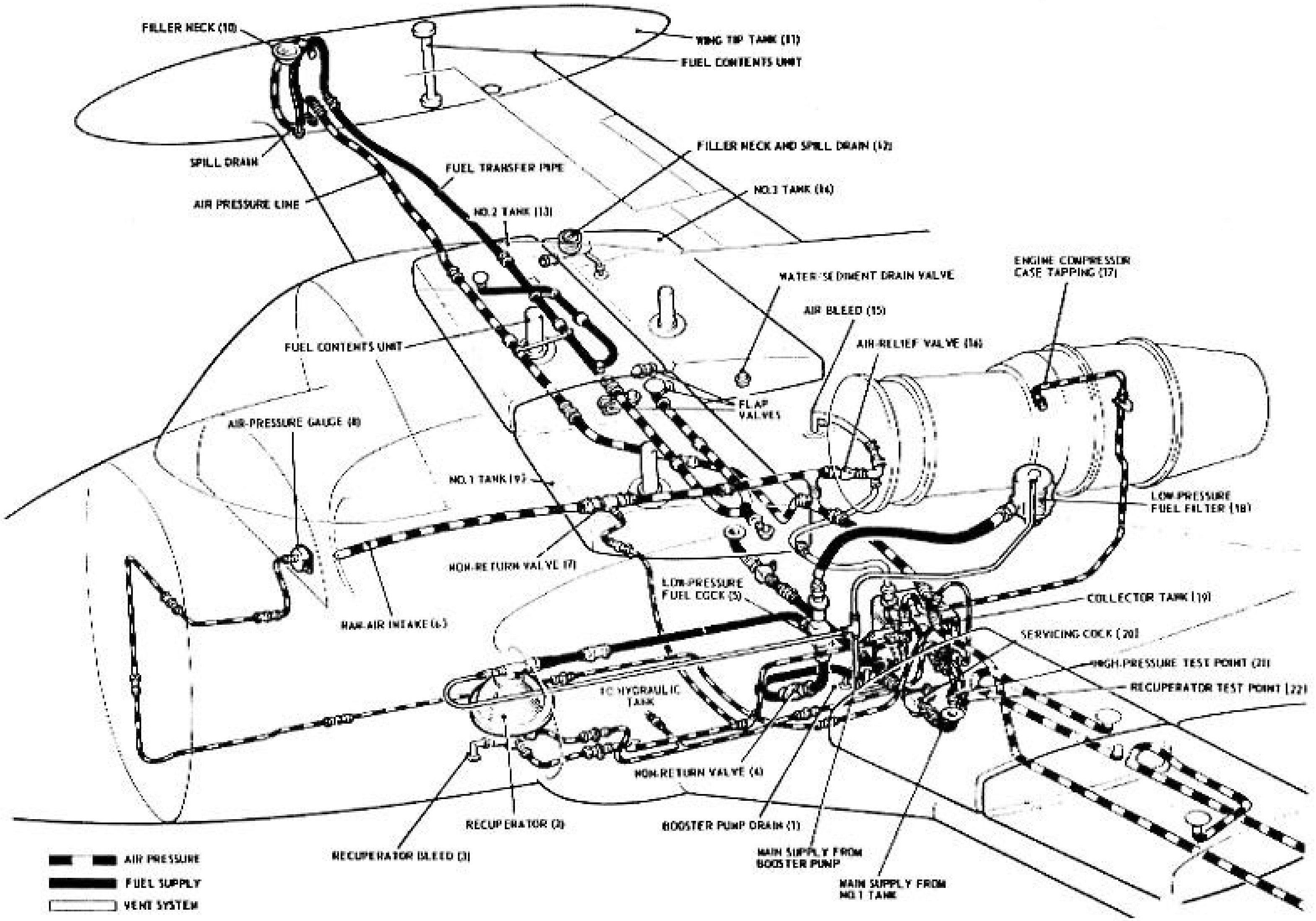
Fig.2B. Viper Mk.20201 Mod. V.3458 and Mk.20401 e.c.u. (starboard side)

hydraulic power circuit



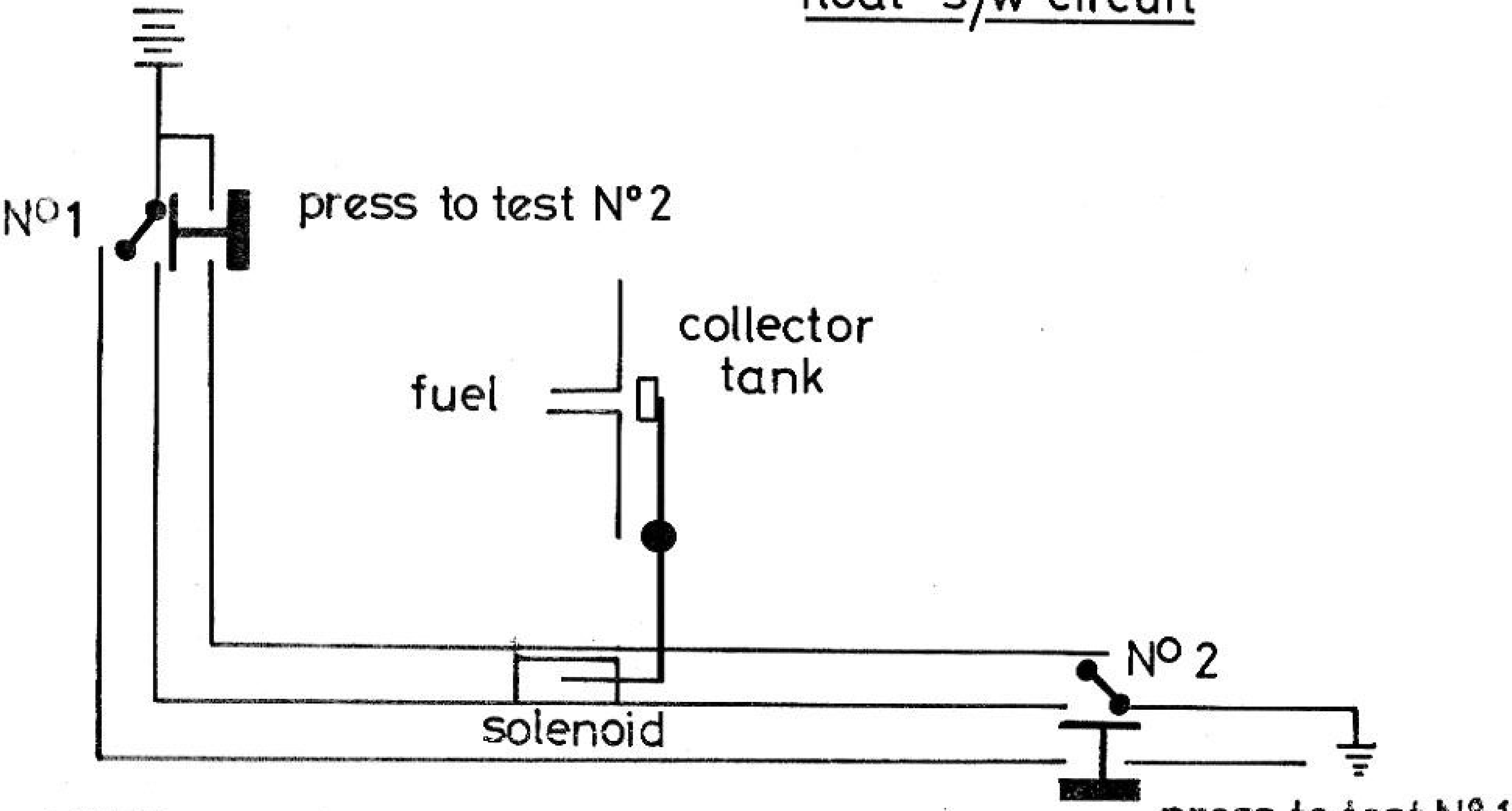


JET PROVOST A C SUPPLY



Location of a/c fuel system components

float s/w circuit



NOTE on A/C press N°1 to test N°1

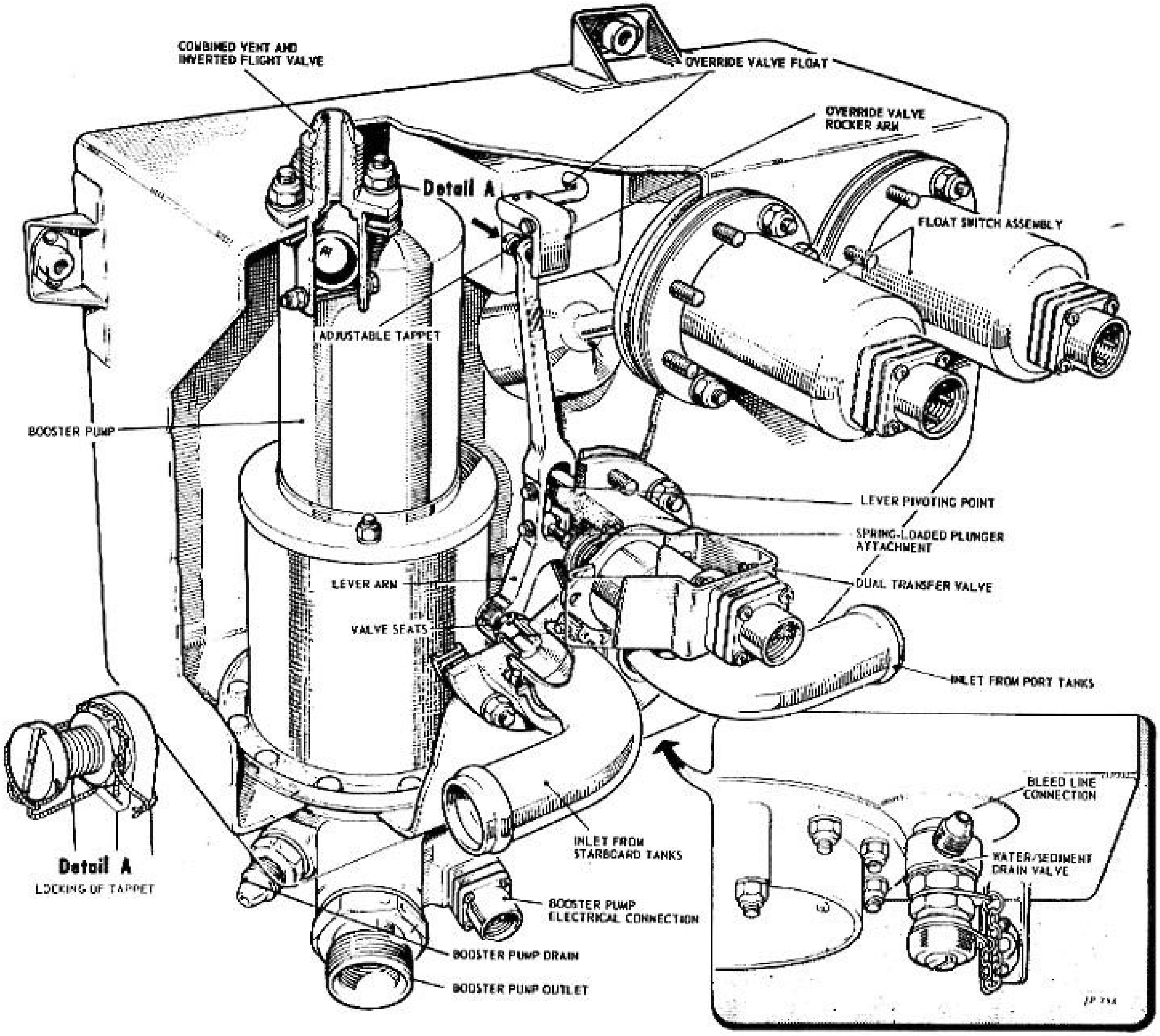
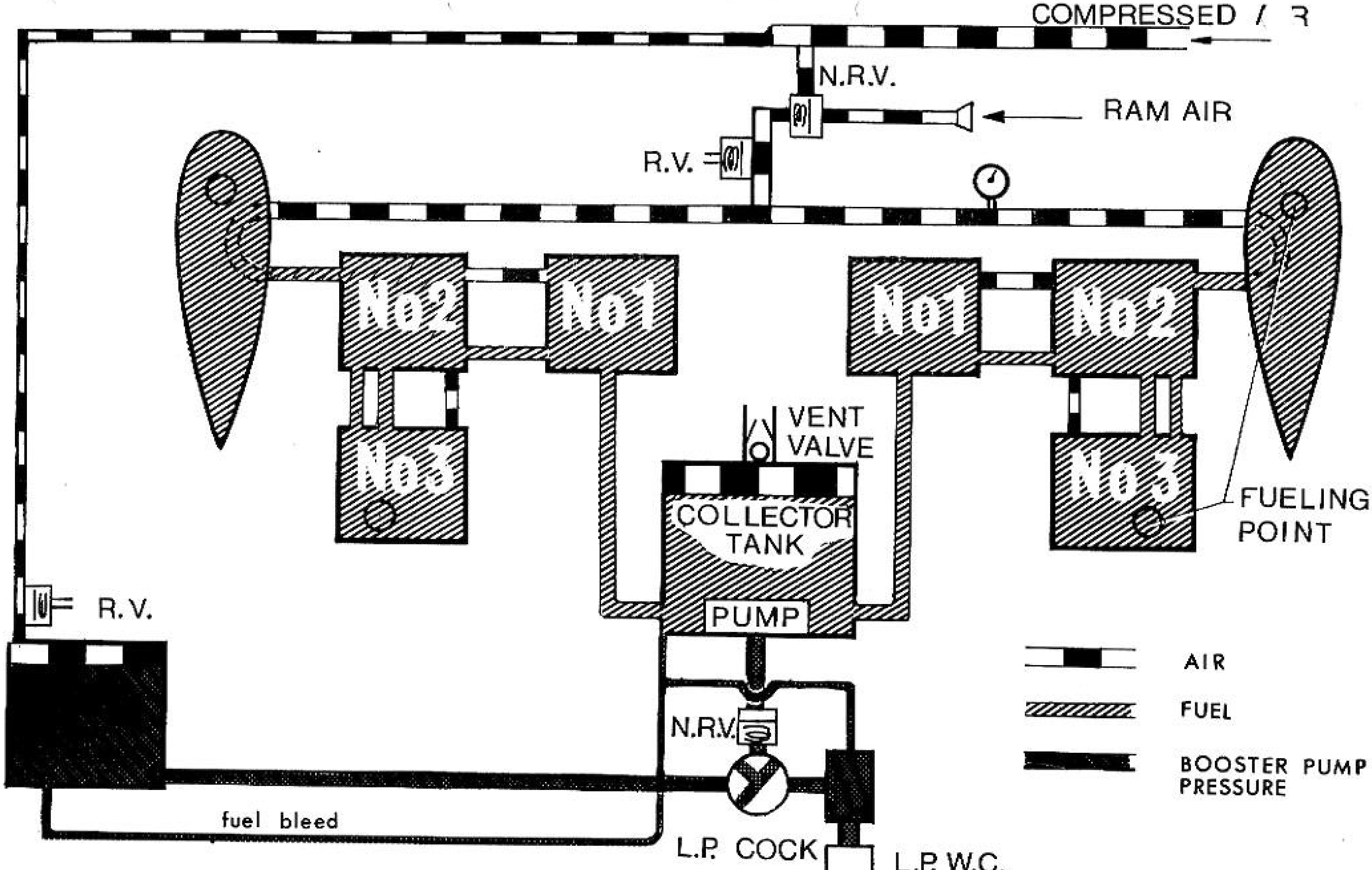


Fig.3. Installation of collector tank



Jet Provost A/C fuel system