Boost Control Solenoid Valve

The turbo boost control solenoid valve is located in the engine bay relay box and is fitted in the turbo wastegate capsule control pressure line. When the solenoid valve is de-energised, the control pressure line is intact and the wastegate capsule controls maximum boost pressure to 0.65 bar (9.5 lb/sq. in.). If the solenoid valve is energised the wastegate capsule is vented to atmosphere so that the capsule spring acts to keep the wastegate closed at all times.

The solenoid valve functions as a frequency valve, which is switched by a square wave signal of constant frequency (32 Hz) but varying pulse width (Pulse Width Modulation). The proportion of time for which the valve is energised controls the amount of 'extra' boost that may be developed before the wastegate opens. The operation of the valve is inhibited both at cold and at excessively hot engine coolant temperatures. At throttle angles below 75%, the control pressure line is intact (solenoid de-energised) with boost limited by the capsule to 0.65 bar (9.5 lb/sq.in)

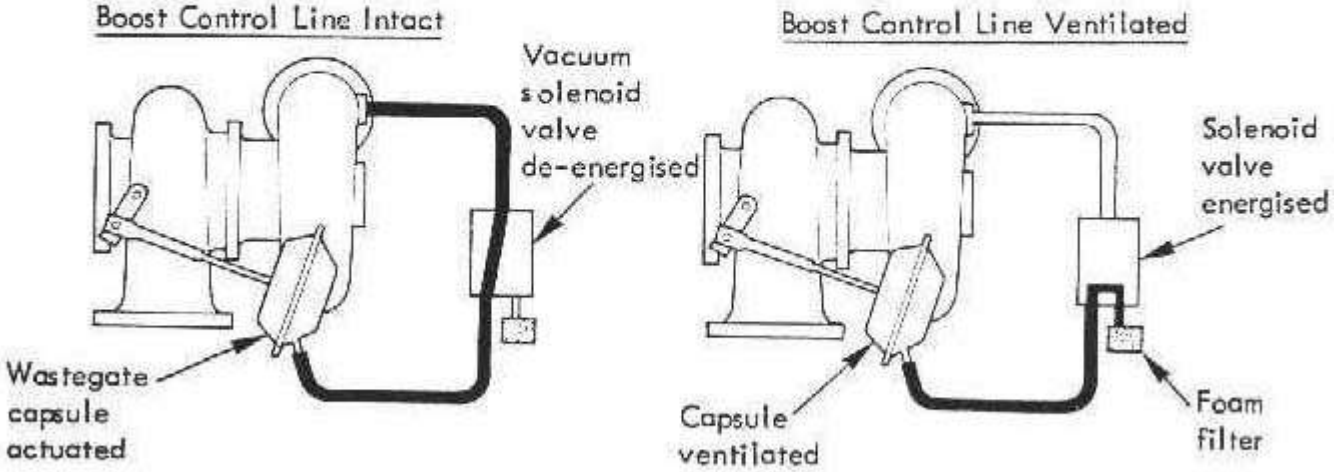
At coolant temperatures between 75°C and 115°C, and at throttle angles greater than 75%, the solenoid valve is activated and the pulse width modulated to allow up to 0.84 bar (12 lb/sq.in) of boost to be developed. Under wide open throttle transient conditions, a short duration of additional boost up to 1.00 bar (14.7 lb/sq.in) may occur.

The ECM will reduce pulse width to lower boost pressure if the knock sensor detects detonation (see above). As an engine safeguard, in case of a boost control system failure, the ECM will shut off the fuel pump and ignition if boost pressure in excess of 1.01 bar (15 lb/sq.in) is detected for more than three seconds. Fuel and ignition are reinstated below 0.61 bar (9 lb/sq.in).

All quoted pressures are approximate and at sea level.

The boost control system is an open loop adaptive system, whereby the solenoid valve pulse width to be used at any particular time is taken from a set of calibration tables, with functions of barometric pressure, throttle position and engine speed. The actual boost pressure is then measured and compared with that demanded. Any error between demanded boost and actual boost is corrected, and the correction value recorded and stored in a table in the ECM memory. This correction table is used next time those operating conditions are met to speed the attainment of the correct pulse width for the required boost pressure. This 'adaptive' method maintains accurate control of boost pressure. If the power supply to the ECM is interrupted, the correction table in the memory will be erased, and must be re-learned in the course of normal driving.

Note that because the ECM monitors boost pressure via the MAP sensor, maximum boost pressure is controlled to absolute values which are independent of atmospheric pressure. For this reason, the maximum readings of the boost gauge in the instrument panel will tend to rise with increasing altitude and decreasing atmospheric pressure.



EB.14. - EXHAUST MANIFOLD, TURBOCHARGER & WASTEGATE (Turbo models)

FUEL INJECTED ENGINES

The cast iron exhaust manifold converges the gas streams from four branches to two, joining cylinders 1 with 4 and 2 with 3. These two gas streams are kept seperated through the cast iron wastegate adaptor and into the turbine housing of the turbocharger.

The exhaust gases spin the turbine wheel of the Garrett Airesearch type T3 turbocharger at speeds of up to 100,000 rpm before exiting the turbine housing and flowing into the exhaust system. The turbine wheel is fixed to a shaft, supported by fully floating bearings, to the other end of which is fixed the compressor wheel inside a compressor housing. The compressor draws air from the fuel injection airflow sensor and centrifuges the air out of the compressor housing into the diffuser and thence to the intake plenum chamber. The extent to which this air is compressed is dependent on throttle opening and engine speed, but is limited by the exhaust wastegate to a maximum boost pressure of 0.65 bar (9.5 lb/sq.in).

The wastegate consists of a coil spring/pneumatically operated poppet valve fitted to the underside of the wastegate adaptor between exhaust manifold and turbocharger. The valve is held shut by a coil spring, and in this position, all the exhaust gases are fed into the turbocharger. A diaphragm pressure chamber on the wastegate is connected by a sensing pipe to the compressor outlet of the turbocharger, such that as boost pressure is built up, the force in the diaphragm chamber opposing the spring pressure increases until the valve is lifted off its seat. A proportion of the exhaust gas is then allowed to bleed off the main stream and by-pass the turbine housing, re-joining the stream via an adaptor between the turbine outlet and the exhaust system.

To protect the engine from damage due to overboost in the event of wastegate failure, an overboost switch is fitted on a plate above the RHR wheelarch, and is connected by hose to the inlet manifold. If boost pressure in excess of 0.71 bar (10.5 lb/sq.in) is detected, the fuel pump feed is cut out until boost pressure falls to a safe level.

The turbocharger bearings are supplied with an oil feed from the oil gallery cover at the right hand rear of the block, and an oil drain hose is provided to return oil to the left hand side of the sump.

The turbocharger unit is a non-serviceable item which must be renewed if faulty. A certain amount of free play in the shaft bearings is a design feature, and should cause no concern unless the amount of play allows the turbine or compressor wheels to contact any part of their housings. The shaft should turn freely and smoothly and the turbine and compressor blades should be free from signs of mechanical damage. Note that great care must be taken when working on the engine to prevent any foreign bodies from entering the turbocharger, or the wheels will be severly damaged.

The wastegate may be dismantled to replace the diaphragm or gaskets.

CAUTION: The wastegate cover, retained by four screws, forms the abutment for the valve closing coil spring, so suitable precautions must be taken when removing the cover.

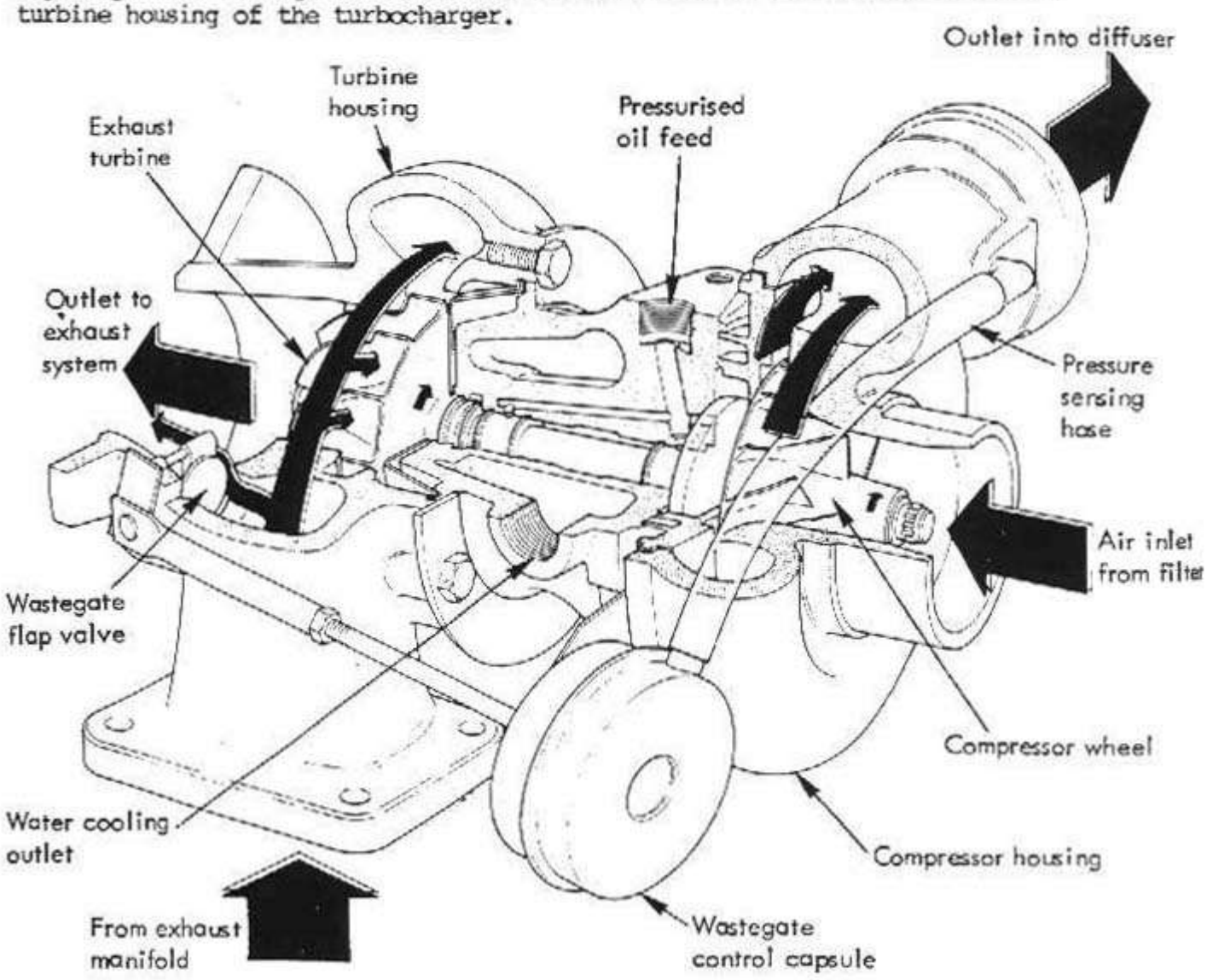
Replace the nut on the valve stem to remove the diaphragm, and on re-assembly, it is recommended to use two nuts for additional security. Re-assemble using new gaskets and the same spacer. The wastegate is calibrated at the factory to provide the specified maximum boost pressure, and on no account should a wastegate spring or spacer be changed.

NOTE: i) The practice of 'revving' the engine before switching off should be discouraged since the turbo will continue to spin, due to its inertia, after the engine has stopped and the pressurised oil supply has ceased.

ii) After a run at high speed, when the turbocharger temperature is high, the engine should be allowed to idle for a few minutes before switching off to allow the turbocharger to cool and reduce the possibility of carbonisation of the oil in the turbocharger bearings.

CARBURETTED ENGINES

The cast iron exhaust manifold converges the gas streams from four branches into two, joining cylinders 1 with 4, and 2 with 3. These two gas streams are kept seperated through the exhaust manifold extension which feeds into the turbine housing of the turbocharger.



A Garrett Airesearch type T3 turbocharger is used with water cooled bearing housing and integral wastegate. The exhaust gases spin the turbine wheel at speeds up to 100,000 rpm, before exiting the turbocharger and flowing into the exhaust system. The turbine wheel is fixed to a short shaft supported by fully floating bearings, to the other end of which is fixed the compressor wheel. The compressor draws air from the airbox and centrifuges the air out of the compressor housing into the diffuser and thence to the carburetter plenum.

chamber. The extent to which this air is compressed is dependent on throttle opening and engine speed, but is limited by the exhaust wastegate to a maximum boost pressure of 0.65 bar (9.5 lb/sq.in).

The wastegate consists of a coil spring/pneumatically operated flap valve fitted between the turbine housing inlet and outlet which, when opened, diverts a proportion of the exhaust gas away from the turbine to limit the boost pressure built up in the inlet. The flap valve is linked to an operating capsule which contains a spring to hold the valve shut, and a diaphragm pressure chamber connected by a short hose to the boost pressure at the compressor outlet. As boost pressure builds up, the force in the pressure chamber, opposing the spring pressure, builds up until the flap valve is opened.

To protect the engine from damage due to overboost in the event of wastegate failure, an overboost switch is fitted on a plate above the RHR wheelarch, and is connected by hose to the plenum chamber. If boost pressure in excess of 0.71 bar (10.5 lb/sq.in) is detected, the ignition feed is cut out until boost pressure falls to a safe level.

The turbocharger bearings are supplied with an oil feed from the oil gallery cover at the right hand rear of the block, and an oil drain hose is provided to return oil to the left hand side of the sump. In order to help protect the turbocharger bearings from the effects of heat soak after the engine has been stopped, a water feed and return system is provided, and connected between the heater take-off at the rear of the block and the header tank. Water circulation around the bearings continues after engine switch off, by thermo-syphon action, and reduces the possibility of carbonisation of the oil in the turbocharger.

The turbocharger unit is, with the exception of the wastegate capsule, a non-serviceable item which must be renewed if faulty. A certain amount of free play in the shaft bearings is a design feature, and should cause no concern unless the amount of play allows the turbine or compressor wheels to contact any part of their housings. The shaft should turn freely and smoothly and the turbine and compressor blades should be free form signs of mechanical damage. Note that great care must be taken when working on the engine to prevent any foreign bodies from entering the turbocharger or the wheels will be severly damaged.

Wastegate Capsule Replacement

To remove the capsule, pull off the pressure sensing hose, remove the circlip from the flap valve operating arm to release the actuator rod, and release the two capsule fixing nuts.

After fitting the new capsule, it is necessary to set the actuator rod length to achieve the specified maximum boost pressure of 0.65 bar (9.5 lb/sq.in). For this purpose a hand pressure pump (e.g. Excel lumbar support bulb) and 0 - 0.7 bar (0 - 10 lb/sq.in) pressure gauge are required:

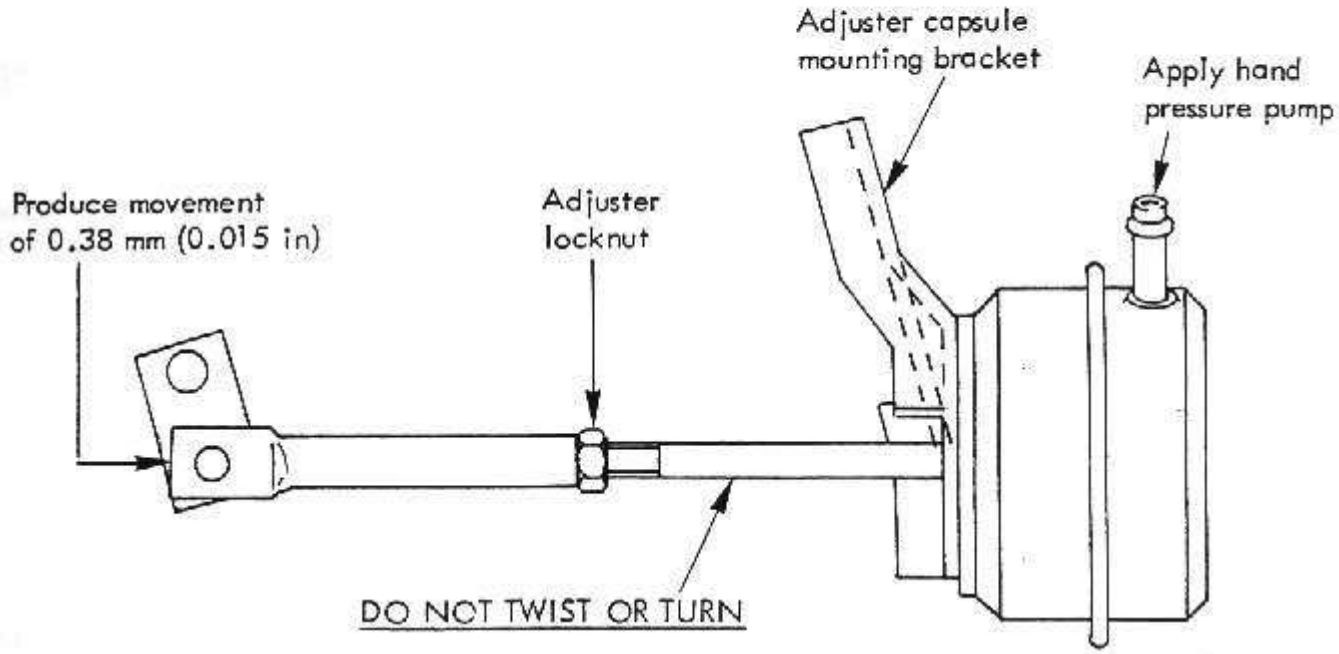
Apply pressure to the capsule, and observe the pressure required to produce an actuator rod movement of 0.38 mm (0.015 in).

Specification = 0.58 $\pm$ 0.02 bar (8.6 $\pm$ 0.25 lb/sq.in)

If the pressure is below specification, the actuator rod should be shortened, and if above specification, lengthened.

CAUTION: Do not turn, twist or force the threaded actuator rod emerging from the capsule and affixed to the diaphragm. Hold this rod stationary whilst slackening the locknut and screwing the extension piece on or off the actuator rod as required.

When the correct specification has been achieved, fit the rod onto the flap valve arm with the circlip, and connect the pressure sensing hose.



Note: i) The practice of 'revving' the engine before switching off should be discouraged since the turbo will continue to spin, due to its inertia, after the engine has stopped and the pressurised oil supply has ceased.

ii) After a fast run, the engine should be allowed to idle for a few minutes before switching off in order to maintain oil circulation whist the turbo cools down and prevent oil carbonisation from heat soak.