Rootes TS3 opposed piston two-stroke diesel engine

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Introduction

An article on the Rootes/Commer/Tilling-Stevens TS3 engine range was first published in the *Power Engineer* in 2008 as part of a series of heritage papers designed to record the history of various engine makes and specific types. This resulted in contact being made with IDGTE during 2019 which provided further detailed information on the engine history. The feedback reaffirmed ongoing active interest in this engine range in New Zealand with fully refurbished and new engines being available. The article has been revised and extended to incorporate the additional information and photographs.

Engine development and design

Concept planning and design for an opposed piston two stroke engine commenced around 1946 at the Humber plant in Stoke Aldermore. The precise origin of the design concept is unknown but there was probably some influence from the work completed previously by Junkers, Sulzers, and/or MAP. The objective was to produce a compact engine with a high power to weight ratio primarily for the fast-developing forward control truck market of the post war era.

In 1947 the Rootes Group (comprising Hillman, Humber, Singer, Commer and Sunbeam-Talbot) acquired the Tilling-Stevens company based at Maidstone, Kent, which included facilities for engine development and manufacturing. Following this acquisition, Rootes Diesel Engineering Division (RDED) was formed and development work continued at the Tilling-Stevens facility on the engine design which eventually became the TS3. Consulting resources were provided by Armstrong-Whitworth for the small team at RDED.

The design featured two opposed inward facing pistons in each of the three horizontal ported cylinder liners which drove the crankshaft. Each piston was connected through a short "piston rod" to a large rocker lever on either side of the crankcase which in turn linked via connecting rods to the single crankshaft underneath (see Figures 1 and 2).

The engine was fitted with a Roots (different company and different spelling!) type blower for scavenging and was driven from the timing gear train at the rear of the engine by a long flexible drive shaft. A direct injection fuel system was incorporated.

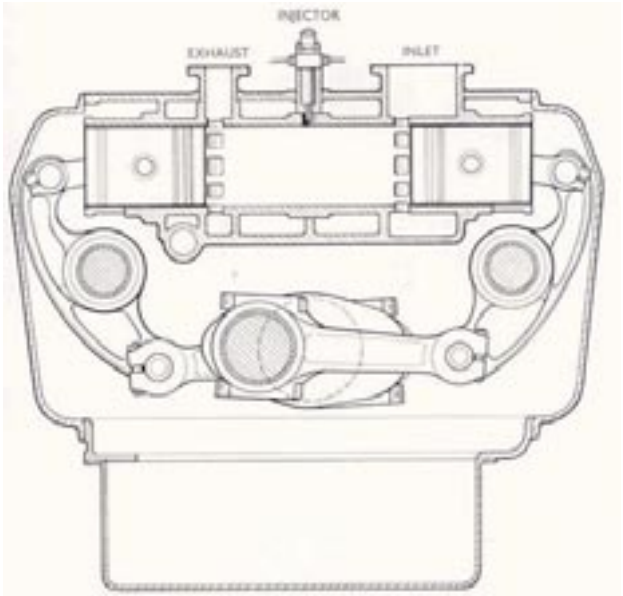

Figure 1: Cross section of the TS3 engine

The design offered distinct advantages in compactness and low weight for the power output although it was far from conventional for commercial vehicle use. There were considerable development problems initially with the rocker lever assemblies, but these were resolved during the pre-production period.

In 1954 the engine commenced production and it was offered on the heavy version of COE Commer trucks, as an alternative to the Perkins diesel engine or the in-line Humber based petrol engine.

The engine initially had a bore of 3.25 inches (82.55mm) and a stroke for each opposed piston of 4.0 inches (101.6 mm), a capacity of 199 cu inches (3,261 cc), a compression ratio of 16:1, and a maximum output of 105HP for the 3D-199 model and 117 bhp at 2400 rpm for the upgraded 3DA-199 model. From 1964 onwards, TS3 units had a larger bore of 3.375 inches and higher output with a final release rating of 135bhp for the 3D-215 model..

Figure 2: TS3 rocker arm and piston assembly

Minor increases in HP and torque were subsequently achieved incrementally with the same engine, by increasing factory fuel settings in the 3DB and 3DC-215 models.

Rootes publications from the era confirm that care was needed to ensure that the right and left rocker arms and connecting rod assemblies were matched in weight to ensure a balanced operation. The lack of cylinder heads was an advantage as head and block joints were eliminated and the piston ring assemblies were an advanced design made from superior material which generally lasted well beyond the manufacturer's recommended life span.

The combined 8" stroke over 3.3/8" diameter pistons meant the TS3 would start instantly even when rings were badly worn or damaged from years of abuse. The use of rocker levers on each side of the engine provided no more than five degrees piston rod angularity, which greatly reduced bore wear and motoring losses from piston side thrust. The cylinder liners crankcases and other engine components were made from advanced and high quality materials for the day, with machining tolerances so accurate that replica parts are difficult to reproduce to the same quality in 2019. Figures 3, 4 and 5 show some of the components.

Figure 4: Cylinder liner

Figure 5: Crankshaft

Commer Truck Application

The engine was initially used in Commer trucks as an ideal compact unit for the forward control cab designs which

emerged in the 1950s to replace the conventional cab layout of the preceding 50 years. The compact size allowed the power unit to be placed low within the truck frame which in turn lowered the centre of gravity and also allowed optimum space for the cab layout. In this application the engine produced a loud and distinctive exhaust note which could be heard from quite a distance particularly on acceleration and there are several online video clips demonstrating the typical sound of this engine. Figures 6 and 7 show a typical truck engine configuration.

Figure 6: TS3 truck engine from the front

Figure 7: TS3 truck engine from the rear

Being so well designed and developed and made so accurately from high quality materials, TS3 engines were found by operators to be so reliable and so fuel efficient under the worst overload conditions, that they became legendary in countries like New Zealand and Australia.

In both countries, it was not unusual during the TS3 era for a 12 tonne maximum rated Commer TS3 truck to be regularly operating at 30 tonne gross vehicle mass (truck and trailer). In forestry operations in New Zealand, a 30 tonne payload of logs was not unusual for these remarkable 12 tonne rated trucks, because the TS3 engines could cope with the power demand.

Rootes Lister developments

A marketing agreement was established with R A Lister (RAL) of Dursley in the late 1950s to extend their power range using the Rootes TS3 engine and leading to the formation of the Rootes Lister subsidiary. RAL undertook the adaption (or 'dressing') of the basic engine with appropriate fittings to provide industrial generating sets, pumping sets, marine propulsion, generating sets, and various plant drive applications.

RAL undertook the design work for bell housings, baseplates, cooling systems, and controls at their Dursley plant to create a range of standard designs based around the TS3 and incorporating the typical green paint finish as used by the company.

The Rootes Lister TS3 engine was offered both for industrial applications (including generator, compressor, and pump sets), and for marine use in small boats or cabin cruisers. For these applications the compact nature of the power unit was used to advantage. In marine applications for example the TS3 was offered at ratings of up to 110bhp at 2,200rpm, and an oil operated reversing gear was offered for propulsion units. A Lister Blackstone Marine brochure of 1966 shows a 50 feet long high speed cabin cruiser "Monaco" fitted with three TS3 propulsion engines.

By far the oldest surviving Rootes Lister TS3 marine engines are still in use in about 20 of the famous orange fishing boats at Mar Del Plata Harbour, Argentina.

The Rootes-Lister engine did not sell in large numbers in the UK when compared with the conventional 4-stroke Lister products, but did sell well in rural Australia due to their high power density and very good fuel efficiency with good engine life compared to other engines. The marine and industrial units continued to be offered until

Figure 8: Illustration of the front end of a Rootes-Lister TS3 and the Roots blower

around 1970. Figure 8 shows a Rootes Lister TS3 illustration taken from a brochure.

TS4 Development

Development of the engine continued at the Rootes Group Diesel Engineering Division at Maidstone, culminating in the four cylinder/8 piston TS4, rated at 200bhp at 2,600rpm and 465 foot pounds of torque at 1,400rpm.

Production of the 4 cylinder prototypes began in 1966. Whilst the TS4 incorporated many of the same running parts as the TS3 production engines at that time it also incorporated large numbers of design changes. The most significant improvement was the incorporation of twin through bolts at either end of the rocker shafts (in place of the studs used in the TS3 design) to keep the crankcase uniformly in compression. The design also incorporated a Holset viscous damper at the front of the crankshaft and inside the crankcase, which allowed the operation speed to increase to 2,600rpm. The design life of the four cylinder versions was 250,000 miles, and certain improvements were incorporated to achieve this objective including better material for the liners and fire rings and also nitriding of the crankshaft journals and rocker pins. Fourteen prototype TS4 engines were manufactured and four survive.

The development phase saw eight of the prototype engines put into transport operator's trucks for road testing, five on test bed and one "spare engine". The targets for test bed engines was 20,000 hours each and the targets for road rehearsal testing was 1.2 million miles. The launch of the new development was however thwarted by Rootes Group's financial problems on the car side of their operation.

Unfortunately, the Rootes Group encountered financial problems beginning with the Acton strike in 1960 and continuing through in to the mid-1960s after building a new factory in Scotland and launching the Hillman Imp car. The company was subject to a takeover by Chrysler in 1967. At that stage Chrysler had a joint venture with Cummins to develop a range of four-stroke diesel engines and it was soon appreciated that the TS3 and TS4 range would be in direct competition with the new Cummins four- stroke range. Hence a decision was taken to terminate the TS3 production and TS4 development and to scrap all TS4 engines, drawings, records, prototype engines, parts dies and patterns.

Four TS4 prototypes were saved by Rootes managers and three TS4 prototypes were eventually donated to museums whilst a fourth unit was retained and eventually used to provide standby power to the Dunstable factory. This fourth engine was preserved after use and eventually found its way into private ownership in New Zealand where it was extensively reconditioned to 'as new' condition using technical advice from former RDED Design Manager Donald Kitchen and former Chief Development Engineer, (the late) Bill Seaman. It was run for the first time after reconditioning in 2008.

Figure 9: Two TS4 prototype Stage I engines at the Science Museum store (with end mounted blowers)

Another TS4 prototype is held at the British Commercial Museum at Leyland and this is unique in being built to a later 'Stage II' design with the blower mounted on top of the crankcase in order to shorten the length of the engine. This would have offered chassis and boat designers an even more compact power unit. Figures 9 and 10 show TS4 prototype engines.

Figure 10: TS4 Stage II prototype engine with top mounted blower at the British Commercial Vehicle Museum in Leyland

End of UK production

Production of the standard Rootes TS3 engine ceased in about 1970 and all development work had also ceased by that date. Chrysler continued to "re-manufacture" Rootes factory seconds as the 3DD-215 range, ending finally in 1974.

A lot of the 3DD-215 "re-manufactured" TS3 engines came to New Zealand including the last engine to be manufactured.

New Zealand activities

Rootes TS3 Engine Services was formed in New Zealand to cater for ongoing interest in the engine, and remaining stocks of spares were secured from available sources. Many of these 'new old stock' spares are still boxed in the original Rootes, Chrysler, or OEM packaging and are available off the shelf today. Manufacture has been undertaken for parts which are no longer available from stock such that complete engines be built from stock parts. This is an unusual scenario for an engine which ceased production over 45 years ago! Fuel injection parts are becoming hard to find in New Zealand and the company is continually looking off-shore for remaining stocks of such parts.

Figure 11: New TS3 marine engine produced in 2019

Figure 12: New TS3 engine being installed into a marine application

A number of new or fully refurbished engines have been manufactured and figures 11 and 12 show an example of a recent production marinised engine.

Heritage

There are a number of preserved Commer trucks fitted with the TS3 in the UK, Ireland, Australia, New Zealand, Norway, South Africa and Finland and there are video clips available to view on YouTube. There are also some boats still fitted with propulsion versions of the engine, with the very oldest being the famous 1954 and 55 orange fishing boats at Mar Del Plata Harbour, Argentina.

Many New Zealand and Australian boat owners have their TS3 engines reconditioned, rather than replaced, because of the TS3's enormous reliability, longevity, power density and fuel efficiency.

The British Commercial Vehicle Museum in Leyland (http://bcvm.co.uk) has various relevant items on display including one of the prototype TS4 engines. The Coventry Transport Museum has a motorized cut-away TS3 display. The Greenock Aviation Museum near Adelaide, South Australia has a Commer TS3 unit along with various other non-aviation items and the Bill Richardson "Transport World" museum in Invercargill, New Zealand has a motorized cut-away and a 1963 Commer TS3 truck on display.

As mentioned previously four of the TS4 prototypes still exist, with one in 'as new' running condition, which will be used in a truck in New Zealand. ■

Acknowledgements

The photographs used in Figures 2, 6 and 7 were kindly provided by Brian Vogt of the Hillman Car Club of South Australia (www.sa.hillman.org.au). Thanks are also due to Mark Erskine of Rootes TS Engine Services (www.commer.co.nz) for providing the photographs used in Figures 3 to 5, and 9 to 12. Mark also assisted with the revised article by proof reading and also providing considerable additional details to further enhance the content. The remaining illustrations were taken from manufacturer's publications in the author's collection.

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