# Tuning Post-Vintage OHV Singles

Peter Roydhouse *Roadholder No. 206 - July-Aug 1999*

**1931 to 1961**

## Introduction

First, it must be stressed that all work to improve engine performance should be carried out in conditions of the utmost cleanliness and steps should be taken to ensure that all components are in good condition and are correctly fitted. Second, great attention to detail is essential. As an example of this, it is generally considered that the barrel and piston assembly must be absolutely square with the crank to ensure minimum friction. It is said that at the BSA factory, during preliminary assembly of Gold Star engines the unit was partially built-up without piston rings. Engineer's blue was then used to determine whether the piston operated centrally in the barrel. Remedial work was done if there was any misalignment. Third, I consider that Phil Irving's book '*Tuning for Speed*' is a must for all who wish to tune a motorcycle engine. It will be recalled that, technically-speaking, a vintage machine is one that was manufactured before the end of 1930. The story begins in 1931.

## 1931

The redesign of pushrod and side valve machines for the 1931 season resulted in stronger and more durable engines. However, unlike the vintage machines, where Norton made special tuning items available for OHV engines, such components were not made available for the new range. This was because the company had decided to concentrate all its efforts on increasing the performance of its range of OHC machines. Nevertheless, there were common dimensions throughout the range of machines, and many of the parts available for OHC engines could be adapted for use in OHV engines.

When they were introduced, the dry sump engines featured the 1" diameter main shafts of the vintage ES2; substantial ball race main bearings; a 7/8" diameter gudgeon pin; very good quality valves (which were larger than most other makes) and valve springs ; and an inlet stub with an internal diameter of 11/16". While modifications to the cam gear included followers with longer levers, the mechanical advantage of these was lower compared to vintage equivalents. It was possible to adapt vintage cams, but subsequent performance was disappointing because the vintage levers provided up to 25% more lift, while the new cam levers provided about 5% more lift. The oil pump was driven by a single-start worm wheel. Later engines had three-start worms giving a useful increase in the rate of oil circulation.

Remember to change the pump gear if the worm wheel is changed. Some people increase the big-end feed jet's drilling to provide more oil to its bearing. Another drilling provides an adjustable feed to the piston, via the base of the cylinder. With increased oil circulation this feature is probably unnecessary and was, in post-war years, discontinued in racing engines. A dry combustion chamber gives better power output.

A larger carburettor, such as the Amal Type 89, a 13/32" choke item used on the CS1, can be fitted on the 500 OHV engine. Many modifications are needed to fit a bigger carb. to the 588cc engine. With the 588 standard carb. adapter the larger Type 89 fouls the petrol tank and its mounting platform. The standard exhaust pipes were 1.7/8" o.d. A smaller diameter pipe gives a slight improvement in performance.

The engines retained the cast iron flywheels and crowded roller bearing big end which were adequate with standard compression of 6.2:1 with the 500 and 5:1 with the 588. The 588 had a concave crown, so fitting a 500 piston gives a performance boost. Small gains of about half a compression ratio can be obtained by shortening the barrel, but to obtain higher compression ratios, pistons from the OHC engines can be fitted to provide a useful gain in performance. The narrower little-end bush used with the OHC engine requires the piston bosses to be machined back slightly. Increased performance exposes the shortcomings of the cast iron crank and crowded roller big-end. While the use of castor oil can give the big-end a better time, the pressed-in mainshafts can become loose, possibly leading to cracks in the flywheels. The higher dynamic loads on the 588s make them the most fragile. A further area of weakness is the crankcase timing-side bearing housing. Loose bearings can be encountered and, under highly stressed conditions, can cause damage which is difficult to cure by welding and machining because of the presence of too many oil leads close by. This problem is found in most engines built prior to 1948.

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## 1933

This year saw the introduction of the 350cc engine (71mm x 88mm) and dimensional changes to the 600, which with a bore and stroke of 82mm x 113mm, became 596cc. Both models had long through barrel and cylinder head holding-down bolts. In the 500, Norton continued to secure the barrel to the crankcase with short studs, and continued to secure the head by short studs in the barrel. The 600 retained a concave piston, and although the company had produced a small number of 596 OHC machines, suitable higher compression pistons were not generally available. The 350 unit had many components from the larger engines, including the cams and the rocker box, but other parts were not interchangeable.

The good news is that the con rod has a narrower little-end, and the piston is identical with that used in the CJ. Other features from the OHC engines included the valve collet system and 11/32" diameter inlet valve stem. The smaller machine's flywheel assembly ran on 25mm shafts, but retained the larger engine's crowded roller big-end bearing. It should be noted that the lever cam followers were shorter than those in the larger engines, and with the inlet providing some 10% increase in effective lift, this should not be exchanged with the exhaust cam follower, which provided about 5% increase.

People have used Big 4 (82mm) pistons and the domed 16H pistons to increase compression in 500 and 600cc engines, but first a spacer under the barrel is required. These SV engine pistons use the 1/8" thick piston rings rather than the 1/16" or 0.060" rings of OHV engines. The thicker rings are not conducive to increased performance.

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## 1934

In this year, a second drive side main bearing was introduced. At the time, Norton favoured double row self-aligning ball bearings. It is suggested that two lipped rollers and a ball bearing are used. The introduction of oil pipes from the rocker box feeding oil to the guides makes it possible to use phosphor bronze guides.

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## 1936

In 1936 the 500s were equipped with long holding down bolts and 1937 saw the introduction of 14mm plugs. Both items made a stronger, more efficient engine.

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## 1938 - 1947

The engines were considerably redesigned to provide valve gear enclosure, and at the same time flat base cam followers were adopted. The lever cam followers provided about 4% increase in effective lift on the cams. Unfortunately, there was no positive lubrication of the enclosed valve gear. Norton relied on oil mist working its way into the rocker box from which there was no provision for drainage. Push rod failure was believed to have been the cause of Vic Brittain's retirement in the 1938 Scottish Six Day's Trial and Ted Breffitt's and Karl Pugh's retirements in the 1939 event.

Most of the engines were identical with earlier units and respond to the same approach to tuning. Seizure of the valve in its guide can occur with hard driving of a newly restored engine. It is possible to provide a bleed from the return oil pipe into the spaces between the rocker bushes. Drain pipes similar to those used by Triumph and BSA should be provided from the spring chambers to the crankcase.

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## Special components used in pre-war works machines

Norton probably had the greatest experience of any British manufacturer in the use of light alloys. Before the outbreak of the Second World War, Norton made OHV engines with Elektron crankcases for the works trials riders. In addition, their machines were fitted with Manx/Inter alloy barrels and alloy heads, both of which were painted black. The factory used modified Inter flywheels fitted with the Inter big-end and 1" diameter mainshafts for some of its works bikes. The con-rods used had 7" centres, which was the standard length for Model 18 and ES2 machines, while old Inters had been fitted with 7.5" rods.

The location of most of the above mentioned component is akin to finding hen's teeth, although the Inter alloy barrels can be purchased at a price. 500T barrels (see below) can also be fitted. Lightening of the cam gear with lever followers is time-consuming and does not result in a significant increase in performance. But it is worth changing the steel pushrods for dural components. Later valve springs provide better surge control, yet lower spring loads. Hairpin springs from Inters have been fitted but probably these offer little advantage over later coil springs. Replacement of steel valve cups with dural items has also been employed.

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## 1948

Norton introduced their post-war OHV engine with an extensive redesign, which gave improved support to the timing side bearing and replaced the lever cam followers with direct acting hollow tappets, whilst positive lubrication of the valve gear was introduced. Valve spring loads were reduced slightly with shorter springs of improved quality. Dural pushrods were used. Smaller diameter flywheels with thicker rims allowed a slightly longer piston to be used, but the Achilles heel of the cast iron crank and crowded roller big-end was continued. Remember that these engines drain their rocker boxes through drillings in the barrel. The rocker gear provides an increased lift at the valve compared to the cam's actual lift.

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## 1949

The redesigned engine was incorporated in the newly introduced trials model, the 500T. Variations from the standard product included the use of a sand cast alloy head and barrel, with a screwed-in aluminium carb adapter. Valve seats in the alloy head were provided by a cast iron skull, which also incorporated the spark plug tapping. Bronze valve guides were available instead of the standard iron guides. The machines were supplied as standard with a 1½" exhaust pipe. No special cams were made. Works scrambles machines benefited from some increase in compression and it was said that they could get about 27h.p. from a modified 500T. Contrary to various authorities, no 350Ts were ever built. Geoff Duke's trials bike was built up with an earlier lever cam engine from 1946.

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## 1952

The 500T model was provided with a Wellworthy Alfin barrel and head. These closely resembled the earlier sand cast items, but were slightly lighter. The Alfin process, an aircraft engine development, centrifuged the iron liner into the aluminium muff. The patentees claimed molecular bonding of iron liner and aluminium. Be that as it may, sleeving of the Alfin barrel is technically difficult; the bonding of aluminium to the original liner allows greater expansion and pressed in liners can drop.

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## 1954

This saw the introduction of Alfin heads (on iron barrels) for the road machines. It was also the last year of production for the 500T.

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## 1956

The 350 engine became available again. It retained the traditional 71mm x 88mm dimensions, but used the 500 crankcase. The flywheels had 1" diameter mainshafts. The other differences with earlier 350 engines were the use of a conrod with 6.3/4" centres and an inlet valve with 3/8" dia. stem. Model 18 type collets were used on both valves. The screwed-in carb. adapter was provided with a flange to mount an Amal Monobloc carb. This instrument was not available for stub mounting.

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## 1957

A further redesign of the engines introduced a head casting incorporating the top push rod tube location and a larger rocker box. The barrel to head spigot was reduced from that of the earlier engines. The use of valve seat insert replaced the earlier iron skull arrangement. Helicoil inserts were provided for rocker box studs and spark plug. The screwed-in carb. adapter was replaced by a conventional flange fitting.

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## 1959

Besides introducing an alternator on the end of the drive shaft, the valve springs were changed to a two rate winding and reduced in diameter, with corresponding smaller valve caps.

## Tuning 1948 - '61 engines

During this period, a few Inter-type flywheels were produced for scrambles and trials machines but the chance of finding these components is slight. It is fairly easy to install a Manx piston to increase compression. The gudgeon pin bosses need attention and it is worth noting that post-war Manx pistons were 79.62mm, i.e., some +.030" up on the standard 79mm. SV engine cams act directly on to the valve, consequently they provide more lift than the OHV cams. The OHV engine has unequal arms on the rocker, thus increasing the effective lift. Cam followers can be lightened by grinding off the flanks which do not come in contact with the cam. This requires the removal of the guides from the crankcase. The smaller diameter two-rate valve springs used in later engines provide useful reduction in valve gear weight, the reduced spring loads are also beneficial. Some slight reduction in rocker weight can be achieved by judicious fettling, and it is possible to make up pushrods to minimise adjuster weight. 500 ports were usually polished by the factory but those of 350s were not. Some streamlining of the inlet guide is possible and it is possible to open up the head to match a 30mm Concentric carb. Problems can arise with earlier screwed-in carb. adapters. If the aluminium 500T type is bored-out beyond 1.1/8", it is prone to break off. Other roads to explore, could be the use of a 350 head machined to fit the 500 barrel. This gives a compression ratio of about 8.5:1 and provides a squish band. Try using a 1.5/8" diameter exhaust pipe.

## BSA components

It is possible to adapt BSA cams, though they are driven by a smaller diameter gear wheel than Norton. They run on a fixed 5/8" shaft, the same size as the axle in a Norton cam. It should be borne in mind that due to the mechanical advantage in Norton valve trains, the cam's effective lift is increased. BSA's M20 cam was also used in their models B31 and B33 and gives about 0.312" lift, similar to the 16H cam. By virtue of the Norton rocker gear's mechanical advantage, the 0.279" lift of the Model 18 cam increases to about 0.320" at the valve. There is a wide range of cams for B32/34 Gold Stars, some with lifts of over 0.400", with sharper timing. Phil Irving lists many of these. Gold Star engines had superior valves, springs and collets than those used in the standard B31/33 engines. These Gold Star valve gear items were developed to match the greater stresses imposed by greater valve lifts.

To exploit bigger lifts in the pushrod Norton, you need to turn to modified Inter valves, which also have a better collet system. The 440cc BSA Victor used a 79mm piston. This can be adapted for use but it is heavier than the Norton component and may cause excessive vibration unless the crank assembly is re-balanced.