Servicing the Double-o.h.c. "MANX" NORTONS

BY BRUCE MAIN-SMITH, PREPARED WITH THE ASSISTANCE OF ALAN WILSON AND EDGAR FRANKS OF NORTON MOTORS LTD.

Part 1

FOR the purposes of this article, it is assumed that the man who will do the work is generally familiar with the design features and construction of the Norton "Manx" racing engines, is a capable mechanic, and has already carried out some of the routine maintenance called for in the course of racing. The information herein some of which has never before been collated—should be regarded as supplementing rather than replacing the literature available from the makers, Norton Motors, Ltd., Bracebridge Street, Birmingham, 6.

Detailed information is given here for post-August, 1951, engines—that is, the double-o.h.c. single-cylinder 350 and 500 c.c. versions as fitted into all "Featherbed" frames. Some of the contents are applicable to certain engines current before the start of the "Featherbed" epoch.

Already possessing a long lineage when it was introduced in 1950, the twin overhead camshaft (or double-knocker) was the direct ancestor of the present-day engines. It was followed in 1951 by a version fitted with a sodium-cooled exhaust valve, this type being installed in the first over-the-counter "Featherbeds" in August, 1951. In 1952, the "40M" (348 c.c.) featured a modified inlet cam (stamped 392), giving more lift but the same timing; 1953 saw little change.

Nineteen fifty-four, however, brought the short-stroke motors, with "square" dimensions and squish heads, these fundamental alterations being made to both capacities. From that period on, few parts affecting performance were interchangeable with those of earlier engines. Changes were made to big-end eyes, valve springs, and also to parts obviously dimensionally different.

In 1955, the flanged timing side main bearing appeared, used in conjunction with a thinner mainshaft bevel. Another series of changes was inaugurated in 1956. Exhaust valve size was reduced, cooling improved, and a new and unorthodox—though more satisfactory—valve timing system came into vogue, used in conjunction with new cams. On the inlet side, the valve seat was blended more effectively into the port. The reverse cone megaphone, made in one piece with the exhaust pipe, became available, as well as the rotating magnet magneto.

Alterations finalized for 1957 include a redesigned crankpin and con.-rod with a sleeved big-end eye, the rod being strengthened. A new inlet cam has been developed for the "350" and both capacities employ sodium-cooled inlet and exhaust valves. The carburetter choke sizes have been increased and the bevel teeth are of a coarser pitch.

Carburation was effected by an RN instrument up to June, 1952, when the GP type became available in quantity; even then, some engines were fitted with RN carburetters, the TT type being available to order. All types are of Amal manufacture. In 1956, the normal GP float chamber was superseded by a Weir version.

Apart from differences obvious to the eye, "Manx" motors can be differentiated by the engine numbers as follows:

Every Norton number is prefixed by a letter, changed yearly. Beginning with A in 1946, the sequence proceeds alphabetically, I being omitted. The letter is followed by 10 for the "500" or 11 for the "350," and then by M for Manx. A final suffix 2 denotes the "Featherbed" frame. Thus, "G10M2" is a 1952 500 c.c. Manx "Featherbed" racer.

The latest engines (made in 1956) were not sold until their power output in the test-house reached 35 b.h.p. at 7,200 r.p.m. for the "40M" and 47 b.h.p. at 6,500 r.p.m. for the "30M." After correcting figures to 30 in. of mercury, a production latitude of −4% was considered permissible. Each customer was provided with a performance record for his engine. In the hands of an experienced tuner, these figures can be improved upon.

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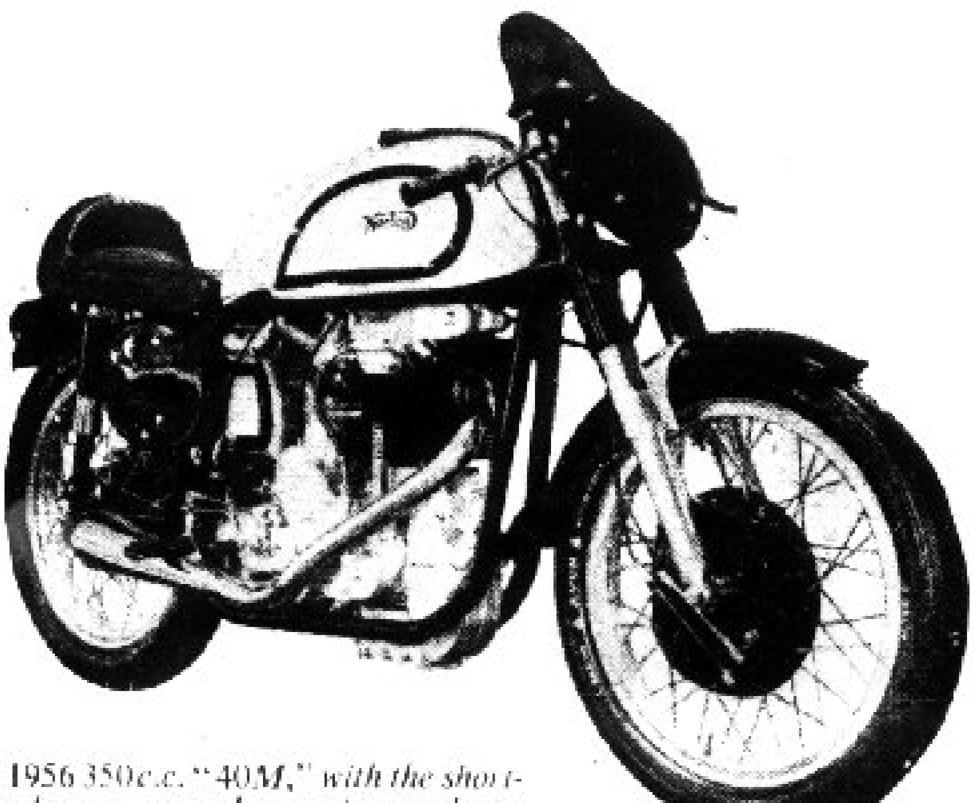


A 1956 350c.c. "40M," with the short-stroke motor and one-piece exhaust system with reverse-cone megaphone.

Motors classified as "long-stroke" (up to late 1953) have the following dimensions:—

71 mm. x 88 mm. = 348 c.c.
and 79.62 mm. x 100 mm. = 499 c.c.

Dimensions of the later "short-stroke" motors are:—

76 mm. x 76.7 mm. = 348 c.c.
and 86 mm. x 85.6 mm. = 499 c.c.

It is appropriate to note at this point that cylinder wear cannot be rectified by boring without going outside the relevant capacity limits; however, actual wear is almost non-existent under road-racing conditions.

Stripping the Engine

After the carburetter, H.T. lead, oil pipes, and rev. counter cable have been disconnected, the complete engine can be taken out of its cradle and offered up to a simple bench stand. With the oil pipes to the cam box and valve guides removed, the piston put on TDC on the compression stroke, and the four top nuts undone, the cam box may be lifted off complete; it is not necessary to free the vertical shaft cover in any way, though all of the joints will have to be broken eventually if a complete strip-down is contemplated.

With the top of the head exposed, the four head retaining nuts on the "30M" are immediately accessible; but on the "40M" it is necessary to remove the valve springs to gain access to them. Undo these 7/16 in. nuts and lift off the head. The barrel, too, is freed at this stage, once the bolts nipping the register have been slackened. There is no need at this or any other stage to take out the four through-studs that screw into the crankcase.

The piston can be detached without warming by taking out both circlips (not to be re-used) and pushing the free-fit-when-cold gudgeon pin out from either side; "works" practice is to push the pin through from the timing side.

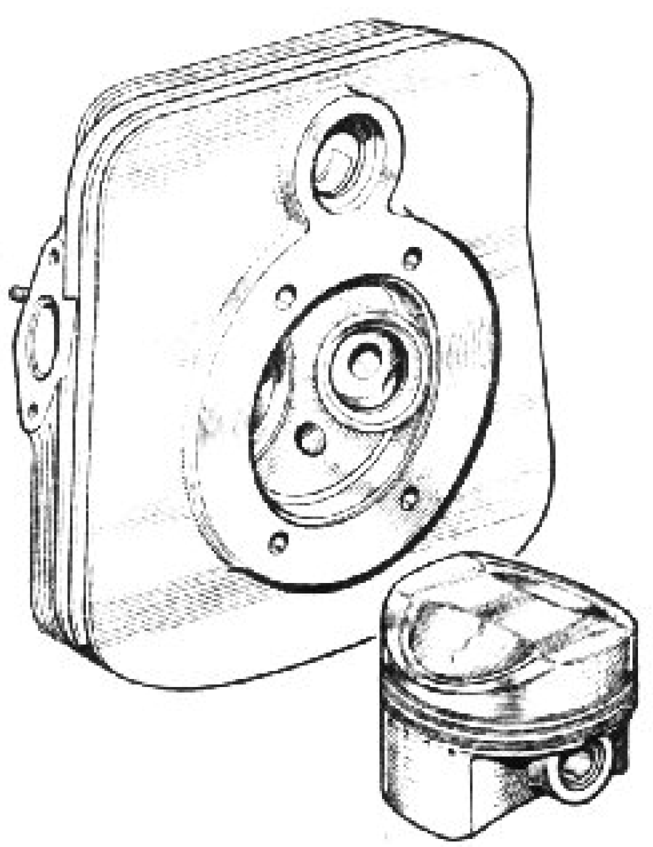
Undo the five cheese-headed ¼ in. screws to release the magneto drive cover plate. The sprockets may be freed from their tapers by running the long cover-plate screw down the extractor threads provided, whereupon the endless chain can be taken off. Four nuts secure the magneto to its platform (early examples have three only) and it is easiest to delay removal until the barrel is out of the way.

Unscrew the 1⅜ in. A/F nut to release the vertical shaft cover; the shaft itself may be removed at leisure, care being taken not to mix the Oldham couplings nor their matching slots and grooves. Different-sized couplings are used in the long-stroke engines to compensate for vertical shaft length when compression ratio changes are made with the aid of cylinder-base compression plates. Four 5/16 in. nuts secure the vertical shaft bottom housing, which comes clear with the bottom bevel.

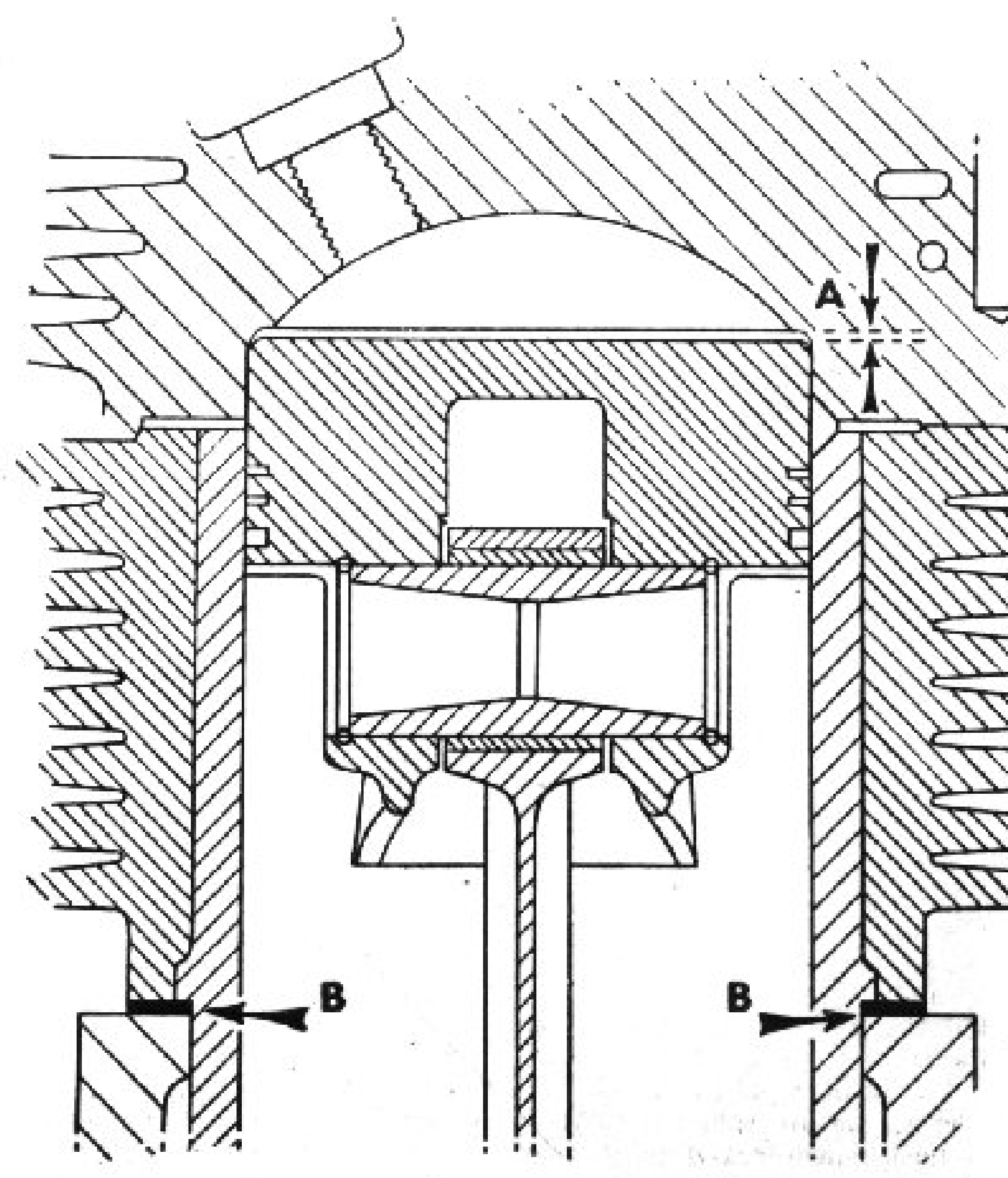
The inner half of the magneto chain cover is retained by the long ¼ in. cheese-headed through-screw already removed, four similar screws sited externally and, between the runs of the chain, a grease-hidden screw and a ¼ in. nut with a locking plate. Their removal frees the plate, which is listed as the bevel cover.

A left-hand-threaded nut secures the pump wheel and the main-shaft bevel, both of which should be removed; the wheel and bevel are only the lightest of push fits on the mainshaft.

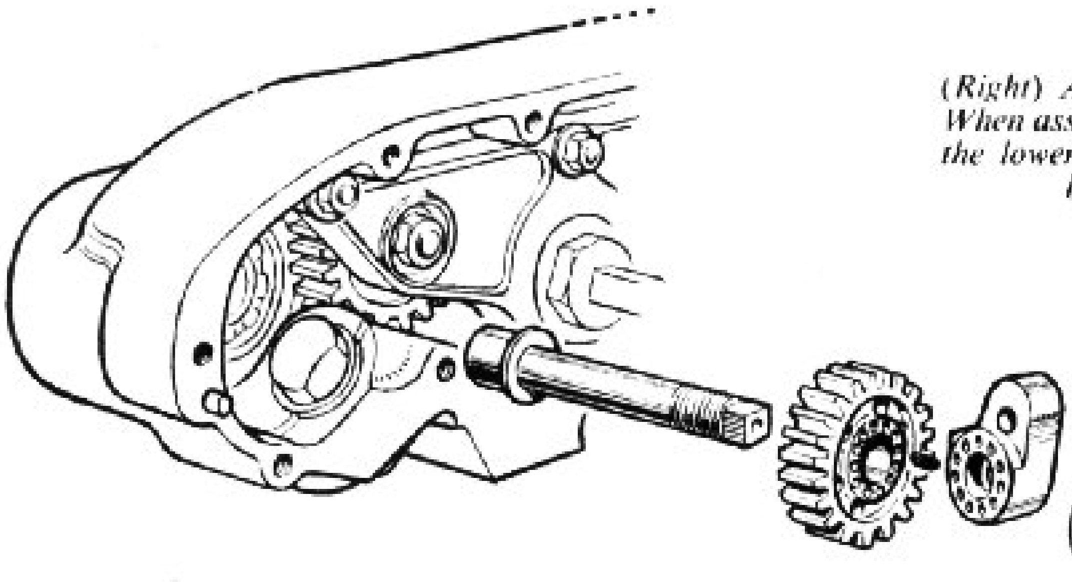
Remove the six remaining through-bolts and the one nut-at-each-end stud to split the crankcases, taking note of what endfloat controlling shims are used and where they are placed.



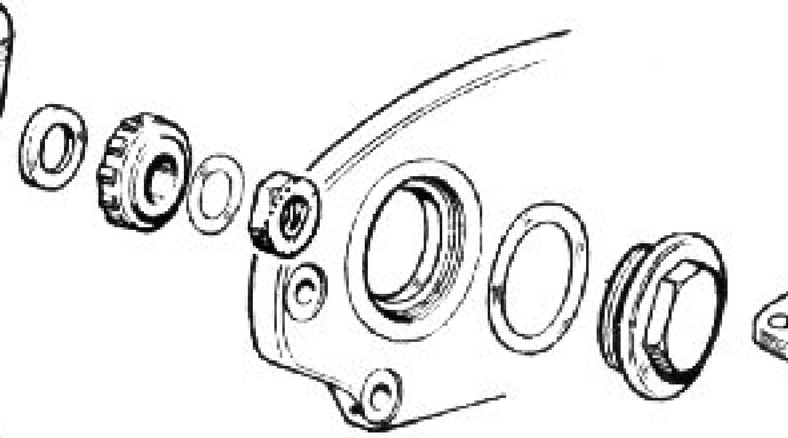
(Left) The "Manx" cylinder-head and piston, showing how the squish effect is obtained. The flat top of the piston fits closely into the head, almost abutting against the land left proud in the hemisphere.

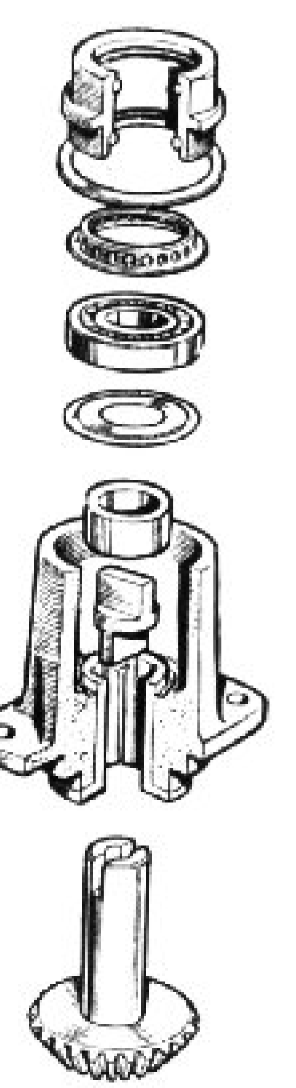


(Right) A cross-section taken laterally through the centre of the cylinder and head assembly, showing the squish clearance between the piston at TDC and the land in the head. This dimension (A) must be maintained at .045 to .055 in. by the thickness of the compression plates inserted between the base of the cylinder and the crankcase (arrowed B).



The cam box, with the cover removed to show the exhaust cam assembly. Vernier adjustment is obtained by the pegged connection between the cam and the cam gear wheel.





(Right) An "exploded" view of the bottom bevel assembly. When assembling, the interference-fit collar shown here above the lower Oldham coupling is offered up to the shank of the bottom bevel before *the coupling is inserted.*

Bottom-half Attention

Flywheel examination consists of the usual routine check for big-end wear, etc. Cost will obviously decide whether a used bearing is to be retained or replaced. In racing, where perfection is the ultimate counsel, many parts are renewed purely as a precautionary measure. However, all "Manx" big-ends have "nil up and down" when new; *any* perceptible radial clearance calls for a new assembly. Tests are made with oil-free bearings.

Up to late 1956, endfloat of the rod on the pin to a maximum of .028 in. was permissible; some endfloat will always be found and in use it will increase. If marks made by the drive-side flywheel rubbing on the rod are found, the connecting rod should be turned through 180° to bring the unscored side into service. A less acute stage can be detected by an examination of the big-end eye, which will also have been rubbing. This year's motors incorporate a thrust pad to cater for this tendency.

The slightest marking on the outside of the rod must be removed, though roughness in the milled lightening groove is not of so great consequence. Putting the rod down carelessly on a hardwood bench can raise tiny burrs or blemishes which must be polished out in a longitudinal direction. Scuffing marks are also to be polished out. Attention to these points cannot be too highly stressed if rod fracture is to be avoided.

In motors where no pressed-in big-end eye is used, early wear can be rectified by regrinding to +.002 or +.004 in. and using oversize rollers; this is a "works" job. It is also possible to fit an unsleeved rod with a 1953 sleeve working in conjunction with its mating long-stroke crankpin and bearings.

If the cage or crankpin is flawed, a complete new assembly is called for, individual components not being supplied. When the whole group of crankshaft parts has been examined, assembly may be carried out. The pin is fitted into the wheels, the timing-side oilways being carefully aligned. Wheels are trued to a maximum runout on the shafts of .0005 in., and three times this amount is permissible on the flywheel rims.

After the removal of security devices, main bearings can be jarred out of their housings when the cases have been heated. Replacement follows standard practice, unless later type bearings are to be used. The "works" can modify the timing-side case so that it will take the flanged main bearing, which is retained by six ¼ in. countersunk screws. The bearing consists of two sets assembled into one entity and termed "angular contact bearings." Dimensions are the same for both capacities and the flanging results in considerably improved support in the crankcase wall.

In the long-stroke engines, drive-side support takes the form of twin bearings. The outer bearing is pressed-in up to the end of a long recess, then a distance piece is inserted, and finally the second bearing. In the short-stroke versions, there is a one-piece outer track that is common to both inners. The sleeve may be pressed in with the oil-hole in any position so far as lubrication is concerned, but the punch slots must line up with two of the screw holes in the security plate. If they do not, the plate may fracture.

This security plate is held by four 3/16-in. Whit. countersunk screws. The screws are soldered to the plate after assembly and the plate is then punch-locked to the sleeve. When the inner tracks are offered up, it should be noted that the innermost edge of one track has a greater radius than the rest; this relieving must go next to the flywheel boss.

Flywheel location is effected by the mainshaft bevel nut pulling the assembly hard against the timing-side main bearings, which are specially designed to take this thrust. Shims are used to obtain .005 to .008 in. endfloat; after setting the endfloat, the shims are rearranged to centralize the rod in the bore. Accuracy of the order of .015 in. is sufficient. Care should be exercised to see that con.-rod endfloat and side-tipping of the small-end eye do not obscure the issue.

With the replacement of the mainshaft bevel, after shimming to obtain good meshing as described later, and also the half-time pinion, work on the bottom half is complete except for minor ancillaries. Oil pumps hardly ever need attention until failure occurs, most probably because of the ingress of foreign matter. They maintain full output for the useful life of the engine and, so far as the private owner is concerned, no servicing is possible owing to the selective assembly of components.

The parts likely to need attention are the driving dogs. The oil pump driving plate is checked for freedom of fit with the pump wheel and the pump shaft. Free, sliding movement is desirable so that the parts will find their own centres in operation.

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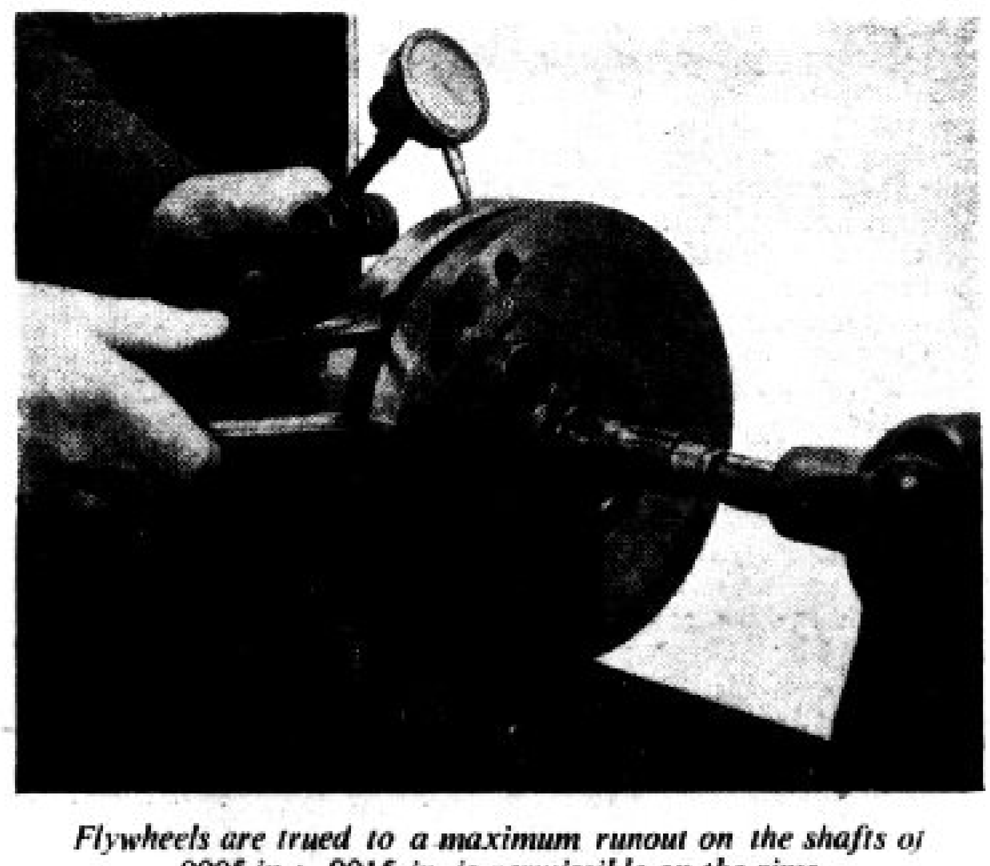
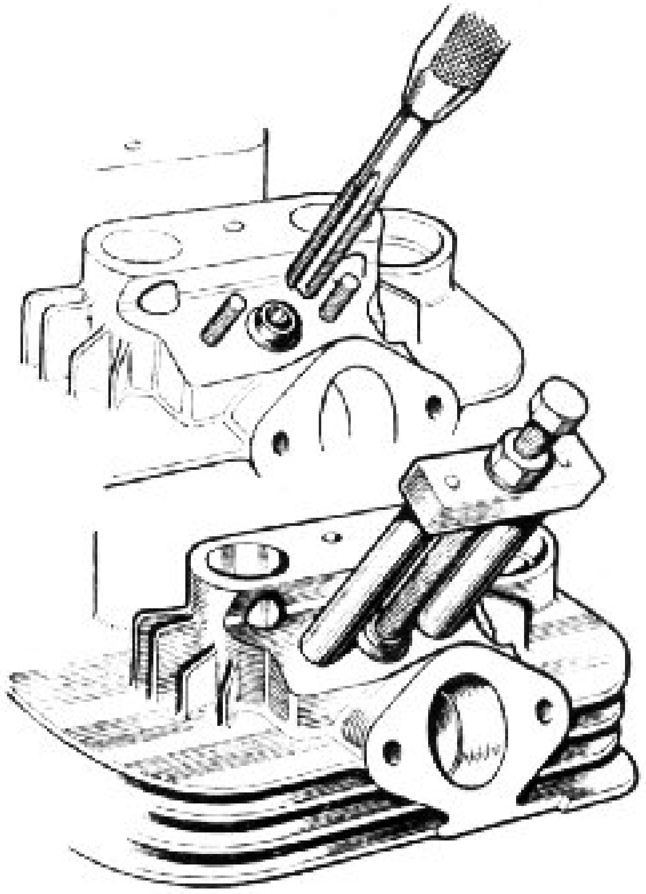
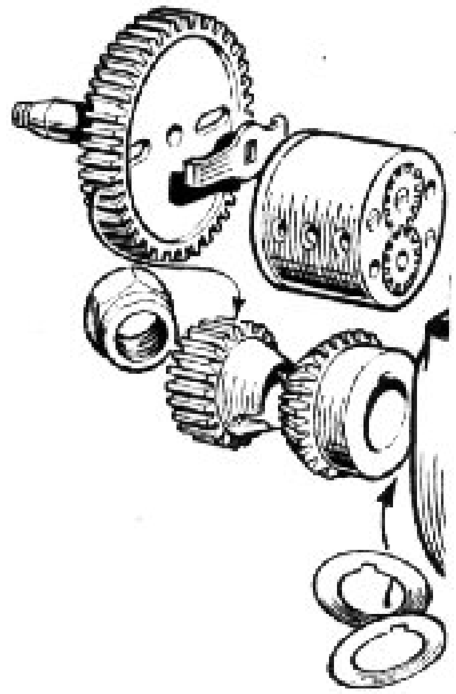


Flywheels are trued to a maximum runout on the shafts of .0005 in.; .0015 in. is permissible on the rims.





(Above) The floating coupling between the oil pump and its gear wheel. (Left) In the upper sketch, a tap is about to be run down the valve guide; below, the valve guide extractor is in position.

Wear is unknown in the working faces of the vertical shaft, so that sloppiness can be rectified only by fitting a new coupling, noting that the two nicks go to the bottom. Stone as necessary.

The final stage is to offer up the steel rubber-cup and bottom housing nut, a copper-asbestos gasket being used between the nut and housing; this gasket acts as a combined oil seal and distance piece. The $1\frac{1}{8}$-in. A/F nut is run up no more than finger-tight at this stage; when the vertical shaft cover is dropped down the barrel tunnel and into the nut, final tightening contracts the oil seal rubbers on to the cover tube.

Before assembling the piston on the rod, the fit of the gudgeon pin must be checked. It must be a free sliding fit when cold in both the small-end bush and the piston bosses. Gudgeon-pin wear is by no means unknown; neither is blueing of the pin and the top of the rod due to heat transfer from the piston. At the "works," new small-end bushes are diamond-bored, in preference to reaming, after pressing-in, so that 95% contact may be obtained. If production limits all go one way, there may be a maximum up-and-down of .001 in.; the minimum is a light push fit. The private owner will be obliged to use a reamer; the sizes are $\frac{7}{8}$ in. on all long-strokes and the short-stroke "40M," and 1 in. on the "30M."

Once used, circlips are never refitted—and the rear of the piston has the larger valve pocket.

With genuine Norton cylinders and pistons, the clearances will be right when new; rigorous inspection ensures that close limits are maintained and it is not necessary to check the sizes of new pistons and barrels, ring widths and grooves, or ring side clearance. Rings are supplied ready gapped. As clearances can only increase due to wear, the table in Part 2 of this article will give all the necessary information for checking ring serviceability; all the other usual criteria apply. All piston parts are fully interchangeable from the spares point of view.

Before the barrel is offered up, it is necessary to regrind the face joint between it and the head; this is done *after* the head has been serviced. Coarse paste is put on the top of the spigot and fine on the joint face, the joint being part-rotated in a small arc around its normal fitted position.

On the long-stroke motors, compression ratio changes may be made either at the piston or at the cylinder base; if many compression plates are used, a thicker Oldham coupling will be required. On the short-stroke motors, only one piston is available for pump fuels and one for alcohol. Moreover, because of the squish head, one cannot resort to variation of cylinder height, though careful "juggling" with plates has enabled changes of up to half a ratio to be made. The normal short-stroke ratios are 9.72 for the "40M" and 9.53 for the "30M," these being suitable for 80 octane fuel in 1956 machinery.

A flat-top piston is used to obtain the squish effect. A land is left proud inside the head and, at TDC, the piston crown almost abutts against this land, squeezing gas into the centre of the chamber even while combustion is in progress.

To allow for flexure in operation and expansion due to heat, a static clearance of .045 to .055 in. at TDC is necessary; this can be measured by depth miking or with plasticine. It is equally important that 1956 engines have a clearance of .260 and .330, $\pm$.005 in., between the piston crown and the exhaust and inlet valves respectively at TDC. Slightly less (.020 in.) is permissible on earlier short-strokes.

The above clearances should be checked when fitting new parts. Too little squish clearance can be obviated by increasing the thickness of the compression plate(s) fitted below the barrel. Once established, the clearance should not be altered. Valve clearances can only be increased by scraping the pockets. (On no account should the piston be lightened.) With the clearances established, the barrel may be fitted, no jointing compound or paper gasket being used between the base and crankcase.

If the bush in which the oil pump gearwheel spindle revolves is worn, it can be renewed by pushing it out and pulling in a new one in a single operation, preferably with the housing warm. After fitting, the oilway is drilled right through and the hole opened out to size with a $\frac{1}{2}$-in. nominal reamer. The bush must be faced down flush with the surrounding magnesium alloy. The job can be improved by a little judicious lapping.

Refettling the Bottom Bevel

The bottom bevel of the vertical shaft works in a phosphor-bronze bush. Access is gained by pulling out the Oldham coupling (usually tight), noting that the lower side has two nicks ground in it. The housing is heated and the vertical shaft ball-race jarred out. When cool, the bevel may be drifted downwards away from its interference-fit collar. Bush renewal should be carried out with the housing hot once more. Drift out the bush from the top, smashing a radial peg in the process, and clean out all debris.

A new bush may be pressed in, and a new locating peg riveted into place. The bore is cleaned-up with a $\frac{3}{4}$-in. adjustable reamer so that the bevel runs freely without sideplay. At the "works," a final lapping with Brasso is standard practice.

Assembly consists of pressing the collar on to the shank of the bevel (between the jaws of a vice) as far as it will go; an old gudgeon pin can serve as a distance piece. The bevel will then be too tight against the flange and should be tapped back the odd thou. so that it is free to spin without hindrance, yet has the minimum possible endfloat. The collar also works in with the Oldham coupling, the bottom half of which is stoned to fit quite tightly after the collar is in position. Long- and short-stroke housings are not interchangeable.

Final assembly consists of inserting the lower vertical shaft self-aligning bearing, there being a dished washer between the bearing and the recess. (If, on swinging the inner through 90°, any balls drop out, the bearing should be renewed.)

Bevel meshing should be such that there is a just-detectable amount of backlash, and yet no binding of teeth too deeply in engagement. Shims of differing thicknesses are available for both the mainshaft bevel and the bottom bevel housing. The inside of the bevel teeth should be approximately level. To time the bottom bevel gears, set the piston on TDC, key the mainshaft bevel to the shaft, and mesh the marked tooth on the bottom vertical shaft bevel with the unmarked mainshaft bevel; only one position can be obtained by following these instructions. A 1957 engine should be timed by setting the piston on BDC before fitting the housing, ensuring that the coupling slot lies in a fore-and-aft position when the housing is finally fitted. On all engines the vertical shaft runs at engine speed.

The top of the lower Oldham coupling is a good, sliding fit in the lower end of the vertical shaft, with no circumferential twist.

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(Concluded)

The Cylinder Head

NO difficulty should be experienced in stripping the head. Standard practice is followed in removing carbon, which should be scraped off only when it is thick. Do not wipe it off when the head is lifted for routine examination.

The first thing to look for on the head is a loose or damaged valve-seat insert, replacement being a "works" job only. If the inserts are fit for further service, check to see whether they are "blurred." Such a condition is one symptom of a worn valve guide. Guide removal calls for the use of a simple extractor (illustrated in Part I of this article), which is screwed into the top of the guide after this component has been tapped to receive it. The guide is extracted upwards after the head has been warmed. New guides are pressed in while the head is still hot, care being taken on the long-stroke engines that the oil holes are lined up. After fitting, the oil holes are then carried right through. It is not necessary to remove the valve-spring retaining plate studs on the short-strokes to renew the guides. The guides are finally cut off flush inside the ports and the ports themselves polished. The private owner is cautioned against altering their volume and shape.

Valve-stem wear or signs of damage from grit on the 45-degree seats (30-degree seats on 1956/7 inlets only) will make renewal imperative. The fresh components should be ground in the customary manner, the minimum possible being done compatible with good seating; only the narrowest of seating land is necessary, provided it is complete through 360 degrees. Late-type sodium-cooled exhaust valves have a greater volume of this readily liquefiable salt, the valve head being partially hollowed out, instead of the stem only, as on the earlier valves.

After the bottom spring plate has been offered up, it is essential that the spring legs should be free to slide when both springs are in position in their grooves; the straight legs may need shortening and the bent ones setting to make assembly possible. "Works" racers have the springs lapped into the spring retaining plate. Fine paste is used, the springs being treated first individually and then together. Assembly is carried out with graphite grease on the plate, the spring coils, and in the valve-stem cup. The cup and the spring top plate are also lapped so that the valve shall be free to rotate in service.

To maintain correct spring tension, it is important that the dimension from the top of the spring plate to the underside of the spring loop should be .660 to .670 in. Shimming is inserted beneath the valve-spring plate when the engine is originally built up and should be carefully replaced or modified as necessary during servicing. The dimension remains constant even when new valve springs are fitted during the course of a season.

To maintain tune, valve springs should be rested, two sets being alternated between meetings. If, after several weeks' resting, any springs have taken a permanent set when checked against a new spring, they should be discarded.

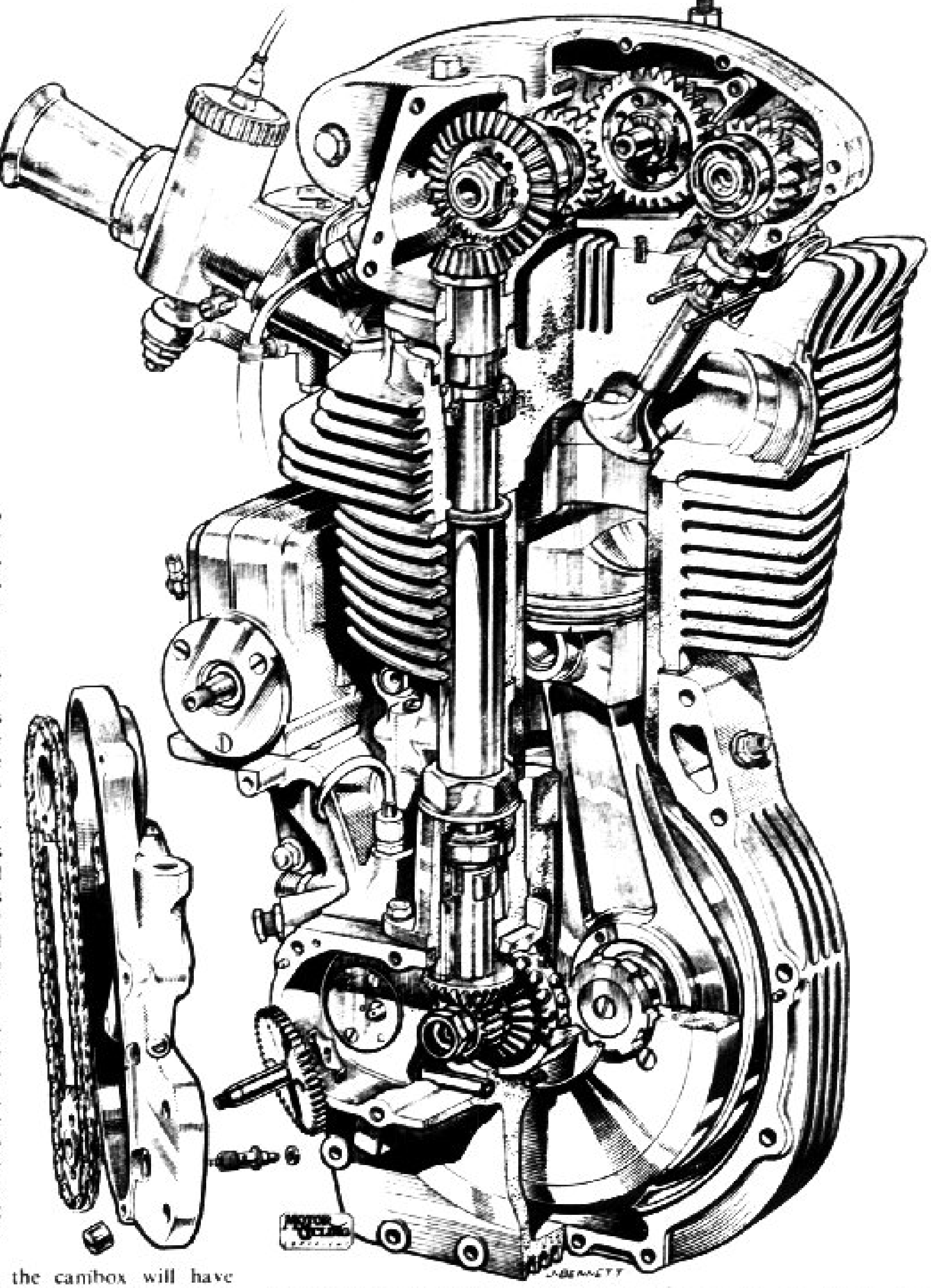
Though valve caps can be fitted at this stage, their final assembly will not be possible until the cam box has been overhauled and fitted. To reduce the number of shims used in obtaining the correct valve clearances, the shims come in three sizes; it is not unusual to find that a shim has disintegrated when an engine is dismantled.

The Cam Box

It is really necessary to dismantle the cam box only partially when the cams are being changed or the valve timing reset (if it is believed to be wrong). Wear on the moving parts is very small indeed and for constructional reasons, certain parts can be serviced only by the makers.

Take off the top bevel housing, the bevel cover and the two locking plates. Undo the nine cover screws and hold the push-rods in position to prevent the cam gear coming out as the cover is with-

Very latest details of the 1957 "Manx" Norton engines—as now being built are revealed in this artist's drawing. Prominent among items of interest applicable to both the 350 c.c. and 500 c.c. versions are the flat-top piston, sodium cooling for both valves (instead of for the exhaust valve only) and the coarse-pitch bevel teeth. However, perhaps the most important modification illustrated is the redesigned crankpin and connecting rod, the big-end eye of which is now sleeved.



drawn. (The term push-rod is applied to the short reciprocating cam-follower.) The cams may be taken out after the push-rods have been dropped, the purpose of the flats is to stop the push-rods rotating under the rubbing action of the cams.

Finally the outrigger plate is released by unthreading three $\frac{5}{16}$-in. and two $\frac{3}{8}$-in. nuts with plain washers. The centre shaft nut has a left-hand thread and its removal frees the bearing, the gear and the distance piece behind the gear, the centre shaft complete with bevel being withdrawn from the opposite side.

Remove the steel thrust washer from the intermediate gear shaft, pick out the rollers and cage, and lift out the gear. Damaged cages must be renewed. Leave the shafts *in situ* unless they need replacement; if they do, they may be drifted out of the warmed box after the nut on the bevel side has been unscrewed. Bearings may be jarred out after immersing the box in boiling water.

It should be necessary to dismantle the camshafts only to fit new parts or set the timing. The cam is located relative to the gear by a vernier adjustment employing a small peg working in an 11- and 12-hole system (see illustration in Part 1). Undo the left-handed camshaft nut and, with the bearing withdrawn from the shaft, slightly raise the cam from the gear so that the peg is partially exposed. Scribe a line to assist reassembly.

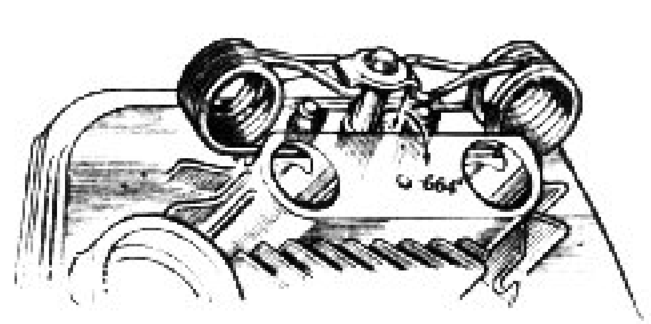
If the push-rod bushes require renewal, the cambox will have to be returned to the "works." Machining is necessary after fitting new bushes and the bushes themselves are lapped to their push-rods with Brasso to get a free sliding fit with the minimum of clearance, so ensuring that oil retention is of a high order. Push-rods are etched with numbers to ensure correct selective assembly.

When reassembling the cambox parts, note that the steel thrust washers have their oil grooves towards the outrigger plate and that all marked teeth are brought into mesh. When the push-rods are slipped up into place, each should be checked for free movement to the extremity of travel; at the same time, there must be a perceptible amount of angular motion. This is controlled by the clearance between the flat of the push-rod and the face of the shaped outer race of the camshaft bearing; .004 to .005 in. would be reasonable. It is measured with a feeler gauge after the camshaft and cover plugs have been removed. (There should be no measurable end float on the camshaft, which must be free-spinning.) • Adjust as necessary by shimming the outside collar of the large nut in the cambox cover. If shims are *added*, it will be necessary to tap the race home. For any shims added or removed, compensation must be made between the side of the cam and the bearing sleeve on the camshaft; this is important as the shims control the end float of the camshaft assembly.

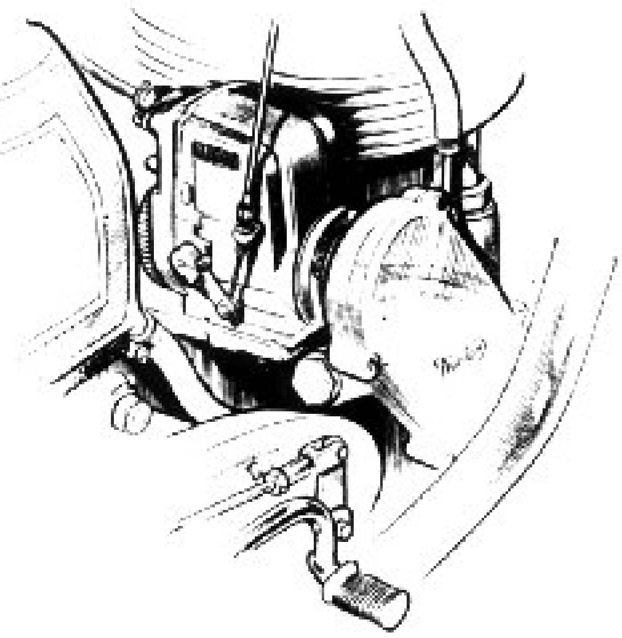
Mesh the top bevels in the same manner as the bottom bevels, and so that the marked teeth are in engagement. Insert the top Oldham coupling with the nick towards the cambox. Place the vertical shaft in position. There is a slightly more prominent collar left proud to take the weight of the shaft on the *bottom* bearing. Many vertical shafts are fitted upside-down because of insufficient attention to this point, with the result that the weight is taken by the lower Oldham coupling, a task for which it was not designed.

Set the engine on TDC and then turn it backwards until the top tongue of the bottom Oldham coupling lies in line with the crankshaft. On the long-strokes, ensure that the cambox distance pieces are in position on the head, rotate the vertical shaft clockwise a quarter of a turn (looking from bottom to top of the shaft) and, holding the box with the bevel side nearest to the engine, enter the shaft into the lower coupling. Swing the box anti-clockwise (viewed from above) into its normal position and fit the retaining bolts, oil feed pipes, and so on. This procedure is specified so that cambox fitting on the long-strokes may be carried out at the track with the engine still in the frame.

Before setting the valve clearances, it is advisable to check the timing. This is done by revising the valve clearances to the figures given in the data panel, and then checking the valve timing. Two



(Left) The all-important spring plate/spring collar dimension that controls the valve spring tension, detailed information upon which is given in the text.



The rotating-magnet version of the Lucas racing magneto fitted to many "Manx" Nortons. Immediately below and to the right of the magneto platform is the hexagonal plug to a gauze oil filter.

methods are used. One is based on degree-plate readings of opening and closing times in the orthodox fashion. The other method, introduced with the 1956 engines, is based on dial gauge readings at TDC and BDC. All necessary information is in the data panel.

Valve clearance is easily reset by depressing the valve with a screwdriver inserted between the cambox and the top collar, removing the valve cap, and changing the shims. Push-rod length is also adjustable by means of three thicknesses of end-caps, removal being effected with the service tool illustrated.

Ignition

When the magneto drive is assembled, and after the timing has been set to the recommended figure, the endless driving chain should be tensioned to ¼ in. up-and-down by moving the magneto on its platform: the chains are of the same length on the two capacities. Apart from seeing that all the working parts of the magneto are clean, and the points gapped to .012 in., no attention is needed between periodic checkovers by the makers, who will ensure that it is kept at peak efficiency.

The chain should be smeared with the correct grease before the outer cover is fitted. In service, oil may find its way in through the bush from the pump housing: there is no objection to this.

Plug, ignition, and carburetter settings depend on the compression ratio, fuel, barometric pressure, humidity and circuit—as well as the rider. Some approximations are listed, but these general settings will have to be modified as close to each race as possible. Valve clearances remain correct for many hundreds of racing miles.

Lubrication

By far the most important lubrication duty is that of servicing the three oil jets. One feeds the big-end, and one each of the two sets of valve gear. These jets must be kept clean. Valve guide lubrication is effected by drain pipes from the cambox to each guide. The exhaust union has a larger bore than the inlet and they must not be interchanged. Many private owners fit clear tubing for the flexible link so that oil delivery may be readily inspected.

The oil should be changed at, say, 200-mile intervals; it is difficult to lay down a hard and fast rule. Do not use flushing oil. For short sprints, the crankcase should be drained.

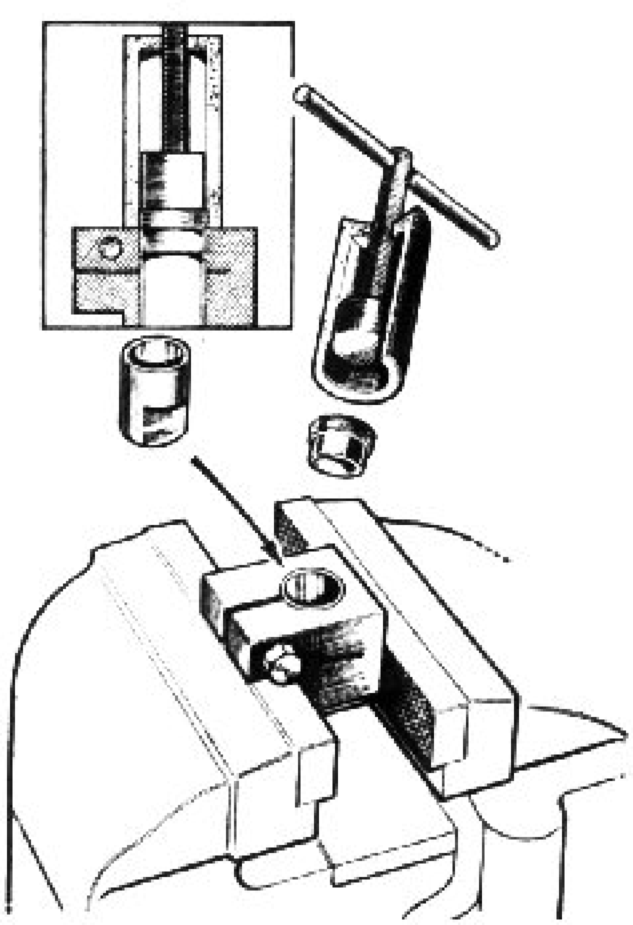
Two filters are incorporated in the circuit. Both are of gauze; one is in the oil tank and comes clear when the drain plug is removed, and the other in the side of the case by the magneto drive. The latter may readily be removed and cleaned as often as desired. (Long-stroke engines have a tank filter only.)

To cut down loss through the drive-side main bearings, late-type engine sprockets have an oil-throwing scroll ground into the periphery of the centre boss. These sprockets can be fitted to earlier short-stroke engines also.

"Breaking-in"

It is recommended that restraint be exercised for the first 150 miles of riding with a new or reconditioned "Manx" engine. At the completion of this "breaking-in" period, any high spots on the piston should be gently eased and the rest of the motor given a general checkover. A Norton "Manx" engine will then be ready for full-throttle work under race conditions.

In our next week's issue will appear advice on preparing the A.J.S. 7R racing model.



A simple extractor for the push-rod endcap; the cap may be removed and shimmed to adjust the rod's effective length.

CAMS AND VALVES, "MANX" ENGINES, 1951—1957 INCLUSIVE
THE NUMBERS QUOTED ARE STAMPED OR ETCHED ON THE COMPONENT

	500 c.c.				350 c.c.			
	Inlet Valve	*Exhaust Valve*	*Inlet Cam*	*Exhaust Cam*	*Inlet Valve*	*Exhaust Valve*	*Inlet Cam*	*Exhaust Cam*
1951 ..	14584	15779	5.9	5.9	7706	7754	3.9	3.9
1952 ..	14584	15779	5.9	5.9	7706	7754	3.9.2	3.9
1953 ..	14584	15779	5.9	5.9	7706	7754	3.9.2	3.9
1954 ..	16530	18496	5816	598	16531	18120	3612	3.99
1955 ..	16530	18496	5816	598	16531	18120	3612	3.99
1956 ..	19102	19104	15822	5914	19482	19105	13817	3916
1957 ..	*20323	19104	15822	5914	*19882	19105	13820	3916

All exhaust valves sodium-cooled
*** Sodium-cooled**

REFERENCE DATA

The "Manx" Norton Series

CYLINDER DIMENSIONS

	Bore	Stroke	Capacity
40M long-stroke:	71 mm. (2.7952 in.)	88 mm. (3.4645 in.)	348 c.c. (21.23 cu. in.)
30M long-stroke:	79.62 mm. (3.1345 in.)	100 mm. (3.937 in.)	499 c.c. (30.45 cu. in.)
40M short-stroke:	76 mm. (2.992 in.)	76.7 mm. (3.0196 in.)	348 c.c. (21.23 cu. in.)
30M short-stroke:	86 mm. (3.3858 in.)	85.62 mm. (3.3707 in.)	499 c.c. (30.45 cu. in.)

DATA COMMON TO ALL TYPES

LUBRICATION

B.P. Energol, SAE 50; Essolube Racer, SAE 60 or Esso Castor Racing; Mobil Oil "D" or "R," SAE 50; Shell X-100, SAE 50; Wakefield Castrol "R."

LEFT-HAND THREADS

Mainshaft bevel wheel nut; cambox centreshaft nut; exhaust and inlet cam nuts.

THREADS

Up to and including ⅜ in. dia. are 26 t.p.i.; above ⅜ in. dia. are generally 20 t.p.i. All threads are to Whitworth form.

JOINTS

Paper gaskets are used where appropriate; all joints are set up with "Wellseal" jointing compound.

VALVE GEAR

Spring loop spring plate dimension: .660/.670 in. Push-rod/race clearance: .004/.005 in.

VALVE AND GUIDE DIMENSIONS

	Inlet	Exhaust
Valve stem dia.:	.3100/.3105 in.	.4022/.4027 in.
Valve guide bore:	.3117/.3120 in.	.4057/.4062 in.

These dimensions are altered for 1957 engines.

CLEARANCE VOLUMES
(Independent of bore/stroke ratio)

Volume in c.c.	C/Ratio 40M	C/Ratio 30M
27	14	—
30	13.5	—
35	11	—
37	10	14
40	9.72	—
42	—	12.5
45	9	—
52	—	10.5
57	—	9.75
58.5	—	9.53
64	—	8.6

PISTON AND RING CLEARANCES

	Long-strokes	Short-strokes 40M	Short-strokes 30M
Piston/cylinder clearance at bottom of skirt	.008/.009 in.	.010/.011 in.	.011/.013 in.
Ring gaps			
Both compression ..	.015/.020 in.	.012/.016 in.	.014/.018 in.
Scraper	.007/.008 in. on all models		
Ring clearances in grooves			
Both compression ..	.0007/.0017 in. } on all models		
Scraper	.0010/.0020 in. } on all models		

VALVE TIMING (DEGREE METHOD)

	1954/5 All-long-strokes	1954/5 40M s/s	1954/5 30M s/s	1956 40M s/s	1956 30M s/s
Exhaust opens BBDC ..	85	94	72	89	82
Exhaust closes ATDC ..	45	70	64	70	64
Inlet opens BTDC	60	82	74	74	70
Inlet closes ABDC	67½	95	94	85	100

All readings to be obtained as accurately as possible.

LIFT METHOD

1956/7 Short-strokes	40M	30M	
At TDC, inlet valve open	.280 in.	.278 in.	(opening)
Exhaust	.160 in.	.180 in.	(closing)
At BDC, inlet valve open	.315 in.	.342 in.	(closing)
Exhaust	.280 in.	.280 in.	(opening)

DATA COMMON TO SHORT-STROKES

PLUGS
Champion NA19; KLG FE290/4 or FE258-2; Lodge RL51.

SQUISH CLEARANCE
Piston crown/cylinder head clearance: .045/.055 in.

VALVE SEAT ANGLE: 45°. (1956/7 inlet: 30°.)

VALVE/PISTON CLEARANCE
Inlet: .330 in. minimum Exhaust: .260 in. min.

IGNITION TIMING
40M: 40° BTDC. **30M:** 35° BTDC

VALVE CLEARANCES
Working clearances: Inlet, .014 in. Exhaust, 0.28 in.
Timing clearances: Inlet and exhaust, .005 in. (On 1956 and 1957 engines use .002 in. on both valves.)

DATA COMMON TO LONG-STROKES

PLUGS
Champion NA19; KLG FE290; Lodge RL51. These may be varied according to the compression ratio in use.

FUELS
An approximate fuel range on the **40M** is:

9 to 10 : 1 c.r.	80 octane
10 to 11	100 octane
13.5 to 14	Methanol

on the **30M:**

8.6 to 9.5	80 octane
9.5 to 10.5	100 octane
12.5 to 14	Methanol

Ratios of over 14 : 1 are unlikely to be obtained because of mechanical limitations. On the short-strokes, fuels and compression ratios are fixed on account of the non-availability of a wide piston range.

VALVE SEAT ANGLE: 45°.

VALVE/PISTON CLEARANCE
Must be correct if valve timing and ratio are in order.

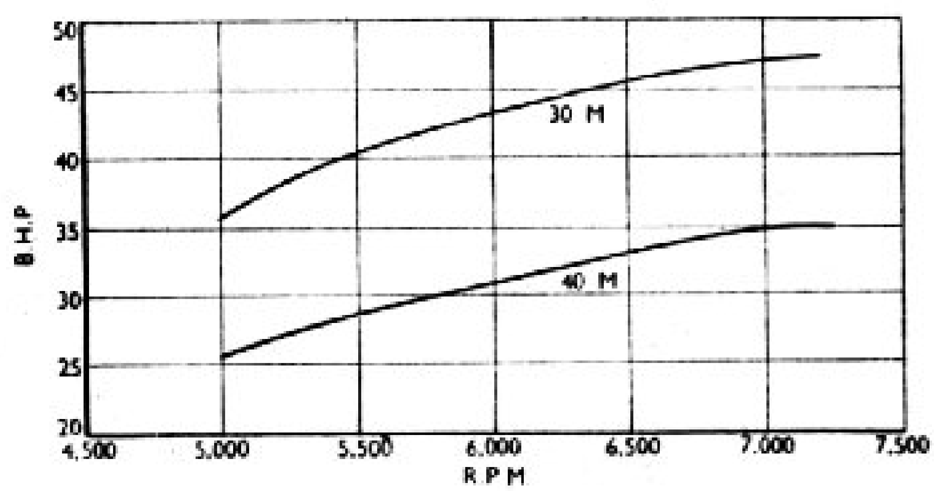
IGNITION TIMING
Both capacities: Up to 10 : 1 c.r.: 36° BTDC.
Over 10 : 1 c.r.: 34° BTDC.

VALVE CLEARANCES
Working clearances: Inlet, .012 in. Exhaust, .024 in.
Timing clearances: Inlet and exhaust, .004 in.

EFFECT OF FUELS ON PERFORMANCE

	B.H.P. 30M (6,000 r.p.m.)	B.H.P. 40M (7,000 r.p.m.)
Pool (70 octane)	36.2	28.5
80 octane, Shell TT, Shell X, Shell Y	37.5	29.5
Shell M	39	32.5
Shell A and 811	40.5	33
Methanol	44.5	34

These figures apply to long-stroke motors; similar variations would be obtained with the higher outputs of the short-stroke motors.



Output curves, based upon data supplied by the manufacturers, for typical 30M and 40M (short-stroke) motors.