**Preparation for Racing**

**Models 30 & 40 International, 30M & 40M Manx.**

**Introduction.**

 The object of these notes is to enable our machines to be prepared with more than usual care and with due regard to the particular features peculiar to the OHC engines. In addition, finer details of tuning are given and it is assumed that all who use this information are technicians who are acquainted with the ordinary routine of motorcycle maintenance and engine tuning. We have endeavoured , as far as it is possible, to give higher technical data of definite use in the preparation of International and Manx machines for racing in conjunction with the present maintenance manual covering these models. The insert numbers refer to paragraphs in the manual.

 Engines fitted to the International and Manx machines are specially built in exactly the same way, by the same men and under the same conditions as our own racing engines. The components are elected from stock with a very much closer viewing than could be applied in ordinary commercial conditions, thus eliminating as far as is humanly possible, any failure when these are used under racing conditions. Selective assembly is undertaken which means that more care and attention is paid to the building of the engine to ensure its absolute freeness and accuracy. On completion each engine is run on the test bench, dismantled and examined and any high spots removed from the piston skirt. Upon reassembly, it is required to develop a certain minimum power before leaving the test house.

 Before passing on to the preparation of an International or Manx engine for racing, it would be as well to enumerate the more important design differences between these engines.

**Crankcase.**

 The Manx crankcase is cast in magnesium alloy having the front engine mounting higher than in the case of the International model. No (oil) tell-tale is incorporated.

**Cylinder Head.**

 The standard International models are normally fitted with a cast iron head but a bi-metal type is available at an extra charge. A large bi-metal head embodying larger valves and ports is use on the Manx machines.

**Piston.**

 A normal slipper type piston in a low expansion silicon alloy is normally used on the standard International machines, whilst a forged type of a slightly different design is employed on the Manx engines. This latter is narrower across the inside of the gudgeon pin bosses.

**Flywheels.**

 The flywheel assembly use in the Manx engine is narrower across the main bearing centres to obtain increased rigidity and is machined to give a slightly lower inertia for a given engine speed. In addition, the timing side bearing is wider, being of a double row ball design.

**Connecting Rod.**

 The Manx connecting rod is broader in section, more heavily webbed around the crankpin eye and narrower at the small end than that fitte to the standard International engine.

**Crankpin Bearing.**

 These are of quite similar design but in the Manx engine the bearing is proportioned to withstand the higher RPM and load factors, it is also dimensionally slightly narrower.

**Rocker Box.**

 In the case of the International engine, the cams are lubricated and the oil controlled by a slotted bush feeding into the cam housing. In the Manx rocker box, oil is fed direct to the cam faces, the supply being metered by a spring loaded bronze jet at the bevel end of the camshaft similar to that which feeds the crankpin bearing via the timing side mainshaft. The cams fitted to these engines are specially suited to the exhaust pipe and megaphone use on the Manx machine.

 A BTH racing magneto is fitted as standard to Manx machines.

 In the case of a new machine either Manx or International, it is strongly recommended that at least a hundred to a hundred and fifty miles are covered before an attempt is made to increase the performance. This will allow all the working surfaces to settle down, at the same time relieving any internal stresses that may have been present.

**Engine.**

 Following removal of the petrol tank, (6) and prior to the removal of the rocker box and cylinder head, it is advisable for future reference to check the following settings:- valve clearance, valve timing, ignition timing and compression ratio. Valve timing should be checked with a degree plate using feelers between the valve and tappet to give 0.004” clearance. The ignition with a 0.0015” feeler between the contact breaker points. For checking the compression ratio, a burette graduate in cubic centimetres will be required. The use of thin cycle oil for this purpose will be found to give the most satisfactory results.

 The rocker box and cylinder head should now be removed (10), prior to lifting the barrel off the crankcase face, care should be taken to ensure that no foreign matte such as a piece of broken piston ring can fall into the crankcases. This can be prevented by locating the piston at the top of its stroke before attempting to lift the barrel and when clear of its crankcase location, the orifice of the crankcase should be covered with a piece of clean rag (22). It is usual at the works to remove the circlip from the piston on the camshaft driving side to ensure it’s refitting the correct way round, marking the inside of the piston skirt at the front will also prove an additional precaution. (Removal and replacement of the circlips can best be undertaken with a pair of pliers having the outside nose rounded and tapered. This will prevent damage to the piston gudgeon pin bore). With a new engine, no attention will be required to the crankcase assembly but where a considerable amount of racing has been undertaken, the flywheels should be revolved by means of the connecting rod (preferably with the primary chain removed) listening carefully for any noises which my arise from the main or crankpin bearings indicating the presence of either foreign matter ora defective bearing. If the flywheels revolve quite sweetly, the next thing is to check the crankpin bearing for wear (26). The connecting rod may have a fair endwise movement, allowing it to be moved sideways through quite a large angle but only a small or scarcely imperceptible amount of up and down movement is permissible. This can only be determined by feel and should be carried out with the crankpin bearing at the top of the stroke, holding the connecting rod in a centralised position.

 Examination of the oil pump (3) is rarely necessary but the feed to the rear of the piston which makes connection at the top of the crankcase space is most important, particularly on the 500cc engines and should be checked thus:-

 Revolve the flywheels in the direction is which they normally rotate and after some fifteen or twenty revolutions, the oil should begin to flow through the holes in the crankcase cylinder face. If this does not occur, the cause is due either to the cylinder feed adjuster screw being set right home or to the bolt assembly requiring cleaning. When reassembling and after fitting the bolt into the crankcase, it is important to tighten the nut on the driving side first in order that the shoulder on the bolt may be correctly located in the crankcase.The approximate setting for the cylinder oil feed adjuster is half a turn from the fully home position (58).

 A further point to check in the crankcase is the oil feed jet to the crankpin bearing (5?). This is situated in the bottom bevel housing cover and connects with the timing side mainshaft. It may be examined by removal of the retaining nut on the outside of the bevel cover. After removing the nut and withdrawing the spring from its housing, the jet may be removed by inserting the tang end of a small file into the outer end of the jet which should be carefully cleaned in petrol, making sure that the restriction hole is perfectly clean. Do not, under any circumstances, attempt to alter the size of this hole. Should the jet seating show signs of wear, the jet should be renewed or faced up in a lathe; the included angle of the seating being 90°, only a minimum of material should be removed to ensure that enough metal remains for further service.

 Unless an engine has seen a considerable amount of racing it is unlikely that the bottom bevels will require any attention. The meshing of thee should be such that there is a slight amount of discernable back-lash all round with the bevels un-lubricated.

 For the remainder of these notes it will be assumed that the engine to be prepared is in a sound mechanical condition and when guidance is required to undertake reconditioning involving dismantling and rebuilding, reference should be made to the manual already referred to.

 Commencing with the piston, carefully remove the rings and lay them aside so that they may be replaced in the same grooves and the same way up as originally. Unlesss the piston rings are obviously worn, damaged, or have lost their tension, there is no reason why they should not be refitted. It is not good practice to fit new rings to an engine immediately before a race where there is insufficient time to allow them to bed down to the cylinder bore. The piston ring to suffer most is the top ring and if this has the same ‘face’ gap as the second ring, when not fitted to the piston, it is reasonable to assume that none of its original tension ha been lost. Unless new rings are being fitted, it is not advisable to remove the carbon from the back of the ring or the bottom of the ring groove (23). While fractured rings are very infrequent, where this has occurred the cause should be looked for. It may be due either to excessive or insufficient side clearance between the ring and the ring groove, a worn cylinder barrel or using a ring not of Norton supply. The top ring should have side clearance of 0.002” and should never exceed 0.005”. Excessive movement of the piston ring will ultimately lead to ring breakage. The side clearance for the middle and scraper ring is smaller than for the top gas ring, as they are not submitted to the same amount of heat, 0.0015 being sufficient. The gap between the side of the piston rings when fitted in the cylinder barrel should be 0.018” to 0.020” for the top compression ring, 0.015” to 0.018” for the second compression ring and 0.008” to 0.010” for the scraper ring. An increase of 0.003” to 0.007” on any of the above clearances of rings that have already been run and bedded down will have very little adverse effect upon performance. In fact such increases in gap clearance are recommended where race starts are made with engines revving for such as a clutch start.To check the ring gap, fit the ring loosely in the cylinder barrel some two or three inches from the bottom of the cylinder bore, insert the piston upside-downinto the top of the cylinder bore and push the ring down until it is approximately 1” to 1.5” from the bottom of the cylinder barrel. Where the gap is insufficient the ring must be filed very carefully with a flat smooth file at the correct angle until the required clearance is obtained.

 Careful examination of the valve recesses in the top of the piston face should be made to determine whether these have been marked by contact with the valves. Where this ha occurred it will be due to using a fairly high compression ratio, over revving either in the gears or through under-gearing, incorrect valve timing, or using valve springs which have lost their normal working tension. Deepening of the valve clearances in the piston is not recommended, owing to the liability of piston failure resulting from the reduction of section between lower edge of the access and top piston ring groove, particularly in the case of the inlet side. Removal of carbon from the top of the piston should be undertaken carefully with a piece of hard copper shaped as a scraper to avoid damaging the polished surface. With forged pistons ‘high spots’ on the thrust faces are very unusual, but should they be observed, as may occur with a new piston, removal should be made with an extremely fine file. Emery cloth should not be used. All Norton forged pistons are machined to allow for expansion under normal racing conditions but any tendency to hard bearing on the extreme edges of the thrust faces as may occur under arduous racing conditions, should be removed as described above. It is at these four positions that any tendency for a piston to tighten up will occur.

 Piston clearances for racing are most important and while an engine may have been carefully run in, it is a wise precaution to check them. With the piston in the cylinder barrel, check the clearance by means of narrow blade feelers (these conform to the circumference of the cylinder more readily and minimise false measurements). The correct clearances are:-

 **Cast Iron Barrel.** **Aluminium Barrel.**

 348cc 490cc 348cc 499cc

Bottom of Skirt 0.007” 0.006” 0.008” 0.008” or 0.018 Max

 0.008” 0.007” 0.009” 0.009” or 0.019 Max

Top of Skirt 0.012” 0.009” 0.011” 0.014” or 0.024” Max

 0.013” 0.010” 0.013” 0.016” or 0.026” Max

 Do not use undue force with the feelers as distortion under pressure will occur and an incorrect reading will be obtained. Clearances smaller than those quoted must be increased. This calls for the careful use of a fine flat broad faced file, always remembering that the clearance must be slightly more at the four corners of the thrust faces as previously mentioned.

 The ring lands above the scraper ring are relieved sufficiently during manufacture and no alteration will be necessary here. In the case of a piston that has seen a considerable amount of racing, it will be observed that the ring lands commence to make light contact with the cylinder bore. This is in no way detrimental other than indicating that the piston clearance at the thrust face and that the piston rings may need replacing. Piston to barrel clearance up to 0.010” in excess of the above dimensions are permissible providing there is no over-oiling of the combustion chamber or the engine is not being used on alcohol fuel, as owing to the greater latent heat of alcohol, the piston does not reach its normal expansion so readily and dilution of the oil by the fuel rapidly occurs. Whilst both types of piston cast and forged, are extremely reliable, it is as well, where considerable racing has been indulged in, to examine closely the gudgeon bores for signs of cracking and where this is found, the piston should be discarded.

 The gudgeon pins are accurately ground to a high micro-finish and should be a hand push fit in the piston bosses. The fit of the gudgeon pin in the small end bush must not be by any means tight, a minimum clearance of 0.0015” to 0.002” on the diameter being necessary. No attention will be necessary at this point unless the clearance exceeds 0.005”. It is a wise precaution to renew the gudgeon pin circlips each time the engine is dismantled or where racing or practicing has exceeded 250 miles. Care should always be exercised when fitting the circlips to avoid permanent distortion and consequent loss of tension.

 Prior to fitting the piston, a small quantity of engine oil should be poured over the crankpin bearing, particularly when the crankcase has been flushed out, a practise that is not too strongly recommended, it being far better to remove the crankcase drain plug whilst the engine and oil are hot as at the end of a race meeting. It is obviously importantto remember to replace the drain plug before the engine is used again.

 Following re-fitting of the piston to the connecting rod, attention should be paid to the cylinder barrel. Carbon at the top of the barrel should be removed carefully with a blunt penknife taking care not to damage the surface. The fit of the cylinder barrel and cylinder head faces is a very important item and should the narrow face of the cylinder barrel show signs of excessive blackening (carbon) indicating an annular gap, it will be necessary to lap the head and barrel together in the following manner:-

Two grades of carborundum paste – fine and coarse – are required. The coarse being applied to the lower and broad face of the cylinder barrel and the fine to the narrow spigot face. With the head inverted and held firmly on the bench, the barrel should also be inverted and fitted in position looking down the bore as a guide to avoid transferring any of the coarse carborundum paste to the narrow seat face. Using a moderate pressure, the barrel should be rotated backwards and forwards approximately 1½” – 2” until all four faces indicate that they are evenly lapped. The use of fine and coarse carborundum compound ensures that the narrow face will have slightly higher unit loading than the broad face thereby providing a more reliable gas seal.

At the conclusion of this work, the cylinder barrel should be thoroughly washed, for preference, first in clean paraffin and then rinsed in petrol. When thoroughly dry and assuming that no adjustment to the compression ratio is required, the bore should be smeared with oil and re-fitted over the piston to the crankcase. Care should be taken during this operation to avoid breaking the piston rings; replacement will be made easier if a slight rocking motion of the cylinder barrel is made with the piston at the top of its stroke.

**Cylinder Head.**

 First remove the carbon from the inside of the cylinder head and for this operation the valves should be in position as they form an effective shield for the valve seats and prevent them from being damaged. The carbon should be removed with a blunt scraper and the inside finished off with very fine emery cloth. Polishing the combustion chamber and ports will delay the formation of carbon and in the case of the inlet port, material, will assist volumetric efficiency. Care must be taken not to deface the valve seats, as during this operation the valves will not be in position. It is essential that everything in relation to the valves and their seats is in good order.

 Valve stems and sides should be examined, only a small amount of wear of the stems or guides is permissible where the race contemplated is up to or over 200 miles in length. In addition to the clearance normally present between the valve and guide which, in the case of the exhaust is 0.005” to 0.006” and the inlet 0.003” to 0.004” wear up to 0.006/7” for the exhaust and 0.004/5” for the inlet should not be exceeded. Where valve guides are worn above these dimensions, they should be replaced (14).

 The valve seats in the head should now receive attention and where they have sunk and are recessed, it will be necessary to remove all metal masking the outside diameter of the valve seating either with cutters or scrapers, an operation which demands great care and patience but which will be well repaid in improved performance. The same remarks apply to any ‘ridging’ of the seat at the inside diameter of the port. It is essential that when a new valve guide is fitted the seat be re-cut to ensure concentricity of the valve seat and its guide.

 In the case of bi-metal heads, great care should be taken only to remove the minimum amount of metal during re-cutting of the seats bearing in mind that any ‘pocketing’ effect arising from the re-cutting will impair the efficiency of the head. The valve seats in bi-metal heads do not have the same tendency to pitting and distortion as those of cast iron heads and it will be found that normally they only require cleaning up between races. Coarse grinding compound should not be used for grinding in valves on these heads, a fine compound being quite sufficient to obtain a first class seating, finishing off with a good grade metal polish (13). It is well to point out here that where sunken valve seats are cleaned up and new valves fitted, the valves require shortening a corresponding amount in order to obtain tappet clearance. This should be done by removing metal from the top of the valve stem preferably by grinding.

 On completion of grinding in the valve (13) the inlet seating in the head should be 1½ - 2mm’s wide and the exhaust 2-2½mm’s. Thorough cleaning of the head and the valve should be made prior to re-assembling, not overlooking the removal of burnt oil in or on the cylinder head finning. This can be responsible for a substantial increase in engine temperature.

 Removal of the valve springs should be made at frequent intervals, 500 racing miles being an average life. It is quite easy to detect when used springs have ‘settled down’ by placing them on a flat surface and comparing with a new one, the height of that part of the spring which engages in the valve spring collar plate. Variation of this dimension will mean a variation of tension when the springs are in position and a spring which has taked a permanent set should be renewed. It is strongly recommended that valve springs should be replaced in pairs rather than run a new spring with a used one.

 The oil feed holes to the valve guides in the cylinder head should be checked to ensure that they are clear following which the valves should be re-assembled, lubricating the stems and seatings with the engine oil normally used (13). Before assembling the valve spring top collars and top collar platesto the valves, they should be examined and any burrs or rough edges removed from the working faces. The upper face of the collar plate should be carefully polished with a medium grade emery cloth on a flat surface. The correct mating of the two faces of these components is very important in order to encourage the valves to rotate during running. This rotation obviates local distortion of the valves and assists in keeping them at an even temperature. Normally rotation sets in at or near peak R.P.M. During assembly of the top collar plate and valve collar, high melting point grease should be employed on the working surfaces including the hairpin spring anchorage. After fitting the valves and springs, the spring tension should be checked, a gap of 17/32” to 9/16” should exist between the upper side of the bottom valve spring collar and the underside of the spring where it is located in the top collar plate (14). Where the gap exceeds these figures, the valve spring bottom collar should be adjusted with packing shims. Re-assembly of the cylinder head to the barrel can now be carried out making sure that the four steel washers in the head recesses are in position. No jointing compound should be used on the head and barrel faces, it being only necessary to ensure that they are perfectly clean. Tightening the sleeve nuts should be carried out in stages evenly at the opposite corners in turn (13).

**Rocker Box.**

 Normally, this assembly needs little attention until a considerable mileage has been covered. It might be as well to explain the potential differences between the International and Manx engines. In the case of the former, oil is fed to the housing via an oil way leading to a tunnel containing an externally slotted bush rotating with the camshaft, the amount being controlled by the slot passing the oil feed hole once every revolution. With the Manx type rocker box, oil is fed and metered through the spring loaded bronze jet into a drilled camshaft (in the same way as the crankpin is lubricated) and hence direct to the cam faces which are both drilled on the lifting side. Where inspection or attention is required internally, this may be carried out by removal of the panel cover (16). In ordinary circumstances the rocker box requires dismantling only for one or more of the following reasons; - excessive oil loss from the rocker locations necessitating replacement of the corks and felts or rubbers, (note:- engines produced since 1946 are fitted with oil retaining pads of canvassing inserted rubber and rockers fitted with modified end plates to the central boss), replacement of worn rocker cam pads or meshing of the top bevels.

 If the cams have to be removed, the nut on the end of the camshaft adjacent to the roller bearing has a left-hand thread and it will be noticed that when the cams are taken apart, they are located relative to each other by means of a small roller; the cam sides are drilled so that a vernier adjustment is available between the individual cams. This enables the position of each cam to be adjusted so that the timing can be set as required (19). When refitting the rocker box to the engine (15), it is essential to check that it stands squarely on all four cylinder head holding down sleeve nuts and any error present must be corrected by facing down the high sleeve nut faces.

 Whenever the rocker box is removed from the cylinder head, it is necessary to check the rocker to valve clearances. For racing, the correct clearance to employ is 0.025” for the exhaust valve and 0.012” for the inlet valve, measured when the engine is cold.

**Valve timing.**

 All engines are of course, correctly timed before being dispatched from the works, but in the case of the standard International models the timing will be set for use with a silencer and should be adjusted to the following figures by advancing the inlet cam by 10 degrees:-

Inlet Valve opens 57.5° BTDC

Inlet Valve closes 60° ABDC

ExhaustValve opens 80° BBDC

ExhaustValve closes 42.5°ATDC

 Manx type machines should already give this reading which will only be accurately obtained when the rocker and pads are unworn. Where complete re-timing of the cams is necessary the following procedure should be adopted:- fit a degree plate to the engine mainshaft, locating the zero with the piston at top dead centre. Having removed the cover from the rocker box bevel chamber, unscrew the hexagonal nut – right-hand thread – which locks the bevel in position on the camshaft. This will enable the peg which locates the bevel to the camshaft to be removed. Revolve the engine forward to the position where the exhaust valve should commence to open – i.e. 85° BBDC – rotate the camshaft by means of the fingers in an anti-clockwise direction until the exhaust cam contacts the exhaust rocker. As the locating shoulder on the camshaft has eleven holes and the bevel twelve holes, it will be found that the locating peg can be inserted through both components where two holes coincide. Replace the nut locking the bevel and check the opening and closing points of the exhaust cam, repeating the procedure as required to obtain the correct timing. This vernier adjustment gives crankshaft movement of approximately 5° allowing timing to be reasonably accurately obtained.

 As previously mentioned the inlet cam is located to the exhaust by means of a small roller connecting the two cam faces. They are also drilled with eleven and twelve holes, respectively giving a micrometer adjustment similar to that already mentioned. By inserting the roller into the appropriate holes, the required setting for the inlet cam can be made. The usual combination of holes is (counting anti-clockwise for the exhaust and clockwise for the inlet);-

 Exhaust No. 5. Inlet No. 1.

 ᶥᶥ No. 6. ᶥᶥ No. 2.

 ᶥᶥ No. 7. ᶥᶥ No. 3.

 The timing quoted is measured when there is a clearance of 0.004” between the rocker adjuster and the valve, using feelers to determine when the cams are opening and closing the valves. Re-assembly of the rocker box should be carried out as described at (19).

**Magneto.**

 For racing purposes we have found the B.T.H. instrument most suitable and it is fitted as standard on Manx and International models used for racing purposes. Obviously, when a magneto of this type requires attention it is a specialised job. There are, however, one or two details to which we would refer in order to obtain maximum efficiency. Every 500 racing miles, the pick-upbrush assembly should be carefully removed and washed in petrol. At the same time, the slip ring should be wiped with a clean piece of rag moistened with petrol. Before replacing the brush assembly, care should be taken to ensure that the petrol is thoroughly dried out. The contact breaker should be removed and cleaned of any carbon dust and oil, only the merest trace of machine or cycle oil is required on the cam track wick which is provided for this purpose. Normally, the contact breaker points need only slight polishing which should be undertaken with a super-fine Swiss file, exercising care not to alter unduly the slight convexity of the contact face. The correct gap between the contact breaker points is 0.012”. It is important that the small clip over the rubber sleeve covering the cable adjuster to the contact breaker housing is sufficiently tight to prevent the ingress of oil; this is the point at which this can occur.

**Lubrication.**

 The lubrication system employed on these machines requires little attention other than that already referred to. It is designed to supply the correct amount of oil to the various working surfaces and the only adjustment that can be effected is the rear feed to the cylinder barrel, no other adjustment whatsoever is provided (5). The oil pressure throughout the engine is controlled by a spring loaded ball release valve which is situated behind the magneto chain cover, the screw which controls the adjustment being identified by the fact it has a slot as well as a hexagon head. If the adjustment has been inadvertently altered, it will be necessary to adjust the oil pressure as follows:-

A connection should be made in the pipe that conveys oil from the crankcase to the rocker box connecting a pressure gauge to a ‘T’ piece so that oil passing to the rocker box is not restricted. The correct pressure is 8 lbs when the oil is warm and 10 – 12 lbs when cold. It is preferable to set the pressure when the engine oil is warm. To increase the oil pressure the hexagonal and slotted head screw should be screwed inwards (clockwise) and vice versa to reduce pressure. The pressure adjusting screw should be re-locked with the small nut provided. Should no suitable pressure gauge be available, the pressure will be approximately correct when the adjuster is unscrewed from its fully in position between 2½ and 3 complete turns (5).

 Obviously it is necessary to use a good quality oil and in these notes we cannot emphasise this too strongly and the brand chosen should be rigidly adhered to. The most suitable lubricant for racing is one having a castor base and we have found Wakefield’s Castrol ‘R’ most satisfactory. It is recommended that the oil tank be drained and re-filled between each race meeting; it is not, however, recommended that the oil tank be flushed out with petrol or a similar fluid during the oil change unless the tank is removed from the machine and thoroughly cleaned out.

**Carburation.**

 Three types of carburettors are used for racing, the track or ‘straight through’ type, the 10TT needle and the remote needle. The track type carburetter is primarily used where maintained full bore work is being undertaken usually using alcohol fuel. Whilst this instrument has been used in the past for road racing on petrol/benzol, its uncontrollability in the lower throttle range is a great disadvantage when compared with the TT and remote needle instruments.

 The carburetter fitted to the International machine is the 10TT type and is matched to the port diameters valve sizes and cam contours employed in the engine. The remote needle is essentially a road racing carburetter fitted to the Manx machines subsequent to 1938, the engines of which have been modified to obtain the optimum results from these instruments. Briefly, the main difference between the 10TT and the R.N. carburetter is that in the former, the throttle needle is situated in the main choke wherein, the R.N. instrument it operates in a separate chamber outside the main choke, thus giving an unobstructed flow through the carburetter.

 In both types of carburetter, the carburetion is controlled from slow running to full bore in four phases:-

1. Starting and slow running by a taper needle control.
2. From slow running to quarter throttle by throttle valve cut away.
3. From quarter throttle to four fifths throttle by taper needle and needle jet.
4. Full throttle by main jet.

The method of tuning these instruments is identical and should be carried out in the following sequences:-

Firstly set the slow running by means of the knurled pilot adjuster needle situated outside the carburetter main body immediately in front of the throttle housing (\*\*). To enrich the mixture, the adjuster should be unscrewed i.e. anticlockwise and vice versa to reduce. A setting should be obtained that will give good starting and blend with the throttle cutaway when opening up.

Next the throttle cutaway should be determined. Normally a No.6slide in the 10TT carburetter and a No.5 in the R.N. give a very good opening up phase on to the throttle needle (85).

Having obtained the required starting and the initial opening up phases the main jet size should now be determined. For this work the machine should be taken to a suitable stretch of road or venue where full throttle can be used for at least 20 seconds using the following procedures:-

At the end of the full throttle run – noting the maximum R.P.M. – the throttle should be snapped shut at the same time completely withdrawing the clutch and applying the brakes (it is advisable to avoid prolonged coasting with the clutch withdrawn to avoid overheating the clutch withdrawal mechanism) allowing the engine to slow down and stop. It is most important not to let the engine turn over or fire after the ‘chop-cut’ (the term used for this procedure in racing circles). What is required is an indication of engine operating conditions at full throttle i.e*.*(The rest of this section is illegible – the following is taken from P.E. Irving’s Tuning for Speed). *If the spark plug has the appearance of polished ebony then the mixture is correct. If it is grey or a lightish colour then the mixture is too weak and a larger jet is required.If the spark plug is heavily coated in soot then the mixture is too rich and a smaller jet is needed. Modern plugs with ceramic insulators are less easy to read than the now obsolete mica patterns. The former exhibit a rather harsher-looking brown colour with a correct mixture rather than the ebony of the mica type, but in either case, any suspicion of greyness on the electrodes or body is a sign of weak mixture and the jet size must be increased..*

**Mainshaft Bearing Re-fitting.**

 Gently warm the crankcases and push the bearings into position. The shielded side of the timing side bearing should be at the bottom of the housing. On the driving side the roller bearing is fitted next to the flywheels. Note that there are distance pieces between the inner and outer races of the two bearings fitted on the drive side. Fit retaining plates and solder over the screw heads. Lubricate the bearings.

**Oil Pump and Pressure Release Re-fitting.**

 If possible obtain a ¼” diameter x 26tpi threaded stud 2” – 3” long and screw this into one of the pump securing holes at the bottom of the pump housing, Gently warm the case, pass the stud through the appropriate hole in the pump body and push the pump into position. The driving shaft should lie towards the right hand side of the pump. Fit securing screws.

 Before fitting the pressure release valve, lie the ball (7/32” diameter) in the bottom of the hole in the crankcase and give it a sharp tap with a brass punch. This will ensure a good seating. Fit spring, adjusting screw and locknut and adjust 2½ - 3 turns back from the fully home position or to use the same position as originally set.

**Assembly of the Crankcase Halves.**

 Fit 0.005” packing shim to timing side mainshaft. Fit flywheels into case, fit and tighten bolts. Check connecting rod small end is central in the crankcase mouth. The side float of the connecting rod on the crankpin should be taken into account when checking. Fit any further shims necessary to centralise the connecting rod. This should be re-checked when the timing side mainshaft nut is tightened up. Pour a little oil over the big end.

**Bevel Chamber - Re-assembly.**

 Fit packing shims, bevel and half time pinion to mainshaft. These fit on a common key. Fit and tighten mainshaft nut left-hand thread. If new bevels have been fitted it will be necessary to fit the bottom bevel housing and re-mesh the bevels. These should be free to rotate with just perceptible backlash all round and should be so meshed that the inside of the bevelled teeth be approximately level. Place oil pump driving plate on end of pump shaft in vertical position, fit half-speed gear and big end oil feed jet and spring to bevel chamber cover. Fit paper washer and check that oil way joint face is clear. Fit and tighten cover, check end float in half-speed gear shaft and shim up as necessary. Complete re-assembly as previous paragraphs.

**Track Type Carburetters.**

 Whilst the track type carburetter is not commonly used thee days, for some who prefer to use this instrument the following settings will be of guidance:-

 Using Pool or 50/50 petrol-benzol mixture:-

 490cc 350cc

 Throttle Slide No.12. No.12.

 Main Jet 480/520. 400/420. (Jets having no bleed

 hole should be used).

 Using Alcohol:-

 Throttle Slide No.12. No.12.

 Main Jet 1100/1300. 900/100.

 As the correct carburetter settings for any given event and locality are subject to many variations such as barometric pressure, humidity, temperature, varying altitudes, duration of the event, etc. it is essential for the rider to determine the accuracy and suitability of all settings contemplated by the method previously described, preferably at the lowest altitude and location of the event

**Compression Ratios.**

 Pool 50/50 Alcohol

30 Iron Head 7.22 7.5 11.5

40 iron Head 7.33 7.75 12.5

30 Alloy Head 7.22 7.5 11.5

40 Alloy Head 7.33 7.75 12.5

30M 7.22 8.9 13

40M 7.33 9.1 14

**Exhaust System.**

 As the type of exhaust system employed exerts a great influence upon carburetion and volumetric efficiency, it will be found that the most suitable exhaust pipe length to use on the International engine is a straight through one terminating at the rear wheel spindle. Such a length of pipe will give a high power output in the lower R.P.M. range without sacrifice of power at full throttle/maximum R.P.M. – conditions ideally suited to short circuits.

 The above applies equally to Manx engines, a very small loss of power occurs at at full throttle, this is more than compensated by the improved lower R.P.M. power obtained as is often required on a short twisty circuit.

**Ignition Timing.**

 On Model 30 engines 40° advance, and on Manx engines 37½° will be found to give a satisfactory all round performance.

 Norton engines are sensitive to ignition settings, particularly when using pool fuel. It is therefore recommended that following an alteration to compression ratio, type of fuel and carburetion settings, tests be made at full throttle, manipulating the ignition leverand noting the R.P.M. readings, re-setting the timing as required.

**Sparking Plugs.**

 For warming up purposes:-

 K.L.G. FE220 718c.L.R.

 Racing.

 K.L.G. 689 (Road racing, Pool and 50/50).

 K.L.G. 646. 590. (Alcohol).

 It is advisable to use a new or reconditioned plug for each event.

Note:- Do not under any circumstances clean sparking plugs having a mica insulation by sand blasting – it is strongly recommended where convenient to return them to the makers.

**Gearbox.**

 Generally speaking this does not require attention being a mineral oil such as Castrol XL. The box should be filled until the oil level is half way up the filler orifice (grease should not be used in these gearboxes). The clutch plates should be examined occasionally - replacing any plates that may have become distorted through overheating. Plates with inserts should only be washed in Benzol or Alcohol. Under no circumstances must paraffin be used.

 Adjustment of the clutch should be that the clutch lever has the maximum amount of free movement whilst it is still possible to push the machine in gear with the clutch fully withdrawn.

**Gear Ratios.**

 Like carburetion, this is a matter which can only be determined by experiment, and depends on the type and length of course over which a particular race is held.

 It should b the aim to keep the engine as near possible to its peak revs in top gear on the fastest stretches, bearing in mind that the lower the gear ratios employed the higher the engine R.P.M. for a given speed, in addition to reducing mechanical reliability.

 In a race where one is pushed, the gear change should be made when peak revolutions have been obtained, this applying particularly to the gear change from 3rd to top. There is often a tendency among less experienced riders to change too early from 3rd to top. It is a fairly general statement to make that any damage sustained to the engine in the gears usually occurs in bottom gear, less frequently in second, and very infrequently in third, and of course, top gear, if suitably chosen, prevents the engine from revving excessively. On the other hand, if one has the lead in the race and wishes to ease the engine slightly, the usual procedure is to make the gear changes a little earlier.

**Tyres.**

 Tyre pressures have a very large bearing upon the controllability of the machine and correct pressures are therefore very important.

 The following recommendations are made:-

 Rigid Frame and Girder Forks . Front 19lbs Rear 21lbs

 Spring Frame and Girder Forks Front 20lbs Rear 24lbs

 Spring Frame and Telescopic Forks Front 21lbs Rear 24lbs

 There is no Royal road to success in connection with motor cycle racing, any more than in other types of sport. There are no secrets of tuning that we are anxious to retain; you will appreciate the it is very difficult to explain to the uninitiated the whole of the details of preparing a machine for successful racing, but we have endeavoured in the foregoing to give you as comprehensive details as possible.

**Sundry Notes.**

 Recommended gearbox mainshaft end float – 0.008” – 0.010”.

 Fairing of the inlet guide in alloy heads is not recommended owing to rapid deterioration of the valve seat arising from accelerated wear.

 It is necessary to check the vertical shaft has sufficient up and down movement when raising the compression ratio by removal of compression plates.

 Always investigate any loss of complete freeness in the engine, gearbox (all gears) and wheel bearings, etc. – quite a lot of power is absorbed for instance, by a rubbing brake shoe.

 Always keep chains adjusted and adequately lubricated.

 Make sure that the gearbox top and bottom securing bolt nuts are adequately tightened, not overlooking to turn the gearbox adjuster bolt anti-clockwise after tightening the top and bottom securing bolt nuts.

 Use only genuine NORTON replacement arts.

 On Manx engines do not interchange the main oil feed jet to the main shaft with that in the rocker box – they have different oil flow orifices.

 Always check the oil circulation – the return flow is visible through the oil tank filler orifice.

 Keep the data book of all settings, etc., used at each race meeting, test etc. They will prove invaluable at a future date.