Whys and Wherefores

Looking Behind the Scenes to Learn How the Character of an Engine is Decided by, and Developed from, Certain Essential Considerations

OF recent times the entity of any complete car embraces such a diversity of intricate mechanical features that it has become impossible to describe within reasonable space the finer points of any one item when dealing with a new model. And yet the reasons underlying the detail work of the design of every single component are of absorbing interest to those who find pleasure in the study of mechanism. From the humble nut and bolt up to the largest cylinder block, every part of the car has been a task of careful study to some expert, for in these days when manufacturing cost is of prime importance, not one ounce of metal, no single operation of machining, and especially no single stroke with a file, is employed if study can show how to dispense with it.

It is with enthusiasm for an immensely interesting study that I am now taking the opportunity to attempt to present some of the reasons—I almost wrote "secrets"—which lie behind the detail design of a modern engine, and I hope that, with me, you will be impressed by the thoroughness of the work which goes on behind the scenes. There is no guess-work nowadays in design; only hard work, patiently performed by men of brains who seldom appear in the limelight. I suppose there is hardly a designer of note who does not regularly take his problems to bed with him.

Designer Always Ahead

When one starts to delve into the design of a current type of component such as an engine, the first small obstacle to surmount lies in the fact that what may be more or less news to the layman is old history to the designer, whose mind is busy on his present problems. At the tail end of 1939 in normal circumstances he is working on the components which should appear in 1941. The 1940 plans would be all finished. This advance work is necessary because production takes a long time to change over, due to the interweaving of so many items. Every designer worth his salt is, however, an enthusiast, if usually an exceedingly sceptical enthusiast, and therefore can be encouraged to come out of his shell in response to questioning.

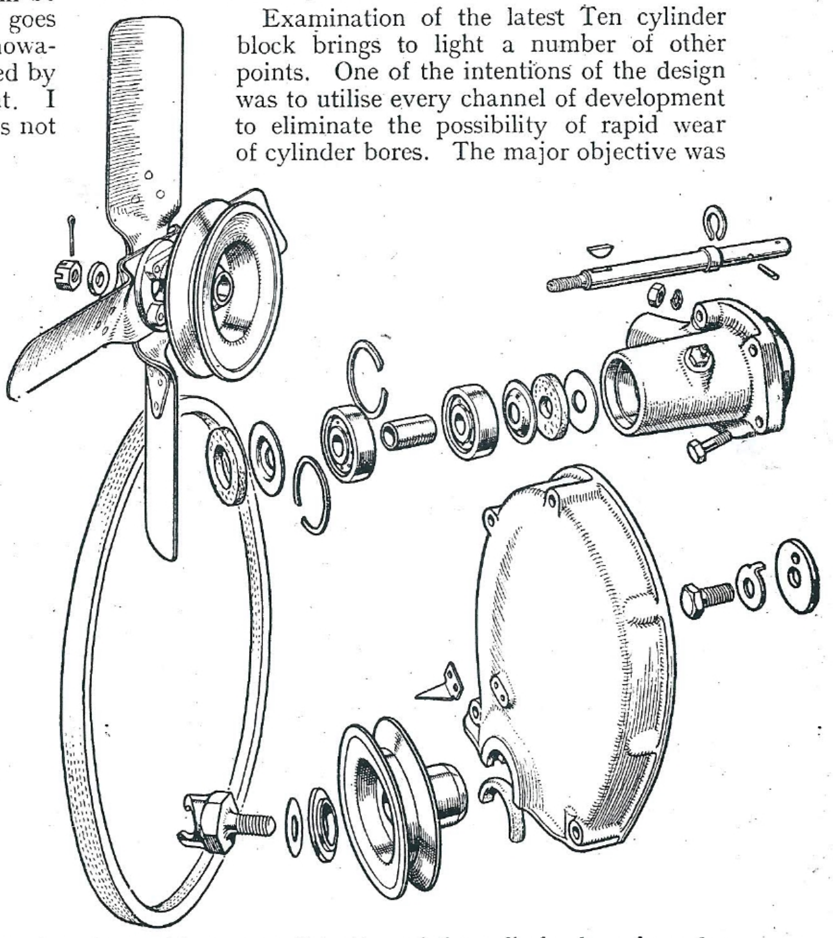
On this occasion the ball was set rolling in the Engineering Department of the Morris Engines Branch when I made this observation: "The Morris Ten engine, Series M, is one of the latest Morris designs in production, and I notice that it differs in a good many respects from other Morris types. For one thing, the ratio of the stroke to the bore is smaller. It is relatively a short-stroke engine. What precisely is the reason?"

This touched on a very pertinent question—one, in fact, that controlled the whole design of the engine. When this engine was requested a major point was that weight must be saved—a lot of weight. To save real weight is a big problem; something drastic has to be done. And one obvious way to do it is to shorten the stroke, for a short stroke means shorter cylinder barrels, a smaller crank chamber, and shorter throws on the crankshaft. Within reasonable limits there are certain definite advantages in a short-stroke engine.

To illustrate the differences between the characteristics of the Series M engine and the earlier type known as the Series III, the following brief table is set down. It shows the saving in weight—this includes clutch and gear box—and the reduction in weight per brake-horse-power, the higher h.p. per litre, etc.

	Series M	Series III
Rating	9.99 h.p.	9.99 h.p.
Bore	63.5 mm.	63.5 mm.
Stroke	90 mm.	102 mm.
Capacity	1140 c.c.	1292 c.c.
Compression ratio	6.5 to 1	6 to 1
Weight of complete unit	363 lbs.	426 lbs.
Lbs. per b.h.p.	9.2	11.5
B.H.P. per litre	34.5	28.6
Lbs. weight per ft. lb. torque	6.8	7.48
Ft. lbs. torque per litre	46.5	43.9
Brake mean effective pressure	116	109

Examination of the latest Ten cylinder block brings to light a number of other points. One of the intentions of the design was to utilise every channel of development to eliminate the possibility of rapid wear of cylinder bores. The major objective was to avoid uneven distortion of the cylinder barrels under heat, and static and working stresses. This is met in several different ways. First, the cylinder barrels are entirely separate, and are surrounded by uninterrupted water spacing, for the walls of the cylinder jacket run right from top to bottom of each barrel. Then at the top, the lugs or bosses, into which the cylinder



# of Design

No. 1. THE MORRIS TEN ENGINE

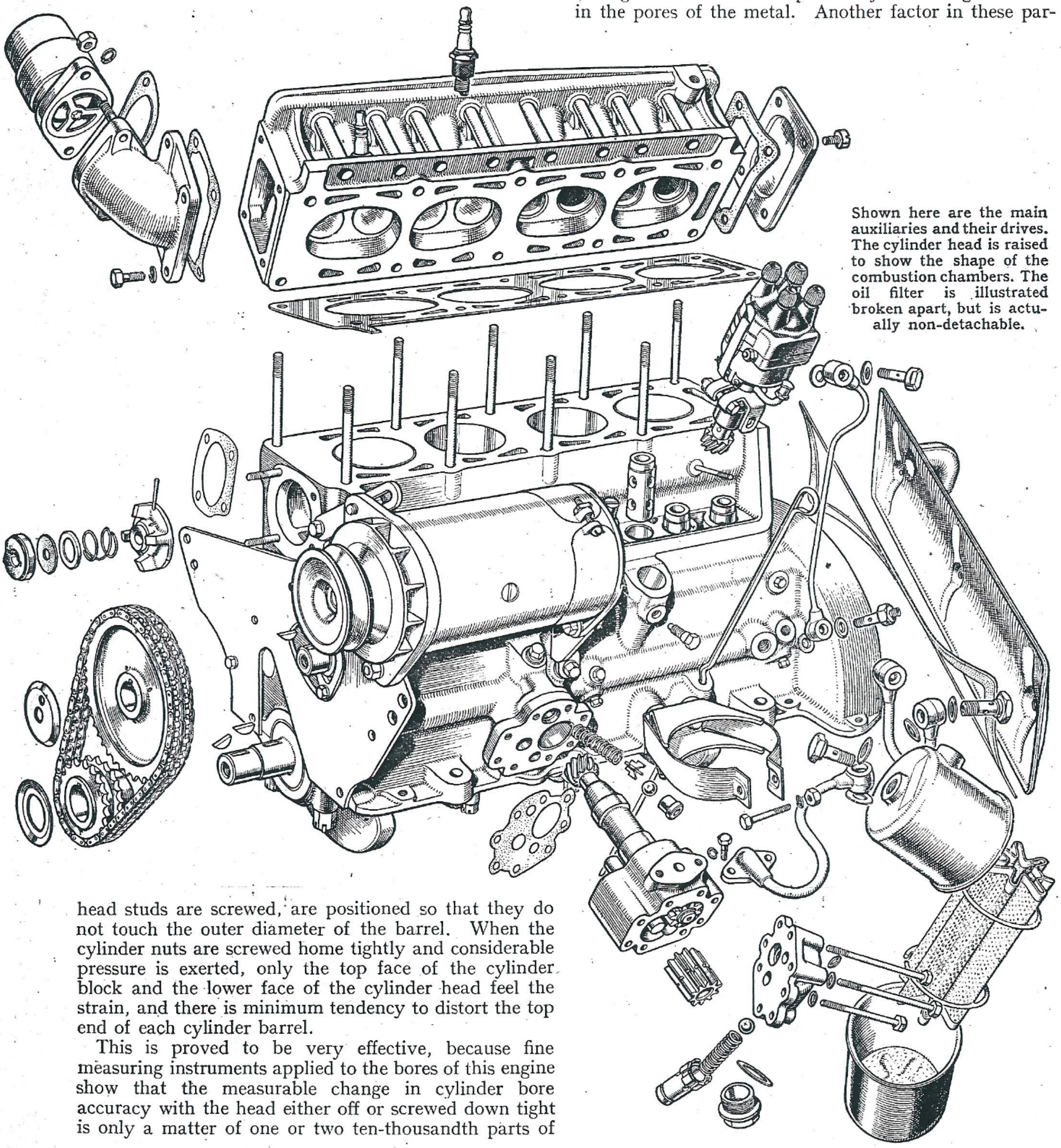
by

MONTAGUE TOMBS

an inch, whereas on many engines of to-day the effect of tightly clamping down the cylinder head may produce uneven distortion in the bores amounting to two or three thousandths.

Just as a matter of interest to those who do not habitually use fine measurements, it may be noted that a very fine human hair measures about two and a half thousandths of an inch, or .0025in. and a coarse hair about four and a half thousandths, or .0045in.

Whilst on the subject of cylinders, the Ten engine has its bores finished by inserting rollers under heavy pressure, which leaves a work-hardened surface. When rolling is used there is no possibility of leaving abrasives in the pores of the metal. Another factor in these par-



Shown here are the main auxiliaries and their drives. The cylinder head is raised to show the shape of the combustion chambers. The oil filter is illustrated broken apart, but is actually non-detachable.

head studs are screwed, are positioned so that they do not touch the outer diameter of the barrel. When the cylinder nuts are screwed home tightly and considerable pressure is exerted, only the top face of the cylinder block and the lower face of the cylinder head feel the strain, and there is minimum tendency to distort the top end of each cylinder barrel.

This is proved to be very effective, because fine measuring instruments applied to the bores of this engine show that the measurable change in cylinder bore accuracy with the head either off or screwed down tight is only a matter of one or two ten-thousandth parts of

WHYS AND WHEREFORES OF DESIGN (CONTINUED)

ticular power units is that Morris Engines possesses a very up-to-date foundry plant which employs a special process on the "all core" principle, meaning that every part of the moulds both exterior and interior is made to fine limits. Control of castings is carried out in such a way as to produce any desired degree of "chill" or extra hardness at chosen points.

Returning to the matter of avoiding distortion in the cylinder barrels and block, the Ten engine has a specially arranged circulation for the water-cooling system. Water is drawn from the radiator by the impeller or pump which is mounted at the front of the block, and is driven in conjunction with the fan by a triangulated vee belt. The impeller feeds the cool water into a separate gallery running alongside the base of the cylinder jackets, and at the rear of the engine the gallery runs upwards and connects straight to the water jacket of the detachable cylinder head. Along this jacket it flows, passing over the valve seats and sparking plug bosses, finally to leave via the header pipe and thermostatic control back to the radiator. The bulk of water within the extensive jacket around the cylinder bores remains, so to speak, in a stagnant state; that is to say, no flow is promoted by the impeller. Instead, an internal thermo-syhon circulation takes place.

Piston Fit

Concurrent with the steps taken to minimise cylinder barrel distortion comes the subject of piston fits. Naturally the more accurate the bore under all working conditions, the closer can be the fit of the piston, provided that the latter is designed to avoid distortion.

In this particular engine the pistons are of die-cast aluminium alloy, tin coated, and provided with four rings above the gudgeon pin, the lower two of which are for oil control. It has to be realised that a piston is obliged to do something more than convey the pressure of the gas expansion to the connecting rod and the crank. The area of its crown in contact with the expansion flame is bound to absorb heat. The less it does absorb the better, but in any case the sooner the heat can be conducted away, the better for all concerned. That is one of the reasons for using aluminium, which has a high rate of conductivity.

Obviously the only way the piston can be rid of the heat is to pass it on to something else. The nearest contact is the cylinder wall. The heat, therefore, flows down from the crown of the piston towards the skirt, and passes via the rings, and the skirt, through the oil film and to the cylinder walls. But as the metal of the piston receives heat it is caused to expand, and unless this expansion is controlled in some way the clearance between piston and cylinder bore when cold will have to be large enough to make sure that no binding or seizing can take place when hot.

This control of expansion in the Morris piston is secured by using a fairly thick and flat section of metal running straight from the crown to the gudgeon pin bosses, and these panels are separated from the pressure faces of the skirt by slots. Hence the expansion does not materially affect the shape of the skirt.

Selective Assembly

Selective assembly is used for marrying individual pistons to cylinder bores. Each of the four bores in the block is accurately measured after the rolling process.

On the top face of the block close to each bore are to be seen cryptic markings. As an example:—

A; +1; OK; +1; OK.

That means a Grade A series of bores of the basic nominal diameter. The bore of the first cylinder is +.01 mm. oversize, the second is dead on size, the third .01 mm. oversize, and the fourth correct. In these bores a series of Grade A pistons would be used, marked as follows: A; −5; −6; −5; −6. This indicates a clearance of .06 mm. as the nominal or basic figure between the piston and the bore. The first bore was .01 mm. oversize, and therefore a piston .05 mm. smaller in diameter than the nominal bore is selected. The second bore was correct, and a piston −.06 mm. is selected. And so on.

Cylinders in after life can be rebored several times. The first rebore would become Grade B and the nominal diameter would be increased by .25 mm. Then the markings would be readable in exactly the same manner, with the prefix B, such as B; +1; OK; +2; +1.

B; −5; −6; −4; −5.

(*To be continued next week.*)

Reducing the Civil Accident Toll

Work of the National Safety First Association

THE National Safety First Association is making strenuous efforts to minimise the toll of civil accidents in wartime. At a special meeting called last week the chief subject of discussion was, inevitably, the black-out. If the road fatality rate for September were to be maintained during a three years' war road deaths would total nearly 40,000, almost equal to an Army Corps.

A striking fact common to all enquiries so far is the great proportion of elderly pedestrians killed. Obviously, infirmity, defective sight, vision and other weaknesses play a part, besides the added susceptibility to shock common to the elderly. For instance, a first examination revealed that 63 per cent. of the victims were over 60, and 14 per cent between 50 and 60. Another examination showed that approximately one-third of the victims were over 70, one-third between 60 and 70, and one-sixth between 50 and 60, only one-sixth being under 50. Still another series showed that 77 per cent. of pedestrian victims were over 50. In a series of 100 such accidents over 80 per cent. of the victims were males.

It is interesting to compare these proportions of male and female victims with the latest available Ministry of Transport figures—those for 1936-37—for pedestrian fatalities generally, i.e., including those which resulted from daylight accidents as well as those which occurred during the hours of darkness.

These figures disclose an overall average of four males to one female in the black-out pedestrian fatalities, in 1939, in comparison with the general average, in 1936-37, of three to two. It is shown very clearly that if elderly people refrained from going out in the black-out except when absolutely necessary, accidents could be greatly reduced. People do not like to think that they are infirm or aged, but a voluntary curfew imposed by common sense would do a great deal to cut down the accidents.

There have been numerous instances in which drivers involved have said that this was their first accident in long periods of driving experience. If the black-out is resulting in drivers who have proved their capacity by many years' immunity from accident having mishaps, its effect on drivers neither so skilful nor so experienced must be still more serious.