B.M.C. 998 cc "A" Series Engine with die-cast aluminium cylinder block

Project Report by

THE BRITISH ALUMINIUM CO. LTD.

DIE-CAST ALUMINIUM CYLINDER BLOCKS

A project by The British Aluminium Company Limited to produce an aluminium alloy cylinder block for the B.M.C. 'A' Series engine

Mr.Harriman has said that on the basis of past experience with sand castings, the substitution of aluminium for iron reduces the weight by half and doubles the price.

The object of the project now reported by B.A. has been to demonstrate that by using modern methods of diecasting it is possible to:-

1. Reduce the weight by more than half.
2. Supply such blocks at a price competitive with iron in the cast form, and perhaps slightly cheaper finish machined.
3. Give substantial production advantages.
4. Overcome the supposed disadvantages of lack of rigidity and susceptibility to noise.

FACTS

(a) The weight of the 998 cc. iron block unmachined is 84 lbs. The weight of the B.A. block is 29 lbs. of which 21 lbs. is aluminium and 8 lbs. the iron cylinder liners, also unmachined.

(b) A cost evaluation by the B.A. would of necessity have to depend upon a number of assumptions, some of which would relate to B.M.C's possible plans and operations. Such an analysis could not be truly acceptable, and we feel that only B.M.C. can evaluate the cost of the finished block within the narrow margins which are vital. We believe however that a full study will lead to a favourable comparison with the existing price of a cast iron block at equal production levels.

We are prepared to collaborate fully with B.M.C. in such a cost study.

(c) Die casting has eliminated a considerable number of machining operations, mainly long intersecting drillings forming the oilways. The precision of the process means less metal to remove elsewhere, and cutting speeds of 1,500 to 2,000 f.p.m. can be used on the aluminium alloy. Thus a machine line for this type of block will have fewer stations, reduced overall machining time, and perhaps more important, considerably reduced floor space requirements.

(d) The block has been cored out wherever possible to eliminate superfluous material and flat surfaces which may pick up and transmit noise have been avoided.

The span of the main bearing studs has been reduced and bearing clearances selected to avoid "rumble" at running temperatures and retain easy cranking at sub zero.

The engine as presented in a Wolseley "Hornet" has covered 1,000 miles.

Another unit to the same specification has completed 130 hours cyclic load test bed running to B.M.C. standard test procedure, followed by over 10,000 miles road and track test running.

An earlier unit has also completed more than 300 hours general test bed running.

PROSPECTS

In association with these tests over 20,000 miles has been covered in the past 18 months with Cross pistons running directly on the aluminium bores of a set of detachable aluminium cylinder liners in a Renault "Dauphine".

In the next stage an "A" Series engine as presented but without iron cylinder liners is to be test run.

Elimination of the liners can be expected to -

1. Reduce further the weight of the block.

2. Reduce the cost of the block also.

THE CASTING

With the approval of Mr. Harriman, together with Mr.Issigonis and Mr.Griffin, B.A. commenced this project on the "A" Series B.M.C. engine early in 1961.

To develop in detail the design proposal, and to obtain facilities for the machining, assembly and testing of engines, Engineering Research and Application Ltd. were made subcontractors in the project.

At the suggestion of Mr.Harriman, dies were made and castings produced by Birmal. In order to keep development costs within reasonable limits the prototype blocks have been produced by low pressure die casting. The block is however designed for large scale production by the high pressure die casting process.

It was decided that although the Cross system for running directly on aluminium cylinder bores showed great promise, the engine should first be produced with cast iron cylinder liners, cast in place in the block. Experience has shown that the cast-in liner can have better thermal properties than the press-fit dry liner and the cost penalty is reduced.

Advantage has been taken of the superior thermal conductivity of aluminium to reduce the length of the water jackets as compared with the iron version. This has a further effect of reducing the amount of aluminium used.

Recesses have been cored out above the main bearings which reduce the weight of metal used without any detrimental effect upon bearing behaviour, and also serve as oil feeds to the bearings.

A double wall treatment of the diaphragm supporting the centre main bearing, and careful ribbing of the two end faces of the block add to the rigidity and quietness of the engine.

A flat external face is provided on the offside of the engine to which is bolted a die casting comprising the main longitudinal oil passages and incorporating the oil filter head and oil pressure relief valve housing. Simple drillings from this face to the recesses above the main bearings provide the oil feeds and complete inspection of the oil circuits is now entirely feasible.

Camshaft and tappets are run directly in the aluminium casting.

Particular attention has been given to depth of stud bosses to ensure adequate thread engagement without the use of inserts.

A new water pump casing in aluminium alloy suitable for production by pressure die casting has been designed and fitted.

In order to fit in with the "Universal" block idea it was decided to run the engine at the 998 cc. capacity as presently fitted to the Wolseley "Hornet" and Riley "Elf".

TEST RESULTS

The first engine was built at Dunstable and put on the test bed early in 1963. This engine had the studs on front and rear main bearings offset towards the centre of the engine as in the standard iron block. During assembly it was considered that symmetrically placed studs would be desirable and this modification was put in hand for subsequent engines.

This engine has been kept for test bed use and has now done over 300 hours on power curves, heat balances etc. It has been verified that the short water jacket is entirely adequate and the heat to oil is the same as in a production iron engine used for data tests.

An advantage of the short jacket and a further reduction in volume of cooling water due to the outer wall of the jacket following more nearly the configuration of the bores has been a marked reduction in warm-up time.

Measurement of the changes in tappet clearance under varying conditions of load and running temperature showed that, with the greater thermal expansion of the aluminium block, clearances could safely be reduced to .004"(Inlet) and .008"(Exhaust).

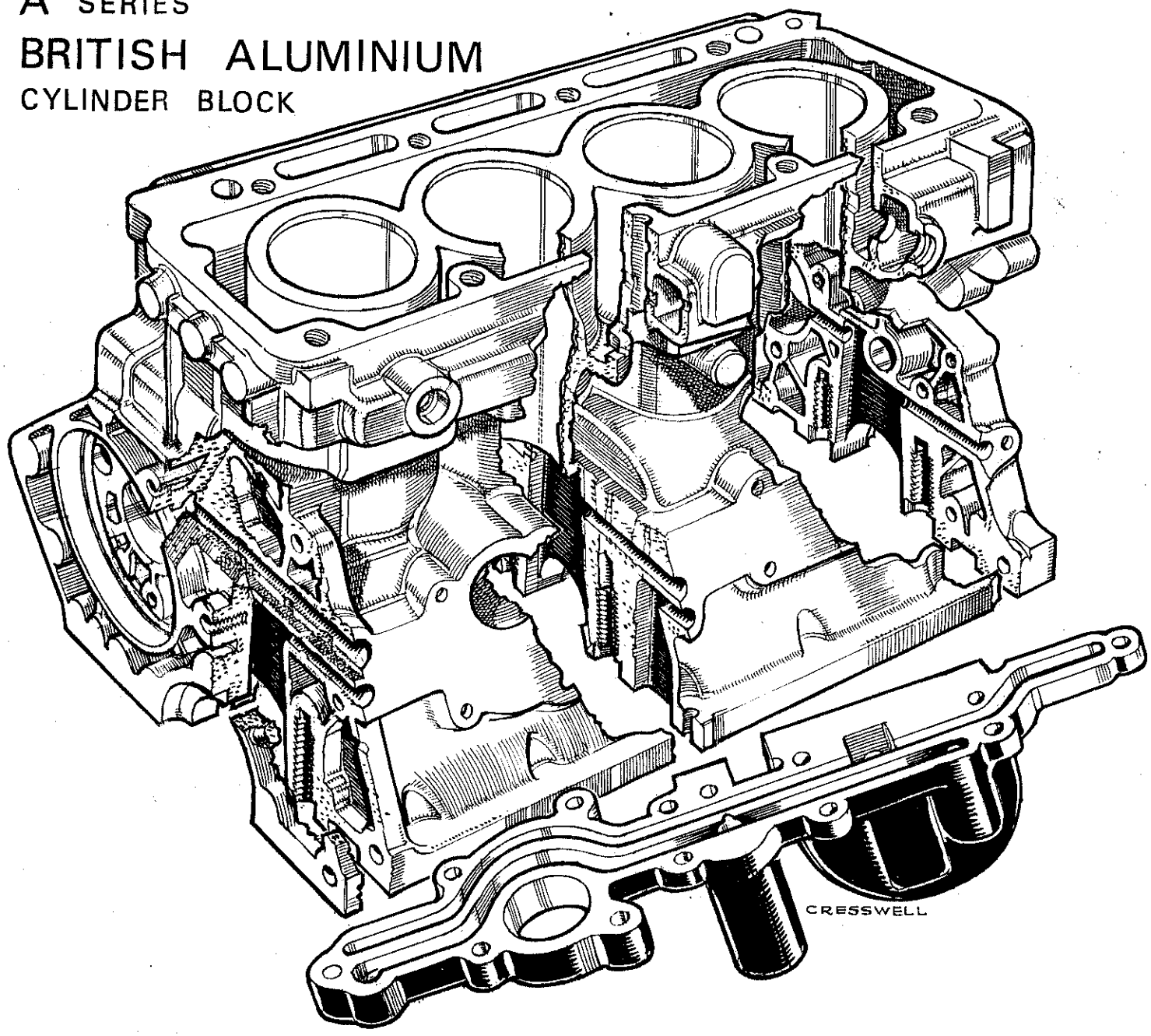
A second engine was assembled with the revised bearing stud positions and bench run under standard B.M.C. cyclic load conditions for a total of 130 hours. It was then installed in a Wolseley "Hornet" and has run for over 10,000 miles with entire satisfaction. This engine is now to be stripped for detailed inspection as it is considered to have had sufficient running to allow reasonable prediction of wear rates.

A third engine to the same specification has been assembled and installed in a second Wolseley "Hornet". This car has been run in for about 1,000 miles and is now to be handed over to B.M.C. for evaluation.

'A' SERIES

BRITISH ALUMINIUM

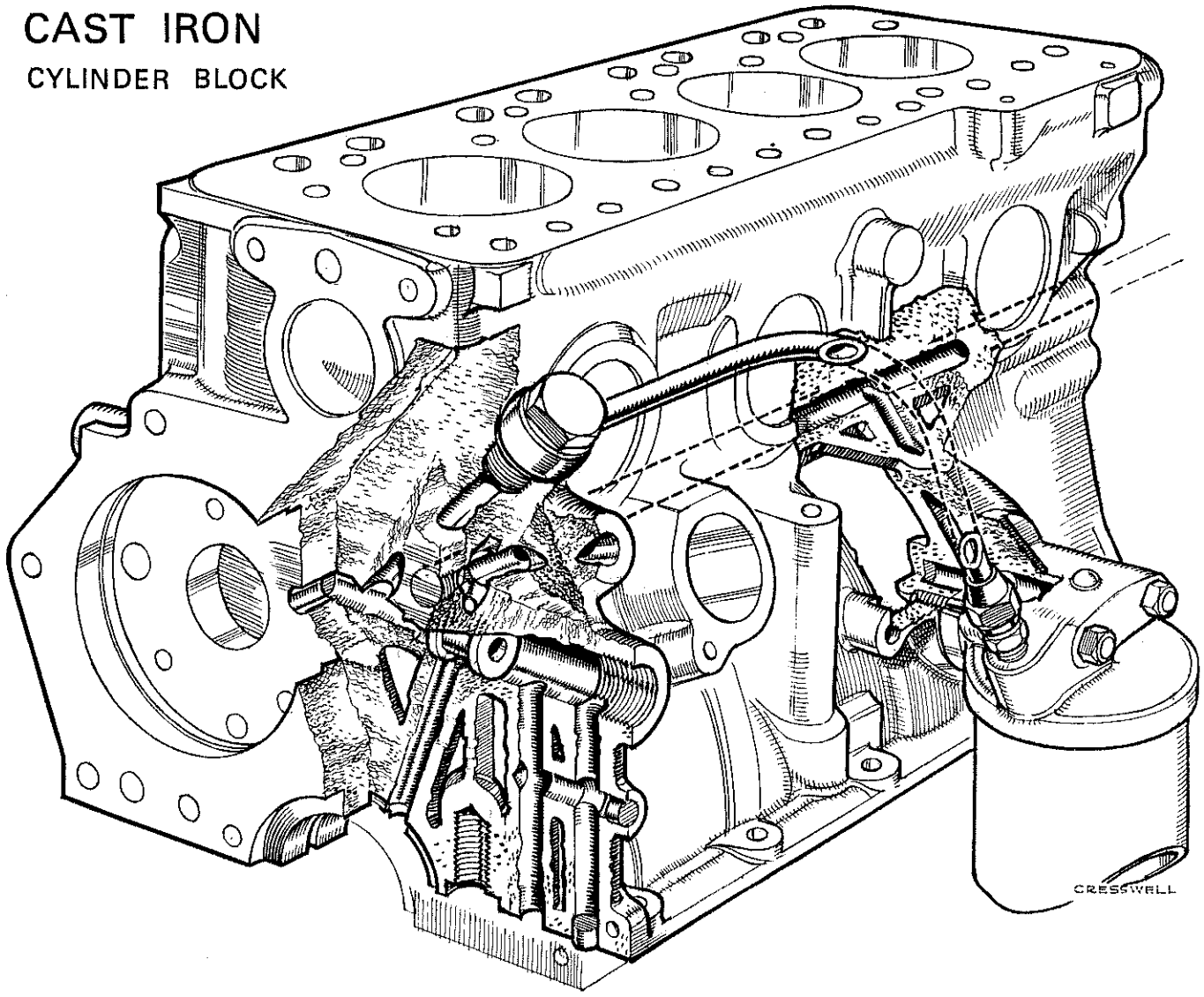
CYLINDER BLOCK



'A' SERIES

CAST IRON

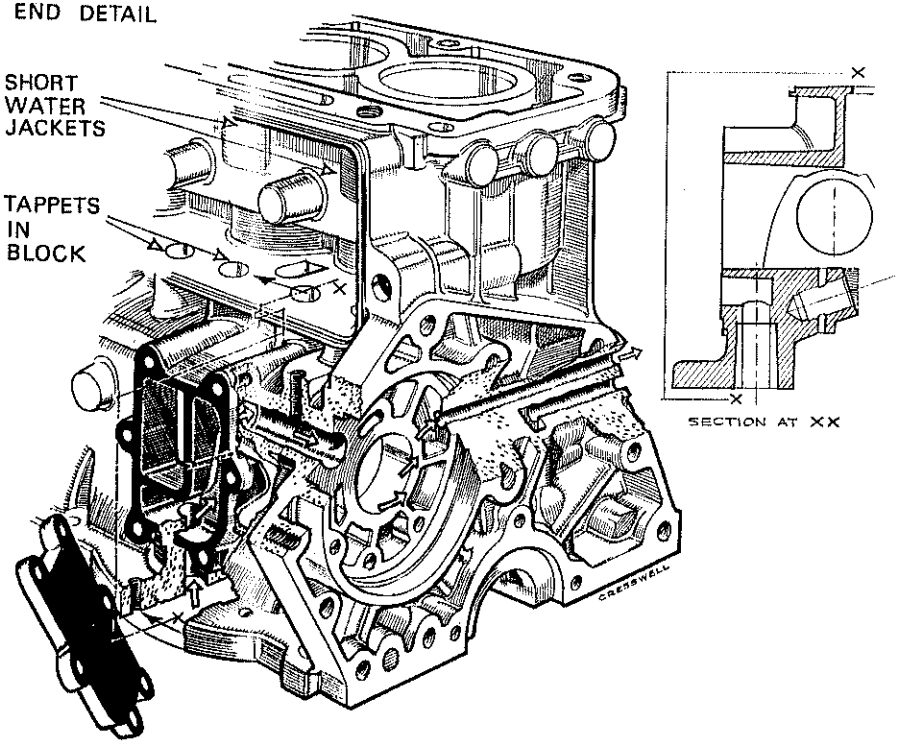
CYLINDER BLOCK

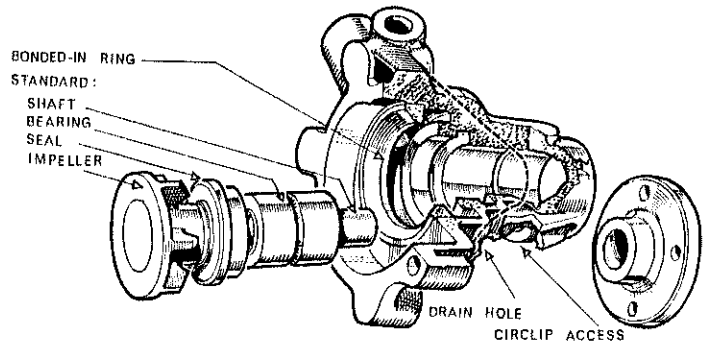


'A' SERIES

BRITISH ALUMINIUM BLOCK

END DETAIL





Surplus metal from above the distributor drive boss must be cored out from the side of the block, and a cover plate provided. So as to profit from necessity the feed to the oil pump is also opened up, and produced entirely in the casting process, being completed by the same cover plate.

The water pump is redesigned as an aluminium die casting, with a bonded-in ring to provide the recess behind the impeller. Coolant flow is at all times equivalent to or better than that provided by a standard pump.

The impeller shaft, seal and bearing are all standard items. With changes in these components a die cast casing without the need for an insert would become possible.