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From Mr. R. A. Wilson-Jones. To:-

Major F. W. Smith.
Major V. T. Mountford.
Mr. V.L. Young.
Mr. J.J. Booker.
Mr. R. Thomas.
Mr. R. Lovekin.

29th September 1960.

Cylinder Head Design

A meeting of the Birmingham A.D. Centre of the Institution of Mechanical Engineers was held Tuesday night to discuss the proposition 'Are compression ratios above 10:1 worth pursuing', Mr. M.Thers of British Petroleum Ltd., opened the discussion and was of the opinion that about 10:1 was the useful practical limit for compression ratios irrespective of what fuels may be available in the future. Mr. Charles Goodacre of The Ethyl Corporation was in favour of compression ratios higher than 10:1.

From the remarks of both the opening speakers and from the general discussion which followed it became evident that one of the problems of very high compression petrol engines is the design of a reasonably compact combustion chamber consistent with the necessary clearances to enable the valves to operate. Both the opening speakers and many of the succeeding ones were of the opinion that the over square engine is unsuitable for very high compression ratios and suggested that if these come into general use engines would have to be made about equal in bore and stroke.

The discussion centred mainly round engines for passenger cars and commercial vehicles in both of which fuel economy is of more importance than it is on motor cycles and specific performance is of less importance. The engines considered were all of the vertical valved type with 'bath tub' combustion chambers and even with this type of engine it was considered desirable for the combustion chamber to take the form of a recess in the piston crown (as in a diesel engine) in order to provide as compact a combustion chamber as possible.

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I spoke late in the discussion and pointed out that the problems in motor cycle engines are not quite the same as in car or commercial vehicles engines. High specific perfomance is very important from our point of view and to obtain this good breathing as well as a high compression ratio is necessary. If it is necessary to reduce the bore of the engine or decrease the angle between the valves in order to obtain a compact combustion chamber with a very high compression engine the breathing must suffer and although the efficiency of the engine may be improved its specific power output will probably be reduced. I suggested therefore that very high compression ratios are not likely to become general in motor cycle engines.

In our own range of engines we have already reached the point where we are having to use an undesirably high dome on the piston in order to obtain a compression ratio of the order of 8:1. This applies particularly to the over square Meteor Minor engine which has its valves set at an included angle of 80°. The long stroke 700 Twins and 350 Bullet engines however also suffer from this defect to some extent. This valve angle dates back to the days when the fuel available limited the useful compression ratio to about 5 or 6 to 1 which could be obtained with a flat or slightly domed piston top. It permits the use of large valves in relation to the bore of the engine and also provides reasonable straight ports without the necessity for extreme angles on down draft on the carburettor. With a long stroke engine having a compression ratio of about 6:1 this valve angle therefore provides very good breathing combined with a good shaped of combustion chamber. When we introduced our first overhead valve engines with enclosed valve gear the valve angle was reduced to 40° which impaired the breathing of the engine and did little to improve the combustion chamber shape at the compression ratio then in use. The performance of the engines in consequence suffered.

With compression ratios of 8:1 or more now ver particularly if the engine is to have a short stroke there is no doubt that a better compromise can be obtained by inclining the valves at less than 80° included angle. This is in fact done on the Crusader engine which gives a compression ratio of 9:1 with a piston with a much smaller dome than that which gives barely 8:1 in the Meteor Minor engine which has the same bore and stroke. As a result of this the Crusader Sports engine in standard production form has a specific power output of 68 bhp per litre as compared with 66 bhp for the Meteor Minor Sports. By Contrast the Constellation has a specific power of 71.5 bhp per litre whereas the 350 Bullet shows only 60 bhp per litre. Since these two models have virtually the same design of cylinder head it would appear that basicly a Twin can have a better specific power output than a Single of half the capacity. In spite of this the Crusader Sports is seen to have a better specific output than the Meteor Minor Sports. While no doubt other factors enter into this there seems reason to suppose that this is largely due to the better shaped combustion chamber of the Crusader Sports engine.

I suggest therefore that as and when engines become due for

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redesign the cylinder heads of the 350 Single, 500 and 700 Twins should be based on the Crusader Sports head with valves at an included angle of 65° or even less if very high ratios are wanted with an over square engine.

R.A. Wilkinson