MOTORCYCLE ENGINEERING—32

Ignition Factors

The critical rôles of timing and plug location

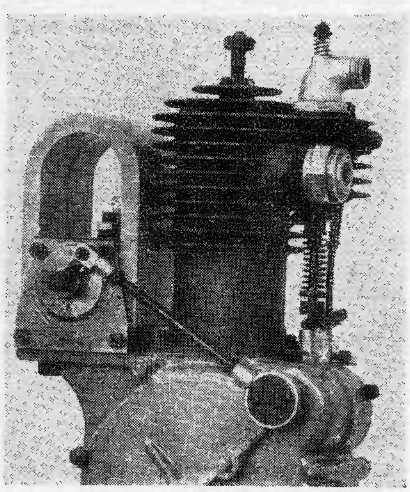
By PHIL IRVING

THE process of combustion which produces the power in an I.C. engine is extremely complex—and seems to become more so with the passage of time, as fuel research workers find out more about it by means of ultra-high-speed cameras, engines with quartz cylinder heads and similar expensive apparatus which was not available to the earlier investigators.

Off with a Bang!

At first it was thought that the whole charge went off with a bang immediately after it was fired, hence the use of the word "explosion." Though inaccurate and misleading, this is still the common term, and is convenient to retain because there is no other single word in the language which is at all applicable to the true state of affairs.

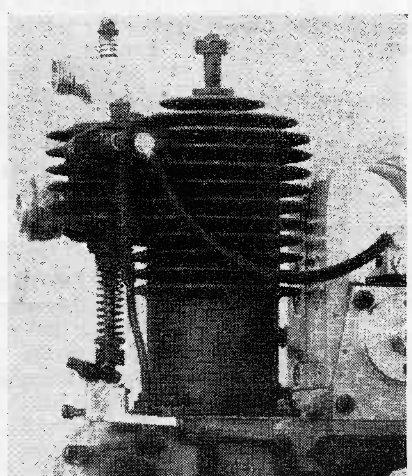
If the whole charge did explode simultaneously, enormous and quite unworkable pressures would be generated. This could happen, for instance, with a mixture of acetylene gas and air, and does happen to some extent with a petrol-air mixture when "pinking" or detonation occurs in the last part of the charge, which ignites as a whole but does not usually commit much destruction because only a small volume of combustible is involved.



A low-tension magneto of the "rock 'n' roll" type as fitted to many engines in pre-high tension days. This example is on the 1902 Simms automatic inlet valve unit

However, it has long been known that the mixture, instead of exploding, is burnt by the action of a flame which starts at the plug and is carried through the combustion space, partly by its own efforts but more by the action of the turbulence or whirling set up in the charge, either by the location of the inlet-port, the squish action created by the shape of the head, or a combination of both, as described in Part 20 of this series.

But in more recent times it has also been discovered that all sorts of chemical reactions are taking place under the conditions of high temperature and pressure which would not occur in straightforward burning in the open air. These have an effect on the tendency of a fuel to "knock" and also on the life of the engine, as compounds leading to the formation of corrosive acids are formed.

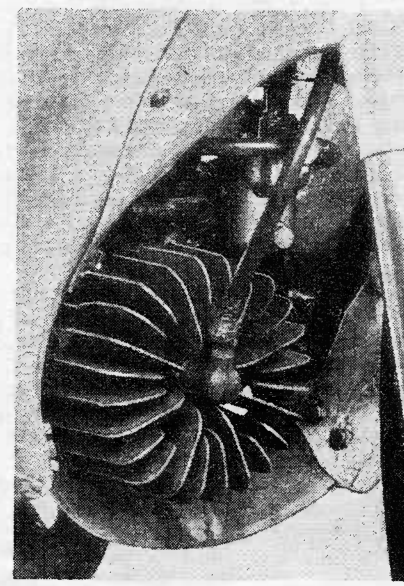


Another view of the Simms system showing the mechanical interrupter fitted into the cylinder valve chamber instead of an electrical sparking plug.

While high-tension spark ignition is the most convenient and precise system yet devised, combustion can be started by other means. In a compression-ignition engine, generally called a diesel, the heat generated by the compression of pure air is sufficient to ignite a jet of fuel sprayed into the combustion chamber. In some varieties compression ratios of about 17 : 1 are employed and thermal efficiencies are very high, but even though the fuel injection is spread over a period of up to 20°, the pressures generated are terrific and the general construction of the engine has to be much more robust than a petrol engine need be.

Ignition can be commenced at more normal compression ratios by the action of hot surfaces—intentionally, by the use of a glow-plug, or inadvertently, from the presence of a hot area, such as the exhaust-valve head or a glowing patch of the incombustible deposits left by some of the modern additives to petrol and lubricating oil.

Combustion may also be started by a residual volume of hot exhaust products left over from the previous strokes, as in the "hot-tube" engines.

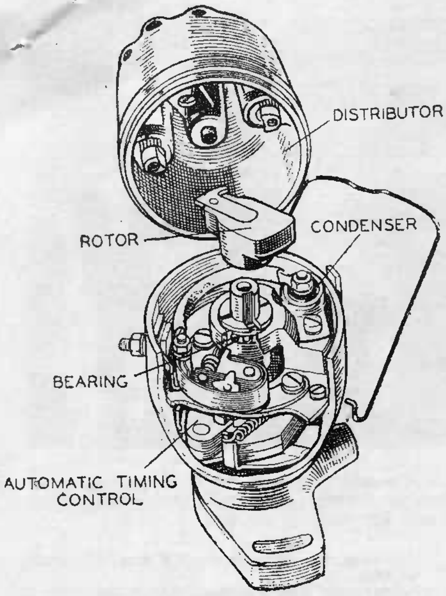


The Ehrlich two-stroke racing engine had the sparking plug located in the centre of the cylinder head.

This process can occur with an exhaust valve which has been drilled up from the head end for lightness; the little pocket of gas so formed may remain hot enough to fire the charge at somewhere near the right time. In fact the old big-port A.J.S., which possessed this feature, would run without a miss for miles with the plug-wire off, once it was properly warm and the throttle was kept more or less wide open.

An unscavenged area in a two-stroke can also provide a source of ignition. In the marine Vincent two-stroke, which had the exhaust ports at one end of the cylinder and the inlet ports at the other, arranged to give a rapid swirling action to the ingoing mixture, self-ignition arose from the core of hot gas remaining in the centre of the cylinder after the charge had spiralled its way down close to the walls and some of it had escaped out of the exhaust ports.

In the experimental stages, by some fluke the point of auto-ignition corresponded exactly to the correct spark-ignition point and power was identical with or without the

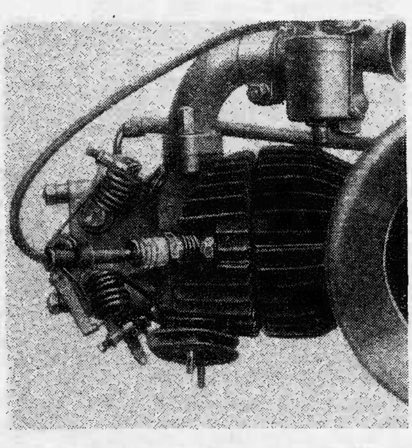


Popular of recent years is automatic ignition advance mechanism adapted to coil equipment. This is an example of the Lucas design employing centrifugally operated bob-weights housed beneath the contact-breaker.

plug-wires on, but a reduction in the amount of swirl by altering the port angles suppressed the effect, while giving higher power and better economy through improved scavenging and less charge-loss.

Auto-ignition in fact does not do much harm provided it occurs *after* the correct spark-ignition point. If it occurs earlier, the general engine temperature begins to rise, auto-ignition then becomes earlier still, and the process snowballs until the engine knocks itself to a standstill or suffers mechanical damage unless given a rest, even if only for a few revolutions. This is what may happen when an engine is run at a compression ratio higher than the fuel it is supplied with will accept, as those who were forced to race T.T. machines on "Pool" spirit just after the war will remember only too well.

From the viewpoint of thermal efficiency, it would be best if ignition started at t.d.c. and was completed in one or two degrees; but this would be undesirable, even if it was possible, because the pressure-rise would be so rapid that extremely rough running would result.



Side location of the plug was favoured by the single-cylinder racing Guzzi—an outstandingly successful Italian design.

It is necessary, therefore, on this count alone, to fire the charge many degrees before t.d.c., so that the pressure can build up fairly gradually to a maximum of three to four times the compression pressure a little after t.d.c., when the piston has started to descend. The high pressure so generated before t.d.c. then constitutes a waste of power and, if the ignition-timing is too far advanced, the useful power developed will be reduced, even though the engine may not give any audible sign of distress by "knocking" or "pinking."

How Much Advance?

The actual amount of advance required is determined by a host of factors, of which the most important are the shape of the combustion chamber, the compression ratio, and the analysis of the fuel. Others are the amount of pre-heating of the charge (or cooling if alcohol is used), the location of hot areas and the efficiency of scavenging of the products of previous combustion. In general, anything which raises the compression pressure and/or temperature tends towards the need for less advance, anything which has the opposite effect tends towards more.

Sometimes these effects overlap or act in opposition. Thus an engine which requires 42° advance at 6.8 : 1 c.r. on petrol may have to be brought back to 34° when raised to 8 : 1 c.r. on the same fuel, but will still require 34° when raised to 13 : 1 and changed over to alcohol. There is no formula for determining the correct figure; previous experience is a good guide, but the final setting can only be obtained by testing.

Some engines are more sensitive to the ignition timing than others. In any case, the higher the power per c.c., the more accurate must the timing be; a degree or two may not make much difference in a touring engine, but may spell failure to a racing engine which is being pushed to the limit.

The amount of advance also varies to some extent with engine speed. At starting, for instance, the engine will kick back at full advance, and when pulling hard at slow or medium speed less advance is required than at open throttle at high speed, because the mixture has a longer time in which to burn completely.

Consequently, it is necessary to incorporate a method of varying the timing, either by moving the contact-breaker or by moving the whole magneto armature relative to the crankshaft by means of some centrifugal contrivance, such as the Lucas or B.T.H. automatic advance devices, though these need to operate only from zero up to 2,500 or 3,000 r.p.m.

From then on to maximum revs in a normal, well-designed engine, the advance appears to be independent of speed, because the higher this is, the higher the turbulence in the mixture becomes, and the rate of combustion is automatically speeded-up in unison with the increase in r.p.m.—a fact which permits some racing engines to be run with fixed ignition timing.

Phil Irving continues his discourse on ignition in next week's article dealing with starting problems and the use of two-plug systems.

A One-make Race Class?

Cut-price Plan for "Bantam"-based Dicing

WHENEVER I see an M.V. "four" or a British production racer costing nearly £500, I think how small are the chances of even the keenest enthusiasts to compete in road races—unless they have won the pools!

Bearing in mind the 750 c.c. Austin and 1,100 c.c. Ford classes in our kindred sport, why not a one-model class in our sport? No doubt everyone reading the foregoing will say: "How boring, just like some of the 500 c.c. races these days; like a string of sausages belting round the track." But it need not be, if sufficient latitude were given in the regulations. However, first let us consider the essential requirements of the machines:

(a) Cheap to buy and repair.

(b) Simple.

(c) Something that has been in production for about 10 years or more—this would give a chance for people who could not afford to buy a new machine as a basis for conversion.

(d) Something on the small side to make it safe for novices.

Based on the above requirements, it would be a two-stroke, and, in view of the fantastic speeds attainable by tuning it, I would suggest the B.S.A. "Bantam," which has been in production, with few modifications, since 1949 and has disc flywheels—which would be a distinct advantage.

It must be admitted that as standard, a "Bantam" looks less of a road-racer than any other machine, but I think this would effectively stimulate ideas to overcome its limitations, and no doubt some very fast and very unusual machines would result.

I have thought of some possible regulations and list them below.

1. Use standard engine and gearbox components (wide or close ratios are available), but any modifications could be made, including lubrication, whilst retaining the basic components.

2. Use the standard main frame loop, but any form of rear suspension could be used.

3. Use standard hubs and rims (for cheapness' sake), but allow welding two front brake halves together for better stopping power.

4. Any front suspension, but use the standard head races and clamps.

These "regulations" have been aimed at cheapness, but would still allow a lot of latitude in design.

My big point is that it would put racing—with a chance to win—within the grasp of hundreds of chaps who can only stand at Silverstone and chew their nails.

M. G. BIRKETT.