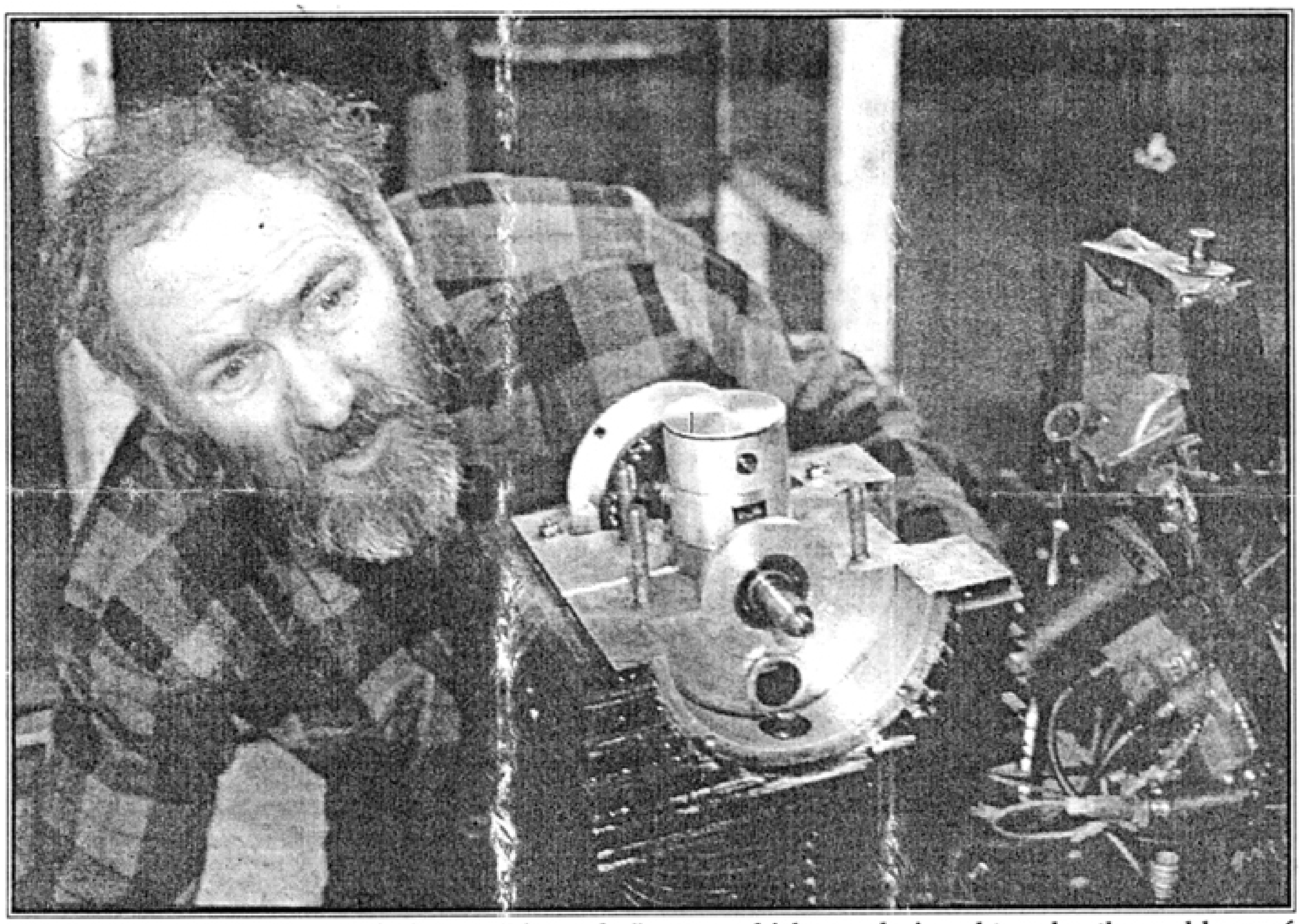
The "Beare 6-Stroke"



Malcolm Beare with the revolutionary "six stroke" motor which was designed to solve the problems of normal poppet valves being too restrictive.

Malcolm Beare is an Australian engineer, living in the "bush" and working on just about any kind of engine needing attention. "Versatility" being a keyword in his profession, he spent time pondering the possibilities of using rotary valves in a four-stroke engine, quiet, compact and inexpensive, but difficult valves in a four-stroke engine, quiet, compact and inexpensive, but difficult to lubricate and keep cool, thus leaving the poppet valve the favourite for most current non-two-stroke units.

Discounting existing rotary valves, Malcolm came up with a new type, of his own design, but utilising existing components, and allied it to a design that managed to take the load (combustion pressure), off the valve during the periods when temperatures and pressures peak.

The rotary valve used now is fourth in the development programme, the first two being tested on boxer twins, and then on a 125cc Honda farm-bike. The current slave unit is an XT500 Yamaha.

Now "how it works" and the construction. The head gasket is standard, as is everything else below it ... but ... above it is quite different.

The camchain is still driven by the crankshaft but instead of driving a camshaft it now drives another crankshaft (at half engine speed) at the very top of the engine, which in turn operates a small conrod and piston in the normal way. The piston slides in the bore with intake and exhaust ports in it, very much like a two-stroke barrel. Continuing the two-stroke theme, the carburettor feeds the cylinder through a reed block. Positioned at the other end of the top crankshaft is a disc valve that regulates the exhaust timing, the only function being to prevent exhaust gases returning into the cylinder during the intake stroke, under light load and without any lubrication difficulties.

Open to experimentation, the displacement of the 'porting piston' is about 15% of the primary piston - 75cc on a 500 (or 18cc for a 125) ... half the bore and half of the stroke. Interesting is the fact that the porting piston assists compressing the mixture and will also return some power, via the camchain, to the main crankshaft after combustion.

The head itself is attractive from the combustion chamber point of view, which like a modern two-stroke lends itself to a good squish piston virtually touching the head for a wide ring around the outside of the cylinder and hemi-spherical courtesy of a hollowed out top in the porting piston.

Due to the half speed of the porting piston - it is full retracted in its bore at the end of the exhaust stroke leaving an extra 75cc over the 50cc combustion chamber volume (10 to 1 compression ratio) to be purged in a 500cc engine. Whilst a tuned four-stroke style exhaust will give a negative pressure at the exhaust port - the two-stroke expansion chamber has the potential to give much more controlled and sustained negative pressure pulses allowing more radical port timing in the Beare head, just as it does in a normal two-stroke. More experimentation with expansion chambers is high on Malcolm's priority list.

Another interesting feature of this fully retracted porting piston is that the intake port is fully open at the beginning of the intake stroke, something even the most radical cam profiles cannot achieve with a conventional poppet valve.

Whilst the intake duties are currently carried out by a reed block, Malcolm is planning to replace it with another disc valve, which would run off the opposite end of the top crank from the exhaust disc with little more complication or cost to the head.

A GP two-stroke revs happily to 13/14000 with reed block induction, so the Beare head with half speed valve should run well with its reed block up to 28000 rpm, although obviously the bottom end would cry enough before this limit was reached. However the intake disc opens another possibility for more precise gas flow.

Although accepted as a trifle more complex than other (but unsuccessful) rotary valve designs, the Beare valve is still simple, utilising existing proven components. The XT500 engine was used purely on a cost basis and not the conservative bore/stroke ratio. The head design and excellent squish potential will lend itself to more radical bore/stroke ratios as there are no obvious limitations to the revs that the rotary valve will handle.

Whilst the current set-up is suitable for a Guzzi style V-twin or Honda VT1100, general use of the Beare head will require the disc to be driven by a right-angle drive (with the porting crank in a similar position to that of a conventional overhead camshaft) so that the conventional configuration of carburettor and exhaust can be retained.

The XT500 conversion, is at this very early stage of development, producing the same power as the standard unit, but it is incredibly quiet ... and achieved without the availability of sophisticated measuring or analytical equipment to establish optimum port design etc.

Now Malcolm Beare seeks the cooperation of investors, or a manufacturer, to push the project forward to production with the obvious benefits of extra performance and quietness. SOS and BOT machines are definite candidates for the Beare treatment, but a much wider application would be preferred and worthwhile, in every respect. The new Beare "rotary valve" design is already well covered by patents.

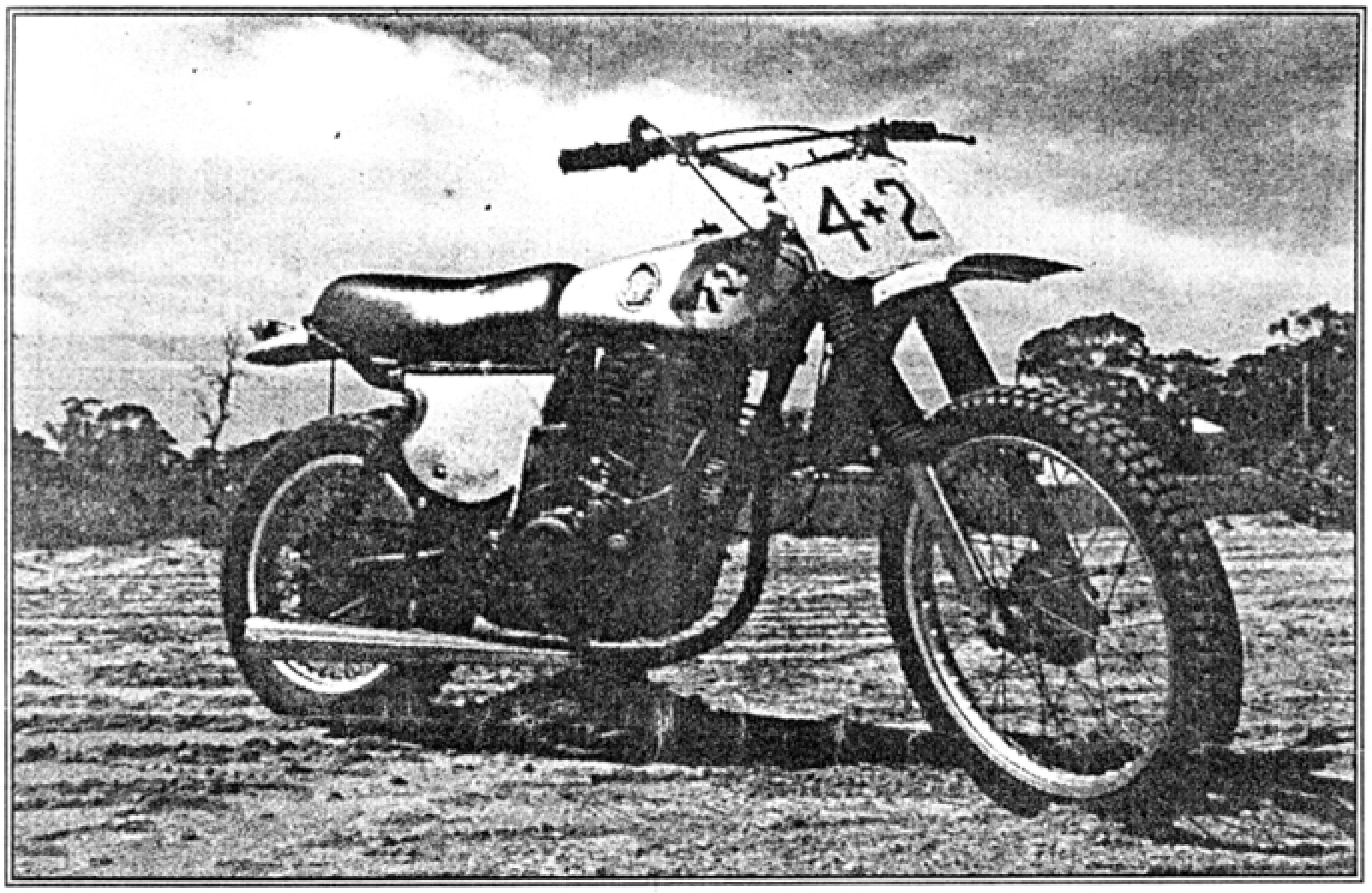
Editors Note: This engine, at time of writing, has not been published in any magazine - even in Australia.

Some additional notes from Malcolm Beare

A small upper piston forms the roof of the combustion chamber, it takes the brunt of the gas sealing and part of the valving, the opening of the exhaust port, and the closing of the intake. The upper porting piston is connected to a small crank driven at half main crank speed. The main crank does the normal 4-strokes, while the upper porting piston does 2-strokes ... 6-strokes for the complete cycle.

During the power stroke, approximately 12% of the power is transmitted through the upper piston. The main piston loses about 3%, therefore there is a net gain of 9% all things being equal.

The crown of the upper piston remains at a much more even temperature, unlike the roof of a conventional combustion chamber, where the exhaust poppet valve is the hottest area. Therefore a gain in thermodynamic efficiency is evident, because a significant increase in compression ratio can be achieved without the onset of detonation or preignition - lower octane or unleaded



The XT500 to which Malcom Beare fitted his "Beare 6-Stroke" engine.

fuel is not a problem. I envisage a gain from approximately 9:1 to 10.5:1, or a compression pressure of approximately 200-220 lbs/sq", from the standard 150 lbs/sq".

I have also found it to be beneficial to have the upper porting piston delayed in reaching its Top Dead Centre, compared to the main piston. This achieves three beneficial effects ...

1. From the combustion point of view, it gives a substantially longer period of relatively constant volume, during which combustion can occur.
2. It also places peak cylinder pressure later in the expansion stroke, thereby taking advantage of more favourable crank angles for producing more torque.
3. The valve timing is also enhanced without having excessively tall ports. It allows later closing of the intake port, but the exhaust timing also occurs later in the cycle - closer to Bottom Dead Centre before opening. This does not matter so much with this engine design as cylinder pressures are higher at this point anyway.

The nature of the valve opening is radically different from poppet valves. The period that the piston ports are open (if one considers the concept of time area) can match or better any poppet configuration. It is the period around Top Dead Centre, at the end of the exhaust stroke and the beginning of the intake stroke, that the better valving is evident.

The exhaust is cut off quickly by the rotary disc valve, and the intake is demand automatic ... the reeds open whenever pressure differentials dictate.

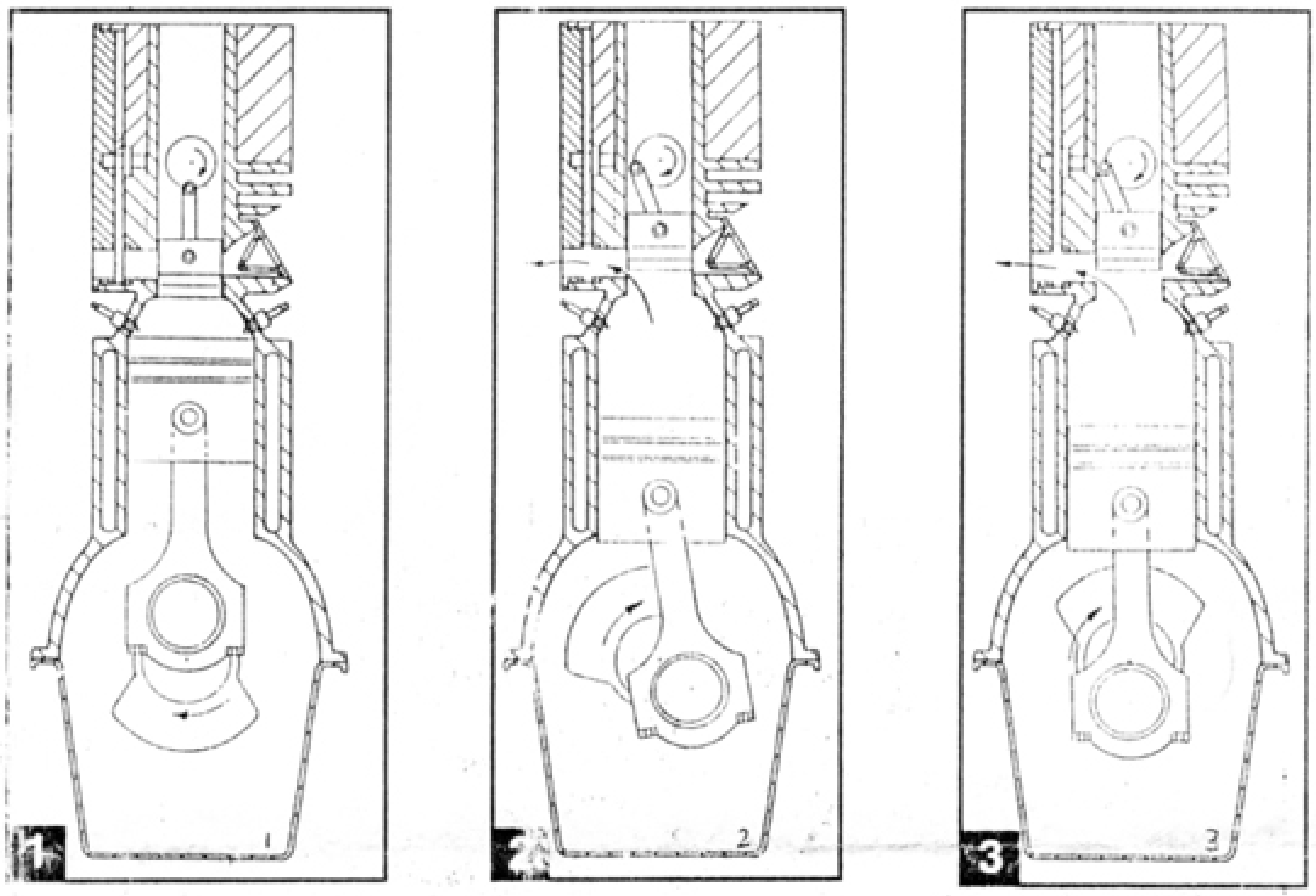
With this improvements in mechanical, thermodynamic, and volumetric efficiency, we could have a world beater.

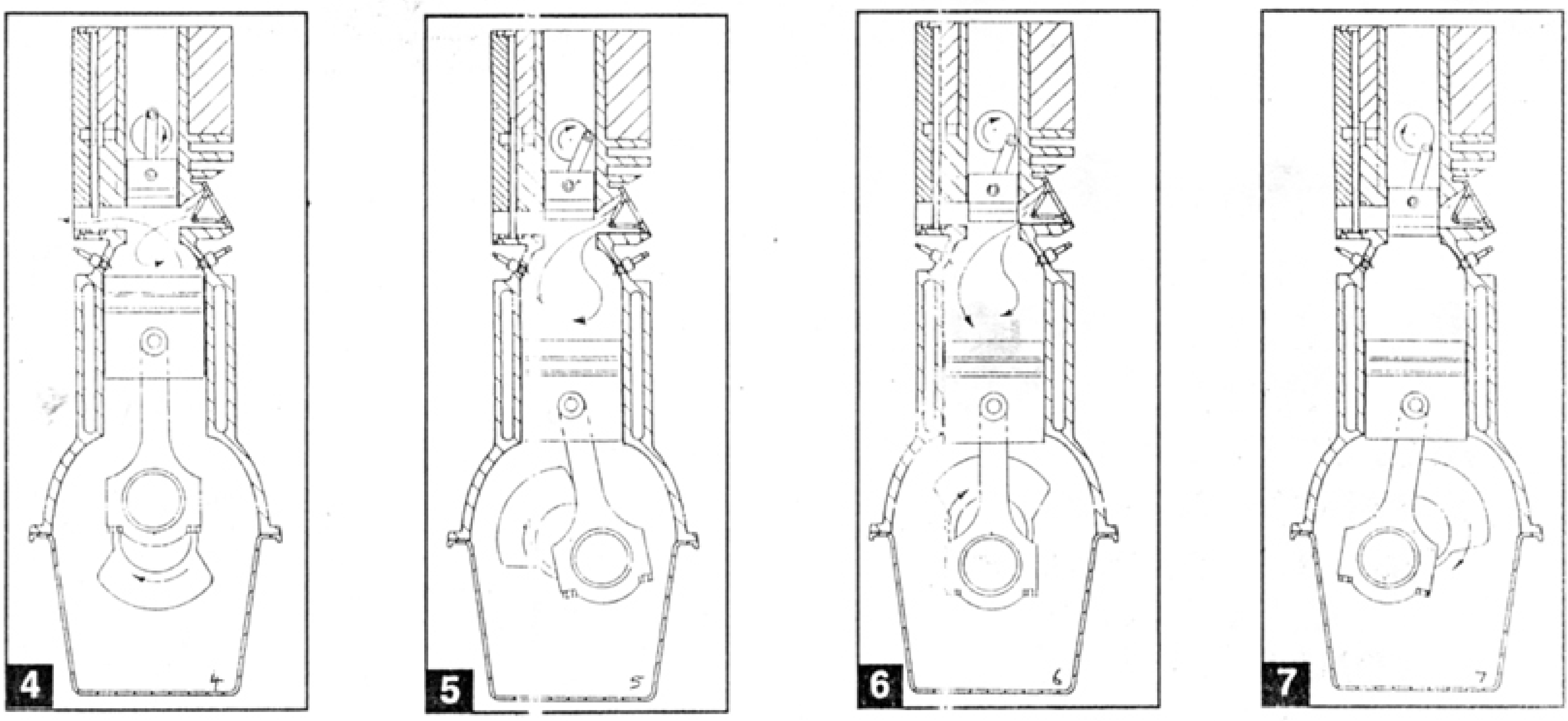
Key To Schematic Drawings Of "6-Stroke" Functioning

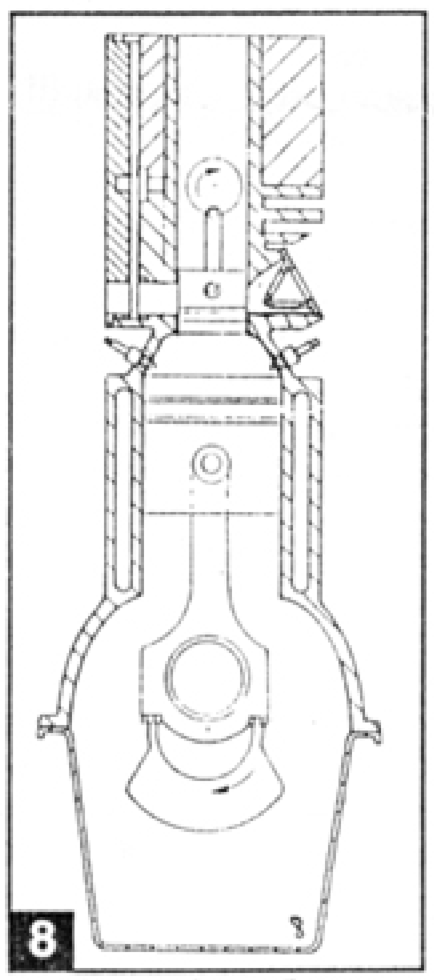
The views are not 100% mechanically accurate, owing to the difficulties of presenting 3D in 2D form ... For example, the conrod of the upper piston is shown pointing towards the crown, as most people can immediately recognise and understand the function. In fact, the upper piston has a deeper skirt, and the conrod is facing away from the crown, which lessens side thrust at the rind end of the piston, and also allows the crankshaft to be lower in the head, plus the use of a smaller rotary disc intake seal valve.

Fig.

1. TDC combustion.
2. 60º BDC, piston port opens, allowing blowdown of exhaust.
3. BDC beginning of exhaust stroke.
4. TDC, end of exhaust stroke, beginning of intake. Rotary disc valve cuts off exhaust at any desired set degree, approx 10º ATDC. Intake is automatic whenever pressure differences or sonic valves in intake dictate.
5. Continuing intake.
6. TDC intake almost closed.
7. Closed at approximately 40º ABDC by upper piston.
8. Now back to TDC compression.







A view of the intake ports with the reed valve block removed.