

Only one rider, John 'no-oil' Lockett troubled Rob's recovery service and even though we were caught in some sudden showers, a good time was had by all. Some rugged scenery, a few challenging hills, good company and a day's Scotting — what more could you ask for? Put it in your diary for 2012.

Geoff Green.

Continuing the recent articles on engine designs from various authors. The following is a copy of an address given to the Institute of Mechanical Engineers in 1978. - *Ed.*

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THE SMALL COMPANY APPROACH TO ENGINE DESIGN AND PRODUCTION

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SYNOPSIS This paper illustrates the methods used by a small company with limited resources, to design and produce a competition engine. The power unit used for illustration is a single cylinder 2 cycle air cooled engine. The unusual features are, an eight speed gear box, cross flow scavenge and swinging arm pivot concentric with final drive sprocket.

INTRODUCTION

1.1. In order to clarify the background to the design parameters for the power unit described by the authors in this paper, a brief history of the Company seems relevant.

An interest by the authors in Vintage racing using a 1928 Scott led to development of the engine to produce more power with reliability. Encouraged by success, an uprated engine was installed in a modern racing chassis, but proved uncompetitive. However, as a road machine, it was a saleable proposition. The Company was formed to produce this machine. The supply of engines suitable for reconditioning soon inhibited the growth of the Company. A new watercooled two-cycle 653 cm³ twin cylinder four speed engine/gearbox was designed using the best design features found by experience. This engine installed in a developed chassis is the 700S and is in current limited production.

1.2. In order to expand the range in limited markets, and to help share the high research and development costs of the 700S, a similar 'limited market' machine requirement was examined. A novel pressed aluminium framed trials machine developed by another company was evaluated and selected as a joint project. The frame is shown in Figure 1. It was also apparent that for any serious long term research work, it would be advantageous to utilise a single cylinder unit. The design philosophy had then to follow the Company policy of unit engineering (i.e. modular construction enabling one, two, three or more cylinder engines to be made from a single cylinder/crank complex) to benefit from the high capital investment in tooling for pistons, forgings, con-rods, liners, gears and selection mechanism, etcetera.

2. DESIGN AND PRODUCTION PARAMETERS

2.1. A small company cannot reasonably be expected to finance large development schemes, after recently completing the launching of a product that will only contribute, for some time, to the recover of the capital outlay.

Therefore this had to be a small budget project. On this basis, it was decided to manufacture three prototype engines.

2.2. Careful study of motorcycle design history has shown a series of shortfalls in current designs. These designs, with modern suspension travels and power throughputs, are being stretched beyond their useful limits, manifesting themselves in failures of transmission components.

2.3. The basic requirement of a trials machine is an ability to trickle through tight and twisty sections, have instant throttle response and high rear wheel torque. Conflicting with these requirements is the need to travel at speed between sections.

2.4. The design also has to bear reference in the small Company to the machine tools available to produce the initial batches. This constrains the design to the use of general purpose machine tools, with the exception of one specialised machine designed and built within the Company and with university help. (Figure 2.)

2.5. Since there is at present, no British engine available, it was estimated that, with some sub-contract manufacture, approximately five hundred engines could be produced and sold per annum.

3. ENGINE DESCRIPTION

The engine is a 326 cm³ piston ported, cross flow, two-cycle, single cylinder air cooled engine, using 76 mm bore x 72 mm stroke, having an integral indirect eight speed three shaft gearbox driven through a metal friction clutch by duplex chain.

The rear gear box output has the rear swing arm pivot concentric with it. A new type of electronic ignition is used.

4.1. Cross flow scavenge

Cross flow scavenge (Figure 3) is a porting configuration, in which the transfer port and exhaust port are diametrically opposed in the cylinder bore. The incoming charge is deflected towards the cylinder head by the shape of the piston. This type of scavenge was selected because the authors believe that the flow pattern is less sensitive to volume flow during scavenging than the more conventional loop scavenge type. Although test bed experience with the 700S would support this view, the authors have not carried out any research, nor are they aware of any, into this particular aspect of scavenging. The main disadvantage of cross flow scavenge is that the transfer port area becomes a limiting factor. This is because the flow has to impinge on the deflector or pass directly into the exhaust port. The area limitation reduces maximum air flow and therefore maximum power. In a trials engine however, the flatter torque curve required should benefit from a more consistent scavenge flow pattern, rather than maximum power which is of less importance.

4.2. Gear box

With a trials machine it is necessary to provide at least four low, fairly close and useable ratios for 'off road' use. Yet the requirement to have a flexible high torque low rotational speed engine with reasonable road speed, is in conflict with this. Clearly the alternative is to provide an adequate number of gears in the box.

Also it is important to present a narrow machine profile, but with a conventional two shaft gear box, a large number of gears conflict with this requirement. However, by adding a third shaft as shown in Figure 4, it is possible to provide a two speed power offtake from the two shaft four speed box, thereby doubling the number of gears trains available without increasing the gearbox width.

4.3. Final drive

The conventional geometry of engine drive sprocket, swing arm pivot and rear wheel spindle, in conjunction with the long suspension movement required in modern competitive machines, results in large variations in final drive chain tension. This variation in chain tension can be avoided by positioning the final drive sprocket and rear swing arm pivot concentrically. This positioning of the swing arm pivot results in the moment about the pivot being directly proportional to chain tension without being influenced by suspension position. See Figure 5.

In order to achieve this positioning, the engine, gear box, swing arm and rear wheel have been considered as a total power plant system. The swing arm with wheel complete is mounted integrally with the engine during assembly, prior to mounting in the frame. This design allows for more freedom in frame design because the constraints of having to provide a rigid rear swing arm pivot in the frame need no longer apply.

4.4. Cooling

The Company's experience on cooling in the main refers to water cooling, but by common consent, most, if not all trials engines are oil cooled. Since market reaction could be hostile in this field air cooling has been selected.

In order to ensure and accurate 'hot round' bore condition, the temperatures of the prototype engines under test will be evaluated using thermal paint and the cooling fins will be reduce to ensure a final condition analogous to the water cooled 700S barrel.

4.5. Porting design

The general port time-areas and passage shapes for the initial prototype have been derived from previous experience, 700S test bed work and computer programs, together with published data from other engines. The exhaust system has been designed using the simple formulae proposed by Blair and Johnston.⁽¹⁾

5.3. Main engine structure

Since the engine is used as a frame member it has to be structurally rigid. The arrangement used is shown in Figure 6. The main castings are split horizontally, the top carrying the front engine mounting. The side covers enclose the primary drive and the ignition, and at the rear carry the swing arm pivot adjacent to the rear engine mountings. The arrangement results in flat joint faces which can be milled,

prior to producing the bearing locations, on a special four shaft boring machine. This is the only special purpose machine tool required. The horizontal split also gives very easy access for assembly, particularly in the gear box. The general casting thickness of 5 mm (0.200 in.) is a result of using sand castings, but a reduction in this general section is anticipated when die castings are introduced for production. This will reduce weight as well as increasing production rate.

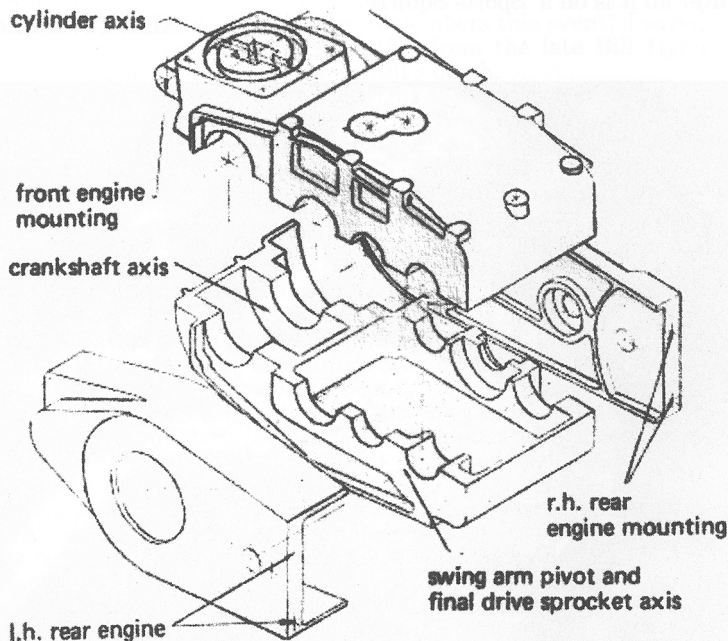


Fig. 6 Main engine castings

silk6

Dear Eddie,
 Though the Vintage Vehicle movement I was recommended to the under-noted company, who stock a large variety of batteries, including a six volt motor cycle selection which may be of interest to members:
 Shield Batteries (NW) Ltd., 33 Viaduct Street, Salford M3 7WX.
 Tel: 0161 835 2444.

Best regards, **Paul.**