I motori della serie SC (Small Car)

Di Giancarlo Cavallini

Ogniqualvolta si apre il cofano di una Herald o Spitfire sono sempre molti e diversi i commenti che si possono ascoltare su quel piccolo motore quasi “perso” in quelle grandi baie, rese ancora più vaste dallo cofano che costituisce l’intera parte anteriore delle carrozzerie di queste automobili. Quel piccolo motore ha una storia e un’evoluzione che, a dispetto delle molte opinioni sulla sua affidabilità, ne fanno di fatto, ieri come oggi, un vero punto di forza di questi modelli.

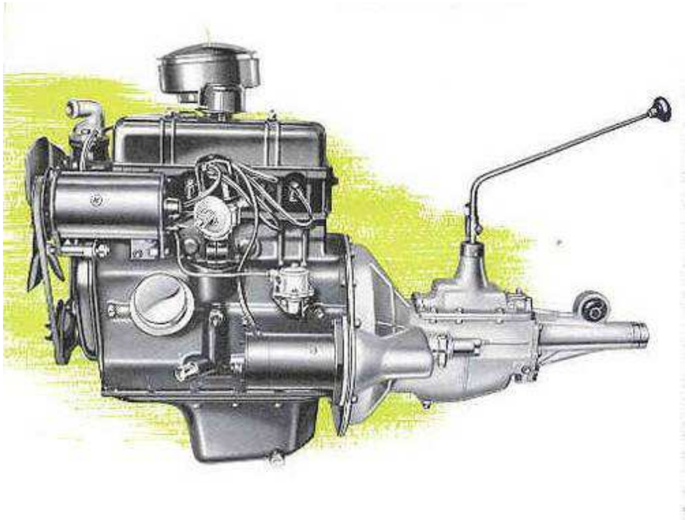

Il motore nella versione 1147cc per la Herald (a sinistra) e la Spitfire Mk2 (a destra).

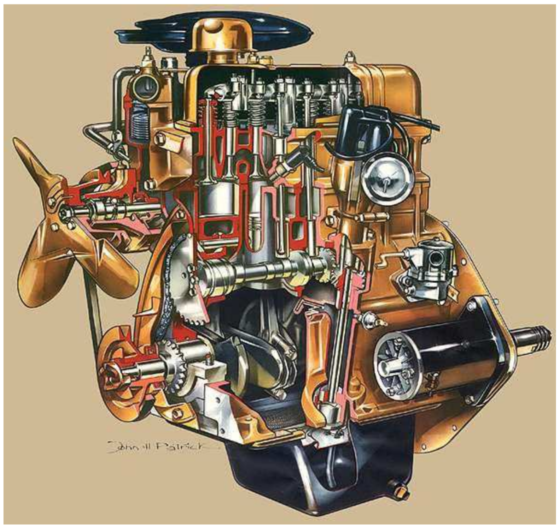
La storia di questo motore ha inizio nel lontano novembre del 1950 quando la Standard approvò il progetto della nuova automobile di classe media con carrozzeria a tre volumi, quattro porte e con motore a quattro cilindri, le future Standard Eight/Ten, destinate a sostituire la Triumph Mayflower.


La Standard 8/10 in due immagini pubblicitarie.

La Direzione della Standard, in quella occasione, decise che il nuovo modello non avrebbe ereditato nulla dai precedenti, ma sarebbe stata invece un'automobile completamente nuova sotto ogni aspetto: nuova la carrozzeria, nuovi gli interni, nuove le sospensioni e nuova anche l'intera meccanica che, nelle previsioni, sarebbe dovuto essere un progetto competitivo per una decina di anni.

In quel periodo alla Standard erano presenti quattro gruppi di progettazione con a capo quattro responsabili coordinati da Harry Webster: motori (David Eley), cambi (Ron Sydney), sospensioni e trasmissione (Howard Grubb) e chassis (Ralph Wigginton).





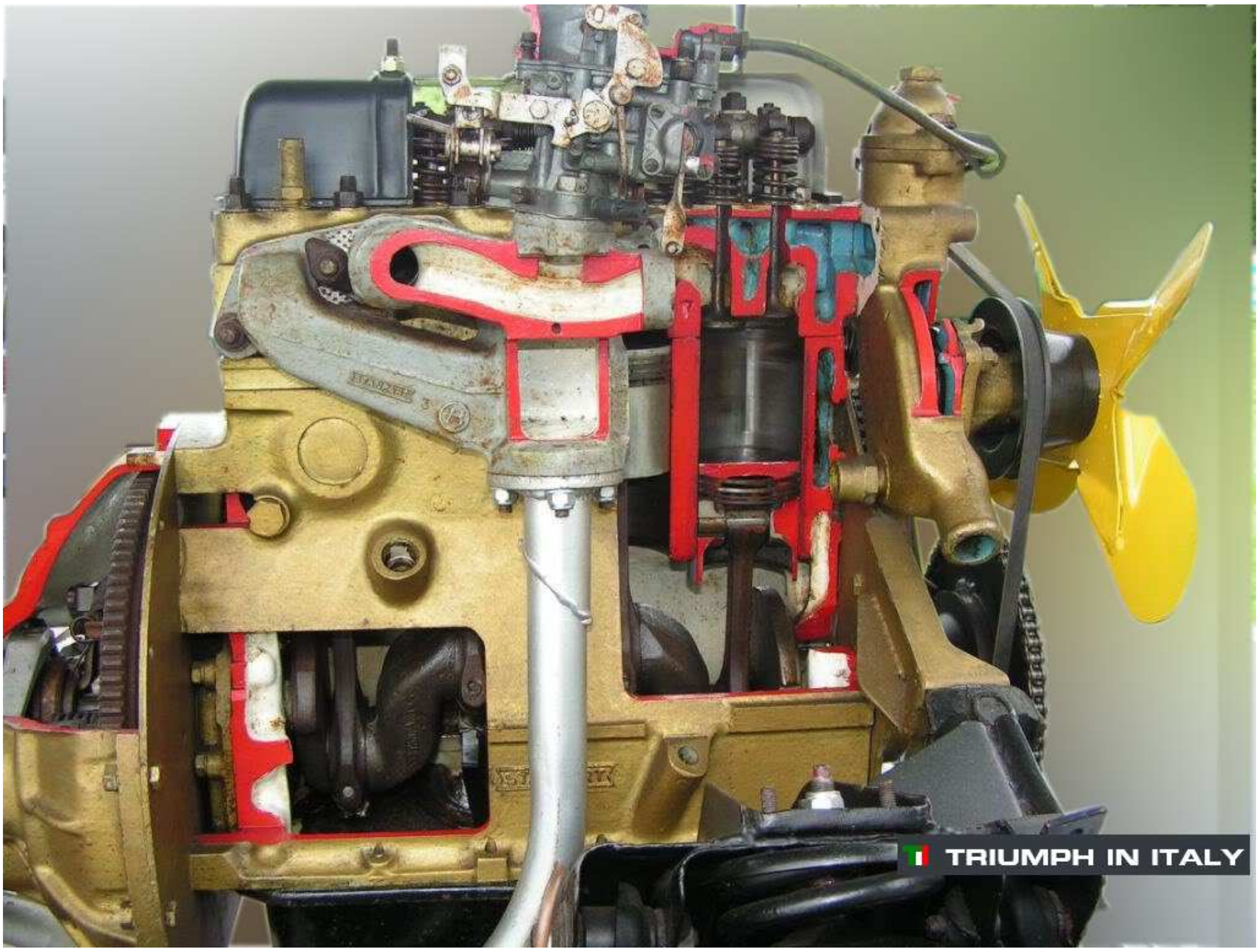
Il team degli ingegneri di David Eley iniziò quindi lo studio di un piccolo motore a quattro cilindri raffreddato ad acqua, a valvole in testa comandate da aste e bilancieri e con albero a camme laterale; la filosofia adottata fu quella di progettare un motore convenzionale e affidabile, tecnicamente semplice, di facile ed economica manutenzione, dai costi di produzione contenuti e interamente in ghisa: nulla di eccezionale, in linea con quanto, in fatto di motori, veniva offerto dei principali concorrenti sia britannici che del continente.

Nessuno, in quel lontano 1950, avrebbe però mai immaginato che quel piccolo motore non solo sarebbe rimasto in produzione per oltre ventisette anni, ma avrebbe dato origine anche ad una famiglia parallela di ottimi motori a sei cilindri. La sola limitazione progettuale imposta ad Eley per il nuovo motore fu la distanza tra i quattro centri delle canne dei quattro cilindri e questo perché l'Azienda non poteva permettersi di aggiornate l'attrezzatura della linea di costruzione dei motori con nuove macchine utensili alesatrici. I motori avrebbero quindi avuto i centri dei cilindri allineati con quelli del motore della Mayflower.

Le versioni del motore di 803 e 948 cc furono progettate contemporaneamente differendo tra loro per l'alesaggio e il disegno interno al monoblocco dei passaggi acqua. Nel disegno generale si decise che tutte le componenti elettriche fossero su di un solo lato, quello di sinistra, mentre l'alimentazione e lo scarico furono posizionati su quello di destra.

Si scelse di alloggiare l'albero motore su tre supporti di banco e di progettare una testa a sei porte, due dedicate alla aspirazione e quattro allo scarico. Quando furono disponibili i primi dati sulla nuova carrozzeria, quali l'area frontale e il coefficiente aerodinamico, il peso, la larghezza degli pneumatici, David Eley fu in grado di impostare la curva di coppia e di potenza del motore.

Con un rapporto di compressione di 7:1 i due piccoli motori, nelle due cilindrate e nelle varie evoluzioni, erogavano da 26 ad un massimo di 45 bhp. Quando nel marzo del 1956 fu approvato il progetto Zobo, la futura Triumph Herald destinata a sostituire la Standard 8/10, fu deciso che il nuovo modello avrebbe adottato la versione 948 del motore, nella versione a un carburatore Solex per la versione berlina e in quella a due carburatori SU H1 per la coupé, dove questa ultima e più potente versione era caratterizzata inizialmente per essere interamente dipinta con un colore bronzo/oro.



Sul finire del 1959 fu richiesto dall'area commerciale di mettere a disposizione per la Herald un'unità motrice ancora più potente ed elastica. La sola strada percorribile che avrebbe garantito di mantenere l'affidabilità era quella dell'aumento della cilindrata ottenibile lavorando sui valori della corsa e/o dell'alesaggio dei cilindri. Ragioni tecniche ed economiche sconsigliarono di agire sul valore della corsa in quanto si sarebbe dovuto riprogettare l'intero monoblocco affinché potesse ospitare un nuovo albero motore di diametro maggiore. La sua maggiore altezza avrebbe poi obbligato a cambiare le attrezzature nella linea di lavorazione i cui macchinari erano stati rinnovati durante il 1955. Al contempo però gli stessi ingegneri evidenziarono come nel basamento del motore di 948 ci fosse poco spazio per un aumento del valore di alesaggio a causa del posizionamento dei prigionieri. L'ipotesi di spostare i prigionieri non fu presa neppure in considerazione in quanto avrebbe significato dover ridisegnare completamente non solo il monoblocco, ma anche la testa, senza parlare poi della necessità di cambiare i trapani multipli e la macchine filettatrici.

Una soluzione poteva essere lo spostamento dei centri dei quattro cilindri per allontanarli tra loro l'un l'altro, ma neppure questa strada poteva essere adottata in quanto lo spostamento dei centri dei cilindri avrebbe comportato tutta la riprogettazione del banco motore. La questione non era di semplice soluzione: erano state date chiare direttive direzionali perché fossero minimi i cambiamenti ai macchinari della linea di lavorazione dei motore, che, come già detto, era composta da macchine utensili completamente automatizzate e recenti.

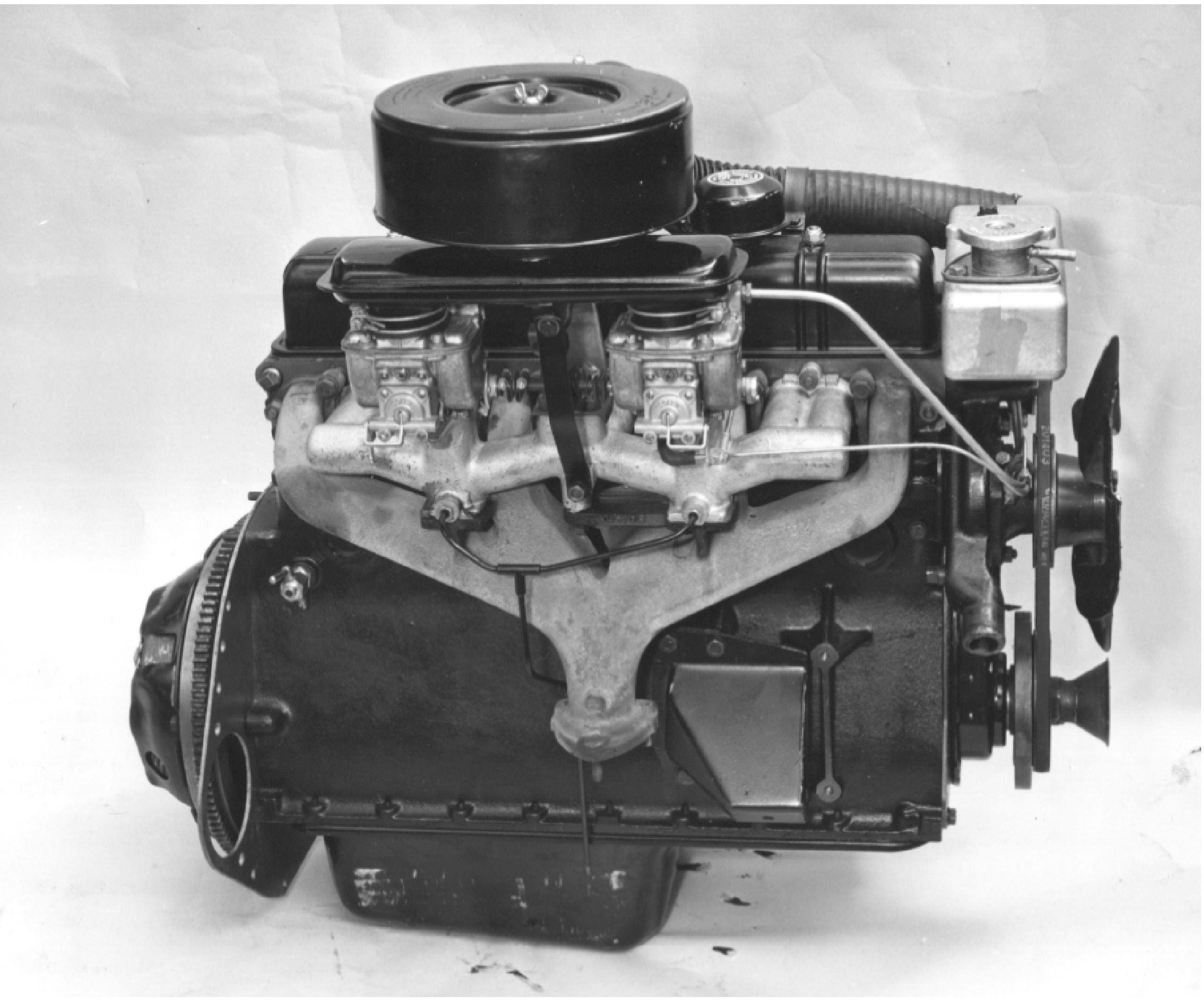
D'altro lato le direttive date ai progettisti nel 1950 sul posizionamento dei cilindri del motore, in funzione dell'attrezzature allora in uso e che ne avevano vincolato la posizione in sede di progetto, adesso sembravano chiuderne lo sviluppo e l'evoluzione. La soluzione fu trovata da Harry Webster: si trattava di una soluzione tanto ingegnosa quanto non convenzionale e che non aveva precedenti. Webster pensò di disassare gli assi dei quattro cilindri rispetto alla linea centrale dell'albero a gomiti. I centri dei quattro cilindri furono quindi spostati verso il lato dell'albero a camme di 5/32 di pollice, equivalenti a 3,97 mm.

Sovrapponendo le guarnizioni della testa del motori 948 (sotto) e 1147 (sopra) si può notare il disassamento dei quattro cilindri; le posizioni dei prigionieri della testa rimangono invariate.

Non solo questa soluzione risolveva immediatamente il problema, ma ci sarebbe stato ancora sufficiente spazio per un nuovo futuro aumento dell'alesaggio a 73,7 mm, per un valore di cilindrata, sempre a parità di corsa, di 1296cc. In quella stessa occasione Webster, coadiuvato da Jim Parkinson, studiò anche le minime modifiche che si sarebbero dovute apportare al monoblocco per potere eventualmente alloggiare un nuovo albero a gomiti capace di consentire una maggiore corsa dei pistoni, mantenendo al contempo invariate le quote di altezza del monoblocco stesso. Negli anni successivi, proprio applicando i risultati di questi studi, fu possibile disegnare un nuovo albero che, con un aumento del raggio di rotazione di 5,75 mm, realizzò un incremento del valore della corsa di 11,5 mm; con un valore finale di corsa di 87,5 e senza modificare l'alesaggio, e quindi la testa del motore, si ottenne una cilindrata finale di 1493 cc. In realtà c'era anche la possibilità, utilizzata poi in pratica solo sui motori a 6 cilindri, di aumentare il raggio di rotazione fino a 9,5 mm, il che avrebbe potuto consentire al quattro cilindri di crescere, in termini di cilindrata, a 1621 cc.

Senza cambiare l'impostazione di base del motore di origine, gli ingegneri della Triumph riuscirono quasi a raddoppiare la cilindrata del motore originale. Il motore di 1493 cc, come visto già progettato nel 1959, fu però messo in produzione per la prima volta solo sul finire degli anni sessanta. Nel decennio successivo fu installato prima sulle Spitfire MKIV destinate al mercato statunitense e successivamente sul modello 1500 e avrebbe consentito alla Triumph di rispondere alle sempre più stringenti normative antinquinamento americane compensando proprio con l'aumento di cilindrata la perdita di potenza del motore: solo aumentando la cilindrata si riuscì infatti a mantenere il valore di potenza della Spitfire ad un livello accettabile e in linea con il carattere sportivo della spider.

DAL QUATTRO AL SEI CILINDRI



Nel 1960 alla Standard fu deciso di installare sulla Vanguard il nuovo motore a sei cilindri di derivazione SC, già pronto da alcuni anni. Questa unità da 1991cc sviluppava 80bhp e adottava le scelte tecniche del motore a quattro cilindri. Il motore a sei cilindri era stato concepito sulla carta fin dal 1952 nella cilindrata di 1422 cc, ma il primo esemplare girò al banco solo nel 1955 per poi essere installato per la prima volta su di un prototipo due anni più tardi, nel 1957. Non c'era quindi alcuna parentela tecnica sia con i vecchi motori a sei cilindri della Standard (1929-1939) sviluppati anche per le Jaguar SS che con i precedenti motori a sei cilindri Triumph che equipaggiarono la Triumph Gloria, quello di derivazione Coventry-Climax (1933-1936) e quello progettato da Donald Healey (1936-1939).

Tutta la parte frontale e posteriore del motore si presentava identica al quattro cilindri e molti erano i componenti e gli accessori in comune. Lo stesso valore della corsa dei pistoni di 76 mm indica come le quote di altezza dei due monoblocchi fossero le stesse, proprio per permettere l'utilizzo delle stesse macchine utensili.

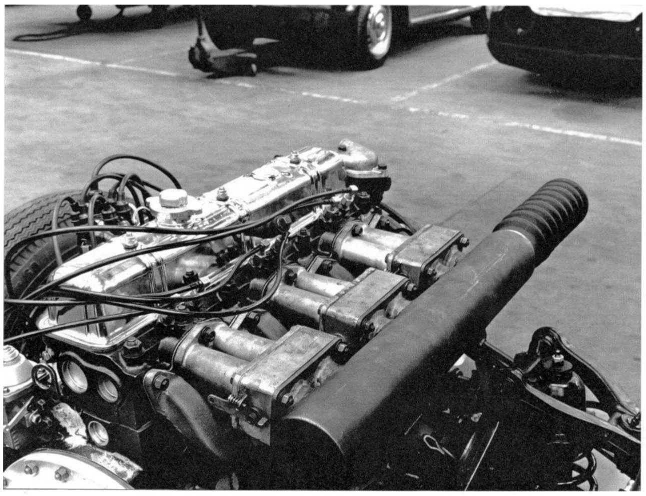
Nel momento stesso in cui il quattro cilindri fu soggetto al disassamento degli assi dei cilindri rispetto all'albero motore, lo stesso avvenne anche per il sei cilindri, consentendo di crescere prima a 1596 cc e poi a 1998 cc.

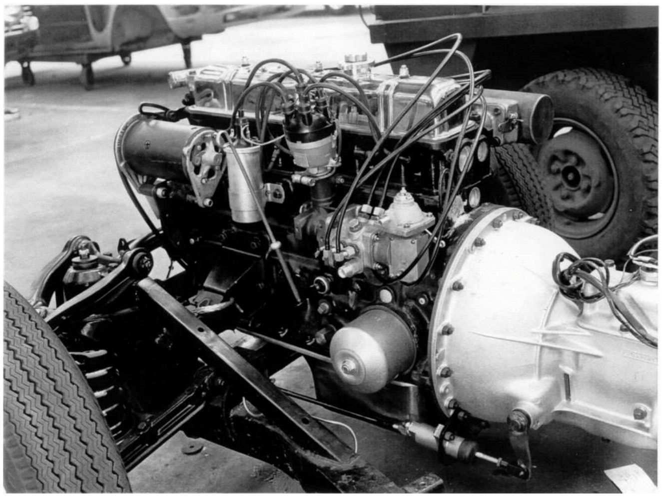
Quando si modificò il monoblocco del quattro cilindri per ottenere una corsa maggiore, nuovamente la stessa soluzione fu applicata per il sei, permettendo il raggiungimento della cilindrata di 2498 cc e di un valore di potenza di 150 bhp.

Il motore a 6 cilindri qui nella versione di 2 litri alloggiato nella GT6.

Sebbene il motore a 6 cilindri avesse un disegno di progetto che adottava l'impostazione e le scelte tecniche del 4 cilindri, David Eley, che era responsabile di entrambi, in diverse occasioni precisò che "il sei cilindri non era una versione del quattro con due cilindri in più".

A sinistra: David Eley (1917 -2009), l'ingegnere progettista dei motori SC. A destra: Eley in posa a fianco della Standard Pennant.





La versione del motore a 6 cilindri di 2.5 litri con sistema di iniezione meccanica Lucas sul telaio della TR6

Motori a 4 cilindri		Motori a 6 cilindri	
Cilindrata (cc)	**Alesaggio x corsa (mm)**	**Cilindrata (cc)**	**Alesaggio x corsa (mm)**
803	58 x 76	1422	63 x 76
948	63 x 76	1596	66,75 x 76
1147	69,3 x 76	1998	74,7 x 76
1296	73,7 x 76	2498	74,7 x 95
1493	73,7 x 87,5		

Anno	Cilindrata (cc)	Potenza (BHP)	Primo modello ad adottarlo
1953	803	28	Standard 8
1954	948	33	Standard 10
1961	1147	39	Triumph Herald 1200
1965	1298	61	Triumph 1300
1970	1493	61	Triumph 1500
1964	1147	109	Triumph Works Spitfire

THE EVOLUTION OF MODERN SMALL CAR ENGINES

(Continued from the May issue)

STANDARD-TRIUMPH. The second paper at last year's I.A.E. Automotive Division Symposium was delivered by D. C. Eley, New Projects Engineer, Standard-Triumph Ltd., and dealt with the conception and design details of their 803-c.c. engine, its redesign to 948 c.c., the design of the twin-carburetter version and a further redesign to 1,147 c.c., in both single- and twin-carburetter versions.

Before engine design was started a careful study was made of the vehicle as a whole and, this decided upon, a power-required curve was drawn, based on frontal area, aerodynamic coefficient, weights, tyre sizes, etc. This determined performance characteristics with the most suitable gearing.

Mr. Eley commenced his paper by outlining his preference for a water-cooled engine, after enumerating the many known advantages of air-cooling—and adding another, viz, that such engines are undoubtedly attractive "in territory where water may not be readily obtainable"!

The point was made that there are few examples of air-cooled units with four or more cylinders in present production. Standard-Triumph went for water-cooling as giving much greater refinement from very much better sound absorption, improved fuel economy on account of a small fan absorbing considerably less power, and simple, smell-free interior heating. The greater power outputs obtainable were regarded as of no moment when dealing with normal mass-production engines.

Two-stroke engines were apparently considered but "those available at the time" did not compare with four-stroke units and noise would have been a big problem. Four cylinders instead of two were chosen for the obvious improvement in refinement, and an in-line arrangement was considered preferable to a vee-four or flat-four as it was cheaper to make and there was ample space between the front wheels to accommodate it. The flat-four was regarded as taking longer to assemble than an in-line engine, having more parts, and as the labour force on the assembly lines cannot be reduced, as in the machine shops, by transfer machinery, this increases cost. The lengthy pipe-work and hot-spot complications were also against the flat-four.

It was realised that an o.h.v. engine was essential to get sufficient power from an economical size of package but to off-set the considerably greater machine-tool and assembly costs vertical valves in bath-tub chambers were chosen, instead of inclined valves in a wedge-shaped chamber.

To obtain a genuine 60 m.p.h., 23 b.h.p. at the road wheels was required, or a test-bed figure of 26 b.h.p. With the fuel available at the time, a 7-to-1 c.r. and Standard-Triumph's knowledge of the type of combustion chamber used, an estimated power curve showed 26 b.h.p. at 4,500 r.p.m. from 800 c.c.

Bore and stroke were dictated by the desirability of using an existing set of new and expensive cylinder boring and honing machinery of the fixed-centres multi-spindle type. A bore of 58 mm., with water all round the barrels, was a practical production casting and, with a stroke of 76 mm., gave a swept volume of 803 c.c. The stroke/bore ratio of 1.3 to 1 was high by modern standards but enabled adequate size valves to be used.

It was known that the design would remain in production for an extended period and the engine was deliberately made robust, particularly the crankshaft, rods and block. Careful consideration was given to accessibility of components, minimum number of parts, simple machining and reduction in cost. All auxiliaries were put on the camshaft side, leaving the other side free for manifolds, carburetter, air cleaner and silencer.

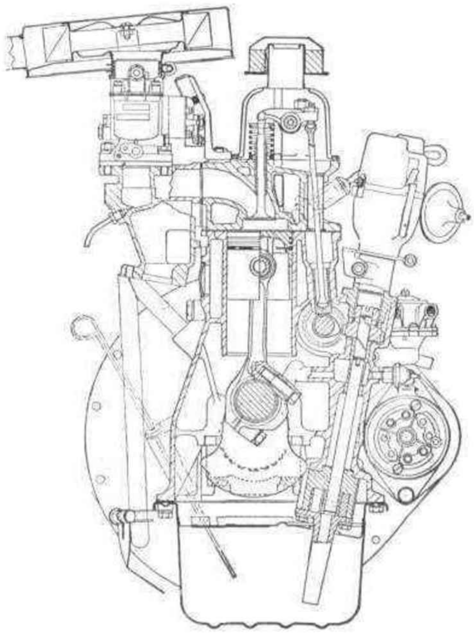
The block was of B.S. 1452/17 cast-iron, extended below the crankshaft, because with the split line on the crankshaft centre-line the only way of obtaining the required block stiffness and gearbox mounting would have been to use the more expensive and vulnerable cast sump. The extended block also allowed for bridge-pieces at front and rear over the bearing caps, thus presenting a continuous flat surface for a simple sump pressing.

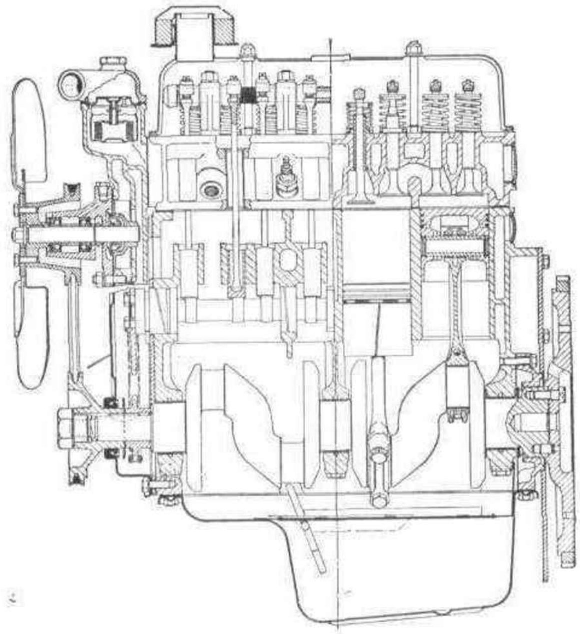
The original design allowed for integral front and rear flanges to eliminate pressed engine mountings. This improved beam strength of the block/gearbox unit, although weight and casting prices increased. Unfortunately the almost new foundry moulding boxes were not large enough to accept flanges and rather than waste many thousands of pounds, pressed mounting plates were adopted.

The design catered for a 3-bearing crankshaft, the bearing caps

Sectional views of the 1,147-c.c. Triumph engine as used in the Triumph Herald and in two-carburetter form in the Triumph Spitfire sports car.

[Drawings by courtesy of the I.M.E.]





located by a tenon in the block and 7/16-in. bolts with spring washers. The bolt centres varied one side to the other to ensure correct assembly of the caps.

The crankshaft was of manganese-molybdenum En. 16T with 277-311 Brinell hardness. The camshaft was of chilled cast-iron running direct in the block, driven by a 3/8 in.-pitch endless chain, of the Simplex type, tensioned by the Company's patented spring-steel blade with chromium-plated surface. Bucket tappets were used, as giving a better bearing extending nearer the nose of the cam than a mushroom tappet and because they can be fitted and removed with the camshaft in position.

Rather unusual, the skew-gears for the distributor and oil-pump were both of cast-iron, but by providing good lubrication and using a 46° helix angle on the driving gear, ensuring correct gear proportions and surface treatment, copper-plating the driven gear and giving the shaft a Bonderite and Parkerizing treatment before dipping it in a Dag compound, completely satisfactory operation was achieved.

The oil pump was positioned above the sump tray and oil level to enable various sump shapes to be used, and is of internal and external rotor type. Due to its high level, oil was not fed back to the suction side. An angled con.-rod enabled withdrawal through the bore but necessitated accurate location of cap to rod by press-fitted hollow dowels in the cap engaging reamed holes in the rod. Strength for strength, this design is heavier than a straight-split rod. The pistons had two compression rings of 4K6 and a slotted scraper ring to D/26 proportions, of DTD 485.

It was decided that siamesed inlet ports would suffice, and save cost by lower weight, simpler castings and less machining, but the expense of a water distribution tube in the head was considered technically justified, water being diverted on plug bosses, valve-seat areas and down into the block. Additional water holes between head and block gave freedom from steam pockets. Normal cast-iron is considered quite suitable, even for tuned engines, providing even sections can be maintained and good directed water flow is provided.

A combined spindle and bearing water pump having been "a most unfortunate and expensive experience on a larger engine unit," separate ball bearings with a seal on their outer ends running on a stainless-steel spindle to which was attached the impeller, was specified. Push-rods were of 7/32-in. steel wire of En 8R and hardened to VPN 600 to 750. The cast-iron B.S. 1452/7 rockers had a ratio of 1.5 to 1 and pads chilled to Rockwell C.48 Min. Cast-iron pedestals were later replaced by pressure die-cast alloy ones. Inlet valves were of Silchrome (En. 52) and exhaust valves of XB (En. 59), both ends flame hardened and the seats at 45°. Eleven 3/8-in. manganese-molybdenum steel (En. 16T) head studs were used; the original c. and a. gasket was replaced by a corrugated steel sheet gasket.

A Solex carburetter fed through a single cast-iron manifold unit. The engine gave its designed power, and 470 lb. in. torque at 2,500 r.p.m., on 74-octane fuel. The Standard Eight went into production in June 1953. Service complaints led to the exhaust pipe attachment being altered from 2- to 3-stud with cheaper steel in place of asbestos washer, spigot protected, to obviate leaks, and flywheel ring hardness had to be reduced from VPN (30kg.) 625-725 to VPN (10 kg.) 525-625 to bring the starter pinion life up to that of the ring.

When the Sales Dept. called for more performance a new cylinder block casting with 63 mm. bore gave a capacity of 948 c.c. Inlet valve throat diameter was increased from 0.94 to 1.06 in., exhaust valve diameter from 0.88 to 0.94 in., lift being unchanged Some 30 b.h.p. at 4,500 r.p.m. was developed, with 555 lb./in. torque, equal to 120 lb./in.^{2} b.m.e.p., lifting car speed from 60/61 to 66/67 m.p.h.

To cater for enthusiasts, a twin-carburetter kit was introduced. An aluminium inlet manifold matched two 1 1/8-in. S.U. carburetters but was very short to enable the rear carburetter to clear the clutch master cylinder, and no air cleaning or silencing was possible. With 8.5-to-1 c.r., high-lift wider-overlap timing (lift, 0.312 in.; timing 18-18-58-58), double valve springs with special collars and cotters, and a separate iron exhaust manifold with free-flowing tracts of fair length, 46 b.h.p. was produced at 5,700 r.p.m. When the 948-c.c. engine went into production in May 1954, the head of the 803-c.c. engine was altered to allow a 1-in.-dia. inlet valve and port, giving a small power increase throughout the range. In April 1956 the steel gasket put the c.r. up to 7.5 to 1, the older c. and a. gasket giving a c.r. of 7 to 1.

With the advent of premium petrol in August 1957 the inlet valves and ports of the 803-c.c. unit were increased to 1.06 in. and the exhaust valve to 0.9375 in., using 948-c.c. valves, the c.r. was put up to 8.25 to 1, 30 1/2 b.h.p. being realised at 5,000 r.p.m., with 510 lb./in. maximum torque. The 948-c.c. engine was given a 28-mm. instead of a 26-mm. carburetter, 12-12-52-52 timing instead of 10-10-50-50, and the c.r. put up to 8.0 to 1, with 0.281 in. valve lift. 36 b.h.p. was developed at 5,000 r.p.m., with 610 lb./in. torque. These engines were designated the "Gold Star" power units.

When the Triumph Herald went into production it had the 948-c.c. engine, giving a top speed of 70/71 m.p.h. As the major components of the engine were made on fully automated machinery and the crankshaft machinery was highly specified, no change in stroke was possible when more performance was sought. So the bore was increased to 69.3 mm., to give 1,147 c.c. This satisfactorily met the performance requirements with a higher axle ratio, but the increased centres and bores interfered with head studs and transfer line locations on the r.h. side of block and head. The problem was solved by moving the bore centre-line 5/32 in. towards the camshaft, giving a *désaxé* condition. In an attempt to use the existing crankshaft, con.-rods with 5/32 in. offset to the big-end were designed. Alas, tests showed that the high-loading on one end of the big-end bearings produced breakdown of the surface and heavy wear of the crankpin, and there was evidence of lack of crankshaft stiffness.

A new design, eliminating big-end offset by moving the webs 1/16 in. from the cylinders, using copper-lead bearings and stiffening the crankshaft with a "flying web" of greater section, was prepared. When redesigning the con.-rod was made so that big- and little-ends could be machined to width at the same time, and subsequent operations eased because the surfaces are at the same height from the location point of view—an immense gain from the production angle.

Mr. Eley felt that full-flow oil filtration was essential with copper-lead bearings but the extra modifications to transfer plant and the added expense caused the experimental engines to be built with by-pass filters. Tests showed that if an engine could be built with the highest degree of cleanliness, bearings and crankshaft were entirely satisfactory. But in practice full-flow filtration was proved to be essential.

For the new 1,147-c.c. engine an up-to-date piston-ring layout was adopted, with DTD 485 top ring chromium-plated, second 4K6 ring taper faced and a DTD 485 slotted scraper ring all to D/24 proportions. Valve size went up to 1.1875 in. inlet, 1.031 in. exhaust, combustion chambers were re-shaped to suit the new bore size, and a 30-mm. carburetter fitted. Output was 41 b.h.p. at 4,600 r.p.m., with 730 lb./in. torque at 2,400 r.p.m.

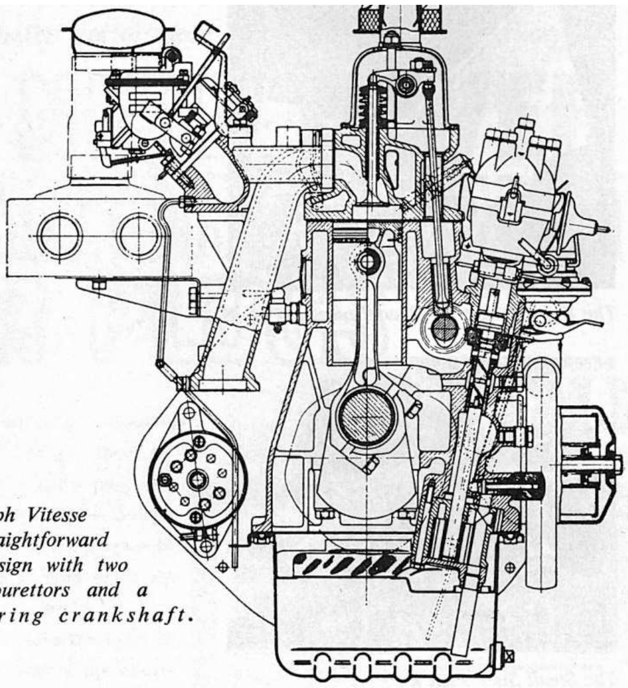
Final testing involved day-and-night running, alternating between motorways and cross-country routes, and even when the 1,147-c.c. engine had outlasted three 948-c.c. engines, it was still operating perfectly satisfactorily.

A twin-carburetter kit retaining the H.1 1 1/8-in. S.U.s of the 948-c.c. kit but a high-lift 18-18-58-58 camshaft, gave some 56 b.h.p. at 5,700 r.p.m. on an 8.5-to-1 c.r. An example of the value of developing hotted-up versions of ordinary engines was provided when development of this and subsequent twin-carburetter engines caused oil leakage from the rear crankshaft seal at high r.p.m. Reducing clearance between crankshaft and aluminium seal gave a considerable improvement but temperature checks showed greater running than static clearance to be to blame, and a full cure came with the introduction of cast-iron housings, first for the high-speed units, then for the whole engine range.

For the Triumph Spitfire a new inlet manifold was designed to take twin HS2 1 1/4-in. S.U.s, and individual pancake air cleaners enabled the length of the inlet manifold tract to be increased. A cast-iron exhaust manifold was retained, of better shape. With the high-lift camshaft and 9-to-1 c.r., 63 b.h.p. at 5,800 r.p.m. was developed, with 780 lb./in. torque at 3,500 r.p.m., giving some 93/94 m.p.h. The modest c.r. and timing were chosen after considerable test work, as they give a tractable engine with low idling speed. The exhaust valves are of 21/4NS. The header tank brackets and petrol pipe clips gave trouble until rubber-mounted.

A de luxe Herald model, the 12/50, was evolved using a free-flow exhaust manifold and the high-lift camshaft, and a 30-mm. d/d. carburetter of the strangler type. The front exhaust pipe was increased to match the manifold and an 8.5-to-1 c.r. used. The engine now gave 50 b.h.p. at 5,300 r.p.m., giving the Herald saloon a top speed of 80 m.p.h., and this direct descendant of the Standard Eight power unit delivers twice the power of the original engine, in comparative, single-carburetter form.—W. B.

THE SMALL SIX



The Triumph Vitesse Six — a straightforward pushrod design with two Solex carburettors and a four-bearing crankshaft.

. . . IT'S BACK IN BUSINESS

says "Sportscar's" Technical Editor PHILIP H. SMITH who welcomes the Triumph Vitesse engine, and prophesies a return to popularity of this type of power unit.

ABOUT 25 YEARS AGO, the small six-cylinder engine finally disappeared from the British market. From those days until quite recently, the smallest-capacity 'six' made in this country has been the Bristol of 1,971 cc. Right up to 2 litres, the four-cylinder unit has been supreme for all purposes, as far as production cars are concerned, and for most other requirements as well.

This might indicate that, on the whole, the 'four' has proved to be the most satisfactory all-round type in sizes up to something approaching 3 litres. It has certainly achieved a good compromise in dimensions and other matters relating to operational efficiency, such as individual cylinder and valve sizes, overall length and height, crankshaft rigidity, adequate bearing size, weight, and so on. In fact, the same basic design of four-cylinder pushrod overhead-valve engine is now the accepted standard, from about 800 to 2,700 cc. Modern techniques in sound-proofing, and vibration-absorbing mountings, enable such units, even when producing high power, to operate with a satisfactory minimum of passenger-inconvenience, *vis-a-vis* noise and vibration.

The trend has evidently been to go from four to six cylinders only when the cubic capacity required was greater than considered feasible with the smaller number of pistons; the result has been that above 2 litres the 'six' is well established. But before the war, and largely because of the influence of various Morris/Wolseley designs, six cylinders were quite popular between about 1,100 and 1,800 cc. and in the sporting sphere were to be found on such potent performers as the 1.5 litre Singer Le Mans, the Riley MPH, the Alvis Silver Eagle, and the MG Magnette.

NOT ENOUGH POWER

In some cases, however, the type disappointed enthusiasts who had experienced the good performance of smaller four-cylinder cars, often of the same make. The power, in relation to the extra cost and capacity, did not seem to be there, whereas fuel consumption took a decided upward leap. No doubt from the manufacturers' angle, too, the greater expense had to be considered in a highly competitive market, while the extra space required for the power unit was a disadvantage. Against this, the 'four' was becoming a highly efficient engine, with its shortcomings in regard to smoothness becoming less important as balancing and flexible-mounting techniques continued to improve.

Nevertheless, it has been evident for some time that, with the great accumulation of design date and manufacturing know-how since those days, it would only be a matter of time before some maker succeeded in combining current practice with two more cylinders in a small-size engine. We have already seen one example, in the Triumph Vitesse of 1.6 litres. It is surprising that no rival has so far appeared, but others can confidently be expected, for the reason that, quite simply, no four-cylinder, however well-designed and made, can match an equivalent six in its smoothness of power-flow. If this likeable characteristic can be combined with the thermal efficiency of the equivalent 'four', to produce power and mpg. figures of equal value, the success of such an engine is assured. It will give a new motoring sensation to the very large number of people who have never had the opportunity of sampling such an engine type, or who have been disappointed by the woolly, underpowered feel of an ancient Hornet or Magna!

No doubt there are many motorists who actually prefer the beefy beat of a four-cylinder, a characteristic which, particularly with large cylinders, gives a forceful impression of power. But such individuals nowadays are often 'vintage types'; the whole trend in engineering today is to obtain maximum continuity of smooth torque, hence the turbine and multi-cylinder locomotive. In motor cars, this comes down to more multiplication of cylinders — not, as hitherto, on the score of maximum swept volume, but in order to obtain superior balance, lighter reciprocating parts, less running inertia generally, and more power strokes per revolution.

The old objections no longer apply. Engines have been getting smaller for some time, and accommodation is not a problem. The very large number of identical components produced by automation in modern factories make the extra two cylinders of minor significance in relation to the cost of the vehicle. It is thus possible to consider objectively the position of the 'six', as a rival to the 'four' in its function as a prime mover of equal cubic capacity and power output.

SUPERIOR BALANCE

Taking first the matter of smooth torque and balance. This is not merely a consequence of individual power strokes being at lower pressure (due to the smaller piston area) and there being more of them per revolution; the dynamic balance of a 'six', apart altogether from power impulses, is infinitely superior to that of a four. There is not room here to go into the reasons for this in detail, but basically the superiority is due to the fact that the secondary vibrations, or out-of-balance forces, which are caused by the different acceleration rates of the pistons, due to crank-and-connecting-rod angularity, can be virtually cancelled-out in a 'six', with its cranks paired at 120 degrees. In the four-cylinder, these vibrations *cannot be cancelled at all*, and the only way of rendering them fairly innocuous is by a careful choice of the ratio of crank-throw to connecting-rod length, and maximum rigidity of parts. All the pistons in the latter engine come to rest simultaneously twice per revolution, whereas the six has only two of its pistons at top or bottom centre at one time, and at 120 deg. intervals, or three times per revolution.

Also, with this firing interval, while the power strokes do not actually overlap, they are virtually continuous, whereas in the 'four' the flywheel has to carry the engine round for some 60 degrees at each 'dead point'. On the 'six', then, the flywheel can be made lighter, reducing engine weight, making for a more lively and responsive engine, because of the reduction of inertia, and facilitating snappy gear-changing, because of the rapidity with which the engine revs up or slows down.

The extra length of the crankcase brings in torsional oscillation problems which are not usually so serious on the shorter 'four', but there is a lot of experience to draw on in rendering them innocuous, though it is usually necessary to add a vibration damper to the front end of the shaft. (The oscillation damper, incidentally, is another accessory which has undergone vast improvement in recent years). There being less impulsiveness in the crankshaft torque, it follows that timing chains, and gear drives to items such as oil-pumps, should have a longer life; it has been long evident that there is much less 'whip' on the timing chain of a 'six' than on an equivalent 'four'.

THERMAL EFFICIENCY

The traditional difficulties with disappointing power output and excessive fuel consumption were due to a lack of appreciation of the real problems concerned with mixture distribution. Much more is known today about such things, and manifold design has improved considerably. Apart from that, however, there is now a more general acceptance of multiple carburettors, without criticism on the score of extra complication. This is a good point, since two carburettors are really essential on a small 'six' if reasonably equal distribution to each inlet port is aimed for; separate ports are, of course, necessary. A modicum of heating applied to the manifold invariably improves the performance at lower and medium speeds, and so long as it is not excessive there will be little debit on power at full throttle and revs.

Modern cooling systems usually incorporate some flow direction for the water, and the extra two cylinders are no problem in this case, though in the past a reasonable temperature grading throughout the head was not easy to achieve, and could lead to fuel waste. Also, some heat loss was often ascribed to the basic fact of having two extra cylinders, totalling a greater area available for heat transfer. It is doubtful if this argument ever amounted to much, and when considered in relation to modern cooling systems it can definitely be ruled out of date, as can the bogy of the extra frictional losses caused by two extra pistons.

There is a definite advantage of the 'six' in terms of valve and port sizes. It is easier to accommodate large valves (*i.e.* in proportion to the capacity of the individual cylinder) when the cylinder diameter is small, and obviously this gives designers more latitude in providing good volumetric efficiency at high rpm.

The extra engine length calls for adequate rigidity in the main casting, but because of the crankshaft arrangement it is probable that there is less local loading than in the case of the 'four', bearing in mind the unbalanced secondary forces of the latter. The usual arrangement of the 'six' is to have four main bearings, with pairs of crank-throws between them. Thus, cylinders three and four have their pistons working in unison, and crank-throws in the same plane, with no intermediate bearing between them. But this effect is counteracted by suitable arrangements of balance weights at this point; both the other crank pairs have 120-degree spacing between the two cranks of a pair.

In view of the present emphasis on five main bearings for four cylinders, it might justifiably be concluded that seven is the desirable number for a 'six'. It is, of course, true that large-engined and luxury vehicles such as the Jaguar, Alvis, Rover and the like use seven 'mains', but on the other hand such potent performers as the Austin Healey 3000 manage very well with four, while the exploits of four-bearing Bristol-engined cars over a very long time in speed events need no mention. To sum this up, the advantages of having three extra bearings on a 'six' would be less than that of the two extra bearings on a 'four', assuming that in all cases the bearings, whatever their number, are up to the job.

REAPING THE BENEFITS

After a long period of successful 'bigger bangers', the fastest racing cars are now reaping the benefits inherent in a multiplicity of small cylinders — and it is unlikely that the process will end with the eight 'pots' used at present. It is surprising how fashion — allied to what is most desirable mechanically — follows the racer. This may well be an added inducement to the emergence of many more small 'sixes' before long — but it is a type which can very well be justified on its merits as a power unit alone.

They call it the smooth six — no wonder!

REPRODUCED BY COURTESY OF 'SPORTSCAR'