Famous Aero Engines

XV.—The Rolls-Royce "Kestrel" and "Buzzard"

IN our issue for October, 1928, we described the Rolls-Royce "Condor III," a 12-cylinder water-cooled engine of 650 h.p. that was designed towards the end of the War. Since that time other interesting aero engines have been added to the range produced by Rolls-Royce Ltd. Among these are the "Kestrel" and "Buzzard" engines respectively, and to-day they and the "Condor III" are the only aero engines in regular production by the firm. The "Kestrel" and "Buzzard" also are 12-cylinder engines and are water-cooled. The cylinders of all three are mounted in two banks, but those of the new types are in blocks while the "Condor III" has separate cylinders. In both new engines the frontal area has been reduced as much as possible in order to keep down the air resistances of the fuselages of the aeroplanes in which they are fitted.

The "Kestrel" was formerly called the Rolls-Royce "F" engine and has a maximum power of 570 b.h.p. It is made in no less than twelve different models. These make use of the same main components but differ from each other in regard to compression ratio, gear ratio, and supercharging.

Two compression ratios are employed in the engines of the "Kestrel" series. These are 6 to 1 and 7 to 1, the engines in which they are used being distinguished by the use in their names of the letters "A" and "B" respectively. Those in which the higher compression is used have a rated output of 480 h.p. This is developed at normal speeds at ground level and is maintained at heights up to 3,000 ft. by opening the throttle to the fullest extent. Three engines of this type are produced and the numbers I, II, or III attached to their names shows which gear ratio is fitted, those marked I having gears with the largest ratio.

Certain models are not supercharged. Others have a moderately increased blast and are said to be moderately supercharged, this being indicated by the use of the suffix "M.S." Their power at ground level is fully maintained by this means up to an altitude of 3,000 ft. The use of the letter "S" after its name denotes that an engine is fully supercharged and capable of maintaining its rated power at ground level at all heights up to 11,500 ft.

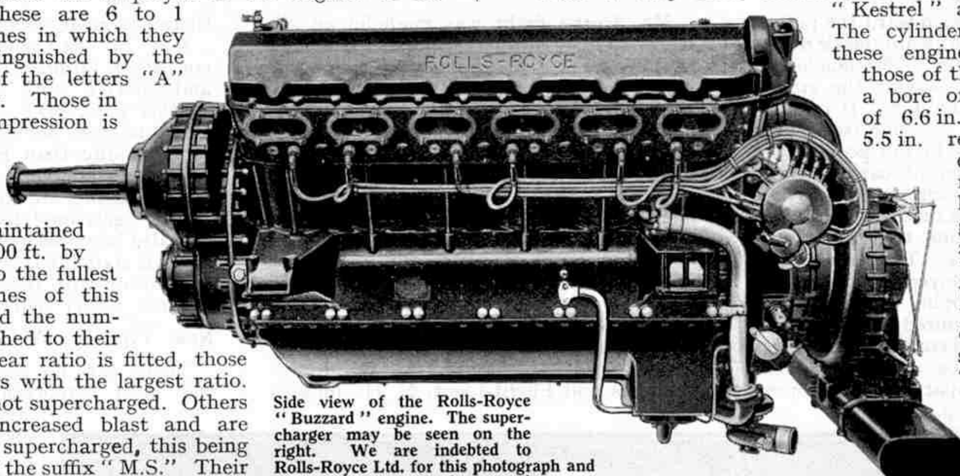
The "Buzzard" engine is rated at 825 b.h.p. It was previously known as the "H" type and was produced to meet the demand for a larger and more powerful engine than the "Kestrel." It is supplied in one form only and is fitted with a supercharger that may be used while machines equipped with the engine are on the ground. Thus it is specially useful on heavy aeroplanes, enabling them to rise easily from land or from water.

The wide range of the engines of the "Kestrel" type makes them suitable for service in many different kinds of aeroplanes. They are largely employed in military machines. Those fitted with them include the Short "Singapore II" among flying boats; such day bombing machines as the Fairey "Fox," Hawker "Hart" and "Avro "Antelope"; the twin-engined Handley Page "Hinaidi," a night bomber; and the Fairey "Firefly" and Hawker "Fury," which are single-seater interceptor fighters.

The use of an engine of the "Kestrel" type in the Hawker "Fury" is interesting, for this aeroplane is the world's fastest military machine. It is of very modern design and details of its performance have only recently been released by the Air Ministry. The standard "Fury" is fitted with the fully supercharged "Kestrel S" engine and has a speed of 207 m.p.h. at an altitude of 10,000 ft. The use of the supercharged engine gives it a speed of 214 m.p.h. when the machine is at a height of 13,000 ft., and it is capable of climbing to an altitude of 20,000 ft. in 9 mins. 40 secs. At that height its speed is 207 m.p.h.

The performance of the Hawker "Fury" is better than that of the experimental machine taking part in the interceptor trials last year, and it is well equipped for performing the duty that would be assigned to it in war conditions of intercepting enemy raiders shortly after crossing the coast line. Although its maximum speed is so high, the "Fury" is easy to handle and has a landing speed below the average of service aircraft. One squadron of the Royal Air Force—No. 43 (Fighter) Squadron—has been completely equipped with machines of this type and used them in a demonstration of formation flying at the R.A.F. display at Hendon on 27th June, 1931. Two other squadrons are to be equipped with the machine later in the year.

The Rolls-Royce "Buzzard" is employed in the Short "Singapore I," a twin-engined flying boat. The Short "Singapore II" already referred to is a development of this machine and four "Kestrel" engines are fitted to it in order to increase the power available, the total output of four engines of this class being greater than that of two "Buzzard" engines. It is interesting to note that the four-engined "Singapore II" is claimed to be the fastest flying boat in the world.



Side view of the Rolls-Royce "Buzzard" engine. The supercharger may be seen on the right. We are indebted to Rolls-Royce Ltd. for this photograph and the lower one on the opposite page.

There is very little difference in construction between the "Kestrel" and the "Buzzard." The cylinders of the second of these engines are larger than those of the "Kestrel," having a bore of 6 in. and a stroke of 6.6 in. against 5 in. and 5.5 in. respectively for the corresponding measurements of the lower powered engines. The "Buzzard" weighs 1,460 lb., a figure that may be compared with the weight of the moderately supercharged "Kestrel III. M.S." engine, which is 900 lb.

In both engines the 12 cylinders are set in two blocks inclined at an angle of 60° to each other. The cylinder blocks are aluminium castings, and the cylinder heads are cast in one piece with the walls forming the water jackets. The separate aluminium bronze valve seats are screwed into the heads and cast-iron valve heads are fitted.

The liners, or cylinder linings, are of high carbon steel, and are of simple design. The flanged joint between the upper end of the liner and the cylinder head is made gastight by means of a soft aluminium ring, while near the lower end of the liner a sliding water-tight joint is formed by means of a rubber ring of oval section that fits into a groove in the liner. Below this joint a flange formed on the liner bears on the crankcase. Long bolts hold the whole assembly in position. These bolts are also fitted between each cylinder bore, passing through aluminium tubes swaged into the cylinder block in order to prevent water leakage. In the "Buzzard" engine two additional bolts per cylinder are provided outside the jacket.

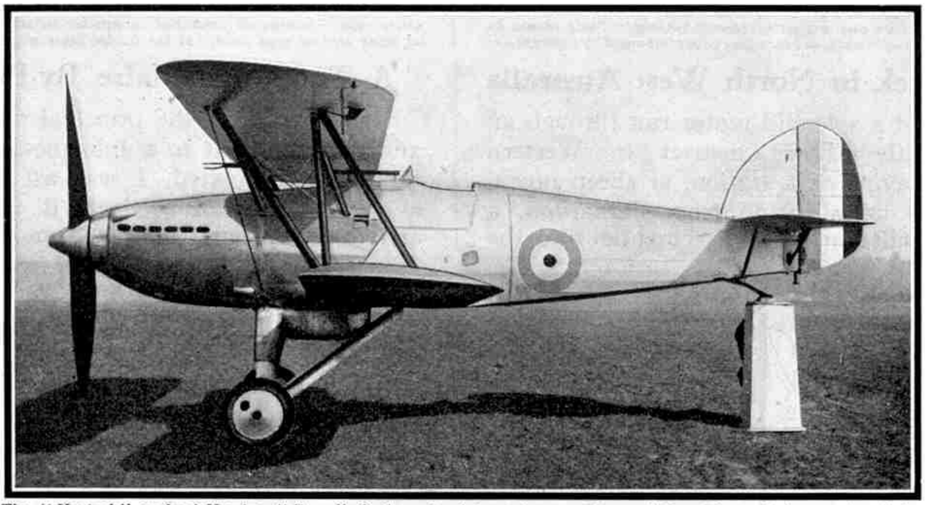
In order to reduce to a minimum the length of the cylinder block, and thus of the whole engine, the steel linings of the cylinders are not separated from each other by aluminium walls. Thus the assembly of this cylinder block is an extremely simple matter, while the water jacket can readily be cleaned out at each overhaul, for when the liners are withdrawn, its interior surfaces are exposed. The exterior surfaces of the cylinder barrels are plated in order to make them immune from the corrosive effects of unsuitable water. The plating can, if desired, be renewed during overhaul. This valuable new feature of Rolls-Royce engines has appreciably reduced maintenance cost.

Each cylinder is fitted with two inlet and two outlet exhaust valves. The valves are machined from chromium silicon steel.

They are operated by an overhead camshaft, a separate rocker being provided for each valve. The valve gear has been specially designed in order to secure a minimum overall height of the cylinder block, and thus to reduce the total head resistance of the engine as much as possible.

The pistons are made from forged aluminium alloy and are machined all over. Three compression rings and one oil scraper ring are fitted and stops are provided to prevent the rings rotating. The hollow gudgeon pins are made of silicon manganese and are steel hardened and ground. They are of the full floating type, axial movement being limited by circlip rings at the ends.

Forked-type connecting rods are employed. The rods are of "H" section made from forgings of 3½ per cent. nickel steel machined all over. The big end of the forked rod consists of a mild steel block split longitudinally and lined with white metal internally, a white metal bearing surface also being provided over the outside of the central portion on which the big end of the blade rod works.



The "Kestrel"-engined Hawker "Fury" single-seater interceptor machine. This photograph is reproduced by permission of the H. G. Hawker Engineering Co. Ltd.

The crankshaft is machined from nickel chrome steel, and runs in seven main bearings fitted into the upper half of the crankcase. Thus the lower half of the crankcase may be removed without interfering with the bearings. The split bearing shells are of mild steel lined with white metal. They are held in place by forged duralumin caps and bolts fitted into parallel guides in the crankcase. In order to prevent any possibility of the cap working in these guides, and also to increase the torsional rigidity of the crankcase, bolts are passed right through the crankcase and the cap, thus making the unit almost equivalent of a solid unsplit bearing. The great advantage of this system is that, as previously mentioned, the lower half of the crankcase can be removed without interfering with the bearings.

The camshafts are of 5 per cent. nickel steel machined from the solid, the actual bearing surfaces being hardened and ground. The rockers, which are of the same material, are machined all over. They have hardened and ground cam follower faces and adjustable tappets are also fitted. The camshaft bearings and wearing surfaces are lubricated from the low-pressure oil system.

Power is transmitted from the crankshaft to the airscrew through single spur reduction gearing. This form of gearing has been chosen because it has the advantage of bringing the airscrew shaft roughly into the centre of the cross section of the engine, thereby assisting the aircraft constructor in obtaining good streamlining. The airscrew hub attachment is similar to that which has been used with success by Rolls-Royce Ltd. for many years. The hub is centralised upon cones at its extremities and driven by splines towards the rear end.

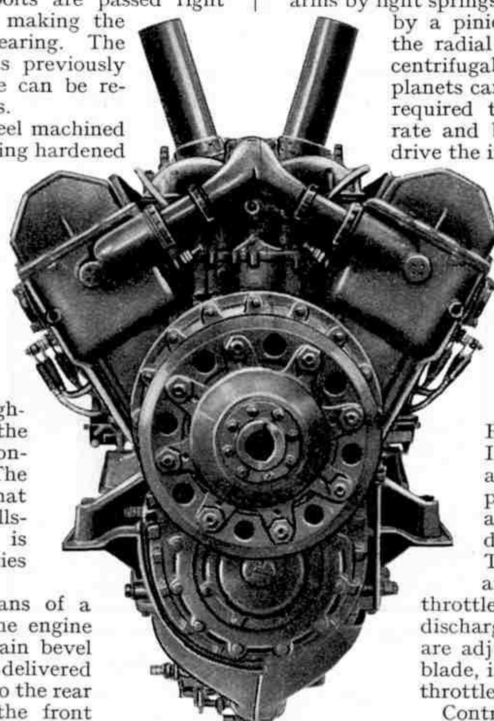
The cooling water is circulated by means of a centrifugal pump situated at the rear of the engine and driven by a vertical shaft from the main bevel wheel of the camshaft drive. Water is delivered from the pump by two separate connections to the rear end of each cylinder jacket, leaving at the front ends by horizontal pipes running between the cylinder blocks to the rear of the engine. Oil is supplied by pumps of the usual gear type. These are driven by splined gearing from the vertical shaft that operates the water pump.

The engines are fitted with hand-starting gear. This is of the worm-and-wheel type and it incorporates a multiple clutch that is designed to slip in the event of a backfire. The worm wheel is mounted on the sleeve carrying the main bevel wheel for the auxiliary drive. Below this worm wheel is a splined shaft on which the worm is mounted, the engine being turned by means of a crank handle at either end of the splined shaft. When the engine fires, the worm will be driven along the shaft clear of the worm wheel. The worm is restored from the free to the working position by means of a small hand-operated lever. In order to make starting easier a mixture of air and petrol may be injected into the induction system. This operation may be carried out from the pilot's cockpit.

In modern aircraft, especially those of high performance type, it is practically impossible to obtain a satisfactory gravity-fed petrol system. A petrol pump to feed the carburetters is therefore a necessity. The type fitted to the Rolls-Royce engine is driven by means of spur-gearing from a small cross-shaft that in turn is worm driven off the vertical shaft of the water pump. The same shaft provides the drive for the generator of the Constantinesco gun synchronising gear.

"Kestrel" engines of types A and B are fitted with two Rolls-Royce duplex carburetters mounted between the cylinder blocks. The supercharger employed in certain models is of the centrifugal type. It is driven from the crankshaft through the medium of the flexible shaft that acts as a spring drive to the camshaft and auxiliaries.

The impellor fan of the supercharger is made of duralumin and is fitted with radial blades that are driven through speed-multiplying planetary gear. This is frictionally driven by means of "slippers" held in engagement with the inside of the gear arms by light springs. The slippers are driven from the crankshaft by a pinion, and as their speed of rotation increases, the radial pressure of the springs also is increased by centrifugal force and consequently the power that the planets can transmit increases considerably. The power required to drive the impellor increases at a similar rate and because of this the gear can be arranged to drive the impellor with a predetermined margin of power above that causing slip, the margin being constant throughout the working range of speed. The object of the special friction drive is to protect the gear against damage caused by sudden acceleration or deceleration of the crankshaft.



Front view of the Rolls-Royce "Kestrel" engine.

The speed of the impellor on the "Kestrel M.S." engine is 15,525 r.p.m., while on an engine fitted with a full supercharger the speed of the impellor is 22,500 r.p.m. at normal engine speed.

A twin-choke tube carburetter of Rolls-Royce design and manufacture is provided. It is incorporated with the supercharger casing at the rear of the engine, and is in such a position that it does not increase the frontal area. The jets are of the submerged type delivering into the air stream through diffusers. Two pilot jets and small auxiliary diffusers are provided for starting purposes and small throttle running, and the points at which they discharge their mixture into the main mixture stream are adjustable, relative to one edge of each throttle blade, in order to ensure a smooth change over as the throttles are opened.

Control of the strength of the mixture to suit different altitudes is effected by hand by means of a conical valve arranged in the fuel passage from the float chamber to each jet. The levers for this purpose, and also for controlling the throttle are connected to a transverse shaft on the rear of the engine. The engine is so arranged that there is no necessity for an additional control for the ignition to be fitted, the setting of the magnetos being operated by the throttle. The ignition timing is fully advanced when the throttle is in the central position.