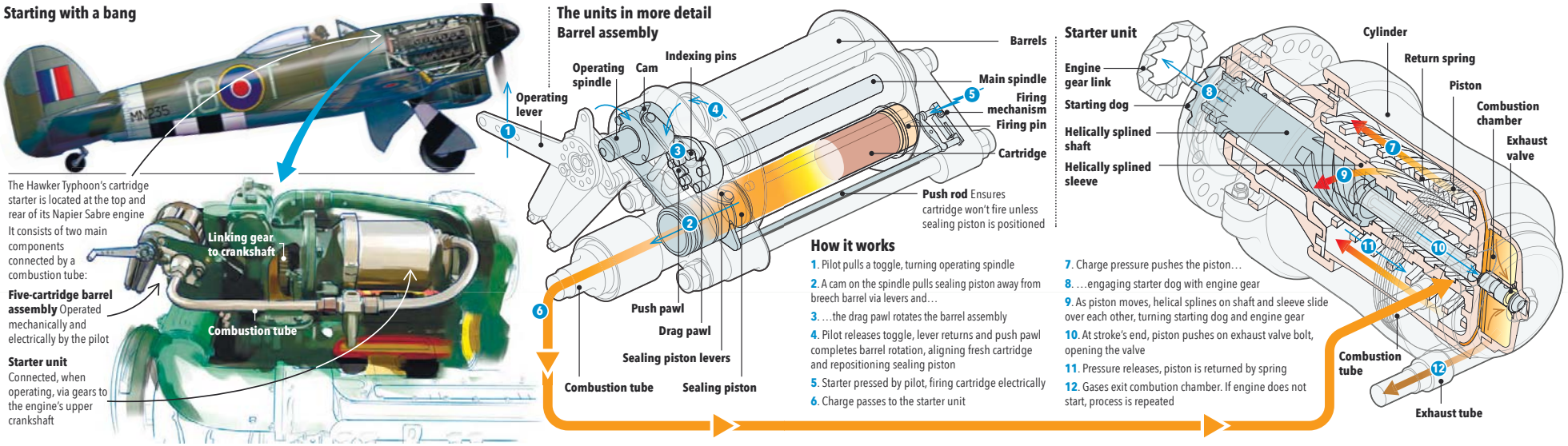
With today's convenient push-button starters, it is easy to forget that this facility was hard-won – previously, many more challenging methods were used to get engines running



CARTRIDGE STARTERS

WORDS: JAMES KIGHTLY **ARTWORK:** IAN BOTT

The critical elements for aircraft engine starting were that the total weight of the starter kit carried in the aircraft had to be minimal, yet still able to start high-performance, and therefore demanding, aero engines. One lightweight starter was the Coffman cartridge, often known colloquially as a 'shotgun starter'.

Patented by an American, Roscoe A. Coffman, in 1935, it was a means of converting a stable, compact burst of energy in order to turn an engine over effectively enough for it to pick up and start running on its own. In simple terms, a gun-like bulletless cartridge was inserted into the breech of a firing chamber, which was connected, via a metal tube, to a device to turn the engine — either a starter motor, as shown, or an element of the engine itself, such as on later jets. With the cartridge fired by the pilot after the engine had been set with the ignition on and the fuel mixture as required, the pilot would trigger the cartridge's primer, igniting the cordite charge. The resulting gas explosion would be forced through the tube (at approximately 1,000psi at 600ft per second) to cause the engine to turn.

A mass cartridge start by Fleet Air Arm Hawker Sea Hawks aboard HMS *Eagle* during Exercise 'Sea Enterprise' in 1955. KEY COLLECTION

As noted in the accompanying illustration, if the engine did not catch and run the process was repeated, but this was the first of the system's shortcomings to be fixed. If the breech had one chamber, the shell had to be physically extracted and a new one inserted. Later versions adopted a revolver-style multi-shell breech set-up, with between two and six shells ready to be used. Early English Electric Canberras, for instance, had the single-cartridge arrangement, which could result in a 10-minute delay while the groundcrew had to wait for the area to cool enough to fit a new one. Subsequent Canberras had a three-cartridge unit. One benefit was that each cartridge was small, easily stored and simple to use, advantageous in comparison to unreliable batteries or bulky and awkward equipment such as the Hucks starter, and easier and safer than the later isopropyl nitrate (avpin) liquid monofuel that was used in some jet engine starting mechanisms.

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The cartridge itself looked like an artillery shell, but there were differences. The base plate was usually over-size to hold it correctly in the chamber, while the front had a lip rolled in from the sides to hold the disc-shaped cover, usually made from something entirely consumable in the discharge such as cardboard.

As is well known from the dramatic engine start sequence in the film *The Flight of the Phoenix*, involving Jimmy Stewart's character Frank Towns, the starter could become ineffective due to a build-up of carbon in the starting tube. In the original novel, by Elleston Trevor, Towns' thoughts illustrate the idea of using a cartridge just to clear the carbon: "Risk the next cartridge on clearing the pots — she was too rich, stank of the stuff. Mixture weak, switches off, throttle wide open and risk it."

The Coffman system was adopted in the late 1930s, notably with the Grumman Wildcat's Pratt & Whitney Twin Wasp, and by 1940 on the Spitfire II's Rolls-Royce Merlin XII. Later wartime use was with the Napier Sabre, as illustrated, while post-war employment came with the DHC Chipmunk's Gipsy Major and the Pratt & Whitney Wasp Junior on the Beaver. One Chipmunk user in the UK remembers that Coffman cartridges were only issued for 'away' landings, hand-swinging propellers otherwise being the rule because of the 2/6d cost per cartridge. Today, most piston-engine types have been reconfigured with other starting systems.

> "One benefit was that each cartridge was small and simple to use, advantageous in comparison to unreliable batteries or equipment like the Hucks starter"

Bizarrely, one standard size of Coffman cartridges was four-gauge, equivalent to that of the 19th century hunter's black powder elephant gun. A similar cartridge system was used in Marshall tractors, and in armoured military vehicles. Today some cartridge engine starters are still used in extreme low-temperature environments, where electric systems are unable to perform properly.

FURIOUS BANGS AND EXTRA FLAMES

Coffman starts could be tricky, as recalled by Royal Australian Navy Hawker Sea Fury pilot Fred Lane: "If the cylinder priming time guess or throttle position was not just right, the impetus from a single Coffman starter cartridge might not be sufficient to keep the engine turning long enough. Firing the second or more cartridges from the six-cartridge breech might or might not work. Sometimes it was best to wait 10 minutes or so, then try again with the throttle advanced a little more than usual. The second problem: instead of turning the engine, the Coffman starter might just 'fizz' for 30 seconds or so and exude a cloud of noxious-smelling smoke."

On jets, a giant plume of black smoke was normal, while on the Gloster Javelin an unsuccessful start caused engine 'flooding' whereupon the subsequent start resulted in a huge exhaust flame — spectacular, but entirely harmless.