THE OFFICIAL LAA MAGAZINE FOR LIGHT FLIGHT IN THE UK

LIGHT Aviation

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HARMON'S SUPER ROCKET

THIS IS NOT JUST ANY RV4, IT'S HARMON'S RV4!

5... 4... 3... 2... 1... BLAST OFF!

SEEING THE WOOD FROM THE TREES
FRANCIS DONALDSON ON NATURE'S OWN COMPOSITE

FLOAT PLANE DREAM BECOMES A REALITY
MIKE LAUNDY FLIES HIS KITFOX FROM THE CORNWALL COAST

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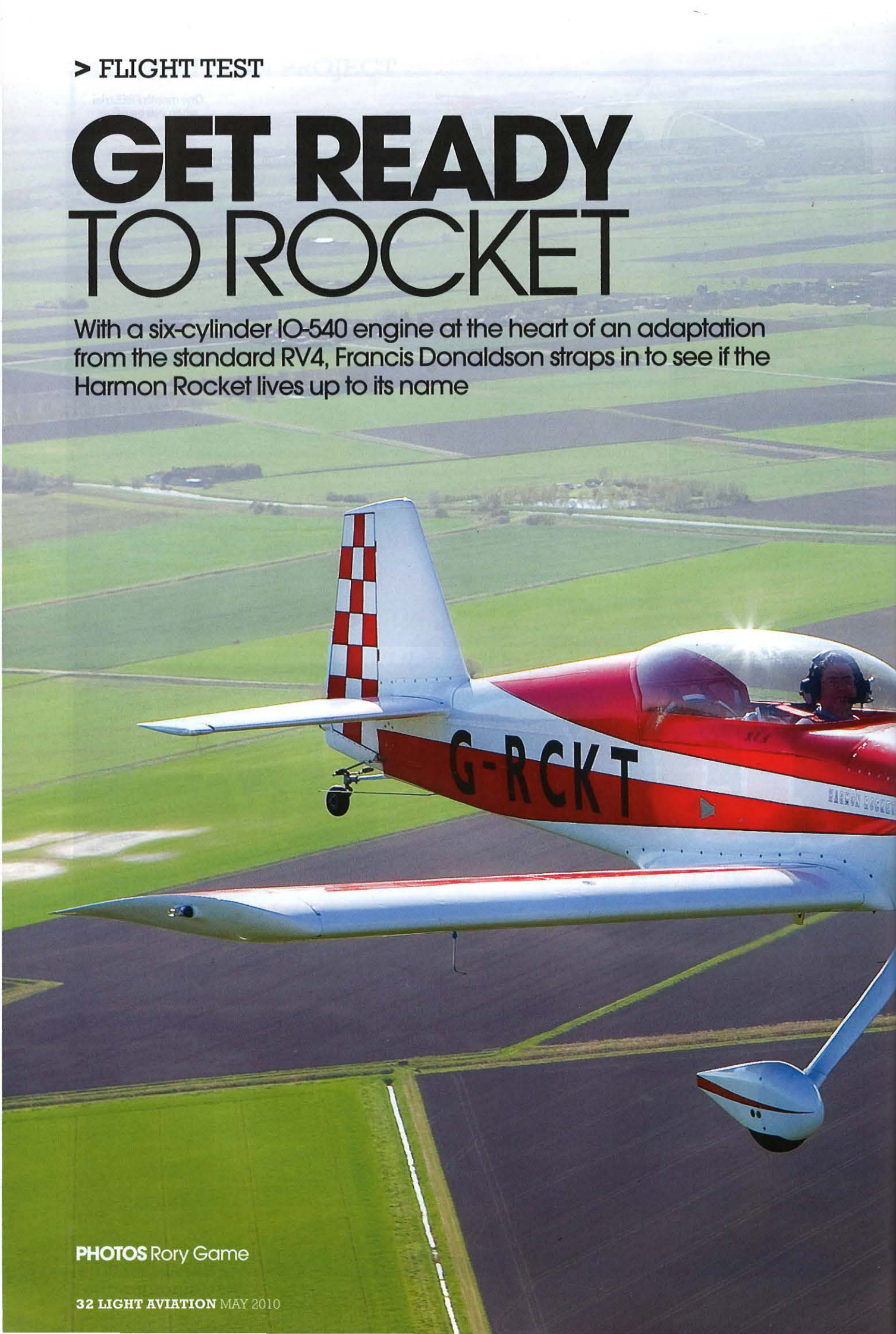
Francis Donaldson flies the Harmon Rocket

GET READY TO ROCKET

With a six-cylinder IO-540 engine at the heart of an adaptation from the standard RV4, Francis Donaldson straps in to see if the Harmon Rocket lives up to its name



PHOTOS Rory Game

Massive 80in-diameter c/s propeller leads the way.

In level flight, speeds above 180kts indicated come without really trying.

IT'S a sunshine-filled and gin-clear afternoon in April, and I am strapped into a high-performance low-wing sports plane, about to celebrate the long awaited arrival of spring. There's not a contrail in the sky over the whole of the UK, for the entire upper airspace is closed to IFR traffic by the threat of invisible volcanic ash.

Rocking gently on its undercarriage as the engine warms up before taking flight, I look out on a ludicrously short pair of scarlet-painted wings, each scarcely more than 9ft long, and a beckoning swathe of green farm strip stretching out ahead. There's a feeling of déjà vu – and I recall another bright red home-built I owned briefly years ago, a Druine Turbulent of similar external dimension. But where the cheeky wood-and-fabric Turb was a single-seater borne tentatively aloft by a 45hp VW engine, today's all-metal chariot is a tandem two-place propelled by a Lycoming of six times the Volks' power. With a compact, low-drag airframe and a power to weight ratio up there with the Extras and Pitts Specials, the aptly-named Harmon Rocket is surely going to be one hot ship.

Take an existing popular high-performance home-built, shoe-horn in an engine with 50% more power, then, for good measure, clip the wingspan for more speed. What do you get? According to conventional wisdom, a nose-heavy, mean-handling winged brick. Fortunately, back in the late 1980s, John Harmon of Bakersfield, California ignored any such gloomy predictions and went ahead with transforming the Vans RV4 into his custom-designed Harmon Rocket II.

After building several single-seat RV3s, including a souped-up version called the Rocket 1, John built an RV4 so he could take his wife along too. Apparently that lady was not too enamoured with long trips, and the concept of the Rocket II was born out of her all too frequent appeals of, 'Are we there yet John?' from the RV4's rather cramped back seat.

John loved the handling of the RV4 but felt he just had to have one with better comfort and a lot more performance. Out went the 150-180hp four-cylinder Lycoming recommended by RV4 designer Richard Vansgrunsven, replaced by a six-cylinder IO-540 turning a whacking great constant-speed propeller to make sure all of the Lycoming's 260 horses could be put to work.

To restore the centre of gravity to its rightful place, the fuselage was stretched in the rear cockpit area, giving a welcome increase in space for the passenger, and the forward fuselage was widened to blend into a broader firewall and cowling, doing away with the RV4's cowl cheeks and giving the pilot 4in more elbow room into the bargain. The 80in-diameter propeller meant longer main undercarriage legs were needed for ground clearance, so Harmon devised his own design of leg from titanium, rather than hardened steel as previously. To supply the thirstier IO-540's needs, the size of the integral fuel tanks that make up the inboard part of the wing's leading edges was increased, upping the total capacity from 32 to 42 US gallons.

All these changes resulted in increased weight – the max gross would have to rise from 1500lb to 1800lb, and then 2000lb. Harmon clipped the wing span by 8in either side to bring the wing spar bending moments back to an acceptable level, aiming to keep the wing good for +6g. To cope with the higher wing loading and Harmon's intention of cruising at speeds well over the RV4's 210mph Vne, the wing ribs were repositioned closer together along the spars, and the thickness of the aluminium alloy wing and fuselage skins were increased. To give it a distinctive look, the RV4's teardrop canopy was replaced by one that is longer and sleeker, and blends into a fastback-style rear fuselage turtledeck.

KEVIN ARMSTRONG'S ROCKET

Completed in June 2006, G-RCKT is the first and so far, only Rocket in the UK. It was built over a ten-year period by LAA'er Kevin Armstrong, who now stands at the wingtip, no doubt trying to calm his nerves. But I had known Kevin from way back before that, for he has the distinction of being the first person in the UK to get a Van's-designed aircraft onto a Permit to Fly, having imported a very early example of the RV4 from the USA in 1990. G-BROP, (latterly in new ownership as G-NADZ) pointed the way for more than 230 Van's aircraft now flying on the LAA system, and a similar quantity in build.

Based at a convenient but not overly-long Cambridgeshire grass strip, Kevin enjoyed

'There's not a contrail in the sky over the whole of the UK, for the entire upper airspace is closed to IFR traffic'

'At full throttle the Lycoming is burning well over 20 gallons an hour'

the RV4 immensely – a total convert to Van's concept of high performance from a simple, slow-landing airframe. When John Harmon's hotted-up version came out, Kevin's contacts in the States brought him the opportunity to try one in flight – and from that moment he knew that one way or another he had to have a Rocket of his own.

Building the aircraft under the supervision of LAA Inspector Pat Barker, Kevin had to deal with the fact that not only was the Rocket an unapproved design, but with the IO-540 it was also way in excess of the LAA's supposed power limit, which then stood at 180hp, as well as busting the LAA's permitted 250mph top-end Vne by 25mph. Fortunately, the LAA was able to negotiate with the CAA to take the Rocket on by special concession, thanks to our existing extensive involvement with the Van's designs.

During the time it took Kevin to build the aircraft, enough examples were clocking up flying hours successfully in other countries to allow the LAA Engineering Department to clear the Rocket's structure on the basis of pedigree and demonstrated history rather than by calculation or load test, for although Harmon has load-tested his airframe for his own peace of mind, he didn't come up with any formal test reports or other substantiating data.

First flown by Kevin himself, Kilo Tango was subsequently evaluated by former CAA test pilot Bob Cole and given a clean bill of health, leading to the issue of a full Permit to Fly in September 07.

LARGER COCKPIT

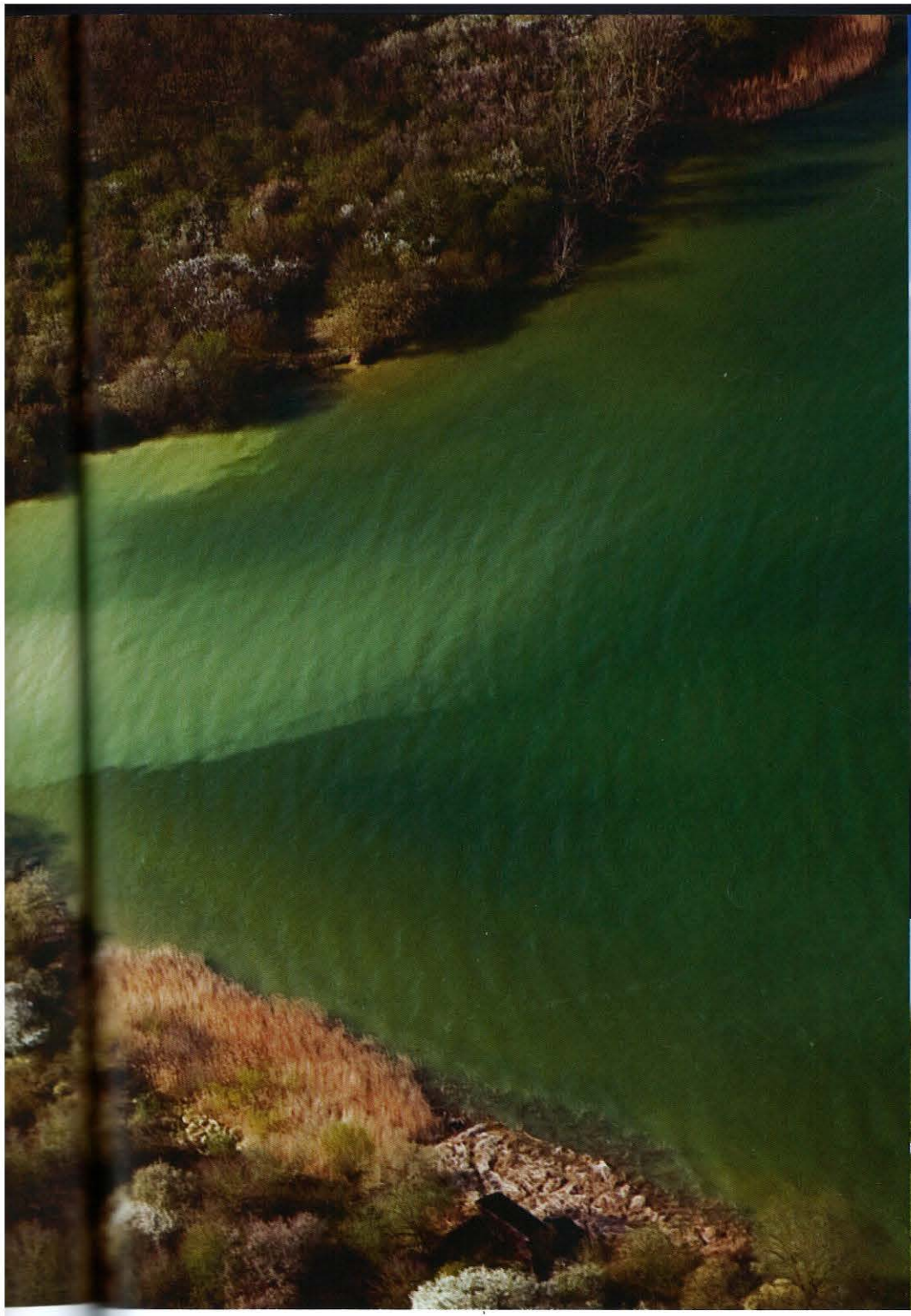
The taller gear and big two-blade Hartzell prop give the Rocket more presence than the '4, and when you get up close and open the side-hinged canopy, it's immediately obvious that the tandem cockpits are altogether more spacious, more even than Van's own RV8. Once seated and strapped in, you find any feeling of claustrophobia has gone, and the Rocket can accommodate full-size people with ease.

Flown solo from the front seat, there's dual stick and rudders for the passenger but little else, so there's no option of a dual conversion as such. The Rocket pilot sits with legs straddling a substantial centre console, glad of the five-point harness that hopefully will stop him submarining in an accident. The wider instrument panel of the Rocket means there's more space for instrumentation and avionics – some in the US have a full IFR fit – although the super-quick handling does not seem to lend itself to instrument flying, intentional or otherwise, so Kevin's has a simple VFR panel.

The overall result is a stunning-looking aeroplane that oozes get-up-and-go.

TIME TO FLY

Enough of the history, it's time to do just that and get up and go, for the oil temperature gauge has come alive. In doing the run-up checks, I'm hampered – even pushing hard on the toe brakes (there's no park brake provided) the Rocket starts to creep forwards over the grass and the tail to lift at anything over about 1600rpm, such is the thrust from that 80in prop. You have to be content with 1500 for the run-ups – which Bob Cole, in his report, excused as



CLOCKWISE FROM ABOVE: effortless power from IO-54 and superb handling from Van's derived airframe; bett ground handling than expected; sleek canopy blends into a fastback-style rear fuselage turtledeck.

being 'no different to a Spitfire'.

It's an injected engine, so there's no carb heat to cycle, just the prop and the key-controlled mags to check, then the lovely six-pot-smooth idle. There are no cowl flaps or other complications.

The throttle quadrant is mounted at just the right spot on the left cockpit sidewall for comfortable operation, so you fly the Rocket right-handed, which is as it should be. Colour coding distinguishes the similar-looking throttle, mixture and rpm levers. There's a simple left/right/off fuel selector at the base of the panel, which carries traditional gauges on its left-hand side to display the engine parameters. All basic stuff, no frills or frippery, but neatly done, workmanlike.

One concession to modernity, significant in an aircraft this thirsty, is a fuel flow meter whose totaliser function gives a more accurate indication of fuel remaining than the old-fashioned quantity gauges in the tanks. It also allows you to lean the engine quickly to a pre-determined fuel flow for a given manifold pressure/rpm combination, which is somehow quicker and easier than leaning to a particular EGT (Exhaust Gas Temperature) value.

Having cycled the electric flaps and trim, and tested 'full and free' on the controls, there's nothing much more to check, for with its fixed gear, the 200kts Rocket is simpler systems-wise than some of today's sophisticated LSA types. As with all Van's designs, the rod-operated control systems for the ailerons and elevators seem miraculously frictionless and totally devoid of backlash or stretch, so the stick moves effortlessly to all four corners.

INSTANT RESPONSE

Lined up now, all clear all around. When you open the throttle, the Rocket seems to move off simultaneously – it's like a dud flight sim program where they've screwed up the equations of motion by forgetting to enter a mass term. You move your throttle hand forward progressively and the Rocket sweeps forward and up into the air, in one easy motion.

With hindsight, you suppose you must have raised the tail and kept it straight with a stab of rudder, but the take-off is so short that these actions are hardly noticed, and the whole process of getting airborne seems as quick and automatic as getting up out of a chair.

Even before the throttle reaches the stop, the rate of climb indicator is showing 2000ft/min up and she is accelerating like a train as we pass through the 90kts flap limiting speed. No wonder Kevin recommended not bothering with take-off flap or full throttle on the runway – it would be all too easy to overspeed the flaps before even passing the upwind end of the grass strip.

Max rate of climb is around 3000ft/min, but at full throttle the Lycoming is burning well over 20 gallons an hour. So, after the initial thrill of seeing such a figure on the VSI and the crazy climb angle that goes with it, you come back to 25 squared. At this weight, this setting gives an effortless 1600ft/min climb at 120kts, using a lot less juice, plus giving a better sight of where you're going and cutting back the noise footprint.

Levelled off, the Rocket accelerates

away very quickly and speeds above 180kts indicated come without really trying, the Rocket seeming to come alive as it gets into its stride. With so much power available, there are lots of possibilities. At low altitude she'll indicate over 200kts at full throttle, but with a fuel flow around 22 US gallons per hour in that mode, you'll empty your tanks in less than two hours. Slicked-up Rockets racing at high density altitudes at Reno clock average speeds of 250mph (217kts) around the six-lap course, so must be doing well over that on the straights.

Performance information from owners on the other side of the Atlantic seems a bit hard to swallow, but Kevin is very happy with the ability to cruise at 200mph (175kts) burning around 15 US gallons per hour at 2300rpm and 23in of manifold pressure. If going for maximum range, it's more economically at 150mph (14kts) at 22 squared burning just 10 US gallons an hour, which gives a four-hour endurance. In terms of miles per gallon, the smaller-engined RVs would always win out, and when all's said and done, a Rocket is never going to be cheap to operate by the standards of most LAA aircraft.

The cruise figures can be improved by going high, of course, although at altitude you must bear in mind that the quoted 275mph Vne for the Rocket is in terms of true, not indicated, airspeed – mistakenly diving to 275mph IAS at altitude would take the Rocket dangerously outside the approved envelope. Since the Rocket's tail surfaces are exactly the same as the RV4's, it's as well not to take any liberties with the Rocket as regards Vne or flutter.

VAN'S HANDLING

The handling of the Rocket is very reminiscent of an RV, as one would expect, but enjoying even more gloriously crisp aileron response thanks to the shorter wingspan. The roll response isn't in the Extra class, but is very impressive nevertheless, and the roll rate follows the lateral position of the stick without perceptible hesitation. In pitch, thanks to the longer fuselage and six-cylinder engine, she's heavier than the RV, but that's not to say she's heavy by normal standards. In fact, flown solo, I would say her control harmony would be hard to improve. Important in an aircraft capable of high speeds, the pitch forces firm up noticeably as the ASI moves into the yellow arc.

Pitch response is more sensitive when flown two-up, due to the CofG moving back with the weight in the rear seat and pilots unaccustomed to sports plane handing might find the aeroplane prone to PIO (Pilot Induced Oscillation). Despite the clipped wings, the Rocket's wing loading is quite low for an aircraft capable of over 200kts (the Glasair III has a 50% higher wing loading, for example), so inevitably you cruise it at speeds that are deep into the yellow arc. You therefore need a reasonably light touch as heavy-handed control inputs could create excessive g forces for the structure. There's been a suspected case of a Rocket pilot not strapping himself in tightly enough, getting into a PIO that was so violent he slammed his head against the canopy and was knocked out.

Directionally, she's quite stiff either feet-on or feet-off. The standard RV4 fin and rudder are clearly up the job despite the destabilising effect of the Rocket's bigger engine and propeller up front – aided, of course, by the Rocket's stretched rear fuselage and higher turtledeck which yields a bit more keel area to the rear fuselage. This directional stiffness means she's not an aeroplane that likes to yaw through more than a few degrees at high speed, so the head-on shot in the photoshoot took a bit of effort.

'The handling of the Rocket is very reminiscent of an RV, but enjoying even more gloriously crisp aileron'

She has an inherent desire to point in the direction she's travelling – no bad thing in a small aeroplane with this much power and torque. Indeed, it's a great credit to the Rocket that changes in power setting need no unusual amount of work on the rudders to keep straight – keeping the ball centred needs no more effort than a low-powered classic like a Luscombe or Cub.

Turning to the other end of the speed envelope, we'll slow the Rocket to the stall. Flown solo, throttled back she needs a fair bit of back pressure on the stick to keep the nose up, a good safety feature. With that parallel chord wing and the RV's benign wing section, we're not expecting violent characteristics, and indeed the Rocket's stall is quite gentle when it eventually comes, indicating about 55kts flapless reducing to just 50kts with full flap. The nose finally falls through quite slowly, along with either wing depending on where you've put the slip ball. There's noticeable pre-stall buffet warning through the stick, especially with the flaps down.

Stalling with power on is more akin to helicopter flying than fixed wing, for she can virtually hang on the prop. It's an extreme area that's not been fully investigated yet, and frankly I'd want to see a pukka spin test report or a parachute and a jettisonable canopy before probing too deeply into this condition. In all normal stalling the Rocket is benign.

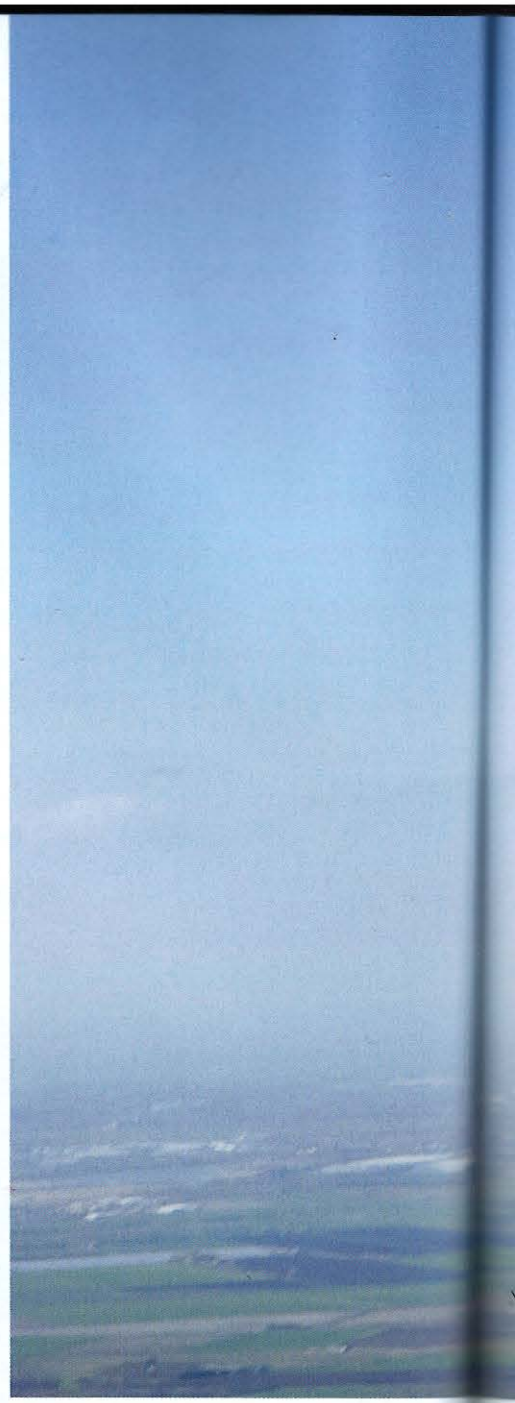
NO AEROBATICS

In the States, the Rocket II is used for aerobatics, where the high power to weight ratio gives it tremendous vertical performance in the looping plane manoeuvres. Even more so than with the RVs, the combination of high speed and moderate wing loading means great care is required to keep within the permitted speed and g envelope during Rocket aerobatics.

Specialist high-powered aerobatic types like the Extra and CAP 232 have much thicker, much stronger wings than the Rocket, whose drag helps keep the speeds down in the descending segments of manoeuvres.

A hooligan's aeroplane par excellence, sadly several Rockets have been lost in fatal accidents in the States through over-exuberant flying associated with aerobatics. In the absence of better technical substantiation, Kevin's aeroplane is presently restricted by the LAA to non-aerobatic flight only.

This is the one aspect of the aeroplane which is disappointing, for these days the LAA permits aerobatics in suitably equipped examples of the RV3, 4, 6, 7 and 8 variants, and for many owners, enjoying exercising them in this all-attitude aspect of sport flying is a major part of their raison d'etre. If you've seen Stan Hodgkins or Justyn Gorman performing in their RVs you'll know that they can do a very tidy display.



PITCH TRIM

As with the RV4, the Rocket can be fitted with a mechanical or electric pitch trimmer. G-RCKT has the electric type, operated by a four-way switch on top of the stick grip. The servo-operated trim tab moves at just the right rate to relieve stick pressures without seeming over-sensitive or fussy. The mechanical trimmer on another review Rocket was criticised for extreme sensitivity, a potentially dangerous characteristic in an aircraft in this class where a sudden unpremeditated pitch trim change could have very alarming and potentially irrecoverable consequences.

RE-ENTRY AND LANDING

Time now to configure the Rocket for re-entry, and after batting along at 180kts, the Rocket feels like it's just crawling along when you retard it back to the 90kts flap limiting speed. Not that slowing it down is a problem, for with the throttle closed, the 80in prop in fine pitch acts as a powerful brake – albeit rather a noisy one, so you may prefer to pull some tight turns to wind the speed back using induced drag.

The Rocket feels very happy at 90kts, and with the flaps down and a few dabs of up trim to counter the trim change, she's rock-steady at the 80kts approach speed, tapering to a fast

With so much power available, there are lots of possibilities, but aerobatics are yet to be approved in the UK.

look' speed of 70kts over the fence, still with excellent control about all three axes. Even still, there's no feeling of being short on energy. I chop the throttle completely as I flare, setting her down on the mainwheels with the tailwheel a few inches off the ground – a tail-low wheeler.

All the way down the approach and landing there has been an excellent view of the strip, and only as the tailwheel finally sinks to the turf does the view directly ahead get interrupted by the flat-topped front of the engine cowl. Amazingly, the Rocket runs straight as its namesake after touchdown, making the whole landing something of a non-event. As Kevin said, once she's down, at anything below 55kts she's through with flying – with a wing loading of 16lb/sq ft this is no Piper Cub, she won't float and, pleasingly, she shows no particular tendency to bounce or to chase her tail. In these respects she's like the similarly-powered Extra 300L to land, but a whole lot easier thanks to the much better view ahead, which comes from the more forward seating position and the nose-down pitch attitude change given by deploying the flaps.

The Rocket is equally at home with a three-point landing or a level wheeler – just keep in mind the not over-generous propeller ground clearance and the frightening cost of engine

'This is one of very few 200kts aeroplanes you'd think of basing on a farm strip

Tail surfaces are standard Van's RV4.

shock load checks and Hartzell props!

The longer undercarriage legs of the Rocket give a more nose-up ground attitude than the RV4, reducing the risk of banging the tailwheel down first in a short-field three-point landing – a fault which usually leads to an unpleasant front to back pitching oscillation that eventually breaks the tapered rod which mounts the tailwheel assembly. Into a light wind, with gentle braking, the landing roll takes no more than 300yds or so, testament to the Rocket's moderate wing loading. This is one of very few 200kts aeroplanes you'd think of basing on a farm strip. It has to be said though that the strip Kevin uses is exceptionally long, flat and smooth – the Rocket's not a machine to put down in any old hay-field.

A cautious taxi back to the hangar follows, weaving gently – the strip has a mole population that can throw up a surprising amount of earth the moment your back's turned. Enough to crack your wheel spat if you're unfortunate enough to smack into one at speed.

BUILDING A ROCKET

So what if you want to build a Rocket for yourself? There's no such thing as a complete Harmon Rocket kit, fast build or otherwise. Instead, you call Van's and ask for an RV4 ▶▶

kit – but give them a list of all the parts you don't need, because you will be substituting the equivalent Rocket bits.

Van's Aircraft's attitude to the Rocket is non-committal. Ever liability-conscious, they don't endorse the design, on the basis that they have no knowledge of the engineering work that has gone into it. But with Van's typically gentlemanly attitude towards their competitors, they don't criticise it either. Of course, Van's knows that these incomplete RV4 kits are going to end up forming the basis of a Rocket, but nowhere in their paperwork will you see any reference to such a purchasing option. If you choose to use their RV4 kit to build something else, you're on your own as far as Van's are concerned. On your head be it.

Then you go to Harmon's website and add all the Rocket conversion parts to your electronic basket, which appears to set you back slightly less than $10,000. This includes such things as the canopy, undercarriage legs, engine mount, cowls, and the various airframe bulkheads, frames and skins. Harmon can also supply wheels, props and spinners, although another company called Frederick Custom Airframe, run by Rocket builder Mark Frederick, also services many of the Rocket builder's needs.

The true cost of building a Rocket rather than an RV4 will amount to a fair bit more however, because of the costlier engine/propeller combination, which typically amounts to around $50,000 for newly-overhauled equipment. Where the powerplant is concerned, the Rocket is not the sort of home-built to make do with second-best.

So what does the extra investment deliver? An aeroplane with a fabulous rate of climb and cruise speeds up to 200kts, a much more comfortable cockpit and exemplary handling both in the air and on the ground, which thanks to its 50kts fully-flapped stall speed is nevertheless still able to operate from a reasonably long grass strip. All this from a simple fixed-gear all-metal airframe with a reliable normally aspirated engine from the likes of a Piper Aztec.

If you trawl through the bubbling enthusiasm overflowing from the owners' websites, you find that many Rocket drivers love to boast about their ability to cruise at typical 170kts RV speeds with only 55% power. They delight in the fact that where a fixed-pitch prop RV4 would be running at near red-line rpm to maintain this pace, the Rocket's IO-540 is loping gently along, relaxed and lowly stressed, like a Pontiac Trans-Am cruising on the freeway. With this low a power setting, the engine's reliability and life should be exceptional, and with so much power in reserve they're poised to leap ahead and outpace any challenging RVs at a touch of the throttle.

I must say I really enjoyed flying the Harmon Rocket. The inherent simplicity, the fantastic speed range and ease of handling, the view out, and the roomy cockpits are just great. There are some aeroplanes you feel instantly at home in from the moment the wheels leave the ground – the combination of control harmony, wing and power loadings, ergonomics and that indefinable 'something' seem spot on. The Bucker Jungmeister, Chipmunk and DH60 Moth are like this. The Rocket is another. John Harmon's adaption of Van's classic is a brilliant piece of kit.

Thanks, Kevin, for the opportunity to fly your pride and joy.

HARMON ROCKET

The cockpit is comfortably wider than on the RV4, allowing greater scope for the instrument fit. Reasonably long grass strip landings not a problem.

ESSENTIAL INFORMATION

PERFORMANCE
Engine Lycoming IO-540 250hp
Cruise speed 230mph
Economy cruise 215mph
Vne 275mph
ROC 3100 fpm
Stall speed 55mph

DIMENSIONS
Wingspan 21ft 10in
Length 21ft 6in
Wing area 109sq ft

WEIGHTS & LOADS
Empty weight 1200lbs
Max weight 2000lbs
Useful load 800lbs
Wing loading 16.4lbs/sq ft

www.harmonrocket.com