To Build a Chain-Drive Racing Special

Les Connett traces the evolution of his unique bike-engined Firebrand Special

TORBAY MOTOR CLUB

Period views of the Kawasaki ZZ-R600 powered Firebrand Special

Above – Chivenor Sprint 2004 - Setting a Standing-Start 1/4 mile in 14.26 seconds

Below – Negotiating the hairpin at a Dunkeswell Sprint

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Preface to the Re-titled 2023 Version

'To Build a Racing Special' was first published during 1995 as a supplement to MissFire, the Torbay Motor Club monthly magazine. Re-published in 1997, in response to Ian Bamsey the editor of Race Tech magazine, who requested it be made available to his readers who may be inspired to build a Racing Special. Now re-titled to reflect the consistent chain-drive influence of my story, this third version published in 2023, records further development, including changes to engine, brakes, differential and aerodynamics, and is distributed by Torbay Motor Club as a digital Flipbook.

Part One

A Special Builder's Tale

Early in 1994 I proudly achieved a life-long ambition to build a Racing Special with the completion of my unique self-designed and constructed lightweight single seat chain-drive racing car – the Firebrand Special.

Three years in the making in my home workshop, my Racing Special featured a fully triangulated tubular steel spaceframe chassis, with all-round independent push-rod operated inboard suspension, chain-driven by a Kawasaki ZZ-R600 motorcycle engine, developing 98bhp at 11,500 rpm.

After completion the car regularly competed in speed hill climb and sprints in the South West of England with promising results, so what follows is my story – a personal account of how an aging hill climb buff, a student of the 'amateur' approach to racing car design, came to fulfil a deep-seated ambition to be a Special Builder, and includes commentary on a variety of factors which significantly influenced me along the way.

A Special Builder Defined

In his book entitled 'Specials', the late John V. Bolster defines a special as:- *'a car built for a specific purpose by an amateur, either entirely to his own design, or by combining the essential parts of a number of makes. The reason for building it is simply to produce a car with a better performance than anything the constructor could hope to afford to buy ready-made.'*

Speed hill climbing has long been a preserve of the Special Builder, particularly at Shelsley Walsh, where the tradition continues to this day of designating selected one-off designs as 'Shelsley Specials', and Bolster's book first published in 1949, contains

technical appraisals of nearly eighty Racing Specials, including many 'Shelsley Specials' constructed between the wars, and is essential reading for anyone interested in the history of uphill racing.

Bolster, the doyen of Special Builders, recounts the trials and tribulations encountered by Special Builders including himself, and anyone contemplating such a project would be well advised to follow his example and persevere against all odds.

Having completed my own project to create the Firebrand Special from scratch, I have first hand experience of the frustrations encountered, and the single-minded purpose needed to finish the job.

In 1929, such was Bolster's determination to build a Racing Special that he constructed his renowned twin-engine 'Bloody Mary' sprint car, (pictured above), without the benefit of power tools. Consequently he was forced to drill every hole using a hand-operated breast-drill, known in the engineering world as a 'gut-buster'. When his chest and stomach became too sore to continue, he placed the work on the floor and contrived to operate the drill by sitting on top of it. *He also became very sore that way.*

Austin Seven Specials Revisited

I had an opportunity to inspect an Austin Seven Special recently created from a box of bits by fellow Special Builder for use in classic trials. This delightful retrospective and unique special took me back to my youth, to the time when I had read everything possible on the popular contemporary pastime of building Austin Seven and other specials. I still have my copy of *'How to Build Austin Specials'* by J.H. Haynes, a soft bound book that I purchased in 1959 for nine shillings (45pence). When I browse again through the fifty crudely printed and illustrated pages, I am reminded how Mr Haynes description of the various options available for the conversion of a rotting pre-war Austin Seven saloon into a two-seat open sports car, had fired my youthful imagination. He had suggested that a basic model, complete with 750cc side valve engine, lowered suspension, raked steering column and aluminium/ash two-seater body, could be fabricated by the amateur Special Builder for a little more than £54.

The dearth of affordable sports cars in the late nineteen fifties gave the more adventurous enthusiast the incentive to consider the conversion of an Austin Seven as

a viable alternative. Whether it was intended for everyday transport or for competition use, the task seemed simple enough as contemporary scrap yards were full of suitable donor vehicles, and spare parts were plentiful and cheap. In addition, companies such as Cambridge Engineering, Speedex Castings and Falcon Shells, the forerunners of our present-day kit car manufacturers, flourished by offering the Special Builder an inviting array of accessories, ranging from go-faster tuning equipment to complete fibreglass body shells, ready to bolt on to the flimsy Austin Seven chassis. However, many enthusiasts were disappointed with the realities of special building, as they found the construction of a dream car beyond their capabilities and abandoned the project before completion. Others remained steadfast, but the results of their labours varied from make-shift conversions with scant regard for engineering principles or roadworthiness, to superb machines which still exist today.

The 750 Motor Club promoted Austin Seven motor sport, including circuit racing, and young designers such as Colin Chapman, Arthur Mallock and Eric Broadley cut their teeth on the creation of Austin Seven Specials for competition purposes.

A Special Builder I Will Be

For my part, I had neither the financial means or the engineering know-how to undertake such a project at that time, but I had acquired an enthusiasm for Special Building that made me resolve that *one day I would build a Racing Special.*

'Lawrie' Bond, the Berkeley and I

A short time later I bought my first car, a four-year old Berkeley sports car. Designed by Lawrence 'Lawrie' Bond, (the originator of the three-wheeled Bond Minicar). Manufactured by Berkeley Coachwork Ltd Biggleswade, pioneers in plastic caravan construction, it featured a superbly styled composite chassis/body of fibreglass mouldings bonded and rivetted to internal aluminium members, with independent suspension on all four wheels. Initially powered by a 'tuned' 15bhp two stroke Anzani 322cc twin cylinder engine, driving the front wheels by chain, via a three-speed gearbox, (plus reverse), the diminutive open two-seater was capable of 70mph and over 50 mpg.

The car caught the imagination of a motoring press starved of modern sports cars, and attracted much public interest. Autosport devoted a two-page spread to long-time Technical Editor – John Bolster's road test in September 1956, in which he reported in glowing terms, including :- "*The little machine holds the road like a racing car, and has very high cornering power. It behaves like the best Continental FWD cars and can really be thrown around.*"

The cover photograph was a fine study of a camera-equipped Berkeley, being driven at speed by Stirling Moss during testing of the marque at Goodwood for BBC Television.

The design was developed, and later models offered a choice of alternative engines, including the 328cc Excelsior Talisman twin; a specially developed 492cc Excelsior three-cylinder engine, and the 692cc Royal Enfield Super Meteor and Constellation engines. A three-wheeled model was also introduced, which was popular amongst those who only held a motorcycle driving licence.

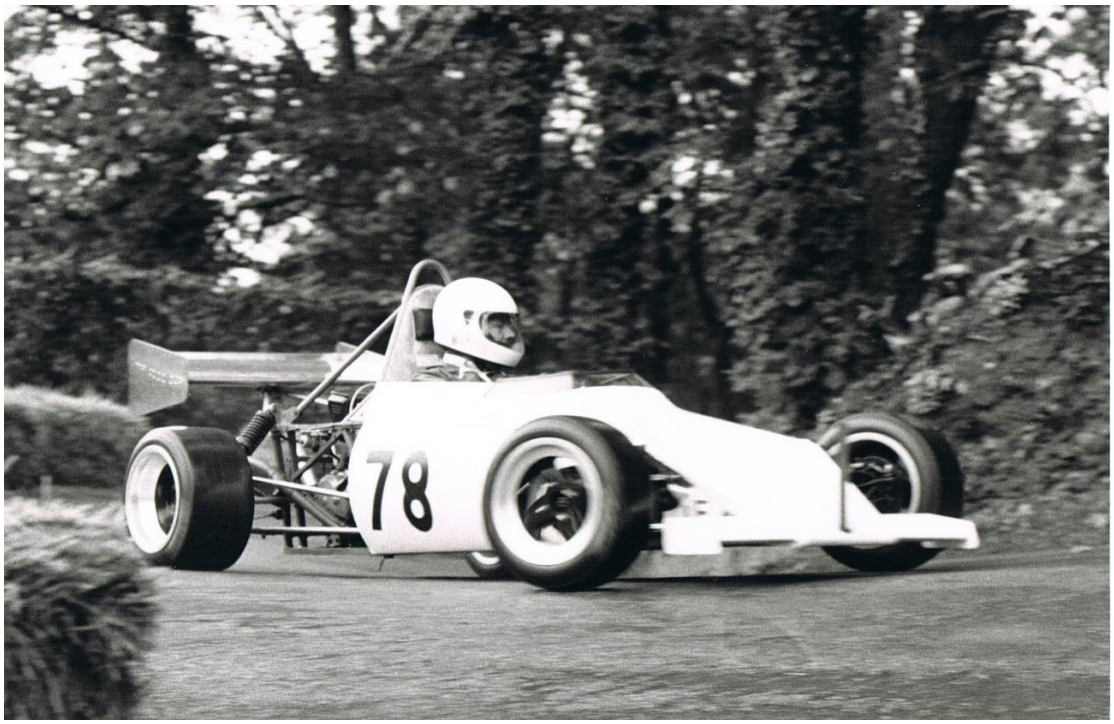
The innovative design of the Berkeley was indicative of 'Lawrie' Bond's Special Building background, for it was here that he had gained valuable experience building and racing specials with aluminium monocoque chassis, long before Colin Chapman claimed credit for the idea.

In June 1947, Bond had appeared at Shelsley Walsh Hill Climb with an extraordinary machine, a 500cc racing special painted bright yellow and subsequently nick-named the 'Doodle Bug' Bond Special by the motoring press. It was a genuine midget racer, not much bigger than a child's pedal car. Using aircraft construction techniques and materials, the ultra-lightweight aluminium monocoque chassis was powered by a front mounted 500cc Rudge Whitworth Ulster motorcycle engine, driving the reinforced front wheels by chain. The wheels themselves being of aircraft tail pattern, as used on the prototype Bond Minicar three-wheeler. There was no suspension, save for the resilience of the pneumatic tyres, and the car was so light that despite additional ballast in the form of packets of wetted sand, it leapt about over the bumps in an alarming fashion, which may have been responsible for his misfortune on a return visit to Shelsley Walsh in September 1947, when he inverted the car in the Esses, and was thrown out, resulting in a broken jaw.

Within months he had designed and constructed the first front wheel drive 500cc Formula III car, the 'Type C' Bond, which he intended to put into commercial production. The ultra-lightweight chassis was of advanced design, being of stressed-skin construction, mainly of light alloy, with a front mounted 497cc Speedway Jap engine driving the front wheels by chain, via a motorcycle gearbox. Rubber was used as the suspension medium at front and rear. Despite expectations, the 'Type C' Bond appears to have achieved little success either in competition or as a commercial venture, but it helped establish Bond's reputation as a designer.

The ownership of a chain-drive Berkeley car of the type shown below, had a profound effect on me, for not only did I learn to drive and even passed my driving test with the car, it is also remembered as a quick little sports car that sometimes overheated the air cooled twin cylinder engine on long hills, and the hood and side-screens leaked when it rained.

However, the chain-drive concept planted the seed of an idea that, subject to a variety of subsequent design influences, came to fruition some thirty years later in the extensive home-spun modification and development of my chain-drive Terrapin-Honda 750, (pictured at a wet Oddicombe Hill Climb in September 1990), and the subsequent design and construction of my unique Kawasaki-powered Firebrand Special.



Sixties Hill Climb Specials Remembered

After spectating at the inaugural Wiscombe Hill Climb, I became an ardent supporter of speed hill climbing. As the nineteen-sixties unfolded, I found myself hooked on the sport where the hills were alive with the sounds of Racing Specials, for this was a motor sport discipline where the Special Builder could put his technical theories to the test, under the most exacting competitive conditions.

Of the many home-built Racing Specials competing on the hills at that time, the Rudeani and the Terrapin most inspired me to continue my own quest to build a Racing Special, for the designer/constructor of each racer had demonstrated that the creation of a successful single-seater was achievable by an amateur, albeit that their original designs had been approached from opposite ends of the design spectrum.

'Design For Competition'

A technical appraisal of both racers appears in 'Design for Competition', an excellent 750 Motor Club publication that I bought in 1966. The book provided my initiation into contemporary chassis and suspension theory and design, and includes a report on a talk on the theory of monocoque chassis construction, given to the London Special Builders Group in February 1965, by a young BRM stress engineer and 1172 Formula competitor. His name was Mike Pilbeam, who went on to have a major influence on the design of hill climb racing cars to bear his name.

Rudeani

I first saw Rudeani at Wiscombe Park in 1965. This tiny rear-engine single seat racing car had been built to a simple concept by two amateurs, Jack Heaton-Rudd and Frank Dean; neither of whom had any knowledge of racing car design but were motivated by their desire to build a Racing Special.

Conceived in 1962, it was originally intended to be on the lines of a kart, perhaps a little larger, with slightly more engineering to it, and powered by a motorcycle engine. No plans existed as construction got under way, other than a series of chalk marks on the garage floor, denoting the layout of the basic spaceframe chassis. All independent suspension was built to look right, as roll centres were not considered initially. Ten inch diameter Mini steel wheels with widened rims were used all round. A motorcycle engine was fitted but quickly removed when Heaton-Rudd, who was left to complete the project alone when his cousin decided to withdraw, acquired a Ford 105E based engine, which he installed in a transverse position in the rear of the tiny chassis. The drive was taken to the rear wheels by a series of chains and jack-shafts, via a motorcycle gearbox. No differential was fitted. With experience gained whilst competing in hill climbs and sprints, Heaton-Rudd developed Rudeani into a highly competitive Racing Special, weighing less than 6 cwt and powered by a 1475cc engine producing 95bhp. (Pictured below at Sawbench Corner, Wiscombe Park Hill Climb).

Terrapin

The ingenious Terrapin-Min, as it was first called, is a rare 'breed' of racing car. The original was designed and built in the mid-sixties by Allan Staniforth and Richard Blackmore, and was followed up with the publication of a book entitled 'High Speed Low Cost' written by Staniforth – who was then a journalist with the Daily Mirror. Giving a step-by-step guide to the construction of the Terrapin, this very informative book was complemented by a commercially published set of engineering drawings of the chassis and suspension detail.

Whereas the design of the Rudeani appears to have evolved as construction progressed, the Terrapin was the result of stringent design criteria established prior

to construction, resulting in a robust chassis, and accurate suspension geometry produced on Staniforth's now famous 'string computer'.

The Terrapin consisted of a tubular steel spaceframe single-seater chassis with stressed alloy side panels, independent suspension all-round with fabricated wishbones, Mini uprights/hubs and powered by a rear mounted Mini engine/gearbox. It was a blueprint for immediate success, subsequently replicated by about fifty amateur constructors world-wide. Other engines were used as individual builders developed the Terrapin concept.

Terrapin Days

Whilst spectating at Oddicombe Hill Climb in March 1984, I walked down to the Paddock to view a Terrapin being raced by Plymouth brothers, Paul and John Crocker. Finding that it was for sale, I left the event having agreed to purchase the car for £1,000. It was delivered to my home a few days later by their father Dave, who thereafter became a firm friend and a willing adviser on many things technical, particularly when he cast his ever critical eye over my sometimes unusual development ideas.

Taking stock of my purchase, I found that I had acquired a single seat Terrapin, powered by a full-race 998cc Mini Cooper-type engine, equipped with 649 camshaft and twin-choke 45DCOE Weber carburettor, and driving through a straight cut close ratio gearbox. Originally built prior to 1970 by two Plymouth enthusiasts Kevin Nolan and Brian Brown, it was recorded as No 21 on the Terrapin Register maintained by Allan Staniforth, and although the racer was quite sound, it was in need of a little tender care. (Pictured below, soon after purchase in 1984).

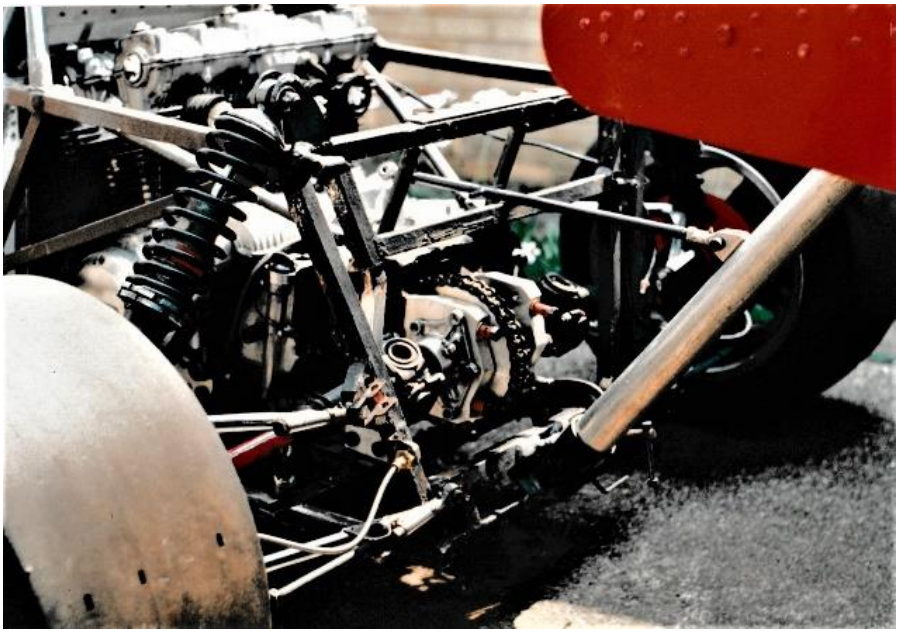
Work started immediately to build a trailer, to transport my pride and joy to my competition debut on the 15th July 1984, at the long since defunct Whitecross Sprint course in the Royal Cornwall Showground, Wadebridge.

I soon acquired the taste for driving a single seat racing car on slicks, and although the Terrapin was not particularly competitive, it was initially fast enough to regularly startle and excite me. Over time, I carried out many home-brewed modifications to

the car, including the reconstruction of the front suspension, uprights and brakes, and fabrication of GRP body panels and various aluminium aerodynamic wings.

After four seasons of competition I decided to undertake a major modification to the Terrapin, so I sold the 998cc Mini power unit to Andrew Dinner, who installed it into his self-built 'Beaver' single seat Racing Special and I bought an engine from a crashed superbike of the day. I paid £70 for a Honda CB750cc four cylinder twin-cam engine, complete with five speed gearbox, from a local motorcycle dealer.

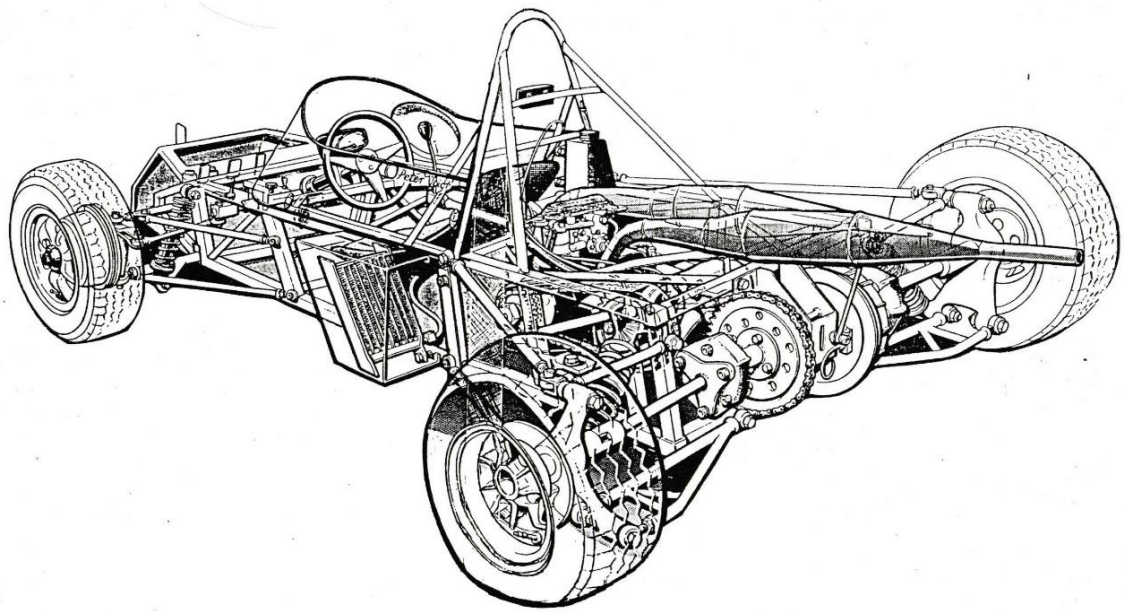
The problem was to accommodate the Honda power unit into the confines of the Terrapin rear engine bay, without carrying out radical surgery to the chassis which would detract from the original Staniforth design, but it was eventually fitted in with very little space to spare. A home-built chain drive differential was bolted to a subframe at the rear of the gearbox, to maintain drive to the existing Mini driveshafts, and ten-inch wide rear wheels. Based upon Mini components, the original crown-wheel was softened in a furnace, (thanks to the Dart Valley Railway steam workshops), and machined to accept a sprocket. (Pictured below during trial-fitting into the chassis - Honda CB750 engine and home built chain-drive Mini-based differential).



The worst job was yet to come – the fabrication of a four-into-two exhaust system which was to prove a monumental headache. Eventually it was achieved with remarkable success, by the simple expedient of packing steel exhaust tubing with fine sand, sealing the ends and bending the tube around a steel former whilst applying just sufficient amounts of heat from an oxy-acetylene torch. As each sand filled tube was effectively solid, it was a two-man job, so I enlisted the help of my son Paul, and I recall carefully applying the heat whilst he gained purchase against the bench with both feet in order to bend the tube against the former. Two-into-one collector boxes were recycled from a friendly exhaust dealer and a pair of Cherry Bomb silencers completed the system. *The finished product was good, but it was a job that I would never again attempt!*

Voight-Renwick Special

Any recollections of the various factors that influenced the design of my Firebrand Special must include the *'Voight-Renwick Special'*, for I consider the diminutive Racing Special made a significant contribution to the design criteria applicable to the modern lightweight chain-drive racing car. (Line drawing shown below).



Peter Voight – Hill Climb Racer

Peter Voight's long hill climb career started in sports cars, but with his sights firmly set on the RAC Hill Climb Championship he acquired the ex-Mike McDowel Palliser-Repco, a single seat racing car renowned for unpredictable handling. He succeeded in solving inherent chassis design problems, but despite some memorable performances, the Championship honours eluded him and with funds exhausted, he decided to temporarily withdraw from competition.

A comeback was planned for the 1974 season, but the lack of sponsorship put a big car and his dream of winning the RAC Hill Climb Championship out of reach; instead the decision was made to build a car for an assault on both the Castrol/BARC and Woking Leader's Hill Climb Championships.

The 500cc Class was singled out for the onslaught. In theory a modern car should have no trouble with the opposition presented by twenty-year old Coopers and the like, but others had tried in the past and been blown-off into the weeds in the process.

Enter The Voight-Renwick Special

The Renwick Developments 500cc Konig-powered sidecar outfits had been successful on the circuits, and so John Renwick was persuaded to part with one of the £1,000 outboard motors, normally used in speedboats. The little flat-four rotary-valve two-stroke engine produced 85bhp, whereas a good 500cc Manx Norton engine produced a little over 50bhp at best. Having acquired the power unit, and with only three months to go, the search was now on for a suitable chassis.

The tiny JW4 (Jonny Walker F4) spaceframe chassis was chosen, and modifications started immediately by putting a hacksaw through everything forward of the dashboard bulkhead, and replacing the previously curved chassis tubes with straight section, forming an all together stiffer triangulated structure, which was then skinned in alloy sheet to provide additional rigidity.

A change of front uprights and the resultant track-rod position required the steering rack to be moved from ahead, to behind the bulkhead. The brake master cylinders that were originally suspended between the driver's knees and operated by complicated linkages, were moved to the front bulkhead to mate with relocated pedals. Chassis mounted suspension pick-up points were altered at both front and rear to remove the respective anti-dive and rear squat tendencies. Ten inch diameter Minilight wheels were shod with Dunlop Intermediate racing tyres.

The diminutive water-cooled engine, which weighed only 50 lbs, was solid mounted to ¼" dural plate and coupled to a standard Norton Commando clutch and gearbox by triplex chain. Final drive was by chain to the original JW4 rear axle, with the solid centre shaft and single rear brake running in self-aligning bearings, mounted on the rear bulkhead. (No differential was fitted)

A tiny petrol tank supplied fuel to a Porsche-style Solex carburettor, and the twin reverse cone exhaust system emitted the most strident and ear-piercing note at high revs, that had to be heard to be believed.

Ready to race, the car weighed a mere 375 lbs, so it was no surprise that with 85bhp on tap, Peter Voight broke Class records at all twelve hills visited in 1974, on his way to taking the Castrol/BARC Championship, but he lost out to a tie-breaker for the Woking Leaders Championship honours. An action picture of this successful duo negotiating Sawbench Corner at Wiscombe Park Hill Climb, is to be found on Page 256 of 'Uphill Racers' – The History of British Speed Hill Climbing by Chris Mason.

What happened to the car ?

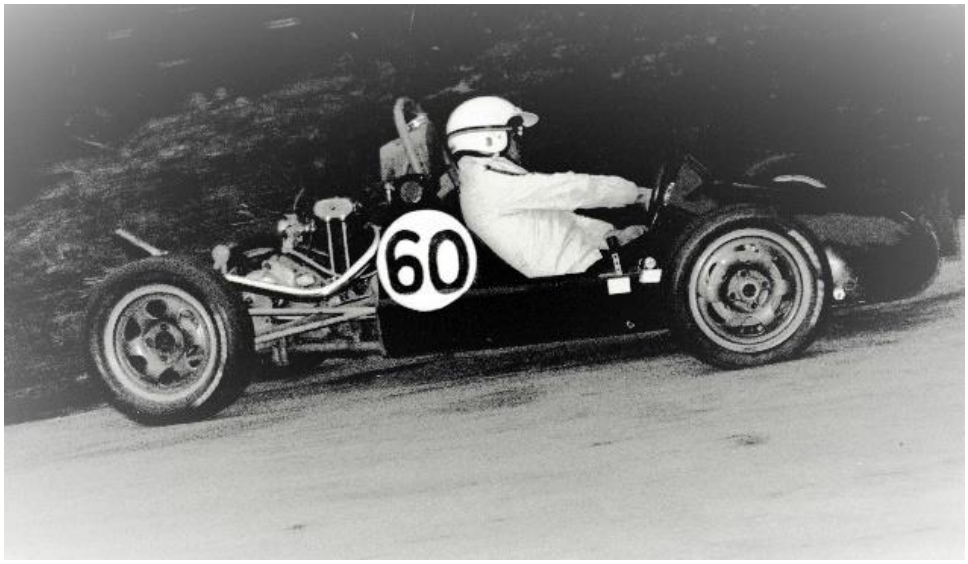
Later the car was successfully raced by Scotsman David Fyfe, before a chequered existence with subsequent owners, including an acrimonious dispute over ownership title. By the late 1980's, it was campaigned in South West speed events as a Suzuki T500-powered Johnny Walker F4, before it disappeared from sight.

Eventually, it re-appeared when it was advertised for sale in Bristol as a Jedi racer, and was bought by a motor sport friend. Suspicious that it was not a Jedi, the new owner asked me to help identify his rather dilapidated purchase. My inspection confirmed that it was not a Jedi single seat racer, and comparison of the chassis with unique features shown in the line drawing on the previous page, confirmed that it was the Voight-Renwick Special chassis, albeit in the guise of the Suzuki T500-powered

Johnny Walker F4 that I had previously seen raced at the now defunct Oddicombe Hill Climb, Torquay.

Much later the car was acquired by my old chum Jeff Luff, the well known film industry special-effects expert and professional model maker. One-time historic 500cc racer and accomplished Special Builder/engineer, Jeff renovated the chassis and reunited it with a Konig flat four engine, to put it back into circulation as a reconstituted Voight-Renwick Special.

The last I heard of the Voight-Renwick Special was that Kenny Baird the well-known Scottish hill climber, demonstrated the reconstructed car on a run at Doune Hill Climb in June 2016.



As proof of Jeff Luff's racing and special building credentials, the picture above shows him competing at the Silver Jubilee Oddicombe Hill Climb in 1986 with his 1952 500cc JAP-powered Staride Formula III car, that he restored from a box of bits.

Tim Barker's 'Johnny Walker Special'

In 1994 another compact Johnny Walker JW4 racer was also used as the basis for of a successful Racing Special built by my pal Tim Barker of Torquay, who squeezed a 125bhp Yamaha 1000cc EXUP motorcycle engine into the tiny chassis. The combination of man and machine was a serious force to be reckoned with in South West speed events, culminating in a well deserved third place in the prestigious 1996 Association of South West Motor Clubs Sprint Championship. The diminutive dimensions of Tim's creation are apparent in the photograph on the next page. Tim later sold his car to an Ulster competitor and withdrew from speed events, although he still tinkers with unusual chassis.

Johnny Walker F4 and the Jedi

Perhaps it was understandable that the previously mentioned Bristol-based vendor mistakenly thought that the Voight-Renwick Special chassis was a Jedi, as there were similarities. Some contemporaries of constructor John Corbyn firmly believed that his design of the prototype Jedi spaceframe chassis was strongly influenced by the Johnny Walker F4 chassis design.

I have included my own photograph below, of the tiny prototype Jedi racer, then powered by a 500cc Suzuki two-stroke engine, in the Wiscombe Park Paddock in September 1984. The driver is unidentified, but standing to the left of the picture is ex-Terrapin racer John Corbyn, who could not have imagined at the time, that nearly forty years and several hundred Jedi-chassis later, the development of his compact design would be so popular, both on the hills and as F1000 on the circuits.

Part Two

'Simple Engineering'

I cannot claim to be a professional engineer - I am just an enthusiastic amateur. I had earned my living as a career Police Officer, so my engineering capability was self-taught; simply by watching others do it or just reading about it. I honed my skills on hard metal by trial and error – and my scrap bin always contained plenty of errors.

The conversion of my elderly Terrapin to accept a 750cc Honda motorcycle engine/gearbox and chain-drive, resulted in a weight reduction of about 1.5cwt, thereby giving the car a new lease of life. The performance and handling improved and the car became more competitive, which in turn lead to modest success in its Class, but to me the true benefit of the conversion was the valuable experience I gained in what I like to refer to as 'simple engineering'.

I can best explain 'simple engineering' as the common-sense approach, whereby all welded or brazed joints are designed to incorporate maximum inherent strength with a good mechanical fit, so the sturdiness of the work is not entirely dependent upon the welded or brazed joint to bond the metal parts together. Also, the amateur constructor with limited engineering know-how, equipment and financial resources, does not attempt any task that is beyond his capabilities. Know your limitations - do not waste materials on a 'bodge-up', it is expensive and an inferior component may endanger your life. Only you know your capability, so if you are not confident of your skills – go to an expert – it is cheaper and safer in the long run.

Designing For Competition – frustrations and all

Over the years I had established a modest workshop in my 18ft x 10ft domestic garage, including gas and electric welding facilities, an ancient 3½ inch engineering lathe – purchased in the 1960's for £5, a pillar drill, angle grinder, electric drill and a full range of good hand tools. As work progressed a new 5 inch engineering lathe was purchased and specialist tools were bought or borrowed, as required.

I had also collected a large amount of information about chassis and suspension design and construction methods, including books, articles, drawings, photographs and the like, so when I decided that the time had come to build my own Racing Special, I was as prepared as I could be to embark on my long-awaited project.

In 1991, whilst I continued to race the much lightened and updated chain-drive Terrapin Honda 750 in hill climbs and sprints, I set about creating my own Racing Special around strict design criteria. This included a lightweight fully triangulated tubular steel spaceframe chassis of maximum torsional rigidity and simple construction; capable of containing my own bulk and a rear-mounted motorcycle power unit with chain-drive to the rear wheels. All-independent pushrod-operated inboard suspension, and fabricated wishbones were required to attach light alloy thirteen-inch diameter wheels shod with racing tyres at each corner, with GRP bodywork and aerodynamic wings to complete the initial design package.

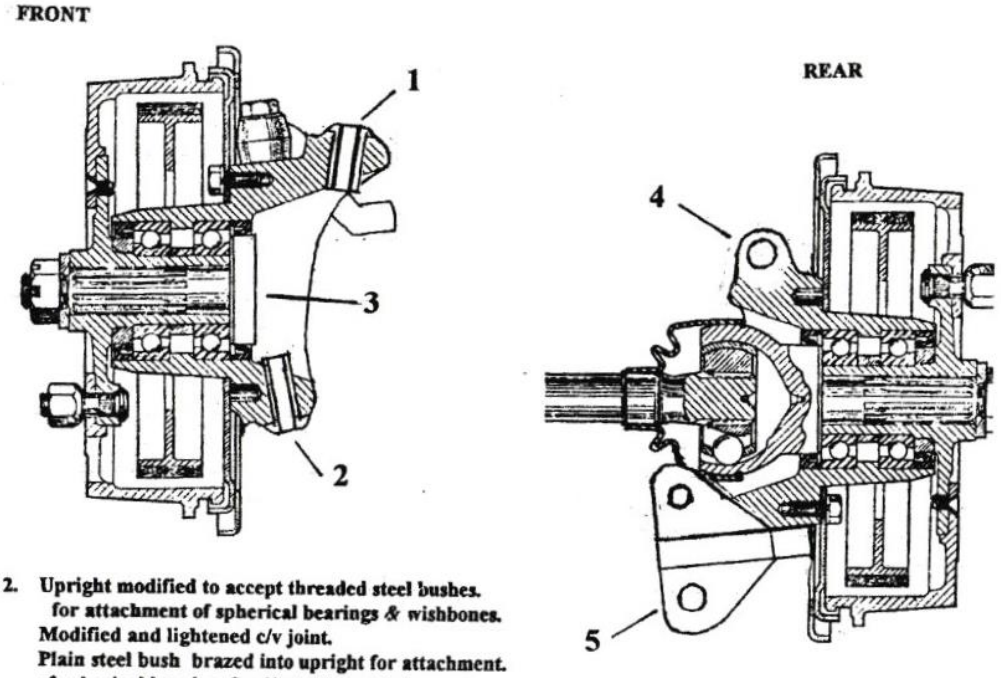
My quest for a pragmatic solution to the design of an all-independent pushrod-operated inboard suspension system, was the point where an amateur designer enters the proverbial minefield. My problem was two-fold. The independent suspension geometry that controlled the attitude of all four the wheels in relation to the chassis, was designed separately from a pushrod-operated inboard springing system, but each assembly had to be compatible with the other, as they would incorporate connecting components.

Initially I produced a variety of suspension geometry designs of my own, but soon accepted that without the benefit of a full-blown computer programme, it could take forever to sort out the infinite combinations of upright dimensions, swing-axle lengths, roll centre heights and chassis pick-up points etc, and still end up with an inferior suspension geometry.

Every action shot that I had seen of my Terrapin provided photographic proof that the Staniforth-designed suspension geometry was efficient and capable of maintaining maximum tyre adhesion by the constant vertical attitude of all four wheels, under demanding racing conditions. What more could an amateur designer ask of a racing car suspension geometry? Therefore, I decided to incorporate the proven Terrapin geometry into my own chassis design, so I referred to my set of commercially available Terrapin engineering drawings for the critical chassis pick-up point dimensions.

In reality my chassis design would utilise just the theoretical points in space that form the basic Terrapin geometry, thereby ensuring controlled movement of each wheel in relation to the chassis, but there the similarity would end, save for the use of Mini front upright/hub assemblies at each corner, as dictated by the geometry.

DETAIL OF MINI UPRIGHT/HUB ASSEMBLY MODIFICATIONS



1 & 2. Upright modified to accept threaded steel bushes. for attachment of spherical bearings & wishbones.
3. Modified and lightened c/v joint.
4. Plain steel bush brazed into upright for attachment. of spherical bearing & adjustable top link.
5. End elevation of 'Connett Plate' bolted to upright.

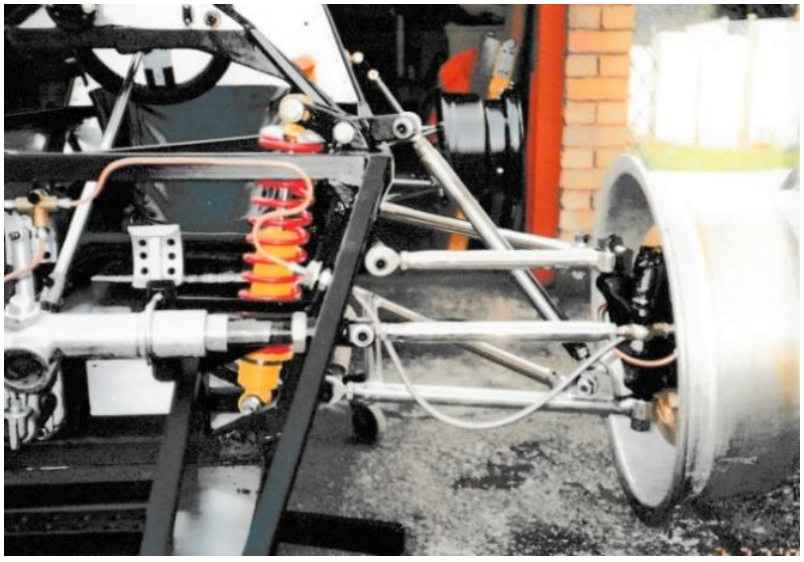
Strong, relatively lightweight and cheap to buy second-hand, the ubiquitous Mini front upright/hub assemblies would accept all-round alloy-Minifin brake drum equipped twin-leading shoe brakes, (disc brakes were not considered necessary at that time), but would require significant modifications to accept threaded steel bushes, as indicated by the drawings on the previous page, to enable the attachment of spherical bearings and the proposed wide based suspension wishbones/radius rods, which in turn would operate the pushrods for the inboard chassis mounted coil spring/damper units.

Having established a suspension geometry acceptable to my specification, I now had to design an appropriate inboard chassis-mounted suspension system using coil spring/damper units. At that time, a number of specialist books discussed similar systems, including the 'Race and Rally Source Book' and 'Competition Car Suspension', both written by Allan Staniforth of Terrapin fame, but the information available to the amateur designer was superficial. In particular, there was no advice about the design, dimensions and leverage ratios of rocker arm and bell-crank mechanisms, for the operation of inboard chassis-mounted coil spring/damper units.

In conversation with Allan Staniforth at a Shelsley Walsh event, he suggested that I simulate these components by cardboard cut-out models to establish a functional design by trial and error. Subsequently, I did just that and calculated the size/leverage ratios of the rocker arm and bell-crank assemblies, by plotting a selection of full-size cardboard cut-out models on graph paper, all pivoting around drawing-pins.

My resultant design used each front lower wishbone to actuate a coil spring/damper unit, chassis mounted vertically inboard either side of the foot pedals, via an adjustable length pushrod and chassis mounted rocker arm assembly. At the rear the Terrapin suspension geometry required the Mini upright/hub assembly to be mounted upside down, so I designed a major modification to the inverted hub assembly for the attachment of a 'Connett Plate' by three bolts, (two bolts used the original threading provided for the attachment of the Mini steering arm). Fabricated from half inch thick Dural, each 'Plate' was intended to serve a dual purpose. Firstly, it would locate the outer end of the rear lower reversed wishbone to the inverted upright/hub assembly. Secondly, it would actuate the coil spring/damper unit mounted inboard centrally to the top of the chassis rear bulkhead, via an adjustable length pushrod and chassis mounted bell-crank assembly. Pictures of the front and rear pushrod operated coil spring/damper units and suspension assemblies during construction, are shown on the next page.

In the knowledge that I would commit my ideas to hard metal, the rocker arms and bell-crank components were designed to be of simple steel construction so that should I have mis-calculated, then alternative parts could be fabricated with ease, save for my accurately machined interchangeable phosphor bronze bushes that would provide each component with a pivot point at the chassis mounting. Much later after testing in competition, my design of the rocker arm and bell-crank components proved satisfactory, so replacement items were fabricated from light alloy.



Front nearside suspension assembly

Rear nearside suspension assembly

The final design details for the chassis were determined by the dimensions of four transverse tubular bulkheads, that create compartments within the chassis. Each bulkhead required sufficient structural integrity to adequately dissipate loads into the longitudinal and triangulated chassis structure.

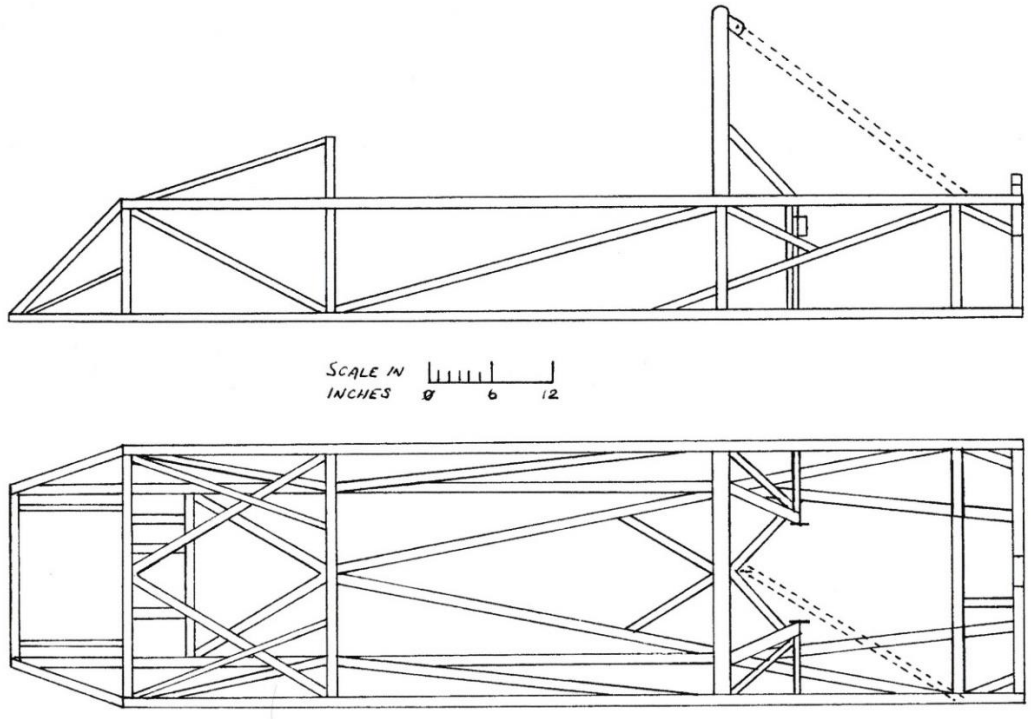
The first, the front bulkhead would carry loads from the pushrod operated inboard suspension, the pick-up points for the front suspension wishbones and the steering-rack. The second, the dashboard bulkhead would also absorb front suspension wishbone loads and locate the steering column whereas the third, the driver's seatback bulkhead was multi-purpose. Not only was it the compulsory firewall between the cockpit and the engine bay, it also absorbed wide-based rear suspension loads, engine mountings and the structural foundation for the essential driver-safety rollover bar. The fourth, the rearmost bulkhead was the most stressed element in the chassis, so it was very carefully designed to absorb pushrod operated inboard suspensions loads,

and the accurately located pick-up points for rear suspension wishbones/links. In addition there were the heavy stresses associated with mountings the chain-drive differential, together with loadings from the drive shafts and driven rear-wheels, plus aerodynamic pressure from the rear wing mounting post.

Having finalised details of the essential transverse tubular bulkheads, together with the associated suspension geometry and inboard springing system, I had established many of the critical dimensions to be incorporated in my chassis design. Although many of the frustrations anticipated during the design phase were now behind me, the final concept of the chassis layout and dimensions did result in more head scratching, and the production of countless sketches and scale drawings subsequently discarded, before I satisfied the design criteria that I had set out to achieve; including overall compliance with rules contained in the MSA Blue Book of the period.

The spaceframe chassis was to be constructed from various sizes of square section 16, 18 and 20 gauge ERW steel tubing, with additional rigidity provided by rivetted and bonded NS4 sheet-alloy side and floor panels. The practice in many contemporary lightweight motorcycle-engine designs for the driver's feet to protrude beyond the centre line of the front wheels was discounted for reasons of safety, so the resultant wheelbase came out at 92 inches. The dimensions of the rear engine bay would allow for various motorcycle engine options, so no choice was made at the design phase.

General arrangement scale drawings of the side elevation and plan views of the Firebrand Special chassis are shown below.



Chassis of Firebrand Special

Starting to cut metal

I reasoned that an amateur constructor was more likely to make a better job of a brazed joint than a welded one, so I decided to use oxy-acetylene and Sifbronze No 2 rods to braze all joints in the construction of my Racing Special. The rods contain 9% nickel, and are exceedingly strong and satisfying to use.

Work started with the fabrication of the four transverse chassis bulkheads from one inch square steel tube in purpose built jigs, to ensure the locational accuracy of the inset threaded steel bushes used as the important suspension wishbone pick-up points.

I then took the four transverse bulkheads to my 'technical advisor' Dave Crocker's workshop at Saltash, where they were accurately clamped to his rigid steel faceplate to minimise distortion, and then 'stitched together' by brazing in the longitudinal chassis tubes and primary triangulation members. Returning home with a substantial part of my spaceframe chassis, I set about adding the Blue Book compliant roll-over bar, additional chassis members and numerous brackets to which the major components such as steering rack, foot pedals, engine mountings, seat belts, etc, would be attached.

Simultaneously various jigs were made in which suspension wishbones were fabricated from 16 gauge ¾ inch round section steel tubing, into the open tube ends were brazed steel threaded bushes to accept the American-made Aurora spherical bearings. Each threaded bush was laboriously machined from solid steel stock on my ancient lathe and threaded by hand-tap; unlike today when you can be saved from such a time-consuming chore, and buy ready-made threaded bushes online.

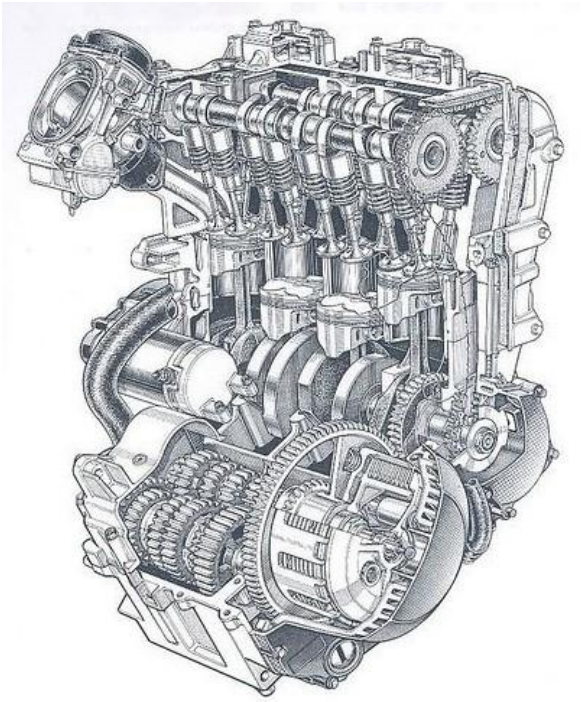
The four Mini front upright/hub assemblies were also extensively modified for use at front and rear of the car, in accordance with the illustration on an earlier page.

Which Bike ?

I believe that the modern high performance motorcycle engine offers the most cost-effective, and reliable power source available to the amateur Special Builder constructing a modern lightweight chain-drive single seat racing car, so eventually I had to choose which power unit to use.

At the time I was a Member of the 500 Owners Association, so my Racing Special had been designed with their Modern Speed Challenge regulations in mind, but I found that the motorcycle industry no longer produced a modern multi-cylinder/valve 500cc engine, suitable for racing purposes.

As an alternative, I was impressed by the performance of the new breed of Japanese 600cc multi-valve engines. The Motorcycle News road-test of the Kawasaki ZZ-R600 solo motorcycle proved it to be the fastest of the new generation of 'hot' 600cc road bikes, with a maximum speed in excess of 150mph. Kawasaki claimed that their normally aspirated 599cc water-cooled – four cylinder – twin overhead camshaft – 16 valve engine, complete with six-speed gearbox, produced 98bhp 11,500rpm, *with the rev-limiter actuated at around 14,000rpm.* In a contemporary Isle of Man TT race, a ZZ-R600-powered Formula 2 sidecar outfit had returned average lap speeds in excess of 103mph on the arduous 37¾ mile TT Mountain Course, with two people on board.



All this performance capability was contained in a power unit so lightweight that I could pick it up and carry it, so I decided that despite giving away 500cc to the opposition in the 'up to 1100cc Class', it would have potential powering my compact Racing Special. Cutaway drawing shown above of a generic Kawasaki 'hot 600' engine.

I found a low mileage Kawasaki ZZ-R600 engine/gearbox for sale at a North Devon bike breakers and bought it for £200. Breakers were already charging premium prices for anyone wanting a larger capacity engine to fit in a kit car, but there was little demand for 600cc engines so the resale value was low at that time. My '98bhp screamer' was exceptional value for money. Many years later I sold it to a motorcycle straight-line sprint competitor for £95.

When installed in my chassis, I had created the first racing car powered by a 'hot' 600cc multi-valve engine, and I became an unintentional trailblazer. Subsequently, my pioneering choice of engine gave rise to the formation of a new 'up to 600cc Class' in speed events, but more of that story later.

Don't remove that Airbox

I received valuable advice on the installation of the ZZ-R600 unit from North Devon sidecar racer – Ian Drowne, who until the end of 1994 when he went circuit racing, held the sidecar record at most of the hill climb venues in the country with his self-built ZZ-R600 powered Formula 2 side car outfit. He later graduated to Formula 1 sidecar racing at a national level.

Ian had strongly advised retention of the standard carburettors and airbox. Pre-dating fuel injection, the engine was dependent upon four normally aspirated carburettors, one to each cylinder, all contained in an airbox with a capacity of eight litres. It was apparent that Kawasaki had invested heavily in the development of their intake system as each carburettor had a long air intake horn attached, so I kept it as

standard and enjoyed an engine that was always capable of screaming crisply to the rev-limiter at about 14,000rpm.

Haven't you finished that Car yet?

That was the question often asked during the three year design and construction period. Usually the questioner had no concept of the countless problems and frustrations encountered by the Special Builder, who normally works in solitary isolation turning his ideas into hard metal.

I now speak from bitter experience as I have often spent an entire evening fabricating a part in my freezing cold garage, only to consign it to the scrap bin when it failed to come up to expectations, and start it all over again the following day.

At the outset I set myself an important objective - *to do something to my project each and every day.*

I managed to satisfy this self-imposed rule in a variety of ways – by fabrication, sourcing new and used parts, cleaning, renovating and painting components, but occasionally I treated myself to a day when I only paid lip service to my rule. On such a day, perhaps I would just order a part, buy a nut and bolt, or as I did one particularly cold winter evening when I forced myself to go into the garage just long enough to ream out a steel bush – but at least it was one job less.

Special Building is an exceptionally lonely form of self-expression, so daily progress is essential to prevent an unfinished project, which is not uncommon amongst would-be Special Builders.

Finishing Off

Adhering to my principle of 'simple engineering' and not attempting the manufacture of any components beyond my own capabilities, I utilised the expertise of Dave Crocker to carry out a number of specialist tasks, including alloy welding and the construction of a well-engineered chain-drive differential, based upon standard Mini components. I successfully constructed the front and rear aerodynamic wings by adapting the age-old method used to build a balsawood model aircraft wing, by using thin NS4 aluminium sheet rivetted and bonded to internal aerofoil-shaped formers and tubing. Robust and effective metal wings can be produced by this method.

Eventually it started to look like a racing car, culminating in the arrival of the high quality fibreglass bodywork and mould. This had been produced from scratch to my own design by a master in the art – Mick Jezekel, who had a workshop at St Breward on Bodmin Moor, where he produced paper thin fibreglass fuselage for radio controlled model aircraft, and other commissions including panels for the Crocker-family Jedi. He later returned to his native Channel Islands.

I am indebted to my son Paul, who used his skills as a television engineer to build an electrical wiring-loom applicable to the Kawasaki multi-valve engine, and dear Marjorie who tolerated the whole project.

The Art of the Special Builder

Throughout the design and build phase of my project I strived to achieve very high standards of engineering and finish in the Firebrand Special, and I believe that it demonstrates the art of the Special Builder at its best.

The Proof of the Pudding ….

Competitive runs on my Firebrand Special debut at the popular St Eval Sprint event in May 1994, were thwarted by minor clutch problems during practice, but it was subsequently shaken-down at selected events during its inaugural season, resulting in one first and three second place positions in the 'up to 1100cc Class'.

Yes - results beyond my wildest expectations – but with close to 100bhp on tap in a car so lightweight in its as-built condition, that three men of average strength could lift it clear of the ground, the resultant performance and handling was quite breath-taking. Weight did increase with development described in Part Three.

Initially the Firebrand Special chassis worked well straight out of the box and development was limited to minor adjustments and the fitting of an aerodynamic undertray to induce additional downforce, in an effort to improve competitive times.

Previously, I mentioned the dearth of suitable modern multi-cylinder/valve 500cc engines for 500 OA competitions, so the progress of my trail-blazing use of a modern 600cc multi-cylinder-powered Firebrand Special was followed with interest during 1994 by John Corbyn, designer/constructor of the highly successful Jedi racing cars, and several of his customers.

The feedback from my use of the Kawasaki ZZ-R600 engine so convinced John Corbyn and associates that the readily available high performance 600cc four cylinder Honda/Kawasaki/Yamaha engines had the potential for a viable low-cost class for single seat racing cars, that they subsequently persuaded the 500 Owners Association of the need for a separate class/category.

From 1995, a new class for racing cars powered by 600cc four-stroke production motorcycle engines was run within the 500 Owners Association Modern Speed Challenge. Our regional Association of South West Motor Clubs also included an 'up to 600cc' racing car class in their hill climb and sprint championships, that eventually became defunct when 600cc supporters faded away.

Formula 600 and beyond

In 1997, with confirmed orders for 22 cars, John Corbyn launched 'Formula 600', a one-make circuit racing series combining the Jedi single seat chassis with the Honda CBR600 100bhp engine. This Corbyn-initiative later evolved into the highly successful super-fast Formula 1000 for one litre superbike-powered Jedi single seat circuit racers.

A number of ex-Formula 600 Jedi circuit racers were subsequently adapted for hill climb and sprint competitions.

As-Built Technical Specification of the Firebrand Special in 1994

Engine
Kawasaki 599cc – 4 cylinder-twin overhead cam-16 valve water-cooled engine
Maximum power – 98bhp @ 11,500rpm.
Standard Keihin carburettor/airbox, gravity fed from alloy tank.
Yamaha FZR600 alloy racing radiator.
Fabricated 4-into-1 large bore exhaust system with Micron silencer.

Gearbox/ Transmission
Integral six speed sequential.
Extensively modified chain-drive Mini differential and standard drive-shafts.
13 tooth gearbox & 45 tooth diff-sprocket linked by 530 size heavy duty chain.

Chassis/Body
Fully triangulated tubular steel spaceframe with stressed NS4 alloy side panels and floor, attached with adhesive and rivets.
Lightweight two-piece GRP bodywork/engine cover secure with Dzus fasteners.
GRP aerodynamic undertray.
Adjustable front and rear aerodynamic wings constructed in NS4 alloy.

Suspension
Front – Mini upright/hub assemblies modified to connect fully adjustable unequal length nickel plated wishbones by Aurora make spherical bearings of various types and sizes.
Chassis mounted 200lbs coil springs on Spax adjustable dampers, actuated via adjustable length pushrods and chassis mounted rocker arm assemblies.
Rear – Mini upright/hub assemblies modified to accept dural 'Connett plates' and fully adjustable nickel plated wishbones/radius rods connected by Aurora make spherical bearings of various types and sizes.
Chassis mounted 140lbs coil springs on Spax adjustable dampers, actuated via adjustable length pushrods and chassis mounted bell-crank assemblies.

Brakes
Mini twin leading shoe hydraulic brakes at front and rear.
Minifin light alloy brake drums.
Dual hydraulic front/rear system, incorporating fabricated pedal and balance bar with Aeroquip brake hoses.

Wheels
Front – 8" x 13" Revolution Competition four spoke alloy wheels, and Avon A36 compound slick racing tyres. (Wet – 6" x 13" Revolution Competition four spoke alloy wheels, and Avon A36 compound factory treaded slick tyres).
Rear – 10" x 13" Revolution Competition four spoke alloy wheels, and Avon A36 compound slick racing tyres. (Wet – 8" x 13" Revolution Competition four spoke alloy wheels, and Avon A36 compound factory treaded slick tyres).

Steering
Mountney 10" steering wheel, rose-jointed stainless steel steering column, connected to Jack Knight Formula Ford high ratio steering rack, adjustable track rods and modified Mini steering arms.

Author and Terrapin-Honda 750 at Martini Corner, Wiscombe Park, circa 1990

Terrapin-Honda 750 - Postscipt

I continued to compete with my Terrapin-Honda 750 as the Firebrand Special neared completion, until I experienced a catastrophic engine failure whilst racing at a St Eval Sprint. Without warning a broken connecting-rod smashed a hole in the front of the cylinder block, locking the rear wheels and bringing the racer to an abrupt halt. Not wanting to lose impetus in the final stages of construction of the Firebrand Special I stored the Terrapin-Honda, where it remained for some time. Eventually I was approached with an offer to buy the stricken car, from a promising young driver Ed Hollier, who with his father Robert, successfully raced a quick home-developed Mini in South West hill climbs events. Ed wanted to extend his talents into single seat racers and saw potential for development of the Terrapin-Honda rolling chassis, particularly as Robert was a talented and experienced fabricator.

Between them they created a new Racing Special by extending the chassis, revising the suspension, bodywork and aerodynamics, to the point where very little remained of the original racer. A state-of-the-art superbike engine of the time, a Kawasaki ZZ-R1100 was fitted and their creation was an immediate recipe for success in the hands of Ed, who has since graduated through various single seat racers to become a leading South West driver, presently with an array of FTD awards won at the Wiscombe Park Hill Climb events.

As I write this in July 2023, Ed has just made a return to the short Cornish hill climb venue at Tregrehan, after a twenty year absence and reset the 'up to 1100cc racing car' class record with his ultra-modern Force H/C racer; a record that has remained unbroken since he set it with his Terrapin on his last visit, all those years ago. I believe that his Terrapin Special remains active in North Country events.

Part Three

Durability of the Firebrand Special

Parts One and Two now give an updated account of how my Firebrand Special was created, so Part Three will describe subsequent development undertaken whilst competing in hill climb and sprint events, from 1994 to 2010. Details of developments will not be in chronological order, but grouped under major components.

By 2010 my personal mobility had diminished, such that if I could get into the confines of the cockpit then it was difficult to get out again without assistance, so I decided to 'retire' my pride-and-joy and preserve it in secure dry-storage.

I did not retire from the sport at that time, but continued over the next ten years to develop and regularly race a saloon in a roadgoing class, that was less physically demanding on an aging driver. I chose to modify a rare twin-cam hot-hatch; a 2004 model 100bhp 1390cc AUB-engined Seat Arosa Sport, that provided me with a decade of alternative enjoyment.

The Firebrand Special was sold in 2019, and subsequent owners continue to compete in selected South West speed events up to the present time; testament to the durability of the design and construction of my Racing Special – it is still racing some twenty-nine years after it first turned a wheel in anger at a St Eval Sprint.

Reliable Kawasaki Engines

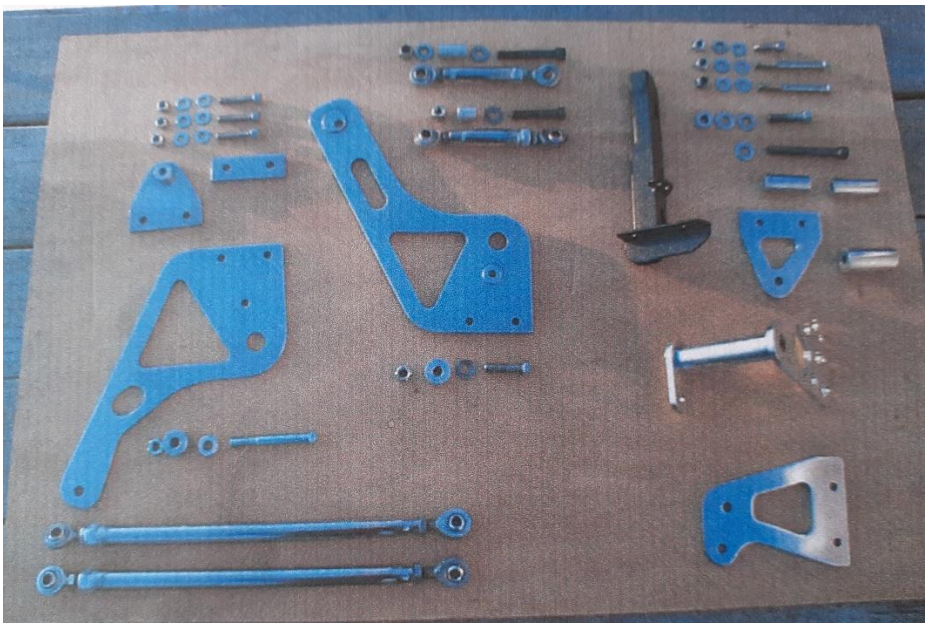
The original 599cc Kawasaki ZZ-R600 DOHC 16 valve engine fitted to the Firebrand Special continued to provide exceptional reliability during the first twelve years of competition in hill climbs and sprints. It was removed from the chassis on one occasion during those years, and then only to facilitate the replacement of the original 16 valve cylinder head with a home-brewed gas flowed version. It remained capable of high revving power delivery to record a standing-start quarter mile time of 14.26 seconds at the Chivenor Sprint in 2004, and the fastest 64 feet time of 2.20 seconds for any racer at the St Eval Sprint in September 2005.

Remarkable reliability from a motorcycle engine designed some fifteen years earlier, but such was the technological progress in Japanese 600cc production engines that it could not continue to compete on a level playing field with modern technology, so I reluctantly decided to replace it at the end of the 2005 season.

As a replacement I bought a low mileage 2002 model Kawasaki ZX636A1P engine with integral six-speed gearbox, complete with exhaust system for £650. It had a direct lineage to my trusty ZZ-R600 engine, having been developed from the next generation ZX-6R engine, but with the bore diameter increased by 2 mm to raise the capacity from 599cc to 636cc. Whilst not remaining true to its 600cc roots, the resultant performance of the Firebrand Special would be enhanced by an additional 37cc; with an advanced combustion chamber design resulting from Kawasaki World Super Bike experience, and a higher revving engine to provide a performance likened to that of a 750. The manufacturer claimed a power output of 118bhp @ 12500rpm, so on paper it offered 20% more power and 10% more torque whilst

retaining the comparative simplicity of normal aspiration by four carburettors. The highly developed fuel injected motorcycle engine then being produced was in my view, too complex for an amateur like myself to install in a home-brewed racing car.

The pressure was on in my garage/workshop to instal the replacement engine in time for the 2006 season. This was problematic as a modern motorcycle engine no longer sat in a motorcycle frame as did the ZZ-R600, but the replacement ZX636R engine was suspended from the frame with the exhaust system passing underneath. It was important that the installation retained the integrity of the original Firebrand Special chassis, whilst adequately suspending the power unit in the engine bay. This was achieved, but the chassis rear bulkhead had to be modified to allow for a higher chain-drive line through it, between the gearbox sprocket and the sprocket driving the differential. Such is the complexity of my design to suspend the ZX636A1P engine in the chassis, the number of home-made and other parts required, including alloy engine plates, tie rods, bushes, nuts, bolts and washers just exceeded one hundred. A sample of those parts is shown in the photograph below.



The ZX636A1P engine was successfully installed in the chassis and the standard exhaust system and Viper silencer adapted to suit. New sprockets and final drive chain were installed; a revised ram-air system was fitted to the airbox, and an electric fuel pump connected to a bespoke alloy petrol tank, (fabricated by Ian Drowne – engineer and ex F1 sidecar racer). Plus, one hundred and one other tasks associated with a major conversion, including the essential cooling system.

Unlike the comparative simplicity of the wiring loom for the original ZZ-R600 engine, the ZX636A1P was quite complex, so my son Paul used his electronic expertise to modify the manufacturer's loom for racing car purposes. He successfully bypassed certain fail safes in the system, and when the time came to start the engine, it refused to fire. Much head scratching ensued, until enquiries with Kawasaki Europe revealed that unless the ignition switch from the bike was used, then an integral anti-hotwire device prevented the engine from firing. Help came from fellow-competitor Peter Tudor, who had solved a similar problem with the

installation of a Suzuki GSXR600 engine in a Force single seater. It required the simple installation of a one pence resistor into the starter circuit, and *'Bingo'* – the ZX636A1P engine started immediately – you just needed to know where to fit it.

Disc Brake Conversion

As built, the Firebrand Special was fitted with Minifin-equipped twin-leading shoe Mini brakes all-round, but improved performance was proving the need for increased braking capability. The logical step was to adapt a set of Mini GT 1275 hubs to fit, with 8.4 inch disc brakes and 4-pot alloy callipers. The uprights/hubs were found to be much beefier components than the modified drum brake version already fitted to the Firebrand Special, with much larger and heavier wheel bearings and associated parts. Firstly the upright/hub castings were modified at top and bottom, to accept threaded steel bushes to connect the wide-based suspension wishbones as described in Part Two. To save weight, without compromise to the substantial casting structure, I re-profiled each upright/hub with grinder to remove a significant amount of surplus material.

The standard disc brake rotors were heavy, so I devised a method to save weight and improve performance by drilling holes in them. I accurately replicated the rotors on graph paper, and geometrically plotted seventy-two points to be drilled. The drawings were then precisely glued to each rotor and each of the seventy-two points marked with a centre punch, to enable every hole to be bored through on a pillar-drill. Sounds a little crude, but it worked, and the rotors are still giving effective service. Green Stuff brake pads were fitted.

AP Suretrac Automatic-Torque Biassing Differential

My old friend and technical advisor Dave Crocker had built the original chain-drive Mini-based differential, that had given good service firmly secured to the rear bulkhead in accurately machined alloy blocks. Much later I was offered the opportunity to buy a second-hand AP Suretrac Automatic Torque Biassing Differential, that a local competitor Paul Tupman had removed from his Mini hill climb racer. He had found that drive was lost when a front wheel lifted off the ground in corners; a not un-common competition stance for a front-wheel drive Mini.

With rear-wheel drive and minimal body roll when cornering, there was little chance of an air-borne driven wheel when racing the Firebrand Special, so if the AP Suretrac ATB could be adapted to fit, then I could expect an improvement in performance. After due consideration I bought the ATB. A picture is shown on the next page of the Firebrand Special cornering with minimal body roll.

Fitting the AP Suretrac ATB was a test of my innovative skills as a Special Builder. It had been designed for the Mini, so normally the engine oil lubricated the ATB. For my purposes, the ATB had to be made sufficiently oil-tight to hold a small quantity of replaceable lubricant; solved by turning an end cap from a two inch length of four inch diameter round alloy bar. Turned on my 5 inch lathe to an exact fit, this was the most demanding project that I had ever undertaken as an amateur machinist - but it worked, and the ATB could retain lubrication whilst racing.

The ATB had a substantial radial flange on which to bolt the final chain-drive sprocket, so after modifications to the existing and accurately machined alloy blocks, the AP Suretrac ATB was securely fixed to the rear bulkhead, as intended.

To me that is what Special Building is all about – there are no plans or kit of parts that you can buy for a project such as mine – you just have to figure it out for yourself. You solve the problem, design the parts, carry out the necessary fabrication and enjoy considerable satisfaction when it all works.

Wheels and Tyres

For the 2008 season I experimented with a change to narrower wheel rims at front and back. I replaced the much used 8 inch wide front rims with 6 inch wide items, and the rear 10 inch rims with 8 inch width, with a corresponding reduction in racing tyre sizes. There was an immediate improvement in turn-in, and a weight saving of 12 pounds over the use of the wider rims. I had always used Avon tyres, but they became so expensive that I later bought a set of Yokohama racing slicks that provided good adhesion for a lightweight Racing Special.

Aerodynamics

Aerodynamics are something of a black art to most competitors, with many such devices fitted just because they look right. I was no exception as I had used a fibreglass copy of a Jedi rear-undertray for many seasons, without knowing if there was any benefit to under-chassis airflow and downforce. Eventually, I proved the value of an alternative aerodynamic package, when I fitted a pair of glass fibre underbody tunnels and undertray, moulded for me by my good friend David Sims, based upon an abbreviated version of the tunnels fitted to the Sims' team Ralt. The resultant increase in downforce was measured by a substantial improvement in my personal best time set at the next St Eval Sprint meeting. So even after fifteen years of competition the performance of the Firebrand Special could be improved, although I cannot not say the same about the driver.

Much later I replaced the original self-made alloy rear wing with a state-of-the-art full width carbon-fibre rear wing, made to my design by Christopher Crocker, (Dave's youngest son), trading as Crocker Mouldings in Plymouth. An excellent device that fitted the original wing-post.

Firebrand Special after 2019

Early in 2019 I completed the sale of my Firebrand Special racing equipe, and the new owner – fellow Torbay Motor Club Member Shaun Tuckey, enthusiastically removed his acquisition from my garage. I had last raced the car at Mamhead Hillclimb in 2010, but due to personal mobility problems, I had carefully dry-stored and maintained it in tip-top condition ever since,.

The sale included my unique self-designed and constructed, 636cc Kawasaki ZX636R A1P-powered Firebrand Special single-seat racing car, along with a purpose built tilting trailer, body mould, spare wheels/tyres, wings, springs, various components and associated bits and pieces. This meant that for the first time since March 1984, when my special-building passion became a reality, my detached 10' x 18' domestic garage, (cum workshop), did not contain a single-seat racing car and associated paraphernalia. After a continuous thirty five year period of racing car occupation, the whole kit and caboodle had been sold and my garage was clear, except for my engineering equipment..

On Sunday 24th March 2019, the Firebrand Special re-appeared in competition at the Treloy Sprint, in the hands of speed event debutant Nathan Tuckey; Shaun's then 23 year old son, who was an ex-motocross racer and keen footballer, but had no previous experience of racing on four-wheels, particularly slick-shod lightweight single-seat racing cars.

My photograph above, was taken as Nathan launched the Firebrand Special off the Start-line, (no wheel spin, just mechanical rear wheel grip), to set the second fastest 64 feet launch time that day at 2.07 seconds. He was only bettered by a whisker, with a 2.06 second time set by a 2100cc Subaru Impreza WRX. During the

day he set creditable times over the fast airfield course, despite his 636cc-powered Firebrand Special having a power deficit of about 80bhp, compared to other runners in the same class.

From the outset I realised that Nathan was going to be the test pilot that the Firebrand Special had always needed, to explore the full performance potential of my design and construction: results that I had been unable to achieve myself, due to advancing age, reduced physical fitness and flashes of blind terror.

That season I started to enjoy vicarious pleasure from Nathan's *'giant killing'* performance; none more so than when I watched him race again at the Treloy Sprint, on Sunday 30th June 2019. In near perfect conditions, he matched his consistent driving performance with the overall performance capability of the Firebrand Special, when the Newquay Auto Club organisers offered all competitors the opportunity for two Practice and eight Timed runs.

During a hectic day of on-track activity, Nathan shared the second fastest time of the day at 41.00 seconds, with a seasoned campaigner who set an identical time with a quick 1441cc bike-engined Radical SR4 sports racing car. All ten times set by Nathan during the competition were grouped within a 0.86 second time frame, and his 64ft launch times were consistently grouped between 2.16 and 2.26 secs, to demonstrate the traction and meteoric acceleration capability of the Firebrand Special off the start-line**.**

Nathan continued to collect awards throughout the 2019 season, and I last saw him *'wringing- the-neck'* of the Firebrand Special at the October sprint at Clay Pigeon Raceway, when his best time was within 2.62secs of the Fastest-Time-of-Day set by South West expert Andrew Forsyth, driving his 1400cc OMS CF84, a powerful single seater with more than double the engine capacity of the Firebrand Special. The picture below shows Nathan with the Firebrand Special on opposite-lock at Clay Pigeon Raceway that day.

I am indebted to Nathan Tuckey for the 2019 season when he tested my design and construction of the Firebrand Special in-extremis; later after a Covid-Lockdown hiatus, he moved on to further success with a very quick 1600cc Ford Ka saloon, developed by his father - Shaun.

As for the Firebrand Special, a new owner - Peter Webster from Camborne, has so far competed with the racer at several events during 2023. He is well known at Cornish events where he has previously raced a very smart Mini saloon, and finished in a creditable 10th place in the Tyremarks 2022 ASWMC Hillclimb Championship. Hopefully, there is yet more to be written about the chain-drive Firebrand Special.

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Suggested reading before starting to build!

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Anyone tempted to build their own Racing Special may like to search for inspiration and guidance on racing car design amongst the many specialist books, before getting out their drawing-board. In no particular order – I can suggest the following titles from amongst my own collection, including some about the fascinating history of the Racing Special movement.

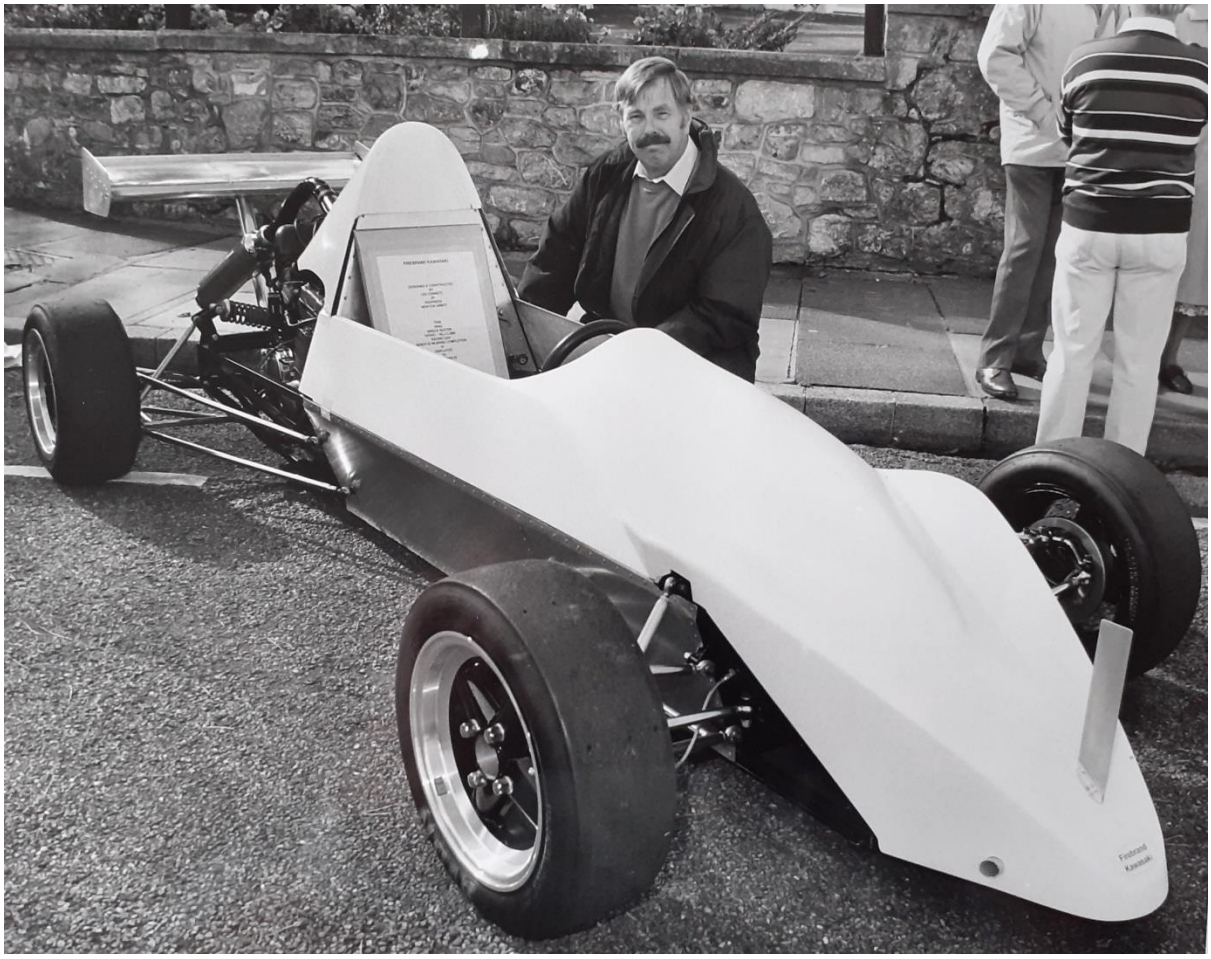
- How To Build Motorcycle-engined Racing Cars by Tony Pashley
- Specials by John V. Bolster
- Vintage Specials by John Bateman
- Special Builders Guide for 1172 & 750 Formulae – 750 Motor Club publication
- How To Build Austin Specials by John Haynes
- Design For Competition – 750 Motor Club publication
- High Speed Low Cost by Allan Staniforth
- Racing & Sports car Chassis Design by M. Costin and D. Phipps
- Race and Rally Car Source Book by Allan Staniforth
- Competition Car Suspension by Allan Staniforth
- 750 Racer by Peter Herbert in association with Dick Harvey
- Engineer to Win by Carol Smith
- Competition Car Preparation by Simon McBeath
- Competition Car Aerodynamics by Simon McBeath
- Competition Car Composites by Simon McBeath
- Building A Special by Ant Anstead
- Build Your Own Sports Car for as little as £250- and Race It by Ron Chapman
- Build Your Own Sports car On a Budget by Chris Gibbs
- Build To Win by Keith Noakes
- How To Build Your Own Tiger Avon by Jim Dudley

Kawasaki ZX-636A1P powered Firebrand Special at a Clay Pigeon Sprint

Mamhead Hill Climb – 2010 – the Author's final event at the wheel

To Build a Chain-Drive Racing Special

Les Connett traces the evolution of his unique bike-engined Firebrand Special



Nearing completion – the Author displayed his unique Firebrand Special in the Top Paddock at the Oddicombe Hill Climb in October 1993.