Model Mechanics

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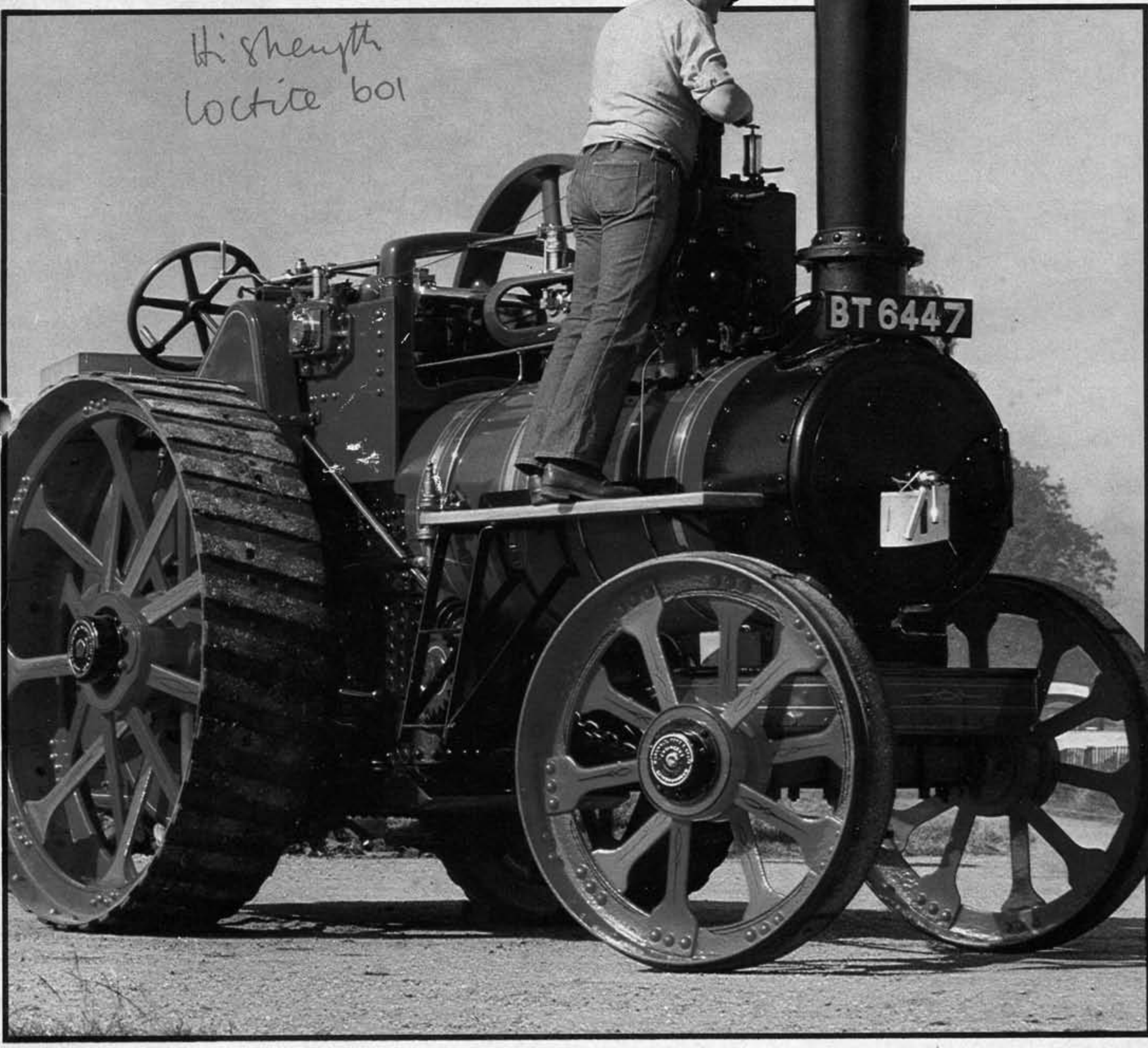
MAP HOBBY MAGAZINE



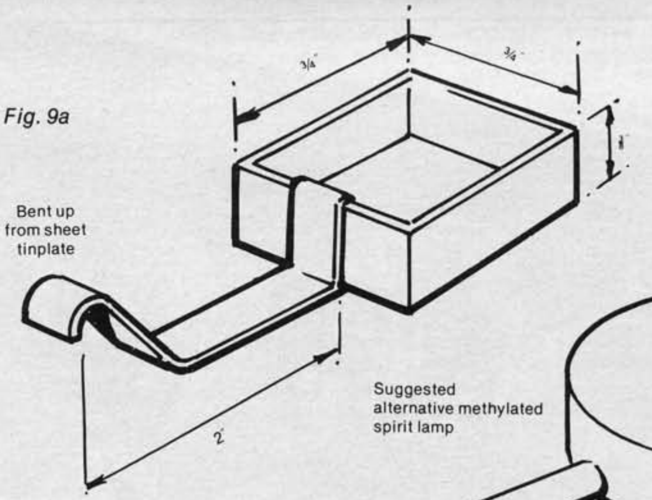
SIMPLE STEAM • TOOLS OF THE TRADE
TETHER RACING CAR • CASS RAILROAD

has the works made from a piece of $\frac{5}{32}$ in. copper tube and this is very satisfactory. It is available from all model engineering supply shops but if this proves difficult it should be possible to get a length of Bundy tubing from one of the bigger garages or service centres. This is a little bigger in diameter but you will only need about 18 in. or so. The centre 10 in. or thereabouts of whatever pipe you have must now be softened by heating. If you have it, a gas (or even a paraffin) blowlamp is fine, if not then a domestic gas ring will be hot enough to raise the tube to a dull red heat — it can be done in sections. This will soften it and after cooling (either by plunging into cold water or just letting it cool naturally, it doesn't matter which) find a bar about $\frac{3}{8}$ in. diameter — a wooden spoon handle might do — and carefully wrap three and a half turns round it as shown in Fig. 8 bringing the two ends together roughly parallel and of the same length. They will be something like an inch apart depending on the diameter of the tube. And that is the engine! The coils are necessary to provide a large enough hot zone to allow the device to work. A simple U seems to be satisfactory for $\frac{1}{16}$ in. diameter tube; the $\frac{5}{16}$ in. diameter tube in the Jetcraft launch requires five or tix turns on a 1 in. mandrell. About three coils as described seem about right for $\frac{5}{32}$ in. or $\frac{3}{16}$ in. tubes.

A means of heating is now required and this can be either a simple holder for a piece of Meta, Esbit or Mamod solid fuel or a small methylated spirit lamp. The latter is in many ways preferable since it will give a longer run but the solid fuel is perhaps more convenient. Fig. 9a shows a simple holder bent up from a small piece of tinplate. If you are a good soft solderer it is not too difficult to make a suitable spirit burner. A convenient basis could be a small tin, say 2 in. or so diameter which would fit into the forward part of the hull. This might have to be cut down to about ¾ in. high with a new lid soldered on with a filler hole and a cap. The burner tube should be as long as possible to take the flame well away from the fuel tank. The tube should be well packed with cotton wick, so adjusted to give a flame not more than about ¾ in. high. A suggested form of such a burner is sketched in Fig. 9b.

Since we shall want some tin for the floor and the deck house of the engine room it might be worthwhile seeking out a sizeable domestic can to be saved from the dustbin. A stout pair of scissors (in the absence of tinsnips) will soon produce a useful sheet of material. The deck house over the engine room is made from just such a flattened sheet of tin (or aluminium would be even better) cut out and bent up as shown in Fig. 10. Holes should be drilled (about $\frac{5}{16}$ in. diameter) in the sides before bending and a hole for the funnel cut and filed to size in the roof. The funnel can be an aluminium tube — perhaps a tablet holder from the chemist will be found of an appropriate size — and this must be fastened to the roof. The amount of heat generated should not be too much but even so glues, or even soft solder if a tin funnel is made, are not very satisfactory at this point. It will be best to cut tabs on the bottom of the funnel and clip or rivet these to the roof to supplement what should be a push fit on the tube.

Fig. 9a



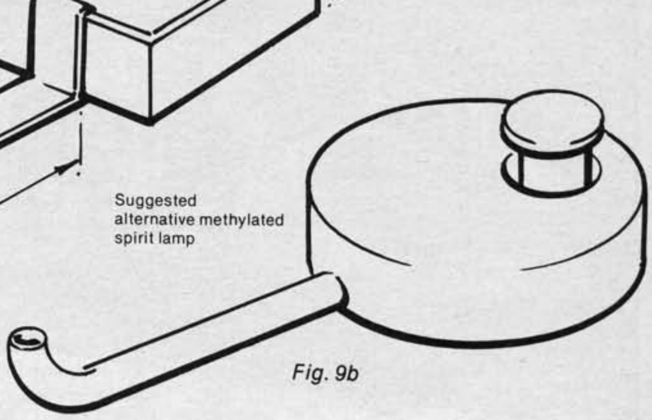
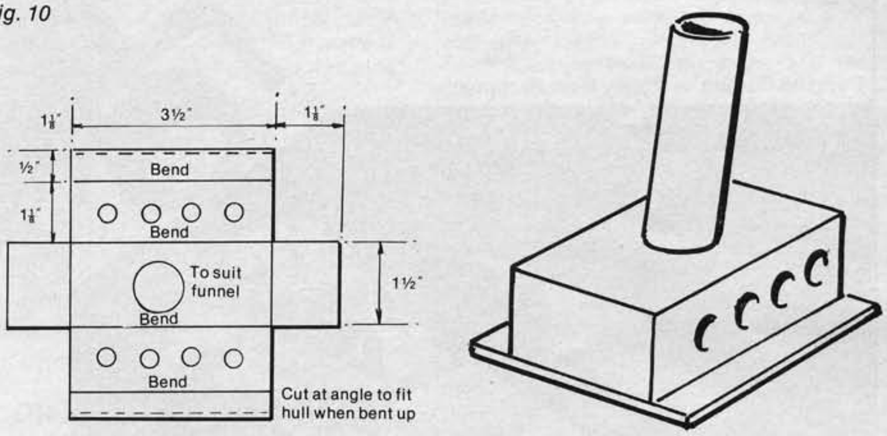


Fig. 9b

Fig. 10

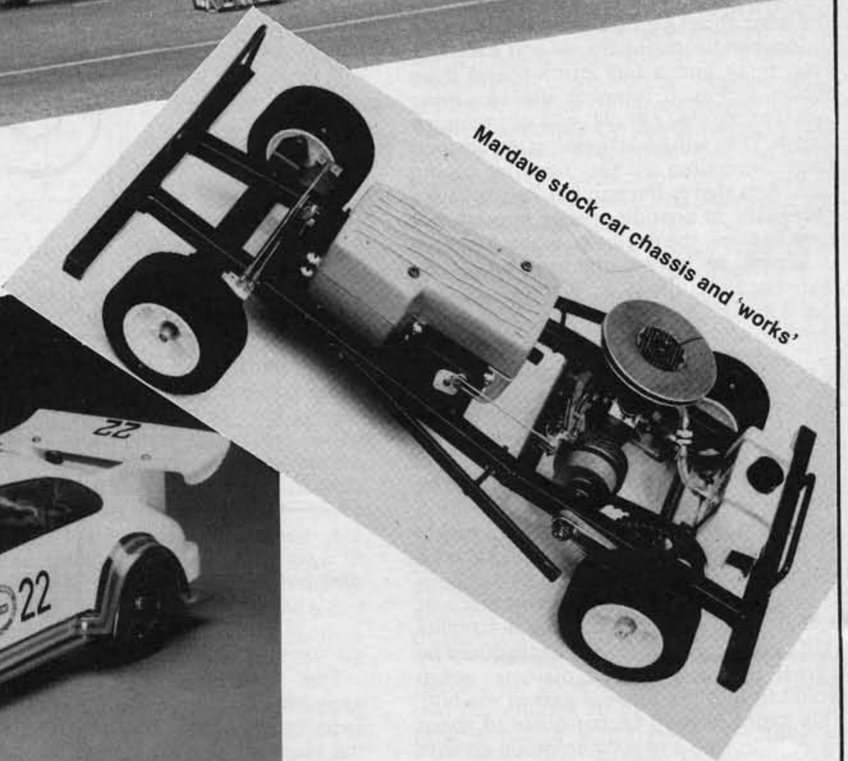


The time has come for a little experimenting in the bath. For the engine to perform satisfactorily it is necessary for the two tube ends to come out not more than $\frac{1}{16}$ in. below the waterline. So, fill the bath, put the coiled pipe on board in roughly the right position together with the fuel holder, the rudder and a tin sheet about 3 in. long to put the lamp on. Then fit the superstructure and funnel and float the vessel so as to determine the position of the waterline — the balsa awning can be ignored at this stage since it is so light. Add any small pieces of lead that may be necessary to get her trim right and mark with some accuracy the waterline on her stern. Equidistant from the centreline drill two holes to fit the tubes at the angle indicated to bring the coil high enough off the bottom to get the lamp underneath. These can then be set in with plenty of epoxy so as to leave about ¼ in. of tube sticking out at the back. Now the rudder can be fitted and the top of the wire bent over to form the tiller. Any fine adjustments of trim can now be made to get the tops of the tubes a fraction of an inch below the water on her first trials. And there is no reason why these should not take place right away. First, however, to be on the safe side fit the piece of tinplate to make a 'floor' to the engine room to protect the wood from the heat. Put the fuel holder on it in place underneath the coil, mark the middle of the sides and drive in four brads leaving them standing proud by about ¼ inch. This will fix the floor and provide a location into which the fuel holder can be dropped. Next introduce a small amount of water into the tube. One of the early boats in my collection was sold complete with a rubber pen filler for this job, the instructions referred to it as a 'supercharger', but it is just as effective to hold it under the tap. Then light a small block of fuel and place under the coil. After a few moments this will heat up and a series of bubbles will come out of the tube ends. Suddenly the whole vessel will come to life with a sort of shuddering series of pops and gurgles and the jets will be in action. She will move off at a dignified pace and run until the fuel gives out.

When her first steam trials have been satisfactorily completed the forward deck, of $\frac{1}{8}$ in balsa, can be glued into position. Any seating desired can also be added to increase her realism and the canopy of balsa or thin card, as are the edges of the awning, can be made and supported by three wires cut from an old coathanger. These are fitted into holes drilled through the deck and into the stem block but be careful not to go right through!

Daisy will well repay some pretty paintwork — perhaps a pale cream above the waterline, sea green below with a white canopy and a red funnel. She is really at home on an indoor pool but on calm days outside she will be found an attractive and a reliable boat which will attract a lot of interest from those who do not know her secret.

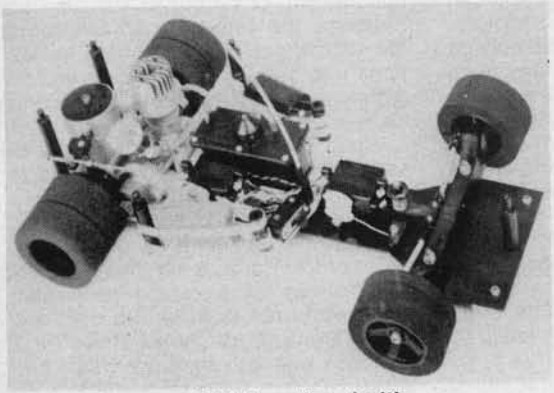
Start of a race at Wrexham Circuit



Mardave stock car chassis and 'works'

Porsche Carrera — a body from Graupner

Mardave BRM electric



Best in Europe — PB International with MacGregor radio. Latest has a PB differential.

Put yourself in the driver's seat!

MODEL CAR RACING could well become one of our most popular modelling hobbies as it happily combines both the pleasure of building the model with the very special thrill of actually controlling it entirely throughout its run. This same pleasure is, of course, also enjoyed in both r/c aeromodelling and boating but not I think with the same degree of really intimate contact. To put it in a nutshell model car racing can be enjoyed with much of the excitement but little of the cost and none of the personal risk of full-size motor racing.

It is now possible to produce in miniature very nearly all the manoeuvres of the full-size racing car, with fast cornering, four-wheel drifts, massive acceleration — only a racing motorcycle can beat it up to 60 m.p.h.! — passing and re-passing, pit stops for re-fuelling, team events, endurance trials — a 24-hour, 500 mile record has been recently set up — in fact you think of it, someone is doing it! There has even been a *steam* powered car on the track — shades of the veteran White Steamer — though not exactly a racing vehicle.

Formula 1 (like full-size Grand Prix cars). Until the introduction of electric car racing it was usual for racing to close down in the winter months, except for one or two hardy individuals, and then start again in the spring. But the electrics have made it an all the year round activity by the use of halls, badminton courts, indeed any indoor flat area of tennis court size to provide room for a track of say, 150 ft. per lap.

The glow-plugged $\frac{1}{8}$th scale cars are the "kings of the raceway" and so tend to attract the beginner in the first place. There is happily a whole range of accessories and equipment at a wide price band to suit nearly everybody. Simplest of all to make, and cheapest to buy, is a Mardave kit. This comprises a flat alloy chassis plate on which a steering unit is mounted at the front, and a stout pair of plummer blocks hold the rear axle in place at the back. The engine is located just inboard of the axle and drives via a spur gear with a ratio of around 4:1 to 5:1.

Drive is via a simple centrifugal clutch which is set to engage when the throttle is opened but will tick over without throwing

acting as a brake when slowed down. The majority of electric cars have one significant difference. They also have a reverse gear! This can be very handy in backing a car away from an obstacle, and certainly saves a lot of marshalling duties during a race.

For the simpler type of i.c. (internal combustion) car a band brake system is employed; the more expensive outfits embody disc brakes — yes, disc brakes. Coming even more into the full-size picture, the latest development is to install a working limited slip differential. There is even some talk of gears.

Just to keep the picture of miniature car against full-size, we must mention that there is also stock car racing in $\frac{1}{8}$th scale. This has proved a very much appreciated variant on the theme for more lighthearted operation. Cars here are robustly built like full-size stox with a welded frame chassis, nerf bars and over-ride bumpers fore and aft. Drive is by belt rather than gears; no brakes are fitted. A standard car is maintained by a price limitation on both car and engine employed. Skills are determined by race successes and the

RADIO-CONTROLLED MODEL CAR RACING

by 'Dickie' Laidlaw-Dickson

This country is fortunate in having more purpose-built racing circuits than any other, thanks to the co-operation of many local authorities and big landowners who have made land available; the rest has been up to willing club members to build their circuits by sheer hard work. Organisation which is so essential to provide a well assorted programme and to establish sensible rules is handled by the British Radio Car Association, a National body which M.A.P. played an early part in establishing with its inaugural race meeting in 1971 and subsequent discussions at Hemel Hempstead. There is also a European body — EFRA, which stands for European Federation of Radio-controlled Automobiles to which nearly every country in Europe belongs, embracing some fourteen national bodies. This enables international racing to take place throughout the season with each country holding its Grand Prix to which member countries are invited, and a grand European Championship taken in turn by the various nations. Finally, World Championships have been established, the first was in California in 1977, the next will be in Geneva next July.

But let us get down to the actual cars and see how the beginner can make a start.

The choices before you

There are two main racing divisions: $\frac{1}{8}$th scale glow-plug powered cars which have a capacity limit of .21 cu. in. (3.5 cc) and 1/12th scale electric powered cars which again conform to an electric motor capacity with a voltage limit of 7.2v (6 nicad cells). The glow-plug cars divide into Sports/GT, the more popular class, and

out its twin shoes to make contact on a bell-housing surrounding it. Integral with this is a medium weight flywheel, which is knurled to enable operation of an electric starter. (This starter is similar to those used to start model aero engines but with a hard rubbing ring instead of the spinner engaging disc).

Wheels are made up of plain hubs, usually of plastic, but for the more exotic of alloy, plus rubber or neoprene tyres of varying degrees of hardness which must be glued on to them. This is most important! Adhering these tyres is a sticky job with Evo-Stik or similar contact glue, after which they should be cleaned up and balanced. Again, the lazy operator can buy wheels and tyres "t and g" as the lists put it or "trued and glued".

Steering follows full-size practice to some degree with Ackermann steering embodied to enable the car to take its bends without slip. According to the price of the equipment bought this will vary from the very simple but adequate to the more elaborate linkage with ball and socket ends for varying toe-in and other adjustments dear to the car driver. But one and all will contain a useful device called a "servo saver". This is an over-ride device to protect the hard-worked radio servo from burning out when trying to turn round an immovable object or the like.

The set-up for a 1/12th scale electric car follows much the same pattern but in a smaller size. Drive is direct from the motor via a spur gear and no clutch is needed here, since the motor can be operated fully from off to full speed, with the motor

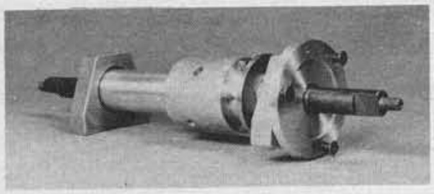
novice starts with a "white top" car progressing through to red — or for the national champion a gold top. Stock car racing requires a smaller area to race on, less expense in maintaining the car, and a somewhat more carefree approach to the hobby.

Radio equipment

We have our car built and ready mechanically. There remains the question of its control. Simple two-channel radio control equipment is all that is required. If you have multi-channel gear already then just use two channels only. A variety of manufacturers can provide suitable sets, Futaba is still the main supplier in this field, but the choice is widened to include MacGregor, Digiace, Sanwa, Skyleader, MRC, Talisman, indeed any of the leading makes. Desirable is that servos should be strong, powerful, swift to respond to signals.

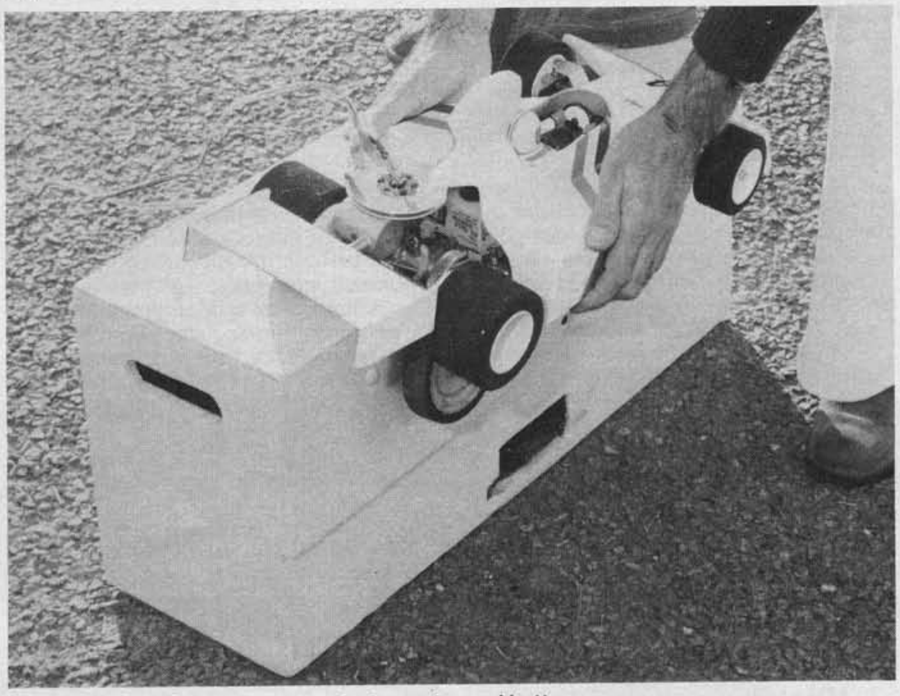
The two servos, preferably waterproof if used for outdoor racing, are installed, one to operate steering and the other to do the double job of throttle and brake. This is achieved by a toggle linkage, so that forward on the control stick gives throttle, backward the brake, with a neutral in between period. Futaba are alone in providing a special set with a "steering wheel" control instead of a stick. This is not very popular in this country, most drivers still use a stick, but it is the usual thing in the U.S.A. Some drivers also fit a trigger speed control like those used for slot car racing — indeed it is the same trigger suitably modified.

With an electric car the same radio equipment is used. However, the more sophisticated driver can fit a proportional



Above — **AMPS differential.**

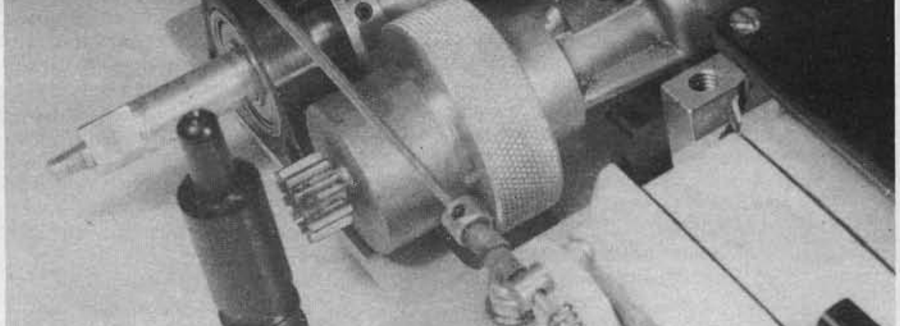
Right — **Model Air Port team from Bristol.**



Starter in a box. Parts are car ex-starter motor and battery.

PB car showing disc brake/throttle connection.

Dutch Stock car meeting.



speed control in place of a rheostat type of speed regulator which is the standard accessory. This will enable him to discard one servo and set the price off against the more expensive proportional control. A battery for the receiver can also be discarded by cutting into the 7.2 volt nicad 6-cells at a suitable point, or a voltage cut-out can be fitted. All these are interesting variants for the electronically-minded.

Just as with boats or aircraft a number of cars can be run simultaneously without radio interference by using the allotted six main frequencies. A further six, making twelve in all, can be run by split frequencies where the circuit is not too large taking cars to the limit of their radio range. There have been occasions where, in Switzerland for example, the Post Office has granted permission for a temporary extension of waveband and as many as fifteen cars have raced together on a big occasion. Certainly in England this seldom goes much above nine or ten cars running together in such events as team races over a three or four hour race, or for the practice laps beforehand. Alas, there is sometimes a degree of interference which requires a regular monitoring at meetings.

Making a start

If you are sufficiently enthused to make a start here are the basic items you will need. First: a kit of parts to make your first car. You *can* make a scratch built-car, but for a first effort settle on a kit. British kits are well to the fore. Mardave is the cheapest at £23.50 or you can go straight away to the top level with a PB International which will cost you £75. Both provide the same items but the more sophisticated nature of the PB will enable you to go faster sooner. On the other hand, if your needs are modest, possession of the lower-priced kit will enable you to take part in limited-cost racing events where no one will have more elaborate a car than yours.

Then you will need a bodyshell for the car. These are offered in a wide variety of shapes for all the popular racing cars and need only to be trimmed to shape and painted. Price again varies, but be modest at first and buy a cheap ABS body which is tough and will take your first spills.

Your motor choice is limited to the 3.5 cc engines, starting with either a Veco 19 or 21, a HB21, an Irvine, or going up in

Inside of starter box.

performance, a SuperTigre X21, an OPS or a K & B. They will require a heatsink to keep the engine cool (HB, Irvine and SuperTigre include heatsink in price) plus a suitable silencer. Racing rules demand a maximum noise output of 80dB at 10 metres so this is an essential. To keep your engine in good trim you should fit a fuel filter between fuel tank and carburettor and, equally important, an air filter over the carb intake. You will be racing in possibly dirty conditions and half an hour's filterless running could mean expensive replacements.

Some kits include a fuel tank, which may be exactly what you want or you may wish to have something better. They come in plastic, nylon and metal, some with sumps, some without. In the same way simple running can be improved by pressurised fuel tanks via the silencer pot . . . but this is for the more advanced.

Radio needs have already been mentioned — but do not forget the licence, five years for just over £2 and no test required.

If you are going electric needs are somewhat simpler, just a car kit plus a 12 volt battery to make quick nicad recharges, and again the radio equipment. Electric kits run from £37.50 upwards. Do not necessarily feel you must have the dearest . . . some of the leading events have been won with "out of the box" moderately priced cars.

If you are already modelling in one way or another you should be reasonably equipped for all the tools you are likely to need to make your model. Items, some already mentioned, that are extra will include the electric starter. Even this you can make yourself from a full-size car ex-starter motor from a breaker's yard, plus the inevitable 12 volt battery. You can fill your fuel tank from the can, but it is as well to have a bulb type fuel filler which just squirts it in. Then the usual field gear of screwdrivers, pliers, spanners, nuts, bolts, wire, tape, even string and spare glow plugs, spare wheels and tyres to change from medium to soft or vice versa if track or weather conditions require it. Again all this, but simpler for electric racing.

Where to go racing

The BRCA has circuits in many parts of the country, and their area representative will tell you the nearest. Clubs are springing up every month and apart from the "purpose built circuit" there are very many occasional use tracks operating on car parks in industrial estates or where the noise of engines will not upset residents. If there is no local club that your model shop can recommend then start your own club with a notice in the local newspaper to get interested people together, and a quiet canvass of local MP, councillors, police, schools . . . it is easier than you think.

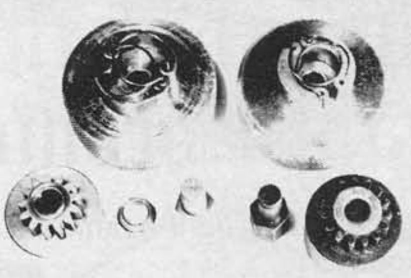
Where to join up

British Radio Car Association

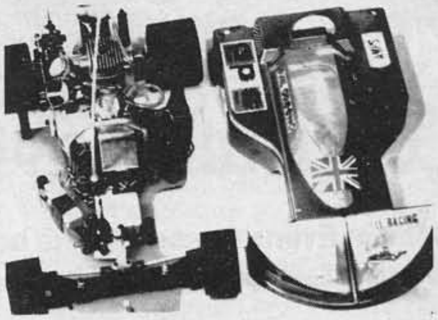
Secretary: Tom Martin, 7 The Green, Werrington, Peterborough, PE4 6RT.

Radio Stock Car Association

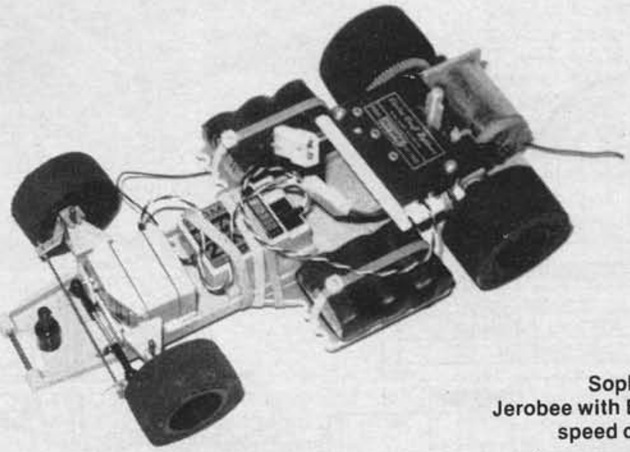
Chairman: Dave Wragg, 1 Bignal Drive, Leicester Forest East, Leicester.



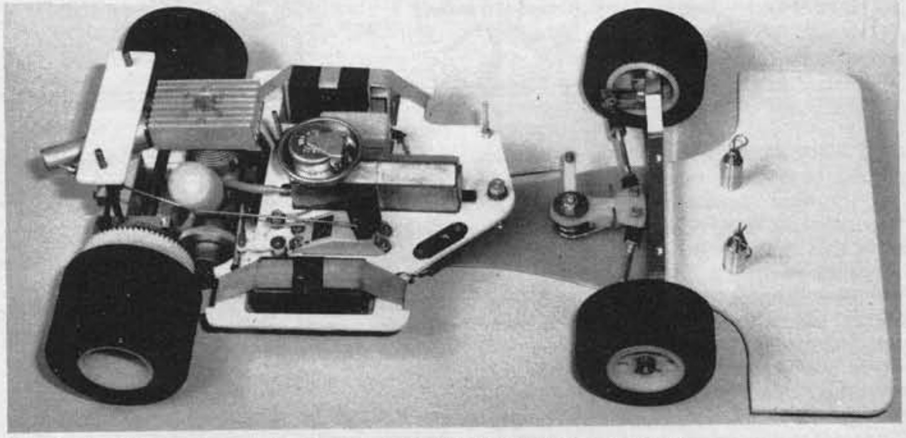
Typical clutch/gear/flywheel.



Phil Greeno's 'breathed on' World Cup winning PB.



Sophisticated electric — the Jerobee with Electrocraft proportional speed control and Futaba radio.

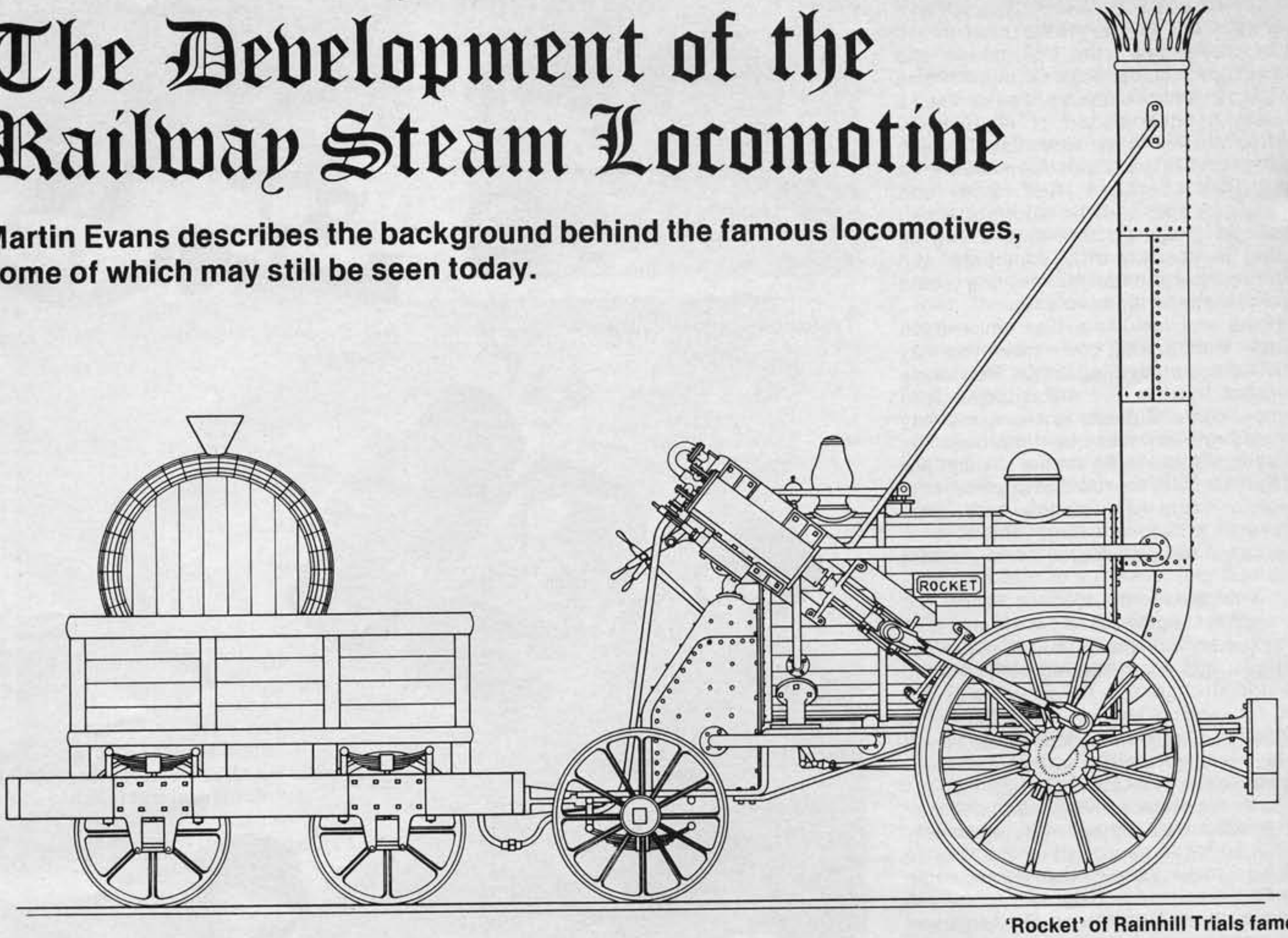


Best in the USA — Associated latest model RC200. Note servo saver.

Assorted R/C goodies from Ted Longshaw's showroom.

The Development of the Railway Steam Locomotive

Martin Evans describes the background behind the famous locomotives, some of which may still be seen today.



'Rocket' of Rainhill Trials fame

VERY FEW PEOPLE nowadays make the mistake of thinking that George Stephenson "invented" the steam railway locomotive. In actual fact, no one person could claim this honour. But perhaps Richard Trevithick came nearer to it than most. His *Penydaren* engine of 1804 was certainly the first steam locomotive to run on rails and to haul a reasonable load.

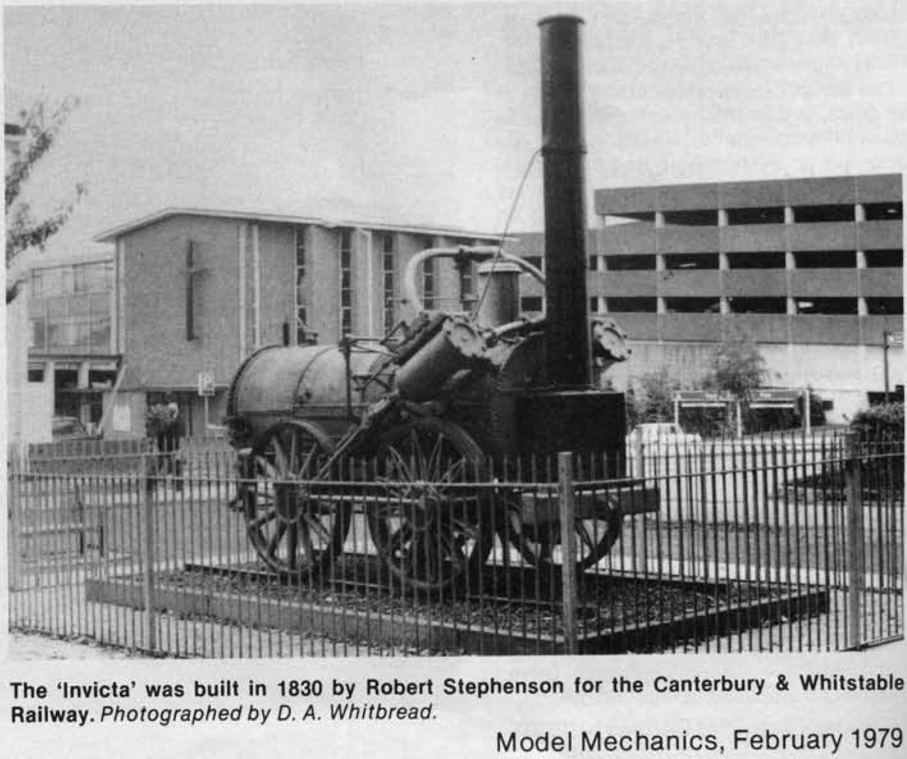
The *Penydaren* engine utilised a horizontal boiler having a single flue, leading to a tall vertical chimney. A single horizontal cylinder drove on to a short transverse crankshaft, and this sported an enormous flywheel and a gearwheel which drove all four wheels through intermediate gears. The wheels were flangeless, as the primitive rail then in use was itself flanged. In 1808, Trevithick took a locomotive to London, setting up a circular track near Euston Square, where he demonstrated the power of steam to unbelieving spectators. It is said that the engine, which Trevithick named *Catch Me Who Can,* reached a speed of 12 m.p.h.

Three years later, Blenkinsop and Matthew Murray built a locomotive somewhat similar to Trevithick's but employing a racked drive, in which geared wheels engaged pegs fitted in the line, so that slipping was impossible, short of something breaking. George Stephenson, however, believed that given adequate adhesive weight, a smooth flanged wheel, working on an unflanged iron rail, would prove successful and in his *Blucher* of 1814, he achieved the feat of hauling a train weighing approximately 30 tons at about 4 m.p.h. Unfortunately, *Blucher* had insufficient boiler power for continuous working.

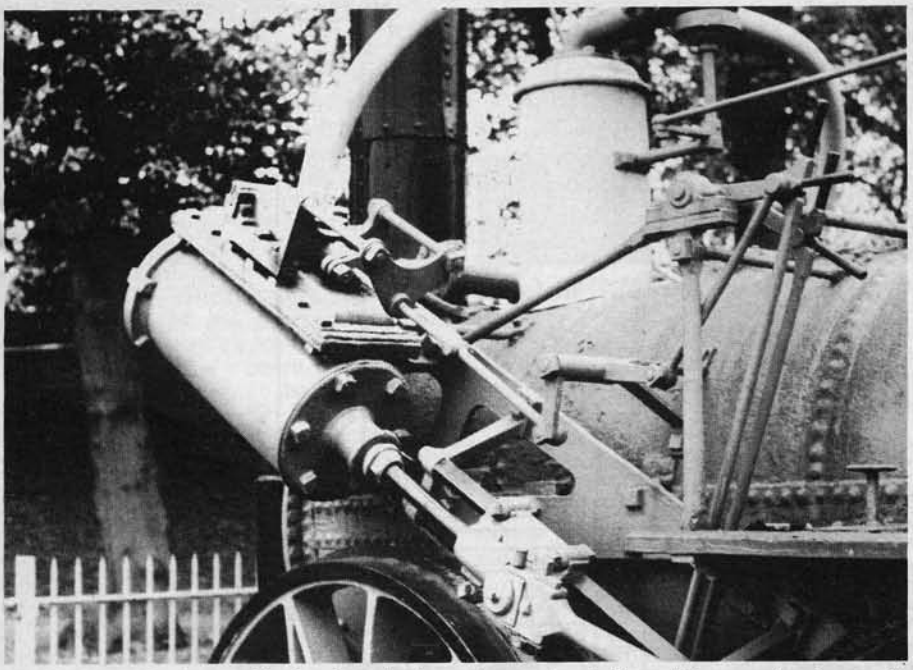
Some controversy raged over who was the first to use a proper blast pipe in the steam locomotive. It was established that Trevithick, in his *Penydaren* engine, arranged for the steam to be ejected up the chimney, but the exhaust pipe had no contracting orifice, and it is not by any means certain that the pipe was set centrally in the chimney.

Hedley, when building his *Puffing Billy* and *Wylam Dilly* arranged for the exhaust steam from the two cylinders to be combined into one pipe which passed into the chimney. Perhaps the first of the early steam engineers to fully realise the importance of a proper blast pipe was Timothy Hackworth with his *Royal George* of 1827.

Meanwhile, the Stockton & Darlington Railway was opening, and in September



The 'Invicta' was built in 1830 by Robert Stephenson for the Canterbury & Whitstable Railway. *Photographed by D. A. Whitbread.*



Mr Whitbread's photo of Invicta's cylinder and crosshead. The old locomotive is now in the National Railway Museum, York, for renovation.

1825, Robert Stephenson's famous *Locomotion* entered service, though not without several teething troubles. *Locomotion* was a very different design to the earlier engines. Her wrought-iron boiler, 10 ft. 4 in. long x 4 ft. diameter, had a single flue 2 ft. diameter; at the front end, the flue was continued upwards as a chimney. There were two vertical cylinders, 9½ in. x 24 in., the lower parts of which were placed inside the boiler barrel. Each cylinder was placed vertically above the centre of a driving axle, its connecting rods being attached to the wheels. The piston rods drove through the tops of the cylinders, and the two crossheads, which were guided by half-beam parallel motions, extended across the top of the boiler to form connections to four long connecting rods, two on each side of the locomotive.

A single eccentric was used for both forward and backward gear. The main eccentric rod was carried upwards to operate the valve of the front cylinder, while a second eccentric rod from the same eccentric worked horizontally on to a bell-crank to drive the valve of the rear cylinder. Connected to the valve spindles were two handles, by means of which the driver could disengage the eccentric rods from the valve levers, and move the latter by hand to start or reverse the engine.

The wheels of *Locomotion* were 4 ft. diameter and the axles worked in plain cast-iron plummer blocks; there was no springing. An interesting point was the arrangements of cranks and coupling rods. The cranks of each pair of wheels being worked from one cylinder were parallel to one another, but were placed at 90 deg. with those of the other pair of wheels, the front cranks leading. Direct outside coupling rods were used, the pins for the rear ends being in return cranks. The coupling rod pins were spherical to allow flexibility.

The boiler was probably designed for a working pressure of 50 p.s.i., and the weight empty was about 6¾ tons, or in working order about 8½ tons. The tender, on four wheels, had wooden frames, with a sheet iron water tank.

The original boiler of *Locomotion* exploded in July 1828, after which Timothy Hackworth rebuilt the engine with a new boiler having a single large flue and two return flues; later, a third boiler was fitted with a single large flue. The engine finished its regular service career in 1841.

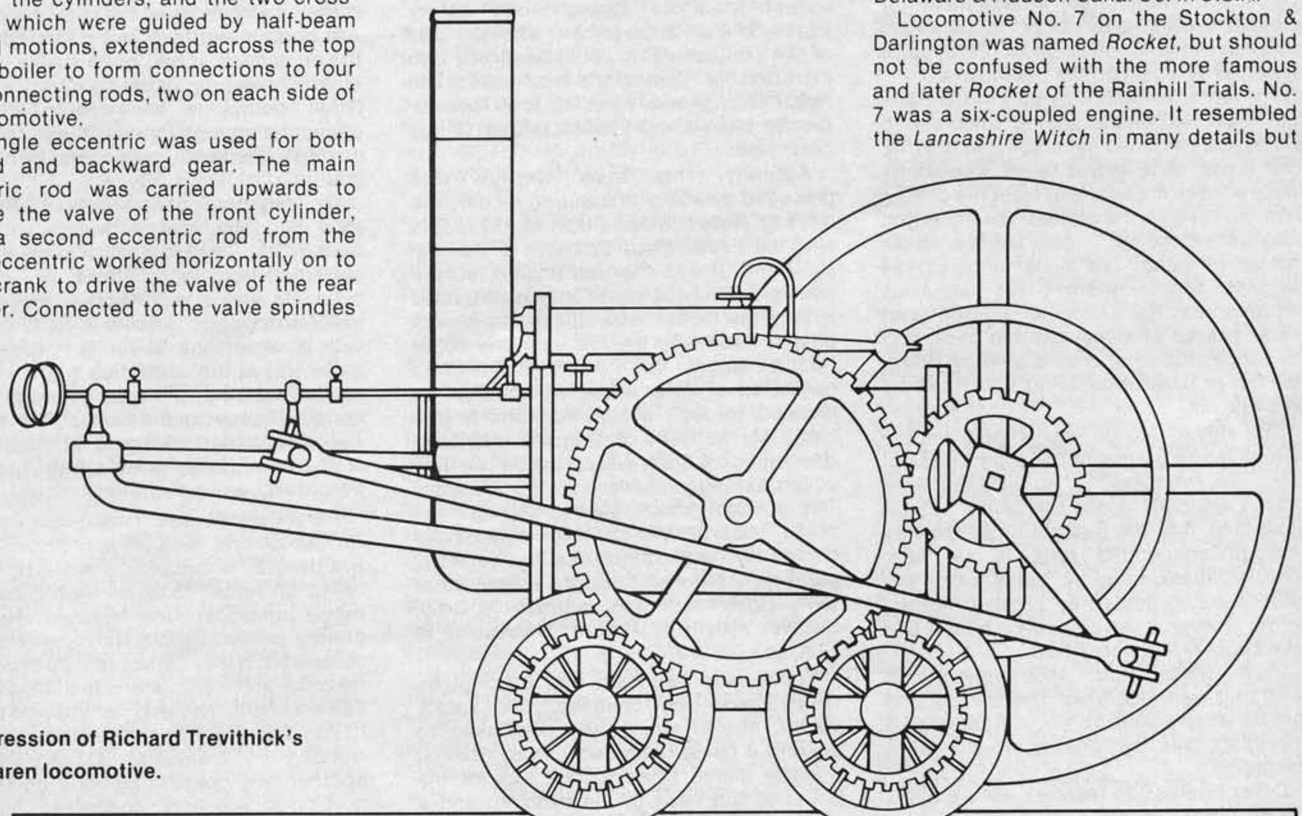
Three other engines of the *Locomotion* type were built by Stephensons for the S&D — *Hope, Black Diamond* and *Diligence*, between November 1825 and May 1826. A fifth locomotive was built for the S&D by Robert Wilson of Gateshead; this engine had four cylinders, but it proved a complete failure and never entered service, its boiler being used for Hackworth's *Royal George* of 1827.

Improvements by Robert Stephenson

On his return from a visit to South America in 1828, Robert Stephenson set about improving the locomotives being built at his Newcastle works. In his *Lancashire Witch*, he used two cylinders outside the boiler inclined at an angle of about 39 deg. Crossheads and guide bars were used. The four coupled wheels, all on laminated springs, were 4 ft. diameter, with wood spokes and iron tyres. The cylinders were 9 in. x 24 in. The exhaust passed through pipes into the chimney, and originally, additional forced draught was applied by bellows placed under the tender and worked by eccentrics; but this was later found to be unnecessary.

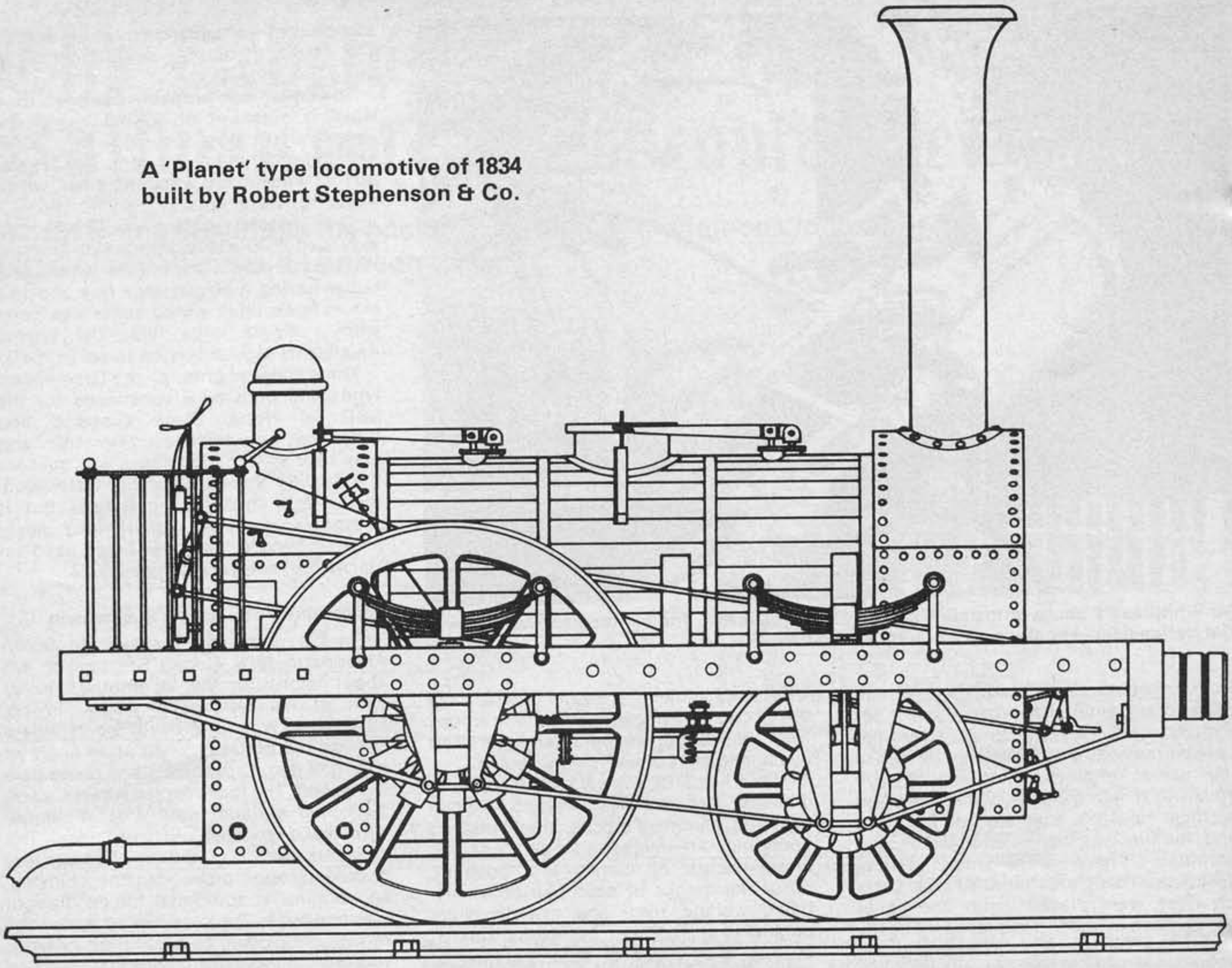
A very similar locomotive, *America*, was supplied by Stephensons in 1828 to the Delaware & Hudson Canal Co. in U.S.A.

Locomotive No. 7 on the Stockton & Darlington was named *Rocket*, but should not be confused with the more famous and later *Rocket* of the Rainhill Trials. No. 7 was a six-coupled engine. It resembled the *Lancashire Witch* in many details but



An impression of Richard Trevithick's Penydaren locomotive.

A 'Planet' type locomotive of 1834 built by Robert Stephenson & Co.



had a somewhat crude arrangement for expansive working by cut-off in the steam pipe, by means of a mushroom valve operated by a cam on the trailing axle.

The *Rocket* which took part in the Rainhill Trials had single driving wheels 4 ft. 8½ in. dia., inclined cylinders 8 in. x 17 in. The brass slide valves were worked by loose eccentrics actuated from the driving axle. To reverse the engine, the eccentric rods were lifted out of gear and the valves moved by hand. The boiler showed the biggest improvement over previous designs, having a copper firebox with water spaces at sides, top and back, and 25 copper tubes of 3 in. dia. were fitted, the boiler itself measuring 6 ft. long by 3 ft. 4 in. dia.

The *Royal George* was a 0-6-0 engine with a much bigger boiler than *Locomotion.* The cylinders, 11 in. x 20 in., were placed vertically above the boiler, one on each side, and the pistons drove directly through connecting rods to the rear wheels. There were no guide bars, the pistons being guided by parallel motion, which worked a valve shaft on which two loose eccentrics were fitted.

From these, both slide valves and reversing were operated. The leading and middle wheels were fitted with laminated springing, but the driving wheels were unsprung.

Other interesting features were a short stroke feed pump operated by an eccentric, direct spring-loaded safety valves, and an arrangement whereby part of the exhaust steam could be turned into a cistern for heating the feed water. The *Royal George* was also the first locomotive to have a contracted orifice to the blast pipe.

Actually, the *Royal George* was preceded by a very interesting locomotive built by Robert Stephenson in 1827. This was the *Experiment,* Stockton & Darlington No. 6. It was the first engine to have two horizontal cylinders. They were placed within the boiler with the back covers almost flush with the fire end. The boiler had a single flue and the fire-grate consisted of water tubes, which could be cleaned through a cast-iron box at the back. At the front or chimney end, they opened into a drum placed inside the flue, which extended forward to the chimney. The exhaust steam passed through the boiler towards the chimney but before being discharged into the atmosphere, part of it passed through a feed-water tank. *Experiment* was originally a 0-4-0, but was rebuilt by Timothy Hackworth in 1830 as a 0-6-0.

There were two cast iron blast pipes fixed inside the chimney; two safety valves, one of which was padlocked to prevent it being tampered with by drivers, a water gauge fitted to one side of the boiler at the back of the cylinder, and a mercurial gauge fitted to one side of the chimney and nearly of the same height.

A brass water feed pump was driven by the crosshead; it had mitre valves, the lift of which was regulated by spiral springs. Other points in the design included laminated springs for all wheels, spherical driving crankpins and cast-iron axle-guards.

Of the other contestants at Rainhill, little need be said. Although very well built, Timothy Hackworth's *Sanspareil* suffered from the effect of vertical cylinders and a very short wheelbase. It had four-coupled wheels 4 ft. 6 in. dia., with a wheelbase about 5 ft. 3 in. The boiler was of the return flue type and there was no framing, the axle bearings being bolted directly to the boiler. The engine was disqualified owing to non-fulfilment of the conditions, being somewhat overweight and lacking springs.

Perseverance was damaged on its way to Rainhill and took no part in the Trials. Braithwaite & Ericsson's *Novelty,* which relied on forced draught from a bellows, made some fast runs, but had very little pulling power. Before its runs had been completed it was damaged by a blow-back from the boiler and later a feed pipe broke. The engine is, however, of interest in that it was fitted with two vertical cylinders, working on cranks at 90 deg. to one another, the connecting rods being in a horizontal position, connected by bell-cranks.

Later engines of Rocket type

With the success of the multi-tubular boiler, further engines similar to the *Rocket* were built in 1830. The first four engines of the *Meteor* class had the inclination of the cylinders much reduced, and the boiler tubes were reduced in diameter to 2 in., with their number increased to 88 or 92. The final form of this design was seen in the *Northumbrian* which was completed in August 1830. This engine had a boiler with 132 tubes of 1⅝ in. diameter, but the most important improvement was the provision of an internal firebox. In this engine, we find the first example of the modern locomotive boiler. The *Northumbrian* had cylinders 11 in. x 16 in. and weighed 7 tons 7 cwt. Like the two *Phoenix* engines built just before, she had a proper smokebox.

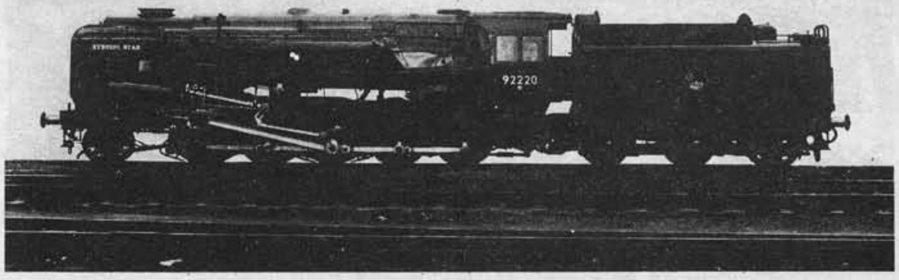
In the years immediately following the Rainhill Trials, there were three schools of thought in locomotive design, headed by Hackworth, Bury and Robert Stephenson respectively. The first engine to have horizontal inside cylinders and a crank-axle was the *Liverpool* built by Bury and Kennedy. This locomotive had 6 ft. coupled wheels, then the largest in the country, and 12 in. x 18 in. cylinders inclined slightly upwards to allow the piston rods to clear the leading axle. Shortly after completion, the engine was fitted with a multi-tubular boiler having Bury's D-shaped firebox with hemispherical top and casing. *Liverpool* showed a considerable advance in locomotive design.

Bury's *Liverpool* and Stephenson's *Planet* (also of 1830) were the first engines to have a true framing. The *Planet* combined horizontal cylinders encased within the smokebox, crank-axle, multi-tubular boiler with firebox inside and a frame which supported the boiler.

For goods traffic, Stephenson modified the *Planet* of 1830 by making the wheels of equal diameter and coupling them together. Engines of this type such as the *Samson* and *Goliath* with 14 in. x 16 in. cylinders proved very successful. An interesting feature of the *Planet* type engines was the valve arrangement. Two slide valves were used on the port face, connected by a single valve spindle, the idea being to shorten the steam passages from the ports to the cylinders. It was found, however, that this design increased the wear in the valve gear and it was accordingly abandoned.

An interesting development occurred in 1832, when a 2-2-0 engine built by Rothwell, Hick & Rothwell of Bolton, and named *Pioneer*, was fitted with a variable blast pipe, which had an inverted cone in the orifice. The amount of opening could be controlled by the driver. No doubt the device was somewhat primitive; nevertheless it showed that even in those early days, engineers were beginning to understand the importance of draughting.

Boiler construction varied a great deal at this period. The copper tubes generally used were found to wear out quickly, through the effect of hard particles in the last, and were dropped in favour of brass tubes, which were usually fitted with steel ferrules at both ends. Firebox side stays were generally of copper, around ¾ in. dia., and threaded full length, being riveted over on the ends. Feed pumps with ball valves in the non-return valves were introduced in 1834; the pumps were either driven by eccentrics or from the crossheads.



Last of the many. 'Evening Star', last steam loco made for B.R. *Photo by courtesy of the Oxford Publishing Co.*

The locomotive bogie, or four wheel truck, was originally patented by William Chapman in 1812. At first, no side play was allowed, the truck pivoting on a central pin. Bogie locomotives were exported to U.S.A. by Stephensons and Tayleur & Co. in 1833.

George Forrester of Liverpool was the first to use horizontal cylinders outside the frames. Three locomotives with this arrangement were built for the Dublin & Kingstown Railway and one for the Liverpool & Manchester in 1834, and later further similar engines for the London & Greenwich. Outside plate frames and bearings were used. The valve gear of Forrester's engines were also the first to use four fixed eccentrics.

Broad-gauge engines

The first engines delivered to the Great Western Railway, which was opened to traffic in 1838, were a very mixed lot, mainly quite unsuitable; more than one was originally supplied with driving wheels no less than 10 ft. dia.! The only successful early G.W.R. engines were the *North Star* and *Morning Star,* built by Stephensons. The former was really built for the New Orleans Railway, U.S.A., but was altered to suit the 7 ft. gauge "Brunel" line. *North Star* had 7 ft. driving wheels and a boiler measuring 8 ft. 6 in. by 4 ft. dia., and the 2-2-2 wheel arrangement. The engine was very successful. It was rebuilt with larger boiler and cylinders in 1854 and then worked until 1870.

When Daniel Gooch took over the locomotive department, he based his first designs on the *North Star* but enlarged most of the dimensions; he was the first locomotive engineer to attempt some form of standardisation. The peculiar type of sandwich frames originated by Stephenson was adopted by Gooch and used right up to 1865. At first, ash was used, between the iron flitch plates, but this gave way to oak and eventually to teak, as it was found that acid in the first two types of wood tended to cause corrosion. The use of sandwich frames on the G.W.R. was probably due to the hardness of the 7 ft. road, as they were allowed a certain amount of give not possible with thick iron or steel frames. For the same reason, the G.W. tended to use longer springs than other companies.

Gooch's broad-gauge engines of the 1846-50 period were well ahead of those of other lines. His *Iron Duke* type, of which 22 were built at Swindon in 1847-51, were quite large 4-2-2's with 8 ft. dia. driving wheels. The cylinders were 18 in. x 24 in., the working pressure originally 100, later increased to 120 p.s.i. The boilers had no less than 1767—1790 sq. ft. of heating surface, with a grate area of 21.6 sq. ft.

Mention should also be made of the "long-boiler" type of locomotive, introduced by Stephensons in 1841. The idea behind this was to obtain greater boiler power while at the same time obtaining a low centre of gravity, which was thought essential at the time. Some 2-4-0 goods and mixed traffic engines were also built with the long boiler. In some cases, the firebox was arranged behind the axle of the single pair of driving wheels, allowing the outside cylinders to be placed well back.

The long boiler passenger engines were not a great success; although the boilers were certainly more efficient thermally, the engines proved unsteady while the long barrel necessitated short fireboxes and restricted grate areas. On the Eastern Counties Railway, better balancing, introduced by Fernihough, improved the long boiler engines. The type was well received in France, and many more were in service there up to about 1873.

One of the most important improvements in locomotive design occurred with the introduction of the link valve gear, now known as the Stephenson link gear. Using two fixed eccentrics on the driving axle, with a link having a curved slot, this gear was first used on one of Stephenson's long boiler goods engines in 1842. Although always called the "Stephenson" gear, it was really due to two employees of the Company, Messrs. Williams and Howe. Isaac Dodds' "wedge" motion was patented in 1839 and applied to engines on the North Midland Railway in 1842. At first, Dodds used the wedge eccentric for reversing only, a second eccentric with expansion valve being added. Later modifications enabled the wedge motion to be used also as an expansion gear and a single eccentric was employed provided with a double wedge. When the wedge was moved by levers along a square section of the axle, it acted upon corresponding inclines inside the eccentric sheave, so that the latter was moved transversely across the axle. The gear as improved by Henry Dubs was fitted to a number of engines built by the Vulcan Foundry in 1852-5. The gear was simple but had the defect that the wedges sometimes seized and rendered the gear immovable.

The Gooch stationary link motion appeared in 1843 and was used on the G.W.R. broad gauge engines for many years; it was also adopted by John V. Gooch on the L.S.W.R., by R. Sinclair on the Great Eastern for a short time, and on a few Caledonian engines in 1875.

To be continued.

Club Report

Those of you who read *Model Engineer* will be already familiar with our Club Chat pages. They are written using information sent to the magazine by club secretaries or from personal visits, etc. Although there are individualists in model engineering as with all walks of life it is fair comment to say that the model engineering societies are the hub of the hobby's activities.

Take any form of modelling activity — a locomotive needs a track, a boat needs water, an aeroplane a flying field. These of course are functional models — not the static ones built for display only. Few of us have the resources of a track in the back garden, or permission to use private water or fields. A club can usually provide all three and the negotiating strength of a responsible body. Many a model maker is today enjoying the fruits of his labours as a result of his club's influence.

It is only natural that in a model engineering society the bias of models is towards steam power and of this a very high proportion is devoted to locomotives and traction engines. True, even among the loco enthusiasts there are those that prefer the diesel-electric power or straightforward petrol-engine propulsion. This only adds to the versatility of the individual. But the larger clubs also have sections for the boating enthusiast, racing cars, flying model aircraft — even small gauge railways. And because of the space available, far more ambitious projects may be undertaken than if the builders were to depend on their own resources.

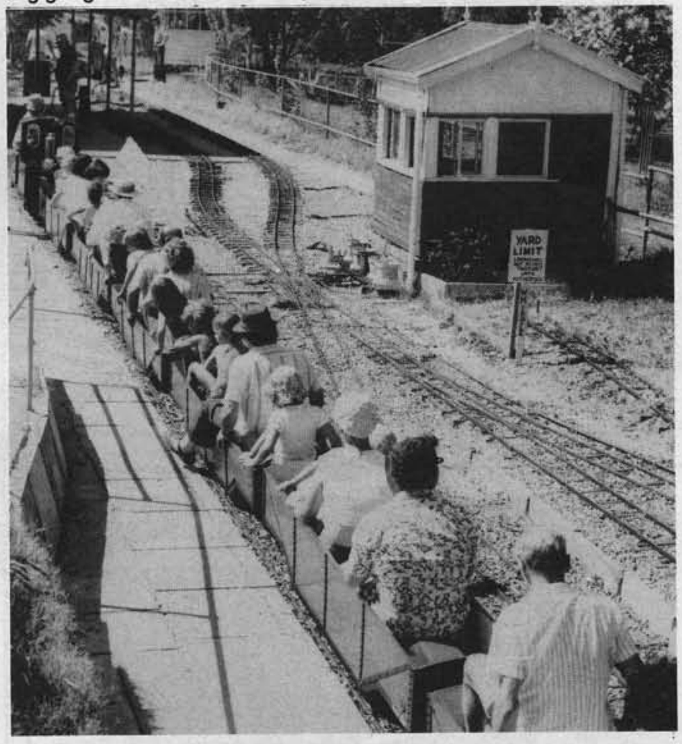
But apart from the facilities a club may offer, perhaps the greatest benefit comes from the social life. Most clubs hold regular meetings — some in schools, some have their own clubhouse, some even prefer the atmosphere and added incentives of the 'local'. And when the weather permits — and even when it is anti-social — the members congregate at whatever venue they choose to operate their models. Often the land used by the club is granted by the local council and certain conditions have to be met. Mostly these amount to a minimum number of days during which the general public are admitted and entertained for a small fee. As the club funds benefit from this urgently needed wealth, there are seldom complaints about this. In any case it is human nature to want our models, built with loving care over a period of, perhaps, several years, to be admired by the uninitiated public.

In addition to these 'Open Days', clubs hold their own private meetings — often at night with the added attraction of a barbeque — and invitation days when other clubs are welcome to attend. Thus the circle of friendship within this wonderful hobby is extended to cover every part of the world where model engineering is practised. At Guildford Model Engineering Society's Stoke Park track last July visitors came from South Africa, Australia, Holland and many other countries just to be in on an international meeting. This particular event was the annual International Model Locomotive Efficiency Competition

Start of something big — Canterbury Club's track.

(IMLEC) which was followed a week later by Guildford's own Model Engineering Exhibition. The IMLEC event — 1978 was the tenth — requires that a locomotive is driven with a certain load for a given length of time, usually 30 minutes. A dynamometer car measures the loco's performance and the amount of coal used is considered in the final efficiency figure. The loco — and driver of course — having the highest efficiency, generally around two per cent, is the winner. Model and Allied Publications Limited sponsor this event and award the prizes. The 1979 event at Bristol will be held over two days for the first time ever and a good week-end is to be expected.

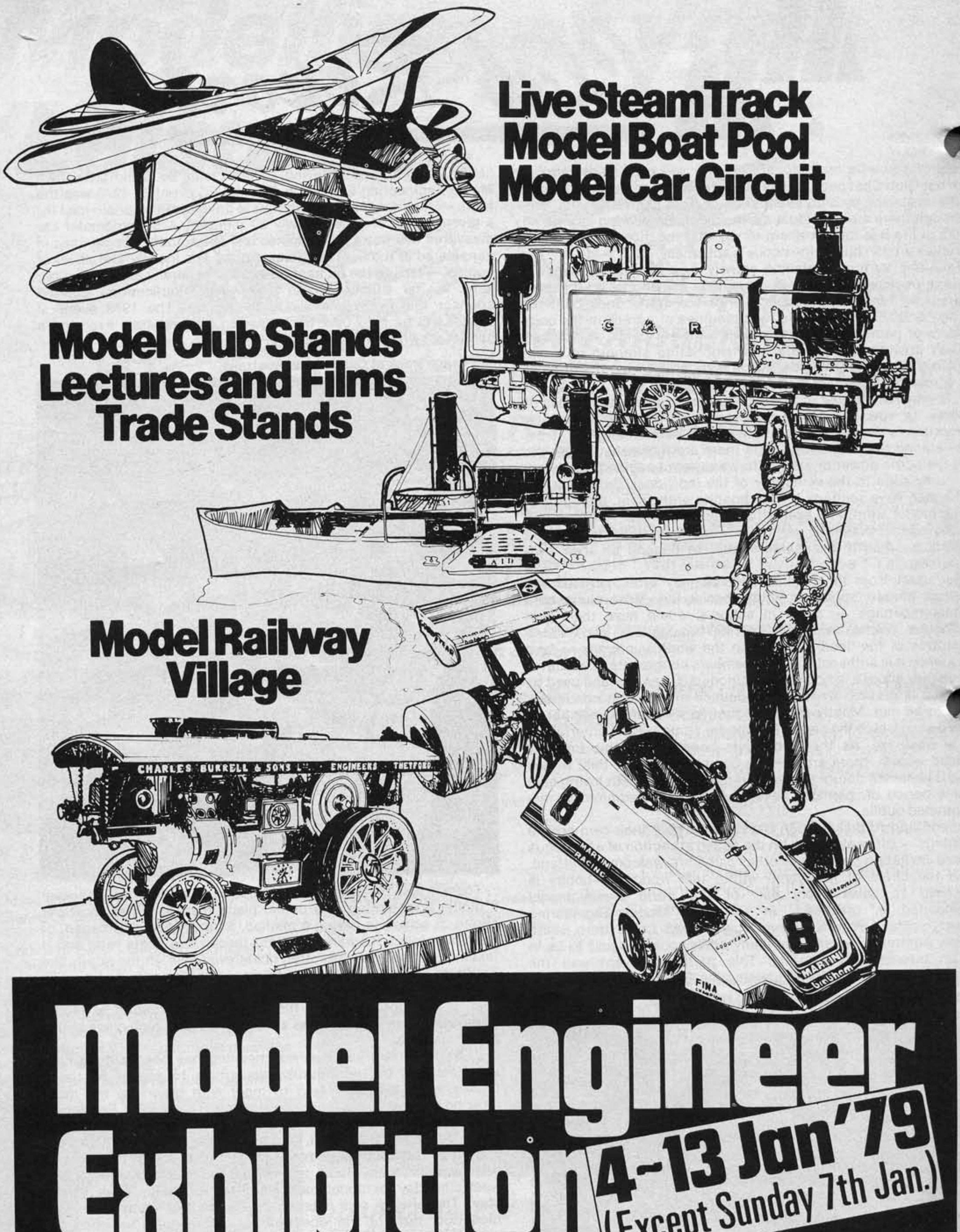
Big gauge track at Castledare, Australia.



There is also the question of insurance. Wherever and whenever a model is operating in a public place there is a risk, however slight, of someone having a mishap, a model being damaged, or possibly stolen. Insurance against these risks costs little and if taken out through a club often costs even less. In the south, the Southern Federation of Model Engineering Societies has over 70 clubs in affiliation — and arranges insurance for a few pence a year. In the north there is the Northern Association of Model Engineers. Both these bodies arrange their own high class rallies and exhibitions.

In the past two years a new meaning has been put on club activities and the opportunity has arisen to enable all those interested in model making to meet with others in the more relaxing atmosphere of a holiday site. In 1977 and 1978, Pontin's in conjunction with Model and Allied Publications, held Festivals at Brean Sands and Southport, laying on all the facilities which each branch of the hobby requires. 1979 will offer the enthusiast yet more venues with Model and Allied Publications arranging a week's holiday for model makers at Primrose Valley, Filey, from 5 May. The site is self catering in chalet and caravan accommodation, but for the operation of all models, facilities are provided.

These, then, are the clubs. A place to go for comradeship, friendly chat on a winter's evening, or a hive of model activity when the season is right. And each month *Model Mechanics* will be carrying information about them, their meetings, visits, future engagements — the sort of information of interest to other club members or the individual who would like to sample club hospitality before he joins. All will be made welcome.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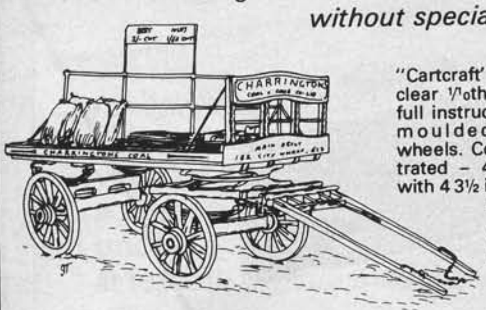

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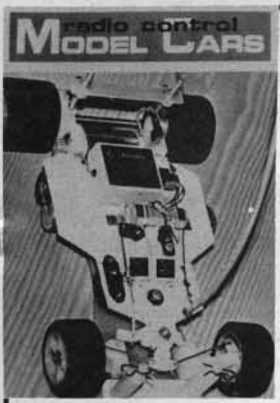

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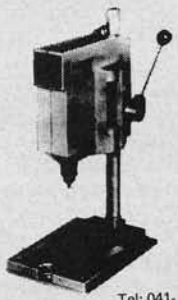

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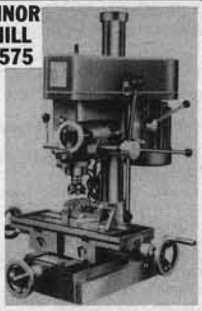

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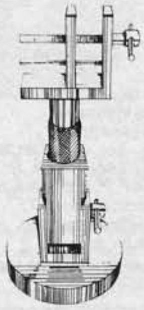

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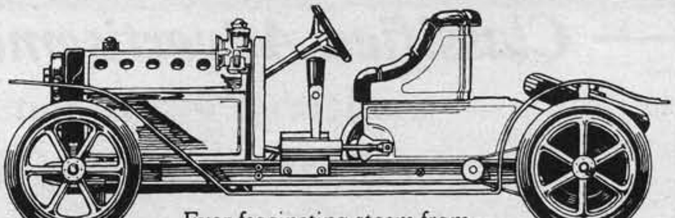

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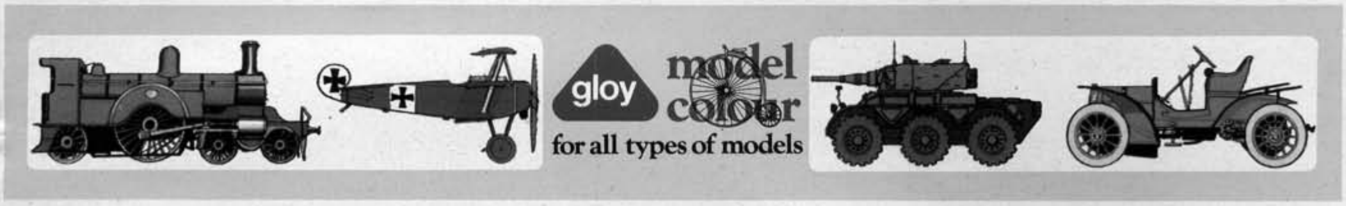

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